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Export Sensitivity to Exchange Rates**

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

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## Abstract

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 paper theoretically and empirically investigates this relationship. It is assumed that more IIT implies a smaller elasticity of substitution among differentiated products and vice versa. The model presented 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 results confirm that export sensitivity to exchange rates declines as the extent of IIT increases. The policy implication of the results is that exchange rate revaluations become a less powerful tool to redress trade imbalances when substantial IIT exists.

Keywords: trade, exchange rates, intra-industry trade

JEL Classification Numbers: F00, F10, F14, F19

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## I. 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), Nedenichek (2000), and Bahmani-Oskooee 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.<sup>1</sup> 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 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 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 2 shows the linkages between IIT, the elasticity of substitution, and differences in production costs using a monopolistic competition model. Section 3 presents the model and Section 4 discusses the data used in the empirical analysis. The results are presented in Section 5 and Section 6 concludes.

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<sup>1</sup> 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.

## II. 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)).<sup>2</sup> 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

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<sup>2</sup> 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:

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

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

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

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 (8) for the derivation of the measure of the extent of IIT.) Figure 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 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 2(b)), on which concerns regarding global imbalances have focused, is very similar to the average for all thirty-eight trading pairs (Figure 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  $z$ .<sup>3</sup> 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:<sup>4</sup>

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

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<sup>3</sup> In the equations, the industry subscript "z" is omitted for variables such as  $F, c, \theta, p, \bar{\alpha}, \bar{\eta}, MC, FC$  for notational convenience.

<sup>4</sup> The derivation of equations (1) to (4) and of equation (7) basically follows Fukao, Okubo and Stern (2003).

subject to

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

$\theta$  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,  $\bar{\alpha}$ , of country  $j$ 's national income,  $Y_j$ , is used for the consumption of industry  $z$ 's products produced in both countries.<sup>5</sup>

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:

$$c_{i,f,j} = \frac{1}{\sum_{i=1}^2 F_i} \cdot \left( \frac{p_{i,f}}{P_j} \right)^{-\theta} \cdot \frac{\bar{\alpha} Y_j}{P_j} \quad (3)$$

$$\text{where } P_j = \left[ \frac{\sum_{i=1}^2 \sum_{f=1}^{F_i} (p_{i,f})^{1-\theta}}{\sum_{i=1}^2 F_i} \right]^{\frac{1}{1-\theta}} \quad (4)$$

Assume further that the number of firms in industry  $z$  in country  $i$ ,  $F_i$ , is defined as a certain ratio,  $\bar{\eta}$ , to country  $i$ 's national income,  $Y_i$ .<sup>6</sup> 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

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<sup>5</sup> If there are  $Z$  industries in country  $j$ ,

$Y_j = \bar{\alpha}_1 \cdot Y_j + \bar{\alpha}_2 \cdot Y_j + \dots + \bar{\alpha}_z \cdot Y_j$ , where  $\bar{\alpha}_1 + \bar{\alpha}_2 + \dots + \bar{\alpha}_z = 1$ . As noted above, the industry subscript  $z$  on  $\bar{\alpha}_z$  is omitted in equation (2).

<sup>6</sup> In other words, it is assumed that product variety depends on national income,  $Y_i$ .

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:

$$EX_{AB}^z = \frac{\bar{\eta}Y_A}{\bar{\eta}Y_A + \bar{\eta}Y_B} \cdot \left(\frac{p_A}{P}\right)^{-\theta} \cdot \frac{\bar{\alpha}Y_B}{P} = \frac{Y_A}{Y_A + Y_B} \cdot \left(\frac{p_A}{P}\right)^{-\theta} \cdot \frac{\bar{\alpha}Y_B}{P} \quad (5)$$

$$EX_{BA}^z = \frac{\bar{\eta}Y_B}{\bar{\eta}Y_A + \bar{\eta}Y_B} \cdot \left(\frac{p_B}{P}\right)^{-\theta} \cdot \frac{\bar{\alpha}Y_A}{P} = \frac{Y_B}{Y_A + Y_B} \cdot \left(\frac{p_B}{P}\right)^{-\theta} \cdot \frac{\bar{\alpha}Y_A}{P} \quad (6)$$

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:

$$p_{i,f} = p_i = \frac{\theta}{\theta - 1} \cdot MC_{i,f} = \frac{\theta}{\theta - 1} \cdot MC_i \quad (7)$$

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:<sup>7</sup>

$$IIT^z = \frac{\text{Min}(EX_{AB}^z, EX_{BA}^z)}{\text{Max}(EX_{AB}^z, EX_{BA}^z)} = \frac{\text{Min}(EX_{AB}^z, IM_{AB}^z)}{\text{Max}(EX_{AB}^z, IM_{AB}^z)} \quad (8)$$

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<sup>7</sup>  $IM_{AB}^z$  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  $EX_{AB}^z$  and  $IM_{AB}^z$ , 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:

$$GLI_{AB}^z = 1 - \frac{\sum |EX_{AB}^z - EX_{BA}^z|}{\sum |EX_{AB}^z + EX_{BA}^z|}$$



Using (5), (6), (7), and (8),  $IIT^z$  can be written as follows, assuming  $MC_A > MC_B$ :<sup>8</sup>

$$IIT^z = \frac{EX_{AB}^z}{EX_{BA}^z} = \left( \frac{p_A}{p_B} \right)^{-\theta} = \left( \frac{\frac{\theta}{\theta-1} \cdot MC_A}{\frac{\theta}{\theta-1} \cdot MC_B} \right)^{-\theta} = \left( \frac{MC_B}{MC_A} \right)^{\theta} \quad (9)$$

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

### III. 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 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),<sup>9</sup> and (iv) North America (Canada and the United States). Six manufacturing industry panels<sup>10</sup> (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.<sup>11</sup>

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<sup>8</sup> While the theoretical model presented here assumes that the elasticity of substitution,  $\theta$ , 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  $\theta$  from trade pair to trade pair because of differences in commodity compositions are allowed for.  $\theta$  may also differ for other reasons, such as differences in competition in a pair of countries. However, these aspects are not considered here.

