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China's Growth and the Agricultural Exports of Southern Africa

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Contents

Acknowledgments	v
Abstract	vi
1. Introduction	1
2. China's Import Demand and Southern Africa's Export Supply of Agricultural Products	3
3. Theoretical Framework	6
4. Empirical Implementation	9
5. Results and Discussion	12
6. Conclusion	19
Appendix	20
References	22

List of Tables

Table 1. China's main agricultural imports (as percentage of total agricultural imports) 4

Table 2. Main agricultural exports of Southern African countries (as percentage of total exports)5

Table 3. Regression coefficients from gravity model[a] 13

Table 4. Importer-fixed effects before and after simulation from regressions for year 2006 (Top 20 countries) 15

Table 5. Exporter-fixed effects before and after simulation from regressions for year 2006 (Top 20 countries) 16

Table 6. Total agricultural exports of selected countries and estimated percentage reduction given a contraction in China's expenditures on food imports 17

List of Figures

Figure 1. China's share of world agricultural imports. 3

Figure 2. Evolution of China's expenditures on food, estimated from regression using fixed effects 14

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ABSTRACT

The implications of China's growth for the development prospects of Sub-Saharan Africa have been the subject of recent attention. Interest in this topic is motivated by the increasing presence of China in the region and the growing bilateral trade links between China and Africa. Against this background, we herein explore whether China's growth has stimulated agricultural exports in selected countries of Southern Africa, namely, Malawi, Mozambique, Tanzania, the Southern African Custom Union (SACU), and Zambia. We find little complementarity between China's agricultural import demand and the export supply of the focus countries. We also explore whether China affects Southern African agricultural exports through the increases in world agricultural prices associated with China's growing demand for food. We find that although China has moderately increased agricultural prices (in an aggregated sense), Southern African exports do not seem to benefit from these price increases.

Keywords: agriculture, China, gravity model, Southern Africa, trade

1. INTRODUCTION

This paper explores the impact of China's economic growth on the agricultural exports of selected Southern African countries. The study can be framed within a broader body of literature looking at the implications of China's growth for the development prospects of Sub-Saharan Africa[1]. A main conclusion of this literature is that China's involvement in Africa is driven by China's need to ensure access to natural resources. Furthermore, this involvement is complex, in that it encompasses political cooperation, investment, aid, and trade. The effects of the close relationship between China and Africa are particularly evident in the area of trade. During the period of 2004-2007, African exports to China increased at an average rate of 46.1 percent per year, positioning China as Africa's third largest export market after the EU and the US (Besada, Wang, and Whalley 2008). However, these aggregate figures mask the fact that growth in Africa's exports to China is driven by exports of oil, metals and other mineral resources coming from a relatively few countries.

In 2007, the exports of oil and related products from Angola, Sudan, Congo, and Equatorial Guinea accounted for 60 percent of all African exports to China (Besada, Wang, and Whalley 2008); Table 1, p.8). Exports from South Africa alone, mostly diamonds, accounted for 18 percent. For most of these countries, China's growth led to an improvement in their terms of trade. Zafar (2007; Table 1, p. 111) finds that during the period of 2002-2005, Angola's terms of trade[2] increased by 26.5 percent, Sudan's by 18.7 percent, Congo's by 23.9 percent, and Equatorial Guinea's by 93.7 percent. Zambia, an exporter of copper, experienced an improvement of 23.4 percent.

From these trends, one might naturally ask why we herein focus on agriculture when most of the effects seem to be concentrated in oil, metals, and other mineral resources. The answer is three-fold. First, a considerable number of African countries are not oil exporters, but rather specialize in agriculture. In the specific case of Southern Africa, 79.5 percent and 56.7 percent of Malawi's and Tanzania's exports comprise agricultural and food products[3]. Second, even in countries that specialize in exports of minerals, the agricultural sector is still very important in any development strategy for three reasons: because it is a major contributor to exports; because it is the main source of employment in most African countries; and because it concentrates most of the poor. In Zambia and Mozambique, 65 percent of the population in each of these countries was living in rural areas in 2006, with 78 and 55 percent, respectively, of these rural populations falling below the poverty line. In the case of Malawi, the rural population represented 83 percent of the total population in that same year, and 66 percent of the rural population was poor. In Zambia, a major exporter of minerals, 70 percent of total employment in 1998 was in agriculture. Third, China (along with India and other developing countries) is often seen as a source of inflationary pressure on food prices, due to growing demand. To the extent that China exerts upward pressure on world food prices, food exporters and importers may be positively and negatively affected, respectively, by higher food prices.

