China-U.S. Trade: A global outlier

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RIETI
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Abstract

China’s computer exports to the United States increased 38 times between 1996 and 2013, growing from 4% to 66% of U.S. computer imports. China’s exports of phones to the United States increased 32 times over this period, growing from 11% to 57% of U.S. phone imports. China’s total exports to the United States also increased rapidly and are four or five times larger than U.S. exports to China. Cointegration evidence indicates that exchange rate depreciations in both China and in supply chain countries significantly increase China’s exports. Evidence from gravity models indicates that China’s exports to the United States have been twice as large as predicted every year since 2004. Thus, China’s exports to the United States are a global outlier.

Keywords: Chinese exports, Exchange rate elasticities, Gravity model
JEL classification: F10, F40

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1This study is conducted as a part of the Project “East Asian Production Networks, Trade, Exchange Rates, and Global Imbalances” undertaken at Research Institute of Economy, Trade and Industry (RIETI).

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1. Introduction

The People’s Bank of China (PBOC) reported that China’s foreign exchange reserves increased by $508 billion in 2013. This was the largest one year increase in China’s reserves ever and brought the total to almost $4 trillion. The Peterson Institute estimates that $14 billion of this $508 billion increase was due to changes in the value of non-US dollar reserves and that $494 billion represented reserve accumulation to prevent the renminbi from appreciating (Troutman, 2014). Until 2005 the PBOC fixed the renminbi to the dollar but now manages it relative to a basket of currencies. However, over the 2010-2013 period the dollar’s weight in this basket remained over 80 percent (Cui, 2014). Thus, China continues to intervene to prevent the renminbi from appreciating against the dollar. How does this intervention affect China’s exports to the US?

51 percent of China’s exports to the US in 2013 were in the Standard Industrial Trade Classification (SITC) category 7. These were primarily cell phones, computers, and white goods. Another 32 percent were in SITC category 8. These were labor-intensive goods such as clothing, furniture, footwear, toys, and sporting goods. 11 percent were in SITC category 6. These were largely metals, metal products, textiles, and rubber. Over the last 20 years between 79 and 87 percent of China’s exports to the US have been in SITC categories 7 and 8 and between 92 and 96 percent have been in SITC categories 6, 7, and 8.1

This paper investigates whether the renminbi and exchange rates in countries supplying parts and components to China affect China’s exports to the US in these three categories. The results indicate that exports in the largest category, SITC 7, are especially sensitive to exchange rates. Using Johansen maximum likelihood techniques and quarterly data over the 1993-2013 period, the results indicate that a 10 percent appreciation of the renminbi against the dollar would

1 These data are from the International Trade Commission website (www.usitc.gov).
reduce SIC category 7 exports by between 16 and 23 percent and a 10 percent appreciation of currences in supply chain countries against the dollar would reduce SIC 7 exports by 10 percent. A 10 percent renminbi appreciation would also reduce category 8 exports by between 7 and 8 percent and a 10 percent appreciation in supply chain countries would reduce SIC 8 exports by 6 percent. Thus China’s and East Asia’s continued interventions to keep their currencies from appreciating against the dollar cause first order increases in China’s exports to the US.

The increase in China’s exports has been breathtaking. For computers (SITC category 752), the value of China’s exports to the US increased 38 times between 1996 and 2013 and the share of China’s exports to the US increased from 4 percent of total US imports to 66 percent. For phones (SITC category 764), the value of China’s exports to the US increased 32 times between 1996 and 2013 and the share of China’s exports to the US increased from 11 percent to 57 percent.2

Figure 1 shows that China’s exports of all goods to the US has also soared and far outstripped US exports to China. As a result, as Figure 2 shows, the US trade deficit with China has grown and in 2013 was almost equal to the US trade deficit with all other countries combined.3 Figure 2 also shows that there has been a major rebalancing of US trade with all other countries but growing imbalances with China. Figure 3 shows that US exports to China equaled $120 billion while US exports to the rest of the world equaled $1.5 trillion. Thus, US trade with China generated the same-sized deficit as US trade with all other countries, even though the value of US exports to China was only one-twelfth of the value of US exports to the rest of the world.

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2 These data come from the US Census Bureau website (www.census.gov).
3 46% of the US deficit in 2013 was with China and 54% was with all other trading partners.
Figures 1-3 suggest that there is something unusual about China’s exports to the US. This paper investigates whether they are an outlier. Using a gravity model and exports between 31 leading exporting nations over the last 25 years, the results indicate that China’s exports to the US have been more than $100 billion greater than predicted in every year since 2005.4

The results reported here indicate that, not only are China’s exports to the US more than predicted, China’s exports to South Korea, Taiwan and other East Asian neighbors are much less than predicted. South Korea and Taiwan’s exports to the US in 2013 exceeded their imports from the US by 50 percent. In addition, these economies are the leading providers of the parts and components that go into China’s computers, cell phones, and other electronics exports. Thus in a value-added sense South Korea and Taiwan’s surpluses with the US are even larger. East Asian countries continue to put heavy weight on the US dollar in their exchange rate baskets. If countries in the region shifted to more flexible exchange rate regimes that gave greater weight to currencies other than the US dollar, the large surpluses that China, South Korea, Taiwan, and other economies in the region are running against the US could cause their currencies to appreciate together against the dollar.

