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Investigating the Effect of Exchange Rate Changes on Transpacific Rebalancing

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Abstract

This paper investigates the role that exchange rate changes can play in rebalancing transpacific trade. It presents evidence from a gravity model indicating that the exports from the People's Republic of China (PRC) to the United States (US) are a key outlier in the global economy and that imbalances between the PRC and the US have remained large during the financial crisis that began in September 2008. It then reports that an appreciation of the yuan against the dollar would be required to rebalance bilateral trade between the US and the PRC. In the case of multilateral trade between the US and the rest of the world, on the other hand, the evidence indicates that a depreciation of the dollar would not substantially reduce the US global trade deficit. In the case of Asia's exports, results presented here and elsewhere indicate that: (i) sophisticated exports produced within regional production networks depend on exchange rates throughout the region; (ii) labor-intensive exports from developing Asian countries are strongly influenced by each country's own exchange rate; (iii) developing Asian countries compete extensively with each other in exports to third markets; (iv) a currency appreciation in developing Asia would increase capital and consumption goods imports; and (v) exchange rate volatility deters parts and components trade in Asia. These findings imply that Asia and the rest of the world would benefit if East Asian currencies could appreciate together against external currencies while maintaining relative currency stability within the region.

JEL Classification: F32, F41

Contents

1. INTRODUCTION

The United States (US) current account deficit as a percent of gross domestic product (GDP) grew from 2% in 1997 to 4% in 2002 to 6% before the financial crisis that began in October 2008. The US ran large trade deficits with East Asia, oil-producing countries, and the rest of the world. Since the crisis began, however, America's deficit with most regions has fallen while its deficit with the PRC has remained intransigent.

Table 1 shows exports, imports, and the trade balance between the US and the rest of the world before and after the Lehman Brothers shock 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 erupted (October 2007–September 2008), the first year after the Lehman shock (October 2008–September 2009), and forecasts for 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, equaling US$227 billion between October 2008 and September 2009. For the PRC, it fell by less than 12% and equaled $237 billion in the same period. Columns (7) through (9) indicate that this pattern is continuing during the second year after the crisis. The US deficit with the PRC since October 2008 roughly equals the US deficit with all non-East Asian countries together.

Table 1: Exports, Imports, and Trade Balance between the US and Other Countries and Regions before and after the Lehman Brothers Shock (billions of US dollars)

	Year before Lehman Brothers Shock			First Year after Lehman Brothers Shock			Second Year after Lehman Brothers Shock (forecast)		
Country or Region	Exports to US	Imports from US	Bilateral trade balance with US	Exports to US	Imports from US	Bilateral trade balance with US	Exports to US	Imports from US	Bilateral trade balance with US
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
East Asia									
People's Republic of China	337	71	266	300	63	237	317	87	230
Japan	146	66	80	99	52	47	109	56	53
Republic of Korea	49	37	12	40	27	13	39	34	6
Taipei,China	38	27	10	29	17	12	31	23	8
East Asia, total	569	201	368	468	160	308	496	200	297
Rest of the World (excluding East Asia)	1,581	1,097	484	1,126	899	227	1,198	953	245

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. The forecast for the second year is derived by multiplying data for the five months for which data is available (i.e., October 2009–February 2010) by 2.4.

Source: US Census Bureau, http://www.census.gov/.

Figures 1 and 2 highlight the unusual nature of the PRC's exports to the US. Figure 1 presents predicted and actual multilateral exports and imports for the 31 largest exporting countries in 2007, just before the crisis. The results were obtained from a gravity model described in Appendix 1. Figure 2 presents data from 2007 on predicted and actual exports of the PRC to 31 countries and predicted and actual imports of the US from 31 countries. The figures indicate that PRC exports, US imports, and especially PRC exports to the US are clear outliers in the global economy.

Figure 1a: Predicted and Actual Exports, 2007

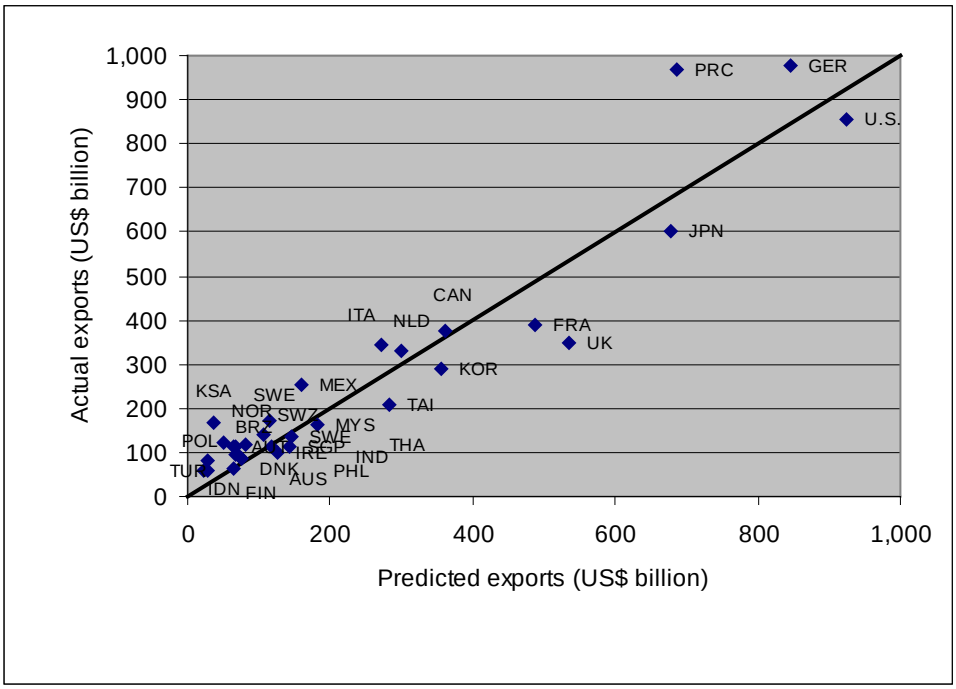
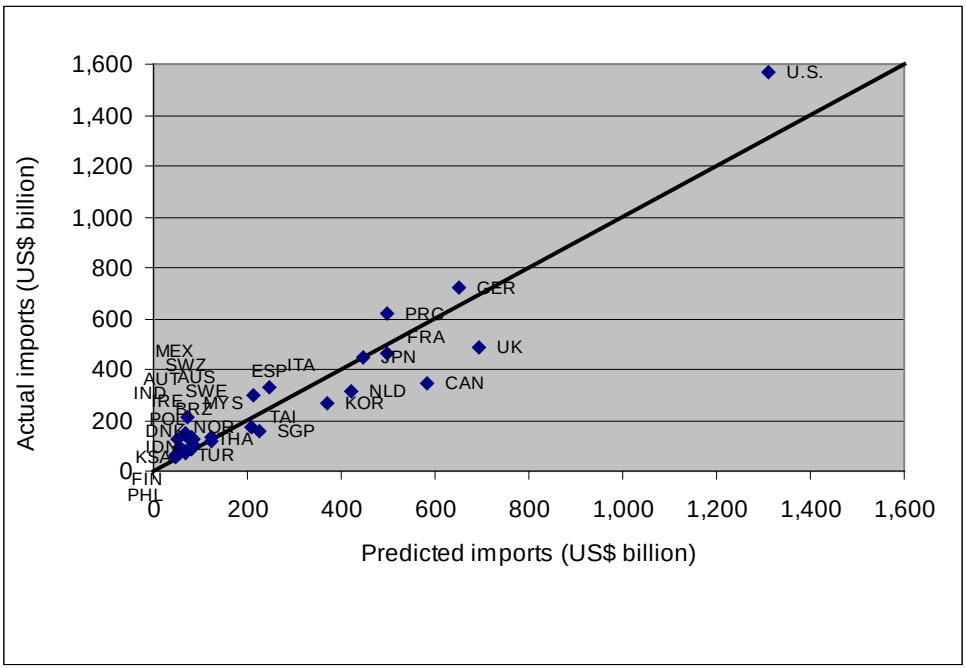


