1. Introduction

Central banks have long been intervening the foreign exchange markets at most times in an attempt to affect the level of the exchange rates and smooth its fluctuations in order to calm disorderly markets. However, recent empirical findings threw some doubts on the effectiveness of intervention policy: in some cases it was found to increase the volatility of the exchange rates.[1] Nowadays, different aspects of central bank intervention operations still remain unanswered and thus become a core subject of research in international finance.

The aim of this paper is to explore the effects of intervention policy in Turkey when financial crises affected the country as of 21 February 2001. The government officially abandoned its currency peg and adopted the floating exchange rate regime. Also, the Central Bank of Turkey subsequently conducted both non-sterilized and sterilized interventions. The sustainability of high debt burden with fluctuating exchange rates was a major concern for both the monetary authorities and the market participants to overcome the financial crises and quickly return to stable currencies. Besides, the study will also explore whether the data reflects the views and statements of the Central Bank of Turkey with regard to its involvement in the foreign exchange rate market.

This research differs from those documented in the literature as it focuses on analyzing the effects of central bank intervention operations in an emerging market upon the outbreak of financial crises. Therefore, the empirical results will be specific to the prevailing conditions in the Turkish economy suffering from persistent high inflation rate and ever expanding foreign and domestic borrowings that sustained for twenty five years till the beginning of this new era. Needless to say, countries such as the United States, Germany, Japan or Australia do not carry these features for which most intervention analysis in the literature was documented.

The paper is organized as follows. Section 2 reviews the literature on the influences of central bank intervention operations. Section 3 discusses the Turkish Central Bank intervention policies adopted during the floating regime. Section 4 presents the data and analyses the exchange rate behavior and intervention episodes. Section 5 summarizes the approach of modeling short-term exchange rate volatility together with the empirical results. Section 5 investigates the probability of intervention. Finally, section 6 concludes.

2. The Effects of Central Bank Intervention

There is extensive research in the literature questioning the efficiency of intervention policy that maintained its role as a frequently used tool by central banks, even after the break down of the Bretton Woods System. As explained in Dominguez and Frankel (1993), by the end of the fixed exchange rate regime, high capital flows between countries outdated the classical arguments about automatic functioning of the floating exchange rate regime within the macroeconomic system. Clean floating therefore, had become undesirable by countries due to observed, unexpected high volatility of the nominal exchange rates. Rather, the need to manipulate the exchange rates suggested the use of central bank intervention policy in order to influence the trend movements or to reduce the unpredictable fluctuations in the exchange rates. Therefore, the limitations imposed by the IMF allowed the use of the intervention policy in situations of considerable turbulence or to achieve target levels of the exchange rates. The implication

[1] See Dominguez (1998), Baillie and Osterberg (1997a,b), Beine et.al. (2002)

of this is the implicit assumption of the effective role of the intervention policy as reported by Dominguez (1998).

The empirical studies on this issue covering the floating exchange rate regime period found mixed results. For instance, Dominguez (1998) modeled the Dollar-Mark, Dollar-Yen interventions by G-3 central banks and found that in general, intervention actions increased exchange rate volatility particularly when the intervention operations were secret. Beine et al. (2002) estimated the effects of interventions within a FIGARCH framework and also evidenced a positive association between short term variability of the foreign exchange rate returns and the intervention operations of the central bank. Baillie and Osterberg (1997) found little evidence for the effectiveness of intervention both on the conditional mean and the variance of the exchange rates. Rather, they found that the probability of intervention is determined by the magnitude of deviation of the nominal exchange rate from its agreed target level and by the current volatility of the exchange rate. Aguilar and Nydahl (2000) investigated the effects of central bank interventions by using a bivariate GARCH in mean model for Swedish Krona-US$ and Swedish Krona-Germany DM. They found little support of the view that intervention operations affect volatility but reported significant leaning against the wind effect for the whole period of the study. On the other hand, Domaç and Mendoza (2001) found that central bank interventions reduced the foreign exchange rate volatility in both Mexico and Turkey both of which adopted inflation targeting policy.

As documented in the literature, central banks may also intervene in other forms such as merely to rebalance their own foreign exchange reserve holdings. No matter for what reason monetary authorities transact in the foreign exchange market, these operations may influence the exchange rates in various mechanisms depending on whether the intervention operations are sterilized or non-sterilized or the market is ambiguous or unambiguous.[2]

Non-sterilized intervention is analogous to monetary policy changing the ratio of domestic and foreign money supplies and thus affects the exchange rates. Sterilized intervention operations, solely alter the composition of foreign and domestic asset outstandings leaving the relative money supply unchanged. In other words, any sale or purchase of foreign exchange is immediately offset by a domestic asset transaction such that the monetary base does not change. Therefore, the effects of sterilized intervention policy are more complicated working through portfolio balance channel or signaling channel. (Dominguez and Frankel, 1993)

In portfolio balance channel, investors diversify their holdings among domestic and foreign assets based on expected returns and variance in returns. According to the theory, if foreign and domestic assets are imperfect substitutes, a sterilized intervention operation supporting the domestic currency (against the domestic currency) will increase (decrease) the relative supply of outstanding foreign assets. This will require a higher expected return on foreign assets (domestic assets) so that investors will willingly hold a greater stock of foreign (domestic) assets that will lead to depreciation of the foreign (domestic) currency.

The signaling channel relies on central bank's intention to convey information to the market about future fundamentals. Given that the central bank is credible, market participants will revise their expectations about the fundamentals influencing the future spot rates. For instance, if the central bank intervenes in support of domestic currency, it may wish to signal contractionary monetary policy in order to reduce expectations of

[2] See Dominguez and Frankel (1993) for detailed explanations.

future inflation. However, the success of such intervention policy depends on efficiency of foreign exchange market as well as the credibility and unambiguity of the intervention signals.[3] Based on most empirical studies, the general finding is that the impact of intervention through signaling channel on the level of exchange rates is indeterminate. However, in many cases, it was recorded to increase exchange rate variance except for one case when intervention signals were credible and unambiguous and the market is efficient.[4]

3. The Turkish Central Bank Intervention Policy:

Upon the outbreak of the inevitable financial crises experienced in February 2001, Turkey switched to floating exchange rate regime as from 22.2.2001 and designed a new monetary and exchange rate policy towards achieving price stability.[5] Hence, a series of structural reforms were initiated in 2001 for strengthening the banking system and to re-establish policy credibility. During this transformation process, the Central Bank had a major role to improve the fragile structure of the economy and reverse the adverse expectations about future inflation rates.[6] With tight fiscal and monetary policy to be pursued over the period, first the monetary targeting and ultimately the inflation targeting was to be accepted as the nominal anchor as soon as the required conditions prevailed in the economy.

In line with the above mentioned policies, the Central Bank emphasized on the role of its transparency to eliminate uncertainties for the market participants. Therefore, it commenced the practice of regular announcements about its prospective monetary policy and also shared its views by the public on any issue that it regarded threatening its commitment to achieving its main goal of price stability.

Within this perspective, the foreign exchange rates were to be determined by the forces of the market conditions. To this end, the Central Bank announced that it had no agreed target level or any intention to alter the direction or the trend movement of the foreign exchange rate that would distort its long-run equilibrium. However, the Central Bank also clearly stated that it would intervene the foreign exchange market, but only in situations of excessive volatility in the short term.

