LEAD-LAG RELATIONSHIP BETWEEN ISE 30 SPOT AND FUTURES MARKETS

Serhat YANIK* & Yusuf AYTURK*

Abstract

The lead-lag relationship between spot and futures markets indicates which market leads to the other. Determining the direction of this casual relationship between spot and futures market carries important information for traders since leading of one market to another enables an arbitrage opportunity. This paper investigates the lead-lag relationship between spot and futures markets in Turkey. The most liquid stock index futures contracts traded in Turkish Derivatives Exchange (TurkDEX) are Istanbul Stock Exchange (ISE) 30 index futures contracts, because of this reason, the lead-lag relationship between ISE 30 index and ISE 30 index futures is examined by using daily observations for sample period February 2005 – March 2011. The results indicate that spot market plays a price discovery role for futures market, implying that spot prices contain useful information about future prices for ISE 30 index. These findings are helpful to financial managers and traders dealing with Turkish stock index futures.

Keywords: *Stock index futures, ISE 30 index, Lead-lag relationship, Error correction model.*

Introduction

Especially after 1980s, there has been rapid fluctuation in interest rates, exchange rates and stock prices. High volatility and risk in financial markets have caused an increasing demand for hedging instruments which are structured to avoid risk by transferring it from one to another. One of the most widely used hedging instruments is futures contracts. A futures contract is a standardized agreement between two different parties to buy or sell a standardized quantity and quality of a specified underlying asset at a predetermined future date at a price agreed today. There are several types of futures contracts written on different underlying assets such as currencies, securities, financial instruments and indices. Stock market indices are the underlying assets of stock index futures contracts. Brooks et al. (2001) point out that stock index futures have attractive features for investors who want to trade on an index portfolio. Traders frequently take opposite positions in both spot and futures markets to avoid market risk. In other words, stock index futures can be used to hedge a well-diversified equity portfolio. Kawaller et al. (1987) classify the usage of stock market index futures into three categories. First one is hedging, which involves buying or selling of index futures in the anticipation of an intended spot market trade. Second is arbitrage, which involves the simultaneous buying and selling of stocks and futures in order to capture change in relative price following a perceived mispricing opportunity. The last one is trading, which involves the active use of futures to speculatively take advantage of expected broad market price changing (Kawaller et al., 1987, p.1311).

Futures prices of stock indices and theoretical relationship between a stock index futures and stock index can be explained by the cost of carry model. Fair value of a futures contract is calculated by this model. It is given by

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

where Ft is the stock index futures contract price at time t, St is the value of the underlying index, r is the continuously compounded risk free rate of return , d is the continuously compounded dividend yield on the underlying asset and T is the time where futures expires so that (T – t) is the time left to maturity. Taking natural logarithms of both sides:

$$\ln F_t = \ln S_t + (r-d)(T-t) \quad (2)$$

This equation implies that there is one-to-one relation between the natural logarithms of spot and futures prices. The difference between two is the cost of carry, (r – d) (T – t), which is the difference between risk free rate of return foregone and the dividend yield until the expiration date of the futures contract. Tse (1995) states that in theory, when we assume that the capital market is efficient and frictionless, the changes in stock market index value and the changes in the same index futures price should be perfectly contemporaneously correlated and not cross-autocorrelated. However, it has been found in many studies that the changes in futures price can be significantly different from those of the spot index occurring at the same time (Tse, 1995, p.553).

Stoll and Whaley (1990) summarize reasons for violation of cost-of-carry model. First of all, the infrequent trading of stocks within the index is one of the most important reasons. Second reason is that transaction costs are different between spot and futures markets and this difference tends to induce noise in the relation. A third reason for violation of the cost-of-carry relation is time delays in the computation and reporting of the stock index value (Stoll and Whaley, 1990, p.444-445) If the changes in futures price can be significantly different from those of the spot index occurring at the same time, an index arbitrage opportunity is appeared. If Ft > St e(r – d) (T – t), profits can be made by buying the stocks of the underlying index at the spot price and shorting futures contract. If Ft < St e(r – d) (T – t), profits can be made by doing the reverse – that is, shorting the stocks of the underlying index in spot market and taking a long position in futures contracts. The results of empirical studies on lead-lag relation between futures and spot prices are very crucial, because if one market leads another, this relationship arises an arbitrage opportunity for traders. However, as arbitrageurs take investing positions to exploit this profit, they will ensure that the equilibrium relationship stated by cost-of-carry model is satisfied over time.

In Turkey, Turkish Derivatives Exchange (TurkDEX) was established in 2002. There are several contracts traded in TurkDEX, these are index futures, currency futures, interest rate futures, commodity futures and precious metal futures. Although Turkish equity market is one of the most important emerging markets, futures contracts based on a stock market index are started to trade on 4th of February 2005. Compared to ISE 100 index futures contracts, the trading volume and number of contracts for ISE 30 index are considerably higher. Because ISE 30 index futures have higher trading volume and number of contracts, in this study, investigation of the lead-lag relation between spot and futures markets for ISE 30 index is preferred rather than indicator ISE 100 index.