In addition to Malawi and Tanzania, our analysis covers Mozambique, Zambia and the countries of the Southern African Custom Unions (SACU)[4], which are treated as an entity due to trade data availability[5]. The next section discusses the structural differences between China's import demand and these countries' export supplies. The main conclusion is that the countries' agricultural exports to China are almost nonexistent. In this sense, there is no reason to expect that China's growth will impact Southern Africa's agricultural exports. However, given the possibility of indirect effects through global prices, we undertake an econometric analysis that allows us to quantitatively estimate the upward pressure on food

[1]See, for example, Goldstein et al. (2006), Zafar (2007), and Besada, Wang, and Whalley (2008).

[2]Export prices divided by import prices.

[3]Average 2000-2005 from The World Bank (2007).

[4]Botswana, Lesotho, Namibia, Swaziland, and South Africa.

[5]Up until 2000, the countries of the SACU reported their trade statistics together.

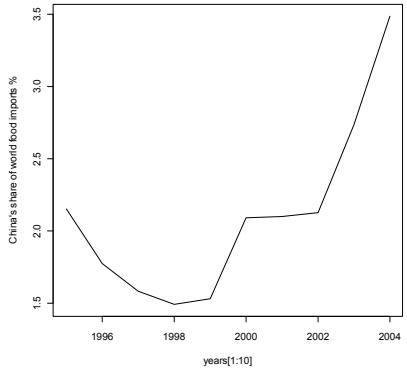
prices attributable to China's growth, and investigate its influence on the focus countries' agricultural exports.

Our econometric strategy, fully developed in Sections III and IV, 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 that differentiates demand by origin. The model is also compatible with a number of specifications on the supply side. These features avoid the need to make 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 Constant Elasticity of Substitution (CES) function underlying the gravity model allow us to capture the broad price effects of China.

2. CHINA'S IMPORT DEMAND AND SOUTHERN AFRICA'S EXPORT SUPPLY OF AGRICULTURAL PRODUCTS

Over the past few years, China has consistently ranked among the 10 top world importers of agricultural products[6]. As shown in Figure 1, China has steadily increased its share of world food imports since 1998, with this share increasing from 2.15 percent in 1995 to 3.49 percent in 2004[7]. Nevertheless, China's share of world food markets (2.51 percent on average for the period 2000-2004) is small compared with those of the world's top food importers, such as the US (11.64 percent), Japan (9.59 percent), Germany (8.2 percent), Great Britain (6.41 percent) and France (5.75 percent). Although data limitations prevent us from providing a more up-to-date analysis, the available evidence suggests that China's shares of global agricultural markets have continued to grow. For instance, the latest trade profiles of the WTO[8] indicate that China's imports represented 6.8 percent of global agricultural markets in 2007. This is above the US share in the same year (5.4), and approaches the shares of Germany (8.9 percent) and France (9.0 percent).

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



Notes: The figure shows the evolution (1995-2004) of China's share of world agricultural imports (in percentage 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.

Source: UN's COMTRADE database.

Table 1 shows the union set of the 20 top agricultural products (according to the four-digit classification of the Harmonized System) imported by China in 1995, 2000, and 2004. These products accounted for 85.73, 70.47, and 78.26 percent of China's total agricultural imports in 1995, 2000, and 2004, respectively. Two general patterns are apparent. First, China's imports are concentrated in a few products, notably soybeans, soybean oil and palm oil, which accounted for 47.4 percent of total China's agricultural imports in 2004. Second, China's import patterns have changed over time. In 1995, wheat and corn together represented 29.81 percent of total food imports, while these staples where only 7.48 percent in 2004. Consistent with the import specialization in oilseeds and grains, more than half of China's agricultural imports come from Brazil, the US and Canada. Malaysia and Thailand are also important providers of oilseeds.

[6]This section is based on trade data retrieved from the UN's COMTRADE database, and these data are used later on in the econometric exercise. Agricultural products are as defined in 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.

[7]For the period of 1995-2004. This is the period for which we have a complete set of partners and reporters. The econometric analysis is extended to 2006, but uses only a representative group of countries for 2005 and 2006.

[8] These trade profiles were updated in April 2009. They are available at http://stat.wto.org/CountryProfile/.

Table 1. China's main agricultural imports (as percentage 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
0303	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
0714	Cassava, arrowroot etc, fresh or dry sago pith	0.71	0.23	1.57
0307	Molluscs & aqua invert nesoi, lve etc. flours etc	0.62	1.91	1.52
1003	Barley	2.52	3.29	1.46
0306	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
0207	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
0803	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

Notes: The table shows the import value of individual agricultural products as the percentage of China's total agricultural imports. The products included are the union of the top 20 products imported by China in 1995, 2000, and 2004. The shares are sorted (in decreasing order) by their values in 2004.

