

Thorbecke, Willem

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**ADB Working Paper Series**

**The Effect of Exchange Rate  
Changes on Trade in East Asia**

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Willem Thorbecke

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Please contact the author(s) for information about this paper.

wthorbecke@adbi.org

Asian Development Bank Institute  
Kasumigaseki Building 8F  
3-2-5 Kasumigaseki, Chiyoda-ku  
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500  
Fax: +81-3-3593-5571  
URL: [www.adbi.org](http://www.adbi.org)  
E-mail: [info@adbi.org](mailto:info@adbi.org)

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**Abstract**

This paper considers how exchange rates affect East Asian trade. The evidence indicates that exports produced within regional production networks depend on exchange rates throughout the region while labor-intensive exports depend on exchange rates in the exporting country. These results make sense since the majority of the value-added of processed exports come from imported parts and components while most of the value-added of labor-intensive exports comes from the domestic economy. Recent findings also indicate that imbalances between the People's Republic of China (PRC) and the United States are a major outlier and that an appreciation of the PRC yuan (CNY) is necessary to reduce these imbalances.

**JEL Classification: F32, F41**

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## 1. INTRODUCTION

East Asia's share of the world's goods exports nearly doubled between 1982 and 2008, increasing from 13% to 23%. The share of People's Republic of China (PRC) alone increased 10 times, from less than 1% to 9.4% during this period. Despite this explosion of exports, there were (until recently) only a few studies that investigated trade elasticities for the PRC (for instance, see International Monetary Fund [IMF] 2005). Since 2005, however, several papers have investigated the factors influencing trade in the PRC and the rest of Asia. The evidence indicates that exchange rate changes, by altering countries' international price competitiveness, significantly affect their exports and imports.

This paper summarizes some of these recent findings. Rather than attempting to make an incremental contribution to this literature, it steps back and looks at the big picture by enumerating some of the key lessons that have emerged from the existing studies.

The evidence indicates that exchange rate effects differ between sophisticated products such as laptop computers and mobile phones produced within regional production networks and simple labor-intensive goods such as textiles and footwear produced primarily by domestic factors of production. In the first case, exchange rates appreciations throughout the region would cause a larger decrease in exports than appreciations in final assembly countries such as the PRC or Thailand alone. In the second case, appreciations in the exporting country would cause a large decrease in exports. These results make sense since the majority of the value-added of sophisticated processed exports comes from outside of the assembly country while the lion's share of the value-added of labor-intensive exports comes from the exporting country itself.

The findings presented here also highlight the unusual nature of trade imbalances between the United States (US) and the PRC. Before the crisis, the US ran large trade deficits with East Asia, oil-producing countries, and the rest of the world. Since October 2008, however, the US deficit with most regions has fallen but its deficit with the PRC has remained intransigent. Evidence from a gravity model indicates that imbalances between the PRC and the US are a major outlier in the global economy. Results from dynamic ordinary least squares (DOLS) estimation indicate that, to reduce these imbalances, an appreciation of the yuan against the dollar is probably necessary.

This paper is organized as follows. The next section considers how exchange rates affect trade within East Asian production networks. Section 3 considers the effect of exchange rate changes on labor-intensive exports from developing and emerging Asia. Section 4 addresses issues related to trans-Pacific rebalancing. Section 5 concludes.

## 2. EAST ASIAN PRODUCTION NETWORKS AND EXCHANGE RATE CHANGES

In Asia, production networks developed in response to the 70% appreciation of the Japanese yen against the dollar between 1985 and 1995. Japanese firms lost their price competitiveness, and responded by shifting labor-intensive assembly operations to other Asian countries. At first they channeled foreign direct investment (FDI) and intermediate goods to the Republic of Korea (hereafter Korea), Taipei,China, and other newly industrialized economies (NIEs). However, as the Korean won, Singapore dollar, and NT dollar appreciated, they relocated lower-end labor-intensive assembly to the PRC and the Association of South East Asian Nations (ASEAN). Firms in the Asian NIEs also began transferring factories to developing Asia, mainly ASEAN (Malaysia, Indonesia, and Thailand primarily) and the PRC. Consequently, "triangular trading patterns" developed in East Asia (see Gaulier, Lemoine, and Unal-Kesenci 2005). Higher skilled workers in Japan, Korea, and Taipei,China produced sophisticated technology-intensive parts and components and

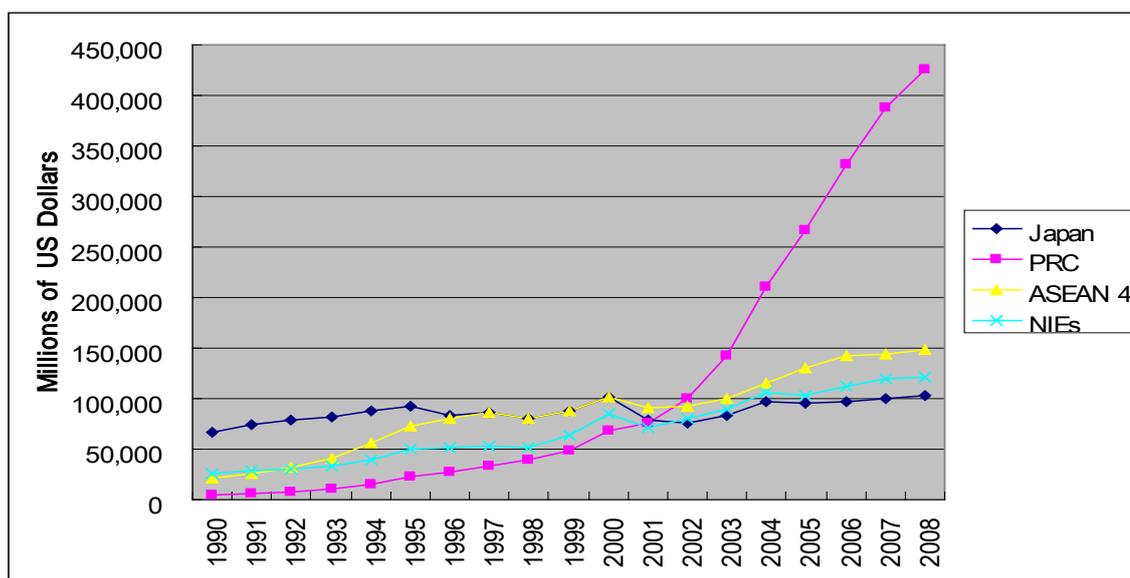
shipped them to the PRC and ASEAN for assembly by lower skilled workers and re-exported to the rest of the world.

