THE EFFECT OF EXCHANGE RATE UNCERTAINTY ON EXPORTS

A CASE STUDY FOR TURKEY

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Abstract

This study investigates possible effects of exchange rate uncertainty on exports in the context of the GARCH (Generalized Autoregressive Conditional Heteroscedasticity) model. The empirical evidence for the 1988:II-1997:II period indicates that exports are adversely affected by the real exchange rate uncertainty while emprical evidence does not indicate statistically significant relationship between imports and real exchange rate uncertainty.

1. INTRODUCTION

The high degree of volatility of exchange rate movements since the beginning of the generalized floating exchange rate regime has led policymakers and researchers to investigate the nature and extent of such movements on trade flows. There is conflicting evidence in the literature about the relationship between exchange rate volatility and trade flows.

On the one hand, a number of studies have argued that if market participants are risk-averse, exchange rate uncertainty causes market participants to reduce their activities in order to minimize their exposure to the effects of exchange rate volatility. Most international transactions are realized after a time lag, and contracts are denominated in terms of the currency of either the exporting or importing country. Unanticipated changes in exchange rates may adversely affect the volume of trade through their effects on profits. The exchange rate risk may increase exporter's profit risk. If exchange exchange rate volatility increases, then profit risk rises. Since exporters are risk-averse and hedging against exchange rate risk is costly or impossible, the increase in profit risk reduces the benefits and therefore the volume of international trade. Akhtar and Hilton (1984), Coes (1981), Cushman (1983,1986), Kenen and Rodrick (1986), Koray and Lastrapes (1989), Thursby and Thursby (1987), Chowdhury (1993), Doroodian and Caporale (1994), Arize (1995), Peree and Steinherr (1988) provided empirical evidence.

On the other hand, Franke (1992), Giovannini (1988),and Sercu and Vanhullle (1992) showed that trade benefits from exchange rate volatility or risk. These studies suggest that trade can be considered as an option held by firms. Like any other option, such as, stocks the value of trade can rise with volatility. According to the model developed by Franke (1992), a firm evaluates the exit (entry) costs associated with leaving (entering) a foreign market against losses (profits) created by exports. Firms with a comparative disadvantage in international trade benefit from an increase in exchange rate volatility since their expected cash flows from exports grow at a higher rate than their entry and exit costs.

The purpose of this paper is to assess which of two factors are more important for the effect of exchange rate uncertainty on exports. We expect that exchange rate volatility may have adverse effects on trade flows because trade is not an option for firms in Turkey. As far as it is observed, they produce to export. We apply the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) technique and use quarterly data for the period

from 1987:I to 1997:II. This technique allows us to capture time-varying conditional variance as a parameter generated from a time series model of conditional mean and variance of the exchange rate. Some other alternative technologies may be used. Arize (1995) used cointegration and error-correction techniques as well as conditional and unconditional measures of exchange-rate uncertainty in order to test the hypothesis that exchange rate uncertainty impedes trade. Also, Chowdhur (1993) used the moving standard deviation of growth rate of the exchange rate to measure volatility. It is assumed that current exchange rate is known; however it is in fact not known and it has to be forecasted. So in this study, the GARCH technique is used in order to forecast the current exchange rate and to perceive volatility.

Liberal economic policies started to be implemented after the 1980's in Turkey but the exchange rate policy was not fully liberalized. Adjustable peg policy was implemented after 1981. The Turkish lira (TL) was daily adjusted in the form of devaluations.Then the exchange policy was liberalized after 1988. Department of money market was established at the Central Bank of the Republic of Turkey with the aim of determining the exchange rate in the market and bringing stability to the foreign exchange market. Role of the Central Bank was to regulate the market and avoid volatilities.

The monetary policy implemented by the Central Bank has aimed to achieve stability in the financial markets since 1996. It has tried to reduce uncertainities in the money markets. It has avoided short-term and fast movements in prices both in the foreign exchange and TL markets. Achieving stability in the foreign exchange market has been an important part of the stability in financial markets in Turkey.

The remainder of this paper proceeds as follows: Section 2 introduces GARCH models, Specification of the model is presented in Section 3. The empirical results are discussed in Section 4. Section 5 provides a brief conclusion.

