Noda, Yosuke and Kuroko, Masato and Yoshino, Hisao (eds.) *International Comparison and Analysis using Trade-related Index numbers*. Institute of Developing Economies, JETRO. 2008.

Chapter 9

The Influence of Intra-Industry Trade on Export Sensitivity to Exchange Rates

Yoko Oguro †

Abstract

Exchange rates play a key role in the literature on the determinants of trade, and this role is currently receiving a great deal of attention in the context of global imbalances. This paper adds to the literature that suggests that exports become less sensitive to exchange rate movements under certain circumstances. Focusing on the industry-specific sensitivity of export quantities to exchange rates in the context of intra-industry trade (IIT), this is, to the author's best knowledge, the first study to theoretically and empirically investigate this relationship. It is assumed that more IIT implies a smaller elasticity of substitution among differentiated products and vice versa. The model presented in this paper suggests that the gap in production costs has an influence on IIT as well. The empirical analysis investigates six cross-country industry-panels for the bilateral trade of eight East Asian countries, Japan, and the United States with the EU, Asia, Japan, and North America. The empirical results confirm that export sensitivity to exchange rates declines as the extent of IIT increases. An obvious policy implication of the findings is that the effectiveness of exchange rate adjustments as a policy tool for addressing trade imbalances diminishes when substantial IIT exists.

Keywords: trade, exchange rates, intra-industry trade

JEL Classification Numbers: F00, F10, F14, F19

Introduction

Exchange rates play a key role in the literature on the determinants of trade, and this role is currently receiving a great deal of attention in the context of global imbalances. But whereas in past decades, trade disputes and exchange rate issues concentrated on Japan, more recently, such frictions have centered on China. There have been growing calls for China to allow its currency to appreciate to help rectify global imbalances. Yet, to what extent exchange rate realignment would indeed affect trade flows is still uncertain, despite the large number of studies that have tried to determine the influence of exchange rates on trade. The traditional approach placed great emphasis on the Marshall-Lerner condition, which is satisfied when the sum of the absolute value of the price elasticities of imports and exports exceeds one, using aggregate trade data (see, e.g., Houthakker and Magee (1969)). That is, studies along these lines examine whether or not the appreciation of a country's currency leads to the deterioration of its trade balance based on the Marshall-Lerner condition. There are also a number of more recent studies for various countries that are concerned with the Marshall-Lerner condition in the framework of partial equilibrium analysis, but empirical results regarding the effect of exchange rates on trade vary (see, e.g., the results of Rose (1990, 1991), Hooper, Johnson and Marquez (1998), and Chinn (2004, 2005)).

In addition, a considerable number of researchers have been interested in a more direct investigation of the relationship between trade and exchange rates. A series of studies on bilateral exchange rate elasticities of trade, mostly on U.S. trade with developed countries, concludes that trade flows are significantly affected by real exchange rates (e.g., Cushman (1990), Marquez (1990), Eaton and Tamura (1994), Bahmani-Oskooee and Brooks (1999), Nedenicheck (2000), and Bahmani-Oskooe and Goswami (2004)). An example of a study that includes developing countries is that by Thorbecke (2006), which uses panel gravity regression analysis to examine the trade of East Asian countries with the OECD countries, Argentina, Brazil, Mexico, and India. The advantage of bilateral trade analysis such as that conducted in these studies is that it reduces the aggregation bias found in the multilateral trade balance approach. However, more detailed and systematic investigation is necessary, because exchange rate elasticities of trade may differ across industries, and may be affected by various surrounding factors. Breuer and Clements (2003) found commodity-specific exchange rate elasticities for trade between the United States and Japan.

This paper adds to the literature that suggests that exports become less sensitive to exchange rate movements under certain circumstances. Focusing on the industry-specific sensitivity of exports to exchange rates in the context of intra-industry trade (IIT), this is, to the author's best knowledge, the first study to theoretically and empirically investigate this relationship. By definition, IIT is the exchange of goods in the same product category, and it is more specifically assumed here that IIT consists of trade in differentiated products. It is further assumed that more IIT implies a smaller elasticity of substitution among products and vice versa.[1] The model presented later in this paper suggests that differences in production costs have an influence on IIT as well.

The empirical analysis investigates cross-country industry-panels for the bilateral trade of notable trading pairs, that is, trade between eight East Asian countries (including China), Japan, and the United States on the one hand and the European Union countries (EU), Japan, Asia, and North America on the other (see Figure 9.1). Furthermore, unlike other studies that use real trade values, the present paper uses export quantity indices to measure real exports in order to determine the real effect of exchange rate movements on exports. Since it is assumed that the price and quantity of exports do not necessarily respond in the same way to exchange rate movements, it is more appropriate to measure "real" exports in quantities. The empirical results confirm that the exchange rate sensitivity declines as the extent of IIT increases as a result of a lower elasticity of substitution among differentiated products. An obvious policy implication of the

Figure 9.1: Thirty-Eight Trade Pairs

EXPORTERS		IMPORTERS	
China		EU	
Hong Kong SAR			(Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy,
Indonesia			Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom)
Japan		Japan	
Korea	EXPORTS →		
Malaysia			
The Philippines		Asia	
Singapore			(China, Hong Kong SAR, Indonesia, Korea, Malaysia, Philippines, Singapore,
Thailand			Taiwan, Thailand)
United States		North America	
			(Canada, United States)

The six industries analyzed in this paper are:
Textiles, pulp and paper, metal products, general machinery, electrical machinery, and precision instruments.

findings is that the effectiveness of exchange rate adjustments as a policy tool for addressing trade imbalances diminishes when there is substantial IIT. The remainder of this paper is organized as follows: Section 1 shows the linkages between IIT, the elasticity of substitution, and differences in production costs using a monopolistic competition model. Section 2 presents the empirical model and Section 3 discusses the data used in the empirical analysis. The results are presented in Section 4.

1. Background and Theory

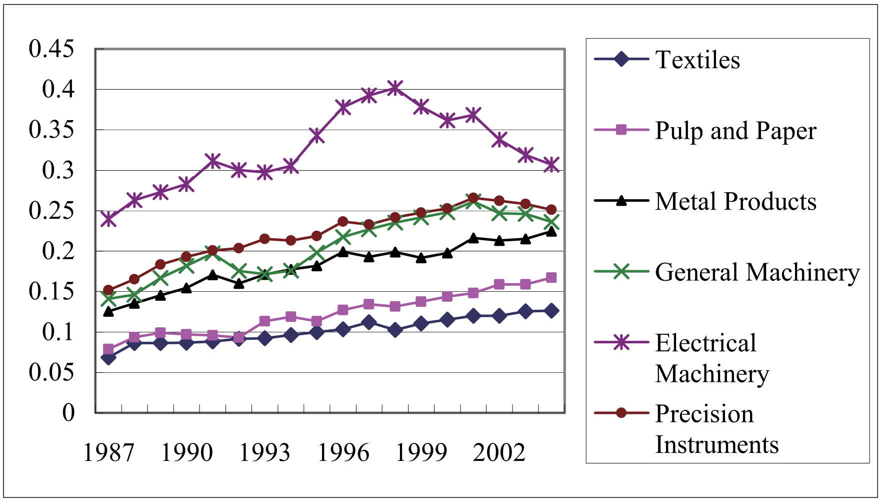
The aim of this paper is to show both theoretically and empirically that trade between a pair of countries becomes less sensitive to exchange rate movements as intra-industry trade (IIT) deepens. IIT is defined as the exchange of goods in the same product category, and it is specifically assumed here that IIT consists of trade in differentiated products. It is further assumed that as product differentiation increases, IIT deepens and, at the same time, the elasticity of substitution among products becomes smaller. Thus, it is assumed that more IIT implies a smaller elasticity of substitution among products and vice versa. That is, if the two countries produce non-differentiated products with a high elasticity of substitution, it would be more efficient for a pair of countries to gather all the production of a particular commodity in the country that has a comparative advantage.

In this paper, it is simply assumed that IIT is the exchange of differentiated products and IIT is not classified into different categories. However, in general, IIT is often divided into two types, vertical intra-industry trade (VIIT) and horizontal intra-industry trade (HIIT) (see, e.g., Fukao, Ishido and Ito (2003); Greenaway, Hine and Milner (1995); and Fontagné, Freudenberg and Péridy (1997)).[2] HIIT is presumed to occur in the case of goods that simply differ in terms of their attributes. On the other hand, VIIT is often considered to be the trade of differentiated products that have quality differences, since IIT is defined as vertical when the unit price of a commodity traded between a pair of countries is substantially different. Suppose countries *A* and *B* produce T-shirts *A* and *B* respectively, and they exchange their products. In the case that the prices of T-shirts *A* and *B* are similar, the exchange is called HIIT. On the other hand, if the prices of T-shirts *A* and *B* differ substantially, the exchange is regarded as VIIT. However, both T-shirts each face their own demand regardless of the types of IIT because they differ. Consequently, this paper assumes that the extent of product differentiation determines the extent of IIT regardless of whether IIT is horizontal or vertical.

Before moving on to the discussion of the theoretical model, it is useful to examine the importance of IIT by having a brief look at recent trends in the extent of IIT (see equation (9.8) for the derivation of the measure of the extent of IIT.) Figure 9.2(a) shows the time-series movements in the average extent of IIT among thirty-eight trade pairs for the six industries analyzed in this paper: textiles, pulp and paper, metal products, general machinery, electrical machinery, and precision instruments. In addition, Figure 9.2(b) shows the trends in China's IIT with four trading partner groups: the EU, Japan, Asia, and North America. The figures indicate that the extent of IIT among the trade pairs analyzed in this paper, as well as for China, has been on an increasing trend. Looking at the two figures, it can be seen that the extent of IIT in the different industries for China (Figure 9.2(b)), on which concerns regarding global imbalances have focused, is very similar to the average for all thirty-eight trading pairs (Figure 9.2(a)). Moreover, the figures show that IIT is playing an increasingly important role both worldwide and in China, and it can be expected that IIT will continue to expand as income and technology levels of developing countries converge to those of developed countries.