The results presented here indicate that such an appreciation would help to rebalance trade between East Asia and the US. It would also increase the purchasing power of Asian consumers and redirect final goods to Asian consumers. In addition a concerted appreciation in the region would maintain intraregional exchange rate stability. Tang (2014) reported that exchange rate stability in Asia facilitates the flow of parts and components within regional production networks. Finally a joint appreciation would have an attenuated impact on East

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4 Thorbecke and Komoto (2010) reported that China’s exports to the US were an outlier in 2007 using one specification of a gravity model. This paper examines whether China’s exports to the US, Europe, and East Asian countries are outliers for every year between 2004 and 2012 using six different specifications of the gravity model.
Asian countries’ effective exchange rates since their exchange rates would not appreciate relative to the neighboring countries that they trade so much with.

The next section examines exchange rate elasticities for China’s exports to the US. Section 3 investigates whether China’s exports to the US are an outlier. Section 4 concludes.

2. Estimating export elasticities for China

2.1 Data and methodology

The imperfect substitutes model is a workhorse for estimating trade elasticities. In this framework, exports are modeled as a function of the real exchange rate and real income:

\[ ex_t = \alpha_{10} + \alpha_{11} rer_t + \alpha_{12} rgdp_t + \varepsilon_t \]  

where \( ex_t \) represents the log of real exports, \( rer_t \) represents the log of the real exchange rate, and \( rgdp \) represents the log of foreign real income.

The U.S. Census Bureau provides data on China’s exports to the US. As discussed above, 51 percent of China’s exports to the US in 2013 were in SITC category 7. These were primarily cell phones, computers, and white goods. Another 32 percent were in SITC category 8. These were labor-intensive goods such as clothing, furniture, footwear, toys, and sporting goods. 11 percent were in SITC category 6. These were largely metals, metal products, textiles, and rubber. Over the last 20 years between 79 and 87 percent of China’s exports to the US have been in SITC categories 7 and 8 and between 92 and 96 percent have been in SITC categories 6, 7, and 8.

The Bureau of Labor Statistics (BLS) provides a price deflator for China’s exports to the US beginning in 2003. Before this the BLS provides a deflator for manufacturing exports to the
US coming from non-industrial countries. These two series are spliced together to obtain a deflator for China’s exports to the US. The real exchange rate employed here is constructed using the consumer price index (CPI). Data on the consumer price index in the US and China are obtained from the OECD. Data on the nominal renminbi/dollar exchange rate and US real GDP are obtained from the Federal Reserve Bank of St. Louis FRED database.

Data on the Chinese CPI are available from the OECD beginning in 1993Q1, so the sample period extends from 1993q1 to 2013Q3. In 1994 China unified its dual exchange rate system. For the exchange rate variable used here, this shows up as a 30 percent spike in the real exchange rate in 1994Q1. By 1996Q1, \( rer \), had returned to its pre-spike value. To ensure that these unusual changes are not driving the results, in one specification elasticities are estimated over the 1996Q1-2013Q3 period.

Figure 1 shows that China’s exports increased ten times between 1996 and 2013. There has been an enormous increase in China’s productive capacity during this time. To control for this China’s capital stock is included as an independent variable.

Data on the Chinese capital stock up until 2011 are obtained from Berlemann and Wesselhöft (2012). The capital stock is assumed to grow 11 percent in 2012 and 2013. Linear interpolation is used to obtain quarterly data.

Some of China exports in each of the SITC categories are “processed exports.” These are final goods produced using parts and components that are imported duty free. The price competitiveness of processed exports should be influenced by exchange rates in the countries

5 The websites for these data are: [www.bls.gov](http://www.bls.gov) and [www.census.gov](http://www.census.gov).
6 Chinn (2006) also combined these two series to deflate China’s exports to the US.
7 The websites for these data are [www.oecd.org](http://www.oecd.org) and research.stlouisfed.org/fred2/.
8 The website for these data is [http://www.hsu-hh.de/berlemann/index_VQxd0Uqt6VmSoYt6.html](http://www.hsu-hh.de/berlemann/index_VQxd0Uqt6VmSoYt6.html).
providing intermediate inputs. To control for exchange rates in these countries, in some
specifications a weighted exchange rate in supply chain countries (SSRER) is included. SSRER
is constructed using the following formula:

\[ SSRER_t = SSRER_{t-1} \prod_{i=1}^{9} \left( \frac{r_{i,t}}{r_{i,t-1}} \right)^{w_{i,t}}, \]  