## 2.1 East Asian Production Networks

The resulting cross border production networks involve complicated combinations of intra-firm trade, arms-length transactions, and outsourcing (Kimura and Ando 2005). They are typically centered around multinational corporations (MNCs) in developed Asia that produce with the help of affiliates, subsidiaries, subcontractors, suppliers, and service providers in other parts of East Asia (see Borrus, Ernst, and Haggard 2000). These networks have allowed MNCs to exploit comparative advantage by slicing up long production processes and allocating the production blocks created in this way throughout Asia. As Fukao et al. (2002) discussed, the production processes of an industry (e.g., the electronics industry) have been split into fragmented production blocks that can be located in different countries based on differences in factor endowments in the fragmented production blocks between developing, emerging, and developed economies in the region.

Parts and components often flow back and forth several times between the countries for processing. The final assembly typically takes place by lower skilled workers in ASEAN and the PRC. In recent years, final assembly has become increasingly centered in the PRC. This is seen in Figure 1, which presents final electronic goods exports from East Asian countries. The figure shows that more and more processed exports have come from the PRC especially post 2000.

**Figure 1: Final Electronics Exports from East Asian Countries and Regions to the World**



Source: CEPII-CHELEM Database.

Table 1 sheds further light on the PRC's processing trade. Imports for processing refer to the parts and components such as hard disk drives that are imported into the PRC duty free and intended solely to produce goods for re-exports. Processed exports refer to final goods such as computers that are produced in this way. The table indicates that two-thirds of the imports for processing come from East Asia, while the US and Europe account for only 5% each. For processed exports, about 20% goes to East Asia, the US, Europe, and Hong Kong, China. Imports for processing come largely from East Asia while processed exports go throughout the world, so the PRC runs deficits of about US\$100 billion with East Asia and surpluses of almost US\$100 billion with Europe and of more than US\$100 billion with the US and Hong Kong, China.

**Table 1: The PRC's Processing Trade, 2006–2009**

	Korea	Taipei,China	ASEAN4	Japan	Singapore	Hong Kong, China	US	Europe	R.O.W	Total
<b>Imports for Processing (%)</b>										
2006	15.08	19.04	10.51	15.89	2.63	2.11	5.23	4.99	24.52	100.00
2007	15.24	18.75	10.65	16.11	2.40	1.98	4.93	5.03	24.91	100.00
2008	15.63	18.07	10.26	16.20	2.28	1.62	5.20	5.72	25.01	100.00
2009	16.95	16.96	9.73	15.53	2.18	1.32	4.80	5.51	27.03	100.00
<b>Processed Exports (%)</b>										
2006	3.95	2.19	3.21	10.35	2.96	22.34	25.23	17.85	11.90	100.00
2007	3.98	1.92	3.25	9.35	2.84	22.42	23.54	18.59	14.10	100.00
2008	4.75	1.88	3.27	9.22	2.79	21.01	22.20	18.71	16.16	100.00
2009	4.96	1.86	3.40	9.13	3.36	20.57	22.68	17.50	16.54	100.00
<b>Balance in processing trade (billions of US dollars)</b>										
2006	-28.29	-50.01	-17.40	1.76	6.65	107.24	111.98	75.06	-18.12	188.87
2007	-31.57	-57.18	-19.18	-1.63	8.73	131.18	127.25	96.29	-4.65	249.24
2008	-27.07	-55.71	-16.72	0.99	10.19	135.76	130.20	104.67	14.46	296.77
2009	-25.50	-43.72	-11.41	3.56	12.72	116.46	117.61	84.93	9.92	264.57

Notes: ASEAN4 includes Indonesia, Malaysia, Philippines, and Thailand. Europe includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Luxembourg, Netherlands, Italy, Portugal, Spain, Sweden and United Kingdom.

Source: China Customs Statistics.

## 2.2 The Impact of Exchange Rate Changes on Processing Trade

Since much of the value added comes from other East Asian countries, one would expect that exchange rate changes in other countries in the region would affect the PRC's processed exports. Ahmed (2009) and Thorbecke and Smith (2010) and Thorbecke (2010a) have presented evidence supporting this. We outline the main findings of each below.

Ahmed (2009) employed an autoregressive distributed lag model and quarterly data over the 1996Q1 – 2009Q2 period and disaggregated PRC yuan (CNY) exchange rate changes into those relative to East Asian countries and those relative to other countries. After 2003, he deflated PRC exports using the US Bureau of Labor Statistics (BLS) deflator for imports coming from the PRC and before 2003 he backcasted this series using the BLS deflator for imports coming from non-industrial countries. He reported that a 10% appreciation of the CNY relative to non-East Asian countries would reduce the PRC's processed exports by 17% and that a 10% appreciation in other East Asian countries would reduce the PRC's processed exports by 15%.

Thorbecke (2010a) also tested whether exchange rate changes in the supply chain countries affect processed exports. Exports were measured in US dollars and deflated using the US producer price index, the US consumer price index, and the Hong Kong, China export price deflator. Since many of Hong Kong, China's exports are re-exports from the PRC, this last measure may be a useful proxy for PRC export prices. Encompassing tests indicated in every case that models including both exchange rates in supply chain countries and the PRC exchange rate are preferable to models including only the PRC exchange rate. Results using dynamic ordinary least squares estimation and quarterly data over the 1993Q4-2008Q1 period indicated that a 10% appreciation of the CNY alone would reduce processed exports by 14% and a 10% appreciation of other East Asian currencies would reduce processed exports by 19%. These results imply that exchange rate changes in other East Asian countries have a large effect on the PRC's processed exports.

