Asymmetric information content of the YTL/US$exchangerate return : new evidence from the post - crisis data using arma - egarch - m modeling$

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ASYMMETRIC INFORMATION CONTENT OF THE YTL/US$ EXCHANGE RATE RETURN: NEW EVIDENCE FROM THE POST-CRISIS DATA USING ARMA-EGARCH-M MODELING

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Abstract: *In this paper, the volatility content of the YTL/US$ exchange rate return has been examined for the post-2001 crisis period till the early periods of 2008. Using exponential GARCH (EGARCH) methodology, estimation results indicate that volatility shocks on exchange rate return seem to be persistent so that the forecasts of the conditional variance converge to the steady state quite slowly. Besides, conditional variance of the exchange rate return reacts differently to equal magnitude negative and positive innovations. Plotting the News Impact Curve reveals that an unanticipated increase in exchange rate return would lead to more uncertainty when compared with the case of an unanticipated decrease.*

Key Words: *Exchange Rate Return*; *Volatility*; *EGARCH Modeling*

Özet: *Bu çalışmada, YTL/US$ döviz kuru getrisinin oynaklık (volatilite) içeriği 2001 krizi sonrası dönem için 2008'in erken dönemlerine kadar incelenmektedir. Üssel GARCH (EGARCH) yöntemi kullanılarak elde edilen sonuçlar döviz kuru getirisi üzerindeki oynaklık şoklarının kalıcı olduğunu ve bu şekilde koşullu varyans tahminlerinin durgun duruma oldukça yavaş bir şekilde yakınsadığını göstermektedir. Ayrıca, döviz kuru getirisinin koşullu varyansı aynı büyüklükteki negatif ve pozitif değişikliklere farklı bir şekilde tepki göstermektedir. Haber Etki Eğrisinin (News Impact Curve) çizimi döviz kuru getirisindeki beklenmedik bir artışın beklenmedik bir azalış durumuyla karşılaştırıldığında daha fazla belirsizliğe yol açtığını ortaya koymaktadır.*

Anahtar Kelimeler: *Döviz Kuru Getirisi*; *Oynaklık*; *EGARCH Modellemesi*

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1. INTRODUCTION

During the winter of 2000-2001, the Turkish economy faced an economic crisis which led to the abolishment of the inflation stabilization program based on nominal exhange anchor, with a great slump in real gross domestic product. Following the collapse of the crawling band regime of the 2000 disinflation program, a new stabilization period began and policy makers attempted primarily to lower inflation rates and domestic interest rates to stabilize the payments system as well as to restructure the highly fragile banking system which helped bring about the events that led to the crisis conditions. Finally, all these immediate post-crisis stabilization attempts was aimed to be resulted in economic growth again in the long-run.[1]

In such a framework, the Turkish economy has still been trying to establish an inflation targeting program supported by free-floating exchange rate system, which was designed to allow the domestic exchange rate to float against major hard currencies. While this framework provides flexibility to policy makers in the conduct of monetary policy, two major independent issues must be highlighted to ensure the proper implementation of discretionary stabilization policies. One of these issues ascertains the magnitude of the volatility in exchange rates, and the other interests in the information content revealing whether positive or negative shocks on the exchange rate changes give rise to more volatility in the foreign exchange market. Concerning the former content, many recent paper in the Turkish economics literature, analyzing how the foreign exchange market responses to central bank interventions in a floating exchange rate system, have been produced by economists such as Ağcaer (2003), Domaç and Mendoza (2004), Selçuk (2005), Ardıç and Selçuk (2006), Guimarães and Karacadağ (2004), Herrera and Özbay (2005), Akıncı, et al (2005a), Akıncı, et al (2005b), and Saatçioğlu et al. (2007). The purpose of this paper is to examine the latter issue of the information content of exchange rate return volatility by applying to some contemporaneous econometric estimation techniques. The next section deals with the methodology of the estimation process. Section 3 gives the estimation results using data from the Turkish economy, and the last section summarizes results to conclude the paper.

[1] Akat (2000), and Ertuğrul and Selçuk (2002) make some criticism of the factors leading the Turkish economy to 2000 stabilization attempt, while letter paper also gives a brief account of the Turkish economy from the late-1980s till the early 2000s.

