China's Import Demand for Agricultural Products

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1. Introduction

China is among the world's largest importers of agricultural products. Since joining the World Trade Organization (WTO) in 2001, China has become a major net agricultural importer (Fig. 1). China's agricultural imports increased by more than 12 times between 1997 and 2015, whereas its agricultural exports only quadrupled. If we include Hong Kong together with China in a single customs region, then China imported $132 billion of agricultural commodities in 2017 from the rest of the world, of which $24.2 billion was sourced from the United States (Table 1).[1] Soybeans are China's leading agricultural import—both from the United States and from the rest of the world—accounting for 57%of agricultural imports from the united States. Other top agricultural imports include cotton, coarse grains, pork, and dairy products. With China's rising income, rapid urbanization, and huge population, we expect that its consumer demand for agricultural products will continue to outpace domestic production.

Since 2017, China's imports of some agricultural products – such as soybeans – have been affected by the trade war between China and the United States, but that is not the topic of this paper. Rather, we take a longer-term perspective, after tariffs between China and all other countries have again been restored to their levels under China's membership in the WTO. Over the longer-term, we are interested in the impact of China's economic growth on its demand for agricultural products, particularly imports from the United States. As is the case for all other products, we must be aware that agricultural products can be either necessities or luxuries. The former have income elasticities less than unity, while the latter have income elasticities greater

[1] The agricultural commodities that we focus on in the paper consist of the 58 BICO products as defined by the United States Department of Agriculture, which classifies agricultural products into bulk, intermediate, consumer oriented, and other agricultural related goods, based on the value or level of processing.

than unity. If the United States provides mainly luxuries (necessities) in agriculture, then as China's income grows we can expect the U.S. supply will expand in greater (lesser) proportion to Chinese income growth.

This distinction between necessity and luxury goods becomes even more important when we recognize that goods exported by a particular country can differ in quality from the same good exported by another country. It may be, then, that a lower-quality variety is a necessity, while a higher-quality variety of the same good is a luxury. As the income of the buying country grows, it is the higher-quality luxury good that will enjoy a rising market share in that country. Recently, Fajgelbaum and Khandelwal (2016) developed a framework that combines an Almost Ideal Demand System (AIDS) defined over products and exporting countries with a gravity equation in trade, so as to identify the nonhomothetic demand from each importer for the products from each exporter. Our goal in this paper is to estimate this system of equations for the 30 Chinese provinces as the importers, on 58 agricultural commodities from 80 major trading partners in the rest of the world, using data for the period 1997-2017.

We develop a sectoral non-homothetic gravity equation by embedding the AIDS demand structure into the multisector Armington model. The non-homothetic gravity equation will be used to estimate the elasticity of individual expenditure shares by sector and country of origin with respect to prices and income. Based on these key estimated parameters, we are able to predict China's future import demand for U.S. agricultural products by feeding in estimates of rising per-capita income and income inequality in various provinces. Hence we will be able to analyze the potential impact on trade patterns of U.S.-China agricultural trade. Our methodology improvement will allow the estimate of income elasticities to *differ by the selling country.* As a result, we can provide a more accurate forecast of import demand growth.

2. AIDS and the Gravity Equation

We begin with the AIDS defined over products *n* and countries *i* importing from countries *j:*

$$S_{ij}^{n} = \frac{X_{ij}^{n}}{Y_i} = \alpha_{ij}^{n} + \sum_{n'} \sum_{j'} \gamma_{jj'}^{nn'} \ln p_{ij'}^{n'} \quad + \beta_j^n \mathrm{y}_i, \tag{1}$$

where on the left-hand side of the equation $S_{ij}^{n} = \frac{X_{ij}^{n}}{Y_i}$ is the share of aggregate expenditure in country *i* allocated to product *n* from country *j*. On the right-hand side, α_{ij}^{n} is a parameter influencing the expenditure share, $p_{ij'}^{n'}$ are the prices of all the products *n'* imported from countries *j'* , with substitution parameters $\gamma_{jj'}^{nn'}$, while y_i denotes the "real income" of importer *i*, with parameters β_j^n indicating possibly non-homotheticity in demand for the product *n* purchased from country *j*. As is common in AIDS estimation, real income can be measured by incorporating an income distribution across consumers, so that it becomes:

$$y_i = \left[\ln\left(\frac{\bar{x}_i}{a_i}\right) + IN_i\right], \tag{2}$$

where a_i is the usual homothetic price index arising from the AIDS demand in country *i*, $\bar{x}_i$ is the mean of the income distribution, and IN_i is its Theil index of income inequality.

To reduce the number of parameters that need to be estimated, Fajgelbaum and Khandelwal (2016) assume that the substitution parameters $\gamma_{jj'}^{nn'}$ are highly symmetric across goods *n* = 1,…,*N* and countries, as follows:[2] equation $\gamma_{jj'}^{nn'} = (1 - \frac{1}{N})\gamma^{n}$ for *n* = *n'* and *j* = *j'*; $\gamma_{jj'}^{nn'} = \gamma^{n}/N$ for *n* = *n'* and *j* ≠ *j'*; and $\gamma_{jj'}^{nn'} = 0$ if for $n \neq n'$. These assumptions greatly

[2] Allowing γ_{jj}^{nn} to depend on the number of goods (*N* = 53) just simplifies the notation below.

simplify the estimation because there will be a single substitution parameter γ^n for each good. In effect, demand becomes a two-tier system with substitution between goods at the upper level, and substitution between countries at the lower level, as follows.

At the upper level, we can sum equation (1) across all exporters *j* to obtain:

$$S_i^n = \sum_j S_{ij}^n = \overline{\alpha}_i^n + \bar{\beta}^n y_i \qquad (3)$$

where $\overline{\alpha}_i^n = \sum_j \alpha_{ij}^n$, and $\bar{\beta}^n = \sum_j \beta_j^n$. The prices at this aggregate level of total expenditure on good *n* by importer *i* do not appear because we have assumed that the substitution parameters are and $\gamma_{jj'}^{nn'} = 0$ if for $n \neq n'$: that is, demand has constant shares with respect to prices, but the shares still depend on real income. This equation shows how the share of spending on product *n* in each country *i* depends on its real income.

Fajgelbaum and Khandelwal (2016) further aim to eliminate prices at the lower level of aggregation, when there is substitution across supplying countries, for three reasons. First, products imported from different source countries vary by quality, and price reflects quality. Second, trade price data are usually calculated as unit values, which is not actually a reliable indicator of commodity prices because they may also include freights and insurance.[3] Third, the key focus of our paper is on the nonhomothetic parameters β_j^n, with less attention to the substitution parameters between countries.

