China's Growth, World Food Prices, and Developing Countries Exports

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Abstract

This paper explores the impacts of China's growth in the international markets of agricultural products. These impacts are important because they are related to two different ongoing discussions about the role of China in the world economy. One of these discussions have to do with China as a source of price inflation while the other has to do with China as an engine of growth for developing countries, in this case, through increased export opportunities. Our results suggest that China has been a source of aggregated mild price inflation in the largest developed economies that occupy the first ranks as food importers. This is probably related to a more intense pressure on world food supplies. When we look at the counterfactual exports of selected exporters, we find that few countries in Latin America (Brazil, Peru), and in Asia (Malaysia, Indonesia), have benefited from China's increased food demand.

1 Introduction

The objective of this paper is to explore the consequences of the growth in China's demand for food for the food prices facing other countries that interact with China in the international markets of agricultural products. Our findings relate to two current debates in the literature concerned with the consequences of China's growth. One of these has to do with the strength of China's economic emergence as an explanation of increases in world food prices. The other is concerned with the role of China as an engine of growth for the agricultural exports of other developing countries.

Regarding the first debate, China's economic growth (along with growth in other developing countries) can be considered a structural cause of increases in food prices. This led some observers to see events such as the food prices surges toward the middle of 2008 as just the acutest expression of the changes promoted by strengthening developing country demand for food. However, as a string of studies motivated by the same events point out, the arguments supporting this view are often flawed. The main reason as explained by Abbot, Hurt, and Tyner (2008) and Headey and Fan (2008) is that China have followed policies of self-sufficiency, and thus its role as an importer of grains is limited. Wright (2008) adds that, in the case of rice, consumption expenditures have risen more slowly than income. This combined with the tendency of staple consumption to decline with income makes China's economic growth and unlikely suspect as a source of inflation of the sort needed to explain the dramatic price surges seen during the last few years. In a less extreme view of things, however, it is not unreasonable to consider rapid increases in in food demand as one of the many factors contributing to and increase in world food prices [See for example Carter, Rausser, and Smith (2008).]

A first objective of our work is to further inform this debate. In particular we employ gravity modeling of bilateral trade flows to obtain counterfactual measures of China's inflationary effects in food prices in a by-country basis. Exploiting the geographic patterns in bilateral trade flows we are able to identify for which countries China matters the most. To the best of our knowledge, these are the first econometric estimates of the likely impacts of China in world food prices.

Our estimates allows investigating a related question, that is, has China being an engine of growth for countries that export agricultural products? In principle, one might suspect that for countries such as Brazil, that export a large amount of soybeans/oil to China, this has been the case. However, it is less obvious if other countries that do not necessarily export the products that China imports the most, may have indirectly benefited from an overall lifting of food price levels attributable to China. This question is particularly relevant for developing countries, and is a central theme in the literature concerned with China and its effects in other developing countries [Goldstein et al. (2006); Obwona and Chirwa (2006); Jenkins, Peters, and Moreira (2008)].

We undertake an econometric analysis that gives a quantitative estimate of the upward pressure on food prices attributable to China's growth, and investigate its influence on several countries' agricultural exports. Our econometric strategy, fully developed in Sections 2 and 3, is derived from the gravity model proposed by Anderson and van Wincoop (2003). This model has several advantages for our purposes. First, it is developed from the demand side with an Armington specification whereby demand is differentiated by product origin. The model is also compatible with a number of specifications on the supply side. These features avoid the need of making assumptions about preferences and production that could be at odds with the sources of product differentiation in the agricultural sector (e.g., love of variety models.) Second, and crucial for this study, the price indexes of the CES function underlying the gravity model, allow us to capture the broad price effects of China.

2 Theorethical Framework

We use the theoretical framework proposed by Anderson and van Wincoop (2003, 2004)[1] to identify the price effects of increases in China's demand for food. This framework offers two main advantages for our work. First, it is general enough to accommodate various interpretations of the source of specialization in the supply side (e.g., national origin or monopolistic competition.) Second, AvW's treatment of the CES price indexes allows capturing the price effects of China's demand, on the price indices of other countries that interact with China in the world agricultural markets.

Following the exposition in Anderson and van Wincoop (2004, p.707,) the CES demand structure[2] implies that the exports X from i to j (in a given product class) are given by:

$$X_{ij} = \left(\frac{p_i t_{ij}}{P_j} \right)^{1-\sigma_k} E_j \tag{1}$$

where σ_k is the elasticity of substitution among origins, p_i is the supply price in country i, t_{ij} are the power of trade costs such that $t_{ij} - 1$ is the ad-valorem tax equivalent of trade costs, E_j are j's expenditures, and

[1] Thereafter AvW.

[2] A CES representation of consumer preferences is generally used to derive the gravity equation.

P_j is the CES price index in the importing country j:

$$P_j = \left[\sum_i p_i t_{ij}{}^{1-\sigma_k} \right]^{1/(1-\sigma_k)} \quad (2)$$

Anderson and van Wincoop (2004) impose the market clearing conditions $Y_i = \sum_j X_{ij}$, where Y_i is the export supply of country i. These market conditions are used to solve for the equilibrium supply prices p_i. The equilibrium supply price is then substituted for p_i in Equations 1 and 2 (see details in Appendix A), thus obtaining the following version of Anderson and van Wincoop (2004, p.708)'s gravity equation[3]:

$$X_{ij} = Y^k E_j Y_i \left(\frac{t_{ij}}{\tilde{\Pi}_i \tilde{P}_j} \right)^{1-\sigma_k} \quad (3)$$

subject to:

$$(\tilde{\Pi}_i)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma_k} E_j \quad \textit{Outward} \quad (4)$$

$$(\tilde{P}_j)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}}{\Pi_i} \right)^{1-\sigma_k} Y_i \quad \textit{Inward} \quad (5)$$

Equation 3 explains the variability of bilateral trade flows in terms of exporters' supply, importers' demand, bilateral trade costs, and the equilibrium price indexes $\tilde{\Pi}_i$ and $\tilde{P}_j$. AvW call these CES price indexes outward and inward multilateral resistance terms respectively. These terms show that the volume of exports from i to j depends simultaneously on the trade barriers that j imposes on all its partners and on the trade barriers that i faces on all its markets. The first effect is captured by the *inward* multilateral term $\tilde{P}_j$; it shows that if j imposes high trade barrier on i's competitors, i's will experience less resistance into j's market, and thus will export more to it. The second effect is captured by the *outward* multilateral resistance term $\tilde{\Pi}_i$; it shows that increased barriers on i's destination markets relative to the barriers imposed by j will also stimulate the flow of i's exports to j.

The interdependence of the price terms is of direct interest for this paper. The variable summarizing the effects of China's growth on the exports of other countries is the expenditure value $E_{j=China}$. Equation 3 shows that exports from i to any j grow proportionally with j's expenditures. This is an obvious result: demand increases with income. Of more interest are the indirect effects that China can have in a country's export demand, given its potential influence on global prices. In the framework of AvW this influence is

[3] AvW present their resulting equilibrium is in terms of production and expenditures relative to world output (i.e., E_j/Y^k, Y_i/Y^k with $Y^k = \sum_i Y_i = \sum_j E_j$.) For convenience in the empirical implementation we state this equilibrium in terms of absolute productions and expenditures. More details are provided in Appendix B

captured by the price terms.