<sup>9</sup> 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.

<sup>10</sup> The paper follows the industry classification in Kuroko (2006), which is based on the SITC.

<sup>11</sup> The pairs Japan–Japan and United States–North America are excluded.

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 1(a) and 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 0.090, respectively. The data used for this study are annual data for the period 1974 to 2004 (see Section IV 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 (5) or (6) and estimated. Equation (5) or (6) can be rewritten as the bilateral real export (export quantities,  $QEX$ ) equation of industry,  $z$ , from country  $i$  to country  $j$  as follows:

$$QEX_{ij}^z = \frac{Y_i \cdot Y_j}{Y_i + Y_j} \cdot \left( \frac{p_i}{P} \right)^{-\theta} \cdot \frac{\bar{\alpha}}{P} \quad (5)'$$

Log linearization of equation (5)' leads to the following gravity equation:<sup>12</sup>

$$\log QEX_{ij}^z = \frac{\bar{\alpha}}{P} + \log Y_i + \log Y_j - \theta \log \left( \frac{p_i}{P} \right) - \log(Y_i + Y_j) \quad (10)$$

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 (10) with some modifications. First,  $Y_i$  and  $Y_j$  are rewritten as the exporter's real GDP ( $GDP_{ex}$ ) and the importer's real GDP ( $GDP_{im}$ ), 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

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<sup>12</sup> See Feenstra (2004) for further discussion on the empirical applications of gravity equations.

substitution,  $\theta$ . 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  $\theta$ .  $GDPpcgap$  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 (11) below, which contains lagged terms, is estimated using panels for each industry:<sup>13</sup>

$$\begin{aligned} \log QEX_{ijt}^z = & a + \sum_{k=0} b_k \log GDPex_{i,t-k} + \sum_{k=0} c_k \log GDPim_{j,t-k} + \sum_{k=0} d_k \log RER_{ij,t-k} \\ & + \sum_{k=0} g_k GDPpcgap_{ij,t-k} \cdot \log RER_{ij,t-k} + \sum_{k=0} m_k IIT_{ij,t-k} \cdot \log RER_{ij,t-k} \\ & + \sum_{k=0} h_k GDPpcgap_{ij,t-k} + \sum_{k=0} n_k IIT_{ij,t-k} + v \text{distance}_{ij} + \omega_{ij} + \varepsilon_{ijt} \end{aligned} \quad (11)$$

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

where  $\omega_{ij}$  represents trade-pair-specific factors other than distance, and  $\varepsilon_{ijt}$  is the error term.

Since it is impossible to control for all trading-pair-specific factors, which are represented by  $\omega$ , 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.

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<sup>13</sup> 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.

#### IV. 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.<sup>14</sup>

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).<sup>15</sup> 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 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

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<sup>14</sup> 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.

<sup>15</sup> Due to data constraints, the Balassa-Samuelson effect cannot be fully excluded.

long. It is assumed that all cross-sectional export equations in the panel of each industry satisfy stationarity.

## V. Empirical Results

To estimate the export equation (11), each industry is specified to have a different lag structure for each explanatory variable using the Akaike Information Criterion (AIC).<sup>16</sup> 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 1(a)) and the fixed effects (Table 1(b)) models are reported for each industry, the discussion below concentrates on the results of the model selected by the Hausman test.<sup>17</sup>

The empirical results for the short-run and long-run steady state are shown in Tables 1(a) and 1(b). In the short-run analysis, most of the coefficients of the variables of primary interest,  $\log RER$  and  $\log RER * IIT$ , are statistically significant at times  $t$  and  $t-2$  in the six industries. The signs of the coefficients of  $\log RER(t)$  and  $\log RER(t-2)$  are negative, and those of  $\log RER * IIT(t)$  and  $\log RER * IIT(t-2)$  are positive, as expected. The results indicate that, at times  $t$  and  $t-2$ , real exports in the six industries are negatively related with  $\log RER$  and a higher extent of IIT reduces export sensitivity to exchange rates. Among the statistically significant coefficients on  $\log RER * GDPpcgap(t)$ ,  $\log RER * GDPpcgap(t-1)$ , and  $\log RER * GDPpcgap(t-2)$ , 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.

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<sup>16</sup> The lag lengths are determined without the  $GDPpcgap * \log RER$ ,  $IIT * \log RER$ ,  $GDPpcgap$ , 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.

<sup>17</sup> All regressions are with heteroskedasticity-robust standard errors.

In the steady state analysis, the coefficients of the variables of primary interest,  $\log RER$  and  $\log RER * IIT$ , are significantly different from zero at the 1 percent level for all six industries. As predicted, the coefficient of  $\log RER$  is negative, whereas that of  $\log RER * IIT$  is positive. For instance, in Table 1(a), in the case of the electrical machinery industry, the estimated coefficient of  $\log RER$  is -3.318 and that of  $\log RER * IIT$  is 7.292. However, only for three out of the six industries, statistically significant coefficients for  $\log RER * GDPpcgap$  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 1(a) and 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.