Figure 1b: Predicted and Actual Imports, 2007



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 = Republic of Korea; KSA = Kingdom of 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.

Note: 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.

Source: Authors' calculations..

Figure 2a: PRC's predicted and actual exports, 2007

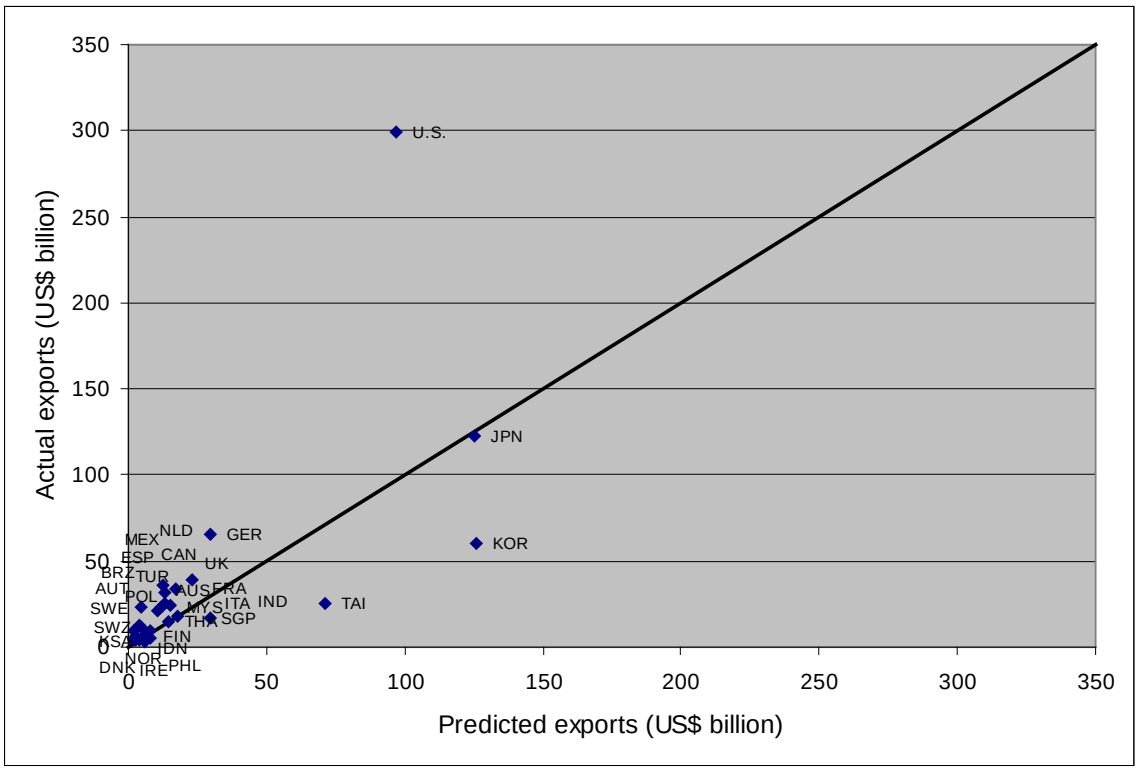
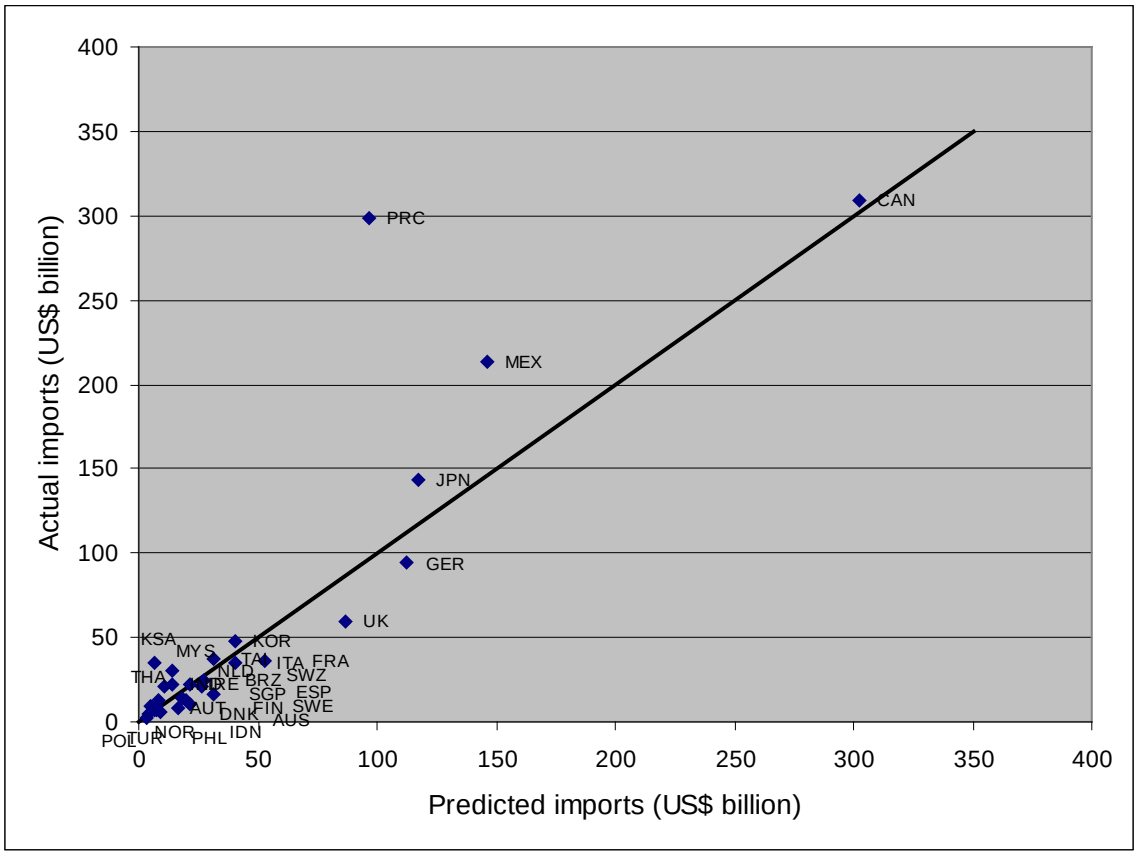


Figure 2b: US predicted and actual imports, 2007



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 = Republic of Korea; KSA = Kingdom of 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.

