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How Would an Appreciation of the Yuan Affect the People's Republic of China's Surplus in Processing Trade?

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Abstract

Enormous trade surpluses are problematic for the People's Republic of China (PRC) and the rest of the world. They primarily stem from processing trade. This paper investigates how exchange rate changes would affect the PRC's imports for processing and processed exports. The results indicate that an appreciation throughout East Asian supply chain countries would reduce the PRC's surplus in processing trade, while an appreciation of the yuan alone might not. Even for an appreciation throughout East Asia, however, the sum of the exchange rate elasticities is not large. Thus, to rebalance the PRC's trade, exchange rate appreciations must be accompanied by other changes such as factor market liberalization and greater enforcement of environmental regulations.

JEL Classification: F32, F41

Contents

1. INTRODUCTION

The People's Republic of China (PRC) has maintained a pegged exchange rate regime targeted at the United States (US) dollar. In the process it has accumulated more than 2.4 trillion dollars in foreign currency reserves. The People's Bank of China has sterilized these interventions and prevented inflation from accelerating. However, sterilization operations have forced commercial banks to hold more and more central bank bills, interfering with the allocation of credit. They have also produced an increasingly inefficient allocation of resources since private and social rates of return are higher for investments in the domestic economy than for investments in US Treasury securities. Many have thus advocated a more flexible exchange rate regime for the PRC.

How would the resulting exchange rate fluctuations affect the PRC's surplus with the rest of the world? The Marshall-Lerner condition implies that, if trade is initially balanced, an appreciation will reduce the trade balance if the sum of (the absolute values of) the demand elasticities for exports and imports exceeds one. In the case of the PRC, the effect of exchange rate changes on the trade balance is more complicated because the PRC's trade surplus since 2008 has been almost entirely concentrated in processing trade. Processed exports are final goods that are produced using parts and components imported from the rest of the world. Since much of the value-added of processed goods comes from other countries, the effect of changes in the yuan on the volume of processing trade may be attenuated.

Yoshitomi (2007) documented that parts and components for the PRC's processed exports came primarily from other East Asian countries. He thus noted that an appreciation of the yuan would only affect the foreign currency costs of the PRC's value-added in processing trade, while a joint appreciation in Asia would affect the foreign currency cost of the PRC's entire output of processed goods.[1] A generalized appreciation should thus have a much larger effect on the PRC's processed exports.

Thorbecke and Smith (2010) constructed a single integrated exchange rate variable to measure changes in the relative foreign currency costs not just of the PRC's value-added but of the PRC's entire output of processed exports. Using dynamic ordinary least squares estimation and an annual panel data set over the 1992–2005 period, they reported that a 10% appreciation throughout the region would reduce processed exports by 10%.

Ahmed (2009) employed an autoregressive distributed lag model and quarterly data over the 1996Q1–2009Q2 period and disaggregated CNY exchange rate changes into those relative to East Asian countries and those relative to other countries. He reported that a 10% appreciation of the yuan relative to non-East Asian countries would reduce PRC's processed exports by 17% and that a 10% appreciation in other East Asian countries would reduce PRC's processed exports by 15%.[2]

This paper extends the previous work in a couple of ways. First, it investigates the factors influencing imports for processing as well as processed exports. This makes it possible to consider how exchange rate changes affect not only the PRC's processed exports but also the PRC's surplus of almost US$300 billion in processing trade. Second, it expands Thorbecke and Smith's data set to include observations from 2006–2008. This period is important because both the yuan and the PRC's processing trade exhibited major fluctuations during these years.

[1] This is not entirely true since not all of the imported inputs used to produce processed exports come from East Asia.

2 Marquez and Schindler (2007) and Cheung, Chinn, and Fujii (2010), and Garcia-Herrero and Koivu (2007) also presented valuable estimates of trade elasticities for the PRC.

The results indicate that an appreciation throughout East Asian supply chain countries would reduce the PRC's processing surplus. The evidence is less clear concerning whether an appreciation of the yuan not accompanied by an appreciation in the rest of Asia would have this effect.

The next section presents a descriptive analysis of the PRC's processing trade. Section 3 presents the data and methodology. Section 4 contains the results and Section 5 discusses the implications of these results. Section 6 concludes.