(2)

where the number 9 above the product operator represents the nine leading supply chain
economies, \( r_{i,t} \) is the CPI-deflated real exchange rate in supply chain country \( i \) relative to the US
dollar, and \( w_{i,t} \) is the value of parts and components (imports for processing) coming into China
from supply chain economy \( i \) divided by the value of parts and components coming from all 9
suppliers together. The sum of the \( w_{i,t} \) thus equals one. The nine leading supply chain
economies, arranged according to the value of parts and components that they provided in 2013,
are South Korea, Taiwan, Japan, the United States, Malaysia, Thailand, Singapore, Germany,
and the Philippines. Data on the share of parts and components coming from each of the nine
supplier economies are obtained from the China Customs Statistics.\(^9\) Data on nominal exchange
rates relative to the US dollar and on consumer prices indices are obtained from the Federal
Reserve Bank of St. Louis FRED database, the OECD, and the websites of the supplier countries’
central banks. SSRER is set equal to 100 in 1993Q1.

According to augmented Dickey-Fuller tests, most of the variables appear to be
integrated of order one. The results in Table 1 indicate that the trace and maximum eigenvalue
statistics permit rejection of the null of no cointegrating relations against the alternative of one
cointegrating relation in almost every case. Johansen maximum likelihood estimation, a
technique for estimating cointegrating relations, is thus employed.

\(^9\) The website is [http://www.customs-info.com/](http://www.customs-info.com/)
To specify the Johansen model, the imperfect substitutes framework with the addition of the Chinese capital stock can be written in vector error correction form as:

$$
\Delta ex_t = \beta_{10} + \varphi_{ex}(ex_{t-1} - \alpha_{10} - \alpha_{11}rer_{t-1} - \alpha_{12}rgdp_{t-1} - \alpha_{13}KStock_{t-1}) + \beta_{11}(L)\Delta ex_{t-1} + \beta_{12}(L)\Delta rer_{t-1} + \beta_{13}(L)\Delta rgdp_{t-1} + \beta_{14}(L)\Delta KStock_{t-1} + \nu_{1t} \quad (3a)
$$

$$
\Delta rer_t = \beta_{20} + \varphi_{rer}(rer_{t-1} - \alpha_{10} - \alpha_{11}rer_{t-1} - \alpha_{12}rgdp_{t-1} - \alpha_{13}KStock_{t-1}) + \beta_{21}(L)\Delta ex_{t-1} + \beta_{22}(L)\Delta rer_{t-1} + \beta_{23}(L)\Delta rgdp_{t-1} + \beta_{24}(L)\Delta KStock_{t-1} + \nu_{2t} \quad (3b)
$$

$$
\Delta rgdp_{t*} = \beta_{30} + \varphi_{gdp*}(rgdp_{t-1} - \alpha_{10} - \alpha_{11}rer_{t-1} - \alpha_{12}rgdp_{t-1} - \alpha_{13}KStock_{t-1}) + \beta_{31}(L)\Delta ex_{t-1} + \beta_{32}(L)\Delta rer_{t-1} + \beta_{33}(L)\Delta rgdp_{t-1} + \beta_{34}(L)\Delta KStock_{t-1} + \nu_{3t} \quad (3c)
$$

$$
\Delta KStock_{t*} = \beta_{40} + \varphi_{KStock}(KStock_{t-1} - \alpha_{10} - \alpha_{11}rer_{t-1} - \alpha_{12}rgdp_{t-1} - \alpha_{13}KStock_{t-1}) + \beta_{41}(L)\Delta ex_{t-1} + \beta_{42}(L)\Delta rer_{t-1} + \beta_{43}(L)\Delta rgdp_{t-1} + \beta_{44}(L)\Delta KStock_{t-1} + \nu_{4t} \quad (3d)
$$

where the \( \varphi \)'s are the error correction coefficients, the \( L \)'s represent polynomials in the lag operator, \( KStock \) represents the Chinese capital stock, and the other variables are defined after equation (1). In some specifications the weighted exchange rate in supply chain countries (SSRER) is also included. The \( \varphi \) coefficients measures how quickly the left hand side variables respond to disequilibria. If these move towards their equilibrium values, then the corresponding \( \varphi \) on the right hand side will be negative and statistically significant.

### 2.2 Results

Table 1 presents the Johansen maximum likelihood estimates from equations (3a)-(3d).

The first row presents results for all goods, the second for SITC category 7 exports, the third for SITC category 8 exports, and the fourth for SITC category 6 exports. In all cases the coefficients on the real exchange rate and US GDP are of the expected signs and statistically significant.