Following the February 2001 crises, the Central Bank created an excess money supply in order to meet the liquidity requirements of the insolvent banks which were transferred to the administration of the Deposit Insurance Fund.[7] This excess liquidity also persisted in the following years of 2002 and 2003.[8] Moreover, the Central Bank's intensive foreign exchange purchases in 2002 and mostly in 2003 had been another main factor contributing to expansion of excess liquidity: reverse dollarization and unexpected capital inflow during these years induced the Central Bank to strengthen its foreign exchange reserve holdings as a precaution for any unpredictable event in the future.[9] This overall excess liquidity in the market had been sterilized by transactions of the Central Bank in the interbank money market and the Istanbul Stock Exchange Market.

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[3] See Dominguez (1998) for detailed explanation.
[4] Dominguez and Frankel (1993a,b)
[5] The Turkish Central Bank Press Announcement, 2001-8, 22.2.2201.
[6] Ibid., 2002-1, 2.1.2.
[7] These banks were extended loans in collateral of the State Domestic Borrowing Securities (DİBS) by the Central Bank.
[8] The Turkish Central Bank Press Announcement, 2004-2, 2.1.2004.
[9] Ibid., 2002-10, 11.2.2002.

On the other hand, in order to protect the banking system, the Central bank provided the banks with foreign exchange cash facilities as an emergency at the burst of the crises. These were realized by non-sterilized sales of foreign exchange for 21 trading days commencing on the date of 22.2.2001 which totaled net of $2 billions over this short period.[10] The practice of sales of foreign exchange had been restarted in 29.3.2001 in form of selling foreign exchange auctions which were sterilized. Besides the main purpose of these foreign exchange selling auctions being to smooth the exchange rate volatility, they were also organized to sterilize a certain portion of the IMF loan which was made available for the use of the Treasury in budget financing. Hence, these selling auctions reflected the amount of liquidity withdrawn from the economy to compensate for the money expansion by the injection of the IMF loan nominated in Turkish Lira.[11] Initially, the Bank predicted that for 2001, the total amount of the IMF loan of $9.6 billion could be required for domestic debt payments in terms of Turkish Lira. However, the selling foreign exchange auctions in 2001 totaled merely $6.64 billions and the Bank did not involve in any other form of intervention operation in 2001.

The above mentioned buying and selling foreign exchange auctions in the foreign exchange market were pre-announced by the Central Bank with the aim of sharing its policy actions by the economic units in line with its new policy of transparency. While the Bank had no commitment to a target level of foreign exchange rate, it had an intention to smooth excess volatility and avoid the departure of the exchange rate from its long-run path: with this perspective, the Central bank intervened the foreign exchange market directly in form of non-sterilized intervention operations for nine times during the period of the study. All these intervention operations were reported and the Bank explicitly announced to make it clear that the objective of the direct intervention operations was to calm disorderly markets by reducing volatility in the short-run.

The summary of the intervention episodes of the Central Bank of Turkey and the type of interventions are presented in Table 1.

[10] Ibid., 2001-14, 13.4.2001.
[11] Ibid., 2001-12, 29.3.2001, 2001-20, 17.5.2001, 2001-32, 11.7.2001, 2001-67, 1.11.2001.

Table 1
Post-float intervention features: 22.2.2001 – 31.12.2003

Intervention Episodes	Type of [(a)] Interventions	Number of days in sub-period	Purpose[12]	Magnitude[(b)] (Billions of US$)	Percentage[(c)]
22.2.01- 28.2.01	unsterilized sales of US Dollars	21	reduce volatility	$ 2.00	2.9%
29.3.01-30.11.01	selling auctions	126	reduce volatility sterilize IMF loans	$ 6.643	17.5%
1.4.02- 28.6.02	buying auctions	33	rebalance foreign exchange reserves	$ 0.795	4.6%
5.5.03- 22.10.03	buying auctions	117	rebalance foreign exchange reserves	$ 5.652	16.3%
11.7.02- 25.9.03	direct interventions (7 days purchases, 2 days sales of US$)	9	reduce volatility	$4.200 (only in 2003 for 6 days of purchases of US$)	1.3%
Total		**306**			**42.6%**

(a) Direct interventions are non-sterilized interventions of sales of foreign exchange on dates of 11.7.2002 and 21.12.2002 and purchases of foreign exchange on dates of 2.12.2003, 12.5.2003, 21.5.2003, 9.6.2003, 18.7.2003, 10.9.2003 and 25.9.2003.
(b) Magnitude of interventions is net amount of sales or purchases of US dollars within the period.
(c) This is the percentage of number of intervention days to total number of trading days within the period of 22.2.2001- 31.12.2003 which corresponds to 718 trading days.
Source: The Central Bank of Turkey, 2001-2003.

As it can be seen from Table 1, sales of foreign exchange are concentrated at the beginning of the February crises which totaled US$8.6 billions covering 20.4% of all the intervention transactions over the period. The foreign exchange buying auctions commenced in the second quarter of 2002 which extended to the year of 2003 and totaled US$6.447 billions covering 20.9% of the period of study. The remaining purchases of US Dollars were realized in form of non-sterilized operations of the Bank which constituted 7 of the 9 intervention operations for which the amounts were unfortunately not publicly announced. However, it was reported that six of these operations which occurred in 2003 totaled US$4.2 billions. Therefore, the total amount of intervention transactions including the sterilized interventions of foreign exchange buying auctions equaled US$9.9 billions in 2003 marking the maximum amount of intervention operations in the direction of buying foreign exchange as compared to other years.[13] This corresponds to almost half of the volume of exports during 2003 which were about $ 23.5 billions.

On daily basis, the buying foreign exchange auctions during 1.4.2002 – 28.6.2002 varied between $ 40 millions and $ 5 millions per day. Considering the second period of buying auctions between 6.5.2003 and 22.10.2003 the amount of purchases started by $ 20 millions per day and consequently increased to $30, $40 and $ 50 millions per day in June and twice in July respectively due to excess supply of foreign exchange in the

[12] Ibid., 2001-44, 17.8.2001, 2002-25, 28.3.2002.
[13] Ibid, 2004 - 2, 2.1.2004.

market.[14] Commencing from 10.9.2003, amounts of buying auctions were determined in a more flexible manner allowing the participating banks and private financial institutions to use an additional optional amount of $20 million per day initially (50% of original amount) in addition to the auction amount of $ 40 millions per day. These amounts were increased consequently to total daily $ 75 million and $120 millions for September and October 2003.[15] These foreign exchange auctions were ceased on 23.11.2003 based on increase in volatility as announced by the Central Bank.[16] Considering both periods of buying auctions, daily maximum and minimum amounts were observed to be $120 and $ 5 millions. These amounts are considerably low as compared to daily volume of foreign exchange transactions by banks and the private institutions: the daily average volume of foreign exchange transactions have been realized as $1525, $1803, $1721, $1490, $1900 and $2194 millions through May and October 2003 respectively.

It is also worth to note that relying on the information summarized in Table 1, the Turkish Central Bank had been observed to be rather active in its intervention operations in both directions accounting for almost half of the trading days of the period which was calculated to be 42.6% of all the trading days of the period of study. Also, from the analysis above, larger magnitudes of interventions on a daily basis relative to the foreign exchange market may have taken place by the official direct interventions in the direction of buying rather than the buying auctions. However, even small amounts of interventions can influence expectations by conveying signals to the market about the Central Banks policy. Any potential effect of such intervention operations will be empirically investigated in the following sections.

4. The Analysis of Exchange Rate Behavior and Intervention Episodes

The study uses intervention data that relies on the announcements and amounts provided by the Central Bank of Turkey for the floating period covering 26.2.2001-31.12.2003. The Central Bank carries out its intervention operations by sales/purchases of US Dollars in the foreign exchange market. It should be noted here that this currency plays a crucial role on the supply side of foreign exchange market in the sense that Turkey's receipts of loans from the IMF or the World Bank are nominated in US Dollars. However, export earnings of Turkey are mostly nominated in Euro. With regard to the supply and demand factors of these two currencies, the effects of the Central Bank's transactions in the foreign exchange market are investigated by using the daily Turkish Lira/US Dollar and Turkish Lira/Euro spot selling exchange rates that are determined at the closing of the previous trading day.