2. DATA AND METHODOLOGY

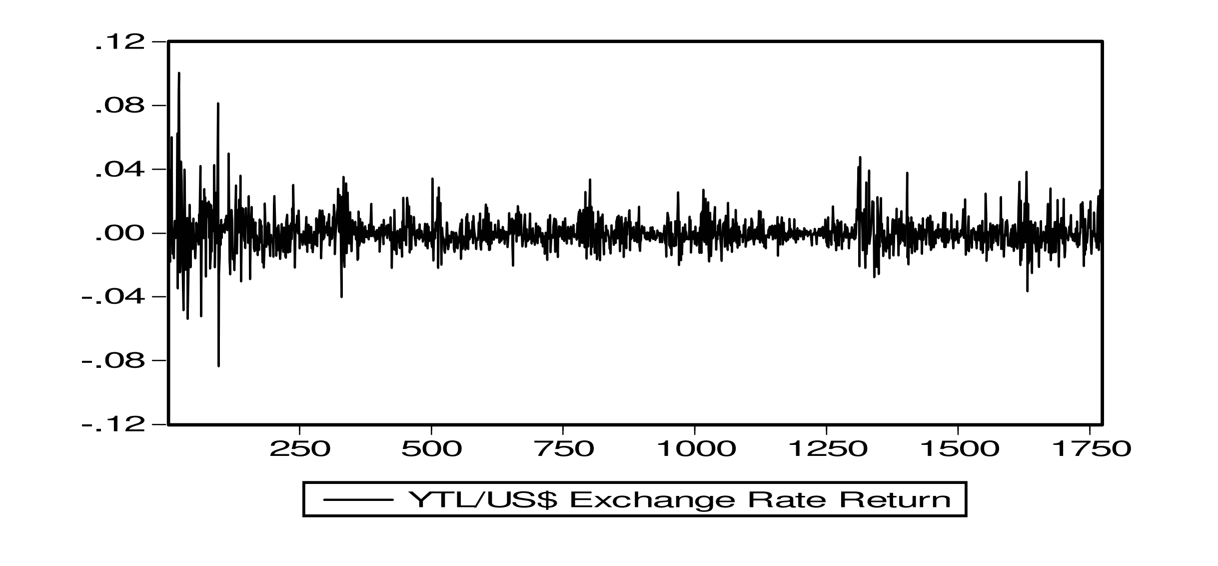
Following the seminal paper of Engle (1982), autoregressive conditional heteroskedastic (ARCH) models have become highly popular in the economics literature to model the conditional volatility in high frequency financial and economic time series. For this purpose, generalized ARCH (GARCH) methodology of Bollerslev (1986) and its more recent variants such as threshold ARCH (TARCH) and Threshold GARCH models introduced by Zakoïan (1994) and Glosten et al. (1993), exponential GARCH (EGARCH) model proposed by Nelson (1991), power ARCH (PARCH) model generalized in Ding et al. (1993) and also component GARCH (CGARCH) models have been widely used to measure the volatility pattern of the financial time series to proxy the uncertainty in economic modeling. Let us follow Nelson (1991) and model the exchange rate return to reveal the information content of volatility. Considering an ARMA structure, the mean and variance (Var.) equations of exchange rate can be written as follows:

$$e_t^{return} = GARCH_t + c_t + \sum_{i=1}^{p} \alpha_i e_{t-i}^{return} + \varepsilon_t + \sum_{j=1}^{q} \delta_j \varepsilon_{t-j} \qquad (1)$$

$$\text{Var.: } \log(\sigma_t^2) = \varpi_t + \sum_{k=1}^{r} \beta_k \log(\sigma_{t-k}^2) + \sum_{l=1}^{s} \eta_l \left|(\varepsilon_{t-1})/(\sigma_{t-1})\right| + \sum_{m=1}^{t} \gamma_m [(\varepsilon_{t-m})/(\sigma_{t-m})] \qquad (2)$$

