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THE INTERACTIONS AMONG THE SPOT, FUTURES AND OPTIONS MARKETS OF BIST-30 INDEX IN TURKEY

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ABSTRACT

This study investigates short-run relationships among spot and derivatives market (including futures and options market) in Turkey. We examine the relationships among BIST-30 Index, BIST-30 Index Futures and BIST-30 Index Options by employing Granger causality and variance decomposition tests for the period from April 4, 2013 and December 31, 2015 by using daily data. Our results show that there is a two-way granger causality relationship between the spot and futures market. However, the effect from spot market to futures market is stronger than the effect from futures market to spot market indicating a weak arbitrage opportunity. On the other hand, we observe a one-way causality from options market to other two markets, which is quite weak.

Keywords: Futures, Options, BIST 30, VIOP, Lead-Lag Relationship.

Jel Code: G11, G14.

TÜRKİYE'DEKİ BIST 30 ENDEKSİNİN SPOT, VADELİ İŞLEM VE OPTİYON PİYASALARI ARASINDAKİ İLİŞKİLER

ÖZET

Bu çalışma Türkiye'deki spot ve türev (vadeli işlem ve opsiyon piyasalarını içeren) piyasalar arasındaki kısa dönemli ilişkileri araştırmaktadır. Çalışmada 4 Nisan 2013 ve 31 Aralık 2015 tarihleri arasındaki günlük data kullanılarak BIST 30 Endeksi, BIST 30 Endeks Vadeli İşlem ve BIST 30 Endeks Opsiyon sözleşmeleri arasındaki ilişkiler Granger nedensellik ve varyans ayrıştırma testleri kullanılarak incelenmiştir. Sonuçlar spot ve vadeli işlem piyasaları arasında iki-yönlü granger nedensellik olduğunu göstermektedir. Ancak spot piyasanın vadeli işlem piyasasına etkisinin, vadeli işlem piyasasının spot piyasasına olan etkisinden daha güçlü bulunmuştur. Bu durum arbitraj fırsatının zayıf olduğunu işaret etmektedir. Diğer taraftan, opsiyon piyasasından bu iki piyasaya tek yönlü ve zayıf bir nedensellik gözlemlenmiştir.

Anahtar Kelimeler: Vadeli işlem, Opsiyon, BIST 30, VIOP, Öncül-Ardıl İlişki.

Jel Kodu: G11, G14.

1. INTRODUCTION

Examining the relationship between the spot and derivative markets is important for the investors and portfolio managers to see whether there exist any arbitrage opportunities in these markets. Many researches argue that the derivatives market leads the spot market because of non-synchronous trading between the two markets and the leverage effect in the futures market. Traders find more attractive to trade on a derivative instrument rather than to trade on the underlying asset in the spot market since trading in derivatives market is less costly than the spot market, thus the market information is firstly reflected in derivatives market. On the other side, there are also many researches arguing that derivatives market prices do not lead the prices in the spot market, especially in the emerging markets.

In theory, in an efficient capital market where all available information is fully and instantaneously utilized to determine the market price of securities, derivatives prices should move concurrently with their corresponding spot prices without any lead and lag in price movements from one market to another. However, due to some

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market imperfections such as transaction costs, non-synchronous trading or leverage effect, significant lead and lag relationships between the two markets are observed.

The non-synchronous trading theory is the major determinant linking stock index futures and stock market. The futures price reflects all available information regarding events that will affect cash prices and responds quickly to new information. Index price movements may similarly convey information regarding subsequent price variation in the futures contract. It is unlikely, however, that the relationships are symmetric. For the index to completely reflect new information, the underlying stocks must trade at prices different from their previous trade. Because most index stocks do not trade at different prices each minute, the index responds to new information with a lag (Kwaller et al., 1987: 1312).

The trading cost hypothesis predicts that the market with the lowest overall trading costs will react most quickly to new information. Since the trading costs are lower in the stock market than in the stock option market, firm-specific information should tend to be revealed first in the stock market. Transaction costs in securities/derivatives markets have at least three components. The largest component is the market maker's bid/ask spread. As compensation for standing ready to provide immediate order execution, market makers sell at a higher price than they buy. A second component is the broker’s commission. A broker executes the trade on behalf of the customer. As compensation for order-processing costs, the broker charges a commission, which is usually quoted per-contract (or share) basis. Finally, there can be a market-impact cost in the form of a price concession for large trades. A market maker's quotes are firm for only a fixed transaction size. Larger orders may move the quote downward or upward. The magnitude of the market-impact cost reflects, among other things, the liquidity and depth of a market (Fleming et al., 1996: 354).

On the other side leverage hypothesis says that, high-leverage securities provide better price discovery. With the same amount of capital available, high-leverage instruments provide more return on investment than low-leverage instruments. Since futures and option positions require smallest initial margin and offer the highest leverage, the derivative markets should lead the stock market. Kawaller et al. (1987) suggest that the leverage effect is one of the primary reasons that informed traders choose the futures market.

