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AN ECONOMETRIC ESSAY FOR THE ASYMMETRIC VOLATILITY CONTENT OF THE PORTFOLIO FLOWS: EGARCH EVIDENCE FROM THE TURKISH ECONOMY

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ABSTRACT

In this paper, the information content of the volatility observed on portfolio flows is tried to be econometrically examined for the Turkish economy. Our findings employing EGARCH estimation methodology reveal that the volatility shocks on the portfolio flows seem to be of a quite persistent form and that the news impact extracted from the model is asymmetric such that the conditional variance of the net portfolio flows reacts more to past negative shocks than to positive innovations of the equal size. Such a result has been attributed to that inside the period under investigation an unanticipated decrease in net portfolio flows would lead to a higher level of uncertainty when compared with the uncertainty resulted from an unanticipated increase and that policy makers *ought to* be prudent against the increasing uncertainties in the economy especially if large portfolio outflows are to be experienced.

Key words: Portfolio Flows; Asymmetric Volatility; EGARCH Modeling; Turkish Economy;

ÖZET

Bu çalışmada, portföy akımları üzerinde gözlemlenen volatilitenin bilgi içeriğinin Türkiye ekonomisi için ekonometrik olarak incelenmesine çalışılmaktadır. EGARCH tahmin yöntemini kullanan bulgularımız portföy akımları üzerindeki volatilite şoklarının oldukça kalıcı bir yapıda bulunduğunu ve modelden çıkarılan haber etkisinin net portföy akımlarının koşullu varyansının geçmiş negatif şoklara eşit büyüklükteki pozitif değişimlere göre daha fazla tepki göstermesi şeklinde oldukça kalıcı bir yapıda olduğunu ortaya koymaktadır. Böyle bir sonuç inceleme dönemi içerisinde net portföy akımlarındaki beklenmedik bir azalmanın beklenmedik bir artıştan kaynaklanan belirsizlik ile karşılaştırıldığında daha yüksek bir belirsizlik düzeyine yol açmasına ve politika yapıcıların özellikle büyük çaplı portföy çıkışlarına maruz kalındığında ekonomideki artan belirsizlikler karşısında ihtiyatlı olmaları gerekliliğine atfedilmiştir.

Anahtar kelimeler: Portföy Akımları; Bakışımsız Volatilite; EGARCH Modellemesi; Türkiye Ekonomisi.

INTRODUCTION

The course of capital flows affecting emerging market economies draws a considerable attention of both researchers and policy makers to search for various consequences occurred on the aggregate economic activity level. Given the limited amount of real and financial resources subject to the developing countries, the aims of policy authorities to attain high growth rates to converge to the developed countries are likely to lead developing countries to be highly sensitive to the effects of these flows. We can observe that a large volatility in capital flows seems to be a stylized fact of the world economy. The World Economic Outlook published by the International Monetary Fund (IMF) (2006) reports that the total net private capital flows comprising net direct investment, net portfolio investment, and other long- and short-term net investment flows in emerging markets were about $200 billion for the 1995-1997 period. In this period, the net private direct investment indicated a stable long-run path of on average $150 billion per year, but the post-1997 periods of the East Asian financial crisis witnessed that initially a decreasing private portfolio inflows and other capital flows and then an increasing private portfolio and other capital outflows for the 2001-2003 period dominated the emerging markets. But there exists an increase again in the flows of the private direct investment and the portfolio investment for the 2004-2006 period yielding about $821 billion in total private inflows. Also the recent World Economic Outlook of IMF (2008) reports a much larger increase in net private capital flows to the emerging markets and developing economies for the years 2007 and 2008 in the sense that the net private capital flows amount to $633 billion and 529$ billion in 2007 and 2008, respectively. Of special importance here is that the private portfolio flows constitute the most volatile sub-component of the total capital flows between developed and developing countries. Indeed, although the net private direct investment and to some extent the net total private capital flows indicate a stable pattern to increase for the post-2000 period, no such characteristics can be observed for the net private portfolio flows which indicate a highly volatile pattern within the period of last decade.