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.<sup>18</sup>

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<sup>18</sup> 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

## VI. 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.

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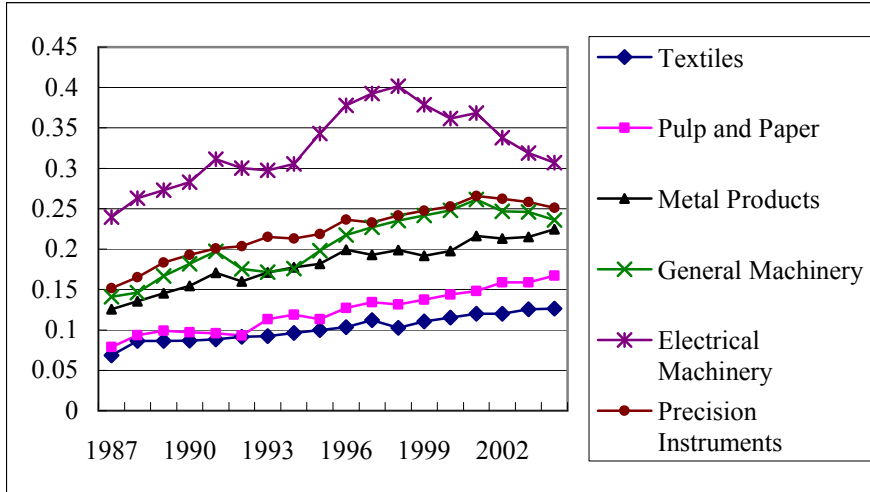
Figure 1: Thirty-Eight Trade Pairs

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

The six industries analyzed in this paper are:

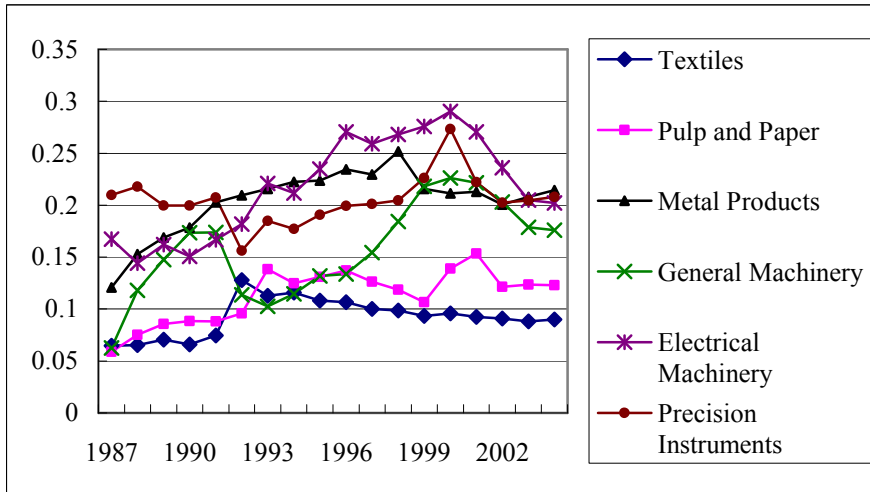
Textiles, pulp and paper, metal products, general machinery, electrical machinery, and precision instruments.

Figure 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 IV for details on data sources.

Figure 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 IV for details on data sources.

