Trakya Üniversitesi Sosyal Bilimler Dergisi
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CONTAGION EFFECTS OF THE CREDIT CRISIS IN FINANCIAL MARKETS OF THE UNITED STATES TO EMERGING COUNTRIES: AN EVIDENCE FROM TURKEY

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ABSTRACT

This study aims to analyze any probable contagion effects of fluctuations in the U.S. stock market on the financial markets of Turkey, namely stock, interest rate, and exchange rate markets. Furthermore, it is also aimed to investigate the intertemporal effects and the degree of these effects among the above-mentioned markets in Turkey. The empirical analysis takes into consideration the volatility changes which are initially observed in May 2006 and deepened in July 2007 in the U.S.A. Granger Causality tests and Vector Autoregressive (VAR) Model have been employed for determining the presence and the degree of the contagion effect. Significant relationships between the markets have been observed.

Key Words: *Contagion effect, U.S. credit crisis, emerging markets, Vector Autoregressive (VAR) Model.*

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Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

A.B.D. FİNANS PİYASALARINDAKİ KREDİ KRİZİNİN GELİŞMEKTE OLAN PİYASA EKONOMİLERİNE BULAŞMA ETKİSİ: TÜRKİYE ÜZERİNE BİR UYGULAMA

ÖZET

Bu çalışma ABD hisse senedi piyasalarındaki volatilitenin gelişmekte olan ekonomiler kategorisinde yer alan Türkiye'de hisse senedi, faiz ve döviz piyasaları üzerindeki olası bulaşma etkisini ve derecesini ve bu piyasaların kendi aralarındaki etkileşimlerini Granger Nedensellik testleri ve Vektör-Otoregresif Modeli (VAR) ile incelemektedir. Çalışmada A.B.D. finans piyasalarında Mayıs 2006'da ilk belirtilerini gösteren ve Temmuz 2007'den itibaren yaşanan finansal kriz öncesi ve kriz dönemleri ele alınmaktadır. Bulgular, piyasalar arasında anlamlı ilişkileri ortaya koymaktadır.

Anahtar Kelimeler: *Bulaşma etkisi, ABD kredi krizi, gelişmekte olan piyasalar, Vektör Otoregresif (VAR) Model*

1. INTRODUCTION

This paper examines the nature and extent of contagion effect of 2007 U.S. credit crisis stemming initially from the sub-prime mortgage crisis on the Turkish financial markets using evidence from movements in the Istanbul Stock Exchange Index, interest rates, and exchange rates.

During crises, investors and economists have often been concerned about the linkages between countries and financial markets, and the possibility that a crisis will spillover and lead to contagion with extreme volatility elsewhere in the world's financial markets. As it is known, the Turkish financial markets are closely linked to the American and European financial markets because of the high proportion of foreign participations. Therefore, it is expected that changes in prices and volatility would spill over from the U.S. markets to the Turkish financial system and contagion effects would be observed . In many academic studies, it is mentioned that volatility, as a risk factor, is tranmitted through time and different market locations.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

The main objective of this study is to investigate the interlinkages between three important financial market indicators of Turkey, namely, exchange rates, stock exchange indices and interest rates with the U.S. stock market volatility (the VIX Index) to determine any contagion effect of the U.S. credit crisis which emerged originally from the sub-prime mortgage market in 2007.[1]The study also aims to investigate the dynamics of the interlinkages between the financial market indicators of Turkey during the same period.

The paper is constituted as follows: Section 2 discusses crises in a theoretical framework. Section 3 summarizes the literature emerging mainly from the Asian countries due to the South-East Asia Crisis in 1997. Section 4 gives the data and methodology and finally Section 5 concludes.

2. THEORY

2.1. FINANCIAL CRISES

In the economic literature, *"crisis"* is defined as sharp fluctuations seen on the prices or quantities in goods, services, or foreign currency markets beyond acceptable changes (Kibritçioğlu, 2000). Most of the severe crises which arose in different economies and spread globally are defined as "*financial (economic) crises"*. Mishkin (2000) describes financial crises as a disruption to financial markets in which adverse selection and moral hazard problems become much worse, so that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities. Crises are actually financial system breakdowns with lack of confidence which result due to heavy sales of financial securities in capital markets with extreme pessimistic expectations, very sharp price declines in the markets, and bankruptcies in private sector companies. Financial crises appear with the speculative attacts of financial investors due to their expectations for country risks and become deep with continuous and heavy attacts. It is stated that all developing countries that are hit by financial crises generally go into recession (Frankel and Chair, 2001).

It is known that as the consequence of financial globalization and liberalization processes, flow of funds among countries have highly increased. As a result of the change with financial globalization, short term

[1] The original empirical analysis has been revised to update the data set which spans the period of April 1, 2004 and November 20, 2009.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

foreign portfolio investments have taken the place of foreign direct investments in 1980's and 1990's (Kibritçioğlu, 2000). It has to be pointed out that this financial process is actually the period when financial crises started. While crises find enviroment in economies with the effects of financial globalization and liberalization, they also influence other economies again with the help of these financial processes. Financial crises which resemble problems and imbalances in economies such as high levels of price variations and increases in the amount of sunk credits, have been widely experienced especially after 1990's[2] (Elitaş et. al., 2004).

It is observed that most of these crises have been seen especially in devoloping countries who have not formed strong enough economic framework, and thus have a high degree of financial vulnerability and face the threat of financial breakdowns due to unexpected and heavy outflow of speculative funds. Besides the infuence of financial globalization and liberalization (such as no barriers between national financial markets, widely open markets to foreign investors and free flow of all types of capital in developing economies), the main factors which create the above-mentioned enviroment and have an effect in the occurance of the crises are summarized in the literature, as weak macro-economic policies (public sector debt and increases in debt levels), exchange rate policies, increases in interest rates, lack of transparency in the public sector regulations, lack of transparency in the public sector relations with the private sector, weaknesses in private sector and savings deficits, negativities in the balance sheets of institutions/companies other than the finance sector due to declines in security prices, weaknesses in finance sector and lack of institutions and regulations, ethical problems in the banking sector (moral hazard), governments and IMF supporting the banking sector, lack of control for increases in credit volume, lack of transparency in data, crowding-effect of investors, effects of the speculators, similar risk perceptions for same-category economies in different geographies, developments in information technologies, and finally insufficiencies of international financial institutions in preventing and predicting crises, especially the slowness of the IMF[3] in

[2] ERM Crisis in the EU countries in 1992-1993, Crisis in Turkey in 1994, Tequila Crisis in Mexico in 1994-1995, South-East Asia Crisis in July - October 1997, Crisis in Russia in July – August 1998, Latin America (Brazil) Crisis in 1999, Crisis in Argentina in 2001 and finally crises in Turkey in November 2000 and February 2001.
[3] For critics about IMF, pls. see: Krueger (2002) and Mussa (2002).