Note: 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.

Source: Authors' calculations.

Given the distinctness of these imbalances, this paper begins by examining the factors affecting PRC exports to the US. The findings indicate that a 10% appreciation of the yuan would cause the PRC's exports to fall by 10% or maybe a little more. On the other hand, the results indicate that a decrease in income in the US would not cause a large drop in the PRC's exports. This evidence is supported by recent experience. During the 2008–2009 crisis, the yuan remained tightly pegged to the dollar. As Table 1 shows, a once-in-a-generation crisis barely reduced the PRC's exports to the US. If policymakers want to reduce imbalances between the PRC and the US, a real appreciation of the yuan is thus probably necessary.[1]

This paper then presents aggregate import and export elasticities for the US and Asian countries that were estimated using a consistent methodology. Results from a dynamic ordinary least squares (DOLS) model indicate that trade elasticities for aggregate US exports and imports are small. Thus exchange rate changes alone may not be sufficient to significantly reduce America's global trade deficit.

[1] A real appreciation could be accomplished by either an appreciation of the nominal exchange rate or an increase in the price level.

These estimates, though, are subject to the aggregation bias first discussed by Orcutt (1950). They can also be distorted by the nature of Asian trade. For example, many of the imports into Asian countries are parts and components that are used to produce goods for re-export to the rest of the world. An exchange rate appreciation that reduces a country's exports can also reduce its demand for imported goods that are used to produce exports. This can cause the estimated exchange rate coefficient in import equations to be biased toward zero (see Kamada and Takagawa 2005).

This paper thus supplements the aggregate estimates of exchange rate elasticities with a review of previously published results. The evidence indicates that: (i) a depreciation of the dollar alone may not be sufficient to substantially reduce America's global current account deficit; (ii) sophisticated exports produced within regional production networks depend on exchange rates throughout the region; (iii) labor-intensive exports from developing Asian countries are strongly influenced by each country's own exchange rate; (iv) developing Asian countries compete extensively with each other in exports to third markets; (v) a currency appreciation in developing Asia would increase capital and consumption goods imports; and (vi) exchange rate volatility deters parts and components trade in Asia.

Two policy implications flow from these findings. First, if the US current account deficit needs to be reduced in the future, absorption-reducing policies such as fiscal consolidation would probably be required. The expenditure-switching effect of a dollar depreciation may not be large enough to significantly reduce America's trade deficit. Second, a joint appreciation throughout East Asia would be beneficial for the region and the world. It would help to maintain exchange rate stability within the region, facilitating the flow of capital goods and parts and components among Asian countries. It would increase the purchasing power of consumers in the PRC and other countries. It also would help reduce Asia's over-reliance on exports to the US and Europe. Finally, it would help overcome prisoner's dilemma problems that arise because the fear of losing competitiveness relative to Asian trading partners sometimes prevents countries in the region from allowing their currencies to appreciate.

One way for East Asian countries to appreciate together would be for the PRC to adopt 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.

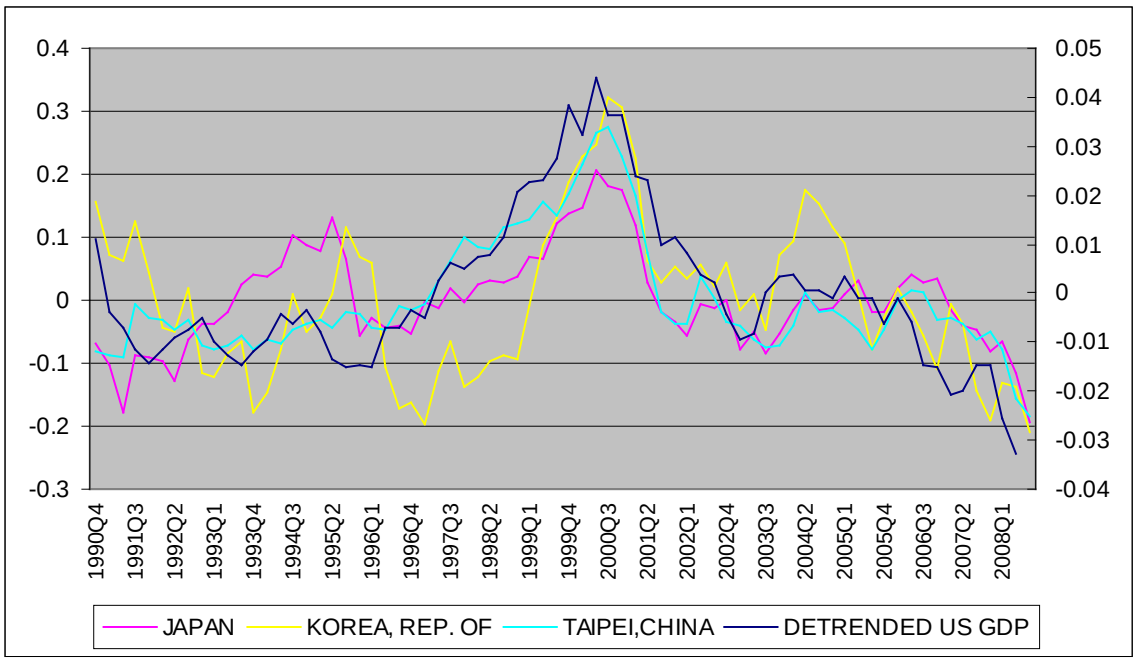
The next section investigates the factors affecting the PRC's exports to the US. Section 3 reports export and import elasticities for the US and selected Asian countries estimated using a consistent methodology. Section 4 concludes the paper.

2. NEW EVIDENCE FOR THE PRC'S EXPORTS TO THE US

2.1 Background

Table 1 shows that the PRC's exports to the US exceed the PRC's imports from the US by a five-to-one ratio. Figure 3 shows that the PRC's exports to the US (but not US exports to the PRC) represent a major outlier for both countries. This section thus investigates the factors affecting the PRC's exports to the US

Figure 3: Detrended, Deseasonalized Exports from Japan; Republic of Korea; and Taipei,China to the US and Detrended US GDP



GDP = gross domestic product, US = United States.

Note: Y-axis on the right side is for detrended US GDP; y-axis on the left side is for Japan; Republic of Korea; and Taipei,China's detrended and deseasonalized exports.

Sources: US Census Bureau, http://www.census.gov/; Federal Reserve Bank of St. Louis FRED database, http://research.stlouisfed.org/fred2/; and authors' calculations.

