Sectoral analysis of Real Exchange Rate Risk on Taiwan's Export: A Rational-Expectations Multivariate GARCH-M Approach

Since the beginning of the generalized floating exchange rate regime in 1973, both real and nominal exchange rates have undergone substantial volatility for developed and developing countries. One of the most debated issues for policy makers and researchers to investigate has been the impact of increased exchange rate volatility on international trade. The conventional argument is that exchange rate fluctuations appear to increase the risk and uncertainty in international transaction, therefore, the imposed cost burden directly reduce the benefit of international trades, hence depress the volume of trade for risk-averse market participants. Indirectly, unanticipated exchange rate variations may induce the structural changes and shifts the marginal producers and traders to non-traded goods in order to isolate themselves from exchanges rate risk. This argument implicitly assume (1) the trader bear all the undiversified exchange rate risk which decrease the risk-adjusted profitability of international trade; (2) the forward exchange rate market which can eliminate the exchange rate risk for the traders is incomplete, expensive or not fully utilized (Sercu, 1992)[1]. Bahmani-Oskooee and Payesteh (1993), Caballero and Corbo (1989), Caporale and Doroodian (1994), Cushman(1983, 1986), Chowdhury (1993), Kenen and Rodrik (1986), Kumar and Dhawan (1991), Pozo (1992), Thursby and Thursby (1987) provide the evidence in support of this view. On the other hand, the belief that exchange rate volatility

---

[1] Even forward exchange rate market exists, the hedging is both a limited and costly way to avoid the exchange rate risk. This may be due, for instance, to (1) the brokerage cost for forward transaction reduces the amount of hedging. (2) institutional regulations that the size and timing of cover offered is limited for trading firms. (3) the forward market might not be complete, particular for the smaller less developed countries (LDCs). (4) the forward rate might be a poor predictor for the future spot rate.

unambiguously reduces the level of trade is challenged by recent literatures. Dellas and Zilberfarb (19933, Franke (1992), Giovannini (1988) and Sercu and Vanhulle (1992) have show that exchange rate volatility may stimulate trade. Many studies considered trade is essentially regarded as an option held by firms. The profit opportunities of an experienced trader with specialized knowledge on the option could offset the risk of exchange rate variability. Franke etl (1992) has stressed that exporter will evaluate the cost to terminate the business associated with abandoning a foreign market against losses created by export. Therefore, it suggests that exchange rate volatility benefits international trade by arguing that the average firm will enter sooner, and exit later if exchange rate volatility rises sufficiently. As such, the number of trading firms will increase as exchange rate volatility rises, and hence international trade will increase. Moreover, De Grauwe (1988) has argued that the increased exchange rate volatility might stimulate the trade volume in the case that the income effect dominates the substitution effect of resource shifted away from the traded-good sector. He suggests the effect of exchange rate volatility on trade depend on the degree of risk aversion. A sufficiently risk aversion exporter may export more to compensate the drop in expected utility of export revenue caused by the increased higher exchange rate volatility. On the contrast of above two extreme propositions, there are numbers of empirical studies fail to establish a systematically significant link between measured exchange rate variability and the volume of international trade, including Assery and Peel (1991), Bahmani-Oskooee (1991), Bailey st al (1986, 1987), Hooper and Kohlhagen (1978), IMF (1984), Gagnon (1993), Gotur (1985), Koray and Lastrpapes (1989), and Medhora (1990). In summary, the previous empirical studies provide conflicting evidence on the effects of volatility on trade.

An important issue is how the export trader formulates the expected exchange rate and risk measures into international trade considerations. Economic agents live in an uncertain world and used to make decisions by rationality based on the time that data is available, as well as generate the forecasts according to the process used to identify the information set. While most literatures suggested rational expectation hypothesis (REH) have more credibility to form the mean of the price expectations than the other alternative approaches, the price uncertainty associated with the expectations, has recently emerged as an important issue. A more general model of extending the REH related to our studies is to concern not only at how the expected exchange rate is likely to affect the decisions at each point in time, but also how the uncertainty associated with expectations for the future affects the current supply decisions. In contrast with current studies focus on the linkage of realized exchange rates to the export volume, this paper attempts to fill the gap by concentrating upon the effects of the expected real exchange rate and risk on the export decisions. This is more consistent with the decision formulation process, because traders make the trade decisions according to their subjective expectation of future exchange rate and risk at the time point that data is available.

The traditional methods for measuring and predicting the exchange rate risk has many problems[2] and do not adequately represent the exchange rate movements. In

[2] The various measures that have often been used for the proxy of exchange rate volatility include average of absolute changes, standard deviation, deviations from trend, the moving standard deviation of percentage changes … etc in the exchange rate. Each of these measures has advantage and drawbacks. (Brodsky (1984), Lanyi and Suss (1982))

this research, we adopt what is perhaps a superior measure of the time varying risk premium: conditioal variance by using Bollerslev's (1986) GARCH (Generalized Autoregressive Conditional Heterscedasticity) model, allows for persistence in conditional variance and leptokurtosis in unconditional distribution, reconciling the empirical findings of exchange rate movements. GARCH process is used as a vehicle in our studies to generated the subjective expectations about the mean and variance of exchange rate and incorporated into the trade supply equation.

