

**Production Sharing, Exchange Rate Changes, and the Trade Balance:  
Evidence from the East Asian Electronics Industry**

Willem Thorbecke\*

*Research Institute of Economy, Trade, and Industry  
Tokyo, Japan*

*and*

*Department of Economics  
George Mason University  
Fairfax, VA USA*

March 2008

*Keywords:* Global supply chain; exchange rate elasticities; East Asia

*JEL classification:* F32, F41

\* Address: RIETI, 1-3-1 Kasumigaseki Chiyoda-ku, Tokyo 100-8901 Japan; Tel.: + 81-3-3501-8286; Fax: +81-3-3501-8416; E-mail: [willem-thorbecke@rieti.go.jp](mailto:willem-thorbecke@rieti.go.jp) .

**Production Sharing, Exchange Rate Changes, and the Trade Balance:  
Evidence from the East Asian Electronics Industry**

**Abstract**

Cross-border production sharing poses conceptual challenges for international economists. One challenge concerns how exchange rate changes affect exports. Much of the value-added of goods produced through fragmented value chains comes from other countries. Thus, exchange rates changes in supply chain countries and not just bilateral exchange rate changes in assembly economies should affect exports. This paper presents evidence that exchange rates appreciations in countries supplying electronic components to East Asian processor economies would reduce final electronics goods exports, while exchange rate appreciations in processor economies would not.

## 1. Introduction

Globalization in recent years has been increasingly accompanied by the slicing up of the value added chain. Firms have broken up long production processes and allocated production blocks across countries based on differences in factor endowments. This cross-border fragmentation involves complicated combinations of intra-firm trade, arms-length transactions, and outsourcing.

Within the Heckscher-Ohlin framework, trade in intermediate goods can be treated as technical progress in the final goods sector (Baldwin, 2006). It permits more final goods to be produced for any given quantity of primary factors.

As Ando, Arndt, and Kimura (2006) discuss, cross-border production fragmentation poses conceptual challenges for international economists. One challenge they highlight is how exchange rate changes affect exports and imports. For instance, much of the value-added of U.S. imports of motor vehicles from Mexico or of electronic equipment from China come from other countries. Thus, they argue, whether and to what extent U.S. import prices change do not depend only on the bilateral exchange rate between Mexico or China and the U.S. If the Chinese yuan appreciates unilaterally against the dollar, for example, the yuan price of imported components from other countries would fall. Cheaper imported inputs would allow Chinese firms to reduce the RMB price of its exports and help offset the effect of the increase in the dollar/yuan exchange rate on U.S. import prices.<sup>1</sup>

Wolf (2006) and Yoshitomi (2007) argue that a unilateral RMB appreciation would not affect China's processed exports much. Wolf (2006) notes that an RMB appreciation would primarily affect the wage component of the costs of processed exports.

---

<sup>1</sup> The IMF (2007) also makes this point.

Since China has an excess supply of labor, wages may fall to offset higher costs arising from a stronger exchange rate. Yoshitomi argues that most of the value-added of China's processed exports comes from other East Asian countries. Thus, a unilateral appreciation of the RMB relative to the countries purchasing the final assembled good should not have much of an effect. Instead, he states, an appreciation of other East Asian currencies should reduce processed exports much more.

Thorbecke and Smith (2008) and Rahman and Thorbecke (2007) investigate how a unilateral appreciation of the RMB and a joint appreciation among countries supplying intermediate inputs would affect China's exports. To do this they estimate a panel that includes ordinary and processed exports from China to 33 countries. They find that joint appreciations among supply chain countries would be required to significantly reduce China's multilateral exports.

This paper examines exports from several Asian processor economies. In East Asia, the slicing up of the value-added chain has led to what has been called triangular trading patterns (see Gaulier *et al.*, 2005). Japan, South Korea, Taiwan and multinational companies located in ASEAN produce sophisticated technology-intensive intermediate goods and capital goods and ship them to China and ASEAN for assembly by lower-skilled workers. The finished products are then exported throughout the world.

As documented below, electronic components is the most exported product category from Japan, South Korea, Taiwan and ASEAN countries to China and ASEAN. Final electronic goods is the most exported category from China and ASEAN to the rest of the world. This paper investigates how exports of final electronic goods in Asia are affected by bilateral exchange rate changes in processor economies and by exchange rate

changes in countries supplying electronic components to processor economies. The results indicate that exchange rates appreciations in countries supplying intermediate inputs would decrease final electronics goods exports from East Asia but appreciations in assembly economies would not.

