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**Processing Trade, Exchange
Rates, and the People's Republic
of China's Bilateral Trade Balances**

Yuqing Xing

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Yuqing Xing was a visiting researcher at the Asian Development Bank Institute from February 2010 to September 2010 and is currently professor of economics at the National Graduate Institute for Policy Studies in Tokyo. The author is grateful for comments from Mario Lamberte, Willem Thorbecke, Yang Yao, and other participants at an ADBI seminar and the Beijing Forum.

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Please contact the author for information about this paper.

Email: yuqing_xing@grips.ac.jp

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

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

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Abstract

This paper analyzes the role of processing trade in the People's Republic of China (PRC)'s bilateral trade balances and the impact of the yuan's appreciation on processing trade. The analysis is based on panel data covering the PRC's 51 trading partners from 1993–2008. The empirical analysis shows that: (1) processing trade accounts for 100% of the PRC's overall trade surplus and can explain most of its bilateral trade balances; (2) the PRC's processing trade shows a significant regional bias—its processing exports to East Asian economies are three times those to other regions while its processing imports from East Asian economies are eleven times those from other regions; (3) the PRC is one of the major sources of its own processing imports, accounting for 16.8% of its total processing imports from all 51 trading partners; and (4) the appreciation of the yuan would affect both processing imports and exports in the same direction—specifically, a 10% real appreciation of the yuan would reduce not only the PRC's processing exports by 9.6% but also its processing imports by 3.9%. Therefore, a moderate appreciation of the yuan would have a very limited impact on the PRC's trade balance.

JEL Classification: F1

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1. INTRODUCTION

Global imbalances have been argued to be one of the major causes responsible for the global financial crisis and the subsequent economic recession in the United States (US) and European countries. In searching for the roots of global imbalances, most debates and studies focus on macro factors such as insufficient domestic consumption in the People's Republic of China (PRC), low saving rates in the US, and the inflexibility of the PRC's exchange rate regime. With a record high of US\$349 billion surplus in goods and services in 2008, the PRC has been urged to boost its domestic consumption and revalue the yuan to mitigate the trade surplus in order to help rebalance the global economy. On the other hand, little attention has been given to micro factors, such as the structures of trade, the proliferations of cross-country production fragmentation, and production networks developed in East Asia. With unprecedented liberalization in trade and capital mobility, these micro factors have reshaped trade patterns, transformed the implications of trade statistics, and affected bilateral trade balances. Therefore, it is important to analyze the PRC's trade balances in a broad context and assess the importance of the structure variables in determining trade patterns and bilateral trade balances.

The PRC's trade differs with conventional international trade modeled in standard textbooks. First of all, foreign-invested firms have produced more than half of the PRC's exports. In some commodities such as electronics and information communication technology (ICT), foreign-invested firms have dominated the PRC's exports and accounted for more than 80% of the exports (Xing 2010a). Besides low labor costs, advanced technology, and production know-how associated with foreign direct investment (FDI), brand names and distribution networks of multinational enterprises (MNE) all contributed to the rapid expansion of the PRC's exports. In other words, it is the combination of foreign capital and technology with the PRC's rich labor endowments that has been powering the sustained high growth of the PRC's exports. In the conventional trade theory, however, all technologies determining comparative advantages or needed for utilizing abundant resources are assumed to be indigenous and existing.

Secondly, processing trade has accounted for more than 41% of the PRC's total trade. In terms of the scale of processing trade and the range of commodities involved, the significance of processing trade in the PRC's external trade is unmatched. The extraordinarily high share of processing trade is a result of the PRC's integration with the world economy, the extension of cross-country production fragmentation into the PRC, and the development of production networks in East Asia. Processing trade has reversed conventional trade patterns such that developing countries, such as the PRC, export high-tech products while industrialized countries like the US import high-tech goods. For instance, the PRC has a comparative advantage in labor-intensive products. However, according to an OECD report, the PRC has surpassed the US and Japan and emerged as the leading exporting country of ICT (OECD, 2006). Moreover, with processing trade, bilateral trade balances between a country used as an export platform and destination markets of final products are inflated, as the former needs to import a large amount of intermediate inputs from third countries for processed export.

A typical example of processing trade is iPhone trade between the PRC and the US. iPhones, the most trendy and advanced mobile phone, are exclusively assembled in the PRC. All parts and components used for iPhones are produced in Germany; Japan; Republic of Korea; Taipei, China; and the US and shipped to the PRC, where the ready-to-use final products are assembled and then exported to the US and other markets. In terms of conventional trade statistics, the production fragmentation and networks involved in manufacturing iPhones have created a nontraditional trade pattern: iPhones invented by the US company Apple are exported to the US from the PRC, which does not have a comparative advantage in producing smartphones at all. It is estimated that iPhone trade

contributed US\$1.9 billion to the US's trade deficit with the PRC in 2009. Measured in value added created by Chinese workers assembling iPhones, however, the US would have a merely US\$75 million deficit from the iPhone trade with PRC. This means that most of the trade deficit was simply a transfer from the third countries, which supply parts and components to Foxconn, an exclusive iPhone assembler located in Shenzhen, PRC (Xing and Deter 2010).

There is a plethora of studies on the PRC's processing trade (e.g., Aziz and Li 2007; Koopman, Wang, and Wei 2008; Thorbecke 2010; Thorbecke and Smith 2010; Ahmed 2009). All of these studies primarily concentrate on the relationship between the yuan's exchange rates and the volume of processing trade and are based on time series data. One of the pitfalls of the existing literature is that the role of production networks in East Asian and geographic factors are ignored. Given that assembling parts into finished products is one of the production processes, that MNE-affiliated Chinese firms are major players in processing trade, and that most processing imports originate from East Asian economies, it is imperative that factors representing production networks and regional factors are included in examining the PRC's processing trade. This study attempts to investigate the PRC's processing trade in a broad framework with emphasis on both regional factors and the yuan's exchange rates. It is based on panel data covering the PRC's bilateral processing trade with 51 trading partners from 1993 to 2008. These trading partners account for 99% of the PRC's processing trade. The panel data allow us to address the regional factor in processing trade.