As a developing country, the Turkish economy has also been subject to the great deal of capital flows and many empirical papers in the Turkish economics literature try to examine the properties of these flows and the relationships between the capital flows and some other main domestic macroeconomic aggregates. Among many others, Agénor et al. (1997) relate the capital flows to the uncovered interest differentials and reveal that positive shocks to the uncovered interest differential would lead to the capital inflows, in turn, resulted in appreciation of the real exchange rate. Kirmanoğlu and Özçiçek (1999) try to reveal the effects of the short-term capital flows on the domestic economy. They find that capital inflows appreciate the domestic currency and lead to lower domestic inflation and interest rates and also promotes the domestic growth. Likewise, Celasun et al. (1999) indicate in an extensive paper on the effects of the capital flows experienced by the Turkish economy that capital flows affect the private consumption and investment positively and contribute to the real income growth process. However, estimation results of Akçoraoğlu (2000) contradict such an inference and yield no causal relationsips running from the international capital flows to the economic growth for the Turkish economy. Alper and Sağlam (2001) examine the transmission mechanism of the capital outflows considering different perspectives. The results give support to that unanticipated capital outflows give rise to the significant real output loses. Biçer and Yeldan (2002) search for the macroeconomic variables that best explain the behavior of the capital inflows for the Turkish economy. Their empirical results suggest that capital inflows have a significant negative correlation with the industrial production and trade openness and that these inflows are positively correlated with the real currency appreciation. They also find that there exists a positive relationship between the stock market and the capital flows. Finally, Çulha (2006) and the Central Bank of the Republic of Turkey (CBRT) (2006) analyze the determinants of the capital flows for the Turkish economy by employing a 'pull-push' factors approach. Their empirical findings reveal that the 'pull' factors are in general dominant over the 'push' factors in determining the capital flows, especially, for the post-2002 period.

In this paper, our contribution to the existing literature upon the Turkish economy is to shed briefly some light upon the information content of the volatility on portfolio flows by employing some contemporaneous estimation techniques to test whether they can be related to an asymmetric conditional variance component. Thus the paper tends to be more an econometric application than a theoretical economic research. To this end, the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) estimation methodology has been used. For this purpose, the next section describes preliminary data issues and tries to highlight the methodological issues used in the model estimation. The section two is devoted to estimating the EGARCH model for the Turkish economy. The last section summarizes results to conclude the paper.

I. PRELIMINARY DATA AND METHODOLOGICAL ISSUES

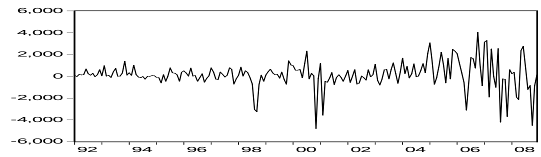
For any given period *t*, the data used ($PORTNET_t$) consider 204 monthly frequency observations of the investigation period 1992M01 2008M12. The portfolio flows data consist of the sum of portfolio investments net of assets and liabilities as equity securities and debt securities in millions of US$s. All the data in their linear forms have been taken from the electronic data delivery system of the Central Bank of the Republic of Turkey (CBRT). Following the seminal paper of Engle (1982), autoregressive conditional heteroskedastic (ARCH) models and their extended version proposed by Bollerslev (1986) as generalized ARCH models have become highly popular in the economics literature to model the conditional volatility in high frequency financial and economic time series. In this sense, many other estimation techniques as more recent variants of the ARCH estimation methodology such as the threshold ARCH (TARCH) and threshold GARCH models intruduced 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 widely been used to measure the volatility pattern of the high frequency economic / financial time series. In this paper, to construct the proxy variable for the uncertainty component of the portfolio flows experienced by the Turkish economy we try to follow the EGARCH methodology proposed by Nelson (1991). For this purpose, let us first define the mean and variance equations as follows:

$$PORTNET_t = c_t + \sum_{i=1}^{p} \alpha_i PORTNET_{t-i} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-12} \quad (1)$$

$$\log(\sigma_t^2) = \varpi + \sum_{k=1}^{r} \beta_k \log(\sigma_{t-k}^2) + \sum_{l=1}^{s} \eta_1 \left| (\varepsilon_{t-1})/(\sigma_{t-1}) \right| + \sum_{m=1}^{t} \gamma_m [(\varepsilon_{t-m})/(\sigma_{t-m})] + \zeta_1 PORTNET_{t-1} \quad (2)$$

where the autoregressive order of the mean equation is determined through conventional model selection information criteria. Following Engle et al. (1987), the $GARCH_t$ term could be included into the mean equation to allow the conditional variance to affect the conditional mean. But since we find this term statistically insignificant in a preliminary investigation of this model, we have dropped it from the equation. 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 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. The 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). We have included one-period lagged value of the level variable into the variance equation to see the potential effect of the variable in the previous period on the current conditional variance. We also assume a MA(1,12) process in the mean equation to provide a parsimonious estimation by reducing the order of the AR process and to account for possible seasonality in the data. To deal with potential model misspecification and to consider the possibility that the residuals of the model are not conditionally normally distributed, 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 time series graph and the descriptive statistics of the monthly net portfolio flows data are reported in Fig. 1 and Tab.1, respectively. Fig. 1 indicates the highly volatile characteristics of the portfolio flows inside the investigation period. Of much more importance here, without taking account of too much detailed information of numbers, can be expressed such that a short glance to the figure reveals that the volatility of portfolio flows accelerates for the post-2000 period and that the extent of fluctuations enlarges especially for the post-2003 periods.