2. INTRODUCTION OF GARCH MODELS

ARCH (Autoregressive Conditional Heteroscedasticity) and GARCH (Generalized Autoregressive Conditional Heteroscedasticity) models enable the econometrician to estimate the variance of a series at a particular point in time. Suppose that real exchange rate π_t has an invariable autoregressive process

$$p_t = i_0 + \sum_{j=1}^{q} i_j p_{t-j} + e_t \quad (1)$$

where i_t is the coefficient of the $i^{(th)}$ lag of real exchange rate, and ε_t is the discrete-time real valued stochastic process.

$$e_t / \Omega_{t-1} \sim (0, h_t^2) \quad (2)$$

Here, the conditional variance of ε_t with a given information set at the same time t-1 is h_t with a mean of zero and Ω_{t-1} includes all information available to agents at time t-1. Then, the conditional expectation of then real exchange rate at time t with the given information set at time t-1 is

$$E_t(p_t / \Omega_{t-1}) = i_0 + \sum_{j=1}^{q} i_j p_{t-j} \quad (3)$$

Engle (1982) introduced the ARCH model that allows the forecast variance of the inflation series to vary systematically over time. In ARCH models, h_t^2 is assumed to depend on the past squared residuals from the π_t equation.

$$h_t^2 = d_0 + \sum_{j=1}^{p} d_j e_{t-j}^2 \qquad (4)$$

Bollerslev (1986) introduced the GARCH (Generalized Autoregressive Conditional Heteroscedasticity) process, which extends the ARCH model to make h_t^2 a function of lagged values of h_t^2 as well as the lagged values of ε_t^2 . In this case h_t^2, the conditional variance is estimated by

$$h_t^2 = d_0 + \sum_{j=1}^{p} d_{1j} e_{t-j}^2 + \sum_{j=1}^{q} d_{2j} h_{t-j}^2 \qquad (5)$$

Bollerslev (1986) required all the coefficients to be positive to ensure that the conditional variance is never negative. Furthermore, the sum of all d_{1j} and d_{2j} coefficients has to be less than one in order for the process to be stationary. Both Engle (1982) and Bollerslev (1986) assumed that errors have normal distribution. Nonetheless, Bollerslev and Wooldridge (1992) argued that normality assumption might be too restrictive; consequently they relaxed this assumption and suggested to use quasi-maximum likelihood (QML) method that gives robust standard errors. Hence, the QML estimation is used.

3. MODEL SPECIFICATION

Firstly, the export demand equation is estimated by the ordinary least squares (OLS) method. The real exchange rate uncertainty developed by using quarterly observation from 1988:II to 1997:II is modelled in the second model. And lastly, the effect of real exchange rate uncertainty on exports and imports demand is assessed. Exports demand equation is reestimated by adding the exchange rate uncertainty variable by the quasi-maximum likelihood method. Quarterly data from 1987:I to 1997:II is used and all data are obtained from International Monetary Fund (IMF) and the data base of the Central Bank of the Republic of Turkey (CBRT).

Exports demand is determined by time trend, the first four lagged values of percentage change in the real exchange rate, foreign income and exports. Last, three additive dummies are included for 1994:1,1994:2 and 1994:3 periods to account the 1994 financial crisis. The real exchange rate is a trade weighted real exchange rate based on consumer price indices (CPI) of major 6 trade partners and Turkey. Foreign income is the sum of gross national product of Germany and the USA.

The prices of domestic products become cheaper in terms of foreign currency as home currency depreciates, so the demand for domestic products increases. Also as foreign income rises, the demand for domestic products increases. Therefore, the expected sign of real exchange rate and foreign income is to be positively associated with export demand.