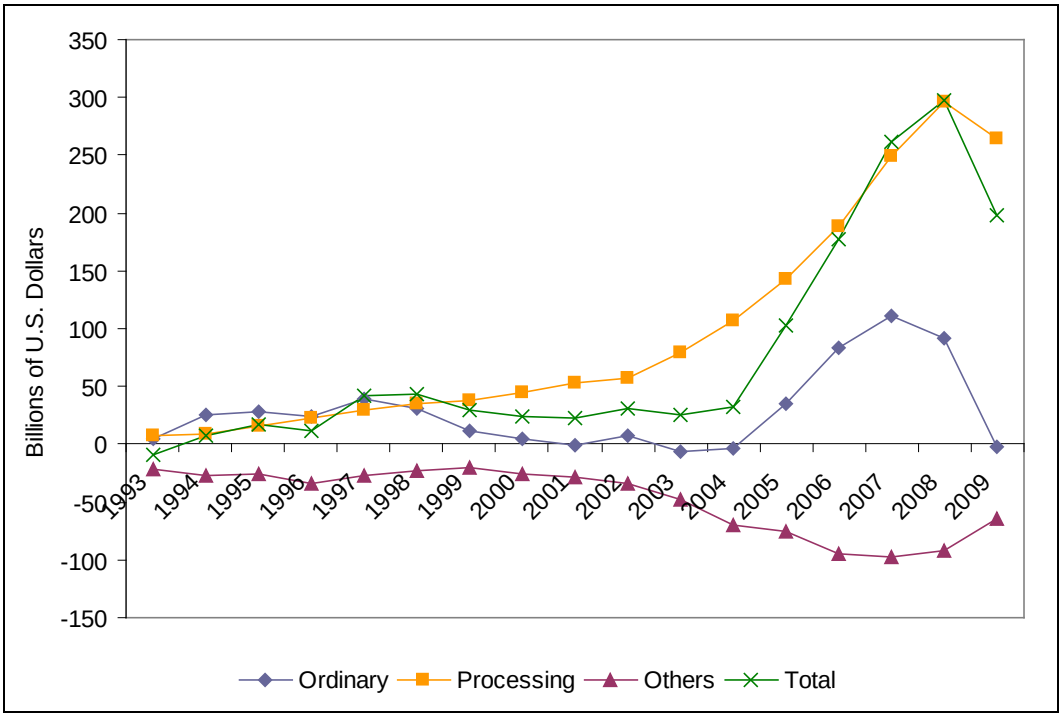
2. PRC'S PROCESSING TRADE

The PRC's Customs Statistics (CCS) distinguishes between imports and exports linked to processing trade and ordinary imports and exports.[3] Imports for processing are goods that are brought into the PRC for processing and subsequent re-export. Processed exports, as classified by the Chinese customs authorities, are goods that are produced in this way. Imports for processing are imported duty free and neither these imported inputs nor the finished goods produced using these imports enter PRC's domestic market. By contrast, ordinary imports are goods that are not imported duty free and ordinary exports are goods that are produced primarily using local inputs. Feenstra and Wei (2009) reported that 84% of the PRC's processed exports were produced by foreign-invested enterprises.

Figure 1 shows that most of the PRC's trade surplus until 2008 and all of the PRC's trade surplus after 2008 was due to processing trade. CCS divides processing trade into two categories, "processing and assembly" trade and "processing with imported materials" trade. As Gaulier, Lemoine, and Unal-Kesenci (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. The surplus in the first category averaged US$20 billion between 2007 and 2009 and the surplus in the second category averaged US$250 billion. This implies that, while the degree of intra-firm imports by foreign-invested enterprises (FIEs) has remained stable, arms length transactions by FIEs in the PRC are increasingly taking place with other firms located in the PRC.

[3] The website for the PRC's Customs Statistics is www.ChinaCustomsStat.com.

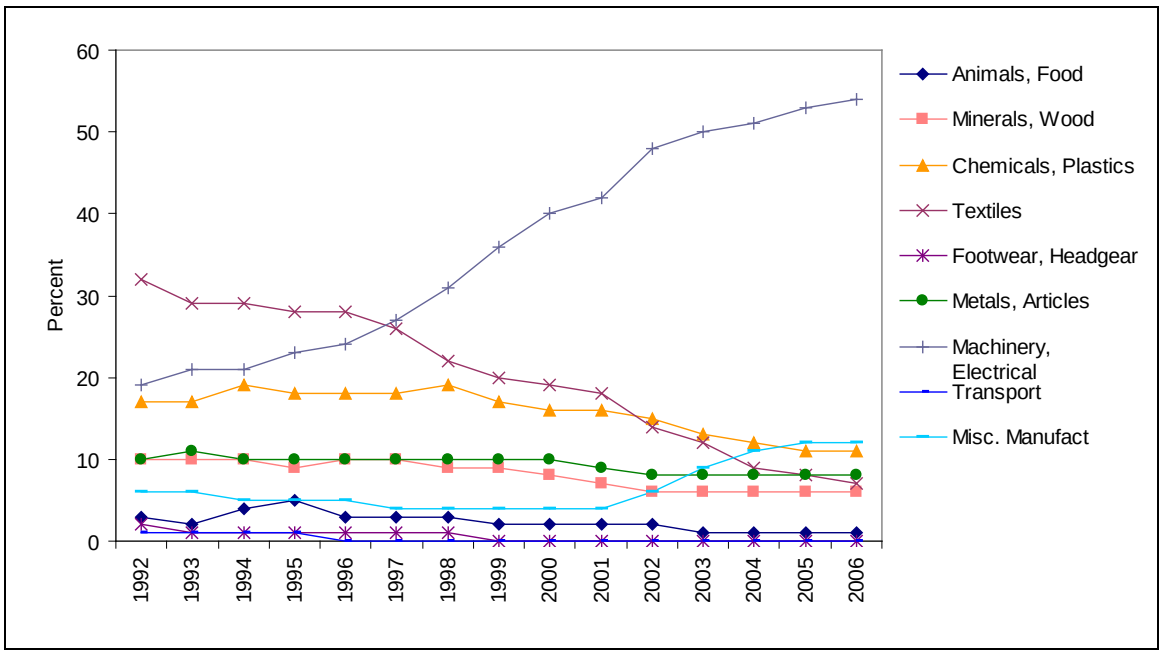
Fig. 1. PRC's Trade Balance by Customs Regime (Billions of US Dollars).



Source: PRC Customs Office.

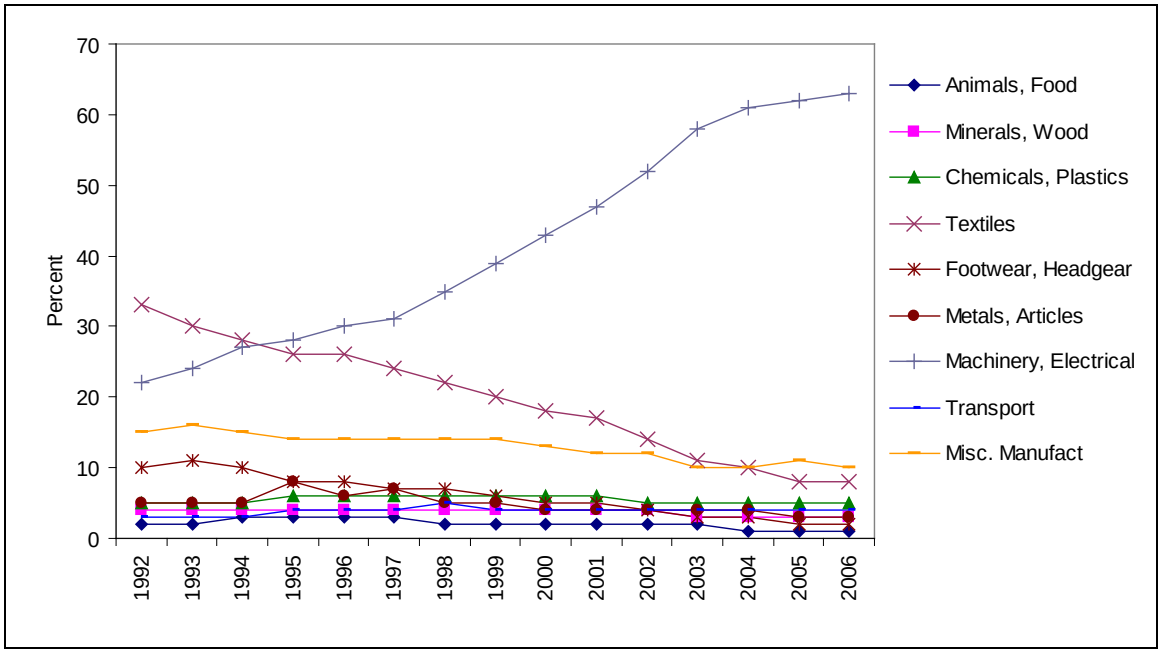
Figure 2 disaggregates processing trade using Harmonized System (HS) classifications. It shows that machinery and electrical products (HS 84–85) have become increasingly important on both the import and export side while textiles (HS 41–43, 50–63) have become progressively less important. Thus processing trade largely involves importing sophisticated parts and components and using them to produce computers, telecommunications equipment, and other high-tech goods.