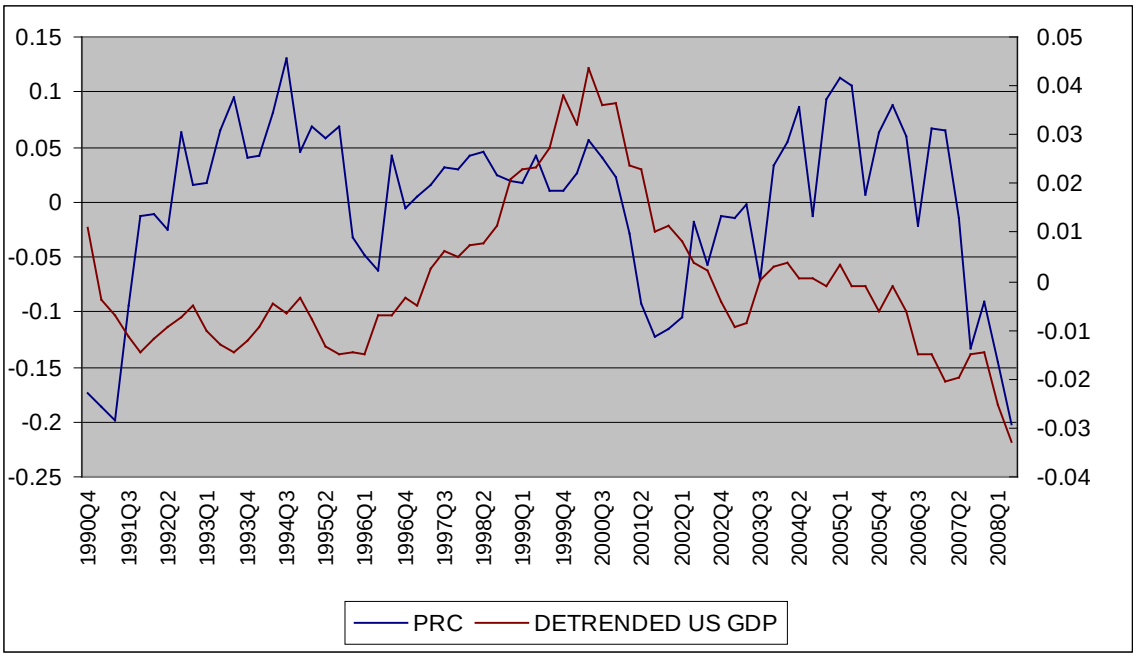
As Wakasugi (2009) argued, there is a fundamental difference between exports from Japan to the US and exports from the PRC to the US. Exports from Japan tend to be high-end, knowledge-intensive goods. Exports from the PRC tend to be more labor-intensive, given the abundance of unskilled labor in the PRC. METI (2009) similarly reported that Japan's exports to the US are dominated by high value-added consumer durables while the PRC's exports are dominated by basic goods such as clothing. The Republic of Korea (hereafter Korea) and Taipei,China's exports to the US are also dominated by high value-added goods such as passenger cars, household appliances, semiconductors, and computers.

Wakasugi (2009) and METI (2009) noted that since the PRC exports primarily basic goods to the US while Japan and the newly industrialized economies (NIEs) export primarily high-end luxury products, the income elasticity of demand for exports from the PRC to the US should be smaller than for exports from more advanced Asian economies to the US. Petri and Plummer (2009) similarly discussed how the product mix of PRC goods may lead to what they call the "Walmart" effect. By this they mean that "if Chinese exports are at low price points within various product categories, they will benefit from a down-market shift in the composition of consumption even if demand for the category as a whole declines" (Petri and Plummer 2009: 705). In other words, the product composition and low price of the PRC's exports may sustain demand even when income in the US falls.

Informal evidence from Figures 3 and 4 supports the hypothesis that the PRC's exports respond less to changes in US income than exports from developed Asia do. Both figures show detrended quarterly output in the US. Figure 3 also shows detrended, deseasonalized real exports from Japan; Korea; and Taipei,China to the US and Figure 4 also shows detrended, deseasonalized real exports from the PRC to the US. The large increase in

detrended output up until the second quarter of 2000 and its subsequent large fall are associated with the dot-com bubble in the US and its bursting. Figure 3 shows that detrended, deseasonalized exports from developed Asia mirrored the pattern of US output at this time. On the other hand, Figure 4 shows a more tenuous relationship between US income over this period and PRC exports to the US.[2]

Figure 4: Detrended, Deseasonalized Exports from the PRC to the US and Detrended US GDP



GDP = gross domestic product, PRC = People's Republic of China, US = United States.

Note: Y-axis on the right side is for detrended US GDP; y-axis on the left side is for the PRC's detrended and deseasonalized exports

Sources: US Census Bureau, http://www.census.gov/; Federal Reserve Bank of St. Louis FRED database, http://research.stlouisfed.org/fred2/; and authors' calculations.

Several authors have presented formal evidence indicating that income elasticities are higher for exports from Japan; Korea; and Taipei,China to the US than for exports from the PRC to the US. Thorbecke (2008a), using a variety of cointegration estimators and quarterly data over the 1988–2005 period, reported that the income elasticity of demand for Japan's exports to the US was approximately 3. Kim (2009), using a Johansen cointegration model and quarterly data over the 1981–1998 period, reported that the income elasticity for Korea's exports to the US was 3.5. Chen (2001), using ordinary least squares (OLS) techniques and quarterly data over the 1981–1998 period, reported that income elasticity for Taipei,China's exports to the US was 2.6. In contrast, both Cheung, Chinn, and Fujii (2010) using DOLS methods and quarterly data over the 1993–2006 period and Thorbecke (2006) using DOLS and Johansen maximum likelihood estimation and quarterly data over the 1988–2005 period failed to find evidence that an increase in income in the US would increase the PRC's exports.

Cheung, Chinn, and Fujii (2010), Thorbecke (2006), and Yu (2009) all reported that a depreciation of the yuan is associated with an increase in the PRC's exports to the US. Cheung, Chinn, and Fujii reported exchange rate elasticities ranging from 0.80 to 2.03,

[2] Figure 2 shows aggregate PRC exports. Some categories of PRC exports are more sensitive to income. Thorbecke and Smith (2010) reported that that sophisticated processed exports from PRC to the world have higher income elasticity than less sophisticated ordinary exports.

Thorbecke reported elasticities ranging from 0.40 to 1.44, and Yu reported an exchange rate elasticity of 1.23.

This section reports updated findings for the PRC's exports to the US. Results from DOLS estimation indicate that an appreciation of the yuan relative to the dollar would reduce the PRC's exports to the US. On the other hand, the econometric results do not provide convincing evidence of a strong relationship between US income and the PRC's aggregate exports.

2.2 Data and Methodology

The imperfect substitutes model of Goldstein and Khan (1985) implies that export functions can be written as:

$$ex_t = \alpha_{10} + \alpha_{11}\, rer_t + \alpha_{12}\, rgdp_t^* + \varepsilon_t, \qquad (1)$$

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

Monthly data on exports from the PRC to the US are available from the US Census Bureau. These data were summed to obtain quarterly values.

