Information content of exchange rate volatility: Turkish experience

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ABSTRACT

This study constructs an empirical model of the volatility of the TL/US$ exchange rate for the Turkish economy during the post-2001 crisis period ending on August 2006. Employing the Exponential GARCH (EGARCH) estimation methodology of econometrics, we find that the volatility of a given shock to the exchange rate is highly persistent and the successive forecasts of the conditional variance converge to the steady state quite slowly. In addition, the conditional variance of the exchange rate reacts differently to a given negative shock than to a positive shock with equal magnitude. The plot of the News Impact Curve indicates that a foreign investor would face a higher uncertainty when there is an unanticipated increase in the exchange rate when compared to an unanticipated decrease.

INTRODUCTION

During the winter of 2000-2001, the Turkish economy faced an enormous crisis due to the failure of the inflation stabilization program which was anchored on the nominal exchange of the TL/$US, with the real GNP slumping over seven percent. Following the collapse of the crawling band regime of the 2000 disinflation program, a new stabilization period began and policy makers attempted both to lower inflation rates and domestic interest rates primarily to stabilize the payments system. Another aim of the new stabilization program was to restructure the fragile banking system which helped bring about the events that led to the crisis conditions. Finally, the third goal was, thanks to the generous support from the IMF, to provide long-run economic growth. While Akat (2000) and Ertuğrul and Selçuk (2001:6-28) mainly criticize 2000 stabilization attempt, detailed analysis and assessments of the *ex-post* policy results of the Turkish 2000-2001 disinflation program are provided by Uygur (2001), Fischer (2001: 3-24), Dornbusch (2001), Eichengreen (2001), Alper (2001: 51-71), Akyüz and Boratav (2001), Alper and Onis (2002), and Ertuğrul and Yeldan (2002: 53-67).

PURPOSE

The predominant characteristic of the post-2001 stabilization program was to allow the domestic exchange rate to float against major hard currencies. While this framework provides flexibility to economic policy makers in the conduct of monetary policy, two major issues must be understood to ensure the proper application of these policies. First, the magnitude of the volatility in exchange rates resulting from positive or negative shocks must be ascertained. Second, the impact of this volatility information on the proper application of discretionary policy tools must be determined. Concerning the former content, recent papers by Ağcaer (2003), Domaç and Mendoza (2004), Selçuk (2005: 295-312), Ardıç and Selçuk (2006: 931-942), Guimarães and Karacadağ (2004), Herrera and Özbay (2005), Akıncı, et al (2005a), Akıncı, et al (2005b), and Korap (2006) addressed the response of the foreign exchange markets to central bank interventions in a floating exchange rate system. The purpose of this paper is to examine the latter issue of the information content of exchange rate volatility using contemporaneous econometric estimation techniques. The next section presents the methodology of the estimation process and constructs an empirical model appropriate to the Turkish economy. The fourth section applies the model and discusses the findings. The final section presents our conclusions and suggestions for future research avenues.

METHODOLOGY AND MODEL CONSTRUCTION

The dependent variable used in this study is the TL/US$ exchange rate in log difference (DLNDOLLAR), and the time period consists of daily observations beginning with February 23, 2001, and ending with August 11, 2006 (1424 business days). The methodology employs the exponential generalized autoregressive conditional heteroskedasticity or EGARCH model proposed by Nelson (1991: 347-370) to determine the volatility of the exchange rate. In addition, we follow QMS (2004: 596-604) to specify the conditional variance in the EGARCH model as:

$$\log(\sigma_t^2) = \omega + \sum_{j=1}^{q} \beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^{p} \alpha_i \left|(\varepsilon_{t-i})/(\sigma_{t-i})\right| + \sum_{k-1}^{r} \gamma_k [(\varepsilon_{t-k})/(\sigma_{t-k})] \quad (1)$$

where σ_t^2 represents the forecasted variance that is conditional on past information of equal shocks. This implies that the leverage effect allowing the variance to respond differently to equal magnitudes of negative (decrease) or positive (increase) shocks is exponential, rather than quadratic, and that forecasts of the conditional variance are guaranteed to be nonnegative. The impact on the conditional variance would be asymmetric if $\gamma_i \neq 0$.