The next section presents the data and methodology. Section 3 contains the results. Section 4 concludes.

## **2. Data and Methodology**

### *2.1 The Electronics Industry in East Asia*

East Asia is characterized by intricate production and distribution relationships, constituting part of a global triangular trading network. Japan, South Korea, Taiwan and multinational companies located in ASEAN produce sophisticated technology-intensive intermediate goods and capital goods and ship them to China and ASEAN for assembly by lower-skilled workers. The finished products are then exported throughout the world.

This pattern is clear in the electronics industry. Figure 1 disaggregates total exports from Japan, South Korea, Taiwan and ASEAN countries to China and ASEAN-5 by product category in 2005. The data are taken from the CEPII-CHELEM database, which divides exports into 71 product categories. The product category ‘electronic components’ is the leading export category in Figure 1.<sup>2</sup> 19% of the exports from developed East Asia and ASEAN to the processor economies are electronic components.

---

<sup>2</sup> Electronic components, as defined by CEPII, correspond to the SITC classification number 776 and the HS classification numbers 8540, 8541, and 8542.

This percentage is almost identical for China and ASEAN-5 taken individually. For China 18 percent of goods coming from the rest of East Asia are electronic components and for ASEAN-5 19 percent of goods are. In both cases this is the single largest product category.

Figure 2 disaggregates total exports from ASEAN-5 and China to the world in 2005. The product category ‘final electronic goods’ is easily the leading export category. Final electronic goods come from four individual categories: consumer electronics goods, computer equipment, telecommunications equipment, and electrical apparatuses.<sup>3</sup> Almost 31% of exports from the processor economies are final electronic goods.

This percentage again does not change much if one looks at China or ASEAN separately. For China 33 percent of goods exported to the rest of the world are final electronic goods and for ASEAN 27 percent of goods are. Again in both cases this is the single largest export category.

Table 1 shows the sources of electronic components and the destinations of final electronic goods. Three-fourths of the electronic components used by China and ASEAN to construct final electronic goods come from other East Asian countries. Three-fourths of the final electronic goods assembled in China and ASEAN go outside the region. Thorbecke and Smith (2008) found a similar pattern looking at total imports for processing and total processed exports from a different data set.

---

<sup>3</sup> Final electronic goods are in four product categories: consumer electronics goods, computer equipment, telecommunications equipment, and electrical apparatuses. As defined by CEPPII, these categories correspond to the SITC classification numbers 75 (excluding 751.3 and 759.1), 761-4, 772, 773, 778, 813 and the HS classification numbers 8469-73, 8505-8508, 8511-13, 8517-22, 8525-39, 8543-48, 9505 (excluding .30).

Thus East Asia as a whole tends to produce manufactured goods by splitting up the value chain within the region and exporting the finished goods to the rest of the world.

## 2.2 Identifying Trade Elasticities

This paper investigates how exchange rate changes in both East Asian assembly countries (ASEAN-5 plus China) and other supply chain countries affect exports of processed goods. To do this it uses data on final electronics exports from the six assembly countries to 31 importing countries and on electronics components exports from ten supply chain countries to the six assembly economies. There has been substantial variation both cross-sectionally and over time in these exchange rates. This approach should thus help to identify in an econometric sense how exchange rate changes affect electronics goods exports.

The imperfect substitutes model of Goldstein and Khan (1985) implies that the quantity of exports *demanded* by other countries depends on income in the other countries and the price of exports relative to the price of domestically produced goods in those countries. The quantity of exports *supplied* depends on the export price relative to the domestic price level in the exporting country. By equating demand and supply one can derive an export function (see, e.g., Chinn, 2005):

$$ex_t = \alpha_{10} + \alpha_{11} rer_t + \alpha_{12} rgdp_t + \varepsilon_t \quad (1)$$

where  $ex_t$  represents real exports,  $rer_t$  represents the real exchange rate, and  $rgdp$  represents foreign real income.

Real exchange rates and real income are often taken as given when estimating export equations (see, for example, Bahmani-Oskooee and Ardalani, 2006). This approach may be subject to simultaneous-equation and omitted-variable bias. If the elasticity of supply is infinite, however, it is possible to identify the parameters in equation (1).

