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THE LEAD-LAG RELATIONSHIP BETWEEN THE EQUITY MARKET AND THE DERIVATIVES MARKET: EVIDENCE FROM BORSA ISTANBUL

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ABSTRACT

Master's Thesis

The Lead-Lag Relationship between the Equity Market and the Derivatives Market: Evidence from Borsa Istanbul

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This study investigates the lead-lag relationship between spot and derivatives markets that are being traded in Borsa Istanbul (BIST). Spot market is represented by BIST-30 Index and derivatives market is represented by futures and options contracts based on BIST-30 Index. Firstly, presence of the relationship is determined through co-integration tests, after then way of the relationship is investigated with Granger causality tests. Finally, the factors of the variances of the variables are determined by variance decomposition analysis.

In co-integration analysis between BIST-30 Index and its' futures contracts, weekly data for the period between January 2010 and December 2015 is used. While the options contracts have begun to be traded in BIST since the beginning of 2013, weekly data for the period between January 2013 and December 2015 is used in co-integration analysis among the options contracts written on BIST-30 Index, BIST-30 Index and futures contracts written on BIST-30 Index. In Granger causality test, daily data for the period between January 2013 and December 2015 is used, in order to detect the way of the relationship among these three markets.

The results of the analysis show that three respective markets are co-integrated with each other. However, there is not lead-lag relationship between spot and futures markets; instead there is two-way causality between them. In terms of information flow between markets, the effect from spot market to futures market is stronger than the effect from futures market to spot market.

On the other side, although there is one-way causality from options market to other two markets, the effect from options market to others is quite weak.

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

ÖZET

Yüksek Lisans Tezi

Spot ve Türev Piyasalar Arasındaki Öncül-Ardıl İlişkisi: Borsa İstanbul Örneği

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Bu çalışma Borsa İstanbul' da (BIST) işlem gören spot ve türev piyasalar arasındaki öncül-ardıl ilişkisini araştırmaktadır. Spot piyasayı BIST-30 endeksi, türev piyasayı ise BIST-30 endeksine dayalı vadeli işlem ve opsiyon sözleşmeleri temsil etmektedir. İlişkinin varlığı öncelikle eş-bütünleşme testleri ile tespit edilmiş, sonrasında Granger nedensellik testleri ile ilişkinin yönü araştırılmıştır. Son aşamada değişkenlerin varyanslarındaki değişimlerin kaynakları varyans ayrıştırması tekniği ile saptanmıştır.

BIST-30 endeksi ile ilgili vadeli işlem sözleşmeleri arasındaki eş-bütünleşme analizinde Ocak 2010 ile Aralık 2015 arasındaki haftalık veri kullanılmıştır. Opsiyon sözleşmeleri Borsa İstanbul' da 2013 yılında işlem görmeye başladığı için, BIST-30 endeksine dayalı opsiyon sözleşmeleri ile BIST-30 endeksi ayrıca BIST-30 endeksine dayalı vadeli işlem sözleşmeleri arasındaki eş-bütünleşme analizinde Ocak 2013 ile Aralık 2015 dönemindeki haftalık veri kullanılmıştır. Granger nedensellik testinde ise, üç piyasa arasındaki ilişkinin yönünün tespiti için Ocak 2013 ile Aralık 2015 dönemindeki günlük veri kullanılmıştır.

Analizler sonucunda üç piyasanın eş-bütünleşik olduğu tespit edilmiştir. Ancak spot ve vadeli işlem piyasaları arasındaki ilişkinin öncül-ardıl ilişkisi değil, iki yönlü nedensellik ilişkisi olduğu tespit edilmiştir. Spot ve vadeli piyasa arasındaki iki yönlü bilgi akışında spot piyasadan vadeli piyasaya olan etkinin, vadeli piyasadan spot piyasaya olan etkiden daha güçlü olduğu görülmüştür.

Diğer yandan opsiyon piyasasından diğer iki piyasaya tek yönlü nedensellik ilişkisi olduğu ancak bu etkinin çok zayıf olduğunu tespit edilmiştir.

Anahtar Kelimeler: Vadeli İşlem Sözleşmeleri, Opsiyon Sözleşmeleri, BIST-30, VIOP, Öncül-Ardıl İlişkisi.

THE LEAD-LAG RELATIONSHIP BETWEEN THE EQUITY MARKET AND THE DERIVATIVES MARKET: EVIDENCE FROM BORSA ISTANBUL

TABLE OF CONTENTS

THESIS APPROVAL PAGE	ii
DECLARATION	iii
ABSTRACT	iv
ÖZET	vi
TABLE OF CONTENTS	viii
ABBREVIATIONS	xi
LIST OF TABLES	xii
LIST OF FIGURES	xiii
INTRODUCTION	1
a. Motivation	1
b. Objective of the Study	1
c. Organization of the Study	2

CHAPTER I
PRINCIPLES OF DERIVATIVES

1.1. MECHANICS OF DERIVATIVES MARKET	3
1.2. MECHANICS OF FUTURES TRADING	5
1.3. STOCK-INDEX FUTURES	6
1.4. MECHANICS OF OPTIONS TRADING	8
1.5. STOCK-INDEX OPTIONS	9
1.6. MARKET STRUCTURE IN TURKEY	10
1.7. THE THEORY OF LEAD-LAG RELATION BETWEEN MARKETS	17

CHAPTER II
LITERATURE REVIEW

2.1. LITERATURE ON THE RELATIONSHIP BETWEEN FUTURES AND SPOT MARKETS 19
2.2. LITERATURE ON THE RELATIONSHIP BETWEEN OPTIONS AND SPOT MARKETS 24
2.3. LITERATURE ON THE RELATIONSHIP AMONG OPTIONS, FUTURES AND SPOT MARKETS 26

CHAPTER III
DATA DESCRIPTION

29

CHAPTER IV
METHODOLOGY

4.1. UNIT ROOT TEST 33
4.2. THE CONCEPT OF CO-INTEGRATION 35
4.3. TESTING FOR CO-INTEGRATION 36
4.3.1. The Johansen Co-integration Test 36
4.4. GRANGER CAUSALITY 38

CHAPTER V
EMPRICAL RESULTS

5.1. UNIT ROOT TEST – AUGMENTED DICKEY FULLER TEST 41
5.2. JOHANSEN CO-INTEGRATION TEST 44
5.2.1. Johansen Co-integration Test for Futures and Options for the Period between 2013 and 2015 44
5.2.2. Johansen Co-integration Test for Spot and Options for the Period between 2013 and 2015 45

5.2.3. Johansen Co-integration Test for Spot and Futures for the Period between 2010 and 2015 46
5.3. GRANGER CAUSALITY TEST 47
5.4. VARIANCE DECOMPOSITION ANALYSIS 49

CONCLUSION 51
REFERENCES 54

ABBREVIATIONS

ADEX	Athens Derivatives Exchange
AEX	Amsterdam Stock Index
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criteria
AR	Auto Regressive Process
ARCH	Auto Regressive Conditional Heteroskedasticity
ARMA	Auto Regressive Moving Average
ARIMA	Auto Regressive Integrated Moving Average
BIS	Bank for International Settlements
BIST	Borsa Istanbul
CBOE	Chicago Board Options Exchange
ECM	Error Correction Model
EGARCH	Exponential Generalized Auto Regressive Conditional Heteroskedasticity
EOE	European Options Exchange
GARCH	Generalized Auto Regressive Conditional Heteroskedasticity
IBEX	Spanish Stock index
ISE	Istanbul Stock Exchange
KOSPI	Korea Composite Stock Price Index
NIFTY	National Stock Exchange of India
NSA	Nikkei Stock Average
OSE	Osaka Securities Exchange
OTC	Over the Counter Markets
SEM	Simultaneous Equation Model
SC	Selection Criteria
SIC	Schwarz Information Criteria
TURKDEX	Turkish Derivatives Exchange
VAR	Vector Autoregressive
VIOP	Borsa Istanbul Derivatives Market

LIST OF TABLES

Table 1.1: Major Exchanges Trading Futures and Options p. 4
Table 1.2: Major Stock-Index Futures p. 7
Table 1.3: Stock-Index Options p.10
Table 1.4: Underlying Assets in BIST p.12
Table 1.5: Trading Volume by Product p.14
Table 1.6: Properties of BIST 30 Index Futures and Options Contracts p.16
Table 3.1: Descriptive Statistics Spot and Derivatives Prices p.32
Table 5.1: Unit Root Tests Results p.42
Table 5.2: Unit Root Tests Results for Differenced Price Series p.42
Table 5.3: Lag Order Selection Criteria for Co-integration between Futures and Options p.44
Table 5.4: Johansen Co-integration Method Results for Futures and Options (2013-2015) p.45
Table 5.5: Lag Order Selection Criteria for Co-integration between Spot and Options p.45
Table 5.6: Johansen Co-integration Method Results for Spot and Options (2013-2015) p.46
Table 5.7: Lag Order Selection Criteria for Co-integration between Spot and Futures p.46
Table 5.8: Johansen Co-integration Method Results for Spot and Futures (2010-2015) p.47
Table 5.9: Probability of Wald Test p.47
Table 5.10: Variance Decomposition of Futures p.49
Table 5.11: Variance Decomposition of Options p.50
Table 5.12: Variance Decomposition of Spot p.50

LIST OF FIGURES

Figure 1.1: Futures at VIOP	p.13
Figure 1.2: Options at VIOP	p.13
Figure 1.3: Trading Volume Share by Product	p.14
Figure 1.4: Trading Volume of Index Futures	p.15
Figure 1.5: Trading Volume of Index Options	p.15
Figure 1.6: An Example of Futures Contract	p.16
Figure 1.7: An Example of Options Contract	p.17
Figure 5.1: Yearly Movements of Price Series	p.41
Figure 5.2: Yearly Movements of Differenced Price Series	p.43
Figure 5.3: Granger Causality Tests – Directions of Relations	p.48

INTRODUCTION

a. Motivation

In the last decades of the 20th century, derivatives have been traded in many exchanges and over the counter markets all over the world. There have been many developments in derivatives market in this period. Many different and new types of forward, futures and options are traded with aim to hedge, speculate or arbitrage. Examining the relationship between the spot and derivative markets are important for the investors and portfolio managers to see whether there exist arbitrage opportunities. 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, for a fully efficient market the information arrives both markets simultaneously, but in practice due to market imperfections, all relevant information cannot be reflected by both markets. Thus, discovering the lead-lag relationship between the spot and the derivative markets helps the traders in their hedging and speculating activities.

b. Objective of the Study

This study focuses on the lead lag relationship among the futures prices, options prices and their underlying asset prices in the spot market in Borsa Istanbul (BIST). In other words, the study aims to answer the question if one of these markets leads the other or not, and how the reaction is observed.

Although several studies are suggesting that futures price changes lead the changes in the spot price in Turkey, there is no study examining the lead/lag relationship between the options and futures market and between the spot and options markets for stock index in Turkey. This study is the first and the most comprehensive one examining the relationship among these three markets namely futures, options and spot market for BIST 30 stock index.