Besides the inappropriate measure of the exchange rate risk, the common weakness in most previous studies on the empirical estimation of the relationship between exchange rate risk and international trade has been concluded by a series of methodological problems that might lead to imprecise statistical results. The commonly observed problems include 1) Most studies focus on the effect of aggregate trade flows, which constraint the relevant variables such as income, exchange rate, and exchange rate risk bear the same response across different sectors and destination markets. The aggregation bias might be serious because the trade decisions is reacted diversely toward the different nature of geographical and sectoral exports (Lorenzo, 1991). For example, some industries like agricultural, compared with manufactured goods, maybe more sensitive to exchange rate risk (Maskus, 1986); In addition, the exporters might exposure to different degree of exchange rate risk and thus have different contract considerations while faced the exports to less developed countries or central planned economy. Moreover, most applied work on this topic, due largely the data limitations, adopts the lower frequency series such as quarterly or yearly data to examine the trade and risk relationship. It is not appropriate because lower frequency data might not be able to precisely reflect the timing of order/deliver lag and risk response on the modern international trade, especially for the highly prompt information and technology industry. 2) Most empirical works on this topic have implicitly assumed that the data used is stationary; nonetheless, most related macroeconomic data, such as export volume, income, exchange rate etc, do not necessarily have this desirable time-series properties in their levels. The traditional statistical tests used for the inference is no longer valid if the long run equilibrium relationship do not exist among variables. 3) Very little attention has been paid on the dynamic specification of the trade structural equations. Most studies only consider the contemporaneous or lagged one period effect of the independent variables on the trade decisions without further investigating any longer lagged response of the endogenous or exogenous variables, which has important implications to reflect the essential different contract periods among different industries[3]. In addition, the past researchers have typically used the two-step estimation procedures without imposing the cross equations restrictions between the structural trade and the generated exchange rate risk equations, and so have encountered "generated regressors" problem (Pagan, 1984). Moreover, Even the recently research has exclusively relied on the contemporary time-varying variance ARCH (GARCH) model to generate the risk premium, the movements of exchange rate and international trade has mostly been ignored. It has generally been predicted that both should be correlated with each other, implying that the covariance is not constant. It is a serious potential mistake to ignore the time varying covariance into considerations (Holt and Aradhyula, 1998). Indeed, unless the model specifications and

[3] For example, it is generally longer contract period for manufactured trade than for most agricultural products because most agricultural market are considered more price flexible than manufactured goods market (Anderson and Garcia, 1989).

statistical approach have been critically considered, the empirical result might be misleading and erroneous.

In contract with the deficiency of the previous studies on this topic, a number of contributions of this paper has been made as follows. First, all the export data examined in this study are disaggregated into monthly series by sectors and destination markets, which contains more information and could better analyze the impact of exchange rate volatility among different sectors and markets destinations. Second, the stationary properties of each relevant variable are examined by employing the unit root test. The logarithmic first difference is conducted for the variables contain unit root, in the case that the cointegrations relationship does not established among the relevant non-stationary variables. Third, to avoid the inference problem, the conditional mean and variance generated from the GARCH model are substituted into the trade equation as regressors and the trade, expected exchange rate, and expected exchange rate volatility equations are jointly estimated together, which is an improvement over traditional two-step iterations. A multivariate GARCH-M model under the REH framework is adopted to allow for time varying variance and covariance, which has not been considered previously. Furthermore, The dynamic model specifications has been extensively examined by a systematical model selections approach and paid more attention on the model diagnostic tests, such as higher order autocorrelations, simultaneous equation bias, heteroskedasticity and non-normal residuals. Fourth, Instead of concentration on the impacts of "realized" exchange rate and associated risk, our model focus on the rational expectations of both the conditional mean and variance of exchange rate, which is more relevant to behavior of economy agent on the evaluation of the trade decisions process.

Fifth, while most empirical studies have concentrate on the experience of industrialized countries, this paper, we attempted to investigate the case of Taiwan, one of the newly industrialized countries (NIC), which have undergone remarkably export growth in the last decades. The relationship of the increased exchange rate variability and export to Taiwan's major trading partners is examined, including United State, German and Japan. The reminder of the paper is as follows: Section 2 discusses the model and related analysis. Section 3 presents the empirical results. A conclusions and summary are provided in section 4.

The Model

Exchange rate expectations and risk measures

Export supply is characterized by a lag between the contract that has been signed and the products are actually delivered. As a result, how the accuracy of exchange rates movement prediction by the trader plays an important role on the quantity supply. Most traders form expectation rationally. Economists have a variety of tools and scheme used to identify expectations models, including naive expectations, adaptive expectations, autoregressive moving-average (ARMA) process, future price, etc. A number of literatures support the belief that ARMA specifications are essentially equivalent to rational expectations and are empirically easier to implement (Feige and Pearce 1976, Nerlove, Grether, and Carvalho, Wallis 1979).

