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Comparing the Effects of Policy Interest Rate Surprises on Foreign Exchange and Stock Index Futures and Spot Markets for Turkey

Macide Çiçek
Assoc. Prof. Dr., Departmant of Economics
Faculty of Economics and Administrative Sciences
Dumlupınar University, Kütahya, Turkey
E-mail: macide_cicek@yahoo.com

Abstract

This study examines the impact of unexpected monetary policy interest rate decisions on foreign exchange futures and spot markets and stock index futures and spot markets in Turkey for the period from January 2006 to April 2010 using T-GARCH (1,1) model. The unexpected Central Bank of Republic of Turkey's overnight borrowing rate changes cause foreign exchange futures and spot returns to rise. Surprise changes have the largest effect on foreign exchange spot returns among all the markets. On the other hand, surprises have a weak influence on foreign exchange futures market returns. The reactions of futures and spot stock index returns to surprises are not significant. Surprises lead to reduce volatility in foreign exchange futures market while enhance in the spot market on the announcement day. The spot stock market volatility doesn't react to monetary surprises significantly on the announcement day while stock futures market volatility does. The policy announcement effect on both the futures and spot stock and foreign exchange markets' volatility continues on the days after the announcement, generally. The reaction of foreign exchange futures market volatility to surprises is the shortest-lived among the markets.

Keywords: Monetary Policy Surprises, Financial Market Reaction to Monetary Policy, Futures Markets, Spot Markets, T-GARCH, Turkey.
JEL Classifications Codes: E44, G12, G14.

1. Introduction

Impact of monetary policy target rate announcements on financial markets has a great importance for investors, policymakers, financial press and academicians. However, not all target rate changes have an effect on asset prices. According to Efficient Market and Rational Expectation hypotheses, only surprise (unexpected) component of target rate changes leads to a significant reaction of asset prices. An expected component of target rate changes may have already been taken into account in asset prices, and not affect them. If the actual target rate announcement is different from that already priced, asset prices would react to this surprise component accordingly, as suggested by Bernanke and Blinder (1992), Kuttner (2001), Bonfim (2003), and Bernanke and Kuttner (2005), among the others. The key issue here is how we measure and separate the expected and unexpected component of monetary policy announcements.

The aim of this study is to determine whether or not there is a difference between the effects of the surprise component of monetary policy announcements on the futures and spot markets categories and to compare the effects with regard to magnitude and speed. With this purpose, this paper investigates the response of the TRY/USD foreign exchange and ISE (Istanbul Stock Exchange) 30 stock index futures and spot markets to unexpected changes in the overnight borrowing rate as a policy interest rate in Turkey for the period from January 2006 to April 2010 by using T-GARCH (1,1) model. After May 18, 2010 the overnight borrowing rate lost policy interest rate nature and one-week repo lending rate gained the main interest rate qualification. In this study, overnight borrowing rate is employed as a policy instrument for the purpose of overlap the period considered.

Central Bank of the Republic of Turkey (CBRT) has been adopted explicit inflation targeting regime since January 1, 2006. CBRT uses short time interest rates as the main policy instrument to achieve and maintain its primary objective of price stability. At the beginning of explicit inflation targeting, CBRT Monetary Policy Committee (MPC) became the decision authority.[1] The interest rate decisions are taken by MPC at the present time. Decisions are made on a voting basis. The analyses and rationale of interest-rate decisions have published shortly after each meeting.

The rest of the paper is structured as follows. The next section reviews the literature. Section 3 describes the calculation of monetary policy surprise both in the literature and in this study with some descriptive statistics. Section 4 presents the empirical model and Section 5 describes the data. Section 5 provides preliminary data analysis for empirical modelling. Section 6 reports empirical results. Section 7 concludes the paper.

2. Previous Research

There has been a growing literature examining the relationship between monetary policy and either the stock or exchange market. Thorbecke (1997), Patelis (1997), Lobo (2002), Rigobon and Sack (2004), Bernanke and Kuttner (2005) find that unexpected changes are negatively related to changes in stock prices, among the others. For example, Rigobon and Sack (2004) report that an unexpected 25-basis-point decrease in the three-month eurodollar futures rate leads to a 1.7 percent increase in the S&P 500 index. Laopadis (2010) find that a disconnection between FED actions and stock market responses in the 1990s relative to in the 1970s and 1980s. In the context of foreign exchange markets, the literature suggest that a positive interest rate surprise should lead to an appreciation of the exchange rate. However, there is a disagreement among theories regarding the direction and the nature of the monetary policy impact on exchange rates.[2] Fatum and Scholnick (2008) find that monetary policy surprises significantly affect exchange rates. On the other hand, Bomfim and Reinhart (2000) and Newby (2002) argue that neither stock market indices nor the foreign exchange rates respond to unexpected interest rate changes.

The asymmetric response in asset prices to bad and good news has been widely analyzed in the literature. Bomfim (2003) finds that positive surprises[3] (meaning bad news for stocks) in Federal funds target rate changes tend to have a larger effect on daily S&P 500 index volatility than negative surprises. Engle and Ng (1993) study the asymmetric response of volatility to lagged stock returns and find that volatility increases more after negative returns. Bernanke and Kuttner (2005) finds that a positive surprise causes a large and significant decline in equity returns. Bernanke and Kuttner (2005) study the effect of FOMC (US Federal Open Market Committee) decisions on daily stock returns but find no evidence for asymmetry. Laopadis (2010) finds that stock prices are more sensitive to changes

1 Prior to 2006, CBRT had implemented implicit inflation targeting as a transition period between 2002 and 2005. Monetary policy decisions were made by the Governor at monthly meetings. MPC played an advisory role. In 2005, monthly meetings of the MPC became pre-scheduled.

2 See Bonser-Neal et al. (2000).

3 A positive surprise (i.e., unexpected increase in the policy interest rate) means that the target rate was increased more or decreased less than the market anticipated. Similarly, a negative surprise (i.e., unexpected decrease in the policy interest rate) means that the target rate was increased less or decreased more than the market anticipated.

in FED's monetary policy during bear markets than bull markets for the period of January 1970 to December 2004 in US. Andersen et al. (2003) examine announcement effects on spot foreign exchange market volatility and find that bad news has greater impact than good news on exchange rates.