The trading platforms of Turkish Derivatives Exchange (TURKDEX) and Borsa Istanbul Derivatives Market (VIOP) merged in 2013. (Borsa Istanbul, 2013) All futures and options contracts started to be traded under the same platform at VIOP. Since the market has a new construction and is a rapidly developing market it worth effort to research the price patterns to help investors to understand the market structure in Turkey. For this purpose, this study covers the period since the options contracts entered in the derivatives market in Turkey until the end of 2015. This period would make it possible to see the development of the three markets and their interactions.

c. Organization of the Study

This study is structured as follows:

Chapter 1 summarizes the derivatives market in the world and in Turkey briefly. Chapter 2 presents literature on the interaction between the derivatives and spot market. Chapter 3 gives the data. Chapter 4 presents the methodology. Empirical results are given in Chapter 5 and the conclusion is presented in Chapter 6.

CHAPTER ONE

PRINCIPLES OF DERIVATIVES

In this chapter, derivatives market and the principles of trading and pricing of derivatives are explained. Additionally, information about the structure of Borsa Istanbul (BIST) with the scope of equity and the derivatives market (VIOP) are given.

1.1. MECHANICS OF DERIVATIVES MARKET

Derivatives can be traded in two basic financial markets: exchanges and over the counter markets (OTC). OTCs are marketplaces where traders and dealers networking via telephone or internet. OTC market size much larger than the exchange traded market size. According to the Bank for International Settlements' semiannual survey (BIS, 2016), notional amount outstanding for OTC derivatives as end of 2015 is 492.911 billion US dollars where amount for derivative financial instruments traded on organized exchanges is 63.446 billion of US dollars. Advantage of the OTC markets is terms of contracts are not specified and traders are free to negotiate, however there can be some credit risk concern with respect to the other party in the contract.

Exchanges, started as physical locations that brings sellers and buyers together but became more than physical places. Also, increase in electronic trading eliminates the need for physical places. Many orders and executions are being conducted electronically in many exchanges. A derivatives exchange is an organized market that sets institutional rules to govern trading contracts. The contracts size, delivery dates, and the condition of the items are standardized by the exchange and the exchange provides a guarantee that the contract will be honored. Price and number of the contracts are negotiated by traders.

There are several major derivative exchanges throughout the world. Table 1.1 depicts the major Futures and Options Markets in the world.

Table 1.1: Major Exchanges Trading Futures and Options

Exchange	Symbol	Website
Australian Stock Exchange	ASX	www.asx.com.au
Bolsa de Mercadorias y Futuros, Brazil	BM&F	www.bmf.com.br
Bursa Malaysia	BM	www.bursamalaysia.com
Chicago Board Options Exchange	CBOE	www.cboe.com
Chicago Mercantile Exchange	CME	www.cmegroup.com
Eurex	EUREX	www.eurexchange.com
Euronext	EURONEXT	www.euronext.com
Hong Kong Futures Exchange	HKFE	www.hkex.com.hk
Intercontinental Exchange	ICE	www.theice.com
International Securities Exchange	ISE	www.iseoptions.com
Japan Exchange Group	JPX	www.jpx.co.jp
London Metal Exchange	LME	www.lme.co.uk
MEFF Renta Fija and Variable, Spain	MEFF	www.meff.es
Mexican Derivatives Exchange	MEXDER	www.mexder.com
Minneapolis Grain Exchange	MGE	www.mgex.com
Montreal Exchange	ME	www.me.org
National Association of Securities Dealers Automated Quotations	NASDAQ	www.nasdaq.com
New York Stock Exchange	NYSE MKT	www.nyse.com
Singapore Exchange	SGX	www.sgx.com
Sydney Futures Exchange	SFE	www.sfe.com.au
Tokyo Financial Exchange	TFX	www.tfx.co.jp
Borsa Istanbul	BIST	www.borsaistanbul.com

Source: Tun, Zaw Thiha, "Examples of Exchange-Traded Derivatives", http://www.investopedia.com/articles/active-trading/032515/examples-exchangetraded-derivatives.asp

There are basically two types of securities in an organized derivatives market: options and futures. Options give the holder right to buy or sell the underlying asset at a stated price in specified time with a paid option premium. Futures contracts are binding commitments to buy or sell the underlying assets at a specified price and at specified settlement date. Futures contracts are being traded in Turkish derivatives exchanges longer time than the options. The first stock index future was introduced in February 2005 where the first Dollar/TRY options contracts were begun to trade in BIST in May 2014 (http://www.borsaistanbul.com/docs/default-source/viop/viop-ozet-bilgiler-dokumani.pdf?sfvrsn=14, 2014). This study is focuses on stock index futures and stock index options contracts that are traded in Turkish Derivatives Market.

1.2. MECHANICS OF FUTURES TRADING

Futures contracts can be traded on a variety of goods: agricultural commodities like corn, rice, sugar, soybeans, metals and energy like copper, gold, oil, foreign currencies, equity indexes and interest rates. Charles P. Jones (2000:487) explains the principals of trading and describes the futures as contracts that specify the underlying asset for delivery with an agreed price, called the futures price. However, deliveries rarely occur, instead traders close out or reverse their positions before the maturity date and take gains or losses in cash. The participant, who commits to purchase the underlying asset on the delivery date, takes the long position. The other participant of the contract, who commits to sell the asset at maturity date, takes the short position. Every long position is offset by a short position and one position's loss equals to the other position's gain. If the spot price at maturity is higher than the futures price long position makes profit. Because it would be possible to buy in futures then sell at the spot market with a higher price. If the futures price higher than the spot price at maturity short position makes profit. This time holder of the put able to buy in spot market then sells in futures market with a higher price.

Each exchange has its own clearing house which is an agency responsible for fulfillment of contracts. The clearing house obligation is to deliver the asset or money to the long position and pay to the short; finally, its position nets to zero. It acts as trading partner for settling accounts, clearing trades, collecting and maintaining margin monies, regulating delivery between buyers and sellers (Bodie, Kane and Marcus, 2009:766). Also, it makes sure that the trade information is reported to both parties in the exchange. Without a clearing house, it would be difficult for each buyer and seller to contact with each other and settle the transaction on their own however the clearing house takes on significant risk that the buyer won't pay. That's why the clearing houses make financial markets stable and efficient.

The investors are required to deposit funds in a margin account. The amount that must be deposited at the time the contract is entered is known as the initial margin. At the end of each trading day, the margin account is adjusted to reflect the investor's gain or loss (Hull, 2008:26). The risk increases when people trade on margin. In order to mitigate this risk clearing house require the exchange members to maintain minimum account balances. This critical value called the maintenance margin. If the value of the account falls below the maintenance margin, the trader receives a margin call. Both parties must establish an initial margin account since the both are exposed to risk of loss. Every day traders realize gains and losses according to futures price changes since the clearing house takes the amount from the margin account for each contract. This daily process is called marking to market and ensures that as the futures price change, profits or losses reflected to the trader's margin account immediately.

Three major participants of futures markets: hedging, speculating and arbitraging. A hedger aims to offset the risk against price movements by contrast the speculators aims to make profit. The advantages for speculators to buy a futures contract rather than directly buying the underlying asset are leverage, smaller transaction costs and ease of trading in futures market. An arbitrager simultaneously buys and sells equivalent assets in different markets to make profit from unequal prices (Charles P. Jones, 2000:491).

1.3. STOCK-INDEX FUTURES

There are several types of financial futures; mostly traded types are stock-index futures, interest rate futures and currency futures. Since this study focuses on the stock-index futures, this type of futures is presented in this part.

Stock-index futures settle in cash on the settlement date because it is impractical to deliver all the stocks in the index. Stock index futures have a multiplier that shows the contract size. The profit for the long position is value of the stock index at maturity date minus futures price. Instead the short trader receives futures prices minus value of the stock index. Traders prefer to invest in stock-index futures rather than the underlying stock because they do not need to select individual stocks and they have low transaction cost advantage. There are many stock-index futures traded in financial markets. Table 1.2 gives a list of some most popular ones.

Table 1.2: Major Stock-Index Futures

Index	Symbol	Exchange	Contract Size	Point Value
US 30	YM	CBOT	$5 x Dow Jones	1=$5
S&P 500	ES	CME	$50 x S&P 500	1=$50
Nasdaq	NQ	CME	$20 x Nasdaq 100	1=$20
SmallCap 2000	TF	ICE	$100 x Russell 2000	1=$100
S&P 500 VIX	VX	CBOE	$1,000 x VIX Index	1=$1000
DAX	FDAX	Eurex	€25 x DAX	1=€25
CAC 40	FCE	Euronext	€10 x CAC 40	1=€10
FTSE 100	Z	LIFFE	£10 x FTSE 100	1=£10
Euro Stoxx 50	FESX	Eurex	€10 x Euro Stoxx 50	1=€10
FTSE MIB	FIB	Borsa Italiana	€5x FTSE MIB	1=€5
SMI	FSMI	Eurex	CHF 10 x SMI	1=CHF10
IBEX 35	IBEX	BME	£10 x IBEX 35	1=€10
ATX	ATX	Eurex	£10 x ATX	1=€10
AEX	FTI	Euronext	€200 x AEX 25	1=€200
BUX	BUX	BSE	Ft10 x BUX	1=Ft100
OBX	OBX	Oslo	NOK100 x OBX	1=kr100
OMXC20	C20	NASDAQ OMX	DKK 100 x OMXC20	1=kr10000
OMXS30	S30	NASDAQ OMX	SEK100 x OMXS30	1=kr100
BIST 30	XU030	BIST	TRY100 x BIST 30	1=TRY100
Nikkei 225	NK	OSE	¥1,000 x Nikkei 225	1=¥1,000
China H-Shares	HHI	HKEx	HK$50 x China H-Shares	1=$1
China A50	SFC	SGX	$1 x China A50	1=$1
S&P /ASX 200	AP	ASX	A$25 x S&P / ASX 200	1=A$25
Singapore MSCI	SG	SIMEX	S$200 x MSCI Singapore	1=S$200

Source: Investing.com, "Real-Time Stock Indices Futures", 10.05.2016, http://www.investing.com/indices/indices-futures

Index arbitrage is possible when the contracts are mispriced. If the futures prices are too high, traders can short the futures and buy the stocks in the index. If the futures prices are too low, takes a long position in futures market and sell the stocks. Thus, investors make a profit by equaling the difference between two positions regardless of what happens to stock prices. Investors must act quickly to take advantage of mispricing between the spot and the futures market. There is a term, program trading that refers buying or selling all stocks in the portfolio quickly and simultaneously via a computer-generated trading program. Program trading and index arbitrage are used together.