Table 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 ** (1.98)	1.169 *** (7.62)	0.981 *** (12.31)	2.491 *** (12.15)	1.329 *** (11.05)	2.729 *** (4.05)
logGDPex(t-1)						-1.454 ** (-2.22)
logGDPex(t-2)						
logGDPim(t)	4.212 *** (4.79)	6.350 *** (4.07)	0.714 *** (6.13)	2.585 (1.04)	1.228 *** (7.63)	1.106 *** (6.33)
logGDPim(t-1)	-2.345 *** (-2.74)	-4.452 *** (-2.92)		-3.511 (-0.95)		
logGDPim(t-2)				2.031 (1.08)		
logRER(t)	-1.432 *** (-5.12)	-1.403 *** (-2.94)	-1.712 *** (-4.81)	-0.151 (-0.22)	-0.637 (-1.50)	-1.600 *** (-3.78)
logRER(t-1)	-0.379 (-1.06)	-0.217 (-0.35)	-0.845 ** (-2.13)	-0.055 (-0.07)	-0.591 (-1.09)	-0.320 (-0.64)
logRER(t-2)	-0.887 *** (-3.72)	-1.919 *** (-4.45)	-1.051 *** (-3.55)	-1.875 *** (-3.65)	-2.090 *** (-5.59)	-0.876 ** (-2.16)
logRER(t)*GDPpcgap(t)	0.025 *** (3.07)	0.044 * (1.69)	-0.034 * (-1.88)	0.051 ** (2.13)	-0.011 (-0.82)	0.106 *** (3.19)
logRER(t-1)*GDPpcgap(t-1)	0.027 ** (2.57)	0.033 * (1.71)	0.007 (0.70)	-0.005 (-0.25)	0.010 (0.53)	0.057 ** (2.04)
logRER(t-2)*GDPpcgap(t-2)	-0.003 (-0.37)	0.004 (0.62)	0.014 *** (2.93)	0.002 (0.24)	-0.011 *** (-3.34)	-0.012 (-1.55)
logRER(t)*IIT(t)	6.962 ** (2.38)	9.006 *** (3.01)	8.612 *** (5.06)	2.283 (0.92)	2.040 * (1.86)	6.789 *** (3.59)
logRER(t-1)*IIT(t-1)	-1.287 (-0.36)	-1.797 (-0.47)	2.214 (1.17)	-0.479 (-0.17)	1.390 (1.01)	0.442 (0.16)
logRER(t-2)*IIT(t-2)	3.250 (1.36)	10.645 *** (4.11)	3.653 *** (2.62)	3.553 * (1.88)	3.862 *** (3.92)	2.782 (1.19)
GDPpcgap(t)	-0.126 *** (-3.08)	-0.222 (-1.64)	0.159 * (1.78)	-0.248 ** (-2.10)	0.038 (0.57)	-0.512 *** (-2.99)
GDPpcgap(t-1)	-0.141 *** (-2.83)	-0.166 * (-1.74)	-0.034 (-0.69)	0.023 (0.27)	-0.067 (-0.70)	-0.295 ** (-2.01)
GDPpcgap(t-2)	0.009 (0.30)	-0.013 (-0.59)	-0.055 *** (-3.02)	-0.007 (-0.23)	0.039 *** (2.95)	0.046 (1.59)
IIT(t)	-33.918 ** (-2.54)	-41.364 *** (-3.02)	-38.603 *** (-4.94)	-7.079 (-0.62)	-8.952 * (-1.75)	-29.955 *** (-3.43)
IIT(t-1)	5.715 (0.35)	8.475 (0.48)	-9.907 (-1.14)	2.349 (0.18)	-6.258 (-0.97)	-1.372 (-0.11)
IIT(t-2)	-15.160 (-1.39)	-48.316 *** (-4.05)	-16.712 *** (-2.59)	-15.423 * (-1.76)	-17.487 *** (-3.78)	-13.078 (-1.26)
_cons	7.980 *** (8.04)	6.418 *** (5.94)	13.106 *** (11.91)	-3.781 * (-1.79)	7.672 *** (7.17)	5.976 *** (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 P>chi2 = 0.4739	chi2(15) =4.18 P>chi2 = 0.9971	chi2(15) =3.93 P>chi2 = 0.9980	chi2(17) =111.80 P>chi2 = 0.0000	chi2(16) =5.93 P>chi2 = 0.9888	chi2(17) = 17.77 P>chi2 = 0.4038
<b>Long-Run Steady State: X = X(t-k) X=logGDPex, logGDPim, logRER, (logRER)*GDPpcgap, (logRER)*IIT, GDPpcgap, IIT k=0,1,2</b>						
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	<b>-2.698 ***</b>	<b>-3.539 ***</b>	<b>-3.608 ***</b>	<b>-2.081 ***</b>	<b>-3.318 ***</b>	<b>-2.796 ***</b>
(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 ***
<b>(d+m ave.IIT)*logRER</b>	<b>-1.893 ***</b>	<b>-1.761 ***</b>	<b>-1.448 ***</b>	<b>-1.135 **</b>	<b>-1.196 ***</b>	<b>-0.949 ***</b>
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 IV for details.