Among the studies which examining futures markets, Bauwens et al. (2005) show that EUR/USD return volatility increases in the pre-announcement periods, particularly before scheduled events and changes in volatility are small in the post-announcement period by using high frequency data sampled at the five-minute frequency. Frino and Hill (2001) examines intraday futures market behaviour around major scheduled macroeconomic information announcements on the Sydney Futures Exchange and find that the majority of adjustment to new information occurs rapidly, within 240 seconds. Simpson (2008) finds that dollar-denominated currency futures prices drop significantly in response to positive surprises but have generally little response to negative surprises. Andersen et al. (2007) characterize the real-time interactions among US, German and British stock, bond and foreign exchange markets to US macroeconomic news using a unique high-frequency futures data set and find that equity markets react differently to news depending on the stage of the business cycle, in particular, bad macroeconomic news has a negative impact on equity market during contractions, but a positive impact during expansions. When conditioning state of the economy, equity and foreign exchange markets appear equally responsive and bond markets react most strongly to macroeconomic news. Lu and Huo (2007) document a weak relationship between monetary surprises and stock index futures in Ausralia for the period from January 1, 1998 to December 31, 2004 using intra-day futures data. For the same country, Lu et al. (2007) investigates the impact of monetary policy surprises on the Australian stock price index futures, AUD/USD exchange futures and 3- and 10-year Treasury bond futures contracts using 30-day and 90-day bank accepted bill rate for the period of January 1996-June 2005. Authors find that the Reserve Bank's surprises have a strong contemporaneous impact on all futures markets when expected monetary policy changes are measured by using 30-day bank accepted bill rate.

The studies that examining futures and spot market's contribution to price discovery, for example, Crain and Lee (1995), Chatrath and Song (1998), Martens and Kofman (1998), Tse et al. (2006), Rosenberg and Traub (2009) find that foreign exchange futures market contributes more to price discovery than does the spot market. Chen and Gau (2010) study how JPY/USD and EUR/USD foreign exchange spot and futures markets respond to news surprises collecting one minute's prices surrounding the releases of major US macroeconomic announcements for the period January 1, 2004 to December 31, 2005 and find the spot rates provide more price discovery than do the futures rates overall; however, the conribution of the futures rates to price discovery increases significantly with trading volume but decreases with the spot market's trading volume.

In Turkey, Aktas et al. (2009) examine the responses of spot ISE 100 stock index, ISE financial index, exchange rates (TRY/Euro and TRY/USD) and some variables to the expected and unexpected CBRT interest rate surprises covering the July 2001-August 2008 period using regression analysis. Authors find that ISE 100 and ISE financial react to monetary surprises insignificantly and exchange rates' reaction is small. They observe that the relationship between monetary surprises and the reactions of stock and foreign exchange markets is not regular. Demiralp and Yilmaz (2010) measure monetary policy expectations through the surveys conducted by CBRT and find that the spot stock market doesn't behave in accordance with the Efficient Market Hypothesis in the January 2002-July 2009 period in Turkey. Cicek (2012) examines the reactions of the three futures markets to the CBRT's policy interest rate surprises, those of TRY/USD foreign exchange, ISE 30 stock index and Treasury-Benchmark interest rate markets in Turkey from 2006 to 2010. According to the empirical results of this study, monetary surprises lead to depreciation of Turkish Lira against dollar significantly and insignificant impacts on the stock index and interest rate futures contracts prices. CBRT's monetary surprises reduce volatility only for foreign exchange futures market on the announcement days, significantly.

3. Measures of Monetary Surprises

Measuring monetary policy surprises may be separated into two categories according to the literature: i) surprises measured by marked-based expectations, ii) surprises measured by survey-based expectations. In the first category, Kuttner (2001) and Bernanke and Kuttner (2005) derive monetary policy surprises through measures of market expectations obtained from federal funds futures contracts. Kuttner (2001) estimates the effect of changes in the Fed funds rate on the treasury bills, notes and bonds using the event study approach for US for the period from 1989 to 2000. The author defined monetary policy surprises as the changes in the Federal Reserve funds future rate on event days and the difference between actual interest rate changes and unexpected changes are the expected changes. His main contribution is to decompose expected changes from unexpected changes using the change in the one-month Fed funds futures yield on the day of the announcement. Bernanke and Kuttner (2005) use Kuttner's (2001) futures methodology to decompose the federal funds rate changes into expected and unexpected changes. Federal funds futures rate is subsequently adopted by Carlson et al. (1995), Robertson and Thornton (1997), Poole and Rasche (2000), Söderström (2001), Bomfim (2003), Faust et al. (2003), Rigobon and Sack (2004), Gurkaynak et al. (2005), and Zebedee et al. (2006), among the others. Gurkaynak et al. (2002) found the Federal Reserve funds future rate is the best measurement of market expectations among six different instruments at horizons for time frames up to approximately five months out. Similarly, Krueger and Kuttner (1996) find that federal funds futures rates are excellent predictors of the federal funds rate. Kuttner (2001) uses the current-month federal funds futures contract; however, Cochrane and Piazzesi (2002) use the one-month Eurodollar rate and Jegadeesh and Pennacchi (1996), and Rudebusch (2002) use the three-months Eurodollar rate. On the other hand, Lamont et al. (2001), Perez-Quiros and Timmermann (2000) use changes in market interest rates or official rates but not futures rates as measures of monetary policy.

In the second category, Ehrmann and Fratzscher (2004), and Reinhart and Simin (1997) identify monetary policy surprises through market expectations obtained from surveys of market participants. Ehrmann and Fratzscher (2004) denote that survey expectations prove to be unbiased and efficient and are very similar to expectations data based on federal funds futures, as employed by Kuttner (2001) and Bernanke and Kuttner (2005). Gurkaynak and Wolfers (2006) find that central tendencies of market-based forecasts are very similar to, but more accurate than surveys.