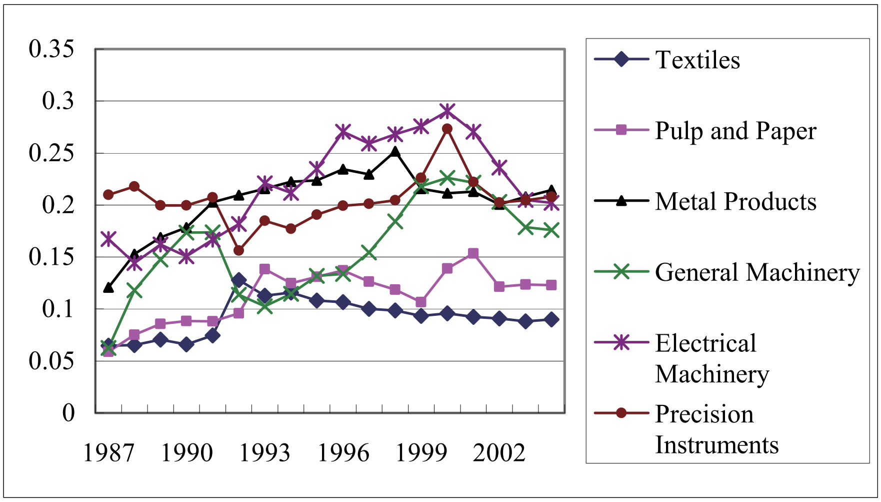
The model presented in this section shows that the extent of IIT is higher the lower the elasticity of substitution between two products or the smaller the gap in production costs between two countries. The model assumes trade in differentiated products in industry z under Dixit and Stiglitz (1977) type monopolistic competition between two countries (i=2). Furthermore, it is assumed that there exist F_i identical firms in country i's industry z.[3] All consumers in a pair of countries have identical preferences. The utility-maximization problem of a representative consumer in importing country j is as follows:[4]

Figure 9.2(a): Degree of Intra-Industry Trade



Note: Average degree of intra-industry trade (IIT) among the thirty-eight trade pairs.
Source: Author's calculations. See Section 3 for details on data sources.

Figure 9.2(b): China's Degree of Intra-Industry Trade



Note: China's average degree of intra-industry trade (IIT) with four trading partners: EU, Japan, Asia, and North America.
Source: Author's calculations. See Section 3 for details on data sources.

$$\max_{c_{i,f,j}} \left(\sum_{i-1}^{2} \sum_{f=1}^{F_i} c_{i,f,j}^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{9.1}$$

subject to

(9.2) $$\sum_{i-1}^{2}\sum_{f=1}^{F_i} p_{i,f} \cdot c_{i,f,j} = \overline{\alpha} Y_j$$

θ denotes the elasticity of substitution among the differentiated products produced by all firms in industry *z*, which is greater than one. $c_{i,f,j}$ is country *j*'s consumption of firm *f*'s output in industry *z* in country *i*. $p_{i,f}$ denotes the price of firm *f*'s product in industry *z* in country *i*. For simplicity, trade costs are assumed to be zero. Moreover, it is assumed that a certain portion, $\overline{\alpha}$, of country *j*'s national income, Y_j, is used for the consumption of industry *z*'s products produced in both countries.[5]

Solving the utility maximization problem, country *j*'s demand for firm *f*'s output in industry *z* in country *i*, $c_{i,f,j}$, is derived as follows:

(9.3) $$c_{i,f,j} = \frac{1}{\sum_{i=1}^{2} F_i} \cdot \left(\frac{p_{i,f}}{P_j}\right)^{-\theta} \cdot \frac{\overline{\alpha} Y_j}{P_j}$$

(9.4) where $$P_j = \left[\frac{\sum_{i=1}^{2}\sum_{f=1}^{F_i} (p_{i,f})^{1-\theta}}{\sum_{i=1}^{2} F_i}\right]^{\frac{1}{1-\theta}}$$

Assume further that the number of firms in industry *z* in country *i*, F_i, is defined as a certain ratio, $\overline{\eta}$, to country *i*'s national income, Y_i.[6] In addition, $p_{i,f} = p_i$, since firms are assumed to be identical in each country. Hence, country *j*'s price index of industry *z*'s output, P_j, above can be simplified as P. Then, the value of exports in industry *z* from country *A* to country *B* and that from country *B* to country *A* respectively are defined as follows:

(9.5) $$EX_{AB}^{z} = \frac{\overline{\eta} Y_A}{\overline{\eta} Y_A + \overline{\eta} Y_B} \cdot \left(\frac{p_A}{P}\right)^{-\theta} \cdot \frac{\overline{\alpha} Y_B}{P} = \frac{Y_A}{Y_A + Y_B} \cdot \left(\frac{p_A}{P}\right)^{-\theta} \cdot \frac{\overline{\alpha} Y_B}{P}$$

(9.6) $$EX_{BA}^{z} = \frac{\overline{\eta} Y_B}{\overline{\eta} Y_A + \overline{\eta} Y_B} \cdot \left(\frac{p_B}{P}\right)^{-\theta} \cdot \frac{\overline{\alpha} Y_A}{P} = \frac{Y_B}{Y_A + Y_B} \cdot \left(\frac{p_B}{P}\right)^{-\theta} \cdot \frac{\overline{\alpha} Y_A}{P}$$

The next step is to solve for p_i. Each identical firm in industry *z* in country *i* is defined to have cost function $C_{i,f}^{z} = C_i^{z}$, consisting of marginal cost $MC_{i,f} = MC_i$, and fixed cost $FC_{i,f} = FC_i$. Using the profit maximization condition, $p_{i,f} = p_i$ is derived as follows:

(9.7) $$p_{i,f} = p_i = \frac{\theta}{\theta - 1} \cdot MC_{i,f} = \frac{\theta}{\theta - 1} \cdot MC_i$$

Following previous studies (such as Fukao, Ishido and Ito (2003); Greenaway, Hine and Milner (1995); and Fontagné, Freudenberg and Péridy (1997)), the degree of intra-industry trade (IIT) is defined as the value of trade overlap for industry *z* and takes a value between 0 and 1:[7]

(9.8) $$\text{IIT}^{z}: \ \frac{Min(EX_{AB}^{z}, EX_{BA}^{z})}{Max(EX_{AB}^{z}, EX_{BA}^{z})} = \frac{Min(EX_{AB}^{z}, IM_{AB}^{z})}{Max(EX_{AB}^{z}, IM_{AB}^{z})}$$

Using (9.5), (9.6), (9.7), and (9.8), IIT^{z} can be written as follows, assuming $MC_A > MC_B$:[8]

$$\text{(9.9)} \qquad \mathrm{IIT}^z = \frac{EX_{AB}^z}{EX_{BA}^z} = \left(\frac{p_A}{p_B}\right)^{-\theta} = \left(\frac{\frac{\theta}{\theta-1}\cdot MC_A}{\frac{\theta}{\theta-1}\cdot MC_B}\right)^{-\theta} = \left(\frac{MC_B}{MC_A}\right)^{\theta}$$

Thus, the model shows that IIT becomes larger as the elasticity of substitution θ and/or the bilateral *MC* gap become smaller.

2. Empirical Model

The hypothesis that export sensitivity to exchange rates is reduced in the context of IIT is tested using a data set for the bilateral trade of ten countries with four major trading partner groups. As shown in Figure 9.1, the ten exporting countries are: China, Hong Kong SAR, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Thailand, and the United States; and the four importing groups are: (i) the EU15 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom), (ii) Japan, (iii) Asia (China, Hong Kong SAR, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, Thailand),[9] and (iv) North America (Canada and the United States). Six manufacturing industry panels[10] (textiles, pulp and paper, metal products, general machinery, electrical machinery, and precision instruments) consisting of the above thirty-eight trade pairs are compiled and examined.[11] The extent of IIT in the six industries varies considerably, ranging from high to low. The average extent of IIT is shown at the bottom of Tables 9.1(a) and 9.1(b) in the row labeled "IIT Average." The extent of IIT in the electrical machinery, precision instruments, and general machinery industries is high with averages of 0.291, 0.184, and 0.177, respectively. This result is in line with the study by Fukao, Ishido and Ito (2003), who also classify these as high IIT industries both in intra-East Asian and in intra-EU trade. The extent of IIT in the metal products industry is in the intermediate range with an average of 0.149, while that in the pulp and paper and textile industries is low with 0.100 and 0.90, respectively. The data used for this study are annual data for the period 1974 to 2004 (see Section 3 below). The data set is an unbalanced panel with the data span for China being the shortest (starting in 1987).

In the empirical analysis, a gravity model is derived from equation (9.5) or (9.6) and estimated. Equation (9.5) or (9.6) can be rewritten as the bilateral real export (export quantities, *QEX*) equation of industry, *z*, from country *i* to country *j* as follows:

$$QEX_{ij}^{z} = \frac{Y_i \cdot Y_j}{Y_i + Y_j} \cdot \left(\frac{p_i}{P} \right)^{-\theta} \cdot \frac{\overline{\alpha}}{P} \qquad (9.5)'$$

Log linearization of equation (9.5)' leads to the following gravity equation:[12]

$$\log QEX_{ij}^{z} = \frac{\overline{\alpha}}{P} + \log Y_i + \log Y_j - \theta \log\left(\frac{p_i}{P} \right) - \log\left(Y_i + Y_j\right) \qquad (9.10)$$

Using this basic model, the aim is to obtain industry-specific exchange rate elasticities and determine the influence of IIT on export sensitivity to exchange rates. The equation to be empirically estimated is derived from equation (9.10) with some modifications. First, Y_i and Y_j are rewritten as the exporter's real GDP (*GDPex*) and the importer's real GDP (*GDPim*), respectively, which are based on national currencies. Second, the real price of a firm's product in country *i*, (p_i/P), is replaced by the real exchange rate (*RER*) between two countries, which is used as a proxy for the relative price. Third, in the empirical analysis, a higher degree of IIT (*IIT*) is used as a proxy for a smaller elasticity of substitution, θ. Thus, it is necessary to control for the influence of the difference in production costs following the theoretical model presented. That is, the cross-term of the absolute inverse value of the bilateral difference in per capita real GDP (*GDPpcgap*) and *RER* is included as well in order to exclude any influence of *GDPpcgap* from *IIT*, which is used as a proxy for θ. *GDPpcgap* is used as a proxy for the gap in production costs between a pair of countries. Fourth, $(Y_i + Y_j)$, which implicitly shows the costs of trade at arm's length, is replaced by the distance between country *i* and *j*. Finally, as real exports might be influenced by past values of variables, lags of each variable are considered. Therefore, equation (9.11) below, which contains lagged terms, is estimated using panels for each industry:[13]

(9-11)

$$\log QEX^{z}_{ijt} = a + \sum_{k=0} b_k \log GDPex_{i,t-k} + \sum_{k=0} c_k \log GDPim_{j,t-k} + \sum_{k=0} d_k \log RER_{ij,t-k}$$
$$+ \sum_{k=0} g_k GDPpcgap_{ij,t-k} \cdot \log RER_{ij,t-k} + \sum_{k=0} m_k IIT_{ij,t-k} \cdot \log RER_{ij,t-k}$$
$$+ \sum_{k=0} h_k GDPpcgap_{ij,t-k} + \sum_{k=0} n_k IIT_{ij,t-k} + v\text{distance}_{ij} + \omega_{ij} + \varepsilon_{ijt}$$

$$b, c, g, m > 0; \quad d, v < 0$$

where ω_i represents trade-pair-specific factors other than distance, and ε_{it} is the error term.