Increasing importance of using index futures to avoid risk since 1980s leads an increase in investigation of the relationship between spot and futures prices. Especially the investigation of price discovery function of spot or futures markets has received much attention from scholars, traders and regulators. Both futures and spot markets of a financial asset react to almost the same information set, but for trader and investors it is important to detect which market reacts first. The main purpose of this study is to investigate whether futures prices lead the spot prices for ISE 30. This paper contributes to very limited literature of Turkish derivatives exchange by examining different time periods. There are two unique contributions of this study to the literature on lead-lag relation between spot and futures prices. Firstly, this paper reinvestigates the lead-lag relationship between Turkish stock index and stock index futures prices using a recent data set of longer period. This paper also examines the consistence of lead-lag relationship between Turkish stock index and index futures prices using two different sub-periods, a pre-crisis and a post-crisis period. In section 2, a literature review is introduced. In section 3, basic information about Turkish Derivatives Exchange (TurkDEX) and the data set is given. In section 4, research methodology and results of the analysis are presented. In section 5, there are some implications for traders and the paper ends with a conclusion.

Literature Review

The literature indicates that the lead-lag relation between stock index spot and futures prices can be in three different forms; these are leading of futures to spot, bidirectional relation and leading of spot to futures. Most widely observed form is that futures prices lead the spot prices, especially in developed markets. In their study, Kawaller et al. (1987) examine the intraday lead-lag relationship between S&P 500 futures and the S&P 500 spot index using minute-to-minute data. By conducting least-squares regression analysis they find that the lead from futures to spot prices statistically significant and extends for between twenty and fourty-five minutes. Herbst et al. (1987) empirically examine the lead-lag relation between index futures prices and cash indices for both Value Line and S&P 500 for the period September 1982 – June 1983. They find that futures prices tend to lead cash indices of both Value Line and S&P 500 for the sample period implying that knowledge of the lead can provide a profitable trading advantage for investors. Tse (1995) examines the lead-lag relation between the spot index and futures prices of Nikkei Stock Average by using daily data for the period December 1988 – April 1993. He finds that lagged changes in the futures price affect the short-term adjustment in the spot index, but not vice versa through the error correction model.

Brooks et al. (2001) investigate the lead-lag relationship between the FTSE 100 index and index futures prices by using 10-min observations from June 1996 – June 1997. They find that lagged changes in the futures price can help to predict changes in the spot price. After they find this predictive ability of futures price, they also test a trading strategy to search for systematic profitable trading opportunities. While their model forecasts produce significantly higher returns than a passive benchmark, same model cannot unable to outperform the benchmark after allowing for transaction costs. Kavussanos et al. (2008) search for the lead-lag relationship in daily returns between spot and futures price series in the FTSE/ATHEX-20 and FTSE/ATHEX Mid-40 markets for the period 2000 – 2003. They find that there is bi-directional lead-lag relationship between spot and futures market. However, they conclude that futures lead the spot index returns by responding more rapidly to economic events than stock prices. Recently, Tse and Chan (2010) examine the lead-lag interaction between futures and spot markets of the S&P500 using the threshold regression model on intraday data. They find that the lead effect of the futures market over the cash market is stronger when there is more market-wide information. Kayali and Celik (2010) investigate the price discovery among ISE 30 index spot, ISE 30 index futures and an Exchange Traded Fund on ISE index for the period April 2009 – July 2010. They find that futures prices lead both spot market and exchange traded fund prices of ISE 30 index.

Kawaller et al. (1987) emphasize that transaction costs is less expensive for a stock index futures contract than for a stock index spot trading, and transaction costs is one of the most important determinants of enhancing efficiency in any financial market. Futures markets with lower transaction costs are more efficient compared to spot markets. Because of this reason, futures markets tend to lead the underlying spot markets. Furthermore, Herbst et al. (1987) state that selling or buying of a single index futures contract is much easier than the individual stocks of the same index in a short period of time. Therefore, traders can reacts to the new information by taking position in stock index futures contracts rather than spot markets implying that stock index futures reflect the effect of new information somewhat sooner than spot stocks market indices (Herbst et al., 1987, p.375). Stoll and Whaley (1990) assert that if investors have strong expectations about the direction of the market as a whole, they may trade in index futures contracts rather than individual stocks because they can use higher degree of leverage and transactions costs are lower in futures markets. As a result of such trading, futures prices move firstly, and then stock prices move when index arbitrage responds to the deviations from the cost-of-carry relationship between spot and futures markets (Stoll and Whaley, 1990, p.445). Tse and Chan (2010) find that the short-selling restrictions in the spot market reduce the effect of the spot index as the leading variable.