In this case there are reasons to believe that the perfect supply elasticity assumption may be reasonable. China and ASEAN have large pools of redundant rural laborers. By migrating to low-skilled assembly activities these workers may enable exporters to increase supply at constant prices.<sup>4</sup> Second, as the IMF (2005) argues, the supply of imports for processing into Asian assembly countries tends to vary one for one with the demand for processed exports. Thus both labor and sophisticated intermediate goods tend to flow elastically into Asian processor economies to accommodate increases in demand in the rest of the world.

### *2.3 Bilateral and Weighted Exchange Rates*

Ando, Arndt, and Kimura (2006), the IMF (2007), and Yoshitomi (2007) all argue that if the bilateral exchange rate in an assembly economy appreciates alone against a country purchasing processed exports, the effect will be limited.<sup>5</sup> On the other hand, if all supply chain country currencies appreciate equally against a country purchasing final goods, export prices will have to rise one-for-one with the currency appreciations to

---

<sup>4</sup> There is some evidence that demand pressures have recently began pushing up costs and export prices in China. Chinn (2008) for instance documents that Chinese tradable prices began increasing in 2007. Since this increase in the “China price” occurred after the sample period used here, it should not affect our ability to identify the parameters in equation (1).

<sup>5</sup> Ando *et al.* state that it is not even certain whether a bilateral exchange rate appreciation in an assembly country relative to a country importing assembled goods will raise import prices.



maintain profit levels. An appreciation among all supply chain countries would thus cause a larger decline in exports.

To see this formally consider a firm under imperfect competition that assembles goods in its home market, imports intermediate inputs from supply chain countries, and sells the final good in an export market. Under quantity competition the price of final exports from the assembly country (country  $i$ ) in the importing country's currency can be written as:

$$P_i = \frac{S_i (\pi_i + ULC_i)}{p(1-\lambda)} + \frac{\sum_{j=1}^N S_j C_j}{p(1-\lambda)}, \quad (2)$$

where  $P_i$  represents the price of the good in the importing country's currency,  $S_i$  is the price of the exporting country's currency in units of the importing country's currency (e.g., if China exports to the United States,  $S_i$  is dollars/RMB),  $\pi_i$  and  $ULC_i$  represent profit and labor costs per unit of export measured in country  $i$ 's currency,  $S_j$  is the price of supply chain country  $j$ 's currency in units of the importing country's currency (e.g., if Japan is the supply chain country and the U.S. is the importing country then  $S_j$  is dollars/yen),  $C_j$  is the cost of intermediate goods produced in supply chain country  $j$  per unit of the final export good measured in country  $j$ 's currency,  $p$  measures the substitutability between the exporting and import-competing firms' goods and equals 1 if the goods are perfect substitutes, and  $\lambda$  represents the market share of the exporting firm in the export market.<sup>6</sup> Import prices thus depend not only on the bilateral exchange rate between the processor economy and the importing country but also on a vector of

---

<sup>6</sup> Results under price competition are similar. Thorbecke (2008) provides a formal derivation of both equation (2) and the corresponding result assuming price competition.

bilateral exchange rates between supply chain countries and the importing country weighted by the value of intermediate goods coming from each of the supply chain countries.

Equation (1) is thus modified to include a weighted exchange rate in the countries supplying intermediate inputs along with the bilateral exchange rate between the processor economy and the country importing the final assembled goods. To calculate the weighted exchange rate, data on electronic components imports into ASEAN and China are used. As Figure 3 shows, more than 90% of electronics components imports in 2005 came from 10 countries. These countries are Germany, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan, Thailand, and the U.S. This same pattern holds for every year from 1993 to 2005. These countries are thus assumed to be the major exporters of electronic components (ELCOM) to China and ASEAN.

For every year between 1993 and 2005 weights are calculated based on the percentage of ELCOM coming from the 10 major exporters to the six processor economies. Weights are calculated separately for each of the six processor economies and for each year. For instance, if 10 percent of Thailand's electronic components imports from the major ELCOM exporters came from Japan in 2001, then  $W_{\text{Thailand,Japan,2001}}$  would equal 0.10. In order to explain Thailand's exports of final electronic goods to an individual country such as the United Kingdom,  $W_{\text{Thailand,Japan,2001}}$  would be multiplied by the exchange rate between Japan and the United Kingdom in 2001 ( $\text{rer}_{\text{UK,Japan,2001}}$ ). In similar ways weights can be calculated for Thailand's imports of electronic components from the other nine major ELCOM exporters. The products of these weights and the bilateral exchange rates between the major ELCOM exporters and