There are a few differences between the EViews specification of the EGARCH model used in this paper and the original Nelson model. First, Neldon assumes that the error term in the mean equation, ε_t, follows a Generalized Error Distribution (GED) function, while we give a choice of normal, Student's *t*-distribution, or GED. Second, Nelson's specification for the log conditional variance is a restricted version of:

$$\log(\sigma_t^2) = \omega + \sum_{j=1}^{q} \beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^{p} \alpha_i \left|(\varepsilon_{t-i})/(\sigma_{t-i}) - E[(\varepsilon_{t-i})/(\sigma_{t-i})]\right| + \sum_{k-1}^{r} \gamma_k [(\varepsilon_{t-k})/(\sigma_{t-k})] \quad (2)$$

which differs slightly from our specification above. Using this model will yield estimates identical to those reported by EViews and this paper except for the intercept term, ω, which will differ depending on the distributional assumption we use and the order p. Also, to deal with potential model misspecification, we calculate robust *t*-ratios using the quasi maximum likelihood method suggested by Bollerslev and Wooldridge (1992: 143-172) so that parameter estimates will be unchanged but the estimated covariance matrix will be altered. In Table 1, we estimate the EGARCH-M model of exchange rate allowing the conditional variance affect the mean equation using the mean and variance relationships described in equations (3) and (4) below:

$$DLNDOLLAR_t = \eta_1 + \eta_2 \sigma_t^2 + \varepsilon_t \quad (3)$$

$$\log(\sigma_t^2) = \omega + \alpha_1 \left|(\varepsilon_{t-1})/(\sigma_{t-1})\right| + \gamma_1 [(\varepsilon_{t-1})/(\sigma_{t-1})] + \beta_1 \log(\sigma_{t-1}^2) \quad (4)$$

MODEL RESULTS

The main output from the EGARCH-M estimation process displayed in Table 1 is divided into two sections. The upper part provides the standard output for the mean equation, while the lower part, labeled "Variance Equation" contains the coefficients, standard errors, *z*-statistics and *p*-values for the coefficients of the variance equation.

EGARCH-M estimation results reveal that the conditional variance has no statistically significant effect on the exchange rate. The variance equation indicates that, since the value of the EGARCH parameter is close to one, the volatility shocks are persistent and the forecasts of the conditional variance converge to the steady state quite slowly, a finding consistent with those obtained by Korap (2006). The conditional variance of the exchange rate reacts differently to equal magnitudes of negative versus positive shocks. Domaç and Mendoza (2004) found similar results for the US$/Mexican Peso, but the leverage effect (γ) in Turkey was found to be not significantlt different from zero. In this study, the leverage effect term, γ, expressed as C(5)*RESID(-1)/SQRT(GARCH(-1)) in the model, is positive and statistically different from zero, indicating that the news (appreciation or depreciation in the exchange rate) impact is asymmetric during the sample period.

Dealing with diagnostics, correlogram-Q statistics for the presence of autocorrelationin the standardized residuals and in the squares of standardized residuals cannot reject the null hypotheses at the conventional levels of significance, since no residual serial correlations in the mean equation are detected. Following Domaç and Mendoza (2004) and Ardıç and Selçuk (2006: 931-942), we also calculate the half-life of the exchange rate volatility, measuring the duration of shocks to the exchange rate. The half-life is defined as the duration of time period it takes for half the magnitude of a unit shock to the level of a series to dissipate (Cashin and McDermott, 2003: 323-324; Civcir, 2002). We find that a volatility shock to the TL/US$ conditional variance reaches the half of its original size in 12 days, which is larger than the estimates of Domaç and Mendoza (2004) and Ardıç and Selçuk (2006: 931-942). These studies estimated the half-life to be between 5 and 11 days.

