An Empirical Analysis of the Cost-of-Carry Model and Istanbul Stock Exchange Futures Contract

Erdem Öncü

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Approval of the Institute of Graduate Studies and Research

Prof. Dr. Elvan Yılmaz
Director

I certify that this thesis satisfies the requirements as a thesis for the degree of Master of Science in Banking and Finance.

Assoc. Prof. Dr. Salih Katırcıoğlu
Chair, Department of Banking and Finance

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Banking and Finance.

Assoc. Prof. Dr. Salih Katırcıoğlu
Supervisor

Examining Committee

1. Prof. Dr. Cahit Adaoğlu _____

2. Assoc. Prof. Dr. Eralp Bektaş _____

3. Assoc. Prof. Dr. Salih Katırcıoğlu _____

ABSTRACT

The aim is to examine the cost-of-carry model in pricing a futures contract. The research is conducted on ‘‘ISE-30 futures’’. Unit Root (ADF, PP and KPSS), Johansen Cointegration, Vector Error Correction Model and Granger causality tests are used for the analysis. This paper determines that all variables are non-stationary at level but transform to stationary at their first differences. The results of Johansen Cointegration test show that there are cointegrating relationships between variables and there are long run concerns among future prices and its predictor variables. The Error Correction Model clarifies that cost of carry and spot prices contribute to futures long term equilibrium level by 26% speed of adjustment every day which is converged by futures prices’ short run values. Finally, Granger causality tests identify that there is unidirectional causality running from spot prices to futures prices which indicating that spot price changes encourage futures price changes.

Keywords: ISE-30 Futures, Cost-of-carry Model, Ise National-30 Index

Öz

Bu çalışmanın amacı, taşıma maliyeti modelinin vadeli işlem sözleşmesi fiyatlandırmasını araştırmaktır. Çalışma IMKB-30 vadeli işlem sözleşmesi üzerine yapılmıştır. Birim Kök (ADF, PP and KPSS) testleri, Johansen Eşbütünleşme testi, Vektör Hata Düzeltme Modeli ve Granger nedensellik testi analizlerde kulanılmıştır. Bu çalışma gösteriyor ki, tüm değişkenler durağan olmayan bir halden fark alma yöntemi ile durağan hale gelmiştir. Johansen Eşbütünleşme testi sonuçlarına göre, değişkenler arasında eşbütünleşme ilişkisi vardır ve uzun dönemli ilişki vadeli fiyatlar ve vadeli fiyatları açıklayıcı değişkenler arasında görülmektedir. Vektör Hata Düzeltme Modeli açıklamasına göre, Vadeli fiyatlar, Spot fiyatlar ve Taşıma maliyetinin etkisiyle uzun dönem denge değerlerine %26 hızla ulaşmaktadır. Son olarak, Granger nedensellik test açıklar ki, Spot fiyatlardan Vadeli fiyatlara doğru tek yönlü bir nedensellik vardır bu demek oluyor ki, Spot fiyatlardaki değişim Vadeli fiyatlardaki değişimi olumlu yönde etkiler.

Anahtar Kelimeler: IMKB-30 vadeli sözleşmeleri, Taşıma maliyeti modeli, IMKB-30 Endeksi

To my family

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LIST OF ABBREVIATIONS

ADF test	Augmented Dickey-Fuller test
AIC	Akaike Information Criteria
GAFTA	Grain And Feed Trade Association
KPSS test	Kwiatkowski–Phillips–Schmidt–Shin
PP test	Phillips-Perron test
SIC	Schwartz Information Criterion
TEOS	Turkdex Exchange Operations System
TurkDex	Turkish Derivatives Exchange
VECM	Vector Error Correction Model

Chapter 1

INTRODUCTION

1.1 Background

Notion of risk management has resulted from the rampant changes in the interest rates, especially in the rates of exchange, which have been following since the 1970s as consequence of the exchange of the Bretton Woods System based on the pegged exchange rate regime with the fluctuating exchange rate. According to Richter and Sheble (2007), nowadays, many financial market participants try to reduce their risk with low cost. This happening leads to increasing in demand for investment and risk management. Futures constitute major part of risk management. Futures Market is the one which have surfaced as a consequence of the need for risk management. Futures Markets are those which have significant functions in the integration with the developed international markets. First, futures market started to operation in the United States in 1982 than financial futures markets were quickly introduced in countries outside the United States.

Today, futures trading play considerable role in the global financial system. Futures markets transference of risk function and price discovery function help people to make more safety, lucrative and efficient investment decisions. Trading in futures markets bring some advantages over trading spot markets. Also futures contracts ensure risk transfer and hedging risks. Fund managers prefer to use futures actively in order to achieve an optimal combination of risk.

Since the beginning of United States stock index futures in 1982, mutual effect of stock market spot price and stock market future price have been scope of investigation. Cost-of-Carry model is a norm model of futures pricing. It describes the relationship between the future price and the current cash price of an asset. Literature consist many studies which analyzes the relationship among stock spot price of stock market and stock market future price from different perspectives.

According to Thongtip (2010), four basic assumptions can explain cost-of-carry model extremely well. First one is market should be perfect. Perfect market involves no transaction cost, taxes and no constraint on short sales. Second one is there is no limitation on lending or borrowing at the same risk. Third one is costless storage. Assets do not depreciate with storage and can be stored costless. The last one is the risk free rate should be certain.

Thongtip (2010) supported that arbitrage is major problem of cost-of-carry model and the equation is quitely reflected by arbitrage transactions. Cost-of-carry model is only valid without arbitrage. Arbitrage can be defined as synchronous buy and sale of an asset for earning profit from a difference in the price. The model cost-of-carry defines the arbitrage free price of derivative contracts. It creates sustainable replicating position of derivative contract in the spot markets and keeping this replication position over the life of the derivative contract. Thongthip (2010) states that price changes must constitute a trend in the other price for holding prices in orientation with the model of Cost-of-carry.

Costs of carry model assume that market is perfect and arbitrage is not viable. But, in the real world we can face some mispricing opportunities. According to Sutcliffe

(2007), empirical findings of Japanese, Canadian, USA, Dutch, British, Hong Kong, Finnish and Australia index futures proved the proof of arbitrage opportunities and countries like Germany and Switzerland haven't got any arbitrage opportunities.

1.2 The Turkish Case

In Turkey, Turkdex futures were started on February 2005. Due to time constriction, TurkDex futures had rare quantities of researches. Bilgin (2011) states that theoretically, Turkdex futures arbitrage consequences demonstrate that significant arbitrage profit is possible for nearly all market participants in the years 2005 and 2006, in which trading quantity is lower and price disequilibrium is strong, however, in the years 2007, 2008 and 2009, trading quantity increases, price disequilibrium declines and professional institutions who face lower trading costs can get benefit from arbitrage.