In order to eliminate prices, they make an assumption that is common in the international trade literature: namely, that international prices p_{ij}^n reflect domestic prices in the exporter p_{jj}^n

[3] For some of the agricultural commodities we are dealing with, their unit values may be an acceptable measure of price. So in future work, we can experiment with including prices in the estimation.

adjusted for "iceberg" costs of trade, whereby the amount $\tau_{ij}^n \geq 1$ of good *n* must be shipped from country *j* in order for one unit to arrive in country *i*. Formally, this assumption means,

$$p_{ij}^n = p_{jj}^n \tau_{ij}^n .$$

Making the various substitution defined above into (1), it turns out that we are able to solve for the country *j* domestic prices using the fact that the income of each exporter in sector *n* equals the sales to all countries (including itself) of that product. Using this market clearing condition, we arrive at the following lower-level AIDS system: there is substitution between exporting countries *j* selling to each importer *i*,

$$\frac{x_{ij}^n}{Y_i} = A_{ij}^n + \frac{Y_j^n}{Y_W} - \gamma^n T_{ij}^n + \beta_j^n \Omega_i, \tag{4}$$

where:

a) the parameters A_{ij}^n capture cross-country differences in tastes across sectors and exporters are related to α_{ij}^n by:

$$A_{ij}^n = \alpha_{ij}^n - \sum_{i'} \left(\frac{Y_{i'}}{Y_W}\right) \alpha_{ij}^n. \tag{5}$$

b) $\frac{Y_j^n}{Y_W}$ measures the supply capacity of exporter *j*, which is the share of country *j*'s output of product *n* to the world's supply of all products Y_W.

c) T_{ij}^n stands for trade costs, with,

$$T_{ij}^n = \ln\left(\frac{\tau_{ij}^n}{\bar{\tau}_i^n}\right) - \sum_{i'} \left(\frac{Y_{i'}}{Y_W}\right) \ln\left(\frac{\tau_{i'j}^n}{\bar{\tau}_i^n}\right) \text{ and } \bar{\tau}_i^n = \exp[\textstyle\sum_j \ln(\tau_{ij}^n)/N]. \tag{6}$$

d) the term Ω_i again reflects real income adjusted for the Theil index, defined by,

$$\Omega_i = y_i - \sum_{i'=1}^{N} \left(\frac{Y_{i'}}{Y_W}\right) y_{i'}$$

$$= \left[\ln\left(\frac{\bar{x}_i}{a_i}\right) + IN_i\right] - \sum_{i'=1}^{N} \left(\frac{Y_{i'}}{Y_W}\right) \left[\ln\left(\frac{\bar{x}_{i'}}{a_{i'}}\right) + IN_{i'}\right] \quad (7)$$

Equation (4) combines features of an AIDS equation and of a gravity equation in trade. The gravity interpretation comes because we have trade costs on the right-hand side. Below we shall assume that trade costs depend on distance. In much the same way as the force of gravity is inversely related to the distance between objects, it is well-established that the amount of trade between countries is inversely related to the distance between them. The AIDS interpretation of this equation come from the non-homothetic component $\beta_j^n \Omega_i$. This component measures the abilities of destination market *i* to purchase imports from various sources, depending on the average real income distribution adjusted by income inequality in the importing country i. The term Ω_i measures the adjusted real income the importer *i* is relative to the rest of the world. For income-elastic or luxury goods goods ($\beta_j^n > 0$), higher adjusted real income means that the country sources a higher share of good *n* from country *j*. For income-inelastic goods or necessities goods goods ($\beta_j^n < 0$), higher adjusted real income means that the country sources a lower share of good *n* from country *j*. What is new in this AIDS-gravity equation is that the income elasticities *differ by the selling country*. The richer is importer *i* (higher $\bar{x}_i$) or the more unequal it is (higher Δ_i), the larger its expenditure share on *countries* for which it has an income elasticity greater than unity for that good ($\beta_j^n > 0$), and conversely the smaller its expenditure share on countries for which it has an income elasticity less than unity for that good ($\beta_j^n < 0$).

For trade costs, we make the standard assumption in the trade literature that they depend on distance between the countries:

$$\ln \tau_{ij}^{n} = \rho^{n} \ln d_{ij} + u_{ij}^{n}, \tag{8}$$

where u_{ij}^{n} is an error term. Substituting this into (4) and (6) we obtain,

$$\frac{X_{ij}^{n}}{Y_i} = A_{ij}^{n} + \frac{Y_j^{n}}{Y_W} - (\gamma^{n}\rho^{n})D_{ij} + +\beta_j^{n}\Omega_i + \varepsilon_{ij}^{n} \tag{9}$$

where D_{ij} measures the bilateral trade costs between exporter *j* and importer *i* in sector *n*, and is obtained in the same manner as (6) but replacing τ with *d*. Likewise, the error term ε_{ij}^{n} is obtained from u_{ij}^{n} in (8).

The final step is to indicate how the terms $\overline{\alpha}_i^{n}$ and A_{ij}^{n} in the upper-level and lower-level equations (3) and (9) are determined. We assume that the coefficients $\overline{\alpha}_i^{n} = \sum_j \alpha_{ij}^{n}$ are obtained from

$$\alpha_{ij}^{n} = \alpha_j(\alpha^{n} + \varepsilon_i^{n}), \tag{10}$$

where ε_i^{n} is an error term, With the assumption that $\sum_j \alpha_j = 1$, we obtain from (3) the upper-level equation:

$$S_i^{n} = \alpha^{n} + \bar{\beta}^{n} y_i + \varepsilon_i^{n}. \tag{11}$$

This upper-level equation slightly simplifies (3), and again, it captures how the share of spending on product *n* in each country *i* depends on its real income.