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

functions such as international control, observation and support (TOBB, 2002; Akdiş, 2001; Demirci, 2005).

Getter et.al, (2007), Brunnermeier (2008), and Adrian and Shin (2008) provide detailed explanations for the severe financial crisis which started in 2007 in the U.S.A. These studies focus on the underlying reasons of the liquidity crunch in the U.S. financial markets and the domino effect of the contagion which resulted a widespread shock in prices of almost all assets in the U.S. and other financial markets.

2.2. FIRST AND SECOND GENERATION CRISES

The leading study for describing financial crises and their predictability was conducted by P. Krugman (1979). His paper was based on the study of Salant and Henderson (1978) and described "first generation" crises. His model concludes that currency crises arise due to inconsistancies between national economic policies and foreign currency system. The missing element in the first generation models is contagion effects.

The "second generation" models of currency crises focused on the existence of multiple equilibria as an explanation for currency crises, such that in currency crisis a movement from one equilibrium towards another "bad" equilibrium is observed Obstfeld (1986). The initial study for "second generation" crises was conducted by Obstfeld (1984 and 1996). The "second generation" models rely on the conclusion that currency crises arise due to sudden pessimistic expectations for the sustainability of macro-economic policies.The mutual interactions between expectations of market players and enviroment due to macro indicators create a self-fulfilling feature which results in financial crises (Hepşen and Gümrah, 2006).

While explaning many financial crises in the 1980's and 1990's, the insufficient explanotary power of "first" and "second generation" models for the Asia crisis in 1997 has led to the description of "third generation" models. It was striking that IMF had predictions for strong growth in the South-Asia countries and moreover, it was hard to find fundamental indicators proving the risks in 1997-1998 or the riskiness of these countries even after the crisis. Krugman (1998) and Sachs (1998) are considered as the leading studies for the "third generation" models which can explain crises in Latin America in 1994-1995 as well as crisis in South-Asia in 1997. These models, which especially emphasize the role of banking and finance sectors, conclude that banking and currency crises create a vicious circle by their

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

mutual effects. The models also explain the contagion feature of crises among countries (Hepşen and Gümrah, 2006).

2.3. THIRD GENERATION CRISIS AND CONTAGION EFFECT

In the past years, crises in one region have been followed by crises in countries that are geographically distant, have different economic structures and do not share significant economic links. Severe and continuing fluctuations in the financial system of a country or region ending up as a crisis and leading to a turmoil in the global financial system, have taken the attention of the academic enviroment from a different perspective (third generation models), in late 1990's and especially after 2000; and related literature focusing on the "spillover" and "contagion" effects of these crises to global financial markets has been constituted.

"Contagion" is defined as the herding behavior which occurs when expectations cause investors to simultaneously pullout of markets as a response to a shock that hits a perceived similar market. The expectations become self-fulfilling when the herding behavior causes a collapse of the market despite sound fundamentals (Tan, 1998) . Edwards (2000), asserts that contagion reflects a situation where the effect of an external shock is larger than expected; implying that contagion effects are different from normal transmissions of shocks across countries, also known as interdependencies (Sander and Kleimeier, 2003). While there is no consensus on the contagion phenomenon, Pericoli and Sbracia (2003) give five diferrent definitions as: 1- Contagion is a significant increase in the probability of a crisis in one country, conditional on a crisis occurring in another country. 2- Contagion occurs when volatility of asset prices spills over from the crisis country to other countries. 3- Contagion occurs when cross-country co-movements of asset prices cannot be explained by fundamentals. 4- Contagion is a significant increase in co-movements of prices and quantities across markets, conditional on a crisis occurring in one market or group of markets. 5- (Shift) contagion occurs when the transmission channel intensifies or, more generally, changes after a shock in one market.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

3. LITERATURE SURVEY

Most researchers studying the transmission of turmoil or crises to other countries believed in the economic sustainability of former countries' macroeconomic fundamentals, such as a prudent fiscal policy, low inflation rates, high domestic savings and investments, and finally sustainable balance of payments positions. On the other hand, the severity, deepness, spread and the speed of this spread together with geographical concern are all beyond the "fundamantals" phenomenon. Therefore, "contagion" became the keyword in empirical studies for crises in the emerging markets in 1992-1993, the Mexica (tequila hangover) in 1994, the Asia countries in 1997, and the Russia in 1998. Four major strategies have been employed in the literature to identify contagion: correlation of asset prices; conditional probability of currency crises; volatility changes; and co-movements of capital flows and rates of return (Sander and Kleimeier, 2003).

The East Asian crisis was a period of financial turmoil that started in July 1997 with the devaluation of the bath in Thailand and affected Asian currencies, stock markets, and asset prices. Asian countries attracted almost half of total capital inflow to emerging markets and were examples of how to conduct economic policy until 1997. The Asian crisis affected all East Asian countries and spread to other countries while becoming a global financial crisis (Mondria and Quintana-Domeque, 2007).

The 1997 Asian financial crisis has become an important focal point in most of the more recent studies on market interdependence and contagion effects among global markets. Therefore, most of the studies surveyed below mainly emerge from the Asian countries.

Jackson (1999) in his book entitled "Asian Contagion", pointed out that the five crisis countries in Asia all had the following five symptoms: (1) a sudden reverse on capital account; (2) fixed exchange rate; (3) overexpansion of domestic credit which led to inappropriate private investment; (4) an incomplete regulation and supervision system; (5) and incorrect economic and financial policies (Gong, Lee, and Chen, 2004).

Eichengreen, et al., (1996) examine a sample of twenty industrial countries for testing contagion effects during currency crises. They find that a speculative attack elsewhere in the world increases the probability of a currency crisis within the domestic economy; however, their test does not distinguish the propagation mechanism of the crisis. Frankel and Schmukler (1996) study the contagion effects of the Mexican crisis by using data on

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

country funds. They use net asset values (NAV) to capture the contagion effects arising from the self-fulfilling expectations of investors. By testing the Granger causality of the net asset values (NAV) and prices of closed-end country funds, they analyze the contagion from both intra and inter-regional perspectives. Their main finding is that the Mexican shocks affected Latin American NAVs directly, while the transmission to Asian NAVs passes through New York. They also find that shocks tend to have a greater effect on countries with weak fundamentals (Tan, 1998).