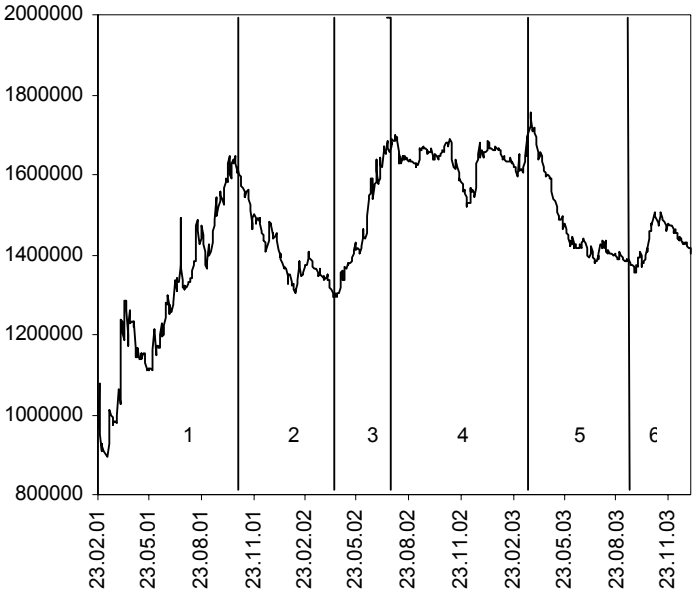
First, the visual inspection of the levels of both exchange rates clearly shows quite a similar pattern. As shown in Figure 1, long swings are easily observed in both exchange rates with same turning points over the period of study: at the beginning, both series exhibit sharp fluctuating increase until October 2001 which is followed by a sudden decline till the midst of April 2002. However, the appreciation of the Turkish Lira against the US Dollar and the Euro was transitory and followed by its depreciation against both currencies thereafter which continued till about July 2002. The domestic currency relatively remained stable at these higher levels until the end of March 2003. Then, it started to fall against both currencies. The central question in this section is whether these long swings are related with the intervention activity of the Turkish Central Bank. To this end, the plot of the TL/US Dollar exchange rate will be analyzed

[14] Ibid., 2003-48, 29.8.2003.
[15] Ibid., 2003-52, 10.9.2003.
[16] Ibid., 2003- 64, 22.10.2003.

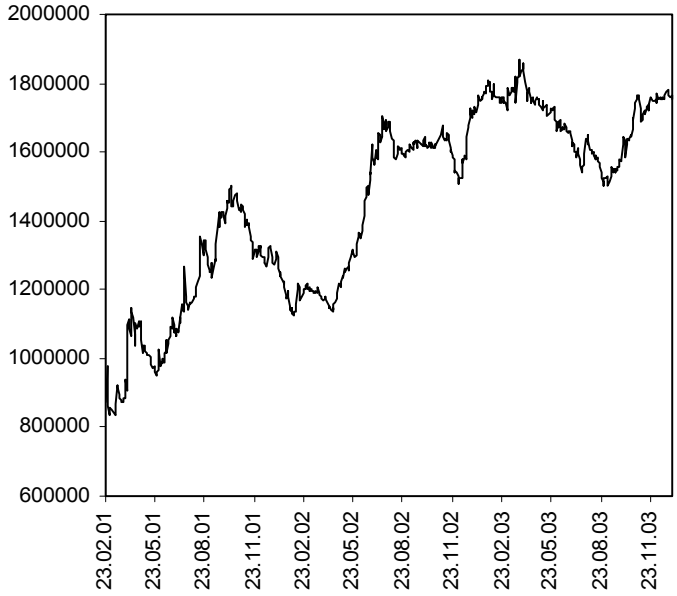
by means of a simple table to see if any relationship between the behavior of the exchange rate and the intervention operations can be evidenced.[17]

Table 2 provides the intervention data corresponding to the periods of swings in the TL/US Dollar exchange rates. Column 1 presents the dates for the visually observed swings in the exchange rate while column 2 lists the corresponding percentage changes in the exchange rate within the given periods indicated in Column 1. Column 3 intends to match the interventions with the periods of swings. Column 4 shows the frequency of interventions corresponding to these periods. Column 5 shows the percentage intervention frequencies within the total number of intervention days for each period shown in column 3. Finally, column 6 portrays the corresponding amounts of interventions.

[17] Since both exchange rates display the same behavior, analysis of the movements of only one of the exchange rates is considered to be sufficient for the purpose of the analysis.



TL/US$ Exchange rates



TL/Euro Exchange rate

Figure 1 The TL/US Dollar and the TL/Euro Exchange Rates

Table 2 Analysis of interventions, exchange rate changes and swings

Periods of Swings in TL/US $	% change in TL/US $ in the period[a]	type of intervention in the period[b]	frequency of intervention in the period	% of intervention frequency over the period	amount of interventions within period
(1) 26.2.01-11.10.01	52.6	22.2.01-28.2.01 (unsterilized sales of US$s)	19	6.25	nearly $2 bill.
		29.3.01-11.10.01 (selling auctions)	93	30.6	$5.893 bill.
(2) 12.10.01-15.4.02	-21.4	11.11.01-30.11.01 (selling auctions)	33	10.8	$0.660 bill
		1.4.02-15.4.02 (buying auctions)	9	2.96	$0.180 bill.
(3) 16.4.02-10.7.02	29.4	18.4.02-28.6.02 (buying auctions)	24	7.90	$0.615 bill.
(4) 11.7.02-31.3.03	2.6	direct interventions on 11.7.02, 2.12.02, 24.12.02	3	1.00	N.A
(5) 1.4.02-25.9.03	-21.0	direct intereventions on 12.5.03, 21.5.03, 9.6.03, 18.7.03, 10.9.03, 25.9.03.	6	1.97	$4.200 bill
		6.5.03-25.9.03 (buying auctions)	117	38.50	$5.652 bill.
(6) 25.9.03-31.12.03	3.5	no intervention	-		
Total			**304**	**100.0**	**.**

N. A: not available

(a) Percent change in TL/US$ exchange rate between the dates of periods in column 1. Positive values represent depreciation and negative values denote appreciation of the Turkish Lira against the US Dollar.

(b) Period of interventions that match the corresponding period of swings. Direct interventions are non-sterilized interventions that are announced to the public by the Central Bank after the action for which daily amounts are kept secret.

Source: The Central Bank of Turkey.

