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Risk Premium and Central Bank Intervention

Pınar Özlü*

Research and Monetary Policy Department
Central Bank of the Republic of Turkey
İstiklal Caddesi No: 10
06100-Ankara, Turkey

Pinar.Ozbay@tcmb.gov.tr
Phone: 90-312-3112211

Abstract

This study examines the relation between the risk premium and central bank intervention. Forward rates are calculated for the Turkish Lira-USD exchange market and then the effect of central bank intervention on the risk premium is estimated. Using high quality daily intervention data from the Central Bank of Turkey as well as implied forward rates, an MA (21)-GARCH (1,1) model is estimated. Both purchases and sales of US dollars by the Central Bank of Turkey appear to have no effect on the size of risk premium for TL/USD for the free float period. Similar results are found for the managed float period. Empirical support was weak for the theoretical model, with intervention having a significant effect on the risk premium.

JEL classification codes: C22, E31.
Keywords: Central Bank Intervention, Risk Premium.

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1. Introduction

The literature concerning the effects of intervention on currency markets and the motivations for such interventions is enormous. The results are mixed and depend on the exchange rate regime, the sample period and also the intervention strategy followed. Although the risk premium is not necessarily the intended target of the intervention, the empirical evidence indicates that some types of intervention can affect the risk premium in forward markets.

The forward exchange rate is a contractual exchange rate established at the time of a transaction that will take place at the maturity time t+1 and usually regarded as the unbiased predictor of the future spot exchange rate. Contrary to popular theory, empirical evidence shows that the forward rate is a biased predictor of the future spot rate and/or is evidence of a risk premium as indicated by Hansen and Hodrick (1980), Hakkio (1981), Baillie et al. (1983), and Baillie (1989). One of the most important unresolved paradoxes in international finance is the forward premium anomaly, where the currency of the country with the higher rate of interest is more likely to appreciate than depreciate. Numerous explanations have been proposed to explain the forward premium anomaly, but, the empirical evidence given in Evans and Lewis (1995), Kaminski (1993), Lewis (1988), Frankel and Froot (1987), Lewis (1989), Elliot and Ito (1995) has not been satisfactory.

In a study by Baillie and Osterberg (1997), Hodrick's model (Hodrick, 1989) is extended to allow central bank intervention to have a direct effect on the risk premium. Baillie and Osterberg (1997) find that purchases of US dollars by the Federal Reserve Bank appear to significantly increase the excess dollar denominated returns for both the DM-USD and the Yen-USD markets. Consistent with this study, Baillie and Osterberg (2000) found that the intervention variables affect the risk premium in an analysis where the relationship between daily deviations from uncovered interest rate parity and intervention are investigated by using daily overnight euro-currency deposit rates.

Central banks use intervention as a policy instrument. Despite its frequent use, intervention continues to be debated as a policy tool due to the controversy over whether it can achieve the policy goals of either changing the level of nominal exchange rates or reducing its volatility. The studies investigating the impact of intervention directly on the levels of exchange rates generally has found that intervention has no statistically significant effect. This paper aims to investigate the effect of intervention on risk premium and to assess whether intervention helps to explain the forward premium anomaly, as found by Baillie and Osterberg (1997, 2000). The analysis is done for Turkish economy, where the economy is small and has high inflation. Section 2 describes the details of the model, Section 3 gives the data, Section 4 presents the estimation output and Section 5 discusses the results.

2. Details of the model: Risk Premium and Intervention

The Covered Interest Rate Parity Condition gives the relationship between spot rates, forward rates and interest rates.