Using (10) and (11) combined with (5), we can solve for $A_{ij}^{n} = \alpha_j(S_i^{n} - S_W^{n} - \bar{\beta}^{n}\Omega_i)$. Substituting this into (9), we obtain our lower-level estimating equation,

$$\frac{X_{ij}^{n}}{Y_i} = \frac{Y_j^{n}}{Y_W} + \alpha_j(S_i^{n} - S_W^{n}) - (\gamma^{n}\rho^{n})D_{ij} + \sum_k(\gamma^{n}\delta_k^{n})G_{k,ij} + (\beta_j^{n} - \alpha_j\bar{\beta}^{n})\Omega_i + \varepsilon_{ij}^{n}\,. \tag{12}$$

whereX_{ij}^{n} is the value of exports from exporter j to importer i in sector n, and Y_i is the total income of importer i, Y_j^n is total sales of exporter j in sector n, Y_W is world total output of all agricultural products, S_i^n is the share of sector n in the total expenditure of country i, S_W^n is the share of sector n in world expenditures, D_{ij} is a measure of the bilateral country distance. In addition to distance D_{ij}, Fajgelbaum and Khandelwal (2016) allow for $G_{k,ij}$, which measures bilateral border and language barriers between exporter *j* and importer *i* in sector *n* to influence the amount of trade. Using such indicator variables is quite standard in gravity equation estimation, but we do not include them here because our focus will be on a single importing country: China, comprised of 31 provinces. Within China, all provinces will have the same principal language (Mandarin) and nearly all will have the same lack of land borders with neighboring suppliers. So our focus will be on *distance* as the measure of trade costs.

3. Data

Our empirical exercise needs disaggregated bilateral trade between Chinese provinces and each of its trading partners, trade costs, and a provincial income inequality measure. While Fajgelbaum and Khandelwal (2016) apply their method to trade between all countries in all goods, our focus here will be on agricultural products only. We focus on China's 31 provinces, purchasing agricultural imports from 80 major agricultural countries of the world. So we have i= 31 importers, j=80 countries, and n=58 agricultural goods. In the Appendix we summarize the sources of our data.

Figure 2 demonstrates the data we use for the estimation. Areas A and B stand for bilateral trade between other countries besides China. Area C represents the imports of Chinese provinces from the rest of the world. Area D stands for the exports from Chinese provinces to

other countries; and area E represents inter-provincial trade within China. The data we use for the estimation covers areas B and C, where importers are the 30 Chinese provinces and some Asian countries, and exporters are the world's major agricultural exporting countries. Because we use international trade data, we are missing domestic demand data. i.e. we don't have the data for diagonal of area A and E.

4. Estimation

Table 2 reports estimates of the $\bar{\beta}^n$ coefficient from equation (3), while Table 3 reports the product-exporter specific β_j^n estimates for the top 19 countries and 14 products from equation (12). The new feature of our non-homothetic system is that each country exporting to China faces its own income elasticity for each product. The income elasticity is:

$$\frac{dlnX_{ij}^n}{dlnY_i} = \frac{dln(S_{ij}^n Y_i\ )}{dlnY_i} = 1 + \frac{dlnS_{ij}^n}{dlnY_i} = 1 + \frac{dS_{ij}^n}{dlnY_i}\frac{1}{S_{ij}^n} = \ 1 + \beta_j^n / S_{ij}^n, \qquad (13)$$

Therefore, when $\beta_j^n > (<)0$, the income elasticity for the products from country *j* is greater (less) than unity. Products with an income elasticity greater (less) than unity are traditionally called necessities (luxuries), indicating that the share of expenditure on these products rise4s (falls) as income grows.

5. Forecasting Chinese Import Demand for Agricultural Products

Using the estimated AIDS-gravity system, we now forecast Chinese import demand for agricultural products. To achieve that goal, we go back to equation (1) of our system. We hold prices fixed so that our forecast purely reflects demand, and we do not factor in any issues of market clearing arising from U.S. export supply or Chinese local supply. We now add a time

subscript to our earlier equations, and we consider the change in any variable *x* over one year, so that $\Delta x_t = x_t - \Delta x_{t-1}$. With prices fixed, the change in the share of Chinese demand from each source country over a full decade is obtained form (1) is:

$$\Delta S_{ijt}^n = S_{ijt}^n - S_{ijt-1}^n = \beta_j^n \Delta y_{it}, \quad (14)$$

where the change in real income is obtained from (2) as:

$$\Delta y_{it} = \left[\Delta \ln\left(\frac{\bar{x}_{it}}{a_{it}}\right) + \Delta IN_{it}\right]. \quad (15)$$

We consider two different scenarios for projecting Chinese import demand for agricultural products over one year. In the first scenario, we assume 5% annual growth in real income for one year, the first term on the right of (12), and no change in income inequality within each province, which is the second terms on the right of (12). So with $\Delta y_i = 0.05$, hat growth in income is multiplied by the nonhomothetic coefficients β_j^n in (12) to obtain the change in the share of import purchases coming from each source country. That change in the share, in turn, can be used to project total purchases under the assumption that real income grows by 5%. We will compare the total projected purchases taking into account the nonhomothetic demand parameters β_j^n to what they would be if demand were homothetic, so that $\beta_j^n = 0$, to give us an idea of how the changes patterns of Chinese import demand will affect different source countries.

In the second scenario, we will assume that the growth in real income and the change in income inequality by province are exactly the same as the *annual average* of their change over the period 2007–17. That is, we just replicate the change in real income and the change in income inequality over one future year as the annual average over the decade before:

$$\Delta y_i = (y_{i2017} - y_{i2007})/10. \quad (16)$$

This growth in real income – now adjusted for the changes in income inequality – is multiplied by the nonhomothetic coefficients β_j^n in (9) to obtain the change in the share of import purchases coming from each source country. Once again, we will compare the total projected purchases taking into account the nonhomothetic demand parameters β_j^n to what they would be if demand were homothetic, so that $\beta_j^n = 0$.

The results of these two exercises for the United States are summarized in Table 4, and for some principal products, the results are summarized for the United States and other exporting countries in Tables 5-12.

It can be seen from these results that a number of important U.S. exports have income elasticities *less than* unity, indicating that those products are *necessities,* meaning that the share of expenditure in China devoted to these goods will fall as China grows. This does *not* mean that the value of exports will fall, but rather that exports cannot be expected to keep pace with income growth in China. These products include soybeans (Table 5), cotton (Table 6), corn (Table 7), pork (Table 9) and beef (Table 10). In each case, some other country is exporting the product to China with an income elasticity exceeding unity, meaning that they will gain an increasing share of expenditure from China: for soybeans and beef, for example, those countries include Australia and Brazil (Tables 5 and 10); for cotton and pork, those countries include Brazil (Tables 6 and 9).

On the other hand, a number of products are sold in smaller amounts but will have growing import demand in China with income elasticities *exceeding* unity, products that are traditionally called *luxury* goods. These include distillers' dried grains (DDG, Table 8), poultry

(Table 11) and tree nuts (Table 12). For poultry and tree nuts, quite a number of countries in addition to the United States will experience rising shares of expenditure as income in China grows.