1.3 Aim and Importance of the Study

This study aims to examine the model of cost-of-carry for determining ISE-30 futures contract. We will see that there are many models to estimate pricing in futures contract. In this study, we will test efficiency of the cost-of-carry model for determining Ise-30 futures contract. This study will answer this question: Is cost-of-carry hypothesis valid for ISE-30 futures? In order to answer this question, I will undertake; Unit Root (ADF, PP and KPSS) tests, Granger Causality test, Engle-Granger Cointegration test and Error Correction model. In the end, we will find short term and long term relationship between spot and future prices, validity of cost-of-carry model for ISE-30 futures. The investigation is conduct on ''ISE-30 futures''. The reason behind preferring ISE-30 futures is that the ISE-30 is index of 30 highly capitalized and actively traded stocks of the Istanbul Stock Exchange, accounting for

70 percent of Turkey's market volume. Furthermore, only ISE-30 futures are executed in United States Futures Market from ISE futures.

1.4 Structure of the Research

This research contains six chapters. First chapter involves exhaustive information about futures and cost-of-carry model. Chapter two presents theoretical and empirical literature. Chapter three contains detailed data about investment background of Turkey. Data and methodology of econometric analysis is devoted in chapter four. Econometrics results are introduced in fifth chapter. In the end, chapter six concludes the findings.

Chapter 2

THEORETICAL CONSIDERATIONS AND EMPIRICAL STUDIES

2.1 Theoretical Considerations

Kolb and Overdahl (2007) found that future value affiliates on the spot value of a good and the cost of stocking the underlying commodities from the present to the futures contract's end of the maturity date. It can be expressed in the following equation.

$$F_t = S_t (1+C_t) \quad (1)$$

In equation (1), C_t is the cost of carrying commodity from present to the delivery date of the futures contract, F_t is the futures price and S_t is the spot price at time t.

Amin and Jarrow (1991) used framework of the Heath et al. (1992) and undertook a study on creating general framework to price contingent claims on foreign currencies. Brenner and Kroner (1995) worked on futures markets and find that stochastic interest rates and asset prices are connected to marking-to-market term. Also, they took the natural logarithm of model of Heath et al. (1992) and found linear relationship between the logarithms of the spot price, future price and differential.

Helmer and Longstaff (1991) improve a closed-form general equilibrium model of stock index future prices in a continuous-time economy touched by stochastic interest rates and market volatility. Their model ignores the taxes and the transaction

costs as well as other market defects. Therefore, Hsu and Wang (2004) studied incomplete arbitrage mechanism under imperfect market. The model can be expressed as:

$$F(S,\ t)\ =\ (St - Dt)e^{u_a^1(\mathrm{T-t})}\ ,$$

$$\text{where} \qquad u_a^1 = [u_p - u\tfrac{\sigma p}{\sigma}] / (1 - \tfrac{\sigma p}{\sigma})\ .$$

Where Ft and St are the futures and spot price respectively; u_a^1 is the value expectancy coefficient; μp and μ are permanent yield of the stock index, the instruments involving of the underlying stocks and futures contracts changes a $\sigma p = 0$ and completely hedged portfolio.

2.2 Empirical Studies

There are many studies that have been done in this area but big parts of them are established on advanced markets like the U.S. Limited studies have been done in other markets. Kawaller et al. (1987) examined intraday price concerns among the futures contract of S&P 500 and the index of S&P 500 and revealed that the futures price changes guide the cash market by among twenty and forty-five minutes. Their findings show that when volatile index infrequently impressed futures over one minute, futures price changes led index movement from 20 to 45 minutes. Brenner and Kroner (1995) states that co-integration among futures and cash prices affiliate the time-series characteristic of cost of carry. Crowder and Phengpis (2005) carried on studies of Brenner and Kroner (1995). He finds that futures and cash prices are co-integrated and there is stable cointegrating relationship among cost of carry yields and three month Treasury bill rate.

Hemler and Longstaff (1991) studied futures contract of NYSE from 1982 to 1987. Their main conclusion is that stock index future prices are concerned to market volatility. Also, they argue that cost of carry model results is weaker than general equilibrium. General equilibrium model assume that all prices are walking around the market equilibrium point. However, some studies have contradicted results. For example, Yu Lu (2011) studied the relationship among the spot market and futures market of Hong Kong during the sample period January 2nd 2007 through February 26th 2010. He found that cost of carry model better than general equilibrium and expectation models.

Wang (2007) tried to develop the cost-of-carry model during the sample period from 1997 to 2005. His consequences clarify that identifying the degree of market defects plays major role when selecting a pricing model to estimate the theoretical values of stock index futures. Hsu and Wang (2006) compared the cost of carry model and other developed models. Their data comprise 1998 to 2004. Their main finding is that cost of carry model has weaker performance than Hemler and Longstaff model and the Hsu–Wang model. Later, Wang (2009) carried on Hsu and Wang (2006) research. He found that cost of carry model provide weaker performance than Hemler and Longstaff model and the Hsu–Wang model. But, the model of cost of carry provides sufficient performance in the Nikkei 225 futures market.

Sequeira and McAleer (2000) investigated cost of carry model and they run unit root and cointegration tests. Results of tests provide considerable contribution for pricing of Australian dollar futures contracts. Also, Jackline and Deo (2011) examined the relationship between the futures market and spot market of S&P CNX Nifty during

the sample period January 2003 through September 2010. Their findings show that price discovery was reached first in the spot market and the futures price series had a better speed of adjustment to the previous deviations.

We can see that traders rarely invest on futures in the emerging markets. Modern example, Lucian (2008) studied on lead-lag relationship Romanian cash market and futures market. According to him, short selling stock is not allowed in the Romanian cash market. At the same time, usage of arbitrage or hedging is significantly low.

In case of ISE 30 futures, Zeynel (2008) investigates the relationship between ISE 30 futures and ISE 30 spot prices and hedge ratios. The daily data covers the period from January 2005 to December 2007. She found that hedging with futures provides substantial advantage in Turkish market. Also, Bilgin (2011) studied on arbitrage between the ISE-30 stock index contract of TURKDEX and underlying ISE-30 stock index. He concludes that significant arbitrage is available for nearly all market participants in years 2005 and 2006.

Chapter 3

INVESMENT ENVIRONMENT IN TURKEY

3.1 The Turkish Economy in General

Turkey have started structural adjustment program in 1980. Most important element of this program is financial liberalization. In other words, globalization of financial system was crucial for development of Turkey. Financial liberalization program designed to solve turkey's internal and external disequilibrium problems. Firstly, liberalization period started with determination of foreign exchange rates which were liberalized and quota and licensing system was abolished. In 1994, banking and currency crisis started in Thailand and Mexico. Turkey lived effects of crisis very sharply. Central Bank of Turkey lost half of its international reserves and interest rate raised to three digit levels. Custom union agreement was signed in December 1995 to expand trade, proximity between Turkey and Europe. In August 1999, Turkey was hit by big earthquake that hit also economy. Turkey saw devastating face of crisis and established BRSA (Banking Regulation and Supervision Agency) in order to approach the task of auditing the sector in single hand.