The simply descriptive analysis shows that processing trade accounts for 100% of the PRC's trade surplus and explains most of the PRC's bilateral trade balances with its major trading partners. By decomposing processing imports according to their origins, we find that the PRC is one of the major sources of its own processing imports, accounting for 16.8% of its total processing imports from all trading partners. This is the first empirical study to uncover the role of the PRC in supplying processing imports. The result has very important implications for assessing the value added of the PRC's processing exports and the effectiveness of the value added tax rebates implemented by the Chinese government for promoting exports. For identifying major factors that determine processing exports and imports, an augmented gravity model with country dummies was estimated. The estimates of the gravity model suggest that the PRC's processing trade has a significant regional bias. The processing exports to the East Asian economies are three times higher than those to other regions while the processing imports from the East Asian economies are more than eleven times higher than those from other regions. With regard to exchange rates, the estimates suggest that the real appreciation of the yuan would reduce not only the PRC's processing exports but also its processing imports. Specifically, a 10% real appreciation will lead to 9.6% decrease in processing exports and 3.9% drop in processing imports. This result is consistent with the fact that processing imports serve as intermediate inputs of processed exports. If processing exports fall, processing imports should fall too.

2. LITERATURE REVIEW

Without advanced technology, brand names, and global marketing networks, it is difficult for developing countries' products to penetrate the world market, in particular the market of industrialized countries. Processing trade provides a shortcut for developing countries to join the international division of labor and utilize their abundant labor forces. Processing trade involves importing parts and components from abroad as intermediate inputs, processing and assembling these intermediate inputs into finished products, and eventually re-exporting the processed products to the global market via international distribution and retail networks of MNEs. Trade liberalization and declined transportation costs have greatly facilitated the development of cross-country production fragmentation and production process specializations. The PRC's economic reform in the last three decades has provided

opportunities for MNEs to integrate the PRC into their production networks and utilize the PRC as a low-cost assembling base.

Processed exports are made of both imported and domestically produced parts and components. The share of domestically made contents determines the domestic contribution in the value added of exports and the extent of various policy impacts on the trade volume. To calculate the share of domestic contents in the PRC's processing exports, Koopman, Wang, and Wei (2008) apply the input-output method to estimate domestic contents in the PRC's exports by sectors. They find that the share of domestic value added is high in normal exports—about 88–95%—but low in processing exports—between 18–26%. Local firms engaging in processing trade are generally exposed to the production know-how and product design of foreign companies. Processing trade also functions as an effective channel for knowledge spillovers, which contribute substantially to the productivity growth of domestic firms. Using firm level data, Yu (2010) shows that processing trade has been a significant channel for technology spillovers to local Chinese companies.

Most studies on the PRC's processing trade focus on the nexus of real exchange rates and trade balances. Garcia-Herrero and Koivu (2009) use cointegration techniques to estimate the long-run elasticities of the PRC's processing exports and imports to real exchange rates. Based on monthly time series data from 1994 to 2005, they show that the PRC's processing exports would be expected to decrease 1.3% for a 1% appreciation of the yuan, and processing imports would decrease too when the yuan appreciates.

Cheung, Chinn, and Fujii (2009) investigate a similar issue over a relatively longer period, 1980 to 2006. They convert monthly data into quarterly data by simple averaging and estimate both processing export and import equations with dynamic ordinary least squares regression. Their empirical findings contradict the expectations of conventional theory, indicating that the PRC's processing exports would increase between 1.86% to 2.68% for a 1% real appreciation of the yuan rather than decrease.

Aziz and Li (2007) analyze the dynamic changes of the export elasticity to real exchange rates from 1995 to 2006. They find that the price elasticity of the PRC's exports increased over time. After decomposing exports into non-processing and processing exports, they show that the price elasticity of processing exports increased significantly while that of the non-processing exports remained unchanged. The rising domestic content of processing trade is argued to be a critical factor in determining the evolution of export elasticity.

Considering that domestic content represents only a small portion of the total value of the PRC's processing trade and a unilateral appreciation by the PRC may have limited impact on the PRC's processing exports, Thorbecke and Smith (2010) analyze not only the impact of a unilateral appreciation of the yuan on the PRC's processing exports, but also a joint appreciation of the currencies of all East Asian economies. They construct an integrated exchange rate—a weighted exchange rate between the yuan and the currencies of other East Asian economies according to the importance of their trade with the PRC. The integrated exchange rate is used to measure the joint appreciation of the other East Asian economies. They argue that a joint appreciation is more effective than unilateral appreciation, because a unilateral appreciation of the yuan by 10% would reduce the PRC's processing exports by 4% while a joint appreciation of 10% on all currencies of the East Asian economies would reduce the PRC's exports by 10%.

Thorbecke (2010) uses extended data from 1992 to 2008 to re-estimate the effect of the integrated exchange rate on the PRC's processing exports and finds that the elasticity of processing exports to the integrated exchange rate is around 1, consistent with the previous result. In addition, he estimated the elasticity of processing imports and shows that a 10% joint appreciation of the East Asian currencies would give rise to a 3.9% to 4.1% increase in the PRC's processing imports. Ahmad (2009) also shows that the joint appreciation of the yuan and the currencies of the PRC's major processing trade partners would be more

effective in curbing the growth of the PRC's processing trade. However, the study does not analyze the sensitivity of processing imports to variations of exchange rates.

