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## How would a slowdown in the People's Republic of China affect its trading partners?

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**ADB Working Paper Series**

**HOW WOULD A SLOWDOWN  
IN THE PEOPLE'S REPUBLIC  
OF CHINA AFFECT ITS TRADING  
PARTNERS?**

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**Abstract**

The People's Republic of China (PRC) has become an important importer for many countries. This paper investigates how turbulence in the PRC can spill over to trading partners through the trade channel. Exports from several East Asian and Southeast Asian countries to the PRC exceed 10% of their gross domestic products. To shed light on economies' exposures to the PRC, this paper estimates a gravity model. The results indicate that Taipei, China and members of the Association of Southeast Asian Nations are exposed to the PRC because they produce goods for the PRC market and are exposed to advanced economies because they ship parts and components to the PRC for processing and reexport to the West. The Republic of Korea is more exposed to a slowdown in advanced economies that purchase processed exports from the PRC than to a slowdown in the PRC. Major commodity exporters such as Australia, Brazil, Indonesia, and Saudi Arabia and exporters of sophisticated consumption and capital goods such as Germany and Switzerland are exposed to a slowdown in the PRC domestic market. This paper also estimates import elasticities for the PRC. The results indicate that imports for processing into the PRC are closely linked to processed exports from the PRC to the rest of the world and that ordinary imports are closely linked to PRC gross domestic product. The renminbi exerts only a weak impact on imports, however. The paper concludes by recommending that firms and countries diversify their export base and their trading partners to reduce their exposures to the PRC and to advanced economies.

**JEL Classification:** F32, F14, F22

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## 1. INTRODUCTION

The People's Republic of China (PRC) is the second-largest economy in the world, the final link in East Asian supply chains, and a voracious consumer of natural resources. The value of the PRC's imports each year exceeds a trillion dollars. Many firms depend on exports to the PRC for a large share of their profits. The PRC's economy, after growing at close to double-digit rates since the early 1990s, has recently encountered turbulence. Net capital outflows have accelerated since 2014 and have generated depreciation pressures. Overcapacity has emerged in several sectors including steel, shipbuilding, and chemicals. Economic challenges abroad are generating headwinds for the PRC economy. How will imports from the PRC's trading partners be affected?

To answer this question, it is necessary to distinguish between different types of imports and different countries. For instance, imports for processing can only be used to produce goods for reexport, while ordinary imports are destined primarily for the domestic market (see Gaulier, Lemoine, and Ünal 2011). Xing (2015) presented econometric evidence indicating that processed exports flow disproportionately to high-income countries. Imports for processing should thus depend on demand conditions and exchange rates in the high-income countries purchasing the final good, while ordinary imports should depend on demand conditions and the exchange rate in the PRC. Countries such as Australia and Brazil that export raw materials such as iron ore should be especially affected by slowdowns in sectors such as steel that require natural resources.

Previous work has investigated the factors affecting the PRC's imports. Cheung, Chinn, and Qian (2012), for instance, employed dynamic ordinary least squares (DOLS) techniques and quarterly aggregate trade data over the 1994–2010 sample period. They reported that the exchange rate coefficient in a standard import equation enters with the wrong sign. Cheung, Chinn, and Fujii (2010) and Garcia-Herrero and Koivu (2007) also found that an appreciation of the renminbi is associated with a decrease in PRC imports in many specifications. The incorrect sign is often explained by the fact that the PRC imports inputs from supply chain countries which are used to produce goods for reexport (see, for example, Kamada and Takagawa 2005).

To control for this, Cheung, Chinn, and Qian (2012) included exports in the import demand function for processed trade. They reported that, in this case, the exchange rate coefficient on imports for processing was correctly signed and was statistically significant at the 10% level and that the elasticity equaled 1.1. They also reported that the coefficient on processed exports in the regression was statistically significant and slightly above unity.

Freund, Hong, and Wei (2011) employed annual data disaggregated at the Harmonized System 4-digit level between the PRC and all of its trading partners over the 1997–2005 period. Estimating a panel data set with the variables measured in first difference form, they reported correctly signed exchange rate elasticities of 0.2 for processed and ordinary imports. They also found that the income elasticities were small.

The International Monetary Fund (IMF) (2011) reported the result of a study using data disaggregated at the Harmonized System 6-digit level. Employing a partial equilibrium model and information from input–output tables, they first examined how relative price changes affect imports, taking into account substitution elasticities and the quantity of imported inputs used to produce exports. They then determined how import demand is affected by shifts in the structure of exports. Finally, they performed simulations

to calculate exchange rate elasticities. Aggregating the sectoral findings to the economy-wide level, they reported that a 10% renminbi appreciation is associated with a 2% decline in imports.

**Table 1: Exports to the People's Republic of China as a Percentage of Gross Domestic Product and a Percentage of Total Exports and Share of Processed Exports Relative to Processed Plus Ordinary Exports**

Exports to the PRC Relative to GDP		Exports to the PRC Relative to Total Exports		Processed Exports/ (Processed Exports + Ordinary Exports)	
Economy	%	Economy	%	Economy	%
Taipei,China	20.5	Taipei,China	35.3	Taipei,China	61.0
Malaysia	16.8	Malaysia	20.1	Malaysia	42.7
Korea, Rep. of	11.2	Korea, Rep. of	28.3	Korea, Rep. of	60.8
Thailand	9.9	Thailand	16.0	Thailand	33.9
Singapore	9.1	Singapore	12.9	Singapore	40.7
Philippines	7.4	Philippines	29.5	Philippines	45.7
Saudi Arabia	5.9	Saudi Arabia	10.3	Saudi Arabia	26.0
Australia	5.4	Australia	30.8	Australia	3.1
Japan	3	Japan	20.7	Japan	39.9
Indonesia	2.8	Indonesia	12.2	Indonesia	13.2
Switzerland	2.6	Switzerland	5.9	Switzerland	16.9
Germany	2.5	Germany	6.5	Germany	9.1
Brazil	2	Brazil	19.0	Brazil	5.1
Finland	1.2	Finland	4.5	Finland	24.7
Netherlands	1.2	Netherlands	1.8	Netherlands	22.3
Sweden	1	Sweden	3.5	Sweden	20.3
Austria	1	Austria	2.6	Austria	12.6
Canada	1	Canada	3.7	Canada	10.7
Denmark	0.9	Denmark	2.9	Denmark	22.0
United Kingdom	0.9	United Kingdom	5.2	United Kingdom	11.7
India	0.9	India	5.5	India	32.5
Mexico	0.8	Mexico	2.6	Mexico	26.0
Ireland	0.8	Ireland	1.7	Ireland	7.1
France	0.7	France	3.8	France	18.4
United States	0.7	United States	8.9	United States	20.5
Norway	0.6	Norway	2.3	Norway	59.2
Italy	0.6	Italy	2.7	Italy	14.9
Poland	0.5	Poland	1.4	Poland	13.7
Spain	0.4	Spain	1.7	Spain	12.8
Turkey	0.4	Turkey	1.8	Turkey	5.5

GDP = gross domestic product, PRC = People's Republic of China.

