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RMB Revaluation and China's Trade: Does the RMB Have a Limited Effect on China's Surplus?

Shi-Shu Peng, Ming-Huan Liou, Hao-Yen Yang, and Chih-Hai Yang*

This study examines the influence of the RMB fluctuations on trade in primary, intermediate, and final goods between China and its 49 major trading partners over the period 1992–2009. The empirical result shows that the sensitivity of trade to the exchange rate varies substantially for different commodities. Overall, China's exports are less sensitive to the exchange rate than imports. Counterintuitively, we find that RMB appreciation reduces China's intermediate goods imports. A possible reason is that the appreciation harms its final goods exports in the assembly sector, thus indirectly lowering the demand for the required intermediate goods imports. This finding, along with the finding that final goods exports, the major source of the trade surplus, are not sensitive to exchange rate changes, are probably the main reasons why RMB appreciation has a limited effect on restraining China's rising surplus.

Keywords: exchange rate elasticity; trade surplus, dynamic panel GMM
JEL classification: F31, F32

1 Introduction

China has experienced spectacular economic growth since implementing its open-door policy in the late 1970s. Among China's economic reform mea-

*The authors are Assistant Professor, Department of Public Finance, National Chengchi University; Senior Researcher, Science and Technology lnternational Strategy Center, lndustrial Technology Research lnstitute; Professor, Department of Finance, National Taipei University of Business; and Professor, Department of Economics, National Central University.

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sures that explain its remarkable growth, one critical development strategy is the export-led growth model (Kwan and Kwok, 1995) that also applies to the growth paths of other East Asian economies, such as Taiwan and South Korea. Along with deepening globalization, China has utilized its advantages in cheaper labor and policy measures to attract foreign direct investment (FDI) and to export labor-intensive and final assembly products. After China joined the WTO in 2001, it further was able to fully integrate into the world trading system, capitalizing upon its abundant labor force to became the so-called "World's Factory" and dominating the production in many information and communication technology (ICT) products in the global market. China's ICT products exports accounted for the global ICT products exports only 1.7% in 1990, while this number has ballooned to 12.30% in 2014.

To coordinate with the export-led growth model, China implemented a weak RMB exchange rate policy, pegging its currency to the US dollar at the rate of 8.7 RMB/dollar in 1994 and keeping it there until the exchange rate reform in 2005.[1] The weak exchange rate policy enables China to create an unfair competitive advantage in world trade and to achieve an extraordinary upsurge in trade surplus. China's trade balance grew from 3.3% of GDP in 1990 to a peak of 10.6% in 2007. In response to the demand for RMB revaluation, China announced an unprecedented regime change of its exchange rate policy on July 21, 2005. This announcement represents a more flexible RMB exchange rate with China's intrinsic value based more on the market mechanism.[2] However, China's trade surplus has continued to increase substantially, reaching about U$378.57 billion in 2014. The extraordinary upsurge has resulted in greater disputes among China's major trading partners, especially the U.S. The critics mainly argue that the RMB was seriously undervalued due to exchange rate manipulation.[3]

Using the iPhone as a case study, Xing and Detert (2010) conversely

[1] Bahmani-Oskooee and Wang (2008) argue that while the nominal rate of the RMB seems to be effectively pegged to the US dollar, the real exchange rate continues to depreciate.

[2] The new regime of the RMB exchange rate is a managed floating exchange rate one that relies upon market supply and demand with a reference to a basket of currencies. It allows the RMB to rise by 2% with a daily 0.3% trading band based on the price of the previous day (Zheng et al., 2006).

[3] Cline and Williamson (2008) provide a survey of the extent of possible RMB undervaluation estimates. They show the typical range of the degree of undervaluation for China's real effective exchange rate is 8% to 55%.

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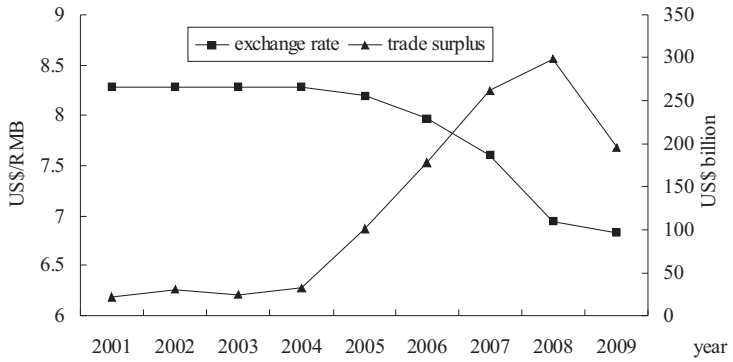


Figure 1: China's Exchange Rate and Trade Surplus

show that after deducting the imported inputs produced in other countries, the trade surplus created by China's exports of iPhones, as measured by domestic value-added, is much smaller than that measured by the value of final goods. In other words, from the perspective of the global value chain and by measuring international trade using domestic value-added, China's trade surplus is not that high. As Athukorala and Yamashita (2009) suggest, the China-U.S. trade imbalance is basically a structural phenomenon resulting from the pivotal role played by China as the final assembly center in East Asia-centered global production networks.

Even though various points are made on the causes of China's trade surplus, the issue regarding the RMB exchange rate remains at the center of the ongoing debate over the source of global current account imbalances, because RMB appreciation seems to have little effect on reducing China's trade surplus. Figure 1 displays the trend of the RMB exchange rate and China's trade surplus. Despite the RMB's gradual appreciation from an average of 8.192 (US dollars in terms of RMB) in 2005 to 6.831 in 2009, which corresponds to a 4.4% annual appreciation rate in the period 2005–2009, the amount of trade surplus still rose rapidly between 2005 and 2008.[4] It casts doubt over whether RMB revaluation has any effect on China's surplus? Are China's exports and imports sensitive to the change in the exchange rate?

Emerging studies have begun to investigate the effect of RMB variation on China's trade or current account, and most of them report that

[4]The sharp shrink in China's surplus in 2009 was caused by the global financial crisis.

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RMB appreciation reduces China's exports or trade surplus, e.g. Bahmani-Oskooee and Wang (2006), Narayan (2006), Zheng et al. (2006), Groenewold and He (2007), Baak (2008), Hua (2008), Yu (2009), Rahman (2009), and Xing (2012). However, as Athukorala (2006) indicates, fragmentation trade has played a pivotal role in the continuing dynamism of East Asian economies and deepened the increasing intra-regional economic interdependence.[5] This view suggests that the aggregated trade data contain little information regarding the feature of the Asian production network whereby China serves as the main final assembly exporter in the global manufacturing chain. Therefore, using disaggregated data to revisit the RMB variation and trade nexus for China may provide more insightful implications.