Since it is impossible to control for all trading-pair-specific factors, which are represented by ω, the thirty-eight trade pairs are considered as thirty-eight cross-sectional groups in each industry-panel. The expected sign of d is negative, whereas g and m are expected to be positive. This is because, in general, exports are negatively affected when the exporter's exchange rate appreciates, and a higher degree of IIT and a smaller per capita real GDP gap are expected to lower export sensitivity to exchange rates.

3. Data

While other studies typically use real trade values, the present paper chooses to use export quantities in order to measure "real" exports. The rationale is that the price and quantity of exports do not necessarily respond in the same way to exchange rate movements. In addition, it is impossible to find industry-specific deflators for the value of each industry's exports. The real export volume (*QEX*) used here is the export quantity index developed by Kuroko (2006) using the United Nations Commodity Trade Statistics Database (Comtrade database). It is useful to use quantity index data rather than quantity data itself since quantity units differ from commodity to commodity.[14]

The real exchange rate (*RER*) is defined as the units of importer currency per unit of exporter currency, and is deflated by the respective consumer price index (CPI).[15]

Exporters' and importers' real GDP (*GDPex*, *GDPim*), exchange rates, and CPIs are taken from the IMF's *International Financial Statistics* (IFS), except in the case of Taiwan, for which data are taken from the database of CEIC Data Company Ltd. Per capita real GDP gaps (1/*GDPpcgap*) are calculated in U.S. dollars. The degree of IIT for each trading pair and for the six industries is calculated from equation (9.8) using the SITC 5-digit-based data of the Comtrade database, which is the most detailed data available. The SITC 5-digit-based extent-of-IIT data are aggregated into the six industries and the thirty-eight trade pairs weighted by trade values. The variables *QEX*, *GDPex*, *GDPim*, and *RER* are indices which are set to 100 for the base year, 2000. Finally, when the trading partner is a group of countries, i.e., the EU, Asia, or North America, *GDPim*, *RER*, and *GDPpcgap* are the weighted averages using GDP (in U.S. dollars) as the weight.

The stationarity of residuals is confirmed by Johansen's (trace) cointegration test for the six industry-panels, as shown in the Appendix Table. The tests were conducted for each trade pair for each industry since each industry data set is a different unbalanced panel. However, for several of the thirty-eight trade pairs in each industry, it was impossible to conduct the cointegration test, since the time-span covered by the data is not sufficiently long. It is assumed that all cross-sectional export equations in the panel of each industry satisfy stationarity.

4. Empirical Results

To estimate the export equation (9.11), each industry is specified to have a different lag structure for each explanatory variable using the Akaike Information Criterion (AIC).[16] Since the analysis uses unbalanced annual data from 1974 to 2004, the maximum lag length adopted is two years (given the limited time series for some pairs). Based on the Hausman test, a random effects model is accepted for the textiles, pulp and paper, metal products, electrical machinery and precision instruments industries, while a fixed effects model is accepted for the general machinery industry. Although regression results based on both the random effects (Table 9.1(a)) and the fixed effects (Table 9.1(b)) models are reported for each industry, the discussion below concentrates on the results of the model selected by the Hausman test.[17]

The empirical results for the short-run and long-run steady state are shown in Tables 9.1(a) and 9.1(b). In the short-run analysis, most of the coefficients of the variables of primary interest, *logRER* and *logRER*IIT*, are statistically significant at times *t* and *t-2* in the six industries. The signs of the coefficients of *logRER(t)* and *logRER(t-2)* are negative, and those of *logRER*IIT(t)* and *logRER*IIT(t-2)* are positive, as expected. The results indicate that, at times *t* and *t-2*, real exports in the six industries are negatively related with *logRER* and a higher extent of IIT reduces export sensitivity to exchange rates. Among the statistically significant coefficients on *logRER*GDPpcgap(t)*, *logRER*GDPpcgap(t-1)*, and *logRER*GDPpcgap(t-2)*, negative coefficients can be found as well for the metal products and electrical machinery industries, which is in conflict with expectations. Thus, broadly speaking, the impact of the gap in production costs on export sensitivity to exchange rates varies across industries.

In the steady state analysis, the coefficients of the variables of primary interest, *logRER* and *logRER*IIT*, are significantly different from zero at the 1 percent level for all six industries. As predicted, the coefficient of *logRER* is negative, whereas that of *logRER*IIT* is positive. For instance, in Table 9.1(a), in the case of the electrical machinery industry, the estimated coefficient of *logRER* is -3.318 and that of *logRER*IIT* is 7.292. However, only for three out of the six industries, statistically significant coefficients for *logRER*GDPpcgap* are obtained. Specifically, significant coefficients with the expected (positive) sign are obtained for the textiles, pulp and paper, and precision instruments industries.

The impact of IIT on trade sensitivity to exchange rates in the steady state can be clearly seen in the two rows highlighted in **bold** in Tables 9.1(a) and 9.1(b). The estimates suggest that, in the case of the electrical machinery industry for example, a one percent increase in the real exchange rate results in a 3.318 percent decline in the quantity of exports in the absence of IIT. When IIT is taken into account, and using the average degree of IIT, the export elasticity of the electrical machinery industry declines to -1.196.

Table 9.1(a). Estimation Results of the Export Equation [Random Effects (GLS)]

	Textiles	**Pulp and Paper**	**Metal Products**	General Machinery	**Electrical Machinery**	**Precision Instruments**
Dependent Variable: logQEX	Estimated Coefficient					
logGDPex(t)	0.151 **	1.169 ***	0.981 ***	2.491 ***	1.329 ***	2.729 ***
	(1.98)	(7.62)	(12.31)	(12.15)	(11.05)	(4.05)
logGDPex(t-1)						-1.454 **
						(-2.22)
logGDPex(t-2)						
logGDPim(t)	4.212 ***	6.350 ***	0.714 ***	2.585	1.228 ***	1.106 ***
	(4.79)	(4.07)	(6.13)	(1.04)	(7.63)	(6.33)
logGDPim(t-1)	-2.345 ***	-4.452 ***		-3.511		
	(-2.74)	(-2.92)		(-0.95)		
logGDPim(t-2)				2.031		
				(1.08)		
logRER(t)	-1.432 ***	-1.403 ***	-1.712 ***	-0.151	-0.637	-1.600 ***
	(-5.12)	(-2.94)	(-4.81)	(-0.22)	(-1.50)	(-3.78)
logRER(t-1)	-0.379	-0.217	-0.845 **	-0.055	-0.591	-0.320
	(-1.06)	(-0.35)	(-2.13)	(-0.07)	(-1.09)	(-0.64)
logRER(t-2)	-0.887 ***	-1.919 ***	-1.051 ***	-1.875 ***	-2.090 ***	-0.876 **
	(-3.72)	(-4.45)	(-3.55)	(-3.65)	(-5.59)	(-2.16)
logRER(t)*GDPpcgap(t)	0.025 ***	0.044 *	-0.034 *	0.051 **	-0.011	0.106 ***
	(3.07)	(1.69)	(-1.88)	(2.13)	(-0.82)	(3.19)
logRER(t-1)*GDPpcgap(t-1)	0.027 **	0.033 *	0.007	-0.005	0.010	0.057 **
	(2.57)	(1.71)	(0.70)	(-0.25)	(0.53)	(2.04)
logRER(t-2)*GDPpcgap(t-2)	-0.003	0.004	0.014 ***	0.002	-0.011 ***	-0.012
	(-0.37)	(0.62)	(2.93)	(0.24)	(-3.34)	(-1.55)
logRER(t)*IIT(t)	6.962 **	9.006 ***	8.612 ***	2.283	2.040 *	6.789 ***
	(2.38)	(3.01)	(5.06)	(0.92)	(1.86)	(3.59)
logRER(t-1)*IIT(t-1)	-1.287	-1.797	2.214	-0.479	1.390	0.442
	(-0.36)	(-0.47)	(1.17)	(-0.17)	(1.01)	(0.16)
logRER(t-2)*IIT(t-2)	3.250	10.645 ***	3.653 ***	3.553 *	3.862 ***	2.782
	(1.36)	(4.11)	(2.62)	(1.88)	(3.92)	(1.19)
GDPpcgap(t)	-0.126 ***	-0.222	0.159 *	-0.248 **	0.038	-0.512 ***
	(-3.08)	(-1.64)	(1.78)	(-2.10)	(0.57)	(-2.99)
GDPpcgap(t-1)	-0.141 ***	-0.166 *	-0.034	0.023	-0.067	-0.295 **
	(-2.83)	(-1.74)	(-0.69)	(0.27)	(-0.70)	(-2.01)
GDPpcgap(t-2)	0.009	-0.013	-0.055 ***	-0.007	0.039 ***	0.046
	(0.30)	(-0.59)	(-3.02)	(-0.23)	(2.95)	(1.59)
IIT(t)	-33.918 **	-41.364 ***	-38.603 ***	-7.079	-8.952 *	-29.955 ***
	(-2.54)	(-3.02)	(-4.94)	(-0.62)	(-1.75)	(-3.43)
IIT(t-1)	5.715	8.475	-9.907	2.349	-6.258	-1.372
	(0.35)	(0.48)	(-1.14)	(0.18)	(-0.97)	(-0.11)
IIT(t-2)	-15.160	-48.316 ***	-16.712 ***	-15.423 *	-17.487 ***	-13.078
	(-1.39)	(-4.05)	(-2.59)	(-1.76)	(-3.78)	(-1.26)
_cons	7.980 ***	6.418 ***	13.106 ***	-3.781 *	7.672 ***	5.976 ***
	(8.04)	(5.94)	(11.91)	(-1.79)	(7.17)	(4.84)
Number of obs.	953	931	912	915	913	896
R-sq: within	0.737	0.742	0.791	0.745	0.799	0.751
between	0.508	0.674	0.522	0.457	0.641	0.518
overall	0.662	0.715	0.708	0.678	0.759	0.711
Hausman Test	chi2(17) =16.71	chi2(15) =4.18	chi2(15) =3.93	chi2(17) =111.80	chi2(16) =5.93	chi2(17) = 17.77
	P>chi2 = 0.4739	P>chi2 = 0.9971	P>chi2 = 0.9980	P>chi2 = 0.0000	P>chi2 = 0.9888	P>chi2 = 0.4038
Long-Run Steady State: X = X(t-k)	X=logGDPex, logGDPim, logRER, (logRER)*GDPpcgap, (logRER)*IIT, GDPpcgap, IIT k=0,1,2					
logGDPex	0.151 **	1.169 ***	0.981 ***	2.491 ***	1.329 ***	1.275 ***
logGDPim	1.867 ***	1.899 ***	0.714 ***	1.106 ***	1.228 ***	1.106 ***
logRER	**-2.698** ***	**-3.539** ***	**-3.608** ***	**-2.081** ***	**-3.318** ***	**-2.796** ***
(logRER)*GDPpcgap	0.049 ***	0.080 ***	-0.013	0.049 *	-0.012	0.151 ***
(logRER)*IIT	8.925 ***	17.854 ***	14.479 ***	5.357 ***	7.292 ***	10.012 ***
GDPpcgap	-0.258 ***	-0.401 ***	0.070	-0.232 *	0.011	-0.761 ***
IIT	-43.363 ***	-81.205 ***	-65.222 ***	-20.153 **	-32.697 ***	-44.404 ***
(1+ave.IIT)*logRER	**-1.893** ***	**-1.761** ***	**-1.448** ***	**-1.135** **	**-1.196** ***	**-0.949** ***