$$(f_{t,l} - s_{t+l}) = (i_{t,l} - i^{*}_{t,l}) \tag{2.1}$$

s_t and $f_{t,l}$ corresponds to logarithmic values of spot and forward exchange rates, respectively. Also $i_{t,l}$ denotes the domestic currency return on an l-period risk free bond, denominated in terms of domestic currency where as $i^{*}_{t,l}$ is the foreign currency return on a risk free bond denominated in terms of the foreign currency. It implies that the country with the higher rate of interest has experienced an expected depreciation of currency. The relationship between forward rates and future spot rates may be simply expressed in terms of the forward rate as being an unbiased predictor of the future spot exchange rate and given by

$$f_{t,l} = E_t s_{t+l} \tag{2.2}$$

where s_{t+l} is the logarithm of the spot exchange rate and $f_{t,l}$ is the logarithm of the forward rate for maturity in time t+l. This is widely rejected by the empirical studies as in Hansen and Hodrick (1980), Hakkio (1981), Baillie et al. (1983), Baillie (1989). This has led to a type of model

$$f_{t,l} = E_t s_{t+l} + \rho_t \tag{2.3}$$

Where ρ_t is a time dependent risk premium. The dependent variable in this study is the forward rate forecast error or in other words risk premium, defined as $(s_{t+k} - f_t)$. Note that

$$(s_{t+k} - s_t) - (i_t - i_t^{*}) = s_{t+k} - s_t - (f_t - s_t) = s_{t+k} - f_t \tag{2.4}$$

Hence,

$$(s_{t+k} - f_t) = \rho_t + u_{t+k} \tag{2.5}$$

where u_{t+k} is the rational expectations error associated with using the forward rate to predict the spot rate k periods and u_t is serially uncorrelated for lags greater than k, so $E(u_t u_{t+h}) = 0$ for $h > k$. This restriction is consistent with u_t, following a moving average process of order k-1.

Baillie and Osterberg (1997) extend Hodrick's 1989 model based on a consumption based asset pricing model, where risk premium depends on the conditional variance of production, money growth rates, consumption's share of production and intervention variables.

$$\rho_t = \alpha_1\sigma_{yt}^2 - \alpha_2\sigma_{yt}^{2*} + \alpha_3\sigma_{\Omega t}^2 - \alpha_4\sigma_{\Omega t}^{2*} + \alpha_5\sigma_{\varsigma_t}^2 - \alpha_6\sigma_{\varsigma_t}^{2*} + \alpha_7\tau_t - \alpha_8\tau_t^* \quad (2.6)$$

Where σ_{yt}^2 and $\sigma_{\Omega t}^2$ are the conditional variances of logarithms of production and the money growth respectively. The variable $\sigma_{\varsigma t}^2$ denotes the conditional variance of the share of the currency used for intervention. The intervention variable $\tau_t = M^* / M$, is defined as the share of currency held by a foreign government for intervention operations. Asterisks denote foreign country equivalents. The difference between this and Hodrick's model is the addition of the conditional means and variances of the two intervention variables in the risk premium. The model does not impose any restrictions on whether or not sterilization occurs. The model is estimated from daily data in order to determine the relatively short-lived effect of intervention on risk premium. Hence it is not possible to include the variances of production, money growth rates, and foreign currency holdings as a proportion of money stock. The spot exchange rate, the forward exchange and the intervention variables, which are all observed daily, are the variables included in the estimated model. Hence the risk premium ρ_t in (2.6) is considered to be determined by

$$s_{t+k} - f_t = \varepsilon_t + \sum_{j=1,21} \theta_j \varepsilon_{t-j} + b_0 + b_1 US_t^b + b_2 US_t^s \quad (2.7)$$

$$\varepsilon_t \sim N \;(0, \sigma^2_t) \quad (2.8)$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (2.9)$$

The first two terms on the right hand side of Eq (2.7) corresponds to u_t and ε_t is a serially uncorrelated white noise processes, and θ_j are the moving average parameters. The explanatory variables US_t^b, US_t^s include the intervention variables. Conditional variance in equation (2.9) is represented by a linear GARCH (1,1) process.

Bollerslev (1986) introduced the GARCH (Generalized Autoregressive Conditional Heteroscedasticity process, which extends the ARCH model to make σ_t^2 a function of lagged values of σ_t^2 as well as the lagged values of ε_t^2. Bollerslev (1986) required all the coefficients to be positive to ensure that the conditional variance is never negative and the sum of coefficients is less than 1 to avoid explosiveness of conditional variance. The quasi-maximum likelihood estimation is used.

