E C O N O M I C S B U L L E T I N

Does the risk of exchange rate fluctuation really affect international trade flows between countries?

Chongcheul Cheong
Kyungpook National University

Abstract

This paper investigates the effect of exchange rate volatility on the UK's import trade. As part of econometric problems arising from a measured volatility, we consider a special case when an ARCH type auxiliary model is used to measure uncertainty in the exchange rate, and discuss a procedure for the correct inference of the OLS estimates of a primary equation in the second stage, which includes the generated variable. By applying this two−step approach, we find a statistically significant, negative impact of exchange rate uncertainty on Britain's imports.

I am grateful to associate editor, Raymond G Riezman, for his invaluable comments and suggestions, which substantially improved the quality of this paper.
Citation: Cheong, Chongcheul, (2004) "Does the risk of exchange rate fluctuation really affect international trade flows between countries?." *Economics Bulletin,* Vol. 6, No. 4 pp. 1−8
Submitted: February 24, 2004. **Accepted:** May 4, 2004.
URL: http://www.economicsbulletin.com/2004/volume6/EB−04F10002A.pdf

1. Introduction

Since the adoption of the floating exchange rate system in the early 1970s, there has been an extensive debate about the impact of exchange rate volatility on international trade. The theoretical literature shows that the effect may be positive or negative. However, despite a large body of the literature, few papers provide statistically convincing evidence on whether exchange rate volatility affects trade flows between countries (see McKenzie (1999) for a comprehensive survey of the literature).

A difficulty with this line of a study is in measuring unexpected fluctuation in exchange rates. Traditionally, several different measures have been used in the literature, e.g., variances or standard deviations, average of absolute changes, and deviations from trend. However, these approaches do not well capture the main feature of higher moments in the exchange rate, which can be characterized as non-constantly varied with clustering. In recent years, with the usefulness of ARCH type models in representing this kind of "volatility clustering" (see Bollerslev et al (1992) for a comprehensive survey), most empirical studies in this line routinely use the models to generate the volatility of exchange rates and estimate a structural equation in the second stage with conventional OLS technique, by replacing the variable of unobserved volatility with the measured proxy.

Pagan (1984), however, demonstrates that even though the application of the OLS method to this two-step procedure leads to consistent estimators, the estimated parameters do not have consistent covariance matrix and, as a result, are inefficient. That is, the standard errors of the OLS estimators are larger than those of conventional OLS estimators, due to the composite error term involving noises in the auxiliary equation used to generate the proxy of volatility in exchange rates. In this case, to have statistically reliable inferences, the non-spherical covariance matrix of the OLS estimates in the second stage should be adjusted by taking account of time dependence and heteroscedasticity in error terms. For this purpose, the methods proposed by White (1984) or Newey and West (1987) are directly applicable.

In the paper we reinvestigates the possible effect of the risk originated in exchange rate uncertainty on the UK's import trade. The main focus is to derive statistically valid OLS estimates with a generated variable of volatility, when an ARCH type model is used to measure risk in exchange rates. The paper is organized as follows. Section 2 describes the data used and how to measure the volatility of the exchange rate. Section 3 presents empirical results. Finally, conclusions are provided in Section 4 with an important implication for the UK's macroeconomic policy of whether the country should adopt the Euro.

2. Data descriptions and the measurement of exchange rate volatility

To investigate the impact of volatility in the exchange rate on trade, a conventional demand function for the import volume of the UK could be simplified as:

$$IM_t = f(RP_t, UY_t, H_t), \tag{1}$$

where IM_t denotes the real import volume; RP_t relative prices; UY_t the UK's income level; and H_t exchange rate volatility. It is expected that while an increase of income has a positive effect on import volume, an increase of relative prices negatively affects the UK imports. However, the effect of exchange rate volatility on trade is ambiguous, depending on the UK traders' attitude to risk in the exchange rate. If the traders are risk-neutral, uncertainty in exchange rates may be an additional opportunity to increase profits and thereby boosts overall trade flows. On the contrary, if the traders are risk-averse, the risk due to exchange rate uncertainty is an additional cost, which will tend to depress trade volumes. Furthermore, even though a relatively well-developed forward market is considered, the ambiguity of the effect of exchange rate volatility on trade is still remained, depending on the net currency position of the economy (see Viaene and de Vries (1992)).