Table 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 * (1.92)	1.229 *** (8.17)	0.981 *** (12.26)	2.640 *** (14.48)	1.388 *** (11.69)	2.792 *** (4.17)
logGDPex(t-1)						-1.430 ** (-2.19)
logGDPex(t-2)						
logGDPim(t)	3.884 *** (4.40)	6.096 *** (3.71)	0.709 *** (5.91)	1.476 (0.60)	1.239 *** (7.92)	1.142 *** (6.76)
logGDPim(t-1)	-1.960 ** (-2.27)	-4.201 *** (-2.60)		-3.203 (-0.91)		
logGDPim(t-2)				2.777 (1.43)		
logRER(t)	-1.455 *** (-5.43)	-1.378 *** (-2.92)	-1.722 *** (-4.94)	-0.146 (-0.23)	-0.667 (-1.61)	-1.615 *** (-3.97)
logRER(t-1)	-0.377 (-1.09)	-0.223 (-0.37)	-0.846 ** (-2.09)	-0.099 (-0.13)	-0.567 (-1.09)	-0.294 (-0.62)
logRER(t-2)	-0.911 *** (-3.97)	-1.885 *** (-4.47)	-1.044 *** (-3.46)	-1.698 *** (-3.44)	-2.100 *** (-5.92)	-0.917 ** (-2.39)
logRER(t)*GDPpcgap(t)	0.026 *** (3.06)	0.041 (1.62)	-0.033 * (-1.77)	0.037 * (1.78)	-0.011 (-0.81)	0.099 *** (2.96)
logRER(t-1)*GDPpcgap(t-1)	0.027 *** (2.68)	0.030 (1.55)	0.007 (0.57)	-0.018 (-0.76)	0.008 (0.47)	0.050 * (1.76)
logRER(t-2)*GDPpcgap(t-2)	-0.003 (-0.43)	0.004 (0.69)	0.013 ** (2.47)	0.001 (0.12)	-0.011 *** (-3.29)	-0.012 * (-1.92)
logRER(t)*IIT(t)	7.247 ** (2.60)	8.939 *** (3.08)	8.671 *** (5.19)	1.736 (0.76)	2.048 * (1.87)	6.789 *** (3.59)
logRER(t-1)*IIT(t-1)	-1.411 (-0.42)	-1.850 (-0.50)	2.232 (1.18)	-0.160 (-0.06)	1.364 (1.00)	0.391 (0.15)
logRER(t-2)*IIT(t-2)	3.405 (1.51)	10.566 *** (4.20)	3.659 *** (2.62)	2.830 (1.60)	3.973 *** (4.08)	3.205 (1.47)
GDPgappc(t)	-0.132 *** (-3.10)	-0.209 (-1.57)	0.156 (1.65)	-0.176 * (-1.76)	0.038 (0.57)	-0.477 *** (-2.77)
GDPpcgap(t-1)	-0.141 *** (-3.03)	-0.151 (-1.57)	-0.034 (-0.58)	0.093 (0.77)	-0.058 (-0.66)	-0.258 * (-1.74)
GDPpcgap(t-2)	0.011 (0.37)	-0.014 (-0.66)	-0.051 ** (-2.55)	-0.004 (-0.13)	0.038 *** (2.91)	0.049 * (1.96)
IIT(t)	-36.006 *** (-2.82)	-41.296 *** (-3.10)	-38.830 *** (-5.03)	-4.557 (-0.43)	-9.117 * (-1.79)	-30.225 *** (-3.44)
IIT(t-1)	6.232 (0.40)	8.643 (0.50)	-9.982 (-1.14)	0.742 (0.06)	-6.188 (-0.96)	-1.282 (-0.11)
IIT(t-2)	-16.173 (-1.56)	-48.201 *** (-4.14)	-16.724 ** (-2.58)	-12.333 (-1.51)	-18.199 *** (-3.96)	-15.438 (-1.58)
_cons	8.068 *** (8.37)	6.021 *** (5.77)	13.153 *** (12.81)	-4.687 ** (-2.46)	7.586 *** (7.63)	5.780 *** (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 P>chi2 = 0.4739	chi2(15)=4.18 P>chi2 = 0.9971	chi2(15)=3.93 P>chi2 = 0.9980	chi2(17)=111.80 P>chi2 = 0.0000	chi2(16)=5.93 P>chi2 = 0.9888	chi2(17) = 17.77 P>chi2 = 0.4038
<b>Long-Run Steady State: X = X(t-k) X=logGDPex, logGDPim, logRER, (logRER)*GDPpcgap, (logRER)*IIT, GDPpcgap, IIT k=0,1,2</b>						
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	<b>-2.743 ***</b>	<b>-3.486 ***</b>	<b>-3.612 ***</b>	<b>-1.942 ***</b>	<b>-3.334 ***</b>	<b>-2.825 ***</b>
(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 ***
<b>(d+m ave.IIT)*logRER</b>	<b>-1.910 ***</b>	<b>-1.729 ***</b>	<b>-1.440 ***</b>	<b>-1.164 **</b>	<b>-1.185 ***</b>	<b>-0.910 ***</b>
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 IV for details.

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

**Industry: Textiles**

Thirty-Eight Trade Pairs	Sample Period	H <sub>0</sub>	H <sub>1</sub>	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 ≤ 11 r < 12	r = 12 r = 13	1.000 0.995	270.359 110.556	0.000 *** 0.256
Hong Kong SAR-Japan	1977-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.997	269.931 106.033	0.000 *** 0.379
Hong Kong SAR-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.791	62.696 4.702	0.000 *** 0.846
Hong Kong SAR-North America	1977-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.987	249.429 105.447	0.000 *** 0.397
Indonesia-EU	1976-2004	r ≤ 11 r < 12	r = 12 r = 13	0.997 0.989	159.143 105.369	0.039 ** 0.399
Indonesia-Japan	1976-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.973	191.003 93.544	0.000 *** 0.750
Indonesia-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.586	62.554 3.005	0.000 *** 0.910
Indonesia-North America	1976-2004	r ≤ 11 r < 12	r = 12 r = 13	0.999 0.977	159.183 97.292	0.039 ** 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 ≤ 11 r < 12	r = 12 r = 13	1.000 0.997	267.133 101.116	0.000 *** 0.533
Korea-Japan	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.965	248.227 80.497	0.000 *** 0.940
Korea-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.770	48.340 5.167	0.000 *** 0.822
Korea-North America	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.995	253.474 110.456	0.000 *** 0.258
Malaysia-EU	1976-2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 0.997	315.755 125.894	0.000 *** 0.684
Malaysia-Japan	1976-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.970	160.950 91.812	0.031 ** 0.789
Malaysia-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.452	36.359 2.328	0.013 ** 0.928
Malaysia-North America	1976-2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 0.996	313.134 146.339	0.000 *** 0.170
Philippines-EU	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.998	269.586 106.658	0.000 *** 0.361
Philippines-Japan	1976-2003	r ≤ 12 r < 13	r = 13 r = 14	0.999 0.982	139.612 83.099	0.006 *** 0.259
Philippines-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.729	51.543 3.995	0.000 *** 0.876
Philippines-North America	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.974	237.583 86.947	0.000 *** 0.874
Singapore-EU	1976-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.996	177.398 92.149	0.003 *** 0.781
Singapore-Japan	1976-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.986	227.469 123.882	0.000 *** 0.053
Singapore-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.855	65.944 7.140	0.000 *** 0.694
Singapore-North America	1976-2004	r ≤ 11 r < 12	r = 12 r = 13	0.997 0.977	158.098 106.249	0.044 ** 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 ≤ 11 r < 12	r = 12 r = 13	1.000 0.994	184.149 109.517	0.001 *** 0.282
United States-Japan	1976-2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 0.999	318.247 145.502	0.000 *** 0.185
United States-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.834	58.470 7.316	0.000 *** 0.680

