LONG MEMORY IN TURKISH STOCK MARKET AND EFFECTS OF CENTRAL BANKS' ANNOUNCEMENTS

Elif ERER, PhD Candidate[*]
Deniz ERER, PhD Candidate[**]

Abstract

This paper investigates the response of stock market volatility to CBRT's and FED's interest rate increase and reduction decisions in Turkey over the period of 02.01.2004-31.01.2017. For this purpose, we used APARCH, FIAPARCH-CHUNG, FIAPARCH-BMM models. The results of analysis indicated presence of long memory in the conditional variance and FIAPARCH-CHUNG is the most appropriate model according to Akaike and Schwarz information criteria. It was seen that interest rate decisions made by CBRT and FED haven't any significant effect on stock market volatility. This situation means that expected interest rate decisions are priced by market participants and investors. Shocks to stock markets have persistent effect on volatility.

Keywords: Monetary Policy, Stock Market Volatility, Long Memory

JEL Classification: E52, C58, E44

1. Introduction

It is quite important for financial investors and policymakers to determine the effect of monetary policies implemented by central banks on stock market volatility because volatility is one of risk measures. Increase in the volatility implies means higher risk (Lim and Sek, 2013). Daly (2008) expresses that high volatility of stock market can reduce investors' confidence, economic activity and investments.

The relationship between monetary policy and stock market constitutes first stage of effect of monetary policy on real economy via

[*] *Institute of Social Sciences, Department of Economics, Ege University, Turkey.*
[**] *Institute of Social Sciences, Department of Economics, Ege University, Turkey.*

channels of monetary transmission such as the wealth effect, the investment effect, the balance sheet effect and the liquidity effect (Mishkin, 1976). Another way to explain the so-called relation bases on the theory of asset pricing. According to this theory, monetary policy affects stock market prices with two ways: cash flows and discount rate (Bernanke and Kuttner, 2005). One of determinants of stock market volatility is monetary policy. Monetary policy decision can increase or decrease stock market prices by affecting short term interest rate. A contractionary monetary policy rises interest rate and leads to reduce stock market prices (Qayyum and Anwar, 2011; Zare, Azali and Habibullah, 2013).

Interest rate declaration by major cental banks affects especially emerging financial markets. These declarations affect the expected values of discounted cash flows by changing short-run interest rate, and thus lead to increase or decrease in stock prices. The higher stock prices and stock returns cause the lower stock market volatility. This situation is called as “leverage effect” (Zare et. al., 2013). As examined the literature about the effect of declaration by central banks on stock market, especially FED’s news are priced by market participants in other countries (Miyakoshi, 2003; Kim, 2003, 2005; Phyklaktis and Ravazzolo, 2005).

We purpose to exhibit the effect of decisions to increase or decrease interest rate implemented by CBRT and FED on Borsa Istanbul index volatility. We came across only a study analysing impact of monetary policy on Turkish stock market volatility (Çelik et. al, 2015). Çelik et. al indicated that impact of a change in CBRT’s policy rate and forward guidance of CBRT, FED and ECB on volatilities of 1. session and 2. session of Borsa Istanbul. However, their study did not consider long memory. So, in this study we estimated so-called relationship by FIAPARCH model taking into account long memory in volatility. Therefore, we aim to contribute to literature. The other contribution of this study is to examine separately effects of both reduction and increment decisions in interest rate. Therefore, we can compare the effect sizes for both decisions and revealed which decision is more effective on stock market volatility in Turkey.

