Süleyman Demirel Üniversitesi
Sosyal Bilimler Enstitüsü Dergisi
Yıl/Volume : 1, Sayı/Issue: 2, s.147-155, Güz 2005

THE EFFECT OF EXCHANGE RATE VOLATILITY ON THE BILETERAL TRADE FLOWS

Yrd.Doç.Dr. Aliye Kayış[*]
Yrd.Doç.Dr. Erdoğan Öztürk[**]

Abstract

This empirical study investigates the effect of exchange rate volatility on bilateral trade. A measure for the exchange rate volatility is obtained using Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. We find that exchange rate volatility has negative and statistically significant effect on the bilateral trade.

Özet

Bu ampirik çalişma, döviz kurlarındaki dalgalanmalarin dış ticaret üzerindeki etkisini araştırmaktadır. Döviz kurundaki dalgalanmalar Genelleştirilmiş Otoregresif Şartlı Değişken Varyans Modeli kullanılarak elde edilmiştir. Döviz Kurundaki dalgalanmaların dış ticaret üzerinde negatif ve istatistiki olarak anlamlı bir etkisinin oldugu bulunmustur.

[*] Süleyman Demirel Üniversitesi, İ.İ.B.F Öğretim Üyesi, aliye@emk.com.tr
[**] Süleyman Demirel Üniversitesi, İ.İ.B.F Öğretim Üyesi.

1. INTRODUCTION

The effect of exchange rate volatility on international trade is a very popular topic of research in international economics. Gagnon (1993) claims that resolution of this issue has obvious implications for the choice of an international monetary system. If fluctuations in exchange rates under the floating exchange regime have depressed the level of trade and reduced the welfare, there would be a strong case for a return to fixed exchange rates.

Higher volatility of exchange rates has been witnessed since the adoption floating regime in 1973. Exchange rate volatility, or more precisely, unexpected exchange rate movements, represents a source of risk. It is argued that exchange rate risk will lead to a lower level of trade assuming that traders are risk averse. This is because most trade contracts are not for immediate delivery of goods; and since they are denominated in terms of the currency of either the importer or the exporter, unanticipated fluctuations in the exchange rate affect realized profits and the volume of trade. In other words, if firms are risk averse, they would presumably tend to favor low-risk activities and avoid high-risk ones. Accordingly, if exchange risk increases, some marginal firms would give up exporting or importing entirely, and others in these activities to concentrate on domestic sales, thereby causing the total volume of international trade to decline. On the other hand, it is implicitly assumed that forward exchange markets can help traders to eliminate this type of variations in profits due to exchange rate risk. But the problem with forward exchange rate is that the majority of currencies are not fully convertible.

In this paper, exports from Hong-Kong, Singapore, and Korea to the United States from 1980 to 1996 are examined using monthly data to test the effect of exchange rate volatility on bilateral trade. Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is used to obtain a measure for the exchange rate volatility.

The remainder of the article is organized as follows. In the next section, the previous empirical studies are reviewed. Section 3 discusses statistical measures for volatility and ARCH type models. In section 4, the econometric model is presented. In the final section estimation results and a brief conclusion is provided.

2. LITERATURE REVIEW

The empirical evidence regarding the effect of exchange rate risk on trade has at best been inconclusive. Some of the empirical studies are unable to establish a systematically significant link between exchange rate volatility and international trade.

IMF(1984) cast doubt on the existence of a strong causal link, either direct or indirect, between exchange rate volatility and international trade. The study affirms that uncertainty tends to inhibit economic activity. But it finds no evidence that exchange rate volatility plays a significant role in reducing trade volume.

Bailey et.al. (1986) presents evidence on the determinants of real exports of the G-7 countries. In this study, absolute value of the quarter to quarter percentage change in the nominal effective exchange rate is chosen as exchange rate volatility. The results indicates that there is a positive effect of exchange rate variability on trade.

Hooper and Kohlhagen (1978) constructs a theoretical model for analyzing the impact of exchange risk on trade prices and volumes. They test it empirically for various U.S. and German trade flow from 1965 to 1975. They use alternative risk proxies and alternative functional forms. They find a significantly negative impact on the market prices. However, they find no effect of exchange rate volatility on the volume of trade.

Koray and Laspartes (1989) characterize the dynamic relationship between bileateral trade flows and exchange rate volatility for the United States using Vector Autoregressive models (VAR). They conclude that there is a weak relationship between exchange rate volatility and trade.

On the other hand, Kenen and Rodrik (1986), Thursby and Thursby (1986), Pozo (1992), Caporale and Doroodian (1994), and Stokman (1995) find negative relationship between exchange rate volatility and international trade.