In this study, the Treasury bill yield which have the shortest maturity is used as a proxy for market participants' expectations to measure and separate the expected and unexpected changes in the CBRT's overnight borrowing rate in Turkey. Shortly, this study uses the Treasury bill rate which has the shortest maturity in the secondary market as an indicator of monetary policy. This is the most flexible short-term interest rate and it may possibly reflect the information content that brings on the changes of policy target rate. Change in market interest rate, developed in Kuttner (2001), is a good proxy for the policy surprise. For Turkey, Cicek (2012) finds that the Treasury bill yield which have the shortest maturity puts in a better performance of reflecting market expectations than the Treasury bill yield which has approximately 90-day maturity. Using this rate, the expected and unexpected components of monetary announcements are calculated as in equation (1) and (2), respectively (See, Lu et al., 2007). Firstly, the expected component of borrowing rate movement, $\Delta R^{e}_{ON,t}$, is calculated as follows:

$$\Delta R^{e}_{ON,t} = R_{t-1} - R_{t-(j-1)}. \tag{1}$$

where R_{t-1} is the Treasury bill yield which have the shortest maturity on the day before a target change; $R_{t-(j-1)}$ is the Treasury bill yield after the previous target change made on the day t-j. Then, the surprise component, $\Delta R^{u}_{ON,t}$, is then calculated as the difference between the actual target change an the expected target change by using equation (2).

$$\Delta R^{u}_{ON,t} = \Delta R_{ON,t} - \Delta R^{e}_{ON,t}. \tag{2}$$

The CBRT overnight borrowing rate data are obtained from Monetary Policy Committee Meeting Decisions at CBRT web page, the Treasury bill yield data which have the shortest maturity are obtained from ISE Bonds and Bills Market Daily Bulletins.

Appendix 1 lists the CBRT meeting dates and the changes in the CBRT overnight borrowing rate target together with the change in the market interest rate (the monetary surprise measure) and the corresponding surprises. In total, the sample includes 54 announcements. The target rate decreases from 13.50% to 6.50% between January 23, 2006 and April 13, 2010. There are 26 positive surprises and 28 negative surprises in the overnight borrowing rate. For example, CBRT lowered the target rate by 0.25% (25 basis points) while market was anticipating a decrease by 0.50% (50 basis points) on April 27, 2006. In this case, a positive surprise occured. CBRT leaved the target rate unchanged while market was anticipating a rise on June 28, 2006, leading to a negative surprise. The average surprise for the 54 CBRT meetings is close to zero and equal to -0.002% with a standart deviation of 0.84%. Maximum surprise is equal to 2.41% and minimum surprise is equal to -1.62%. The distribution of surprises is somewhat asymmetric with skewness equal to 0.54. Kurtosis value is equal to 3.48 and exceeds 3.

4. The Model

In this study, the T-GARCH model is used to test the impact of monetary surprises on Turkish financial asset returns and return volatility to take care of existing leverage effect. It is often observed in financial markets research that a downward price movement in the market will generate a higher volatility response than an equivalent upward movement. This is described as asymmetric news impact. In order to capture asymmetric news impact, the T-GARCH specification proposed by Glosten, Jaganathan, and Runkle (1993) and Zakoian (1994) is used in this study. The T-GARCH model allows a response of volatility to news with different coefficients for good and bad news. As is seen later on, descriptive statistics have supported the use of GARCH model.

The extended T-GARCH (1,1) model adopted for this paper is specified as follows:

$$r_{i,t} = b_{i,0} + b_{i,1} r_{i,t-1} + b_2 ms_t + \varepsilon_t ; \varepsilon_t / \Phi_{t-1} \approx N(0, h_t) \text{ ve} \tag{3}$$

$$h_{t,1} = \omega + \alpha \varepsilon_{t-1}^2 + \gamma \zeta_{t-1} \varepsilon_{t-1}^2 + \beta h_{t-1} + \sum_{j=0}^{2} \theta_j ms_{t-j}. \tag{4}$$

where

$$\zeta_{t-1} = \begin{cases} 1, \text{if } \varepsilon_{t-1} < 0 \\ 0, \text{if } \varepsilon_{t-1} \geq 0. \end{cases}$$