Britain could be calculated. The sum would then give a weighted exchange rate for final electronics goods exports from Thailand to Britain

$$(wrer_{Thailand,UK,2001} = \sum_{k=1}^{10} w_{Thailand,k,2001} * rer_{UK,k,2001}).$$

More generally, the weighted exchange rate between East Asian assembly country i and country j purchasing final electronics goods exports from i would be given by:

$$wrer_{i,j,t} = \sum_{k=1}^{10} w_{i,k,t} * rer_{j,k,t} \quad (3)$$

where  $wrer_{i,j,t}$  is the weighted exchange rate,  $w_{i,k,t}$  is the proportion of electronic components coming into processor country i from ELCOM exporter j, and  $rer_{j,k,t}$  is the bilateral exchange rate between country j that purchases final electronic goods and country k that produces electronic components.

To calculate  $wrer$  in this way it is necessary to measure exchange rates using a common numeraire. We can do this by employing the real exchange rate variables constructed by the Centre D'Etudes Prospectives et D'Information Internationales (CEPII). These variables compare observed exchange rates to PPP ones, and exceed 100 when the currency is overvalued. They are thus comparable both cross sectionally and over time. These variables are obtained from the CEPII-CHELEM database.

#### 2.4 Data and Econometric Methodology

The dependent variable is the log of final electronic goods. Final electronic goods come from four product categories: consumer electronics goods, computer equipment,

telecommunications equipment, and electrical apparatuses.<sup>7</sup> Data for exports of these four categories measured in U.S. dollars are obtained from the CEPII-CHELEM database and deflated using BLS price deflators for these four categories.

The panel data set includes final exports from six East Asian processor economies (China, Indonesia, Malaysia, the Philippines, Singapore, and Thailand) to 31 countries over the 1994-2005 period.<sup>8</sup>

The independent variables include the weighted real exchange rate ( $wrer$ ) and the bilateral real exchange rate ( $rer$ ) between the processor economy and the importing country. Real income in the importing country ( $rgdp$ ) is also included. It is measured in one specification in constant U.S. dollars (base year 2000) and in a second specification in PPP dollars. As discussed above,  $wrer$  is constructed using real exchange rate data obtained from the CEPII-CHELEM database. Data on  $rer$  and  $rgdp$  are also obtained from CEPII-CHELEM. An increase in either  $wrer$  or  $rer$  represents an appreciation of the exchange rate.

We estimate the model using dynamic ordinary least squares (DOLS). DOLS involves regressing the left hand side variable on a constant, the right hand side variables, and lags and leads of the right hand side variables. The individual export equations have the form:

---

<sup>7</sup> As defined by CEPII, these categories correspond to the SITC classification numbers 75 (excluding 751.3 and 759.1), 761-4, 772, 773, 778, 813 and the HS classification numbers 8469-73, 8505-8508, 8511-13, 8517-22, 8525-39, 8543-48, 9505 (excluding .30).

<sup>8</sup> The countries are: Argentina, Australia, Austria, Belgium, Brazil, Canada, China, Denmark, Finland, France, Germany, Greece, Indonesia, India, Ireland, Italy, Japan, Malaysia, Mexico, the Netherlands, New Zealand, the Philippines, Portugal, Singapore, South Korea, Spain, Sweden, Taiwan, Thailand, the United Kingdom, and the United States.

$$\begin{aligned}
ex_{i,j,t} = & \beta_0 + \beta_1 rer_{i,j,t} + \beta_2 wrer_{i,j,t} + \beta_3 rgdp_{j,t} + \sum_{k=-p}^p \Delta rer_{i,j,t-k} + \sum_{k=-p}^p \Delta wrer_{i,j,t-k} \\
& + \sum_{k=-p}^p \Delta rgdp_{j,t-k} + \delta_i + \mu_j + \gamma_t + u_{i,j,t}, \tag{4} \\
& t = 1, \dots, T; \quad i = 1, \dots, N.
\end{aligned}$$

Here  $ex_{i,j,t}$  represents real exports from processor economy  $i$  to country  $j$ ,  $rer_{i,j,t}$  represents the bilateral real exchange rate between countries  $i$  and  $j$ ,  $wrer_{i,j,t}$  represents the weighted exchange rate between countries  $i$  and  $j$ ,  $rgdp_{j,t}$  equals real income in importing country  $j$ , and  $\delta_i$ ,  $\mu_j$ , and  $\gamma_t$  are country  $i$ , country  $j$ , and time fixed effects.