While ARMA model are recognize to form the exchange rate expectation well, the exchange rate uncertainty emerges as another important central issue in the export supply decisions. In econometric analysis, exchange rate uncertainty is commonly approximated by exchange rate variability, was mostly obtained by computing the sample standard deviation or moving standard deviation of percentage changes. The traditional procedures employed to measure the risk variables has been criticized for a) the computation is ad hoc on the arbitrary choice of the order of the moving average process; b) lacks a parametric way to model the time-varying risk variable; c) do not make optimal use of the relevant information from the exchange rate data generating process; and d) understate the effect of the variability due to the nonormal properties of exchange rate changes[4] (Arize 1997).

Most recently, a growing body of literature has reported evidence that short run exchange rate changes exhibit volatility clustering, implying the variance is varying over time rather than constant. In contrast to the shortcomings of traditional exchange rate risk measure, the contemporary GARCH model not only allows the variance varying systematically over time, but characterizes frequently observed leptokurtosis (heavy tails) in unconditional distribution (Hsieh 1989, Baillie and Bollerslev ,1989 and 1990) and also appealing parameterizes the conditional variance dynamic, which contains more information about the exchange rate behavior and is more relevance to rational economic agents planning their behavior, thus becoming an increasing popular and superior measure of the time varying risk premium. This alternative measure of volatility is used to generate the exchange rate risk associated with the expected exchange rate in our econometric model. In our model, the exchange rate mean equation is presented by a univariate ARMA(m,n) process and the conditional variance is specified as the linear combination of past squared innovations and past value of conditional variance. Both

[4] Exchange rate changes appear to be leptokurtic (heavy tails) in their distribution, see Westerfield (1977), McFarland, Pettit and Sung (1982), Diebold and Nerlove (1986) Bagshaw and Humpage (1986) MilhNj (1987) and Baillie and Bollerslev(1987).

expectations of mean and variance of real exchange rate are formed rationally based on the information set on each time point. Equation (1)-(4) below report the GARCH(1,1)[5] specification used in this paper:

$$\Phi_m(L)\ DLRX_t = \mu + \Phi_n(L)\ \varepsilon 1_t \qquad (1)$$

$$\varepsilon 1_t \mid \varphi_{t-1} - N(0, h_t) \qquad (2)$$

$$\varepsilon 1_t = z_t \sqrt{h_t} \qquad (3)$$

$$E(\varepsilon 1_t^2 \mid \varphi_{t-1}) = h_t = w_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-1}^2 + \sum_{i=1}^{p} \beta_i h_{t-i} \qquad (4)$$

α

Where $DLRX_t$ is the first difference in the natural logarithm real exchange rate with respect to the previous period, implying the changes in the real exchange rate between month t and t-1. L represents a polynomial lag operator. Since the real exchange rates (REX) in our analysis all exhibit stochastic trend in their level, the first difference of natural logarithm is performed on the real exchange rate (RX) to achieve stationary properties. The real exchange rate (RX) is defined as E * ($P_{foreign}$ / P_{Taiwan}) , where E is the Taiwan nominal exchange rate with respect to the foreign dollar (for example, NT$/US$) and $P_{foreign}$ and P_{Taiwan} stand for the foreign and Taiwan WPI, respectively[6]. The coefficients, w_0 > 0 and α_i and β_i ≥0 to ensure strictly positive conditional variance. $\varepsilon 1_t$ represents the residuals from equation (1), and are a function of the independent and identically distributed z_t, which have zero mean and unit variance, and of the variance, h_t, conditional on the information set φ_{t-1} available at time t-1.

Export Supply Equation

---

[5] The GARCH(1,1) specification we employ is generally excellent for a wide range of financial data (Bollerslev, Chou, and Kroner, 1992).

[6] Some literatures have suggested that using the domestic price index (CPI) as a proxy for nontradeable price, and a foreign whole sale price (WPI) as a proxy for the tradeable good. (Harberger 1986)

Equation (1) to (4) demonstrate how the GARCH model could be used to construct as measures of expected exchange rate and associated uncertainty, and its use as explanatory variables provides the mean for testing the hypothesis that the amount of uncertainty associated with the expectations for the future affects current export decisions. To complete the model, the export supply model needs to be determined. Following the general consensus in the literature that there is a long run relationship between export supply, the level of economic activity, real exchange rate and a measure of exchange rate risk. Assuming linearity the structural model is specified as:

$$\mathrm{Ln}(\mathrm{Q}_{\mathrm{ij,t}}) = \sum_{k=1}^{k1} \delta_{1k} \ln(\mathrm{IP}_{\mathrm{i,t-k}}) + \sum_{k=1}^{k2} \delta_{2k} \ln(\mathrm{RX}^{e}_{\mathrm{ij,\,t-k}}) + \sum_{k=1}^{k3} \delta_{3k} \ln(\mathrm{RX}^{v}_{\mathrm{ij,\,t-k}}) + \delta_4 \mathrm{T} + \sum_{k=1}^{k5} \delta_{5k} \mathrm{D}_{\mathrm{k}} + \sum_{k=1}^{k6} \delta_{6k} \ln(\mathrm{Q}_{\mathrm{ij,t-k}}) + \varepsilon 2_{ij,t} \quad (5)$$