3. Data

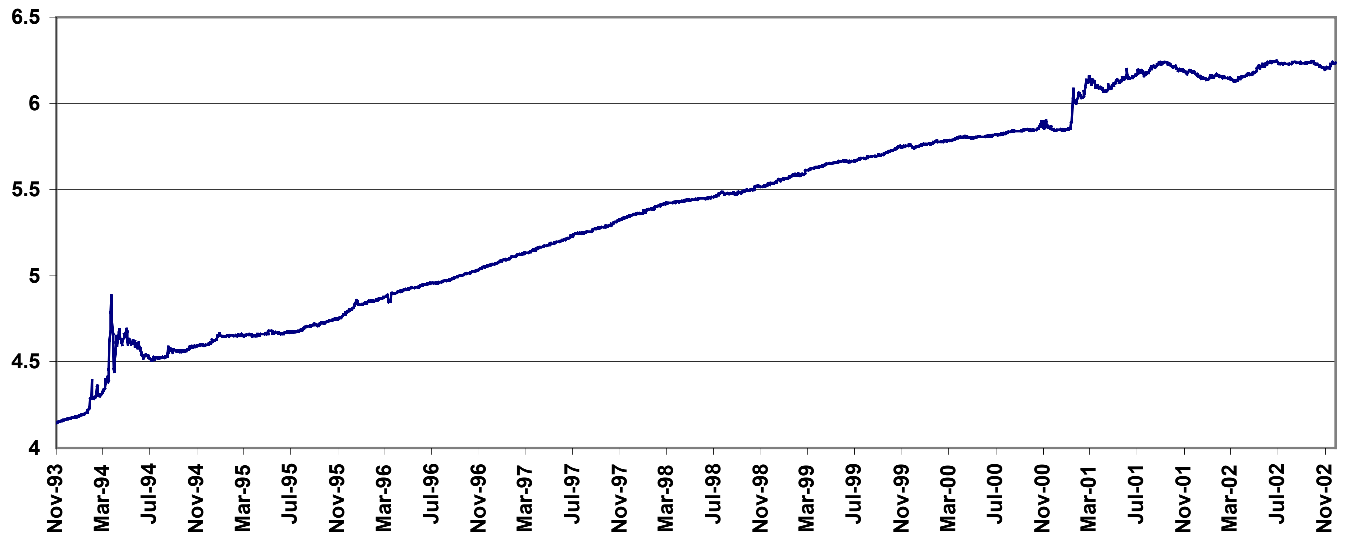
In this study, the Central Bank of Turkey, the Istanbul Stock Exchange and Federal Reserve Bank Board of Governors provide the data. The November 1993 through December 2002 data sample consists of daily spot offer rates, interbank overnight interest rates, Treasury bill rates, 30-day euro dollar rates and daily intervention variables. Intervention values are millions of US dollars. This study uses the daily amount of net dollar purchases (sales), daily spot offer rates and interest rates. The analysis separately covers both the managed float and free float period in terms of exchange rate regime. The development of a futures market is very new to the Turkish Economy. The forward exchange rate is calculated. The implied forward rate[1],[2] is

$$F_{t,30} = \frac{S_t(1 + i^*{}_t(\frac{30}{36000}))}{(1 + i_t(\frac{30}{36000}))} \tag{3.1}$$

where $F_{t,30}$ is the daily 30-day forward rate, S_t is the daily spot rate as *TL/USD* see Figure 1 and Figure 2. $i^*{}_t$ is a proxy the 30-day treasury-bill interest rates for Turkey. Daily interest rates for treasury bills traded in the secondary market are obtained from the Istanbul Stock Exchange. The interest rate of which the Treasury bill has the closest maturity to 30 days is chosen for each day. i_t is a proxy for 30-day euro dollar rates.