The data set extends from 1993 to 2005. One lead and lag is used in the DOLS estimation. The panel includes annual exports to 33 countries.<sup>9</sup>

### 3. Results

The first two columns of Table 2 present the results from estimating equation (3) over the whole sample period. The income elasticity is positive and statistically significant in both cases. The results are similar whether income is measured in 2000 dollars or in PPP dollars. For GDP in 2000 dollars the coefficient is 3.93 and for GDP in PPP dollars the coefficient is 3.82. These high income elasticities reflect the fact that electronic goods are primarily high-tech goods such as digital cameras and laptop computers that consumers are more likely to purchase as their incomes increase.

---

<sup>9</sup> The countries are: Argentina, Australia, Austria, Belgium, Brazil, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Indonesia, Iceland, Ireland, Italy, Japan, Luxembourg, Malaysia, Mexico, the Netherlands, New Zealand, the Philippines, Portugal, Russian Federation, Singapore, South Korea, Spain, Sweden, Taiwan, Thailand, the United Kingdom, and the United States.

These results combined with the evidence in Table 1 that 75 percent of final electronics goods exports go outside of the region indicate that it will be difficult for East Asian countries to decouple from the rest of the world. A slowdown outside of the region would cause a large drop in East Asia's exports of electronics goods. Since the U.S. purchases one-third of the electronics goods exported from China and ASEAN, a slowdown in the U.S. would especially curtail final goods exports. A drop in final goods exports would in turn reduce intermediate goods exports from Asian supply chain countries, reducing production and employment throughout the region.

The coefficient on the weighted exchange rate is of the expected negative sign, indicating that an appreciation of *wrer* reduces processed exports. The coefficient is statistically significant in both cases. In the specification with GDP measured in 2000 dollars it takes on a value of -0.91 and in the specification with GDP measured in PPP dollars it takes on a value of -1.00. Thus a ten percent appreciation of *wrer* would reduce exports by about 10 percent. These results indicate that exchange rate appreciations in countries such as Taiwan and Japan that supply electronic components would decrease final electronics goods exports from East Asian processor economies.

The coefficient on the bilateral exchange rate in processor countries is not of the expected negative sign. Instead it is positive, indicating that an appreciation of *rer* increases processed exports. The coefficient is statistically significant in both cases. In the specification with GDP measured in 2000 dollars it takes on a value of 0.98 and in the specification with GDP measured in PPP dollars it takes on a value of 0.93. Rahman and Thorbecke (2007) report a similar pattern employing data on China's processed exports to 33 countries.

It is possible that the positive coefficient on the bilateral real exchange rate is driven by the Asian Crisis. During this time countries such as Indonesia and Thailand suffered large depreciations. At the same time exports from these countries were hindered because of difficulties that firms faced obtaining short term credit from banks.

To control for the effect of the Asia Crisis the model is re-estimated excluding the 1996-1999 period. The results, presented in the third and fourth columns of Table 2, exhibit the same pattern as the results from the whole sample period. The coefficient on income and the weighted exchange rate are of the expected signs and highly statistically significant. The coefficient on the bilateral exchange rate, however, remains positive and statistically significant.

In traditional formulations (e.g., equation 1) the bilateral exchange rate is used without controlling for the weighted exchange rate. Table 3 presents results using this specification. The coefficient on income remains large and statistically significant. The coefficient of the bilateral exchange rate remains positive and statistically significant, indicating as before that an appreciation of the bilateral exchange rate would increase exports.

These results perhaps reflect the fact that exchange rate appreciations in processor economies provide benefits to firms in these countries. They reduce import prices and enable firms to import more sophisticated intermediate and capital goods. This increase in high-tech inputs then enables firms to export more. Any upward pressure on labor costs in the currency of the country importing the final electronic goods might be offset

by a reduction in wages in the processor economy.<sup>10</sup>

An important implication of these findings is that what matters for East Asian electronics goods exports is not the exchange rate in assembly countries but the exchange rates among countries supplying intermediate imports. An appreciation among these currencies would reduce electronics goods exports.