Some potential drawbacks in the studies above are worth improving as follows. First, the previous literature focuses mostly on the movements of the RMB before 2006 without considering its fluctuations between 2006 and 2009, or after the exchange rate reform was launched in mid-2005. Second and more crucially, most studies assume that the price elasticity of different trading commodities responding to the RMB variation is identical. Though few research studies divide China's trade into ordinary trade and processing trade (whether the value-added goods are for both domestic sales and exports or only exports.), none of them examine the effect of the RMB variation on both exports and imports for the division of primary, intermediate, and final goods. A sound exchange rate policy considers not only exports, but also imports, and not only final goods, but also intermediate and primary goods. This is particularly relevant to China, because: (1) its final assembly exports in the global vertical integrated supply chain depend heavily on importing components and intermediate goods; (2) China, to maintain its persistent growth, is now a major importing country of primary goods, which is usually argued as a main reason for their mounting international prices. Previous studies tell a partial story, since they fail to consider these aspects. To examine the real effect of RMB appreciation on China's trade surplus, a wider study on both exports/imports and primary/intermediate/final goods, we believe, will bring more insights about the exchange rate policy.

This paper attempts to fill this important gap in the literature and extends the preceding works in the following ways. First, we observe longer

[5]Athukorala (2006) defines the fragmentation as the cross-border dispersion of component production/ assembly within vertically integrated production processes.

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and more recent trade data to revisit the impact of the RMB variation on trade between China and its 49 major trading partners. The time span of the sample is 1992 to 2009, including RMB reform after 2005. Second, we categorize China's trading commodities into primary, intermediate, and final goods by applying the standard of the Broad Economic Classification (BEC) system to coordinate with our 6-digit HS code trade data. Specifically, we use the World Input-Output Database (WIOD) to differentiate final goods by their reliance on imported inputs, avoiding the double counting problem. This enables us to examine whether and how much various exporting and importing goods are sensitive to the RMB exchange rate. Moreover, this study sheds lights on how this exchange rate adjusts along with the change of trade structure during different economic development stages. Third, to deal with the potential recognized problems in which the time series data of trade are non-stationary and the decision of the exchange rate is endogenous, we employ the Generalized Method of Moment (GMM) technique on dynamic panel data in this paper.

The remainder of this paper is organized as follows. Section 2 briefly reviews the related literature of the effect of RMB appreciation on China's trade balance by using disaggregated data. Section 3 discusses some stylized facts of China's trade. Section 4 presents the empirical model and data. Section 5 reports and analyzes the empirical results. Concluding remarks are summarized in the final section.

2 Literature Review

There is an emerging body of literature examining the response of China's trade balance to the real exchange rate through disaggregate data, e.g., commodity or industry trade data. Bahmani-Oskooee and Wang (2007) and Bahmani-Oskooee and Wang (2008) claim that using aggregated data to investigate the short-run and long-run effects of exchange rate depreciation on trade surplus suffers from aggregation bias.[6] They thus employ industry-level trade data to examine the hypothesis of the short-run effect (J-curve effect) in trade between the U.S. and China, concluding that there is no ev-

[6]Bahmani-Oskooee and Wang (2007) and Bahmani-Oskooee and Wang (2008) define the aggregation bias as the effect of the exchange rate on trade being offset by some insignificant industry trade. This implies disaggregated data are appropriate for evaluating the exchange rate effect.

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idence that changes in the exchange rate will cause the U.S. trade deficit to rise in the short run; however, the real RMB-dollar rate has played a significant role in the long run. Their findings contradict most previous research studies that use aggregated trade data.

Another line of research additionally focuses on estimating the exchange rate elasticity of China's trade. Mann and Plück (2005) calculate the exchange rate elasticity of U.S. trade flow by employing commodity-level bilateral trade data for 31 countries. The authors find that the trade pattern between the U.S. and China is pretty different from those between the U.S. and the rest of the world, especially in terms of American imports of capital goods and exports of capital and consumption goods.

Marquez and Schindler (2007) attempt to figure out the relationship between the shares of China's exports and imports within global trade volume and the real effective value of the RMB, using monthly trade data disaggregated into two categories of ordinary and processing goods. They present that a 10% real appreciation of the RMB lowers the share of aggregate Chinese exports by nearly 1%. In addition, they find that ordinary and processing trades exhibit different responses to exchange rate changes.[7]

Thorbecke and Zhang (2009) examine the impact of RMB revaluation on China's labor-intensive manufacturing exports and report that RMB appreciation will substantially reduce exports in the clothing, furniture, and footwear industries. Their findings, in which an appreciation among its competitors' currencies would raise China's exports, highlight the importance of the third-party effect.

Thorbecke and Smith (2010) investigate the impact of the joint appreciation of East Asian currencies on China's trade, using processing trade panel data that include China's exports to 33 countries. They report that a 10% RMB appreciation will reduce ordinary and processing exports by 12% and less than 4%, respectively. Furthermore, as processing exports are sophisticated, capital-intensive goods, an appreciation in East Asia currencies will lead to more of their expenditure transferring towards U.S. and European goods and contribute more towards ameliorating the global imbalance than merely an appreciation in only the RMB or another single Asian currency

[7]Thorbecke and Smith (2010) report that China's processing exports are produced through intricate production and distribution networks centered in East Asian countries e.g., Japan, South Korea, Taiwan, and multination corporations in ASEAN. These processing exports account for about 53% of China's total exports in 2006.

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alone. Similarly, Xing (2012) examine the impact of RMB appreciation on China's processing trade, as processing trade accounted for a predominately share of China's annual trade surplus. Based on panel data of bilateral processing trade between China and its partners from 1993 to 2008, this study finds that a 10% real appreciation of RMB would reduce China's processing exports and imports by 9.1% and 5.0%, respectively.[8]

3 Data and the Stylized Facts of China's Trade

To examine the effect of the RMB revaluation on China's trade, we utilize yearly trade data between China and its 49 major trading partners over the period 1992–2009.[9] The sample set not only contains the period when China's trade regime was transformed from being state-controlled to market-oriented, but also includes the post-2005 exchange rate reform period. Moreover, in order to disaggregate the data, we compile the Harmonized System (HS) codes at the 6-digit level with the BEC system and classify China's exports and imports into primary, intermediate, and final goods. This helps to depict the characterization of China's trade. (See the Appendix Table). To mitigate the double counting issue that final goods rely on imported inputs, we adopt the World Input-Output Database (WIOD) to differentiate final goods from imported inputs.[10] The sample set is quite representative, since the trade volume with these countries accounts for approximately 90% of China's total trade during the sample period.