Most of accounting rules are changed and sector becomes more profitable. Also, Turkey enrolled the IMF programs in 2001 and Economic growth was revived Now, Turkey's dynamic economy has complex mix of contemporary industry and commerce. Banking, transport and communication sectors are playing major role in rapidly growing private sector of Turkey. Main advantages of Turkey are high

growth and stable economy, young aged population, geographical benefits and structural reforms. Istanbul is largest city in the Middle East and Balkans. Recently, Istanbul is becoming significant actor in the global economy. EU picked Istanbul for "European Capital of Culture 2010". Now, Turkey is member of many international organizations these are; the International Chamber of Commerce (ICC), D-8, Council of Europe, World Trade Organizations (WTO), Economic Cooperation Organization (ECO), the United Nations Conference on Trade and Development (UNCTAD), the Organization of the Black Sea Economic Cooperation (BSEC), the World Customs 8 Organization (WCO). Economic power and military power make Turkey important country in Eastern Europe and Asia.

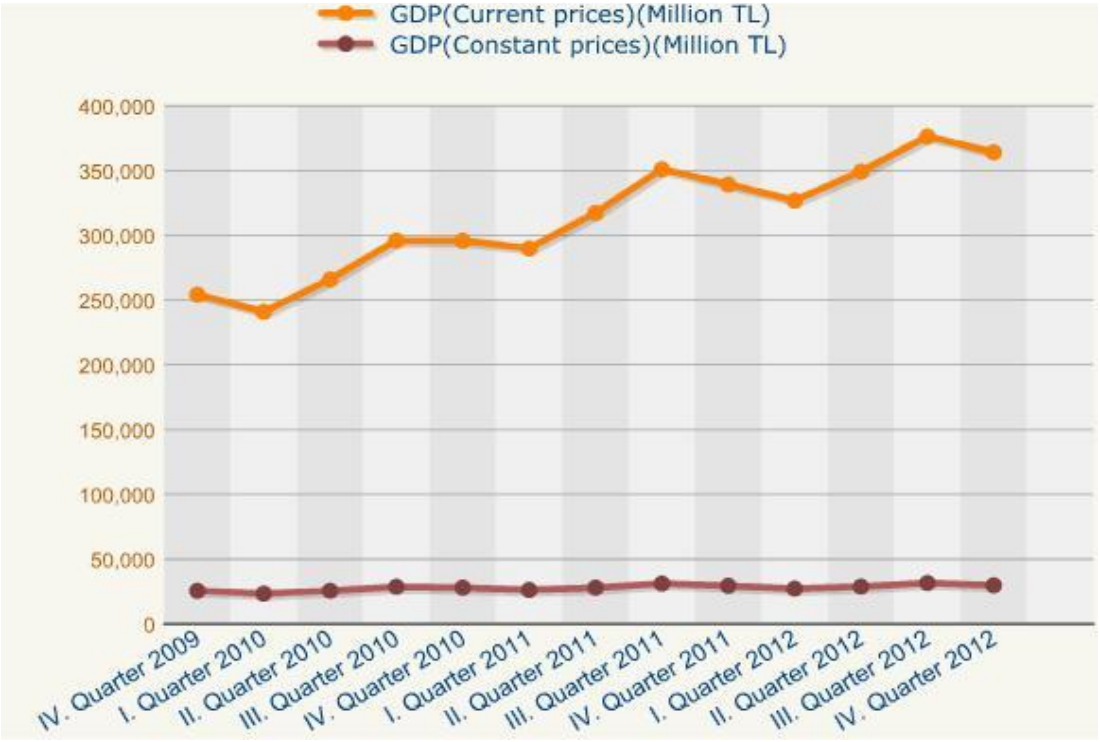

Figure 3.1 GDP: (Current prices) (Million TL) and GDP (Constant prices) (Million TL)
Source: TURKSTAT (2013)

Turkey enjoyed adequate economic performance between IV. quarter 2009 and IV. quarter 2012 with 44 percent of GDP (Current prices) growth. In 2012 Turkey's GDP was $ 794,468 million, which shows that Turkey's GDP is increasing rapidly. According to Anadolu Agency (2013) Turkey stands at rank 2 with its economic growth rate following Estonia in the Euro zone. Turkish economy has expanded since final quarter of 2009 despite the global economic crisis. When we compare Turkey gdp growth rate and countries of Euro zone gdp growth rates, Turkey's gdp growth rates was higher than most of the developing and developed European countries since final quarter of 2009. Recent findings show that Turkey is reached elites of Europe Countries.

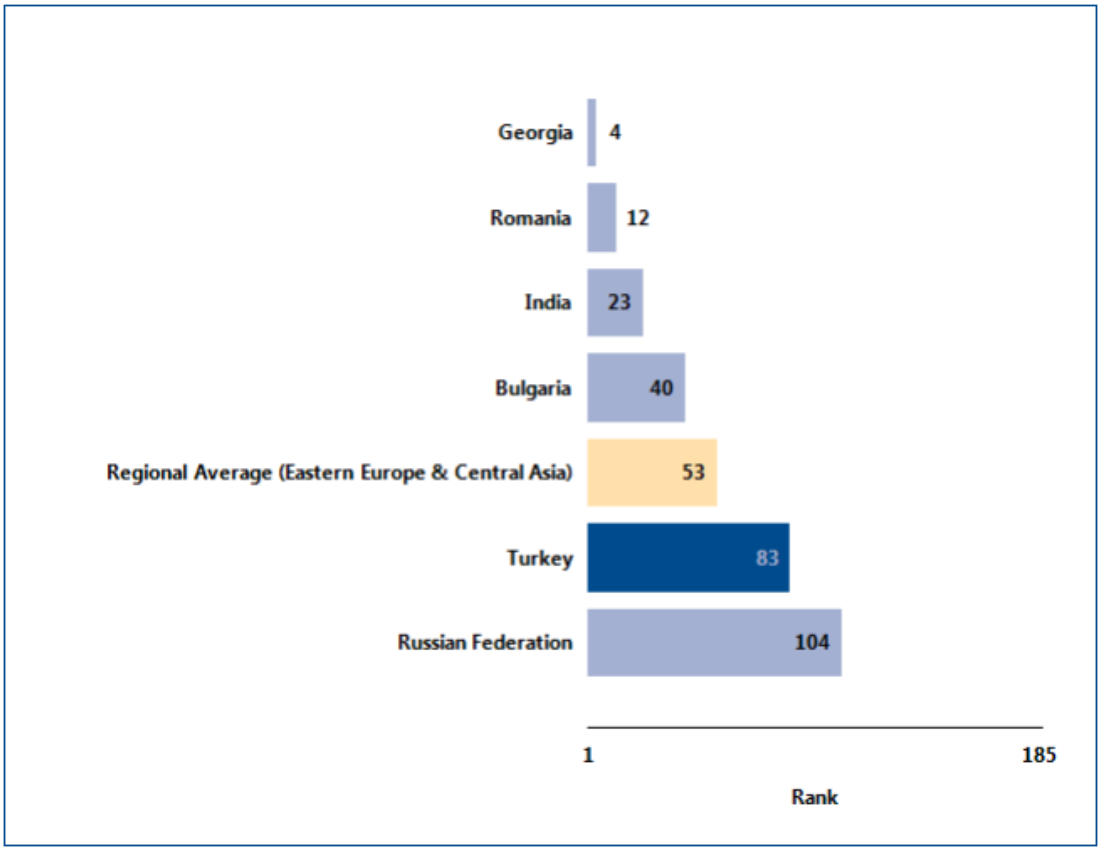

Figure 3.2: How Turkey and comparator economies rank on ease of getting credit
Source: Doing Business (2013)

