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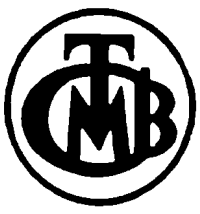

Causes and Effectiveness of Foreign Exchange Interventions for the Turkish Economy*

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Abstract

Foreign exchange rate interventions of the central banks for the emerging market economies are studied only to a limited extent. However, due to the different characteristics of these economies, especially in terms of the exchange rate dynamics, such an analysis can reveal important information. This study analyzes both the causes and the effectiveness of foreign exchange interventions of the Central Bank of the Republic of Turkey in the post-crisis period. We find that, as officially stated by the Central Bank, the main motivation behind the interventions is the excessive volatility in the exchange rate. Regarding the effectiveness of the interventions, the large and isolated purchase-based interventions seem to be effective in decreasing the volatility in the exchange rate.

Keywords: Foreign Exchange Interventions, Emerging Markets, Probit Analysis, and GARCH Models

JEL Codes: C22, C35, E58

I. Introduction

There is a dense literature devoted to the foreign exchange market operations conducted by the central banks, which especially intensified after a considerable amount of countries have shifted to implementing inflation targeting regimes. The role of the exchange rates both as a policy variable and as a determinant of the price dynamics has been reexamined after then. In this context, the interventions of the central banks in the foreign exchange market, - both to affect the level of the exchange rates and to reduce the excess volatility, have also been analyzed in details. It has been argued in Domac and Mendoza (2002) that if foreign exchange interventions are carried out with finesse and sensibly, they could play a useful role under inflation targeting framework in containing the adverse effects of temporary exchange rate shocks on inflation and financial stability. Therefore, there is room for foreign exchange interventions in inflation targeting regimes, especially to reduce excessive fluctuations in the foreign exchange markets. However, the findings of Baillie and Osterberg (1997), Herrera and Ozbay (2005), Dominguez (1998) and Bonser-Neal and Tanner (1996) show that foreign exchange interventions do not have any significant impact on the volatility of the exchange rates. For that reason, it can be conveniently stated that the empirical findings regarding the effectiveness of foreign exchange interventions produce mixed results.

On the other hand, the literature on foreign exchange interventions can further be improved in two directions. First, there are only a limited number of studies that concentrate on the emerging market economies, with the important exceptions of Agcaer (2003) and Herrera and Ozbay (2005). However, characterized by having unstable foreign exchange markets, fragile financial sector, and an ambiguous relation between the exchange rates and the interest rates, emerging market cases can reveal important information about the dynamics of foreign exchange interventions of the central banks. Second, despite the vast amount of studies that study the effectiveness of central bank interventions, only a few of them such as Kim and Sheen (2002), McKenzie (2004) and Ito and Yabu (2004) focused on the causes of these interventions. However, pinning down the factors that cause central banks to intervene can better reveal the goals and the preferences of the policymakers. Furthermore, assessing these factors together with the results obtained from these interventions will

provide better information about the success of the central banks in the foreign exchange markets.

Based on the above discussion, this study analyzes both the causes and the effectiveness of foreign exchange interventions for the Turkish economy in the post-crisis period. While a probit model and Granger causality tests are applied to determine the factors that lead to the intervention of the Central Bank of the Republic of Turkey (CBRT henceforth) in the foreign exchange market, a GARCH framework is employed to evaluate the effectiveness of the interventions for the sample period. Such a framework makes it possible to test whether the foreign exchange interventions are effective on both the level and the volatility of the exchange rate. Finally, the results obtained from the Granger causality tests will also reveal whether the signaling channel operates as expected: if the interventions of the central banks provide signals about the future course of the monetary policy, i.e. if intervention variables Granger cause interest rates, then signaling channel is supported.

The Turkish economy in the post crisis period, as our case study, constitutes a very interesting case for two reasons. First, after the collapse of the exchange rate based stabilization program in February 2001, there was a high degree of uncertainty in the foreign exchange markets, which further intensified with a high degree of political instability. These developments had induced the CBRT to take precautionary actions and stabilize the market. Second, this period witnessed some criticisms about the operation of the uncovered interest rate parity condition. The investors mostly perceived an increase in the interest rates as an overall increase in the risk that is inherent in the economy while a decrease led to opposite effects. Therefore, a change in the interest rates actually led to unexpected fluctuations in the foreign exchange market, which makes the problem at hand even more challenging.

When all of these above-mentioned factors are combined with the attempts of the CBRT to shift to an inflation-targeting regime, an analysis of the foreign exchange interventions becomes far from being straightforward. In line with the objective of inflation targeting framework, the CBRT has explicitly stated that it would be ready to intervene in the foreign exchange market to remove any excess volatility that could have damaged the well functioning of the financial markets. Therefore, this study will

also reveal whether the official statements of the CBRT are supported by the empirical findings.

The outline of this study is as follows: The following two sections briefly summarize the characteristics of the foreign exchange market for the Turkish economy and present a brief discussion of the factors that lead the central banks to intervene in the foreign exchange markets.[1] Then, the causes of the CBRT's interventions are analyzed both by a probit model and Granger causality tests. The latter exercise will also reveal whether the signaling channel is valid. Next, the effectiveness of these interventions is evaluated within a GARCH framework. The final section concludes.

II. The Turkish Economy

This section first presents an overview of the macroeconomic environment for the Turkish economy in the post-crisis period, with a special emphasis on the foreign exchange markets and the interventions conducted by the CBRT. In the next section, there is a brief discussion that focuses on the factors that may induce the central banks to conduct foreign exchange market interventions.