In the study, we use monthly data from January 1974 to July 2000.[1] While the import volume index is used as the measure of import trade, the relative price variable is measured by the ratio of the import price index to the UK consumer price index (CPI).[2] As a proxy for the income level, the UK's industrial production index is used since this series is available on a monthly basis, while other measures, such as GDP or GNP, which are commonly used in empirical studies, are only available on a quarterly basis. Exchange rate volatility, however, is not directly observed. Given that volatility in exchange rates is generally characterized as the clustering of large shocks to conditional variance, a GARCH model is formulated to capture non-constant time varying conditional variance, and then the standard deviation obtained from the conditional variance is used as a proxy for exchange rate volatility. The underlying model is a GARCH (1,1) based on an autoregressive model of order 2 (*AR(2)*) of the first difference of the nominal effective exchange rate index in logarithm (ex_t), which takes the following form[3]

$$\Delta ex_t = \eta_0 + \eta_1 \Delta ex_{t-1} + \eta_2 \Delta ex_{t-2} + \varepsilon_t, \qquad \varepsilon_t \mid I_{t-1} \sim N(0, h_t^2),$$
$$h_t^2 = \rho_0 + \rho_1 \varepsilon_{t-1}^2 + \rho_2 h_{t-1}^2. \tag{2}$$

The estimated equation is:

$$\begin{aligned} \Delta ex_t &= \underset{(0.0008)}{0.0003} + \underset{(0.06)}{0.41} \Delta ex_{t-1} - \underset{(0.06)}{0.11} \Delta ex_{t-2} \\ h_t^2 &= \underset{(0.000007)}{0.00006} + \underset{(0.07)}{0.26} \varepsilon_{t-1}^2 + \underset{(0.05)}{0.56} h_{t-1}^2 , \end{aligned} \tag{3}$$

where the values in parentheses represent standard errors. Except the constant term in the *AR(2)*, all the coefficients in equation (3) are statistically significant at the 5% significance levels. The coefficients of ρ_0, ρ_1, and ρ_2 exceed zero, and $\rho_1 + \rho_2 = 0.82 < 1$. These results ensure that the conditional variance is strictly positive, satisfying the necessary conditions of equation (2). Overall, the estimated model seems to appropriately capture the underlying data generation process, and thus is used to generate exchange rate volatility in equation (1).[4]

3. The effect of exchange rate volatility on trade volume

Since the main purpose of this study is to deliver statistically reliable evidence on the impact of exchange rate volatility on trade, information on data, such as nonstationarity and cointegration, is utilized to adequately approximate the data generation process during the

[1] All the indices used in this study are based on 1995 = 100 and were obtained from *the UK National Statistics*. For details on the construction of the indices, see the UK National Statistics website (www.statistics.gov.uk).

[2] Alternatively, the relative price measure can be respecified by decomposing it into the domestic price level, the foreign price level, and the nominal exchange rate, in order to separately capture the effects of changes in "deep" parameters.

[3] West et al (1993) show that GARCH (1,1) relatively performs better than other alternative ARCH-type models.

[4] See Holly (1995) who provides the strong evidence of GARCH (1,1) even at the quarterly frequency of the same data.

sample period in question. For this, a parsimonious, data-based dynamic model is formulated by applying the general-to-specific modeling approach suggested by Hendry (1995).

For analysis, all variables were transformed into logarithms. Lower case letters denote the logs of the corresponding capitals in equation (1). For the variables of im_t and uy_t, seasonally adjusted series were used, but, for rp_t and h_t , unadjusted data were used since a preliminary investigation does not show any seasonal fluctuations in the data. To examine the non-stationarity of the data, we first conducted augmented Dickey-Fuller (ADF) tests (Dickey and Fuller, 1979). With an initial maximum lag of twelve, the auxiliary lags were selected on the basis of the Akaike Information Criterion (AIC). For the variables of levels, the testing equation included an intercept and a linear trend, whereas in the case of the differenced variables only an intercept was included. The test results reported in Table 1 indicate that im_t and rp_t are integrated with *I(1)*, but uy_t and h_t appear to be *I(0)* at the 5% levels. However, based on the Schwarz Bayesian Criterion (SBC), uy_t is integrated with order one at the 5% level (not reported to save space). Considering the weak testing power of the ADF test, we assume that all variables are *I(1),* except h_t which clearly seems to be *I(0).*

To examine whether the relevant variables are cointegrated, the maximum likelihood testing procedure suggested by Johansen (1988) was applied with the treatment of h_t as *I(1),* even though some caveats might be applied. In an initial 12th –order vector autoregressive (VAR) model with a constant term but no trend, three lags were selected for the test on the basis of the AIC criterion. The intercept term was not restricted to lie in the cointegration space. The standard statistics of the Johansen test reported in Table 2 show that both the maximum eigenvalue and trace statistics strongly reject the null of no cointegration in favour of at least one cointegrating relationship, and little evidence exists for more than one.