Fig. 1 Time Series Graph of the Portfolio Flows ($ million)



Tab. 1 Descriptive Statistics

Series: $PORTNET_t$			
Sample 1992M01 2008M12		Observations	204
Mean	147.42	Skewness	0.8140
Median	110.50	Kurtosis	7.3426
Maximum	4024.0	Jarque-Bera	182.82
Minimum	-4799.0	$Q(1)$	7.5595
Std. Dev.	1196.5	$Q(12)$	24.519

In the light of these stylized facts, we can observe that the periods which have been subject to large inflows or outflows such as the second half of 1998, November-2000 and February-2001 crisis periods and post-2003 periods represent significant departures from the mean and median value of the net portfolio flows. High standard deviation of the series also reflects this characteristic of the data. In the table we also present the Ljung-Box (LB) Q statistics at lag k to test for the null hypothesis that there is no autocorrelation of the deviations and the squared deviations of the data from its sample mean up to the order k. Descriptive statistics reveal that the data are somewhat biased to the right and have an excess kurtosis which means that the data seem to be peaked relative to the normal distribution. Finally the Jarque-Bera and LB Q-statistics at lag k indicate that the large and significant autocorrelations of the 1st and 12th order and the significant departure from normality provide evidence of the ARCH effects.

II. CONDITIONAL VOLATILITY ESTIMATES

Following the preliminary data issues examined in the former section, we now try to estimate the conditional mean and variance equations for the net portfolio flows experienced by the Turkish economy. The autoregressive (AR) order of the mean equation is determined by way of minimizing Akaike model selection information criterion, so various models including different lag structures have been estimated. Considering the maximum lag length as 12, we have searched for the true data generating process of our model outlined above and decided to use an AR(5) specification with the smallest estimated statistic as a chosen model. As is briefly expressed above, an MA(1,12) process has been included into the mean equation which serves to provide a parsimonious ordering of the AR process and to account for possible seasonality in the data. The statistical significance of the MA(1,12) coefficients would imply the presence of seasonal effects in the data. The results of the Eq. 1 and Eq. 2 estimated by the method of maximum likelihood and using the Marquardt optimization algorithm as well as the quasi-maximum likelihood covariances and standard errors described by Bollerslev and Wooldridge (1992) are reported in Tab. 2 below. Note that for the conditional distribution of the error structure, normal (Gaussian) distribution is assumed (standard errors are in parentheses):

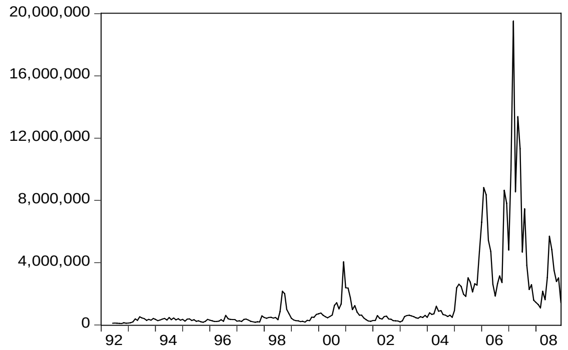
Tab. 2 Estimates of the EGARCH Model (Dependent Variable: *$PORTNET_t$*)

	Coefficients	Std.Error		*p*-value
c	192.89	77.502		0.0128
α_1	-0.7442	0.0835		0.0000
α_2	0.1613	0.0651		0.0132
α_3	0.1570	0.0724		0.0301
α_4	0.2094	0.0745		0.0050
α_5	0.0098	0.0699		0.8886
θ_1	1.0591	0.0267		0.0000
θ_2	0.0599	0.0267		0.0247
	Variance Equation			
ϖ	0.3551	0.3416		0.2985
β	0.9440	0.0265		0.0000
η	0.4628	0.1402		0.0010
γ	-0.3365	0.1724		0.0509
ζ	0.0004	0.0001		0.0000
R^2	0.1499		Mean dep. var.	148.65
Adj. R^2	0.0951		S.D. dep. var.	1211.5
S.E. of Reg.	1152.5		AIC	16.384
Log likelihood	-1617.2		SC	16.599
F-stat.(prob)	2.7334 (0.0020)		DW-stat.	2.0027
Q(12) (prob)	6.4451 (0.265)		$Q^2(12)$(prob.)	4.0148 (0.547)
ARCH LM(12)	F-stat. 0.2858		Prob.F(12,174)	0.9909

