RIETI Discussion Paper Series 12-E-003

Investigating China's Disaggregated Processed Exports: Evidence that the RMB matters

THORBECKE, Willem
RIETI

RIETI
Research Institute of Economy, Trade & Industry, IAA

The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 12-E-003
January 2012

Investigating China's Disaggregated Processed Exports: Evidence that the RMB matters

Willem THORBECKE*
Research Institute of Economy, Trade and Industry

Abstract

China's trade surplus is entirely in processing trade. Processed exports are final goods produced using parts and components coming from East Asian supply chain countries. Many claim that because much of the value added of China's processed exports comes from East Asian countries, exchange rates in supply chain countries should affect China's processed exports and the renminbi should not. To investigate these issues, this paper disaggregates processed exports into their two main categories—processing with imported materials (PWIM) exports and processing and assembly (PAA) exports. For PWIM exports, much of the value added comes from China, while for PAA exports, most of the value-added comes from supply chain countries. Dynamic ordinary least squares (DOLS) results indicate that East Asian exchange rates affect both types of exports and that the renminbi significantly affects PWIM exports but not PAA exports. Since PWIM exports are now six times the value of PAA exports, these results indicate that the renminbi matters for aggregate processed exports.

Keywords: Exchange rate elasticities; China.
JEL classification: F32, F41

* Senior Fellow, Research Institute of Economy, Trade and Industry, 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

1. INTRODUCTION

China is now the first or second largest trading partner for 78 countries and the world's largest exporter of capital goods (IMF, 2011). China's surging exports and its exchange rate have elicited consternation from economists, workers, politicians, and pundits. Many argue that China should let the renminbi appreciate to slow its export juggernaut. How would a stronger RMB affect China's exports?

As Yu (2011) noted, China's entire trade surplus is in a customs regime called processing trade. Imports for processing are intermediate inputs that are imported duty free to produce processed final goods for re-export. Neither the imported inputs nor the final assembled goods can enter China's domestic market. China's other major customs regime is called ordinary trade. Ordinary trade, which is now in deficit, includes imports and exports that do not receive special tariff treatment and that can enter China's domestic market.

Research into the effect of exchange rate changes on processed exports has yielded mixed results. Cheung, Chinn, and Qian (2011), using dynamic ordinary least squares (DOLS) techniques with quarterly data over the 1994 – 2010 period, reported that a 10 percent appreciation of the RMB would decrease China's processed exports by about 10 percent. Thorbecke (2011), using DOLS estimation with quarterly data over the 1993-2008 period and the stock of FDI to control for foreign capital firms in China, reported that a 10 percent appreciation of either the renminbi or of the currencies of East Asian supply chain countries would reduce processed exports by about 17 percent. On the other hand Cheung, Chinn, and Fujii (2010), using DOLS techniques with quarterly data over the 1993 – 2006 period and the capital stock to measure Chinese productive capacity, found that an appreciation of the RMB is associated with an increase in China's processed exports (i.e., the coefficient has the wrong sign). Xing and

Detert (2010), accounting for the costs of manufacturing an iPhone, found that Chinese workers added only $6.50 of value to the total cost of $179 and concluded that an appreciation of the yuan would do little to reduce the demand for iPhones.

Many have used Xing and Detert's (2010) study and similar studies to conclude that the renminbi does not matter for rebalancing China's processing trade. Pilling (2011), for instance, quoted their study and argued that the renminbi is not important because "Many items supposedly made in China are just assembled in China….Most of the manufacturing cost comprises high-precision components made not in low-wage economies, but in high-wage ones such as Japan and South Korea." UNCTAD (2011) and the WTO (2011) have made similar points.

Arguments such as these, however, may not be relevant for China today. This can be seen by disaggregating China's processing trade into its two main categories, processing and assembly (PAA) trade and processing with imported materials (PWIM) trade. As Gaulier *et al.* (2005) discussed, the first category refers to foreign suppliers importing intermediate goods that belong to them and using these inputs to produce goods for re-export. The second category refers to foreign suppliers importing inputs from other firms and using these to produce goods for re-export. If following Tong and Zheng (2008) we measure value added in processing trade as the difference between processed exports and imports for processing, Figure 1a shows that China's value-added in the first category is small and Figure 1b shows that China's value-added in the second category is large. PAA trade thus corresponds to Pilling's (2011) description whereas PWIM trade does not.

Figure 2 shows China's trade balance in PAA trade and PWIM trade. Its surplus in PAA trade is only about 10 billion US dollars and its surplus in PWIM trade exceeds 300 billion US

dollars.[1] Koopman *et al.* (2008) noted that the effect of exchange rate changes in processing countries on trade volumes should depend on the share of domestic content in exports. One would thus expect the renminbi to have a large effect on PWIM exports and a small or negligible effect on PAA exports. One the other hand, one would expect exchange rates in supply chain countries to affect both categories since in both cases much of the value added comes from imported parts and components.

To test whether this is so this paper extends the work of Thorbecke (2011). He constructed an integrated exchange rate to measure how exchange rates affect the relative foreign currency cost not just of China's value-added in processing trade but of China's entire output of processed exports. The integrated exchange rate is a weighted average of the renminbi exchange rate and the exchange rates in supply chain countries, with weights determined by the proportion of the value-added coming from China and from supply chain countries. He reported that an appreciation of the integrated exchange rate would cause a large decrease in China's processed exports.

This paper uses Thorbecke's (2011) approach, but examines the effect of exchange rate changes on PAA and PWIM exports separately. While both types of exports should be affected by exchange rates in supply chain countries and thus by integrated exchange rates, PWIM exports should be affected much more than PAA exports by changes in the renminbi.