For all goods, the results indicate that a 1 percent appreciation of the RMB would decrease China’s exports by 1.36 percent and a 1 percent increase in US GDP would increase
exports by 2.42 percent. For SITC category 7, a 1 percent appreciation would decrease exports by 1.62 percent and a 1 percent increase in US GDP would increase exports by 3.82 percent. For SITC category 8, a 1 percent appreciation would decrease exports by 0.79 percent and a 1 percent increase in US GDP would increase exports by 3.2 percent. For SITC category 6, a 1 percent appreciation would decrease exports by 1.33 percent and a 1 percent increase in US GDP would increase exports by 4.9 percent.

The Chinese capital stock is associated with an increase in exports for SITC category 7 but not for categories 6 or 8. China’s SITC 7 exports are primarily capital intensive goods such as cell phones and computers; while the other categories contain many labor intensive goods such as clothing, furniture, footwear, toys, textiles, and sporting goods.

The error correction coefficient $\phi_{ex}$ for exports is negative and statistically significant in every case, implying that exports move towards their equilibrium values. The results in the first row indicate that the gap between the actual and the long run values closes at a rate of 21 percent per quarter; the results in the second row indicate that the gap closes at a rate of 16 percent per quarter; the results in the third row indicate that the gap closes at a rate of 29 percent per quarter; the results in the fourth row indicate that the gap closes at a rate of 22 percent per quarter.

The error correction coefficient $\phi_{rer}$ for the renminbi/dollar real exchange rate is positive and statistically significant in every case, indicating that the renminbi/dollar rate moves away from its equilibrium value. In other words, an unexpected surge in China’s exports to the US tends to be followed by a depreciation of the renminbi against the dollar. The effect is quantitatively large, with the gap between actual and long run values expanding at a rate of 20 percent per quarter. This may reflect China’s continued interventions in the foreign exchange market.
The results for the seasonal dummies, not reported, indicate that *ceteris paribus* aggregate exports are 16 percent less in the first quarter of the year compared with the previous quarter. Exports are lower in the first quarter because the Chinese New Year holidays occur at this time.

The model was re-estimated over the 1996Q1-2013Q3 period to see whether the unusual exchange rate changes over the 1994-96 period affected the findings. The results, available on request, indicate that exchange rate elasticities in all categories are larger over the later sample period. Thus the pre-1996 exchange rate spike is not driving the results.

Table 2 presents the findings controlling for exchange rates in supply chain countries. For SITC category 8 goods, both cointegration tests point to one cointegrating relation. For SITC category 7 goods, the trace test indicates one cointegrating relation. The maximum eigenvalue statistic permits rejection of the null of no cointegrating relations against the alternative of one cointegrating relation at the 0.065 significance level. For total exports the trace test indicates one cointegrating relation and the maximum eigenvalue test indicates no cointegrating relations. For category 6 goods, both tests point to zero cointegrating relations.

The elasticities for the RMB/Dollar rate are larger in Table 2 than in Table 1 for all goods and for category 7 goods. The elasticity is almost the same for category 8 goods. Thus, controlling for exchange rates in supply chain countries, the evidence continues to indicate that the renminbi exerts important effects on China’s exports. In addition, the elasticities for exchange rates in supply chain countries are positive and statistically significant for category 7 and category 8 goods, indicating that an appreciation in supply chain countries relative to the US dollar would reduce China’s exports. The results indicate that a 10 percent appreciation in supply chain countries would reduce category 7 exports by 10 percent and category 8 exports by 6 percent.
Overall the results in Table 2 are most compelling for category 8 goods. Not only do the trace and maximum eigenvalue tests both indicate one cointegrating relation for this category, the error correction coefficient $\phi_{ex}$ implies a very tight relationship between exports and the independent variables. The gap between actual exports and their long run equilibrium values closes at a rate of 36 percent per quarter. Thus if a shock causes exports to deviate from equilibrium values, *ceteris paribus* 85 percent of the gap will close after 4 quarters.

The results including exchange rates in supply chain countries may be the strongest for labor-intensive (category 8) exports because, as Feenstra and Wei (2010) report, textiles were the largest category of processed exports at the beginning of the sample period. In addition, more than half of processed exports at that time were labor-intensive goods such as textiles, footwear, headwear, and miscellaneous manufacturing. Since these goods were produced with imported inputs coming from supply chain countries, exchange rates throughout the supply chain influenced their competitiveness.

The error correction coefficients in Table 2 for the renminbi/dollar real exchange rate ($\phi_{rer}$) and for exchange rates in supply chain countries ($\phi_{ssrer}$) are positive and statistically significant for total exports, SITC 7 exports, and SITC 8 exports. This indicates that both the renminbi and exchange rates in supply chain countries tend to move away from their equilibrium values. This may reflect interventions in the foreign exchange market by China and other East Asian countries.