The up and down swings of the exchange rate displayed in Figure 1 are analyzed in six sub-periods for which the intervention features are presented in Table 2. At first glance, it can easily be observed that most of the intervention actions took place during the first period which engaged 36.8% of all the trading days. Despite the total amount of US$ 7.9 billions of net sales in the foreign exchange market the Turkish Lira depreciated by 52.6% against the US Dollar in this period which covered almost the whole year of 2001. The reversal of this trend movement corresponds to the last 33 days of the selling auctions that totaled merely US$ 660 millions. The other intensive intervention operations are observed to coincide with the fifth period which covers the second and third quarter of 2003. In this cycle, the Central Bank conducted six non-sterilized intervention transactions which totaled US$ 4.2 billions. Together with the intensive foreign exchange buying auctions covering in total 40.5% of frequency of intervention, it amounted US$ 9.9 billions marking the maximum amount in 2003 relative to other years. However, during this period, the Turkish Lira appreciated by 21%. Other two salient characteristics are observed in periods two and three. First, in period two, when the Central Bank interventions were at minimum levels, 10.8% of frequency being in the

direction of sales and 2.96% in the direction of buying foreign exchange, the Turkish Lira appreciated by as much as 21.4% during a six month period. Secondly, although the Central Bank purchased only US$615 millions via foreign exchange buying auctions in period three corresponding to second and third quarters of 2002, the Turkish Lira depreciated by a non-negligible ratio of 29.4%. These features raise the question whether the Central Bank actually is trying to reverse the trend movement of the exchange rates. During periods of huge TL appreciation which took place in the last quarter of 2001 and the first quarter of 2002 as well as the second and third quarters of 2003, it is interesting to observe that the Central Bank ceased the selling foreign exchange auctions and commenced the buying foreign exchange auctions in 2001. Also, the Central Bank has intervened the foreign exchange market directly by purchases of U.S dollars during the second and third quarters of 2003 totaling US$9.9 billions including the buying foreign exchange auctions. These may suggest that the Central Bank, being aware of excess volatility of the exchange rate, not only intended to smooth its fluctuations but also may actually be in an effort to impede the huge appreciation of the Turkish Lira against these currencies as opposed to its announcements of having no intention what so ever to affect the level of the currency.[18] . Finally, within the sixth period of no intervention which is rather a short period, the Turkish Lira depreciated by 3.5%.

The general picture of these intervention operations on the level of the exchange rate may suggest considering the possibility that the Central Bank's actions may actually be affecting the level of the exchange rate and reverse its direction but only in situations of intensive interventions amounting to large values. Finally, from the above analysis, it is also observed that the Central Bank's interventions had not been uniform over the period: most interventions are concentrated during the first nine months of 2001 and over the whole year of 2003.

In order to complement this simple analysis, possible short-term effects of the Central Bank's actions on both the level and the volatility of the exchange rate returns will be econometrically examined within a GARCH family framework. In general, the intervention policy is based on daily decisions. Another point is that, central banks rarely intervene the foreign exchange market continuously. Therefore, daily data are required to capture the effects of central bank intervention. The intervention policy in Turkey for the period differs from usual practices in the sense that daily amounts of sales and purchases of U.S Dollars are planned and pre-announced transactions that are continuous over a stretch of time.

5. The Statistical Features of the Data and the Methodology

It is well documented in the literature that short-term exchange rate returns exhibit excess kurtosis and thus have fat tails.[19] This behavior is well captured within the family of ARCH and GARCH models introduced respectively by Engle(1982) and Bollerslev(1986). For this reason, this paper studies potential effects of interventions on exchange rate volatility with time-dependent conditional heteroscedasticity approach. Many studies in intervention analysis used simple order of GARCH model of Bollerslev(1986). However, one major disadvantage of the GARCH model is the assumption about positive and negative shocks having same effect on volatility. In order to overcome this weakness, recent studies employed exponential GARCH or EGARCH model of Nelson(1991) allowing for any asymmetric effect by inclusion of negative

[18] According to the press announcements of the Central bank, the appreciation of the Turkish Lira is due to reversal of the expectations to the positive side about the Turkish economy and thus, the Turkish Lira gained a confidence raising the demand to hold securities nominated in the Turkish Lira.

[19] Hsieh(1988), Hsieh(1989), Diebold and Nerlove(1989)

variables into the conditional variance equation. Furthermore, Beine et al.(2002) modeled central bank intervention by a fractionally integrated GARCH (FIGARCH) model. The FIGARCH model implies long memory behavior and slow rate of decay after volatility shocks. Their results show that the traditional GARCH estimations underestimate the effects of volatility and the FIGARCH model outperforms the GARCH estimations.

This paper attempts to model the movements in the exchange returns of TL/US$ and TL/Euro within an EGARCH framework of Nelson (1991).[20] For the TL/US Dollar return series, the conditional mean is filtered by two AR terms[21] and daily effects with additional explanatory variables. Therefore, the proposed model is EGARCH(1,1) expressed as

$$r_t = \mu + \theta_1 r_{t-1} + \theta_2 r_{t-2} + a D_t + b' X_t + \varepsilon_t \quad (1)$$

$$\varepsilon_t \mid \Omega_{t-1} \sim \Delta(0, \sigma_t^2) \quad (2)$$

$$\log(\sigma_t^2) = \omega + \alpha_i (\varepsilon_{t-1} / \sigma_{t-1}) + \alpha_1^* (|\varepsilon_{t-1} / \sigma_{t-1}|) + \beta_1 \log(\sigma_{t-1}^2) + \gamma' X_t \quad (3)$$

where $r_t = 100\log(S_t/S_{t-1})$ is the nominal exchange rate returns in percentages with S_t being the nominal exchange rate in levels and μ, the unconditional mean of the process and σ_t^2 the conditional variance of ε_t and Ω_{t-1} is the information set at time t-1, Δ is the conditional distribution, | | is the absolute value operator and ε_t is the disturbance term. D_t is a dummy variable capturing Monday effect: it is set to 1 on days when the market opened following a weekend.[22] Equations (1) and (3) describe the conditional mean and the conditional variance equations of the model respectively. The vector X_t embodies the Turkish Central Bank intervention and policy variables as follows

$$X_t = \{BUY, SELL, OI, IUR, ONI\}$$

where "BUY" and "SELL" denote daily net amounts of US Dollar purchases and sales by the Turkish Central Bank respectively in form of scheduled pre-announced daily auctions. Since the non-sterilized intervention amounts are not available on a daily basis, these are included into the model by a dummy variable, OI (-1,0,1) for days when sales, no intervention and purchases of US Dollars took place respectively. "IUR" is also a dummy variable capturing the signaling effect of the intensive sales of US Dollars of the central bank at the beginning of the financial crises. The difference between official intervention (OI) and non-sterilized intervention (IUR) variables is that the first refers to reported intervention operation on the day the action took place while the latter includes those unreported sales of Dollar transactions at the time of intervention upon the burst of the bubble in February 2001. Actually, both are non-sterilized intervention transactions. Finally, the Central Bank's monetary policy actions are captured by ONI, the changes in the overnight interest rates.

[20] The FIGARCH model could not be employed because as Baillie, Bollerslev and Mikkelsen (1996) illustrated the implementation of this approach does not allow truncation at low lag order which biases the results severely. They advise using a truncation lag order of 1000.

[21] The choice is based on AIC, BIC and Ljung-Box Q^* statistics for the conditional mean equation before modeling the restricted model without intervention and policy variables. However, for the TL/Euro return series, the conditional mean equation is determined as an ARMA(1,1) model.

[22] Other dummy variables for the week days turned out to be statistically insignificant. A day dummy variable which equaled 1 on days when the market reopened following a weekend, or a holiday was also found to be significant but at a lower level of significance than the Monday dummy variable.

In the conditional variance equation, α shows the leverage parameter, the asymmetry effect of positive and negative shocks to volatility, while α^* measures the impact of large shocks on the next period conditional variance and β reflects the degree of persistence of the shock to the volatility: closer the value of the parameter to 1 longer is the persistence of the shock to the conditional variance.