Thorbecke and Smith (2010) constructed a single integrated exchange rate variable to measure changes in the relative foreign currency costs not just of the PRC's value-added but of the PRC's entire output of processed exports. Exports were deflated using the BLS deflator for imports coming from non-industrial countries, the US consumer price index, and the Hong Kong, China export price deflator. Using DOLS estimation and an annual panel data set including exports to 33 countries over the 1992–2005 period, they reported that a 10% appreciation throughout the region would reduce processed exports by 10%.

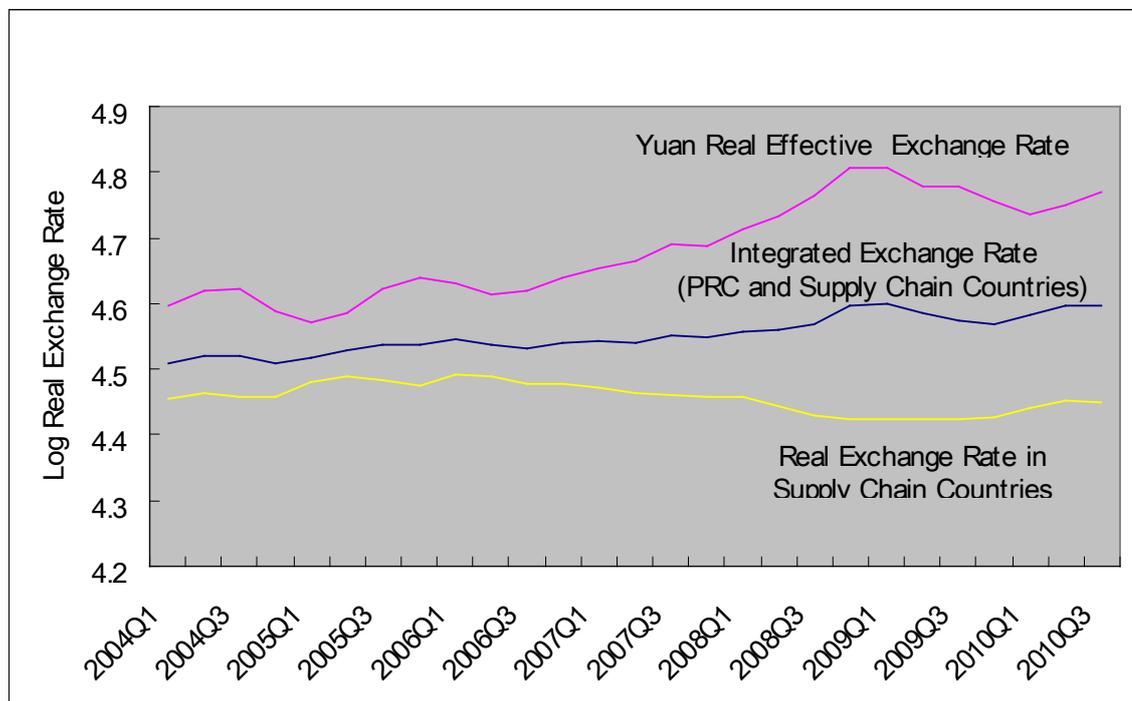
The results of Ahmed (2009), Thorbecke (2010a), and Thorbecke and Smith (2010) thus indicate that exchange rates throughout Asian supply chain countries exert important effects on processed exports.<sup>1</sup> One gets a different picture of the price competitiveness of the PRC's processed exports by taking account of exchange rate changes in other East Asian countries. Figure 2 shows the real effective exchange rate (REER) of the CNY, the real exchange rate in supply chain countries other than the PRC, and a single integrated exchange rate (IRER) that is a weighted average of the CNY exchange rate and the exchange rate in supply chain countries. The real exchange rate in supply chain countries was calculated by weighing real exchange rate changes in individual supply chain countries by each country's value-added in the PRC's processed exports. The weights for the IRER were also determined by the proportion of the value-added coming from the PRC and from

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<sup>1</sup> Exchange rate changes can only generate expenditure-switching effects if there is sufficient pass-through of exchange rate changes to tradable prices. The IMF (2005) estimates that a 10% appreciation of the yuan raises the foreign currency prices of China's exports by 5%. Vigfusson, Sheets, and Gagnon (2007) found that 10% currency appreciations would raise the foreign currency prices of the Asian NIEs' exports by 7% and of Japan's exports by 5%. Thus there should be sufficient exchange rate pass-through for exchange rate appreciations in Asia to reduce exports.

supply chain countries. Figure 2 shows that the CNY appreciated by 20% between 2005 and 2010. The IRER, however, appreciated only by 8% over this period. In an arithmetic sense, the effect of the CNY appreciation on the IRER since 2005 has been almost exactly offset by the 20% depreciation of the Korean won and the 14% depreciation of the NT dollar over this period.

**Figure 2: PRC's Real Effective Exchange Rate, Weighted Exchange Rate for Supply Chain Countries, and Integrated REER for the PRC's Proceeded Exports**



Source: International Monetary Fund, Bank for International Settlements, and calculations by the author.

This fact helps explain the puzzle that Cline (2010) discusses concerning why the PRC's bilateral trade surplus with the US did not narrow when the CNY appreciated between 2005 and 2008. Part of the explanation, as Cline discussed, is that exchange rate changes affect trade with a lag. Another part of the explanation, though, is that depreciations in other East Asian supply chain countries offset much of the effect of the appreciation of the CNY.