Sources: CEPII-CHELEM Database, China Customs Statistics, and calculations by the author.

This paper first investigates what countries are exposed to a slowdown in the PRC through trade. Table 1 reports economies' exports to the PRC in 2014 relative to their gross domestic products (GDPs) and their total exports.<sup>1</sup> The table also reports the ratio of processed exports to the sum of processed and ordinary exports. There are 13 economies in the table with export/GDP ratios exceeding 2%. The most exposed economies in Asia, according to this criterion, are Taipei,China; the Republic of Korea; members of the Association of Southeast Asian Nations (ASEAN); and Japan. Those most exposed outside of Asia are Australia, Brazil, Germany, Saudi Arabia, and Switzerland. Table 1 shows that those most exposed in Asia export the largest share of processed goods to the PRC and that those most exposed outside of Asia export primarily ordinary goods.

To shed further light on these economies' exposures to the PRC economy, this paper employs a gravity model. The gravity model is a workhorse for explaining bilateral trade flows. It controls for distance and economic size. The results indicate that both Germany and countries exporting primary products, such as Australia, Brazil, and Saudi Arabia, export much more to the PRC than the model predicts. To investigate what countries are exposed to the PRC domestic market and what countries are exposed to the markets purchasing processed exports from the PRC, the paper also uses a gravity model that differentiates between imports for processing and ordinary imports. The Republic of Korea and Taipei,China are large positive outliers in sending imports for processing to the PRC, while Australia, Brazil, and Germany are large positive outliers in sending ordinary imports to the PRC.

The paper then investigates import elasticities for the PRC. For processing trade, it reports almost a one-to-one relationship between imports for processing and processed exports and exchange rate elasticities that are correctly signed and equal to 0.2. For ordinary trade, it reports income elasticities of 2 and exchange rate elasticities that are correctly signed and equal to 0.4. These results imply that a reduction in processed exports driven by factors in advanced economies and a reduction in PRC GDP matter for PRC imports. A renminbi depreciation would only matter if it were large.

The next section employs a gravity model to investigate the economies that are exposed to the PRC through trade. Section 3 estimates trade elasticities. Section 4 concludes.

## **2. USING A GRAVITY MODEL TO INVESTIGATE IMPORTS INTO THE PEOPLE'S REPUBLIC OF CHINA**

### **2.1 Data and Methodology**

The gravity model is useful for estimating bilateral trade flows. Traditional gravity models posit that bilateral trade between two countries is directly proportional to GDP in the two countries and inversely proportional to the distance between them (Tinbergen 1962). These models often include other factors affecting bilateral trade costs, such as whether trading partners share a common language. Many have noted that the gravity model is one of the most successful empirical models in

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<sup>1</sup> The focus is on 31 major exporters from Asia and the rest of the world. These economies are listed at the end of Section 3.1.



economics (see, for example, Leamer and Levinsohn 1995; and Baltagi, Egger, and Pfaffermayr 2014).

Traditional gravity models take the form:

$$\ln Ex_{ijt} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln DIST_{ij} + \beta_4 LANG + \beta_5 FTA_{ij} + \delta_i + \Omega_j + \pi_t + \varepsilon_{ijt} \quad (1)$$

where  $Ex_{ijt}$  represents 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 variable equaling 1 if the countries share a common language and 0 otherwise;  $FTA$  is a dummy variable equaling 1 beginning in the year when a free trade agreement (FTA) enters in force between two countries and 0 before; and  $\delta_i$ ,  $\Omega_j$ , and  $\pi_t$  are country  $i$ , country  $j$ , and time fixed effects.

Anderson and van Wincoop (2003) have constructed theoretical foundations for gravity models. They demonstrated that exports should depend on outward and inward multilateral resistance terms. These terms take into account that exports and imports between two countries depend, not only on trade costs between the two countries, but also on trade costs between third countries. As an example, trade between country  $i$  and country  $j$  can be affected if country  $i$  enters into an FTA with a third country  $k$ .

Theoretically based gravity models can be estimated by the equation:

$$\ln Ex_{ijt} = \beta_0 + \beta_1 \ln DIST_{ij} + \beta_2 LANG + \beta_3 FTA + \delta_i + \Omega_j + \varepsilon_{ijt} \quad (2)$$

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 outward and inward multilateral resistance terms.<sup>2</sup>

The gravity models above are log-linear and have frequently been estimated using panel least squares methods. Santos Silva and Tenreyro (2006) demonstrated that this technique can lead to biased estimates when there is heteroskedasticity in the data-generating process. They found based on simulations that Poisson pseudo-maximum likelihood (PPML) estimators often perform better both in terms of bias and efficiency.

To provide robust estimates of imports into the PRC, a variety of specifications are employed. These include the models in equations (1) and (2) and models estimated using both panel least squares and PPML techniques.

Data on exports and GDP are obtained from the CEPII–CHELEM database. Data on distance and common language are obtained online (from [www.cepii.fr](http://www.cepii.fr)). Distance is measured in kilometers and represents the geodesic distance between economic centers. Data on whether countries had an FTA in place are taken from the database entitled “Participation in Regional Trade Agreements” that is available from the World Trade Organization.<sup>3</sup>

The gravity model is estimated as a panel using annual data for the following economies: Australia; Austria; Brazil; Canada; the PRC; Denmark; Finland; France; Germany; India; Indonesia; Ireland; Italy; Japan; the Republic of Korea; Malaysia; Mexico; the Netherlands; Norway; the Philippines; Poland; Saudi Arabia; Singapore;

<sup>2</sup> Time-varying fixed effects are often included in equation (2). When estimated for this paper, however, results with time-varying fixed effects led to badly behaved residuals and R-squared statistics more than 20% lower than in the other specifications. Since the goal of using gravity models in this paper is prediction, results with time-varying fixed effects are not included.