IIT Average	0.090	0.100	0.149	0.177	0.291	0.184
Min.	0.001	0.000	0.000	0.000	0.000	0.000
Max.	0.444	0.495	0.519	0.734	0.938	0.665
Std. Dev.	0.075	0.091	0.102	0.144	0.193	0.124

*, **, ***: 10%, 5%, 1% significance of P>|z|, and P>F for the long-run analysis.
The numbers in parentheses are z-values from heteroskedasticity-robust standard errors.
Exporters: China, Hong Kong SAR, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand, United States.
Importers: EU, Japan, Asia, North America.
IIT: Author's calculations. See Section 3 for details.

Table 9.1(b). Estimation Results of the Export Equation [Fixed Effects (within)]

	Textiles	Pulp and Paper	Metal Products	**General Machinery**	Electrical Machinery	Precision Instruments
Dependent Variable: logQEX	Estimated Coefficient					
logGDPex(t)	0.150 *	1.229 ***	0.981 ***	2.640 ***	1.388 ***	2.792 ***
	(1.92)	(8.17)	(12.26)	(14.48)	(11.69)	(4.17)
logGDPex(t-1)						-1.430 **
						(-2.19)
logGDPex(t-2)						
logGDPim(t)	3.884 ***	6.096 ***	0.709 ***	1.476	1.239 ***	1.142 ***
	(4.40)	(3.71)	(5.91)	(0.60)	(7.92)	(6.76)
logGDPim(t-1)	-1.960 **	-4.201 ***		-3.203		
	(-2.27)	(-2.60)		(-0.91)		
logGDPim(t-2)				2.777		
				(1.43)		
logRER(t)	-1.455 ***	-1.378 ***	-1.722 ***	-0.146	-0.667	-1.615 ***
	(-5.43)	(-2.92)	(-4.94)	(-0.23)	(-1.61)	(-3.97)
logRER(t-1)	-0.377	-0.223	-0.846 **	-0.099	-0.567	-0.294
	(-1.09)	(-0.37)	(-2.09)	(-0.13)	(-1.09)	(-0.62)
logRER(t-2)	-0.911 ***	-1.885 ***	-1.044 ***	-1.698 ***	-2.100 ***	-0.917 **
	(-3.97)	(-4.47)	(-3.46)	(-3.44)	(-5.92)	(-2.39)
logRER(t)*GDPpcgap(t)	0.026 ***	0.041	-0.033 *	0.037 *	-0.011	0.099 ***
	(3.06)	(1.62)	(-1.77)	(1.78)	(-0.81)	(2.96)
logRER(t-1)*GDPpcgap(t-1)	0.027 ***	0.030	0.007	-0.018	0.008	0.050 *
	(2.68)	(1.55)	(0.57)	(-0.76)	(0.47)	(1.76)
logRER(t-2)*GDPpcgap(t-2)	-0.003	0.004	0.013 **	0.001	-0.011 ***	-0.012 *
	(-0.43)	(0.69)	(2.47)	(0.12)	(-3.29)	(-1.92)
logRER(t)*IIT(t)	7.247 **	8.939 ***	8.671 ***	1.736	2.048 *	6.789 ***
	(2.60)	(3.08)	(5.19)	(0.76)	(1.87)	(3.59)
logRER(t-1)*IIT(t-1)	-1.411	-1.850	2.232	-0.160	1.364	0.391
	(-0.42)	(-0.50)	(1.18)	(-0.06)	(1.00)	(0.15)
logRER(t-2)*IIT(t-2)	3.405	10.566 ***	3.659 ***	2.830	3.973 ***	3.205
	(1.51)	(4.20)	(2.62)	(1.60)	(4.08)	(1.47)
GDPgappc(t)	-0.132 ***	-0.209	0.156	-0.176 *	0.038	-0.477 ***
	(-3.10)	(-1.57)	(1.65)	(-1.76)	(0.57)	(-2.77)
GDPpcgap(t-1)	-0.141 ***	-0.151	-0.034	0.093	-0.058	-0.258 *
	(-3.03)	(-1.57)	(-0.58)	(0.77)	(-0.66)	(-1.74)
GDPpcgap(t-2)	0.011	-0.014	-0.051 **	-0.004	0.038 ***	0.049 *
	(0.37)	(-0.66)	(-2.55)	(-0.13)	(2.91)	(1.96)
IIT(t)	-36.006 ***	-41.296 ***	-38.830 ***	-4.557	-9.117 *	-30.225 ***
	(-2.82)	(-3.10)	(-5.03)	(-0.43)	(-1.79)	(-3.44)
IIT(t-1)	6.232	8.643	-9.982	0.742	-6.188	-1.282
	(0.40)	(0.50)	(-1.14)	(0.06)	(-0.96)	(-0.11)
IIT(t-2)	-16.173	-48.201 ***	-16.724 **	-12.333	-18.199 ***	-15.438
	(-1.56)	(-4.14)	(-2.58)	(-1.51)	(-3.96)	(-1.58)
_cons	8.068 ***	6.021 ***	13.153 ***	-4.687 **	7.586 ***	5.780 ***
	(8.37)	(5.77)	(12.81)	(-2.46)	(7.63)	(5.02)
Number of obs.	953	931	912	915	913	896
R-sq: within	0.738	0.742	0.791	0.746	0.799	0.752
between	0.442	0.658	0.520	0.427	0.604	0.432
overall	0.639	0.710	0.708	0.673	0.750	0.697
Hausman Test	chi2(17) =16.71	chi2(15) =4.18	chi2(15) =3.93	chi2(17) =111.80	chi2(16) =5.93	chi2(17) = 17.77
	P>chi2 = 0.4739	P>chi2 = 0.9971	P>chi2 = 0.9980	P>chi2 = 0.0000	P>chi2 = 0.9888	P>chi2 = 0.4038
Long-Run Steady State: X = X(t-k)	X=logGDPex, logGDPim, logRER, (logRER)*GDPpcgap, (logRER)*IIT, GDPpcgap, IIT k=0,1,2					
logGDPex	0.150 *	1.229 ***	0.981 ***	2.640 ***	1.388 ***	1.362 ***
logGDPim	1.924 ***	1.895 ***	0.709 ***	1.050 ***	1.239 ***	1.142 ***
logRER	**-2.743** ***	**-3.486** ***	**-3.612** ***	**-1.942** ***	**-3.334** ***	**-2.825** ***
(logRER)*GDPpcgap	0.050 ***	0.075 ***	-0.014	0.020	-0.014	0.136 ***
(logRER)*IIT	9.240 ***	17.655 ***	14.562 ***	4.406 ***	7.386 ***	10.385 ***
GDPpcgap	-0.261 ***	-0.375 ***	0.071	-0.087	0.019	-0.686 ***
IIT	-45.947 ***	-80.854 ***	-65.536 ***	-16.148 **	-33.504 ***	-46.945 ***
(1+ave.IIT)*logRER	**-1.910** ***	**-1.729** ***	**-1.440** ***	**-1.164** **	**-1.185** ***	**-0.910** ***

IIT Average	0.090	0.100	0.149	0.177	0.291	0.184
Min.	0.001	0.000	0.000	0.000	0.000	0.000
Max.	0.444	0.495	0.519	0.734	0.938	0.665
Std. Dev.	0.075	0.091	0.102	0.144	0.193	0.124

*, **, ***: 10%, 5%, 1% significance of P>|t|, and P>F for the long-run analysis.
The numbers in parentheses are t-values from heteroskedasticity-robust standard errors.
Exporters: China, Hong Kong SAR, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand, United States.
Importers: EU, Japan, Asia, North America.
IIT: Author's calculations. See Section 3 for details.

As a whole, the results provide empirical support for the hypothesis that higher IIT reduces the export sensitivity to exchange rates as a result of a lower elasticity of substitution among differentiated products. In other words, the empirical results show that a reduction in exports as a result of the appreciation of an exporter's currency becomes less pronounced the higher the extent of IIT. According to the theoretical model presented above, IIT is higher the smaller the gap in production costs given the elasticity of substitution is the same between a pair of countries. However, the influence of the gap in production costs on the export elasticities varies across industries. The results presented here provide some insights as to why the exchange rate elasticities of exports of Asian countries with high or increasing IIT may be low or declining. For policy makers, these results imply that the effectiveness of exchange rate adjustments with the aim of addressing trade imbalances diminishes with the extent of IIT.[18]

Conclusion

Exchange rates have long been at the center of the debate on global imbalances. While in the 1980s, imbalances between Japan and the United States directed the spotlight at the yen, more recently it has been the imbalances between China and the United States, which have led to calls for a revaluation of yuan. Generally, it is assumed that the appreciation of an exporter's currency will increase the relative price of exports and hence is expected to reduce exports.

Against this background, the main purpose of this paper was to examine the hypothesis that export sensitivity to exchange rates is reduced as the extent of IIT increases. The hypothesis is based on the assumption that a higher degree of IIT implies a lower elasticity of substitution among differentiated products and vice versa. That is, it is assumed that as product differentiation increases, IIT deepens, and at the same time the elasticity of substitution among products becomes smaller. A theoretical model was proposed that explains this relation. According to the model presented, a higher degree of IIT is also linked with a smaller bilateral gap in production costs. In order to test this model empirically, estimations were conducted using six separate industry panels for thirty-eight trading pairs that include China, the United States, and Japan. The six industries chosen in this paper vary regarding the extent of intra-industry trade (IIT).