Kenen and Rodrik examines short term volatility in the real effective exchange rates of industrial countries and its impact on their imports. They find that the volatility of real exchange rates does appear to have a depressing effect on the volume of international trade.

Thursby and Thursby model bilateral export among seventeen industrial countries. For ten of them, exchange rate volatility has a significant negative effect on exports; for the rest, the effect is negative but not statistically significant.

Pozo examines British export to the United States from 1900 to 1940. She includes dummy variable into export equation in order to capture the effect of different exchange rate regimes in the study period. She uses GARCH specification to measure exchange rate volatility. Pozo's findings support the hypothesis that exchange rate volatility has a depressing effect on the volume of trade.

Caporale and Doroodian extend Pozo's analysis. They also use GARCH specification to obtain measure of exchange rate volatility. Using monthly data from the beginning of the 1974 tto the end of the 1992, they test whether or not exchange rate volatility has an adverse effect on the value of the United State imports from Canada. Similar to the Pozo's findings, they conclude that the effect is negative and significant during the study period.

Stokman tests the effect of exchange rate risk on intra-European Community trade. He uses a formula that is developed by European Commission to measure exchange rate volatility. The results show that intraa-EC trade has substantially benefited from the diminished exchange rate risk.

It is also interesting to note that Dellas and Zilberford (1993) show that a positive effect of exchange rate volatility on trade has a theoretical basis. They claim that there can be no theoretical presumption that an increase in exchange rate volatility will effect the bilateral trade adversely.

They conclude that the effect of exchange rate volatility depends on the risk aversion parameter of the model.

3. EXCHANGE RATE VOLATILITY

In the literature, the world volatility takes a very specific meaning. "Volatility is the day to day, month to month variability of exchange rates, a variability that may have no trend to it" (Marston et.al. 1988, pp.83). In other words volatility is a high frequency concept referring to movements in the exchange rate over relatively short periods of time. But it is not only component of the variability. There is also another component of exchange rate variability which is called misalignment. Misalignment refers to longer-lasting movements of exchange rates. Williamson (1985) defines misalignment as a persistent departure of the exchange rate from its long run equilibrium. Misalignment refers to the capacity for an exchange rate to depart from its fundamentals over a longer period of time. Distinction between volatility and misalignment is important because there is evidence that the movements in exchange rate reflected in the volatility measures are unanticipated. So, trading firms must cope with uncertainty about exchange rates. That means international trade is affected by this kind of variability. In contrast to exchange rate volatility, misalignments are mostly anticipated and they undermine economic performance in several dimensions. They may generate adjustment cost, recession, deindustrialization, inflation and protectionism. In this paper, we are only concerned with the impact of high frequency movements of exchange rate, volatility, on bilateral trade.

Since 1973, collapsing fixed parity system, Bretton-Woods, and moving to flexible exchange rates, the nature of exchange rate variability has changed considerably. There is strong evidence that volatility is much greater under flexible rates than under fixed rates regimes. Before the collapse of the Bretton-Woods system, exchange rates were fixed at an official rate and adjustment took the form of infrequent discrete jumps in the level of exchange rates. After 1973, exchange rates were allowed to adjust more or less continuously in response to market forces. There was widespread surprise in the early years of floating at the size of the short-term fluctuations in exchange rates, but there were expected to diminish as markets learned to cope with rapid changing in market conditions. But volatility has not diminished (Kenen and Rodrik, 1986).

Various statistical measures of volatility have been used in the literature. These measures are standard deviation, deviation from trend, the difference between previous forward and current spot rates, Gini mean difference coefficient, and scale measure of variability. However, these all measures have their known shortcomings. Instead of using above measures of volatility, Autoregressive Conditional Heteroskedasticity (ARCH) type of models have often been used in the literature lately.

ARCH model first introduced by Engle (1982). Later, different extensions of the model such as Generalized ARCH, FACTOR ARCH, GARCH-M, Integrated GARCH etc., are introduced. Although Engle was mainly concerned with inflation, these kind of models are also often used in

the finance literature. ARCH type models have been very popular as a measure to capture the changes in variance in financial time series.

ARCH type models are non-linear and non-gaussian models.[2] A non-linear time series model is basically one in which an observation can not be expressed as a linear combination of current and past values of a series of independent random variables. Most time series models are based on the assumption of normality. Models for non-Gaussian observations are usually non-normal. Estimation of these kind of models are quite complex and requires more computer intensive techniques.