According to Doing Business report 2011 Turkey has improved ease of getting credit with new law and it was ranked as 65. Now, Turkey stays at 83 in the ranking of 185 economies rank on ease of getting credit (figure 3.2). We can see that reforms of financial development of Turkey have decelerated since 2011.

3.2 Major Factors of Foreign Entity in Turkey

Pull and push factors are playing major role for investing. From Turkey point of view, i will examine pull and push factors. Many advantage of Turkish financial system lures foreign participants. Pull factors can be classified with 4 groups. First one is economic indicators. Population increases, per capital income, interest rates and inflation rates are all symbolize value of economic indicators. Second one is ‘’Reform’’ policies. EU accession process started 2005 and results make the foreign investors satisfied. Third one is development of system. After the crises, Turkey decides to change system, many reforms applied and exchange rate system is changed. The last one is product differentiation. In Turkey, Banks have large variety of products and it attracts foreign customers. Modern example, National bank of Greece bought Finansbank because of Finansbank car credits.

Liberalization of financial sector has limitation. Such as low profit margin, low variety product, political diseases deters foreign participants. Moreover, regulatory restrictions at home also affect foreign participation ratio. Main push factor in Turkey is political diseases. There have been 59 different governments in the 83-year history of Turkish Republic and it shows high political risk. Positive environment of sector can be change suddenly with political shock which it is very familiar situation for Turkey. We also consider public confidence to push factor. In my opinion, one of decent push factor is religion. All Christian based countries have excessive

Christians. Clearly, we can say more than %2 percent of world heavily reject invest at Muslim countries. But, many investor support the idea of money is the wise man's religion.

Rather than pull or push factors, other countries are also being important factor. Since 20 years, many rules have been occupied the place of free investment. Organizations like WTO, agreements like GAFTA break the rules. Now people can invest foreign countries freely. The growth rates in the developed countries have been very poor during last 10 years. For example, average growing rate of EU banking sector %1 in last 10 years. Turkey also offers high profit margin with low risk of default. In this regard, Turkey is one of the best alternatives for foreign entrepreneurs. But, still Turkey has foreign debt problem. More than half GNP of Turkey is foreign debt and most of it long term.

3.3 Turkish Derivatives Exchange (TurkDex)

In 1989, first studies were started for establishing futures market. In these studies, agricultural products play major role. Then, studies carried on project of Turkey capital market modernization in 1991. In the end, futures part of Turkey capital market modernization failed. In 1995, second attempts were started for establishing future market. In 1997, Istanbul Gold Exchange started to operate gold futures. In 2001, Istanbul Stock Exchange started to operate currency future contracts. In 2005, rights for operating futures transferred to TurkDex.

TurkDex is "the Turkish Derivatives Exchange" which began to operate in İzmir on February 4, 2005 with 34 members. It offers financial and commodity instruments. Its main priority is to improve and provide derivatives to help traders, hedgers,

speculators and investors to decrease their risks actively. TurkDex is a private corporation and shareholders of TurkDex well-known institutions of Turkey. Major shareholders of Turkdex are The Union of Chambers and Commodity Exchanges of Turkey (25%), Istanbul Stock Exchange (18%) and Izmir Mercantile Exchange (17%). Exchange may unilaterally close all or some part of open positions in case of war, natural disaster, government intervention to the prices and similar cases. Takasbank undertake all clearing actions. Takasbank behaves like to buyer to every seller, and the seller to every buyer. Takasbank guarantees settlement of transactions and behaves as central counterparty. But the guarantee is limited and equal to the size of the guarantee fund.

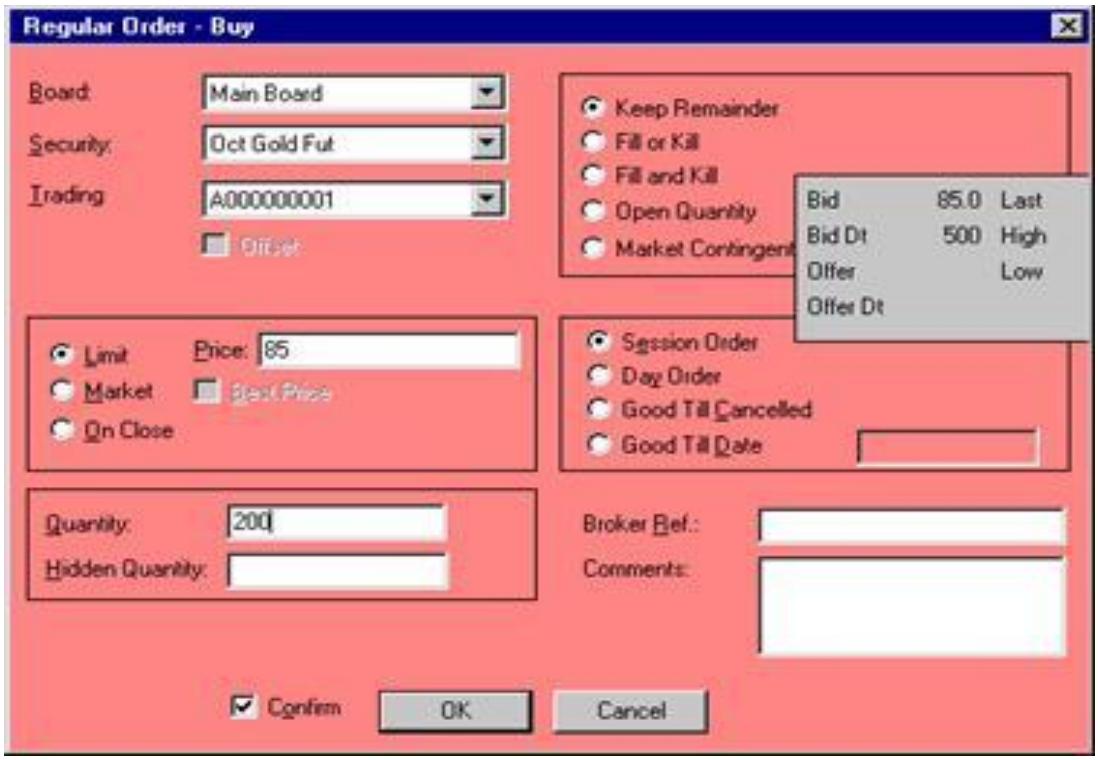

Illustration 1.1: TEOS Order Menu
Source: Vadeli Opsiyonlar Borsası (Turkish Derivatives Exchange) (2013)

TurkDex uses computer software program for executions. Program name is TEOS. TEOS subsystems are electronic trading and matching system, market reporting and monitoring system, margin verification and risk calculation system and security administration system. TEOS is a structure that involves an electronic order matching system and remotely accessible network. Database, Trading Engine and Trader Workplace are main parts of TEOS. Database contains information and parameters and reports. Order matching and managing risks can be done in Trading Engine. Trader Workplace provides connection between clients and Trading Engine. The software contains requirements of Turkish financial system and Turkdex.