The important implication of the results presented in this section is that the renminbi/dollar exchange rate exerts first order effects on Chinese exports. The elasticities are especially large for China’s SITC category 7 exports. This category is composed primarily of computers, cell phones, and other sophisticated goods.
3. Using a gravity model to explain China’s exports

3.1 Data and methodology

As the imperfect substitutes model is a workhorse for estimating trade elasticities, the gravity model is a workhorse for estimating bilateral trade flows. Traditional gravity models, as developed by Tinbergen (1962), posit that bilateral trade between two countries is directly proportional to GDP in the two countries and inversely proportional to the distance between them. In addition to GDP and distance these models typically include other factors affecting bilateral trade costs such as whether trading partners share a common language. As Leamer and Levinsohn (1995) and Baltagi, Egger, and Pfaffermayr (2014) discussed, gravity models yield some of the clearest and most robust findings not only in international economics but in all of economics. This model is thus used to predict China’s exports.

Traditional gravity models take the form:

$$\ln \text{Ex}_{ijt} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln \text{DIST}_{ij} + \beta_4 \text{LANG} + \hat{\alpha}_i + \Omega_j + \pi_t + \varepsilon_{ijt} \quad (4)$$

where $\text{Ex}_{ijt}$ represents real exports from country $i$ to country $j$, $t$ represents time, $Y$ represents GDP, DIST represents the geodesic distance between two countries, LANG is a dummy variables equaling 1 if the countries share a common language and 0 otherwise, and $\hat{\alpha}_i$, $\Omega_j$, and $\pi_t$ are country $i$, country $j$, and time fixed effects.

Anderson and Van Wincoop (2003) have derived theoretical foundations for the gravity model. They showed that exports should depend on outward and inward multilateral resistance terms. These terms capture the fact that exports and imports between two countries depend, not only on trade costs between the two countries, but also on changing trade costs between third
countries. For instance, exports from country $i$ to country $j$ can be affected if country $i$ enters a preferential trade agreement with a third country $k$.

Theoretically based gravity models can be estimated by the equation:

$$\ln Ex_{ijt} = \beta_0 + \beta_3 \ln \text{DIST}_{ij} + \beta_4 \text{LANG} + \partial_i + \Omega_j + \epsilon_{ijt} \quad (5)$$

where the variables are as defined above. Here the distance and language variables capture trade costs for exports between countries $i$ and $j$ and the exporter and importer fixed effects variables capture the multilateral resistance terms. Time-varying fixed effects can also be included.

Equations (4) and (5) are log-linear models and are often estimated using panel least squares methods. Santos Silva and Tenreyro (2006) have shown that this approach can lead to biased estimates when there is heteroskedasticity in the data-generating process. They reported simulation results indicating that Poisson pseudo-maximum-likelihood (PPML) estimators perform better both in terms of bias and efficiency in several cases.

Since the goal in this paper is to try to predict China’s exports, a variety of specifications are employed. These include the models in equation (4) and (5) and models estimated using both panel least squares and PPML techniques. The results are similar across all of these specifications.

Anderson, Vesselovsky, and Yotov (2013) have shown that exchange rates can exert real effects in the context of structural gravity models when there is incomplete pass-through or scale effects. The exchange rate is thus included as another explanatory variable.
Data on exports, GDP, and real exchange rates are obtained from the CEPII-CHELEM data base. Exports are measured in current dollars. The real exchange rate is the CPI-deflated bilateral real exchange rate between the exporting and importing countries measured in levels.

Data on distance and common language are obtained from www.cepii.fr. Distance is measured in kilometers and represents the geodesic distance between economic centers. Common language is a dummy variable equaling 1 if two countries share a common language and 0 otherwise.

The gravity model is estimated as a panel using annual data for 31 countries over the 1988-2012 sample period. The countries are Australia, Austria, Brazil, Canada, China, Denmark, Finland, France, Germany, India, Indonesia, Ireland, Italy, Japan, Malaysia, Mexico, the Netherlands, Norway, the Philippines, Poland, Saudi Arabia, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, the United Kingdom, and the United States.

3.2 Results

Table 3 presents gravity estimates across all six specifications. The coefficients on distance, common language, importer GDP, and exporter GDP are of the expected signs and statistically significant. The results in every specification indicate that distance is an important deterrent of trade and that sharing a common language is an important facilitator of trade. The results in columns (5) and (6) indicate that GDP in exporting and importing countries are also strongly related with trade. The coefficient on the real exchange rate is positive in three cases and negative in three cases.

10 Traditional models have been estimated using real exports while structural models are estimated using nominal exports. The results in this paper were very similar using either measure. When GDP is included in the estimation here, real GDP is employed following previous researchers (e.g., Bénassy-Quéré and Lahrèche-Révil, 2003).
Figure 4 plots the average of predicted and actual exports in 2012 across the six specifications in Table 3. Analogous figures for each of the six specifications individually are available on request. In Figure 4 values above the diagonal line indicate that exports are more than predicted and values below the line indicate that exports are less than predicted. The vertical distance between the observation and the diagonal line measures the degree of over- or under-prediction. The figure indicates that China’s predicted exports to the US in 2012 were $209 billion while China’s actual exports were $395 billion. Thus China’s exports to the US were almost twice as large as predicted, with the difference between the actual and predicted values equaling $186 billion. In all six specifications China’s exports to the US were at least $120 billion more than predicted in 2012. Thus there is robust evidence across all of the specifications that China’s exports to the US are an outlier.