The aim of this paper is to examine the short-run relationships among the spot, and derivative markets (including futures and options) for BIST-30 index which is the highest traded instruments in Derivatives Market of Turkey. Although there are several studies examining the relationship between the BIST-30 index and BIST 30 index futures, this study is the first one including the BIST-30 index options that exhibiting a rapidly growing trend in its trading volume in recent years in Turkey.

This paper is structured as follows: Following the introduction section 1 give information about the Derivatives Market in Turkey. Section 2 presents literature on the interaction between the derivatives and spot market. Section 3 gives the data and the methodology. Empirical results are given in Section 4 and then we conclude the paper.

2. DERIVATIVES MARKET IN TURKEY

The first derivatives exchange in Turkey, TURKDEX, was founded in Izmir in 2002 and began to operate in 2005. The stock index future was introduced on February 4, 2005 as one of the first financial derivative products in an organized exchange in Turkey. The merger of Turkish Derivatives Exchange (TURKDEX) and Borsa Istanbul Derivatives Market (VIOP) trading platforms was realized on August 2013, Turkish Derivatives Exchange has continued its operations under the roof of Borsa Istanbul, on the single platform of VIOP. Options contracts have begun trading since the beginning of 2013. On the other hand, the stock index options were firstly introduced on April 4, 2013 in Turkey.

Table 1 shows the trading volume of VIOP by product. In 2015, total trading volume increased by 32% and reached 575 billion TL. The major part of the trading volume belongs to index futures. Since the option contracts are very new in Turkey, their trading volume is low. However, there is an obvious increase in trading of the options contracts.

Table 1. Trading Volume by Product (TRY)

Product Line	Trading Volume (TRY) 2014	Trading Volume (TRY) 2015	Change (2014-2015)
Index Futures	400,623,922,570	460,307,059,375	15%
Index Options	984,914,140	2,836,368,995	188%
Single Stock Futures	134,940,357	1,751,850,335	1,198%
Single Stock Options	63,870,150	527,253,250	726%
FX Futures	31,986,126,488	103,608,640,569	224%
FX Options	60,005,550	4,196,083,225	6,893%
Precious Metals Futures	1,867,597,277	1,463,283,349	-22%
Power Futures	448,116	301,141,309	67,102%
ETF Futures	-	14,194,835	-
Total	**435,721,826,048**	**575,005,895,535**	**32%**

Source: BORSA ISTANBUL, (2016), "Derivatives Market 2015", [Access address: http://www.borsaistanbul.com/en/data/data/viop-derivatives-market, Access date: 06.09.2016].

Table 1 and Figure 1 depicts the proportion of the trading volume for each derivative instrument and indicates that most of the transactions are made on index futures, following FX futures and Index options. Therefore, in this study, we take index futures and options which have higher trading volumes.

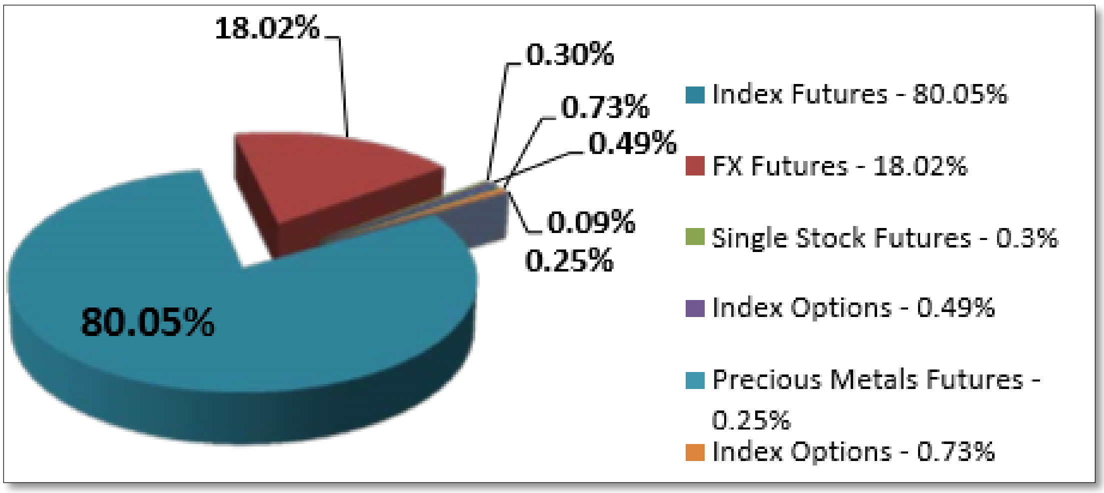

Figure 1. Trading Volume Share by Product

Figures 2 and 3 exhibit the changes in the trading volume of both index futures and index options respectively. These figures indicate a more rapid increase for the index options as compared with the index futures.