The results reported here confirm this hypothesis. Appreciations of the integrated exchange rate cause large drops in both PAA and PWIM exports. In the case of PAA exports, this response is driven entirely by exchange rates changes in supply chain countries. In the case of PWIM exports, this response is caused by changes in both the renminbi and the exchange rates in supply chain countries. Changes in the RMB also have a larger effect than

[1] These numbers are final values for 2010 and forecasts for 2011 based on data from January – August 2011.

exchange rate changes in supply chain countries on PWIM exports. Since China's surplus is concentrated in PWIM trade, these results indicate that an RMB appreciation would contribute to rebalancing China's processing trade.

The next section presents the data and methodology. Section 3 presents the results. Section 4 discusses the policy implications of the results. Section 5 concludes.

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.

To test for how exchange rates in China and in supply chain countries affect China's exports it is necessary to measure China's value-added in processing trade. Following Tong and Zheng (2008), China's value-added in processing trade can be measured as the difference between the value of China's processed exports (VPE_t) and the value of imports for processing from all supply chain countries ($\sum_i VIP_{i,t}$):

$$VA_{Chin,t} = (VPE_t - \sum_i VIP_{i,t}) / VPE_t = 1 - \sum_i VIP_{i,t} / VPE_t, \qquad (2)$$

where $VA_{Chin,t}$ equals China's value-added in processing trade. Each year data on the total value of processed exports and the total value of imports for processing are used to calculate China's value-added. These data are obtained from China Customs Statistics.

To calculate the share of total costs from other supply chain countries Thorbecke (2011) focused on the nine major providers of imports for processing. These are Germany, Japan, Malaysia, the Philippines, Singapore, South Korea, Taipei,China, Thailand, and the United States. He calculated weights ($w_{i,t}$) by dividing their contribution to China's imports for processing by the amount of imports for processing coming from the nine major suppliers together. He then used these weights together with data on China's value-added to calculate an integrated exchange rate index ($irer_t$) for the entire value (both domestically produced and imported) of China's processed exports by using the following formula:

$$irer_t = irer_{t-1}(chinareer_t / chinareer_{t-1})^{VA_{Chin,t}} \prod_{i=1}^{9} (reer_{i,t} / reer_{i,t-1})^{(1-VA_{Chin,t})w_{i,t}}, \qquad (3)$$

where $chinareer_t$ is China's real effective exchange rate at time t and $reer_{i,t}$ is the real effective exchange rate for supply chain country i at time t.. An increase in $chinareer_t$, $reer_{i,t}$, and $irer_t$ represent real exchange rate appreciations. $irer_t$ is set equal to 100 in 1992q4.

Data on the real effective exchange rate for South Korea and Taiwan were taken from the Bank for International Settlements. For the other countries, real exchange rate data were obtained from *International Financial Statistics*.[2]

As discussed above, data on imports for processing and processed exports were used to calculate China's value-added ($VA_{Chin,t}$). Data on imports for processing disaggregated by

[2] The websites for these data are: www.imf.org and www.bis.org.

country were used to calculate the weights on supply chain countries ($w_{i,t}$). These data were obtained from China Customs Statistics.

Data on China's processing and assembly exports and processing with imported materials exports were obtained from the CEIC database. These data are available monthly in U.S. dollars and were summed to obtain quarterly values.

Following previous authors, exports were deflated in several ways. The preferred specification employed the Hong Kong export price deflator (see Cheung, Chinn, and Qian, 2011, who only reported results using this measure). Since many of Hong Kong's exports are re-exports from China, this variable is a useful proxy for Chinese export prices. Another specification, following Cheung, Chinn, and Fujii (2010), utilized the U.S. producer price index. A final specification, following Eichengreen *et al.* (2004), used the U.S. consumer price index.

Thorbecke (2011) showed that the lion's share of processed exports go to higher income countries. Therefore quarterly data on income in North America, Europe, Japan, Australia, and South Korea were used to represent real income in the importing countries.[3] These data are seasonally adjusted and measured in real U.S. dollars. They were obtained from the OECD.[4]

The stock of FDI and a WTO dummy variable that takes on a value of 1 after China joined the WTO are also included as independent variables. Feenstra and Wei (2010) noted that 84 percent of processed exports are produced by foreign-invested enterprises. It is thus desirable to control for the stock of FDI. Many have argued that China's WTO accession had a positive effect on China's processing trade. Data on the stock of FDI were obtained from the United Nations Conference on Trade and Development (UNCTAD) website.[5] The WTO dummy

[3] Europe includes France, Germany, Italy, the Netherlands, Spain, and the United Kingdom.
[4] The website for these data is http://stats.oecd.org
[5] The website is www.unctad.org. The data are measured in U.S. dollars. Following Eichengreen and Tong (2007), they were deflated using the U.S. consumer price index.

variable was set equal to one starting in 2000, since Garcia-Herrero and Koivu (2007) posited that China's WTO accession began affecting China's trade after it became certain that China would join the WTO in the beginning of 2000. Further information on the data used here is available in Thorbecke (2011).