3. THE STYLIZED FACTS OF THE PRC'S PROCESSING TRADE

3.1 Sources of Processing Imports

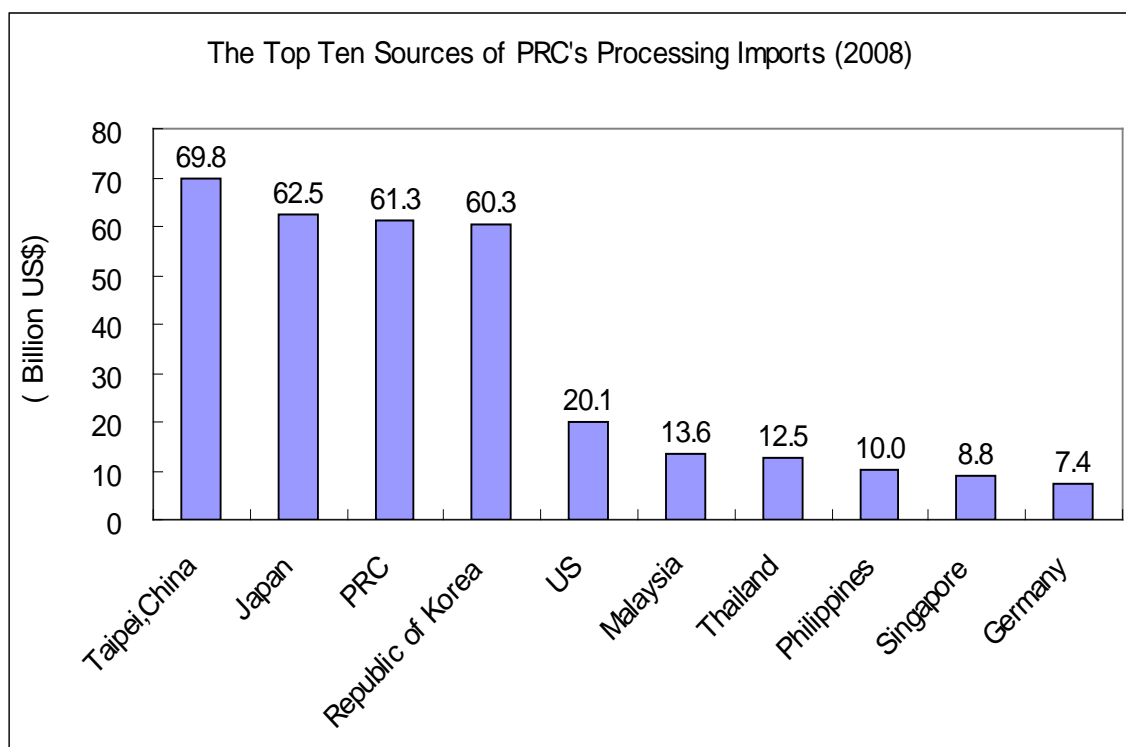
The PRC's processing trade shows a distinctive geographic feature. The sources of the PRC's processing imports primarily cluster around East Asian economies. Among the top ten sources, which accounted for 88% of total processing imports in 2008, eight were from East Asia: Taipei,China; PRC; Japan; Republic of Korea; Malaysia; Thailand; Philippines; and Singapore (Figure 1). These eight East Asian economies together accounted for US\$294 billion, or about 77%, of the total processing imports. Taipei,China is the largest single source for the PRC's processing imports. US\$64 billion processing imports came from Taipei,China. Japan and the Republic of Korea were third and fourth largest with US\$61.3 billion and US\$59.1 billion, respectively. The US and Germany were the only two non-East Asian economies among the top ten. Even though Germany is the fourth largest economy in the world, it accounted for only US\$7.2 billion processing imports, much smaller than those from Malaysia, Thailand, the Philippines, or Singapore.

There are three reasons why the East Asian economies have become the main sources of the PRC's processing imports. First of all, Japan; Taipei,China; Republic of Korea; and Singapore are the major sources of FDI in the PRC. From 1985 to 2008, cumulative FDI from these four economies amounted to US\$192 billion. Excluding Hong Kong, China, Japan is the largest FDI source for the PRC (Xing 2010b). Secondly, MNEs from these economies have built up their production networks in East Asia. Abundant labor endowment makes the PRC an ideal place for processing and assembling parts and components into finished products for the world market. With the direct investment, MNEs from East Asian economies have extended their production networks and integrated the PRC into their production chains (Kimura and Obashi 2010). Finally, Taipei,China's manufacturers have been the leading original equipment makers (OEM) for information communication technology, such as personal computers, laptop computers, servers, etc. They have relocated their production facilities to the mainland PRC, boosting the PRC's processing trade in ICT substantially (Xing 2010a).

It is noteworthy that in 2008 US\$61 billion process imports were originally produced in the PRC, making the PRC the second largest source of its own processing imports. These processing imports were first manufactured by domestic firms, then exported to Hong Kong, China, and eventually re-imported back as intermediate inputs by firms producing exports. For promoting exports, the PRC government has been offering value added tax rebates to exporting firms. With the round-tripping of domestically made products between the PRC and Hong Kong, China, the exporting firms are able to receive 17.5% value added tax rebates while importing firms benefit from the reduced prices due. In 1993, the processing imports originating from the PRC amounted to US\$1.1 billion, about 2.9% of the total processing imports. By 2008, the share surged to 16.2%, suggesting that the tax incentive has been very effective in promoting both exports and imports. In the literature on processing trade, the role of the PRC as an important source of processing imports has been ignored. Given that a substantial amount of imported parts and components were actually made in the PRC, it is highly possible that the domestic contents of processing exports were underestimated in the existing literature. In addition, the large volume of round-tripping of made-in-PRC products implies that the preferential tax policy is a critical factor in facilitating the high growth of processing trade. Abolishing the tax incentive may be more

effective for curbing the trade surplus and rebalancing the growth path of the Chinese economy.

Figure 1



Source: Author's calculations based on data provided by PRC Customs.

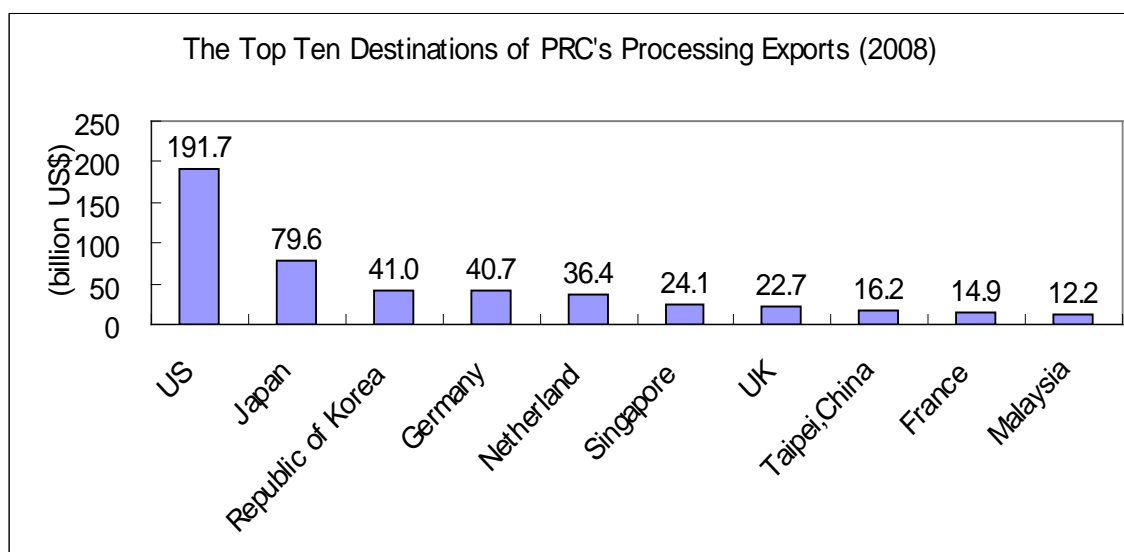
3.2 Destination Markets of Processing Exports