To deflate the PRC's exports to the US we used the US Bureau of Labor Statistics price deflator for manufactured imports from non-industrial countries. Chinn (2006) found that this series closely matches the Bureau of Labor Statistics price deflator for imports from the PRC, which became available in 2003.

Data for quarterly real GDP for the US were obtained from Organisation for Economic Co-operation and Development trade statistics. These data were seasonally adjusted.

The real exchange rate was calculated as the product of the yuan price of dollars and the ratio of the US to the PRC price levels. An increase in real exchange rate thus represents a depreciation of the yuan. In one specification, we followed Cheung, Chinn, and Fujii (2010) in using exchange rates before 1994 that are adjusted for the fact that some transactions took place at the official exchange rate and some took place at the "swap" rate.

Thorbecke (2006) argued that the PRC's exports to the US compete with exports from emerging Asia. Ahearne et al. (2003) presented evidence that economies in Asia follow a "flying geese" pattern, with the PRC and Association of Southeast Asian Nations-4 (ASEAN-4) moving into product categories relinquished by the Asian NIEs as they move up the value chain.[3] Similarly, Gaulier, Lemoine, and Unal-Kesenci (2005) reported based on a detailed analysis of trade flow data that there is essentially a complimentary relationship between the PRC and the NIEs. On the other hand, they found that there is a competitive relationship between the PRC and ASEAN in the export of labor-intensive final goods to third countries. Thus, in empirical work, it is important to control for competition between exports from the PRC and exports from ASEAN.

A real exchange rate index (I_t) between the US and the ASEAN-4 countries (Indonesia, Malaysia, Philippines, and Thailand) can be calculated using the following formula:

$$I_t = I_{t-1} \prod_{i=1}^{4} (r_{i,t} / r_{i,t-1})^{w_{i,t}}, \qquad (2)$$

where $r_{i,t}$ is the real exchange rate between ASEAN country i and the US in quarter t and $w_{i,t}$ is the weight assigned to ASEAN country i in quarter t. $r_{i,t}$ equals the currency price of dollars times the ratio of the US price level to the price level of country i. An increase in $r_{i,t}$ (and thus

[3] They defined the NIEs as Korea; Singapore; and Taipei,China and ASEAN-4 as Indonesia, Malaysia, Philippines, and Thailand.

I_t) represents an appreciation of the dollar. $w_{i,t}$ is calculated as the ratio of exports from country i to the US divided by exports from all four ASEAN countries to the US. The sum of the $w_{i,t}$ thus equals 1. I_t is set equal to 100 in 1985Q1.

Following Cheung, Chinn, and Fujii (2010), we also included the capital stock to control for supply side factors. For the PRC, Bai, Hsieh, and Qian (2006) have constructed data on the capital stock. These data were converted to quarterly values using linear interpolation and updated over the last few years using data from the Economist Intelligence Unit database.

The model was estimated using DOLS. DOLS involves regressing the left-side variable on a constant, the right-side variables, and lags and leads of the right-side variables. The equation has the form:

$$x_t = \beta_0 + \beta_1 rer_t + \beta_2 rgdp_t + \beta_3 K_t + \beta_4 eri_t + \beta_5 Time + \sum_{j=-p}^{p} \alpha_{rer,j} \Delta rer_{t-j}$$
$$+ \sum_{j=-p}^{p} \alpha_{rgdp,j} \Delta rgdp_{i,t-j} + \sum_{j=-p}^{p} \alpha_{K,j} \Delta K_{t-j} + \sum_{j=-p}^{p} \alpha_{eri,j} \Delta eri_{t-j} + u_t, \quad (3)$$

where x_t represents exports from the Asian country to the US, rer_t represents the bilateral real exchange rate index, $rgdp_t$ equals real income in the US, K_t denotes the capital stock in the Asian country, eri represents the exchange rate index for other Asian countries, and $Time$ is a time trend. Seasonal dummy variables are also included. x_t, rer_t, $rgdp_t$, K_t, and eri_t are measured in natural logs.

Data on the import price indices are available beginning in 1990Q4 and data on the consumer price index are available until 2008Q4. We estimated equation (4) using a DOLS (2, 2) model.[4] Because this involves using two leads and lags of the first differences of the right-side variables, the actual sample period for the estimation is 1990Q4–2008Q2.

2.3 Results

Tables 2 and 3 present the results. Table 2 contains the findings for the bilateral exchange rate adjusted for swap transactions and Table 3 contains the findings for the unadjusted bilateral exchange rate.

[4] A DOLS (2, 2) model employs two leads and two lags of the first differences of the right-side variables.

Table 2: DOLS Estimates of the PRC's Exports to the US, 1990–2008

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
US GDP	0.36	0.80	–0.16	–1.00	1.24*	6.00***	0.65	5.42***
	(0.85)	(0.96)	(0.76)	(0.79)	(0.73)	(0.12)	(0.48)	(0.07)
PRC Weighted RER relative to the dollar	0.95***	1.58***	0.50**	1.52***	0.66***	0.82***	0.52***	0.78***
	(0.33)	(0.14)	(0.23)	(0.13)	(0.11)	(0.14)	(0.09)	(0.15)
PRC capital stock	0.43	1.42***	–0.07	1.82***				
	(0.52)	(0.25)	(0.41)	(0.22)				
Indonesia, Malaysia, Philippines, Thailand RER Indices	–0.19	–0.39***			–0.13	–0.61***		
	(0.14)	(0.11)			(0.11)	(0.11)		
Time	0.03**		0.05***		0.04***		–0.04***	
	(0.01)		(0.01)		(0.00)		(0.00)	
Adjusted R-squared	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
No. of observations	68	68	68	68	68	68	68	68

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

DOLS = dynamic ordinary least squares, GDP = gross domestic product, PRC = People's Republic of China, RER = real exchange rate, US = United States.

Notes: DOLS (2, 2) estimates. Heteroskedasticity-consistent standard errors are in parentheses.

Table 3: DOLS Estimates of the PRC's Exports to the US, 1990–2008

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
US GDP	0.76	2.48*	0.68	0.18	0.41	5.85***	–0.24	5.39***
	(0.82)	(1.45)	(0.61)	(1.36)	(0.71)	(0.11)	(0.36)	(0.08)
PRC RER relative to the dollar	0.52**	1.45***	0.20	1.20***	0.71***	0.78***	0.57***	0.55***
	(0.25)	(0.28)	(0.15)	(0.27)	(0.12)	(0.16)	(0.08)	(0.21)
PRC capital stock	–0.44	0.92	–0.68**	1.45***				
	(0.29)	(0.38)	(0.26)	(0.39)				
Indonesia, Malaysia, Philippines, Thailand RER Indices	–0.10	–0.48**			–0.08	–0.61***		
	(0.16)	(0.20)			(0.10)	(0.10)		
Time	0.05***		0.06***		0.04***		–0.04***	
	(0.01)		(0.01)		(0.00)		(0.00)	
Adjusted R-squared	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98
No. of observations	68	68	74	74	68	68	74	74

*** and ** denote significance at the 1% and 5% levels, respectively.

DOLS = dynamic ordinary least squares, GDP = gross domestic product, PRC = People's Republic of China, RER = real exchange rate, US = United States.