Source: UN COMTRADE database

Almost no agricultural exports go from the Southern African countries to China. Both the share of Southern African products in China's total food imports, and the share of China in Southern African agricultural exports are negligible (< 1 percent). This has important implications for our work. In principle, we can rule out any direct effect of China's growth in food demand on the exports of Southern Africa. However, as mentioned in the introduction, it is still possible that Southern African countries benefit indirectly from food price increases induced by China's growth in food demand.

If China is a source of higher food prices, Southern Africa (SA) could see an increase in its export values through two pathways. First, if the products that China demands overlap with the products that SA supplies, the Southern African countries will benefit from higher prices even if they sell in markets different from those involving China. Second, even if China's demand and SA's supply have little in common, the inflationary effects of China's demand could spill over beyond the products they import directly, due to complementarities in production and consumption. The first possibility is explored in the rest of this section. The latter concept is more complex, and is revisited in subsequent sections.

In considering whether the countries of Southern Africa have a supply that overlaps with China's demand, we examine Table 2, which shows the union set of the five top agricultural export products for each Southern African country in 1995, 2000 and 2004. In 2004, these products represented 81.69 percent of total agricultural exports in Zambia, 85.16 percent in Mozambique, and 95.26 percent in Malawi. The share of this set in total exports is lower in Tanzania (67.53 percent) and the SACU (48.41 percent), indicating that these countries have more diversified product baskets.

Comparison of the products in this table with those from Table 1 reveals a strikingly limited overlap between China's import demand and the export supply of the Southern African countries. In particular, no top export of Tanzania appears as a top import of China.

Table 2. Main agricultural exports of Southern African countries (as percentage of total exports)

Partner	Code HS-4	Product Description	1995	2000	2004
Zambia	2401	Tobacco, unmanufactured tobacco refuse	11.00	20.48	36.97
	1005	Corn (maize)	6.56		18.78
	1701	Cane or beet sugar & chem pure sucrose, solid form	29.58	11.34	10.11
	0603	Cut flowers & buds for bouquets etc., prepared	12.73	26.61	9.73
	0708	Leguminous vegetables, shelled or not, fr or chill		9.60	6.09
	0901	Coffee, coffee husks etc substitutes with coffee	14.04	8.49	
SACU	0805	Citrus fruit, fresh or dried	10.56	8.87	12.43
	2204	Wine of fresh grapes grape must nesoi		6.84	11.88
	0806	Grapes, fresh or dried	7.03	7.13	10.01
	0808	Apples, pears and quinces, fresh	8.55	5.11	7.74
	1701	Cane or beet sugar & chem pure sucrose, solid form	9.59	8.93	6.35
	2008	Fruit, nuts etc prepared or preserved nesoi	5.88		
Tanzania	0304	Fish fillets & oth fish meat, fresh, chill or froz	8.36	28.79	24.00
	2401	Tobacco, unmanufactured tobacco refuse	7.83	12.07	17.12
	0801	Coconuts, brazil nuts & cashew nuts, fresh or dry	21.87	9.34	12.04
	0901	Coffee, coffee husks etc substitutes with coffee	38.11	19.66	10.02
	1207	Oil seeds & oleaginous fruits nesoi, broken or not			4.37
	0713	Leguminous vegetables, dried shelled	4.39		
	1512	Sunfl-seed, safflow or cottonsd oil etc, no ch mod		2.83	
Malawi	2401	Tobacco, unmanufactured tobacco refuse	77.55	71.80	68.60
	1701	Cane or beet sugar & chem pure sucrose, solid form	3.89	5.97	12.13
	0902	Tea, whether or not flavored	7.04	17.48	10.19
	0802	Nuts nesoi, fresh or dried			2.75
	0713	Leguminous vegetables, dried shelled	1.63	0.65	1.58
	0901	Coffee coffee husks etc substitutes with coffee	5.44	1.44	
Mozambique	0306	Crustcns live, fresh etc, ckd etc. flrs mls h cnsump	48.09	49.32	37.02
	2401	Tobacco, unmanufactured tobacco refuse		9.64	17.68
	0801	Coconuts, brazil nuts & cashew nuts, fresh or dry	13.87	13.79	15.50
	1701	Cane or beet sugar & chem pure sucrose, solid form	15.92	10.60	9.93
	1207	Oil seeds & oleaginous fruits nesoi, broken or not			5.03
	0307	Molluscs & aqua invert nesoi, lve etc. flours etc		4.71	
	1005	Corn (maize)	6.72		
	1203	Copra	3.98		

Notes: The table shows the value of specific agricultural products as percentage of the total agricultural exports of the focus Southern African countries. The products included are the union of the top five products exported in 1995, 2000, and 2004. The shares are sorted (in decreasing order) by their values in 2004.