In the same fashion, the top ten destination markets of the PRC's processing exports are listed in Figure 2. It is well acknowledged that Hong Kong, China has functioned as a distribution market for the PRC's products to the rest of the world. In analyzing the top ten markets, Hong Kong, China was excluded. Instead, the processing exports to Hong Kong, China were allocated to the rest of the PRC's trading partners in proportion to their shares of the total processing exports. The top ten markets together accounted for US\$490 billion, about 71% of the total processing exports in 2008. Compared with the sources of processing imports, the destination markets of processing exports are relatively more diversified.

The US was the largest single market for the PRC's processing exports. In 2008, US\$192 billion, about 28% of the total processing exports, was purchased by American consumers. As illustrated in Figure 1, the US was also one of the top ten sources of the PRC's processing imports. The volume of the processing imports from the US, however, was only one tenth of the processing exports to the US, implying that the US is much more important as a market rather than as a source of processing trade for the PRC. Japan ranked second with US\$80 billion and was followed by the Republic of Korea with US\$41 billion. Of the top ten destination markets, five are located in East Asia: Japan; Republic of Korea; Singapore; Taipei,China; and Malaysia. Together these five East Asian economies accounted for US\$173 billion, about 26% of the total processing exports. Compared with their 77% share in processing imports, East Asian countries' share in the PRC's processing exports is much smaller. This suggests that most of the processing imports from East Asian economies are used as intermediate inputs for finished products targeting third markets and that the PRC has primarily functioned as a big assembling factory for MNEs from East Asian economies. The rest of the top ten destination markets are all in the European Union. They are

Germany, the Netherlands, the United Kingdom (UK), and France. Germany was the fourth largest market, followed by the Netherlands. The PRC's processing exports to these four countries together amounted to US\$115 billion. The different geographic concentrations between processing imports and exports indicate that geographic proximity and production networks in East Asia affect the volume and the pattern of processing trade.

Figure 2

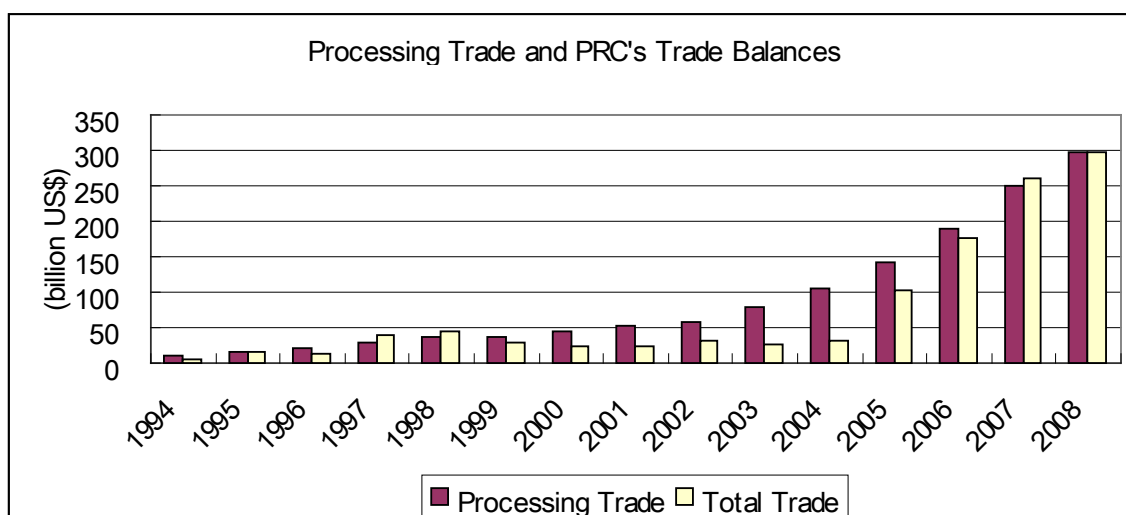


Source: Author's calculations based on data provided by PRC Customs.

3.3 Processing Trade and the PRC's Trade Balance

According to the statistics of PRC Customs, in 2008 the PRC had US\$298 billion trade surplus in goods. The trade surplus was only US\$5.4 billion in 1994. Decomposing trade into normal and processing trade reveals that the drastic growth of the trade surplus is mainly due to the rapid expansion of processing trade. Even though processing trade accounted for less than half of the PRC's total external trade, the trade surplus in processing trade in 2008 totaled at US\$297 billion, equivalent to the entire trade surplus. In other words, processing trade constituted almost 100% of the PRC's trade surplus. Figure 3 shows the evolution of balances in overall and processing trade from 1994 to 2008. The figure unambiguously indicates that the increase in the overall trade surplus is completely attributed to the surplus generated from processing trade. Low-skilled labors are the major input for processing and assembling parts and components into finished products. The huge surplus from processing trade is consistent with the PRC's tremendous labor endowment. Further, the mismatching between sources and markets of processing trade implies that the PRC has been utilized by MNEs from other East Asian economies such as Japan; Republic of Korea; Taipei,China; and Singapore as a processing center for third-country markets, thus a large portion of the processing trade surplus was actually the transferred surplus from these economies to the PRC.