For instance, the mechanics of Equation 4 show that a decrease in China's expenditures (E_{China}) cause an increase in the price index $\tilde{\Pi}_i$. In Equation 3, an increase of $\tilde{\Pi}_i$ is associated with a increase in the bilateral exports from i to j ($\forall j \neq China.$) We can look at this increase from two perspectives. First, because of the equilibrium condition $Y_i = \sum_j X_{ij}$, a decrease of the exports from i to China (due to lower China's expenditures) keeping i's production (Y_i) constant, will in general tip more of i's exports to other destinations. Alternatively, a decrease in China's expenditures E_{China} is equivalent to an increase in China's import barriers $t_{i,China}$, which is reflected in an increase in the multilateral resistance term of each exporting country i, $\tilde{\Pi}_i$.

More important for our objectives, the higher $\tilde{\Pi}_i$s following a decrease in E_{China}, decreases the price index of other importers j ($\tilde{P}_j$s) as can be seen in the mechanics of Equation 5. The intuition is that, by reducing China's demand for food while keeping world supplies fixed, the price indices of other importing countries should decline as more supplies becomes available. In other words, as long as China is an important source of inflation on food prices, a reduction of China's expenditures should reduce the cost that other countries face in attaining a given level of utility. In the CES framework, this level of utility is given by the CES aggregate that underlies the gravity equation, and its price is given by the CES price index in 2. In the empirical section, we will use counterfactual changes in these price indexes as a measure of the inflationary effect of China's economic growth. It is worth noticing that the impacts of China obtained using this framework have a geographical pattern determined by the trade costs (greatly conditioned by distance), between different exporters and China. To fix ideas, in Equation̈refeq:pii, the reduction in the outward multilateral resistance terms ($\tilde{\Pi}_i$) will be larger for those exporters facing the lowest trade costs into China's markets, $t_{i,j=China}$. Thus, the reductions in $\tilde{P}_j$ are going to be largest in those countries supplied by China's closest partners.

For exporting countries, the reduction in the price indexes in the importing locations implies a lower price for their exports. This is evidenced in Equation 2 which shows that, keeping trade costs constant, the decrease in the price indexes $\tilde{P}_j$ is consistent with a decrease of i's supply prices, p_i. This is another effect that we will be looking at more closely as it will capture whether a counterfactual reduction in China's demand would push world prices down thus contracting the agricultural exports of other countries (even if they do not export directly to China), thus giving us a counterfactual of China's effects on other countries exports. As before, the effects obtained under the proposed framework will be conditional on bilateral trade patterns — in particular, the exporters that will have a larger effect on their exports values are those depending more heavily on the markets that will experience the largest reductions in their price indices, that as we discuss, are those supplied by China's closest suppliers.

Our general strategy is to trace the temporal evolution of E_{China} where k refers to aggregated agricultural goods. With the temporal evolution of expenditures at hand, we calculate the prices that would sustain observed exports in the absence of growth in China's expenditures. This entails solving Equation 3 subject to Equations 4 and 5. From the comparative statics we would expect that in the absence of China's growth the outward multilateral resistance term ($\tilde{\Pi}_i$) for each country i would increase, decreasing the price index P_j reflecting a reduction of i's supply price. This gives us our first set of relevant results, i.e., the effects of China's growth in the food prices facing other countries. Once we obtain the equilibrium prices with attenuated China's expenditures, we use Equation 3 to recover the bilateral exports of each country i. These simulated exports should be lower than observed exports as long as China is an important destination (simply because we reduced China's expenditures.) In the absence of strong ties with China, the simulated exports should be lower than the observed exports as long as the reduced expenditures of China result in reductions of the supply prices receiving exporting countries.

A caveat to be noticed is that the analysis is inherently partial-equilibrium and of a short-run horizon. It is partial-equilibrium because it focused solely on agricultural products abstracting from interactions between productive sectors. For example, Abbot, Hurt, and Tyner (2008) argue that China is connected to higher food prices not through increased food demand, but through the increases in oil prices that are in turn linked to food prices through biofuel policies. We abstract from such interactions. Moreover, in predicting price changes and the trade patterns (simulated exports) that would prevail in the absence of China's expenditure growth, we do not take into account wage effects that could come from cheaper food and thus impact trade patterns in non-obvious ways. The analysis is short run because we do not allow any adjustment on the supply side. In this regard, the results are indicative of a sudden drop in China's demand. To the extent that these limitations are bore in mind, the results offer a useful upper bound benchmark of China's economic growth on the international food markets.

3 Empirical Implementation

We use import data (from the UN's Comtrade database) on the aggregated agricultural sector, comprised by the first 24 chapters of the Harmonized System. This level of aggregation is consistent with our objective of identifying in the data the generalized price effects attributable to China's increased demand for agricultural products. In order to get a period long enough for the potential effects of China's growth to manifest themselves, the data covers the period 1995-2006. The data included are the imports and exports of a set of 70 countries that cover most of the global trade in agricultural products. Because we will be comparing parameter estimates from different years, only those transactions that are positive in every year during the period of 1995-2006 are included.

The empirical strategy consists of identifying China's expenditures by taking advantage of the differences in China's import values across exporters. To accomplish this, start by taking natural logarithms of Equation 3 and rearrange to get[4]:

$$\log(X_{ij}) = \log(Y) + \log\left(\frac{E_j}{\tilde{P}_j^{1-\sigma}}\right) + \log\left(\frac{Y_i}{\tilde{\Pi}_i^{1-\sigma}}\right) + (1-\sigma)\log(t_{ij}) \tag{6}$$

where all variables have been previously defined. Differing from Anderson and van Wincoop (2003), we do not impose unitary income elasticities on Equation 6[5]. This allows us to have the expenditures explicit on the right hand side of Eq. 6. Although data on expenditures and production could be obtained with some effort, the price indexes are unobservable. In the original work of Anderson and van Wincoop (2003) these price indexes are recovered by assuming symmetric trade costs and minimizing the sum of squares of an equation similar to 6, subject to the price equations. A simpler alternative suggested by AvW and discussed in Feenstra (2002) is to use exporter and importer fixed effects to account for the unobserved price indexes. The fixed effects are especially appealing in our framework because they would capture not only differences in the unobservable price indices, but also differences in expenditures and production.

Following standard practice, and in analogous way to AvW, we define the trade costs (t_{ij}) as a multiplicative function of distance between partners and other factors that are known to condition bilateral trade flows such as border ($BORD_{ij}$) and language ($LANG_{ij}$) commonality, whether the countries are both landlocked ($LOCK_{ij}$,) whether they belong in the same preferential trade agreement (PTA_{ij})[6], and other factors (ϵ_{ij}.) Then, t_{ij} can be written as:

$$t_{ij} = (DIST_1^{\delta} e^{\delta_2 BORD_{ij} + \delta_3 LANG_{ij} + \delta_4 PTA_{ij} + \delta_5 LOCK_{ij} + \epsilon_{ij}}) \tag{7}$$

Denoting the country fixed effects by EXP_i (for exporters) and IMP_j (for importers) the estimating

[4]From now on we omit the subscript k as it is understood that we focus on the agricultural sector as a whole.

[5]The imposition of unitary income elasticities implies that the regressand is $\log(X_{ij}/E_jY_i,)$ i.e., the log of exports divided by the product of the income/production terms.

[6]This is a crude proxy for applied bilateral tariffs which are not available to us for the period considered here.

equation is:

$$\log(X_{ij}) = \beta_0 + \sum_i \alpha_i^X EXP_i + \sum_j \alpha_j IMP_j + \beta_1 \log(DIST_{ij}) + \beta_2 BORD_{ij} + \beta_3 LANG_{ij} + \beta_4 PTA_{ij} + \beta_5 LOCK_{ij} + (1-\sigma)\epsilon_{ij} \tag{8}$$

Where β_0 is an intercept, $\alpha_i^X = \log(Y_i/\tilde{\Pi}_i^{1-\sigma},)$ $\alpha_j^M = \log(E_j/\tilde{P}_j^{1-\sigma})$ and $\beta_i = (1-\sigma)\delta_i$ are parameters to be estimated, and ϵ_{ij} is a stochastic error assumed to have a zero mean and to be uncorrelated with any of the regressors.