The IMF (2005) argued that imports for processing should vary one-for-one with processed exports. Imports for processing should thus flow elastically into assembly economies in response to an increase in the demand for processed exports in the rest of the world. IMF (2005) also noted that the price elasticity of imports for processing should be small because these goods are not produced domestically, resulting in little potential for import substitution.<sup>2</sup>

In previous work Cheung, Chinn, and Fujii (2010), Marquez and Schindler (2007), and Garcia-Herrero and Koivu (2007) reported that an appreciation of the CNY is often associated with a decrease in imports from the rest of the world (i.e., the coefficient is wrong-signed). The wrong sign could occur because an exchange rate appreciation will reduce the demand for processed exports and thus the demand for imports for processing.

<sup>2</sup> However, the huge surpluses in processing trade that have emerged since 2005 suggest that firms in recent years have been able to source more intermediate goods from within the PRC. Thus the demand for imports for processing may have become more price elastic in recent years.

### 2.3 Impact of Exchange Rate Volatility

While there is no evidence that an appreciation in the importing country would substantially increase imports for processing, there is both theoretical and empirical evidence indicating that exchange rate volatility between supply chain countries would deter processing trade. This effect arises because the service link cost for production blocks separated by national borders is an increasing function of risk and uncertainty, and exchange rate volatility increases risk and uncertainty.

In a recent survey of Japanese MNCs, Ito et al. (2008) found that exchange rate stability between Asian currencies is essential for the uninterrupted flow of parts and components within regional production networks.

Both Thorbecke (2008) and Hayakawa and Kimura (2009) presented econometric evidence that exchange rate volatility reduces the flow of parts and components within regional trade networks. Thorbecke (2008), using DOLS estimation and annual data over the 1985–2005 period reported that exchange rate volatility caused a large decline in the flow of parts and components within East Asian production networks. Hayakawa and Kimura (2009), using a gravity equation and annual data over the 1992–2005 period, found that exchange rate volatility significantly reduced trade in intermediate goods within East Asian production networks.

Carlos Ghosn, chief executive officer of Nissan Motor Corporation, recently commented that exchange rate volatility was harmful to fragmented production networks because it militated against long-term planning (see Crooks 2010). As a result, Nissan planned to shift production from Japan to dollar-linked economies such as the PRC to avoid mismatches between currencies in which costs are incurred and currencies in which revenues are generated.

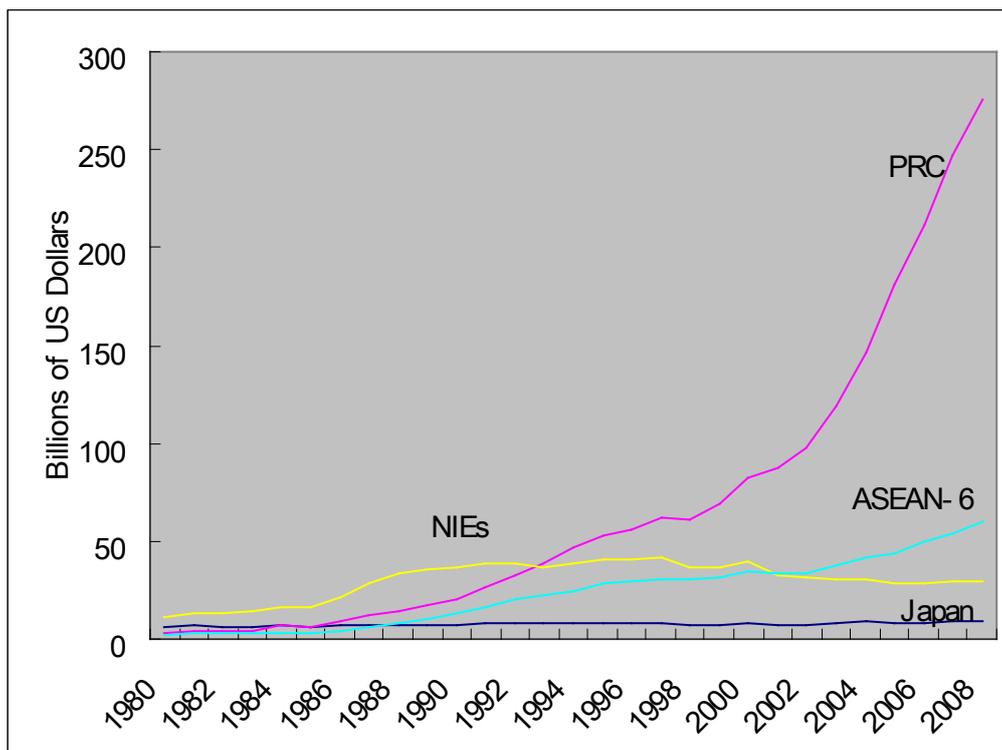
Interestingly, exchange rate volatility may not be as harmful to production networks centered on the US. Turkcan and Keskinel (2009) examined the impact of exchange rate volatility on fragmentation in the US auto parts industry. Using DOLS estimation over the 1996–2008 period, they reported that exchange rate volatility has a positive but insignificant effect on US auto industry exports. Future research should investigate whether exchange rate volatility has different effects on production networks centered in East Asia and those centered in the US.