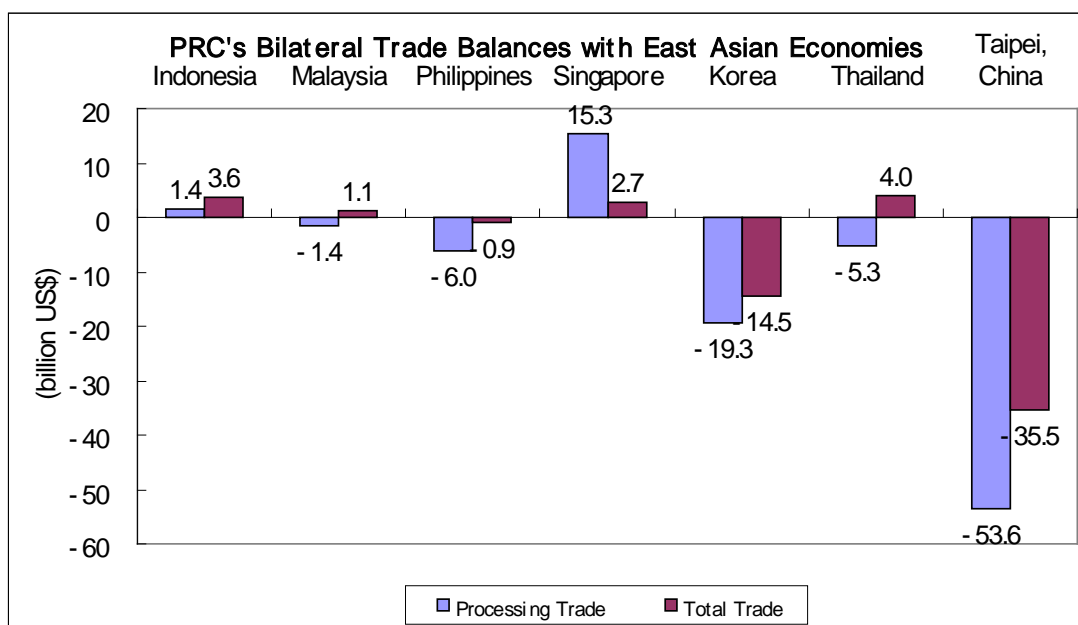
Figure 3



3.4 Processing Trade and the PRC's Bilateral Trade Balance with Emerging East Asian Economies

In terms of bilateral trade, processing trade also dominates the direction of PRC's bilateral trade balances. In spite of maintaining a huge trade surplus in its overall trade, the PRC has been running either trade deficits or relatively small trade surplus with emerging East Asian economies (Figure 4). The PRC's bilateral balances with these economies in processing trade primarily determined the overall corresponding bilateral trade. Specifically, the PRC had a US\$53.6 billion deficit in processing trade with Taipei, China and the corresponding overall trade deficit was US\$35.5 billion; with Republic of Korea, the PRC had a US\$19.3 billion deficit in processing trade so its overall trade deficit was US\$14.5 billion; with the Philippines, the PRC had a US\$6.0 billion deficit in processing trade and a US\$0.9 billion deficit in overall trade. The PRC had relatively small trade surpluses with Thailand and Malaysia. The surpluses in processing trade with these two countries helped reduce their overall trade deficits with the PRC.

Figure 4

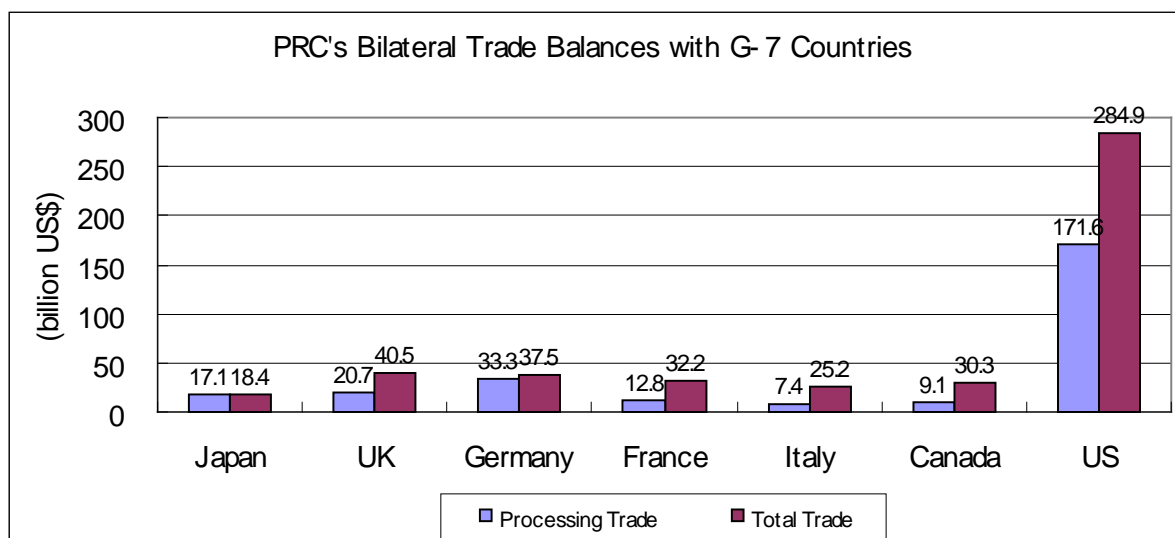


Sources: Author's calculations based on data provided by PRC Customs and UNCOMTRDE.

3.5 Processing Trade and the PRC's Bilateral Trade Balances with G-7 Countries

Similarly, processing trade also dominates the PRC's bilateral trade balances with the G-7 countries. The trade data reported by the G-7 countries shows that all G-7 countries have had persistent trade deficits with the PRC. A comparison of their overall trade deficits with the balances in processing trade with the PRC indicates that running a huge deficit in processing trade is one of the major reasons for building up persistent trade deficits (Figure 5). Among the G-7 countries, the US had the largest trade deficit of US\$285 billion with the PRC in 2008, of which US\$172 billion or about 60% was attributed to processing trade. Compared with the US, Japan and Germany had much smaller trade deficits simply because they had relatively smaller deficits in processing trade. Japan's deficit in processing trade amounted US\$18 billion, about one tenth of the US's. It explained 100% of Japan's trade deficit with the PRC. As showed previously, Japan was not only the second largest market for the PRC's processing exports but also the second largest source of the PRC's processing imports. The geographic proximity and export-oriented Japanese FDI in the PRC made Japan the largest source of processing imports among the G-7 countries, thus limiting its overall trade deficit. Germany had a US\$33 billion deficit in processing trade, about 90% of the total trade deficits. Among the G-7 countries, the UK had the second largest trade deficit US\$40.5 billion with the PRC and half of the deficit from processing trade.