6. Conclusions

Predicting China's import demand for agricultural imports has been difficult due to trade barriers and other market-distorting interventions. Using highly disaggregated provincial level imports and exports inside China, our paper proposes a non-homothetic system that incorporates regional consumption variability and estimates China's imported demand of agricultural commodities. The new feature of our non-homothetic system is that each country exporting to China faces its own income elasticity for each product.

Our results will benefit U.S. agricultural exporters by improving the quality of assessments of China's market potential. Our estimation methodology also has broad applicability to readily available bilateral trade and production data for countries throughout the world.

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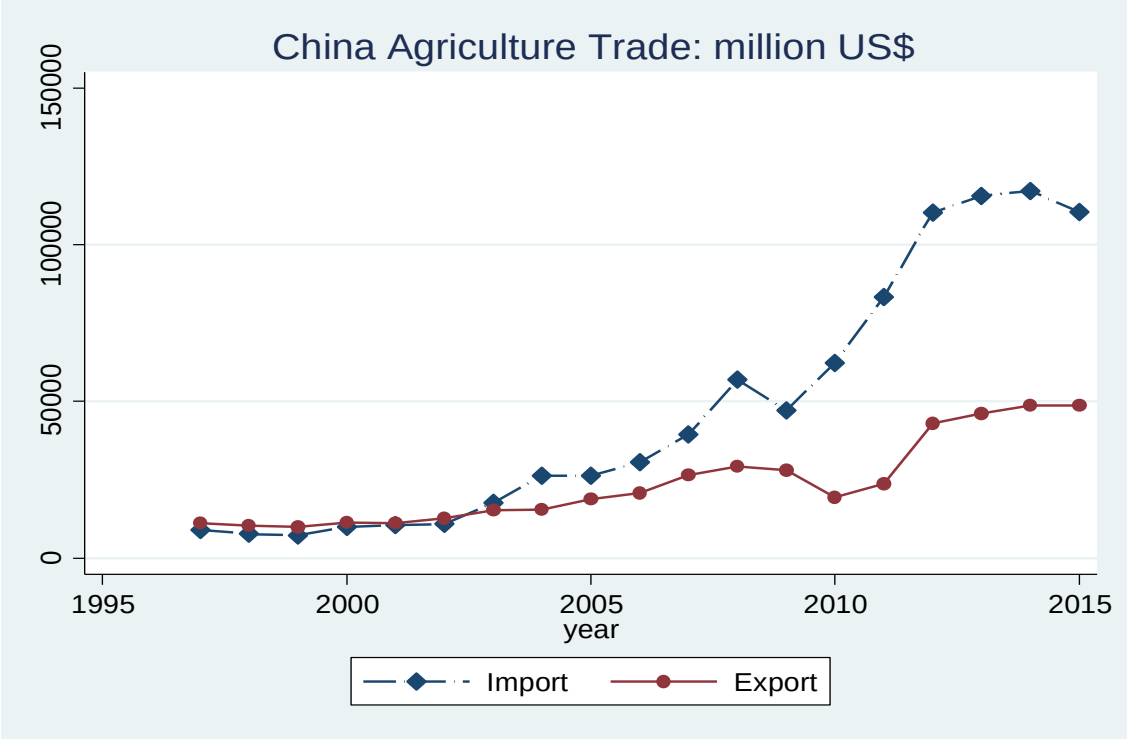
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Figure 1: Chinese Agricultural Imports and Exports, 1997-2015



Source: China Customs Trade Data

Figure 2: Demonstration of Data Used

		Country 1 2 … 80	**Chinese Province** *importer i* 1 2 … 31
Country *exporter j*	1 2 … 80	ROW Trade (A)	Chinese Provinces' imports from other countries (C)
province	1 2 … 31	Chinese Provinces' exports to ROW (D)	Internal China Trade (E)

Table 1: China's Top Imported Products from ROW and USA, 2017

category	BICO product	Rank in US Exports	Share in US Exports	Rank in World Exports	Share in World Exports
B	Soybeans	1	57.4%	1	29.9%
O	Forest Products	2	8.6%	2	8.9%
B	Cotton	3	4.0%	16	1.7%
B	Coarse Grains (ex. corn)	4	4.0%	14	2.2%
I	Hides & Skins	5	3.7%	15	2.2%
O	Fish Products	6	2.5%	5	4.1%
C	Pork & Pork Products	7	2.2%	10	2.8%
C	Dairy Products	8	2.2%	6	4.0%
C	Prepared Foods	9	1.8%	3	4.5%
C	Fresh Fruit	10	1.7%	7	3.8%
I	Hay	11	1.6%	33	0.4%
B	Wheat	12	1.6%	25	0.8%
I	Other Intermediate Products	13	1.5%	4	4.5%
B	Tobacco	14	0.7%	21	0.9%
B	Corn	15	0.7%	31	0.5%
C	Processed Fruit	16	0.6%	27	0.7%
C	Tree Nuts	17	0.6%	28	0.6%
I	Planting Seeds	18	0.6%	39	0.3%
C	Processed Vegetables	19	0.5%	19	1.3%
I	Essential Oils	20	0.5%	36	0.3%
I	Feeds & Fodders NESOI	21	0.5%	37	0.3%
C	Wine & Beer	22	0.3%	12	2.3%
I	Soybean Oil	23	0.3%	32	0.4%
C	Meat Products NESOI	24	0.3%	20	1.1%
I	Distillers Grains	25	0.3%	50	0.1%
B	Peanuts	26	0.2%	44	0.1%
I	Vegetable Oils NESOI	27	0.2%	13	2.3%
C	Chocolate & Cocoa Products	28	0.1%	34	0.4%
C	Beef & Beef Products	29	0.1%	11	2.4%
B	Pulses	30	0.1%	35	0.4%
C	Coffee, Roasted and Extracts	31	0.1%	43	0.2%
I	Live Animals	32	0.1%	40	0.2%
C	Condiments & Sauces	33	0.1%	46	0.1%
C	Snack Foods NESOI	34	0.1%	30	0.5%
B	Oilseeds NESOI	35	0.1%	23	0.8%
C	Fruit & Vegetable Juices	36	0.0%	42	0.2%
C	Distilled Spirits	37	0.0%	26	0.7%
I	Sugars & Sweeteners	38	0.0%	22	0.9%
C	Dog & Cat Food	39	0.0%	53	0.0%
C	Nursery Products & Cut Flowers	40	0.0%	41	0.2%
C	Non-Alcoholic Bev. (ex. juices, coffee, tea)	41	0.0%	49	0.1%