Most popular contracts in 2005 and 2006 were currency futures contracts and ISE-30 futures contracts were most popular contracts in 2007, 2008 and 2009.TurkDEX is one of the world fastest developing derivatives exchange. Today, major derivatives exchanges contain TurkDex. TurkDEX future contracts are in transparent platform and very liquid. The most liquid financial instrument of Turkish capital markets is the ISE-30 equity index futures. Trading daily average value is about 1.2 billion USD. TurkDEX collateralized 732 million USD in April 2011 for managing risk. It adjusted margin levels regularly.

Turkdex ISE-30 futures total trading value is given as Fig 3.3. As can be seen in Figure 3.3, ISE-30 futures have positive trend until 2011 and we can see little decrease in 2011. In this thesis, study is conducted on ‘‘ISE-30 futures’’. ISE-30 is index of 30 highly capitalized and actively traded stocks of the Istanbul Stock Exchange, accounting for 70 percent of Turkey’s market volume.

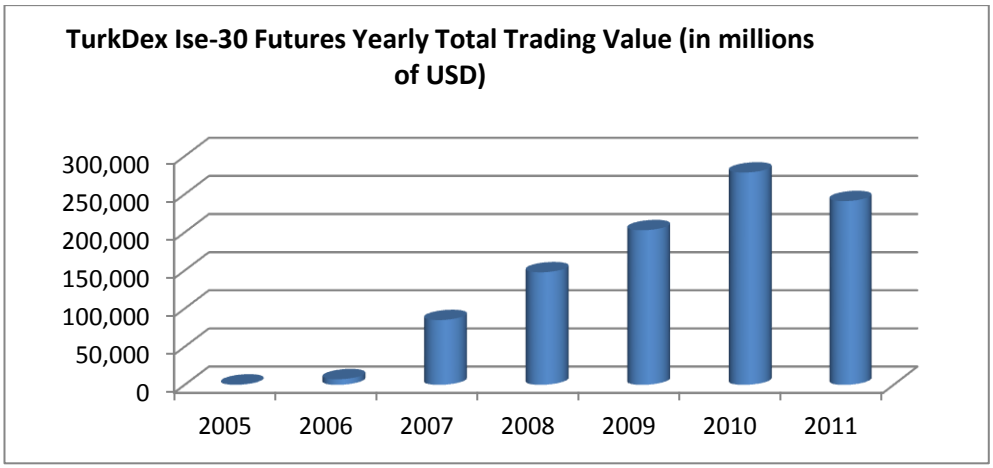

Figure 3.3: Total Trading Value of ISE-30 Futures (in millions of USD)
Source: TurkDex (2011)

Furthermore, only ISE-30 futures are executed in United States Futures Market from ISE futures. From ISE-30 point of view, foreign investors have not any regulatory restrictions and tax duty. All types of investors are lured by the small contract size of ISE-30 futures (about 4.000 USD).

Chapter 4

DATA AND METHODOLOGY

4.1 Data

ISE-30 is index of 30 highly capitalized and actively traded stocks of the Istanbul Stock Exchange. The Ise-30 futures traded at the Turkish Derivatives Exchange (TurkDex). Daily data used in this study and have been taken from archives of TurkDex, Istanbul Stock Exchange and Central Bank of the Republic of Turkey (2013). The data contains eighteen Ise-30 futures series from the 1th of January 2010 to the 31th of December 2012. Also, risk free interest rate is used to find out a cost of carry. In this study, overnight repo rates (repurchase rate) are used as risk free rates.

4.2 Methodology

In this study, five models of analysis were derived. First, the Augmented Dickey-Fuller (ADF), Philips-Perron (PP) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests were undertaken. Second, Johansen co integration test was employed to test long run relationship between spot prices and futures prices. Lastly, Granger Causality tests were undertaken to specify direction of causality among the variables.

4.2.1 Empirical Model

Since the beginning of stock index futures in the United States in 1982, there are many studies in the finance literature have attempted to clarify the specifications of

future pricing. Cost of carry model describes the relationship between the future price and the current spot price of an asset.

$$F_t = F(S_t,\ C_t) \tag{1}$$

In this equation, futures price (F_t) is the function of cost of carry (C_t) and spot price (S_t).

$$F_{t,T} = S_t.e^{(r_f - r_d).\tau + q_{t,T}} \tag{2}$$

Ft refers future price, St refers spot price, rf represents risk free rate, rd is dividend yield and $q_{t,T}$ refers marking to market feature. We can describe cost carry model econometrically with the following equation (Tharavanij, 2012):

$$F_{t,T} = \beta_1.St + \beta_2 (r_f .\ \tau) + \beta_3.\tau + \alpha + \varepsilon_t \tag{3}$$

According to Tharavanij (2012), the model can enforce several limitations. These are: α= q and β_1=1, β_2=1, β_3= -rd when rd and qt, τ are approximately fixed.

4.2.2 Unit Root Tests

In economy, many variables are non-stationary. The presence and form of non-stationary have detected by unit root tests. Why do we need to test for non-stationary? Because, we need to know series are stationary before the estimating economic model and making co integration test. According to Gujarati (2003), Dickey – Fuller test does not work when u_t are correlated. Therefore, Dickey and Fuller developed Augmented-Dickey Fuller (ADF). Augmented-Dickey Fuller (ADF) test is well known and it is valid in large samples. ADF test showed in the following model.

$$\Delta y_t = a_0 + \lambda y_{t-1} + a_2 t + \sum_{i=2}^{p} \beta_j \Delta y_{t-i-1} + \in_t \quad (4)$$

Katırcıoglu et al (2007) found that where y is the series; t = time (trend factor); α = constant term (drift); ε_t = Gaussian white noise and p = the lag order. Akaike Information Criteria (AIC) chose the number of lags "p" in the dependent variable to ensure that the errors are white noise. The alternative hypothesis (H_1) clarifies that the series is stationary whereby the null hypothesis (H_0) represents that series is non-stationary. Philips-Perron test is used to test the null hypothesis in the time series analysis. The Philips-Perron t-statistic computed as

$$t_{pp} = \frac{\gamma_0^{\frac{1}{2}} t_b}{\omega} - \frac{(\omega^2 - \gamma_0) T s_b}{2\omega\hat{\sigma}} \quad (5)$$

In this equation α is the standard error of the test regression and t_b, t_{sb} is the t-statistic and standard error of β. Main advantage of Philips-Perron test is that Philips-Perron tests are robust to unspecified autocorrelation and general forms of heteroscedasticity in the error term u_t. Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests are used to test null hypothesis and observe time series is stationary around a deterministic trend. The KPSS test statistic of the null level stationary is:

$$KPSS = \frac{1}{\hat{\sigma}_u^2 T} \sum_{t=1}^{n} s_t^2, \quad (6)$$

where $S_t = \sum_{j=0}^{t} u_j$ and u_t is the residual regression of a regression Y_t. The KPSS is most commonly used stationary test.