Figure 4 also shows that China’s exports to Germany were $21 billion or 33 percent more than predicted. In some of the six specifications, though, China’s exports to Germany in 2012 were less than or equal to their predicted values.

Figure 4 also indicates that China’s exports to South Korea, Taiwan, Japan, and Singapore in 2012 were much less than predicted. For South Korea, the shortfall was $107 billion; for Taiwan, $83 billion; for Japan, $81 billion, and for Singapore $22 billion. In percentage terms, South Korea’s exports were 42 percent of the predicted value; Taiwan’s were 32 percent of the predicted value; Japan’s were 69 percent of the predicted value; and Singapore’s were 52 percent of the predicted value. In all six specifications China’s exports to South Korea and Taiwan in 2012 were large negative outliers in both percentage terms and in value terms across all six specifications.
Figure 5 plots the difference between actual and predicted exports from China to the US, Europe, Japan, South Korea, and Taiwan over the 2004 to 2012 period. The figure again plots the average across all six specifications. The results for each of the individual specifications are available on request. Figure 5 indicates that China’s exports to the US were $160 billion more than predicted just before the global crisis in 2007. With the crisis, they fell to $138 billion more than predicted in 2009 and then rose steadily to $186 more than predicted in 2012. The same pattern, with China’s exports far more than predicted before the crisis and then falling slightly before expanding again, is seen in each of the six individual specifications.

China’s exports to Europe in Figure 5 were $75 billion more than predicted in 2010. However, with the European crisis this fell to $37 billion more than predicted in 2012. Across all six specifications there is no robust evidence that China’s exports to Europe are an outlier.

Figure 5 also indicates that the shortfall in China’s exports to Japan, South Korea, and Taiwan has been larger than $50 billion in every year since 2007. In each of the individual specifications China’s exports to South Korea and Taiwan are perennially less than one would expect based on the gravity model.

The important implication of these results is that China’s exports to the US year after year are far more than one would predict based on the workhorse gravity model. China’s exports to South Korea and Taiwan, on the other hand, are consistently much less than one would predict.

4. Conclusion

11 Europe includes Austria, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.
In 2013 China exported $79 billion worth of cellphones and other telecommunication equipment to the US, $74 billion worth of computers and office equipment, and $41 billion worth of household appliances. While the level of China’s exports of these SITC category 7 goods is impressive, the rate of increase has been awesome. China’s exports of phones to the US (SITC category 752) increased 32 times in value between 1996 and 2013 and its share of total US imports in this category increased from 11 percent to 57 percent. China’s exports of computers to the US (SITC category 764) increased 38 times between 1996 and 2013 and its share of total US imports in this category increased from 4 percent to 66 percent.

This paper investigates whether exchange rates affect China’s exports of these capital-intensive SITC category 7 goods and also exports of labor-intensive SITC category 8 goods (primarily clothing, furniture, footwear, toys, and sporting goods) and SITC category 6 goods (largely metals, metal products, textiles, and rubber).

Results from Johansen maximum likelihood estimation indicate that both the renminbi and exchange rates in countries supplying parts and components to China affect China’s exports to the US. For SITC category 7 goods a 10 percent appreciation of the renminbi would reduce exports by between 16 and 23 percent and a 10 percent appreciation of currencies in supply chain economies would reduce exports by 10 percent. For SITC category 8 goods a 10 percent appreciation of the renminbi would reduce exports by between 7 and 8 percent and a 10 percent appreciation of currencies in supply chain economies would reduce exports by 6 percent. Thus the $4 trillion in reserves that China accumulated between 2000 and 2013 to prevent the renminbi from appreciating against the dollar and reserve accumulation in other East Asian economies has contributed to a first order increase in China’s exports of computers, cell phones, and other goods to the US.
China’s exports to the US in 2013 were four and a half times larger than US exports to China. The US trade deficit with China in 2013 was almost equal to the US trade deficit with all other countries combined. However, US exports to China equaled only $120 billion while US exports to the rest of the world equaled $1.5 trillion. These facts suggest that China’s exports to the US are disproportionate.

This paper investigates whether they are an outlier. Using a gravity model and exports between 31 leading exporting nations over the last 25 years, the results indicate that China’s exports to the US have been more than $100 billion greater than predicted year after year.

Not only are China’s exports to the US more than expected, its exports to South Korea, Taiwan, and other East Asian economies are much less than expected. South Korea and Taiwan are the leading suppliers of parts and components that China uses to produce goods for re-export. In a value-added sense, China’s surplus with the US is thus also a surplus between these East Asian newly industrialized economies (NIEs) and the US. The NIE’s direct exports to the US in 2013 also exceeded their imports from the US by 50 percent. Other East and Southeast Asian economies also run trade surpluses with the US, both directly and indirectly because of the imports for processing they ship to China to produce goods for re-export to the US.