where e_t^{return} represents one period exchange rate return as a differenced form in natural logarithms. Following Engle et al. (1987), $GARCH_t$ introduces the conditional variance into the mean equation to influence the conditional mean. ε_t is the white-noise error term produced in the mean equation, and σ_t^2 gives the one period ahead forecast variance based on past information and is called as the conditional variance, so that the leverage effect allowing the variance to respond differently following equal magnitude negative or positive shocks is exponential, rather than quadratic, and that forecasts of the conditional variance are guaranteed to be nonnegative. Such an impact will be asymmetric if $\gamma_m \neq 0$. If $[(\varepsilon_{t-m})/(\sigma_{t-m})]$ is positive, the effect of the shock on the log of the conditional variance is expected to be $(\eta+\gamma)$, and if $[(\varepsilon_{t-m})/(\sigma_{t-m})]$ is negative, the effect of the shock on the log of the conditional variance is expected to be $(\eta-\gamma)$ (Enders, 2004). To deal with potential model misspecification, we have calculated robust t-ratios using the quasi-maximum likelihood method suggested by Bollerslev and Wooldridge (1992), so that parameter estimates will be unchanged but the estimated covariance matrix will be altered. The variable (e_t^{return}) used for empirical purposes in the mean equation is the YTL/US$ exchange rate in log differenced form, and the time period consists of daily observations beginning from 02/03/2001 till 13/03/2008 considering 1772 observations. The data have taken from the electronic data delivery system of the Central Bank of the Republic of Turkey. The time series graph of the variable is given below:

Fig. 1. Time Series Graph of the YTL/US$ Exchange Rate Return



In Fig. 1, we can easily notice that exchange rate return has a quite volatile characteristic inside the period and seems explicitly to be stationary. Tab. 1 indicates some descriptive statistics as well as the Ljung-Box Q statistics for the exchange rate return at lag k to test for the null hypothesis that there is no autocorrelation of the deviations and the squared deviations of the exchange rate return from its sample mean up to the order k. In Tab. 1, Skewness is a measure of asymmetry of the distribution of the series around its mean, and the skewness of a symmetric distribution, such as the normal distribution, would be zero. Descriptive statistics reveal that exchange rate return is biased to the right and has a right tail. Kurtosis measures the peakedness or flatness of the distribution of the series and the kurtosis of the normal distribution is 3. If the kurtosis exceeds 3, the distribution would be peaked relative to the normal. An excess kurtosis can easily be noticed for the exchange rate return. Jarque-Bera is a test statistic for testing whether the series is normally distributed under the null hypothesis. The test statistic measures the difference of the skewness and the kurtosis of the series with those from the normal distribution. In our case, a significant departure from normality due to the excess kurtosis is also found. Finally, Q(*k*) is the Ljung-Box Q-statistics at lag *k* to test for the null hypothesis that there is no autocorrelation up to the order *k*. Results indicate that large and significant autocorrelations of the 20th and 36th order and the significant departure from normality provide evidence in favor of ARCH effects:[2]

Tab. 1. Descriptive Statistics of the Variable e_t^{return}

Series: e_t^{return}

Sample 02/03/2001 13/03/2008

Observations 1772				probs.
Mean	0.000156	Skewness	1.277606	
Median	-0.000778	Kurtosis	16.56829	
Maximum	0.100510	Jarque-Bera	14074.67	
Minimum	-0.083600	Q(20)	55.930	(0.000)
Std. Dev.	0.010769	Q(36)	105.02	(0.000)

3. RESULTS

Before testing the whole model, we examined the ARMA (*p*, *q*) structure of the model. Based on the minimized Akaike information criterion (AIC) and Schwarz criterion (SC) results, an ARMA (3,2) time series filter is found the most appropriate for the conditional mean equation.[3] Following the preliminary data and model construction issues, an ARMA (3,2)-EGARCH (1,1)-M model is estimated. The results of the Eqs. 1-2 using Marquardt optimization algorithm and quasi-maximum likelihood (QML) covariances and standard

[2] For a more detailed technical interpretation of ARCH errors, see Enders (2004: 112-20). Although the time series representation of the variables indicate explicitly that the data are of stationary form, we also employed augmented Dickey-Fuller and Phillips-Perron unit root tests to test for the stationary characteristics of the high frequency data and found an overwhelming evidence for both the tests that stationarity of the exchange rate return cannot be rejected. The results not reported here are available from the authors upon request.