Using the export quantity index data to measure real exports, the empirical results confirm that the negative impact of exchange rate appreciation on exports decreases the higher the degree of IIT as a result of a lower elasticity of substitution among differentiated products. However, the impact of the gap in production costs on trade sensitivity to exchange rates varies across industries.

The empirical finding that IIT lowers trade sensitivity to exchange rates suggests that the role that exchange rates can play in addressing trade imbalances diminishes in circumstances where IIT is high. Both the theoretical model presented above (see equation (9)) as well as recent trends suggest that IIT is bound to continue to increase as income and technology levels of developing countries converge to those of developed countries. Consequently, exchange rate devaluations (or revaluations) are becoming a less powerful tool to redress global imbalances, and the empirical results obtained here suggest that even if China were to revalue its currency, the desired effect may be smaller than many of those calling for such a step expect.

---

† Ph.D. candidate at Hitotsubashi University and research fellow of the Japan Society for the Promotion of Science (DC2). E-mail address: oguro.yoko@ gmail.com (Please remove the space after the @-sign.)

I would like to thank Kyoji Fukao for invaluable advice and encouragement. I am grateful to Yougesh Khatri, Eiji Ogawa, Kentaro Iwatsubo, and Daiji Kawaguchi for helpful suggestions and encouragement. I am also grateful to Akira Ariyoshi, David Cowen, Eiji Kurozumi, Naohito Abe, and Tangjun Yuan for helpful comments. In addition, I particularly would like to thank Masato Kuroko and Yosuke Noda for providing the necessary data; without their help this work would not have been possible. However, all remaining errors are solely my responsibility.

[1] Brander and Krugman (1983) show that it is possible that IIT includes trade in standardized products as well. The analysis in this paper is based on the assumption that nearly standardized products (=products with a high substitution elasticity) play a negligible role in IIT.

[2] In these previous studies, IIT is first defined as cases where the extent of trade overlap is greater than 10 percent, and is then classified into VIIT and HIIT based on unit value ratios:

$\frac{UVE^z}{UVI^z} < \frac{1}{A}, \frac{UVE^z}{UVI^z} > A$: vertical intra-industry trade (VIIT)

$\frac{1}{A} \leq \frac{UVE^z}{UVI^z} \leq A$: horizontal intra-industry trade (HIIT)

where A is 1.15 or 1.25, UV is the unit value, and E and I are the exports and imports of industry z.

[3] In the equations, the industry subscript "z" is omitted for variables such as $F, c, \theta, p, \overline{\alpha}, \overline{\eta}, MC, FC$ for notational convenience.

[4] The derivation of equations (9.1) to (9.4) and of equation (9.7) basically follows Fukao, Okubo and Stern (2003).

[5] If there are *Z* industries in country *j*,

$$Y_j = \overline{\alpha}_1 \cdot Y_j + \overline{\alpha}_2 \cdot Y_j + \cdots + \overline{\alpha}_z \cdot Y_j, \text{ where } \overline{\alpha}_1 + \overline{\alpha}_2 + \cdots + \overline{\alpha}_z = 1.$$

As noted above, the industry subscript *z* on $\overline{\alpha}_z$ is omitted in equation (9.2).

[6] In other words, it is assumed that product variety depends on national income, Y_i.

[7] IM^z_{AB} represents country *A*'s imports of industry *z* goods from country *B*. The calculation of the IIT index for country *A* in this paper is conducted using EX^z_{AB} and IM^z_{AB}, and is inevitably biased because the export data are reported on an f.o.b. basis while the import data are measured on a c.i.f. basis.

Grubel and Lloyd (1975) developed a similar index for IIT, and the index is one of the earliest works on IIT:

$$GLI^z_{AB} = 1 - \frac{\sum |EX^z_{AB} - EX^z_{BA}|}{\sum |EX^z_{AB} + EX^z_{BA}|}$$

[8] While the theoretical model presented here assumes that the elasticity of substitution, θ, is the same among products in the same product category, and thus the same between two countries that engage in IIT, this assumption is relaxed in the empirical analysis for each industry later in this paper and differences in θ from trade pair to trade pair because of differences in commodity compositions are allowed for. θ may also differ for other reasons, such as differences in competition in a pair of countries. However, these aspects are not considered here.

[9] When one of the countries in Asia as defined here is an exporter, the country itself is excluded from the group, Asia. For instance, China is excluded from Asia for the trading pair China–Asia.

[10] The paper follows the industry classification in Kuroko (2006), which is based on the SITC.

[11] The pairs Japan–Japan and United States–North America are excluded.

[12] See Feenstra (2004) for further discussion on the empirical applications of gravity equations.

[13] Each industry panel consists of the thirty-eight bilateral real export equations.

The empirical results do not differ substantially when the distance term is or is not included, and the term is therefore omitted from the regressions.

[14] Kuroko's (2006) export quantity index is calculated by dividing the export value index by the Fisher unit price index. Almost 75 percent of Comtrade data is in kilograms.

[15] Due to data constraints, the Balassa-Samuelson effect cannot be fully excluded.

[16] The lag lengths are determined without the *GDPpcgap*logRER*, *IIT*logRER*, *GDPpcgap*, and *IIT* terms, based on a fixed effects model. The lag structures chosen by the Bayesian Information Criterion (BIC) are also considered as a cross-check.

[17] All regressions are with heteroskedasticity-robust standard errors.

[18] A concrete example is provided in Oguro, Fukao and Khatri (2007) , which presents the simulation of real exchange rate elasticities of China's exports to North America.

References

Bahmani-Oskooee, Mohsen and Gour Gobinda Goswami (2004) “Exchange Rate Sensitivity of Japan's Bilateral Trade Flows,” *Japan and the World Economy* 16(1): 1-15.

Bahmani-Oskooee, Mohsen and Taggert J. Brooks (1999) “Bilateral J-Curve Between U.S. and Her Trading Partners," *Weltwirtschaftliches Archiv* 135(1): 156-165.

Brander, James and Paul Krugman (1983) “A ‘Reciprocal Dumping’ Model of International Trade,” *Journal of International Economics* 15(3-4): 313-321.

Breuer, Janice Boucher and Leianne A.Clements (2003) “The Commodity Composition of US-Japanese Trade and the Yen/Dollar Real Exchange Rate,” *Japan and the World Economy* 15(3): 307-330.

Chinn, Menzie D. (2004) “Incomes, Exchange Rates and the US Trade Deficit, Once Again,” *International Finance* 7(3): 451-469.

Chinn, Menzie D. (2005) “Doomed to Deficits? Aggregate U.S. Trade Flows Re-Examined,” *Review of World Economics* 141(3): 460-485.

Cushman, David O. (1990) “U.S. Bilateral Trade Equations: Forecasts and Structural Stability,” *Applied Economics* 22(8): 1093-1102.

Dixit, Avinash K. and Joseph E. Stiglitz (1977) “Monopolistic Competition and Optimum Product Diversity,” *American Economic Review* 67(3): 297-308.

Eaton, Jonathan and Akiko Tamura (1994) “Bilateralism and Regionalism in Japanese and U.S. Trade and Direct Foreign Investment Patterns,” *Journal of the Japanese and International Economies* 8(4): 478-510.

Feenstra, Robert C. (2004) *Advanced International Trade*, Princeton, New Jersey: Princeton University Press.

Fukao, Kyoji, Hikari Ishido and Keiko Ito (2003) “Vertical Intra-Industry Trade and Foreign Direct Investment in East Asia,” *Journal of the Japanese and International Economies* 17(4): 468-506.

Fukao, Kyoji, Toshihiro Okubo, and Robert M. Stern (2003) “Trade Diversion under NAFTA,” in Robert M. Stern (ed.), *Japan’s Economic Recovery: Commercial Policy, Monetary Policy, and Corporate Governance*, Cheltenham: Edward Elgar Publishing.

Fontagné, Lionel, Michael Freudenberg, and Nicholas Péridy (1997) “Trade Patterns Inside the Single Market,” *Working Paper* 1997-07, Centre d’Etudes Prospectives et d’InformationS Internationales (CEPII).

Greenaway, David, Robert C. Hine and Chris Milner (1995) "Vertical and Horizontal Intra-Industry Trade: A Cross Industry Analysis for the United Kingdom," *The Economic Journal* 105(433): 1505-18.

Grubel, Herbert G. and P.J.Lloyd (1975) *Intra-Industry Trade: The Theory and Measurement of International Trade in Differenced Products*, New York: Wiley.

Hooper, Peter, Karen Johnson and Jaime Marquez (1998) "Trade Elasticities for G-7 Countries," *International Finance Discussion Papers* 609, Board of Governors of the Federal Reserve System.

Houthakker, Hendrik S. and Stephen P. Magee (1969) "Income and Price Elasticities in World Trade," *The Review of Economics and Statistics* 51(2): 111-25.

IMF, *International Financial Statistics*, Washington, D.C.: International Monetary Fund.

Kuroko, Masato (2006) "Trade Indices," Database compiled as part of the research project, "Compilation and Application of Trade Indices III: Relation Between Trade Price Indices and Other Trade Indices," Institute of Developing Economies, JETRO.

Marquez, Jaime (1990) "Bilateral Trade Elasticities," *The Review of Economics and Statistics* 72(1): 70-77.

Nadenichek, Jon (2000) "The Japan-US Trade Imbalance: A Real Business Cycle Perspective," *Japan and the World Economy* 12(3): 255-271.

Oguro, Yoko, Kyoji Fukao and Yougesh Khatri (2007) "Trade Sensitivity to Exchange Rates in the Context of Intra-Industry Trade," forthcoming as an IMF Working Paper.

Rose, Andrew K. (1990) "Exchange Rates and the Trade Balance: Some Evidence from Developing Countries," *Economics Letters* 34(3): 271-275.

Rose, Andrew K. (1991) "The Role of Exchange Rates in a Popular Model of International Trade: Does the 'Marshall-Lerner' Condition Hold?" *Journal of International Economics* 30(3-4): 301-316.

Thorbecke, Willem (2006) "The Effect of Exchange Rate Changes on Trade in East Asia," *Discussion Paper* 06009, Research Institute of Economy, Trade and Industry (RIETI).

United Nations, *United Nations Commodity Trade Statistics Database*, online: <http://comtrade.un.org/db/>.

