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Effect of the Subprime Crisis on Return and Volatility of the Turkish Stock Market

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Abstract: The aim of this paper is to investigate the return and volatility behaviors of the Turkish Stock Exchange in response to the mortgage crisis using daily observations for the period June 2004 to June 2014. The data are divided into three sub-periods to allow for the investigation of the behavior of the stock market during each sub-period. We employ the GARCH, EGARCH and GARCH-M models to capture volatility. The results indicate that the subprime crisis both induced a notable increase in volatility and changed the relationship between risk and expected return on the Turkish Stock Exchange.

Keywords: *Volatility, Subprime crisis, Turkish Stock Market*

1. Introduction

Emerging markets play an important role in portfolio investment and risk management as they follow capital flows around the world. Because the low degree of correlation with developed markets gives investors an opportunity to diversify, examining the behavior of stock returns and volatility in emerging markets has become common topic in finance literature. Volatility in financial markets has received substantial attention in the literature, particularly with respect to volatility clustering, risk-return relationships and duration of shocks. It is important for investors to know how a subprime crisis shapes stock market return and volatility structure. For example, a higher return is expected by investors because of increasing volatility during a crisis period. Moreover, mortgage crisis causes large drops in asset prices and market values of portfolios covering asset-backed securities as evidenced by the collapse of AIG, FannieMae, Freddie Mac, Lehman Brothers and also show their roles in the financial contagion of the crisis. Longstaff (2010) contends that such financial contagion is extended via liquidity and risk-premium channels.

The impacts of subprime crisis have been an important issue in academic literature during and shortly after crisis period because of its very severe effects on financial markets and reel economy in all over the world. Therefore, there are many studies that have attempted to investigate the impacts of crisis especially in terms of the impact of volatility on stock return behaviors. We summarized herein several of these studies. Celikkol et al. (2010) analyzed the impact of the bankruptcy of Lehman Brother's on the volatility structure of the Turkey Stock Exchange and found that the bankruptcy increased the volatility and returns in the stock market index. Çağıl and Okur (2010) used GARCH models to investigate the impact of the 2008 financial crisis on the Istanbul Stock Exchange. The result of the study revealed that unconditional volatility of the Istanbul Stock Exchange increased between 2007 and 2010.Singhania and Anchalia (2013) investigated the impact the 2008 subprime crisis and the last European debt crisis had on the Asian stock market. Their findings indicate that all stock market returns exhibited volatility clustering, volatility persistence, asymmetry and leverage effects. Furthermore, the two financial crises impacted the Asian financial markets differently. While Japan, China and India were affected positively by the subprime crisis, the European debt crisis had a negative impact on the stock returns of India and China. Ramlall (2010) found that the US subprime crisis significantly impacted volatility clustering and induced the increment of leverage effects in major international financial markets. He further noted that the GARCH (1,1) model is sufficient for modeling conditional volatility.

Al-Rjoub and Azzam (2012) examined the behavior of the Jordanian stock exchange during the financial crisis. The data consisted of daily, weekly and monthly return series from banks, insurance, services, industrial sectors and the ASE index from 1 January 1992 to 2 July 2009. They employed the GARCH-M model to capture the relation between returns and volatility, and they used the Chow breakpoint to examine the beginning and ending dates of the crash and to detect structural changes in parameters. The results showed that the crisis negatively affected all stock returns and that the time-varying trend in the volatility increased during crisis periods. Michelfelder and Pandya (2005) investigated the return volatility of both emerging and mature stock markets by using the EGARCH-SGED model. The majority of

market returns exhibited negatively skewed distributions. They also found that the half-life of volatility in an emerging market was shorter than in mature markets, and they emphasized that the impact of non-trading days on volatility was greater in mature markets than in emerging markets. Cheong et al. (2012) investigated the impact of the 2007-2008 subprime crises on long-run and short-run components of volatility on the US, Malaysia and Indonesian equity markets. Cheong divided the stock return data into three periods based on the subprime crisis timeline. The results showed that the half-life of volatility of the US equity market was shorter than that of the other equity markets. In addition, they also reported that the advantage effect of the subprime crisis on stock market volatility was temporary, which means that the permanent volatility component had no asymmetric response to volatility.