Tan (1998) studies the nature and extent of contagion during the Asian financial turmoil using movements in the national stock markets of Indonesia, Malaysia, Philippines, Singapore, Thailand, Hong Kong, Korea and Taiwan. He determines the extent of stock price movements in the crisis-affected countries on those of other countries. He also proves the difference in co-movements of stock prices before and after the crisis. The study confirms the contagion effect during the Asian crisis using a vector error correction model, and impulse response functions and variance decomposition of a daily VAR model.

The Mexican crisis and its effects on Latin American and Asian countries spawned empirical interests on the contagion effects in emerging markets. Prior to this, not much empirical work had been done to examine contagion in such markets (e.g., Doukas (1989), Hardouvelis, LaPorta and Wizman (1994)). Calvo and Reinhart (1996) examine the contagion effects of capital flows by analyzing the cross-country correlations among emerging market stock returns. They found that stock return correlations tended to be higher during the crisis period. Likewise, the application of principal components analysis also points to greater co-movement during the crisis period (Tan, 1998)[4].

Forbes and Rigobon (1999) tries to discriminate empirically between contagion and interdependencies by testing whether or not cross-market correlation increase statistically significantly in crises periods. For the 1994 Mexican crises, the 1997 Asian crises, and the 1987 US stock market crash, the authors have found only interdependencies, no contagion. For the EMS crisis, Favero and Giavazzi (2000) find evidence for contagion examining the the spreads between German short-term interest rates and the interest

[4] Pls. also see: Gerlach and Smets (1994), Huh and Kasa (1997), Goldfajn and Valdes (1995), Wolf (1996), Rogers (1994) Cashin, Kumar and McDermont (1995) for studies related with contagion for the Latin American and the Asian crises (Tan,1998).

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

rates of some other European countries effected by the crisis.

Chou, et al., (1999) analyze the price and volatility linkages of the Taiwan stock market with that of the USA by testing the hypothesis that the short-term volatility and price changes spill over from the developed markets, especially the US market. They use daily stock price indices of Taiwan and the USA for 1991-1994 and analyze three returns as close-to-open, open-to-close, and close-to-close by conducting univariate GARCH method. Their findings support volatility spillover effect from the US stock market to the Taiwan stock market especially with the model using close-to-open returns. The authors attribute the findings to the high level of international trade of Taiwan with the USA and increasing foreign participation in the Taiwan stock market.

Baig and Goldfajn (1999) perform cross-market correlations for exchange rates, stock market returns, interest rates, and sovereign bond spreads using the Forbes and Rigobon (1999) methodology for the financial markets of Thailand, Malaysia, Indonesia, Korea, and the Philippines (Asia-5 countries) during the crises. The sample period is between July 2 1997 and May 18 1998. They employ correlations and VAR methodology to examine the extent of comovement in the markets and to estimate the impulse responses to shocks in each of the currency and stock markets during the crises. They prove that there is evidence for the cross-border contagion in the currency and equity markets.

Sheng and Tu (2000) aim to analyze the linkages among national stock markets before and during the Asian financial crisis period. They examine whether there exist different degrees of linkages before and during the Asian financial crisis by employing Johansen (1988) multivariate cointegration and error-correction model to investigate the nature and extent to which national stock markets contribute to the crisis. process. They decompose the forecast error variance to show the proportion of the movements in one market due to its own shocks versus shocks from other markets. The multivariate cointegration and error-correction tests provide some evidence to support the existence of cointegrational relationships among the national stock indices during, but not before, the period of the financial crisis. The forecast error variance decomposition shows that the ‘degree of exogeneity’ for all indices has been reduced, implying that no countries are ‘exogenous’ to the financial crisis. Granger’s causality test suggests that the US market’s persisting dominant role still exists on all the Asian countries during the crisis period.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

Tuluca and Zwick (2001) analyze the comovement of returns from 13 Asian and non-Asian (USA, Canada, Mexico, Brazil, the United Kingdom) markets by using daily returns before and after the Asian crisis in 1997. They apply Granger-causality, factor analysis, and Box-M tests on 15-month intervals surrounding July 1997 to compare the pre-crisis and post-crisis intervals. They find seven-fold increase in bidirectional causality (an increase in the bilateral comovement of returns) for the post-crisis period which proves an increase in the general comovement of global equity returns after the crisis.

Chen, et al., (2003) perform analysis over the period of 1992 to 2002 to identify changing patterns in the inter-relation of the ASEAN[5] (Association of Southeast Asian Nations) members' stock markets before, during, and after the Asian crisis. The authors conduct Granger-causality and variance decomposition methods with the daily closing values of the stock exchange indices and conclude that there are comovements, causal relationships, responses to cross-market shocks, and long-run interdependence which put forward the intra-regional contagion effects of the crisis.

Sander and Kleimeier (2003) investigate changes in the existance and the directions of causality by applying Granger-causality method and VAR model on daily spreads of $ denominated sovereign bonds, as a measure of percieved country risk, for the Asian and Russian crises between December 19 1996 and March 16 2000 with four sub-periods. Results show evidence for new and changed causality patterns in Asian region. With the addition of the Russion crises, causality patterns have changed both on regional and global levels, showing the importance of global financial markets in regional and global financial contagion.

Pericoli and Sbracia (2003) provide a theoretical study to highlight the possible channels for transmission of financial shocks internationally. They give different measures of contagion and provide a theoretical multi-factor model for detecting channels by which crises propagate across countries.

Gong, et al., (2004) study the nature of crisis transmission and the channels by which the crisis in 1997 was transmitted among the Asian financial markets. The study estimates a VAR and an OLS models between

[5] The original five ASEAN members are Singapore, Malaysia, Indonesia, Thailand, and Philippines. The member countries are intra-regional trading partners with close regional economic cooperation (Chen, et al., 2003).