<sup>3</sup> This database is available online (at [www.wto.org](http://www.wto.org)).

Spain; Sweden; Switzerland; Taipei, China; Thailand; Turkey; the United Kingdom; and the United States. The sample period extends from 1988 to 2014.<sup>4</sup>

## 2.2 Results

Table 2 presents the results from estimating the gravity models. Columns (1) and (3) present results from PPML estimation, and columns (2) and (4) present results from panel ordinary least squares (OLS) estimation. Columns (1) and (2) present results from estimating equation (1), and columns (3) and (4) present results from estimating equation (2). The model performs well with all of the coefficients of the expected signs and is statistically significant at the 1% level. The coefficients on exporter and importer GDP are close to the value of unity that Anderson (2011) noted has been found in many studies.

**Table 2: Panel Ordinary Least Squares and Poisson Pseudo-Maximum Likelihood Gravity Estimates, 1988–2014**

	(1)	(2)	(3)	(4)
Distance	−0.59*** (0.02)	−0.78*** (0.08)	−0.55*** (0.02)	−0.77*** (0.01)
Common Language	0.27*** (0.03)	0.40*** (0.02)	0.27*** (0.03)	0.40*** (0.01)
Free Trade Agreement	0.68*** (0.03)	0.72*** (0.02)	0.94*** (0.03)	0.74*** (0.03)
Exporter GDP	1.05*** (0.04)	1.13*** (0.02)		
Importer GDP	1.00*** (0.03)	1.12*** (0.02)		
Constant	−16.2*** (0.48)	−17.8*** (0.29)	17.4*** (0.18)	15.0*** (0.50)
Estimation Technique	PPML	OLS	PPML	OLS
Fixed Effects Specification	Exporter, Importer, Time	Exporter, Importer, Time	Exporter, Importer, Time	Exporter, Importer, Time
Adjusted R-squared		0.84		0.72
No. of Observations	25,092	25,042	25,093	24,130
Sample Period	1988–2014	1988–2014	1988–2014	1988–2014

GDP = gross domestic product, OLS = ordinary least squares, PPMS = Poisson Pseudo-Maximum Likelihood.

Notes: The table contains panel OLS and PPML estimates of gravity models. Bilateral exports from 31 major exporters to each of the other 30 countries over the 1988–2014 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.

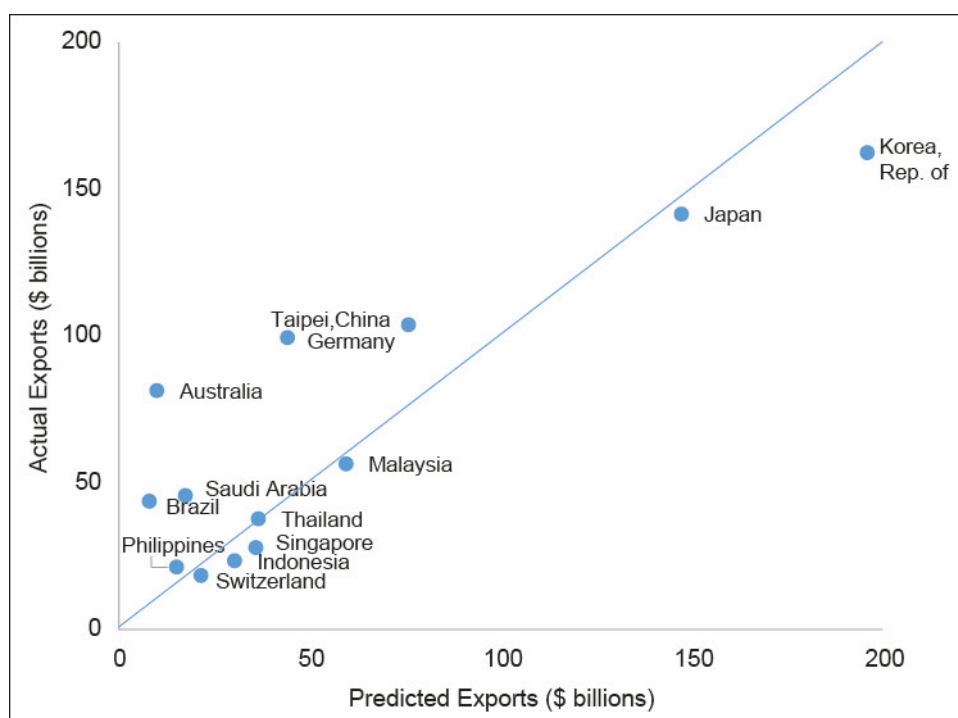
\*\*\* denotes significance at the 1% level.

Sources: CEPII-CHELEM database and author's calculations.

<sup>4</sup> Goods imports are employed because comprehensive data on services imports between the 31 economies over the sample period were not found. According to data from the State Administration of Foreign Exchange, goods imports have, on average, equaled more than 85% of goods and services imports into the PRC since 2003. Thus, this study focuses on the lion's share of the PRC's imports.

To investigate which economies are more exposed to the PRC than one would expect based on distance, economic size, and the other gravity variables, Figure 1 plots the difference between actual exports to the PRC in 2014 and the average of predicted exports to the PRC in the four specifications.<sup>5</sup> In Figure 1, 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 results indicate that Australia’s exports to the PRC were \$71 billion more than expected; Germany’s exports \$55 billion more than expected; Brazil’s exports \$44 billion more than expected; Saudi Arabia’s exports \$29 billion more than expected; Taipei,China’s exports \$28 billion more than expected; and the Republic of Korea’s \$34 billion less than expected. Indonesia, Malaysia, and Japan also exported less than predicted.

**Figure 1: Actual and Predicted Imports into the People’s Republic of China from its Trading Partners in 2014**



Note: Predicted exports are determined by a gravity model for trade between 31 leading exporters over the 1988–2014 period.

Sources: CEPII–CHELEM database and calculations by the author.