II.1. Macroeconomic Environment

As implied in the preceding section, the recent historical record of the Turkish economy exhibits a structure in which there is a clear overlapping between the exchange rate volatility and the interest rate instability. The unstable growth performance, persistently high inflation under the constraints of the public sector deficits and the volatile short-term capital flows that are accompanied by political instability are other important characteristics. Therefore, it is not surprising to witness a series of economic crises in the last decade: the currency crisis in 1994, contagion effects of both the Asian and Russian crises in 1997 and 1998, and finally the deep financial crises in November 2000 and February 2001. Following each crisis, some regulatory arrangements and structural reforms were put into effect by the Turkish authorities, where the IMF supported almost all of the attempts.

[1] The literature survey about the effectiveness of foreign exchange interventions are skipped since it is already documented in Sarno and Taylor (2001).

Recently, the financial turmoil following the twin crises in November 2000 and February 2001 led to the adoption of a floating exchange rate, where the program's policies have been significantly strengthened relative to its predecessors, including an increased emphasis on transparency, accountability and good governance in both the private and the public sectors. Furthermore, the control of the CBRT over the short-term interest rates was strengthened in line with the adoption of the floating exchange rate regime. Finally, monetary policy was foreseen as evolving towards a regime of formal inflation targeting by an independent CBRT. On the other hand, although committed to the floating exchange rate regime, the monetary authority has also indicated that it may intervene in the market to smooth out excessive short-run exchange rate volatility. The CBRT would stand ready to conduct foreign exchange purchase auctions to improve the international reserve position conditional on the strength of the balance of payments position and the reverse currency substitution.

Although the explicit statements of the CBRT and the floating exchange rate regime seemed to offer a clear picture in terms of the foreign exchange markets, there were two critical issues to be taken into account. The first issue was the huge level of debt stock for the government together with the excessively high interest rates. There were serious doubts about the sustainability of debt, which induced investors to demand high levels of risk returns. In such an environment, targeting inflation and following tight monetary policy as a means of price stability could certainly have negative impact on the debt burden. Second, the relationship between interest rates and exchange rates was not clear, at best. The recent studies that analyze the validity of the uncovered interest rate parity condition for the emerging market economies point out that an increase in the interest rates to achieve low levels of inflation can also be anticipated as an increase in overall risk in the economy, which in turn, could cause depreciation of the domestic currency. In such a case, the effects of tight monetary policy on the exchange rate dynamics cannot be foreseen to full extent. [2]

[2] See Blanchard (2004) and Favero and Giavazzi (2004) for a detailed discussion.

CBRT Interventions and Auctions

Following the February 2001 crisis, the monetary and exchange rate policies of the CBRT were made explicit by the official statement published on early 2002. There, CBRT highlighted that it was not going to infer to the level or trend of the exchange rate, but only intervene in a strictly limited fashion to limit the excessive volatility in the exchange rate market. Despite the fact that the exchange rate system was a float – or "almost pure float"-, the level of foreign exchange reserves was important both because of the forthcoming debt repayments to the IMF and the CBRT's intension to clear some of the foreign exchange liabilities like the deposits of the workers abroad. Therefore, CBRT also announced that it would stand ready to conduct transparent and pre-announced purchase auctions conditional on the strong balance of payments position and ongoing reverse currency substitution.[3,4]

In this framework, CBRT had two main channels to intervene in the foreign exchange market: pre-announced auctions and the interventions. After the initial impact of the financial crisis has been removed, the Turkish lira is observed to have a steady appreciation trend against US dollar. Therefore, the interventions were mainly in the form of purchases (Table 1). Also, on the auction side, the total number of auctions that are held by the CBRT is 243 and 150 of these auctions are in the form of purchases. Similar to the interventions, the purchase auctions also take place in the second and third quarters of 2003 (Table 2).[5]

Table 1: Volatility Interventions (2001-2003)

Date	Type of Intervention	Amount (Million USD)
11.07.2002	Sale	3
02.11.2002	Purchase	16
24.12.2002	Sale	9
2002 Net Purchase		**4**
12.05.2003	Purchase	62
21.05.2003	Purchase	517
09.06.2003	Purchase	566
18.07.2003	Purchase	938
10.09.2003	Purchase	704
25.09.2003	Purchase	1442
2003 Net Purchase		**4229**

Source: CBRT

[3] Ozatay (2004).

[4] Pre-announced auctions started in April 2002.

[5] In 2001, the primary purpose of the foreign exchange sale auctions and sale interventions was to eliminate the liquidity-increasing effect of the utilization of the IMF credit used by the Treasury for domestic financing. Therefore, these operations should be evaluated separately.

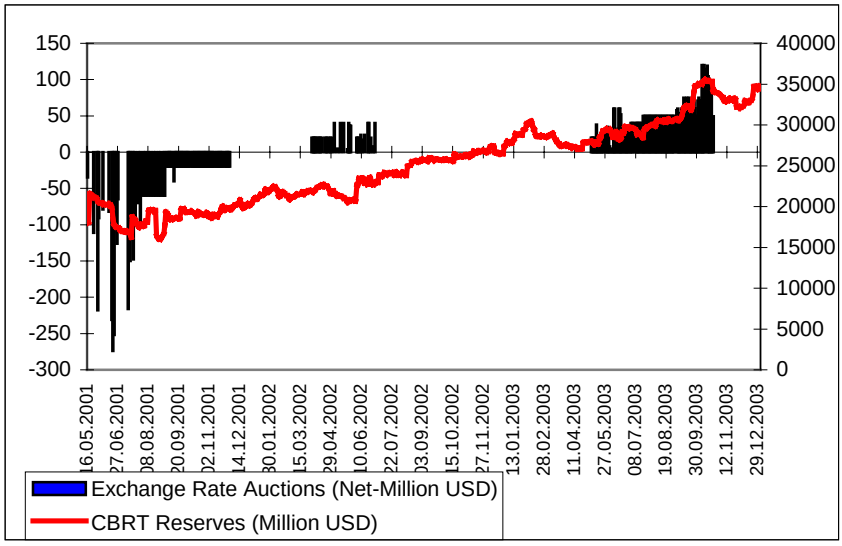
Table 2: Sale and Purchase Auctions (2001-2003)