2. Literature Review

It is largely examined how monetary policy affect stock market volatility in the literature (Lobo, 2002; Bomfim, 2003; Chen and Clements, 2007; Farka, 2009; Vahammaa and Aijo, 2011). Some of these studies embrace so-called relationship in terms of volatility asymmetry (Lobo, 2000; Bernanke and Kuttner, 2005, Chulia et. al., 2010). Lobo (2000) examined the effect of changes in FED interest rates on stock market volatility using ASAR-EGARCH model and stated that expected monetary policy changes are perceived as a signal by investors, and thus the changes in policy interest rates have not any effect on stock market volatility when expected. Kim and Honda and Kuroki (2006) revealed the response of stock market to the monetary policy in Japon. They pointed out that unexpected interest rate reductions augment stock market returns and diminish stock market volatility. Nguyen (2009) examined the spillover effect of FED's and ECB's interest rate announcements on 12 stock market returns and volatilities in Asia-Pacific for 1999-2006 using GARCH models. Stock market returns decreases In case of unexpected increases in policy interest rate. In addition, the announcements made by both central banks raise stock market volatilities. The news about FED' and ECB's policy decisions lead to persistence in volatility. FED's announcements are more quickly absorbed by market participants than ECB's news. Chulia vd. (2010) examined that the asymmetric impacts of FED announcements on stock market volatility using realized volatility over the period of 1997-2006. In the study, they used high-frequency intraday data connected S&P100. In the result of the analysis, they found that bad news more affected stock market volatility than good news. Moreover, presence of news is more important for bad news while the magnitude of so-called news is more important for good news. Chulia et. al. (2010) indicated that the responses of stock market volatility to FED's announcements about negative and positive interest rate decisions are different using realized volatility model. The effect size of positive interest rate decisions is higher. Kishor and Marfatia (2013) stated that the responses of stock markets in emerging countries and Europe to FED's monetary policy surprises are negative and higher in crisis periods.

Also, there are the few studies which has investigated so-called relationship over different business cycles (Guo, 2004;

Andersen et. al., 2007; Chen et. al., 2007; Jansen and Tsai, 2010; Chen, 2013). Konrad (2009) stated that the response of German stock market volatility to interest rate changes made by central bank is higher in bear markets. Using pooled mean group estimation and Markov switching regression, Zare et. al. (2013) found that interest rate increases made by central bank affect strongly stock market volatility in bear markets than bull markets in ASEAN5 over the period of 1991:1-2011:12. This indicates that monetary policy is more effective in bear markets. Chen (2013) investigated how FED monetary policy movement affected airline, gambling, hotel and travel and leisure index returns in bull and bear markets. For this purpose, he utilised from event study based on Markov-switching model. From the result of the study, it was seen that airline, gambling and hotel index returns gave greater reaction to monetary policy in bear markets in comparision to bull markets. However, travel and leisure index returns was greatly affected by monetary policy in bear markets.

As examined the studies in Turkey, Duran et. al (2010) analysed impact of monetary policy on stock market prices and market interest rates by using GMM method considering heteroscedasticity and found that raises in policy rate reduce stock market prices. Duran et. al (2012) examined effect of monetary policy on asset prices by heterocedastic-based GMM method and conclude that raises in policy rate cause decreases in stock market prices. Çelik et. al (2015) indicated effects of CBRT's policy rate and forward guidance of CBRT, FED and ECB on 1. session and 2. session volatilities of Borsa Istanbul. They used GARCH, EGARCH, TARCH, GJR-GARCH and APARCH models. In the end of this study, they found that a raise in policy rate lead to decrease volatility of session, forward guidance raises volatilities of 1. session and 2. session, but it decreases volatility in whole day. Gökalp (2016) investigated effects of lower bound and upper bound of interest rate corridor on Turkish stock market return by using event study and GMM method. From estimation results of his study, he concluded that raises in upper bound lead to decrease stock market prices while decreases in lower bound cause to increase stock market prices. When examined discrimination of sectors, he found effects of lower bound and upper bound differentiate regarding sectors. Gökalp (2016) analysed separately impacts of expected and unexpected monetary policy on stock market prices. From his estimation results, he inferred that both expected and unexpected interest rate decisions affect negatively and significantly stock market prices and effect of unexpected interest rate decision is more than expected interest rate decision.

3. Data and Methodology

In this study, we used APARCH and FIAPARCH models in order to obtain conditional volatility of BIST 100 index. APARCH model is introduced by Ding, Garnger and Engle (1993). APARCH model determines fat tail, excess kurtosis and leverage effect. This model is expressed as follows:

$$y_t = x_t\xi + \varepsilon_t \qquad t = 1,2,\dots,T$$

$$h_t^2 = \omega + \sum_{j=1}^{q} \alpha_j \left(|\varepsilon_{t-j}| - \gamma_j\varepsilon_{t-j}\right)^{\delta} + \sum_{i=1}^{p} \beta_i (h_{t-i})^{\delta}$$