## 3. LABOR-INTENSIVE EXPORTS FROM EAST ASIA

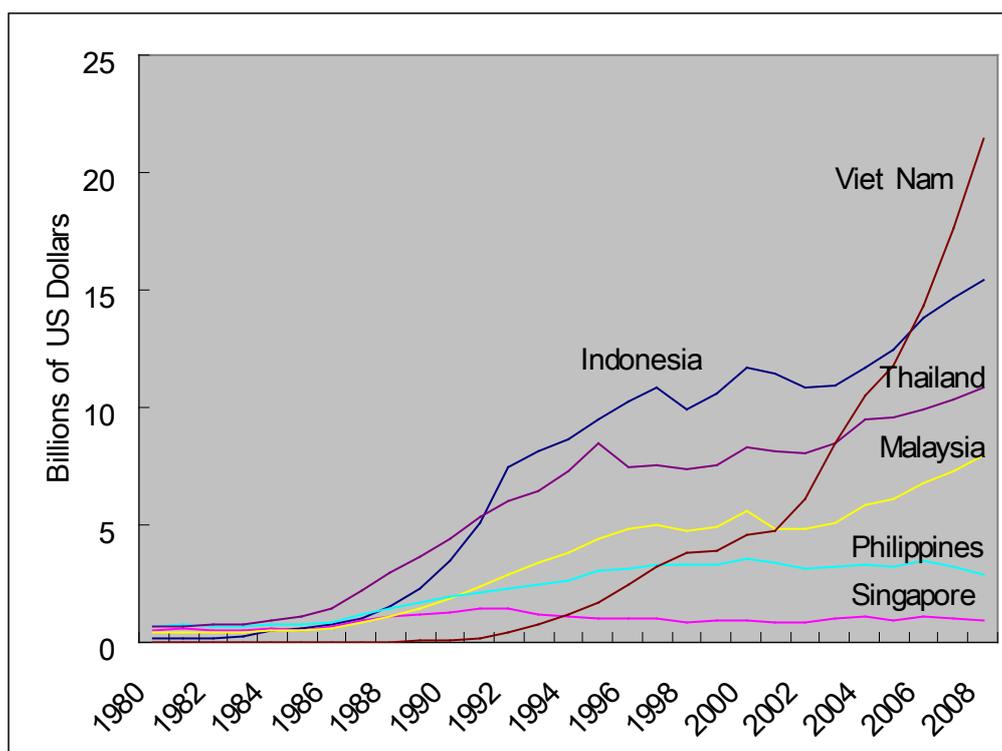
While East Asian economies export large volumes of sophisticated processed exports, they also exported almost US\$400 billion in labor-intensive manufacturing exports in 2008. These goods tend to be produced largely with domestic inputs, and much of the value-added is supplied domestically. For instance, Koopman, Wang, and Wei (2008) reported that the PRC's value-added in electronic computers was less than 5% in 2002, while its value-added in wearing apparel was almost 70%.

Figure 3 shows exports of labor-intensive manufacturing goods from East Asian countries and regions to the world. Labor-intensive exports are defined to include carpets, clothing, fabrics, furniture, knitwear, leather, and yarns. The main exporters of these goods are the labor-abundant developing and emerging economies such as the PRC, Indonesia, and Viet Nam. Exports from capital-abundant developed economies such as Japan are miniscule, as one would expect. One would expect significant competition between Asian countries in exporting labor-intensive goods to third markets. Profit margins for these goods are thin (see Ito et al. 2008), and exporters will face pressure to pass through exchange rate changes into import prices.

**Figure 3a: Value of Labor-Intensive Manufacturing Exports from East Asian Countries and Regions to the World**



**Figure 3b. Value of Labor-Intensive Manufacturing Exports from ASEAN Countries to the World**



Source: CEPII-CHELEM Database.

Thorbecke and Zhang (2009) and Thorbecke (2010b) found labor-intensive exports from the PRC and ASEAN countries to be very sensitive to both exchange rates in the exporting country and to exchange rates in other countries exporting labor intensive exports to third markets. In both cases, exports were measured in dollars and deflated using BLS price deflators for the categories of labor-intensive exports employed. Using DOLS estimation and an annual panel data set including exports to 30 countries over the 1987–2006 period, Thorbecke and Zhang (2009) reported that for the PRC a 10% appreciation of the CNY would reduce labor-intensive exports by about 17% and a 10% depreciation among competing countries will decrease exports by about 9%. Using DOLS estimation and an annual panel data set including exports to 25 countries over the 1983–2007 period, Thorbecke (2010b) found that for ASEAN countries, a 10% appreciation in the exporting country would reduce that country's labor-intensive exports by about 20% and a 10% depreciation among competing countries would decrease the ASEAN country's exports by about 12%. These results support the claim that profit margins for these goods are thin, and that there is extensive competition between labor-abundant countries in exporting to third markets.

Figure 3 shows that the PRC is the largest exporter of labor-intensive goods. There is a close correspondence between labor-intensive exports and the PRC customs regime called "ordinary" exports. As Gaulier, Lemoine, and Unal-Kesenci (2005) discussed, ordinary exports are produced primarily using local PRC inputs. Since the PRC is a labor-abundant country, ordinary exports are largely labor-intensive goods. Feenstra and Wei (2010) report that the largest category of ordinary exports is textiles.

Table 2 disaggregates the PRC's ordinary trade by country and region. About 25 of ordinary imports come from East Asia, about 15 from Europe, less than 10 from the US, and more than 40 from the rest of the world. Many of the ordinary imports coming from the rest of the world in recent years have been commodities. The largest recipient of the PRC's ordinary exports have been the US and Europe. The PRC runs surpluses with the US and Europe in ordinary trade and deficits with Asia. With the world as a whole, it ran a slight deficit overall in ordinary trade in 2009.

**Table 2: The PRC's Ordinary Trade, 2006–2009**

	Korea	Taipei,China	ASEAN4	Japan	Singapore	Hong Kong, China	US	Europe	R.O.W	Total
<b>Ordinary Imports (%)</b>										
2006	8.03	4.55	6.01	12.66	1.52	0.93	8.50	15.79	42.02	100.00
2007	7.05	4.26	6.43	11.77	1.24	1.06	8.41	15.78	44.01	100.00
2008	6.15	3.51	5.46	10.88	1.33	1.00	8.21	13.95	49.49	100.00
2009	6.47	3.73	6.22	11.75	1.21	0.69	9.39	15.95	44.58	100.00
<b>Ordinary Exports (%)</b>										
2006	5.47	2.11	5.09	8.98	1.67	7.71	16.60	17.91	34.46	100.00
2007	5.48	1.90	5.19	7.76	1.97	6.40	14.90	18.70	37.72	100.00
2008	5.95	1.77	5.72	7.57	1.75	5.17	14.13	19.15	38.77	100.00
2009	4.24	1.55	6.19	7.80	1.64	6.04	14.84	18.77	38.92	100.00
<b>Balance in normal trade (billions of US dollars)</b>										
2006	-3.96	-6.37	1.15	-4.76	1.89	28.97	40.81	21.94	3.46	83.14
2007	-0.69	-8.04	0.36	-8.65	5.29	29.89	44.19	33.05	14.47	109.87
2008	4.18	-8.37	6.64	-12.11	3.97	28.55	46.60	47.00	-26.55	89.91
2009	-12.11	-11.74	-0.47	-21.44	2.20	28.30	28.46	14.24	-32.04	-4.59

Notes: ASEAN4 includes Indonesia, Malaysia, Philippines, and Thailand. Europe includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Luxembourg, Netherlands, Italy, Portugal, Spain, Sweden and United Kingdom.