The trade data X_{ij} on the left hand side of Equation 8 are the imports described above. The distance between exporter and importer is measured in kilometers, according to the great circle formula. The rest of the conditioning factors are measured each with a dummy variable that takes the value of one when a pair of countries share a border, speak the same language, are both landlocked, or belong in the same preferential trade agreement, and zero otherwise. Information on 65 existing PTAs was obtained from Fontagne and Zignago (2007). The rest of the data come from Mayer and Zignago (2006).

For exploring whether China's increases in demand for agricultural products imply higher agricultural prices, we simulate the pattern of bilateral exports that would have prevailed in 2006 if China's demand had stagnated at its 1995 levels. The idea is that, if China's demand is related to increased prices, the stagnation of China's demand should result in lower CES prices in other importing countries, and thus in lower export values in exporting regions.To illustrate our approach, we can sum over j the bilateral exports of i given in Equation 3, obtaining:

$$X_i = Y \frac{Y_i}{(\tilde{\Pi}_i)^{1-\sigma}} \sum_j \left[\left(\frac{t_{ij}}{\tilde{P}_j} \right)^{1-\sigma} E_j \right] \tag{9}$$

The first step in the simulation is to substitute China's expenditures in 1995 for China's expenditures in 2006 in every bilateral transaction of exporter i with China. The expenditure terms also affect total exports in 9 through its effects on the exporters' price indices $\tilde{\Pi}_i$ discussed in Section 2-Eq. 4. In an analogous way, we recalculate these indices by substituting China's expenditures in 1995 for the expenditures in 2006. These counterfactual $\tilde{\Pi}_i$s are simultaneously determined with the counterfactual importers' price indices $\tilde{P}_j$, which reflect the price level in other importing countries. The maintained hypothesis is that these price indexes should decline with the attenuation of China's demand for food.

From the exporters' viewpoint, a reduction of China's expenditures E_{China} will affect the price indexes of other countries P_j, and i's total exports *directly* through the changes in direct sales, and also *indirectly*, through the changes in other importer's price indexes (P_j.)

In terms of the parameter in the regression equation (8,) holding China's expenditures constant at 1995 levels reduces across the board all the importers' fixed effects. In turn, a reduction in the importer's fixed effect maps one-to-one to the reduction of the importer's price index. This is evident when we rewrite the importer fixed effect as:

$$\alpha_j^M = \log(E_j) + \log(P_j^{\sigma-1})$$

Which shows that keeping E_j constant, a reduction of α_j^M implies a reduction of $P_j^{\sigma-1}$. This is consistent with our discussion in Section 2, where a reduction in E_{China} will reduce the importer price indices P_j implying a reduction of the import price at each location j, and therefore of the supply price received by exporters in i.

Also from our discussion in Section 2, a decrease in E_{China} increases the multilateral resistance facing exporter i ($\tilde{\Pi}_i$.) To see how changes in $\tilde{\Pi}_i$ affect the exporter fixed effects, rewrite them as:

$$\alpha_i^X = \log(Y_i) + \log(\Pi_i^{\sigma-1})$$

This expression shows that by holding output (Y_i) constant, the increase in Π_i equals the increase in the simulated exporter fixed effects. These larger fixed effects have a positive effect on the exports from i to j, and thus that they work on an opposite direction that the changes in the importer fixed effects. This is a consequence of the market equilibrium underlying AvW's model, whereby the reduction on exports to the country expending less (i.e., China) must be compensated with increases in exports to the rest of the destinations.

To recover the observed estimates of $\tilde{\Pi}_i$, Equation 4 is rewritten using the estimated trade costs[7] $\widehat{t_{ij}^{1-\sigma}}$, the estimated importers' fixed effects $\hat{\alpha}_j^M$, and the fact that $\alpha_j^M = \log(E_j/\tilde{P}_j^{1-\sigma}.)$ This yields:

$$\widehat{\Pi_i^{1-\sigma_k}} = \sum_j e^{\hat{\alpha}_j^M} \widehat{t_{ij}^{1-\sigma}} \tag{10}$$

Likewise, the empirical importers' price indices ($\hat{P}_j$) are obtained by combining $\widehat{t_{ij}^{1-\sigma}}$, the estimated exporters' fixed effects $\hat{\alpha}_i^X$, and the fact that $\alpha_i^X = \log(Y_i/\tilde{\Pi}_i^{1-\sigma},)$ thus obtaining the empirical counterpart of

[7] As it is customary, we denote estimates with a hat $\hat{}$. The hat covers the term $1-\sigma$ because we recover the trade costs using: $DIST_{ij}^{\hat{\beta}_1} e^{\hat{\beta}_2 BORD_{ij} + \hat{\beta}_3 LANG_{ij} + \hat{\beta}_4 PTA_{ij} + \hat{\beta}_5 LOCK_{ij}}$. Because $\beta_i = (1-\sigma)\delta_i$, the result of this operation is $\widehat{t_{ij}^{1-\sigma}}$.

Equation 5:

$$\widehat{P_j^{1-\sigma_k}} = \sum_i e^{\hat{\alpha}_i^X} \widehat{t_{ij}^{1-\sigma}} \quad (11)$$

The price indices are used to solve for the importers' expenditures $\hat{E}_j$ and the exporters' outputs $\hat{Y}_i$ using the estimated fixed effects $\hat{\alpha}_j^M$ and $\hat{\alpha}_i^X$[8]. As mentioned before, the equilibrium implied by AvW's model requires simultaneous estimation of the price indices. Our approach is to find the counterfactual set of price indices $[\widehat{\Pi_{ci}^{1-\sigma}}, \widehat{P_{cj}^{1-\sigma}}]$ (the subscript c emphasizes the counterfactual nature of these indices) that minimizes the sum of squared residuals (SSR) of Equation 8, given the parameter estimates on trade costs (distance, border, etc.) and the set of production and expenditure values $[\hat{Y}_i, \hat{E}_j]$ recovered from the exporter and importer fixed effects. This is done in the next section.

4 Results and Discussion

Equation 8 is estimated using Ordinary Least Squares for each year during the period of 1995-2006. Full sets of fixed effects are used for both importers and exporters. The US is used as the omitted category. This implies that the measures of supply (output deflated by i's price index) and demand (expenditures deflated by j's price index) are relative to the average level of (the log of) bilateral US imports and exports. The output of the regressions is shown in Table 2.

The sectoral gravity models work as expected. For instance, the negative coefficient on distance implies that countries that are farther apart trade less. Countries that share a border, speak the same language, or are both landlocked tend to trade more than countries that do not share those characteristics. So do countries that belong in the same trade agreement, although this effect seems to be more evident toward the more recent years. For the most part, these coefficients are stable over time, economically important, and statistically significant. The last row of Table 2 shows the R^2 values. They indicate that the models explain on average over three fourths of the level of variation in bilateral trade, although we should be cautious with this interpretation as the fixed effects tend to overstate their magnitude.