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

Refer to Equation (11) and Table 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 <sub>0</sub>	H <sub>1</sub>	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 ≤ 12 r < 13	r = 13 r = 14	1.000 0.969	208.754 64.004	0.000 *** 0.852
Hong Kong SAR-Japan	1977-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.978	233.416 80.324	0.000 *** 0.942
Hong Kong SAR-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.919	62.541 9.619	0.000 *** 0.479
Hong Kong SAR-North America	1977-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.977	241.258 101.709	0.000 *** 0.514
Indonesia-EU	1976-1978, 1980-1986, 1988-2004	NA				
Indonesia-Japan	1979-1980, 1982-2004 (test through 1982-2004)	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.799	57.288 6.384	0.000 *** 0.749
Indonesia-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.747	58.024 6.027	0.000 *** 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 ≤ 11 r < 12	r = 12 r = 13	1.000 0.995	255.373 105.116	0.000 *** 0.407
Korea-Japan	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.998	275.119 103.145	0.000 *** 0.469
Korea-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.570	53.112 3.602	0.000 *** 0.891
Korea-North America	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.972	251.386 90.662	0.000 *** 0.812
Malaysia-EU	1976-1977, 1979-1980, 1982-2004 (test through 1982-2004)	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.645	51.319 4.869	0.000 *** 0.838
Malaysia-Japan	1978-2004	r ≤ 12 r < 13	r = 13 r = 14	1.000 0.962	189.606 55.871	0.000 *** 0.950
Malaysia-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.742	45.862 4.419	0.001 *** 0.859
Malaysia-North America	1976-1977, 1979-1980, 1982-2004 (test through 1982-2004)	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.740	46.144 4.565	0.000 *** 0.852
Philippines-EU	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.993	276.147 118.018	0.000 *** 0.113
Philippines-Japan	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.994	272.026 104.462	0.000 *** 0.427
Philippines-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.755	46.279 5.226	0.000 *** 0.819
Philippines-North America	1976-1980, 1982-2003	r ≤ 17 r < 18	r = 18 r = 19	1.000 0.544	35.419 1.573	0.000 *** 0.622
Singapore-EU	1976-2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 1.000	337.174 154.862	0.000 *** 0.066
Singapore-Japan	1976-2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 0.992	322.524 144.656	0.000 *** 0.201
Singapore-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.800	64.856 4.824	0.000 *** 0.840
Singapore-North America	1976-2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 0.993	325.675 139.834	0.000 *** 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 ≤ 11 r < 12	r = 12 r = 13	0.999 0.982	165.845 98.724	0.016 ** 0.608
United States-Japan	1976-2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 0.993	316.261 132.261	0.000 *** 0.511
United States-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.708	53.959 4.595	0.000 *** 0.851

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

Refer to Equation (11) and Table 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 <sub>0</sub>	H <sub>1</sub>	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	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	1.000 0.973	189.740 89.835	0.000 *** 0.828
Hong Kong SAR-Japan	1977-2004	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	0.998 0.983	160.477 106.534	0.033 ** 0.364
Hong Kong SAR-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.951	92.027 15.700	0.000 *** 0.761
Hong Kong SAR-North America	1977-2004	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	1.000 0.972	198.048 109.361	0.000 *** 0.286
Indonesia-EU	1979-2004	$r \leq 11$ $r < 12$	$r = 12$ $r = 13$	1.000 0.986	204.252 73.982	0.000 *** 0.571
Indonesia-Japan	1985-2004	NA				
Indonesia-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.868	94.034 16.103	0.000 *** 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	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.992	307.204 130.491	0.000 *** 0.561
Korea-Japan	1976-2003	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	0.999 0.976	168.876 103.452	0.010 ** 0.459
Korea-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.752	78.747 10.762	0.000 *** 0.921
Korea-North America	1976-2003	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.994	331.913 150.847	0.000 *** 0.106
Malaysia-EU	1976-2004	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.979	334.059 117.635	0.000 *** 0.848
Malaysia-Japan	1979-2004	$r \leq 11$ $r < 12$	$r = 12$ $r = 13$	1.000 0.977	195.255 69.837	0.000 *** 0.710
Malaysia-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.584	64.937 6.528	0.001 *** 0.973
Malaysia-North America	1977-1980, 1982-2004 (test through 1982-2004)	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.858	67.730 12.536	0.001 *** 0.880
Philippines-EU	1984-1985, 1990-2003	NA				
Philippines-Japan	1976-2003	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.975	324.419 129.711	0.000 *** 0.583
Philippines-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.795	80.353 11.210	0.000 *** 0.912
Philippines-North America	1976-1980, 1982-2003 (test through 1982-2003)	$r \leq 15$ $r < 16$	$r = 16$ $r = 17$	1.000 0.632	54.793 3.006	0.000 *** 0.910
Singapore-EU	1976-2004	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.998	337.295 145.199	0.000 *** 0.190
Singapore-Japan	1976-2004	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	1.000 0.944	181.270 103.874	0.002 *** 0.446
Singapore-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.739	91.139 9.413	0.000 *** 0.943
Singapore-North America	1976-2004	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.972	261.984 110.687	0.000 *** 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	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.988	355.218 142.195	0.000 *** 0.250
United States-Japan	1976-2004	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.958	333.792 117.965	0.000 *** 0.843
United States-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.854	89.960 15.858	0.000 *** 0.753

\*\*, \*\*\*: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend. Refer to Equation (11) and Table 1 for the model tested.