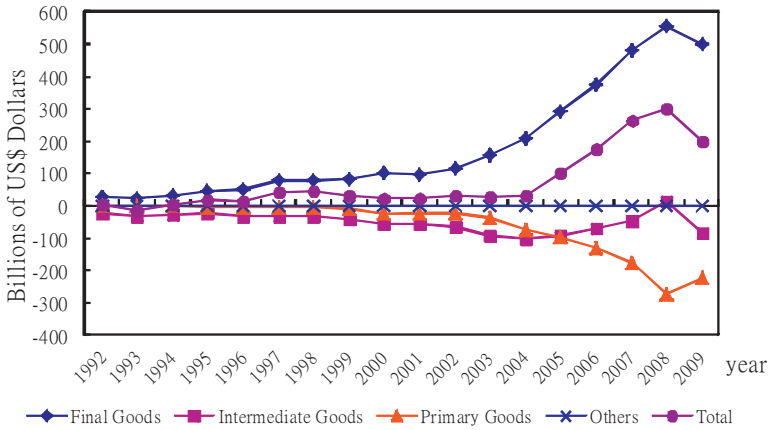
According to Erumban et al. (2011), the international supply and use tables are used to construct the symmetric world input-output table (WIOD). Let S and M denote supply and imports, respectively. Subscripts i, j and k denote products, industries and the country from which imports are origi-

[8]There are also some working papers examining how exchange rate change affects China's processing trade, such as Ahmed (2009), Cheung, Chinn, and Fujii (2009), Garcia-Herrero and Koivu (2008), and Thorbecke (2010).

[9]The sample countries include: Angola, Argentina, Australia, Brazil, Canada, Chile, Denmark, Finland, France, Germany, Hungary, India, Indonesia, Iraq, Italy, Japan, Kazakhstan, Kuwait, Malaysia, Mexico, Netherlands, Nigeria, Oman, Pakistan, Panama, Peru, Philippines, Poland, Russian Federation, Saudi Arabia, Singapore, South Korea, Spain, Sudan, Sweden, Switzerland, Taiwan, Thailand, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Venezuela, and Vietnam.

[10]See the Appendix Figure. As the WIOD contains information starting from 1995, the shares for years 1992–1994 are calculated using the interpolation.

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Source: Authors' calculations based on data provided by the Bureau of Foreign Trade, Ministry of Economic Affairs, Taiwan.

Figure 2: China's Trade Balance of Different Commodities

nating, whereas superscripts D and M represent domestically produced and imported products respectively. Then, total supply for each product i is given by the summation of domestic supply and imports. Total use is the summation of final domestic use (F), exports (E) and intermediate use (I). We thus obtain the identity of supply and use as follows

$$\sum_j S_{i,j}^D + \sum_k M_{i,k} = \left(F_i^D + E_i^D + \sum_j I_{i,j}^D \right) + \left(\sum_k F_{i,k}^M + \sum_k E_{i,k}^M + \sum_k \sum_j I_{i,j,k}^M \right). \quad (1)$$

Adopting the ratio of $\sum_k F_{i,k}^M$ and $\sum_k \sum_j I_{i,j,k}^M$ from international supply and use tables to differentiate final goods from imported inputs, we can differentiate final goods from imported inputs.

Before introducing the empirical specification, we first illustrate some stylized facts of China's trade. Figure 2 portrays the trend of China's trade balance for all goods and for different stages of production, i.e., primary, intermediate, and final goods. This figure reveals that China's outstanding export performance mainly relates to its integration in the international pro-

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duction fragmentation. Overall, the trade surplus rose steadily before 2004 and increased much faster until 2008, the year of the global financial crisis.

By dissecting China's trade surplus, we find that the trade in final goods is the only force driving the overall surplus to increase. The trade surplus in final goods rose steadily in the 1990s. After China joined the WTO in 2001, it became fully integrated into the world trading system and enjoyed the relative advantage in the international production chain, especially in the assembly export sector. China's trade surplus in final goods increased sharply, reaching a historical high of around US$557 billion in 2008. However, China's final assembly exports depend heavily on importing intermediate goods from its East Asian neighbors, inducing a trade deficit in intermediate goods. As for trade in primary goods, to sustain its spectacular growth China has to not only import them as inputs for final assembly production, but also invest heavily in infrastructure. Therefore, China's demand for primary goods has surged up sharply, leading to an increasing trade deficit in primary goods since 2002 and onward. The trade deficits in primary and intermediate goods were about US$221 billion and US$83 billion in 2009, respectively. In fact, trade in primary goods has already become the largest source of China's overall trade deficit since 2005.

We now analyze the change of China's trade structure in terms of its trading partners for goods in different categories. We see from Table 1 that final goods exports always have the highest proportion of 60% and 61% in overall exports, with the highest shares of 69% and 52% to the destinations of advanced regions (Europe, U.S., and Hong Kong), for the years 1992 and 2009, respectively. China's intermediate goods imports have the highest proportion of 61% and 55% in overall imports, with the highest shares of 61% and 44% from the originations of its neighboring East Asian region (Taiwan, South Korea, Japan, and Hong Kong), for the years 1992 and 2009, respectively.[11] This can be explained by China's role of serving as a main producer of final assembly goods in the vertically integrated production chain in East Asian countries and thus importing intermediate inputs from this area. We also observe China becoming a major primary goods consumer and importer, since its importing share has risen drastically from

[11]Hong Kong exhibits an interesting role in 1992, especially for China's exports: due to its functions of transship and entrepot, Hong Kong is usually not the final destination for most of China's trade. To avoid overestimation, we exclude Hong Kong in our sample in this paper.