Figure 2 shows China's importer fixed effects (in the upper panel) and food expenditures (in the lower panel) obtained as outlined above. The latter are indexed such that the value in year 1995 is unity. Notice that these fixed effects are negative, indicating that China's imports of agricultural products are below the US average level of agricultural trade. As we move towards the more recent years, the estimated fixed effects grow (become less negative). In the lower panel of Figure 2, the expenditures, as inferred from the regression

[8] I.e., $\alpha_j^M = \log(E_j/\tilde{P}_j^{1-\sigma}) \Rightarrow E_j = e^{\hat{\alpha}_j^M} \widehat{P_j^{1-\sigma}}$ and $\alpha_i^X = \log(Y_i/\tilde{\Pi}_i^{1-\sigma}) \Rightarrow Y_i = e^{\hat{\alpha}_i^X} \widehat{\Pi_i^{1-\sigma}}$.

coefficients, declined during 1996 an 1997, coinciding with the regional recession associated with the Asian financial crisis. After that, expenditures recovered, and by 2003, they were 3.5 times larger than in 1995. The figure shows a decline from 2003 to 2004, a slight recovery in 2005, and and a new contraction in 2006. This roughly agrees with Gale's assertion that China's agricultural imports from the US boomed during 2003-2004, although he registers the peak in 2004; our figures are not directly comparable because his are nominal, while ours are real in the sense that they are relative to the US' trade behavior. For our purposes, the relevant fact is that by 2006 China's expenditures on food were two times larger than in 1995.

As mentioned in the previous section, the parameter estimates on fixed effects and trade costs (distance, border, etc.) are used to find the set of importer and exporter price indexes $[\widehat{\Pi_i^{1-\sigma}}, \widehat{P_j^{1-\sigma}},]$ and the production and expenditure values $[\hat{Y}_i, \hat{E}_j]$ consistent with the exports observed in 2006. This gives us an approximation to the price effects of China's growth. We then simulate the exports that would have prevailed in 2006 if China's demand had stagnated at its 1995 levels. For this, we substitute China's expenditures in 1995 for China's expenditures in 2006, and calculate the counterfactual set of price indices $[\widehat{\Pi_{ci}^{1-\sigma}}, \widehat{P_{cj}^{1-\sigma}}]$ that is consistent with the exports observed in year 2006. Because the price indices are simultaneously determined, we obtain them by finding the set of fixed effects that minimize the SSR of Equation 8, assuming stagnation in China's demand. The minimization exercise yields a SSR of 5,277.46, slightly above 5,241.09, the SSR of the original regression[9]. The main consequence of holding China's expenditures constant at 1995 levels is to reduce across the board all the importers' fixed effects.

This is verified in Table 3 which shows, for the whole sample, the importer fixed effects before and after the simulation. Recall that, keeping other things constant, importer j's fixed effect indicates the difference between the average level of j's import and the total trade (exports plus imports) in agricultural products of the omitted category, i.e., the U.S. So, for example, using the fixed-effects based on the observed data (Table 3, Column 1), China's trade is 81% lower than the US agricultural trade[10]. After the simulation (Column 2), China's fixed effect drops, and China's imports appear to be 92% lower than those of U.S. total trade. This result is expected and is just indicating that China's average level of imports (in value terms) declined when we reduced China's demand for food. The third column of Table 3 shows the value of the difference between the fixed effects, which are negative for all countries. In our interpretation of the fixed effects as expenditures deflated by price indices, and keeping expenditures fixed, this means that the rpice

[9]The GAMS program employed for this is available upon request. The initial values for the unknown $[\widehat{\Pi_{ci}^{1-\sigma}}, \widehat{P_{cj}^{1-\sigma}}]$ were the indices $[\hat{\Pi}_i, \hat{P}_j]$ whose estimation was discussed above. The subscript c is to emphasize the counterfactual nature of the new price indices.

[10]Calculated using $e^{\alpha_j^M} - 1$, where $\alpha_{i(j)}^{X(M)}$ is the country fixed effect of interest. Using the values in Table 3, in the case of China, the calculation is $e^{-1.7} - 1$.

indices have fallen in all the countries in the sample. Thus, a sudden reduction of China's expenditures in agricultural goods causes a reduction in the price indices of other countries. The third column of Table 3 reveals that for most countries, the difference between observed and fixed effects is -0.04, or loosely speaking, most price indexes fall by 4%[11].

The last column of Table 3 shows the difference between the fixed effects, and how much that difference represents of the original values. This last measure is an indication of how much higher are prices at the destinations j as a consequence of China's increased demand for food. The first country is of course China, where in the absence of demand growth, the CES price index would be 51.3% lower. Follows Japan where the "inflationary" effect of China's growth on Japan's food prices is about 10%. After that is Germany (4.2%), England (2.9%) and other large Asian and European economies in which the CES price index is between 1.5% to 2.5% higher as a consequence of China's growth. The first ten economies in Table 3 are amongst the world largest food importers, thus it is not surprising that it is in these economies where price rises associated with more competition with China for (presumably in the short-run) fixed supplies of food are largest. It should be kept in mind that these are aggregated effects, thus these values represent the increase in *all* food prices.

The exporter fixed effects also change after the simulation. Table 4 shows the first 20 countries with the largest change in the exporter fixed effect. The first country is Brazil, in which the percentage change in the fixed effects is of 13.6% implying that the multilateral resistance term faced by this country increased by this much. These increases in the multilateral resistance imply that, if China had not grown the way it did and keeping national outputs constant, countries such as Brazil would be exporting more to other countries other than China. Notice that the countries with the largest increase in their multilateral resistance terms are countries with large exports of a reduced number of agricultural commodities such as Brazil (soybeans), Argentina (soybeans, corn), Malaysia (palm oil), Indonesia (palm oil). This suggests that it is for these countries were China's effects on agricultural exports are more important.

The changes in the importer and exporter price indices just discussed are the changes in prices needed to obtain the *observed* bilateral exports in the presence of attenuated China's demand. However, we can also use them to infer how different would had been the exports of countries that export agricultural products in the presence of stagnated China's demand. To this end, using the parameter estimates of Equation 8 and

[11] An important consideration here is that these are movements relative to the US's, so, to value the real deflationary effect, we should allow the US's fixed effect to move. This can be addressed varying the reference group, an exercise that will be performed later as a robustness test. Another possibility is to normalize both before and after-simulation fixed effects to the average level of US trade, so effectively perceiving how much this level changes, and thus correcting the estimates for this difference.

the terms recovered from them throughout this section, we rewrite a counterfactual version of Equation 9 as:

$$X_{ci} = e^{\hat{\beta}_0} \frac{\hat{Y}_i}{\widehat{\Pi_{ci}^{1-\sigma}}} \left[\sum_{j \neq China} \left(\frac{\widehat{t_{ij}^{1-\sigma}}}{\widehat{P_{cj}^{1-\sigma}}} \right) \hat{E}_j + \left(\frac{\widehat{t_{i,China}^{1-\sigma}}}{\widehat{P_{cChina}^{1-\sigma}}} \right) \hat{E}_{cChina} \right] \tag{12}$$

Where X_{ci} are the total exports of country i that would have prevailed (hence the subscript c for counterfactual) in the absence of China's demand growth. As explained before, the first order effect of a stagnation in China's demand is through $\hat{E}_{cChina}$ (i.e., China's expenditures in 1995), explicit within the summation symbol of Equation 12. To assess the importance of this channel, Equation 12 is first calculated using the original (as opposite to counterfactual) $\widehat{\Pi_i^{1-\sigma}}$ and $\widehat{P_j^{1-\sigma}}$. The resulting exports are then substracted from the observed exports (shown in the first column of Table 5), and the difference is expressed as percentage of the latter. The results are in the second column of Table 5.