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

January 1990 and December 1998. They give a detailed literature survey and indicate that most of the studies show that the competitive devaluation effect (through a close trade relationship) and the crisis transmission effect were the two major channels through which the Asian financial crisis was transmitted. Macroeconomic fundamental factors did not really matter, as well as some other political factors (Gong, et al., 2004). Their empirical evidence shows that crises can be transmitted through a trade relationship, a transmission effect, and a cash-in (panics due to rapid outflow of international funds) effect. The authors, however, do not namely mention the crisis transmission as contagion in their papers.

In another research, Chung (2005) has analysed the impact of changes in Thai baht exchange rate on prices, trading activity and the liquidity of American Depository Receipts (ADR) and country funds trading on the NYSE and Nasqad during the period of the Asian financial crisis. He determined that there is a news transmission from the Asian markets to the ADRs and country fund markets. The other result of his investigation is about contagion effects of Thai baht on Asian ADR prices as well as Asian and Eastern Europen country fund prices. The results show a contagion effect from volatility in the Thai baht exchange rate to Assian ADRs and country funds. It is also mentioned in the article that an increase in the spread dimension of liquidity during times of high Thai baht exchange rate volatility. His empirical evidences based on SPDR also show that US market remained totaly insulated from the impact of Thai baht exchange information.

When the literature on contagion of crises is reviewed, only a few papers have investigated the relationship between developed and emerging markets[6]. Caporale, et. al., (2006) examine the international volatility transmission of the 1997 South East Asia financial crisis across emerging and developed stock markets, analyzing South East Asian, European, Japanese and US stock markets and working with daily stock indices for pre-1997 and post-1997 periods. They find that, prior to the crisis, there were bidirectional volatility spillovers between the South East Asian, European, Japanese and US stock markets. In the post-crisis period causality links became unidirectional, running only from the South East Asian markets, where the crisis originated, to the others (Caporale, Pittis, and Spagnolo, 2006).

[6] Pls. see: Liu, et al., (1998), Cheung, et al., (2002), Favero and Giavazzi (2002), and Walti (2003) for this issue (Caporale, Pittis,and Spagnolo, (2006)).

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

Mondria (2006) explains that financial contagion is an increase in uncertainty in one market as the consequence of a financial crisis in another independent market due to attention reallocation of investors over short periods of time. During the periods of a financial crisis, news, rumors, and investor concerns increase and investors allocate more (optimally reallocate) resources to process information about the shaken stock market due to the crisis. This results in an endogenous increase in the volatility around the world stock markets (Mondria and Quintana-Domeque, 2007).

Mondria and Quintana-Domeque (2007) investigate the effect of attention reallocation of investors as a mechanism through which financial crises are transmitted between regions and they base their study on Mondria (2006) which offers a new explanation for contagion between regions. They study financial contagion from Southeast Asia to Latin America and they analyze the effect of volatility increases in Southeast Asian stock market on the volatility of the Latin American stock markets through attention reallocation between 1997-1998 using daily data.Their results show that the more attention allocated to one market in a financial crisis, the higher the stock market volatility of other emerging markets.

The study of Jorion and Zhang (2008) analyzes the credit contagion caused by the direct counterparty effects. The study examines industrial and financial firms and provides evidence that counterparty default risk is a potential channel of credit contagion between borrowers and lenders.

The survey of Arvai, et.al. (2009) gives a detailed explanation for the financial interlinkages within Europe and describes the underlying reasons for the potential channels of contagion via financial linkages. The study focuses on the mechanism of the banking system in the Western and emerging countries of Europe to explain how a credit crunch would be amplified through contagion channels.

4. DATA AND METHODOLOGY

The main objective of this study is to investigate the interlinkages between three important financial market indicators of Turkey, namely, exchange rates, stock exchange indices and interest rates with the U.S. stock market volatility. The Chicago Board of Options Exchange Volatility Index (VIX) is a videly used measure of market risk which uses the implied volatility and is often referred to as the “investor fear gauge”.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

The average of buying and selling rates of U.S. Dollar / TL exchange rate announced by the Central Bank of Turkey have been chosen as the reference exchange rates (FX) since other exchange rates against TL are determined by their cross rates against U.S. Dollar. Istanbul Stock Exchange-100 (ISE100) Index has been used as the stock exchange indicator and compound interest rates of the most active government bond traded in the secondary market (INT) are used as the interest rate indicator.

The empirical analysis covers daily observations from April 1, 2004 to November 20, 2009. In February 2007, the first attack of the financial turbulence related to the U.S. sub-prime mortgage crisis has occurred. So, February 2007 is set as the midpoint of all the sample data in this analysis. The time period between April 1, 2004 and January 31, 2007 represents pre-crisis period and dates between February 1, 2007 and November 20, 2009 represent the financial crisis period. The data set has been constituted with the daily data of the variables, rather than weekly or monthly, to observe the short term effects. For investigating the contagion effect more accurately, the data set has been divided into two equal sub-periods, namely the period before and during the financial crisis. The log returns of the series are analysed by computing the natural logarithmic difference of each variables and the descriptive statistics of the variables are given in Table 1. In Graph 1, the original series and the log returns of the variables are plotted.