Appendix Table. Results of Johansen's (Trace) Cointegration Test

Industry: Textiles

Thirty-Eight Trade Pairs	Sample Period	H_0	H_1	Eigenvalue	Trace	p-value
China-EU	1989-2003	NA				
China-Japan	1989-2003	NA				
China-Asia	1989-2003	NA				
China-North America	1989-2003	NA				
Hong Kong SAR-EU	1977-2004	$r \leq 11$	$r = 12$	1.000	270.359	0.000 ***
		$r \leq 12$	$r = 13$	0.995	110.556	0.256
Hong Kong SAR-Japan	1977-2004	$r \leq 11$	$r = 12$	1.000	269.931	0.000 ***
		$r \leq 12$	$r = 13$	0.997	106.033	0.379
Hong Kong SAR-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	62.696	0.000 ***
		$r \leq 17$	$r = 18$	0.791	4.702	0.846
Hong Kong SAR-North America	1977-2004	$r \leq 11$	$r = 12$	1.000	249.429	0.000 ***
		$r \leq 12$	$r = 13$	0.987	105.447	0.397
Indonesia-EU	1976-2004	$r \leq 11$	$r = 12$	0.997	159.143	0.039 **
		$r \leq 12$	$r = 13$	0.989	105.369	0.399
Indonesia-Japan	1976-2004	$r \leq 11$	$r = 12$	1.000	191.003	0.000 ***
		$r \leq 12$	$r = 13$	0.973	93.544	0.750
Indonesia-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	62.554	0.000 ***
		$r \leq 17$	$r = 18$	0.586	3.005	0.910
Indonesia-North America	1976-2004	$r \leq 11$	$r = 12$	0.999	159.183	0.039 **
		$r \leq 12$	$r = 13$	0.977	97.292	0.650
Japan-EU	1976-1991, 1995-2003	NA				
Japan-Asia	1981-1991, 1995-2003	NA				
Japan-North America	1976-1991, 1995-2003	NA				
Korea-EU	1976-2003	$r \leq 11$	$r = 12$	1.000	267.133	0.000 ***
		$r \leq 12$	$r = 13$	0.997	101.116	0.533
Korea-Japan	1976-2003	$r \leq 11$	$r = 12$	1.000	248.227	0.000 ***
		$r \leq 12$	$r = 13$	0.965	80.497	0.940
Korea-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	48.340	0.000 ***
		$r \leq 17$	$r = 18$	0.770	5.167	0.822
Korea-North America	1976-2003	$r \leq 11$	$r = 12$	1.000	253.474	0.000 ***
		$r \leq 12$	$r = 13$	0.995	110.456	0.258
Malaysia-EU	1976-2004	$r \leq 10$	$r = 11$	1.000	315.755	0.000 ***
		$r \leq 11$	$r = 12$	0.997	125.894	0.684
Malaysia-Japan	1976-2004	$r \leq 11$	$r = 12$	1.000	160.950	0.031 **
		$r \leq 12$	$r = 13$	0.970	91.812	0.789
Malaysia-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	36.359	0.013 **
		$r \leq 17$	$r = 18$	0.452	2.328	0.928
Malaysia-North America	1976-2004	$r \leq 10$	$r = 11$	1.000	313.134	0.000 ***
		$r \leq 11$	$r = 12$	0.996	146.339	0.170
Philippines-EU	1976-2003	$r \leq 11$	$r = 12$	1.000	269.586	0.000 ***
		$r \leq 12$	$r = 13$	0.998	106.658	0.361
Philippines-Japan	1976-2003	$r \leq 12$	$r = 13$	0.999	139.612	0.006 ***
		$r \leq 13$	$r = 14$	0.982	83.099	0.259
Philippines-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	51.543	0.000 ***
		$r \leq 17$	$r = 18$	0.729	3.995	0.876
Philippines-North America	1976-2003	$r \leq 11$	$r = 12$	1.000	237.583	0.000 ***
		$r \leq 12$	$r = 13$	0.974	86.947	0.874
Singapore-EU	1976-2004	$r \leq 11$	$r = 12$	1.000	177.398	0.003 ***
		$r \leq 12$	$r = 13$	0.996	92.149	0.781
Singapore-Japan	1976-2004	$r \leq 11$	$r = 12$	1.000	227.469	0.000 ***
		$r \leq 12$	$r = 13$	0.986	123.882	0.053
Singapore-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	65.944	0.000 ***
		$r \leq 17$	$r = 18$	0.855	7.140	0.694
Singapore-North America	1976-2004	$r \leq 11$	$r = 12$	0.997	158.098	0.044 **
		$r \leq 12$	$r = 13$	0.977	106.249	0.373
Thailand-EU	1976-1987, 1990-2001	NA				
Thailand-Japan	1976-1987, 1990-2001	NA				
Thailand-Asia	1981-1987, 1990-2001	NA				
Thailand-North America	1976-1987, 1990-2001	NA				
United States-EU	1976-2004	$r \leq 11$	$r = 12$	1.000	184.149	0.001 ***
		$r \leq 12$	$r = 13$	0.994	109.517	0.282
United States-Japan	1976-2004	$r \leq 10$	$r = 11$	1.000	318.247	0.000 ***
		$r \leq 11$	$r = 12$	0.999	145.502	0.185
United States-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	58.470	0.000 ***
		$r \leq 17$	$r = 18$	0.834	7.316	0.680

, *: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend.
Refer to Equation (9.11) and Table 9.1 for the model tested.

Appendix Table. (continued) Results of Johansen's (Trace) Cointegration Test

Industry: Pulp and Paper

Thirty-Eight Trade Pairs	Sample Period	H_0	H_1	Eigenvalue	Trace	p-value
China-EU	1989-2003	NA				
China-Japan	1989-2003	NA				
China-Asia	1989-2003	NA				
China-North America	1989-2003	NA				
Hong Kong SAR-EU	1978-2004	$r \leq 12$	$r = 13$	1.000	208.754	0.000 ***
		$r \leq 13$	$r = 14$	0.969	64.004	0.852
Hong Kong SAR-Japan	1977-2004	$r \leq 11$	$r = 12$	1.000	233.416	0.000 ***
		$r \leq 12$	$r = 13$	0.978	80.324	0.942
Hong Kong SAR-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	62.541	0.000 ***
		$r \leq 17$	$r = 18$	0.919	9.619	0.479
Hong Kong SAR-North America	1977-2004	$r \leq 11$	$r = 12$	1.000	241.258	0.000 ***
		$r \leq 12$	$r = 13$	0.977	101.709	0.514
Indonesia-EU	1976-1978, 1980-1986, 1988-2004	NA				
Indonesia-Japan	1979-1980, 1982-2004	$r \leq 16$	$r = 17$	1.000	57.288	0.000 ***
	(test through 1982-2004)	$r \leq 17$	$r = 18$	0.799	6.384	0.749
Indonesia-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	58.024	0.000 ***
		$r \leq 17$	$r = 18$	0.747	6.027	0.772
Indonesia-North America	1976-1980, 1982-1983, 1986-2004	NA				
Japan-EU	1976-1991, 1995-2003	NA				
Japan-Asia	1981-1991, 1995-2003	NA				
Japan-North America	1976-1991, 1995-2003	NA				
Korea-EU	1976-2003	$r \leq 11$	$r = 12$	1.000	255.373	0.000 ***
		$r \leq 12$	$r = 13$	0.995	105.116	0.407
Korea-Japan	1976-2003	$r \leq 11$	$r = 12$	1.000	275.119	0.000 ***
		$r \leq 12$	$r = 13$	0.998	103.145	0.469
Korea-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	53.112	0.000 ***
		$r \leq 17$	$r = 18$	0.570	3.602	0.891
Korea-North America	1976-2003	$r \leq 11$	$r = 12$	1.000	251.386	0.000 ***
		$r \leq 12$	$r = 13$	0.972	90.662	0.812
Malaysia-EU	1976-1977, 1979-1980, 1982-2004	$r \leq 16$	$r = 17$	1.000	51.319	0.000 ***
	(test through 1982-2004)	$r \leq 17$	$r = 18$	0.645	4.869	0.838
Malaysia-Japan	1978-2004	$r \leq 12$	$r = 13$	1.000	189.606	0.000 ***
		$r \leq 13$	$r = 14$	0.962	55.871	0.950
Malaysia-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	45.862	0.001 ***
		$r \leq 17$	$r = 18$	0.742	4.419	0.859
Malaysia-North America	1976-1977, 1979-1980, 1982-2004	$r \leq 16$	$r = 17$	1.000	46.144	0.000 ***
	(test through 1982-2004)	$r \leq 17$	$r = 18$	0.740	4.565	0.852
Philippines-EU	1976-2003	$r \leq 11$	$r = 12$	1.000	276.147	0.000 ***
		$r \leq 12$	$r = 13$	0.993	118.018	0.113
Philippines-Japan	1976-2003	$r \leq 11$	$r = 12$	1.000	272.026	0.000 ***
		$r \leq 12$	$r = 13$	0.994	104.462	0.427
Philippines-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	46.279	0.000 ***
		$r \leq 17$	$r = 18$	0.755	5.226	0.819
Philippines-North America	1976-1980, 1982-2003	$r \leq 17$	$r = 18$	1.000	35.419	0.000 ***
		$r \leq 18$	$r = 19$	0.544	1.573	0.622
Singapore-EU	1976-2004	$r \leq 10$	$r = 11$	1.000	337.174	0.000 ***
		$r \leq 11$	$r = 12$	1.000	154.862	0.066
Singapore-Japan	1976-2004	$r \leq 10$	$r = 11$	1.000	322.524	0.000 ***
		$r \leq 11$	$r = 12$	0.992	144.656	0.201
Singapore-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	64.856	0.000 ***
		$r \leq 17$	$r = 18$	0.800	4.824	0.840
Singapore-North America	1976-2004	$r \leq 10$	$r = 11$	1.000	325.675	0.000 ***
		$r \leq 11$	$r = 12$	0.993	139.834	0.304
Thailand-EU	1977-1987, 1990-2001	NA				
Thailand-Japan	1979-1987, 1990-2001	NA				
Thailand-Asia	1981-1987, 1990-2001	NA				
Thailand-North America	1976-1980, 1982-1987, 1990-2001	NA				
United States-EU	1976-2004	$r \leq 11$	$r = 12$	0.999	165.845	0.016 **
		$r \leq 12$	$r = 13$	0.982	98.724	0.608
United States-Japan	1976-2004	$r \leq 10$	$r = 11$	1.000	316.261	0.000 ***
		$r \leq 11$	$r = 12$	0.993	132.261	0.511
United States-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	53.959	0.000 ***
		$r \leq 17$	$r = 18$	0.708	4.595	0.851

, *: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend.
Refer to Equation (9.11) and Table 9.1 for the model tested.