The conditional distribution of the disturbance term is generalized error distribution (GED) for which the H_o: $\nu = 1$ is rejected where ν is the parameter governing the thickness of the tails of conditional density of residuals. The GARCH family models can well be estimated assuming Gaussian distribution as shown by Baillie et al. (1996a), Bollerslev and Wooldridge (1992) as the QML estimates behave relatively well. However, among others, Bollerslev (1987), Hsieh (1989), Baillie and Bollerslev (1989) and Palm and Vlaar(1997) showed that t-distribution captures the excess kurtosis of the residuals of conditional heteroskedasticity better. Therefore, it is expected that the use of a more appropriate distribution will better capture the heavy tailed conditional distribution of these residuals. Nelson (1991) proposed estimating the EGARCH model by maximum likelihood (ML) using the generalized error distribution normalized to have zero mean and unit variance υ_t . Therefore, the log-likelihood to be maximized is

$$LL_t = -\frac{1}{2}\log\left(\frac{\Gamma(1/\nu)^3}{\Gamma(3/\nu)(\nu/2)^2}\right) - \frac{1}{2}\log\sigma_t^2 - \left(\frac{\Gamma(3/\nu)(y_t - X_t'\theta)^2}{\sigma_t^2\Gamma(1/\nu)}\right)^{\nu/2} \qquad (4)$$

Where Γ (•) is the gamma function and ν is a positive parameter determining the thickness of the tails. The distribution becomes Gaussian for $\nu = 2$ and. If, $\nu < 2$, the distribution has thicker tails than the Gaussian distribution[23]: a special case of thick tails contains the double exponential distribution in case of $\nu = 1$.

Following Dominguez (1998), three specifications of the conditional variance equation are estimated for the EGARCH (1,1) model. The first specification is the restricted model excluding the intervention variables while the second includes the intervention variables in magnitudes if available and as dummies otherwise. The third specification includes all the intervention variables only as dummies (-1,0,1): this will test whether it is the presence of the Central Bank in the foreign exchange market that influences the volatility regardless of the magnitude of intervention operations.

First, the statistical features of the return series, r_t, of TL/US$ and TL/Euro are analyzed that are summarized in Table 3 for the period of 26.2.2001 – 31.12.2003.

[23] Hamilton, J.D., , Time Series Analysis, 1994.

Table 3 Daily exchange rate statistics for 26.2.2001 – 31.12.2003

	Variable: $r_t = 100.\log(S_t/S_{t-1})$				Variable: S_t			
	TL/USD$		TL/Euro		TL/US$		TL/Euro	
Mean	0.0211		0.0416					
Std. Deviation	0.6464		0.6884					
Skewness	0.6930		0.7052					
Kurtosis	22.079		16.839					
JB[a]	10901		5765					
Q(10)[b]	23.65		17.71					
Q(20)	46.01		37.74					
Q^2(10)[c]	228.04		194.50					
Q^2(20)	263.83		223.08					
N[e]	715		715					
	AC[d]	PAC[d]	AC	PAC	AC	PAC	AC	PAC
Lag 1	0.015	0.015	-0.003	-0.003	0.988	0.988	0.993	0.993
Lag 2	-0.148	-0.148	-0.119	-0.119	0.978	0.092	0.987	0.075
Lag 3	-0.002	0.003	0.029	0.028	0.967	-0.045	0.980	-0.047
Lag 4	0.032	0.010	0.023	0.009	0.954	-0.052	0.973	-0.055
Lag 5	0.057	0.058	0.066	0.074	0.942	-0.014	0.966	0.004

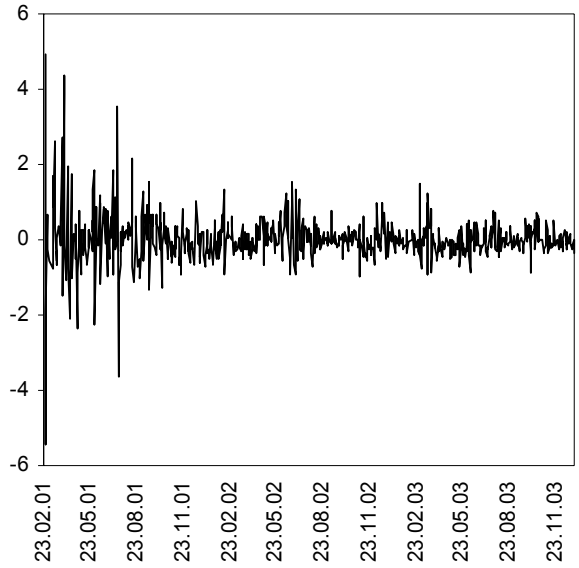
(a) JB is the value Jarque-Bera test statistic. (b) Q(k) is the portmanteau statistics for autocorrelation at lag k, where k=10 and 20. (c) Q^2 (k) is the portmanteau statistics for ARCH effects at lag k where k=10 and 20. (d) AC and PAC denote sample autocorrelation and partial autocorrelation coefficients.(e) N denotes the number of observations.

As it can be clearly seen from the table, both series have high degree of excess kurtosis. The Box-Pierce Q-statistic tests[24] at lag 10, Q(10) and lag 20, Q(20), indicate serial correlation at these lags while the very high values of the test statistic for the squared return series are indicative of ARCH effects. The autocorrelation and partial autocorrelation coefficients of the daily spot rates in their levels, S_t, indicate nonstationarity of the series while the first difference of the spot rates in logarithms achieve stationarity: the conventional Dickey-Fuller tests for unit roots rejected the null of a unit root.[25] Although, the exchange rate return series are themselves uncorrelated, they exhibit correlation in their second moments which also can be visually observed from the plot of these series as in Figure 2. The formal LM tests at various lags also confirm the situation for which the test results are not reported here to save space.

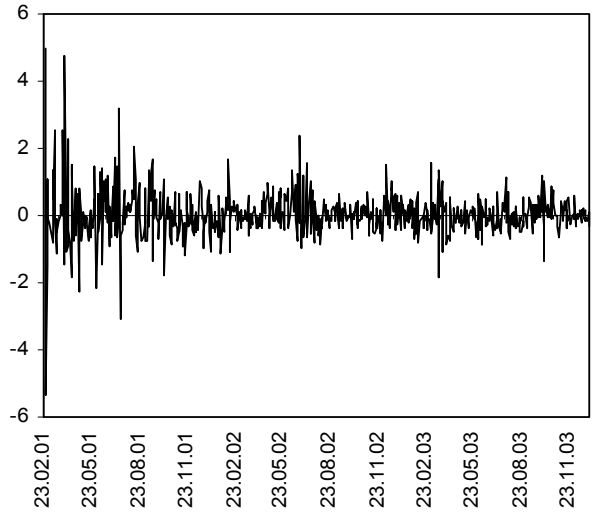
Table 4 presents the estimation results for the restricted EGARCH(1,1) model together with the unrestricted version with the intervention variables in magnitudes and as dummies.

[24] Under the null hypothesis, the Q-statistics asymptotically follow a chi-square distribution with k degrees of freedom.

[25] The Unit root test results are not shown here to save space.