$$\varepsilon_t = \sigma_t z_t \quad , z_t \sim N(0,1)$$

$$k(\varepsilon_{t-j}) = |\varepsilon_{t-j}| - \gamma_j\varepsilon_{t-j}$$

$$y_t = x_t\xi + \varepsilon_t \ ; \ t = 1,2,\dots,T,$$

mean equation, can be rewritten as

$$y_t = E(y_t|\psi_{t-1}) + \varepsilon_t.$$

where $\psi_t = \{y_t, y_{t-1}, \dots, y_1, y_0, x_t, x_{t-1}, \dots, x_1, x_0\}$. $\xi, \omega,\ \alpha_j, \gamma_j,\ \beta_i$ ve δ are parameters. γ_j is leverage effect. Positive γ_j states that negative information have a stronger effect on volatility than positive information.

Volatility tends to change quite slowly over time in APARCH model. Thus, the Fractionally Integrated APARCH (FIAPARCH) model is developed by Tse (1998). FIAPARCH model takes into account long memory in volatility. FIAPARCH (p,d,q) model is expressed as follows:

$$\sigma_t^{\delta} = \omega[1-\beta(L)]^{-1} + \{1 - [1-\beta(L)]^{-1}\emptyset(L)(1-L)^d\}(|\varepsilon_t| - \gamma\varepsilon_t)^{\delta}$$

where $-1 < \gamma < 1$ and $\delta > 0$. When γ is positive, negative information have a stronger effect on volatility tahn positive information. If $0 < d < 1$, the conditional volatility shows long memory characteristic. When d=0, FIAPARCH model reduces to the APARCH model.

The aim of this study is to compare effects of monetary policies implemented by CBRT and FED on the volatility of BIST 100 index. Thus, we used dummy variables that reflect policy rate increase and reduction decisions. We used BIST 100 stock market daily closing price index covering the period of 02.01.2004-31.01.2017. BIST 100 index is drawn from Yahoo Finance database. We calculated return series as follows:

$$r_t = \frac{log(P_t)}{log(P_{t-1})}$$

where P_t is closing price of BIST 100 index. All variables used in the study are shown in Table 1.

Table 1

Variables Used In The Study and Their Defitions

Değişkenler	Açıklamaları
RBIST100	Daily return of Borsa Istanbul 100 (BIST 100) index
Dummy	Dummy variable indicating interest rate increase or reduction decisions made by central banks

Figure 1

Daily Returns of BIST 100 Index

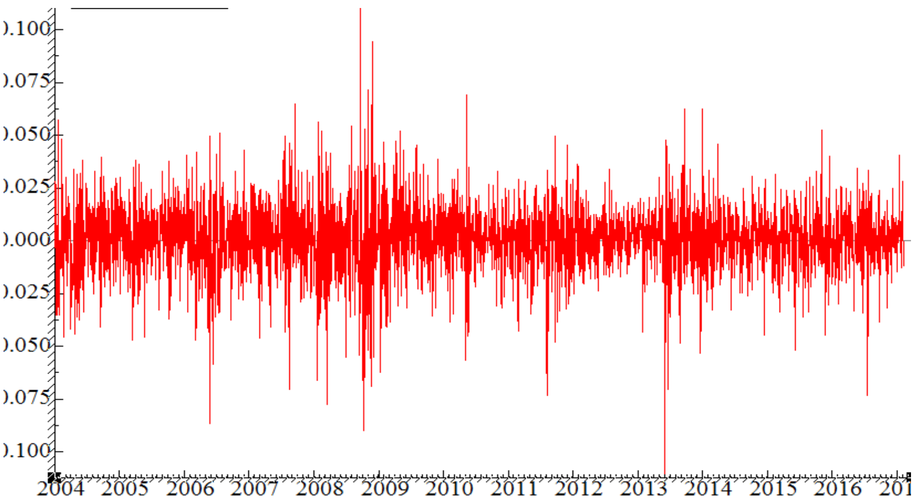

Figure 1 show daily BIST 100 index return. As examined Figure 1, it has seen that large changes in the return tend to be follow by large change and small changes tend to be follow by small changes. This situation is defined as volatility cluster. Besides, it can be expressed that the volatility rises in 2007 and 2008 years when reflect financial crisis periods.