Floros (2009) examines the price discovery between futures and spot markets in South Africa over the period 2002 – 2006. He conduct a cointegration test, a Vector Error Correction model, a Granger causality test and an Error Correction model with TGARCH errors. The results of this study show that FTSE/JSE Top 40 stock index futures and spot markets are cointegrated. Granger casuality, VECM and ECM-TGARCH (1,1) results suggest a bidirectional casuality (feedback) between spot and futures prices. Chan et al. (1991) examine the intraday relationship between price changes and price change volatility in the stock index and stock index futures markets by using the S&P 500 stock index and stock index futures data set from 1984 to 1989. The results of this study is consistent with the hypothesis that new market information disseminates in both the futures and stock markets and that both markets serve important price discovery roles (Chan et al., 1991, p.682). Turkington and Walsh (1999) study the interactions between Australian futures and spot markets by using high frequency (5 minutes) data. They find strong evidence of bidirectional causality (feedback) between spot and futures prices. Pradhan and Bhat (2009) explain why bidirectional relation between spot and futures markets exists by referring to the findings of Chan et al. (1991). If traders have firm-specific information, they firstly buy or sell individual stocks listed in an index in spot market rather than a futures contract in futures market to make a profit by using this information. But when they have market-wide information, they firstly tend to buy or sell index futures contracts to make a profit by using this information. In the first situation, spot market leads futures market; in the latter futures prices lead the spot prices. Therefore, if firm-specific information arrives constantly and if it is important, a strong bidirectional or feedback lead-lag relationship between spot and futures markets would be evident (Pradhan and Bhat, 2009, p.84).

Wahab and Lashgrai (1993) reexamine empirically the daily price change relation between stock index and stock index futures markets for S&P500 index and FTSE100 index. They find that the lead from spot-to-futures is probably stronger when viewed relative to the lead from futures-to-spot, on a daily basis. Kasman and Kasman (2008) check the existence of a long-run equilibrium relationship and casual relationship between spot and futures prices of ISE 30 index for the period February 2005 – October 2007. They find that there is evidence of cointegration between spot and futures prices of ISE 30 index and they also find that spot prices lead the futures prices for ISE 30 index for the sample period. Pradhan and Bhat (2009) investigate price discovery, information and forecasting in Nifty futures markets for the period 2000 – 2007. They conduct Johansen’s Vector Error Correction Model to find any causal relationship between spot and futures prices. They find that spot market leads the futures market which means spot prices tend to reflect new information more rapidly than future prices. Finding a leading price discovery role of spot markets is not consistent with the majority of the literature about lead-lag relationship between spot and futures prices. However, if important firm-specific information arrives sooner than market-wide information, spot prices would lead futures prices.

Data Description

Turkish Derivatives Exchange (TurkDEX) was established in 2002 and TurkDEX is the only derivatives exchange in Turkey. Derivative contracts of assets, liabilities and indicators are traded in a competitive and secure environment of TurkDEX and it has a totally electronic trading platform. Trading of futures contracts in TurkDEX started in February 2005.

A single trading session without a lunch break is held between 9.15 a.m. and 5.35 p.m. In a normal session, transactions are executed based on the price and time priority rule and continuous auctioning. The non-trading period is between 8.45 a.m. and 9.15 a.m. during this period, the system keeps running but order entries and trade executions are not permitted. The last 10 minutes of the normal session is called the "closing period". Settlement prices for the regular trading day shall be announced at 5.45 p.m. Margin calls shall be issued in the Takasbank Derivatives System (TVIS) screen of the concerned members after the announcement of the settlement prices. The time period between 5.45 p.m. on the transaction day (T+0) and 2.30 p.m. on the following Exchange Day (T+1) is called the "clearing period" (TurkDEX, www.turkdex.org.tr, Invest in Turkey; Invest in TurkDEX, March 2011, p.20).

TurkDEX futures contracts are mainly "mini-sized" contracts which are cash settled. There are several futures contracts traded in TurkDEX. These are equity index futures (ISE-30, ISE-100 and ISE 30-100 Index Spread), interest rate futures (T-Benchmark Government Bond), currency futures (USD/Turkish Lira, EURO/Turkish Lira and EURO/US Dollar Cross Currency) and commodities (Wheat Futures, Cotton Futures, Gold Futures and US Dollar/Ounce Gold Futures) as of April 2011. Among equity index futures, most liquid futures contract is the TurkDEX-ISE 30 Equity Futures. Therefore, in this paper the relation between spot and futures price levels of ISE 30 index is investigated.

There are some advantages of TurkDEX-ISE 30 Equity Futures for investors and investing environment in Turkey. It offers hedging of investors' equity exposure with a single transaction; and best of all it is tax free. ISE-30 equity index futures provide the means of going short in equities easily. It is also a low-cost alternative to spot market due to leverage effect. Small contract size is attractive for all investors (contract size is around $5,000) and lastly trading activity at TurkDEX stimulated the OTC market and index equity options trading soared after the introduction of index futures (TurkDEX, www.turkdex.org.tr, 2011).