It is also possible to hedge market risk, called systematic risk, using index futures for stock investors. For example, when the investors have a portfolio in spot market and expect a market downturn, to hedge this risk they can sell an appropriate number of stock-index futures. As a result, when the portfolio falls in value, the futures contract would offset the loss. Stock-index futures offset changes in value of the stock portfolios because the futures prices are highly correlated with the changes in the value of the underlying stocks. The greater the correlation between the futures and stocks, the more effective hedging the market risk of a portfolio.

1.4. MECHANICS OF OPTIONS TRADING

There are two types of options as call option and put option. A call option has the right to purchase an asset for a specified price before or on a specified expiration date (Bodie, Kane and Marcus, 2009:678). The holder of a call option chooses to exercise if the market value of the asset to be purchased is higher than the exercise price. The net profit would be the value of the option minus the price that is paid to purchase the option contract. Otherwise, if the asset price is less than the exercise price, the option is left unexercised because the call becomes worthless. The price that is paid to the seller of the option (writer) is called option premium. When the option is unexercised the seller has a profit equal to the premium. But if the call is exercised, the seller has a profit premium income minus the difference between the value of the asset and the exercise price that is paid for the assets. If the difference is larger than the premium, the seller has a loss.

A put option has the right to sell an asset for a specified price before or on a specified expiration date (Bodie, Kane and Marcus, 2009:679). A put will be exercised by the holder if the exercise price is higher than the market price of the asset. The holder can purchase the asset at the market price and immediately delivers to the writer for the exercise price. The value at expiration is exercise price minus asset market price. On the other hand, seller of the put option can make profit only if the premium is greater than the value at expiration.

The buyer and the seller of the options have opposite expectations about the price of the underlying stock. The call buyer expects the stock price to rise where the call writer expects the stock price to fall or remain steady. The put buyer expects the price of the stock to fall where put writer expects to get higher or remain steady.

An option is described as in the money when its exercise is profitable for its holder. Conversely, an option is out of the money when exercise is unprofitable. In addition, options are called as at the money when the exercise price and asset market price are equal.

There are two styles of options: A European option allows its holder to exercise only on the expiration date. An American option allows its holder to exercise before the expiration date and they are generally more valuable than the European counterparts.

Some options are traded on over-the-counter markets (OTC) since they offer the advantage of tailored terms the option contract according to needs of the traders like the expiration price, expiration date, and number of shares. However, the costs of establishing an OTC option contract are higher than for exchange traded options.

Exchange traded options contracts are standardized by allowable expiration dates and exercise price for each listed option. Standardization makes all market participants to trade in a limited and uniform set of securities. This increases the depth of trading, lowers transaction costs, and results a more competitive market. Additionally, exchanges offer ease of trading as a central market place for investors; and provide liquidity as a secondary market which is very important requirement for successful trading.

There are several types of assets underlying of options. Stock options, index options, futures options, foreign currency options, and interest rate options are widely traded types. In this study, the stock-index options are described in detail.

1.5. STOCK-INDEX OPTIONS

Stock index options are contacts on a stock market index such as BIST-30, S&P 500, Japan Index, Nasdaq-100 Index, etc. After they firstly introduced in 1983, the stock-index options quickly became the fastest growing assets in the Unites States and as the beginning of 1999, they were available on a variety of market indexes. There is a list of some most popular stock-index options that are traded respectively in US, Europe and Turkey in Table 1.3.

Table 1.3: Stock-Index Options

Index	Symbol	Exchange
Dow Jones Industrial Average Index Options	DJX	CBOE
Nasdaq 100 Index Options	NDX	CBOE
S&P 100 Index Options (American style)	OEX	CBOE
Russell 1000 Index	RUI	CBOE
Russell 2000 Index	RUT	CBOE
S&P 500 Index Options	SPX	CBOE
CBOE Volatility Index® (VIX®) Options	VIX	CBOE
S&P 100 Index Options (European style	XEO	CBOE
DAX 30 options	ODAX	Eurex
SMI® Options	OSMI	Eurex
BIST 30 Index Options	O_XU030	BIST

Sources: Chicago Board of Exchange, "CBOE Products", http://www.cboe.com/products/; Eurex Exchange, "Equity Index Derivatives", http://www.eurexchange.com/exchange-en/products/idx; Borsa Istanbul, "Equity Index Options", http://www.borsaistanbul.com/en/products-and-markets/products/options/equity-index-options

Stock-index options enable investors to trade on general stock market movements or industries in the same way with trading on the individual stock. Unlike stock options which may require actual delivery of the stock, buyers of the stock index options receive cash from the seller upon exercise.

Stock-index options can be used, either speculating or hedging. For example, if an investor owns a diversified portfolio of stocks and expects a market decline can buy a put option on the market index. In effect, loss on the portfolio is offset by the gain on the stock-index options. If the market rises, the maximum loss would be premium that is paid for the option where the potential gain can be higher because of the leverage effect of options. The effectiveness of the hedge depends on the similarity between the portfolio and the market index.

1.6. MARKET STRUCTURE IN TURKEY

At date 30th of December 2012, with the Capital Markets Board Law no. 6362 Borsa Istanbul (BIST) was founded and had official authorization to operate at 3th of April, 2013. With this new law Istanbul Stock Exchange (ISE), which was founded in 1985, re-structured and re-branded as BIST and it is including all the exchanges in

Turkey together. BIST recognized internationally and has international membership in various international federations:

- World Federation of Exchanges, WFE
- Federation of Euro-Asian Stock Exchanges, FEAS
- Federation of European Securities Exchanges, FESE
- International Capital Market Association, ICMA
- International Organizations of Securities Commissions, IOSCO
- Islamic Financial Services Board, IFSB
- International Islamic Financial Market, IIFM
- WFDB - World Federation of Diamond Bourses
- LBMA – London Bullion Market Association
- KPCS – Kimberley Process Certification Scheme
- Association of Futures Markets, AFM
- Futures Industry Association, FIA

Equities, exchange traded funds, warrants, options, futures, certificates, debt instruments and lease certificates are instruments that are traded in Borsa Istanbul. It is organized as five main markets: Equity Market, Emerging Companies Market, Debt Securities Market, Precious Metals and Diamonds Market and Derivatives Market (VIOP). On all markets transactions are done electronically and market information is available on real-time streaming.

The first derivatives exchange in Turkey, TURKDEX, was founded in Izmir in 2002 and began to operate in 2005. After the re-organization of BIST, it became one of the main categories and organized as VIOP. There are twelve separate markets which are on the main board of VIOP:

- Equity Options Main Board
- Equity Futures Main Board
- Equity Index Options Main Board
- Equity Index Futures Main Board
- FX Futures Main Board
- FX Options Main Board
- Precious Metals Futures Main Board

- Commodity Futures Main Board
- Power Futures Main Board
- Foreign Indices Futures Main Board
- Metal Futures Main Board
- ETF Futures Main Board

The following equities, price indices, currencies, commodities, precious metals and energy products in Table 1.4 are traded as underlying assets in VIOP:

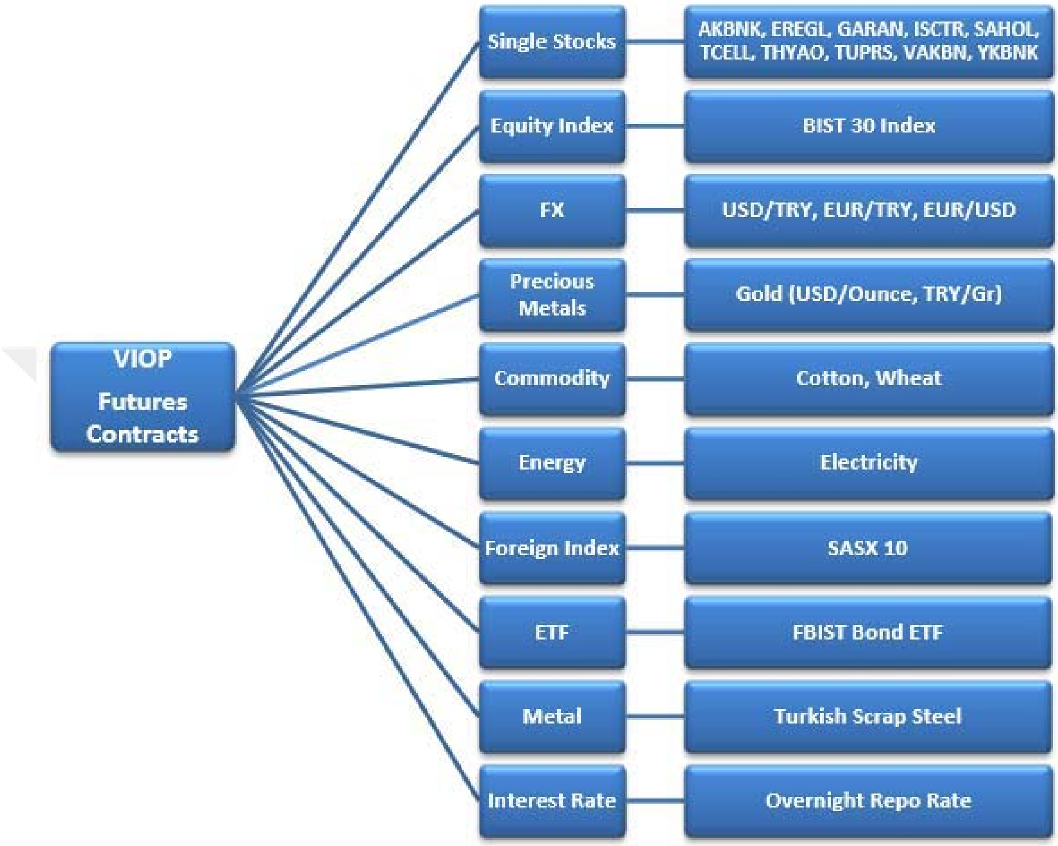
Table 1.4: Underlying Assets in BIST

Equity	
T. Garanti Bankası A.Ş	GARAN
T. İş Bankası A.Ş	ISCTR
Akbank T.A.Ş.	AKBNK
Türkiye Vakıflar Bankası T.A.O.	VAKBN
Yapı ve Kredi Bankası A.Ş.	YKBNK
Türk Hava Yolları A.O.	THYAO
Ereğli Demir ve Çelik Fabrikaları T.A.Ş.	EREGL
H.Ö. Sabancı Holding A.Ş.	SAHOL
Turkcell İletişim Hizmetleri A.Ş.	TCELL
Tüpraş Türkiye Petrol Rafinerileri A.Ş.	TUPRS
Index	
BIST 30 Price Index	XU030
Currency	
USD / Turkish Lira	USDTRY
Euro / Turkish Lira	EURTRY
Euro/USD	EURUSD
Commodity	
Aegean Standard 1 Cotton	
Anatolian Red Hard Wheat	
Precious Metals	
Pure Gold (TRY/gram)	
Pure Gold (USD/ounce)	
Energy	
Base Load Electricity	
Foreign Indices	
The Sarajevo Stock Exchange Index 10	SASX 10
Metal	
HMS 1&2 80:20 CFR Iskenderun Steel Scrap Index	HMSTR
ETF	
FBIST ETF (FTSE Istanbul Bono FBIST B Type Exchange Traded Fund)	FBIST

Source: Borsa Istanbul, "Derivatives Market- Underlying Assets", http://www.borsaistanbul.com/en/products-and-markets/markets/derivatives-market-viop/underlying-assets

Figure 1.1 shows the types of futures contracts and Figure 1.2 shows the types of options contracts at VIOP.