Thao and Daly (2012) focused on the impact of the recent subprime crisis in the Southeast Asian region between 2006 and 2010. The results revealed a bi-directional relationship between the equity markets exists. Arora et al. (2009) examined the behavior of stock returns and the volatility of the indices of emerging markets and developed markets. After noting the importance of the time interval, they employed the GARCH and TAR-GARCH methodologies to return series on daily, weekly, monthly and annual frequencies. The result showed the GARCH (1,1) adequately explains the volatility pattern in most markets and that asymmetric volatility appeared in some stock exchanges with varied frequencies. Lastly, they reported that the ratio of stock returns to volatility for emerging markets was higher than it was for developed markets. Nieh et al. (2012) utilized the Enders–Siklos asymmetric threshold cointegration test and found that China had an increased impact on the Asian markets during the subprime crisis. They further found that asymmetric cointegration relationships between the US and Asian markets existed during both periods of the crisis. Beyond these findings, they suggested that the recent financial crisis bounded international portfolio diversification. Majid and Kassim (2009) explored empirically the effects of the subprime crisis by using daily data of five selected stock markets for the period February 15, 2006, to December 31, 2008. They employed the VAR framework and variance decomposition methods to detect the cointegration of stock markets. The results showed the increased level of correlations between the markets during the subprime crisis. According to the cointegration test results, markets had a long-run equilibrium relationship during this period. Finally, the study revealed the increasing effect of major financial markets on emerging markets.

The papers mentioned above were generally conducted during the subprime crisis period. However, since impact of subprime crisis has taken long time in all over the world, it is still being an important issue on academic literature. Additionally, newly improving econometric methods pay attention to the contagion and spillover between emerging and mature markets instead of country specific effects after the crisis periods. For example Yan et al. (2015) examine the subprime crisis in terms of transmition mechanisms and find that the subprime crisis is transmitted other equity markets via cross-border banking credit rather than international portfolio or trade flows. They also propose to apply banking regulation and capital constraints to decrease the weakness of financial markets. Galariotis et al. (2015) investigate the behaviors of market participants and their decisions on same direction and find that herding behaviors in UK and US stock market change during the subprime crises period due to fundamental macroeconomic news. Kim and Ryu (2015) focus on the futures market traders based on Korea and US during subprime crisis. They find that foreign investors are more sensitive than domestic investors to the subprime shocks during the crisis. Luchtenberg and Vu (2015) investigate the determinants of financial contagion during the 2008 financial crisis and stress the importance of relation between interest rates and financial contagion. Unlike previous studies, Shalini and Prasanna (2015) put emphasis on the impact of the financial contagion on commodity market. They point out the role of systematic risk in volatility patterns of Indian commodity markets.

Vithessonthi and Tongurai (2015) examine the impacts of subprime crisis in terms of firm performance. According to their results, while leverage effect is positive for small firms, large firms have negative leverage effect in Thailand equity market. Since stock market is used as proxy for real economy, Guo (2015) detect significant cross-correlation between China's stock market and GDP. He also suggests that policymakers should improve deregulation related with financial markets. In another study, Zhang and Li (2013) employing the DCC-GARCH approach find that subprime crisis have permanent impact on conditional correlation relationships between U.S, Europe and BRICS countries. Using event study methodology, Aizenman et al. (2015) point out the differences of effects of shocks originated from US subprime and Europen debt crisis on emerging markets. They stated subprime crisis have a consistently negative impact on the equity and bond markets in emerging markets. While there are many studies on financial crashes in developed and emerging markets, there have not been many works focused on the

Turkish financial markets. The Turkish stock market was negatively affected by the subprime crisis of 2007-2008 such that Turkey's market capitalization declined by more than half in 2008. Not only did the stock market register its largest drop of 63% as a result of the financial crisis, but the turnover ratio of the BIST, which was %154 in 2005, dropped to nearly %118 in 2008 (Gammoudi and Cherif M, 2014). We fill this gap by investigating the subprime crisis for the Turkish stock market using ARCH family models to examine the dynamics of the stock returns and volatility, thereby expanding the recent works of Chong (2011), who studied the impact of the subprime credit crisis of 2007 on the return and volatility of the S&P 100 Index. Return data are divided into 3 periods to investigate the behavior of stock market returns and volatility and then analyze the effects of the crisis on the market. The ARMA-GARCH approach is employed to detect volatility clustering and the duration of shocks. The results show that the crisis has only a transitory impact on the volatility of the market and no significant effect on stock market return. The remaining paper is organized as follows. Section two discusses the data and methodology employed in the study, and section three presents the results of the models. Section four contains concluding remarks.

2. Methodology

The US subprime mortgage crisis started with the increase in the Libor-OIS spread on June 1 2007,and ended April 2, 2009, with the declaration of leaders to supply more than 1 trillion dollars to improve international finance and trade and thus improve the economic outlook for the future(Ait-Sahalia et al., 2012). This study was divided into three periods, namely, the pre-crisis period from June 04, 2004, to July 29, 2007;the crisis period, which began on June 2, 2007,and ended on April 2, 2009; and the post-crisis period, which began on April 3, 2009,and, for the purposes of this study, ran through June 03, 2014.The groupings of data into the three sub-periods allowed us to assess whether the volatility of the stock markets changed due to the crisis. For this purpose, we used general autoregressive conditional heteroskedasticity models to capture volatility persistence, asymmetric volatility and return- volatility relations in the stock market. Data were obtained from a data stream data base. Returns are calculated by taking the first differences of the natural logarithms of the closing price index:

$$R_t = (\ln P_t - \ln P_{t-1}) \quad (1)$$

Where R_t represents stock return at time t, P_t represents the closing value of the BIST index at time t, P_{t-1} represents the closing value of the BIST index at time t -1.