4.2.3 Co-integration Tests

According to Gujarati (2003), co-integration clarifies longrun equilibrium relationship between series. For example, separately, logarithmic domestic production and logarithmic domestic consumption are not covariance stationary. But, they are stationary together that means they are cointegrated. Eagle-Granger two step method allows one cointegrating relationship. But, the Johansen test allows more than one cointegrating relationship.

Cheung and Lai (1993) found that the maximum eigen value test for cointegration is weaker than the trace test. Engle and Granger (1987) proposed the simple following two-step estimator. First step is determining static cointegrating relationship. Second step is estimating the error correction model. Katırcıoglu et al (2007) clarify that there are problems which stems from Engle and Granger (1987) procedure and Johansen (1988) test is the more reliable test to avoid problems. VAR model represented in the following equation:

$$X_t = \Pi_1 X_{t-1} + ... + \Pi_K X_{t-K} + \mu + e_t \qquad \textbf{(for } t=1, \ldots T\textbf{)} \qquad (7)$$

In this equation, X_t, X_{t-1}, ..., X_{t-K} are vectors of current and lagged values of P variables respectively which are known as $I(1)$ in the model; matrices of coefficients with (PXP) dimensions are $\Pi_1, ..., \Pi_K$; μ is an intercept vector[1]; and e_t is a vector of random errors (Katırcıoglu et., 2007). The assumption established the number of lagged variables that error terms are not auto correlated. The number of co-integrating relationship(s) (i.e. r) which is determined by testing whether its Eigen values (λi) are different from zero is showed by the rank of Π. According to Katırcıoglu et al (2007), using the Eigen values of Π ordered from the largest to the smallest is for computation of trace statistics[2] that is proposed by Johansen (1988)

and Johansen and Juselius (1990). Trace statistic *(λtrace)* is computed by the following formula[3]:

$\lambda_{trace} = -T\sum Ln(1-\lambda_i)$, *i = r+1, …, n-1* and the null hypotheses are : (8)

H0: r = 0 H1: r ≥ 1

H0: r ≤ 1 H1: r ≥ 2

H0: r ≤ 2 H1: r ≥ 3

4.2.4 Error Correction Model

Engle and Granger (1987) clarified that Granger representation theorem, states that the relationship between X and Y variables can be expressed as ECM (Error Correction Model) if X and Y variables are cointegrated. ECM model of cost of carry model is:

$$Z_t = \ln F_{t,T} - a_0 - a_1 \ln S_t - a_2 \tau - a_{3,Q} \sum_{Q=1}^{3} D_Q \quad (9)$$

[1] μ is a vector of *I(0)* series and represent dummy variables. This ensures that errors *et* are white noise.
[2] Asymptotic critical values of Osterwald-Lenum (1992) are used in this study.
[3] Firstly, we test the null hypothesis that there are not any co-integrating relationships. The alternative hypothesis (i.e. $s \leq 1, \ldots, s \leq n$) are to be tested sequentially if null hypothesis is rejected,. Cannot be rejected in the first place if s=0, it clarifies that independent variables and dependent variable haven't any cointegrating relationship.

In the above mentioned model, Zt is the deviation from long run equilibrium. Thongtip (2010) conclude that if Z_t=0, the futures and spot prices are called to be in long equilibrium.

4.2.5 Granger Causality Test

Clive Granger won Nobel Prize in Economics with Granger Causality test. The Granger Causality test is identifying that one time series is useful in forecasting another or not. Granger Causality tests need a Vector Error Correction Mechanism (VECM) if there is cointegration relationship (Katırcıoglu et al., 2007). Cost of carry model Vector Error Correction Mechanism (VECM) can be shown as:

$$\Delta \ln F_{t,T} = a_1 + y_{Ft-1} + \sum_{i=1}^{h_1} \alpha_{11,i} \Delta \ln F_{t-i,T} + \sum_{j=2}^{h2} \alpha_{12,j} \Delta \ln S_{t-j} + \varepsilon_{1,t} \quad (10)$$

$$\Delta \ln F_{t,T} = \alpha_1 + y_{Ft-1} + \sum_{i=1}^{h_1} \alpha_{21,i} \Delta \ln F_{t-i,T} + \sum_{j=2}^{h2} \alpha_{22,j} \Delta \ln S_{t-j} + \varepsilon_{2,t} \quad (11)$$

Thongtip (2010) mention that using the Engle-Granger methodology or Johansen methodology on cost of carry model expressed the ($F_{T,t}$) and (S_t) series are co-integrated of order (1).

Chapter 5

ECONOMETRIC RESULTS

5.1 Unit Root Test for Stationarity

Augmented-Dickey Fuller (ADF), Philips-Perron, Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests are used to test stationary of variables. All tests are mentioned in chapter 4. Tests have been executed at level and first difference which can be seen in Table 5.1.

According to result of ADF, PP, KPSS tests, these tests have estimated different conclusions. KPSS test is robust than other tests. Therefore, we should accept consequences of KPSS test. KPSS test clarifies that all variables are non-stationary at level but become stationary at their first differences. Empirical model is explained in the chapter 4 which is supported by consequences of tests. Tables 5.1 express the consequences of ADF, PP, KPSS tests.