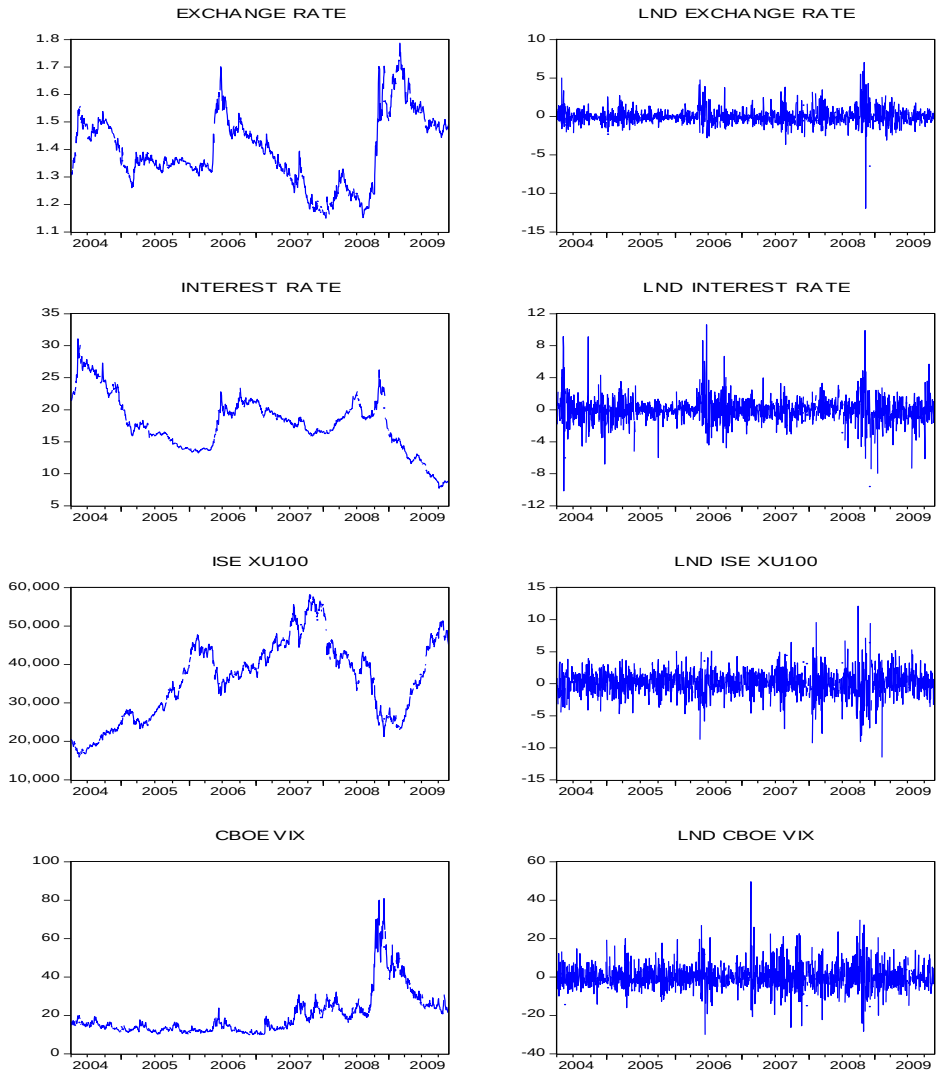
In Table 1, the difference between the standard deviation values shows an increase in the fluctuations of the series. Negative skewness values indicate that there are more negative values during financial crisis period and one can see sudden decreases in the mean values. Briefly, the descriptive statistics imply a pronounced change in the financial environment.

Table 1: Descriptive Statistics

	April 1, 2004–January 31, 2007				**February 1, 2007 – November 20, 2009**			
	LNDFX	**LNDINT**	**LNDISE**	**LNDVIX**	**LNDFX**	**LNDINT**	**LNDISE**	**LNDVIX**
Mean	0.012	-0.013	0.109	-0.072	0.007	-0.128	0.015	0.118
Median	-0.066	0	0.221	-0.655	-0.067	-0.096	-0.026	-0.671
Maximum	5.016	10.634	5.103	26.892	7.043	9.89	12.127	49.601
Minimum	-2.775	-10.147	-8.671	-29.987	-11.935	-9.68	-11.442	-28.347
Std. Dev.	0.873	1.761	1.733	5.581	1.26	1.593	2.373	7.641
Skewness	1.094	0.709	-0.394	0.389	-0.643	-0.477	-0.08	0.659
Kurtosis	7.981	10.679	4.046	6.02	18.905	9.881	6.171	7.037
Sum	8.116	-8.676	71.279	-47.407	4.2	-81.948	9.377	75.591
Sum Sq. Dev.	498.09	2023.88	1960.86	20337.18	1017.08	1627.16	3610.15	37429.56
Obs.	654	654	654	654	642	642	642	642

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

Graph 1: The Original and the Log Returns of the Ser



Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

The analysis performs unit root tests for observing the stationarity of the variables and their results are given in Table 2. Standard Augmented Dickey Fuller (ADF), Philips Perron (P-P) and Kwiatkowski, Philips, Schmidt and Shin (KPSS) tests are applied to identify the order of integration for each sample period. The results of the ADF analysis will help to construct an appropriate estimation of the Vector Autoregression (VAR) model.

Table 2: Results of ADF, P-P and KPSS Unit Root Tests

		Pre-Crisis (April 1, 2004–January 31, 2007)			
		LNDVIX	**LNDFX**	**LNDINT**	**LNDISE100**
ADF	Constant	-15.2687	-6.635	-8.1426	-23.984
	Constant&Trend	-15.2566	-6.64	-8.1645	-23.9673
P - P	Constant	-32.3098	-25.24	-25.043	-23.974
	Constant&Trend	-32.2768	-25.23	-25.048	-23.957
KPSS	Constant	0.0299	0.0766	0.2564	0.0891
	Constant&Trend	0.0299	0.0799	0.1499**	0.0788

		During Crisis (February 1, 2007–November 20, 2009)			
		LNDVIX	**LNDFX**	**LNDINT**	**LNDISE100**
ADF	Constant	-21.0393	-5.491	-5.254	-24.2072
	Constant&Trend	-21.0742	-5.524	-5.3664	-24.1948
P - P	Constant	-30.752	-25.08	-24.36	-24.2102
	Constant&Trend	-30.9989	-25.08	-24.399	-24.1977
KPSS	Constant	0.175	0.1691	0.3584*	0.2011
	Constant&Trend	0.0395	0.1139	0.1108	0.1749**

* and ** denotes stationarity at % 99 percent and % 95 percent respectively.

4.1. GRANGER CAUSALITY TEST

As seen in Table 2, the ADF test results indicates that log returns of all variables are stationary. Therefore, Granger-Causality test can be conducted.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

Granger-Causality test involves estimating the following equations;

$$Y_t = a + b_i Y_{t-i} + c_i X_{t-i} + u_t$$
$$X_t = a' + b_i' X_{t-i} + c_i' Y_{t-i} + u_t' \quad (1)$$

where a and a' are constant coefficients, u_t and u_t' are random disturbance terms. Briefly, the Granger-causality test consists of running regressions of one variable with its lagged values and with that of other variables. Hence, if the lagged values of one variable do not yield a statistically significant relationship, then it can be stated that the variable "does not Granger-cause of the other variable". The null hypotheses of the Granger-causality being tested are that the joint significance of all c_i is zero, if each variable return does not Granger-cause on one and another. Hence, the test is the standart F-test. The results of pairwise Granger-causality tests with the hypotheses for variables are reported in Table 3.