Sale Auctions		Purchase Auctions			
2001	**Amount (Million USD)**	**2002**	**Amount (Million USD)**	**2003**	**Amount (Million USD)**
January		January		January	
February		February		February	
March	350	March		March	
April	1040	April	280	April	
May	1130	May	242	May	340
June	1198	June	273	June	630
July	1035	July		July	990
August	600	August		August	1,050
September	380	September		September	1,316.7
October	420	October		October	1,325.6
November	400	November		November	
December		December		December	
Net Purchase	**6553**		**795**		**5652,3**

Source: CBRT

Regarding the foreign exchange auction system, the CBRT pre-announced the terms of the auction at the beginning of each month, thus leaving no room for a surprise for the market agents. Therefore, auctions differ significantly from the interventions. Given the primary aim of building up reserves, the effectiveness of auctions is much more straightforward to identify and they do not serve the purpose of reducing the excess volatility. Therefore, this study focuses more on the interventions and attempts to reveal whether the CBRT's intention to dampen excessive volatility in foreign exchange market is supported by the empirical findings (Figure 1).

Figure 1: Exchange Rate Auctions and CBRT Reserves (2001-2003)



Source: CBRT

Consequently, the message to be drawn from this section is clear: the Turkish foreign exchange market seems to inherit the general characteristics of the emerging markets. The unclear relation between the exchange rates and the interest rates, and the excess sensitivity of the foreign exchange markets to both economic and non-economic factors make it necessary for CBRT to closely monitor and intervene in the market to remove excess volatility in the exchange rate. Such a motive does not contradict with the inflation-targeting framework that has been implemented in the post-crisis period.

III. Why do Central Banks Intervene?

Despite the vast literature on the effectiveness of foreign exchange interventions, only a few studies focused on the factors that induce central banks to intervene in the market. Most of these studies such as Herrera and Ozbay (2005), McKenzie (2004) and Ito and Yabu (2004) analyze the issue in a discrete choice model framework. In an earlier study, Kim and Sheen (2002), using probit and friction models for the case of Australia, show that exchange rate trend correction, exchange rate volatility smoothing, overnight interest rate differentials and the profitability with foreign currency reserve inventory considerations determine the intervention behavior. With the exception of Herrera and Ozbay (2005), these studies focus solely on the industrialized economies. However, as mentioned in the preceding section, emerging markets may reveal important information about the foreign exchange market interventions, thanks to their different macroeconomic dynamics.

Although using different techniques, one common characteristic of the above-mentioned studies is that the exchange rate volatility emerges as the main motivation behind the central bank interventions. Therefore, it is important to review the findings about the relationship between exchange rate volatility and interventions. It has been often stated by the central banks that exchange rate volatility is the main motivation behind the central bank interventions. Therefore, it is not surprising that the recent studies focused on the effects of intervention on the exchange rate volatility. Most of these studies have looked at the relation between foreign exchange intervention and the conditional exchange rate volatility, usually via GARCH models. Dominguez (1998), for example, examines the effects of the US, German and Japanese monetary and intervention policies on dollar-mark and dollar-yen exchange rate volatility over the 1977-1994 period. The results indicate that intervention operations generally

increase exchange rate volatility. This is particularly true of secret interventions that are undertaken without notification of the public. In another study, Bonser-Neal and Tanner (1996) examine the effects of the central bank interventions on the ex ante volatility of the US dollar-German mark and the US dollar-Japanese yen from 1985 to 1991. They find little support for the hypothesis that central bank intervention is associated either with a positive change in the ex ante exchange rate volatility or with no change at all.

Domac and Mendoza (2002) investigate whether central bank foreign exchange interventions have any impact on the volatility of the exchange rate in Mexico and Turkey since the adoption of the floating regime. Their empirical results suggest that both the amount and the frequency of the foreign exchange interventions have decreased the volatility of the exchange rates in these countries.

Finally, it should be noted that, there may also be other important factors that may lead the central banks to intervene in the foreign exchange market. However, these factors are viewed to be important as long as they cause an increase in the volatility of the exchange rate. In this context, political instability, the perceived risk in the economy or changes in the monetary policy emerge as possible candidates. Therefore, the empirical analysis should also take these factors into account.

IV. Empirical Analysis

IV.1. Causes of Intervention

In this section, we employ two methodologies, probit analysis and Granger-causality tests, to have a better understanding of the main motivations behind the CBRT interventions. The results of both methodologies are discussed and compared as an attempt to find a robust conclusion. Such an exercise is also important from two different perspectives: First, as mentioned before, in an inflation-targeting framework, the changes in the exchange rate is not of primary interest as long as price dynamics are not distorted, which implies that the central banks can intervene in the foreign exchange market to remove any excess volatility in the exchange rates, but should not view the level of the exchange rate as a target. Actually, this implication is explicitly stated by the CBRT. Therefore, the results will reveal whether the official statements of the CBRT are consistent with its actions. Second, the causality tests will indicate

whether the signaling channel is valid for the foreign exchange interventions conducted by the CBRT. If foreign exchange interventions precede changes in the interest rates, then it is a sign for the existence of the signaling channel.