The model was estimated using DOLS. [6] This involves regressing the left-hand-side variable on a constant, the right hand side variables, and lags and leads of the first differences of the right hand side variables. The equation has the form:

$$x_t = \beta_0 + \beta_1 irer_t + \beta_2 rgdp_t + \beta_3 FDI_t + \beta_4 WTO + \beta_5 Time + \sum_{j=-p}^{p} \alpha_{irer,j} \Delta irer_{t-j}$$
$$+ \sum_{j=-p}^{p} \alpha_{rgdp,j} \Delta rgdp_{i,t-j} + \sum_{j=-p}^{p} \alpha_{FDI,j} \Delta FDI_{t-j} + u_t, \quad (4)$$

Here x_t represents China's real PAA or PWIM exports to the world, $irer_t$ represents the integrated real exchange rate index, $rgdp_t$ equals real income in the rest of the world, FDI_t represents the stock of foreign direct investment, WTO is the WTO dummy variable, and $Time$ is a time trend. Seasonal dummy variables are also included.[7] x_t, $irer_t$, $rgdp_t$, and FDI_t are measured in natural logs.

The same sample period that Thorbecke (2011) employed is used here. These data extend from 1993Q1 to 2008Q4. Equation (4) is estimated using a DOLS(2,2) model, implying that two leads and two lags of the first differences of the right hand side variables are employed. Thus the actual sample period for the estimation is 1993Q4 – 2008Q1.

[6] Phillips-Perron unit root tests indicate that real PAA and PWIM exports, the integrated real exchange rate, and real income are all integrated of order one. In addition, both the trace and maximum eigenvalue statistics from Johansen cointegration tests indicate that there is one cointegrating relationship between real PAA or PWIM exports and these other variables. Thus DOLS, a technique for estimating cointegrating relations, was employed.

[7] There were large unexplained drops in processed exports in the first quarter of 1993, 1994, 1995, and 1996. These were controlled for with a dummy variable.

3. RESULTS

Tables 1-4 report the results from estimating equation (4). In these tables the first two columns report the results for the preferred specification with exports deflated using the Hong Kong unit value index, the next two columns for exports deflated using the U.S. PPI, and the last two for exports deflated using the U.S. CPI. Also in the tables, columns (1), (3), and (5) report results excluding a time trend and columns (2), (4), and (6) present results including a time trend. The probability values reported in the four tables indicate that all of the models pass Lagrange Multiplier tests for heteroskedasticity, fourth order serial correlation, and fourth order autoregressive conditional heteroskedasticity (ARCH).[8]

Table 1 reports the results with PAA exports as the left hand side variable. The first row reports the income elasticities. The preferred specification is in columns (1) and (2) with exports deflated using the Hong Kong unit value index. The results are similar, though, in the other columns. The income elasticity equals 5.76 in column (1) and 8.42 in column (2) and both estimates are statistically significant at the 1 percent level. These results indicate that processed exports are very sensitive to income in the rest of the world. Other investigators have reported similar findings for China's processed exports. Cheung, Chinn, and Qian (2011) reported income elasticities between 3.6 and 6.9, Thorbecke (2011) reported elasticities between 5.6 and 7.9, and Ahmed (2009) found an income elasticity of 6.3.

The second row of Table 1 reports results for the integrated exchange rate. The coefficient on the integrated exchange rate equals -1.39 in column (1) and -1.88 in column (2). In both cases the estimates are statistically significant at the 1 percent level.

[8] The heteroskedasticity test is based on a regression of the squared residuals on the original regressors.

The coefficient on the stock of FDI in China is not statistically significant. This is not surprising since Figure 1a indicates that little of the value added of PAA exports comes from China.

Table 2 reports results from estimating equation (4) with PAA exports as the left hand side variable but with the renminbi exchange rate and the exchange rates in supply chain countries included separately. The income elasticities in the first row are similar to those reported in Table 1. The coefficient on the exchange rate in supply chain countries in the second row now equals -1.45 in column (1) and -1.68 in column (2). In both cases the p-value equals 0.06. The coefficients on the RMB exchange rate in the third row are close to zero and not statistically significant. These results imply that, for processing and assembly exports, exchange rate appreciations in East Asian supply chain countries would cause a large drop in exports but an appreciation of the renminbi would not.

Table 3 reports the results from estimating equation (4) with PWIM exports as the left hand side variable. The income elasticity in the first row equals 8.46 in column (1) and 5.74 in column (2). They are thus close to the values reported in Table 1. In column (1) the coefficient is statistically significant at the 1 percent level and in column (2) the coefficient is statistically significant at the 10 percent level.

The second row of Table 3 reports results for the integrated exchange rate. The coefficient on the integrated exchange rate equals -3.72 in column (1) and -3.22 in column (2). In both cases the estimates are statistically significant at the 1 percent level.

Table 4 reports the results from estimating equation (4) with PWIM exports as the left hand side variable but with the renminbi exchange rate and the exchange rates in supply chain countries included separately. The income elasticities in the first row are similar to those

reported in Table 3. The coefficient on the exchange rate in supply chain countries in the second row now equals -2.02 in column (1) and -1.83 in column (2). The coefficient on the renminbi exchange rate in the third row now equals -2.51 in column (1) and -2.39 in column (2). All four estimates are statistically significant at the 1 percent level. These results imply that, for processing with imported materials exports, exchange rate appreciations in East Asian supply chain countries would cause a large drop in exports and an appreciation of the renminbi would cause an even larger drop. The reason that the coefficient on the integrated exchange rate for PWIM exports in Table 3 is much larger than the coefficient on *irer* for PAA exports in Table 1 is that for PWIM exports both exchange rates in supply chain countries and the renminbi matter while for PAA exports only exchange rates in supply chain countries matter.

Interestingly, the coefficient on the stock of FDI in the fourth row of Table 4 is statistically significant (at least at the 10 percent level). Since a large share of the value of PWIM exports is produced by foreign capital firms in China, it makes sense that the stock of FDI in China should have explanatory power.