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Table 1: China's Commodity Trade by Stages of Production in 1992 and 2009

	Imports (%)							
	World	Europe	U.S.	Hong Kong	S. Korea & Taiwan	Japan	ASEAN-6	ROW
1992								
Total imports	100	12	11	25	11	17	5	19
Final goods	30	21	13	18	10	23	1	13
Intermediate goods	61	9	9	32	12	17	5	16
Primary goods	9	4	16	4	1	3	18	54
Others[a]	0	11	1	1	0	8	0	78
2009								
Total imports	100	11	8	1	19	13	11	38
Final goods	23	22	10	1	19	15	10	22
Intermediate goods	55	10	7	1	26	17	12	27
Primary goods	22	3	8	1	1	2	6	81
Others[a]	0	1	1	0	0	0	77	20
	Exports (%)							
	World	Europe	U.S.	Hong Kong	S. Korea & Taiwan	Japan	ASEAN-6	ROW
1992								
Total exports	100	8	10	44	4	14	5	15
Final goods	60	8	12	49	1	12	2	16
Intermediate goods	30	8	7	45	6	10	9	16
Primary goods	10	7	8	13	14	37	10	11
Others[a]	0	0	1	6	1	1	73	17
2009								
Total exports	100	15	18	14	6	8	9	30
Final goods	61	17	22	13	4	8	6	29
Intermediate goods	38	13	13	15	8	7	12	32
Primary goods	1	8	6	10	30	18	11	16
Others[b]	0	9	6	3	20	28	12	22

Notes: ASEAN-6 includes Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam; European countries are Denmark, Finland, France, Germany, Hungary, Italy Netherlands, Poland, Spain, Sweden, and Switzerland.

Source: Authors' calculations based on data provided by the Bureau of Foreign Trade, Ministry of Economic Affairs, Taiwan.

a. Other goods imports are around 0.05% and 0.1% in 1992 and 2009, respectively.

b. Other goods exports are around 0.09% and 0.26% in 1992 and 2009, respectively.

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9% to 22% while its exporting share has fallen from 10% to 1% between 1992 and 2009.

4 Empirical Specification and Estimation Strategy

4.1 Empirical model

To evaluate the effect of RMB variation on China's trade, we apply the commodity version of the imperfect substitute model developed by Goldstein and Khan (1985). They assume that trading activity depends on the real exchange rate and the trading partner's income level. The basic model is specified as follows:

$$\mathrm{EX}_{ijt} = \alpha_1 + \alpha_2 \mathrm{RER}_{ijt} + \alpha_3 \mathrm{RGDP}_{jt} + u_{ijt}, \tag{2}$$

$$\mathrm{IM}_{ijt} = \beta_1 + \beta_2 \mathrm{RER}_{ijt} + \beta_3 \mathrm{RGDP}_{it} + \beta_4 \mathrm{RGDP}_{jt} + u_{ijt}, \tag{3}$$

where EX_{ijt} represents country i's exports to country j in year t; IM_{ijt} represents country i's imports from country j in year t, with both variables measured in real terms; RER_{ijt} stands for the bilateral real exchange rate between countries i and j in year t; RGDP_{jt} and RGDP_{it} represent country j's and country i's real income, respectively. Hereafter, country i represents China, the home country, while country j is the foreign country.

As is well known, most economic time series data are non-stationary, implying that there exist potential problems of unit root and autocorrelation. Trade is also usually thought to be habitual - namely, trading behavior may be influenced by such behavior in previous years. The most common approach in the empirical trade literature to test such a hysteresis effect is adding a lagged term in the specification: a positive and significant estimated coefficient of this lagged one-year term may suggest the presence of habitual behavior. We therefore augment the earlier specifications as follows:

$$\begin{aligned}\ln \mathrm{EX}_{ijt} = {} & \alpha_0 + \alpha_1 \ln \mathrm{EX}_{ijt-1} + \alpha_2 \ln \mathrm{RER}_{ijt} + \alpha_3 \ln \mathrm{RGDP}_{jt} \\ & + \alpha_4 \ln \mathrm{FDI}_{it} + \alpha_5 \mathrm{WTO}_t + \alpha_6 \mathrm{FTA}_{ijt} + \alpha_7 \mathrm{CRISIS}_t \\ & + \lambda_j + u_{ijt}, \end{aligned} \tag{4}$$

$$\begin{aligned}\ln \mathrm{IM}_{ijt} = {} & \beta_0 + \beta_1 \ln \mathrm{IM}_{ijt-1} + \beta_2 \ln \mathrm{RER}_{ijt} + \beta_3 \ln \mathrm{RGDP}_{it} \\ & + \beta_4 \ln \mathrm{RGDP}_{jt} + \beta_5 \ln \mathrm{POP}_{it} + \beta_6 \ln \mathrm{FDI}_{it} + \beta_7 \mathrm{WTO}_t \\ & + \beta_8 \mathrm{FTA}_{ijt} + \beta_9 \mathrm{CRISIS}_t + \lambda_j + u_{ijt}, \end{aligned} \tag{5}$$

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where EX_{ijt} and IM_{ijt} represent China's real exports and imports in different categories in year t (i.e., total trade, and primary, intermediate, and final goods trade). As Thorbecke (2010) indicates, most of Hong Kong's exports are re-exports from China, and thus it is proper to use Hong Kong's export price as the deflator for China's exports and vice versa for imports. We hence deflate the export (import) variables by the Hong Kong export (import) price indices. The terms EX_{ijt-1} and IM_{ijt-1} are one-year lagged exports and imports controlling for the persistent effect in the trade structure, and both variables are expected to have positive coefficients.

The term RER_{ijt} symbolizes the bilateral real exchange rate between China and its trading partner j and is deflated by the consumer price index (CPI). This variable is our main concern in that it may reduce China's exports and augment imports as it increases (appreciates). The overall effect of RMB appreciation on China's trade surplus, however, depends on the relative magnitudes of elasticity of the different categories of trading commodities. The terms $RGDP_{it}$ and $RGDP_{jt}$ represent the real GDP of China and its trading partner for year t, respectively. The two variables capture the scale of the economy or demand size and are expected to have positive effects on trade. Moreover, POP_{it} denotes China's population size in order to capture the effects of its massive labor force and potential market opportunity. Finally, FDI_{it}, the variable for China's foreign direct investment amount, measures its production capacity (Ahmed, 2009; Garcia-Herrero and Koivu, 2008; Thorbecke, 2010; Xing, 2012).[12]

We further consider the effect of trade liberalization from China's entry into WTO by using a dummy variable equal to one for the years 2002–2009.[13] FTA is a dummy equaling one for years when a country has signed a free trade agreement with China. During the sample period, China signed an FTA with the Association of Southeast Asian Nations (ASEAN) in 2002 (went into effect in 2005) and with Chile and Pakistan in 2006. The global financial crisis in 2008 resulted in the collapse of global trade. We thus add a dummy variable, CRISIS, equaling one for the year 2009 to capture the

[12]Some studies use China's capital stock in manufacturing as the proxy for production capacity, e.g., Rahman and Thorbecke (2007), Thorbecke and Zhang (2009), Thorbecke and Smith (2010), and Thorbecke (2010). These papers often quote the capital stock estimates from Bai, Hsieh, and Qian (2006); however, the data are only available during 1978 to 2006.

[13]China joined the WTO on November 10, 2001 and became an official member on January 1, 2002.