In the face of these large surpluses with the US, East Asian economies attach large weight to the US dollar in their multiple currency baskets and intervene actively to prevent their currencies from appreciating against the dollar. If they were to attach more weight to other currencies and employ a wider band around the reference rate, the outsized surpluses that Asian countries run against the US could cause their currencies to appreciate against the dollar. The results in this paper indicate that this would help to rebalance trade between East Asia and the
US. A joint appreciation would also have an attenuated effect on Asian countries’ real effective exchange rates since exchange rates among regional trading partners would remain stable.

Such an appreciation would increase the purchasing power of East Asian consumers. This would be helpful, since less than 10 percent of China’s, South Korea’s and Taiwan’s imports in 2012 were consumption goods. This compares with 16 percent for Japan, 20 percent for the Euroland, and 22 percent for the US.¹²

China’s exports to the US have been inordinate. They have been financed by trillions of dollars of reserve accumulation. South Korea and Taiwan are also running surpluses with the US that are financed partly by reserve accumulation. This arrangement is not good for East Asia or for the US. The Chinese government has wisely decided to allow market forces to play a decisive role in resource allocation. Other Asian governments should follow suit. As they allow market forces to play a greater role in exchange rate determination, the enormous surpluses that they run with the US year after year will cause their currencies to appreciate together against the dollar and redirect final goods to Asian consumers.

¹² These data come from the CEPII-CHELEM database.
Figure 1. The Value of US Exports to China and Chinese Exports to the US. 
Source: US Census Bureau.
Figure 2. US Trade Deficit with China and All Other Countries.  
Figure 3. The Value of US Exports to China and to All Other Countries.  
Figure 4. China’s Actual and Predicted Exports to 30 Countries in 2012.  
*Note:* Predicted exports are determined based on gravity models for trade between 31 leading exporters over the 1988-2012 period.  
*Source:* CEPII-CHELEM Database and calculations by the author.
Figure 5. The Difference between China’s Actual and Predicted Exports to the US, Europe, Japan, South Korea, and Taiwan.

Note: Predicted exports are determined based on gravity models for trade between 31 leading exporters over the 1988-2012 period. Europe includes Austria, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. Source: CEPII-CHELEM Database and calculations by the author.
Table 1 Johansen MLE estimates for Chinese exports to the United States$^1$.

<table>
<thead>
<tr>
<th>Number of Cointegrating Vectors</th>
<th>Number of Observations</th>
<th>RMB-Dollar Real Exchange Rate</th>
<th>Income</th>
<th>Chinese Capital Stock</th>
<th>Error Correction Coefficients:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exports</td>
</tr>
<tr>
<td><strong>All Goods</strong></td>
<td>1,1</td>
<td>81</td>
<td>1.36*** (0.26)</td>
<td>2.42*** (0.60)</td>
<td>0.75*** (0.16)</td>
</tr>
<tr>
<td>(Lags: 1; Sample: 1993:III-2013:III; Trend in data; Seasonal dummies for the first, second, and third quarters included)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SITC 7</strong></td>
<td>1,1</td>
<td>81</td>
<td>1.62*** (0.30)</td>
<td>3.82*** (0.68)</td>
<td>0.87*** (0.19)</td>
</tr>
<tr>
<td>(Lags: 1; Sample: 1993:III-2013:III; Trend in data; Seasonal dummies for the first, second, and third quarters included)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SITC 8</strong></td>
<td>1,1</td>
<td>81</td>
<td>0.79*** (0.20)</td>
<td>3.20*** (0.45)</td>
<td>0.17</td>
</tr>
<tr>
<td>(Lags: 1; Sample: 1993:III-2013:III; Trend in data; Seasonal dummies for the first, second, and third quarters included)</td>
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<td></td>
</tr>
<tr>
<td><strong>SITC 6</strong></td>
<td>1,0</td>
<td>81</td>
<td>1.33*** (0.34)</td>
<td>4.90*** (0.78)</td>
<td>0.28</td>
</tr>
<tr>
<td>(Lags: 1; Sample: 1993:III-2013:III; Trend in data; Seasonal dummies for the first, second, and third quarters included)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

$^1$Number of Cointegrating Vectors indicates the number of cointegrating relations according to the trace and maximum eigenvalue test using 5% asymptotic critical values.