Notes: DOLS (2, 2) estimates. Heteroskedasticity-consistent standard errors are in parentheses.

Thorbecke and Smith (2010) argued that the preferred specification for the PRC should include the capital stock and exclude the time trend. In this specification the coefficient on the yuan exchange rate in Tables 2 and 3 is statistically significant and equals about 1.5. These results imply that a 10% appreciation of the yuan would reduce the PRC's exports to the US by about 15%. The coefficients on US income and the PRC capital stock are positive, but in one case only the coefficient on US income is statistically significant and in the other case only the coefficient on the capital stock is statistically significant. These conflicting results probably occur because both the PRC capital stock and US income resemble deterministic trends. Finally, the coefficient on the ASEAN exchange rate index is negative and significant. The results indicate that a 10% appreciation of ASEAN countries would increase the PRC's exports by 4% to 5%.

Across the 16 different specifications in Tables 2 and 3, the coefficient on the yuan exchange rate is positive in every case and statistically significant in 15 of the 16 cases. These results provide robust evidence that an appreciation of the yuan would reduce PRC exports to the US. The average value across all of the specifications is approximately unity. For income and the PRC capital stock, the coefficient values are sensitive to the econometric specification.

The evidence of a tenuous relationship between aggregate PRC exports and US income is supported by experience during 2008–2009. The yuan remained tightly pegged to the dollar, and a once-in-a-generation crisis barely reduced the PRC's exports to the US and its trade surplus. If policymakers want to reduce imbalances between the US and the PRC, an appreciation of the yuan is probably necessary.

3. ESTIMATING ELASTICITIES OF EXPORTS AND IMPORTS FOR TRANSPACIFIC COUNTRIES

3.1 Data and Methodology

This section presents estimates of aggregate trade elasticities estimated using a consistent methodology. Estimates are presented for the US and for PRC; Japan; Korea; Malaysia; Philippines; Thailand; and Taipei,China. For India and Indonesia, data were not available over a long enough time period to estimate the model using the same methodology.

Equation (1) presented export functions based on the imperfect substitutes model. Import functions based on the imperfect substitutes model can be written as:

$$im_t = \alpha_{10} + \alpha_{11}\, rer_t + \alpha_{12}\, rgdp_t + \varepsilon_t, \quad (4)$$

where im_t represents the log of real imports, rer_t represents the log of the real exchange rate, and $rgdp_t$ represents the log of domestic real income.

Quarterly data on aggregate exports and imports are available from the International Monetary Fund's International Financial Statistics (IFS). For most countries these data are measured in dollars and were deflated using the US producer price index from IFS. For Japan they are measured in yen and are deflated using Japanese export and import prices from IFS. For the US they are measured in dollars and are deflated using US export and import prices from IFS.

To calculate rest of the world income for each exporting country we constructed a weighted index of income changes in the top 10 export destinations. The index was calculated using the following formula:

$$rgdp_t^* = rgdp_{t-1}^* \prod_{i=1}^{10} (rgdp_{i,t} / rgdp_{i,t-1})^{w_{i,t}} , \quad (5)$$

where $rgdp_t^*$ is rest of the world income for an exporting country, the subscript i indexes the 10 largest export markets, $rgdp_i$ is income in country i, and w_i is the share of exports going to country i relative to exports going to the 10 largest export markets. The weights were calculated using annual data from the CEPII-Chelem database and converted to quarterly data using linear interpolation. The index was set equal to 100 in 1981Q1.

Data on real income and the real effective exchange rate were obtained from various sources. These are discussed in the Appendix 2.

Export and import functions are estimated using DOLS:

$$x_t = \beta_0 + \beta_1 rer_t + \beta_2 rgdp^*_t + \sum_{j=-p}^{p} \alpha_{rer,j} \Delta rer_{t-j} + \sum_{j=-p}^{p} \alpha_{rgdp,j} \Delta rgdp^*_{i,t-j} + u_t ,$$

$$im_t = \beta_0 + \beta_1 rer_t + \beta_2 rgdp_t + \sum_{j=-p}^{p} \alpha_{rer,j} \Delta rer_{t-j} + \sum_{j=-p}^{p} \alpha_{rgdp,j} \Delta rgdp_{i,t-j} + v_t , \quad (6)$$

where the variables are defined above.

For most countries we used data from 1981Q1 to 2008Q3. We estimated Equation (6) using a DOLS (2, 2) model. Because this involves using two leads and lags of the first differences of the right-side variables, the actual sample period for the estimation is 1981Q4–2008Q1. In the case of PRC, Philippines, and Thailand we could only obtain consistent data over the 1990Q1–2008Q3 period and the actual sample period for the estimation is thus 1990Q4–2008Q1.

3.2 Results and Discussion

Table 4 presents the results. Income coefficients for every country are positive and statistically significant. These results indicate that for each country an increase in domestic income would increase imports and an increase in rest of the world income would increase exports.

Table 4: DOLS Estimates of Transpacific Export and Import Elasticities

Explanatory variables	United States		Japan		Rep. of Korea		Taipei,China	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Income of trade partners	1.76***	2.14***	1.11***	2.31***	1.94***	1.32***	1.75***	1.45***
	(0.02)	(0.01)	(0.01)	(0.06)	(0.04)	(0.02)	(0.07)	(0.03)
RER	–0.35***	0.28***	–0.32***	–0.34***	–0.21*	1.08***	1.12***	0.92***
	(0.05)	(0.03)	(0.02)	(0.04)	(0.11)	(0.08)	(0.20)	(0.12)
Adjusted R-squared	0.99	0.99	0.99	0.96	0.97	0.98	0.95	0.97
Period	1981Q4 – 2008Q1	1981Q4– 2008Q1	1981Q4– 2008Q1	1981Q4– 2008Q1	1981Q4– 2008Q1	1981Q4– 2008Q1	1981Q4– 2008Q1	1981Q4– 2008Q1
No. of observations	106	106	106	106	106	106	106	106

Explanatory variables	PRC		Malaysia		Philippines		Thailand	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Income of trade partners	5.51***	1.74***	2.20***	1.57***	2.64***	1.62***	1.98***	1.54***
	(0.14)	(0.04)	(0.08)	(0.07)	(0.17)	(0.14)	(0.03)	(0.08)
RER	–1.20***	–1.09***	0.59***	0.45**	0.44**	1.11***	0.78***	0.52***
	(0.25)	(0.26)	(0.14)	(0.18)	(0.19)	(0.16)	(0.12)	(0.14)
Adjusted R-squared	0.96	0.97	0.98	0.96	0.86	0.85	0.98	0.87
Period	1990Q4 – 2008Q1	1990Q4– 2008Q1	1981Q4– 2008Q1	1981Q4– 2008Q1	1990Q4– 2008Q1	1990Q4– 2008Q1	1990Q4– 2008Q1	1990Q4– 2008Q1
No. of observations	73	70	106	106	70	70	70	70

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

DOLS = dynamic ordinary least squares, PRC = People's Republic of China, RER = real exchange rate.