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Table 2: Data Source and Variable Definition

Variable	Definition	Data source
$\ln EX_{ijt}$	China's real exports flow to country j in year t, deflated by Hong Kong export price index	Bureau of Foreign Trade, Ministry of Economic Affairs, Taiwan
$\ln IM_{ijt}$	China's real imports flow from country j in year t, deflated by Hong Kong import price index	Bureau of Foreign Trade, Ministry of Economic Affairs, Taiwan
$\ln RER_{ijt}$	Bilateral real exchange rate between China and its trading partner in year t, deflated by consumer price index (CPI). An increase in $\ln RER_{ij}$ represents RMB appreciation	World Bank
$\ln RGDP_{jt}$	Real GDP of China's trading partner in year t	World Bank/Directorate-General of Budget, Accounting and Statistics, Taiwan
$\ln RGDP_{it}$	Real GDP of China in year t	World Bank
$\ln POP_{it}$	Total population of China in year t	World Bank
$\ln FDI_{it}$	Foreign investment stock of China in year t	UNCTAD
WTO	WTO dummy, set to 1 from 2002 to 2009.	World Trade Organization
FTA	FTA dummy, set to 1 for ASEAN from 2005 to 2009; set to 1 for Chile and Pakistan from 2006 to 2009	World Trade Organization

exogenous macroeconomic shock on China's exports and imports. All variables above enter the equation in the form of logarithm except the dummy variables of WTO, FTA, and CRISIS. Finally, λ_j is a time-invariant individual country effect, and the error term u_{ijt} is assumed to be log normally-distributed.

Our main purpose is to differentiate the potential differences in the effects of the exchange rate on different categories of trading commodities. In particular, we shall estimate equations (4) and (5) for primary, intermediate, and final goods. Table 2 summarizes the sources and definitions for all

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Table 3: Panel Unit Root Test

	LLC	Probability	IPS	Probability
Total exports	17.880	1.00	1.513	1.00
Primary goods exports	3.409	0.99	29.375	1.00
Intermediate goods exports	1.765	0.96	0.136	0.55
Final goods exports	7.264	1.00	−0.975	1.00
Total imports	12.165	1.00	4.596	1.00
Primary goods imports	10.989	1.00	9.314	1.00
Intermediate goods imports	5.635	1.00	0.751	0.77
Final goods imports	3.973	1.00	−1.175	0.12
ln RER	0.774	0.78	−0.801	0.21
$\ln \mathrm{RGDP}_j$	7.851	1.00	16.401	1.00

Note: The null hypotheses assume individual unit root process.
*** and ** indicate significance at the 1% and 5% levels, respectively.

variables above.

4.2 Estimation strategy

The data in this paper are panel data. Three econometric problems emerge. First, we consider the presence of habitual behavior on trade, suggesting the need for dynamic panel techniques. Second, the time dimension of panel data might be non-stationary due to the existence of a unit root. Third, there is a potential endogeneity problem between explanatory variables and trade that the decision of the exchange rate level is widely recognized as an endogenous strategy for a country.

Concerning the second problem, we test the time series property of our data using the panel unit root test proposed by Levine, Lin, and Chu (2002) and Im, Pesaran, and Shin (2003). As shown in Table 3, the statistics for all variables are all smaller than the critical value at the 10% statistical significance level. This implies that the null hypothesis of an existing panel unit root cannot be rejected.

To control for the panel unit root problem and eliminate the possible endogeneity problem, this study employs the GMM method for the panel dynamic model developed by Arellano and Bover (1995) and Ahn and Schmidt (1995). The dynamic GMM approach provides asymptotically efficient es-

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timators even under a weak assumption on the disturbance. It is also robust in the presence of heteroscedasticity across countries and shows a correlation of disturbances within countries over time. Even though, we remain to treat the exchange rate as an endogenous variable when we conduct the dynamic GMM estimation,[14] as China is widely criticized for manipulating the exchange rate to enhance its export competitiveness by many countries in practice.

5 Empirical Results

5.1 The effect of RMB appreciation on China's total trade

Does RMB appreciation restrain China's trade surplus? We first look at the overall effects of exchange rate changes on exports and imports. Table 4 displays the estimating results using the dynamic panel GMM method (models (1) and (2) for total exports and total imports, respectively). The Sargan test shows that the joint null hypothesis, in which the dynamic panel data GMM model is correctly specified and the instruments are valid, cannot be rejected. The second-order serial correlation test suggests that there is no serial correlation as assumed. The two tests ensure the adequateness of our estimating strategy.

We first find that the effect of the real bilateral exchange rate between China and its trading partners on exports (imports) is significantly negative (positive), implying that RMB appreciation significantly decreases (increases) the volume of China's exports (imports) in general. In particular, we find that a 10% RMB appreciation results in a 2.7‰ decrease (3.8‰ increase) in China's exports (imports). Combining the two effects together, a 10% RMB appreciation on average has a 6.5‰ negative impact on trade balance, which is consistent with the findings in most previous studies.

Despite we find a significant exchange-rate elasticity of exports, the estimated magnitude is quite small relative to that estimated using firm-level data. For example, Tang and Zhang (2012) suggest an exchange-rate elasticity of exports hovering about 0.4%, using monthly data that cover the

[14]The estimating technique of dynamic GMM uses lag periods of all predetermined variables as instrumental variables. When the ln RER is treated as an endogenous variable, it will be excluded from instrumental variables. On the other hand, other lagged predetermined variables are used as instrumental variables for exchange rate.

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Table 4: RMB and China's Total Trade Over 1992–2009, GMM Estimation

	(1)		(2)	
Specifications	Total Exports	t-ratio	Total Imports	t-ratio
Total (−1)	0.749***	(106.84)	0.500***	(36.59)
ln RER	−0.027***	(−3.44)	0.038**	(2.04)
ln $RGDP_j$	0.054**	(1.93)	1.089***	(7.27)
ln $RGDP_i$			0.819***	(6.45)
ln POP			19.673***	(30.74)
ln FDI	0.157***	(6.02)	−1.444***	(−28.96)
WTO	0.393***	(65.03)	−0.077***	(−8.58)
FTA	0.082***	(4.76)	−0.416***	(−4.12)
CRISIS	−0.390***	(−71.66)	0.010	(0.78)
Sargan test (p-value)[1]	45.46 (1.00)		42.52 (1.00)	
Serial correlation 2 test (p-value)[2]	−0.33 (0.74)		−1.64 (0.10)	
Observations	708		708	

Note: *** and ** indicate significance at the 1% and 5% levels, respectively. 1. The Sargan test provides a test of the validity of the moment conditions. The null hypothesis is that the instruments are not correlated with the residuals. 2. The null hypothesis of serial correlation 2 test is that the error term in the first difference regression exhibits no second-order serial correlation.

universe of Chinese export transactions over the period 2000–2006. Obtaining a small exchange-rate elasticity of exports in this aggregate study is not surprising due to the exchange rate disconnect puzzle (Obstfeld and Rogoff, 2000). To clarify the export effect of exchange rate change in aggregate exports, it is better to decompose the change in exports into the production decisions of heterogeneous exporters selling multiple products. As the aggregate trade data do not contain detailed firm-transaction information, this limitation prevents this study from accounting for the export effect of exchange rate change caused by firm heterogeneity.