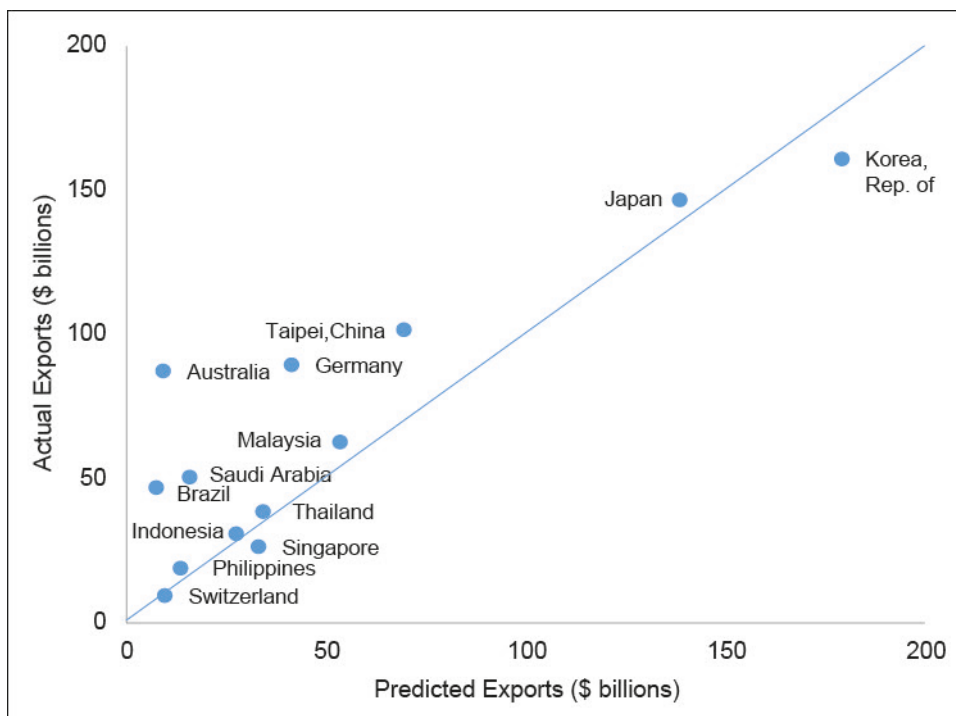
Figure 2 plots the analogous results for 2013. The figure indicates that Australia’s exports to the PRC were \$78 billion more than expected; Germany’s exports \$48 billion more than expected; Brazil’s exports \$39 billion more than expected; Saudi Arabia’s exports \$35 billion more than expected; Taipei,China’s exports \$32 billion more than expected; and the Republic of Korea’s \$18 billion less than expected. Indonesia, Malaysia, and Japan exported more than predicted to the PRC in 2013.

In every year since the Global Financial Crisis of 2008, exports from Germany; Australia; Brazil; Saudi Arabia; and Taipei,China to the PRC have been large positive outliers. Between 2009 and 2013, exports from Japan, Malaysia, Indonesia, and Thailand to the PRC have been more than predicted. On the other hand, exports

<sup>5</sup> Results for each of the four specifications individually are available on request.

from the Republic of Korea, on average, have been \$20 billion less than predicted since 2009.

**Figure 2: Actual and Predicted Imports into the People’s Republic of China from its Trading Partners in 2013**



Note: Predicted exports are determined by a gravity model for trade between 31 leading exporters over the 1988–2014 period.

Sources: CEPII–CHELEM database and calculations by the author.

To shed further light on these patterns, Table 3 reports the leading export categories from the economies listed in Figures 1 and 2. The table is ordered so that the leftmost column presents data for the economy with the largest ratio of exports to the PRC relative to GDP, the second column from the left presents data on the economy with the second-largest ratio of exports to GDP, and so on. For the six most exposed economies (Taipei,China; Malaysia; the Republic of Korea; Thailand; Singapore; and the Philippines), exports of electronics products predominate. Electronic parts and components is the most exported category for five of the six most exposed economies, and on average across the six economies equals one-third of their exports to the PRC. The share of all electronics products relative to total exports ranges from 33% for Thailand to 60% for the Philippines. Thus, one reason why Asia’s exports to the PRC are large is because the PRC is part of the regional electronics value chain.

For Australia, Brazil, and Indonesia, commodities and primary products make up most or virtually all of the exports. For Saudi Arabia, crude oil makes up 77% of its exports. For Germany, exports related to the automobile industry comprise more than 30% of exports. Sophisticated machinery, capital goods, and machine tools also make up a large share of Germany’s exports. Japan’s exports to the PRC are diversified, with no single category exceeding 10% of its exports to the PRC.

**Table 3: Leading Export Categories of Major Exporters to the People's Republic of China in 2014**  
(with % of total exports from the exporter to the People's Republic of China in parentheses)