Source: UN COMTRADE database

The only important export of the SACU, Malawi, and Zambia that is also imported by China is sugar cane (HS4 1701), which comprises only 1 percent of China's imports. Mozambique also exports fish products (HS 0306), which represent a very small fraction (1 percent) of China's total food imports. Thus, on the surface it seems as though the direct-demand effects of China on SA's exports are negligible. It is also apparent that the there is little overlap between SA's agricultural supply and China's agricultural demand in tertiary markets. This leaves potential inflationary pressures attributable to China's growth in demand as the only channel through which China can affect the exports of the African countries. In order to study this channel, we developed a formal model, which is discussed in the following sections.

3. THEORETICAL FRAMEWORK

We use the theoretical framework proposed by Anderson and van Wincoop (2003, 2004) 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, Anderson and van Wincoop's treatment of the CES price indexes allows us to capture the price effects of China's demand on the demands of other countries importing from SA. As noted above, these indirect effects are key because the direct exports from SA to China are quite limited.

Following the exposition in Anderson and van Wincoop (2004, p.707), the CES demand structure[9] implies that the exports X from country i to country j in product class k are given by:

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

where σ_k is the elasticity of substitution among origins, p_i^k is the supply price in country i, t_{ij}^k are the power of 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 and is given by:

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

Anderson and van Wincoop (2004) impose the market-clearing conditions $Y_i^k = \sum_j X_{ij}^k$, where Y_i^k is the export supply of country i. These market conditions are used to solve for the equilibrium supply prices p_i^k. The equilibrium supply price is then substituted for p_i^k in Equations (1) and (2) (see Appendix for details). The authors present their resulting equilibrium in terms of production and expenditures relative to world output (i.e., E_j^k/Y^k, Y_i^k/Y^k with $Y^k = \sum_i Y_i^k = \sum_j E_j^k$). For convenience in the empirical implementation (more on this below), we state this equilibrium[10] in terms of absolute productions and expenditures, obtaining the following version of Anderson and van Wincoop (2004, p.708)'s gravity equation:

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

subject to:

$$\left(\widetilde{\Pi}_i^k\right)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} E_j^k \tag{4}$$

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

[10] See Appendix for details.

$$(\widetilde{P}_j^k)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} Y_i^k \tag{5}$$

Equation (3) explains the variability of bilateral trade flows in terms of exporters' supply, importers' demand, bilateral trade costs, and the equilibrium price indexes $\widetilde{\Pi}_i^k$ and $\widetilde{P}_j^k$. Anderson and van Wincoop call these CES price indexes "multilateral resistance terms." 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 $\widetilde{P}_j^k$; this shows that if j imposes high trade barriers on i's competitors, i will experience less resistance into j's market, and thus will export more to *j*. The second effect is captured by the *outward* multilateral resistance term $\widetilde{\Pi}_i$; this 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 that summarizes the effects of China's growth on the exports of other countries is the expenditure value $E_{j=China}^k$. 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. However, as discussed in the previous section, the direct exports of the focus countries to China are of limited significance. Because of this, we are more interested in the indirect effects that China can have on a country's demand, given its potential influence on global prices. In the framework of Anderson and van Wincoop, this influence is captured by the price terms.

For instance, the mechanics of Equation (4) show that a decrease in China's expenditures (E_{China}^k) causes an increase in the price index $\widetilde{\Pi}_i^k$. In Equation (3), an increase of $\widetilde{\Pi}_i^k$ is associated with an 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 $Y_i^k = \sum_j X_{ij}^k$, a decrease of exports from i to China (due to lower China's expenditures), keeping i's production (Y_i^k) constant, will generally tip more of i's exports to other destinations. Alternatively, a decrease in China's expenditures E_{China}^k is equivalent to an increase in China's import barriers $t_{i,China}^k$, which is reflected in an increase of the multilateral resistance term for each exporting country i, $\widetilde{\Pi}_i^k$.