Figure 1.1: Futures at VIOP



Source: Borsa Istanbul, "Derivatives Market 2015", January 2016,
http://www.borsaistanbul.com/en/data/data/viop-derivatives-market

Figure 1.2: Options at VIOP

Source: Borsa Istanbul, "Derivatives Market 2015", January 2016,
http://www.borsaistanbul.com/en/data/data/viop-derivatives-market

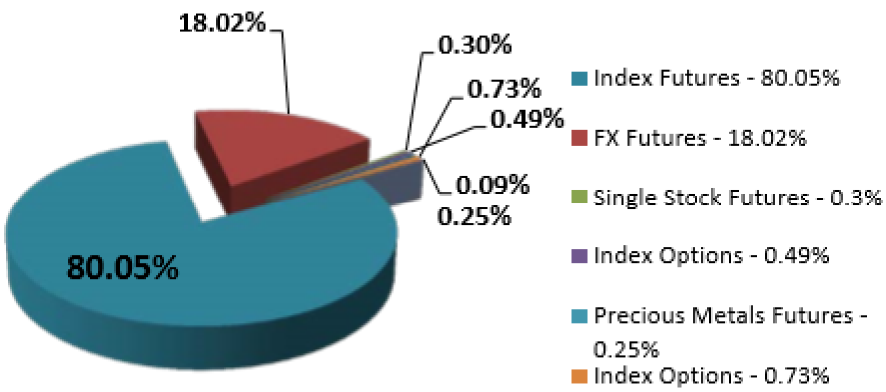
In this study, spot market will be represented by the BIST-30 Index and the derivatives market will be represented by the futures contracts written on BIST-30 index and the options contracts written on BIST-30 Index; which are the mostly traded derivatives instruments in VIOP. Table 1.5 shows the trading volume of VIOP by product. In 2015, total trading volume increased by 32% and reached 575 billion TL. Index futures and index options are takes the highest part of the total trading volume, which is visualized also in Figure 1.3.

Table 1.5: 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%**

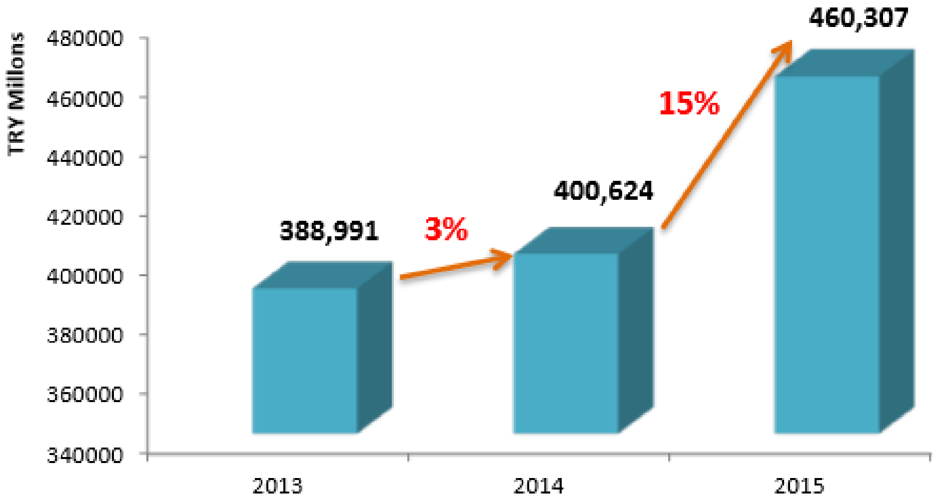
Source: Borsa Istanbul, "Derivatives Market 2015", January 2016, http://www.borsaistanbul.com/en/data/data/viop-derivatives-market

Figure 1.3: Trading Volume Share by Product



When we look at the index futures' development by years, trading volume increased by 15% and reached TRY 460 billion in 2015 as shown in Figure 1.4.

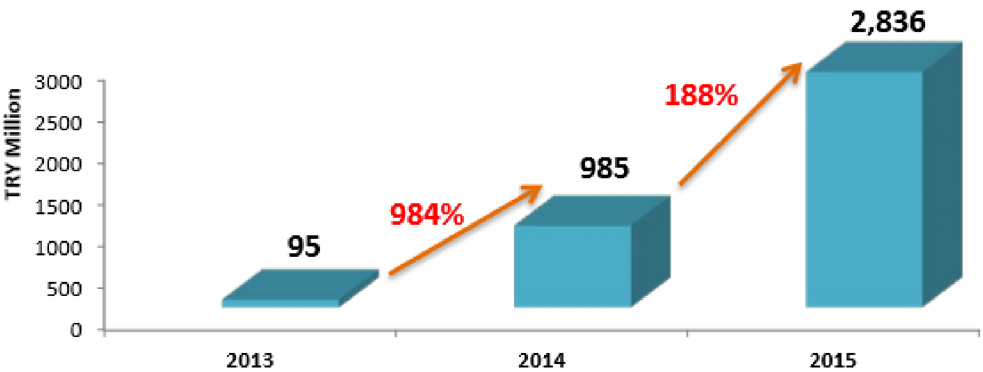
Figure 1.4: Trading Volume of Index Futures (TRY)



Source: Borsa Istanbul, "Derivatives Market 2015", January 2016, http://www.borsaistanbul.com/en/data/data/viop-derivatives-market

On the other side, index options has a rapid growth in the same period and trading volume increased by 188% and reached TRY 2.8 billion in 2015 as shown in Figure 1.5.

Figure 1.5: Trading Volume of Index Options (TRY)



Source: Borsa Istanbul, "Derivatives Market 2015", January 2016, http://www.borsaistanbul.com/en/data/data/viop-derivatives-market

Table 1.6 summarizes the properties of BIST 30 Index Futures and BIST 30 Index Options contracts.

Table 1.6: Properties of BIST 30 Index Futures and Options Contracts

Specification	BIST 30 Index Futures	BIST 30 Index Options
Underlying Security	BIST 30 price index	BIST 30 price index
Contract Size	(BIST 30 Index/1,000)*TRY 100	(BIST 30 Index/1,000)*TRY 100
Tick Size	Price tick is 0.025 which corresponds to TRY 2.5	Price tick is 0.01 which corresponds to TRY 1
Contract Months	February, April, June, August, October and December	February, April, June, August, October and December
Settlement Method	Cash Settlement	Cash Settlement
Settlement Period	T+1	T+1
Trading Hours	09:10 to 17:45 with a non-trading period between 12:30-13:55	09:10 to 17:45 with a non-trading period between 12:30-13:55

Source: Borsa Istanbul, "Vadeli İşlem ve Opsiyon Piyasası", Kasım 2014, http://www.borsaistanbul.com/docs/default-source/viop/viop-ozet-bilgiler-dokumani.pdf?sfvrsn=14

Figure 1.6 shows an example of BIST 30 Index Futures contract code. The contract codes for futures contracts are created in a way to include information on the contract type, underlying asset, maturity date and whether the contract size is standard or not.

Figure 1.6: An Example of Futures Contract

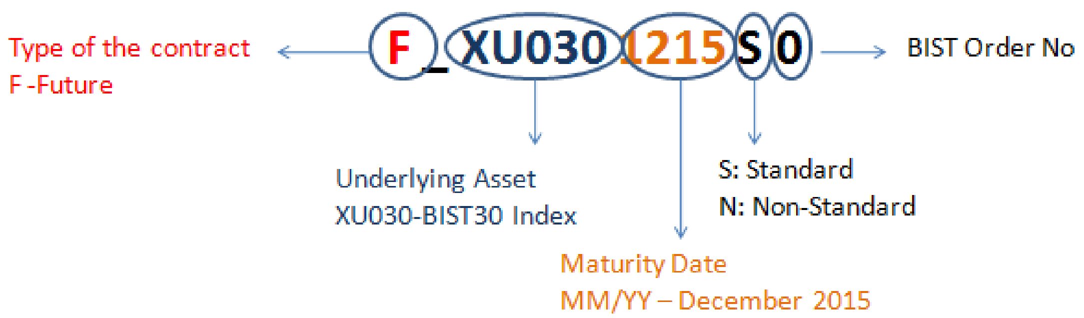
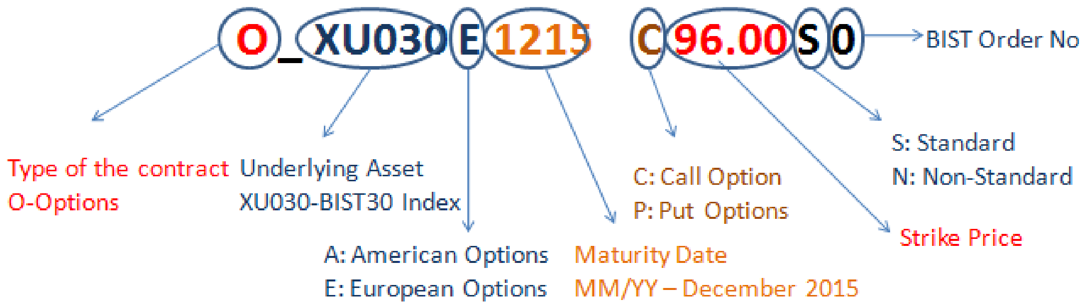


Figure 1.7 shows an example of BIST 30 Index Options contract code. For option contracts, contract codes are created in a way to include information on the contract type, underlying asset, maturity date, option style, maturity date, C/P, strike price and whether the contract size is standard or not. This example contract is a call option which gives the holder right to buy BIST-30 Index for 96, 00 TL strike price

on 31.12.2015. Since it is a European option, it allows exercising only on maturity date.

Figure 1.7: An Example of Options Contract



1.7. THE THEORY OF LEAD-LAG RELATION BETWEEN MARKETS

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 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 the 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, Koch and Koch, 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, Ostdiek, and Whaley, 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.

CHAPTER TWO

LITERATURE REVIEW

Many researchers have focused on the relationship between the derivatives markets and the spot markets with different techniques and scopes. Most of them investigate the relationship between the futures and the spot market. But we observe just a few studies examining the relationship among these three markets including the spot, futures and options. Additionally, we do not observe any study analyzing the relationship between spot and options markets and between the futures and options markets for Turkey. Before 1990's most of the studies about the futures and the spot market relation use the regression and correlation analysis, then there is a trend for using co-integration techniques. Lead-lag relation about price discovery follows this trend. This new lead-lag relationship method trying to answer the question of which market reacts first when information comes based on short-run and long-run deviations. Below, there are selected literature reviews on this question with different methodologies as well as different countries.