I	Animal Fats	42	0.0%	48	0.1%
B	Coffee, Unroasted	43	0.0%	47	0.1%
B	Rubber & Allied Gums	44	0.0%	8	3.7%
C	Tea	45	0.0%	45	0.1%
B	Other Bulk Commodities	46	0.0%	29	0.6%
C	Fresh Vegetables	47	0.0%	56	0.0%
C	Spices	48	0.0%	52	0.0%
C	Eggs & Products	49	0.0%	58	0.0%
O	Ethanol	50	0.0%	55	0.0%
I	Soybean meal	51	0.0%	54	0.0%
O	Biodiesel & Blends > B30	52	0.0%	57	0.0%
C	Poultry Meat & Prods. (ex. eggs)	53	0.0%	24	0.8%
B	Rice	54	0.0%	18	1.4%
I	Oilseed Meal/Cake (ex. soybean)	55	0.0%	38	0.3%
B	Cocoa Beans	56	0.0%	51	0.0%
I	Palm Oil	57	0.0%	9	3.3%
B	Rapeseed			17	1.6%
2017 Total Ag Import Value (billion US$)		USA: 24.2		World 132	

Notes: authors' calculation using trade data from China and Hong Kong's customs office.

Table 2: Estimates of $\bar{\beta}^n$ Coefficient in Equation 3

BICO Category	Agricultural Products	$\bar{\beta}^n$ Estimate	Std. Error
Bulk	Wheat	-0.011***	(0.004)
Bulk	Corn	0.001	(0.005)
Bulk	Coarse Grains (ex. corn)	-0.009**	(0.004)
Bulk	Rice	-0.003	(0.004)
Bulk	Soybeans	0.030***	(0.004)
Bulk	Rapeseed	-0.012**	(0.005)
Bulk	Oilseeds NESOI	0.003	(0.003)
Bulk	Cotton	-0.012***	(0.003)
Bulk	Peanuts	0.001	(0.006)
Bulk	Pulses	0.005	(0.004)
Bulk	Coffee, Unroasted	0.001	(0.005)
Bulk	Cocoa Beans	-0.001	(0.008)
Bulk	Tobacco	0.003	(0.004)
Bulk	Rubber & Allied Gums	-0.025***	(0.003)
Bulk	Other Bulk Commodities	-0.005*	(0.003)
Intermediate	Soybean meal	-0.041***	(0.004)
Intermediate	Oilseed Meal/Cake (ex. soybean)	0.002	(0.004)
Intermediate	Soybean Oil	-0.014***	(0.004)
Intermediate	Palm Oil	-0.021***	(0.003)
Intermediate	Vegetable Oils NESOI	-0.006**	(0.003)
Intermediate	Distillers Grains	0.003	(0.006)
Intermediate	Hay	0.003	(0.006)
Intermediate	Feeds & Fodders NESOI	0.000	(0.003)
Intermediate	Live Animals	0.011***	(0.003)
Intermediate	Hides & Skins	-0.007**	(0.003)
Intermediate	Animal Fats	-0.000	(0.004)
Intermediate	Essential Oils	0.002	(0.003)
Intermediate	Planting Seeds	0.003	(0.003)
Intermediate	Sugars & Sweeteners	0.002	(0.003)
Intermediate	Other Intermediate Products	-0.015***	(0.003)
Consumer-ready	Beef & Beef Products	0.005	(0.004)
Consumer-ready	Pork & Pork Products	0.009**	(0.004)
Consumer-ready	Poultry Meat & Prods. (ex. eggs)	0.003	(0.004)
Consumer-ready	Meat Products NESOI	0.002	(0.003)
Consumer-ready	Eggs & Products	0.002	(0.004)
Consumer-ready	Dairy Products	0.009***	(0.003)
Consumer-ready	Fresh Fruit	0.003	(0.004)
Consumer-ready	Processed Fruit	0.003	(0.003)
Consumer-ready	Fresh Vegetables	0.003	(0.004)

Consumer-ready	Processed Vegetables	0.000	(0.003)
Consumer-ready	Fruit & Vegetable Juices	0.001	(0.003)
Consumer-ready	Tree Nuts	0.002	(0.004)
Consumer-ready	Chocolate & Cocoa Products	0.002	(0.003)
Consumer-ready	Snack Foods NESOI	0.003	(0.003)
Consumer-ready	Condiments & Sauces	-0.000	(0.003)
Consumer-ready	Prepared Foods	0.014***	(0.003)
Consumer-ready	Spices	0.002	(0.003)
Consumer-ready	Tea	0.001	(0.004)
Consumer-ready	Coffee, Roasted and Extracts	0.001	(0.004)
Consumer-ready	Non-Alcoholic Bev. (ex. juices, coffee, tea)	0.000	(0.004)
Consumer-ready	Wine & Beer	0.005	(0.003)
Consumer-ready	Dog & Cat Food	0.001	(0.006)
Consumer-ready	Nursery Products & Cut Flowers	0.003	(0.003)
Other	Distilled Spirits	0.003	(0.004)
Other	Ethanol	0.003	(0.004)
Other	Biodiesel & Blends > B30	0.008***	(0.003)
Other	Forest Products	-0.009***	(0.003)
Other	Fish Products	0.001	(0.003)
Observations	23,812		
R-squared	0.386		