More important for our objectives, the higher $\widetilde{\Pi}_i^k$s following a decrease in E_{China}^k decreases the price index of other importers j ($\widetilde{P}_j^k$s), as can be seen in the mechanics of Equation (5). Note that a reduction in China's demand for food should decrease the price index in other importing countries, as more supplies becomes available to other countries that compete with China for fixed food supplies. For exporting countries, the reduction in the price indexes in the importing locations yields a lower price for their exports. This is evidenced in Equation (2), which shows that, keeping trade costs constant, a decrease in the price indexes $\widetilde{P}_j^k$ is consistent with a decrease of i's supply prices, p_i^k. This is precisely the 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 and subsequently contract the agricultural exports of Southern African countries (even if they do not export directly to China).

Our general strategy is to trace the evolution of E^{k}_{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 growth in China's demand, the outward multilateral resistance term for each country i would increase, decreasing the price index P_j and reflecting a reduction of i's supply price. Once we obtain the equilibrium prices with attenuation of China's expenditures, we use Equation (3) to recover the bilateral exports of each country i. These simulated exports should be lower than the 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 received by the African countries.

One notable caveat is that the analysis is partial equilibrium in nature, focusing solely on agricultural products and does not examine interactions across productive sectors. Abbot, Hurt, and Tyner (2008) argue that China is connected to higher food prices not through increased food demand, but rather through increases in oil prices that are in turn linked to food prices through biofuel policies. We do not consider such interactions. Another partial equilibrium feature of our work is that in predicting 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 (thereby impacting trade patterns in non-obvious ways). As such, the estimates we obtain below should be considered the upper bound of the potential effects linked to China's growth.

4. EMPIRICAL IMPLEMENTATION

We use import data (from the UN's COMTRADE database) on the aggregated agricultural sector, which comprises the first 24 chapters of the Harmonized System. This level of aggregation is consistent with our objective of identifying generalized price effects attributable to China's increased demand for agricultural products. The data covers the period 1995-2006, which we consider to be a long enough duration to evidence potential effects of China's growth. Our database includes imports and exports of a consistent set of 70 countries, covering most global trade in agricultural products. Because we compare parameter estimates from different years, only those transactions that are positive in every year during the period of 1995-2006 are included.

We first identify China's expenditures by taking advantage of the differences in China's import values across exporters. To accomplish this, we start by taking natural logarithms of Equation (3) and rearrange to get[11]:

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

where all variables are as previously defined. To account for the second and third terms on the right hand side of equation (6), which includes the unobservable price indexes, we follow the method of Anderson and van Wincoop and use exporter- and importer-fixed effects. These are especially appealing in our framework because they capture not only differences in the unobservable price indexes, but also differences in expenditures and production.[12]

Following standard practice, and in a manner analogous to that described by Anderson and van Wincoop, we define the trade costs (t_{ij}), the last term in equation (6), as a multiplicative function of distance between partners and other factors that are known to condition bilateral trade flows; these include 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})[13], and other factors (ε_{ij}). Then, t_{ij} can be written as:

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

Denoting the country-fixed effects by EXP_i (for exporters) and IMP_j (for importers), the estimating equation is:

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

where β_0 is an intercept, $\alpha_i^X = \log(Y_i/\widetilde{\Pi}_i^{1-\sigma},)$ $\alpha_j^M = \log(E_j/\widetilde{P}_j^{1-\sigma})$ 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 not to be correlated with any of the regressors.

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[11] We henceforth omit the subscript k as it is understood that we focus on the agricultural sector as a whole.

[12] In the original work of Anderson and van Wincoop (2003), 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. Differing from Anderson and van Wincoop (2003), we do not impose unitary income elasticities on Equation (6), which implies that the regressand is $\log(X_{ij}/E_j Y_i)$, i.e., the log of exports divided by the product of the income/production terms. This allows us to have the expenditures be explicit on the right-hand side of Eq. (6).

[13] This is a crude proxy for applied bilateral tariffs, which we were unable to obtain for the period considered herein.

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 each measured 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 regional agreements was obtained from Fontagne and Zignago (2007). The rest of the data come from Mayer and Zignago (2006).

To explore whether China's increasing demand for agricultural products leads to more agricultural exports from Southern Africa, we simulate the 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 exports in , the stagnation of China's demand should result in lower SA's exports. Comparison of the simulated and observed exports gives us an idea of the effects related to China's growth. We try to capture both direct and indirect effects. To see this more clearly, we can sum over j the bilateral exports of i given in Equation (3), obtaining:

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

The reduction in China's expenditure ($E_{j=China}$) will affect i's total exports *directly* through changes in direct sales, and also *indirectly* through changes in other exporters' and importers' price indexes, $\widetilde{\Pi}_i$ and $\widetilde{P}_j$, respectively.