Engle and Granger (1987) suggest that if data are non-stationary but cointegrated, a useful econometric model for these time series is an error correction model (ECM). Following this suggestion, we use an unrestricted single equation-based ECM which is equivalent to an second-order autoregressive distributed lag (ADL) model, under the assumption that the variables of rp_t, uy_t, and h_t are weakly exogenous:[5]

$$\begin{aligned}\Delta im_t &= c_0 + \sum_{i=1}^{1} c_{1i}\Delta im_{t-i} + \sum_{i=0}^{1} c_{2i}\Delta rp_{t-i} + \sum_{i=0}^{1} c_{3i}\Delta uy_{t-i} + \sum_{i=0}^{1} c_{4i}\Delta h_{t-i} \\ &\quad + c_5 im_{t-1} + c_6 rp_{t-1} + c_7 uy_{t-1} + c_8 h_{t-1} + u_t.\end{aligned} \tag{4}$$

For the level terms, a statistically identified equation in the cointegrating space could be used in a restricted way, but here we estimate the terms unrestrictedly in order to fully utilize the underlying data information (see Hendry (1995)).

The initial estimation shows that most of the coefficients are not easily interpretable and statistically insignificant. Since the over-parameterisation of the unrestricted model may capture accidental features of the sample, we sequentially simplified the model by eliminating insignificant parameters to reduce the sample dependence of the model. A finally derived model is

[5] See Engle et al (1983) for a detailed explanation on weak exogeneity.

$\Delta im_t =$	- 0.42	$- 0.41\,\Delta im_{t-1}$	$+ 0.37\,\Delta uy_t$	$+0.48\,\Delta uy_{t-1}$	$- 0.09\, im_{t-1}$
	(0.23)	(0.05)	(0.17)	(0.17)	(0.03)
	[0.19]	[0.05]	[0.17]	[0.14]	[0.03]
	$+0.19\, uy_{t-1}$	$- 0.07\, rp_{t-1}$	$- 0.39\, h_{t-1}$		
	(0.07)	(0.03)	(0.50)		
	[0.07]	[0.02]	[0.13]		(5)

$R^2 = 0.25$, $\hat{\sigma} = 0.04$, $DW = 2.19$, $F_{AR}(12{,}294) = 2.95$, $F_{ARCH}(12{,}294) = 2.54$, $\chi^2_N(2) = 14.01$, $F_{RESET}(1{,}305) = 0.03$, $F_H(1{,}312) = 0.86$, ( ) standard errors; and [ ] standard errors adjusted by the White (1984) method.

The estimated coefficients are statistically significant, except the measure of exchange rate volatility. The statistical insignificance of the variable might be caused by the direct OLS estimation of (5) with the generated regressor of volatility. As examined in Pagan (1984), since a GARCH model was used to measure the volatility variable, the initial OLS parameters reported in (5) would be consistent but have large standard errors, because of the composite error that involves noises in the GARCH auxiliary equation. To correct the latter problem, the White (1984) method was applied with 8 bandwidth parameters.[6] The adjusted standard errors reported in equation (5) show that the statistical efficiency of the OLS estimators was much improved. Particularly, the case of exchange rate volatility is dramatic. The coefficient of the generated regressor becomes statistically significant at the conventional 5% level. For the robust results, 6 and 7 bandwidths were used, but no difference was found.

The empirical results indicate that the short-run changes in imports are mainly affected by the UK's income level. There are no impact effects from prices and exchange rate volatility in the short-run. This seems to reflect the stickiness of import contracts. The measured feedback coefficient, – 0.09, has an expected sign with statistically significance, but indicates a slow adjustment to the past disequilibrium in import trade volumes. Although the short-run parameters are the subject of economic theory considerations in relation to the time form responses and speed of adjustment, these may not be the major concern related to the theoretical hypotheses characterizing the relationships between variables in equilibrium. By setting all changes in the short-run to zero, a long-run static equation of (5) is obtained:

$$im_t = -4.67 + 2.11uy_t - 0.78rp_t - 4.33h_t \ .$$

As expected, the relative price level negatively affects import trade in the long run, while the income level has a positive effect. The long-run coefficient of the volatility measure, which is our major concern in this study, shows a negative sign. This evidence supports the theoretical view of the negative effect of exchange rate volatility on international trade and is contrasted to Holly (1995) who finds the positive effect using the UK's export data.