The effects of other variables conform to our expectations. The presence of habitual behavior is confirmed since the estimated coefficients of the lagged exports and imports are significantly positive. The foreign country's real GDP is positively related to China's exports, which is consistent with

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the fact that China's main exporting markets are concentrated on developed countries. It is worth noting that the coefficient of foreign income (0.054) dominates that of RER (−0.027), implying that even though the RMB appreciates, foreign demand for China's exports will still be solid if the global economy is still booming. This finding, to some extent, verifies the opposite trend between China's trade surplus and the movement of the RMB in the past few years.

China's real GDP and population have positive and significant impacts on imports (with coefficients 1.089 and 19.673, respectively), indicating that higher real GDP and population enhance its demand for importing goods. The effects of these two variables also dominate the trade effect of the RMB variation. Moreover, the estimated coefficient of ln $RGDP_j$ is significantly positive, suggesting that China imports more goods from countries with a larger market size. As for China's accumulated FDI and the dummy WTO, as expected they play an export-enhancing role (significant coefficients of 0.157 and 0.393, respectively), probably because more inward FDI would induce more assembly exports, and WTO entry enables China to be integrated into the world trade system. FDI and WTO membership negatively influence China's imports, however, after controlling for other variables. One possible explanation may be that China developed import-substitution industries in the post-WTO period.

The global financial crisis in 2008 (CRISIS) is expected to have a negative and significant impact on China's exports, while it seems to less relevant to imports. Signing FTAs is as expected to exhibits a significantly positive impact on exports, whereas it is negatively related to imports. The possible interpretations are multifold. First, the trade effect of FTA might vary across various trading goods. Second, a considerable trade promotion effect of FTA generally takes about five years (Baier and Bergstrand, 2007), but the FTAs signed between China and its trading partners have gone into effect only in the last couple of years. Finally, signing FTAs has sometimes been more politics-oriented rather than trying to achieve a positive trade effect for China (Tran, 2010).

5.2 The Effect of RMB Appreciation on China's Trade by Stages of Production

We now focus on the question of whether and how various trading commodities respond to exchange rate variation. Table 5 presents the estimates

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Table 5: RMB and China's Various Exports Over 1992–2009, GMM Estimation

	(1)		(2)		(3)	
Specifications	Primary Goods	*t*-ratio	Intermediate Goods	*t*-ratio	Final Goods	*t*-ratio
Primary Goods	0.299***	(21.46)				
Intermediate Goods			0.834***	(95.91)		
Final Goods					0.678***	(79.02)
ln RER	−0.262***	(−8.79)	−0.030***	(−3.66)	−0.049***	(−7.08)
RGDP	1.341***	(11.35)	0.073*	(1.89)	0.096***	(6.45)
ln FDI	−0.792***	(−6.90)	0.066*	(1.73)	0.158***	(8.06)
WTO	0.779***	(33.28)	0.412***	(61.04)	0.397***	(68.02)
FTA	−0.342***	(−8.96)	−0.036*	(−1.96)	0.380***	(16.63)
CRISIS	0.277***	(9.00)	−0.514***	(−46.69)	−0.214***	(−23.72)
Sargan test	43.29 (1.00)		44.95 (1.00)		45.53 (1.00)	
Serial correlation 2 test (p-value)	1.51 (0.13)		−1.22 (0.22)		−0.05 (0.95)	
Observations	755		755		755	

Note: *** and ** indicate significance at the 1% and 5% levels, respectively. 1. The Sargan test provides a test of the validity of the moment conditions. The null hypothesis is that the instruments are not correlated with the residuals. 2. The null hypothesis of serial correlation 2 test is that the error term in the first difference regression exhibits no second-order serial correlation.

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Table 6: Chow Test on Exchange Rate Elasticity Among Commodities

	F-Statistic (p-value)	
	Export	Import
Primary goods vs. Intermediate goods	403.90 (0.00)	224.90 (0.00)
Primary goods vs. Final goods	495.70 (0.00)	11.19 (0.00)
Intermediate goods vs. Final goods	40.12 (0.00)	35.59 (0.00)

Note: All F-tests are significant at the 1% statistical level.

of the dynamic GMM model for China's various exporting commodities (models (3), (4), and (5) for primary, intermediate, and final goods, respectively).

The real exchange rate variation, which is our main focus variable, still has negative and significant effects on the exports of various commodities, suggesting that RMB appreciation reduces China's exports in various commodities in general. The coefficients for primary, intermediate, and final goods exports are −0.262, −0.030, and −0.049, respectively, meaning that a 10% RMB appreciation cuts the exports of various commodities by 2.62%, 0.30%, and 0.49%, which are not large amounts.

Do the exchange rate elasticities vary significantly across commodity groups? The Chow tests are reported in Table 6.[15] As all the F-statistics for the Chow test are significant at the 1% level, it suggests that the exchange rate elasticity across commodity groups of exports exhibits a considerable difference. Obviously, primary goods exports are the most sensitive to changes in the real exchange rate, followed by final goods exports, while intermediate goods exports are the least sensitive. In terms of magnitude, the exchange rate elasticity of primary goods is 8.73 and 5.35 times larger than that of intermediate goods and final goods, respectively.

Two observations can be made here. First, as depicted in Figure 2, China's trade deficit in primary goods has become larger since the early 2000s and up until 2008, which encompasses the period before and after the RMB revaluation. Other factors must be driving this deficit up before

[15]To conduct the Chow test for testing whether coefficients in two samples are equal, we have to include interaction terms between commodity group dummies with all independent variables. As the estimating result for each test (six tests) contains too many variables, we report only the F-statistics in Table 6.

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the revaluation other than the exchange rate change; after the revaluation, since the elasticity is not large, it must be other factors that are also driving the even sharper increase.[16] One possible explanation, we think, for this rising trade deficit in primary goods is that China needs more primary goods as resources to sustain its economic growth. Second, China's final goods exports are not sensitive to the exchange rate appreciation, implying that RMB appreciation may not considerably harm final goods exports.