2.1. LITERATURE ON THE RELATIONSHIP BETWEEN FUTURES AND SPOT MARKETS

There is a plethora of studies examining the relationship between the spot and the futures market. Among them, Modest and Sundaresan (1983) investigates whether there has been any evidence of arbitrage opportunities between the settlement prices of S&P 500 futures contracts and spot indexes for the period from June 1982 to December 1982. The result of the study indicates that there are arbitrage opportunities where futures prices are at a discount relative to the spot value of the index. Similarly, Herbst, McCormak and West (1987), examine the relationship between S&P 500 futures and spot indexes. They conclude that the futures prices significantly lead their spot market prices and lead time is actually up to 16 minutes. Kwaller, Koch and Koch (1987) examine the relationship between S&P 500 futures and the S&P 500 index using minute-to-minute data. Results suggest that futures price leads index movements by 20-45 minutes where the lead from cash prices to futures price rarely extends beyond one minute. They estimate using three stages least squares regression along with Granger-Sims causality.

Stoll and Whaley (1990) do a similar research for futures prices and prove that S&P 500 and Major Market Index futures contract by the Chicago Board of Trade returns lead stock index returns by about five minutes on average, but occasionally as long as ten minutes or more. They argue that the cost-of-carry relationship may be disturbed due to three effects: First one is infrequent trading of stocks within the index; secondly difference in transaction costs in the spot and futures markets, and third one is time delays in the computation and reporting of stock index values. Correspondingly, if new information arrives in the spot and futures markets simultaneously and the price change in the futures market is recorded instantaneously, delays would tend to show that the futures market leads the spot market. This result shows the greater speed with which investors' views are reflected in the futures markets. In the study observed stock index returns have been purged of infrequent trading and bid/ask price effects via ARMA filtering.

Chan, Chan, and Karolyi (1991) extend the studies of lead-lag relationship between the stock and futures markets by focusing on the intraday volatility of the cash and futures price changes and not just on the price changes themselves across two markets. They utilize from the statistical model based on the autoregressive conditional heteroskedastic (ARCH) and generalized (GARCH) with S&P 500 index and stock index futures prices. Their results show much stronger dependence in both directions in the volatility of price changes between the cash and futures markets than that observed in the price changes alone. This results are inconsistent with some previous findings concerning that information flows systematically to the futures market before the cash market. In contrast, they suggest that new information that originates either market can predict the future volatility in the other market so both markets serve important price discovery roles. Chan (1992) employ a further analysis about the lead-lag relation between cash and stock market by using price records of MMI and S&P 500 futures contracts in two sample periods: August 1984-June 1985 and January 1987 – September 1987. His result indicates that when more stocks move together the futures leads the cash index to a greater degree. This proves that the futures market is the main source of market-wide information while the cash market is the main source of firm-specific information. Since firm-specific information is diversifiable and market-wide information is systematic, the discovery of market-wide information is more important, so he hypothesized that the feedback from the futures market into the stock market is larger than the reverse.

Tse (1995)'s investigation on Japanese Stock Index, supports the leading of futures on Nikkei Stock data from December 1988 through January 1993 with the Error Correction Model (ECM). He also compares the forecasting power of the ECM with Autoregressive Integrated Moving Average (ARIMA), Vector Autoregressive (VAR) Model and Martingale models, and finds higher predictive ability of the ECM. A further research on relation between futures and spot market in Japan is accomplished by Iihara, Takunaga and Kato (1996). This study investigates the intertemporal relationship between the Nikkei Stock Average (NSA) and NSA index futures using minute-by-minute transactions data from the Osaka Securities Exchange (OSE). The research focuses on three time periods in the sample. The first period includes the year 1989 (bull market). The second period includes the year 1990 until the introduction of the special price quotation in Japanese trading system on August 24, 1990 (bear market). The third period begins after the introduction of the stricter measures and continues to March, 1991 (bear market). Their empirical result indicates that futures returns strongly lead cash returns for all three periods, but third-period futures returns do not lead stock returns as much as the first-period and the second-period futures returns because the price movement limit prevents both the stock and futures prices from having high fluctuations.

Many studies are emerged for other countries such as Korea, Greece, India, Spain and Brazil with smaller size derivatives exchange, supporting the findings of lead/lag interaction in the literature. Min and Najand (1999) find a consistent result in Korean Market with previous studies for the U.S. and other countries' futures markets. In this study, they use 10-minute intraday data from 3 May 1996 through 16 October 1996 for the KOSPI 200 index and its nearby futures contracts. The Dynamic Simultaneous Equation Models (SEM) like Kwaller, Koch and Koch (1987) and Vector Autoregression Model (VAR) methodologies are used in the research. They find that the futures market leads the cash market by as long as 30 minutes.

Additionally, Greece Floros and Vougas (2008) use cointegration analysis between Greek spot and futures market over the period of the crisis, 1999-2001 in the Athens Derivatives Exchange (ADEX). Their results show that Greek futures markets are more efficient than underlying stock markets implying that futures markets play a price discovery role in Greece. Kavussanos et al. (2008) study on the same markets but with different time span: 2000 through 2003. Both researches execute cointegration and ECM analysis resulting with similar findings.

Singh and Bhatia (2006) deal with Indian cash index and index futures markets with intraday data in daily volatility of the NIFTY index. In the Indian context, their study shows that index futures market leads the spot market strongly. Similarly, Srinivasan (2009) studied on the causal relationship between Nifty spot index and index futures market in India. The study discovers that there exists a long-run relationship and the bidirectional relationship between the futures and spot market prices in India.

On the other hand, Nieto et al. (1998) analyzes Granger causality between the daily observations from Spanish Stock index (IBEX 35) and its futures contract and they employ Johansen cointegration with VAR representation as a method to examine the long-run relationship between these two markets. The data used for the study covers the period March 1994 – September 1996. Empirical findings of the study agree with previous researches and reveal that futures prices lead spot prices in short run. However, in long run no lead/lag pattern in the methodology. Another study by Lafuente (2002) examines the relation in Spain by examining both returns and volatilities jointly. A similar pattern is detected for bidirectional causal relationship between market volatilities. On the other hand, unidirectional lead/lag pattern is observed from futures to spot in returns.

Another study by Mattos and Garcia (2004) analyze the agricultural futures market with daily data of 1997 until 2001 for Brazil. They use the same methods with Nieto et al. (1998), but they conclude that in short run no lead/lag structure is present. Whereas, in the long run with higher trading volume is linked to the presence relationships between cash and futures prices in Brazil.

Aside from this literature, For Turkey, the relationship between spot and derivatives market is firstly studied by Baklaci and Tutek (2006). The derivatives market in Turkey has been in operation since February 2005. They examined the impact of futures market on spot volatility in the Turkish derivatives market, using data from 2004 to 2006 by separating the whole sample into two sub periods that contain pre- and post-futures trading periods. Their results indicate that even though it has been in operation for a short period, 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 via 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.

2.2. LITERATURE ON THE RELATIONSHIP BETWEEN OPTIONS AND SPOT MARKETS

The literature also covers some researches in the scope of options and the spot market relations. 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. The study contains daily closing prices in a time range 1973 to 1976. According to their model, the option price is a function of the current value of the underlying stock and they use the Black-Scholes option pricing model to calculate implied stock with the observed call options prices. Then they investigate the relationship by using these calculated implied stock prices between observed stock prices. 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 through June 1977 and August 1978 and with intraday transaction data records every 15-minute interval. They also used Black-Sholes option pricing model to calculate implied stock prices and compare these with observed stock prices like Manaster and Rendleman (1982). A critical aspect of Bhattacharya's test design mentioned in Stephan and Whaley (1990), that it only detects whether the option market leads the stock market and not vice versa.

Anthony (1988) takes another approach by examining the interrelation between common stock and call option trading volume from January 1, 1982 to June 30, 1983. The study, using Granger causality tests via the conventional vector-autoregression (VAR) and examine whether trading in the option market causes trading in the stock market. The result shows that trading in call options leads trading in the underlying shares with a one day lag.

Stephan and Whaley (1990) use time series regression by breaking price data into 5-minute intervals to investigate intraday relations between price changes of options and stocks traded on Chicago Board Options Exchange (CBOE) during the first quarter of 1986. They use of intraday transaction data with concentrating on the lead-lag relation directly. Unlike previous studies, they claim that stock prices lead option prices about fifteen to twenty minutes on average.

However, Chan, Chang and Johnson (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.

Vijh (1990) and Srinivas (1993) examine this relationship indirectly by looking at how option prices move with option trades. Vijh (1990) concludes that the price effect of large option trades is small, therefore suggesting that option trades are not informative. Srinivas (1993) argues that this is due to a bias in Vijh's sample selection and presents evidence that option trades are informative. 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, Chang and Johnson (1993), they find no significant lead-lag relationship in quote midpoints.

Diltz and Kim (1996) and O'Connor (1999) examine the lead-lag relationship between stocks and options quotes using an error correction model that shows that the observed stock price and the option-implied stock price are co-integrated. Diltz and Kim (1996) suggest, from daily data for eight firms negotiated on the CBOE in the first quarter of 1986 that the causality is bi-directional. However, O'Connor (1999), using the TORQ database for 19 firms during November and December, 1990, finds that the stock market tends to lead the option market, and that the lead time is related to various measures of option liquidity and trading costs. Stucki and Wasserfallen (1994) find the same result. They conclude that the Swiss stock market lead the Swiss Options and Financial Futures Exchange (SOFFEX) by ten minutes on average.

More recently, Richard, Yusif, and Liuren (2006) apply a portfolio approach to analyze price discovery in the United States stock and stock options. They consider that option prices vary with not only the underlying asset price, but also volatilities and higher movements and find that price discovery on the directional movement of the stock price mainly occurs in the stock market. However, the options market becomes more informative during periods of significant options trading activities. Furthermore, Yusif and Liuren (2008) study price discovery in the United States stock options market. They describe the International Securities Exchange and present a comparison of the different exchanges' market-making systems along several dimensions, including the size of the typical bid-ask spread, how much a trade in each market contributes to a general updating of prices across the whole market, and how frequently trades are executed inside the quoted bid-ask spread. Their results indicate that the electronic marketplace performs very well relative to the more traditional trading floors on these dimensions.

On the other hand, several authors study price discovery in Asian option markets. For example, Kedar and Mishra (2007) study the informational role of the options market in predicting the future price index in the underlying cash market in India. To explore the relationship, daily data for both price as well as non-price variables, for two different sub-periods have been employed. Their findings confirm that the open-interest-based predictors are found to be significant in predicting the future price in the underlying cash market in both sub-periods. Nevertheless, during the recent sub-period, the trading volume shows some more impact when compared to open interest in the matter of price prediction in the cash market.