TL/US$ return series



TL/Euro return series

Figure 2 TL/USD and TL/Euro return series

Table 4 - The impact of the central bank interventions for 26.2.2001-31.12.-2003

$$r_t = \mu + \theta_1 r_{t-1} + \theta_2 r_{t-2} + a D_t + b_1 BUY_t + b_2 SELL_t + b_3 ONI_t + b_4 IUR_t + b_5 OI_t + \varepsilon_t$$

$$\varepsilon_t | \Omega_{t-1} \sim ged(0, \sigma_t^2)$$

$$\log(\sigma_t^2) = \omega + \alpha_1(\varepsilon_{t-1}/\sigma_{t-1}) + \alpha_1^*(|\varepsilon_{t-1}/\sigma_{t-1}|) + \beta_1 \log(\sigma_{t-1}^2) + \gamma_1 BUY_t + \gamma_2 SELL_t + \gamma_3 ONI_t + \gamma_4 IUR + \gamma_5 OI_t$$

	TL/US$			TL/Euro[a]		
	Restricted	Magnitudes	Dummy Variab.	Restricted	Magnitudes	Dummy Variab.
μ	-0.0088 (-0.7223)	-0.0207* (-1.3748)	-0.0132 (-0.8522)	0.0060 (0.2484)	0.0088 (0.3136)	0.0079 (0.2764)
θ_1	0.1094*** (3.0894)	0.1032*** (2.8293)	0.0975*** (2.6464)	-0.5689*** (-3.6585)	-0.5213 (-3.4493)	-0.4826*** (-3.1102)
θ_2	-0.1203*** (-3.5747)	-0.1299*** (-3.6761)	-0.1195*** (-3.4683)	0.6646*** (4.7284)	0.6164*** (4.3879)	0.5758*** (3.9325)
a	-0.1067*** (-3.8747)	-0.10357*** (-3.4922)	-0.1078*** (-3.7475)	-0.3230*** (-7.3171)	-0.0505** (-1.6756)	-0.0555** (-1.8432)
b_1		0.0003 (0.6202)	-0.0036 (-0.1455)		-0.0001 (-0.1164)	0.0004 (0.0098)
b_2		-0.0028*** (-2.6511)	0.1165*** (2.3302)		-0.0002 (-0.1430)	0.0877 (1.1126)
b_3		-0.0049 (-0.7310)	-0.0051 (-0.8653)		-0.0097*** (-2.2554)	-0.0104*** (-2.3032)
ω	-0.4499*** (-6.6702)	-0.5464*** (-5.8923)	-0.5997*** (-56221)	-0.3230*** (-7.3171)	-0.4577*** (-5.2127)	-0.4242*** (-4.6204)
α_1	0.2819** (1.9368)	0.3951** (1.9077)	0.4395** (2.2811)	0.3414** (2.0040)	0.3498** (1.7991)	0.4069** (2.1042)
α_1^*	0.4021*** (5.6295)	0.3071*** (4.0095)	0.3629*** (4.5375)	0.3087*** (5.6620)	0.2840*** (4.0091)	0.2962*** (4.4151)
β_1	0.9121*** (39.8948)	0.8536*** (26.3009)	0.8409*** (21.8819)	0.9322*** (44.7653)	0.8593*** (23.0925)	0.8829*** (22.2684)
γ_1		-0.009 (-0.8377)	-0.0601 (-0.8865)		0.0002 (0.2080)	0.0144 (0.2838)
γ_2		-0.0051*** (-4.1165)	0.2385*** (2.9793)		-0.0040*** (-3.3876)	0.1426*** (2.2276)
γ_3		-0.0084** (-2.2860)	-0.0079** (-2.0711)		-0.0062** (-1.7855)	-0.0049** (-1.7497)
γ_4		-0.1752* (-1.3189)	-0.2358** (-1.6430)		-0.1266 (-1.0348)	-0.1939** (-1.5884)
γ_5		0.6207 (1.1142)	0.7089 (1.2143)		0.1099 (-0.2150)	-0.0384 (-0.0753)
ν[c]	1.0857	1.2204	1.1711	1.1322	1.3249	1.2911
AIC	819.21	786.23	800.18	1095	1077.02	1084.54
BIC	860.37	873.10	887.06	1136	1163.89	1171.41
LL[d]	-400.61	-374.12	-381.09	-538.63	-519.5097	-523.27
$Q_z(20)$[e]	28.10 (0.1725)	24.94 (0.2998)	29.29 (0.1366)	28.098 (0.1725)	15.49 (0.8402)	15.98 (0.8169)
$Q_z^2(20)$[e]	68.41 (0.0000)	13.78 (0.9089)	16.6 (0.7815)	68.42 (0.0000)	21.88 (0.4668)	19.87 (0.5912)
Skewness	1..356	0.744		1.021	0.471	
Kurtosis	10.17	5..52		7..97	4.41	

*, **, *** indicate rejection at the 10%, 5% and 1% significance levels respectively. The t-statistics are in brackets. $Q_z(20)$ and $Q_z^2(20)$ are Box-Pierc Q-statistics with 20 lags for the standardized residuals and the squared standardized residuals with p-values in brackets where $z = \varepsilon_t / \sigma_t$. (a) The conditional mean equation for the TL/Euro series becomes an ARMA(1,1) model. (b)This coefficient measures the MA coefficient of ARMA(1,1) model of conditional mean equation employed for the TL/Euro return series. (c) ν is the estimated ged- parameter. (d) LL is the value of the log-likelihood function. (e) p-values are in brackets .

The use of the dummy variables for the non-sterilized interventions, namely, OI and IUR, for which amounts are not provided, limits the analysis of this type of intervention to the signaling effect.

Looking at the estimation results in Table 4, it is important to note that the leverage parameter, α_1, is found to be significant in all cases, at least at the 5% level of significance and its value is positive. This result suggests that the conditional variance is asymmetric but is influenced more from positive shocks rather than negative shocks of equal size: volatility increases followed by good news. This implies that more than expected depreciation of the Turkish Lira against these foreign currencies generates larger volatility than its more than expected appreciation. Considering clustering effect coefficient, α_1^* is also highly significant in all the estimated models indicating that impact of larger shocks on next periods volatility is larger.

The other important point to be mentioned here is that the GARCH parameter β, is not only highly significant for both models of TL/US$ and TL/Euro, but also its value is very close to 1 being approximately 0.85 in models with intervention variables indicating long persistence of any shock to the conditional variance. Also, the inclusion of the intervention and overnight interest rate variables reduce the effect of the persistence of the shocks from about 0.91 and 0.93 estimated for the restricted models of Dollar and Euro respectively. Furthermore, the GED parameter is estimated to be significantly below 1 suggesting that disturbances do not follow a double-exponential distribution nor a Gaussian distribution. In addition to these basic important findings, the estimation results suggest the following comments for the effects of the Central Bank's actions in the foreign exchange market.

First, buying foreign exchange auctions are found to have no significant effect on the level of both currencies: b_1 is statistically insignificant in the conditional mean equations in all cases. If the intervention signals are fully credible, unambiguous and foreign exchange markets are efficient, then purchases of foreign currency should signal expansionary monetary policy. In this case the Turkish Lira is expected to depreciate against these currencies and have no influence on the conditional variance.[26] The statistically insignificant coefficients of the buying auctions may be due to the signals given by the Central Bank in an attempt to convince the market that it is merely committed to reduce volatility of the exchange rates and has no target level of the rate. However, sales of US Dollars by scheduled, pre-announced daily auctions are highly significant in the conditional mean equation causing depreciation of the TL/US$ while it has no effect on the TL/Euro currency. In other words, the sales of Dollars is associated with depreciation of the Turkish Lira against the U.S Dollar: revisiting Table 2, it can be seen that almost all the sales of U.S Dollars, 92.3%, took place during the first three quarters of 2001 immediately with the outbreak of the financial crises in February during which the Turkish Lira continued to lose value against these two foreign currencies. This unexpected sign may be arising due to market inefficiency or the intervention signals being not credible or being ambiguous. An alternative explanation may be the endogeneity bias.[27] The usual traditional interpretation of the reverse causality is leaning-against-the-wind effect[28] which is a common finding in the literature as in Dominguez

[26] Dominguez (1998) discussed the possible scenarios of effects of intervention on the conditional mean and variance of the exchange rate in detail.

[27] Intervention analysis in the literature usually faces with endogeneity bias as central banks may actually be intervening the foreign exchange market due to the volatility of the exchange rates and to influence the level of its currency.