A first order effect would be through the direct sales to China, as evidenced by the term E_j within the summation on the right-hand side of Equation (9). Thus, our first step in the simulation is to substitute China's expenditure in 1995 for China's expenditure in 2006 in every bilateral transaction of exporter *i* with China. In an analogous way, we recalculate the price indexes by substituting China's expenditures in 1995 for those in 2006. The counterfactual $\widetilde{\Pi}_i$ s are simultaneously determined with the counterfactual importers' price indexes $\widetilde{P}_j$, which reflect the price level in other importing countries. Our hypothesis is that these price indexes should decline with the attenuation of China's demand for food.

In terms of the parameter in the regression equation (8), holding China's expenditures constant at 1995 levels reduces all of the importers' fixed effects across the board. 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:

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

Thus, keeping E_j constant, a reduction of α_j^M implies a reduction of $P_j^{\sigma-1}$. Consistent with the concepts discussed in Section III, a reduction in E_{China} will reduce the importer price indexes P_j, leading to a reduction of the import price at each location j, and a subsequent decrease in the supply price received by exporters in i.

Also as discussed in Section III, a decrease in E_{China} increases the multilateral resistance facing exporter i ($\widetilde{\Pi}_i$.) To see how changes in $\widetilde{\Pi}_i$ affect the exporter-fixed effects, we rewrite them as:

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

This expression shows that by holding output (Y_i) constant, an 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 they oppose the changes in the importer-fixed effects. This is a consequence of the market equilibrium underlying Anderson and van Wincoop's model, whereby a reduction on exports to the country expending less (i.e., China) must be compensated by increases in exports to the rest of the destinations.

To recover the observed estimates of $\widetilde{\Pi}_i$, Equation (4) is rewritten using the estimated trade costs[14] $t_{ij}^{1-\sigma}$, the estimated importer-fixed effects $\hat{\alpha}_j^M$, and the fact that $\alpha_j^M = \log(E_j/\widetilde{P}_j^{1-\sigma})$. This yields:

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

Likewise, the empirical importers' price indexes ($\hat{P}_j$) are obtained by combining $t_{ij}^{1-\sigma}$, the estimated exporters' fixed effects $\hat{\alpha}_i^X$, and the fact that $\alpha_i^X = \log(Y_i/\widetilde{\Pi}_i^{1-\sigma})$ to yield the empirical counterpart of Equation (5), which is given as:

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

The price indexes are then 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 $\hat{\alpha}_i^X$[15]. As mentioned above, the equilibrium implied by Anderson and van Wincoop's model requires simultaneous estimation of the price indexes.

Our approach is to find the counterfactual set of price indexes $[\Pi_{ci}^{1-\sigma}, P_{cj}^{1-\sigma}]$ (the subscript c emphasizes the counterfactual nature of these indexes) 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.

[14] As it is customary, we denote estimates with a hat . covers the term 1 - σ because we recover the trade costs using: Because $\beta_i = (1 - \sigma)\delta_i$, the result of this operation is .

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

5. RESULTS AND DISCUSSION

Equation 8 is estimated using Ordinary Least Squares for each year during the period 1995-2006. Full sets of fixed effects are used for both importers and exporters. The US is used as the omitted category for estimation purposes and the coefficients of the fixed effects obtained from the regression are used to estimate changes in China's income and the price indices of the different countries. 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. As a practical matter, omitting the US as both an importer and exporter yields estimates of the fixed effects in terms of deviations of the average level of the (log) of imports and exports in the US. Both the relative nature of the fixed effects (and hence, of the price estimates) and the choice of omitted country have implications for the final results; however some characteristics of US trade make the country a suitable reference for analyzing impacts on Southern African countries (see below for a more detailed discussion).

The output of the regressions is shown in Table 3. The sectoral gravity models work as expected. For instance, the negative coefficient of the distance variable indicates 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 these characteristics. So do countries that belong in the same trade agreement, although this effect seems to be more evident in more recent years. For the most part, these coefficients are stable over time, economically important, and statistically significant. The last row of Table 3 shows the R^2 values, which indicate that the models explain on average over three fourths of the variation in bilateral trade. Notably, however, we should interpret this with some caution, as the magnitude of the fixed effects tends to be overstated.