IV.1.1. Probit Analysis

There are several motives behind the central banks' intervention in foreign exchange markets. Kim and Sheen (2002) range these motives as perceived trend correction, volatility smoothing, exchange rate overshooting, profitability and inventory considerations. There is, on the other hand, considerable evidence indicating that central banks do mostly respond to trend changes (i.e., reacting to deviations of the spot rate from some target level) and to exchange rate volatility.

Following Kim and Sheen (2002), we estimate a probit model to determine the probability of purchase and sale interventions of the CBRT.[6] For this purpose, we generate a binary choice dependent variable corresponding to outcomes for both types of interventions (purchase/sale). Considering the scope of this study and intervention policy of the CBRT, we basically test if the CBRT intervene in order to change exchange rate trend or reduce excessive volatility, and model the probability of purchase and sale interventions separately as the following form:

$$Prob(Intv_{p,s,t=}1|FX)=F(\alpha_0 + \alpha_1 VOL_t + \alpha_2 ERDEV_t)$$

Intv is a dummy variable that takes the value of one if there is a foreign exchange intervention, -either purchase or sale-, and zero otherwise. *FX* indicates the variables related to foreign exchange measures. These variables include the volatility, *VOL*, and the deviations from the long-run trend, *ERDEV*. We measured volatility with the conditional variance of daily exchange rate changes generated from a GARCH(1,1) model estimated in Section IV.2.[7] The volatility variable is expected to have positive effect on both purchase and sale intervention probabilities given the CBRT's volatility intervention strategy described in the preceding section. Similarly, the current exchange rate deviations from the long-run trend, denoted by *ERDEV*, which are calculated as positive (negative) percentage deviations of the current exchange rate from its 90-day moving average, is expected to have a negative (positive) effect on the

[6] In a similar vein, Fatum (2000) estimated Logit functions to investigate the factors influencing the likelihood of the success of intervention operations.
[7] Several volatility measures are used, but the results remained robust.

purchase intervention probability, or vice versa, for the sale intervention probability.[8] In other words, *ERDEV* can be an indicator for the direction of the volatility in the exchange rate, that is *VOL*. One can expect that if the volatility is high and downward (upward), then purchase (sale) intervention probability should increase. The estimation results for each of the purchase and sale interventions are presented in Table 3.

Table 3: Probit Estimation Results
(Sample: May 16, 2001 to December 31, 2003)

$Prob(Int_{p\text{-}s,t=1} | \ VOL, ERDEV,) = F(\alpha_0 + \alpha_1 VOL_t + \alpha_2 ERDEV_t)$

	Purchase	Sale
α_0	2.01	4.29
	*(2.1)**	*(2.42)**
α_1	0.36	0.73
	*(3.60)***	*(3.93)***
α_2	-4.84	9.01
	*(-4.90)***	*(2.77)***
LR	21.1	106.85
Prob.	*(0.00)*	*(0.00)*

Z-values are in parenthesis. *, ** denote significance at 5 and 1 percent significance levels, respectively.

Estimation results show that purchase and sale intervention probabilities respond positively and significantly to the changes in the exchange rate volatility, *VOL*, which indicates that a higher probability of intervention by the CBRT is associated with a higher volatility in the Turkish lira-US dollar rate. The probability of intervention is also significantly associated with the current exchange rate deviations, *ERDEV*. It should be reminded that *ERDEV* is positive in the depreciation trend, and negative in the appreciation trend. Therefore, as expected, the signs of effects are estimated to be positive and significant for the sale intervention, and negative and significant for the purchase intervention. Thus, the results verify the official statement of the CBRT, indicating its intention to intervene in the market when there is high volatility in the Turkish lira–US dollar rate. Also as expected, the action is a purchase intervention when the Turkish lira is in appreciation trend, and a sale intervention, otherwise.

These results suggest that, as officially stated by the CBRT, the volatility of the exchange rate seems to be the main driving force of the intervention probability at the

[8] Percentage deviations of the current exchange rate from 5- and 30-day moving average were also tested, but the results did not change.

expected directions, providing empirical support for the "leaning against the wind" hypothesis.

IV.1.2. Granger Causality Tests

In this section, in order to examine whether intervention operations predict future changes in the monetary policy; that is, whether intervention provides a signal for the future monetary policy, we conduct Granger causality tests as suggested by Lewis (1993).[9] Besides the effectiveness of the signaling channel, Granger causality framework also allows us to test whether the monetary policy variables help predict the CBRT interventions. For this purpose, we estimate a bivariate Vector autoregression (VARs) for each monetary policy variable and intervention. The estimated equations are in the following form:

$$\Delta M(i)_t = \sum_{k=1}^{p} \alpha_k \Delta M(i)_{t-k} + \sum_{k=1}^{p} B_k INTV(j)_{t-k} + \varepsilon_t$$

$$\Delta INTV(j)_t = \sum_{k=1}^{p} \alpha_k \Delta M(i)_{t-k} + \sum_{k=1}^{p} B_k INTV(j)_{t-k} + \varepsilon_t$$

$$E(\varepsilon_t \varepsilon_t') = V$$

where *M(i)* denotes monetary policy variables such as money base, *MONBASE*, short term interest rates, *CBRATE*, as well as variables such as CBRT reserves, *CBRES*, exchange rate volatility, *VOL*, and exchange rate deviation from its 90 days average, *ERDEV*. Also, *INTV(j)* is the intervention variable indicating purchase (j=p) and sale (j=s), and ε_t is a bivariate i.i.d. random variable with zero mean.