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.10

Table 3: Product-Exporter Specific β_j^n Estimates in Equation 12

Country	Soybeans	Forest Products	Cotton	Hides & Skins	Distillers Grains	Coarse Grains (ex. corn)	Fish Products	Corn	Pork & Pork Products	Biodiesel & Blends > B30	Dairy Products	Wheat	Prepared Foods	Hay
USA	-0.047***	0.013***	-0.006***	0.005***	0.005	-0.009***	-0.005**	-0.022***	-0.003	0.007***	0	-0.012***	0.005***	-0.006**
Brazil	-0.067***	-0.009***	0.012***	-0.017***	0.001	0.001	0.035***	-0.021	0.009	-0.008**	-0.007	-	-0.001	-
Australia	0.051***	-0.002	-0.008***	-0.027***	-0.029	-0.028***	-0.001	0.001	0.002	0.001	0.004**	-0.006*	-0.001	0.005
Thailand	0.136***	0.014***	-0.007	0.006	-0.001	-0.001	-0.002	0.008	0.001	0.001	-0.004	0.174	0.001	-
Canada	0.005	0.009***	0.004	0.003	0.001	-0.002	0	0.003	0.002	-0.004*	0	-0.040***	0.001	0.001
Malaysia	0.023*	0.016***	0.012***	0.018***	-	-0.016	0.006**	0.001	0.001	-0.001	0.002	0.01	0.003	0.005
Indonesia	0.01	0.019***	0.002	0.007	-	0.005	0.002	-0.011	-0.004	-0.004	0.003	-	0	0.002
New Zealand	0.121	0.007***	0.011	0.005*	-	-0.015	0.006*	-	0.002	-0.001	0.003	-	0.001	0.001
Argentina	-0.011***	-0.009***	0.003	0.014***	-	0.007	0.009**	0	0.001	-0.005	-0.002	-0.053	-0.001	0.001
Russia	-0.046***	-0.097***	0.080***	0.047***	-	-0.011	0.014***	-0.005	-0.027*	-0.036***	-0.007*	0.004	-0.011***	-0.001
Vietnam	-	-0.039***	0.008	0.008**	0.001	0.027	-0.001	0	0.001	0.001	-0.002	-	-0.002	0.001
France	0.025	0.001	0.004	0	0	-0.018***	0.003	0.012	0.001	-0.001	0.002	-0.007	0.001	-0.001
India	0.008	0.001	-0.001	0.004	-	0.004	0.004	-0.001	-0.001	0	-0.002	0.001	0	0.001
Netherlands	-0.008	0	-0.001	0	-0.001	-0.001	0.004	-0.024	0.002	0.001	-0.002	-	0.001	0
Germany	0.004	0.008***	0	-0.001	0	0	0.001	-0.001	0.004	0.004***	0.001	-0.003	0.001	0
Uruguay	-0.010**	0	0.001	0.003	-	0.001	0.004	-	-0.001	0.002	0	-	0	-
Korea Rep	-0.001	0.006***	0.001	0.001	0.001	-0.001	0	-0.003	0.005	-0.001	0.001	0.017	0.002	-0.001
Chile	0.018	-0.001	-0.002	0.003	-	0.043***	0.002	0.001	0.002	-0.017***	0	-	0	-
Japan	0.004	0.001	0	0.001	0	0.005	-0.002	0.002	0.001	0.015***	0	0.005	0.002	0

Table 4: One-year Forecast Scenario of United States for Selected Products

	Scenario 1: 5% Income Growth			Scenario 2: Same Income and Inequality Growth as the average of 2007-17 Period		
	Export value (million US$)			Export value (million US$)		
Ag Product (1)	Homothetic (2)	Non-homothetic (3)	Difference (4)	Homothetic (5)	Non-homothetic (6)	Difference (7)
Soybeans	14594.80	14235.22	-2.46%	16390.92	15478.14	-5.57%
Forest Products	2185.76	2286.77	4.62%	2456.87	2712.52	10.41%
Cotton	1027.75	1003.00	-2.41%	1144.69	1084.75	-5.24%
Hides & Skins	945.89	987.51	4.40%	1052.24	1155.47	9.81%
Distillers Grains	68.56	94.77	38.23%	78.02	141.97	81.97%
Coarse Grains (ex. corn)	1006.17	972.43	-3.35%	1158.01	1074.45	-7.22%
Fish Products	638.55	615.89	-3.55%	719.24	672.43	-6.51%
Corn	167.36	105.75	-36.81%	199.41	61.68	-69.07%
Pork & Pork Products	561.83	533.94	-4.96%	695.18	630.34	-9.33%
Dairy Products	556.31	545.74	-1.90%	627.59	601.71	-4.12%
Wheat	410.48	360.15	-12.26%	470.11	350.98	-25.34%
Prepared Foods	447.76	463.92	3.61%	497.54	538.24	8.18%
Hay	418.98	384.53	-8.22%	472.18	399.12	-15.47%
Other Intermediate Products	391.99	364.84	-6.93%	441.07	374.80	-15.02%
Fresh Fruit	421.17	454.92	8.01%	484.82	568.36	17.23%
Tobacco	175.78	214.51	22.03%	205.68	306.48	49.01%
Soybean Oil	73.82	44.69	-39.46%	78.80	20.90	-73.48%
Processed Vegetables	132.24	144.78	9.49%	148.70	179.14	20.47%
Essential Oils	129.18	139.56	8.04%	147.49	173.00	17.30%
Processed Fruit	163.42	173.14	5.95%	183.05	207.58	13.40%
Planting Seeds	147.69	163.24	10.53%	162.23	199.98	23.27%
Tree Nuts	152.11	156.13	2.64%	173.17	183.15	5.76%
Feeds & Fodders NESOI	126.83	110.08	-13.21%	143.11	105.31	-26.41%
Wine & Beer	84.91	78.93	-7.04%	96.87	84.06	-13.22%
Vegetable Oils NESOI	44.87	58.34	30.02%	50.79	84.02	65.43%
Meat Products NESOI	73.22	76.68	4.73%	94.58	103.18	9.09%
Chocolate & Cocoa Products	26.83	30.55	13.87%	30.28	39.69	31.07%
Peanuts	62.49	62.17	-0.52%	66.68	65.93	-1.11%
Live Animals	19.81	31.07	56.82%	22.63	50.36	122.58%
Oilseeds NESOI	13.30	7.30	-45.13%	15.19	2.07	-86.35%
Pulses	26.00	58.15	>100%	29.24	112.86	>100%
Fruit & Vegetable Juices	11.47	16.11	40.48%	13.39	24.85	85.60%
Non-Alcoholic Bev.	3.14	7.58	>100%	3.57	14.22	>100%
Coffee, Roasted and Extracts	21.03	24.91	18.43%	24.03	33.39	38.96%

Snack Foods NESOI	14.27	23.46	64.38%	15.84	38.75	>100%
Condiments & Sauces	14.49	20.63	42.43%	16.29	31.44	92.99%
Distilled Spirits	10.17	4.39	-56.84%	11.58	2.82	-75.68%
Sugars & Sweeteners	7.75	5.74	-25.92%	8.78	5.08	-42.20%
Beef & Beef Products	26.37	19.15	-27.39%	29.79	18.78	-36.96%
Nursery & Cut Flowers	4.31	19.67	>100%	4.62	42.41	>100%
Animal Fats	2.56	9.53	>100%	2.73	19.39	>100%
Dog & Cat Food	4.58	7.31	59.64%	4.91	11.39	>100%
Coffee, Unroasted	1.04	4.63	>100%	1.17	9.95	>100%

Note: Only products with exports >$1 million in 2017 and in the forecast are reported.