Due to the potential effects on world prices, we argued that there may be indirect effects benefiting exporting countries, even if they do not directly export to China. Our discussion of the importer fixed effects confirmed that in few developed countries, China's increased demand for food has been a somehow important source of price inflation; it would be expected then that exporters shipping agricultural goods to these countries benefit from higher prices. To be able to asses the relative importance of these indirect effects, the third column of Table 5 shows the results of repeating the exercise outlined in the paragraph above, but using now $\widehat{P_{cj}^{1-\sigma}}$ instead of $\widehat{P_j^{1-\sigma}}$. The results are shown in the third column of Table 5. These percentages capture both the first order effects discussed in the previous column, and the indirect effects through changes in global prices. Notice that the indirect effects are now discernible in the data. For instance, Malawi would have exports 3.58% lower than observed, if China's expenditures had not grown since 1995. The results are similar for Mozambique (-3.58%), Tanzania (-5.15%), Zambia (-4.01%) and the SACU (-4.01%). In principle, it would be tempting to link these results to a generalized effect of China on world food prices, however, given the level of aggregation in the data, it is quite possible that the results are rather artificial. To see this more clearly, we could think that China's effects are limited to oilseeds. In the aggregate data, an increase in the price of the oilseeds appear as a diluted increase in the price of all food products. Then we are valuing the SA exports with this effect, even if they do not export oilseeds.

For some countries in Asia and Latin America a contraction in China's expenditures seems to be more important. In our countefcatual, Indonesia's agricultural exports are 7.37% lower than observed. When we consider the indirect effect of China in world supply prices (i.e., indirect effects), Indonesia exports would be 10.52% lower than observed. The results for Malaysia are similar. In Latin America, the contraction of the exports ranges from 7.29% in Argentina, to 9.64% in Peru. As in all the other cases, the indirect effects account for an additional disminution in export values of aproximately 3.5%. This comparison shows that the data combined with the model of AvW can effectively capture the effects of changes in China's expenditures.

5 Conclusions

The objective of this paper was to explore the impacts of China's growth in the international markets of agricultural products. These impacts are important because they are related to two different ongoing discussions about the role of China in the world economy. One of these discussions have to do with China as a source of price inflation while the other has to do with China as an engine of growth for developing countries, in this case, through increased export opportunities.

The framework of choice for capturing and separating the direct and indirect effects of China was the gravity model proposed by Anderson and van Wincoop (2003), but applied to the agricultural sector. This framework is general enough to accommodate several supply-side structures, allowing us to focus on the demand side. Using aggregated data on trade in agricultural products for the period of 1995-2006, we used the model to trace the evolution of China's expenditures during the last decade.

Our results suggest that China has been a source of aggregated mild price inflation in the largest developed economies that occupy the first ranks as food importers. This is probably related to a more intense pressure on world food supplies. When we look at the counterfactual exports of selected exporters, we find that few countries in Latin America (Brazil, Peru), and in Asia (Malaysia, Indonesia), have benefited from China's increased food demand. This is explained by the fact that these countries are oilseed exporters, a commodity group in which China have been particularly active. When we take into account the indirect effects esteeming from China's growth, we find that these are pretty small. Thus, it is difficult to conclude that China has been an engine of growth for agricultural exports in general.

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Table 1: China's main agricultural imports (as % of total agricultural imports)

Code HS-4	Product Description	1995	2000	2004
1201	Soybeans, whether or not broken	0.79	23.85	31.82
1511	Palm oil & its fractions, not chemically modified	9.07	4.79	8.52
1001	Wheat and meslin	21.25	1.55	7.48
1507	Soybean oil & its fractions, not chemic modified	10.74	1.32	7.06
303	Fish, frozen (no fish fillets or other fish meat)	3.22	7.19	6.92
2301	Flour, meal etc of meat etc, not for human greavs	3.46	6.65	3.51
2106	Food preparations nesoi	0.17	0.57	1.60
714	Cassava, arrowroot etc, fresh or dry sago pith	0.71	0.23	1.57
307	Molluscs & aqua invert nesoi, lve etc. flours etc	0.62	1.91	1.52
1003	Barley	2.52	3.29	1.46
306	Crustcns live fresh etc, ckd etc. flrs mls h cnsump	1.33	2.27	1.42
1701	Cane or beet sugar & chem pure sucrose, solid form	9.41	1.21	1.26
1006	Rice	4.55	1.18	1.15
1514	Rapeseed, colza or mustard oil etc, not chem modif	4.33	0.29	0.99
207	Meat & ed offal of poultry, fresh, chill or frozen	0.84	5.05	0.70
1205	Rape or colza seeds, whether or not broken	0.27	6.91	0.61
803	Bananas and plantains, fresh or dried	0.44	1.78	0.43
2402	Cigars, cigarettes etc., of tobacco or substitutes	3.45	0.41	0.24
1005	Corn (maize)	8.56	0.00	0.00

Source: UN Comtrade Database. Notes: The table shows the import value of individual agricultural products as percentage of China's total agricultural imports. The products included are the union of the top 10 products imported by China in 1995, 2000, and 2004. The shares are sorted (in decreasing order) by their values in 2004.

Table 2: Regression coefficients from gravity model. Country fixed effects are ommited.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Constant	26.224***	26.456***	26.591***	26.291***	26.394***	26.211***	26.379***	25.896***	25.789***	26.484***	26.560***	26.775***
	(0.514)	(0.512)	(0.487)	(0.495)	(0.492)	(0.464)	(0.451)	(0.460)	(0.450)	(0.464)	(0.461)	(0.466)
Log(Distance)	-1.170***	-1.179***	-1.184***	-1.150***	-1.177***	-1.149***	-1.180***	-1.131***	-1.109***	-1.192***	-1.216***	-1.223***
	(0.050)	(0.050)	(0.048)	(0.049)	(0.049)	(0.046)	(0.044)	(0.045)	(0.044)	(0.045)	(0.045)	(0.045)
Share border	0.569***	0.589***	0.620***	0.631***	0.562***	0.591***	0.594***	0.608***	0.634***	0.642***	0.673***	0.709***
	(0.165)	(0.157)	(0.153)	(0.153)	(0.155)	(0.159)	(0.146)	(0.146)	(0.145)	(0.140)	(0.141)	(0.139)
Common language	0.667***	0.679***	0.655***	0.665***	0.696***	0.637***	0.670***	0.719***	0.681***	0.669***	0.622***	0.610***
	(0.103)	(0.100)	(0.097)	(0.096)	(0.094)	(0.094)	(0.091)	(0.090)	(0.090)	(0.093)	(0.093)	(0.094)
Both landlocked	0.846***	0.872***	0.885***	0.907***	0.890***	0.902***	0.680***	0.613***	0.641***	0.517**	0.422*	0.301
	(0.233)	(0.216)	(0.232)	(0.246)	(0.219)	(0.206)	(0.196)	(0.199)	(0.204)	(0.212)	(0.240)	(0.259)
Trade Agreement	-0.317***	-0.243**	-0.182*	-0.068	-0.051	0.105	0.089	0.243***	0.310***	0.233***	0.127	0.059
	(0.110)	(0.107)	(0.103)	(0.105)	(0.105)	(0.098)	(0.093)	(0.091)	(0.089)	(0.088)	(0.089)	(0.090)
N	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114	3114
$RMSE$	1.479	1.435	1.400	1.396	1.350	1.314	1.287	1.309	1.296	1.308	1.336	1.328
R^2	0.717	0.727	0.733	0.728	0.744	0.754	0.761	0.757	0.761	0.768	0.758	0.759

Robust standard errors in parentheses. **** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.10$