Where $Q_{ij,t}$ is the export volume (the export value deflated by the export price index by specific industry) of industry i to the trading partner j, in time t. $IP_{j,t}$ is the industrial production of the importing country j in time t. $RX^{e}_{ij,t}$ is the Taiwan expected real exchange rates with respect to the currency of importing country j for the industry i in time t. $RX^{v}_{ij,t}$ is the computed real exchange rate volatility estimated by GARCH process for the industry i to the exporting country j in time t. T is the time trend, used to capture an up/downward trend of the export volume, commonly observed for the technology changes or depressed industry. The monthly dummies, D, are adopted to eliminate the monthly effects for period t with 1 and zero elsewhere. Finally, lagged export volume was included in the specification to reflect the adjustment of export amount to the desired level viewed by the exporter from previous period. $\varepsilon 2_{ij,t}$ indicates random error term with Gauss-Markov properties. All the variables except the time trend and dummy variables are all taken as the natural logarithm form, representing a constant elasticity structure. The specification of the exogenous variables is allowed up to 12 lagged values to reflect the order/delivery lags and expectations. In contrast with the previous studies paid less attention on the dynamic structure of the model employed, our specification is based on a systematic model selection procedure in which the variety of lag models were examined. Starting with the longest lagged variables, the statistically insignificant variables are eliminated step by step, unless the elimination introduced serial correlation. Next, we narrowed the pool of possible models to those having a p-value for the Ljung-Box portmanteau Q(12) statistic of greater than 0.3, a reasonable level selected to support the white noise assumption. Finally, we chose the specification having the lowest Schwarz Bayesian criterion (SBC) value from among the candidate models having passed the Q(10) screens. In other words, the Ljung-Box Q statistic was used to identify a few possible models and then the information criterion (SBC) selected the most parsimonious specification with the optimal lag for the export supply equation.

Estimation Framework

In our model, GARCH model in which a time-dependent conditional mean (equation 1) and variance (equation 4) are estimated as a proxy for expected exchange rate level and volatility. While the generated mean and variance of real exchange rate could be used to substitute into the export supply in equation (5), several estimation problems arise. Pagan and Ullah (1988) pointed that the resulting parameter estimates will be inconsistent if standard OLS procedure is used. Pagan (1984) claims the estimation of a structural model could lead to biased estimates of the parameters' standard errors while the instruments generated from a stochastic model are directly substituted into the structural equation. To account for the so-called "generated regressors" problem infrequently dealt with the applied work, the parameters of the conditional mean, and time varying conditional variance equations are simultaneously estimated with the structural trade equation by using a FIML (Full Information Maximum Likelihood) method to achieve the efficiency. Specifically, our model is closely related to the multivariate GARCH model described by Bollerslev (1990) and ARCH-M model by Engle, Lilien, and Robins (1987) and is a type of rational expectations model include both first and second moment of exogenous variables in the structural equations.

The bivariate GARCH-M system employed in our studies allows for the time varying conditional variance and covariance, an important considerations in rational expectation with risk terms, but assumes the conditional correlation (ρ) between any two conditional variance is constant through time. Although the correlation could be in general time varying, the constant assumption is appealing to simplify the computation and inference procedure and has been proved reasonable in many applications (XXX Bollerslevs 1990, Bollerslev, Engle, and Wooldridge 1988, Engle, Ng and Rothschild 1990xxx). The time varying covariance is taken as the proportional to the square root of the product of the corresponding two conditional variance. Specifically, following the equation (1) to (5), $\varepsilon 1_t$ are assumed to follow the GARCH process of the real exchange rate changes in equation (1) with the conditional variance h_t; and, $\varepsilon 2_t$ are the error terms from export supply equation in equation (5) with constant variance σ_{22}. Under certain regularity[7], both series are jointly distributed with the multivariate normal distribution with zero mean and the time-varying variance-covariance matrix H_t. The system could be described as:

$$\hat{\varepsilon}_t = \begin{bmatrix} \varepsilon 1_t \\ \varepsilon 2_t \end{bmatrix} \quad (6)$$

$$\hat{\varepsilon}_t \mid \varphi_{t-1} \sim N(0, H_t) \quad (7)$$

$$H_t = \begin{bmatrix} h_t & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix} \quad (8)$$

$$\sigma_{12} = \sigma_{21} = \rho \sqrt{(h_t \sigma_{22})} \quad (9)$$

Where ρ is a time invariant scalar between -1 and 1; ρ and σ_{22} are the parameters need to be estimated in the system. With the above assumption, Eq. (1), (4) and (5) are simultaneously estimated by nonlinear estimation routine such as Brendt, Hall, Hall, and Hausman (BHHH) algorithm and Newton algorithm using Gauss Constraint Maximum Likelihood (CML) module. Let θ denotes all the unknown parameters in $\hat{\varepsilon}_t$ and H_t. Under standard regularity conditions the maximum likelihood (ML) estimators for θ are consistent and asymptotically efficient and the usual statistics holds. The log-likelihood function for the general heteroskedasticity model becomes:

$$L(\theta) = -\frac{TN}{2} \log 2\tau - \frac{1}{2} \sum_{i=1}^{T} (\log | H_t | + \hat{\varepsilon}_t' H_t^{-1} \hat{\varepsilon}_t)$$

[7] Bollerslev and Wooldridge (1989) and Weiss (1986) documented that, under the situation that the normality assumption is violated, the quasi-maximum likelihood estimation will still be consistent and asymptotically normal, if the first two moment are correctly specified.