Appendix Table. (continued) Results of Johansen's (Trace) Cointegration Test

Industry: Metal Products

Thirty-Eight Trade Pairs	Sample Period	H_0	H_1	Eigenvalue	Trace	p-value
China-EU	1989-2003	NA				
China-Japan	1989-2003	NA				
China-Asia	1989-2003	NA				
China-North America	1989-2003	NA				
Hong Kong SAR-EU	1977-2004	$r \le 10$	$r = 11$	1.000	189.740	0.000 ***
		$r \le 11$	$r = 12$	0.973	89.835	0.828
Hong Kong SAR-Japan	1977-2004	$r \le 10$	$r = 11$	0.998	160.477	0.033 **
		$r \le 11$	$r = 12$	0.983	106.534	0.364
Hong Kong SAR-Asia	1981-2003	$r \le 14$	$r = 15$	1.000	92.027	0.000 ***
		$r \le 15$	$r = 16$	0.951	15.700	0.761
Hong Kong SAR-North America	1977-2004	$r \le 10$	$r = 11$	1.000	198.048	0.000 ***
		$r \le 11$	$r = 12$	0.972	109.361	0.286
Indonesia-EU	1979-2004	$r \le 11$	$r = 12$	1.000	204.252	0.000 ***
		$r \le 12$	$r = 13$	0.986	73.982	0.571
Indonesia-Japan	1985-2004	NA				
Indonesia-Asia	1981-2003	$r \le 14$	$r = 15$	1.000	94.034	0.000 ***
		$r \le 15$	$r = 16$	0.868	16.103	0.741
Indonesia-North America	1987-2004	NA				
Japan-EU	1976-1991, 1995-2003	NA				
Japan-Asia	1981-1991, 1995-2003	NA				
Japan-North America	1976-1991, 1995-2003	NA				
Korea-EU	1976-2003	$r \le 9$	$r = 10$	1.000	307.204	0.000 ***
		$r \le 10$	$r = 11$	0.992	130.491	0.561
Korea-Japan	1976-2003	$r \le 10$	$r = 11$	0.999	168.876	0.010 **
		$r \le 11$	$r = 12$	0.976	103.452	0.459
Korea-Asia	1981-2003	$r \le 14$	$r = 15$	1.000	78.747	0.000 ***
		$r \le 15$	$r = 16$	0.752	10.762	0.921
Korea-North America	1976-2003	$r \le 9$	$r = 10$	1.000	331.913	0.000 ***
		$r \le 10$	$r = 11$	0.994	150.847	0.106
Malaysia-EU	1976-2004	$r \le 9$	$r = 10$	1.000	334.059	0.000 ***
		$r \le 10$	$r = 11$	0.979	117.635	0.848
Malaysia-Japan	1979-2004	$r \le 11$	$r = 12$	1.000	195.255	0.000 ***
		$r \le 12$	$r = 13$	0.977	69.837	0.710
Malaysia-Asia	1981-2003	$r \le 14$	$r = 15$	1.000	64.937	0.001 ***
		$r \le 15$	$r = 16$	0.584	6.528	0.973
Malaysia-North America	1977-1980, 1982-2004	$r \le 14$	$r = 15$	1.000	67.730	0.001 ***
	(test through 1982-2004)	$r \le 15$	$r = 16$	0.858	12.536	0.880
Philippines-EU	1984-1985, 1990-2003	NA				
Philippines-Japan	1976-2003	$r \le 9$	$r = 10$	1.000	324.419	0.000 ***
		$r \le 10$	$r = 11$	0.975	129.711	0.583
Philippines-Asia	1981-2003	$r \le 14$	$r = 15$	1.000	80.353	0.000 ***
		$r \le 15$	$r = 16$	0.795	11.210	0.912
Philippines-North America	1976-1980, 1982-2003	$r \le 15$	$r = 16$	1.000	54.793	0.000 ***
	(test through 1982-2003)	$r \le 16$	$r = 17$	0.632	3.006	0.910
Singapore-EU	1976-2004	$r \le 9$	$r = 10$	1.000	337.295	0.000 ***
		$r \le 10$	$r = 11$	0.998	145.199	0.190
Singapore-Japan	1976-2004	$r \le 10$	$r = 11$	1.000	181.270	0.002 ***
		$r \le 11$	$r = 12$	0.944	103.874	0.446
Singapore-Asia	1981-2003	$r \le 14$	$r = 15$	1.000	91.139	0.000 ***
		$r \le 15$	$r = 16$	0.739	9.413	0.943
Singapore-North America	1976-2004	$r \le 9$	$r = 10$	1.000	261.984	0.000 ***
		$r \le 10$	$r = 11$	0.972	110.687	0.926
Thailand-EU	1976-1987, 1990-2001	NA				
Thailand-Japan	1976-1987, 1990-2001	NA				
Thailand-Asia	1981-1987, 1990-2001	NA				
Thailand-North America	1976-1987, 1990-2001	NA				
United States-EU	1976-2004	$r \le 9$	$r = 10$	1.000	355.218	0.000 ***
		$r \le 10$	$r = 11$	0.988	142.195	0.250
United States-Japan	1976-2004	$r \le 9$	$r = 10$	1.000	333.792	0.000 ***
		$r \le 10$	$r = 11$	0.958	117.965	0.843
United States-Asia	1981-2003	$r \le 14$	$r = 15$	1.000	89.960	0.000 ***
		$r \le 15$	$r = 16$	0.854	15.858	0.753

, *: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend.
Refer to Equation (9.11) and Table 9.1 for the model tested.

Appendix Table. (continued) Results of Johansen's (Trace) Cointegration Test
Industry: General Machinery

Thirty-Eight Trade Pairs	Sample Period	H0	H1	Eigenvalue	Trace	p-value
China-EU	1989-2003	NA				
China-Japan	1989-2003	NA				
China-Asia	1989-2003	NA				
China-North America	1989-2003	NA				
Hong Kong SAR-EU	1977-2004	r ≤ 13	r = 14	1.000	197.949	0.000 ***
		r ≤ 14	r = 15	0.991	67.278	0.781
Hong Kong SAR-Japan	1977-2004	r ≤ 13	r = 14	1.000	176.324	0.000 ***
		r ≤ 14	r = 15	0.904	49.105	0.981
Hong Kong SAR-Asia	1981-2003	r ≤ 18	r = 19	1.000	29.819	0.002 ***
		r ≤ 19	r = 20	0.897	4.552	0.226
Hong Kong SAR-North America	1977-2004	r ≤ 13	r = 14	1.000	202.466	0.000 ***
		r ≤ 14	r = 15	0.994	79.364	0.377
Indonesia-EU	1976-1979, 1987 -2004	NA				
Indonesia-Japan	1976, 1978-1983, 1985-2004	NA				
Indonesia-Asia	1981-2003	r ≤ 18	r = 19	1.000	29.795	0.002 ***
		r ≤ 19	r = 20	0.006	0.011	0.803
Indonesia-North America	1976-1978, 1982-1983, 1987-2004	NA				
Japan-EU	1976-1991, 1995-2003	NA				
Japan-Asia	1981-1991, 1995-2003	NA				
Japan-North America	1976-1991, 1995-2003	NA				
Korea-EU	1976-2003	r ≤ 13	r = 14	1.000	188.073	0.000 ***
		r ≤ 14	r = 15	0.950	55.107	0.955
Korea-Japan	1976-2003	r ≤ 13	r = 14	1.000	217.499	0.000 ***
		r ≤ 14	r = 15	0.994	82.597	0.273
Korea-Asia	1981-2003	r ≤ 18	r = 19	1.000	33.244	0.001 ***
		r ≤ 19	r = 20	0.877	4.187	0.265
Korea-North America	1976-2003	r ≤ 13	r = 14	1.000	200.548	0.000 ***
		r ≤ 14	r = 15	0.979	65.953	0.812
Malaysia-EU	1979-2004	r ≤ 15	r = 16	1.000	119.493	0.000 ***
		r ≤ 16	r = 17	0.750	19.621	0.959
Malaysia-Japan	1979-2004	r ≤ 15	r = 16	1.000	108.576	0.000 ***
		r ≤ 16	r = 17	0.938	25.103	0.883
Malaysia-Asia	1981-2003	r ≤ 18	r = 19	1.000	26.005	0.005 ***
		r ≤ 19	r = 20	0.224	0.508	0.753
Malaysia-North America	1979-1980, 1982-2004	r ≤ 18	r = 19	1.000	26.856	0.004 ***
	(test through 1982-2004)	r ≤ 19	r = 20	0.300	0.713	0.730
Philippines-EU	1976-1980, 1984, 1986-2003	NA				
Philippines-Japan	1977-1979, 1985-2003	NA				
Philippines-Asia	1981-2003	r ≤ 18	r = 19	1.000	27.934	0.003 ***
		r ≤ 19	r = 20	0.222	0.503	0.754
Philippines-North America	1976-1980, 1982-2003	NA				
Singapore-EU	1976-2004	r ≤ 12	r = 13	1.000	241.788	0.000 ***
		r ≤ 13	r = 14	0.991	92.969	0.763
Singapore-Japan	1976-2004	r ≤ 12	r = 13	1.000	279.962	0.000 ***
		r ≤ 13	r = 14	0.998	120.069	0.087
Singapore-Asia	1981-2003	r ≤ 18	r = 19	1.000	33.860	0.001 ***
		r ≤ 19	r = 20	0.168	0.368	0.768
Singapore-North America	1976-2004	r ≤ 12	r = 13	1.000	258.998	0.000 ***
		r ≤ 13	r = 14	0.968	105.289	0.402
Thailand-EU	1977-1987, 1990-2001	NA				
Thailand-Japan	1976-1987, 1990-2001	NA				
Thailand-Asia	1981-1987, 1990-2001	NA				
Thailand-North America	1976-1980, 1983-1987, 1990-2001	NA				
United States-EU	1976-1977, 1979-2004	r ≤ 15	r = 16	1.000	114.891	0.000 ***
	(test through 1979-2004)	r ≤ 16	r = 17	0.908	24.161	0.901
United States-Japan	1976-1977, 1979-2004	r ≤ 15	r = 16	1.000	105.651	0.000 ***
	(test through 1979-2004)	r ≤ 16	r = 17	0.842	20.330	0.953
United States-Asia	1981-2003	r ≤ 18	r = 19	1.000	29.950	0.002 ***
		r ≤ 19	r = 20	0.245	0.562	0.747

, *: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend.
Refer to Equation (9.11) and Table 9.1 for the model tested.