Granger causality test results are displayed in Table 4.[10] It has been found that there is no causality between both types of interventions and the base money. On the other hand, the short-term interest rate Granger-causes only intervention sales. It is also found that there is causality running from both sale and purchase based interventions to CBRT interest rates. These results have several implications: First, as consistent with the CBRT's announcements, short-term interest rate emerges as the main

[9] Lindberg (1994) also used Granger causality to test whether sterilized interventions work through the signalling channel for the Sweden.
[10] The LR test results for lag length selection are not presented but available upon request.

monetary policy instrument. Second, interventions in the foreign exchange market signal the future course of monetary policy; that is, both purchase and sale based interventions Granger-cause CBRT interest rate changes. However, the existence of "signaling channel" in case of sale interventions should be evaluated cautiously in that, if the central bank intervenes in the markets with a sale operation, then it should signal a tight monetary policy, which would require an increase in the interest rates. However, there is only a single observation of a rate increase in the sample period. Therefore, the existence of signaling channel is only supported for the purchase-based interventions.

Table 4
Granger-Causality Test Results[11]
Sample: May 16, 2001- December 31, 2003

Granger Causality Tests between Monetary Variables and Intervention Purchase					
A. Predicted Variables (causality from purchase intervention to...)					
Frequency	MONBASE	CBRATE	CBRES	Vol	ERDEV
Daily	14.9	25.41	8.49	20.15	6.81
	(0.24)	*(0.03)*	*(0.01)*	*(0.04)*	*(0.81)*
B. Cauual Variables (causality to purchase intervention from...)					
Frequency	MONBASE	CBRATE	CBRES	Vol	ERDEV
Daily	15.1	20.46	4.68	8.98	3.54
	(0.24)	*(0.12)*	*(0.10)*	*(0.62)*	*(0.98)*
Granger Causality Tests between Monetary Variables and Intervention Sale					
A. Predicted Variables (causality from sale intervention to...)					
Frequency	MONBASE	CBRATE	CBRES	Vol	ERDEV
Daily	6.74	150.64	137.37	42.04	60.87
	(0.98)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
B. Causal Variables (causality to sale intervention from...)					
Frequency	MONBASE	CBRATE	CBRES	Vol	ERDEV
Daily	6.87	139.71	97.76	29.71	74.81
	(0.98)	*(0.00)*	*(0.00)*	*(0.01)*	*(0.00)*

P-values are in the parenthesis.

Moreover, both the purchase and the sale interventions Granger-cause CBRT reserves. However, there is an asymmetry where CBRT reserves Granger cause only the sale interventions, indicating that the strong reserve position of the CBRT seems to be an important factor for the sale interventions in the case of depreciating domestic currency. In other words, the CBRT intends to conduct sale operations only when it has enough foreign exchange reserves.

[11] The intervention variables are lagged one period to see the possible influence of intervention after the sterilization process has been completed. However, the results do not change significantly. Hence the results are not reported in the table but available upon request.

Both purchase and sale interventions Granger cause exchange rate volatility, implying that any type of CBRT interventions lead to changes in the volatility in the foreign exchange market. However, test results do not reveal any information about the sign of the volatility changes. Therefore, GARCH framework is applied to examine the effectiveness of these interventions. Moreover, only the volatility in the foreign exchange markets Granger-cause sale interventions. Finally, while there is a two-way causality between *ERDEV* and sale interventions, there is no causality found between purchase interventions and *ERDEV*.

As a result, the probit analysis and the Granger causality tests provide insights about the motivation of the CBRT in intervening the foreign exchange market. First, consistent with the official statement of the CBRT, an increase in the volatility induces an intervention, as the probit analysis suggests. As mentioned before, there is room for such a policy in an inflation-targeting framework. On the other hand, although a two-way causality between interest rates and interventions has been found, the results do not completely favor the existence of signaling channel, at least for the sale interventions in the examined period.

IV.2. Effects of Intervention: GARCH Framework

The last section implies that, the interventions of central banks in the foreign exchange market need not contradict with the characteristics of an inflation-targeting framework. In fact, the findings suggest that the CBRT conducts interventions to remove any excess volatility in the market.

Then, it should be examined whether these operations have become effective. Time series techniques are one of the most popular techniques that have been widely used to analyze the effectiveness of the foreign exchange interventions. Both the effects of changes in the fundamentals and the other relevant variables -such as the specific type of intervention- that are known to affect the exchange rates can be controlled. In this context, autoregressive conditional heteroscedasticity models, which provide a framework to test the effectiveness of the interventions simultaneously on both the mean and the conditional variance of the exchange rates, are widely employed. In this section, a GARCH framework is employed for the post crisis period, that is May 16, 2001 to December 31, 2003.

The mean and the variance equations are in the following forms:

$$DLUSD_t = \beta_0 + \beta_1 DLUSD_{t-1} + \beta_2 DLUSD_{t-2} + \beta_3 INT_t + \beta_4 EMBI_t + \beta_5 INTV_{p,s,t-1} + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 \varepsilon_t^2 + \alpha_3 INT_t + \alpha_4 EMBI_t + \alpha_5 INTV_{p,s,t-1}$$

Throughout the analysis, we employ fundamentals -that are known to affect the level and the variance of the exchange rate- and the intervention variables both in the mean and in the variance equations. *DLUSD* is the log difference form of the Turkish lira-US dollar exchange rate. *INT* is the secondary market Treasury bill rate to account for the relationship between the exchange rate and the interest rates. *EMBI* is the Turkish government bonds spread, used as a proxy for risk measurement. In the core model (Model 1), only the fundamentals are employed.