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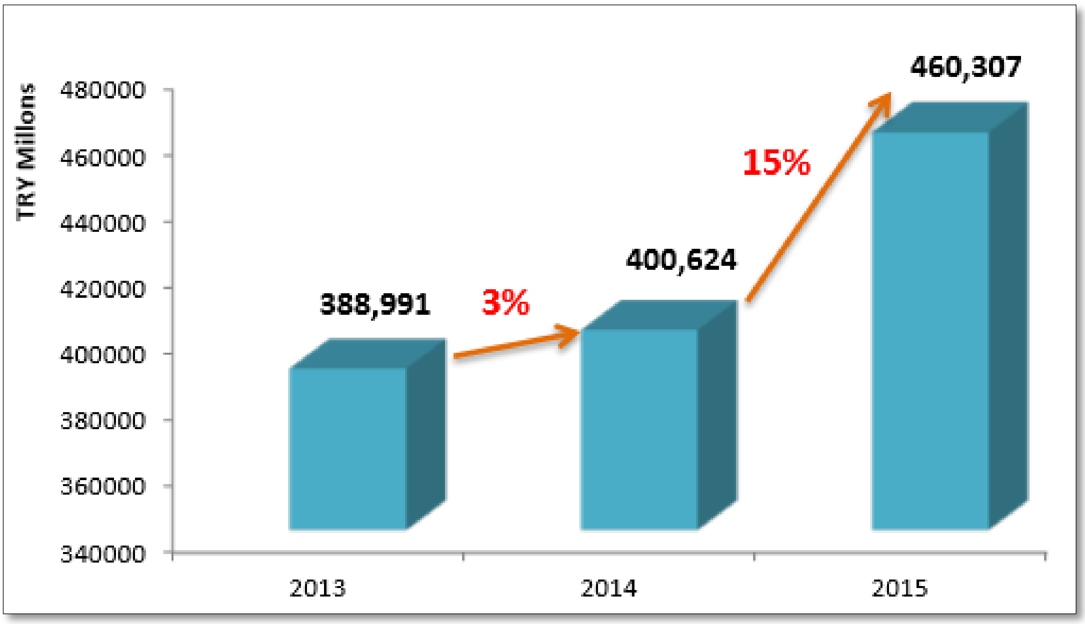

Figure 2. Trading Volume of Index Futures (TRY)

Source: BORSA ISTANBUL, (2016), "Derivatives Market 2015", [Access address: http://www.borsaistanbul.com/en/data/data/viop-derivatives-market, Access date: 06.09.2016].

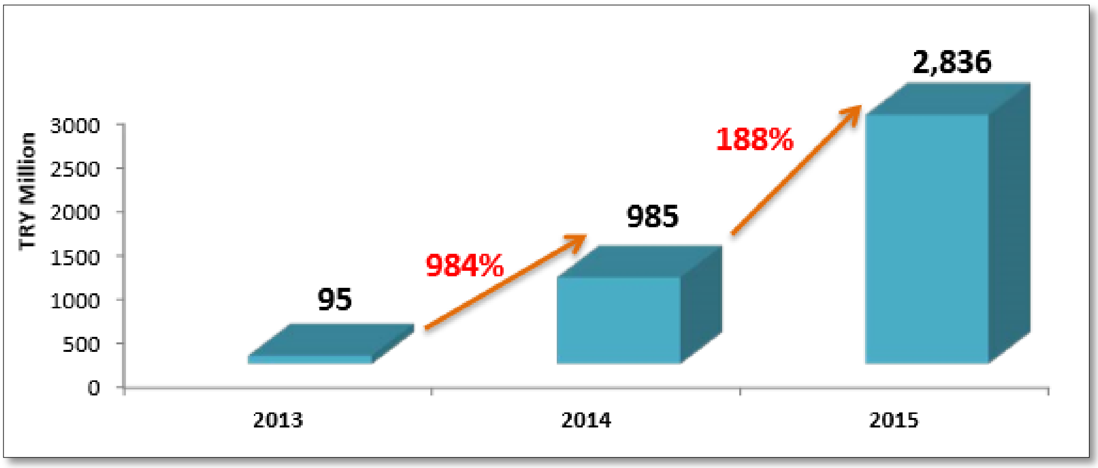

Figure 3. Trading Volume of Index Options (TRY)

Source: BORSA ISTANBUL, (2016), "Derivatives Market 2015", [Access address: http://www.borsaistanbul.com/en/data/data/viop-derivatives-market, Access date: 06.09.2016].

3. LITERATURE REVIEW

There is a plethora of studies examining the relationship between the spot and the futures market. Early studies mostly focus on the U.S. financial markets such as Modest and Sundaresan (1983), Herbst et al. (1987), Kwaller et al. (1987), Stoll and Whaley (1990), Chan et al. (1991) and Chan (1992). There are studies such as Tse (1995) and Takunaga and Kato (1996) for the Japan, Min and Najand (1999) for Korean market, Floros and Vougas (2008) and Kavussanos et al. (2008) for Greece, Singh and Bhatia (2006) and Srinivasan (2009) for India, Nieto et al. (1998) and Lafuente (2002) for Spain and Mattos and Garcia (2004) for Brazilian markets. Most of these studies argue that the futures market leads spot market.