The important implication of these results is that the renminbi exerts important effects on PWIM exports. Between January 2010 and August 2011, the value of PWIM exports was six times the value of PAA exports. Thus these findings indicate that the renminbi matters for overall processed exports (i.e., the sum of PWIM and PAA exports). Exchange rates in East Asian supply chain countries also affect processed exports. Contrary to what some have argued, however, this fact does not imply that the renminbi does not also matter.

4. DISCUSSION

This paper presents evidence that exchange rates in both China and in East Asian supply chain countries exert major effects on processed exports. These results make sense since much of the value-added comes from both China and from supply chain countries.

While exchange rates throughout the region matter, there is little discussion between East Asian policy makers on exchange rate issues. This lack of official interaction contrasts with the intensive private sector integration occurring within regional production networks.

A useful first step would be for East Asian government officials to begin a dialogue on exchange rate issues. This discussion could be undertaken by specialists behind closed doors. Eichengreen (2011) noted that discussions by specialists can facilitate policy coordination by insulating the process from politics.

One issue that specialists could discuss is reserve accumulation. If a country like China continues to accumulate reserves, this might encourage countries such as Malaysia, Taiwan, or Thailand that trade heavily with China or that compete with China in third markets to also continue accumulating reserves. With many countries in the region holding more than enough reserves for precautionary reasons, it is not clear that further reserve accumulation is desirable. These domestic savings could be channeled to productive investments in the domestic economy such as rural sector education rather than earning low returns in external reserves such as US Treasuries. Asian countries may need to coordinate together a move away from continued reserve accumulation. In addition, countries with experience in this area could share lessons with other countries.

Another issue that could be discussed would be whether a joint appreciation against the US dollar is desirable. Massive exports within production networks to the US may be

unsustainable. It may thus be beneficial to target markets within Asia. Appreciations within Asia would increase the purchasing power of consumers in the region and allow them to import more.

A third issue to consider is exchange rate volatility. Researchers have reported that exchange rate volatility reduces the flow of parts and components in the region. Ito et al. (2008) found based on a survey of Japanese MNCs that intra-Asian exchange rate stability is crucial for the flow of parts and components within regional production networks. Thorbecke (2008) reported that exchange rate volatility deterred the flow of electronic parts and components within East Asian production networks. Hayakawa and Kimura (2009) found that exchange rate volatility reduced trade in intermediate goods within East Asian.

A fourth issue is the wide exchange rate swings between countries that compete extensively. For instance, the Korean won appreciated 30 percent against the Japanese yen between 2003 and the onset of the Global Financial Crisis in the summer of 2007. It then depreciated almost 60 percent versus the yen between the summer of 2007 and the end of 2011. These huge exchange rate swings are disruptive to exporting industries in both countries. While politicians often take a short-term perspective, one of the strengths of many East Asian countries is the ability to analyze situations from a longer term perspective.[9] Specialists insulated from political pressure could discuss whether these large swings in exchange rates are in the long run interests of the countries involved. If not, they could consider ways to moderate the exchange rate swings.

Hopefully these behind the scenes interactions by economists and trained officials could point to a vision of how exchange rate policy in the region should evolve. It may also point to

[9] Li Ruogu, former Deputy Governor of the People's Bank of China, said, "How long is the short run, you ask? You must understand. China is 8000 years old. So when I say, short run, it could be 100 years." This quotation is cited in Frankel (2011).

concrete steps that could be implemented by policy makers in the short and medium runs. If so, this would help remedy the disconnect between uncoordinated exchange rate policies and the intense market driven integration in the region.

5. CONCLUSION

The IMF (2011) reported that China is now the first or second largest trading partner for 78 countries, up from 13 countries in 2000. It has also become the largest exporter of capital goods. Many claim that this acceleration of China's exports has been facilitated by an undervalued exchange rate and that the renminbi needs to appreciate.

Others argue that China's exchange rate is irrelevant since its surplus is entirely in processing trade. For instance, Pilling (2011) asserted that the renminbi does not matter because most of the manufacturing cost of China's high wage items comes from countries such as Japan and South Korea. UNCTAD (2011) and the WTO (2011) have made similar arguments.

Given the concern over China's export juggernaut, it is important to bring empirical evidence to bear on this issue. To obtain this evidence, Thorbecke (2011) argued that it would be useful to examine separately China's two main categories of processed exports, processing and assembly exports and processing with imported materials exports. For PAA exports, Figure 1a makes clear that almost all of the value-added comes from outside of China. For PWIM exports, Figure 1b indicates that much of the value-added comes from within China.

One would thus expect the renminbi to have a small or negligible effect on PAA exports but a larger effect of PWIM exports. One would expect exchange rates in East Asian supply chain countries to have a large effect on both categories.

This paper presents DOLS evidence confirming that this is true. An appreciation of the renminbi would cause a large decrease in PWIM exports but would not affect PAA exports. An appreciation in East Asian supply chain countries, however, would cause a large decrease in both PWIM and PAA exports.

The share of domestic content in China's processing exports has been increasing recently. Knight and Wang (2011) reported that China's high investment levels in recent years have enabled firms to substitute foreign sources of intermediate products with domestic sources. Kuijs (2011) observed that China has developed deeper supply chains in the processing sector and that more of the value-added of processed exports can now be produced in China. In addition, rising wages and the proliferation of industrial clusters indicate that China's value-added has been increasing rapidly. This rise in value-added implies that the renminbi should matter even more for processed exports going forward.

China faces difficult choices with its exchange rate policy. It is committed to rebalancing away from an overdependence on exports. However, an exchange rate appreciation could lead to expectations of future appreciations and speculative inflows. A stronger renminbi would also lead to capital losses on China's trillions of dollars of foreign exchange reserves. It is unclear how policy makers should navigate through these shoals. It is clear though from the results presented here that the renminbi significantly affects processed exports. Thus, when debating policy options, economists and policy makers should not argue that because of processing trade the renminbi does not matter.