#### **4. Conclusion**

Globalization in recent years has been increasingly accompanied by the slicing up of the value added chain. Firms have broken up long production processes and allocated production blocks across countries based on differences in factor endowments. This process is particularly evident in East Asia. Within East Asian production networks, electronics goods is easily the most produced category.

This study examines how exchange rate changes affect electronics goods exports. The results indicate that exchange rate appreciations in countries supplying parts and components reduce electronics goods exports from East Asian processor economies but that exchange rate appreciations in the processor economies do not. In addition, the findings indicate that an economic slowdown outside of East Asia would cause a large drop in exports from the region.

Ando, Arndt, and Kimura (2006) note that, because of cross-border production networks, the effects of an RMB appreciation might disappoint U.S. officials. U.S. officials have been advocating RMB appreciation as a way of resolving trade imbalances between China and the rest of the world. The results in this paper indicate that, if policy

---

<sup>10</sup> In terms of equation (2), the effects of an increase in  $S_i$  may be offset by a decrease in  $ULC_i$ , leaving the product  $S_i ULC_i$  unchanged.



makers want to reduce imbalances between East Asia and the rest of the world, they should focus on exchange rates in countries producing sophisticated technology-intensive intermediate goods rather than exchange rates in assembly countries such as China. Appreciations in these countries combined with slower growth in the U.S. or more rapid growth in Asia would help to rebalance trade between East Asia and the rest of the world.

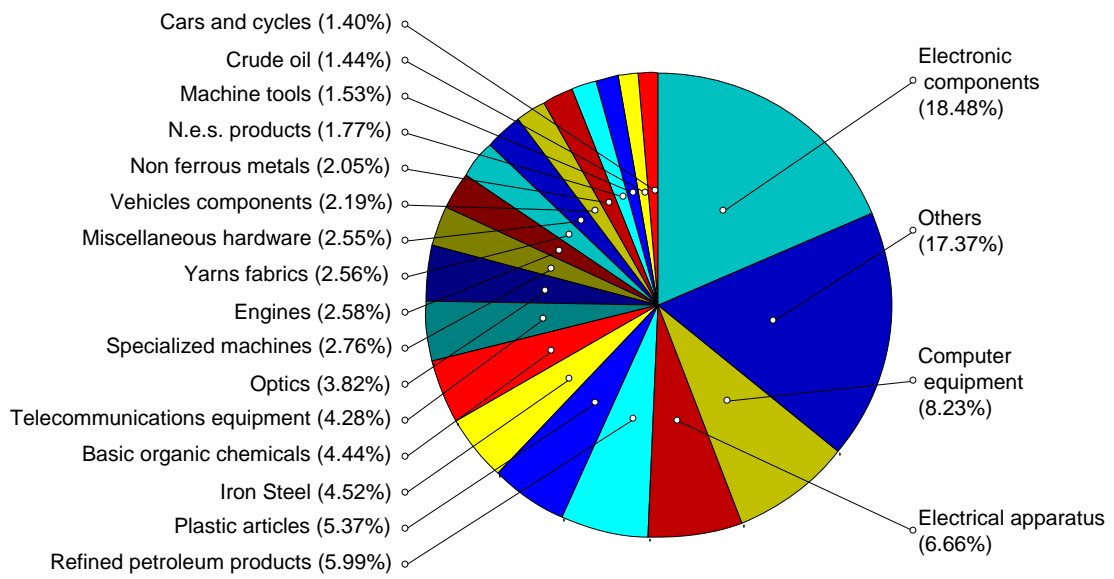


Fig. 1. Exports from Japan, South Korea, Taiwan, and ASEAN-5 to China and ASEAN-5 by Product Category, 2005. Source: CEPII-CHELEM Database