However, we observe just a few studies examining the relationship between options and spot market with mixed results. An early study about the options and spot market link by Manaster and Rendleman (1982) investigates the role of stock option prices as predictors of the prices of the underlying stocks in the U.S. They conclude that closing option prices contained information is reflected in stock prices and options prices leads the stock prices. Bhattacharya (1987) confirms the result of Manaster and Rendleman (1982), but with different time range. In his study, Anthony (1988) shows that trading in call options leads trading in the underlying shares with a one-day lag. Unlike previous studies, Stephan and Whaley (1990) claim that stock prices lead option prices about fifteen to twenty minutes on average. However, Chan et al. (1993) argue that the Stephan and Whaley (1990) result is biased due to infrequent trading, different price discreteness rules in the stock and option markets, and the fact that a one-tick change in the stock price corresponds to an option price change that is less than one tick. They conclude that neither market leads. Krinsky and Lee (1997) find that Stephan and Whaley's (1990) result seems to reverse around the time of earnings announcements, with options leading stocks in these periods, but like Chan et al. (1993), they find no significant lead-lag relationship in quote midpoints. In their studies, Diltz and Kim (1996) and Stucki and Wasserfallen (1994) argue that stock market tends to lead the option market.

For Turkey, the relationship between spot and derivatives market is firstly studied by Baklaci and Tutek (2006). They examined the impact of futures market on spot volatility in the Turkish derivatives market, using data from 2004 to 2006 and their results indicate the futures market in Turkey has significant impact in reducing volatility in the spot market and improving efficiency. Kasman and Kasman (2008) examine the impact of futures on volatility of the underlying asset by using asymmetric GARCH model, for the period July 2002 - October 2007. They use Istanbul Stock Price Index 30 (ISE 30) futures and spot prices. They conclude that the introduction of futures trading reduced the conditional volatility of ISE-30 index. Results further indicate that there is a long-run relationship between spot and futures prices and causality runs from spot prices to future prices, but not vice versa because of the higher efficiency of the corresponding spot market in Turkey.

Kapusuzoğlu and Tasdemir (2010) try to explain the impact of VOB futures market on ISE national 100 index prices through market efficiency. Like the previous studies co-integration and Granger causality are performed on the daily closing prices beginning from November 1, 2005 until June 30, 2009. At the end of the study, it has been concluded that the VOB derivatives and ISE spot markets are both efficient in weak form, and that the futures market price is not effective on the spot market price. What they find is on the contrary to the expected, the spot market price is effective on the futures market price. This result is parallel to Kasman and Kasman (2008); spot market is found to lead futures market significantly.

Cagli and Mandaci (2013), investigate the long-run relationship between the spot and futures prices of both BIST-30 Index and foreign currencies Turkish Lira - US Dollar and Turkish Lira - EUR. They use weekly data between February 2005 and October 2012 by employing unit root and co-integration tests to check whether these markets are efficient. They find that spot and futures prices of the underlying assets including BIST-30 Index, USD and EUR are co-integrated. Their results indicate that these markets have a long-run relationship under multiple structural breaks and the markets are efficient in the long-run. We do not observe a study including options into analysis since the transactions of option contracts have just begun since the beginning of 2013 in Turkey.

4. DATA AND METHODOLOGY

We use daily closing value data of spot, futures and options contracts for ISE 30 index the period beginning from April 5, 2013 with the introduction of the index options in Turkey to December 31, 2015. We requested from Data Store of Borsa Istanbul.

BIST 30 index data contains the information about trade date and daily closing value of the index which is the final price of the trade date. On the other hand, derivatives data set provides us the contract code, trade date and daily settlement prices for futures and options. Contract code shows the underlying asset as the BIST 30 price index and expiry months. Trade date corresponds to the date that transactions are occurred. Daily settlement price is simply used for determining profit or loss for the day and it is determined by weighted average price of all trades performed within the last 10 minutes before the closing of the trading session. If number of trades performed within the last 10 minutes before the closing of the trading session is less than 10, weighted average of the last 10 trades before the closing will be set as the settlement price.

Prices of different futures or options contracts cannot be used in the analysis because they contain different information. To avoid possible problems, the contract with the nearest maturity date is to be used because the nearest contract is the one highly transacted. Thus, the nearest contract has more information due to its high

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trading volume. In VIOP, contracts with three different expiration months nearest to the current month are traded concurrently for February, April, June, August, October and December. For example, in January contracts that mature in February, April and June can be transacted and the nearest contract is the February contract. An only price of the February contract is necessarily used in the analysis.

In the case of options, the implied stock prices are calculated similar to Fleming et al (1996), De Jong and Donders (1998), and Booth et al (1999). Since the BIST index options are the European type, the Black and Scholes (1973) option pricing formula, adjusted for options prices.

$$S_{c,t}^{imp} = f^{-1}(c_t) \tag{1}$$

where $S_{c,t}^{imp}$ denotes the implied index value from the European call option price at time t and $f(S_t)$ the option pricing formula and c_t, the call option price.