GARCH model

The autoregressive conditional heteroskedasticity (ARCH) model developed by Engle (1982) explains the forecast of conditional variance in terms of past squared residuals. Bollerslev (1986) generalized the ARCH model by adding its lagged values to the conditional variance equation, which is termed the generalized autoregressive conditional heteroskedasticity (GARCH).The conditional variance equation in the GARCH (1,1) model takes the form of Equation (1).

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (2)$$

GARCH models satisfy the stability conditions that remain for constraints $0< \omega$, $0\leq\alpha$, $0\leq\beta$, $\alpha+\beta<1$.While the reaction to volatility is measured by α, the persistence of volatility is measured by the β parameter. If the sum (α+β) is close to one, then shocks to the current volatility continue for a long time into the future. If the sum is equal to one, unconditional variance is non-stationary, and as such, it cannot be modelled by a vanilla GARCH.

GJR-GARCH model

The GJR-GARCH model, which was proposed by Glosten et al. (1993), captures the asymmetric effect of positive and negative shocks on volatility. The GJR-GARCH (1,1) model is formulated following Alexander(2008):

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \lambda 1_{\{\varepsilon_{t-1<0}\}}\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (3)$$

In this model,ε_{t-1}^2<0 (negative shocks) andε_{t-1}^2>0 (positive shocks) have different effects on the conditional variance. If the leverage effect exists, effects of negative shocks on conditional volatility are given by $\alpha + \lambda$.

GARCH in Mean Model

Sharpe (1964) posits that according to the capital asset-pricing model, a higher expected return is associated with higher risk. He also contends that the model implies a positive linear relationship between the expected return of any asset and its risk, which is measured by a constant beta. Engle et al. (1987)allow for modelling risk and volatility simultaneously in a conditional mean equation, known as

the GARCH in mean model, as a function of the conditional variance. A simple GARCH(1,1)-M model can be written as:

$$r_t = u + \delta\sigma_t^2 + a_t, \quad (4)$$
$$\sigma_t^2 = \omega + \theta a_{t-1}^2 + \beta\sigma_{t-1}^2$$

The parameter δ can be interpreted as a risk premium, while a positive and significant c means that the return is positively related to its volatility.

3. Results

We present the descriptive statistics of a return series that includes the first through fourth moments for before the crisis, during the crisis and after the crisis in Table 1.

Table 1: Descriptive Statistics of Return Series

	Before crisis	During crisis	After crisis
Mean	0.0013	-0.0013	0.0008
Std. Dev.	0.0161	0.0242	0.0154
Skewness	-0.4532	0.1081	-0.4356
Kurtosis	4.3887	5.4117	6.8554
Jarque-Bera pr.	0.0000	0.0000	0.0000
ADF	0.0000	0.0000	0.0000

The Turkish stock market faced negative returns with the onset of the subprime crisis, while the after-crisis market recorded positive average daily returns. Volatility as measured by the standard deviation, increased during the crisis compared to before the crisis. However, the returns for all periods except during the crisis are negatively skewed, thus indicating that, in general, the BIST has more losses than gains in these periods, but that during the crisis period, higher returns were observed. During all periods, the values of kurtosis of log-returns are greater than three. This means that the stock returns are not normally distributed and that, as a result, we need to include time-varying variance in the model, which leads to the use of the GARCH model. The table also presents the augmented Dickey–Fuller (ADF) results, which indicate that return series are stationary in all periods.

Table 2 presents the results of the GARCH models for the pre-crash period, the crisis period and the post-crash period. The persistence measure (α + β)for all periods is significantly different from unity, thus indicating that volatility has a significant impact on stock prices. The increase in the β parameter suggests that the pre-crash period source of volatility stems from previous volatility, while the smaller value of α implies that large market shocks have little impact on future volatility. The GJR-GARCH model shows a positive and significant γ parameter for all periods, suggesting that negative shocks have a greater impact on subsequent volatility. With respect to the leverage effect, the subprime crisis has induced more asymmetric behavior in the volatility of the BIST as a result of negative news, finding that further emphasizes that future stock volatility is more heavily influenced by past negative events.