Table 2

Descriptive Statistics of BIST 100 Return

Statistics	BIST100
Mean	0.000448
Median	0.000429
Standart Devition	0.016803
Skewness	-0.272470
Kurtosis	6.508303
J-B	1779.427***
Q(15)	22.639*
Observation	3388

Notes: *, **, *** *represent the significance at 10%, 5% and 1% levels.*

The descriptive statistics relating to so-called return are seen in the Table 2. As examined Table 2, mean of the return is positive. According to skewness and kurtosis values, returns are not normally distributed and display the characteristic fat-tailed behaviour. When considered Q(15) statistics, it is seen that returns have serial dependence.

4. Empirical Results

We utilized from APARCH, FIAPARCH-BMM and FIAPARCH-CHUNG models to analyze sensitive of the stock market volatility to both CBRT's and FED's interest rate decisions in Turkey. Table 3 reports APARCH, FIAPARCH-BMM and FIAPARCH-CHUNG model estimation results.

Table 3
APARCH, FIAPARCH-BMM and FIAPARCH-CHUNG Model Estimation Results

Models	APARCH(1,1)	FIAPARCH-BMM(1,1)	FIAPARCH-CHUNG
α_0	0.732409***	1.782937	85.017234
	(1.5288)	(2.3669)	(70.343)
α_1	0.090331***	0.099467	0.135874
	(0.018250)	(0.10765)	(0.10392)
β_1	0.844386***	0.236783**	0.315231***
	(0.033364)	(0.11342)	(0.10273)
γ_1	0.427965***	0.551390***	0.626634***
	(0.18371)	(0.17598)	(0.20132)
δ_1	1.653690***	1.618179***	1.281916***
	(0.48141)	(0.25033)	(0.18892)
GED	1.536929***	1.318205***	1.325310***
	(0.001971)	(0.055922)	(0.056356)
d-Figarch		0.220952***	0.264644***
		(0.049483)	(0.035835)
Akaike	-5.450183	-5.540229	-5.541516
Schwarz	-5.435208	-5.514907	-5.523428
Q(50)	197.79***	59.5216	60.0046
ARCH-LM(5)	0.80444	0.37310	0.53898
$Q^2(50)$	42.9818	40.2473	42.6844

*Notes: Standard errors are given in parenthesis; Q(50) is Ljung-Box Q test statistics at lags 50; *, **, *** represent the significance at 10%, 5% and 1% levels; ARCH-LM is heteroscedasticity test statistics; $Q^2(50)$ is Ljung-Box test statistics relating to square errors at lags 50; d-Figarch is test statistics relating to long memory.*

As examined diagnostic test results relating to residuals from APARCH(1,1) model, it is seen that autocorrelation problem at 50th lag is not removed. Also, d parameters indicating long memory in FIAPARCH-BMM(1,1) and FIAPARCH(1,1) models are significant at 0.01 significant level. This situation means that APARCH model have long memory. According to Akaike and Schwarz information criteria, FIAPARCH-CHUNG(1,1) model was selected. Tale 5 reports the estimation results of FIAPARCH-CHUNG(1,1) model created to exhibit the effects of CBRT's and FED's interest rate increase and reduction decisions on BIST100 index volatility.

Table 4

FIAPARCH-CHUNG Model Estimation Results Relating to CBRT's and FED's Interest Rate Decisions