The Black-Scholes pricing formula for a call option is

$$C_0 = S_0 N(d_1) - Xe^{-rt} N(d_2) \tag{2}$$

where

$$d_1 = \frac{\ln\left(\frac{S_0}{X}\right) + \left(r + \frac{q^2}{2}\right)T}{q\sqrt{T}} \tag{3}$$

$$d_2 = d_1 - q\sqrt{T} \tag{4}$$

and the call option pricing model's parameters are:

C_0 is current call option price which is collected from the VIOP data set, S_0 is current stock price which is collected from the BIST 30 index data and $N(d)$ is the probability that a random draw from a standard normal distribution will be less than d. In Excel, this function is calculated by NORMSDIST (). X is the exercise price which is also written on the options contract name, e is the base of the natural log function, approximately 2.71828. In excel, it is calculated using the function EXP(x).

r represents the risk-free rate which is treasury bond rates were collected from the Central Bank of Turkey (CBT) for the years between 2013 and 2015. The riskless rate for each option maturity is computed using the annualized continuously compounded rate on Treasury bond whose maturity most closely matched the maturity of the option. T is time to maturity of the option, in years. ln is the natural logarithm function. In Excel, it is calculated as LN(x). q is the standard deviation of the annualized continuously compounded rate of return of the stock.

By using Black – Scholes formula and the parameters that are described above, implied stock prices are calculated in excel.

Descriptive statistics are summarized in Table 2 to understand the general structure of three price series.

Table 2 indicates that for all three groups, means increase in 2015 significantly. Kurtosis and skewness show the shape of the price series. For all years, the prices are leptokurtic, in other words prices have a sharp peak and fat tails. The price observations show a right skewed pattern in 2014. However, in 2013 and 2015 spot and futures prices are left skewed where the implied index prices are right skewed. The p-values show that none of the prices are normally distributed.

Before implementing the causality tests to examine the relationship between these markets, we use unit root tests to see whether the series are stationary or not. Therefore, in this thesis, we employ Augmented Dickey-Fuller (ADF) unit root tests.

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Table 2. Descriptive Statistics Spot and Derivatives Prices

BIST-30 Index			
	2013	**2014**	**2015**
MEAN	95.754	92.233	98.926
MEDIAN	95.214	95.192	98.984
MAXIMUM	115.341	106.150	112.515
MINIMUM	80.311	74.428	88.433
STD. DEV.	8.288	9.030	5.983
SKEWNESS	0.356	-0.556	0.182
KURTOSIS	2.753	2.212	2.443
PROB (J-B)	0.553	0.150	0.619
BIST-30 Index Futures			
	2013	**2014**	**2015**
MEAN	96.042	92.673	99.556
MEDIAN	95.575	95.550	99.125
MAXIMUM	115.125	105.875	113.825
MINIMUM	79.950	74.700	89.125
STD. DEV.	8.223	9.157	6.097
SKEWNESS	0.331	-0.565	0.222
KURTOSIS	2.765	2.199	2.529
PROB (J-B)	0.597	0.141	0.635
Implied BIST-30 Index Value by Options			
	2013	**2014**	**2015**
MEAN	89.398	89.055	99.107
MEDIAN	90.405	91.290	99.350
MAXIMUM	100.080	105.010	111.820
MINIMUM	73.750	68.800	86.080
STD. DEV.	5.616	8.893	5.801
SKEWNESS	-0.481	-0.505	-0.006
KURTOSIS	3.269	2.274	2.382
PROB (J-B)	0.400	0.050	0.160

Non-stationarity implies the presence of a unit root in the time series under consideration. Thus, testing for a unit root can be used to establish the order of integration. The general formula for the non-stationarity as below where y_t is a time series process, b is trend term and μ is the intercept coefficient.

$$y_t = \mu + bt + \varphi y_{t-1} + u_t, \quad (5)$$

When b = 0 the equation become random walk with drift model as:

$$y_t = \mu + \varphi y_{t-1} + u_t, \quad (6)$$

The model can be generalized to the case where $\varphi > 1$ and y_t is the explosive process. This case is ignored because shocks have an increasingly large influence through time.

The case where $\varphi = 1$, is used to characterize the non-stationary. Shocks stick to the system and never die away. If the data is in this form of case, it should be converted to the other case where $\varphi < 1$. The differenced series will be stationary and the shocks to the system gradually would die away.

Differenced series is defined as:

$$\Delta y_t = y_t - y_{t-1} \quad (7)$$

where $\varphi = 1$, the formula as below:

$$y_t = \mu + y_{t-1} + u_t \quad (8)$$

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If we take (8) and subtract y_{t-1} from both sides:

$$y_t - y_{t-1} = \mu + y_{t-1} + u_t, \quad - y_{t-1} \tag{9}$$

(7) is substituted in (9) and the formula becomes:

$$\Delta y_t = \mu + u_t, \tag{10}$$

which is a stationary series. In this case stationarity is induced by "differencing once" and it is denoted as I (1) (integrated of order 1). We can generalize this concept to consider the case where the series contains more than one "unit root". Respectively, I (0) series is a stationary series, I (1) series contains one-unit root, and I (2) series contains two unit roots and so would require differencing twice to induce stationarity.