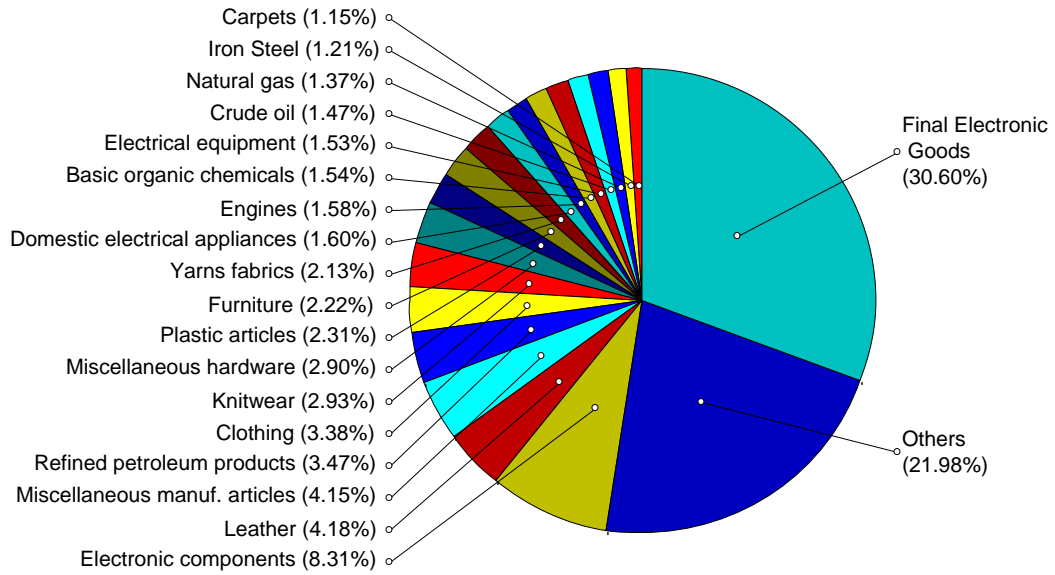


Fig. 2. Exports from China and ASEAN-5 to the World by Product Category, 2005. Source: CEPII-CHELEM Database.

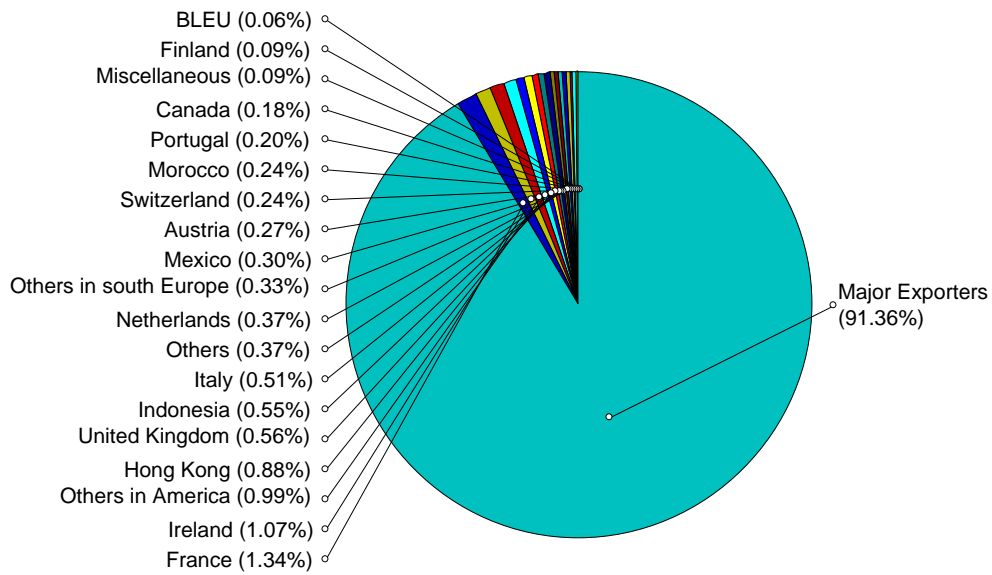


Fig. 3. Countries Exporting Electronic Components to China and ASEAN- 5, 2005. Note: Major Exporters are defined as: China, Germany, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan, Thailand, and the U.S.  
 Source: CEPII-CHELEM Database

Table 1

ASEAN-5 and China's electronics exports and imports, 2005 (percent)

	<b>Electronic Components Imports (%)</b>							
	World	S. Korea & Taiwan	Japan	ASEAN-5	China	United States	Europe	Rest of World
ASEAN-5 & China	100	26	16	31	3	12	6	5

	<b>Final Electronics Goods Exports (%)</b>							
	World	S. Korea & Taiwan	Japan	ASEAN-5	China	United States	Europe	Rest of World
ASEAN-5 & China	100	5	10	10	3	31	18	25

*Notes:* Source: CEPII-CHELEM Database. Europe includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Luxembourg, Netherlands, Italy, Portugal, Spain, and Sweden.