Table 5.1: ADF, PP and KPSS tests for Unit Root

Statistics (Level)	ln Spot price	lag	ln Future price	lag	Cost of carry	lag
τ_T (ADF)	-1.58	(0)	-1.6	(0)	-7.1*	(0)
τ_μ (ADF)	-1.36	(0)	-1.38	(0)	-7.1*	(0)
τ (ADF)	0.85	(0)	0.82	(0)	-3.61*	(1)
τ_T (PP)	-1.55	(8)	-1.64	(5)	-7.27*	(9)
τ_μ (PP)	-1.34	(8)	-1.43	(5)	-7.27*	(9)
τ (PP)	0.89	(10)	0.83	(7)	-3.8*	(1)
τ_T (KPSS)	0.34***	(22)	0.34***	(22)	0.144**	(20)
τ_μ (KPSS)	0.40**	(22)	0.41**	(22)	0.137	(20)
Statistics (Level)	Δln Spot price	lag	Δln Future price	lag	ΔCost of carry	lag
τ_T (ADF)	-27.73*	(0)	-27.05*	(0)	-17.58*	(2)
τ_μ (ADF)	-27.73*	(0)	-27.05*	(0)	-17.59*	(2)
τ (ADF)	-27.72*	(0)	-27.04*	(0)	-17.60*	(2)
τ_T (PP)	-27.75*	(10)	-27.05*	(8)	-30.58*	(10)
τ_μ (PP)	-27.74*	(9)	-27.05*	(8)	-30.60*	(10)
τ (PP)	-27.73*	(9)	-27.04*	(7)	-30.62*	(10)
τ_T (KPSS)	0.10	(10)	0.094	(8)	0.013	(10)
τ_μ (KPSS)	0.13	(10)	0.12	(7)	0.013	(10)

Note:

Spot price represents spot price of ISE-30 index; Future price is the future prices of ISE-30 index futures; Cost of carry represents the cost of carry underlying asset to maturity ($r_f.\tau$). All of the series are at their natural logarithms. T represents the most general model with a drift and trend; $\tau\mu$ is the model with a drift and without trend; τ is the most restricted model without a drift and trend. Numbers in brackets are lag lengths used in ADF test (as determined by AIC set to maximum 3) to remove serial correlation in the residuals. When using PP test, numbers in brackets represent Newey-West Bandwith (as determined by Bartlett-Kernel). In the case of KPSS test, numbers in parantheses represent Newey-West Bandwith (Bartlett-Kernel). Both in ADF and PP tests, unit root tests were performed from the most general to the least specific model by eliminating trend and intercept across the models (See Enders, 1995:254-255). *, ** and *** denote rejection of the null hypothesis at the 1 percent, 5 percent and 10 percent levels respectively. Tests for unit roots have been carried out in E-VIEWS 6.0.

5.2 Co-integration Analysis

Unit roots test showed us all variables are stationary at first difference. That means we can not use ordinary regression. We have to examine Johansen co-integration test. Non-stationary variables which are integrated in the same order are main requirement of Johansen Co-integration test (Katırcıoglu, 2009). I have to emphasize that spot price, future price and cost of carry were found as integrated of order I (1).

There are three hypotheses in the consequences of Johansen Co-integration test. The alternative hypothesis (H_1) clarifies that the number cointegrating vectors are less than one or equal to one whereby the null hypothesis (H_0) represents that there are no co-integrating vectors between the variables. And the last one is that there are co-integrating vectors are at most two.

Johansen Co-integration test results showed us alternative hypothesis (H_1) trace statistic is greater than critical value at alpha 5 percent and 1 percent. It means that there are cointegrating relationships between variables and there are long run relationship between future prices and its explanatory variables. Table 5.2 shows the Johansen Co-integration results.

Table 5.2: Johansen Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.113201	140.1988	29.68	35.65
At most 1 **	0.065154	51.41762	15.41	20.04
At most 2	0.002201	1.628559	3.76	6.65

Note:
Trace test indicates 2 cointegrating equation(s) at both 5% and 1% levels
*(**) denotes rejection of the hypothesis at the 5%(1%) level

5.3 Level Equations and Error Correction Model Estimation

Co-integration results prove that ISE-30 index spot and future prices move together in the long run. Now, we will estimate long term coefficients in the $F_t = F(S_t, C_t)$

model and ECM (Error Correction Model) for estimating short term coefficients and ECT (Error Correction Term).

Futures prices, Spot prices and Cost of carry short term coefficients are not statistically significant at all α levels. ECT is 26%, negative and statistically significant at α=0.1.

Consequences show that Spot prices and Cost of carry contribute futures long term equilibrium level by 26% speed of adjustment every day which is converged by Futures prices short run values.

When Spot prices increase by 1%, Futures prices decreases by 1.013% in long term and it is statistically significant. Moreover, when cost of carry increase by 1%, Futures prices decreases by 0.0006% in long term and it is not statistically significant.

Table 5.3: Error Correction Model

Cointegrating Eq:	CointEq1
LNFUTURE(-1)	1
LNSPOT(-1)	-1.013768 -0.00482 [-210.494]
COSTOFCARRY(-1)	-0.00064 (0.00072) [-0.89430]
C	0.153111

Table 5.3: Error Correction Model (Continued)

Error Correction:	D (LNFUTURE)
CointEq1	-0.26233 (0.12457) [-2.10581]
D(LNFUTURE(-1))	0.135742 (0.14064) [0.96520]
D(LNSPOT(-1))	-0.136256 (0.14172) [-0.96141]
D(COSTOFCARRY(-1))	0.002253 (0.00156) [1.44088]
C	0.000469 -0.00058 [0.81256]
R-squared	0.009227
Adj. R-squared	0.003828
Sum sq. resids	0.18039
S.E. equation	0.015677
F-statistic	1.709001
Log likelihood	2024.879
Akaike AIC	-5.466521
Schwarz SC	-5.435362
Mean dependent	0.000462
S.D. dependent	0.015707

5.4 Granger Causality Test

After we proved cointegrating relationship between variables we should test Granger Causality to understand direction of causality between the variables. In other words, we should look at one time series is useful in forecasting another or not. If there is cointegrating relationship, Granger Causality test require a VECM (Enders, 1995).

Granger Causality Test results show that there is unidirectional causality running from Spot prices to Futures prices. It means that Spot price changes encourage Futures prices changes. Moreover, there is single causality running from Futures prices to Spot prices. Furthermore, there is bi-directional causality observed among Cost-of-carry to all.

Table 5.4: Granger Causality Tests under Block Exogeneity Approach

Dependent variable: LNFUTURE

Excluded	Chi-sq	df	Prob
LNSPOT	3.198	1	0.073
COST-OF-CARRY	0.148	1	0.7
ALL	3.244	2	0.197

Dependent variable: LNSPOT

Excluded	Chi-sq	df	Prob
LNFUTURE	3.034	1	0.073
COST-OF-CARRY	0.011	1	0.913
ALL	3.096	2	0.212

Dependent variable: COST-OF-CARRY

Excluded	Chi-sq	df	Prob
LNSPOT	0.67	1	0.413
LNFUTURE	0.464	1	0.495
ALL	7.783	2	0.02

Chapter 6

CONCLUSION AND POLICY IMPLICATIONS

6.1 Conclusion

Since the beginning of stock index futures in the United States in 1982, futures pricing become more crucial. Cost-of-Carry model is a norm model of futures pricing. Cost-of-carry model determines the relationship between the future price and the current spot price of an asset. This research has investigated the cost-of-carry model in pricing futures contract. The research is conduct on ‘‘ISE-30 futures’’. The reason behind preferring ISE-30 futures is that only ISE-30 futures are executed in United States Futures Market from ISE futures. This study examined the cost-of-carry model in pricing‘‘ISE-30 futures’’. This study clarified that our model can explain ISE-30 futures. Also, this research finds that short term coefficients of Futures prices, Spot prices and Cost of carry are not statistically significant. Following our sample data between 1th of January 2010 to the 31th of December 2012, Ise-30 index spot prices and futures prices move together in the long run. Spot prices and Cost of carry subscribe to futures long term equilibrium level by 26% speed of adjustment every day which is converged by Futures prices short run values. Cost-of-carry and Spot prices affects to futures not significant because of low r-square rate. Granger causality tests have determined that single causality runs from Spot prices to Futures prices which mean that the Spot price changes encourage the Futures prices changes.