Table 5: One-year Forecast of China's Import Demand for Soybeans

	Scenario 1: 5% Income Growth			Scenario 2: Same Income and Inequality Growth as the average of 2007-17 Period		
	Export value (million US$)		Difference	Export value (million US$)		Difference
Country	Homothetic	Non-homothetic		Homothetic	Non-homothetic	
United States	14594.80	14235.22	-2.46%	16390.92	15478.14	-5.57%
Brazil	21961.57	21468.00	-2.25%	24672.78	23431.38	-5.03%
Canada	972.69	992.74	2.06%	1108.40	1160.89	4.73%
Argentina	2817.97	2722.98	-3.37%	3143.77	2910.40	-7.42%
Russia	166.41	159.24	-4.31%	155.01	146.07	-5.77%
Uruguay	1082.24	1025.73	-5.22%	1216.82	1069.84	-12.08%
Ukraine	9.71	8.44	-13.02%	11.32	9.00	-20.55%
Ethiopia	4.76	0.90	-81.14%	5.40	0.12	-97.86%
Kazakhstan	2.96	1.15	-61.15%	3.60	0.00	-100%

Note: Only countries exporting >$1 million in 2017 and in the forecast are reported.

Table 6: One-year Forecast of China's Import Demand for Cotton

	Scenario 1: 5% Income Growth			Scenario 2: Same Income and Inequality Growth as the average of 2007-17 Period		
	Export value (million US$)		Difference	Export value (million US$)		Difference
Country	Homothetic	Non-homothetic		Homothetic	Non-homothetic	
United States	1027.75	1003.00	-2.41%	1144.69	1084.75	-5.24%
Brazil	131.15	220.74	68.31%	142.09	368.81	>100%
Australia	507.69	473.24	-6.79%	562.71	477.55	-15.13%
Canada	1.52	7.31	>100%	1.61	17.80	>100%
Malaysia	5.04	47.07	>100%	5.39	115.62	>100%
Russia	1.26	230.68	>100%	1.33	601.88	>100%
India	227.90	225.80	-0.92%	253.50	248.26	-2.07%
Singapore	1.20	2.29	90.71%	1.36	3.93	>100%
Spain	1.00	0.04	-96.02%	1.07	0.00	-100%
S.Africa	5.71	10.77	88.40%	6.09	19.08	>100%
Italy	1.57	1.58	0.12%	2.10	2.11	0.32%
Cameroon	11.09	1.82	-83.55%	12.19	2.22	-81.77%
Pakistan	1.31	11.19	>100%	1.40	27.24	>100%
Uzbekstan	72.16	72.68	0.72%	86.18	87.51	1.55%
Zimbabwe	1.48	18.88	>100%	1.58	45.81	>100%
Cote d'lvoir	18.75	14.15	-24.57%	20.03	11.43	-42.92%
Mexico	18.23	16.47	-9.65%	19.44	16.17	-16.83%
Togo	24.29	24.68	1.60%	25.93	26.94	3.89%
Sudan	25.18	22.81	-9.43%	26.97	23.10	-14.34%
Benin	65.02	60.93	-6.28%	69.08	58.55	-15.24%
Iran	108.81	91.87	-15.57%	119.70	77.08	-35.60%
United Arab E.	4.17	1.48	-64.40%	4.80	0.00	-100%
Turkey	17.58	10.08	-42.62%	18.96	4.26	-77.55%
Kazakhstan	5.90	16.52	180.00%	7.00	27.53	293.05%
Israel	12.67	12.77	0.82%	14.01	14.27	1.81%
Greece	18.32	18.52	1.10%	19.73	20.23	2.53%
Egypt	8.28	3.98	-51.94%	9.03	1.17	-87.03%

Note: Only countries exporting >$1 million in 2017 and in the forecast are reported.

Table 7: One-year Forecast of China's Import Demand for Corn

Country	Scenario 1: 5% Income Growth Export value (million US$) Homothetic	Non-homothetic	Difference	Scenario 2: Same Income and Inequality Growth as the average of 2007-17 Period Export value (million US$) Homothetic	Non-homothetic	Difference
United States	167.36	105.75	-36.81%	199.41	61.68	-69.07%
Ukraine	388.06	153.40	-60.47%	453.25	51.88	-88.55%
Myanmar	25.68	25.66	-0.08%	30.73	30.63	-0.34%
Laos,PDR	47.39	46.87	-1.10%	56.70	54.10	-4.58%

Note: Only countries exporting >$1 million in 2017 and in the forecast are reported.

Table 8: One-year Forecast of China's Import Demand for DDG

Country	Scenario 1: 5% Income Growth Export value (million US$) Homothetic	Non-homothetic	Difference	Scenario 2: Same Income and Inequality Growth as the average of 2007-17 Period Export value (million US$) Homothetic	Non-homothetic	Difference
United States	68.56	94.77	38.23%	78.02	141.97	81.97%
Canada	1.25	2.67	>100%	1.38	4.95	>100%

Note: Only countries exporting >$1 million in 2017 and in the forecast are reported.

Table 9: One-year Forecast of China's Import Demand for Pork

	Scenario 1: 5% Income Growth			Scenario 2: Same Income and Inequality Growth as the average of 2007-17 Period		
	Export value (million US$)		Difference	Export value (million US$)		Difference
Country	Homothetic	Non-homothetic		Homothetic	Non-homothetic	
United States	561.83	533.94	-4.96%	695.18	630.34	-9.33%
Brazil	118.13	153.96	30.33%	134.20	220.60	64.38%
Canada	480.05	490.37	2.15%	548.75	574.54	4.70%
France	239.76	244.32	1.90%	273.99	285.15	4.07%
Netherlands	327.06	337.18	3.10%	377.01	401.93	6.61%
Germany,FR	637.84	662.83	3.92%	731.83	793.37	8.41%
Chile	105.57	115.60	9.50%	121.15	145.73	20.29%
Denmark	420.27	431.77	2.74%	483.33	511.69	5.87%
Spain	677.95	697.77	2.92%	772.44	822.26	6.45%
Belgium	40.84	46.05	12.74%	47.01	59.79	27.20%
United Kingdom	100.90	112.96	11.95%	115.93	145.60	25.59%
Italy	2.95	7.07	>100%	3.30	12.92	>100%
Ireland	103.05	109.07	5.85%	118.74	133.57	12.49%
Finland	3.42	11.79	>100%	4.05	24.77	>100%
Mexico	3.34	7.71	>100%	3.90	14.93	>100%
Romania	14.68	16.44	11.99%	18.53	22.69	22.47%
Slovenia	39.08	48.50	24.08%	41.12	64.63	57.17%

Note: Only countries exporting >$1 million in 2017 and in the forecast are reported.