Table 2  
 Panel DOLS estimates of electronics exports from China and  
 ASEAN-5 to 31 countries

GDP (2000 dollars)	3.93*** (0.70)		3.99*** (0.69)	
GDP (PPP dollars)		3.82*** (0.71)		3.85*** (0.70)
Weighted RER	-0.91*** (0.32)	-1.00*** (0.32)	-1.40*** (0.33)	-1.50*** (0.32)
Bilateral RER	0.98*** (0.20)	0.93*** (0.21)	1.59*** (0.22)	1.55*** (0.22)
Adjusted R-Squared	0.89	0.88	0.89	0.88
No. of Observations	1980	1980	1440	1440
Sample	whole period	whole period	excludes 1997-99	excludes 1997-99

*Notes:* DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. The data extend from 1993 to 2005. Since the DOLS estimation uses one lead and lag the actual sample period is 1994-2004. \*\*\* (\*\*) denotes significance at the 1% (5%) level.

Table 3  
 Panel DOLS estimates of electronics exports from China and  
 ASEAN-5 to 31 countries

GDP (2000 dollars)	4.23*** (0.69)		4.32*** (0.69)	
GDP (PPP dollars)		4.11*** (0.70)		4.17*** (0.70)
Bilateral RER	0.66*** (0.19)	0.57*** (0.20)	0.90*** (0.21)	0.81*** (0.21)
Adjusted R-Squared	0.88	0.88	0.88	0.88
No. of Observations	1980	1980	1440	1440
Sample	whole period	whole period	excludes 1997-99	excludes 1997-99

*Notes:* DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. The data extend from 1993 to 2005. Since the DOLS estimation uses one lead and lag the actual sample period is 1994-2004. \*\*\* (\*\*) denotes significance at the 1% (5%) level.

## References

- Ando, Mitsuyo, Arndt, Sven, Kimura, Fukunari, 2006. Production networks in East Asia: strategic behavior by Japanese and U.S. Firms. Available at SSRN: <http://ssrn.com/abstract=981769>.
- Bahmani-Oskooee, Mohsen, Ardalani, Zohre, 2006. Exchange rate sensitivity of U.S. trade flows: evidence from industry data. *Southern Economic Journal* 72 (3), 542-559.
- Baldwin, Richard, 2006. Globalisation: the great unbundling. Unpublished manuscript, Graduate Institute of International Studies, Geneva.
- Chinn, Menzie, 2005. Doomed to deficits? aggregate U.S. trade flows re-visited. *Review of World Economics* 141 (3), 460-85.
- Chinn, Menzie, "Trade, exchange rates and pass through," February 18, 2008. Available at [www.econbrowser.com](http://www.econbrowser.com).
- Gaulier, Guillaume, Lemoine, Françoise, and Unal-Kesenci, Deniz, 2005. China's integration in East Asia: production sharing, FDI, and high-tech trade," CEPII Working Paper No. 2005-09. Centre D'Etudes Prospectives et D'Information Internationales, Paris.
- Goldstein, Morris and Khan, Mohsin, 1985. Income and price effects in foreign trade. In: Jones, Ronald, Kenen, Peter (Eds.), *Handbook of International Economics*. Elsevier, Amsterdam.
- IMF, 2005. Asia-Pacific economic outlook. International Monetary Fund.
- IMF, 2007. Asia-Pacific economic outlook. International Monetary Fund.
- Rahman, Mizanur, and Thorbecke, Willem, 2007. How would China's exports be affected by a unilateral appreciation of the RMB and a joint appreciation of countries supplying intermediate imports? RIETI Discussion Paper 2007/03 07-E-012, Research Institute of Economy, Trade, and Industry, Tokyo. Available at: <http://www.rieti.go.jp>.
- Thorbecke, Willem, 2008. A framework for understanding vertical specialization and exchange rate changes. Unpublished manuscript, Research Institute of Economy, Trade, and Industry, Tokyo.
- Thorbecke, Willem and Smith, Gordon, 2007. How would an appreciation of the RMB and other East Asian currencies affect China's exports? *Review of International Economics*, forthcoming.



Wolf, Martin, 2006. Comment on 'A domestic spending surge is the best thing for China'. December 4. Available at [www.ft.com](http://www.ft.com).

Yoshitomi, Masaru, 2007. Global imbalances and East Asian monetary cooperation. In: Chung , Duck-Koo, Eichengreen, Barry (Eds.), *Toward an East Asian Exchange Rate Regime*. Brookings Institution Press, Washington DC.