TABLE 1

DOLS Estimates of China's Processing and Assembly Exports over the 1993-2008 Period

	Exports deflated by:					
Independent Variables	*Hong Kong unit value index*	*Hong Kong unit value index*	*PPI-finished goods*	*PPI-finished goods*	*U.S. CPI*	*U.S. CPI*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Rest of the World GDP	*5.76***	*8.42***	*4.55***	*7.37**	*4.76***	*8.08**
	(0.46)	*(2.74)*	*(0.47)*	*(3.01)*	*(0.47)*	*(2.77)*
Integrated RER	*-1.39***	*-1.88***	*-0.91**	*-1.43**	*-0.59*	*-1.20***
	(0.47)	*(0.58)*	*(0.47)*	*(0.56)*	*(0.47)*	*(0.55)*
FDI Stock	*-0.06*	*-0.08*	*0.12*	*0.10*	*0.07*	*0.05*
	(0.09)	*(0.10)*	*(0.10)*	*(0.11)*	*(0.09)*	*(0.10)*
WTO Dummy	*-0.04*	*-0.05*	*-0.05*	*-0.06*	*-0.06*	*-0.08**
	(0.04)	*(0.04)*	*(0.04)*	*(0.05)*	*(0.04)*	*(0.04)*
Time		*-0.02*		*-0.02*		*-0.02*
		(0.02)		*(0.02)*		*(0.02)*
Adjusted R-squared	*0.993*	*0.993*	*0.990*	*0.990*	*0.990*	*0.990*
SER	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Serial Independence[a]	*0.36*	*0.34*	*0.37*	*0.36*	*0.27*	*0.20*
Heteroskedasticity[b]	*0.86*	*0.80*	*0.75*	*0.64*	*0.69*	*0.49*
ARCH[c]	*0.58*	*0.38*	*0.51*	*0.25*	*0.63*	*0.23*
No. of observations	*58*	*58*	*58*	*58*	*58*	*58*

Notes: DOLS (2, 2) estimates. Heteroskedasticity-consistent standard errors are in parentheses.
*** (**) [*] denotes significance at the 1% (5%) [10%] level. Rest of the World GDP is real, seasonally adjusted GDP in OECD countries. Integrated RER is a weighted average of the renminbi exchange rate and the exchange rates in supply chain countries, with weights determined by the proportion of the value-added coming from China and from supply chain countries. FDI Stock represents the stock of FDI in China, measured in US dollars and deflated using the US consumer price index. WTO Dummy is a dummy variable that equals 1 beginning in 2000 and 0 before this.

[a]Probability values from a Lagrange Multiplier test for the null hypothesis that there is no fourth order serial correlation.

[b] Probability values from a Lagrange Multiplier test for the null hypothesis of homoskedasticity from a regression of the squared residuals on the original regressors.

[c] Probability values from a Lagrange Multiplier test for the null hypothesis that there is no fourth order autoregressive conditional heteroskedasticity.

TABLE 2

DOLS Estimates of China's Processing and Assembly Exports over the 1993-2008 Period

Independent variables	*Exports deflated by:*					
	Hong Kong unit value index	*Hong Kong unit value index*	*PPI-finished goods*	*PPI-finished goods*	*U.S. CPI*	*U.S. CPI*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Rest of the	*6.19****	*8.34***	*5.21****	*7.37***	*5.42****	*7.84***
World GDP	*(0.68)*	*(3.19)*	*(0.70)*	*(3.37)*	*(0.68)*	*(3.15)*
Supplier's	*-1.45**	*-1.68**	*-1.39**	*-1.62**	*-1.21**	*-1.48**
RER	*(0.73)*	*(0.86)*	*(0.70)*	*(0.85)*	*(0.70)*	*(0.82)*
RMB RER	*-0.18*	*-0.34*	*0.23*	*0.07*	*0.20*	*-0.02*
	(0.49)	*(0.49)*	*(0.48)*	*(0.49)*	*(0.48)*	*(0.48)*
FDI Stock	*-0.36*	*-0.30*	*0.34*	*-0.28*	*-0.40*	*-0.33*
	(0.36)	*(0.36)*	*(0.36)*	*(0.36)*	*(0.35)*	*(0.35)*
WTO	*-0.04*	*-0.05*	*-0.04*	*-0.04*	*-0.06*	*-0.07*
Dummy	*(0.04)*	*(0.05)*	*(0.04)*	*(0.05)*	*(0.04)*	*(0.05)*
Time		*-0.01*		*0.01*		*-0.02*
		(0.02)		*(0.02)*		*(0.02)*
Adjusted R-squared	*0.993*	*0.993*	*0.990*	*0.995*	*0.990*	*0.989*
SER	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Serial Independence[a]	*0.38*	*0.34*	*0.33*	*0.33*	*0.28*	*0.24*
Heteroskedasticity[b]	*0.83*	*0.83*	*0.91*	*0.90*	*0.78*	*0.76*
ARCH[c]	*0.53*	*0.48*	*0.44*	*0.51*	*0.48*	*0.49*
No. of observations	*58*	*58*	*58*	*58*	*58*	*58*

Notes: DOLS (2, 2) estimates. Heteroskedasticity-consistent standard errors are in parentheses.
*** (**) [*] denotes significance at the 1% (5%) [10%] level. Rest of the World GDP is real, seasonally adjusted GDP in OECD countries. Supplier's RER is the real exchange rate in supply chain countries, calculated by weighing real exchange rate changes in individual supply chain countries by each countries' value-added in processed exports. RMB RER is the RMB real effective exchange rate. FDI Stock represents the stock of FDI in China, measured in US dollars and deflated using the US consumer price index. WTO Dummy is a dummy variable that equals 1 beginning in 2000 and 0 before this.