To test for the presence of unit roots, and hence for the degree of integration of individual series, several statistical tests may be used. The most popular one is developed by Dickey and Fuller (1979). The basic objective of the study is testing the null hypothesis: H_0: Series contains a unit root and H_1: Series is stationary

$$H_0: \Delta y_t = u_t, \ (\varphi = 1) \tag{11}$$

$$H_1: \Delta y_t = \psi y_{t-1} + \mu + bt + u_t \ (\varphi < 1) \tag{12}$$

The test statistics are defined as, $\psi\hat{}/\widehat{se(\hat{\psi})}$ but does not follow the usual t-distribution under the null hypothesis since the H_0 is non-stationary and follows a non-standard distribution. In particular, u_t will be autocorrelated if there was autocorrelation in the dependent variable of the regression (Δy_t), which is not modeled in Dickey-Fuller (1979) test. The solution is to augment the test using p lags of the dependent variable. The new model in this case:

$$\Delta y_t = \psi y_{t-1} + \sum_{i=1}^{p} \Delta y_{t-i} + \varepsilon_t \tag{13}$$

where y_t is the series being tested, p is the number of lags in the testing equation and ε_t is the residual. The test with the new model is called Augmented Dickey-Fuller (ADF) test based on same critical values with the Dickey-Fuller (DF). In ADF test, it is crucial to determine the correct lagged values of the dependent variable are included to take account of any serial correlation, and p is chosen to ensure that the residuals are white noise. There are three famous information criteria as Akaike (AIC), Schwarz (SIC) and Hannan-Quinn. In this study, AIC is selected to specify the true lag length and to obtain stationarity of the residuals.

To be sure about the stationarity, the series of spot, futures and options will be tested to see if they have a unit root in the beginning of the analysis, ADF tests the hypothesis that the series has a unit root indicating non-stationary. Therefore, rejecting the null hypothesis indicates that the series is stationary.

Following the ADF test, we employ Granger causality test to see the lead-lag relationship among these indices. It was introduced by Granger (1969) and the basic idea is analyzing of expected future values of an economic variable that is affected by another time series variable's or it self's past values. Granger causality is stated as that if time series x_t and y_t are known and y_t estimated by only data of x_t, it can be said that x_t is the granger cause of y_t. Granger (1969) explains the causality as if time series variable x_t, enables to predict time series of y_t, x_t is the granger cause of y_t and denoted as $x_t \longrightarrow y_t$. The granger causality test is used for analyzing the direction of information flow between variables. The causality can be bidirectional, both from x_t to y_t and y_t to x_t.

There are three different types of these tests: Simple Granger-causality tests, Multivariate causality tests and Granger-causality tests taking place in a vector auto regression (VAR).

Simple Granger-causality tests operate in a single equation with two variables and their lags. It is tested whether the lags of the lagged spot variables are equal to zero. If this hypothesis can be rejected, it is said that spot granger causes futures.

Multivariate causality tests include more variables beside spot and futures prices in the equation. The principle remains the same as in the case of simple Granger causality tests, except that now the influence of other variables can affect the test results. For instance, it may be that the effect on futures price does in fact run via the options price. In a two-variable test without options price effect might be misleading.

There are Granger causality tests taking place in a vector autoregression (VAR). Here the multivariate model is extended to allow for the simultaneity of all included variables. The purpose of this paper lead/lag structure detection, using multivariate Granger causality method by the following VARs:

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$$\Delta S_t = \mu + \sum_{i=1}^{p} \beta_i \Delta S_{t-i} + \sum_{j=1}^{p} \alpha_j \Delta F_{t-j} + \sum_{j=1}^{p} \gamma_j \Delta O_{t-j} + v_{s,t} \quad (14)$$

$$\Delta F_t = \mu + \sum_{i=1}^{p} \beta_i \Delta F_{t-i} + \sum_{j=1}^{p} \alpha_j \Delta S_{t-j} + \sum_{j=1}^{p} \gamma_j \Delta O_{t-j} + v_{f,t} \quad (15)$$

$$\Delta O_t = \mu + \sum_{i=1}^{p} \beta_i \Delta O_{t-i} + \sum_{j=1}^{p} \alpha_j \Delta S_{t-j} + \sum_{j=1}^{p} \gamma_j \Delta F_{t-j} + v_{O,t} \quad (16)$$

There are two null hypotheses for each model: In Equation 14, we are testing H_0: Futures prices do not cause spot prices and H_{01}: Options prices do not cause spot prices. Similarly, in Equation 15, we are testing H_0: Option prices do not cause futures prices and H_{01}: Spot prices do not cause futures prices. And in Equation 16 testing H_0: Futures prices do not cause option prices and H_{01}: Spot prices do not cause option prices.

Finally, there are variance decomposition analyses for respective three indices to understand the strength of the interaction between them. The variance decomposition indicates the amount of information each variable contributes to the other variables. It determines how much of the variance of each of the variables can be explained by the other variables.