Table 1: EGARCH Process For Determining The Exchange Rate Volatility

Dependent variable:	*DLNDOLLAR*			
Method:	ML-ARCH (Marquardt) – Normal Distribution			
Sample (adjusted):	02/23/2001 – 11/08/2006			
Included observations:	1424, after adjusting endpoints			
Method:	Bollerslev-Wooldridge robust standard errors & covariance			
Variance backcast	ON			
Variance Equation:	LOG(GARCH) = C(3) + C(4) * ABS(RESID(-1) / SQRT (GARCH(-1))) + C(5) * RESID(-1) / SQRT(GARCH(-1)) + C(6) * LOG(GARCH(-1))			
	Coefficient	Std.Error	*z*-statistic	Prob.
GARCH	3.503727	2.356567	1.486793	0.1371
C	-0.000493	0.000208	-2.369710	0.0178

Variance Equation Estimates

C(3)	-0.838553	0.057070	-14.69347	0.0000
C(4)	0.389616	0.025762	15.12349	0.0000
C(5)	0.088724	0.016110	5.507259	0.0000
C(6)	0.942930	0.005944	158.6301	0.0000
AIC	-6.670481			
SC	-6.648313			
Q(20)	25.617	Prob. 0.179		
Q(36)	40.734	Prob. 0.270		
$Q^2(20)$	23.709	Prob. 0.255		
$Q^2(36)$	34.986	Prob. 0.517		

Having established the EGARCH-M model for the TL/US$ exchange rate, we now plot the News Impact Curve (NIC) for the TL/US$ exchange rate using EViews 5.1. The NIC plots the volatility, σ^2, against the impact, $z = \varepsilon / \sigma$, where:

$$\log \sigma_t^2 = \hat{\omega} + \hat{\beta} \log \sigma_{t-1}^2 + \hat{\alpha} |z_{t-1}| + \hat{\gamma} z_{t-1} \qquad (5)$$

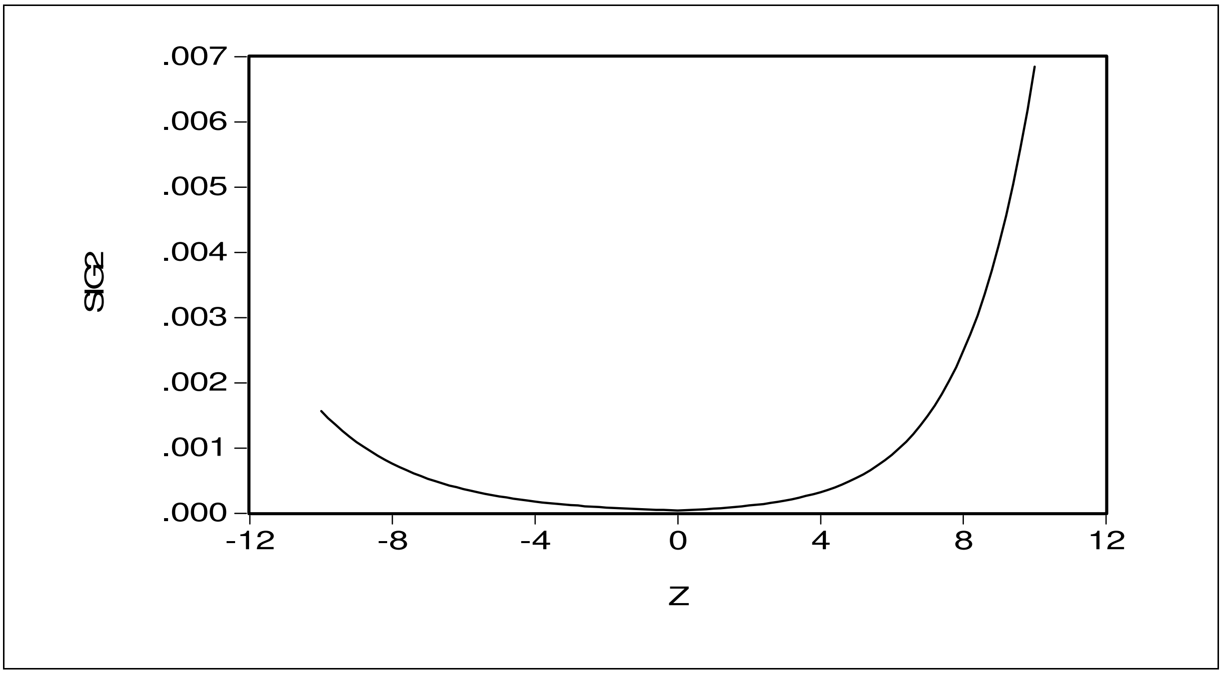
We fix last period's volatility, σ_{t-1}^2, equal to the median of the estimated conditional variance series and estimate the one-period impact conditional on the last period's volatility. We folloe EViews syntax and first generate the conditional variance series (GARCH01). Next, we store the median bt entering "scalar med = @median(garch01)" in the command window, where GARCH1 is the name of the conditional variance series produced in Table 1 above. Third, we generate the z series, which is the x-axis amount of the news impact curve, using the commands "smpl 1 100" and "series z = -10 + @trend(1)*20/100", which constructs an equispaced series between -10 and 10. Fourth, we generate the σ^2 series using the variance equation in Table 1 and the command "series log(SIG2) = eq01.c(3) + eq01.c(6)*log(med) + eq01.c(4)*abs(z) + eq01.c(5)*z, where SIG2 is the name for the σ^2 series. Finally, the EViews automatically creates the series SIG2 from the log specification. Highlighting the two series Z and SIG2 shows a customized graph depicting the estimated news impact curves from EGARCH model fitted with the daily exchange rates used in this paper. The NIC for the TL/US$ exchange rate is shown in Figure 1.[1]