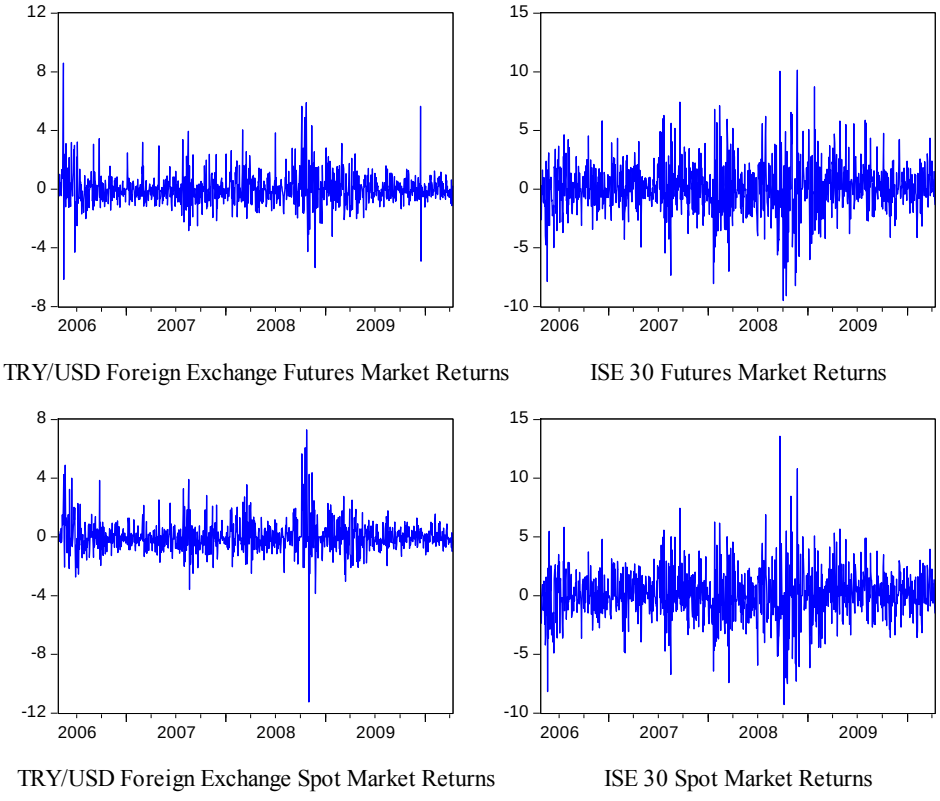
In equation (3), $r_{i,t}$ is the daily returns from market *i*, (*i* is one of the four markets considered in this study) from day t-1 to day t. t suggests that the policy interest rate announcement days. ms_t is the surprise component of the overnight borrowing rate changes. As mentioned above, the Treasury bill yield which have the shortest maturity is used to gauge the monetary surprises. $\boldsymbol{\Phi_{t-1}}$ represents the information set available at the end of day t-1. Equation (4) specifies the conditional variance. ζ_{t-1} is announcement day dummy variable. Parameter $\boldsymbol{\alpha}$ captures the ARCH effect while $\boldsymbol{\beta}$ captures the persistence in volatility. In this model, good news $(\varepsilon_t > 0)$ and bad news $(\varepsilon_t < 0)$ have differential effects on the conditional variance - good news has an impact of $\boldsymbol{\alpha}$, while bad news has an impact of $\boldsymbol{\alpha} + \boldsymbol{\gamma}$. Parameter $\boldsymbol{\gamma}$ is used to catch the asymmetric effect of return volatility. A significant $\boldsymbol{\gamma}$ means that the negative shocks have a greater effect than the positive shocks. The asymmetric nature of the returns is given by the non-zero value of the coefficient $\boldsymbol{\gamma}$, while a positive value of $\boldsymbol{\gamma}$ indicates "leverage effect". The term "leverage effect", first noted by Black (1976), refers to the volatility tends to rise in response to bad news and to fall in response to good news.

It is also tested the lagged effects of the borrowing rate movements on the returns and return volatility of selected financial futures and spot markets. Two-day lags are chosen based on Schwarz criterion.

5. Data

There are three primary data sources used in this analysis: i) surprise component of CBRT announcement data, ii) exchange rate and stock index futures data (TRY/USD exchange rate futures contract prices and ISE 30 stock index futures contract prices), iii) exchange rate and stock index spot data (TRY/USD spot rates and ISE 30 stock index spot values). The calculation of surprise component is given in Section 3. The other data consist of daily continuously returns on four assets. Daily percentage changes of prices are used as returns for each asset. TRY/USD foreign exchange futures contracts prices (**F_FXUSD**) and the ISE 30 stock price index futures contract prices (**F_IX30**) are obtained from Turkish Derivatives Exchange (TURKDEX) Data Center. The cash settlement prices are used in these futures contracts. The most traded futures contracts on the TURKDEX are selected. The ISE 30 stock price index spot values (**S_IX30**) are obtained from ISE Stock Market Daily Bulletins and the TRY/USD foreign exchange spot rates (**S_FXUSD**) are obtained from CBRT's Electronic Data Delivery System (EDDS). The sample period spans from January 2006 until April 2010. As it has been mentioned before, since the CBRT overnight borrowing rate lost policy interest rate nature on May 18, 2010, the sample is ended up in April 2010. Figure 1 plots the return series.

Figure 1: Return Series



In order to check the stationary property of concerned variables and their order of integration, the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and the Phillips-Perron (PP) (Phillips, 1987; Phillips and Peron, 1988) tests are conducted. Table 1 shows the results of the ADF and PP stationary tests of prices (raw data) and returns (daily percentage changes). The ADF and PP test statistics are greater than -3.4363 of 1% critical value so that we do not reject the null hypothesis in the

price series. This confirms that the price series are non-stationary. The null hypothesis of non-stationary is rejected for all variables at their return level at %1 significance level. Hence, it can be concluded that return series are stationary and integrated of order 1.

Table 1: ADF and PP Stationary Tests

	ADF Test Statistic	PP Test Statistic
F_FXUSD	-1.8193	-1.8321
%ΔF_FXUSD	-32.2325***	-32.2328***
F_IX30	-1.0527	-1.0686
%ΔF_IX30	-31.704***	-31.7098***
S_FXUSD	-1.7602	-1.7998
%ΔS_FXUSD	-31.2876***	-31.2767***
S_IX30	-1.0258	-1.0778
%ΔS_IX30	-31.3215***	-31.3213***

Note: *** indicates stationary time series at %1 significance level. %1 critical value is -3.4364 for ADF and PP tests.

Table 2 gives summary statistics for daily returns for selected foreign exchange and stock futures and spot markets. As can be seen in the first row of table 1, returns are positive and approximately 1% per trading day in the foreign exchange futures and spot markets and nearly 5% in the stock futures and spot markets. The magnitude of daily returns is larger in the stock markets than foreign exchange markets. The highest maximum return is observed in stock index spot returns and lowest maximum return is observed in foreign exchange spot returns. The highest minimum return is observed in foreign exchange futures returns and the lowest minimum return is observed in foreign exchange spot returns. Stock index futures and spot returns are more volatile than foreign exchange returns during the period. Because, daily standart deviation is higher than foreign exchange rate returns. All the return series are significantly positively skewed, indicating that distribution of the series has a long right tail. High positive skewness values suggest that there is a significant asymmetric response to positive shocks. Kurtosis of all series exceeds 3, which is the normal value, and the distribution for all series is peaked (leptukurtic) relative to the normal distribution. This finding is further strengthened by Jarque-Bera (JB) normality test and the null hypothesis of normal distribution is rejected at 1% level of significance for all return series.