Fig. 2a: Imports for Processing by Industry (% of Total Value)



Source: Feenstra and Wei (2009).

Fig. 2b: Processed Exports By Industry (% of Total Value)



Source: Feenstra and Wei (2009).

Table 1 shows the PRC's processing trade disaggregated by country between 2006 and 2008. Two-thirds of the PRC's imports for processing came from Japan, members of the Association of Southeast Asian Nations (ASEAN), and the newly industrialized economies (NIEs), while only about 5% each came from the US and Europe. On the other hand, East Asia, the US, Europe, and Hong Kong, China each received about 20% of processed exports.[4] As a result, the PRC ran deficits of about US$100 billion with East Asia in processing trade and surpluses of US$100 billion with Europe and US$130 billion the US and Hong Kong, China.

[4] Processed exports to Hong Kong, China largely represented entrepôt trade.

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

Imports for Processing (%)									
	World	Korea	Taipei,China	Japan	ASEAN	Hong Kong, China	United States	Europe	Rest of World
2006	100	15.08	19.04	15.89	13.15	2.11	5.23	4.99	24.52
2007	100	15.24	18.75	16.11	13.05	1.98	4.93	5.03	24.91
2008	100	15.63	18.07	16.20	12.54	1.62	5.20	5.72	25.01
Processed Exports (%)									
	World	Korea	Taipei,China	Japan	ASEAN	Hong Kong, China	United States	Europe	Rest of World
2006	100	3.95	2.19	10.35	6.18	22.34	25.23	17.85	11.90
2007	100	3.98	1.92	9.35	6.09	22.42	23.54	18.59	14.10
2008	100	4.75	1.88	9.22	6.06	21.01	22.20	18.71	16.16
Balance in Processing Trade (Billions of US dollars)									
	World	Korea	Taipei,China	Japan	ASEAN	Hong Kong, China	United States	Europe	Rest of World
2006	188.88	(28.29)	(50.01)	1.76	(10.74)	107.24	111.98	75.06	(18.12)
2007	249.23	(31.57)	(57.18)	(1.63)	(10.46)	131.18	127.25	96.29	(4.65)
2008	296.77	(27.07)	(55.71)	0.99	(6.53)	135.76	130.20	104.67	14.46

Notes: ASEAN includes Indonesia, Malaysia, Philippines, Singapore, and Thailand and Europe includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Luxembourg, Netherlands, Italy, Portugal, Spain, Sweden and United Kingdom.
Source: PRC Customs Statistics.

3. DATA AND METHODOLOGY

3.1 Specifying Export and Import Functions

According to the imperfect substitutes model of Goldstein and Khan (1985), export and import functions can be represented as:

$$ex_t = \alpha_{10} + \alpha_{11} rer_t + \alpha_{12} y_t^* + \varepsilon_{1t} \quad (1)$$

$$im_t = \alpha_{20} + \alpha_{21} rer_t + \alpha_{22} y_t + \varepsilon_{2t} \quad (2)$$

where ex_t represents real exports, rer_t represents the real exchange rate, yt* represents foreign real income, im_t represents real imports, y_t represents domestic real income, and all variables are measured in natural logs.

In the case of the PRC's processing trade, it is necessary to modify these equations. Below I consider some of the other factors that should affect imports for processing and processed exports.

For imports for processing, the International Monetary Fund (IMF) (2005) noted that the price elasticity should be small because the intermediate goods are not produced domestically, resulting in little potential for import substitution. However, the huge surpluses in processing trade that have emerged since 2005 suggest that firms have been able to source more intermediate goods from within the PRC. Thus the demand for imports for processing may have become more price elastic in recent years.

The IMF (2005) also argued that imports for processing should vary one-for-one with processed exports. Imports for processing should thus flow elastically into the PRC in response to an increase in the demand for processed exports in the rest of the world. Processed exports are therefore included as a right hand side variable to explain imports for processing. Since imports for processing are not intended for the domestic market but only for the assembly of processed exports, the preferred specification below includes processed exports but not PRC income.

Foreign direct investment (FDI) flows and multinational corporations (MNCs) also play important roles in processing trade (see Gaulier, Lemoine, and Unal-Kesenci 2005). As discussed above, 84% of the PRC's processed exports in 2006 were produced by foreign-invested enterprises (Feenstra and Wei 2009). FDI is thus included as a right hand side variable. As Marquez and Schindler (2007) noted, the effect of FDI on imports could be positive or negative depending on whether the investment generates substitution effects or complementary effects.

Following previous authors (e.g., Garcia-Herrero and Koivu 2007), a World Trade Organization (WTO) dummy variable is included as a right hand side variable. The PRC's WTO accession may have given foreign firms more confidence to enter into longer-term relationships with PRC firms. Garcia-Herrero and Koivu (2007) posited that the PRC's WTO accession began affecting the PRC's trade after it became certain that the PRC would join the WTO in the beginning of 2000. The WTO dummy variable is thus set equal to one beginning in 2000.