Figure 5

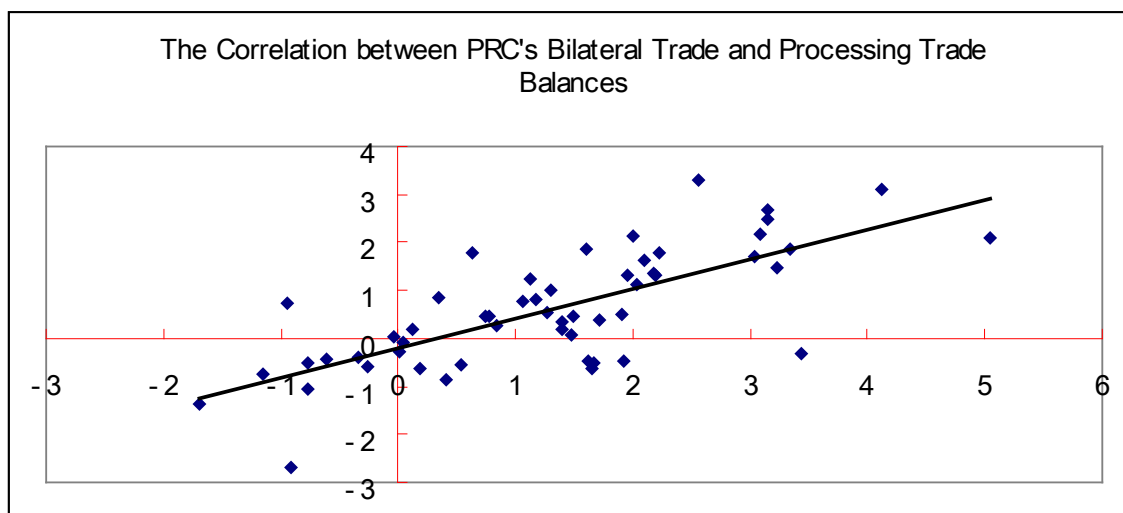


Sources: Author's calculations based on data provided by PRC Customs and UNCOMTRADE.

3.6 Processing Trade and the PRC's Bilateral Trade Balances with 51 Trading Partners

For having a more general picture on the relationship between processing trade and the PRC's bilateral trade balances, I expanded the analysis beyond G-7 and East Asian economies by including 51 of the PRC's major trading partners, which accounted for 99% of the PRC's processing trade. Using 2008 data, I calculated the PRC's bilateral trade balances with these 51 trading partners and the corresponding bilateral balances in processing trade. The bilateral trade balances are defined as the ratio of exports to imports (processing exports to processing imports). The scattered chart of bilateral trade balances against balances in processing trade is showed in Figure 6, where the vertical axis measures the logarithm of the PRC's trade balances with each of the selected trading partners and the horizontal axis the logarithm of the corresponding balance in processing trade. The scattered chart implies a strong log-linear relationship between the two variables. In particular, the correlation coefficient was estimated at 0.73, close to a perfect linear relationship, indicating that the processing trade balances could explain most of the PRC's trade balances with the trading partners. In a nutshell, the descriptive analysis on East Asian economies, G-7 countries, and the 51 trading partners suggests that processing trade has determined the PRC's bilateral trade balances.

Figure 6



Note: Horizontal axis: $\log(\text{processing exports/processing imports})$; vertical axis: $\log(\text{exports/imports})$; the fitted line: a result of a linear regression of the two variables.

Source: Author's calculations.

4. DETERMINATION OF PROCESSING TRADE

Previous sections analyzed the relationship between processing trade and the PRC's overall as well as bilateral trade balances and concluded that processing trade is responsible for 100% of PRC's overall trade balance and most of the bilateral trade balances. This section will empirically investigate the factors determining the PRC's processing trade. The empirical analysis is based on the gravity model, which has been used widely as a baseline model for estimating the frontier of bilateral trade, the impact of free trade agreements, and border effects on trade volumes. Eichengreen and Irwin (1998) called the gravity model the "workhorse for empirical studies" of regional integration. Processing exports and imports are examined separately. Following the standard gravity model, I employed the following augmented gravity model to explain the PRC's processing imports:

$$\log(PIM_{it}) = \alpha_0 + \beta_1 \log(GDP_{it}) + \beta_2 \log(GDP_{ct}) + \beta_3 \log(REX_{it}) + \beta_4 \log(FDI_{it}) + \beta_5 \log(D_i) + \alpha_1 EA_i + \alpha_2 WTO_i + \alpha_3 AC_{it} + \varepsilon_{it} \quad (1),$$

where PIM_{it} stands for real processing imports of the PRC from its trading partner i ; GDP_{it} is the real gross domestic product (GDP) of partner i and GDP_{ct} the real GDP gross domestic product of the PRC; REX_{it} denotes real exchange rates between the yuan and the currency of the trading partner i ; FDI_{it} represents cumulative direct investment in the PRC from partner i from 1985 to year t ; D_i measures the distance between the PRC and partner i ; EA_i is a dummy variable, equal to one if partner i belongs to East Asia, otherwise zero. The coefficient α_1 represents the common intercept of all East Asian economies and is considered a quantitative measure of the effect of the production network within the region. WTO_i is a dummy variable indicating the impact of World Trade Organization (WTO) membership on processing imports and equal to one for the period of 2002 to 2008; the dummy variable AC is included to measure the impact of the Asian financial crisis in late 1990. It takes a value of one for the years 1997 and 1998 and zero for other years.