Taipei,China	Malaysia	Republic of Korea	Thailand	Singapore
Electronic components (31.0)	Electronic components (49.5)	Electronic components (21.8)	Computer equipment (15.5)	Electronic components (37.1)
Optics (14.8)	Refined petroleum products (7.7)	Optics (11.6)	Electronic components (10.9)	Refined petroleum products (15.3)
Plastic articles (9.7)	Computer equipment (5.4)	Electrical apparatus (10.7)	Nonedible agricultural prod. (10.3)	Plastic articles (12.3)
Basic organic chemicals (8.1)	Fats (4.2)	Basic organic chemicals (8.5)	Plastic articles (9.7)	Basic organic chemicals (4.8)
Electrical apparatus (7.4)	Electrical apparatus (4.1)	Plastic articles (7.2)	Basic organic chemicals (8.8)	Computer equipment (4.5)
Yarns and fabrics (2.9)	Plastic articles (2.7)	Telecommunications equipment (5.6)	Other edible agricultural prod. (6.8)	Precision instruments (4.0)
Telecommunications equipment (2.9)	Telecommunications equipment (2.5)	Refined petroleum products (4.7)	Rubber articles (incl. tires) (4.9)	Electrical apparatus (3.0)
Non-ferrous metals (2.3)	Natural gas (2.5)	Vehicles components (3.5)	Electrical apparatus (3.9)	Paints (2.6)
Specialized machines (2.2)	Non-ferrous ores (2.4)	Specialized machines (3.0)	Refined petroleum products (3.7)	Miscellaneous manuf. Articles (1.8)
Miscellaneous hardware (2.0)	Basic organic chemicals (2.2)	Computer equipment (2.9)	Telecommunications equipment (3.2)	Telecommunications equipment (1.8)
Computer equipment (1.8)	Rubber articles (incl. tires) (2.1)	Iron Steel (2.4)	Jewelry, works of art (2.9)	Specialized machines (1.4)
Machine tools (1.7)	Toiletries (1.8)	Engines (2.0)	Optics (2.3)	Engines (1.3)
Iron Steel (1.6)	Non-edible agricultural prod. (1.7)	Misc. hardware (1.7)	Electrical equipment (1.8)	Misc. hardware (1.0)
Philippines	Saudi Arabia	Australia	Japan	
Electronic components (32.5)	Crude oil (77.1)	Iron ores (56.9)	Electronic components (9.2)	
Computer equipment (22.2)	Basic organic chem. (12.3)	Coals (9.3)	Electrical apparatus (8.6)	
Non-ferrous ores (15.8)	Plastic articles (7.3)	Non-monetary gold (7.8)	Plastic articles (6.1)	
Telecommunications equipment (4.3)	Refined petroleum products (1.3)	Non-ferrous ores (6.8)	Specialized machines (6.1)	
Electrical apparatus (4.2)	Natural gas (0.7)	Non-edible agricultural prod. (4.5)	Basic organic chemicals (6.0)	
Non-ferrous metals (2.8)	Unprocessed minerals (0.6)	Non-ferrous metals (2.4)	Optics (5.7)	
Other edible agricultural prod. (2.7)	Non-ferrous ores (0.3)	Meat (1.4)	Vehicles components (4.8)	
Coals (2.3)	Yarns fabrics (0.3)	Cereals (0.9)	Miscellaneous hardware (4.5)	

*continued on next page*

**Table 3** *continued*

<b>Philippines</b>	<b>Saudi Arabia</b>	<b>Australia</b>	<b>Japan</b>
Electrical equipment (2.2)	Non-ferrous metals (0.1)	Other edible agricultural prod. (0.7)	Cars and cycles (4.3)
Optics (1.4)	Paints (0.1)	Fats (0.5)	Engines (4.0)
Plastic articles (1.3)	Basic inorganic chemicals (0.1)	Pharmaceuticals (0.3)	Iron Steel (3.9)
Refined petroleum products (1.1)	Leather (0.02)	Beverages (0.2)	Telecommunications equipment (3.9)
Vehicles components (0.9)	Clothing (0.02)	Paper (0.2)	Precision instruments (3.4)
<b>Indonesia</b>	<b>Switzerland</b>	<b>Germany</b>	<b>Brazil</b>
Coals (24.2)	Non-monetary gold (47.4)	Cars and cycles (16.8)	Other edible agricultural prod. (38.9)
Fats (10.8)	Pharmaceuticals (13.4)	Vehicles components (10.6)	Iron ores (30.0)
Non-ferrous ores (8.1)	Clockmaking (8.3)	Electrical apparatus (7.8)	Crude oil (10.7)
Toiletries (6.1)	Machine tools (3.8)	Engines (7.1)	Paper (4.1)
Non-edible agricultural prod. (5.6)	Specialized machines (3.2)	Specialized machines (6.9)	Non-ferrous ores (2.1)
Paper (5.1)	Precision instruments (2.9)	Miscellaneous hardware (6.3)	Sugar (2.0)
Basic organic chemicals (4.5)	Engines (2.6)	Precision instruments (6.3)	Leather (2.0)
Wood articles (4.2)	Basic organic chemicals (2.2)	Aeronautics (4.3)	Iron Steel (1.2)
Refined petroleum products (3.9)	Electrical apparatus (2.2)	Machine tools (4.0)	Meat (1.2)
Natural gas (3.6)	Miscellaneous hardware (1.9)	Plastic articles (2.7)	Non-ferrous metals (1.1)
Electrical apparatus (2.9)	Miscellaneous manuf. Articles (1.7)	Electrical equipment (2.6)	Non-edible agricultural prod. (1.1)
Yarns fabrics (1.9)	Jewelry, works of art (1.2)	Pharmaceuticals (2.2)	Fats (0.9)
Non-ferrous metals (1.9)	Electrical equipment (0.9)	Electronic components (2.1)	Jewelry, works of art (0.8)

Sources: CEPII–CHELEM database and calculations by the author.

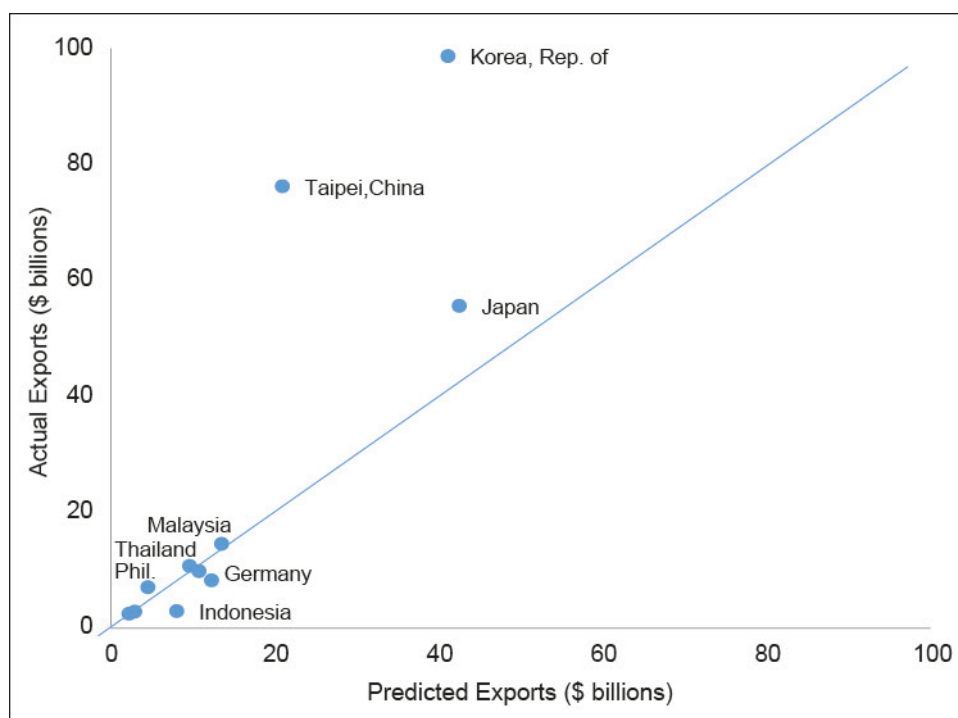
Another way to investigate what the PRC is importing from these countries is to estimate a gravity model including processing and ordinary trade separately. As Gaulier, Lemoine, and Ünal (2011) discussed, imports for processing are goods that are imported under a special customs regime and that can only be used to produce goods (processed exports) for reexport and ordinary imports are intended primarily for the domestic market.