Estimation Results

Data Description

Nine sectoral categories of goods toward three major trading partners is used to examine the extent that real exchange rate volatility affected the export volume. The classification of sectoral categories, corresponding to SCC code (The Standard Classification of Commodities of the Republic of China), is defined by "*Commodity-Price Statistics Monthly in Taiwan Area of the Republic of China*". The disaggregated export value data is generated from the tape of "*Monthly Statistics of Exports and Imports, Republic of China*", which allows the reconstruction of Taiwan's export value toward to the specific industry and country. The nine export categories include 1)Animal, Vegetable Products & Prepared Foods; 2) Textiles & Textile Articles; 3)Wood, Paper, Pulp & Articles; 4) Chemicals, Plastics, Rubber & Articles; 5) Primary Metals & Articles; Machinery, 6) Optical & Precision Instruments; 7) Electronic Machinery and 8) Transportation Eq. & Parts. The importing countries examined in our studies include the United State, Japan and German, covering the monthly series from 1989 to 1998. Export volume for each category is constructed as the ratio of NT-denominated export value to the export price, where the export price for each category is taken from "*Commodity-Price Statistics Monthly in Taiwan Area of the Republic of China*". All other data in this study including industrial production, nominal exchange rate, and whole sale price index are obtained from the International Monetary Fund Economic Information System (IMFEIS) and Taiwan AREMOS system.

The results of Regressions

Table 1. United States.

Variables/lag	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export supply equation parameters								
Constant	402.079	339.329	1497.162	0.004	712.719	-632.491	1341.948	14.191
	(334.678)	(328.111)	(2631.174)	(0.013)	(2067.552)	(132.979)	(252.749)	(42.631)
Lnip								
0								
1	10.817							
	(5.963)							
2				0.097	4.310	11.091	16.914	7.372
				(1.169)	(7.942)	(3.099)	(3.690)	(1.021)
3		-15.125	-34.738					
		(3.285)	(5.452)					
$lnRx^e$								
0								
1	28.815				10.505	6.501		
	(9.849)				(8.778)	(4.285)		
2								
3			32.186	8.932				2.947
			(9.453)	(8.133)				(0.641)
4								
5		31.428						
		(9.250)						
6							25.084	
							(6.667)	
$lnRx^v$								
0								
1	-240.114				-154.696	-0.676		
	(25.331)				(252.455)	(0.557)		
2								
3			-121.912	-31.135				-45.371
			(329.243)	(34.338)				(2.191)
4								
5		-62.952						
		(11.278)						

6							-338.608	
							(22.789)	
Q1	-7.596	-17.086	-9.840	1.749	-0.463	-0.462	-7.138	0.734
	(5.886)	(3.984)	(4.848)	(2.416)	(4.705)	(2.975)	(2.663)	(2.709)
Q2	15.297	-2.968	7.896	8.658	11.740	8.829	-3.687	3.763
	(4.074)	(3.148)	(6.052)	(2.143)	(4.454)	(2.459)	(1.931)	(2.429)
Q3	8.452	20.762	31.371	8.949	10.328	11.048	0.595	3.590
	(4.385)	(2.485)	(3.703)	(1.791)	(3.028)	(2.163)	(1.970)	(2.170)
AR(1)					-3.343	-1.795		
					(1.386)	(0.939)		
AR(2)			3.978	2.254		2.059		
			(0.856)	(0.849)		(0.735)		
AR(3)				3.033	3.742	2.203		
				(0.907)	(0.954)	(0.924)		
AR(4)					2.792			
					(0.769)			
AR(5)								
AR(6)								
Exchange rate equations parameters								
conditional mean equation								
constant	0.133	0.124	0.194	0.135	0.184	0.167	0.246	0.160
	(0.069)	(0.069)	(0.087)	(0.121)	(0.159)	(0.073)	(0.058)	(0.007)
dlRx								
0								
1	4.054	4.136	3.503	4.007	3.532	3.460	3.260	3.777
	(0.944)	(0.865)	(0.796)	(1.036)	(1.933)	(0.894)	(0.834)	(0.095)
2								
3								
4								
5								
6								
Conditional variance equation								
r	0.010	0.010	0.051	0.010	0.246	0.148	0.155	0.010
	(.)	(.)	(0.023)	(.0	(0.463)	(0.174)	(0.003)	(.)
r	0.000	0.000	0.000	0.000	0.000	0.123	0.000	0.000
	(.)	(.)	(0.001)	(.)	(.)	(0.105)	(.)	(.)