Table 10: One-year Forecast of China's Import Demand for Beef

	Scenario 1: 5% Income Growth			Scenario 2: Same Income and Inequality Growth as the average of 2007-17 Period		
	Export value (million US$)		Difference	Export value (million US$)		Difference
Country	Homothetic	Non-homothetic		Homothetic	Non-homothetic	
United States	26.37	19.15	-27.39%	29.79	18.78	-36.96%
Brazil	915.96	926.18	1.12%	1064.42	1090.00	2.40%
Australia	707.26	728.71	3.03%	802.65	856.32	6.69%
Canada	83.22	78.71	-5.42%	92.55	83.61	-9.66%
New Zealand	415.96	413.33	-0.63%	478.05	471.69	-1.33%
Argentina	388.55	403.95	3.96%	448.95	487.80	8.65%
Uruguay	720.41	738.96	2.57%	838.08	884.38	5.52%
Chile	15.34	14.98	-2.34%	17.63	16.95	-3.85%
S.Africa	4.52	6.25	38.20%	5.19	9.22	77.50%
Mongolia	2.30	2.26	-1.73%	2.04	2.00	-2.29%

Note: Only countries exporting >$1 million in 2017 and in the forecast are reported.

Table 11: One-year Forecast of China's Import Demand for Poultry Products

	Scenario 1: 5% Income Growth			Scenario 2: Same Income and Inequality Growth as the average of 2007-2017 Period		
	Export value (million US$)		Difference	Export value (million US$)		Difference
Country	Homothetic	Non-homothetic		Homothetic	Non-homothetic	
United States	0.06	9.19	>100%	0.07	16.03	>100%
Brazil	919.75	939.45	2.14%	1053.82	1103.04	4.67%
Argentina	118.93	122.24	2.79%	137.16	145.37	5.99%
Chile	40.30	54.33	34.82%	46.29	80.86	74.67%
Poland	3.82	7.75	>100%	4.37	13.98	>100%

Note: Only countries exporting >$1 million in 2017 and in the forecast are reported.

Table 12: One-year Forecast of China's Import Demand for Tree Nuts

Country	Scenario 1: 5% Income Growth Export value (million US$) Homothetic	Non-homothetic	Difference	Scenario 2: Same Income and Inequality Growth as the average of 2007-2017 Period Export value (million US$) Homothetic	Non-homothetic	Difference
United States	152.11	156.13	2.64%	173.17	183.15	5.76%
Australia	60.63	105.28	>100%	72.15	182.92	>100%
Thailand	66.21	113.41	71.29%	76.02	193.80	>100%
Malaysia	4.82	33.16	>100%	5.48	76.43	>100%
Indonesia	90.87	86.90	-4.37%	111.93	104.28	-6.84%
Russia	25.59	31.02	21.23%	26.77	37.84	41.34%
Vietnam	66.82	42.26	-36.76%	75.53	28.92	-61.72%
India	2.89	3.12	8.27%	3.57	4.26	19.16%
Korea Rep	17.84	17.78	-0.34%	19.65	19.50	-0.76%
Chile	2.47	1.38	-44.22%	2.75	1.20	-56.15%
Japan	5.39	7.94	47.32%	6.31	12.84	>100%
S.Africa	7.18	9.52	32.64%	9.03	14.60	61.73%
Philippines	16.67	14.31	-14.16%	19.67	13.98	-28.93%
Italy	2.08	7.70	>100%	2.41	17.02	>100%
Pakistan	39.98	32.22	-19.41%	47.71	38.48	-19.35%
Nigeria	5.25	5.15	-1.98%	5.57	5.34	-4.08%
Korea,DPR	82.35	78.05	-5.21%	97.39	89.66	-7.94%
Mongolia	94.81	87.74	-7.46%	114.22	102.11	-10.60%
Togo	2.47	2.42	-2.20%	2.65	2.52	-5.05%
Iran	50.53	50.29	-0.48%	58.89	58.39	-0.86%
Turkey	28.74	32.82	14.22%	30.65	40.35	31.64%
Mali	2.57	5.58	>100%	2.74	10.41	>100%

Note: Only countries exporting >$1 million in 2017 and in the forecast are reported.

Appendix

A. Sources of Data

The Chinese import statistics, by the Harmonized System (HS) classification and by source country and destination province over 1997-2017, were acquired by UC Davis from the Customs General Administration of the People's Republic of China. These data were purchased from Mr. George Chen, China Customs Statistics Information Center, Economic Information Agency, Hong Kong; EIAET@PACIFIC.NET.HK . These statistics treat Hong Kong as a separate customs region. The Hong Kong trade statistics for imports, exports, and re-exports over 1997-2015, by HS classification and by source and destination countries, Census and Statistical Department, Hong Kong Special Administrative Region, were also purchased. We merged these dataset to create Chinese imports (including those coming from Hong Kong) of agricultural products by destination province, for 1997-2017 (we assume that the Hong Kong trade was similar in proportional terms in 2016 and 2017 to what it was in 2015).

We further convert the HS classification to the BICO agricultural product classification developed by the U.S. Department of Agriculture. Based on value or level of processing, agricultural goods are broken into distinct categories: bulk, intermediate, consumer-ready, and other products. Bulk goods, like grains, soybean, cotton, and oilseeds, are relatively standardized products used as raw materials and inputs. They are sold in large quantities at relatively low unit costs. Comparatively, consumer-ready products are high value products that are usually ready for immediate use by consumers. They are typically higher value goods, mostly finished products, like meats, dairy, eggs, fruits and vegetables, processed goods, chocolates and wines. Compared

with bulk commodities, they are less substitutable, because they are easy to be differentiated by brand, quality, sanitary standards, and source countries. Other products are agriculture-related products such as fish products, forest products, ethanol, and biodiesel.

Provincial level GDP, population, retail price indexes, and income data are obtained from China Statistical Yearbooks 1997-2017. Provincial level income inequality GINI indexes are from Tian (2012) and then extrapolated to 2017. Distance between Chinese provinces and each of their trading partners is measured as the sum of internal and external distance, which takes into account the fact that the interior provinces first transport the goods to the economic center or harbors by railway, and then send the goods from the economic center or harbors to the rest of the world. The internal distance is the number of hours required to travel by train between the interior province and the economic center (Beijing) or harbor cities (Tianjin, Shanghai, and Guangdong); this variable is obtained from the Chinese Railroad Timetable. The external distance is the shipping distance from the harbor to the capital of other countries. The shipping distance is obtained from World Map, which is designed for sketching the maritime transportation.