For processed exports much of the value-added comes from imported inputs, especially inputs produced in other East Asian countries. A generalized appreciation in East Asia would thus have a larger effect on the costs of the PRC's processed exports measured in the importing country's currency than a unilateral appreciation of the CNY. A unilateral appreciation would only change the relative foreign currency cost of the PRC's value-added

in processed exports.5 An integrated exchange rate is thus included that weights exchange rate changes in supply chain countries by the countries' value-added in processing trade.

3.2 Constructing an Integrated Exchange Rate

Following Tong and Zheng (2008), the PRC's value-added in processing trade can be measured as the difference between the value of the PRC's processed exports (VPE_t) and the value of imports for processing from all supply chain countries ($\sum_i VIP_{i,t}$):

$$VA_{Chin,t} = (VPE_t - \sum_i VIP_{i,t}) / VPE_t = 1 - \sum_i VIP_{i,t} / VPE_t, \quad (3)$$

where $VA_{Chin,t}$ equals the PRC's value-added in processing trade. Annual data on the total value of processed exports and the total value of imports for processing is used to calculate the PRC's value-added.

To calculate the value-added in supply chain countries this paper focuses on the nine leading providers of imports for processing to the PRC. These are Germany, Japan, the Republic of Korea (hereafter Korea), Malaysia, the Philippines, Singapore, Taipei,China, Thailand, and the US. For these suppliers weights ($w_{i,t}$) are calculated by dividing their contribution to PRC imports for processing by the amount of imports for processing coming from the nine major suppliers together. These weights are used to calculate a weighted exchange rate ($wrer_{j,t}$) between the PRC and each country *j* that purchases processed exports from the PRC by calculating the inner product of the weights and the bilateral real exchange rates between the countries supplying imports for processing and country *j*:

$$wrer_{j,t} = \sum_i w_{i,t} * rer_{i,j,t}, \quad (4)$$

where $rer_{i,j,t}$ is the bilateral real exchange rate between supply chain country i and country j purchasing the final processed exports.

The weighted exchange rate $wrer_{j,t}$ is then combined with the bilateral exchange rate between the PRC and country j ($rer_{Chin,j,t}$) to calculate a single integrated exchange rate ($irer_{j,t}$) measuring how exchange rate changes affect the entire cost of the PRC's exports of processed goods to country j:

$$irer_{j,t} = VA_{Chin,t} * rer_{Chin,j,t} + (1 - VA_{Chin,t}) * wrer_{j,t}. \quad (5)$$

To calculate $irer$ in this way it is necessary to measure exchange rates using a common numeraire. This can be done by employing the real exchange rate variables constructed by the Centre D'Etudes Prospectives et D'Information Internationales (CEPII). The CEPII real exchange rate between countries i and j is calculated by first dividing gross domestic product (GDP) in US dollars for country i by GDP in purchasing power parity (PPP) for country i and doing the same for country j. The resulting ratio for country i is then divided by the ratio for country j. This variable measures the units of consumer goods in country i needed to buy a unit of consumer goods in country j. It can be compared across countries as well as across time. Because it is comparable across countries, it can be used in equation (2) to

[5] This is true assuming that all of the PRC's imports for processing come from Asia.

calculate $irer$. Higher values of $wrer$ and $irer$ represent stronger exchange rates in the PRC and in supplier countries.

The other independent variables are the PRC's capital stock in manufacturing, the stock of FDI, and a WTO dummy variable. Cheung, Chinn, and Fujii (2010) have found that the PRC capital stock helps to explain PRC exports. As discussed above, the FDI stock and the PRC's WTO accession may help to explain the increase in processing trade.

The dependent variables are PRC imports for processing and PRC processed exports. These are obtained from the PRC's Customs Statistics. Following Cheung, Chinn, and Fujii (2010), the Hong Kong, China to PRC re-export unit value index is used to deflate the PRC's imports and the Hong Kong, China to US re-export unit value index is used to deflate the PRC's exports. The data are discussed in more detail in the Data Appendix.

3.3 The Econometric Model

Panel A of Table 2 reports the results from a battery of panel unit root tests.[6] Column (1) presents the Im, Peseran, and Shin W-statistic, column (2) the asymptotically distribution free (ADF) Fisher Chi-square statistic, column (3) the Phillips-Perron Fisher Chi-square statistic, column (4) the Levin, Lin, and Chu t-statistic, and column (5) the Hadiri heteroscedastic consistent Z-statistic. For the first four tests, the null hypothesis is that the variable has a unit root while for the fifth test the maintained hypothesis is that the variable is stationarity. In most cases the results indicate that the series have unit roots. Panel unit root tests are not conducted for the series with no cross-sectional variation (i.e., the PRC capital stock, PRC inward FDI, and PRC income).

Panel B of Table 2 reports the results of the Kao residual cointegration test.[7] For both the export and the import equation the results indicate that the null hypothesis of no cointegration can be rejected. Panel dynamic ordinary least squares (DOLS) estimation, a technique for estimating cointegrating relations, is thus employed.

Table 2: Unit Root and Cointegration Tests

Panel A. Unit Root Tests					
Variable	(1)	(2)	(3)	(4)	(5)
Processed Exports	47.84	1.30	50.65	-4.14**	13.24**
Imports for Processing	58.87	0.04	56.1	-5.70**	13.22**
Integrated Exchange Rate	18.66	4.62	15.89	4.15	10.00**
Rest of World Income	54.69	3.29	28.26	-4.73**	12.45**

(1) PP test – Fisher Chi-square statistic (null hypothesis: unit root)

(2) Im, Pesaran, and Shin W-statistic (null hypothesis: unit root)

(3) ADF – Fisher Chi-square statistic (null hypothesis: unit root)

(4) Levin, Lin, and Chu t-statistic (null hypothesis: unit root)

(5) Hadiri Heteroscedastic Consistent Z-statistic (null hypothesis: stationarity)

Note: Lag selection is based on the Schwartz Information Criterion.

**denotes significance at the 5% level.

[6] These tests are discussed in Breitung (2000), Choi (2001), Hadiri (2000), Im, Peseran, and Shin (2003), Levin, Lin, and Chu (2002), and Maddala and Wu (1999).