In this study, natural logarithms (ln) of spot and futures daily closing prices of ISE 30 index are used for the entire sample period February 2005 – March 2011. Spot prices of ISE 30 index (price index, not return index) are obtained from ISE website and ISE 30 index futures prices are obtained from TurkDEX website. Table 1 indicates descriptive statistics for natural logarithms of spot and futures prices. Mean, maximum and minimum prices of spot and futures market is too close to each other. Standard deviation of futures prices is slightly higher than spot prices. Jarque-Bera statistics imply that both prices and ln values of prices are not normally distributed, while skewness values are close to zero and kurtosis values are close to three.

Table 1: Summary Statistics of ISE 30 spot and futures prices for the Period February 2005 – March 2011

Number of Observations: 1549

Statistics	ln S	ln F	Spot Prices (S)	Futures Prices (F)
Mean	10.8635	10.8626	54289.49	54278.51
Median	10.8797	10.8804	53088.43	53125.00
Maximum	11.4214	11.4325	91249.88	92275.00
Minimum	10.2059	10.2091	27062.22	27150.00
Std. Dev.	0.2813	0.2839	14858.28	15007.95
Skewness	-0.2073	-0.1961	0.2934	0.3035
Kurtosis	2.2240	2.2049	2.3205	2.3162
Jarque-Bera	49.9537*	50.7300*	52.0175*	53.9598*

* These values are statistically significant at 5% level.

Research Methodology and Results of the Analysis

The casual relationship between spot and futures prices can be one-way or bidirectional. In the literature, studies investigating lead-lag relation between spot and futures markets find that futures prices lead spot prices especially in developed markets. However, in Turkey, a previous study by Kasman and Kasman (2008) indicates that spot and futures prices of ISE 30 index are cointegrated and spot prices lead futures prices. In order to reinvestigate the casual relationship between spot and futures prices and direction of causality, we conduct Granger causality test. A Vector Autoregressive Model (VAR) model can be used to test the direction of the causality.

$$ln F_t = \lambda_0 + \sum_{k=1}^{n} \lambda_k \, ln \, F_{t-k} + \sum_{k=1}^{n} \square_k \, ln \, S_{t-k} \qquad (3)$$

$$\ln S_t = \Psi_0 + \sum_{k=1}^{n} \Psi_k \ln F_{t-k} + \sum_{k=1}^{n} \varphi_k \ln S_{t-k} \qquad (4)$$

where k represents the lag order. In Granger causality test, it is very critical to determine appropriate lag length because this test is very sensitive to the lag order selection. We determine the lag order by using several VAR lag order selection criteria including sequential modified LR test, final prediction error, Akaike information criterion, Schwarz information criterion, Hannan-Quinn information criterion. The results of VAR lag order selection criteria tests are reported in Table 2.

Table 2: VAR Lag Order Selection Criteria

Lag	Log L	LR	FPE	AIC	SC	HQ
0	4383.62	NA	1.15e-05	-5.6941	-5.68717	-5.6915
1	9179.14	9572.3390	2.28e-08	-11.9209	-11.9001	-11.9131
2	9248.87	139.0193	2.09e-08	-12.0063	-11.9716	-11.9934
3	9267.40*	36.8919*	2.05e-08*	-12.0252*	-11.9767*	-12.0071*
4	9270.94	7.0427	2.06e-08	-12.0246	-11.9622	-12.0014
5	9275.20	8.4606	2.05e-08	-12.0250	-11.9486	-11.9966
6	9278.19	5.9112	2.06e-08	-12.0236	-11.9334	-11.9901
7	9281.38	6.3188	2.06e-08	-12.0226	-11.9185	-11.9839
8	9284.46	6.0922	2.06e-08	-12.0214	-11.9034	-11.9775
9	9286.47	3.9716	2.07e-08	-12.0188	-11.8870	-11.9698
10	9288.90	4.7919	2.07e-08	-12.0168	-11.8711	-11.9626

* indicates lag order selected by the criterion

LR: sequential modified LdR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

All of the lag order selection criteria indicate that VAR (3) model should be preferred for testing Granger causality. Table 3 reports the results of Granger causality tests for ln values of spot and futures prices. The results indicate that ln values of spot prices cause ln values of futures prices at 5 per cent significant level, but ln values of futures prices do not cause ln values of spot prices for the period February 2005 – March 2011. The results imply that spot market leads the futures market in the long-term. This causal relationship from spot prices to futures prices is consistent with the previous studies of Kasman and Kasman (2008) for ISE 30 index, but, these results are different from the findings of Kayali and Celik (2010) stating that futures market leads the spot market for ISE 30 index and the result is not consistent with the literature on the lead-lag relation between futures and spot markets in especially developed countries.