Figure 2 shows China's importer-fixed effects (upper panel) and food expenditures (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 average US level of agricultural trade. As we move toward more recent years, the estimated fixed effects grow (become less negative). In the lower panel of Figure 2, we see that the expenditures, as inferred from the regression coefficients, declined during 1996 and 1997, coinciding with the regional recession associated with the Asian financial crisis. After that, expenditures recovered; 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 a new contraction in 2006. This roughly agrees with the assertion of Gale (2005) that China's agricultural imports from the US boomed during 2003-2004 (although he registers the peak in 2004). These figures are not directly comparable because Gale's values are nominal, while ours are real in the sense that they are relative to the trade behavior of the US. For our purposes, it is most relevant that China's expenditures on food, relative to the agricultural expenditures of the US, doubled between 1995 and 2006. This figure roughly agrees with the trends of China's import growth of agricultural products discussed at the beginning of Section II, confirming that the US is an appropriate benchmark (omitted category in the estimation of Equation 8) for use in measuring the evolution of China's expenditures[16].

[16] For example, if the imports and exports of the country chosen as an omitted category move in tandem with those of China, China's measured fixed effects will be relatively constant through time; this will hinder the identification of changes in expenditures. Using the same logic, if the chosen omitted category has average levels of trade that increase faster (slower) than those of China, the evolution of China's expenditures would be under (over) stated. The US offers a unique perspective insofar it is both a large importer and a large exporter, with a relatively stable average trade level through time.

Table 3. Regression coefficients from gravity model[a]

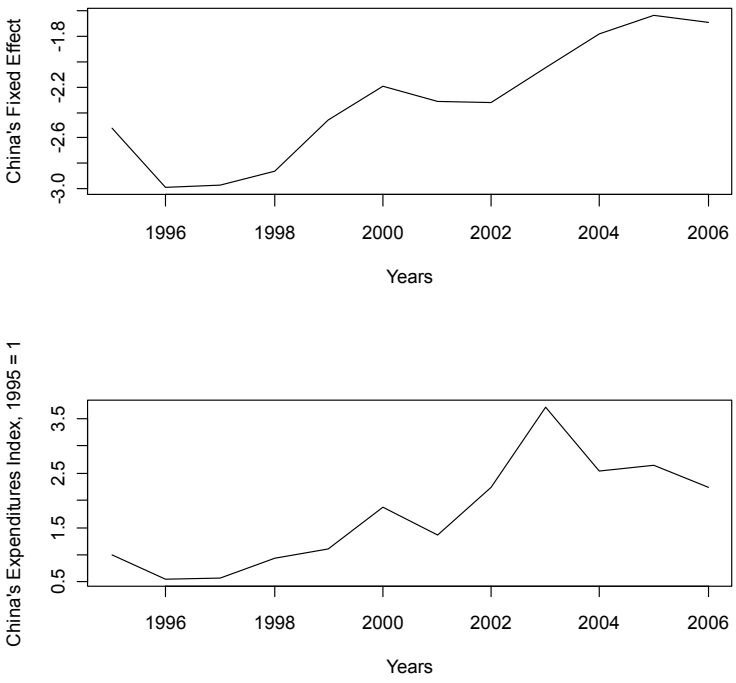
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Constant	26.224*** (0.514)	26.456*** (0.512)	26.591*** (0.487)	26.291*** (0.495)	26.394*** (0.492)	26.211*** (0.464)	26.379*** (0.451)	25.896*** (0.460)	25.789*** (0.450)	26.484*** (0.464)	26.560*** (0.461)	26.775*** (0.466)
Log (Distance)	-1.170***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

Notes: [a] Country-fixed effects are omitted. [b] Root-mean-square error

Robust standard errors are given in parentheses: **** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.10$

Source: Based on author's estimation

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



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 were $(e^{\hat{\alpha}_j^M} - 1)100 = 81.65$ percent lower than the US's average level of trade. The lower panel shows the evolution of China's aggregate expenditures on food, which is inferred from the estimated fixed effects from Eq. (8). To facilitate interpretation, the expenditures are indexed relative to 1995. To obtain the expenditures, we: (1) estimate Eq. (8) for each year of the period 1995-2006; (2) use the importer-fixed effects to obtain the importers' price indexes using $P_j^{1-\sigma_k} = \sum_i e^{\hat{\alpha}_i^X} t_{ij}^{1-\sigma}$; and (3) use each importer's price index to solve for its expenditures, i.e., $\alpha_j^M = \log(E_j / \widetilde{P}_j^{1-\sigma}) \Rightarrow E_j = e^{\hat{\alpha}_j^M} P_j^{1-\sigma}$.