For Korea, Hee, Jangkoo, and Doojin (2008) examine if informed trading is present in the index option market by analyzing the KOSPI 2002 options. They find that adverse-selection costs constitute a nontrivial portion of the transaction costs in index options trading. Approximately one-third of the spread can be accounted for by information asymmetry costs. Moreover, their regression analysis shows that option-related variables are significantly associated with estimated information asymmetry costs, even when controlling for proxies for informed trading in the index futures market.

2.3. LITERATURE ON THE RELATIONSHIP AMONG OPTIONS, FUTURES AND SPOT MARKETS

Fleming, Ostdiek, and Whaley (1996) determine the first study that is focusing on relationship among options, futures and spot markets. Return series for S&P 500 stock index and S&P 500 index futures, also series for S&P 100 stock index and S&P 100 index options are created and causality is analyzed via multiple regression models. The empirical evidence shows that derivatives market leads the spot market respectively S&P 500 index futures appear to lead the S&P 500 stock index, and S&P

100 index options appear to lead the underlying S&P 100 index. Additionally, their result supports that the returns of the S&P 500 futures leads S&P 100 options prices. They explain these lead-lag patterns with transaction cost hypothesis. The transaction cost hypothesis predicts that the market with the lowest overall transaction costs will react most quickly to new information. The costs of trading in the derivatives market is substantially lower than spot market. Therefore, index futures and option price changes should lead price changes in the spot market. Similarly, with lower transaction costs in the index futures market than in the index option market, index futures price changes should lead index option price changes.

De Jong and Donders (1998) search the relationship among three markets. The data is obtained from European Options Exchange (EOE) and Amsterdam Stock Index (AEX), AEX index futures and AEX index options with two samples of data one from January 20 to July 17 of 1992 and the other includes the first quarter of 1993. They avoid from non-trading problem using an estimator developed by De Jong and Nijman (1997). With that adjusted estimator, regression and cross correlation analysis are conducted. Empirical results confirm previous findings that futures, options and the cash index are contemporaneously correlated and that there is an asymmetric relation between the futures market and the options and spot market, respectively. There is strong evidence that relative changes in the index value implied by the prices of the FTI-contract lead both changes in the value of the cash index and changes in the index value implied in option prices by five to ten minutes on average. The lead-lag relations between the cash index and the options are largely symmetrical, indicating that neither market systematically leads the other.

In the following years, some other researchers examine the interrelation among these three markets including Booth et al. (1999) and Kang, Lee and Lee (2006). Booth et al. (1999) examines the intraday price discovery process among stock index, index futures, and index options in Germany using DAX index securities and intraday transactions data for the time Dec 5, 1994 through July 11, 1997. Price discovery process is analyzed by cointegration and ECM. It is found that futures market leads both options and spot markets and spot market seems to lead the options market. Because the transaction costs of the futures appear to be the lowest of the three and those of the options to be the highest, the results are consistent with the transaction cost hypothesis.

Korean KOSPI200 spot market, the KOSPI200 futures market, and the KOSPI200 options market investigation for the last quarter of 2001 through 2002 is provided by Kang, Lee and Lee (2006). The study analyzes the lead/lag relations of prices/returns and the volatilities. They implement OLS regressions like Stephan and Whaley (1990) and others. However, they prefer to use the implied forward prices extracted from the put-call parity relation rather than option pricing models in these regressions which bring the advantage of model-free approach. In conclusion, the following findings are documented: KOSPI200 futures and options markets lead the KOSPI200 spot market by up to 10 minutes in terms of returns and by 5 minutes in terms of volatilities, even after purging the infrequent trading effect as well as the bid-ask spread effect. The KOSPI200 options market leads and lags the KOSPI200 futures market by 5 minutes only in terms of returns; in terms of volatilities no lead/lag relation is detected. The observed lead-lag relations seem to be caused by the difference in transaction costs of the three markets.

CHAPTER THREE

DATA DESCRIPTION

The purpose of this study is to investigate the relationship among spot markets, futures market, and option markets in Turkey. The spot market represented by price series of BIST-30 Index, futures market represented by futures price written on BIST-30 index where it consists of 80,50 % of trading volume of derivatives market in Turkey and the options market represented by options price written on BIST-30 Index. The historical data for the market information is requested from Data Store of Borsa Istanbul.

The stock index future was introduced on 4 February 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. In co-integration analysis, we use weekly data of the futures and spot index prices beginning from 6 January 2010 to 31 December 2015 to analyze more wide time range for these markets. On the other hand, the stock index options were introduced on 4 April 2013 in Turkey. Hence, in co-integration analysis of options, we use weekly data beginning from 5 April 2013 to 31 December 2015 beginning from the first trade date of the stock index options.

In Granger causality test and following variance decomposition test, we use daily data of spot, futures and options markets for the period beginning from 5 April 2013 to 31 December 2015.

This time frame is covering the period of which all three markets have been growing rapidly. According to VIOP announcements; 2015 total trading volume reached a record of 90.3 million contracts, up 52 percent from 2014. Total traded volume reached 575 billion TL in nominal terms, breaking a record. As part of that increase, total options volume grew by 10 times to a record 2.6 million contracts, whereas total futures volume up 48 percent reaching a record 87.6 million contracts. Additionally, daily average number of open interest reached 875,134 contracts, up 83 percent. Trading levels increased exponentially and VIOP became the "world's fastest growing derivatives market" in 2015. Correspondingly analyzing this time frame would give latest information about the market in Turkey. (Borsa Istanbul, (08.02.2016). http://www.borsaistanbul.com/en/news/2016/02/08/borsa-istanbul-derivatives-market-viop-becomes-the-world-s-fastest-growing-derivatives-market-in-2015)

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 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 also calculated like 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.

$$S_{c,t}^{imp} = f^{-1}(c_t) \qquad (3.1)$$

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

$$C_0 = S_0 N(d_1) - Xe^{-rt} N(d_2) \qquad (3.2)$$

where

$$d_1 = \frac{\ln\left(\frac{S_0}{X}\right) + \left(r + \frac{q^2}{2}\right)T}{q\sqrt{T}} \qquad (3.3)$$

$$d_2 = d_1 - q\sqrt{T} \qquad (3.4)$$

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 3.1 to understand the general structure of three price series.

Table 3.1: Descriptive Statistics Spot and Derivatives Prices

BIST-30 Index						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
MEAN	74,8072	74,1904	77,5644	95,7539	92,2326	98,9258
MEDIAN	73,0980	75,5506	75,4341	95,2138	95,1921	98,9841
MAXIMUM	89,7961	85,2510	97,4423	115,3413	106,1498	112,5147
MINIMUM	61,7620	60,6859	62,0022	80,3106	74,4280	88,4332
STD. DEV.	7,5370	6,9548	8,9624	8,2882	9,0300	5,9826
SKEWNESS	0,4365	-0,3493	0,5313	0,3563	-0,5556	0,1817
KURTOSIS	2,1242	2,7708	2,7007	2,7529	2,2118	2,4425
PROBABILITY	0,2099	0,2502	0,2591	0,5528	0,1503	0,6190
BIST-30 Index Futures						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
MEAN	74,9830	74,2880	77,9894	96,0420	92,6730	99,5563
MEDIAN	73,5375	75,2750	75,6250	95,5750	95,5500	99,1250
MAXIMUM	90,5750	85,9500	98,0250	115,1250	105,8750	113,8250
MINIMUM	61,3750	60,8250	62,5500	79,9500	74,7000	89,1250
STD. DEV.	7,6536	7,0646	9,0740	8,2233	9,1571	6,0972
SKEWNESS	0,3973	-0,3149	0,5070	0,3314	-0,5648	0,2223
KURTOSIS	2,1753	2,6630	2,7530	2,7646	2,1994	2,5294
PROBABILITY	0,2551	0,2641	0,2525	0,5973	0,1413	0,6350
Implied BIST-30 Index Value by Options						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
MEAN				89,3984	89,0547	99,1071
MEDIAN				90,4050	91,2900	99,3500
MAXIMUM				100,0800	105,0100	111,8200
MINIMUM				73,7500	68,8000	86,0800
STD. DEV.				5,6155	8,8926	5,8013
SKEWNESS				-0,4814	-0,5054	-0,0060
KURTOSIS				3,2693	2,2738	2,3816
PROBABILITY				0,4001	0,0497	0,1599

For all three prices means increase in 2015. Table 4.1 indicates that in 2015 prices begin from low values and move upward 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. According to corresponding p-values, none of the prices are normally distributed.

CHAPTER FOUR

METHODOLOGY

Before implementing the co-integration and 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 Dickey-Fuller (ADF) unit root tests. This chapter contains information about the statistical tests we use in this study.

4.1. UNIT ROOT TEST

A stationary variable may be defined as a series with a constant mean and constant, finite variance. A non-stationary series on the other hand, will have a time-varying mean, or variance, so that any reference to the mean or variance should include reference to the particular period under consideration. Stationarity is a key concept in co-integration analysis because if non-stationary series are tested, several weaknesses would arise. Firstly, persistence of shocks will be infinite for non-stationary series. But on the other hand, if a shock hits a stationary series, effects of the shock gradually die away. Secondly, non-stationary process may lead spurious regression problem. If two or more variables are trending over time, a regression of one on the other could have a high R^2 even if they are totally unrelated. Thus, usage of non-stationary data may lead to misleading results. One other weakness is that standard assumptions for analysis will not be valid when testing non-stationary data. In other words, problem with regressing non-stationary series is that t- and F-tests no longer have the standard distributions associated with stationary series, so the hypothesis tests about the regression parameters cannot be undertaken correctly. To avoid all these weaknesses, stationary should be tested before statistical analysis. In this study, the stationarity conditions of all three markets need to be tested, before analyzing the lead-lag relationship.

Whether a time series is stationary depends on whether it has a unit root. 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.

$y_t = \mu + bt + \varphi y_{t-1} + u_t,$ (4.1)

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

$y_t = \mu + \varphi y_{t-1} + u_t,$ (4.2)

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:

$\Delta y_t = y_t - y_{t-1}$ (4.3)

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

$y_t = \mu + y_{t-1} + u_t$ (4.4)

If we take (4.4) and subtract y_{t-1} from both sides:

$y_t - y_{t-1} = \mu + y_{t-1} + u_t, - y_{t-1}$ (4.5)

(4.3) is substituted in (4.5) and the formula becomes:

$\Delta y_t = \mu + u_t,$ (4.6)

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.

In order 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: $\Delta y_t = u_t, (\varphi = 1)$ (4.7)

H_0: Series contains a unit root

H_1: $\Delta y_t = \psi y_{t-1} + \mu + bt + u_t$ ($\varphi < 1$) (4.8)

H_1: Series is stationary

The test statistics are defined as, $\hat{\psi}/\widehat{se(\psi)}$ 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:

$$\Delta y_{t} = \psi y_{t-1} + \sum_{i=1}^{p} \Delta y_{t-i} + \varepsilon_t \qquad (4.9)$$

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 means non-stationary. Therefore, rejecting the null hypothesis means that the series is stationary.