Table 3: Results of Granger Causality Test

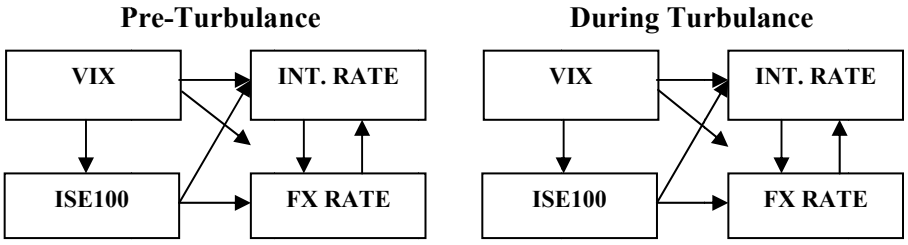
Lags		**1**	**2**	**3**	**5**	**10**
Null Hypothesis:	**Obs**	**F-St.**	**F-St.**	**F-St.**	**F-St.**	**F-St.**
LINT does not Granger Cause LFX	654	*387.01	*201.7	*132.4	*79.2	*38.8
LFX does not Granger Cause LINT		0.01	***2.74	**2.68	*3.14	*4.22
LISE100 does not Granger Cause LFX		*157.8	*101.2	*67.7	*40.9	*21.53
LFX does not Granger Cause LISE100		0	0.05	0.14	1.05	1.3
LVIX does not Granger Cause LFX		**5.63	*31.7	*21.7	*13.2	*7.40
LISE100 does not Granger Cause LINT		*62.4	*32.6	*22.1	*13.1	*8.28
LINT does not Granger Cause LISE100		2.01	***2.7	1.94	1.18	1.13
LVIX does not Granger Cause LINT		*49.7	*24.58	*16.7	*10.04	*6.19
LVIX does not Granger Cause LISE100		*45.7	*23.4	*15.96	*9.91	*5.14
Lags		**1**	**2**	**3**	**5**	**10**
Null Hypothesis:	**Obs**	**F-St.**	**F-St.**	**F-St.**	**F-St.**	**F-St.**
LINT does not Granger Cause LFX	642	*301.42	*151.3	*105.3	*64.4	*32.60
LFX does not Granger Cause LINT		**4.46	**4.42	1.72	1.32	1.37
LISE100 does not Granger Cause LFX		*221.6	*136.3	*90.6	*55.8	*29.47
LFX does not Granger Cause LISE100		0.00	0.01	0.63	0.39	0.80
LVIX does not Granger Cause LFX		*30.24	*109.81	*73.02	*46.78	*24.40
LISE100 does not Granger Cause LINT		*24.10	*12.00	*8.07	*5.10	*3.26
LINT does not Granger Cause LISE100		0.17	0.11	1.43	0.75	0.66
LVIX does not Granger Cause LINT		*82.66	*44.05	*28.07	*17.28	*9.08
LVIX does not Granger Cause LISE100		*62.85	*33.4	*22.19	*13.72	*7.12

* denotes significance at 1 %, ** denotes significance at 5 % and *** denotes significance at 10 %.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

The Granger-causality test provides a multi-interrelationship system between the variables both in the pre-crisis and the crisis periods as shown below. This interrelationship basically shows the presence of a significant effect of the VIX index on the Turkish financial market indicators. Besides, in Turkey Istanbul Stock Exchange (ISE) has a dominant effect both on interest rates and exchange rates, while interest rates affect the exchange rate. Contrary to the expectations, there is a two way causality between interest rate and exchange rate. For pre-crisis period two way causality is valid for 2, 3, 5 and 10 lags causality from exchange rate to interest rate for 3, 5 and 10 lags cannot be observed.

Figure 1: The Causality Relationship Between the VIX Index and the Turkish Financial Market Variables (2 Lags)



4.2. VECTOR AUTOREGRESSION (VAR) MODEL

The VAR is commonly used for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach models every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. It is common in economics to have models where some variables are not the only explanatory variables for a given dependent variable, and the dependent variable may also be explained by the variables that are out of the system. In those cases, models of simultaneous equations are necessary to identify which of them are endogenous and exogenous (Enders, 2002). According to Sims (1980), if there is simultaneity among a number of variables, then all of these variables should be treated in the same way. In the case of having two variables, it can be modeled as the time path of Y_t by current and past realizations of both itself, Z_t and their past sequences. If we apply this model to the estimated model aimed in this study, we have the following equations system:

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

$$ISE100_t = a_{10} + a_{11}ISE100_{t-1} + a_{12}INT_{t-1} + a_{13}FX_{t-1} + a_{14}VIX_t + e_{1t}$$

$$INT_t = a_{20} + a_{21}ISE100_{t-1} + a_{22}INT_{t-1} + a_{23}FX_{t-1} + a_{24}VIX_t + e_{2t}$$

$$FX_t = a_{30} + a_{31}ISE100_{t-1} + a_{32}INT_{t-1} + a_{33}FX_{t-1} + a_{34}VIX_t e_{3t}$$

(2)

In a VAR model, the goal is to find the important interrelationships among the variables and not to make short-term forecasts. In principle, there is nothing to prevent from incorporating a large number of variables in the VAR. It is possible to construct an n-equation VAR with each equation containing p lags of all n variables in the system. As a practical matter, degrees of freedom are quickly eroded as more variables are included (Enders, 2002). Additionally, it is important to determine the appropriate lag lengths in each equation. However, to preserve the symmetry of the system and to be able to use Ordinary Least Squares (OLS) efficiently, it is common to use the same lag length for all equations. In practice, it is preferred choosing a lag length arbitrarily by allowing enough lags to ensure that the residuals are white noise while maintaining the precision of estimates. There are also alternative methods for determining an appriopriate lag length such as the Akaike Information Criteria (AIC), the Schwartz Information Criteria (SIC), the Hannan-Quinn Criteria (HQ), and the Final Prediction Error (FPE). All four methods have been used to determine lag length up to 10 lags in this study. The lag lengths of the VAR model have been identified as 2 (one day) for the pre-crisis period and 3 (two days) for the crisis period. Portmanteau and Autocorrelation LM tests indicate no serial correlations[7]. Granger causality tests indicate that the VIX is an exogeneous variable. Thus, the VIX variable has been included as an exogeneous variable with 2 lags for pre-crisis period and 6 lags for the crisis period.

[7] Portmanteau Autocorrelation Tests Q value for pre turbulance and during turbulances are 123.21 and 109.6 respectively (5 % significance level). Autocorrelation LM test indicates no autocorrelation up to 5 lags for both pre turbulance and turbulance periods.