Table 2: Summary of Descriptive Statistics on Daily Return Series

	Futures Markets		Spot Markets	
	%ΔF_FXUSD	%ΔF_IX30	S_FXUSD	%ΔS_IX30
Mean	0.0177	0.0498	0.0172	0.0482
Minimum	-6.1588	-9.4911	-11.2501	-9.2805
Maximum	8.5885	10.1386	7.2968	13.5706
Std. Dev.	1.1327	2.2358	1.1024	2.1839
Skewness	0.9193	0.1137	0.0278	0.1828
Kurtosis	10.4241	5.3039	17.7848	5.9768
Jarque-Bera	2520.333 (0.00)	230.9220 (0.00)	9517.747 (0.00)	387.5402 (0.00)

Note: Figures in brackets are p-values for JB normality test.

The results from Ljung-Box portmanteau statistics, which are used to test the null hypothesis of "No Autocorrelation" against the alternative of existence of autocorrelation, are reported in table 3. According to the results, it is strongly rejected that the null hypothesis in case of the square of the standardized residuals for all series. The assumption of homoscedasticity in the return series is found to be invalid as confirmed by the Ljung-Box test statistics for the squared returns. The presence of autocorrelation suggests that return series are dependent on the past. Notably, it is inferred that the null hypothesis is not rejected in case of standardized residuals for foreign exchange futures market due to

all Q-statistics for standardized residuals are insignificant for different lags. This may indicate weak-form market efficiency for this market.

Table 3: Autocorrelation in Residuals and Squared Residuals

	Futures Markets				Spot Markets			
	%ΔF_FXUSD		%ΔF_IX30		%ΔS_FXUSD		%ΔS_IX30	
	Q-Stat.	Prob.	Q-Stat.	Prob.	Q-Stat.	Prob.	Q-Stat.	Prob.
Q(1)	0.0545	0.815	1.6713	0.196	0.8655	0.352	2.1423	0.143
Q(3)	0.4890	0.921	2.2727	0.518	1.2177	0.749	2.7819	0.426
Q(6)	2.4987	0.869	7.2905	0.295	15.950**	0.014	5.8236	0.443
Q(10)	5.1428	0.881	9.3595	0.498	19.713**	0.032	14.232	0.163
Q(15)	16.974	0.320	23.648*	0.071	33.393***	0.004	30.553**	0.010
Q(21)	23.001	0.344	26.737	0.180	45.407***	0.002	39.410***	0.009
Q(28)	26.055	0.570	38.555*	0.088	52.960***	0.003	41.833**	0.045
Q(36)	37.641	0.384	52.482**	0.037	59.061***	0.009	67.234***	0.001
$Q^2(1)$	145.28***	0.000	13.655***	0.000	24.446***	0.000	4.2896**	0.038
$Q^2(3)$	156.73***	0.000	69.626***	0.000	29.401***	0.000	37.211***	0.000
$Q^2(6)$	185.05***	0.000	128.54***	0.000	152.78***	0.000	87.001***	0.000
$Q^2(10)$	211.82***	0.000	189.87***	0.000	241.77***	0.000	119.82***	0.000
$Q^2(15)$	232.95***	0.000	275.58***	0.000	277.36***	0.000	196.71***	0.000
$Q^2(21)$	251.25***	0.000	340.42***	0.000	339.08***	0.000	261.07***	0.000
$Q^2(28)$	276.07***	0.000	376.36***	0.000	343.99***	0.000	290.56***	0.000
$Q^2(36)$	315.45***	0.000	437.00***	0.000	345.55***	0.000	360.47***	0.000

Note: *** indicates significance at 1%; **indicates significance at 5% and *indicates significance at 10% level.

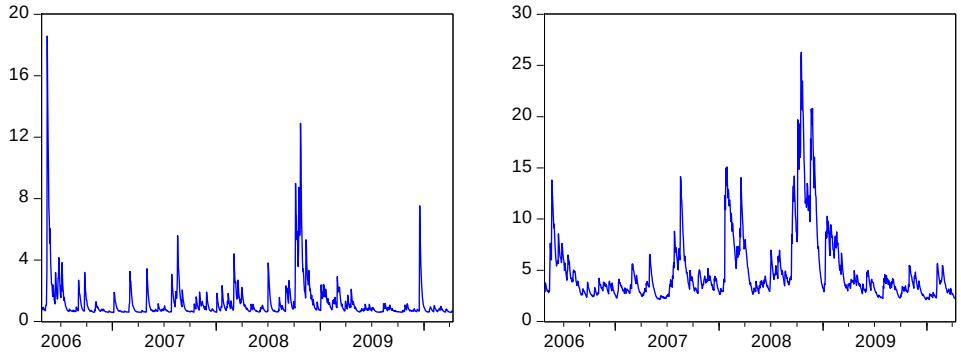
In order to confirm the presence of ARCH effect in the return series, the most commonly used test, for examining the null hypothesis of homoscedasticity against the alternative hypothesis of heteroskedasticity, is Engle's (1982) Lagrange Multiplier (LM) test is applied and the results are presented in table 4. The ARCH-LM test results show that the null hypothesis of "No ARCH Effect" is strongly rejected. F-statistics resulting from the ARCH-LM test are very significant for all returns, suggesting the presence of ARCH effect up to order 1, 3, 6, 10, 15 in the returns. Figure 2 plots the volatility series and suggests that volatility clustering is a feature of the data.