r	0.988	0.989	0.939	0.989	0.681	0.673	0.804	0.988
	(0.000)	(0.000)	(0.026)	(0.002)	(0.588)	(0.323)	(0.002)	(.)
variance-covariance parameters								
- 22	364.125	165.423	143.708	66.554	69.524	68.614	77.411	79.884
	(65.126)	(22.155)	(21.655)	(8.249)	(28.456)	(9.475)	(7.663)	(9.131)
- 12(- 21)	-0.125	0.026	0.163	-0.025	-0.160	0.027	0.020	-0.003
	(0.092)	(0.093)	(0.125)	(0.099)	(0.093)	(0.092)	(0.108)	(0.097)

Table 2. Japan

Variables/lag	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export supply equation parameters								
constant	270.216	-134.337	8741.958	707.330	551.906	376.084	93.605	871.789
	(2119506)	(261.408)	(216.052)	(167.052)	(176.280)	(167.191)	(171.311)	(1203.079)
lnip								
0			8.781					
			(3.703)					
1	7.910							
	(8.429)							
2		14.601		5..906	6. 247	8.889	8.856	5.601
		(3.432)		(2.852)	(4.061)	(3.771)	(4.461)	(4.146)
3								
LnRx^e								
0					3..609	8.525		
					(1.597)	(3.695)		
1				7.197				
				(2..916)				
2	-51.808							
	(46.744)							
3								
4			487.201					-30.813
			(12.795)					(25.168)
5		-20.510					9.039	
		(11.538)					(4.987)	
6								
lnRx^v								
0					-0.409	-0.272		
					(0.207)	(0.213)		
1				-0.368				
				(0.261)				

2	-7.664							
	(20.385)							
3								
4			-0.550					-8.605
			(0.331)					(12.174)
5		0.109					-0.194	
		(0.214)					(0.293)	
6								
Q_1	1.321	-6.332	-2.466	-5.459	-0.065	-10.878	-9.742	-6.494
	(6.135)	(3.749)	(3.578)	(3.076)	(1.049)	(3.092)	(4.619)	(3.626)
Q2	5.540	-4.626	1.542	2.243	5.483	1.523	-0.436	-1.563
	(4.761)	(3.622)	(3.617)	(2.769)	(3.450)	(3.073)	**(3.333)**	(3.916)
Q3	1.692	9.610	-8.236	-4.706	-5.260	-5.799	-6.640	-0.895
	(5.094)	(3.067)	(3.008)	(2.510)	(2.825)	(2.675)	(3.406)	(4.587)
AR(1)	4.567	1.472					3.894	2.791
	(0.893)	(0.763)					(0.873)	(1.179)
AR(2)		1.349			3.814	1.852	3.416	
		(0.913)			(0.963)	(0.921)	(1.097)	
AR(3)								
AR(4)				1.667		2.793		
				(0.836)		(0.894)		
AR(5)				0.513				
				(0.682)				
AR(6)				0.838				
				(0.771)				
Exchange rate equations parameters								
Conditional mean equation								
Constant	0.179	0.288	-0.020	0.549	0.625	0.514	0.545	0.190
	(0.191)	(0.149)	(0.002)	(0.249)	(0.302)	(0.207)	(0.263)	(0.265)
DlRx								
0								
1								
2								
3								
4								
5								
6	-1.528	-2.073	0.077	-0.961	-1.782	-1.345	-1.006	-1.684

	(1.141)	(0.681)	(0.052)	(0.812)	(0.846)	(0.802)	(1.157)	(1.265)
Conditional variance equation								
r	**0.326**	0.093	0.052	0.069	0.058	0.081	0.103	0.193
	(0.412)	(0.073)	(0.045)	(0.051)	(0.051)	(0.060)	(0.071)	(0.227)
r	**0.002**	**0.034**	0.025	**0.025**	0.032	0.034	0.034	**0.001**
	(0.006)	(0.032)	(0.013)	(0.015)	(0.013)	(0.021)	(0.034)	(0.001)
r	**0.963**	**0.965**	**0.974**	**0.974**	0.967	0.965	0.966	**0.978**
	(0.045)	(0.032)	(0.013)	(0.015)	(0.013)	(0.021)	(0.034)	(0.025)
Variance-covariance parameters								
- 22	308.516	140.025	167.246	109.052	184.211	136.647	166.336	176.787
	(33.003)	(18.087)	(4.487)	(14.713)	(23.062)	(17.724)	(24.874)	(24.532)
- 12(- 21)	-0.144	-0.185	-0.140	-0.338	-0.049	-0.245	-0.191	0.003
	(0.134)	(0.091)	(0..094)	(0.093)	(0.100)	(0.096)	(0.106)	(0.101)

Table 3. Germany

Variables/lag	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export supply equation parameters								
Constant	752.306	-214.428	1166.866	750.687	1197.367	-180.042	-571.441	6886.928
	(428.781)	(505.325)	(772.460)	(310.696)	(3758.391)	(1231.400)	(225.181)	(816.872)
lnip								
0			11.387	4.539	17.387			
			(5.686)	(4.528)	(6.855)			
1	-8.585							
	(7.913)							
2						14.924	8.605	
						(5.968)	(8.449)	
3		13.193						-7.399
		(6.063)						(7.551)
$lnRx^e$								
0			-30.439					
			(21.118)					
1		12.841						
		(15.776)						
2					3.118	77.510		
					(6.332)	(50.135)		
3				73.649				0.793
				(20.842)				(0.220)
4							59.132	
							(27.843)	
5	22.857							
	(9.601)							