In Tab. 2, we observe that most of the autoregressive parameters and MA(1,12) coefficients are statistically significant. The variance equation indicates that the value of the EGARCH parameter is close to one which means that 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 negative and statistically different from zero, the news impact is asymmetric and the conditional variance of the net portfolio flows reacts differently to equal magnitudes of negative versus positive shocks. We have also found that net portfolio flows in the previous period significantly lead to somewhat increasing volatility. Dealing with the diagnostics, that the

Q(12)-statistic is found insignificant means that the mean equation is correctly specified, and also that the Q^2(12)-statistic is found insignificant means that the variance equation is correctly specified. ARCH LM statistic and correlogram-Q statistics estimated for the presence of autocorrelation in the standardized residuals and in the squares of standardized residuals cannot reject the null hypothesis at the conventional levels, therefore, we can infer that there exists no remaining serial correlation in the model. Below we give the graph of the conditional variance series extracted from the EGARCH equation:

Fig. 2 Graph of the Conditional Variance



We can easily notice that the post-2003 periods witness an increasing volatility represented by the conditional variance estimated. On this point, plotting the quantiles will enable us an other way to examine the distribution of the standardized residuals. If the residuals are normally distributed, the points in the Quantile-Quantile plots should lie alongside a straight line. By setting identical axes to facilitate comparison with the diagonal line, we see in Fig. 3 below that primarily large negative shocks drive the departure from normality. 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:

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

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 in Fig.4.

Fig. 3 Quantile-Quantile Graph

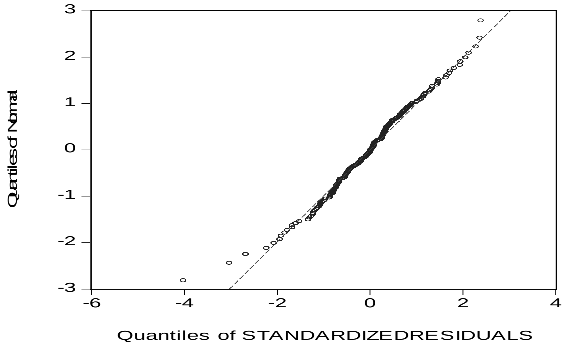
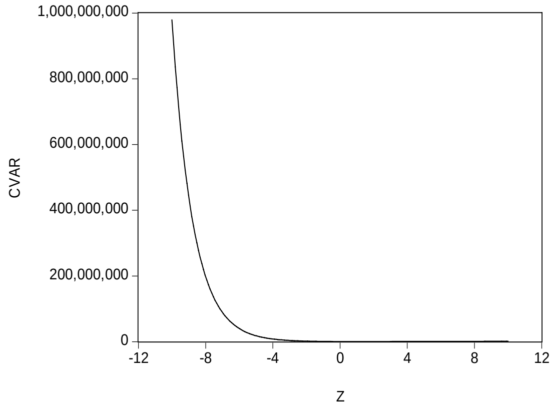


Fig. 4 News Impact Curve (NIC) of the Conditional Variance



Above CVAR is used for the σ^2 series and z indicates an equispaced series between 10 and -10. In Fig. 4, an asymmetric leverage effect can easily be observed supporting the estimation results reported in Tab. 2 above. More explicitly, such a finding means that the conditional variance of the net portfolio flows reacts more to past negative shocks than to positive innovations of the equal size. The economic consequence of these findings is that inside the period under investigation an unanticipated decrease in net portfolio flows would lead to a higher level of uncertainty when compared with the uncertainty resulted from an unanticipated increase. All in all, we must emphasize that policy makers will have to be prudent against the increasing volatilities occurred in the economy especially if large capital outflows are to be experienced.

CONCLUDING REMARKS

The course of capital flows affecting emerging market economies has been of a special importance for both researchers and policy makers to observe their impacts occurred on the economic activity. In this paper, our contribution to the existing literature upon this issue of interest is to shed some light upon the information content of the volatility on portfolio flows for the case of the Turkish economy. Thus the paper tends to be more an econometric application than a theoretical economic research. Following the re-examination of the pure data characteristics of the net portfolio flows experienced by the Turkish economy, results obtained from employing EGARCH estimation methodology reveal that the volatility shocks on the portfolio flows seem to be highly persistent and that the news impact extracted from the model is asymmetric such that the conditional variance of the net portfolio flows reacts more to past negative shocks than to positive innovations of the equal size. Such a finding has been attributed to that inside the period under investigation, an unanticipated decrease in net portfolio flows would lead to a higher level of uncertainty when compared with the uncertainty resulted from an unanticipated increase and that policy makers will have to be prudent against the increasing volatilities occurred in the economy especially if large outflows are to be experienced.

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