	Country	Before (1)	After (2)	Difference (3)	Diff as % of "Before" (4)
9	China	-1.70	-2.57	-0.87	51.28
33	Japan	-0.45	-0.49	-0.05	10.36
14	Germany	-0.95	-0.99	-0.04	4.17
22	United Kingdom	-1.27	-1.31	-0.04	2.99
58	Singapore	-3.07	-3.15	-0.09	2.80
21	France	-1.47	-1.51	-0.04	2.67
27	Indonesia	-2.56	-2.62	-0.07	2.64
18	Spain	-1.48	-1.52	-0.04	2.55
50	Netherlands	-1.61	-1.65	-0.04	2.45
32	Italy	-1.63	-1.67	-0.04	2.39
34	Rep. of Korea	-2.12	-2.17	-0.05	2.21
2	Australia	-2.03	-2.07	-0.04	2.19
48	Malaysia	-3.23	-3.30	-0.07	2.14
25	China, Hong Kong SAR	-2.46	-2.51	-0.05	1.99
55	Poland	-2.98	-3.02	-0.04	1.32
52	New Zealand	-3.43	-3.48	-0.04	1.30
23	Greece	-3.17	-3.21	-0.04	1.27
62	Sweden	-3.15	-3.19	-0.04	1.24
15	Denmark	-3.22	-3.26	-0.04	1.21
69	So. African Customs Union	-3.15	-3.19	-0.04	1.20
56	Portugal	-3.21	-3.24	-0.04	1.19
7	Switzerland	-3.42	-3.46	-0.04	1.16
6	Brazil	-3.28	-3.31	-0.04	1.11
28	India	-3.83	-3.87	-0.04	1.09
53	Oman	-4.47	-4.51	-0.05	1.06
51	Norway	-3.65	-3.69	-0.04	1.06
3	Austria	-3.83	-3.87	-0.04	1.04
31	Israel	-3.70	-3.73	-0.04	1.03
20	Finland	-3.95	-3.99	-0.04	1.00
13	Czech Rep.	-4.07	-4.11	-0.04	0.97
57	Romania	-4.18	-4.22	-0.04	0.96
16	Algeria	-4.09	-4.13	-0.04	0.94
41	Maldives	-6.16	-6.21	-0.05	0.88
8	Chile	-4.30	-4.33	-0.04	0.88
29	Ireland	-4.28	-4.32	-0.04	0.87
63	Turkey	-4.57	-4.61	-0.04	0.87
36	Lithuania	-4.45	-4.48	-0.04	0.87
46	Mauritius	-5.31	-5.35	-0.04	0.83
38	Morocco	-4.54	-4.58	-0.04	0.82
26	Hungary	-5.02	-5.06	-0.04	0.79
12	Cyprus	-5.19	-5.23	-0.04	0.78
45	Mozambique	-5.44	-5.48	-0.04	0.77
1	Argentina	-4.92	-4.95	-0.04	0.77
40	Madagascar	-5.64	-5.68	-0.04	0.73
60	Slovakia	-5.51	-5.55	-0.04	0.73
19	Estonia	-5.45	-5.49	-0.04	0.72
37	Latvia	-5.37	-5.41	-0.04	0.72
42	Mexico	-2.84	-2.86	-0.02	0.71
47	Malawi	-7.02	-7.07	-0.05	0.69
54	Peru	-5.06	-5.10	-0.03	0.68
68	Venezuela	-4.46	-4.49	-0.03	0.68
10	Colombia	-4.66	-4.69	-0.03	0.67
70	Zambia	-6.66	-6.70	-0.04	0.66
64	United Rep. of Tanzania	-6.06	-6.10	-0.04	0.65

61	Slovenia	-6.17	-6.21	-0.04	0.64
65	Uganda	-6.21	-6.25	-0.04	0.64
39	Rep. of Moldova	-6.56	-6.60	-0.04	0.61
43	TFYR of Macedonia	-6.49	-6.53	-0.04	0.61
66	Uruguay	-6.34	-6.37	-0.04	0.61
30	Iceland	-5.92	-5.95	-0.03	0.57
44	Malta	-6.58	-6.62	-0.04	0.57
17	Ecuador	-5.51	-5.54	-0.03	0.56
5	Bolivia	-6.83	-6.87	-0.04	0.53
11	Costa Rica	-5.61	-5.64	-0.03	0.49
59	El Salvador	-5.58	-5.61	-0.03	0.45
4	Burundi	-7.90	-7.94	-0.04	0.45
24	Guatemala	-5.73	-5.76	-0.02	0.43
49	Nicaragua	-6.93	-6.96	-0.03	0.38
35	Saint Lucia	-8.19	-8.21	-0.02	0.25
67	USA	0.00	0.00	0.00	

Table 3: Importer fixed effects before and after simulation from regressions for year 2006 (All countries).

Source: Author's elaboration based on regression output. Notes: The first column are the importer fixed effects originally obtained from estimating Eq. 8 for year 2006. Next are the importer fixed effects obtained by minimizing the sum of squared residuals obtained by taken costs, expenditures and outputs as given, and reducing China's expenditures on food to its 1995 levels. Follows a columns with the difference between "Before" and "After". The last column express this difference as percentage of the original fixed effects. Because we hold expenditures constant, the reduction of this fixed effects is equivalent to a reduction of the prices of imported food in each country.

Table 4: Exporter fixed effects before and after simulation from regressions for year 2006 (Top 20 countries).

	Country	Before (1)	After (2)	Difference (3)	Diff. as % of “Before” (4)
1	Brazil	-0.29	-0.25	-0.04	13.60
2	Argentina	-0.57	-0.53	-0.04	6.75
3	China, Hong Kong SAR	-5.48	-5.22	-0.26	4.77
4	Malaysia	-2.13	-2.03	-0.09	4.46
5	India	-2.44	-2.33	-0.11	4.44
6	Indonesia	-1.90	-1.81	-0.08	4.29
7	China	-1.10	-1.06	-0.04	3.93
8	Japan	-3.86	-3.72	-0.14	3.69
9	Australia	-1.66	-1.60	-0.06	3.66
10	Rep. of Korea	-4.39	-4.23	-0.16	3.59
11	New Zealand	-1.60	-1.55	-0.05	3.25
12	Netherlands	-1.33	-1.29	-0.04	3.00
13	France	-1.50	-1.46	-0.04	2.65
14	Germany	-1.52	-1.48	-0.04	2.62
15	Chile	-1.48	-1.45	-0.04	2.58
16	Spain	-1.78	-1.74	-0.04	2.28
17	Singapore	-3.80	-3.72	-0.08	2.18
18	Italy	-1.91	-1.86	-0.04	2.18
19	United Kingdom	-1.91	-1.87	-0.04	2.05
20	So. African Customs Union	-2.41	-2.36	-0.04	1.86

Source: Author’s elaboration based on regression output. Notes: The first column are the exporter fixed effects originally obtained from estimating Eq. 8 for year 2006. Next are the exporter fixed effects obtained by minimizing the sum of squared residuals obtained by taken costs, expenditures and outputs as given, and reducing China’s expenditures on food to its 1995 levels. Follows a columns with the difference between “Before” and “After”. The last column express this difference as percentage of the original fixed effects. Because we hold output constants, the increases in these fixed effects reflect larger exports to other countries as China reduces its expenditures on food.