Appendix Table. (continued) Results of Johansen's (Trace) Cointegration Test

Industry: Electrical Machinery

Thirty-Eight Trade Pairs	Sample Period	H_0	H_1	Eigenvalue	Trace	p-value
China-EU	1989-2003	NA				
China-Japan	1989-2003	NA				
China-Asia	1989-2003	NA				
China-North America	1989-2003	NA				
Hong Kong SAR-EU	1977-2004	$r \leq 9$	$r = 10$	1.000	312.477	0.000 ***
		$r \leq 10$	$r = 11$	0.995	130.055	0.573
Hong Kong SAR-Japan	1977-2004	$r \leq 10$	$r = 11$	0.999	179.208	0.002 ***
		$r \leq 11$	$r = 12$	0.985	111.866	0.225
Hong Kong SAR-Asia	1981-2003	$r \leq 14$	$r = 15$	1.000	81.784	0.000 ***
		$r \leq 15$	$r = 16$	0.791	10.807	0.920
Hong Kong SAR-North America	1977-2004	$r \leq 10$	$r = 11$	1.000	192.970	0.000 ***
		$r \leq 11$	$r = 12$	0.991	108.662	0.304
Indonesia-EU	1977-1980,1982, 1984, 1986 -2004	NA				
Indonesia-Japan	1976, 1978-2004	$r \leq 10$	$r = 11$	1.000	289.855	0.000 ***
	(test through 1978-2004)	$r \leq 11$	$r = 12$	0.998	105.744	0.388
Indonesia-Asia	1981-2003	$r \leq 14$	$r = 15$	1.000	83.320	0.000 ***
		$r \leq 15$	$r = 16$	0.941	15.839	0.754
Indonesia-North America	1976-1980, 1982, 1985-2004	NA				
Japan-EU	1976-1991, 1995-2003	NA				
Japan-Asia	1981-1991, 1995-2003	NA				
Japan-North America	1976-1991, 1995-2003	NA				
Korea-EU	1976-2003	$r \leq 9$	$r = 10$	1.000	328.280	0.000 ***
		$r \leq 10$	$r = 11$	0.998	137.586	0.361
Korea-Japan	1976-2003	$r \leq 11$	$r = 12$	0.995	126.578	0.037 **
		$r \leq 12$	$r = 13$	0.964	79.295	0.379
Korea-Asia	1981-2003	$r \leq 14$	$r = 15$	1.000	83.376	0.000 ***
		$r \leq 15$	$r = 16$	0.910	15.149	0.786
Korea-North America	1976-2003	$r \leq 10$	$r = 11$	0.999	157.606	0.047 **
		$r \leq 11$	$r = 12$	0.962	93.402	0.753
Malaysia-EU	1976, 1978-2004	$r \leq 10$	$r = 11$	1.000	288.113	0.000 ***
		$r \leq 11$	$r = 12$	0.991	116.786	0.131
Malaysia-Japan	1979-2004	$r \leq 11$	$r = 12$	1.000	246.099	0.000 ***
		$r \leq 12$	$r = 13$	0.997	82.833	0.266
Malaysia-Asia	1981-2003	$r \leq 14$	$r = 15$	1.000	73.190	0.000 ***
		$r \leq 15$	$r = 16$	0.809	11.064	0.915
Malaysia-North America	1979-2004	$r \leq 11$	$r = 12$	1.000	218.760	0.000 ***
		$r \leq 12$	$r = 13$	0.979	82.163	0.286
Philippines-EU	1976, 1982-2003	$r \leq 15$	$r = 16$	1.000	57.333	0.000 ***
		$r \leq 16$	$r = 17$	0.780	6.750	0.723
Philippines-Japan	1976, 1979-1980, 1982-1983, 1987-2003	NA				
Philippines-Asia	1981-1982, 1984-2003	NA				
Philippines-North America	1976-1977, 1986-2003	NA				
Singapore-EU	1976-2004	$r \leq 9$	$r = 10$	1.000	334.131	0.000 ***
		$r \leq 10$	$r = 11$	0.995	134.803	0.438
Singapore-Japan	1976-2004	$r \leq 10$	$r = 11$	0.997	157.198	0.049 **
		$r \leq 11$	$r = 12$	0.947	98.862	0.603
Singapore-Asia	1981-2003	$r \leq 14$	$r = 15$	1.000	80.900	0.000 ***
		$r \leq 15$	$r = 16$	0.814	11.517	0.905
Singapore-North America	1976-2004	$r \leq 10$	$r = 11$	1.000	168.173	0.011 **
		$r \leq 11$	$r = 12$	0.933	89.470	0.834
Thailand-EU	1977-1987, 1990-2001	NA				
Thailand-Japan	1977-1987, 1990-2001	NA				
Thailand-Asia	1981-1987, 1990-2001	NA				
Thailand-North America	1976-1980, 1982-1987, 1990-2001	NA				
United States-EU	1976-1977, 1979-2004	$r \leq 11$	$r = 12$	1.000	211.020	0.000 ***
	(test through 1979-2004)	$r \leq 12$	$r = 13$	0.967	67.769	0.768
United States-Japan	1976-1977, 1979-2004	$r \leq 11$	$r = 12$	1.000	218.871	0.000 ***
	(test through 1979-2004)	$r \leq 12$	$r = 13$	0.983	67.342	0.779
United States-Asia	1981-2003	$r \leq 14$	$r = 15$	1.000	75.312	0.000 ***
		$r \leq 15$	$r = 16$	0.915	12.865	0.870

, *: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend.

Refer to Equation (9.11) and Table 9.1 for the model tested.

Appendix Table. (continued) Results of Johansen's (Trace) Cointegration Test

Industry: Precision Instruments

Thirty-Eight Trade Pairs	Sample Period	H_0	H_1	Eigenvalue	Trace	p-value
China-EU	1989-2003	NA				
China-Japan	1989-2003	NA				
China-Asia	1989-2003	NA				
China-North America	1989-2003	NA				
Hong Kong SAR-EU	1977-2004	$r \leq 11$	$r = 12$	1.000	239.680	0.000 ***
		$r \leq 12$	$r = 13$	0.995	87.086	0.872
Hong Kong SAR-Japan	1977-2004	$r \leq 11$	$r = 12$	1.000	233.280	0.000 ***
		$r \leq 12$	$r = 13$	0.945	81.434	0.933
Hong Kong SAR-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	60.042	0.000 ***
		$r \leq 17$	$r = 18$	0.797	5.066	0.828
Hong Kong SAR-North America	1977-2004	$r \leq 11$	$r = 12$	1.000	258.954	0.000 ***
		$r \leq 12$	$r = 13$	0.999	119.006	0.100
Indonesia-EU	1976 -2004	$r \leq 10$	$r = 11$	1.000	328.649	0.000 ***
		$r \leq 11$	$r = 12$	0.987	130.423	0.563
Indonesia-Japan	1978-1979, 1981-1982, 1985-2004	NA				
Indonesia-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	62.729	0.000 ***
		$r \leq 17$	$r = 18$	0.775	6.751	0.723
Indonesia-North America	1977-1978, 1980, 1982, 1985-2004	NA				
Japan-EU	1976-1991, 1995-2003	NA				
Japan-Asia	1981-1991, 1995-2003	NA				
Japan-North America	1976-1991, 1995-2003	NA				
Korea-EU	1976-2003	$r \leq 11$	$r = 12$	1.000	254.430	0.000 ***
		$r \leq 12$	$r = 13$	0.964	90.564	0.814
Korea-Japan	1976-2003	$r \leq 11$	$r = 12$	1.000	270.289	0.000 ***
		$r \leq 12$	$r = 13$	0.989	103.042	0.472
Korea-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	50.015	0.000 ***
		$r \leq 17$	$r = 18$	0.739	6.086	0.768
Korea-North America	1976-2003	$r \leq 11$	$r = 12$	1.000	241.211	0.000 ***
		$r \leq 12$	$r = 13$	0.978	80.669	0.939
Malaysia-EU	1979-2004	$r \leq 13$	$r = 14$	1.000	161.666	0.000 ***
		$r \leq 14$	$r = 15$	0.938	37.235	0.948
Malaysia-Japan	1979-2004	$r \leq 13$	$r = 14$	1.000	151.935	0.000 ***
		$r \leq 14$	$r = 15$	0.959	43.652	0.855
Malaysia-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	52.814	0.000 ***
		$r \leq 17$	$r = 18$	0.740	6.635	0.731
Malaysia-North America	1979-2004	$r \leq 13$	$r = 14$	1.000	154.953	0.000 ***
		$r \leq 14$	$r = 15$	0.925	40.415	0.912
Philippines-EU	1979-2003	$r \leq 14$	$r = 15$	1.000	117.478	0.000 ***
		$r < 15$	$r = 16$	0.862	22.552	0.927
Philippines-Japan	1976, 1983-1990, 1992-2003	NA				
Philippines-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	57.021	0.000 ***
		$r \leq 17$	$r = 18$	0.771	4.808	0.841
Philippines-North America	1980, 1982-2003	$r \leq 17$	$r = 18$	1.000	38.857	0.000 ***
	(test through 1982-2003)	$r \leq 18$	$r = 19$	0.741	2.700	0.461
Singapore-EU	1976-2004	$r \leq 10$	$r = 11$	1.000	303.583	0.000 ***
		$r \leq 11$	$r = 12$	0.993	125.602	0.692
Singapore-Japan	1976-1978, 1980-2004	$r \leq 14$	$r = 15$	1.000	113.249	0.000 ***
	(test through 1980-2004)	$r < 15$	$r = 16$	0.886	22.417	0.929
Singapore-Asia	1981-2003	$r \leq 16$	$r = 17$	1.000	55.029	0.000 ***
		$r \leq 17$	$r = 18$	0.334	1.408	0.948
Singapore-North America	1976-2004	$r \leq 11$	$r = 12$	0.997	168.265	0.011 **
		$r \leq 12$	$r = 13$	0.983	115.502	0.152
Thailand-EU	1978, 1980-1981, 1984-1987, 1990-2001	NA				
Thailand-Japan	1977-1979, 1981, 1984-1987, 1990-2001	NA				
Thailand-Asia	1981, 1984-1987, 1990-2001	NA				
Thailand-North America	1979-1980, 1984-1987, 1990-2001	NA				
United States-EU	1976-1977, 1979-1988, 1990-2004	NA				
United States-Japan	1976-1977, 1979-1988, 1990-2004	NA				
United States-Asia	1981-1988,1990- 2003	NA				

, *: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend.
Refer to Equation (9.11) and Table 9.1 for the model tested.