[3] Alternative ARMA (*p* ,*q*) structures, for *p* = 0, 1, 2, 3 and *q* = 0, 1, 2, 3, applied for modeling porposes reveal that no change in the conditional variance equation occurs but statistical significance of the mean equation coefficients is highly sensitive to the model chosen for this purpose.

errors described by Bollerslev and Wooldidge (1992) are given below. We find no significant effect of conditional variance on the mean equation. The variance equation indicates that, since the value of the EGARCH parameter is close to one, the volatility shocks seem to be highly persistent so that conditional variance converges to the steady state quite slowly. Since the leverage term γ is positive and statistically different from zero, the news impact is aymmetric and the conditional variance of the exchange rate return reacts differently to equal magnitudes of negative versus positive shocks. Dealing with diagnostics, ARCH LM statistics and correlogram-Q statistics cannot reject the null hypothesis at the conventional levels in the sense that no remaining serial correlation in the mean equation is detected. The graph of the conditional variance series extracted from the EGARCH equation is also given in Fig. 2.

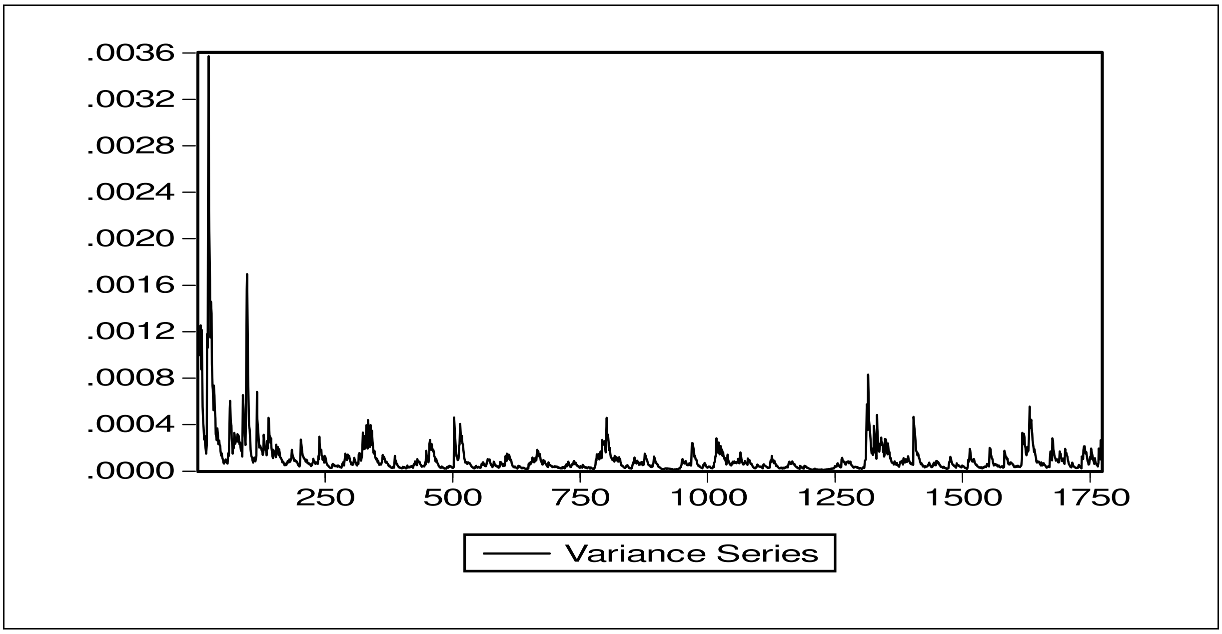
Table 2. EGARCH Estimation Results of the YTL/US$ Exchange Rate Return

Dependent Variable: e_t^{return}
Method: Maximum Likelihood – ARCH (Marquardt) – Normal Distribution
Sample (adjusted): 5 1773
Included observations: 1769 after adjustments
Bollerlev-Wooldridge robust standard errors & covariance