Furthermore, in order to assess the predictable part of the real exchange rate, We estimate the following models for the real exchange rates used in export demand equation.

$$\pi_{6t} = \alpha_0 + \alpha_1 * P_{1t} + \alpha_2 * P_{2t} + \alpha_3 * P_{3t} + \alpha_4 * \pi_{6\,(t-1)} + \alpha_5 * \pi_{6\,(t-2)} + \varepsilon_t \qquad (6)$$

$$\text{where } \varepsilon_t \sim (0, h_t^2) \qquad (7)$$

P_{1t},P_{2t} and P_{3t} are additive crisis dummies included for 1994:1,1994:2 and 1994:3 periods to control the 1994 financial crisis. π_{6t} denotes the percentage change in the real exchange rate. The lagged order is determined by the final prediction error criterion. Final prediction error criterion sets the lagged order such that it eliminates the autocorrelation in the error term. This is crucial since autocorrelated errors indicate the presence of the ARCH effect even if the ARCH effect is not present.

We allow the variance of the ε_t is time dependent. By using the GARCH methodology, we model the conditional variance for the equation above as

$$h_t^2 = \gamma_0 + \gamma_1 * h^2_{t-1} + \gamma_2 * h^2_{t-2} + \gamma_3 * \varepsilon^2_{t-1} + \gamma_4 * \varepsilon^2_{t-2} \quad (8)$$

h_t is used as the measure of the uncertainty.

Later, the following linear models to assess the effect of exchange rate uncertainty on exports are estimated.

$$X_t = f(t, P_{1t}, P_{2t}, P_{3t}, \pi_{6\,(t-1)\text{ to }(t-4),}\ X_{(t-1)\ \text{to}\ (t-4),}\ YF_{(t-1)\text{ to }(t-4),}\ h_t), \quad (9)$$

where t denotes the trend, P_{1t}, P_{2t}, P_{3t} are quarterly dummies used to control the effect of the 1994 crisis. π_6 denotes the percentage change in the trade-weighted real exchange rate based on CPI's of major 6 trade partners of Turkey. Increase in the real exchange rate denotes depreciation of the Turkish Lira. X_t denotes the percentage changes in exports and YF denotes the percentage change of foreign income. Numbers in subscript parentheses indicate the lagged order.

4. EMPIRICAL EVIDENCE

The equations 6,8 and 9 are estimated by using the quasi-maximum likelihood method. The estimated coefficients of the equations and t-ratios are reported below.

$$\pi_{6t} = -0.0176 + 0.170P_{1t} + 0.306\ P_{2t} + -0.011\ P_{3t} + -0.016\ \pi_{6(t-1)} + -0.183\ \pi_{6(t-2)} + \varepsilon_t$$

(-2.687) (19..617) (29.927) (-0.358) (-0.185) (-9.309) (10)

$$h_t^2 = 0.0002 + 0.174h^2_{t-1} + 0.0166\ h^2_{t-2} + 0.591\ \varepsilon^2_{t-1} + 0.914\ \varepsilon^2_{t-2}$$

(4.852) (4.150) (0.243) (1.851) (1.607) (11)

$$X_t = 0.055 + 0.002t + - 0.036P_{1t} + - 0.140\ P_{2t} + -0.004\ P_{3t} + 0.682\ \pi_{6(t-1)} + -0.204\ \pi_{6(t-2)} + -0.064\ \pi_{6(t-3)} + 0.198\ \pi_{6(t-4)}$$

(1.828) (3.677) (-1.432) (-2.107) (-0.043) (3.330) (-2.223) (-0.291) (1.505)

$$+ - 0.873X_{(t-1)} + -0.991X_{(t-2)} + -1.023X_{(t-3)} + -0.026\ X_{(t-4)} + 0.627YF_{(t-1)} + 6.469\ YF_{(t-2)} + -0.150YF_{(t-3)}$$

(-6.050) (-5.675) (-5.864) (-0.176) (1.252) (6.646) (-0.166)

$$+ 0.339YF_{(t-4)} + -2.207h_t$$

(0.780) (-3.260) (12)

The estimated coefficient of the trend indicates that the Turkish exports tend to increase over time. Furthermore, exports tend to decrease in the first three quarters compare to the fourth quarter. Real exchange rate is positively associated with the exports (the sum of the real exchange rate coefficients is positive) even if in the second and third lagged, real depreciation decreases the exports.

The current exports are negatively affected by its previous values. This is quite important for the stability of the econometric model. This indicates that an adverse shock to exports is going to die out rather than persist forever. Last, foreign income increases our exports after its second quarter in a statististically significant fashion. Even if the estimated coefficient is negative for the third quarter, it is individually statistically insignificant and the

sum of the last four lagged coefficients is positive.