5. EMPIRICAL RESULTS

5.1. Unit Root Test Results

Table 3 gives the ADF test results. Since the probability values are greater than the 0.05, H1 is rejected and H_0 is accepted indicating the existence of a unit root. To make the series stationary, the series differenced once and then the series become stationary with the p value less than 0.05 as shown in Table 4.

Table 3. Unit Root Tests Results

	ADF	
	t-Statistic	**Probability**
Futures Index Prices	-2.218666	0.2001
Spot Index Prices	-2.228330	0.1967
İmplied Index Prices by Options	-2.107064	0.2421

Table 4. Unit Root Tests Results for Differenced Price Series

	ADF	
	t-Statistic	**Probability**
(D)Futures Index Prices	-19.08210	0.0000
(D)Spot Index Prices	-19.26923	0.0000
(D)İmplied Index Prices by Options	-11.11610	0.0000

5.2. Granger Causality Test Results

Granger Causality test allows us to test whether one market lag the other. The Wald test brings about; bidirectional relation, no relation or one-way causality. The test is performed for searching the leading ability of each series. Table 5 shows the result of Wald statistics searching the leading ability of options and spot price series where the dependent variables are on the rows. The first rows hypotheses are:

H_0: Option prices do not granger cause futures prices,

H_1: Option prices granger cause futures prices.

H_{01}: Spot prices do not granger cause futures prices,

H_{11}: Spot prices granger cause futures prices.

Table 5. Granger Causality Tests Results

		Wald Tests		
		Futures	**Options**	**Spot**
1	**Futures**	-	0.0041	0.0000
2	**Options**	0.7986	-	0.7521
3	**Spot**	0.001	0.0100	-

The probability values for options (0.0041) and spot price (0.000) are less than 0.05, so both H_0 and H_{01} are rejected indicating both options price and spot price granger cause futures prices.

The hypotheses for the second row are:

H_0: Futures prices do not granger cause option prices,

H_1: Futures prices granger cause option prices.

H_{01}: Spot prices do not granger cause option prices,

H_{11}: Spot prices granger cause option prices.

The probability values for futures (0.7986) and spot (0.7521) are more than 0.05, so both H_0 and H_{01} are accepted indicating futures prices and spot prices do not ganger cause options prices.

The hypotheses for the third row are:

H_0: Futures prices do not granger cause spot prices,

H_1: Futures prices granger cause spot prices.

H_{01}: Options prices do not granger cause spot prices,

H_{11}: Options prices granger cause spot prices.

The probability values for futures (0.0001) and options (0.0100) are less than 0.05, so both H_0 and H_{01} are rejected indicating that both futures prices and options prices granger cause spot prices.

Figure 6 summarizes the directions of relations among price series to clarify the relationship.

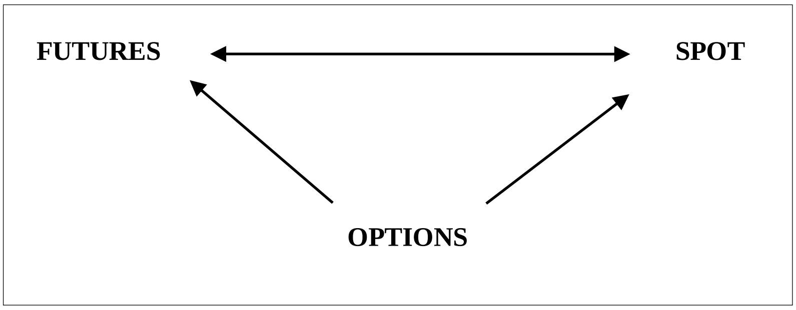

Figure 4. Granger Causality Tests – Directions of Relations

To sum up, there is a bidirectional relationship between the futures and spot price series in other words, a price change in one market influences another. Beside that there is one-way causality from options to futures and from options to spot market. Thus, any change in options market would lead a change in futures and spot markets.

5.3. Variance Decomposition Analysis

Table 6 shows the variance decomposition of futures price series. In the first period, the variance in futures market implied from itself by 100%. Later, in the following periods, shocks to the options market and the spot market account for around 1% and 58% of the variation in the futures market respectively where the shocks to the futures market account for almost 41% of the variation in the futures market. It is stated that the main contribution to the variance of the futures market is coming from the spot market.

Table 6. Variance Decomposition of Futures

Period	S.E.	Futures	Options	Spot
1	0.990727	100.0000	0.000000	0.000000
2	1.573769	40.23823	0.000376	59.76139
3	1.580256	40.08434	0.637436	59.27822
4	1.604994	41.57546	0.912855	57.51169
5	1.612541	41.38238	0.934855	57.68276
6	1.613305	41.42418	0.942525	57.63329
7	1.618264	41.35838	0.937013	57.70401
8	1.619292	41.36653	0.976870	57.65660
9	1.619477	41.35815	0.986962	57.65489
10	1.619677	41.36417	0.993014	57.64282

Table 7 shows the variance decomposition of options price series. In the first period, the variance in options market implied from itself by 99.96% where the shocks to the futures market account for only 0.03% of the variance of the options market. In the following periods, effect of other markets to options market is very low where the 99.57% of the variance is due to options market itself. The non-existence of any impact from other markets to options market is consistent with the result of granger causality test.