	Coefficients	Std. Error	*p*-value
GARCH	2.8789	3.2290	0.3726
c	-0.0003	0.0002	0.1672
α_1	0.2176	0.0309	0.0000
α_2	-0.9945	0.0059	0.0000
α_3	0.0691	0.0294	0.0190
δ_1	-0.1441	0.0068	0.0000
δ_2	0.9895	0.0044	0.0000
ϖ	-0.9122	0.1634	0.0000
β	0.9328	0.0146	0.0000
η	0.3560	0.0470	0.0000
γ	0.1163	0.0357	0.0011

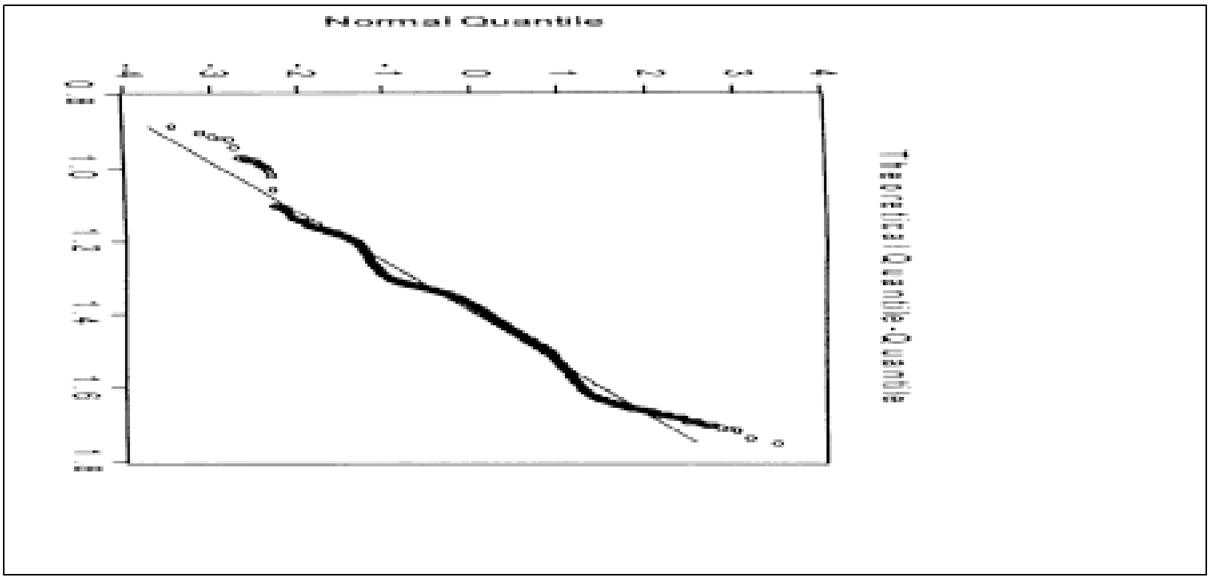
Akaike info criterion	-6.7254	F-statistic	1.8505
Schwarz criterion	-6.6914	Prob (F-statistic)	0.0478
Q(20)	16.477	Prob	0.351
Q(36)	34.334	Prob	0.311
$Q^2(20)$	0.1085	Prob	0.766
$Q^2(36)$	18.316	Prob	0.965
ARCH LM(1)	0.3806	Prob F(1, 1766)	0.5374
ARCH LM(30)	0.5017	Prob. F(30,1708)	0.9891

Fig. 2. Graph of the Conditional Variance Series



One way of further examining the distribution of the standardized residuals is to plot the quantiles. If the residuals are normally distributed, the points in the Quantile-Quantile plots should lie alongside a straight line. We see in Fig. 3 below that both large positive and negative shocks drive the departure form normality.