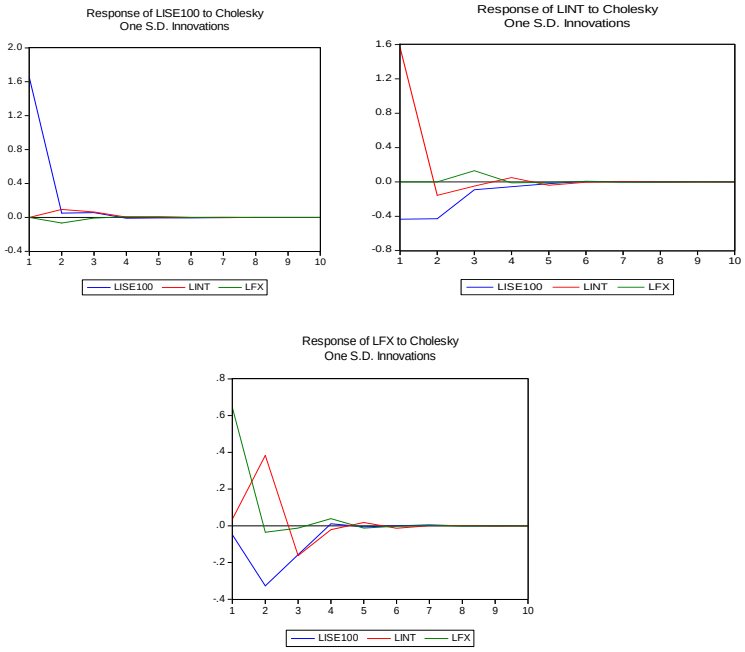
Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

4.3. IMPULSE RESPONSE FUNCTIONS

The impulse response analysis is used widely in the empirical literature to uncover the dynamic relationship between macroeconomic variables within vector-autoregressive (VAR) models. Impulse responses measure the time profile of the effect of a shock, or impulse, on the (expected) future values of a variable. By imposing specific restrictions on the parameters of the VAR model, shocks can be interpreted in economic sense (Watson, 1994). The standard approach to identifying impulse responses imposes restrictions on a VAR model estimated in the (log) levels of the variables. However, if present, cointegration imposes restrictions on the VAR. It is known that if these restrictions are not imposed and a nonstationary VAR model in levels is estimated, impulse responses are inconsistent at long horizons. More specifically, the impulse responses are inconsistent at long horizons as the horizon increases with the sample size; this is because the nonstationarity means the true impulse responses do not tend to zero as the horizon increases – the effect of the unit root persists, but the unit roots are estimated with error. Impulse responses trace out the responsiveness of the dependent variables in the VAR to a given one standard deviation shocks to each of the variables. For each variable from each equation seperately , a unit shock is applied to the error, and the effects upon the VAR system over time are noted. If there are n variables in the system, a total of n^2 responses could be generated. Provided that the system is stable, the shock should gradually die away (Enders,2002).

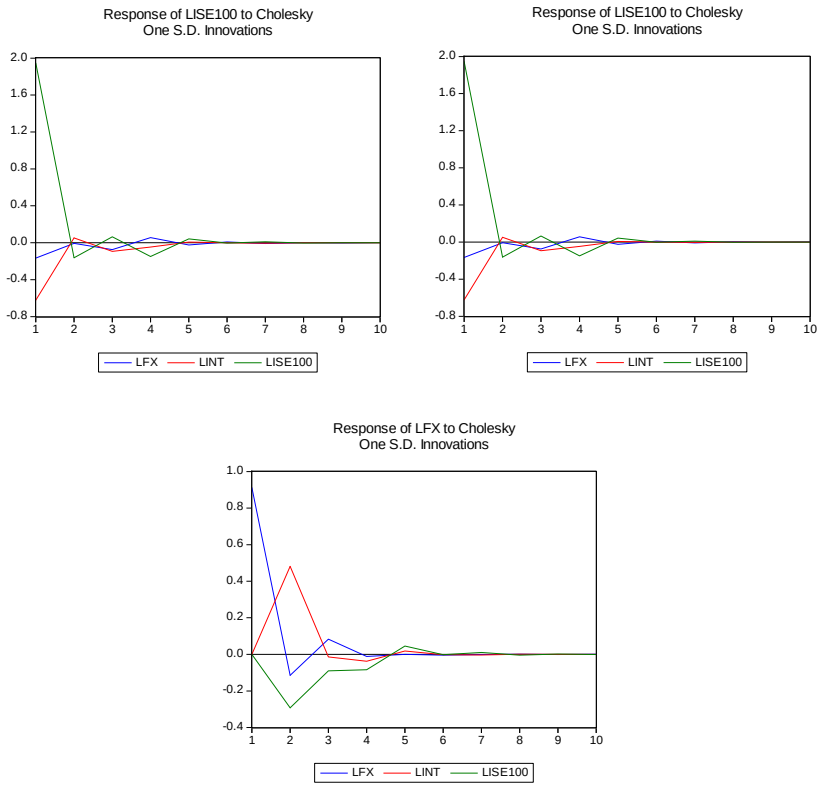
Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

Graph 2: Impulse Response Function Graphs
Pre-Crisis (April 01,2004 – January 31, 2007)



Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

Graph 2 (continued)
During Crisis (February 01, 2007–November 2009)



The sensitivity of the variables to themselves and to other variables in the system of VAR, that is the amount of response and the time of response as a result of one standard deviation shock given to each variable has been determined by the impulse response functions in the study. Graph 2 and Graph 3 provide mutual reactions of each variable and Table 4 lists the amount and lag of each response. Plotting the impulse response functions is a practical way to visually represent the behavior of the series in response to various shocks. Results indicate that responses of the variables to each other are slightly higher and seem to last longer during the crisis period.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

Table 4: Impulse-Response Function Values
Pre-Crisis (April 01,2004–January 31, 2007)

	Response of LISE100			Response of LINT			Response of LFX		
Period	**LISE100**	**LINT**	**LFX**	**LISE100**	**LINT**	**LFX**	**LISE100**	**LINT**	**LFX**
1	1.6476	0.0000	0.0000	-0.4354	1.5650	0.0000	-0.0484	0.0355	0.6451
2	0.0509	0.0945	-0.0655	-0.4282	-0.1572	-0.0001	-0.3274	0.3837	-0.0352
3	0.0575	0.0636	-0.0082	-0.0914	-0.0471	0.1303	-0.1568	-0.1619	-0.0124
4	-0.0101	0.0046	0.0064	-0.0562	0.0500	-0.0119	0.0114	-0.0214	0.0387
5	-0.0066	0.0075	0.0044	-0.0204	-0.0378	-0.0057	-0.0054	0.0179	-0.0124
10	0.0001	-0.0001	0.0000	-0.0001	0.0004	-0.0002	0.0002	0.0002	0.0002
15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