[7] This test is discussed in Kao (1999).

Panel B. Kao Residual Cointegration Test	
Export Equation	7.17**
Import Equation	-3.18**

(1) t-statistic from Kao Residual Cointegration test of the null hypothesis of no cointegration..

Note: Lag selection is based on the Schwartz Information Criterion.

**denotes significance at the 5% level.

Source: Estimation by the author.

DOLS involves regressing the left hand side variable on a constant, the right hand side variables, and lags and leads of the right hand side variables. The individual import equations have the form:

$$im_{i,t} = \beta_{10} + \beta_{11} irer_{i,t} + \beta_{12} rgdp_{C,t} + \beta_{13} tex_t + \beta_{14} FDI + \beta_{15} WTO + \sum_{j=-p}^{p} \alpha_{1,irer,j} \Delta irer_{1,i,t-j} +$$

$$\sum_{j=-p}^{p} \alpha_{1,rgdp,j} \Delta rgdp_{C,t-j} + \sum_{j=-p}^{p} \alpha_{1,tex,j} \Delta tex_{t-j} + \sum_{j=-p}^{p} \alpha_{1,FDI,j} \Delta FDI_{t-j} + \mu_i + u_{it}, \qquad (6)$$

$$t = 1, \cdots, T; \qquad i = 1, \cdots, N.$$

Here $im_{i,t}$ represents real imports for processing from country i to the PRC, $irer_{i,t}$ represents the integrated real exchange rate, $rgdp_{C,t}$ equals real income in the PRC, tex_t represents the PRC's total real processed exports to the world, FDI_t denotes the stock of foreign direct investment, WTO is the WTO dummy variable, μ_i is a country i fixed effect, and p represents the number of leads and lags. $im_{i,t}$, $irer_{i,t}$, $rgdp_{C,t}$, tex_t and FDI_t are measured in natural logs. $im_{i,t}$ and $irer_{i,t}$, vary both over time and across countries and $rgdp_{C,t}$, tex_t and FDI_t only vary over time.

The individual export equations have the form:

$$ex_{i,t} = \beta_{20} + \beta_{21} irer_{i,t} + \beta_{22} rgdp_{i,t} + \beta_{23} K_t + \beta_{24} FDI + \beta_{25} WTO + \sum_{j=-p}^{p} \alpha_{2,irer,j} \Delta irer_{i,t-j} +$$

$$\sum_{j=-p}^{p} \alpha_{2,rgdp,j} \Delta rgdp_{i,t-j} + \sum_{j=-p}^{p} \alpha_{2,ex,j} \Delta K_{t-j} + \sum_{j=-p}^{p} \alpha_{2,FDI,j} \Delta FDI_{t-j} + \mu_i + u_{it}, \qquad (7)$$

$$t = 1, \cdots, T; \qquad i = 1, \cdots, N.$$

Here $ex_{i,t}$ represents real processed exports from the PRC to country i, $irer_{i,t}$ represents the integrated real exchange rate, $rgdp_{i,t}$ equals real income in the importing country, K_t represents the Chinese capital stock in manufacturing, FDI_t denotes the stock of foreign direct investment, WTO is the WTO dummy variable, μ_i is a country i fixed effect, and p represents the number of leads and lags. $ex_{i,t}$, $irer_{i,t}$, $rgdp_{i,t}$, K_t and FDI_t are measured in natural logs. $ex_{i,t}$, $irer_{i,t}$, and $rgdp_{i,t}$ vary both over time and across countries and K_t and FDI_t only vary over time.

Annual data over the 1992 to 2008 period are used. One lead and lag is employed in the DOLS estimation.

4. RESULTS

Table 3 presents the results for imports for processing. The coefficients on the exchange rate are positive and statistically significant in every specification, indicating that an appreciation of the integrated exchange rate will increase imports for processing. The coefficients indicate that a 10% appreciation of *irer* will increase imports for processing by between 3.9% and 4.1%. Although not reported in Table 3, these coefficients remain virtually unchanged if a trend term is included

Table 3: Panel DOLS Estimates of the PRC's Imports for Processing From 25 Countries over the 1992–2008 Period.

Independent variables	(1)	(2)	(3)	(4)	(5)
CNY Exchange rate	0.41**	0.41***	0.39**	0.40***	0.42***
	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
PRC's Income	-9.70***		2.75	-1.83	
	(2.22)		(2.01)	(1.21)	
Processed exports	-3.66	0.95***		1.84***	1.02***
	(3.02)	(0.07)		(0.62)	(0.08)
FDI stock	21.27***	0.01	-0.66		-0.13
	(4.86)	(0.25)	(2.06)		(0.26)
WTO dummy	0.24	0.17*	0.20	0.26***	
	(0.15)	(0.09)	(0.14)	(0.08)	
Adjusted R-squared	0.95	0.95	0.95	0.95	0.95
No. of observations	350	350	350	350	350

Notes: DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. Imports are deflated using the Hong Kong, China to PRC. re-export unit value index. The data extend from 1992 to 2008. Since the DOLS estimation uses one lead and lag of the first difference of the right-hand side variables the actual sample period is from 1994-2007. Country fixed effects are also included.

*** (**) denotes significance at the 1% (5%) level.

Source: Estimation by the author.

In the preferred specifications in columns (2) and (5) that include processed exports but not the PRC's income, the coefficients on processed exports are close to unity. These results support the hypothesis of the IMF (2005) that there is approximately a one-for-one relationship between processed exports and imports for processing.

The IMF (2005) also posited that the exchange rate elasticity for imports for processing should be small because there are few domestic substitutes. However, the evidence discussed in Section 2, that interfirm transactions by FIEs in the PRC are increasingly taking place with other firms located in the PRC, suggests that the exchange rate elasticity may have increased in recent years. The exchange rate elasticities reported in Table 3 are only significant when data from 2005–2008 are included. Future work should investigate whether imports for processing have become more sensitive to exchange rate changes over the last few years as the PRC has developed more domestic substitutes to imported parts and components.