Table 7. Variance Decomposition of Options

Period	S.E.	Futures	Options	Spot
1	2.239570	0.039687	99.96031	0.000000
2	2.430067	0.078324	99.84327	0.078401
3	2.431231	0.118294	99.79783	0.083877
4	2.431964	0.167648	99.74043	0.091923
5	2.434026	0.276132	99.63103	0.092839
6	2.435874	0.297008	99.59120	0.111794
7	2.435970	0.297644	99.59010	0.112256
8	2.436097	0.305860	99.58048	0.113655
9	2.436201	0.311983	99.57428	0.113735
10	2.436214	0.312702	99.57330	0.113997

Table 8 shows the variance decomposition of spot price series. In the first period, the variance in options market implied from itself by 75% where the stocks to the futures market and options market account for 24% and 3% of the variation in the spot market series. The table indicates that futures market shocks account for a higher proportion of the variance of the spot market than that of the options market.

Table 8. Variance Decomposition of Spot

Period	S.E.	Futures	Options	Spot
1	1.528599	24.07188	0.037926	75.89019
2	1.534312	24.03930	0.587009	75.37369
3	1.536770	24.03906	0.629671	75.33126
4	1.561629	25.32902	1.531771	73.13921
5	1.573414	25.94148	1.981320	72.07720
6	1.575129	25.94362	2.003223	72.05316
7	1.575739	25.99570	2.006893	71.99740
8	1.576815	26.03606	2.051023	71.91292
9	1.577367	26.03194	2.097779	71.87028
10	1.577489	26.02832	2.102040	71.86964

6. CONCLUSION

The aim of this paper is to investigate the short-run relationship between the spot, futures and the options prices of the underlying asset specifically BIST 30 index which has the highest trading volume in the derivatives market of Turkey. Hence, in this study, we use Granger causality test and variance decomposition test to figure out the short-run relationship among these markets and understand the lead-lag relationships between prices of these three markets over April 4, 2013 through December 31, 2015 by using daily data. We infer 'implied index values by options price' from transaction prices of options contracts by 'inverting' the pricing formula for the BIST-30 Index value. As far as we know, this is the first study examining the relationship among the spot, futures and the options market for Turkey.

Granger causality test results show that there is a unidirectional Granger causality running from options market to both futures market and spot market. On the other hand, there is bidirectional causality between futures and spot market. Our results on the variance decomposition analysis are parallel to our Granger causality test results. According to our variance decomposition analysis, the impact of the spot market on the variance of the futures market is higher than the impact of the futures market on the variance of the spot market. Additionally, the variation in the options market is only explained by the shocks to this market itself. Our results indicate that while the effect from options to the other markets is very low, the effect from futures to spot market and from spot to futures market is much higher. Higher interaction between futures and spot market can be attributed to higher market efficiency in both of these markets rather than options market, because options market was established just three-years ago in Turkey.

Additionally, our results provide information about the price discovery process of the spot, futures and options markets. Since our results indicate that relative changes in the index value implied by the prices options contract lead both changes in the value of the spot index and changes in the value of the futures index, we can say that the options market contributes to the price discovery process in both futures and spot markets. Our results are consistent with the leverage hypothesis indicating that the highly leverage securities provides better price discovery. According to this theory, since futures and option positions require smallest initial margin and offer the highest leverage, the derivative markets should lead the spot market.

On the other side, the lead-lag relations between the spot index and the futures are bidirectional, indicating that neither market systematically leads the other. However, the spot index leads the index futures more strongly than futures leads the spot market. Thus, we conclude that the three markets are linked informationally, with enabling arbitrage opportunities. Our short-term relationship analysis results are not consistent the studies of Kasman and Kasman (2008) and Kapuzoğlu and Taşdemir (2010). They find a unidirectional relationship from spot to index futures and argue that it is the result of the higher efficiency in the spot market. Our bidirectional findings between these markets may be the result of the rapid increase in the trading volume in the futures market relative to the spot market and the futures market is getting efficient in Turkey.

Our results are important for the investors, portfolio managers and policy makers. The existence of short-run relationship among these markets indicates that the markets are efficient and reduces the diversification benefits for the investors and portfolio managers trying to reduce risk through diversification. In other words, portfolios including these assets will not provide benefit to the investors and portfolio managers for a short time period.

As a further study, the relationship among the spot, futures and options prices can be examined for the other assets such as the foreign exchanges including the US dollar and Euro traded in Turkish Derivatives Market. And it may be better when it is possible to use short interval data such as 10-minutes or 5- minutes. It may be more useful for the speculators or arbitragers to see the results with short-intervals. Since we observe much more missing data with short-intervals, we cannot use it in our analysis. Additionally, further studies may employ more advanced co-integration methods including the structural breaks.

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