One of the most popular ARCH type model is GARCH models and developed by Bollerslev (1986). The dynamic properties of GARCH models with respect to variance are parallel to ARIMA models. Although ARCH model just allows for moving average component in the hetoreskedastic variance, GARCH procedure allows researcher to capture the time varying conditional variance as a parameter generated from a time series model of then exchange rate. Application of GARCH model to capture the conditional variance of real exchange rates is particularly interesting for the flexible exchange rate period. Since the post Bretton-Wood era has generated more volatile real exchange rates than the fixed exchange regime.

In this paper GARCH (1,1) specification is used to measure exchange rate volatility. GARCH(1,1) specification can be written as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \gamma_i Y_{t-i} + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i} + \varepsilon_t \qquad (1)$$

$$\varepsilon_t \,|\psi_{t-1} \square\, N(0, h_t)$$
$$h_t = \beta_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 h_{t-1} \qquad (2)$$

where Y_t is the variable under investigation and Y_{t-1} is the lagged value of Y_t. α's, γ's and β's are population parameters to be estimated. ε_t is real-valued discrete time stochastic process, ψ_{t-1} is the information set available at time t-1, and h_t is the conditional variance (in contrast to ARCH specification, inclusion of the lagged conditional variance into the model makes this specification GARCH). The following restrictions on β's must be hold

$$\beta_0 > 0, \beta_1 \geq 0, and\ \beta_2 \geq 0$$

[2] For more detailed explanation see Harvey, A. (ed.), Time Series, The International Library of Critical Writings in Econometrics.

In addition to these restrictions Bollerslev (1986) show that GARCH (1,1) is stationary if and only if the following restriction hold:

$$\beta_1 + \beta_2 < 1$$

In other words, the process is not stationary if the sum of the coefficients, excluding constant term, in the variance equation is equal or greater than unity.

After estimating the GARCH model presented in Equations 1 and 2, we can test for the ARCH effect using Lagrange multiplier test by estimating the following equation

$$\beta_1 + \beta_2 < 1$$

The appropriate test statistic is distributed Chi-squared with p degrees of freedom.

4. ECONOMETRIC MODEL

Export from Hong-Kong, Korea, and Singapore to the United States from 1980.1 to 1996.2 are examined to determine the effect of exchange rate volatility on the volume of bilateral trade. Following Pozo (1992), it is assumed that basic determinants of volume of export from each country to the U.S., in real terms, are U.S. industrial production index , exchange rates and a measure of exchange rate volatility. In mathematical form model can be expressed as

$$REXP_i = \beta_0 + \beta_1 USRIP_i + \beta_2 RER_i + \beta_3 VER_i + \xi_i \qquad (3)$$

where REXP is the volume of export in real terms and obtained by deflating the exports by each country's wholesale price index. USRIP is the index of U.S. real industrial production. RER is real exchange rate[2]. VER is exchange rate volatility and obtained by taking the square root of the conditional heteroskedastic variance, ht, from GARCH(1,1) specification. ξ is the error term, distributed identically and independently.

Before estimating the Equation 3 , we find the best fitting ARIMA (p,d,q)[3] model for each country's real exchange rates. After finding the best

[2] RER is obtained for each country by the following formula: RER=(ER*WPI)/(WPIUS) where WPI is wholesale price index.

[3] In ARIMA(p,d,q) notation p and q stand for the degree of autoregressive and moving average terms, respectively and d stands for the times of the differences of variable taken to obtain stationary variable. For example, if

fitting ARIMA processes, Equations 1 and 2 are estimated to obtain the conditional variances. As mentioned before, we obtain a measure for exchange rate volatility using these conditional variances. After these steps, export demand functions for each country in Equation 3 are estimated by least square estimation method (LSE). The results are presented in the following section.

5. RESULTS

Since the level variables are found to be non-stationary, we take first differences of the variable RER for each country. After taking the first differences, variables become stationary. Since first differences are stationary, d equals 1 for the each country. p and q values can be found after estimating the Equations 1 and 2. The results from the Equations (1) and (2) are presented in Table 1 and Table 2. In Equation 1, the number of autoregressive terms are 2 for Singapore, 1 for HongKong and 2 for Korea. And the number of moving average terms are 2, 1 and 2 forn Singapore, Hong-Kong and Korea, respectively. These values determine the best fitting ARIMA model. So, best fitting processes are ARIMA(2,1,1), ARIMA(1,1,1) and ARIMA(2,1,1) for Singapore, Hong-Kong and Korea, respectively. As can be seen from the Table 2, the findings reveal an ARCH effect in the exchange rate models.