6.2 Implications

Investing in futures is not appropriate for all investors, and compromises the risk of loss. Futures are cheap substitutes for cash markets and futures price is not easily determined. Investors should observe the market principles and economic mechanics for determining price of futures. There are many models for pricing futures. This study has proved the cost of carry model can explain futures pricing. Ise-30 futures are used in this research. Foreign market participants constitute 70% of investors' share of TurkDex Ise-30 Futures. Political stability is very crucial for luring foreign participants. There have been 59 different governments in the 83-year history of Turkish Republic and it deters foreign investors. Another crucial point is tax approaches. There is no tax duty on gains resulted from transactions on TurkDex. It explains why the most of Ise-30 futures holders are foreign. Political stability and tax advantage should be sustainable for keeping foreign market participant at high levels. In the end, this study has found lower r-square rate. Therefore, developed models like Helmler-Longstaff or Hsu-Wang model can be applied for future Ise-30 researches.

REFERENCES

Amin, K., and Jarrow, R. (1991). Pricing foreign currency options under stochastic interest rates, *Journal of International Money and Finance, 10*(3), 310-329.

Anadolu Agency, (2013), http://www.aa.com.tr/en (May, 2013)

Bilgin, U. (2011). Vadeli İşlem Piyasalarında Arbitraj ve Vadeli İşlem ve Opsiyon Borsası (VOB) İçin Bir Araştırma, Master Thesis, Ankara University, Ankara, Turkey.

Brenner, R. J., and Kroner, K. F. (1995). Arbitrage, Cointegration, and Testing the Unbiasedness Hypothesis in Financial Markets. *Journal of Financial and Quantitative Analysis*, 30(1), 23-42.

Cheung, Y., and Lai, K. (1993), A Fractional Cointegration Analysis of Purchasing Power Parity, *Journal of Business and Economic Statistics*, 102-112.

Crowder, W. J., and Phengpis, C. (2005). Stability of the S&P 500 Futures Market Efficiency Conditions. *Applied Financial Economics*, 15, 855-866.

Doing Business, (2013), http://www.doingbusiness.org/ (May, 2013)

Enders, W., (1995). *Applied Econometric Time Series*, John Wiley & Sons, Inc., U.S.A.

Engle, R.F., Granger, C.W.J. (1987), Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, 55 (2), 251-276.

Gujarati, D.N. (2003). *Basic Econometrics*. New York: McGraw Hill Book Co.

Heath, D., Jarrow, R., and Morton, A. (1992). Bond pricing and the term structure of interest rates: a new methodology for contingent claims valuation. *Econometrica*, 60(1), 77-105.

Hemler, M., and Longstaff, F. (1991). General Equilibrium Stock Index Futures Prices: Theory and Empirical Evidence. *Journal of Financial and Quantitative Analysis*, 26(3), 287-308.

Hsu, H., and Wang, J. (2004). Price Expectation and the Pricing of Stock Index Futures. *Review of Quantitative Finance and Accounting*, 23(2), 167-184.

Hsu, H., and Wang, J. (2006). Price Expectation and the Pricing of Stock Index Futures: Evidence from Developed and Emerging Markets. *Review of Pacific Basin Financial Markets and Policies*, 9(4), 639-660.

Jackline, S., Deo, M. (2011), Price Discovery in Indian Stock Market. *Asia Pacific Journal of Research in Business Management*, 2(1), 56-65.

Johansen, S. (1988). "Statistical analysis of cointegrated vectors", *Journal of Economic Dynamics and Control,* Vol. 12, pp.131–154

Johansen, S., & Juselius, K. (1990), "Maximum likelihood estimation and inference on cointegration: With an application to demand for money", *Oxford Bulletin of Economics and Statistics*, Vol.52, pp.169–210.

Katircioglu, S. (2009). Trade, Tourism and Growth: The Case of Cyprus, *Applied Economics*, 41 (21): 2741-50.

Katircioglu, S., Kahyalar, N. and Benar, H. (2007), Financial Development, Trade and Growth Triangle: The Case of India, *International Journal of Social Economics*, 34 (9): 586-598.

Kawaller, I., Koch, P., Koch, T., (1987). The Temporal Price Relationship between S&P 500 Futures and the S&P 500 Index. *Journal of Finance*, Vol. 42, pp. 1309-1329.

Kolb, R., and Overdahl, J. (2007). *Futures, Options, and Swaps*, United States: Blackwell Publishing.

Lu, Y., (2011), The Pricing of Stock Index Future, Master Thesis, Copenhagen Business School, Copenhagen, Denmark.

Richter, C., and Sheblé, G. (1998). Bidding strategies that minimize risk with options and futures contracts, in Proceedings of the 1998 American Power Conference, session 25, Open Access II-Power Marketing, paper C.

S. Thongthip (2010). Lead-Lag Relationship and Mispricing in SET50 Index Cash and Futures Markets, Master Thesis, Thammasat University, Bangkok, Thailand.

Sequeira, J., and McAleer, M. (2000). Testing the risk premium and cost-of-carry hypotheses for currency futures contracts. *Applied Financial Economics, 10*(3), 277-289.

Streche, Lucian (2008), Lead – Lag Relationship between the Romanian Cash Market and Futures Market, Working Paper. Bucharest University of Economics, Bucharest, Romania.

Sutcliffe, Charles (2007). Stock index futures, Ashgate Publishing Company.

Tharavanij, P., (2012), Empirical Test of the Cost-of-Carry Model: A Case of Thai Stock Index Futures Contract, *International Research Journal of Finance and Economics*, 101, 28-38.

Turkstat, (2013). http://www.turkstat.gov.tr (May, 2013).

Vadeli Opsiyonlar Borsası, (2013). http://www.vob.org.tr (May 2013)

Wang, J. (2007). Testing the General Equilibrium Model of Stock Index Futures: Evidence from the Asian Crisis. *International Research Journal of Finance and Economics* (10).

Wang, J. (2009). Stock Market Volatility and the Forecasting Performance of Stock Index Futures. *Journal of Forecasting*, *28*, 277-292.

Zeynel, E. (2008), Hedgıng Effectiveness Based on the Use of Index Contracts in the Futures Markets: Practices in Turkish Derivatives Exchange, Master Thesis, Süleyman Demirel Univesity, Isparta, Turkey.