Table 3: Granger Causality Test Results

Number of Observations: 1546

Dependent Variables	ChiSquare Statistics	
	ln S	ln F
ln F	35.2279*	-
ln S	-	7.6997ns

* : significant at 5 per cent.

ns : not significant

The market efficiency implies that the spot and futures prices should never deviate too much, which represents a strongly possible cointegrating relationship (Brooks et al. 2001, p.36). In this study, the Engle and Granger (1987) single equation technique is preferred to the Johansen (1988) systems method, because there are only two variables, the spot and futures prices and hence there can be at most one cointegrating vector. If there is a cointegrating relationship between the spot and futures prices, the cointegrating regression equation would be given by

$$\ln F_t = \gamma_0 + \gamma_1 \ln S_t \qquad (5)$$

Granger causality test indicates that spot prices lead the futures prices, because of this reason, the dependent variable is natural logarithms of futures prices and independent variable is natural logarithms of spot prices. Cointegration between ISE 30 spot index and ISE 30 index futures prices requires both price series to be integrated of same order and a linear combination of the two series is stationary. We employ the standard Augmented Dickey Fuller (ADF) tests to test for nonstationarity. ADF unit root test results are reported in Table 4 indicating that ln values of futures and spot prices are integrated of order 1, that is (I(1)).

Table 4: ADF Unit Root Test Results

Variables	with trend/without trend	ADF Statistics	
		Level	First Difference
ln S	with trend	-1.7206ns	-37.1784*
	without trend	-1.3650ns	-37.1903*
ln F	with trend	-1.7164ns	-37.3933*
	without trend	-1.3581ns	-37.4053*

* : significant at 1 per cent.

ns : not significant at 1, 5 or 10 per cent.

After detecting I(1), We can use the Engle-Granger (1987) two-step approach for testing cointegration between the ln values of the spot and futures prices of ISE 30 index. If there is a cointegration between the ln values of the spot and futures prices of ISE 30 index, then the Granger representation theorem states that there is a corresponding Error Correction Model (ECM). For the spot and futures prices of ISE 30 index, the ECM can be written as

$$\Delta \ln F_t = \beta_0 + \delta \hat{z}_{t-1} + \sum_{i=1}^{r} \beta_i \Delta \ln S_{t-i} + \sum_{j=1}^{s} \alpha_i \Delta \ln F_{t-j} + \varepsilon_t \qquad (6)$$

where $\hat{z}$ are from the first stage regression of ln values (the equilibrium correction term), they are the residuals of OLS estimation of equation (5). In the next step, the Engle-Granger methodology for testing cointegration between spot and futures prices of ISE 30 requires to estimate a regression of the ln values of spot and futures prices and also in a cointegration relationship, residuals of the model ($\hat{z}$) would be stationary. Table 5 indicates the results from estimating equation (5). Regression results indicates that $\gamma 1$ coefficient is 1.0084 and it is statistically significant at 1 per cent level implying that there is a very strong relationship, one-to-one, between ln Ft and ln St, as it is expected. The cointegration regression residuals are tested to determine whether spot and futures prices are actually cointegrated. Table 6 shows the results of ADF unit root tests for residuals of $\hat{z}$ in cointegration equation. We reject the null hypothesis of a unit root in residuals, and we therefore can conclude that there exists a cointegrating relationship between spot and futures prices of ISE 30 index for the entire sample period February 2002 – March 2011.

Table 5: Test for Cointegration

$ln\ F_t = \gamma_0 + \gamma_1\ ln\ S_t$

Coefficient estimated	Coefficient value	t-ratio
γ0	-0.091862	-7.7227*
γ1	1.008369	921.2342*
* : significant at 1 per cent.		

Table 6: ADF Test of Cointegration Errors

Variables	with trend/without trend	ADF Statistics (Level)
$\hat{z}$	without trend	-8.174721*
	with trend	-8.394494*
* : significant at 1 per cent.		

In the last step of Engle-Granger (1987) methodology, Error Correction Model is estimated as stated in Table 7. One lag of ln Ft and ln St is selected as the optimum number of lags for inclusion in the ECM based on Schwarz information criterion. The results of ECM model indicate that all regressors are significant except the constant coefficient, implying that changes in futures prices of ISE 30 index depend on the cointegration error terms, and lagged changes in the spot and futures prices of the index. The coefficients of ln St-1 and ln Ft-1 have different signs. Positive coefficient of ln St-1 (0.1895, statistically significant at 1 per cent level) indicates that the future prices move in the same direction of the previous movement of the spot price, meaning that there is a price discovery role of the spot prices for the futures prices. In other words, spot prices of ISE 30 index lead the futures prices of ISE 30 index. On the other hand, negative coefficient of ln Ft-1 (-0.1272, statistically significant at only 10 per cent level) shows that the current price change in futures market is negatively related with previous price changes in futures market. The coefficient of error correction terms (δ) is negative and statistically significant. This coefficient suggests that if futures price is larger than the equilibrium price at time t-1, then it is expected to be corrected in the next period.

Table 7: Estimated Error Correction Model

$\Delta \ln F_t = \beta_0 + \delta \hat{\varepsilon}_{t-1} + \beta_1 \Delta \ln S_{t-1} + \alpha_1 \Delta \ln F_{t-1} + \varepsilon_t$

Coefficient estimated	Coefficient value	t-ratio
β0	0.000468	0.9199 ns
δ	-0.177344	-3.9599 *
β1	0.189529	2.7780 *
α1	-0.127187	-1.8797***

*	: significant at 1 per cent.
**	: significant at 5 per cent.
***	: significant at 10 per cent.
ns	: not significant at 1, 5 or 10 per cent.