Real bilateral exchange rates REX_{it} is downloaded from the Centre D'Etudes Prospectives et D'Information Internationales (CEPII). Higher real exchange rates imply a real depreciation of the yuan. Hence, if the appreciation of yuan enhances processing imports, the coefficient β_3 should be negative and significant. The regression equation was estimated with panel data covering 51 of the PRC's trading partners from 1993 to 2008. Processing trade data was provided by PRC Customs. Processing imports were deflated with the consumer price index of the US. Real GDP and consumer price indices were retrieved from International Financial Statistics of the International Monetary Fund. The distance between the PRC capital Beijing and the capital city of partner i was used for variable D_i . Cumulative FDI was computed based on annual FDI inflows published in various issues of PRC Statistics Yearbook. The model was estimated with the method of ordinary least squares (OLS).

Table 1 summarizes the estimates of processing trade. The elasticities of processing imports to the incomes of both the PRC and the destination markets are 0.64 and 0.47 respectively and are statistically significant at 1%. The elasticity to FDI is estimated to be 0.25 and is statistically significant at 1%. The coefficient of the geographic distance between the PRC and its trading partners is positive and statistically significant at 5%, suggesting that the transportation cost did not hinder processing imports. The Asian financial crisis affected the processing imports negatively as the coefficient of the dummy variable AC is -0.29 and statistically significant at 5%. On the other hand, WTO membership was not a significant factor in promoting processing imports.

Table 1: The Determination of the PRC's Processing Trade: Pooled OLS Estimates

	Processing Imports		Processing Exports	
	Coefficient	Std. Error	Coefficients	Std. Error
Constance	-6.37	1.55	-10.40	1.17
Log(GDP)	0.64***	0.03	0.54***	0.03
Log(GDPc)	0.47***	0.18	1.36**	0.14
Log(REX)	-0.40***	0.09	0.08	1.06
Log(FDI)	0.25***	0.03	0.29***	0.02
Log(D)	0.07**	0.08	-0.33***	0.06
EA (East Asia)	2.26***	0.16	0.56***	0.12
WTO	0.17	0.15	-0.01	0.11
AC (Asian Crisis)	-0.29**	0.12	-0.06	0.09
Adj. R-square	0.77		0.84	
Sample size	816		816	

Source: Author's estimates. ** and *** indicate statistic significance at 5% and 1% respectively.

The dummy variable representing East Asian economies is the focal point of the regression. The estimated coefficient of the East Asian dummy EA is 2.26 and is statistically significant at 1%, indicating that geographic location of trading partners affected the PRC's processing imports. Using the estimated coefficient, it is clear that the PRC imported 9.6 times more parts and components for processing from East Asian economies than from other regions, should other factors determining processing imports be held constant. This result is consistent with the descriptive fact that the East Asian economies accounted for 77% of total processing imports. The contribution of FDI in the PRC and incomes of both the PRC and its trading partners to processing imports have been controlled by other independent variables. The estimated regional bias toward East Asia may be attributed to the production networks developed in the region. With regard to real exchange rates, the estimated elasticity is -0.40 and significant at 1%, implying that a 10% devaluation of the yuan would be expected to result in a 4% decrease in processing imports.

To identify factors determining processing exports, I used the same model specification to estimate the function of processing exports. The estimates are also reported in Table 1. The elasticity of processing exports to the PRC's GDP is 1.36 and that to the destination market's

GDP is 0.54. Both are statistically significant at 5%. The estimates show that the PRC's GDP—a measure of production capacity—affects exports more than the income of destination markets. Direct investment from trading partners contributed to processing exports positively. For a 10% increase in cumulative FDI, processing exports to the FDI source economies would be expected to rise 2.9%. Unlike in the case of processing imports, the distances between the PRC and its trading partners reduced the volume of processing exports. The elasticity to distances is -0.33 and significant at 1%.

The dummy variable representing East Asian economies remains an important regional factor determining processing exports. On the other hand, the magnitude of the impact is relatively small compared with the impact on processing imports. The coefficient of the East Asian dummy is 0.56 and significant at 1%. The value of the East Asian dummy implies that the PRC's processing exports to the East Asian economies are on average 1.8 times higher than that to other regions if other conditions are held constant. The elasticity of processing exports to real exchange rates is estimated 0.08 but statistically insignificant, suggesting that the variations of real exchange rates did not affect the PRC's processing exports. Except for Cheung, Chinn, and Fujii (2009), all studies on the relationship between the yuan's exchange rates and the PRC's processing exports conclude that the yuan's appreciation would be able to reduce processing exports.

In the regression model, only an East Asian dummy was included. The model was estimated with panel data. As argued by Cheng and Wall (2005), the estimates of standard panel data are biased if no heterogeneity is allowed in the regression equations. With such heterogeneity, a country would export different amounts with two different countries, even if the two markets have the same GDP and are equidistant from the exporter. Destination market-specific factors, such as common languages, culture links, history, etc., are the sources of the heterogeneity. Baldwin and Taglioni (2006) argue that the heterogeneity is the “gold medal” problem in estimating gravity models with panel data, and suggested including country dummies for controlling the heterogeneity and correcting the bias.

For controlling all possible heterogeneity, I re-specified the gravity model for processing imports/exports as:

$$\log(PIM_{it}) = \alpha_0 + \alpha_i + \beta_1 \log(GDP_{it}) + \beta_2 \log(GDP_{ct}) + \beta_3 \log(REX_{it}) + \beta_4 \log(FDI_{it}) + \alpha_2 WTO_i + \alpha_3 AC_{it} + \varepsilon_{it} \quad (2)$$

In Equation 2, α_i is a country-specific intercept and measures the impact of heterogeneity on processing trade. Since the distance between the PRC and its trading partners represents one aspect of the heterogeneity and is correlated with α_i , it is excluded in the new model specification. Country dummies for each individual trading partner are employed in the estimation of Equation 2. This estimation method is equivalent to the fixed effect model. However, with these country dummies, we are able to quantify the impact of country-specific factors on processing trade and assess whether East Asian economies as a group remain a critical factor in determining the PRC's processing trade.