[28] That means the central bank attempts to reverse the direction of the trend movement of its currency.

and Frankel (1993), Baillie and Osterberg (1997b) and Beine et al. (2002). This possibility will be checked by a probit regression in the next section. Secondly, another important finding is that the non-sterilized sales of Dollars (IUR) and non-sterilized direct interventions (OI) are found to be ineffective in the conditional mean equations for both exchange rate returns and thus not reported at all to save space.[29] Besides, none of the intervention variables are estimated to be significant for the TL/Euro returns in the mean equation. Third, the overnight interest rate changes (ONI) is evidenced to depreciate the Turkish Lira against Euro only. With the shift to floating exchange rate regime, the Central Bank started to use the short-term interest rates as its main monetary policy tool as a stabilizing policy together with its intervention policy. Only in July 2001, considering the inflationary pressures of depreciation of the Turkish Lira either directly or indirectly via expectations, the Central Bank increased the short-term interest rates to withdraw excess liquidity from the market.[30] However, for the rest of the period, the short-term interest rates have been consequently lowered. Therefore, the changes of overnight interest rates are expected to depreciate the Turkish Lira although this link between the exchange rate and the interest rates is not straightforward as it reflects the policy actions of the Central Bank and give signals about the Central Bank's policy influencing expectations. The purchases of US Dollars signal expansionary monetary policy that is expected to depreciate the Turkish Lira against Dollars. However, this also leads to higher expected future inflation exerting an upward pressure on the interest rates. But, the Central Bank, with an attempt to reverse the higher expectations for the rate of inflation lowers the short-term interest rates to signal the market that future inflation rate will not increase. This, in return should depreciate the Turkish Lira if the signals are credible, unambiguous or the market is efficient. The insignificant effect of overnight interest rate changes on the US Dollars may be because of this two-way indirect relationship between interest and exchange rates when expectations and market conditions are involved. Another point here is that the Monday effect is highly significant in both the magnitudes and the dummy regressions but in the opposite direction indicating decreases in the exchange rate returns on the opening day of the market after either a weekend or a holiday. This may be because of frequent holidays which are followed by a week-end immediately followed by the opening of the market.

Considering the conditional variance equations, the most important evidence is that the sales of foreign exchange significantly reduce volatility of both exchange rates in line with the goal of the Central Bank. However, neither the direct interventions (OI) nor the scheduled buying foreign exchange auctions are found to influence the conditional variance of the exchange rate returns as opposed to the Central Bank's explicit announcements for the direct intervention operations. In addition, the overnight interest rate changes are estimated to exert highly significant negative impact on the variability of both series: decreases in interest rates signal the Central Bank's determination in lowering the rate of inflation and in cases when the central bank is credible and signals are unambiguous, market participants are expected to anticipate a lower rate of inflation and more stable markets. Therefore, the results suggest that the Central Bank's interest rate policy is successfully implemented.

The regressions in dummy form indicate that the presence of the Central Bank in the foreign exchange market by selling auctions is sufficient to influence the exchange rate returns since similar results are obtained from regressions in magnitudes.

[29] Also, the exclusion of these variables did not change the estimation results.
[30] The Turkish Central Bank Press Announcements, 2001-33, 16.7.2001.

Looking at the standardized residuals obtained from these regressions, both the restricted models without intervention and policy variables and the intervention models in magnitudes indicate that the conditional mean models are appropriate since the standardized residuals have no significant autocorrelations at lag 20. However, the standardized residuals squared in the restricted models are correlated at lag 20. These significant correlations may be due to the intervention operations and the overnight interest rate differential since the models estimated in unrestricted form capture these correlations and reduce Q_z^2 to rather low values below the critical χ^2 value with k-2 degrees of freedom: p-values in brackets are rather high. In addition, the coefficient of skewness and kurtosis of the standardized residuals are reduced almost by half for both of the exchange rate models with the inclusion of the intervention and the policy variables as compared to the basic models. The Likelihood ratio test statistics (LRS) are also computed as LRS = 2 (ll(u) – ll(r)) where ll(u) is the value of the log-likelihood function under the unrestricted specification equations (1) – (3) and ll(r) is the value under the restricted specification, restrictions being imposed on the coefficients under the null hypothesis, $H_o : b_1 = b_2 = b_3 = b_4 = b_5 = \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$. The test statistics are computes as 52.98 and 38.24 respectively for the TL/USD and the TL/Euro models in magnitudes that are well above the critical χ^2 values confirming the overall significance of these models rejecting the null hypothesis. This statistic is a χ^2 with 10 degrees of freedom.

The estimates are checked for their robustness in terms of the distribution by comparing the quasi maximum likelihood (QML) and the maximum likelihood (ML) estimates obtained assuming the residuals follow student t-distribution and generalized error distribution (GED).

Comparison of the results assuming errors follow student-t and GED distributions for the TL/US$ and the TL/Euro models indicated very similar results in general: t and GED distributions yielded almost same coefficients with same signs. The buying foreign exchange auctions, OI and IUR were found to be insignificant in both the conditional mean and variance equations for both exchange rates. The selling auctions were found significant by both distributions for the TL/US$ model in both the mean and the variance equations while the same variable was found insignificant in the mean but highly significant in the variance equation for the TL/Euro model. The only difference between the t and the GED distributions arose only in the mean equations: for the Dollar model, buying auctions are estimated to be significant at 9% significance level assuming errors follow t-distribution while this variable was found insignificant assuming GED distribution.

Comparison of the QML and the ML estimation results almost exhibited very similar results. For both the Dollar and the Euro models the selling foreign exchange auctions and interest rate changes significantly decreased volatility in all cases. The differences between QML and the ML estimates are few: for the Dollar model, the QML estimation of OI is found to be significant at the 9% level of significance with a positive coefficient of 0.5970 in the variance equation while the ML estimates of the variable are reported as insignificant at the 13% level of significance although the estimated coefficients are quite close. Considering the Euro model, IUR is statistically insignificant in both mean and variance models. However, the level of significance is only 0.12% for the coefficient estimated by the QML method. All other coefficients are estimated to be quite similar having same sign by these two methods of estimation. According to the Schwarz

Criterion (SC), the ML estimates were preferred to the QML estimates indicating that thicker tail distributions provided estimates outperforming those of the other.[31]

5. Modeling the probability of intervention

In the previous section it was found that interventions in the direction of selling foreign exchange through auctions exerted a highly significant 'incorrectly signed' effect for the TL/USD spot rate. For the robustness of the estimations, the issue will be analyzed in this section by estimating the probability of intervention of the Central Bank to the foreign exchange market. The purpose is to determine whether past conditional exchange rate returns or its volatility Granger cause intervention. The negative sign of selling foreign exchange auctions in the mean equation may be the result of this reverse causality between interventions and exchange rates. For testing this possibility, two approaches can be used. The first one is used by Baillie and Osterberg (1997b) which is based on a proxy for the equilibrium exchange rate[32] and measure the deviation from the target level to determine if the central bank intervenes when the current rate deviates from the target rate. For the deviation in the volatility, the conditional and the unconditional variances of the exchange rates are to be considered. The second approach which is used by Dominguez (1998) specifies a trend variable proxied by a moving average of past values to be used in place of a target rate. For the Turkish case, the second approach is considered to be more appropriate since the Central Bank of Turkey announced that it had no commitment to a target level of exchange rate. Secondly, in applications of the first approach, as Beine et al. (2002) reported, the equilibrium exchange rate may be proxied by the purchasing parity (PPP) exchange rate. Considering the underlying assumptions for the PPP calculations and the economic differences between Turkey and the advanced countries, the reliability of the PPP rate is believed to be poor. Based on these considerations, the second approach is preferred to the other for the case of Turkey.