Table 4: ARCH-LM Heteroskedasticity Test

	Futures Markets				Spot Markets			
	%ΔF_FXUSD		%ΔF_IX30		%ΔS_FXUSD		%ΔS_IX30	
	F-Stat.	Prob.	F-Stat.	Prob.	F-Stat.	Prob.	F-Stat.	Prob.
ARCH-LM(1)	168.0105***	0.0000	13.75888***	0.0002	24.89389***	0.0000	4.282785**	0.0387
ARCH-LM(3)	59.2982***	0.0000	19.54633***	0.0000	8.906846***	0.0000	11.24507***	0.0000
ARCH-LM(6)	31.70827***	0.0000	14.06123***	0.0000	22.33482***	0.0000	10.62974***	0.0000
ARCH-LM(10)	19.54773***	0.0000	11.55474***	0.0000	18.09819***	0.0000	7.735088***	0.0000
ARCH-LM(15)	9.157985***	0.0000	9.135416***	0.0000	13.41644***	0.0000	7.251580***	0.0000

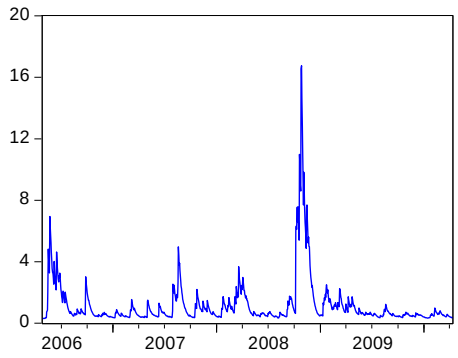
Note: *** indicates significance at 1%; **indicates significance at 5% and *indicates significance at 10% level.

Figure 2: Volatility Series

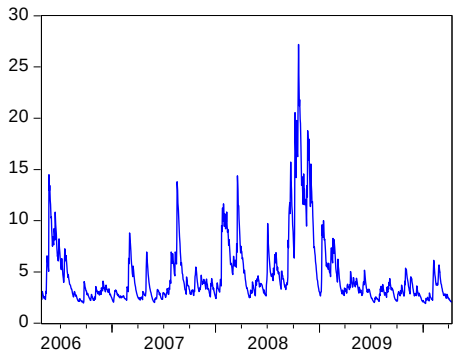


TRY/USD Foreign Exchange Futures Market Volatility ISE 30 Futures Market Volatility

Figure 2: Volatility Series - continue



TRY/USD Foreign Exchange Spot Market Volatility



ISE 30 Spot Market Volatility

6. Empirical Results

ARCH specification requires that an assumption be made about the conditional distribution of the error term. Normal (Gaussian) distribution, *t*-distribution, and Nelson's (1991) Generalized Error Distribution (GED) are commonly employed when working with ARCH models. In this study, it is assumed that the standart errors follow a normal distribution. And, given a distributional assumption, ARCH models are typically estimated by the method of maximum likelihood. According to Bollerslev and Wooldridge (1992), the quasi-maximum likelihood estimator (QMLE) provides asymptotic standard errors that are valid under non-normality.

The T-GARCH (1,1) results are given in table 5 and 6. Table 5 presents the empirical results of the impact of monetary surprises on the return and return volatility of TRY/USD foreign exchange futures and spot markets. The impact of borrowing rate surprises on the mean of the currency futures contracts settlement prices (captured by coefficient b_2) is significant at 10% level in the foreign exchange futures market, while significant at 1% level in the foreign exchange spot market. On average, a one percentage point surprise rise in borrowing rate leads to a 0.19% increase in foreign exchange spot returns and 0.04% increase in futures returns, suggesting that depreciation of Turkish Lira against dollar. As it is understood, monetary surprises affect the mean returns positively in the both of the markets, however this impact is highly significant and bigger in the spot market. Futures market returns show a little response to surprise. Parameter γ is negative, suggesting that the impact of past innovations on current volatility is asymmetric and it is found to be significant at the 5% level in futures market while significant at %1 level in the spot market. Negative value of γ reflects the condition that volatility tends to rise in response to positive surprises and fall in response to negative surprises. This result is consistent with the skewness values shown in table 2. The futures market data seems to have a bit greater asymmetry effect.

Table 5: Impact of Unexpected O/N Interest Rate Changes on Foreign Exchange Futures and Spot Markets

PANEL A: Maximum Likelihood Parameter Estimations						
	TRY/USD Exchange Rate Futures Market			TRY/USD Exchange Rate Spot Market		
	Coefficient	Prob.	Std. Error	Coefficient	Prob.	Std. Error
b_0	0.0037	0.8935	0.0282	0.0044	0.8612	0.0256
b_1	0.0031	0.9336	0.0381	0.0394	0.2783	0.0363
b_2	0.0418*	0.0767	0.0236	0.1939***	0.0000	0.0295
ω	0.2013***	0.0018	0.0646	0.0455***	0.0010	0.0138
α	0.2702***	0.0042	0.0943	0.1823***	0.0000	0.0428
γ	-0.2473**	0.0124	0.0989	-0.1967***	0.0000	0.0434

Table 5: Impact of Unexpected O/N Interest Rate Changes on Foreign Exchange Futures and Spot Markets - continue

β	0.6631***	0.0000	0.0828	0.8640***	0.0000	0.0452
θ_0	-0.2821***	0.0000	0.0351	0.2863***	0.0000	0.0354
θ_1	0.4747***	0.0000	0.1001	-0.3034***	0.0002	0.0826
θ_2	0.1664**	0.0148	0.0682	0.2956***	0.0001	0.0766

PANEL B: Diagnostic Checks of the Models		
	TRY/USD Exchange Rate Futures Market	**TRY/USD Exchange Rate Spot Market**
Mean	0.0135	0.0060
Std. Dev.	1.0104	1.0001
Skewness	1.0549	0.8495
Kurtosis	7.2601	6.9602
Jarq.-Bera	972.7788*** (0.0000)	799.3256*** (0.0000)
ARCH-LM (1)	0.9536 (0.3290)	0.0009 (0.9755)
LB (1) for $Z_{i,t}$	0.5490 (0.459)	0.9774 (0.323)
LB (1) for $Z_{i,t}^2$	0.9581 (0.328)	0.0010 (0.975)

Note: *** indicates significance at 1%; **indicates significance at 5% level. Figures in brackets are p-values.