Notes: DOLS (2, 2) estimates. Heteroskedasticity-consistent standard errors are in parentheses.

There is evidence of an asymmetry between the income elasticities for imports and exports. For the US, the income elasticity of imports is greater than the income elasticity of exports. On the other hand, for all the East Asian countries except Japan, the income elasticity of imports is less than the income elasticity of exports.

The exchange rate elasticities take on the unexpected signs in many cases for Asian countries but take on the expected signs and are statistically significant for the US. For Asian countries, the exchange rate estimates may be distorted because of the nature of East Asian production networks (see, e.g., Kamada and Takagawa 2005). For the US, the results indicate that a 10% appreciation of the dollar would reduce exports by about 4% and increase imports by about 3%.

There are a few problems with the aggregate estimates reported in Table 4. One, already mentioned, is that these estimates can be distorted by the nature of processing trade within Asia. For example, many of the imports into Asian countries are parts and components that are used to assemble goods for re-export to the rest of the world. An exchange rate appreciation in the assembly country that reduces exports will also reduce the demand for imported goods that are used to produce the exports. This can cause estimated exchange rate coefficients in import equations to be biased toward zero. A second problem, noted long ago by Orcutt (1950), is that estimates of aggregate trade elasticities may be biased if elasticities differ by sector. A third problem, emphasized by Kenen (2007), is that it may be necessary to disaggregate trade flows by country or by group of countries to avoid biased results. A fourth problem is that employing the same specification for all countries does not take into account country-specific characteristics.

It is thus useful to review other evidence concerning how exchange rate changes affect exports and imports. Below we discuss additional evidence for both the US and for Asian countries.

Chinn (2004, 2005a, 2005b) and others, in a series of valuable studies using cointegration techniques, uncovered several stylized facts concerning US trade elasticities:

(i) Exchange rate elasticities for US exports in real terms are precisely estimated and range from 0.68 to 0.84.

(ii) Exchange rate elasticities for US imports in real terms are not statistically significant unless computers and oil are excluded. These amount to 15% of total imports. If they are excluded, price elasticities for the remaining 85% of imports are statistically significant but low. They range from 0.29 to 0.49.

(iii) The sum of the export and import elasticities just barely exceeds one (1.15 if we use the midpoints), implying that the Marshall-Lerner condition for a depreciation to improve the trade balance in nominal terms is just barely met.

(iv) The income elasticity of demand for US exports is between 1.7 and 2.0.

(v) The income elasticity of demand for US imports is 2.4.

(vi) The Houthakker-Magee effect (i.e., the finding that income elasticities for US imports substantially exceed income elasticities for US exports) is still present in the estimates. The difference in the income elasticities, however, appears to have fallen since Houthakker and Magee's original work in 1969.[5]

Chinn concluded based on these estimates that a depreciation of the dollar, if not accompanied by a decrease in expenditures in the US or an increase in expenditures in the rest of the world, would be unlikely to substantially reduce the US trade deficit.

[5] Bosworth and Collins (2010), on the other hand, found that the Houthakker-Magee asymmetry has disappeared, with income elasticity of demand for US exports of 2.7 and income elasticity of demand for US imports of 2.4. They also found larger exchange rate coefficients than those reported by Chinn (2005a, 2005b).

For Asian countries it has been useful to disaggregate imports and exports by category. Some of the key import categories are parts and components, capital goods, and consumption goods. Some of the key export categories are labor-intensive manufacturing goods and technologically-sophisticated goods.

Parts and components trade within East Asia has exploded along with the growth of regional production and distribution networks. IMF (2005) noted that the flow of imports for processing is driven by the demand for final exports in the rest of the world. It estimated that the exchange rate elasticity for imports for processing in Asian processor economies is small (about 0.1).

While the level of the exchange rate may not matter much for parts and components trade within East Asian production networks, both theoretical and empirical evidence indicates that exchange rate volatility matters a lot. Theoretically 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. Empirically, using panel DOLS techniques over the 1985–2005 period, Thorbecke (2008b) reported that a one standard deviation increase in the coefficient of variation of the exchange rate between two Asian countries would reduce electronic components imports on average by US$300 million per year. Similarly, estimating a gravity model over the 1992–2005 period, Hayakawa and Kimura (2009) found that exchange rate volatility as measured by the standard deviation of the rate of change of the exchange rate decreased parts and components trade in Asia more than tariff barriers did. Ito et al. (2008), surveying Japanese multinational corporations, reported that exchange rate stability between Asian countries is essential for the uninterrupted flow of parts and components within regional production networks.

In capital goods trade there is essentially a complimentary relationship between firms in Japan; Korea; and Taipei,China and firms in developing Asia. Sophisticated capital goods are produced in developed Asia and exported to developing Asia, and many of these goods are difficult to procure elsewhere. Thorbecke (2008a, 2009a), using a gravity model and annual data over the 1982–2003 period, found that an appreciation in developed Asia relative to developing Asia would cause a large drop in capital goods trade. This would harm firms in developed Asia by reducing their exports and also harm firms in developing Asia by making it harder to purchase vital inputs that are difficult to procure elsewhere.

Consumption imports also have the potential to play an important role in Asia. In the PRC, for instance, the lion's share of imports represent inputs into the production process and consumption imports accounted for only 8% of the total in 2007. [6] An increase in consumption goods exports would benefit PRC consumers. Thorbecke (2009b), using a panel DOLS model and annual data over the 1985–2006 period, reported that a 10% appreciation of the yuan would increase the PRC's consumption imports from the rest of the world by 13%.

Two key export categories within Asia are final electronics goods such as consumer electronics goods and computer equipment and labor-intensive manufactures such as clothing, furniture, and footwear. Final electronics goods are produced largely within East Asian production and distribution networks. Japan; Korea; and Taipei,China produce sophisticated technology-intensive intermediate goods and ship them to the PRC and ASEAN for assembly and re-export. Value-added in the assembly countries is typically small. [7] Labor-intensive manufactures, on the other hand, are typically produced in developing Asia largely using domestic inputs. [8]

[6] In the US, by contrast, consumption goods imports were 25% of total imports in 2007. The source of these statistics is the CEPII-Chelem database.

[7] According to Koopman, Wang, and Wei (2008), PRC value-added in these sectors is small relative to the costs of the intermediate goods imported from abroad. For instance, they reported that PRC value-added in

For final electronics goods, the evidence indicates that exchange rates in the countries producing parts and components are an important determinant of exports from developing Asia. For instance Ahmed (2009) and Thorbecke and Smith (2010) found that an appreciation in East Asian supply chain countries would cause a large drop in processed exports. Thorbecke (2009c) reported similar results for the East Asian computer industry.[9]

For labor-intensive manufacturing goods, Thorbecke (2009d) and Thorbecke and Zhang (2009) found that an appreciation in the developing Asian country exporting the goods would cause a large drop in exports. The results indicate that there is also substantial competition between different countries in Asia that export labor-intensive goods to third markets. Similar results, reported in Section 2, indicate that a depreciation in ASEAN countries would cause a large drop in the PRC's exports to the US.