As the previous analysis suggests, the exchange rate dynamics and the intervention variables affect each other contemporaneously. Therefore, the lagged value of the latter has been used to avoid a possible simultaneity problem. Among intervention variables, to account for the asymmetric effects of purchases and sales on the exchange rate, these variables, which are denoted as *INTP* and *INTS*, are used separately in Model 2. Also, following Beine and Szafarz (2003), we have created several dummy variables: (i) in model 3, *successive intervention* dummy variable takes the value of one for the purchases (sales), *DSUCINTP (DSUCINTS),* if intervention at day *t* is preceded by intervention in the same direction at day from *t-1* to *t-15*, and zero otherwise; (ii) in model 4, *isolated intervention* dummy variable takes the value of one for the purchases (sales), *DISOINTP (DISOINTS),* if intervention at day *t* is preceded by no intervention in a *15-day* period; (iii) finally, in models 5 and 6, *size* dummy variables are generated separately for large purchases (sales), *DLINTP (DLINTS*), and small purchases (sales), *DSINTP(DSINTS*), where large (small) intervention dummy variable takes the value of one if the amount of intervention / reserves ratio at day *t* is greater (less) than the whole sample average of daily the intervention, and zero otherwise.

In Model 1, we run the regression, where the contemporaneous values of the *INT* and the *EMBI* spread appear both in the mean and the variance equations, whereas the lagged values of the exchange rate change appear only in the mean equation. Interest

rates are estimated to be positive and statistically significant in the mean equations of all the models. *EMBI* spread, on the other hand, is estimated to be positive and significant mostly in the variance equations. These results support the arguments of Blanchard (2004) and Favero and Giavazzi (2003), which state that an increase in interest rates to achieve low levels of inflation may actually cause depreciation of the domestic currency, which is caused by a higher risk perception in the economy. All of these results regarding purchases and sales can be seen in Table 5 and Table 6 respectively.

Table 5: GARCH Estimation Results - Purchase Interventions

Mean Equation $DLUSD_t = \beta_0 + \beta_1 DLUSD_{t-1} + \beta_2 DLUSD_{t-2} + \beta_3 INT_t + \beta_4 EMBI_t + \beta_5 INTV_{p,t-1} + \varepsilon_t$

	Core Model	***Intervention INTP***	***Successive DSUCINTP***	***Isolated DISOINTP***	***Large DLINTP***	***Small DSINTP***
	(Model 1)	***(Model 2)***	***(Model 3)***	***(Model 4)***	***(Model 5)***	***(Model 6)***
β_0	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(-1.75)*	(-1.75)*	(-1.77)*	(-1.70)*	(-1.66)*	(-1.74)*
β_1	0.066	0.061	0.059	0.010	0.006	0.062
	(1.51)	(1.37)	(1.33)	(0.23)	(0.14)	(1.38)
β_2	-0.079	-0.083	-0.086	-0.02	-0.020	-0.083
	(-1.96)**	(-2.04)**	(-2.11)**	(-0.50)	(-0.48)	(-2.04)**
β_3	0.001	0.001	0.001	0.002	0.002	0.001
	(5.70)**	(5.68)**	(5.64)**	(8.64)**	(8.66)**	(5.60)**
β_4	0.001	0.001	0.001	0.001	0.001	0.001
	(1.59)	(1.65)*	(1.69)*	(2.39)**	(2.34)**	(1.62)
β_5	-	-0.001	-0.002	-0.001	-0.003	-0.001
		(-0.75)	(-1.17)	(-0.19)	(-1.35)	(-0.87)
Variance Equation	$h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 \varepsilon_t^2 + \alpha_3 INT_t + \alpha_4 EMBI_t + \alpha_5 INTV_{p,t-1}$					
α_0	9.41E-09	3.55E-08	1.32E-07	-5.40E-06	-5.57E-06	2.60E-07
	(0.01)	(0.01)	(0.05)	(-3.95)**	(-2.93)**	(0.08)
α_1	0.244	0.244	0.246	0.215	0.210	0.236
	(4.98)**	(4.80)**	(4.80)**	(5.25)**	(5.23)**	(4.90)**
α_2	0.663	0.665	0.661	0.675	0.684	0.676
	(12.36)**	(12.66)**	(12.57)**	(16.80)**	(19.85)**	(12.78)**
α_3	5.30E-06	5.25E-06	5.21E-06	8.44E-06	8.56E-06	5.08E-06
	(1.71)*	(1.68)*	(1.65)*	(3.16)**	(3.30)**	(1.63)
α_4	1.39E-06	1.36E-06	1.33E-06	3.20E-06	3.13E-06	1.22E-06
	(2.22)**	(2.62)**	(2.54)**	(15.89)**	(36.63)**	(1.91)*
α_5	-	1.15E-06	4.02E-06	-3.51E-0.5	-3.20E-05	6.89E-06
		(0.84)	(0.63)	(-2.99)**	(-3.65)**	(0.95)
Q(20)	28.34	27.81	27.09	25.97	26.31	27.05
$Q^2(20)$	25.53	26.04	26.56	28.70	27.39	26.19
AIC	-6.62	-6.61	-6.61	-6.56	-6.56	-6.61
SC	-6.55	-6.53	-6.53	-6.48	-6.48	-6.53
LnL	2197.42	2197.67	2198.13	2181.58	2180.95	2198.01

Figures in parenthesis are z-values. *, ** denote significance at 10 and 5 percent significance levels, respectively. The critical value of $X^2(20)$ is 31.41 at 5 percent significance level.

In the following models, to account for the possible asymmetric effects of purchase and sale interventions, the intervention variables and the relevant dummies are tested separately. As Table 5 and Table 6 report, both purchase and sale interventions –in all specifications- are estimated to have insignificant impact on the depreciation rate, also, sale interventions lead to higher volatility in the exchange rate whereas purchase

interventions are estimated to be insignificant in the variance equation. These results may indicate that CBRT's interventions are not effective in "leaning against the wind". In addition, they also do not serve the purpose of decreasing the volatility of the exchange rate.