Source: China Customs Statistics.

Many have found that ordinary exports are sensitive to appreciations in the CNY. Marquez and Schindler (2007), for instance, used ordinary least squares and monthly data over the January 1997 to July 2006 sample period. To avoid using proxies for PRC trade prices, they employed the share of the PRC's imports relative to world imports as their left hand side variable. They also employed the International Monetary Fund, Bank for International Settlements, and Federal Reserve Board measures of the REER. They found that, depending on the exchange rate measure, a 10% appreciation of the CNY would have reduced the PRC's ordinary exports by between US\$51 and 63 billion in 2006.

Ahmed (2009) employed an autoregressive distributed lag model and quarterly data over the 1996Q1 – 2009Q2 period. He deflated PRC exports by using the US Bureau of Labor Statistics (BLS) deflator for imports coming from the PRC after 2003 and by backcasting this series before 2003 using the BLS deflator for imports coming from non-industrial countries. In one of his preferred specifications, he included foreign consumption as an explanatory variable. In this case, he reported that a 10% appreciation of the CNY would reduce the PRC's ordinary exports by 19%.

Cheung, Chinn, and Fujii (2010) employed DOLS techniques and quarterly data over the 1993Q3 – 2004Q2. They deflated PRC exports using the US producer price index (PPI) for finished goods, the price indices constructed by Gaulier, Lemoine, and Unal-Kesenci (2006, hereafter GLÜ-K), and the Hong Kong, China unit value index. They reported that a 10% appreciation of the CNY would reduce the PRC's ordinary exports by between 3% and 6%.

Thorbecke and Smith (2010) also employed DOLS estimation and an annual panel data set including exports to 33 countries over the 1992–2005 period. They deflated exports using the BLS deflator for imports coming from non-industrial countries, the US consumer price index, and the Hong Kong, China export price deflator. They found that a 10% appreciation of the CNY would reduce ordinary exports by about 12%.

While the results indicate that an appreciation of the CNY should reduce ordinary exports, the results are ambiguous for ordinary imports. Cheung, Chinn, and Fujii (2010) deflated PRC imports using the US PPI, the GLÜ-K index, and the Hong Kong, China unit value index. Employing DOLS and quarterly data over the 1993Q3 – 2004Q2, they reported that an appreciation of the CNY was associated with a decline in ordinary imports (i.e., the coefficient had the wrong sign). Marquez and Schindler (2007) examined the share of the PRC's imports relative to rest of the world imports. They found that a 10% appreciation of the CNY caused ordinary imports to increase by about US\$15 billion. These conflicting results could arise because some ordinary imports are used to produce goods for re-exports. An exchange rate appreciation that reduces the PRC's exports will reduce the demand for these imported inputs.

To correct for this bias, Thorbecke (2009, 2010c) examined the imports of final consumption goods into East Asian countries. These goods are intended primarily for the domestic market rather than for re-export. Data on consumption goods imports were measured in US dollars and deflated using the BLS price indices for consumption goods. Using DOLS techniques and quarterly data on consumption goods imports from 27 countries over the 1985–2006 period, Thorbecke (2009) found that a 10% appreciation of the CNY would increase the PRC's consumption imports by about 13%. In follow up work focusing only on countries that provided at least one of consumption imports into individual East Asian countries, Thorbecke (2010c) reported exchange rate appreciations in other East Asian countries also raised consumption imports.<sup>3</sup> Thus an appreciation of the currency that raises consumers' purchasing power should increase the demand for consumption imports.

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<sup>3</sup> Using this new specification, there is no longer evidence that an appreciation of the CNY will increase the PRC's consumption imports. One reason why the PRC's exchange rate elasticity may no longer be statistically significant is that only 11 countries are included in the sample of countries exporting to the PRC. These include the US and several Asian countries whose currencies were closely linked with the dollar for many years. Since

## 4. EXCHANGE RATES AND TRANS-PACIFIC REBALANCING<sup>4</sup>

Before the crisis, the US ran large trade deficits with East Asia, oil-producing countries, and the rest of the world. Since October 2008, however, the US deficit with most regions has fallen but its deficit with the PRC has remained intransigent. This fact is documented in Table 3. The table shows exports, imports, and the trade balance between the US and the rest of the world before and after the Lehman Brothers fall in September 2008. Exports and imports both exhibited sharp drops beginning in October 2008. The sample is thus divided into the year before the crisis (October 2007–September 2008), the first year after the Lehman shock (October 2008–September 2009), and the second year after the Lehman shock (October 2009–September 2010). For non-East Asian countries, the deficit fell by 76% during the post-crisis period and equaled US\$227 billion between October 2008 and September 2009. For the PRC, it fell by less than 12% and equaled US\$237 billion between the fourth quarter of 2008 and the third quarter of 2009. Columns (7) through (9) indicate that this pattern is continuing, with the PRC making up 44% of the US deficit during the first year after the Lehman shock and 42% during the second year after Lehman.

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the CNY was pegged to the dollar for most of the sample period, there might not have been enough exchange rate variation in the data to give the tests sufficient discriminatory power.