6								
lnRx[v]								
0			-3.822					
			(5.811)					
1		-4.819						
		(0.685)						
2					-14.414	-17.444		
					(37.755)	(1.426)		
3				-18.230				-61.151
				(6.370)				(4.724)
4							-8.980	
							(1.174)	
5	-4.776							
	(1.309)							
6								
Q_1	-6.824	-24.727	-9.383	6.225	6.029	0.503	-14.345	19.588
	(7.728)	(5.057)	(5.827)	(3.160)	(4.389)	(4.283)	(7.143)	(7.554)
Q2	-20.198	1.287	5.653	15.796	0.601	6.780	-28.574	-3.759
	(6.804)	(4.423)	(4.398)	(3.215)	(5.593)	(3.471)	(3.901)	(10.829)
Q3	-8.667	10.613	4.880	8.604	5.777	0.409	-20.883	-20.300
	(6.883)	(6.115)	(4.579)	(2.955)	(5.055)	(4.300)	(8.415)	(6.906)
AR(1)	2.024	3.539	0.862		2.335	1.704	3.129	5.418
	(0.731)	(0.911)	(1.003)		(0.770)	(1.133)	(3.801)	(1.760)
AR(2)	2.591		3.298	0.565		1.527		
	(0.938)		(0.981)	(0.975)		(1.022)		
AR(3)								
AR(4)								
AR(5)					1.033			
					(0.524)			
AR(6)		4.327					3.272	
		(0.718)					(3.085)	
Exchange rate equations parameters								
conditional mean equation								
constant	0.051	0.339	0.266	0.137	0.453	0.200	0.157	0.365
	(0.060)	(0.348)	(0.189)	(0.049)	(0.306)	(0.046)	(0.097)	(0.044)
dlRx								
0								
1								

2								
3								
4								
5								
6	-1.108	-1.448	-1.960	0.398	-1.551	0.481	-0.465	-1.244
	(1.145)	(1.048)	(0.928)	(0.246)	(0.889)	(0.282)	(0.670)	(0.779)
Conditional variance equation								
r	**0.019**	0.071	0.646	0.017	0.719	0.024	0.078	1.785
	(0.002)	(0.012)	(0.458)	(0.002)	(0.512)	(0.007)	(0.095)	(0.200)
r	**0.000**	**0.000**	0.000	**0.000**	0.001	0.000	0.000	**0.000**
	(.)	(.)	(.)	(.)	(0.002)	(.)	(.)	(.)
r	**0.999**	**0.995**	**0.926**	**0.999**	0.924	0.999	0.994	**0.820**
	(.)	(0.001)	(0.045)	(.)	(0.052)	(0.000)	(0.009)	(0.020)
variance-covariance parameters								
- 22	693.482	367.233	366.467	149.303	203.516	110.241	148.097	364.913
	(108.333)	(45.868)	(61.581)	(28.759)	(28.342)	(29.557)	(111.925)	(60.138)
- 12(- 21)	-0.039	-0.244	-0.107	-0.163	-0.098	-0.095	-0.204	-0.056
	(0.110)	(0.103)	(0.081)	(0.083)	(0.122)	(0.134)	(0.109)	(0.099)

Conclusions

Empirical evidence reported in the Table indicates that real exchange rate risk are insignificant in most industries, but there were potentially large on some sectors and some countries. Difference effects on sectors and countries imply that risk might have induced resource shift in allocation.

Reference

Anderson, M, and P. Garcia, "Exchange Rate Uncertainty and the Demand for U.S. Soybeans",
American Agricultural Economics Association, August 1989, 721-729.

Bahmani-Oskooee, M. and Payesteh, S., "Exchange Rate Uncertainty and teh Trade Flows of Developing Countries", Journal of developing Areas, Vol 25, July 1991, 497-508.

Bahmani-Oskooee, M. and Payesteh, S. , "Does Exchange rate Volatility Deter Trade Volume of LDC ?", Journal of Economic Development, Vol 18, Number 2, December, 1993.

Bailey, M.T. and G.S. Tavlas, " Trade and Investment Performance under Floating Exchange Rates: The U.S. Experience." IMF Working Paper, Spring 1988.

Bailey, M.J., Trvias, G.S., and M. Ulan, "Exchaneg Rate Variability and Trade Performance: Evidence for the Big Seven Industrial Countries", Weltwirstchaftliches Archiv, Vol 122, 1986, 466-477.

Bailey, M.J., Trvias, G.S., and M. Ulan, "The Impact of Exchange Rate Volatility on Export
Growth: Some Theoretical Considerations and the Empirical Results", Journal of Policy Modeling, Vol 9, 1987, 225-244.