Table 2 summarizes the estimates of Equation 2. According to the new estimates, the exchange rate elasticity of processing exports is 0.96 and significant at 1%, indicating that a 10% real appreciation of the yuan would give rise to a 9.6% decrease in the PRC's processing exports. This result is consistent with most of existing studies of the PRC's processing exports. On the other hand, processing imports would fall too when the yuan appreciates. The exchange rate elasticity of processing imports is 0.39 and statistically significant at 10%, implying that a 10% real depreciation of the yuan would lead to a 3.9% decrease in processing imports. This result apparently contradicts the conventional theoretical argument on the relationship between exchange rates and imports. But, it is consistent with the fundamental nature of processing imports. When processing exports decrease, the demand for processing imports should shrink accordingly as processing

imports are the intermediate inputs of processed exports. Since both processing exports and imports fall simultaneously, the impact of the yuan's appreciation on the PRC's trade balance is limited.

Table 2: The Determination of the PRC's Processing Imports: OLS with Country Dummies

	Processing Imports		Processing Exports	
	Coefficient	Std. Error	Coefficients	Std. Error
Constance	-13.63	1.11	-23.69	0.97
Log(GDP)	1.18***	0.23	1.25***	1.25
Log(GDPc)	0.90***	0.15	1.77***	1.77
Log(REX)	0.39*	0.11	0.96***	0.10
Log(FDI)	0.05*	0.03	0.09***	0.03
WTO	0.08	0.07	-0.10	0.06
AC (Asian Crisis)	-0.20***	0.06	0.03	0.05
Country Dummies				
Hong Kong, China	2.39***	0.29	4.07***	0.25
Indonesia	0.80**	0.33	0.56**	0.29
Japan	-0.32	0.91	-0.82	0.79
Macau	2.32***	0.62	4.08***	0.54
Malaysia	2.42***	0.21	2.16***	0.18
Philippines	1.50***	0.20	1.76***	0.17
Singapore	2.22***	0.22	2.70***	0.19
Republic of Korea	1.61***	0.52	0.70	0.46
Thailand	1.87***	0.25	1.47***	0.22
Taipei,China	2.97***	0.36	1.21***	0.32
The average of East Asian economies	1.78***	0.24	1.79***	0.21
The average of East Asian Economies excluding Hong Kong, China and Macau	1.63***	0.32	1.22***	0.28
Average of 51 countries' dummies	-0.82***	0.27	0.09	0.24
Adj. R-square		0.94		0.95
Sample size		816		816

Source: Author's estimates. ** and *** indicate statistic significance at 5% and 1% respectively.

For evaluating the impacts of country-specific factors, the coefficients of East Asian economies' dummies of both processing imports and exports are reported in Table 2. With regard to processing imports, the coefficients of ten East Asian economies' dummies ranged from -0.32 (Japan) to 2.97 (Taipei,China) and averaged 1.78, much higher than the average of all country dummies, which is -0.89. Using the estimated function, we could quantify the difference in the volume of processing imports due to geographic location. Specifically, the estimated regional difference suggests that the PRC's processing imports from East Asian economies are 13.5 times of those from other regions if other factors are held constant. Excluding Macau and Hong Kong, China, the processing imports originating from East Asian economies remain 11 times those from other regions.

The regional bias is also evident in the PRC's processing exports. The coefficients of East Asian economies' dummies are between -0.82 (Japan) and 4.08 (Macau) and average 1.79. The average of all country dummies is 0.09. Transferring the regional dummy difference into

the volume in processing exports implies that the PRC's processing exports to East Asian economies are 5.5 times those to other regions. Since most of processing exports to Macau and Hong Kong, China are re-exported to third countries, the result may overestimate the regional bias in processing exports. Excluding Macau and Hong Kong, China, the PRC's processing exports to the East Asian economies would be 3.1 times those to other regions should other factors be held constant. Compared with processing imports, the degree of the bias toward East Asia in processing exports is relatively small. The empirical results based on the augmented gravity model are consistent with the conclusions derived from descriptive analysis in the section: East Asia is the major source of the PRC's processing imports while the rest of the world is the major market for the PRC's processing exports. FDI is included as one of the independent variables. The East Asia-specific effect should be independent of FDI. Hence, the only meaningful and logical explanation for the significant role of East Asian economies in the PRC's processing trade is the well established production network within the region. As long as the PRC continues to serve as an assembling base for MNEs of East Asian economies, the possibility for a substantial decrease in the PRC's processing trade surplus is very slim. The huge sunk costs are a major obstacle for MNEs in relocating their processing capacities to other countries, unless the yuan were to appreciate sharply in the short run.

5. CONCLUDING REMARKS

Processing trade is a special form of trade. Decomposing the PRC's trade surplus into normal and processing trade suggests that processing trade is the sole contributor to its overall trade surplus. In addition to incomes, FDI, and exchange rates, the geographic factor affects the pattern and volumes of processing trade significantly. Excluding Macau and Hong Kong, China, the PRC's processing imports from East Asian economies are 11 times those from other regions while its processing exports to East Asian are 3 times those to other regions. Both descriptive and econometric analyses indicate that East Asia is the major source of processing imports while the rest of world serves as the destination market of processing exports. This special trading pattern reflects the role of production networks developed by MNEs of East Asian economies in the region and implies a transfer of trade surplus from East Asian economies to the PRC. Therefore, as long as the PRC continues to be used as an export platform, it would be unrealistic to expect the PRC's processing trade surplus to drop substantially in the short run. Our analysis does suggest that the appreciation of the yuan would mitigate processing exports. However, it is equally important to consider that processing imports would also decrease when the yuan appreciates. Hence, the combined effects of the yuan's appreciation on the balance of processing trade would be very limited.

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APPENDIX: THE PRC'S TRADING PARTNERS COVERED IN THE SAMPLE

Argentina; Australia; Austria; Belgium; Brazil; Canada; Chile; Denmark; Finland; France; Germany; Greece; Hong Kong, China; Hungary; India; Indonesia; Iran; Ireland; Israel; Italy; Japan; Republic of Korea; Luxembourg; Macau; Malaysia; Mexico; the Netherlands; New Zealand; Norway; Pakistan; Peru; the Philippines; Poland; Portugal; Romania; Russia; Saudi Arabia; Singapore; South Africa; Spain; Sri Lanka; Sweden; Switzerland; Taipei, China; Thailand; Turkey; Ukraine; the UK; the US; Uruguay; Viet Nam.