In this gravity model, the PRC is treated as two separate economies. The first receives imports for processing (primarily parts and components) from other countries and ships processed exports (final assembled goods) abroad. The second purchases ordinary imports (imports for the domestic market) from other countries and ships ordinary exports (exports with high domestic value added) abroad.

Data on ordinary and processing trade over the 1992–2014 sample period come from the China Customs Statistics. Data are obtained for the following economies: Australia; Austria; Brazil; Canada; the PRC (ordinary trade); the PRC (processing trade); Denmark; Finland; France; Germany; Indonesia; Ireland; Italy; Japan; the Republic of Korea; Malaysia; Mexico; the Netherlands; the Philippines; Singapore; Spain; Sweden; Taipei,China; Thailand; the United Kingdom; and the United States. The other data for the gravity model are obtained from the sources listed above, and the model is estimated for the same four specifications discussed above.

Figure 3 plots the average of predicted and actual imports for processing into the PRC in 2014 across the four specifications, and Figure 4 plots this for ordinary imports into the PRC in 2014. The Republic of Korea and Taipei,China stand out as clear positive outliers in processing trade, with the Republic of Korea exporting \$58 billion more than predicted and Taipei,China exporting \$55 billion more than predicted. Exports from Malaysia, Thailand, and the Philippines are very close to their predicted values. Exports from Indonesia are much less than predicted, indicating that Indonesia has succeeded less than its ASEAN neighbors in joining regional value chains.

**Figure 3: Actual and Predicted Imports for Processing into the People’s Republic of China from its Trading Partners in 2014**



Phil. = Philippines.

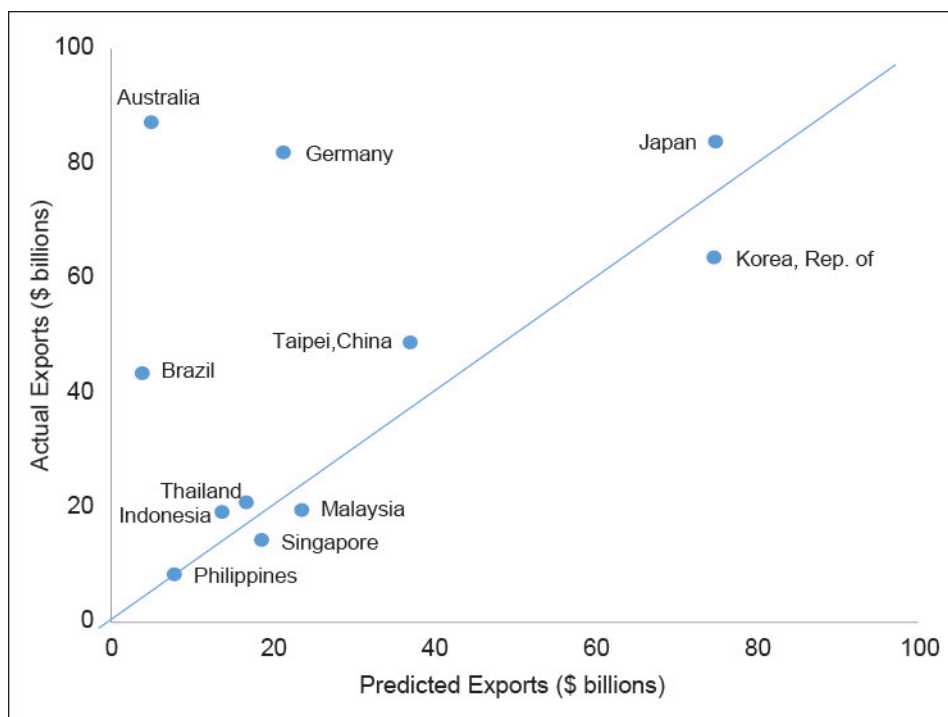
Note: Predicted exports are determined by a gravity model for trade between 26 leading exporters over the 1992–2014 period.

Sources: CEPII–CHELEM database and calculations by the author.

In Figure 4, Australia, Brazil, and Germany are positive outliers in ordinary trade. Australia’s predicted exports equaled \$5 billion, and its actual exports equaled \$89 billion. Brazil’s predicted exports equaled \$4 billion, and its actual exports equaled \$45 billion. Germany’s predicted exports equaled \$21 billion, and its actual exports equaled \$82 billion. For Brazil and Australia, Table 3 indicates that this surplus reflects commodity exports. For Germany, Table 3 indicates that the surplus reflects exports related to the auto and machinery industries. Japan and Taipei,China exported about

\$10 billion more than predicted and the Republic of Korea about \$10 billion less. The Republic of Korea's shortfall in overall exports to the PRC (seen in Figure 1) thus reflects lower-than-expected exports aimed at the local market rather than a shortfall of parts and components destined for assembly in PRC and reexport to the rest of the world.

**Figure 4: Actual and Predicted Ordinary Imports into the People's Republic of China from its Trading Partners in 2014**



Note: Predicted exports are determined by a gravity model for trade between 26 leading exporters over the 1992–2014 period.

Sources: CEPII–CHELEM database and calculations by the author.

Are the results for the Republic of Korea driven by foreign value added that is incorporated into the country's exports instead of domestic value added? Its exports of parts and components to the PRC are primarily electronics goods. The country's domestic content in electronics parts and components (ep&c) production has become large as companies, such as Samsung and LG, have invested heavily in plant, equipment, and technology. One way to observe this is to look at the value of ep&c exports from the Republic of Korea to the world divided by the value of ep&c imports into the Republic of Korea from the world. Many countries in Asia rely heavily on value added from ep&c imports to produce ep&c exports.<sup>6</sup> For the Republic of Korea, this ratio grew from 1 in 2001 to almost 2 in 2014.<sup>7</sup> Thus, its outsized parts and components exports to the PRC, which are evident in Figure 3, reflect significant value added coming from the Republic of Korea.