Fig. 3. Quantile-Quantile Graph

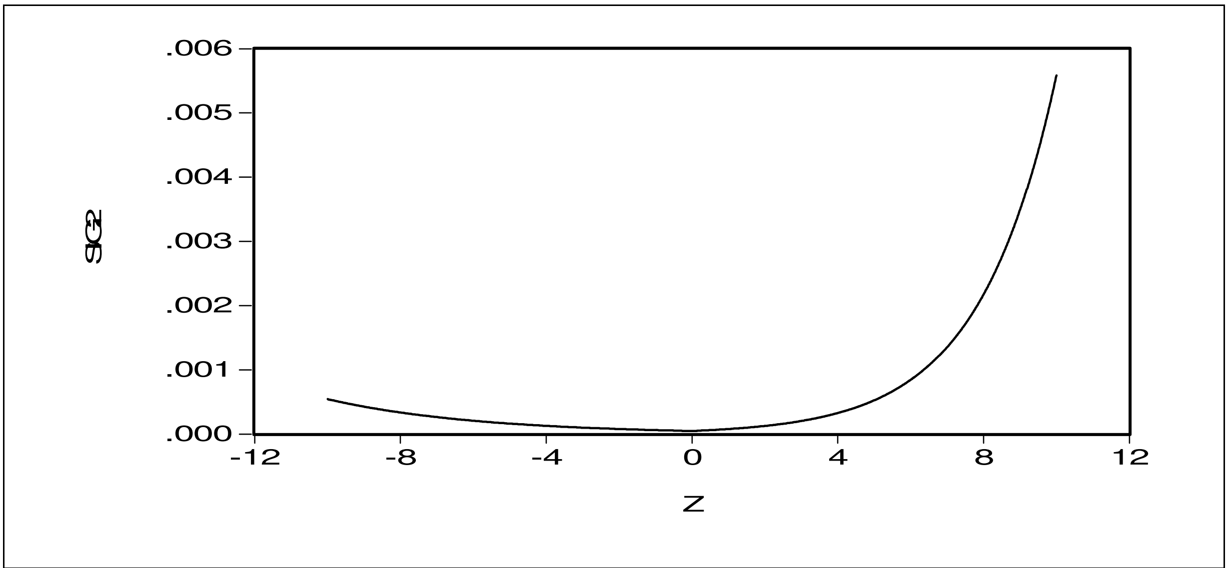


Having estimated the model, we now plot the News Impact Curve (NIC). Our goal here is to plot the volatility against the impact $z = \varepsilon / \sigma$ where:

$$\log \sigma_t^2 = \hat{\omega} + \hat{\beta} \log \sigma_{t-1}^2 + \hat{\alpha} |z_{t-1}| + \hat{\gamma} z_{t-1} \qquad (3)$$

We fix last period's volatility, σ_{t-1}^2, to the median of the estimated conditional variance series and estimate the one-period impact. The NIC is indicated below. In Fig. 4, SIG2 is used for the σ^2 series and *z* indicates an equispaced series between -10 and 10. In the figure, an asymmetric leverage effect can easily be observed. Such a finding means that the conditional variance of the exchange rate return reacts more to past positive shocks than to negative innovations of equal size. The economic consequence of this findings is that inside the period under investigation an unanticipated increase in exchange rate return would lead to a higher level of uncertainty when compared with the level of uncertainty resulted from an unanticipated decrease in the exchange rate return.

Fig. 4. News Impact Curve (NIC) of the YTL/US$ Exchange Rate Return Conditional Variance



4. CONCLUDING REMARKS

During the winter of 2000-2001, the Turkish economy faced an economic crisis which led to the abolishment of the inflation stabilization program based on nominal exchange anchor, with a great slump in real gross domestic product. Since then, a new economic regime based on floating exchange rate against major currencies has been dominated in the economy by policy makers. In this framework, one of the issues of interest in the eyes of economic agents is the degree of the volatility of exchange rate return as well as the information content of such volatility. In our paper, we try to investigate the latter information content for the YTL/US$ exchange rate return, and for this purpose we aply to the exponential GARCH (EGARCH) estimation methodology. Results indicate that volatility shocks to the exchange rate return seem to be highly persistent so that the forecasts of the conditional variance converge to the steady state quite slowly. Besides, conditional variance of the exchange rate return reacts differently to equal magnitude negative and positive innovations. Plotting the News Impact Curve reveals that an unanticipated increase in the exchange rate return would lead to more uncertainty when compared with the case of an unanticipated decrease.

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