Bollerslev, Tim, Robert F. Engle, and Jeffrey M. Wooldridge "A Capital Asset Pricing Model with Time Varying Covariance." Journal of Political Economy 96, Feb. 1988, 116-131.

Caballero, R.J. and V. Corbo," The effect of Real Exchange Uncertainty on Exports: Empirical Evidence," The World Bank Economic Review, Vol 3, 1989, 263-278.

Caporate Tony and Khosrow Doroodian, "Exchange Rate Variability and the Flow of International Trade", Economics Letters, 46, 1994, 49-54.

Cushman, D.O., "The effects of Real Exchange Rate Risk on International Trade", Journal of International Economics, Vol 15, 1963, 45-63.

Cushman, D. O., "Has Exchange Rate Risk Depressed International Trade ? The impact of Third Country Exchange Rate Risk", Journal of International Money and Finance, Vol 5, 361-379.

Dellas, H. and B.-Z. Zillberfarb, 1993, "Real Exchange Rate Volatility and International Trade: A Reexamination of the Theory", Southern Economic Journal, 59, 641-647.

Engle, Robert F., Victor Ng, and Michael Rothschild, Asset Pricing with a Factor ARCH Covariance Structure: Empirical Estimates for Treasure Bills, Journal of Econometrics, 1990 ????

Engle, Robert and Tim Bollerslev, "Modeling the persistence of Conditional Variance.", Econometric Review, 8, 1986, 1-50.

Engle Robert, David M. Lilien, and Russel P. Robins, "Estimating Time Varying Risk Premia in the Term Structure: The ARCH-M Model." Econometrica, March 1987, 391-407.
Feige, Edgar L. and Douglas K. Pearce, " Economically Rational Expectations." Journal of Political Economy, June 1976, 499-522

Franke, Gunter, "Exchange Rate Volatility and International Trading Strategy", Journal of International Money and Finance, Vol10, 1991, 292-307.

Gagnon, J., "Exchaneg Rate Variability and the Level of International Trade", Journal of International Economics, Vol 25 1993, 269-287.

Goutor, P., "Effects of Exchaneg Rate Volatility on trade: Some Further Evidence," IMF Staff Papers, 32, 1985, 475-512.

Harberger, A., "Economic Adjustment and Real Exchange Rate," in S. Edwards and L. Ahamed (eds.), " Economic Adjustment and Exchange Rates in Developing Countries, University of Chicago Press, 1986.

Holt, Matthew T. and Satheesh V. Aradhyula, "Endogenous Risk in Rational-Expectations Commodity Models: A Multivariate Generalized ARCH-M Approach", Journal of Empirical Finance, 1998, 5, 99-129.

Hooper, P. and S.W. kohlhagen, "The effects of Exchange Rate Uncertainty on the Price and Volume of International trade," Journal of International economics, Vol 8, Nov. 1978, 483-511.

Hsieh, David, "Modeling Heteroskedasticity in Daily Foreign Exchange Rates." Journal of Business and Economic Statistics 7, 1989, 307-31.

Kenen, Peter B., and Dani Rodrik, "Measuring and Analyzing the Effects of Short-term Volatility in Real Exchange Rates," Review of Economics and Statistics 68, May 1986, 311-315.

Kumar, R. and R. Dhawan, "Exchange Rate Volatility and Pakistan's Exports to the Developed World," 1974-85, World Development, Vol 19 1991, 1225-1240.

Lorenzo, Bini-Smaghi "Exchange Rate Variability and Trade: Why is it So Difficult to Find Any Empirical Relationship?" Applied Economics, 1991, 23, 927-936.

Maskus K.E. “ Exchange Rate Risk and U.S. Trade: A Sectoral Analysis”, Federal Reserve Bank of Kansas City, Economic Review, no. 3. 1986, 16-28.

Medhora, R., "The effect of Exchange Rate Variability on Trade: The Case of the West African Monetary Union's Imports", World Development, Vol 18, 1990, 313-324.

Nerlove, Marc, David M. Grether, and Jose L. Carvalho. “Analysis of Economic Time Series.” New York: Academic Press, 1979

Pagan, Adrian,” Econometric Issues in the Analysis of Regressions with Generalized Regressors.” International Econometric Review, February 1984,221-47.

Poso, S., "Conditional Exchange Rate Volatility and the Volume of International Trade: Evidence from the early 1900s," Review of Economics and Statistics, Vol 74, 1992, 325-329.

Sercu, Piet and Vanhulle, Cynthia, "Exchange Rate Volatility, International Trade, and the Value of Exporting Firms", Journal of Banking and Finance, Vol 16, 1992, 155-182.

Sercu, Piet, “ Exchange Risk, Exposure, and the Option to Trade” Journal of International Money and Finance, Dec 1992, 579-93.

Thursby, Marie C. and Jerry G. Thursby, "Bilateral Trade Flows, the Linder Hypothesis, and Exchange Risk," Review of Economics and Statistics, 1978 Fall, 69-79.

Wallis, Kenneth F., “Econometric Implications of the Rational Expectation Hypothesis.”

Econometrica, February 1980, 49-71