Kasman and Kasman (2008) investigate the lead-lag relationship for two years, Kayali and Celik (2010) use a data set of one year period. They searched for lead-lag relation by considering limited time periods. After we conduct the analysis for the entire sample period of February 2005 – March 2011, in order to robust the results and test the consistency of the relation between spot and futures prices of ISE 30 index, we also investigate two different sub-periods, a period before the financial crisis, February 2005 – July 2008 and a post-crisis period, January 2009 – March 2011. Table 8 indicates descriptive statistics for two sub-periods. Mean, maximum and minimum natural logarithms of spot and futures prices are too close to each other for two sub-periods. Jarque-Bera statistics indicate that natural logarithms of spot and prices are not normally distributed.

Table 8: Summary Statistics of ISE 30 spot and futures prices for Sub-periods

Term	07/02/2005 – 31/07/2008 Number of Observations: 883		01/01/2009 – 31/03/2011 Number of Observations: 565	
Statistics	ln S1	ln F1	ln S2	ln F2
Mean	10.8034	10.8005	11.0092	11.0097
Median	10.8208	10.8232	11.1083	11.1035
Maximum	11.2195	11.2302	11.4214	11.4325
Minimum	10.3063	10.3031	10.2849	10.2768
Std. Dev.	0.2141	0.21797	0.3105	0.3129

Skewness	-0.4059	-0.36735	-0.9394	-0.9404
Kurtosis	2.6101	2.58623	2.7123	2.7188
Jarque-Bera	29.8400*	26.1590*	85.0409*	85.1464*

* These values are statistically significant at 5% level.

We determine the optimum lag order, by using several VAR lag order selection criteria including sequential modified LR test, final prediction error, Akaike information criterion, Schwarz information criterion, Hannan-Quinn information criterion. For the first sub-period, all of the lag order selection criteria indicates that VAR (3) model should be preferred for testing Granger causality. For post-crisis period, the results of several lag order selection criteria indicate different optimum lag orders. Based on Schwarz information criterion, we select VAR (2) model for post-crisis period.

Table 9: Granger Causality Test Results

Panel A: Granger Causality Test Results for the pre-crisis period

Number of Observations: 880

Dependent Variables	ChiSquare Statistics	
	ln S1	ln F1
ln F1	35.08482*	-
ln S1	-	0.871414ns

* : significant at 1 per cent.

ns : not significant 1, 5 or 10 per cent.

Panel B: Granger Causality Test Results for the post-crisis period

Number of Observations: 563

Dependent Variables	ChiSquare Statistics	
	ln S2	ln F2
ln F2	11.30454*	-
ln S2	-	5.941250ns

* : significant at 5 per cent.

ns : not significant at 1 or 5 per cent

Table 9 reports the results of Granger causality tests for before and after the financial crisis sub-periods. The results indicate that natural logarithms of spot prices significantly cause futures prices during both of two sub-periods in the long-term. Results of different sub-periods are consistent with the results of the entire sample period implying that casual relationship between ISE 30 spot and futures market is stable and do not change although we test this relationship for different time periods. Consistency of this relation gives very crucial information to traders, because when they detect such a relationship between spot and futures markets and they expect that this relation is not changing, they can easily buy or sell ISE 30 futures contracts in futures markets with respect to the change in value of ISE 30 stock index.

Cointegration equations are estimated for pre-crisis and post-crisis periods after ADF tests for integration of order 1 (I(1)). Results of ADF unit root tests indicate that for both sub-periods, ln values of spot and futures prices are integrated at first order, they are I(1).

Table 10: ADF Unit Root Test Results

Panel A: ADF Unit Root Test Results for the pre-crisis period

Variables	with trend/without trend	ADF Statistics	
		Level	First Difference
ln S1	with trend	1.7081 ns	-29.1574*
	without trend	-1.7316 ns	-29.1573*
ln F1	with trend	-1.6850 ns	-30.0116*
	without trend	-1.6584 ns	-30.0177*

Panel B: ADF Unit Root Test Results for the post-crisis period

Variables	with trend/without trend	ADF Statistics	
		Level	First Difference
ln S2	with trend	-1.1306 ns	-23.1386*
	without trend	-1.5537 ns	-23.1169*
ln F2	with trend	-1.1021 ns	-23.3176*
	without trend	-1.5184 ns	-23.3011*

* : significant at 1 per cent.

ns : not significant at 1, 5 or 10 per cent.

Again, we use two-step approach of Engle-Granger (1987). Estimations of cointegration regression equations are presented in Table 11. One-to-one relationship between spot and futures markets can be seen from $\gamma 1$ coefficients for both sub-periods. These coefficients are too close to one and statistically significant. In the first step of Engle-Granger (1987) methodology, the cointegration regression residuals are tested to determine whether spot and futures prices are actually cointegrated.