After finding the best fitting ARIMA model, we derive the conditional variances to use as variable in Equation 3. Then square root of the conditional variances are used as the variable VER in Equation 3. The estimation results of the export demand functions are presented in the Table 3.

As can be expected, the coefficients of the variable USIP are positive and statistically significant for all cases. It means that an increase in industrial production of U.S. increases the export to the U.S. Similar to the USIP, the coefficients of RER are also positive. An increase in RER increases the volume of export. Because RER is defined as a domestic currency value of 1 U.S. dollar, an increase in RER means appreciation of the U.S. dollar.

---

d=o then the level variable is stationary. If d=1 then the variable is said to be integrated degree of 1 which means the variable becomes stationary after taking the first difference. For more detailed explanation see Harvey (1994).

Table 1. Estimation Results of Equation 1

	HONG-KONG	SINGAPORE	KOREA
DRERt-1	0.926 (14,76)*	-1.35 (-11.19)*	-0.234 (-3.16)**
DRERt-2	-	1,566 (11,754)*	-0.167 (-2.125)
Et-1	0.039 (0.38E-05)	0.506 (3.856)**	-0.584 (-10.61)*
Et-2	-	0.633 (4.586)*	0.441 (5.95)*
Costant	-192,66 (12,373)*	-0.2707 (-4.001)*	-0.8387 (-2.87)

Table 2. Estimation Results of Equation 2

	HONG-KONG	SINGAPORE	KOREA
E2t-1	0.5436 (2.33)	0.164 (3.25)**	0.135 (9.56)*
Ht-1	0.436 (2.24)	0.750 (13.32)*	0.534 (4.91)*
Constant	545.83 (1.34)	0.621 (0.61)	0.634 (2.87)
ARCH Test	16.28*	14.12*	22.10*

The values in the parenthesis are t-values.
* and ** stand for the significance levels at 1% and 5%, respectively.

Table 3. Estimation Results of Equation 3

	HONG-KONG	SINGAPORE	KOREA
USIP	8.58 (705)	0.3056 (13.7)	1.764 (52.76)
REXR	8.168 (1.62)	3.741 (9.39)	0.159 (4.02)
VER	-0.31 (-3.1)	-0.494 (-7.01)	-5.18 (-9.13)
Constant	-204.83 (-707)	141.15 (4.86)	-105.99 (-26.1)

6. CONCLUSION

This study supports the hypothesis that exchange rate volatility has a negative effect on the bilateral trade flows. Using monthly data from 1980 to 1996, it is found that there is a positive relationship between the volume of trade and

the industrial production index. A positive relationship also exists between the volume of trade and real exchange rate. On the other hand, an increase in the exchange rate volatility decreases the volume of trade.

REFERENCES

Arize, A.C., (1995). "The effects of exchange rate volatility on US exports: an empirical investigation." Southern Economic Journal 62, 34–43.

Bailey, M. J. , Tavlas, G.S. and Ulan, M. (1987). The impact of exchange rate volatility on export growth." Journal of Policy Modeling 9, pp. 225-244

Bollerslev, T., 1986, Generalized autoregressive conditional heteroskedasticity." Journal of Econometrics, 31. pp. 307-327

Caporale, T. and Doroodian, K., "Exchange rate variability and the flow of international trade." Economics Letters, 46, pp. 49-54.

Dellas, Harris and Ben-Zion Zilberfarb. 1993. "Real Exchange Rate Volatility and International Trade: A Reexamination of the Theory." Southern Economic Journal 59: 651-657. April.

Engle, R.F. 1982. "Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of UK Inflation." Econometrica 504: 987-1007

Gagnon, J.E. (1993). "Exchange rate variability and the level of international trade." Journal of International Economics, 34, pp. 269-287.

Hooper, P. and Kohlhagen, S.W. (1978). " The effects of floating exchange raten uncertainity on the prices and volume of international trade." Journal of International Economics, 8, pp.483-451.

Kenen, P. T.; Rodrik, D. (1986). "Measuring and Analyzing the E.ects of Short-term Volatility in Real Exchange Rates."Review of Economics and Statistics, 68, pp. 311-5.

Koray, F.; Lastrapes, W. D. (1989). "Real Exchange Rate Volatility and U.S. Bilateral Trade: A VAR Approach." Review of Economics and Statistics, 71, pp. 708-12.

Poso, S. (1992). "Conditional exchange rate variability and the volume of international trade:evidence from the early 1990s" Review of Economics and Statistics 74, pp.325-329.

Thursby, M.C. and Thursby, J.G. (1987). Bilateral trade flows, the Linder hypothesis, and exchange rate risk" Review of Economics and Statistics 69, pp. 488-495