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

**Industry: General Machinery**

Thirty-Eight Trade Pairs	Sample Period	H <sub>0</sub>	H <sub>1</sub>	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	$r \leq 13$ $r < 14$	$r = 14$ $r = 15$	1.000 0.991	197.949 67.278	0.000 *** 0.781
Hong Kong SAR-Japan	1977-2004	$r \leq 13$ $r < 14$	$r = 14$ $r = 15$	1.000 0.904	176.324 49.105	0.000 *** 0.981
Hong Kong SAR-Asia	1981-2003	$r \leq 18$ $r < 19$	$r = 19$ $r = 20$	1.000 0.897	29.819 4.552	0.002 *** 0.226
Hong Kong SAR-North America	1977-2004	$r \leq 13$ $r < 14$	$r = 14$ $r = 15$	1.000 0.994	202.466 79.364	0.000 *** 0.377
Indonesia-EU	1976-1979, 1987-2004	NA				
Indonesia-Japan	1976, 1978-1983, 1985-2004	NA				
Indonesia-Asia	1981-2003	$r \leq 18$ $r < 19$	$r = 19$ $r = 20$	1.000 0.006	29.795 0.011	0.002 *** 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	$r \leq 13$ $r < 14$	$r = 14$ $r = 15$	1.000 0.950	188.073 55.107	0.000 *** 0.955
Korea-Japan	1976-2003	$r \leq 13$ $r < 14$	$r = 14$ $r = 15$	1.000 0.994	217.499 82.597	0.000 *** 0.273
Korea-Asia	1981-2003	$r \leq 18$ $r < 19$	$r = 19$ $r = 20$	1.000 0.877	33.244 4.187	0.001 *** 0.265
Korea-North America	1976-2003	$r \leq 13$ $r < 14$	$r = 14$ $r = 15$	1.000 0.979	200.548 65.953	0.000 *** 0.812
Malaysia-EU	1979-2004	$r \leq 15$ $r < 16$	$r = 16$ $r = 17$	1.000 0.750	119.493 19.621	0.000 *** 0.959
Malaysia-Japan	1979-2004	$r \leq 15$ $r < 16$	$r = 16$ $r = 17$	1.000 0.938	108.576 25.103	0.000 *** 0.883
Malaysia-Asia	1981-2003	$r \leq 18$ $r < 19$	$r = 19$ $r = 20$	1.000 0.224	26.005 0.508	0.005 *** 0.753
Malaysia-North America	1979-1980, 1982-2004 (test through 1982-2004)	$r \leq 18$ $r < 19$	$r = 19$ $r = 20$	1.000 0.300	26.856 0.713	0.004 *** 0.730
Philippines-EU	1976-1980, 1984, 1986-2003	NA				
Philippines-Japan	1977-1979, 1985-2003	NA				
Philippines-Asia	1981-2003	$r \leq 18$ $r < 19$	$r = 19$ $r = 20$	1.000 0.222	27.934 0.503	0.003 *** 0.754
Philippines-North America	1976-1980, 1982-2003	NA				
Singapore-EU	1976-2004	$r \leq 12$ $r < 13$	$r = 13$ $r = 14$	1.000 0.991	241.788 92.969	0.000 *** 0.763
Singapore-Japan	1976-2004	$r \leq 12$ $r < 13$	$r = 13$ $r = 14$	1.000 0.998	279.962 120.069	0.000 *** 0.087
Singapore-Asia	1981-2003	$r \leq 18$ $r < 19$	$r = 19$ $r = 20$	1.000 0.168	33.860 0.368	0.001 *** 0.768
Singapore-North America	1976-2004	$r \leq 12$ $r < 13$	$r = 13$ $r = 14$	1.000 0.968	258.998 105.289	0.000 *** 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 (test through 1979-2004)	$r \leq 15$ $r \leq 16$	$r = 16$ $r = 17$	1.000 0.908	114.891 24.161	0.000 *** 0.901
United States-Japan	1976-1977, 1979-2004 (test through 1979-2004)	$r \leq 15$ $r \leq 16$	$r = 16$ $r = 17$	1.000 0.842	105.651 20.330	0.000 *** 0.953
United States-Asia	1981-2003	$r \leq 18$ $r < 19$	$r = 19$ $r = 20$	1.000 0.245	29.950 0.562	0.002 *** 0.747