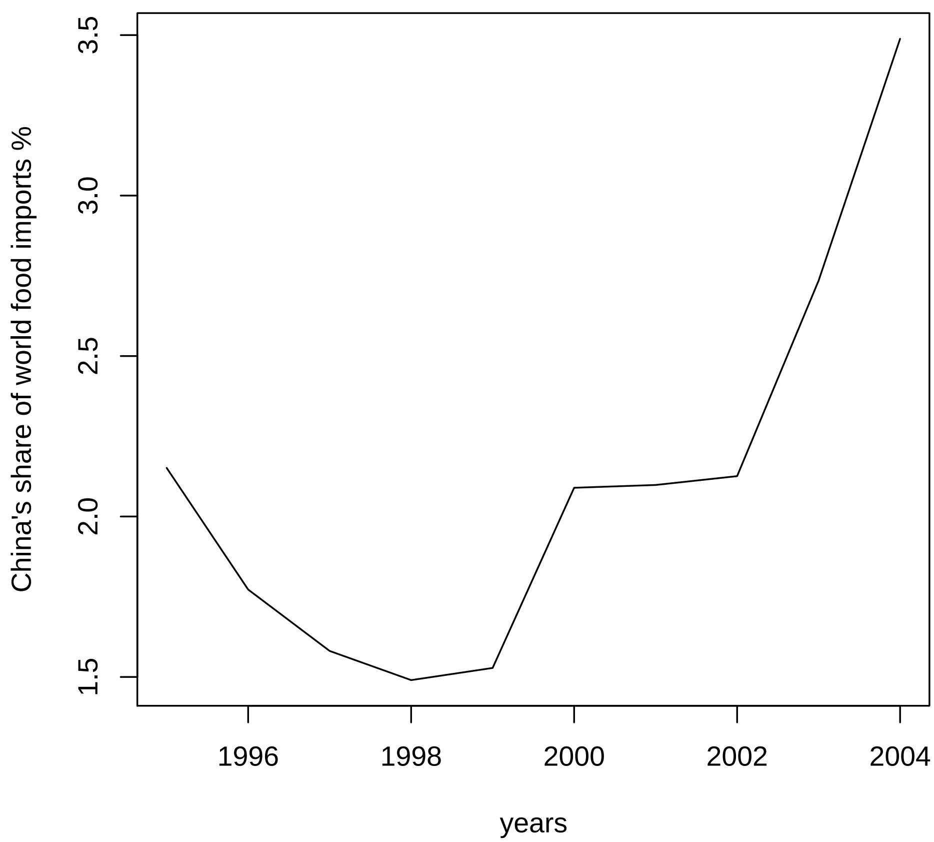
	Country	Export Value (1)	Direct Effect (2)	Direct Effect + Imp. Pr. Effect (3)
1	Malaysia	7559254.51	-13.13	-16.58
2	Peru	3775658.26	-9.65	-12.06
3	Japan	2543263.06	-8.91	-11.86
4	Brazil	25949264.72	-8.36	-11.26
5	Indonesia	9748761.03	-7.37	-10.52
6	China, Hong Kong SAR	422810.28	-7.37	-11.04
7	Argentina	19122031.40	-7.29	-10.48
8	Rep. of Korea	2377607.18	-5.59	-9.03
9	USA	50683304.55	-5.01	-8.40
10	Singapore	1716256.58	-4.90	-9.11
11	Uruguay	1727614.80	-4.82	-7.46
12	New Zealand	8844920.00	-3.70	-6.93
13	India	6270457.37	-3.52	-6.78
14	Australia	16036478.77	-2.68	-6.48
15	Chile	10044406.25	-1.80	-4.27
16	Norway	5579345.65	-1.71	-5.32
17	Finland	1020249.16	-1.63	-5.09
18	United Rep. of Tanzania	541595.11	-1.40	-5.15
19	Iceland	1745130.56	-1.30	-4.70
20	Oman	63129.80	-1.27	-5.20
21	Israel	1737483.35	-1.11	-4.42
22	France	41266675.12	-0.68	-4.24
23	United Kingdom	17510032.44	-0.58	-4.04
24	Sweden	3771581.17	-0.52	-3.87
25	Denmark	14277425.67	-0.46	-4.22
26	So. African Customs Union	4595551.67	-0.45	-4.15
27	Guatemala	2052434.93	-0.31	-1.97
28	Netherlands	46021041.81	-0.30	-3.93
29	Ireland	11144351.56	-0.28	-3.87
30	Madagascar	391575.75	-0.28	-3.97
31	Portugal	3230857.79	-0.23	-3.85
32	Turkey	5005074.68	-0.20	-3.73
33	Switzerland	3692267.89	-0.20	-3.82
34	Poland	8566677.73	-0.19	-3.92
35	Italy	24389666.11	-0.17	-3.53
36	Spain	27220095.93	-0.16	-3.81
37	Mexico	12907147.10	-0.16	-0.76
38	Germany	42106737.86	-0.13	-3.87
39	Hungary	3657063.14	-0.11	-3.95
40	Estonia	409604.60	-0.10	-3.86
41	Greece	3685637.60	-0.09	-3.73
42	Morocco	2657086.78	-0.08	-3.75
43	Costa Rica	3281144.68	-0.07	-2.07
44	Austria	6999648.94	-0.05	-3.45
45	Ecuador	4228361.75	-0.04	-2.52
46	Colombia	4704865.84	-0.03	-2.34
47	Czech Rep.	2777579.26	-0.02	-3.86
48	Saint Lucia	31563.70	-0.00	-3.71
49	TFYR of Macedonia	210147.03	-0.00	-3.68
50	Bolivia	365201.32	-0.00	-3.15
51	Lithuania	1028766.12	-0.00	-3.78
52	Malta	133396.16	-0.00	-4.30
53	Malawi	356976.28	-0.00	-3.46
54	Algeria	69951.21	-0.00	-3.75

55	Venezuela	482757.82	-0.00	-2.36
56	Burundi	26005.22	-0.00	-3.59
57	El Salvador	533481.75	-0.00	-1.69
58	Zambia	156658.23	-0.00	-4.01
59	Cyprus	246731.74	-0.00	-3.86
60	Nicaragua	610283.79	0.00	-1.29
61	Mozambique	225011.20	0.00	-3.59
62	Mauritius	610644.64	0.00	-3.45
63	Uganda	332135.00	0.00	-3.67
64	China	26737921.73	0.00	-3.75
65	Rep. of Moldova	185246.83	0.00	-3.85
66	Maldives	75384.82	0.00	-4.03
67	Romania	746870.36	0.00	-3.77
68	Slovakia	1226279.75	0.00	-3.86
69	Slovenia	415079.37	0.00	-3.81
70	Latvia	490181.65	0.00	-3.69

Table 5: Total agricultural exports of selected countries and estimated percentage reduction given a contraction on China's expenditures on food imports.