An asymmetric leverage effect can easily be seen in Figure 1. This finding contradicts the results obtained by Domaç and Mendoza (2004) estimating a fully symmetric NIC with an insignificant leverage effect for Turkey. Following Domaç and Mendoza (2004), from the standpoint of the foreign investor, the response of the conditional variance would be greater to bad news (depreciations) than to good news (appreciations) of the same magnitude. Thus, the conditional variance of the TL/US$ exchange rate shows a larger reaction to past positive shocks than to negative one of equal size. The economic consequence of this finding is that an unanticipated increase in exchange rate would lead to a higher level of uncertainty when

[1] The detailed information in these paragraph has been organized by Levent Korap by use of QMS (2004) and included into the main text of the paper by Ara Volkan.

compared to the level of uncertainty generated by an unanticipated decrease in the exchange rate.

Figure 1: News Impact Curve (NIC) Of The TL / US$ Exchange Rate



CONCLUDING REMARKS

When the inflation stabilization program based on fixed exchange rates failed in 2001, Turkish economic policy makers instituted a substitute based on floating exchange rates, where the exchange markets determined the local currency value against major world currencies such as the dollar. In this framework, a major policy issue is the degree of volatility displayed by the value of the Turkish Lira against the dollar. In addition, a major policy implementation issue is the use of the information content of such volatility in applying discretionary tools. This study first determines that volatility of a positive or negative shock to the TL/US$ exchange rate is highly persistent, where the forecast of the conditional variance converge to the steady state quite slowly. Next, we demonstrate that the conditional variance of the exchange rate reacts differently to equal magnitudes of negative and positive shocks, with the News Impact Curve indicating that an unanticipated increase in the exchange rate leads to more uncertainty when compared to an unanticipated decrease of equai magnitude. Thus, from the standpoint of the foreign investor, different investment strategies should be employed when an increase in the value of the Turkish Lira is anticipated compared to the strategies appropriate when a decrease is forecasted.

SUGGESTIONS FOR FUTURE RESEARCH

Future research may evaluate several foreign exchange investment strategies and determine those appropriate for use during positive shocks to the TL/US$ exchange rate and those to be used when negative shocks occur. In addition, various economic policy tools can be evaluated with the aim of determining the ones that are best in simultaneously minimizing the volatility in exchange rates and reducing the time it takes for the exchange rate shocks to dissipate.

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