\*\*, \*\*\*: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend. Refer to Equation (11) and Table 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 <sub>0</sub>	H <sub>1</sub>	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	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.995	312.477 130.055	0.000 *** 0.573
Hong Kong SAR-Japan	1977-2004	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	0.999 0.985	179.208 111.866	0.002 *** 0.225
Hong Kong SAR-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.791	81.784 10.807	0.000 *** 0.920
Hong Kong SAR-North America	1977-2004	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	1.000 0.991	192.970 108.662	0.000 *** 0.304
Indonesia-EU	1977-1980, 1982, 1984, 1986-2004	NA				
Indonesia-Japan	1976, 1978-2004 (test through 1978-2004)	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	1.000 0.998	289.855 105.744	0.000 *** 0.388
Indonesia-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.941	83.320 15.839	0.000 *** 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	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.998	328.280 137.586	0.000 *** 0.361
Korea-Japan	1976-2003	$r \leq 11$ $r < 12$	$r = 12$ $r = 13$	0.995 0.964	126.578 79.295	0.037 ** 0.379
Korea-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.910	83.376 15.149	0.000 *** 0.786
Korea-North America	1976-2003	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	0.999 0.962	157.606 93.402	0.047 ** 0.753
Malaysia-EU	1976, 1978-2004	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	1.000 0.991	288.113 116.786	0.000 *** 0.131
Malaysia-Japan	1979-2004	$r \leq 11$ $r < 12$	$r = 12$ $r = 13$	1.000 0.997	246.099 82.833	0.000 *** 0.266
Malaysia-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.809	73.190 11.064	0.000 *** 0.915
Malaysia-North America	1979-2004	$r \leq 11$ $r < 12$	$r = 12$ $r = 13$	1.000 0.979	218.760 82.163	0.000 *** 0.286
Philippines-EU	1976, 1982-2003	$r \leq 15$ $r < 16$	$r = 16$ $r = 17$	1.000 0.780	57.333 6.750	0.000 *** 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	$r \leq 9$ $r < 10$	$r = 10$ $r = 11$	1.000 0.995	334.131 134.803	0.000 *** 0.438
Singapore-Japan	1976-2004	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	0.997 0.947	157.198 98.862	0.049 ** 0.603
Singapore-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.814	80.900 11.517	0.000 *** 0.905
Singapore-North America	1976-2004	$r \leq 10$ $r < 11$	$r = 11$ $r = 12$	1.000 0.933	168.173 89.470	0.011 ** 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 (test through 1979-2004)	$r \leq 11$ $r < 12$	$r = 12$ $r = 13$	1.000 0.967	211.020 67.769	0.000 *** 0.768
United States-Japan	1976-1977, 1979-2004 (test through 1979-2004)	$r \leq 11$ $r < 12$	$r = 12$ $r = 13$	1.000 0.983	218.871 67.342	0.000 *** 0.779
United States-Asia	1981-2003	$r \leq 14$ $r < 15$	$r = 15$ $r = 16$	1.000 0.915	75.312 12.865	0.000 *** 0.870

\*\*, \*\*\*: 5%, 1% significance. "r" is the number of cointegration. Tests are conducted with constant and no trend. Refer to Equation (11) and Table 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 <sub>0</sub>	H <sub>1</sub>	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 ≤ 11 r < 12	r = 12 r = 13	1.000 0.995	239.680 87.086	0.000 *** 0.872
Hong Kong SAR-Japan	1977-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.945	233.280 81.434	0.000 *** 0.933
Hong Kong SAR-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.797	60.042 5.066	0.000 *** 0.828
Hong Kong SAR-North America	1977-2004	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.999	258.954 119.006	0.000 *** 0.100
Indonesia-EU	1976 -2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 0.987	328.649 130.423	0.000 *** 0.563
Indonesia-Japan	1978-1979, 1981-1982, 1985-2004	NA				
Indonesia-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.775	62.729 6.751	0.000 *** 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 ≤ 11 r < 12	r = 12 r = 13	1.000 0.964	254.430 90.564	0.000 *** 0.814
Korea-Japan	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.989	270.289 103.042	0.000 *** 0.472
Korea-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.739	50.015 6.086	0.000 *** 0.768
Korea-North America	1976-2003	r ≤ 11 r < 12	r = 12 r = 13	1.000 0.978	241.211 80.669	0.000 *** 0.939
Malaysia-EU	1979-2004	r ≤ 13 r < 14	r = 14 r = 15	1.000 0.938	161.666 37.235	0.000 *** 0.948
Malaysia-Japan	1979-2004	r ≤ 13 r < 14	r = 14 r = 15	1.000 0.959	151.935 43.652	0.000 *** 0.855
Malaysia-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.740	52.814 6.635	0.000 *** 0.731
Malaysia-North America	1979-2004	r ≤ 13 r < 14	r = 14 r = 15	1.000 0.925	154.953 40.415	0.000 *** 0.912
Philippines-EU	1979-2003	r ≤ 14 r < 15	r = 15 r = 16	1.000 0.862	117.478 22.552	0.000 *** 0.927
Philippines-Japan	1976, 1983-1990, 1992-2003	NA				
Philippines-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.771	57.021 4.808	0.000 *** 0.841
Philippines-North America	1980, 1982-2003 (test through 1982-2003)	r ≤ 17 r < 18	r = 18 r = 19	1.000 0.741	38.857 2.700	0.000 *** 0.461
Singapore-EU	1976-2004	r ≤ 10 r < 11	r = 11 r = 12	1.000 0.993	303.583 125.602	0.000 *** 0.692
Singapore-Japan	1976-1978, 1980-2004 (test through 1980-2004)	r ≤ 14 r < 15	r = 15 r = 16	1.000 0.886	113.249 22.417	0.000 *** 0.929
Singapore-Asia	1981-2003	r ≤ 16 r < 17	r = 17 r = 18	1.000 0.334	55.029 1.408	0.000 *** 0.948
Singapore-North America	1976-2004	r ≤ 11 r < 12	r = 12 r = 13	0.997 0.983	168.265 115.502	0.011 ** 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 (11) and Table 1 for the model tested.