[a]Probability values from a Lagrange Multiplier test for the null hypothesis that there is no fourth order serial correlation.

[b] Probability values from a Lagrange Multiplier test for the null hypothesis of homoskedasticity from a regression of the squared residuals on the original regressors.

[c] Probability values from a Lagrange Multiplier test for the null hypothesis that there is no fourth order autoregressive conditional heteroskedasticity.

TABLE 3

DOLS Estimates of China's Processing with Imported Materials Exports over the 1993-2008 Period

Independent Variables	*Exports deflated by:*					
	Hong Kong unit value index	*Hong Kong unit value index*	*PPI-finished goods*	*PPI-finished goods*	*U.S. CPI*	*U.S. CPI*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Rest of the World GDP	*8.46****	*5.74**	*7.25****	*4.69*	*7.46****	*5.40*
	(0.39)	*(3.07)*	*(0.39)*	*(2.96)*	*(0.40)*	*(3.24)*
Integrated RER	*-3.72****	*-3.22****	*-3.24****	*-2.77****	*-2.92****	*-2.54****
	(0.41)	*(0.64)*	*(0.40)*	*(0.61)*	*(0.42)*	*(0.67)*
FDI Stock	*-0.12*	*-0.09*	*0.06*	*0.08*	*0.02*	*0.04*
	(0.10)	*(0.09)*	*(0.10)*	*(0.10)*	*(0.11)*	*(0.10)*
WTO Dummy	*0.01*	*0.03*	*0.00*	*0.02*	*-0.01*	*-0.00*
	(0.04)	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*
Time		*0.02*		*0.02*		*0.01*
		(0.02)		*(0.02)*		*(0.02)*
Adjusted R-squared	*0.996*	*0.996*	*0.997*	*0.998*	*0.997*	*0.997*
SER	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
Serial Independence[a]	*0.54*	*0.54*	*0.47*	*0.57*	*0.49*	*0.53*
Heteroskedasticity[b]	*0.81*	*0.64*	*0.80*	*0.82*	*0.74*	*0.67*
ARCH[c]	*0.40*	*0.67*	*0.41*	*0.28*	*0.70*	*0.75*
No. of observations	*58*	*58*	*58*	*58*	*58*	*58*

Notes: DOLS (2, 2) estimates. Heteroskedasticity-consistent standard errors are in parentheses.
*** (**) [*] denotes significance at the 1% (5%) [10%] level. Rest of the World GDP is real, seasonally adjusted GDP in OECD countries. Integrated RER is a weighted average of the renminbi exchange rate and the exchange rates in supply chain countries, with weights determined by the proportion of the value-added coming from China and from supply chain countries. FDI Stock represents the stock of FDI in China, measured in US dollars and deflated using the US consumer price index. WTO Dummy is a dummy variable that equals 1 beginning in 2000 and 0 before this.

[a]Probability values from a Lagrange Multiplier test for the null hypothesis that there is no fourth order serial correlation.

[b] Probability values from a Lagrange Multiplier test for the null hypothesis of homoskedasticity from a regression of the squared residuals on the original regressors.

[c] Probability values from a Lagrange Multiplier test for the null hypothesis that there is no fourth order autoregressive conditional heteroskedasticity.

TABLE 4

DOLS Estimates of China's Processing with Imported Materials Exports over the 1993-2008 Period

Independent variables	*Exports deflated by:*					
	Hong Kong unit value index	*Hong Kong unit value index*	*PPI-finished goods*	*PPI-finished goods*	*U.S. CPI*	*U.S. CPI*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Rest of the World GDP	*7.15*** (0.49)*	*5.43* (2.87)*	*6.17*** (0.51)*	*4.46 (2.95)*	*6.38*** (0.51)*	*4.92 (2.98)*
Supplier's RER	*-2.02*** (0.55)*	*-1.83*** (0.67)*	*-1.95*** (0.58)*	*-1.77** (0.69)*	*-1.78*** (0.60)*	*-1.62** (0.71)*
RMB RER	*-2.51*** (0.39)*	*-2.39*** (0.37)*	*-2.10*** (0.37)*	*-1.97*** (0.34)*	*-2.13*** (0.38)*	*-2.02*** (0.37)*
FDI Stock	*0.50* (0.26)*	*0.45* (0.25)*	*0.52 (0.27)*	*0.47* (0.26)*	*0.46 (0.28)*	*0.42 (0.27)*
WTO Dummy	*-0.03 (0.04)*	*-0.02 (0.04)*	*-0.02 (0.04)*	*-0.02 (0.04)*	*-0.05 (0.05)*	*-0.05 (0.05)*
Time		*0.01 (0.02)*		*0.01 (0.02)*		*0.01 (0.02)*
Adjusted R-squared	*0.998*	*0.998*	*0.997*	*0.997*	*0.997*	*0.997*
SER	*0.04*	*0.05*	*0.04*	*0.04*	*0.04*	*0.04*
Serial Independence[a]	*0.22*	*0.23*	*0.33*	*0.33*	*0.21*	*0.23*
Heteroskedasticity[b]	*0.79*	*0.88*	*0.69*	*0.81*	*0.81*	*0.89*
ARCH[c]	*0.73*	*0.94*	*0.91*	*0.98*	*0.74*	*0.90P*
No. of observations	*58*	*58*	*58*	*58*	*58*	*58*