Table 11: Tests for Cointegration

$\ln F_t = \gamma_0 + \gamma_1 \ln S_t$

Panel A: Test Results for the pre-crisis period		
Coefficient estimated	Coefficient value	t-ratio
γ0	-0.175949	-7.6469*
γ1	1.016010	477.1365 *
Panel B: Test Results for the post-crisis period		
Coefficient estimated	Coefficient value	t-ratio
γ0	-0.083068	-8.5855*
γ1	1.007589	1146.952*

* : significant at 1 per cent.

Table 12 shows the results of ADF unit root tests for residuals of $\hat{z}$ in cointegration equation for sub-periods. We reject the null hypothesis of a unit root in residuals, and I therefore can conclude that there exists a cointegrating relationship between spot and futures prices of ISE 30 index for both of two sub-periods.

Table 12: ADF Unit Root Tests of Cointegration Errors

Panel A: Test Results for the pre-crisis period		
Variables	with trend/without trend	ADF Statistics (Level)
$\hat{z}$	with trend	-6.6167*
	without trend	-6.2088*
Panel B: Test Results for the post-crisis period		
Variables	with trend/without trend	ADF Statistics (Level)
$\hat{z}$	with trend	-5.4076*
	without trend	-5.4221*

* : significant at 1 per cent.

Error Correction Model is estimated for sub-periods as stated in Table 13. For pre-crisis sub-period, one lag of ln Ft and ln St and for post-crisis sub-period differently five lag of ln Ft and ln St is selected as the optimum number of lags for inclusion in the ECM based on Schwarz information criterion.

For pre-crisis period, the results of ECM indicates that all regressors are significant except the constant coefficient, implying that changes in futures prices of ISE 30 index depend on the cointegration error terms, and lagged changes in the spot and futures prices of the same index. The coefficients of ln St-1 and ln Ft-1 have different signs. Positive coefficient of ln St-1 (0.293948, statistically significant at 1 per cent level) indicates that the future prices move in the same direction of the previous movement of the spot price, meaning that there is a price discovery role of the spot prices for the futures prices. In other words, spot prices of ISE 30 index lead the futures prices of ISE 30 index. On the other hand, negative coefficient of ln Ft-1 (-0.285162, statistically significant at only 1 per cent level) shows that the current price change in futures market is negatively related with previous price changes in futures market. The coefficient of error correction terms (δ) is negative and statistically significant. This coefficient suggests that if futures price is larger than the equilibrium price at time t – 1, then it is expected to be corrected in the next period.

The results of ECM for post-crisis sub-period, show that all regressors are statistically significant. The coefficients of ln St-5 and ln Ft-5 have different signs. Positive coefficient of ln St-5 implies that spot prices of ISE 30 index lead the futures prices of ISE 30 index. On the other hand, negative coefficient of ln Ft-5 shows that the current price change in futures market is negatively related with previous price changes in futures market. The coefficient of error correction terms (δ) is negative and statistically significant, suggesting that if futures price is larger than the equilibrium price at time t – 1, then it is expected to be corrected in the next period.

The results of Error Correction Model for pre-crisis and post-crisis sub-periods are consistent with entire sample period. The findings from sub-periods robust the lead-lag relation between spot and futures prices for ISE 30 index.

Table 13: Estimated Error Correction Model

Panel A: Test Results for the pre-crisis period

$$\Delta \ln F_t = \beta_0 + \delta \hat{z}_{t-1} + \beta_1 \Delta \ln S_{t-1} + \alpha_1 \Delta \ln F_{t-1} + \varepsilon_t$$

Coefficient estimated	Coefficient value	t-ratio
β0	0.000455	0.7167 ns
δ	-0.145395	-2.9011 *
β1	0.293948	3.8125 *
α1	-0.285162	-3.6954 *

Panel B: Test Results for the post-crisis period

$$\Delta \ln F_t = \beta_0 + \delta \hat{z}_{t-1} + \beta_1 \Delta \ln S_{t-5} + \alpha_1 \Delta \ln F_{t-5} + \varepsilon_t$$

Coefficient estimated	Coefficient value	t-ratio
β0	0.001387	1.8828***
δ	-0.313866	-2.6200 *

β1	0.345882	2.3974 **
α1	-0.339326	-2.4192 **

*	: significant at 1 per cent.
**	: significant at 5 per cent.
***	: significant at 10 per cent.
ns	: not significant at 1, 5 or 10 per cent.

Conclusion

In this paper, the lead-lag relation between ISE 30 spot and futures markets is investigated by testing Granger causality between spot and futures prices and by following Granger-Engle two-step methodology for the sample period February 2005 – March 2011. The results for the entire sample indicate that spot prices lead futures prices for ISE 30 index. We also analyze the same relation by applying the same tests for different sub-periods, a pre-crisis and a post-crisis period. The results of sub-periods are consistent my findings for the entire sample. For two different sub-periods, ISE 30 spot prices lead ISE 30 futures prices.