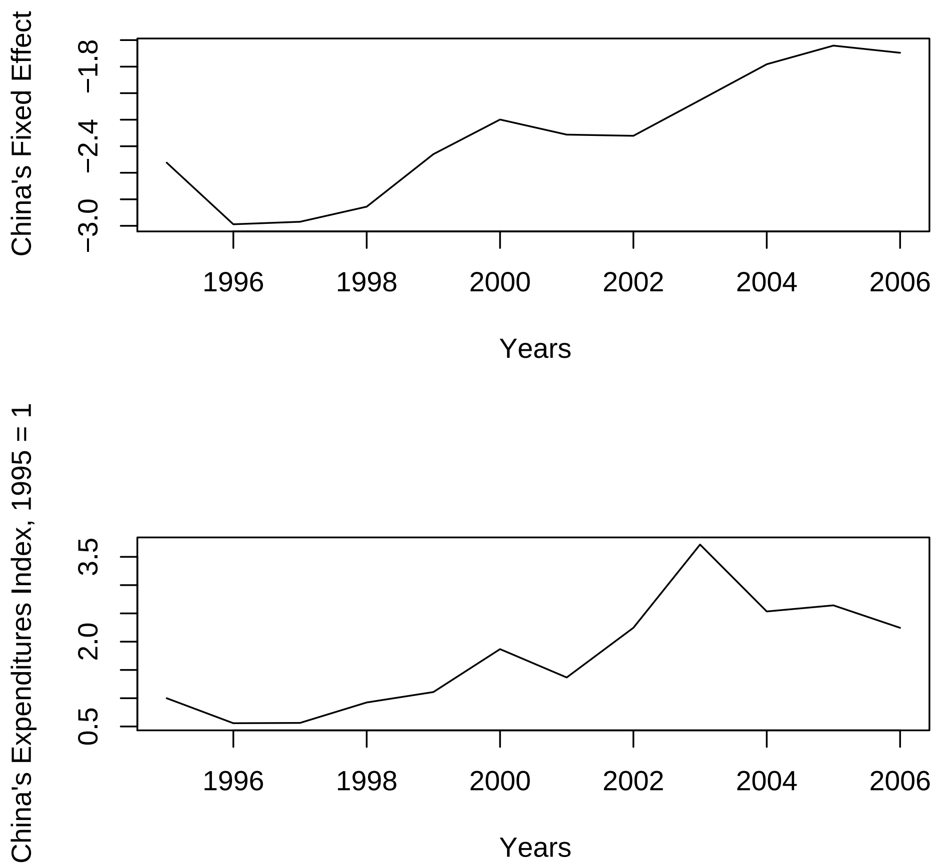
Source: Author's elaboration based on regression output. Notes: The first column are the total agricultural exports in 2006 (US$ thousands). The second column is the percentage by which, exports simulated holding China's expenditures constant, differ from the observed exports. The third column is the percentage by which, exports simulated holding China's expenditures constant and taking into account reductions in the CES import prices, differ from the observed exports. The last column is the percentage by which, exports simulated holding China's expenditures constant and taking into account changes in both importer and exporter price indexes, differ from the observed exports.

Figure 1: China's share of world agricultural imports.



Source: UN's Comtrade database. Notes: The figure shows the evolution (1995-2004) of the Chinese share of world agricultural imports (in % terms). The agricultural imports are the sum of the first 24 chapters of the Harmonized System. These chapters comprise the bulk of the agricultural products defined in the WTO Uruguay Agreement on Agriculture.

Figure 2: Evolution of China's expenditures on food, estimated from regression fixed effects.



Source: Author's elaboration based on regression output. Notes: The upper panel shows the evolution of China's importer fixed effects ($\hat{\alpha}_j^M$). These are a measure of the percentage by which China's imports differ from US average trade; for example, in 2006 China's imports where $(e^{\hat{\alpha}_j^M} - 1)100 = 81.65\%$ lower than the US average level of trade. The lower panel shows the evolution of China's aggregate expenditures on food inferred from the estimated fixed effects from Eq. 8. To facilitate interpretation, the expenditures are indexed relative to 1995. The procedure to get the expenditures involves: (1) estimating Eq. 8 for each year of the period 1995-2006; (2) using the importers' fixed effects to obtain the importers' price indices using $\widehat{P_j^{1-\sigma_k}} = \sum_i e^{\hat{\alpha}_i^X} \widehat{t_{ij}^{1-\sigma}}$; and (3) using each importer's price index to solve for its expenditures, i.e., $\alpha_j^M = \log(E_j/\tilde{P}_j^{1-\sigma}) \Rightarrow E_j = e^{\hat{\alpha}_j^M} \widehat{P_j^{1-\sigma}}$.

Appendices

A Derivation of the gravity equation.

From the text, the exports X from i to j in product class k are given by:

$$X_{ij}^k = \left(\frac{p_i^k t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k \tag{A-1}$$

where σ_k is the elasticity of substitution among origins, p_i^k is the supply price in country i, t_{ij}^k are trade costs such that $t_{ij}^k - 1$ is the ad-valorem tax equivalent of trade costs, E_j^k is the expenditure of j in product k, and P_j^k is the CES price index in the importing country j:

$$P_j^k = \left[\sum_i p_i^k {t_{ij}^k}^{1-\sigma_k}\right]^{1/(1-\sigma_k)}$$

Anderson and van Wincoop (2003, p.175) achieve "general equilibrium determination of prices" by imposing the market clearing condition:

$$Y_i^k = \sum_j X_{ij}^k \quad i \in j \tag{A-2}$$

I.e., in equilibrium, country i's output Y equals the sum of its exports and own consumption. Anderson and van Wincoop (2003) solve for the equilibrium prices p_i^k by first substituting A-1 into A-2:

$$Y_i^k = \sum_j \left(\frac{p_i^k t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k = {p_i^k}^{1-\sigma_k} \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k \tag{A-3}$$

so obtaining:

$$p_i^k = \left[\frac{Y_i^k}{\sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k}\right]^{\frac{1}{1-\sigma_k}}$$

This equilibrium suply price is substituted back in Expression A-1:

$$X_{ij}^k = \frac{Y_i^k}{\sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k} \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k$$

yielding AvW's gravity Equation:

$$X_{ij}^k = \frac{E_j^k Y_i^k}{Y^k} \left(\frac{t_{ij}^k}{P_j^k \Pi_i^k}\right)^{1-\sigma_k}$$

where:

$$(P_j^k)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} \frac{Y_i^k}{Y^k}$$

$$(\Pi_i^k)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} \frac{E_j^k}{Y^k}$$

B Modification of the system by AVW

The objective is to slightly modify the system of AVW to eliminate the world production term Y^k from the demand function X_{ij}^k and the price terms P_j^k and Π_i^k. This simplifies the identification of China's expenditures $E_{j=China}^k$ and the interpretation of the constant term in the econometric implementation. Start with the system proposed by AVW (Equations 5, 6 and 7 in AVW, p. 708):

$$X_{ij}^k = \frac{E_j^k Y_i^k}{Y^k} \left(\frac{t_{ij}^k}{P_j^k \Pi_i^k}\right)^{1-\sigma_k}$$

subject to:

$$(P_j^k)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} \frac{Y_i^k}{Y^k}$$

$$(\Pi_i^k)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} \frac{E_j^k}{Y^k}$$

where X_{ij}^k are the exports from i to j in product class k, E_i^k and Y_i^k are the value of production and expenditure in country i for product class k, t_{ij}^k are trade barriers (understood in a broad sense), $\tilde{P}_j^k$ and $\tilde{\Pi}_i^k$ are the CES price indices in countries i and j respectively, and σ_k is the elasticity of substitution among origins.

Rewrite X_{ij}^k with the price indexes in explicit form:

$$X_{ij}^k = \frac{E_j^k Y_i^k}{Y^k} \frac{(t_{ij}^k)^{1-\sigma_k}}{\sum_i \left(\frac{t_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} \frac{Y_i^k}{Y^k} \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} \frac{E_j^k}{Y^k}}$$

Simplify the Y^k terms:

$$X_{ij}^k = Y^k E_j^k Y_i^k \frac{(t_{ij}^k)^{1-\sigma_k}}{\sum_i \left(\frac{t_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} Y_i^k \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k}$$

rename the price indices purged of Y_k as $\tilde{\Pi}_i$ and $\tilde{P}_j$, then, rewrite the system as:

$$X_{ij}^k = E_j^k Y_i^k Y^k \left(\frac{t_{ij}^k}{\tilde{\Pi}_i^k \tilde{P}_j^k}\right)^{1-\sigma_k}$$

subject to:

$$(\tilde{P}_j^k)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} Y_i^k$$

$$(\tilde{\Pi}_i^k)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k$$

This is the system of Equations 3, 5, and 4 in the text.