Models	Interest Rate Increment Decisions		Interest Rate Reduction Decisions	
	CBRT	FED	CBRT	FED
α_0	85.741218	84.958527	83.132739	114.458148
	(76.183)	(78.055)	(74.428)	(71.107)
α_1	0.137816	0.134981	0.131651	0.153411
	(0.10398)	(0.10547)	(0.10213)	(0.10572)
β_1	0.320344***	0.314145***	0.312415***	0.343884***
	(0.10230)	(0.10378)	(0.10117)	(0.10864)
γ_1	0.621529***	0.626544***	0.612511***	0.664502***
	(0.20858)	(0.21263)	(0.20477)	(0.18043)
δ_1	1.280437***	0.20791***	1.289441***	1.228700***
	(0.20152)	(6.167)	(0.20322)	(0.14732)
Dummy	0.002155	-0.000313	-0.001064	-0.002242*
	(0.0023509)	(0.00090029)	(0.00086522)	(0.0014672)
GED	1.326359***	1.325565***	1.328468***	6.510186***
	(0.056436)	(0.056392)	(0.056458)	(0.73450)
d-Figarch	0.265723***	0.264548***	0.266519***	0.274590***
	(0.036087)	(0.036256)	(0.035799)	(0.035320)
Akaike	-5.541375	-5.540945	-5.542137	-5.541916
Schwarz	-5.521479	-5.521049	-5.522241	-5.522020
Q(50)	59.7211	59.8945	59.7306	59.3266
ARCH-LM(5)	42.7748	0.54557	0.45642	0.60111
$Q^2(50)$	0.59284	42.7262	41.1285	42.7208

*Notes: Standard errors are given in parenthesis; Q(50) is Ljung-Box Q test statistics at lags 50; *, **, *** represent the significance at 10%, 5% and 1% levels; ARCH-LM is heteroscedasticity test statistics; $Q^2(50)$ is Ljung-Box test statistics relating to square errors at lags 50; d-Figarch is test statistics relating to long memory.*

As seen in Table 5, γ_1 variable indicating leverage effect is significant at 0.01 level and positive for all models. This situation states that negative news have a stronger impact on stock market volatility than positive news. However, dummy variable indicating interest rate decisions of central banks is not significant for all models. In other words, BIST100 volatility is not susceptible to interest rate increase and reduction decisions made by CBRT and

FED. The reason is that so-called decisions are expected by market participants and investors, and they priced previously these decisions. Besides, d parameter is significant for all models. In other words, shocks are persistent effect on BIST100 volatility.

5. Conclusions

In this study, we analysed impact of decisions to increase and decrease in policy rates made by CBRT and FED on stock market volatility in Turkey. In this purpose, we estimated APARCH(1,1), FIAPARCH-BMM(1,d,1) and FIAPARCH-CHUNG(1,d,1) models and found that the most appropriate model considering the persistence in volatility is FIAPARCH-CHUNG(1,d,1) model. The estimation results of this model indicated that stock market volatility is not sensitive to so-called central banks' interest rate decisions in Turkey. This is because the expected interest rate announcements are priced by the market participants and investors in advance. Besides, there exists positive leverage effect, which means negative information have higher effect on stock market volatility than positive information.

References

1. Andersen, T. G., Bollerslev, T., Diebold, F. X., & Vega, C. (2007). "Real-time price discovery in global stock, bond and foreign exchange markets", Journal of International Economics, 73, 251–277.
2. Bernanke, B., & Kuttner, K. N. (2005). "What explains the stock market's reaction to Federal Reserve policy?", The Journal of Finance, 60(3): 1221-1257
3. Bomfim, A. N. (2003). "Pre-announcement effects, news effects, and volatility: Monetary policy and the stock market", Journal of Banking and Finance, 27(1): 133-151.
4. Çelik, Ş., Erer, D., Erer, E. and Güleç, Tuna C. (2015). "TCMB Para Politikası Kararlarındaki ve TCMB, FED ve ECB Sözlü Yönlendirmelerinin BIST 100 Oynaklığı Üzerindeki Etkisinin Analizi (2002-2014)", Maliye Finans Yazıları 103, 51-84.
5. Chen, E. T. J., & Clements, A. (2007). "S&P 500 implied volatility and monetary policy announcements", Finance Research Letters, 4(4): 227-232