4. Conclusions

In this paper, we have investigated a possible effect of risk in exchange rates on import trade in the UK. To examine this issue, we applied a dynamic modelling approach and made an effort to find statistically valid evidence by considering the non-spherical covariance matrix

[6] White (1984) suggests choosing the bandwidth parameter to grow more slowly than $T^{1/3}$. Alternatively, the spectral-based procedure proposed by Newey and West (1987) can be applied.

of the OLS estimates in the second stage with a generated variable of volatility. The empirical results show that uncertainty in exchange rates negatively affects international trade in the case of the UK and, more importantly, the effect is statistically significant. The latter finding may provide an answer on the puzzle of why most previous studies in this line have not found statistically convincing results, and highlights the importance of applying an appropriate econometric technique.

One of the important rationales in using a single currency in a specific region is that it may eliminate exchange rate uncertainty, encourage trade across borders, and, consequently, increase the economic growth and welfare of member countries (see, for examples, Frankel and Rose (2002) and Glick and Rose (2002)). Currently, one of the controversial economic policies facing Britain is whether the country should join the European Economic and Monetary Union (EMU) and adopt the Euro. An implication of our finding to UK's macroeconomic policy is that if the country adopts the Euro, there will be a positive impact on the UK's trade and economic performance with reduced exchange rate volatility, even though the overall benefits will be partial because there still remains uncertainty on the euro/dollar exchange rate.

A caveat must be mentioned. In this study we only focused on the case of imports. For a systematic analysis, however, it would be desirable to look at the cases of imports and exports simultaneously, thus checking whether the effect of uncertainty in exchange rates on both sides is symmetric. This issue could be another direction for future research.

REFERENCES

Bollerslev, T., R. Y. Chou, and K. F. Kroner (1992) "ARCH modelling in finance: a review of the theory and empirical evidence" *Journal of Econometrics* 52, 5-59.

Dickey, D. A. and W. A. Fuller (1979) "Distribution of the estimators for autoregressive time series with a unit root" *Journal of the American Statistical Association* 74, 427-431.

Engle, R. F. and C. W. J. Granger (1987) "Co-integration and error correction: Representation, estimation and testing" *Econometrica* 55, 251-276.

Engle, R. F., D. F. Hendry and J.-F. Richard (1983) "Exogeneity" *Econometrica* 51, 277-304.

Frankel, J. and A. Rose (2002) "An estimate of the effect of common currencies on trade and income" *Quarterly Journal of Economics* 117, 437-466.

Glick, R. and A. Rose (2002) "Does a currency union affect trade? The times-series evidence" *European Economic Review* 46, 1125-1151.

Hendry, D. F. (1995) *Dynamic econometrics,* Oxford, U.K: Oxford University Press.

Holly, S. (1995) "Exchange rate uncertainty and export performance: supply and demand effects" *Scottish Journal of Political Economy* 42, 381-391.

Johansen, S. (1988) "Statistical analysis of cointegration vectors" *Journal of Economic Dynamics and Control* 12, 231-254.

McKenzie, M. D. (1999) "The impact of exchange rate volatility of international trade flows" *Journal of Economic Survey* 13, 71-106.

Newey, W. K. and K. D. West (1987) "A simple positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix" *Econometrica* 55, 703-708.

Pagan, A. R. (1984) "Econometric issues in the analysis of regressions with generated regressors" *International Economic Review* 25, 221-247

Viaene, J. M. and C. G. de Vries (1992) "International trade and volatility" *European Economic Review* 36, 1311-1321.

West, K. D., H. J. Edison and D. Cho (1993) "A utility based comparison of some models of exchange rate volatility" *Journal of International Economics* 35, 23-45.
White, H. (1984) *Asymptotic theory for econometricians*, Academic Press, New York.

TABLES

Table 1: Augmented Dickey-Fuller test statistics

Variables	im_t	rp_t	uy_t	h_t
t-value	- 2.08 (5)	- 3.34 (12)	- 3.50 (8)	- 5.94 (6)
Variables	Δim_t	Δrp_t	Δuy_t	
t-value	- 10.46 (4)	- 4.75 (12)	- 5.22 (8)	

Notes: (1) The critical values of the ADF test are –3.43 for the level variables and –2.87 for the differenced ones, at the 5% levels, respectively. (2) The selected lags are in parentheses.

Table 2: Cointegration analysis

Eigenvalues	0.12	0.04	0.03	0.002
Hypothesis	$\gamma = 0$	γ 1	γ 2	γ 3
Max statistic	38.72	11.79	9.85	0.72
95% c.v.	27.42	21.12	14.88	8.07
Trace statistic	61.08	22.35	10.57	0.72
95% c.v.	48.88	31.54	17.86	8.07

Note: γ indicates the number of cointegrating vectors.

Figure 1. Plot of the volatility measured by the GARCH model.