For ordinary exports from the Republic of Korea such as smartphones, computers, and cosmetics that are destined for the PRC market, much of the value added also comes from the Republic of Korea. To the extent that ordinary exports from the Republic of

<sup>6</sup> For instance, Hiratsuka (2011) documented how companies in Thailand assemble hard disk drives using imported printed circuit boards, pivots, voice coils, bases, media, and other core components.

<sup>7</sup> This ratio is calculated using data from the CEPII–CHELEM database.



Korea have more foreign value added than processed exports do, the exposure of firms in the Republic of Korea to the PRC market would be even less than that implied by Figure 4. Thus, the results reported here for the Republic of Korea should be robust to considerations of foreign value added incorporated into its exports.

This evidence for the Republic of Korea may shed light on a finding of Inoue, Kaya, and Ohshige (2015). Using a Global Vector Autoregressive model and quarterly data over the period covering the first quarter (Q1) of 1979 until Q3 2014, they reported that a 1% negative PRC GDP shock would only reduce the Republic of Korea's GDP by 0.07%. If firms in the Republic of Korea are more exposed to countries buying final exports from the PRC than to the PRC domestic market, it makes sense that a slowdown in the PRC would have an attenuated effect on the Republic of Korea's economy.

### **3. USING THE IMPERFECT SUBSTITUTES MODEL TO ESTIMATE IMPORT ELASTICITIES FOR THE PEOPLE'S REPUBLIC OF CHINA**

In the same way that the gravity model is a workhorse for estimating bilateral trade flows, the imperfect substitutes model is a workhorse for estimating trade elasticities. As discussed by Goldstein and Khan (1985), the imperfect substitutes model implies that imports should depend on the real exchange rate and on real GDP in the importing country:

$$\ln(im_t) = \alpha_1 + \alpha_2 \ln(rer_t) + \alpha_3 \ln(Y_t) + \varepsilon_t \quad (3)$$

where  $im_t$  represents real imports,  $rer_t$  represents the real exchange rate, and  $Y_t$  represents domestic real GDP.

For ordinary imports, the specification in equation (1) is employed. For imports for processing, following the work of Ahuja et al. (2012); Baak (2014); Cheung, Chinn, and Qian (2012); Nishimura and Hirayama (2013); and others, the equation is modified. Processed exports are included as a right-hand-side variable to explain imports for processing. Since imports for processing cannot flow to the PRC market but can only be used to produce goods for reexport, this is a better scale variable for processing trade.

Annual data over the 1992–2014 period are obtained from China Customs Statistics on imports for processing and ordinary imports from 24 leading exporting economies into the PRC. The exporting economies are Australia; Austria; Brazil; Canada; Denmark; Finland; France; Germany; Indonesia; Ireland; Italy; Japan; the Republic of Korea; Malaysia; Mexico; the Netherlands; the Philippines; Singapore; Spain; Sweden; Taipei, China; Thailand; the United Kingdom; and the United States. Annual data for total processed exports are also obtained from China Customs Statistics.

Following Cheung, Chinn, and Fujii (2010) and Cheung, Chinn, and Qian (2012), Hong Kong, China to the PRC reexport unit value indices are used to deflate PRC imports and Hong Kong, China to the United States reexport unit value indices are used to deflate PRC exports. These data are obtained from the Hong Kong Customs and Excise Department and the CEIC database.

Data on real GDP and the real exchange rate are obtained from the CEPII–CHELEM database. Real GDP is measured in 2011 dollars. The bilateral real exchange rate between the PRC and country  $j$  is measured in purchasing power parity terms, as in Freund, Hong, and Wei (2011) and Tang (2014). An increase in the exchange rate

variable represents an appreciation of the renminbi, implying that the coefficient on the exchange rate will be positive if a renminbi appreciation increases exports.

In November 2012, Xi Jinping became the General Secretary of the Communist Party of China and vowed to crack down on corruption. One form of corruption that aroused media commentary was government officials receiving and wearing expensive imported luxury goods. Qian and Wen (2015) reported that the anticorruption campaign resulted in a large drop in luxury imports. To control for this, a dummy variable is included in the regression for ordinary imports that equals 1 in 2013 and 2014 and 0 otherwise.

To specify the econometric model, a battery of panel unit root tests and Kao residual cointegration tests are performed. The results point to a cointegrating relationship for the specification with ordinary imports but some ambiguity for the specification with imports for processing. Panel dynamic ordinary least squares (DOLS), a technique for estimating cointegrating relations, is thus employed for ordinary imports. Both DOLS and panel ordinary least squares (OLS) are employed for imports for processing. DOLS is a fairly robust estimator (see, for example, Kao and Chiang 2000, and Wagner and Hlouskova 2010). The results reported for imports for processing are very close using either panel DOLS or panel OLS. Thus, we should be able to draw reliable inferences about trade elasticities for imports for processing.

### 3.1 Results

Table 4 presents the results from estimating the import elasticities. Column (1) presents the findings for imports for processing using panel OLS estimation, column (2) presents the findings for imports for processing using panel DOLS estimation, and column (3) presents the findings for ordinary imports using panel DOLS estimation.

**Table 4: Panel Dynamic Ordinary Least Squares and Ordinary Least Squares Estimates of Import Elasticities for Imports for Processing and Ordinary Imports, 1992–2014**

	(1)	(2)	(3)
Processed Exports	1.00*** (0.03)	0.92*** (0.02)	
Real GDP			1.92*** (0.04)
Real Exchange Rate	0.19** (0.08)	0.16** (0.08)	0.41*** (0.15)
Import Category	Imports for Processing	Imports for Processing	Ordinary Imports
Estimation Technique	OLS	DOLS	DOLS
Fixed Effects Included	Yes	Yes	Yes
Adjusted R-squared	0.92	0.95	0.92
No. of Observations	552	516	550
Sample Period	1992–2014	1993–2014	1992–2014

DOLS = Panel Dynamic Ordinary Least Squares, GDP = gross domestic product, OLS = Panel Ordinary Least Squares.