Why are China's exports of intermediate and final goods less sensitive to RMB fluctuations? One possible reason may be that China plays a pivotal role in international production fragmentation. China and other East Asian countries form a strong vertical specialization network, mainly focusing on final goods production in this global supply chain by importing intermediate goods, which is irreplaceable in the short run. Intermediate goods exported from China are generally middle quality and transported to ASEAN. Hence, although RMB appreciation increases China's exporting price, the low-priced intermediate goods are less affected; overall, China's role as the top supplier of final goods is still hard to sway.[17]

The influences of other variables remain similar to those in Table 4. The lagged one-year exporting commodity variable is associated with a significantly positive coefficient in all categories, indicating that China's various commodity exports exhibit a persistent property. The FDI variable has significant but mixed impacts on the exports of various commodities: the coefficient is −0.792 for primary goods, but 0.066 and 0.158 for intermediate and final goods, respectively. As more foreign affiliates are established in China by multinationals, they demand more primary goods domestically or from overseas, possibly leading to a decrease in China's primary goods exports. These affiliates, however, are expected to export final goods through assembly production. Some with even higher technological capability may produce and export intermediate goods for other low-labor-cost Southeast Asian developing countries for further assembly production.

We find that joining the WTO statistically improves China's exports for all kinds of commodities. However, the export promotion effect of signing

[16]The effect of real exchange rate change on primary goods imports is also not large, showing a significant coefficient of 0.084 as in Table 6.

[17]Athukorala and Yamashita (2009) conclude that the Sino-U.S. trade imbalance is basically a structural phenomenon resulting from the pivotal role played by China as the final assembly centre in East Asia-Centered global production networks.

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FTAs applies only to final goods exports. Finally, the great global recession in 2009 lowered China's exports of intermediate and final goods, but not primary goods.

How does RMB fluctuation affect China's imports of various commodities? Table 7 presents the estimating results of the dynamic GMM model for China's various importing commodities (models (6), (7), and (8) for primary, intermediate, and final goods, respectively).

Economic theory predicts that, other things being equal, currency appreciation by the home country will raise the purchasing power of its people and hence induce more imports. As shown in Table 7, this prediction holds for China's imports of primary and final goods with significant and positive estimated coefficients for the variable RER of 0.084 and 0.085 respectively, indicating a similar influence. Nevertheless, this prediction does not hold for its imports of intermediate goods with a significant and negative coefficient of −0.053, which implies that RMB appreciation will not induce, as expected, the imports of intermediate goods, but rather lower their imports. While the magnitude of exchange rate elasticity is similar between imports of primary goods and final goods, the Chow tests displayed in Table 6 indicate a significant difference in this elasticity across commodity groups. Thus, exchange rate change remains to be an influential factor on impacting imports of various commodities.

One possible explanation regarding the negative exchange rate elasticity for intermediate goods imports is as follows. We reasonably may argue that a strong RMB helps China's final assembly exporters by reducing their costs of purchasing intermediates from the main source - East Asian countries. Recall that, however, such a strong RMB will also reduce (elasticity equal to −0.049) these exporters' volume of final goods exports, which is the lion's share in China's trade balance, and thus indirectly cut their import demand of foreign intermediates.

As for the influences of other variables, they largely demonstrate similar effects on the imports of various commodities, as the persistent effect of trade still holds for such imports. Specifically, the coefficient attached to the lagged one-year primary goods imports is significantly larger than those attached to both intermediate goods and final goods. The result indicates China's persistent need for importing primary goods. In contrast, the low magnitude for the coefficient of lagged one-year final goods imports may be attributed to the increasing amount of final goods supplied by domestic firms in China. China's real GDP and population exhibit positive impacts

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Table 7: RMB and China's Various Imports Over 1992–2009, GMM Estimation

Specifications	(1) Primary Goods	*t*-ratio	(2) Intermediate Goods	*t*-ratio	(3) Final Goods	*t*-ratio
Primary Goods	0.392***	(70.46)				
Intermediate Goods			0.269***	(30.98)		
Final Goods					0.127***	(18.42)
ln RER	0.084***	(4.72)	−0.053***	(−4.66)	0.085***	(3.77)
$RGDP_i$	3.390***	(6.74)	1.396***	(7.86)	1.059***	(6.58)
$RGDP_j$	0.105	(0.22)	−0.038	(−0.15)	−0.219	(−1.08)
POP	9.569***	(5.36)	14.830***	(16.25)	20.360***	(9.62)
ln FDI	−1.328***	(−18.36)	−1.141***	(−11.70)	−1.293***	(−17.37)
WTO	0.085***	(3.80)	0.062***	(4.73)	−0.045***	(−3.46)
FTA	−0.259**	(−2.43)	−0.074	(−0.98)	0.422**	(2.50)
CRISIS	−0.185***	(−4.83)	0.150***	(6.59)	0.193***	(5.85)
Sargan test	44.41 (1.00)		41.51 (1.00)		44.47 (1.00)	
Serial correlation 2th test (p-value)	−1.20 (0.23)		0.64 (0.52)		−1.21 (0.22)	
Observations	708		708		708	

Note: *** and ** indicate significance at the 1% and 5% levels, respectively. 1. The Sargan test provides a test of the validity of the moment conditions. The null hypothesis is that the instruments are not correlated with the residuals. 2. The null hypothesis of serial correlation 2 test is that the error term in the first difference regression exhibits no second-order serial correlation.

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on all categories of imports, and both of their elasticities are larger than that of exchange rate elasticity. This suggests that China's domestic demand may be a critical stimulus for the imports of various goods. On the other hand, China's imports are not related to exporters' market size.

Accumulated FDI shows a negative impact on the imports of all goods, implying that multinationals that establish foreign affiliates in China may be helping to build stronger import-substitution industries.[18] The effect of the WTO dummy is mixed: it has positive effects on the imports of primary and intermediate goods, but negative for final goods. Signing FTAs do, as expected, increase China's imports of final goods, whereas signing them has a negative relationship with primary goods imports. Because China imports intermediate goods mainly from its East Asian neighbors rather than its FTA partner countries, it shows no significant impact of FTA on intermediate goods imports.