Table 6: GARCH Estimation Results - Sale Interventions

Mean Equation $DLUSD_t = \beta_0 + \beta_1 DLUSD_{t-1} + \beta_2 DLUSD_{t-2} + \beta_3 INT_t + \beta_4 EMBI_t + \beta_5 INTV_{s,t-1} + \varepsilon_t$						
	Core Model	***Intervention INTS***	***Successive DSUCINTS***	***Isolated DISOINTS***	***Large DLINTS***	***Small DSINTS***
	(Model 1)	***(Model 2)***	***(Model 3)***	***(Model 4)***	***(Model 5)***	***(Model 6)***
β_0	-0.002 (-1.75)*	-0.002 (-1.76)*	-0.002 (-1.75)*	-0.001 (-1.77)*	-0.002 (-1.65)**	-0.002 (-1.84)*
β_1	0.066 (1.51)	0.068 (1.62)	0.063 (1.51)	0.062 (1.42)	0.058 (1.38)	0.073 (1.73)
β_2	-0.079 (-1.96)**	-0.073 (-1.79)*	-0.073 (-1.81)*	-0.081 (-2.01)**	-0.074 (-1.84)*	-0.073 (-1.79)*
β_3	0.001 (5.70)**	0.001 (5.52)**	0.001 (5.57)**	0.001 (5.80)**	0.001 (5.63)**	0.001 (5.49)**
β_4	0.001 (1.59)	0.001 (1.57)	0.001 (1.55)	0.001 (1.62)	0.001 (1.45)	0.001 (1.68)
β_5	-	0.001 (0.08)	0.001 (0.37)	-0.006 (-1.43)	0.001 (0.02)	-0.001 (-0.07)
Variance Equation $h_t = \alpha_0 + \alpha_1 h_{t-1} + \alpha_2 \varepsilon_t^2 + \alpha_3 INT_t + \alpha_4 EMBI_t + \alpha_5 INTV_{s,t-1}$						
α_0	9.41E-09 (0.01)	3.04E-06 (1.12)	2.80E-06 (1.11)	1.01E-07 (-0.03)	1.62E-06 (0.76)	3.12E-06 (1.08)
α_1	0.244 (4.98)**	0.194 (3.95)**	0.188 (3.94)**	0.231 (5.02)**	0.171 (3.70)**	0.217 (4.31)**
α_2	0.663 (12.36)**	0.681 (9.12)**	0.697 (9.94)**	0.685 (13.49)**	0.745 (11.91)**	0.649 (9.64)**
α_3	5.30E-06 (1.71)*	3.76E-06 (1.40)	3.52E-06 (1.31)	5.20E-06 (1.71)*	3.48E-06 (1.32)	4.34E-06 (1.57)
α_4	1.39E-06 (2.22)**	8.06-07 (1.94)*	7.43E-07 (1.88)*	1.29E-06 (2.08)**	6.836E-07 (1.98)**	9.61E-07 (2.14)**
α_5	-	0.001 (1.84)*	0.001 (1.87)*	-8.24E-05 (-2.59)**	0.001 (1.85)*	0.001 (1.78)*
Q(20)	28.34	28.16	26.15	28.57	25.40	29.52
$Q^2(20)$	25.53	24.12	24.36	25.66	25.10	23.77
AIC	-6.62	-6.63	-6.63	-6.61	-6.62	-6.63
SC	-6.55	-6.55	-6.55	-6.53	-6.54	-6.55
LnL	2197.42	2204.20	2204.59	2198.14	2201.41	2203.95

Figures in parenthesis are z-values. *, ** denote significance at 10 and 5 percent significance levels, respectively. The critical value of $X^2(20)$ is 31.41 at 5 percent significance level.

Nevertheless, when dummy variables characterizing the size and the persistence of the interventions are tested in the consecutive models, the results change to some extent. As Table 5 reports, isolated and large purchase interventions are estimated to have negative effect on the volatility of the exchange rate. In Model 3 and Model 6, successive and small purchase interventions are estimated to be insignificant. On the sales side, as Table 6 reports, all types of interventions, except the isolated ones, are estimated to be significant and positive indicating that these interventions lead to higher volatility, whereas, only isolated sale interventions result in lower volatility in the exchange rate.

Consequently, the above analysis suggests that neither purchase nor sale interventions are effective in changing the level of the exchange rate. Such a finding is in line with the official statement of the CBRT declaring explicitly that it has no intention to intervene the level or the trend of the exchange rate. The main purpose of the interventions is announced to decrease the short-run fluctuations of the exchange rate. In that respect, large and isolated purchase interventions as well as the isolated sale ones seem to be effective. This result may indicate that the strength of the CBRT in the foreign exchange market, which is measured by the size of the intervention, matters to some extent. However, the estimation results on sale interventions should be evaluated cautiously, because these operations dominantly took place in 2001, which is a period where markets were not yet stabilized.[12] Therefore, the analysis period may not be appropriate to draw sound conclusions on the effectiveness of the CBRT's sale interventions.

As a side result, the "uncovered interest rate parity" condition points out that a decrease in the interest rates by the CBRT leads to appreciation of the domestic currency, supporting the arguments put forth by Blanchard (2004) and Favero and Giavazzi (2004).

[12] In 2001, the primary purpose of the foreign exchange sale auctions and sale interventions was to eliminate the liquidity-increasing effect of the utilization of the IMF credit used by the Treasury for domestic debt financing. Therefore, these operations should be evaluated separately.