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

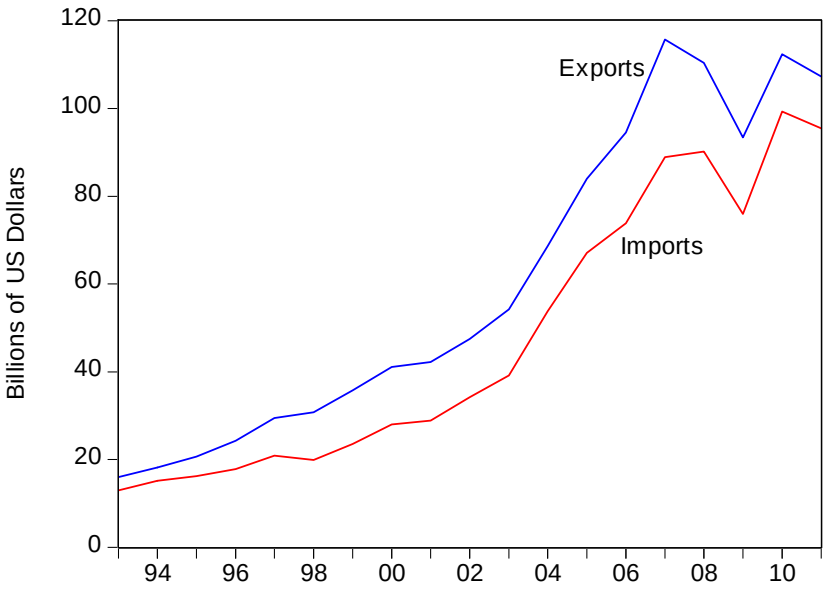
*** (**) [*] denotes significance at the 1% (5%) [10%] level. Rest of the World GDP is real, seasonally adjusted GDP in OECD countries. Supplier's RER is the real exchange rate in supply chain countries, calculated by weighing real exchange rate changes in individual supply chain countries by each countries' value-added in processed exports. RMB RER is the RMB real effective exchange rate. FDI Stock represents the stock of FDI in China, measured in US dollars and deflated using the US consumer price index. WTO Dummy is a dummy variable that equals 1 beginning in 2000 and 0 before this.

[a]Probability values from a Lagrange Multiplier test for the null hypothesis that there is no fourth order serial correlation.

[b] Probability values from a Lagrange Multiplier test for the null hypothesis of homoskedasticity from a regression of the squared residuals on the original regressors.

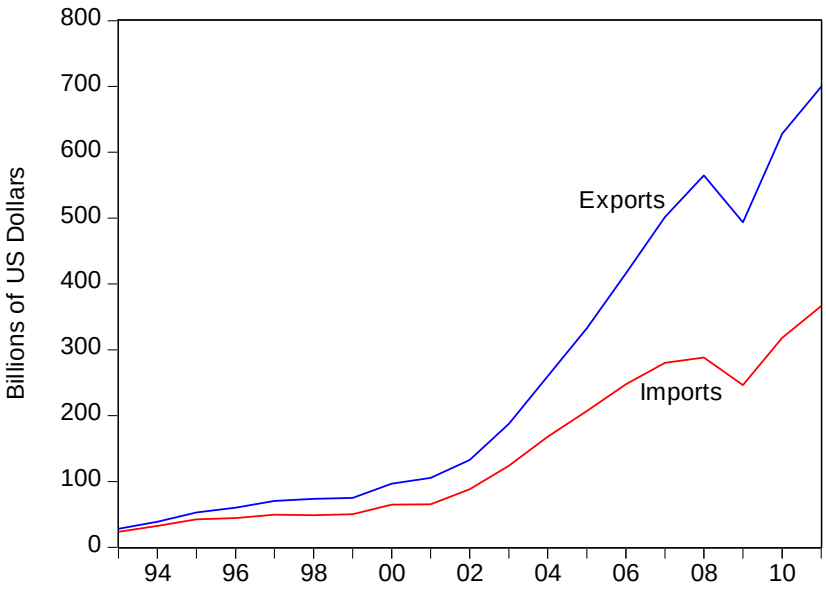
[c] Probability values from a Lagrange Multiplier test for the null hypothesis that there is no fourth order autoregressive conditional heteroskedasticity.

FIGURE 1a
Value of China's Processing and Assembly Exports and Imports, 1993-2011



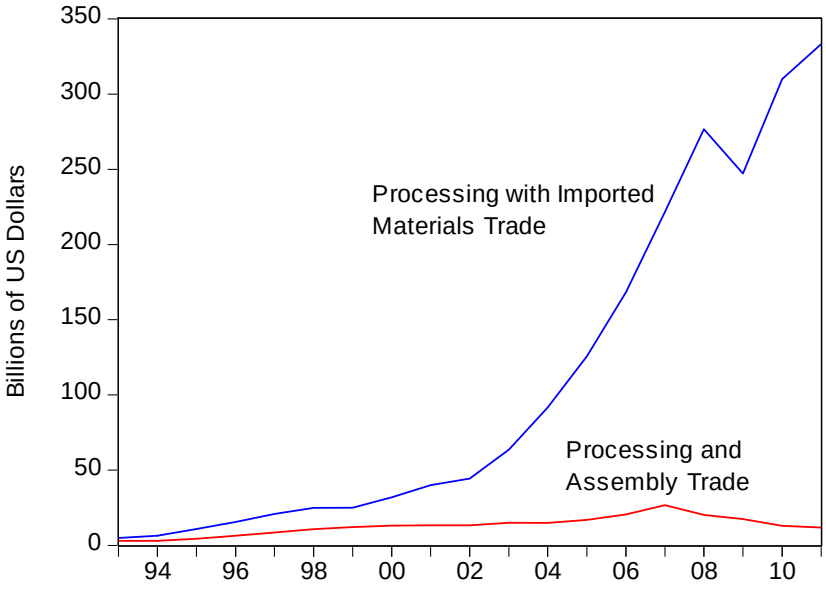
Source: CEIC Database
Note: Values for 2011 are estimates based on data for the first 8 months of 2011