<sup>4</sup> This section draws on Thorbecke (2010d).

**Table 3: Exports, Imports, and Trade Balance between the US and other Countries and Regions before and after the Lehman Brothers Shock, (Billions of US dollars)**

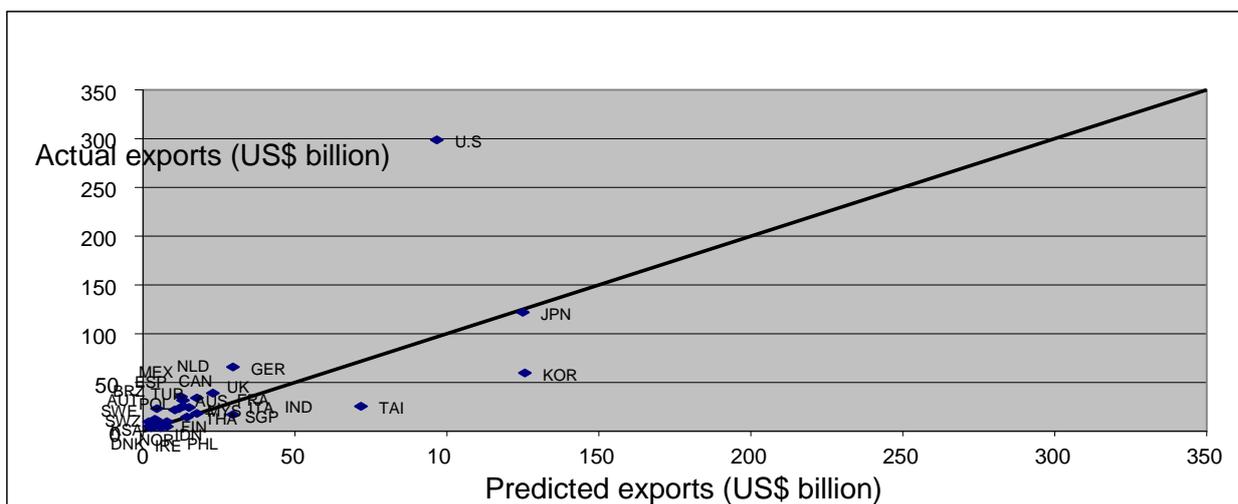
Country or Region	Year before the Lehman Brothers Shock			First Year after the Lehman Brothers Shock			Second Year after the Lehman Brothers Shock		
	(1) Exports to the US	(2) Imports from the US	(3) Bilateral trade balance with the US	(4) Exports to the US	(5) Imports from the US	(6) Bilateral trade balance with the US	(7) Exports to the US	(8) Imports from the US	(9) Bilateral trade balance with the US
People's Republic of China	337	71	266	300	63	237	348	86	262
Rest of East Asia	233	130	102	168	96	72	195	120	75
Rest of the World (excluding East Asia)	1,581	1,097	484	1,126	899	227	1,300	1,018	281
World	2,150	1,298	852	1,594	1,059	535	1,843	1,224	618

Notes: The year before the Lehman Brothers shock is from October 2007 to September 2008. The first year after the Lehman Brothers shock is from October 2008 to September 2009. The second year after the Lehman Brothers shock is from October 2009 to September 2010. Rest of East Asia includes Japan, the Republic of Korea, and Taipei, China.

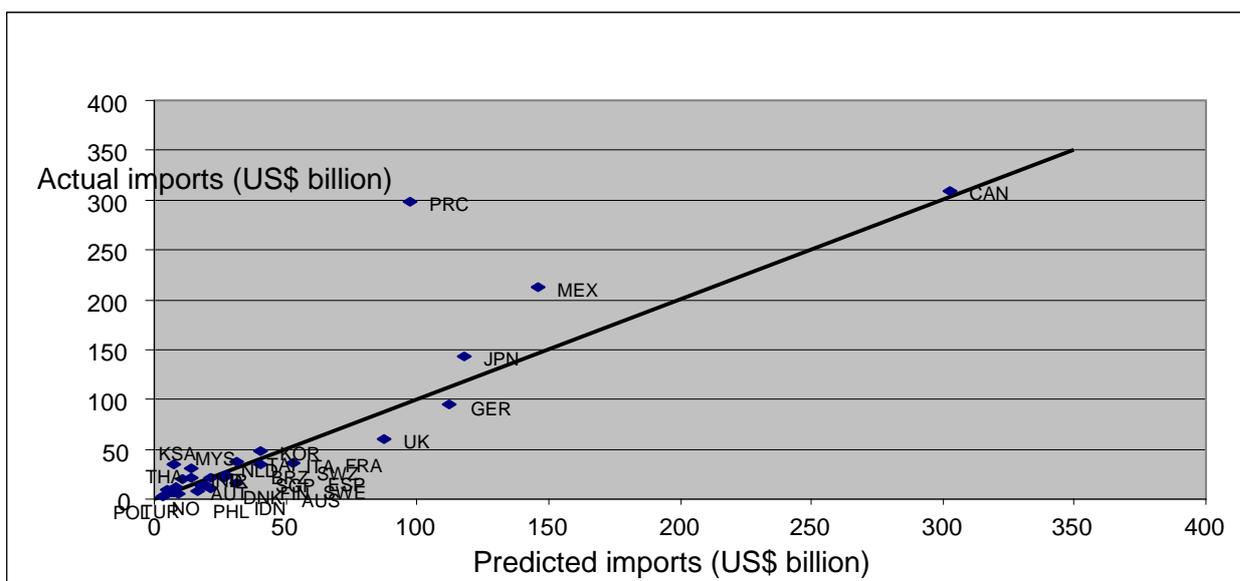
Sources: US Census Bureau (Available at: <http://www.census.gov/>)

Thorbecke and Komoto (2010) highlighted the unusual nature of the PRC's exports to the US. They estimated a gravity model that sought to explain trade between 30 countries over the 1988–2007 period using income in the exporting and importing countries, the real exchange rate, distance, a common language dummy, importer and exporter fixed effects, dummy variables for Mexico and Canada, and a time trend. Exports were measured in dollars and deflated using the consumer price index. They found that the PRC exports to the world and the US imports from the world in 2007 were both much more than the model predicted. They also found that in the PRC's case the main outlier was exports to the US and in the case of the US, the main outlier was imports from the PRC. The PRC's exports to the US in 2007 were US\$200 billion more than the model predicted. These results are presented in Figure 4.