The contemporaneous impact of policy target rate announcements on the volatility of currency futures market, captured by parameter θ_0, is negative and significant at the 1% level in the foreign exchange futures market, indicating that the CBRT's monetary policy stance plays a key role reducing return volatility in this market on the policy announcement days. Quite the contrary, parameter θ_0 is positive in the foreign exchange spot market at the 1% significance level, indicating that monetary policy induces return volatility in the spot market on the policy announcement days. It follows from this that monetary policy surprises influences futures and spot markets in opposite direction. However, the size of the affect is almost the same between the markets. The one day-lagged effect of monetary surprises on volatility, captured by θ_1, is statistically significant at 1% level in the both markets, but it is positive in the futures market while negative in the spot market as such in the policy announcement days. In other words, monetary surprises lead to an increase in the volatility of TRY/USD foreign exchange futures market a day later, in contrast with lead to a decrease in volatility of TRY/USD foreign exchange spot market. Parameter θ_2 is positive and significant at 5% and 1% level in the futures and spot markets, respectively. This finding shows that announcement effect on market volatility lasts two more days after the announcement day and monetary policy leads to an increase in the volatility of the markets. However, two day-lagged effect is greater in the spot foreign exchange rate market than the futures market.

According to table 5, the ARCH parameter (α) and GARCH parameter (β) are positive and significant at 1% significance level, indicating the presence of ARCH and GARCH effects in the returns. GARCH effect is stronger in the spot market returns, suggesting that volatility shocks are more persistent than futures market.

According to the empirical results of the impact of monetary surprises on the futures and spot ISE 30 stock price index returns presented in table 6, monetary surprises have an insignificant positive impact on the mean returns in the futures market and an insignificant negative impact in the spot market. This evidence indicates that returns in these markets aren't positively or negatively related to monetary surprises significantly.

Table 6: Impact of Unexpected O/N Interest Rate Changes on Stock Index Futures and Spot Markets

PANEL A: Maximum Likelihood Parameter Estimations						
	ISE 30 Futures Market			**ISE 30 Spot Market**		
	Coefficient	**Prob.**	**Std. Error**	**Coefficient**	**Prob.**	**Std. Error**
b_0	0.0884*	0.0656	0.0480	0.0963*	0.0882	0.0565

Table 6: Impact of Unexpected O/N Interest Rate Changes on Stock Index Futures and Spot Markets - continue

b_1	0.0327	0.2962	0.0313	0.0233	0.4748	0.0326
b_2	0.0372	0.8747	0.2359	-0.1645	0.4787	0.2323
ω	0.3337***	0.0022	0.1088	0.2283***	0.0010	0.0792
α	0.0445*	0.0695	0.0245	0.0328	0.1250	0.0214
γ	0.1249**	0.0117	0.0495	0.1277**	0.0102	0.0497
β	0.8261***	0.0000	0.0430	0.8562***	0.0000	0.0386
θ_0	1.0851**	0.0382	0.5236	0.1677	0.7788	0.5974
θ_1	1.1623***	0.0076	0.4353	1.6576***	0.0017	0.5287
θ_2	-0.9249	0.1228	0.5993	-1.0453**	0.0417	0.5133

PANEL B: Diagnostic Checks of the Models

	ISE 30 Futures Market	**ISE 30 Spot Market**
Mean	-0.0099	-0.0158
Std. Dev.	1.0050	0.9999
Skewness	0.3795	0.2128
Kurtosis	4.5691	4.1501
Jarq.- Bera	130.7743*** (0.0000)	64.73439*** (0.0000)
ARCH-LM (1)	2.4388 (0.1187)	3.4735* (0.0626)
ARCH-LM (2)	1.4350 (0.2386)	2.3010 (0.1007)
LB (1) for $Z_{i,t}$	0.0692(0.792)	0.2182 (0.640)
LB (1) for $Z_{i,t}^2$	2.4466 (0.118)	3.4810* (0.062)
LB (3) for $Z_{i,t}^2$	3.6373 (0.303)	5.0398 (0.169)

Note: *** indicates significance at 1%; **indicates significance at 5% level. Figures in brackets are p-values.

The effect of monetary surprises on futures and spot market volatility on the announcement day, captured by parameter θ_0, is positive in the both markets and significant at 5% level in the futures market while insignificant in the spot market. Monetary surprises influence stock index futures market volatility significantly and much more than spot market on the announcement days. One dag-lagged effect of monetary surprises is positive and significant at 1% level in the both markets. The impact is a bit greater in the spot market. The two day-lagged effect of monetary surprises is negative for both the markets but significant at 5% level only in the spot market, suggesting that monetary surprises reduce stock spot market return volatility significantly two days after the announcement day. Parameter γ for the asymmetric volatility response is found to be positive and significant at 5% level for both the futures and spot markets. Positive value of γ indicates the evidence of leverage effect. In addition, asymmetry is found to be uniformly present in the futures and spot markets as can be seen from the similar magnitude of parameter γ.

The ARCH parameter (α) is positive in both the markets and it is significant at 10% level in the futures market whereas insignificant in the spot market, indicating the absence of ARCH effect in the spot market. GARCH parameter (β) are positive and significant at 1% significance level in the both markets, indicating the presence of GARCH effect in the returns. GARCH effect is quite strong and has close magnitude between the markets. It should be noted that the persistence of volatility shocks is at the least in the futures foreign exchange returns.

As is seen from the PANEL B appear in the table 5 and 6, the specification is adequate to estimate the conditional variance and heteroskedasticity is accounted for by all models, since the insignificant ARCH-LM statistics confirm the absence of ARCH effect in the residual up to order 1 and 2 (except ARCH-LM (1) statistic for ISE 30 spot market). Ljung-Box (1) statistic traces the presence of serial correlation only for ISE 30 spot market. The non-normality of the residual series is

eminent, as evidenced by Jarque-Bera statistics. This problem, nonetheless, is compensated by the use of the robust standart error as proposed by Bollerslev and Wooldridge (1992) and then heteroscedasticity-consistent standard errors are used to calculate the t-statistics.

7. Summary and Concluding Remarks

In this study, it is examined that the impact of unexpected policy interest rate decisions regarding changes in the overnight borrowing rate on the foreign exchange and stock index futures and spot markets in Turkey over the January 2006-April 2010 period using daily data. The T-GARCH (1,1) model is used to estimate the reactions of these markets to unexpected monetary policy announcements. The sample inludes fifty-four interest rate decisions and twenty-six of them are positive surprises and twenty-eight of them are negative surprises. The Treasury bill yield which have the shortest maturity is used as a proxy for the market expectations.