In this respect, for a test of endogeneity bias, it is required to enter the endogenous variables r_t and h_t, generated from estimating equations (1) through (3) by imposing a restriction on $\gamma = 0$, into the probit regression model as exogenous variables. The dependent variable will be a dummy variable, I, taking value of 1 in absolute value for days of intervention and 0 otherwise. Following Dominguez (1998) the probit intervention model is specified as follows,

$$|I_t| = \alpha_o + \alpha_1 \left(r_{t-1} - \frac{1}{k} \sum_{n=1}^{k} r_{t-n}\right) + \alpha_2 \left(\sigma^2_{t-1} - \frac{1}{k} \sum_{n=1}^{k} \sigma^2_{t-n}\right) + \varepsilon_t \qquad (5)$$

where the first term in the brackets is the deviation of the exchange rate and the second term defines the deviation in the conditional variance from, 5-day and 10-day moving average of each variable respectively. An alternative specification as 1 day lags of changes in spot rates and conditional variance not in deviation form also was considered. The results of these probit estimations that are found significant are given in Table 5.[33]

[31] Estimation results are not reported but are available on request from the author.

[32] Funabashi (1989) computed this target rate in his study of central bankers estimation for the nominal exchange rates.

[33] The explanatory variables could cause multicollinearity problem but their correlations are found to be very low.

Table 5 The estimation results of probit intervention models

	TL/USD	TL/Euro
Dependent variable I_t		
Constant	-0.3449*** (0.065)	-0.4342*** (0.072)
r_{t-1}	-0.0468 (0.104)	-0.0724 (0.088)
σ_{t-1}	0.5908*** (0.162)	0.7152*** (0.152)
LR	31.63***	38.58***
Dependent variable D_t^{buy}		
Constant	-0.2759*** (0.092)	-0.1352 (0.102)
r_{t-1}	0.3673** (0.173)	0.3190** (0.145)
σ_{t-1}	-2.4686*** (0.403)	-2.3363*** (0.339)
LR	59.00***	65.78***
Dependent variable D_t^{sell}		
Constant	-0.9208*** (0.061)	-1.0612*** (0.079)
r_{t-1}	0.0470 (0.099)	-0.0046 (0.116)
σ_{t-1}	0.1573* (0.084)	0.4348*** (0.146)
LR	12.32***	34.55***
Dependent variable D_t^{IUR}		
Constant	-2.3413*** (0.118)	-2.4952*** (0.129)
r_{t-1}	-0.1415 (0.138)	-0.2097* (0.129)
σ_{t-1}	0.5122*** (0.108)	0.6895*** (0.119)
LR	39.57***	44.54***
Dependent variable D_t^{OI}		
Constant	-1.9241*** (0.157)	-1.9423*** (0.150)
r_{t-1}	0.4003* (0.215)	0.3089* (0.191)
σ_{t-1}	-0.6494 (0.501)	-0.4366 (0.325)
LR	2.62	2.26

*, ** and *** indicate rejection at the 10%, 5% and 1% respectively. Asymptotic standard errors are in brackets. LR refers to the exclusion of r_{t-1} and σ_{t-1}^2 from the probit estimation. The test statistic follows a χ^2 distribution with 2 degrees of freedom.

It is important to note here that since the conditional variance is a generated series used as a regressor in the probit model, the standard errors of the estimates have to be interpreted with caution.

These results indicate that 1 day past conditional volatility is highly significant Granger causing intervention for exchange rates. However, past exchange rate changes appear to have no influence on probability of intervention for both exchange rates.[34] These findings do not support a leaning-against-the wind interpretation for the negative sign of selling foreign exchange auctions in the Dollar model in magnitudes. One possible explanation may be that the results are very specific to the particular time period that correspond to the turbulence experienced immediately following the crises. In an effort to investigate this issue in more detail, alternative probit specifications were estimated by separating buying and selling foreign exchange auctions as well as the direct intervention operations (OI and IUR). This will help to disentangle the effects of conditional volatility on different intervention operations. The dependent variables are defined as dummy variables (D_t) in absolute value for each type of intervention respectively. The results reveal that 1-day lagged exchange rate changes have a highly significant effect on the probability of intervention via buying auctions. This result can be interpreted as that the Central Bank heavily intervened the foreign exchange market using the buying auctions to reverse the trend movement of the Turkish Lira against these currencies which confirms the previous suggestions proposed by graphical analysis of the behavior of the two rates and the periods of swings with intervention episodes summarized in Table 2, Section 4. However, the levels of the exchange rates do not lead to probability of intervention by the selling auctions. One possible explanation for the negative sign of the selling auctions may be the negative expectations about the consequences of the financial crises and ambiguity in the foreign exchange market as well as incredibility of the Central Bank at the time of intervention by the selling foreign exchange auctions. This explanation sounds rather reasonable because the selling auctions took place immediately after the outbreak of the crises that continued till December in 2001.

Considering the conditional volatility, it significantly Granger causes both foreign exchange auctions and non-sterilized intervention transactions that took place at the beginning of the crises (IUR). Surprisingly, no evidence is found in support of excess volatility increasing the probability of the Central Bank's direct interventions (OI) as opposed to the Central Bank's announcements. The likelihood ratio test statistic in the probit estimations for OI indicates that past exchange rate changes and conditional variance of the exchange rates are insignificant in explaining the official interventions while this test statistic is highly significant in the other probit regressions.

6. Conclusions

Based on these findings, little evidence is found that the Turkish Central Bank intervention transactions influence exchange rate volatility during the period of 26 February 2001 and 31 December 2003. The direct intervention operations (OI) that are announced to smooth volatility of exchange rates are found to be ineffective at all. This may be as a result of these announcements of the Central Bank being made at the end of the day on completion of the intervention transactions which actually could have had influence on volatility during the day. However, we do not have intra-day data (not even

[34] Other specifications with deviations from 5 and 10 day moving averages of both explanatory variables are also estimated. However, as the explanatory variables are found to be contemporaneously correlated leading to multicollinearity problem these estimations are not reported.

the daily amounts) on direct intervention transactions. On the other hand, the results suggest that the level changes of both rates lead to probability of direct official intervention (OI) by the Central Bank which also contradicts with the announcements of the Bank. Rather, based on the probit regression results, one day past volatility of the exchange rates increase the probability of intervention via scheduled pre-announced selling auctions and IUR while it decreases the probability of intervention in form of buying foreign exchange auctions. Another important finding is that the Central Bank can significantly influence the foreign exchange market via the changes in overnight interest rates that depreciate TL against the Euro and decrease conditional volatility of both exchange rates as can be seen from Table 4. Successful interest rate policy of the Central Bank may be an implication of an increase in credibility of the Central Bank as compared to the beginnings of the period of study.

These results suggest that although inclusion of the intervention and policy variables improved the EGARCH (1,1) estimations, the motivations of the Central Bank to intervene are found to be more clear based on the probit regressions. Accordingly, the Central Bank's official intervention operations not only had been unsuccessful in reducing volatility as opposed to the Bank's announcements but the Bank itself intervened the market via selling foreign exchange auctions and unannounced non-sterilized sales of Dollars on observation of exchange rate volatility in the foreign exchange market. Also one day past level changes of the exchange rate induced the Bank to conduct official direct interventions. The probability of buying auctions are also found to be significantly influenced by both past level changes and the volatility of the exchange rates. The unexpected negative sign of selling auctions for TL/US$ in the conditional mean equation cannot be explained by endogeneity bias. It may be the result of signals being ambiguous or market inefficiency or incredibility of the Central Bank during that specific period when the sales of foreign exchange auctions took place. Finally, the empirical results indicate that shocks to exchange rate volatility have asymmetric effects that are persistent.

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