FIGURE 1b
Value of China's Processing with Imported Materials Exports and Imports, 1993-2011



Source: CEIC Database
Note: Values for 2011 are estimates based on data for the first 8 months of 2011

FIGURE 2
China's Trade Surplus in Processing and Assembly Trade and Processing with Imported Materials Trade, 1993-2011



Source: CEIC Database
Note: Values for 2011 are estimates based on data for the first 8 months of 2011

REFERENCES

Ahmed, S. (2009), *Are Chinese Exports Sensitive to Changes in the Exchange Rate?,* International Finance Discussion Papers No. 987 (Washington DC: Federal Reserve Board).

Cheung, Y., M. Chinn and E. Fujii (2010), 'China's Current Account and Exchange Rate', In: R. Feenstra and S.-J. Wei (eds.), *China's Growing Role in World Trade*. (Chicago: University of Chicago Press), 231-280.

Cheung, Y., M. Chinn and X. Qian (2011), 'Are Chinese Trade Flows Different?', Paper presented at the JIMF 4th Annual Conference at UC Santa Cruz, 24 September. (available at: sciie.ucsc.edu).

Eichengreen, B. (2011), *International Policy Coordination: The Long View*, Working Paper, University of California, Berkeley. (available at: www.econ.berkeley.edu/~eichengr/).

Eichengreen, B. and H. Tong (2007), 'Is China's FDI Coming at the Expense of Other Countries', *Journal of the Japanese and International Economies*, **21**, 2, 153-172.

Eichengreen, B., Y. Rhee and H. Tong (2004), *The Impact of China on the Exports of other Asian Countries*, NBER Working Paper No. 10768 (Cambridge: NBER).

Frankel, J. (2011), *China-US Currency Issues,* presentation at Harvard University, 17 January. (available at: www.hks.harvard.edu/fs/jfrankel/currentpubsspeeches.htm).

Garcia-Herrero, A. and T. Koivu (2007*), Can the Chinese Trade Surplus be Reduced Through Exchange Rate Policy*, BOFIT Discussion Papers 6 (Helsinki: Bank of Finland's Institute for Economies in Transition).

Gaulier, G., F. Lemoine and D. Unal-Kesenci (2005), *China's Integration in East Asia: Production Sharing, FDI, and High-tech Trade,* CEPII Working Paper No. 2005-09 (Paris: CEPII).

Goldstein, M. and M. Khan (1985), 'Income and Price Effects in Foreign Trade', In R. Jones and P. Kenen (eds.), *Handbook of International Economics, Vol. 2*. (Amsterdam: North-Holland), 1041-1105.

Hayakawa, K. and F. Kimura (2009), 'The Effect of Exchange Rate Volatility on International Trade in East Asia,' *Journal of the Japanese and International Economies* **23**,4, 395–406.

IMF (2011), *People's Republic of China Spillover Report for the 2011 Article IV Consultation and Selected Issues* (Washington DC: IMF).

Ito, T., S. Koibuchi, Y. Sasaki, K. Sato, J. Simizu, K. Hayakawa, and T. Yoshimi (2008), *Currency invoicing and foreign exchange risk management: A case study of Japanese firms.* RIETI Discussion Paper 08-J-009 (Tokyo: RIETI).

Knight, J., and W. Wang (2011), 'China's Macroeconomic Imbalances: Causes and Consequences', *The World Economy*, **34**, 9, 1476-1506.

Koopman, R., Z. Wang and S.-J. Wei (2008*), How Much of Chinese Exports is Really Made in China? Assessing Domestic Value-added When Processing Trade is Pervasive*, NBER Working Paper 14109 (Cambridge: NBER).

Kuijs, L., (2011), 'How Will China's External Current Account Surplus Evolve in Coming Years', East Asia and Pacific on the Rise Weblog, June 8 (available at: www.worldbank.org)

Pilling, D. (2011), 'Why Americans Should Love to Learn the Renminbi', *Financial Times* 12 October.

Thorbecke, W. (2011), 'Investigating the Effect of Exchange Rate Changes on China's Processed Exports', *Journal of the Japanese and International Economies*, **25**, 2, 33-46.

Thorbecke, W. (2008), 'The Effect of Exchange Rate Volatility on Fragmentation in East Asia: Evidence from the Electronics Industry', *Journal of the Japanese and International Economies*, **22**, 4, 535-544.

Tong, S. and Y. Zheng (2008), **'**China's Trade Acceleration and the Deepening of an East Asian Regional Production Network', *China and World Economy*, **16**, 1, 66-81.

UNCTAD (2011), *Background Note on Processing Trade and its Implication for Understanding Global Imbalances* (Geneva: UNCTAD).

WTO (2011), *Measuring Trade in Value Added and its Implications for Understanding Global Imbalances* (Geneva: WTO).

Xing, Y.and N. Detert (2010), *How the iPhone Widens the United States Trade Deficit with the People's Republic of China,* ADBI Working Paper 257 (Tokyo: ADBI).

Yu, M. (2011), 'No One Wins in a Trade War', East Asia Forum Weblog, 15 November (available at: www.eastasiaforum.org).