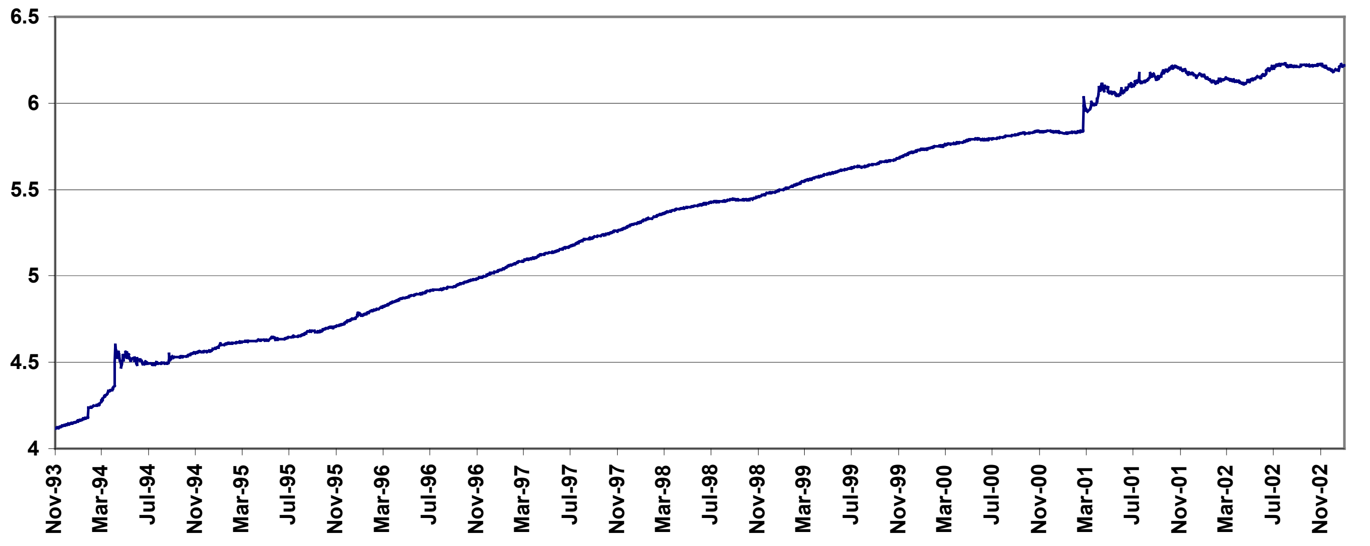
[1] 360-day is assumed as the basis for interest quotations instead of 365, see Grabbe (1996).
[2] The Implied Forward Rate is calculated as given in Grabbe (1996).

Figure 1. Forward Exchange Rate TL/USD(*)



(*) Daily values for the log of forward rate of TL/USD including the full period of 1 November 1993 through 31 December 2002.

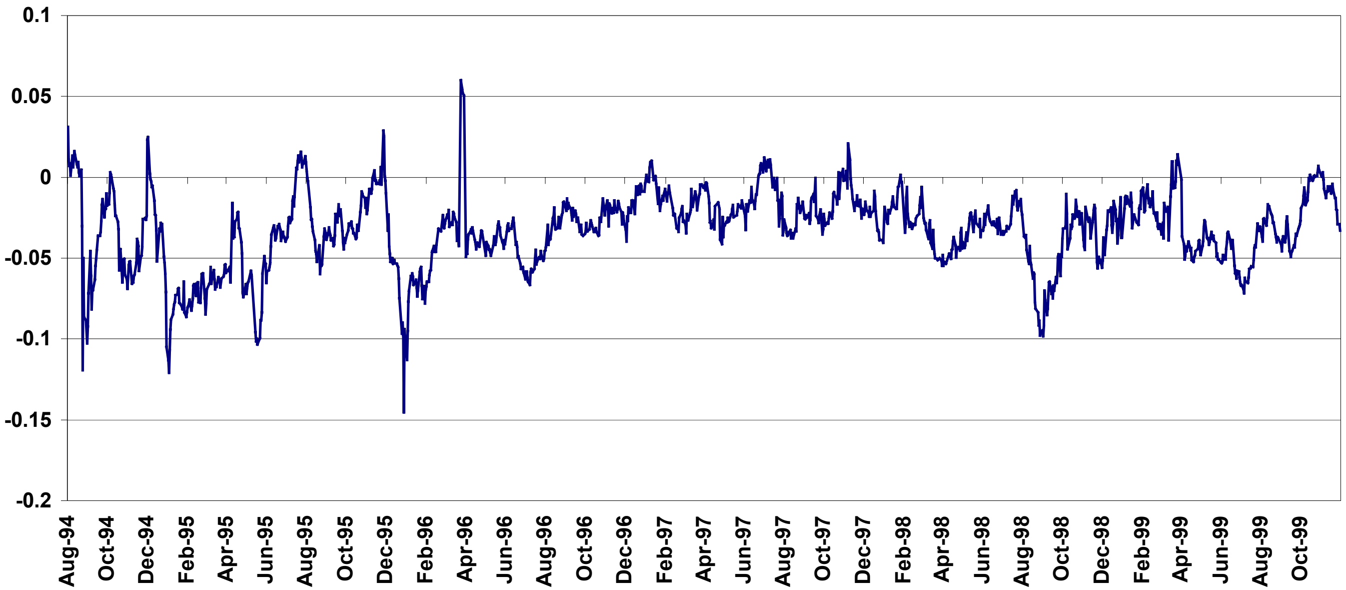
Figure 2. Spot Exchange Rate TL/USD(*)