**Figure 4a: The PRC's Predicted and Actual Exports, 2007**



**Figure 4b: US Predicted and Actual Imports, 2007**



Notes: Predicted exports or imports represent the sum of predicted exports or predicted imports from 31 countries based on a gravity model. The gravity model includes income in the exporting and importing countries, the real exchange rate, distance, a common language dummy, importer and exporter fixed effects, dummy variables for Mexico and Canada, and a time trend as explanatory variables. AUS=Australia, AUT=Austria, BRZ=Brazil, CAN=Canada, DNK= Denmark, ESP= Spain, FRA=France, FIN=Finland, GER=Germany, IDN=Indonesia, IND=India, IRL=Ireland, ITA=Italy, JPN= Japan, KOR=Korea, KSA=Saudi Arabia, MEX=Mexico, MYS=Malaysia, NLD= Netherlands, NOR=Norway, PHL=Philippines, POL=Poland, PRC= People's Republic of China, SGP= Singapore, SWE=Sweden, SWZ= Switzerland, TAI=Taipei,China, THA=Thailand, TUR=Turkey, UK=United Kingdom, US= United States

Source: Thorbecke and Komoto (2010).

The massive imbalances between the PRC and the US have been financed by the accumulation of US Treasury securities (external reserves) by the People's Bank of China (PBoC). Many argue that continued foreign reserve accumulation by the PBoC is unsustainable because it produces an increasingly inefficient allocation of resources. Both private and social rates of return are much higher for investments in the PRC economy than for investments in US securities. For instance, investing in education would pay high dividends by helping PRC firms to assimilate new technologies and move up the value chain.

A related issue to the PRC's foreign reserve accumulation is whether sterilization measures by the PBoC have worked well. If not, maintaining the current exchange rate arrangement will prove problematic. Concerning this issue, Ouyang, Rajan, and Willett (2010) conclude that the PBoC's sterilization was effective and the PRC played the role of the reserve sink, like Germany in the Bretton Woods system. On the other hand, Wang (2009) found that the share of sterilization was only 43% if M2 rather than the monetary base is examined. In addition, from the results of recursive estimation, both papers agree to the view that the sterilization has been getting more difficult year by year.

If the PRC were to stop accumulating additional reserves and invest in the domestic economy, its currency would appreciate. How would this affect trans-Pacific imbalances? Cheung, Chinn, and Fujii (2010), using DOLS methods and quarterly data over the 1993 to 2006 period, report that a 10% appreciation of the CNY would reduce the PRC's exports to the US by between 8% and 20%. Thorbecke (2006), using DOLS and Johansen maximum likelihood estimation (MLE) and quarterly data over the 1988 to 2005 period, finds that a 10% appreciation of the CNY would reduce the PRC's exports to the US by between 4% and 14%. An appreciation of the CNY against the US dollar should thus help reduce imbalances between the two countries.

If the PRC does not let the CNY appreciate and if the imbalances prove unsustainable, how else would adjustment occur? Cheung, Chinn, and Fujii (2010) and Thorbecke (2006) both reported that a fall in income in the US would not affect the PRC's exports. One explanation for this is the "Walmart effect" discussed by Petri and Plummer (2009). They argued that since PRC exports are at low price points within product categories, the demand for PRC imports may increase even as overall demand shrinks. The idea that there is a tenuous relationship between PRC exports and US income is supported by recent experience. The CNY remained tightly pegged to the US dollar, and a once-in-a-generation crisis barely reduced either the PRC's exports to the US or its trade surplus. A real appreciation of the CNY is thus probably necessary to reduce imbalances between the PRC and the US.

If a real appreciation cannot be achieved by nominal exchange rate adjustment, it is likely that it will be achieved by inflation in the PRC and deflation in the US. This would be painful for both countries.

## 5. CONCLUSION

This paper has surveyed recent research on the relationship between exchange rates and trade in Asia. The results indicate that exports produced within regional production networks depend on exchange rates throughout East Asia. The continuous flow of parts and components within regional production networks also depends on relative exchange rate stability in the region. Labor-intensive exports depend on exchange rates in the exporting country. Finally, imbalances between the PRC and the US are sensitive to changes in the CNY/US dollar exchange rate.

These results indicate that, while Asian economies cooperate in regional production and distribution networks, they also compete in the export of labor-intensive manufacturing goods to third markets. This competition makes individual countries in Asia resistant to

allowing their currencies to appreciate unilaterally relative to the currencies of neighboring currencies. However, if trans-Pacific imbalances are unsustainable, exchange rates will have to appreciate eventually.

In this case it would be desirable for East Asian currencies to appreciate in concert against external currencies while maintaining relative stability vis-à-vis each other. This outcome would benefit East Asia in several ways. Relative stability in intra-regional exchange rates would facilitate the flow of parts and components within regional production networks. Appreciations would allow Asian consumers to import more from the rest of the world and give Asian firms an incentive to produce for domestic markets. Concerted appreciations would also help prevent unpleasant outcomes such as beggar-thy-neighbor policies and excessive reserve accumulation.

How could Asia achieve a concerted appreciation? A crucial first step would be for the PRC to keep making progress towards its self-proclaimed goal of adopting a regime characterized by a multiple-currency, basket-based reference rate with a reasonably wide band. In this case, the huge surpluses generated within East Asian production networks would cause currencies in the region to appreciate together. Market forces could then allocate these appreciations across supply chain countries as a function of the size of their surpluses in processing trade.

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