Table 4 presents the results for processed exports. The coefficients on the integrated exchange rate are negative and statistically significant in every specification, indicating that an appreciation in the PRC and other supply chain countries will reduce processed exports. The coefficients indicate that a 10% appreciation across East Asia will reduce processed exports by between 7.8 and 18.7%. Although not reported in Table 4, these coefficients remain highly significant when a trend term is included.

Table 4: Panel DOLS Estimates of the PRC's Processed Exports to 25 Countries over the 1992–2008 Period

Independent variables	(1)	(2)	(3)	(4)
Integrated exchange rate	-0.79***	-1.20***	-0.78***	-1.87***
	(0.16)	(0.21)	(0.16)	(0.36)
ROW Income	0.42**	1.64***	0.44***	3.08***
	(0.18)	(0.22)	(0.15)	(0.42)
Capital stock	2.39***		1.62***	
	(0.39)		(0.11)	
FDI stock	-1.01**	1.56***		
	(0.51)	(0.28)		
WTO dummy	-0.07	0.70***	0.09	0.41***
	(0.14)	(0.17)	(0.07)	(0.12)
Adjusted R-squared	0.98	0.97	0.98	0.95
No. of observations	350	350	350	350

Notes: DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. Exports are deflated using the Hong Kong, China to US re-export unit value index. The data extend from 1992 to 2008. Since the DOLS estimation uses one lead and lag of the first difference of the right-hand side variables the actual sample period is from 1994-2007. Country fixed effects are also included.

*** (**) denotes significance at the 1% (5%) level.

Source: Estimation by the author.

The coefficients on rest of the world income are positive and statistically significant in every specification, indicating that an increase in income in the rest of the world will increase processed exports. The coefficient values equal about 0.4 when the capital stock is excluded, and vary between 1.64 and 3.08 when the capital stock is included.

The coefficients on the capital stock are also positive and statistically significant in every specification. The coefficient values vary between 1.62 and 2.39. These values indicate that a 10% increase in the Chinese capital stock would increase processed exports by between 16 and 24%. These values are close to those reported by Cheung, Chinn, and Fujii (2010).

Table 5 presents the results for imports for processing using the yuan exchange rate as an independent variable instead of the integrated exchange rate. The coefficients on the exchange rate are positive and statistically significant in every specification, indicating that an appreciation of the yuan will increase imports for processing. The coefficients indicate that a 10% appreciation of the yuan will increase imports for processing by between 3.6 and 3.9%.

Table 5: Panel DOLS Estimates of the PRC's Processed Imports From 25 Countries over the 1992–2008 Period

Independent variables	(1)	(2)	(3)	(4)	(5)
CNY Exchange rate	0.37**	0.36**	0.36**	0.37**	0.39***
	(0.16)	(0.16)	(0.16)	(0.16)	(0.15)
PRC's Income	-10.94***		2.07	-2.48	
	(2.12)		(1.52)	(1.79)	
Processed exports	-3.92***	0.91***		2.01**	0.97***
	(1.01)	(0.03)		(0.83)	(0.06)
FDI stock	22.95***	-0.13	-0.20		-0.29*
	(3.64)	(0.10)	(1.60)		(0.16)
WTO dummy	0.26**	0.19***	0.21***	0.25**	
	(0.12)	(0.05)	(0.06)	(0.12)	
Adjusted R-squared	0.95	0.95	0.95	0.95	0.95
No. of observations	350	350	350	350	350

Notes: DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. Imports are deflated using the Hong Kong, China to PRC. re-export unit value index. The data extend from 1992 to 2008. Since the DOLS estimation uses one lead and lag of the first difference of the right-hand side variables the actual sample period is from 1994-2007. Country fixed effects are also included.

*** (**) [*] denotes significance at the 1% (5%) [10%] level.

Source: Estimation by the author.

Table 6 presents the results for processed exports using the yuan exchange rate instead of the integrated exchange rate. The results indicate that an appreciation of the CNY would reduce processed exports. The coefficients on the yuan exchange rate are smaller that the coefficents on the integrated exchange rate. They average -0.77, compared with an average of -1.16 for the coefficients on the integrated exchange rate in Table 3. These results indicate that an appreciation throughout Asia would have a larger effect on processed exports than an appreciation of the yuan alone.

Table 6: Panel DOLS Estimates of the PRC's Processed Exports To 25 Countries over the 1992–2008 Period

Independent variables	(1)	(2)	(3)	(4)
CNY Exchange Rate	-0.68***	-0.95***	-0.71***	-0.74***
	(0.14)	(0.16)	(0.13)	(0.16)
ROW Income	0.38**	1.62***	0.38**	5.03***
	(0.19)	(0.26)	(0.18)	(0.39)
Capital stock	2.51***		1.94***	
	(0.33)		(0.07)	
FDI stock	-0.80*	2.16***		
	(0.42)	(0.28)		
WTO dummy	-0.07	0.67***	0.07	0.54***
	(0.10)	(0.16)	(0.05)	(0.17)
Adjusted R-squared	0.98	0.97	0.98	0.95
No. of observations	350	350	350	350

Notes: DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. Exports are deflated using the Hong Kong, China to US re-export unit value index. The data extend from 1992 to 2008. Since the DOLS estimation uses one lead and lag of the first difference of the right-hand side variables the actual sample period is from 1994-2007. Country fixed effects are also included.

*** (**) [*] denotes significance at the 1% (5%) [10%] level.

Source: Estimation by the author.

5. DISCUSSION

PRC policymakers have noted that the PRC's trade surplus is too large and needs to be rebalanced. The PRC's surplus in recent years has been concentrated in processing trade. How would an appreciation of Asian currencies or of the yuan alone affect the PRC's processing trade balance?

The Marshall-Lerner condition implies that if exports initially equal imports an appreciation will reduce the trade balance if the sum of (the absolute values of) the demand elasticities for exports and imports exceeds one. If the current account is not initially balanced it is necessary to employ a general version of the Marshall-Lerner condition (see Appleyard and Field 2001). This condition states that an appreciation will reduce the trade surplus if:

$$Z < \alpha_{21} + Z\,\alpha_{11} \qquad (8)$$

where Z is the ratio of exports to imports, α_{21} is the price elasticity of imports, and α_{11} is the price elasticity of exports. According to the PRC Customs Statistics, processed exports exceeded imports for processing over the last five years by a ratio of 1.73 to 1. Z thus equals 1.73. The coefficient α_{21} in Table 3 averages 0.41. Thus, inequality (8) implies that an appreciation of the integrated exchange rate would reduce the trade surplus if the absolute value of the export elasticity is greater than 0.76. It is greater than this in all four cases in Table 4 and averages 1.16. This evidence indicates that a generalized appreciation in Asian supply chain countries would reduce the surplus in processing trade.