Detecting a leading price discovery role of spot markets is not consistent with the majority of the literature about lead-lag relationship between spot and futures prices. However, if important firm-specific information arrives sooner than market-wide information, spot prices would lead futures prices. Derivative instruments are more complex in their nature compared to basic financial instruments such as stocks, treasury-bills or corporate bonds. In Turkey, although futures contracts have been traded for more than 6 years, still many investors are confused about the operational rules of this new market. Rules, risk and return which investors confront are totally different in derivatives markets from spot markets. Investors may not grasp the risk and return relationship in futures markets totally. There is also a high leverage in futures market. Because of these reasons, investors hesitate to trade in futures market which affects the relationship between spot and futures markets in Turkey. In this situation, in Turkey, traditional spot markets have the price discovery role over futures market. Consistency of price discovery role of spot prices gives very crucial information to traders, because when they detect such a relationship between spot and futures markets and they expect that this relation is not changing, they can easily buy or sell ISE 30 futures contracts in futures markets with respect to the change in value of ISE 30 stock index.

Our data set have an important drawback which we could not access intraday high frequency data of ISE 30 futures index from TurkDEX website. Recently lead-lag relation between spot and futures markets has been investigated by using high frequency data. In further studies about lead-lag relation between ISE 30 spot and futures markets in Turkey, high frequency (for example 5 minutes) data should be used.

References

BROOKS C., ALISTAIR G.R. and RITSON S. (2001), “A Trading Strategy Based on the Lead-lag Relationship between the Spot Index and Futures Contract for the FTSE 100”, International Journal of Forecasting, 17, pp. 31-44.

CHAN, K., CHAN, K.C. and KAROLYI, G.A. (1991), “Intraday Volatility in the Stock Index and Stock Index Futures Markets”, The Review of Financial Studies, 4(4), pp. 657-684.

ENGLE, R.F. and GRANGER, C.W.E. (1987) “Cointegration and Error Correction: Representation, Estimation and Testing”, Econometrica, (55), pp. 251-276.

FLOROS, C. (2009), “Price Discovery in the South African Stock Index Futures Market”, International Research, (34), pp. 148-159.

HERBST, A., MCCORMACK, J. and WEST, E. (1987), “Investigation of a Lead-Lag Relationship Between Spot Indices and Their Futures Contracts”, Journal of Futures Markets, (7), pp. 73-381.

JOHANSEN, S. (1988), “Statistical Analysis of Cointegration Vectors”, Journal of Economic Dynamics and Control, (12), pp. 231–254.

KASMAN, A. and KASMAN, S. (2008), “The Impact of Futures Trading On Volatility of The Underlying Asset In The Turkish Stock Market”, Physica A, (387), pp. 2837-2845.

KAVUSSANOS, M.G., VISVIKIS I.D. and ALEXAKIS, P.D. (2008), “The Lead-Lag Relationship Between Cash and Stock Index Futures in a New Market”, European Financial Management, 14(5), pp. 1007-1025.

KAWALLER, I.G., KOCH, P.D. and KOCH, T.W. (1987), “The Temporal Price Relationship between S&P 500 Futures and the S&P 500 Index”, Journal of Finance, (42), pp. 1309-1329.

KAYALI, M.M. and CELIK, S. (2010), “Price Discovery in Turkish Index Markets: Empirical Evidence from ISE-30 Index”, International Research Journal of Finance and Economics, (57), pp. 226-237.

PRADHAN, K.C. and BHAT K.S. (2009), “An Empirical Analysis of Price Discovery, Causality and Forecasting in the Nifty Futures Markets”, International Research Journal of Finance and Economics, (26), pp. 83-92.

STOLL, H.R. and WHALEY, R.E. (1990), “The Dynamics of Stock Index and Stock Index Futures Returns”, Journal of Financial and Quantitative Analysis, (25), pp. 441-468.

TSE, Y.K. (1995), “Lead-Lag Relationship Between Spot Index and Futures Price of the Nikkei Stock Average”, Journal of Forecasting, (14), pp. 553-563.

TSE, Y.K. and CHAN, W.S. (2010), “The Lead-Lag Relation Between The S&P500 Spot and Futures Markets: An Intraday-Data Analysis Using a Threshold Regression Model”, The Japanese Economic Review, 61(1), pp. 133-144.

TURKINGTON, J. and WALSH, D. (1999), “Price Discovery and Causality in the Australian Share Price Index Futures Market”, Australian Journal of Management, 24(2), pp. 97-113.

WAHAB M. and LASHGARI M. (1993), “Price Dynamics and Error Correction in Stock Index and Stock Index Futures Markets: A Cointegration Approach”, Journal of Futures Markets, 13(7), pp. 711-742.

www.imkb.gov.tr

www.turkdex.org.tr

www.turkdex.org.tr, Invest in Turkey; Invest in TurkDEX, March 2011.