4.2. THE CONCEPT OF CO-INTEGRATION

Co-integration theory describes the movements of multidimensional economic series. This technique is an innovation in theoretical econometrics that has created the most interest among researchers in the last decade because it seems that lots of economic series behave that way and this is often predicted by theory. According to Harris (1995:6), the economic interpretation of co-integration states that if two or more series are linked to form an equilibrium relationship spanning the long run, then even though the series themselves may contain stochastic trends and thus be non-stationary, they will nevertheless move closely together over time and the difference between them will be stable. The co-integrated economic series tend to move together and to arrive an equilibrium level after some short run deviations.

For the scope of this study, if all spot, futures and options price series are individually non-stationary but after differencing of order 1, they form a stationary linear combination, then the series are said to be co-integrated. BIST-30 index and the price of its associated futures and options contracts move through time, each roughly following a random walk. Testing the hypothesis that there is a statistically significant connection between the spot and derivatives markets could now be done by testing for the existence of a co-integrated combination of the series. This technique is applied to discover the temporal lead/lag relation among spot index, index futures and index options market in Turkey because it helps to differentiate between short run and long run deviations from equilibrium providing information on price discovery, lead/lag relation and market efficiency.

Co-integration is introduced by Granger (1981) and Engle & Granger (1987) extension of this procedure, and followed by a multivariate co-integration technique known as the Johansen (1988) approach.

4.3. TESTING FOR CO-INTEGRATION

The co-movements of BIST-30 index spot, futures and options prices have been investigated before testing whether the spot and futures prices are co-integrated. Each series is tested for the stationary property of using the unit root test. The results for the ADF test for unit root indicate that the series are I(1). Since the condition of the same order of integration is met, the next step is to examine the existence of long-run relationship among the price series. The Engle–Granger (EG) two-step procedure and the Johansen co- integration tests are described in this chapter.

4.3.1. The Johansen Co-integration Test

Unlike EG (1987), Johansen (1988) is a multivariate approach with n variables all integrated of same order. Since this method has multivariate components, the long run model is in form of Vector Autoregressive (VAR) Model as:

$$X_t = \beta_0 + \sum_{i=1}^{k} \beta_i X_{t-i} + v_t \quad (4.13)$$

where X_t is the vector of differenced forms of futures, options and spot prices, β_0 is the intercept vector and v_t is the error term. Differently from EG (1987), in this approach long run behavior of more than two variables can be investigated.

Steps of estimating Johansen's (1988) Co-integration:

Step 1: As in Engle & Granger (1987) case, at the beginning of the study, stationarity conditions of the components must be investigated. All respective price series should be integrated of order 1 and differenced series are stationary which is analyzed via ADF test. If the necessary condition is satisfied, suitable ECM of (4.13) is constructed by model (4.15).

Step 2: Re-parameterization of (5.13) results in the below ECM:

$$\Delta X_t = \beta_0 + \sum_{j=1}^{k-1} \tau_j \Delta X_{t-j} + \pi X_{t-k} + \varepsilon_t \quad (4.14)$$

where $\tau_j = \sum_{p-1}^{j} \beta - I$ is short-run adjustment and $\pi = -(I - \sum_{m-1}^{k} \beta_m)$ is long-run response matrix. Mathematical equations, of Johansen ECM in (4.14) can be written to test for the existence of any long-run relation among the variables F_t, S_t and O_t, such as:

$$\Delta S_t = \beta_S + \sum_{i=1}^{k-1} \beta_{1s,i} \Delta S_{t-i} + \sum_{i=1}^{k-1} \beta_{1f,j} \Delta F_{t-j} + \sum_{i=1}^{k-1} \beta_{1f,j} \Delta O_{t-j} + \theta_S \hat{u}_{t-1} + \theta_F \hat{u}_{t-1} + \theta_O \hat{u}_{t-1} + v_{s,t} \quad (4.15)$$

$$\Delta F_t = \beta_f + \sum_{i=1}^{k-1} \beta_{2s,i} \Delta F_{t-i} + \sum_{i=1}^{k-1} \beta_{2f,j} \Delta S_{t-j} + \sum_{i=1}^{k-1} \beta_{2f,j} \Delta O_{t-j} + \theta_F \hat{u}_{t-1} + \theta_S \hat{u}_{t-1} + \theta_O \hat{u}_{t-1} + v_{f,t} \quad (4.16)$$

$$\Delta O_t = \beta_f + \sum_{i=1}^{k-1} \beta_{2s,i} \Delta O_{t-i} + \sum_{i=1}^{k-1} \beta_{2f,j} \Delta S_{t-j} + \sum_{i=1}^{k-1} \beta_{2f,j} \Delta F_{t-j} + \theta_O \hat{u}_{t-1} + \theta_S \hat{u}_{t-1} + \theta_F \hat{u}_{t-1} + v_{O,t} \quad (4.17)$$

In equation 4.15, Spot (S_t) price series is the dependent variable, in equation 4.16, Futures (F_t) price series is the dependent variable, and in equation 4.17, Options (O_t) price series is the dependent variable.

Step 3: In this step of the Johansen's strategy, the lag length is specified. Select the correct lag length, k, of the vector autoregressive (VAR) model. Model selection criteria as the Akaike information criterion (AIC) or the Schwarz Bayesian Information Criterion (SBIC) may be used. Thus, the lag length k in equations (4.15) and (4.16) is specified by Akaike information criterion (AIC) in this study.

Step 4: In this approach, two tests of co-integration relation are performed, namely, trace test and highest eigenvalues test. Null hypothesis of both tests indicates that there are at most r co-integration vectors. The test of co-integration conducted on the rank of π matrix through its eigenvalues. The rank r is important since it determines the number of co-integrated vectors. Let n denote the number of variables of X matrix. If r = n, then we say all the variables in X are stationary. If r = 0, there are no stationary linear combinations of components of X. When $0<r<n$, there exist r co-integration vectors. In empirical analysis, it is expected to identify 1 co-integration vector to be able to prove co-integration. Since X_t composes of three vectors one is futures prices F_t, one is option prices O_t and the other is spot market prices S_t, n is equal to 3. If r = 3, spot, futures and options prices will be stationary thus it is not sensible to work on co-integration. If r = 0, co-integration relation cannot be constructed since no such linear combination is found which is stationary. However, when r = 1, there exists one co-integration vector.

For this study, expectation is to find 1 or 2 co-integration vector making this method available for investigating lead/lag pattern. After confirming 1 or 2 co-integration vectors, VEC models can be constructed to come up with the lead/lag pattern.

4.4. GRANGER CAUSALITY

Granger causality 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 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:

$$\Delta S_t = \mu + \sum_{i=1}^{p} \beta_i \, \Delta S_{t-i} + \sum_{j=1}^{p} \alpha_j \, \Delta F_{t-j} + \sum_{j=1}^{p} \gamma_j \, \Delta O_{t-j} + v_{s,t} \quad (4.18)$$

$$\Delta F_t = \mu + \sum_{i=1}^{p} \beta_i \, \Delta F_{t-i} + \sum_{j=1}^{p} \alpha_j \, \Delta S_{t-j} + \sum_{j=1}^{p} \gamma_j \, \Delta O_{t-j} + v_{f,t} \quad (4.19)$$

$$\Delta O_t = \mu + \sum_{i=1}^{p} \beta_i \, \Delta O_{t-i} + \sum_{j=1}^{p} \alpha_j \, \Delta S_{t-j} + \sum_{j=1}^{p} \gamma_j \, \Delta F_{t-j} + v_{O,t} \quad (4.20)$$

There are two null hypotheses for each model:

- Equation 4.18 testing H_0: Futures prices do not cause spot prices, H_{01}: Options prices do not cause spot prices;
- Equation 4.19 testing H_0: Option prices do not cause futures prices H_{01}: Spot prices do not cause futures prices;
- Equation 4.20 testing H_0: Futures prices do not cause option prices; H_{01}: Spot prices do not cause option prices.

Finally, there are variance decomposition analyses for respective three markets 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.

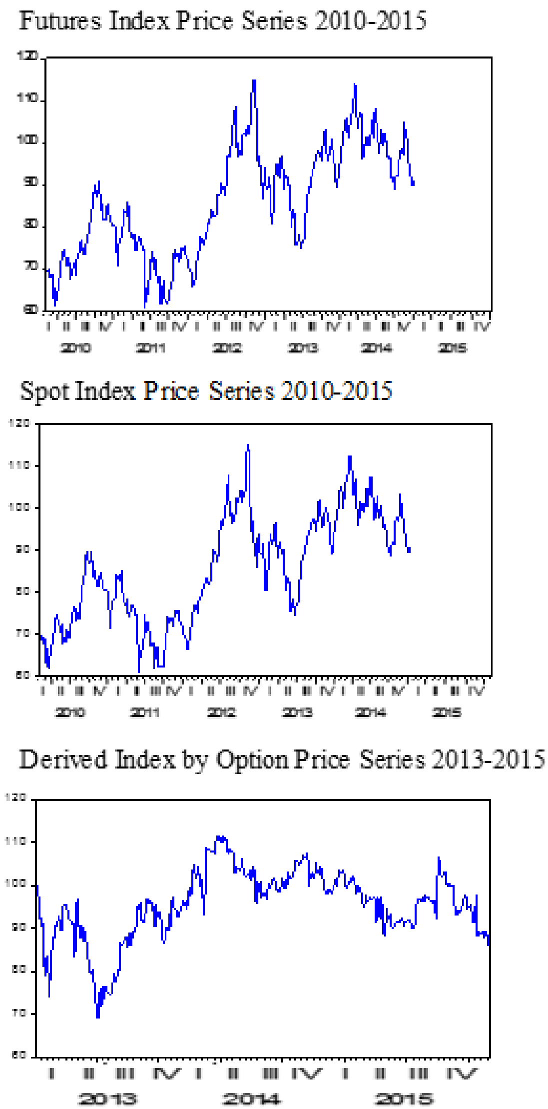
CHAPTER FIVE

EMPRICAL RESULTS

5.1. UNIT ROOT TEST – AUGMENTED DICKEY FULLER TEST

Figure 5.1 visualize the raw price series and they seem to be non-stationary. Although non-stationarity is obvious by visual inspection, a statistical test is needed to say that the prices are non-stationary. ADF test is performed in the E-views statistical software.

Figure 5.1: Yearly Movements of Price Series



The hypotheses are as below and Table 5.1 Summarizes the unit root test result for each price series.

H_0 = Price series is not stationary; there is a unit root.

H_1 = Price series is stationary; there is not a unit root.