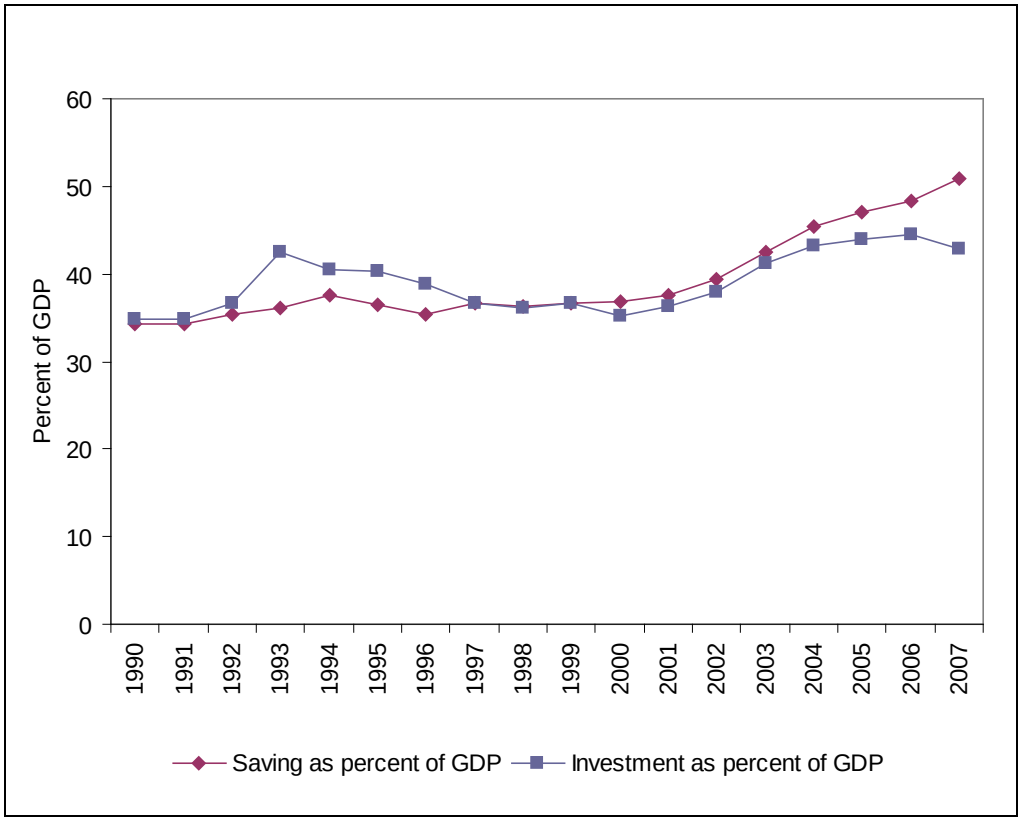
In the case of a CNY appreciation alone, the coefficient α_{21} in Table 5 averages 0.37. Thus, according to (8), an appreciation of the yuan would reduce the trade surplus if the absolute value of the export elasticity is greater than 0.79. It is greater than this in only one of the four cases in Table 4. Thus it is not clear than an appreciation of the yuan unaccompanied by appreciations in supply chain countries would reduce the surplus in processing trade.

How could a joint appreciation throughout East Asia be achieved? One way would be for the PRC to adopt an exchange rate 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 based on their value-added in processing trade.

Even in the case of an exchange rate appreciation throughout Asia, however, the exchange rate elasticities in Tables 3 and 4 are not large. Thus the results in this paper imply that exchange rate changes alone may not substantially reduce the processing balance.

To consider other ways to reduce the surplus, it is helpful to look at national saving and investment in the PRC. These are plotted in Figure 3. The figure shows that saving and investment began diverging after 2002. As the Asian Development Bank (ADB) (2009) reported, the shortfall of investment relative to saving was driven by an increase in corporate saving in the PRC. It rose from 17% of national disposable income in 2002 to 23% in 2007.

Figure 3: PRC's Saving and Investment as a % of GDP (1990–2007).



Source: International Monetary Fund via CEIC database (http://www.ceicdata.com/), accessed April 16, 2010.

What caused corporate saving to rise so rapidly? The Asian Development Bank (2009) reported that after-tax corporate profits rose by 6% of GDP between 2003 and 2006. Part of this increase was due to rapid economic growth and rising output prices that increased the profitability of state-owned enterprises (SOEs) and private firms. Since SOEs typically do not pay dividends, higher profits directly increase the firms' gross saving.

Several other factors also contributed to high and rising saving rates among SOEs. Many have monopolies in various sectors, such as China Mobile in telecommunications and China National Petroleum Corporation in oil. As Xing (2009) discussed, the resulting monopoly profits contributes to high corporate savings, extraordinarily high compensation among executives at SOEs, and a skewed income distribution.

In addition, as Huang (2009) documented, factor market distortions provided a subsidy to producers of almost 2 trillion yuan (7% of GDP) in 2008. These subsidies include a yuan that is undervalued, artificially low land prices and real interest rates, administered prices for fuel and electricity, and environmental laws that are not rigorously enforced. These subsidies transferred resources to the corporate sector and increased their profitability. If these subsidies were removed and PRC enterprises faced higher prices for resources, land, electricity, and other items, then their global competitiveness would decline and this would reduce the production of tradables in the PRC.

Thus if policymakers in the PRC want to rebalance growth, exchange rate appreciations in Asia would probably have to be accompanied by other changes. These include deregulation, liberalization of factor markets, and the removal of policy distortions that favor the tradables sector over the non-tradables sector.