\*\* denotes significance at the 1% level, \*\*\* denotes significance at the 5% level.

Notes: For the DOLS, lag length for each cross section is selected based on the Schwarz Criterion. For the OLS estimation, White standard errors are reported. For the results in column (2), the sample begins in 1993 because the Schwarz Criterion selected one lag for every cross section. An increase of the bilateral real exchange rate implies an appreciation of the renminbi. The predicted sign of the coefficient is positive.

Sources: China Customs Statistics, CEPII–CHELEM database, and calculations by the author.

The results in columns (1) and (2) point to a tight link between imports for processing and processed exports. The coefficient on processed exports equals 1.0 for the OLS estimation and 0.9 for the DOLS estimation. The IMF (2005) noted that imports for processing should vary one-to-one with processed exports. Cheung, Chinn, and Qian (2012) reported that the coefficient on processed exports in the regression for imports for processing was slightly above unity. The results reported here are consistent with the IMF's claim and with Cheung et al.'s findings.

The coefficient on the real exchange rate in the regressions for imports for processing in columns (1) and (2) equals 0.19 for the OLS estimation and that for the DOLS estimation equals 0.16. These coefficients are statistically significant at the 5% level. These values are close to the values of 0.2 found by Freund, Hong, and Wie (2011) and the IMF (2011) and much less than the elasticity of 1.1 reported by Cheung, Chinn, and Qian (2012).

The results in column (3) indicate that the income elasticity for ordinary imports is close to 2 and is statistically significant at the 1% level. Thorbecke (2016) reported income elasticities averaging close to 2 for imports of consumer goods (a subset of ordinary imports) into the PRC.

The exchange rate elasticity for ordinary imports equals 0.41, and is statistically significant at the 1% level. This coefficient implies that a 10% renminbi depreciation would reduce ordinary imports by 4.1%. This relatively small effect may reflect the fact that the lion's share of the PRC's ordinary imports has been inputs into the production process such as minerals, machinery, and base metals rather than final goods (see, for example, Feenstra and Wei 2010; and Gaulier, Lemoine, and Ünal 2011). Even in 2014, only 10% of the PRC's total imports were consumption goods. Inputs into the production process may be more sensitive to the business cycle and less sensitive to price changes than consumer goods.<sup>8</sup>

In intriguing work at the Chinese Academy of Social Sciences, Prof. Wu Haiying investigated the sensitivity of PRC imports to world GDP, PRC GDP, and the PRC real effective exchange rate. The motivation for including world GDP is that many of the PRC's imports are used to produce goods for reexport and the demand for these reexports should depend on income in the rest of the world. Employing quarterly data over the Q1 1995–Q4 2009 period, she reported an elasticity to world GDP of 1.36 and an elasticity to PRC GDP of 1.08. Her results imply that imports into the PRC are sensitive to demand conditions in both the rest of the world and in the PRC.<sup>9</sup>

The findings in this paper also imply that countries exporting to the PRC are exposed to a slowdown in the rest of the world that would reduce the PRC's processed exports and to a slowdown in the PRC that would reduce its ordinary imports. They are not as exposed to a depreciation of the renminbi, unless the depreciation is very large.

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<sup>8</sup> Investigating only consumption imports, Thorbecke (2016) reported exchange rate elasticities averaging unity.

<sup>9</sup> Prof. Wu Haiying found a larger exchange rate response than those reported in this paper. This could be due to the fact that her sample period ends 5 years earlier than the sample period employed here. I am indebted to Prof. Yu Yongding for making me aware of Prof. Wu's work.

## 4. CONCLUSION

This paper has investigated countries' exposures to the PRC through trade. It finds that, while East Asian and Southeast Asian countries export a lot to the PRC, the story is complicated. The Republic of Korea, for instance, is more dependent on exporting parts and components that are used to produce final goods for reexport to the rest of the world than it is on exporting to the PRC domestic market. Taipei,China exports a lot of goods in both the processing and the ordinary customs regimes, so it is exposed to both the advanced economies and to the PRC economy. Malaysia, the Philippines, and Thailand also export a lot in both categories. Since the PRC is a large economy that is close by, these ASEAN neighbors are clearly vulnerable to a slowdown in the PRC. Countries exporting commodities and primary products such as Australia, Brazil, Indonesia, and Saudi Arabia and countries exporting sophisticated consumer and capital goods such as Germany and Switzerland are also exposed to the PRC economy.

This paper also estimates trade elasticities for the PRC's imports. Imports for processing are sensitive to processed exports and ordinary imports are sensitive to PRC GDP. Their response to exchange rate changes, though, is small. This implies that a slowdown in the PRC's processed exports or PRC GDP would matter more for imports than a renminbi depreciation would unless the depreciation is large.

There are several policy lessons that flow from these findings. Countries such as Australia and Indonesia whose exports include a large share of primary products are very exposed to a slowdown in the PRC. They should seek to diversify their export base to include more manufactured products. Indonesia should also seek to strengthen its link to global value chains by improving infrastructure and human capital and by fighting corruption (see Kawai and Lee 2015).

The Republic of Korea and Taipei,China are especially exposed to a slowdown in processing trade. Their challenge is compounded because the PRC's high investment levels in recent years have enabled firms in the PRC to substitute parts and components produced in the PRC for imported parts and components (see, for example, Kuijs 2011, and Knight and Wang 2011). The Republic of Korea and Taipei,China should seek to innovate and produce technologically advanced intermediate goods to ensure that their products remain in demand in the PRC.

All of East Asia and Southeast Asia, including the PRC, would also benefit if multinationals and others involved in processing trade could find new sources of demand and become less dependent on demand in the West.

It is an old saw in economics that diversification reduces risk. In the face of slowdowns in the PRC and the rest of the world, this maxim is especially relevant. Companies and countries should diversify their export base, diversify their trading partners, and reduce their exposure to the PRC or any other single country. They should also specialize and find niches where they have comparative advantage.

From the PRC's point of view, the results here might seem to imply that a depreciation would not do much to harm imports. However, if PRC policy makers are concerned about medicines, foods, and other goods destined for PRC consumers, then the exchange rate effects for these goods may be larger (see, for example, Thorbecke 2016). This gives policy makers in the PRC one more reason to avoid a large depreciation of the renminbi.

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