(*) Daily values for the log of spot rate of TL/USD including the full period of 1 November 1993 through 31 December 2002.

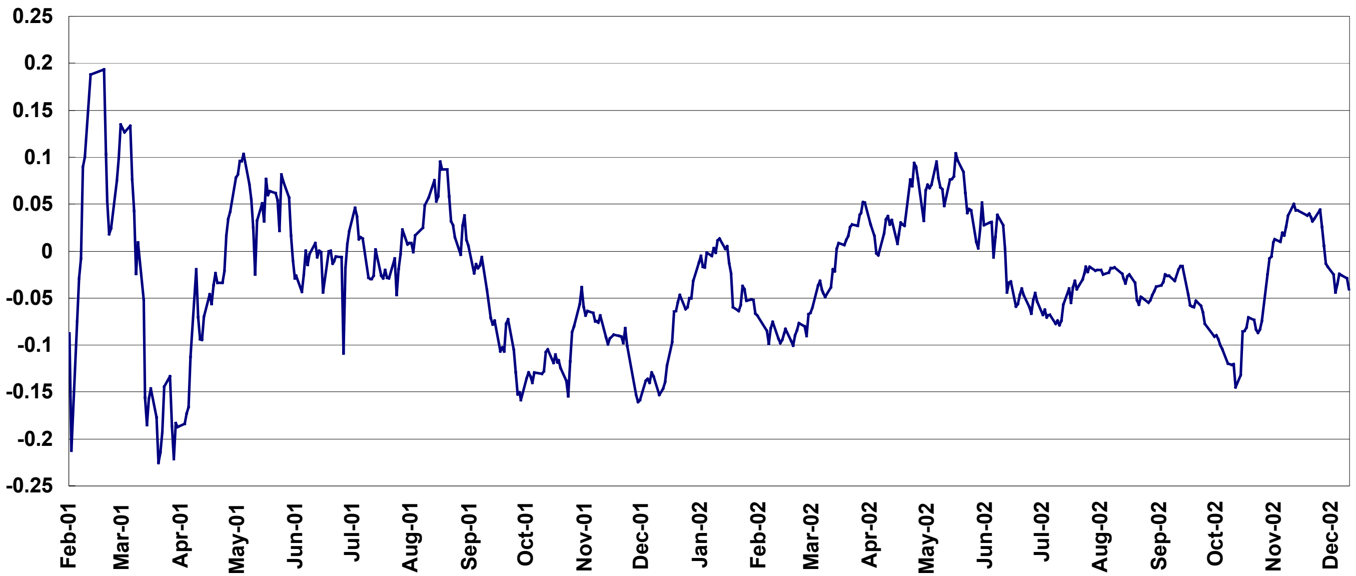
In this study, the forward rate quotations are matched with the future spot rate so that both represent contracts that would be delivered on the same day. The details of settlement procedures in the spot and forward markets are discussed in detail in a study by Riehl and Rodriquez (1977). The important aspect here is the number of working days in the contract period varies. One reason is that delivery delays often occur around the first of the month. Contracts also are not settled on weekends or on holidays in either of the two countries for a given exchange rate. This exact matching reveals that for the data used in this study, k, the number of working days from the day of the forward quote to the time of settlement in the spot market varies from 20 to 26. Since the most common value of k in our sample is 22, u_t, the forecast error is estimated as an MA (21) process. This analysis has been done for two sub-periods due to the difference in economic policies. The first sub-period covers between August 1, 1994 and November 30, 1999 and the second one between February 22, 2001 and December 31, 2002. The forecast error for two sub-periods are shown in Figure 3 and in Figure 4.