6. CONCLUSION

PRC's pegged exchange rate has caused problems in the PRC and the rest of the world. In the PRC it has interfered with the allocation of credit by forcing commercial banks to hold increasingly large quantities of central bank bills. In other Asian countries the PRC's peg has caused central banks to intervene in currency markets and accumulate reserves in order to maintain competitiveness against the PRC. Many have thus argued that the PRC should move to a more flexible exchange rate regime.

This paper has investigated how the resulting exchange rate changes would affect the PRC's trade surplus. Since 2008 this surplus has been concentrated in processing trade. Processed exports are final goods produced using parts and components coming primarily from other Asian countries.

The results indicate that an appreciation throughout Asia would reduce the PRC's surplus in processing trade. An appreciation of the yuan alone may not reduce the surplus.

One way for supply chain countries to have their currencies appreciate together would be for the PRC to adopt an exchange rate 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 based on their value-added in processing trade.

However, the fact that the exchange rate elasticities reported in this paper are not large suggests that greater exchange rate flexibility needs to be accompanied by other policies in order to rebalance growth. These include enforcing environmental regulations and liberalizing the markets for land, labor, fuel, and capital. After the PRC began liberalizing its product markets in the late 1970s, growth exploded in a quantitative sense. Liberalizing factor markets and fighting environmental degradation could similarly spark an explosion of growth in a qualitative sense.

REFERENCES

ADB. 2009. Asian Development Outlook 2009: Rebalancing Asia's Growth. Manila: ADB.

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

Appleyard, D. R., and A. J. Field. 2001. International Economics, Fourth edition. San Francisco, CA: Irwin/McGraw Hill.

Bai, C.-E.., C.-T. Hsieh, and Y. Qian. 2006. Returns to Capital in China. Brookings Papers on Economic Activity 2006 (1): 61–88.

Breitung, J. 2000.The Local Power of Some Unit Root Tests for Panel Data. In *Advances in Econometrics, Vol. 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels*, edited by B. Baltagi. Amsterdam: JAI Press.

Bosworth, B., and S. Collins. 2010. Rebalancing the US Economy in a Post-Crisis World. Paper presented at the Conference on Transpacific Rebalancing. ADBI/Brookings Institution. 3–4 March.

Cheung, Y.-W., M. Chinn, and E. Fujii. 2010. China's Current Account and Exchange Rate. In China's Growing Role in World Trade, edited by R. Feenstra and S.-J. Wei. Chicago, IL: University of Chicago Press forthcoming.

PRC Customs Statistics database. Available ChinaCustomsStat.com.

Choi, I. 2001. Unit Root Tests for Panel Data. *Journal of International Money and Finance* 20 (2): 249–272.

Feenstra, R., and S.-J. Wei. 2009. Introduction. In China's Growing Role in World Trade, edited by R. Feenstra and S.-J. Wei. Chicago, IL: University of Chicago Press forthcoming.

Garcia-Herrero, A. and T. Koivu. 2007. Can the Chinese Trade Surplus be Reduced with the Exchange Rate Policy? BOFIT Discussion Paper, 07-06. Bank of Finland.

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. S. Khan. 1985. Income and Price Effects in Foreign Trade.In Handbook of International Economics, Vol. 2, edited by R. W. Jones and P. Kenen. Amsterdam: North-Holland.

Hadri, K. 2000. Testing for Stationarity in Heterogeneous Panel Data. *Econometric Journal* 3 (2): 148–161.

Huang, Y. 2009. The Future of the International Currency System: A Chinese Economist's Perspective. Paper presented at the Conference on Asian Architecture and Global Governance, ADBI/ADB, Manila, 29 October.

Kao, C. D. 1999. Spurious Regression and Residual-Based Tests for Cointegration in Panel Data. *Journal of Econometrics* 90,(1): 1–44.

Im, K. S., M. H. Pesaran, and Y. Shin. 2003. Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics* 115 (1): 53–74.

IMF. 2005. Asia-Pacific Economic Outlook. Washington, DC: IMF.

Levin, A., C. F. Lin, and C.-S. J. Chu. 2002. Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. *Journal of Econometrics* 108 (1): 1–24.

Maddala, G. S., and S. Wu. 1999. A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and Statistics* 61 (S1): 631–652.

Marquez, J., and J. W. Schindler. 2007. Exchange Rate Effects on China's Trade. Review of International Economics 15 (5): 837–853.

Thorbecke, W., and G. Smith. 2010. How Would an Appreciation of the RMB and other East Asian Currencies Affect China's exports? Review of International Economics 18 (1): 95–108.

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.

Xing, Y. 2009. Consumption, Income Distribution, and State Ownership in China. Paper written for the ADBI Annual Conference on the Effects of Social Policy on Domestic Demand, 4 December.

Yoshitomi, M.. 2007. Global imbalances and East Asian monetary cooperation. In Toward an East Asian Exchange Rate Regime, edited by D.-K. Chung and B. Eichengreen. Washington DC: Brookings Institution Press.

APPENDIX: DATA

The data were obtained from various sources:

1. Data on the PRC's imports for processing and processed exports from 1992–2008 were obtained from PRC Customs Statistics.
2. Data on the Hong Kong, China to the PRC and the Hong Kong, China to US re-export unit value indices were obtained from the CEIC database.
3. Data on the US Producer Price Index and Consumer Price Index were obtained from the IMF via the CEIC database.
4. Data on the consumer price index-deflated real exchange rate and real income from 1992–2007 were obtained from the Centre D'Etudes Prospectives et D'Information Internationales-Comptes Harmonisés sur les Echanges et l'Economie Mondiale CEPII-CHELEM data base. It is available at: https://chelem.bvdep.com/ The data were updated to include 2008 using data from the IMF International Financial Statistics.
5. Data on the stock of FDI were obtained from the United Nations Conference on Trade and Development (UNCTAD) (Available from: http://stats.unctad.org/FDI/TableViewer/tableView.aspx?ReportId=1254).
6. Data for the PRC capital stock were obtained from Bai , Hsieh, and Qian (2006). Based on Cheung, Chinn, and Fujii (2010), it was assumed to grow by 12% in 2005. Based on input from the World Bank, it was assumed to grow 10.44% in 2006, 10.01% in 2007, and 9.63% in 2008.