V. Conclusion

There is a dense literature regarding both the causes and the effectiveness of the central bank interventions in the foreign exchange market. However, most of these studies stop short of extending their analysis to emerging market economies. These economies are mostly characterized by having shallow foreign exchange markets and therefore exhibit excess sensitivity to capital flows. Also, most of these countries have started to implement either implicit or explicit forms of inflation targeting, which have reshaped their preferences toward exchange rate targets. Adding highly dynamic macroeconomic environment and the uncertainty about the operation of the uncovered interest parity condition to the picture, there may be important insights from studying foreign exchange interventions in these economies.

Taking the above discussion as the starting point, this study analyzes both the causes and the effectiveness of the foreign exchange interventions conducted by the CBRT in the post-crisis period. Probit models along with the Granger causality tests are employed to reveal the preferences of the CBRT in its interventions. It has been found that, as officially stated by the CBRT, the excessive volatility emerges as the main motivation behind the interventions. On the other hand, "the signaling channel", which states that interventions are effective since they reveal important information about future monetary policy actions, is not completely supported. Such a channel seems to operate only through purchase interventions.

Regarding the effectiveness of interventions, GARCH models point out that neither purchase nor sale interventions are effective in changing the appreciation/depreciation trend of the Turkish lira, thus, not supporting the "leaning against the wind" hypothesis. However, this result is very much in line with the official statement of the CBRT, which explicitly announces that it has no intention to alter the level or the trend of the exchange rate. The main aim is stated as to decrease the volatility in the exchange rate. In that respect, large and isolated purchase interventions seem to be effective. However, this result cannot be supported by the sale interventions. Bearing in mind that almost all sale interventions took place in 2001, where the markets were still in turmoil, the analysis period may not be that appropriate to evaluate the effectiveness of the CBRT's sale interventions. Finally, the estimation results of the GARCH models indicate that the uncovered interest rate parity condition for Turkey

operates such that there is a positive relationship between the interest rate and the depreciation rate of the Turkish lira between May 16, 2001 and December 31, 2003.

There are two points that we have to pay attention in interpreting these results. First, the period witnesses mostly the rate cuts. Thus, we cannot have a clear picture about the operation of uncovered interest rate parity condition when, actually, the CBRT tightens its policy. Next, excluding the period right after the crisis, the Turkish lira was consistently in an appreciation trend. Again, we cannot have a robust policy implication when there is excessive volatility on a depreciation trend that would induce the CBRT to intervene in the market.

REFERENCES

Agcaer, A. (2003): "Dalgalı kur rejimi altında Merkez Bankası müdahalelerinin etkinliği: Türkiye üzerine bir çalışma" (Effectiveness of Central Bank interventions under the floating exchange rate regime: Turkish experience), Central Bank of Turkey, Ankara.

Baillie R.T. and W.P. Osterberg (1997): "Central Bank And Risk in The Forward Market", *Journal of International Economics*, 43, 483-497.

Beine, M. and A. Szafarz (2003): "The Design of Effective Central Bank Interventions: the Yen/Dollar Case," *Working paper*, CEB 03/008.

Blanchard, O. (2004): "Fiscal Dominance and Inflation Targeting: Lessons from Brazil", *NBER Working Paper*, No: 10389.

Bonser-Neal, C. and G. Tanner (1996): "Central Bank Intervention and the Volatility of Foreign Exchange Rates: Evidence from the Options Market," *Journal of International Money and Finance*, Vol.15, No. 6, p. 853-78.

Domac, I., and A. Mendoza (2002): "Is there Room for Forex Interventions under Inflation Targeting Framework? Evidence from Mexico and Turkey", Central Bank of Turkey, *Discussion Paper*, December.

Dominguez, K. M. (1998): "Central Bank Intervention and Exchange Rate Volatility," *Journal of International Money and Finance*, 17 (1998), 161-190.

Fatum, R. (2000): "On the Effectiveness of Sterilized Foreign Exchange Intervention" *SCCIE Working Paper,* No: 99-2.

Favero, C. and F. Giavazzi (2004): "Inflation Targeting and Debt: Lessons From Brazil", *NBER Working Paper*, No: 10390.

Herrera A.M. and P. Ozbay (2005): "A Dynamic Model of Central Bank Intervention", Central Bank of Turkey, *Working Paper*, No.05/01.

Ito T. and T. Yabu (2004): "What Prompts Japan to Intervene in the Forex Market? A New Approach to a Reaction Function", *NBER Working Paper,* No: 10456.

Kim, S. and J. Sheen (2002): "The Determinants of Foreign Exchange Intervention by Central Banks: Evidence from Australia," *Journal of International Money and Finance*, 21, p. 619-49.

Lewis, K. (1993): "Are Foreign Exchange Intervention and Monetary Policy Related and Does It Really Matter?" *NBER Working Paper,* No: 4377.

Lindberg, H. (1994): " The Effects of Sterilized Interventions through the Signaling Channel: Sweden 1986-1990, " *Sveriges Riskbank, Working Paper,* No.19.

McKenzie M. (2004): "An Empirical Examination of Relationship Between Central Bank Intervention and Exchange Rate Volatility: Some Australian Evidence", Australian Economic Papers, 43: 59-74.

Ozatay, F. (2004): "Exchange Rate Policy in the Post-Crisis Period in Turkey," paper presented at the BIS Deputy Governors' Meeting, 2-3 December 2004, Basle.

Sarno, L. and M. P. Taylor (2001): "Official Intervention in the Foreign Exchange Market: Is it Effective and, If so, How does it work?," *Journal of Economic Literature*, Vol. 39, p.839-68.