Figure 3. Forward Rate Forecast Error(*)



(*) Daily Forward rate forecast error of TL/USD including the full period of 1 August, 1994 through 30 November, 1999.

Figure 4. Forward Rate Forecast Error(*)



(*) Daily Forward rate forecast error of TL/USD including the full period of 22 February 2001 through 31 December 2002.

4. Estimates

The details of the estimated model from the daily risk–premium and intervention data are given in Table 1 and Table 2. The model possesses estimated moving average coefficients that approximately decline linearly with the lag. Diagnostic testing of the model fails to provide evidence for a higher order moving average process. Also a linear GARCH (1,1) process is found to be an adequate representation of the conditional second moments for the managed float period and a linear integrated GARCH (1,1) is adequate for free float period. Q_{20} and Q^2_{20} are the Q-statistics for the L-Jung-Box test of white noise for the linear and squared standardized residuals.

The most interesting aspects of the estimated models in Tables 1 and 2 concerns the coefficients of the variables associated with intervention. In particular, unlike Baillie and Osterberg (1997), both purchases and sales of US dollars by the Central Bank of Turkey appear to have no effect on the size of risk premium for TL/USD for the free float period. Similar results are found for the managed float period but the buying of US dollars appears to have significant effect at a 20 percent significance level. This finding is expected to be the result of high inflation in Turkish Economy. Efforts of disinflation were not successful through 1990s and stability in the foreign exchange market was uncommon. Under these circumstances, factors affecting the interest rates are related to stability in both the domestic market and government debt management. The Central Bank of Turkey aimed at achieving stability in the markets. Under these circumstances, no relation is expected between risk premium and intervention.

Table 1: Estimation of Intervention/Risk Premium Model: TL/$ (a)

Conditional Mean Parameters	Coefficient	Standard Error	Coefficient	Standard Error
b_0	-0.02 ***	0.01	-0.02 ***	0.004
$b_1(US^b)$			0.00	0.0002
$b_2(US^s)$			0.00	0.0001
θ_1	0.88 ***	0.04	0.89 ***	0.055
θ_2	0.73 ***	0.07	0.73 ***	0.062
θ_3	0.69 ***	0.12	0.70 ***	0.098
θ_4	0.68 ***	0.14	0.69 ***	0.121
θ_5	0.65 ***	0.13	0.66 ***	0.11
θ_6	0.66 ***	0.11	0.67 ***	0.108
θ_7	0.60 ***	0.08	0.60 ***	0.078
θ_8	0.54 ***	0.06	0.54 ***	0.065
θ_9	0.56 ***	0.05	0.56 ***	0.059
θ_{10}	0.57 ***	0.05	0.57 ***	0.058
θ_{11}	0.54 ***	0.07	0.54 ***	0.075
θ_{12}	0.47 ***	0.06	0.46 ***	0.065
θ_{13}	0.45 ***	0.06	0.45 ***	0.063
θ_{14}	0.45 ***	0.06	0.45 ***	0.064
θ_{15}	0.43 ***	0.06	0.42 ***	0.059
θ_{16}	0.34 ***	0.06	0.34 ***	0.064
θ_{17}	0.22 ***	0.05	0.22 ***	0.058
θ_{18}	0.20 ***	0.05	0.20 ***	0.058
θ_{19}	0.20 ***	0.05	0.21 ***	0.056
θ_{20}	0.17 ***	0.05	0.17 ***	0.049
θ_{21}	0.10 ***	0.03	0.10 ***	0.042
Conditional Variance Parameters				
ω	0.00	0.00	0.00 *	0.00
α	0.30	0.10	0.30 **	0.13
β	0.60 **	0.10	0.61 ***	0.10
Skewness	1.07		1.00	
Kurtosis	23.34		22.45	
Q_{20}	24.20		22.44	
Q_{20}^2	13.36		13.23	
T	1347		1347	