In summary, we find that China's exports and imports are not so sensitive to RMB fluctuations. RMB appreciation, according to our estimation results, seems unable to reduce China's trade surplus by much, because: (1) the sizes of the impacts of the exchange rate revaluation are not large for the trade of goods with "correct" signs (negative for exports of all goods, and positive for imports of primary and final goods); (2) the decrease in China's imports of intermediates due to RMB appreciation will even raise, instead of lower, the trade surplus. Moreover, China's trade surplus will rise, even though the RMB is appreciating, if there are other positive factors such as a booming global economy. We note that this does not imply that China can allow the RMB to appreciate freely at will, since most of China's final assembly exporters are labor-intensive, low-technology, and low domestic value-added (Koopman, Wang, and Wei, 2009; Thorbecke and Smith, 2010), and as such they are highly vulnerable to any small RMB appreciation. China's monetary authority may want to take into account these exporters' sustainability under RMB appreciation before implementing any change in exchange rate policy.

[18]In fact, the literature does not reach a conclusion about the effect of accumulated FDI on China's imports. For example, Garcia-Herrero and Koivu (2008) and Thorbecke (2010) obtain contradicting effects of FDI stock on China's processing imports or general imports.

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6 Concluding Remarks and Policy Implications

Many studies argue that China's enormous trade surplus is attributed to the weak exchange rate policy and thus creates an unfair competitive advantage. China's major trading partners, especially the U.S. and some European countries, have urged Chinese monetary authorities to launch exchange rate reform or shift to a more flexible exchange rate regime. In response to this pressure for an RMB revaluation, China's government began exchange rate reform in mid-2005, yet RMB appreciation does not seem to have any effect on curbing China's trade surplus. It casts an important debate of whether the revaluation of the RMB can indeed affect China's surplus. In particular, the question is: does RMB appreciation reduce China's exports and boost imports?

In this paper we categorize China's trading commodities into different categories according to their production stages (primary, intermediate, and final goods) and examine the impacts of RMB variation on the trade of various commodities. Different from previous studies that mostly focus on the small variation in the RMB before the exchange rate reform in 2006, we utilize disaggregated trade data between China and its 49 major trading partners over 1992–2009 for this investigation. The stylized facts show that the trade in final goods is the main source of China's trade surplus, while its trade deficit largely arises from the trade in primary goods, especially since 2005 and onward. The higher needs of primary imports come not only from China's final assembly exporting sectors, but also from its domestic sectors.

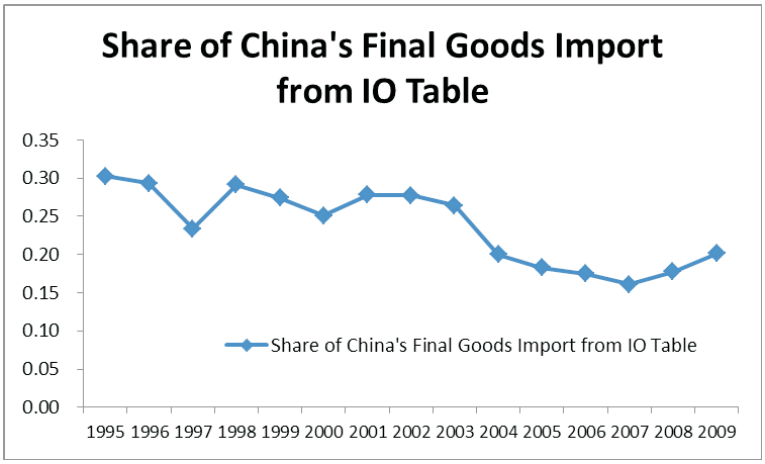
The empirical results draw some important findings and implications. First, China's exports are less sensitive to RMB revaluation than imports with small exchange rate elasticity estimates, except for primary goods. Second and counter-intuitively, RMB revaluation affects the imports of intermediates negatively, probably because intermediate imports are mostly the induced demand from final goods' exporting sectors. Third, together with the first finding, we explain why RMB appreciation has limited effects on curbing China's trade surplus. Fourth and lastly, according to our estimates, the effect of China's domestic demand on imports dominates that of the RMB revaluation effect, suggesting that China may also want to speed up its economic transformation from an export-led model to a domestic-oriented model, in order to soften the trade imbalance issue.

The main research constraint of this study is the classifications of commodities. The processing trade regime is important for China and it can be

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further divided into "processing with assembly (or pure assembly)" and "processing with imported inputs (import-and-process)", because firms engaged in processing with imported inputs are probably more impacted by exchange rate movements than other exporters. Therefore, using more detailed disaggregated data to examine the issue can help disentangle the exchange rate movement effect across various exporters and importers.

Appendix



Source: World Input-Output Database (WIDO).

Figure A1: Share of Imported Intermediate goods to Final Goods in China

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Table A1: Commodity classification of the BEC system

Production Stages	BEC Code	Title BEC
Primary goods	111	Food and beverages mainly for industry
	21	Industrial supplies, n.e.c., primary
	31	Fuels and lubricants, primary
Intermediate goods	121	Food and beverages, processed, mainly for industry
	22	Industrial supplies, n.e.c., processed
	321	Motor spirit
	322	Other processed fuels and lubricants
	42	Of capital goods, except transport equipment
	53	Of transport equipment
Final goods	41	Capital goods except transport equipment
	521	Other industrial transport equipment
	112	Food and beverages, primary, mainly for household consumption
	122	Food and beverages, primary, processed, for house consumption
	51	Passenger motor cars
	522	Other non-industrial transport equipment
	61	Durable consumer goods n.e.c.
	62	Semi-durable consumer goods n.e.c.
	63	Non-durable consumer goods n.e.c.

Note: United Nations Statistics Division and Lemoine and Ünal-Kesenci (2004).

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人民幣升值與中國的貿易: 是否人民幣對中國貿易餘額影響效果有限?

彭喜樞
國立政治大學財政系
劉名寰
工業技術研究院產業科技國際策略發展所
楊浩彥
國立台北商業大學財務金融系
楊志海
國立中央大學經濟系

本文探討人民幣匯率波動對中國的初級財貨, 中間財與最終財貿易的影響。利用中國在1992年至2009年間與49個主要貿易對手國的貿易資料進行研究, 實證結果發現不同財貨的貿易對於匯率變動的敏感度具顯著差異。整體而言, 中國出口的匯率敏感度較進口爲低。本文發現人民升值反而降低了中間財的進口, 可能導因於人民幣升值降低最終財的組裝產品出口, 間接使得所需進口的中間財減少。由於最終財出口爲中國貿易餘額的最大來源, 但其對於匯率變動的敏感度較低, 致使人民幣升值對於抑制中國貿易餘額攀升的效果相當有限。

關鍵詞: 匯率彈性, 貿易餘額, 動態一般化動差模型
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