6. Chen, Ming, Hsiang (2013). "Asymmetric Response of Hospitality Stock Prices to FED Policy Actions", International Journal of Hospitality Management, 33: 129-139.
7. Chulia, H., Martens, M., & Dijk, D. (2010). "Asymmetric effects of federal funds target rate changes on S&P100 stock returns, volatilities and correlations", Journal of Banking & Finance, 34(4): 834-839.
8. Daly, K. (2008). "Financial Volatility: Issues and Measuring Techniques", Physicia A 387, 2377-2393.
9. Ding, Z.; Granger, C.W.J. and Engle, R.F. (1993). "A Long Memory Property of Stock Market Returns and a New Model", Journal of Empirical Finanace 1, 83-106.
10. Duran, M., Gürkaynak, R., Özlü, P. and Ünalmış, D. (2010). "TCMB Faiz Kararlarının Piyasa Faizleri ve Hisse Senedi Piyasaları Üzerine Etkisi", Central Bank Review, 2010-8.
11. Duran, M., Özcan, G., Özlü, P. and Ünalmış, D. (2012). "Measuring The Impact of Monetary Policy on Asset Prices in Turkey", Economic Letters 114, 29-31.
12. Farka, M. (2009). "The effect of monetary policy shocks on stock prices accounting for endogeneity and omitted variable biases", Review of Financial Economics, 18(1): 47-55.
13. Gökalp, B.T. (2016). "Para Politikası Kararlarının Hisse Senetlerinin Fiyatları Üzerindeki Etkileri", Suleyman Demirel University The Journal of Faculty of Economics and Administrative Sciences 21(4), 1379-1396.
14. Guo, H. (2004). "Stock prices, firm size, and changes in the federal funds rate target", The Quarterly Review of Economics and Finance, 44(4), 487-507.
15. Honda, Y. ve Kuroki, Y. (2006). "Financial and Capital Markets' Responses to Changes in the Central Banks' Target Interest Rate: The Case of Japan", The Economic Journal, sayı: 116, no: 513, WILEY, 812-842.
16. Jansen, D. W., & Tsai, C. L. (2010). "Monetary policy and stock returns: Financing constraints and asymmetries in bull and bear markets", Journal of Empirical Finance, 17, 981-990.
17. Kim, S. and Nguyen, D. Q. (2009). "The Spilover Effects of Target Interest Rate News From the U.S. FED and the European Central Bank on the Asia-Pacific Stock Markets", International Financial Markets, Institutions and Money, 19: 415-431

18. Kim, S.-J., (2003). "The spillover effects of U.S. and Japanese public information news in advanced Asia-Pacific stock markets", Pacific Basin Finance Journal 11, 611-630.
19. Kishor, N. K. and Marfatia, H. (2013). "The Time-Varying Response of Foreign Stock Markets to U.S. Monetary Policy Surprises: Evidence From the Federal Funds Futures Market", International Financial Markets, Inst. and Money, 24: 1-24.
20. Konrad, E. (2009). "The impact of monetary policy surprises on asset return volatility: the case of Germany", Financial Markets and Portfolio Management, 23(2), 111-135.
21. Lim, C.M. and Sek, S.K. (2013) "Comparing thr Performances of GARCH-type Models in Capturing The Stock Market Volatility in Malaysia", Procedia Economics and Finance 5, 478-487.
22. Lobo, B. (2000). "Asymmetric Effects of Interest Rate Changes on Stock Prices", The Financial Review, Eestern Finance Association, 35, 125-144.
23. Lobo, B. J. (2002). "Interest Rate Surprises and Stock Prices", Financial Review, 37(1): 73-91.
24. Mishkin, F.S. (1976). "Illiquidity, Consumer Durable Expenditure and Monetary Policy", The American Review, 642-654.
25. Miyakoshi, T. (2003). "Spillovers of stock return volatility to Asian equity markets from Japan and the U.S.", Journal of International Financial Markets, Institutions, and Money 13, 383-399.
26. Phylaktis, K., Ravazzolo, F., 2005. "Stock market linkages in emerging markets: implications for international portfolio diversification", International Financial Markets, Institutions and Money 15, 91-106.
27. Qayyum, A. and Anwar, S. (2011). "Impact of Monetary Policy on the Volatility of Stock Market in Pakistan", MPRA Paper No. 31188.
28. Tse, Y.K. (1998). "The Conditional Heteroscedasticity of the Yen-Dollar Exchange Rate", Journal of Applied Econometrics 193, 49-55.
29. Vahamaa, S., & Aijo, J. (2011). "The Fed's policy decisions and implied volatility", The Journal of Futures Markets, 31(10): 995-1009

30. Zare, R.; Azali, M. and Habibullah, M.S. (2013). "Monetary Policy and Stock Market Volatility in the ASEAN5: Asymmetries Over Bull and Bear Markets", Procedia Economics and Finance 7, 18-27.