(a) **Full period of 1 August, 1994 through 30 November, 1999.**
(*) **Denotes 10% significance level.**
(**) **Denotes 5% significance level.**
(***) **Denotes 1% significance level.**

$$(s_{t+k} - f_t) = \varepsilon_t + \sum_{j=1,21} \theta_j \varepsilon_{t-j} + b_0 + b_1 US_t^{\,b} + b_2 US_t^{\,s}$$

$$\varepsilon_t \sim N\ (0, \sigma_t^2)$$

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

Table 2: Estimation of Intervention/Risk Premium Model: TL/$ [(a)]

Conditional Mean Parameters	Coefficient	Standard Error	Coefficient	Standard Error
b_0	-0.035 **	0.016	-0.03 **	0.016
$b_1(US^b)$			0.00	0.0007
$b_2(US^s)$			0.00	0.0014
θ_1	0.99 ***	0.058	0.99 ***	0.060
θ_2	0.80 ***	0.067	0.80 ***	0.068
θ_3	0.83 ***	0.081	0.85 ***	0.081
θ_4	0.70 ***	0.083	0.70 ***	0.082
θ_5	0.75 ***	0.085	0.76 ***	0.088
θ_6	0.74 ***	0.092	0.75 ***	0.097
θ_7	0.70 ***	0.096	0.70 ***	0.100
θ_8	0.65 ***	0.096	0.66 ***	0.099
θ_9	0.75 ***	0.086	0.75 ***	0.092
θ_{10}	0.87 ***	0.081	0.87 ***	0.079
θ_{11}	0.76 ***	0.067	0.77 ***	0.069
θ_{12}	0.76 ***	0.076	0.77 ***	0.082
θ_{13}	0.79 ***	0.087	0.80 ***	0.085
θ_{14}	0.68 ***	0.063	0.67 ***	0.063
θ_{15}	0.66 ***	0.078	0.68 ***	0.083
θ_{16}	0.61 ***	0.082	0.60 ***	0.081
θ_{17}	0.56 ***	0.090	0.55 ***	0.086
θ_{18}	0.61 ***	0.093	0.62 ***	0.095
θ_{19}	0.41 ***	0.099	0.40 ***	0.099
θ_{20}	0.45 ***	0.101	0.45 ***	0.093
θ_{21}	0.26 ***	0.073	0.27 ***	0.072
Conditional Variance Parameters				
ω	0.00	0.00	0.00	0.00
α				
β	0.13 **	0.061	0.13 **	0.061
Skewness	-0.33		-0.31	
Kurtosis	5.71		5.64	
Q_{20}	14.39		15.63	
Q_{20}^2	13.19		13.16	
T	467		467	

[(a)] Full period of 22 February 2001 through 31 December 2002.
[(*)] Denotes 10% significance level.
[(**)] Denotes 5% significance level.
[(***)] Denotes 1% significance level.

$$(s_{t+k} - f_t) = \varepsilon_t + \sum_{j=1,21} \theta_j \varepsilon_{t-j} + b_0 + b_1 US_t^b + b_2 US_t^S$$

$$\varepsilon_t \sim N \ (0, \sigma_t^2)$$

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

5. Conclusions

This paper is concerned with the relation between the risk premium and central bank intervention. Forward rates are calculated for the Turkish Lira-USD exchange market and then the effect of central bank intervention on the risk premium is presented. Using high quality daily intervention data from the Central Bank of Turkey as well as implied forward rates, an MA (21)-GARCH (1,1) model is estimated. Both purchases and sales of US dollars by the Central Bank of Turkey appear to have no effect on the size of risk premium for TL/USD for the free float period. Similar results are found for the managed float period. Empirical support was weak for the theoretical model, with intervention having a significant effect on the risk premium.

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