During Crisis (February 01, 2007–November 20, 2009)

	Response of LISE100			Response of LINT			Response of LFX		
Period	**LISE100**	**LINT**	**LFX**	**LISE100**	**LINT**	**LFX**	**LISE100**	**LINT**	**LFX**
1	2.0500	0.0000	0.0000	-0.4194	1.3731	0.0000	-0.0740	-0.1337	0.8999
2	-0.1686	0.0030	-0.0208	-0.1732	-0.0448	0.0999	-0.4138	0.3872	-0.0924
3	0.0964	-0.0590	-0.0766	-0.1116	0.0459	0.0673	-0.0877	-0.0518	0.0695
4	-0.1316	-0.0948	0.0316	-0.0775	0.0943	0.0190	-0.0676	-0.0579	-0.0261
5	0.0401	0.0224	-0.0183	-0.0199	0.0009	0.0070	0.0372	0.0303	0.0074
10	-0.0004	-0.0003	0.0007	-0.0002	0.0003	0.0001	-0.0011	-0.0004	0.0003
15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

4.4. VARIANCE DECOMPOSITION

Variance decomposition offers a slightly different method for examining VAR system dynamics. It gives the proportion of the movements in the dependent variables that are due to their own shocks, versus shocks to the other variables. A shock to the n^{th} variable will directly affects the variable itself, but it will also be transmitted to all other variables in the system through the dynamic structure of the VAR (Brooks, 2002). This study finally examines the variance decomposition of each variable caused by other variables in the VAR system.

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

Table 5: Variance Decomposition
Pre-Crisis (April 01,2004–January 31, 2007)

	Variance Decomposition of LISE100				Variance Decomposition of LINT				Variance Decomposition of LFX			
Per.	S.E.	LISE100	LINT	LFX	S.E.	LISE100	LINT	LFX	S.E.	LISE100	LINT	LFX
1	1.64	100.0	0.00	0.00	1.62	7.18	92.81	0.00	0.64	0.55	0.30	99.14
2	1.65	99.51	0.32	0.15	1.68	13.09	86.90	0.00	0.82	16.21	21.98	61.80
3	1.65	99.36	0.47	0.15	1.69	13.26	86.14	0.59	0.85	18.45	24.05	57.48
4	1.65	99.36	0.47	0.16	1.69	13.34	86.05	0.59	0.85	18.42	24.04	57.53
5	1.65	99.36	0.47	0.16	1.69	13.35	86.05	0.59	0.85	18.41	24.07	57.51
10	1.65	99.36	0.47	0.16	1.69	13.35	86.04	0.59	0.85	18.41	24.09	57.49
15	1.65	99.36	0.47	0.16	1.69	13.35	86.04	0.59	0.85	18.41	24.09	57.49
20	1.65	99.36	0.47	0.16	1.69	13.35	86.04	0.59	0.85	18.41	24.09	57.49
30	1.65	99.36	0.47	0.16	1.69	13.35	86.04	0.59	0.85	18.41	24.09	57.49

During Crisis (February 01, 2007–November 20, 2009)

	Variance Decomposition of LISE100				Variance Decomposition of LINT				Variance Decomposition of LFX			
Per.	S.E.	LISE100	LINT	LFX	S.E.	LISE100	LINT	LFX	S.E.	LISE100	LINT	LFX
1	0.91	100.00	0.00	0.00	1.43	8.53	91.46	0.00	2.05	0.65	2.14	97.19
2	1.07	99.99	0.00	0.01	1.45	9.78	89.73	0.47	2.05	15.19	14.42	70.37
3	1.08	99.77	0.08	0.14	1.45	10.28	89.02	0.68	2.06	15.65	14.47	69.87
4	1.08	99.53	0.29	0.17	1.46	10.49	88.80	0.69	2.06	15.92	14.64	69.42
5	1.09	99.51	0.30	0.17	1.46	10.51	88.79	0.69	2.06	16.01	14.69	69.29
10	1.09	99.51	0.30	0.18	1.46	10.51	88.78	0.69	2.06	16.02	14.69	69.28
15	1.09	99.51	0.30	0.18	1.46	10.51	88.78	0.69	2.06	16.02	14.69	69.28
20	1.09	99.51	0.30	0.18	1.46	10.51	88.78	0.69	2.06	16.02	14.69	69.28
30	1.09	99.51	0.30	0.18	1.46	10.51	88.78	0.69	2.06	16.02	14.69	69.28

CONCLUSION

This study analyzes the contagion effects of the U.S. credit crisis, emerging originally from the sub-prime mortgage market, on the Turkish financial market indicators and furthermore investigates the dynamics of the interlinkages between those indicators.

Granger causality analysis indicates that the Istanbul Stock Exchange, domestic interest rates and U.S. Dollar/TL exchange rate are highly sensitive to fluctuations – as measured by the Chicago Board of Options Exchange Volatility Index (VIX) – in the U.S. financial markets both in the pre-crisis and crisis periods. The severity and the duration of the effects of the VIX fluctuations on the Turkish financial market parameters have increased during the U.S. credit crunch. This may be due to the concerns about capital

Trakya Üniversitesi Sosyal Bilimler Dergisi
Haziran 2010 Cilt 12 Sayı 1 (388-414)

flows out of emerging markets.

Results show that the ISE-100 Index has been a better indicator of the domestic and U.S. financial market fluctuations than TL interest rates and U.S. Dollar/TL exchange rates. Furthermore, fluctuations of both interest rates and exchange rates mainly stem from the volatilities in the VIX and ISE-100 Index. An interesting finding is that exchange rates have no effect on TL interest rates and ISE-100 Index in the two sub-periods. The effect of the ISE-100 Index on the U.S. Dollar/TL exchange rate has increased while the effect of domestic interest rates decreased during the crisis period. This may be due to changing attitudes and preferences of international and Turkish investors. Stocks and government debt securities are the main investment opportunities in the Turkish economy and the supply and the demand for U.S. Dollar are highly correlated with and responsive to changes in stock prices and domestic interest rates.

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