Table 2: Parameter Estimates of GARCH Models

GARCH (1,1)						
	ω	α	β	α + β	LM test	Q(24)
Before crisis	2.67E-05**	0.106*	0.787*	0.893**	0.96	0.72
During crisis	2.86E-05***	0.107*	0.846*	0.953**	0.41	0.59
After crisis	7.84E-06*	0.079*	0.887**	0.966**	0.27	0.55
GJR - GARCH (1,1)						
	ω	α	β	γ	LM test	Q(24)
Before crisis	3.57E-05*	-0.013	0.763*	0.195*	0.94	0.77
During crisis	3.75E-05**	-0.012	0.845*	0.216*	0.60	0.24
After crisis	1.05E-05*	0.034*	0.868*	0.100*	0.65	0.58
GARCH in Mean (1,1)						
	ω	α	β	δ	LM test	Q(24)
Before crisis	2.63E-05*	0.106*	0.789*	-0.112	0.95	0.68
During crisis	3.44E-05***	0.116*	0.830*	-0.036	0.45	0.46
After crisis	8.43E-06*	0.078*	0.885*	0.094*	0.24	0.46

Note: *, **, *** statistically significant at the 1%, 5% and 10% level, respectively

The impact of volatility on stock return is found to be both inverse and insignificant for the pre-crisis and crisis periods. However, in the post-crisis period, we find that a positive and significant relationship between volatility and return also means a significant time-varying risk premium in the Turkish stock market as after-crisis investors are compensated for their exposure to higher risk. Table 3 illustrates the summary statistics of a conditional volatility series that is estimated using GARCH family models for all periods. The results from Table 3 confirm that the mean of volatility increases during the subprime crisis period. However, the standard deviation increases more than three times during the crisis period compared to the pre-crisis period. It is further noted that both skewness and kurtosis are lower during the crisis period. Such findings imply that large changes in volatility are more frequent in the pre- and post-crisis periods, while the subprime crisis restricts the intervals of future expected returns.

Table 3: Summary Statistics for Conditional Volatility Series

GARCH (1,1)					
	Mean	**Median**	**Std. Dev.**	**Skewness**	**Kurtosis**
Before crisis	0.000257	0.000222	0.000112	2.701123	14.11685
During crisis	0.000597	0.000477	0.000348	1.830987	6.532438
After crisis	0.000241	0.000196	0.000149	2.80005	13.82755
GJR - GARCH (1,1)					
Before crisis	0.000258	0.000208	0.000150	3.875164	27.15005
During crisis	0.000597	0.000433	0.000423	2.314944	9.115442
After crisis	0.000243	0.000187	0.000186	3.974337	25.03065
GARCH in Mean (1,1)					
Before crisis	0.000257	0.000223	0.000111	2.677976	13.91476
During crisis	0.000601	0.000483	0.000351	1.892831	7.071602
After crisis	0.00024	0.000195	0.000147	2.801948	13.63975

4. Conclusion

The financial markets of a country are useful when reflecting on economic conditions. Thus, policy makers implement deliberate strategies to manage volatility in their stock markets, and accordingly, they must estimate volatility and take into account the impact of financial crises on markets. In this study, we investigate the role of a subprime crisis on the behavior of the daily returns of the BIST (Borsa Istanbul Stock Exchange) and estimate the volatility for the period June 04, 2004, to June 03, 2014. We divide the total sample into three periods, namely, the pre-crisis period from June 04, 2004, to July 29, 2007;the crisis period, which runs from June 2, 2007,to April 2, 2009; and the post-crisis period from April 3, 2009, to June 03, 2014. We estimate the alternative GARCH models, namely, the EGARCH and GARCH in Mean model, to model the asymmetric behavior of volatility and examine the time-varying risk premium in the stock market. The findings of our study reveal that the subprime crisis had a positive and transitory impact on the volatility of returns of the Turkey Stock Market, which is consistent with the results by Celikkol et al. (2010) and Çağıl and Okur (2010). Although there are leverage effects on the volatility of stock returns for the full sample, the crisis provoked a notable increase in the asymmetric parameter, which indicates that negative market news induces greater impact on future volatility than positive news.

With respect to the relationship between expected stock returns and conditional volatility, using the GARCH in mean model, we found a positive and significant relationship in the post-crisis period while such a relationship is insignificant in other periods. This suggests that different risk-return trade-off patterns among the whole sample could be derived from a varied mean of the volatility level. Unlike our paper by applying newly econometric techniques such as Ho (2015) use entropy density function to analyze the subprime crisis and find S&P500 index exhibited regular pattern whereas Germany and Korea, exhibit no significant pattern during the financial crisis period. Moreover Mensi et al. (2014) examine the impact of onset of subprime crisis on co movement of BRICS markets by employing quantile regression methodology. They point out that the uncertainty in economic policy of U.S has not affected the BRICS stock markets. On the other hand Koksal and Orhan (2013) point out the decoupling of emerging and developed markets during the subprime crisis according to VAR models result.

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