Empirical results show that the Central Bank of Republic of Turkey's overnight borrowing rate surprises have a significant and positive impact on the mean of TRY/USD exchange rate futures contracts cash settlement prices and on the mean of TRY/USD foreign exchange spot rates, suggesting that the depreciation of Turkish Lira against US Dollar. The impact of surprise is much more bigger and more significant in the foreign exchange spot market than the futures market. It is inferred that foreign exchange spot market may respond more slowly to surprises. The effect of monetary surprises on the volatility of TRY/USD futures market is statistically significant and negative on the policy announcement day, suggesting that monetary policy plays an important role in reducing volatility. Conversely, monetary surprises have a significant but positive impact on the volatility of TRY/USD spot returns. The volatility of TRY/USD foreign exchange futures and spot markets reacts to surprises in a lagged action, indicating that volatility doesn't revert to pre-surprise levels on the days after the announcement. One day-lagged impact is significant and in opposite direction, it is positive in the futures market while negative in the spot markets. Two day-lagged affect is positive and significant for two markets, and bigger in the spot market.

Unexpected overnight borrowing rate changes have no statistically significant effect on the mean of the ISE 30 stock futures contract prices and ISE 30 stock index spot values. Also, ISE 30 spot market volatility doesn't react to monetary surprises significantly on the announcement day. However, ISE 30 futures market volatility reacts to monetary surprises positively and significantly on the announcement day. One day-lagged affect is positive and highly significant for stock futures and spot markets volatility. Two day-lagged effect has a negative sign in the both of the markets, however, significant only in the spot market.

Asymmetric effect is significant in all the markets, however, it is negative in the foreign exchange futures and spot markets while positive in the stock futures and spot markets. This indicates that an asymmetric response to positive returns in the conditional variance equation in the foreign exchange futures and spot markets. It is also found that volatility shocks are less persistent in the futures markets than the spot markets considered in this study. Particularly, volatility shocks have the least persistency in the foreign exchange futures market.

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Appendix 1: Dates and Movements of the CBRT's O/N Borrowing Rate Target: Jan. 2006-Apr. 2010

Date of Change	Level of O/N (%)	Change in O/N (%)	Change in Treasury Bill Yield (%)	Unexpected Component of O/N Change (%)
	(1)	(2)	(3)	(4)
09.12.2005	13.50	-	-	-
23.01.2006	13.50	0.00	0.57	-0.57
23.02.2006	13.50	0.00	-0.09	0.09
23.03.2006	13.50	0.00	-0.08	0.08
27.04.2006	13.25	-0.25	-0.50	0.25
25.05.2006	13.25	0.00	0.99	-0.99
07.06.2006	15.00	1.75	0.05	1.70
25.06.2006	17.25	2.25	0.39	1.86
28.06.2006	17.25	0.00	0.21	-0.21
20.07.2006	17.50	0.25	-0.51	0.76
24.08.2006	17.50	0.00	1.48	-1.48
26.09.2006	17.50	0.00	-0.90	0.90
19.10.2006	17.50	0.00	1.14	-1.14
23.11.2006	17.50	0.00	-0.46	0.46
21.12.2006	17.50	0.00	1.62	-1.62
16.01.2007	17.50	0.00	-1.42	1.42
15.02.2007	17.50	0.00	1.09	-1.09

15.03.2007	17.50	0.00	-0.43	0.43
18.04.2007	17.50	0.00	-2.41	2.41
14.05.2007	17.50	0.00	1.30	-1.30
14.06.2007	17.50	0.00	-0.71	0.71
12.07.2007	17.50	0.00	0.50	-0.50
14.08.2007	17.50	0.00	-0.09	0.09
13.09.2007	17.25	-0.25	0.45	-0.70
16.10.2007	16.75	-0.50	-1.04	0.54
14.11.2007	16.25	-0.50	0.06	-0.56
13.12.2007	15.75	-0.50	-0.03	-0.47
17.01.2008	15.50	-0.25	-0.34	0.09
14.02.2008	15.25	-0.25	0.05	-0.30
19.03.2008	15.25	0.00	0.68	-0.68
17.04.2008	15.25	0.00	-0.23	0.23
15.05.2008	15.75	0.50	0.13	0.37
16.06.2008	16.25	0.50	1.33	-0.83
17.07.2008	16.75	0.50	-0.04	0.54
14.08.2008	16.75	0.00	-0.42	0.42
18.09.2008	16.75	0.00	0.55	-0.55
22.10.2008	16.75	0.00	0.31	-0.31
19.11.2008	16.25	-0.50	0.02	-0.52
18.12.2008	15.00	-1.25	-1.29	0.04
15.01.2009	13.00	-2.00	-0.69	-1.31
19.02.2009	11.50	-1.50	-1.18	-0.32
19.03.2009	10.50	-1.00	-2.51	1.51
16.04.2009	9.75	-0.75	-0.55	-0.20
14.05.2009	9.25	-0.50	-0.30	-0.20
16.06.2009	8.75	-0.50	-0.15	-0.35
16.07.2009	8.25	-0.50	-0.99	0.49
18.08.2009	7.75	-0.50	-0.38	-0.12
17.09.2009	7.25	-0.50	-0.23	-0.27
15.10.2009	6.75	-0.50	-0.60	0.10
19.11.2009	6.50	-0.25	-0.18	-0.07
17.12.2009	6.50	0.00	0.30	-0.30
14.01.2010	6.50	0.00	-0.45	0.45
16.02.2010	6.50	0.00	-0.21	0.21
18.03.2010	6.50	0.00	0.17	-0.17
13.04.2010	6.50	0.00	-0.46	0.46

Note: (4) = (2) – (3). Column (4) is based on equation (2), using the Treasury bill yield which have the shortest maturity to compute the surprise in the CBRT overnight borrowing rate change.