Table 5.1: Unit Root Tests Results

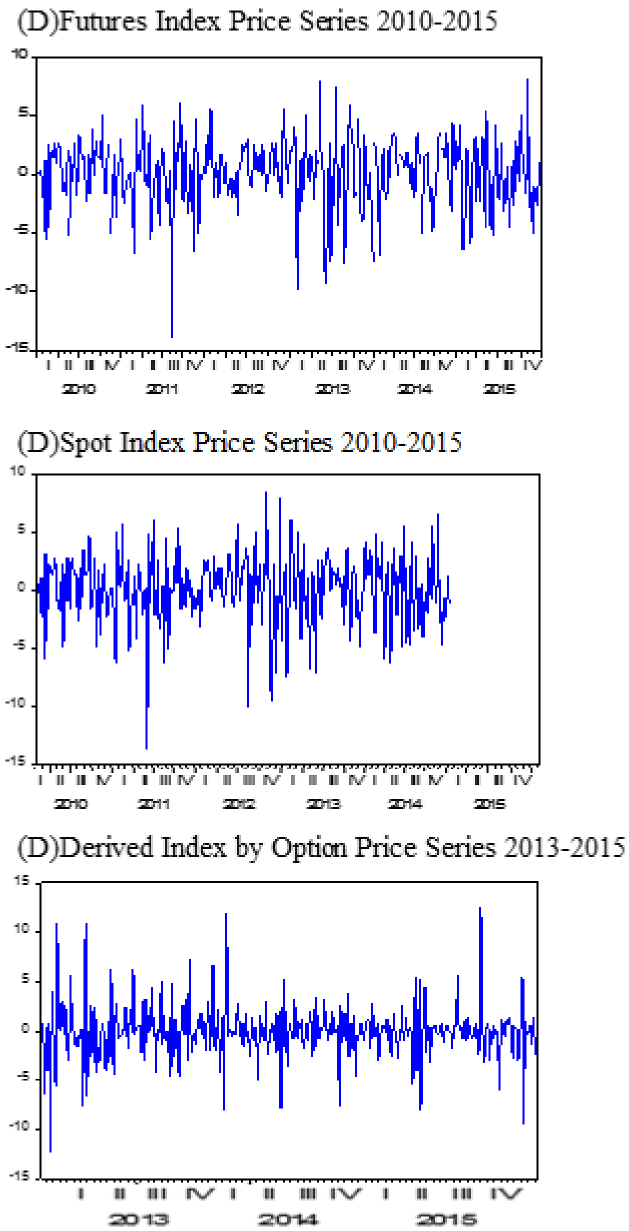
	ADF	
	t-Statistic	**Probability**
Futures Index Prices	-2.218666	0.2001
Spot Index Prices	-2.228330	0.1967
İmplied Index Prices by Options	-2.107064	0.2421

Since the probability values are greater than the 0.05; H_0 is accepted so there is a unit root. In order to make the series stationary, the series differenced once. After differencing once, the series becomes stationary where the p value less than 0.05 as below table. Table 5.2 shows the unit root test results and Figure 5.2 shows the movements of price series after differencing once.

Table 5.2: 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

Figure 5.2: Yearly Movements of Differenced Price Series



Since unit root tests shows that futures, options and spot price series are stationary, co-integration tests are ready to be performed. These tests will show if there is at least one-way causality relation between variables.

5.2. JOHANSEN CO-INTEGRATION TEST

5.2.1. Johansen Co-integration Test for Futures and Options for the Period between 2013 and 2015

In co-integration analysis, we use weekly data of futures and options for the period between 2013 and 2015. The designation of the lag length is an important point in error correction model. In our model the lag length is determined as 1, which is shown on below Table 5.3. As the information criterion, the minimum of Akaike and Schwarz information criteria is chosen.

Table 5.3: Lag Order Selection Criteria for Co-integration between Futures and Options

Lag	LogL	LR	FPE	AIC
0	-749.8212	NA	117.4728	10.44196
1	-743.2803	12.80928*	113.4008*	10.40667*
2	-741.0502	4.305212	116.2281	10.43125
3	-740.0111	1.977163	121.1193	10.47238
4	-736.3929	6.784150	121.7843	10.47768
5	-733.7633	4.857482	124.1580	10.49671
6	-730.9961	5.034848	126.3513	10.51383

Then, the series are tested through trace and maximum eigenvalue statistics to decide if series have a long run relationship. The hypotheses are:

Ho: There is no co-integration between variables.

H1: There is co-integration between variables.

Results of these tests are summarized below in Table 5.4:

Table 5.4: Johansen Co-integration Method Results for Futures and Options (2013-2015)

Test	Null	Alternative	Eigenvalue	Test Stat.	Critical Value	p-value
Trace	r = 0	r ≤ 1	0.436752	151.6137	12.32090	0.0001
	r ≤ 1	r = 2	0.362615	66.65637	4.129906	0.0001
Max-eigenvalue	r = 0	r ≤ 1	0.436752	84.95728	11.22480	0.0001
	r ≤ 1	r = 2	0.362615	66.65637	4.129906	0.0001

Since the probability values are 0.0001 and less than 0.05, and there are at least 2 co-integration vectors making this method available for investigating lead/lag pattern. H_o is rejected and it can be said that there is co-integration between futures and options prices; as a result, the series have a long-run equilibrium level.

5.2.2. Johansen Co-integration Test for Spot and Options for the Period between 2013 and 2015

In co-integration analysis, we use weekly data of spot and options for the period between 2013 and 2015. Table 5.5 shows the lag length is chosen as 1 and the most meaningful information criterion is Akaike.

Table 5.5: Lag Order Selection Criteria for Co-integration between Spot and Options

Lag	LogL	LR	FPE	AIC
0	-749.2694	NA	116.5761	10.43430
1	-743.0547	12.17055*	113.0460*	10.40354*
2	-740.5408	4.853263	115.4086	10.42418
3	-739.8178	1.375705	120.7945	10.46969
4	-735.8303	7.476414	120.8365	10.46987
5	-733.5270	4.254717	123.7512	10.49343
6	-730.2465	5.968740	125.0427	10.50342

Results for co-integration between spot and futures are summarized below in Table 5.6.

Table 5.6: Johansen Co-integration Method Results for Spot and Options (2013-2015)

Test	Null	Alternative	Eigenvalue	Test Stat.	Critical Value	p-value
Trace	r = 0	r ≤ 1	0.436490	154.8106	12.32090	0.0001
	r ≤ 1	r = 2	0.376526	69.92232	4.129906	0.0001
Max-eigenvalue	r = 0	r ≤ 1	0.436752	84.88829	11.22480	0.0001
	r ≤ 1	r = 2	0.362615	69.92232	4.129906	0.0001

Since the probability values are 0.0001 and less than 0.05, H_o is rejected and it can be said that there at least 2 co-integration vector between spot and options prices.

5.2.3. Johansen Co-integration Test for Spot and Futures for the Period between 2010 and 2015

In this co-integration analysis, we use weekly data of spot and futures for the period between 2010 and 2015. Table 5.7 shows the lag length is chosen as 6 and the most meaningful information criterion is Akaike.

Table 5.7: Lag Order Selection Criteria for Co-integration between Spot and Futures

Lag	LogL	LR	FPE	AIC
0	-1894.768	NA	1503.885	12.99156
1	-1472.034	836.7824	85.43575	10.12352
2	-1449.331	44.62777	75.16379	9.995417
3	-1354.080	185.9341	40.23262	9.370414
4	-1325.803	54.81148	34.06995	9.204131
5	-1301.886	46.03262	29.72618	9.067711
6	-1296.163	10.93702*	29.37874*	9.055908*
7	-1295.418	1.413221	30.04300	9.078203
8	-1294.018	2.636376	30.58540	9.096013

Results for co-integration between spot and futures are summarized below in Table 5.8.

Table 5.8: Johansen Co-integration Method Results for Spot and Futures (2010-2015)

Test	Null	Alternative	Eigenvalue	Test Stat.	Critical Value	p-value
Trace	r = 0	r ≤ 1	0.425452	162.9821	12.32090	0.0001
	r ≤ 1	r = 2	0.000188	0.055392	4.129906	0.8470
Max-eigenvalue	r = 0	r ≤ 1	0.425452	162.9267	11.22480	0.0001
	r ≤ 1	r = 2	0.000188	0.055392	4.129906	0.8470

Since the probability value is 0.0001 and less than 0.05, H_o is rejected and it can be said that there is one co-integration vector between spot and futures prices. Alternative p-value is 0.8470 and greater than 0.05 so we have at most one co-integration vector between these time series.

After this stage, the direction of causality is being analyzed.

5.3. GRANGER CAUSALITY TEST

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. In this test, we use daily data for spot, futures and options for the period between 2013 and 2015.

Table 5.9 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 5.9: Probability of Wald Test

		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 that means options price and spot price 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 that means futures prices and spot prices do not 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.

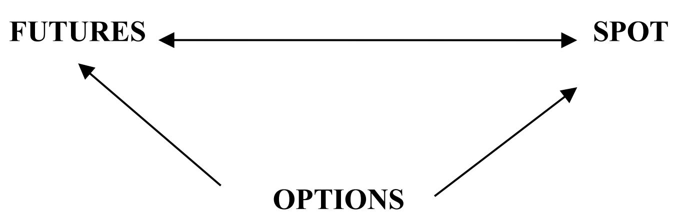
H_{01}: Options prices do not granger cause spot prices,

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 that means futures prices and options prices granger cause spot prices.

In order to clarify the relationship, the figure 5.3 summarizes the directions of relations among price series.

Figure 5.3: Granger Causality Tests – Directions of Relations



In conclusion, 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.

As a result, any change in options market would lead a change in futures and spot markets.

5.4. VARIANCE DECOMPOSITION ANALYSIS

Table 5.10 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 5.10: 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 5.11 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 table concludes that there is almost no effect from other markets to options market which is consistent with the result of granger causality test.

Table 5.11: 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 5.12 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 5.12: 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

CONCLUSION

The aim of this thesis is to investigate the long and 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. Therefore, in this study, first we employ Johansen co-integration test to investigate the long-run relationship between futures and spot market over the period January 2010 through December 2015 by using weekly data. However, since options market was introduced in April 2013 to Turkish derivatives market, we test the co-integration between option and futures and between options and spot market over the period beginning from April 2013 to December 2015 by using weekly data. Then 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 2013 through December 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.

Our empirical results state that, futures, options and the spot prices of BIST 30 index are co-integrated indicating a long-run relation among these markets. Our co-integration test results are consistent with the studies of Kasman and Kasman (2008), Kapuzolu and Taşdemir (2010) and Çağlı and Mandacı (2013) indicating that the markets are efficient in the long run. Our results are consistent with the efficient market theory.

On the other hand, 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 as financial instruments were 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 options contract prices 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 stock 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 lead spots. Thus, we conclude that the three markets are linked informationally, enabling arbitrage opportunities. Our short-term relationship analysis results are not consistent with 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 both long-run and 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 both the short and long 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, we cannot use it in our analysis. Since, we observe much more missing data with short-intervals. Additionally, further studies may employ more advanced co-integration methods including the structural breaks.

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