4. CONCLUSION

This paper has considered the role that exchange rate changes can play in transpacific rebalancing. It first documented that PRC exports to the US were a major outlier in the global economy before the financial crisis that began in October 2008 and that imbalances between the PRC and the US have barely fallen since the crisis began. Evidence presented here indicates that an appreciation of the yuan relative to the dollar would be necessary to reduce these imbalances.

At the global level, however, a depreciation of the dollar may not rebalance America's trade. Multilateral trade elasticities reported here and also those reported by Chinn (2005a, 2005b) indicate that a depreciation of the dollar would not substantially reduce the aggregate US trade deficit. Thus, if the current account deficit remains a problem for the US going forward, absorption-reducing policies such as fiscal consolidation would probably be required.

This paper has also reviewed evidence concerning how exchange rates affect Asian exports and imports. The evidence indicates that: (i) sophisticated exports produced within regional production networks depend on exchange rates throughout the region; (ii) labor-intensive exports from developing Asian countries are strongly influenced by each country's own exchange rate; (iii) developing Asian countries compete extensively with each other in exports to third markets; (iv) an appreciation in developing Asia would increase capital and consumption goods imports; and (v) exchange rate volatility deters parts and components trade in Asia.

These findings imply that Asia and the rest of the world would benefit if East Asian currencies could appreciate together against external currencies while maintaining relative currency stability within the region. Since ordinary exports tend to be simple, labor-intensive goods while processed exports are sophisticated, capital-intensive goods, a generalized appreciation in East Asia would generate more expenditure-switching toward goods produced outside the region and contribute more to resolving global imbalances than an appreciation of the yuan or of other Asian currencies alone. In addition, exchange rate stability in Asia would facilitate the flow of parts and components and provide a stable backdrop for regional production and distribution networks. Further, it would prevent unpleasant outcomes such as beggar-thy-neighbor policies that arise because Asian economies not only cooperate within production networks but also compete in third markets.

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electronic computers was less than 5% in 2002 and that PRC value-added in telecommunications equipment was less than 15%.

[8] Koopman, Wang, and Wei (2008) reported that PRC value-added in these industries is approximately 70%.

[9] In recent years more of the assembly operations have migrated to the PRC. As more of the value-added is produced in PRC, an appreciation of the yuan should have a larger effect on processed exports.

One way for Asian countries involved in processing trade to appreciate together would be for the PRC to adopt 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.

Concerted appreciations in East Asia would give firms in the region an incentive to redirect production away from export markets toward domestic markets. This would not only lead to a more sustainable long-term equilibrium by reducing Asia's dependence on Western consumers but would also allow workers in the region to enjoy more of the fruits of their own labor.

APPENDIX 1: GRAVITY MODEL USED TO CONSTRUCT FIGURES 1 AND 2

Predicted exports and imports in Figures 1 and 2 were derived from a gravity model. Gravity models posit that bilateral trade between two countries is directly proportional to gross domestic product (GDP) in the two countries and inversely proportional to the distance between them. In addition to GDP and distance, these models typically include other factors affecting bilateral trade such as whether trading partners share a common language.[10] Leamer and Levinsohn (1995: 1384) stated that gravity models yield "some of the clearest and most robust findings in economics."

The baseline model has the form:

$$\ln Ex_{ijt} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln DIST_{ij} + \beta_4 Lang + \beta_5 \ln RER_{ijt} +$$

$$\beta_6 USCAN + \beta_6 USMEX + \beta_7 TIME + \partial_i + \Omega_j + \pi_t + \varepsilon_{ijt}, \quad \text{(A1)}$$

where Ex_{ijt} represents exports from country i to country j, t represents time, Y_{it} and Y_{jt} represent real GDP in countries i and j, $DIST_{ij}$ represents the geodesic distance between countries i and j, $LANG_{ij}$ is a dummy variable equaling 1 if countries i and j share a common language and 0 otherwise, RER_{ijt} is the bilateral real exchange rate between country i and country j, USCAN and USMEX are dummy variables equaling 1 for trade between the United States (US) and Canada or the US and Mexico and zero otherwise, and ∂_i and Ω_j are country i and country j fixed effects. The gravity model was estimated as a panel using annual data for 31 countries over the 1988–2007 sample period. The model performs well. All of the variables are of the theoretically expected sign and are highly statistically significant.[11]

[10] Data sources are presented in Appendix 2.

[11] Detailed results are available on request.

APPENDIX 2: DATA SOURCES

The data were obtained from various sources:

I. Gravity Model for 31 leading countries in 2007

1. Trade data for the 31 countries were obtained from the CEPII-Chelem database.
2. Real exchange rates also came from the CEPII-Chelem database.
3. Data on the consumer price index came from the International Monetary Fund's International Financial Statistics (IFS).
4. Data on real gross domestic product (GDP), geodesic distance, and common language were obtained from the CEPII website (www.cepii.fr).

II. PRC's Exports to the United States (US)

1. Data on exports of the People's Republic of China (PRC) and Association of Southeast Asian Nations (ASEAN) to the US were obtained from the US Census Bureau.
2. Quarterly data on import price indices from 1990Q4–2008Q were obtained from the US Bureau of Labor Statistics. US producer price index and US consumer price index were obtained from the CEIC database.
3. Data on quarterly real GDP for the US were obtained from Organisation for Economic Co-operation and Development (OECD) trade statistics.
4. Data on nominal exchange rates and consumer prices index were obtained from IFS.
5. Capital stock data were obtained from the University of Pennsylvania Center for International Comparison, Economist Intelligence Unit, and Cheung, Chinn, and Fujii (2010).

III. Export and Import Elasticities for Asian Countries and the US

1. Quarterly export and import data were obtained from IFS.
2. Data on nominal exchange rates, the consumer price index, the producer price index, import prices, and export prices were obtained from IFS.
3. Quarterly GDP data for the PRC, Indonesia, Malaysia, Philippines, and Thailand were obtained from Rajaguru and Abeysinghe (2004)[12]; quarterly GDP data for Australia, Belgium, Canada, France, Germany, Italy, Japan, Republic of Korea, Mexico, Netherlands, United Kingdom, and US were obtained from the OECD; and quarterly GDP data for India were obtained from the CEIC database.
4. Real effective exchange rates were obtained from different sources: for India; Indonesia; Republic of Korea; and Taipei,China, data came from the Bank for International Settlements; for PRC, Japan, Malaysia, Philippines, and US, data came from IFS; and for Thailand, data came from the Central Bank of Thailand.
5. Data on the top 10 export destinations for countries in the sample were obtained from the CEPII-Chelem database.

[12] Updated data are available at http://courses.nus.edu.sg/course/ecstabey/gdpdata.xls. Following the authors' recommendation, these data were seasonally adjusted before being included in the model and were extended for the last couple of years using real GDP growth rates available from the Economist Intelligence Unit country data.

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