The estimated coefficient for the uncertainty variable h_t is negative and statistically significant. This suggests that exchange rate uncertainty decreases the exports.

Two basic types of residual based robustness statistics are applied (Q statistics and ARCH-LM test). Then, whether the residuals and standardised residual terms are autocorrelated or not is tested. The probability values of autocorrelation coefficients for the standardised residuals are 0,67, 0,62 and 0,61 for the 4^{th} ,8^{th} and 12^{th} lags so there is no autocorrelation. Also the Engles' ARCH LM test fails to detect autocorrelations for the 4^{th}, 8^{th}, and 12^{th} lags. Hence, all the robustness statistics were satisfactory on the specification of our model. The sum of the coefficient estimates of equation 14 is greater than 1. This suggests that the conditional variance is explosive. This could be due to small sample that we had to use. The results are also robust for different ARCH specifications.

The same method for the imports demand equation is used and found that the estimated coefficient for the uncertainty variable h_t is positive and statistically insignificant. This suggests that exchange rate uncertainty increases the imports however, empirical evidence does not indicate statistically significant relation.

5. CONCLUSION

In this study main determinants of export demand and the impact of adverse effects of the real exchange rate uncertainty on exports in Turkey for the period of 1988-1997 are tested.

The basic finding of this paper is that real exchange rate and foreign income are significant in determining exports demand. For the imports demand, real exchange rate, domestic income and exports are significant. While real exchange rate uncertainty significantly reduces the exports, it is not significantly effective on the imports.

The adopted monetary policy during the last two years that targets the real exchange rate is very important in terms of reducing the exchange rate volatility and improving the trade performance.

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APPENDIX

The same method used for the estimates of export demand equation is also used for the import demand equation.

Equations 1,2 and 3 are estimated by using quasi-maximum likelihood method for import demand. The coefficient estimates of these equations are reported below.

$$\pi_{2t} = 0.005 + 0.151P_1 + 0.234\ P_2 + -0.119\ P_3 + 0.234\ \pi_{2(t-1)} + -0.151\ \pi_{2(t-2)} + \varepsilon_t$$

(1.027) (26.076) (14.926) (-3.994) (3.583) (-1.564) (1)

$$h_t^2 = 0.001 + -0.108h^2_{t-1} + 0.006h^2_{t-2} + -0.061\ \varepsilon^2_{t-1} + 0.824\ \varepsilon^2_{t-2}$$

(4..372) (-2.248) (0.115) (-1..338) (9.472) (2)

$$M_t = 0.008 + -0.230\ P_3 + -0.885\ \pi_{2t} + 0.146\ YT_t + 0.462X_t + -0.300M_{(t-1)} + 0.449h_t$$

(0.462) (-5.757) (-4.208) (1.638) (6.241) (-5.832) (1.335) (3)

M_t denotes percentage change in imports. P_3 is the third quarter dummy used to control the effect of 1994 crisis. First and second quarter dummies are not statistically significant. π_{2t} denotes the percentage change in weighted real exchange rate based on consumer price indices of the USA, Germany and Turkey. Increase in the real exchange rate denotes depreciation of the TL. YT denotes the percentage change of domestic income and X_t denotes the percentage changes in exports. Number in subscript parentheses indicates the first lagged order.

First of all, imports tend to decrease in the third quarter compare to the fourth quarter in 1994. Real exchange rate is negatively associated with imports, meaning that depreciation of the TL decreases imports. Domestic income and exports increase our imports. Last, the

current import is negatively affected by its previous value.

The estimated coefficient for the uncertainty variable h_t is positive and statistically insignificant. This suggests that exchange rate uncertainty increases the import but empirical evidence is not statistically significant. The test statistics for robustness performed reasonably well. The probability values of autocorrelation coefficients for the standardised residuals are 0,52, 0,34 and 0,32 for the 4^{th} ,8^{th} and 12^{th} lags so there are is autocorrelation, and the Engles's ARCH LM test fails to detect autocorrelations for the 4^{th}, 8^{th}, and 12^{th} lags.