*** (**) denotes significance at the 1% (5%) level.
Table 2 Johansen MLE estimates for Chinese exports to the United States

<table>
<thead>
<tr>
<th>Number of Cointegrating Vectors</th>
<th>Number of Observations</th>
<th>RMB-Dollar Real Exchange Rate</th>
<th>Weighted Real Exchange Rate in Supply Chain Countries</th>
<th>Income</th>
<th>Chinese Capital Stock</th>
<th>Error Correction Coefficients:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exports</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>RMB-Dollar Real Exchange Rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Weighted Real Exchange Rate in Supply Chain Countries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Income</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Capital Stock</td>
</tr>
</tbody>
</table>

**All Goods**

(Lags: 1; Sample: 1993:III-2013:III; Trend in data; Seasonal dummies for the first, second, and third quarters included)

<table>
<thead>
<tr>
<th></th>
<th>1,0</th>
<th>81</th>
<th>1.68*** (0.33)</th>
<th>0.61* (0.32)</th>
<th>0.87 (0.85)</th>
<th>1.00*** (0.21)</th>
<th>-0.16*** (0.05)</th>
<th>0.13*** (0.04)</th>
<th>0.08*** (0.03)</th>
<th>-0.00</th>
<th>0.00</th>
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**SITC 7**

(Lags: 1; Sample: 1993:III-2013:III; Trend in data; Seasonal dummies for the first, second, and third quarters included)

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<th></th>
<th>1,0</th>
<th>81</th>
<th>2.25*** (0.40)</th>
<th>1.00*** (0.38)</th>
<th>0.86 (1.03)</th>
<th>1.54*** (0.26)</th>
<th>-0.14*** (0.04)</th>
<th>0.11*** (0.03)</th>
<th>0.07*** (0.03)</th>
<th>0.00</th>
<th>0.00*</th>
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</table>

**SITC 8**

(Lags: 1; Sample: 1993:III-2013:III; Trend in data; Seasonal dummies for the first, second, and third quarters included)

<table>
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<th></th>
<th>1,1</th>
<th>81</th>
<th>0.72*** (0.17)</th>
<th>0.63*** (0.17)</th>
<th>2.25*** (0.45)</th>
<th>0.32*** (0.12)</th>
<th>-0.36*** (0.09)</th>
<th>0.20*** (0.07)</th>
<th>0.14*** (0.05)</th>
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**SITC 6**

(Lags: 1; Sample: 1993:III-2013:III; Trend in data;)

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<th></th>
<th>0.0</th>
<th>81</th>
<th>0.90*** (0.33)</th>
<th>0.28 (0.32)</th>
<th>6.20*** (0.87)</th>
<th>0.05 (0.22)</th>
<th>-0.24*** (0.08)</th>
<th>0.17*** (0.05)</th>
<th>-0.04</th>
<th>0.00</th>
</tr>
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</table>
Seasonal dummies for the first, second, and third quarters included)

1Number of Cointegrating Vectors indicates the number of cointegrating relations according to the trace and maximum eigenvalue test using 5% asymptotic critical values.

*** (**) denotes significance at the 1% (5%) level.
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
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<th>(6)</th>
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<tr>
<td>Distance</td>
<td>-0.83***</td>
<td>-0.99***</td>
<td>-0.76***</td>
<td>-0.91***</td>
<td>-0.82***</td>
<td>-0.99***</td>
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<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.00)</td>
<td>(0.03)</td>
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<td>Common Language</td>
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<td>0.38***</td>
<td>0.45***</td>
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<td>(0.03)</td>
<td>(0.02)</td>
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<td>(0.01)</td>
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<td>-0.23***</td>
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<td>-0.11**</td>
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<td></td>
<td>(0.07)</td>
<td>(0.03)</td>
<td>(0.00)</td>
<td>(0.56)</td>
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<tr>
<td>Exporter GDP</td>
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<td>1.17***</td>
<td>1.28***</td>
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<td>(0.05)</td>
<td>(0.02)</td>
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<tr>
<td>Importer GDP</td>
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<td>0.87***</td>
<td>0.66**</td>
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<td>(0.03)</td>
<td>(0.06)</td>
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<tr>
<td>Constant</td>
<td>20.3***</td>
<td>20.9***</td>
<td>17.6***</td>
<td>19.5***</td>
<td>-13.6***</td>
<td>-10.6***</td>
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<tr>
<td></td>
<td>(0.12)</td>
<td>(0.08)</td>
<td>(0.00)</td>
<td>(0.56)</td>
<td>(1.0)</td>
<td>(0.93)</td>
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<tr>
<td>Estimation Technique</td>
<td>PPML</td>
<td>OLS</td>
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<td>OLS</td>
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<td>0.83</td>
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<tr>
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<td>23199</td>
<td>23224</td>
<td>23199</td>
<td>23224</td>
<td>23199</td>
</tr>
</tbody>
</table>

**Notes:** The table contains panel OLS and Poisson Pseudo Maximum Likelihood (PPML) estimates of gravity models. Bilateral exports from 31 major exporters to each of the other 30 countries over the 1988-2012 period are included. For the panel OLS estimates, heteroskedasticity-consistent standard errors are in parentheses. For the PPML estimates, Huber-White standard errors are in parentheses.

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