Source: Author's elaboration based on regression output

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 $\left(\Pi_i^{1-\sigma}, P_j^{1-\sigma} \right)$,and the production and expenditure values $[\hat{Y}_i, \hat{E}_j]$ consistent with the exports observed in 2006. 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 indexes $[\Pi_{ci}^{1-\sigma}, P_{cj}^{1-\sigma}]$ that are consistent with exports observed in the year

2006. Because the price indexes are simultaneously determined, we obtain them by finding the set of fixed effects that minimize the sum of squared residuals (SSR) of Equation (8), assuming stagnation in China's demand. The minimization exercise yields a SSR of 5,277.46, which is slightly above the SSR of the original regression (5,241.09)[17]. Therefore, the main consequence of holding China's expenditures constant at 1995 levels is an across-the-board reduction in all importer-fixed effects.

The hypothesized reduction of the importer-fixed effects is verified in the first two columns of Table 4, which shows the first 20 countries with the largest estimates before and after the simulation. Recall from our discussion in Section IV (see the paragraphs following Equation 9) that if we hold the expenditures in agricultural goods constant, the importer-fixed effects are interpreted as changes in the CES price indexes prevailing in each location. Because these fixed effects are measured relative to the US, the CES price indexes are relative to the CES price index in the US. The next two columns of Table 4 show the difference between the fixed effects and its proportion of the original values. The latter are interpreted as the changes in CES prices in each location (normalized by the US CES price). The first country is of course China, where in the absence of demand growth, the relative CES price index would be 51.3 percent lower. Next is Japan where the relative "inflationary" effect of China's growth on the country's food prices is about 10 percent. After that we see Germany (4.2 percent), England (2.9 percent) and other large Asian and European economies, in which the CES price index is 1.5- 2.5 percent higher as a consequence of China's growth. The first 10 economies in Table 4 are among the world's largest food importers; thus, it is not surprising that these economies evidence the largest price increases associated with more competition with China for (presumably in the short-run) fixed supplies of food. It should be kept in mind that these are aggregated effects, i.e., these values represent increases in *all* food prices. The exporter-fixed effects also change after the simulation. Table 5 shows the first 20 countries with the largest changes in the exporter-fixed effects. The first country is Brazil, in which we see a 13.6 percent change in the fixed effects, implying that the multilateral resistance term faced by this country increases by this much. As before, these multilateral resistance terms are measured relative to the corresponding values in the US.

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

	Before	**After**	**Difference**	**% of ``Before''**
China	– 1.70	– 2.57	0.87	51.28
Japan	– 0.45	– 0.49	0.05	10.36
Germany	– 0.95	– 0.99	0.04	4.17
Great Britain	– 1.27	– 1.31	0.04	2.99
Singapore	– 3.07	– 3.15	0.09	2.80
France	– 1.47	– 1.51	0.04	2.67
Indonesia	– 2.56	– 2.62	0.07	2.64
Spain	– 1.48	– 1.52	0.04	2.55
Netherlands	– 1.61	– 1.65	0.04	2.45
Italy	– 1.63	– 1.67	0.04	2.39
Korea	– 2.12	– 2.17	0.05	2.21
Australia	– 2.03	– 2.07	0.04	2.19
Malaysia	– 3.23	– 3.30	0.07	2.14
Hong Kong	– 2.46	– 2.51	0.05	1.99

[17]The General Algebraic Modeling System (GAMS) program employed for this is available upon request. The initial values for the unknown $[\Pi_{ci}^{1-\sigma}, P_{cj}^{1-\sigma}]$ 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.

Table 4. Continued

	Before	After	Difference	% of "Before"
Poland	– 2.98	– 3.02	0.04	1.32
New Zealand	– 3.43	– 3.48	0.04	1.30
Greece	– 3.17	– 3.21	0.04	1.27
Sweden	– 3.15	– 3.19	0.04	1.24
Denmark	– 3.22	– 3.26	0.04	1.21
SACU	– 3.15	– 3.19	0.04	1.20

Notes: The first column shows the importer-fixed effects obtained from estimating Eq. (8) for year 2006. Next are the importer-fixed effects obtained by minimizing the sum of the squared residuals obtained by taking the costs, expenditures and outputs as given, and reducing China's expenditures on food to its 1995 levels. Following this is a column representing the difference between "Before" and "After." The last column express this difference as a percentage of the original fixed effects. Because we hold expenditures constant, the reduction of fixed effects is equivalent to a reduction of the prices of imported food (relative to food prices in the US) in each country.

Source: Author's elaboration based on regression output

The increases in the multilateral resistances shown in Table 5 suggest that if China hadn't grown the way it did, but rather maintained constant national outputs, countries such as Brazil would have exported more to countries other than China. Notably, the countries with the largest increases in their multilateral resistance terms have large exports of relatively few agricultural commodities; these include Brazil (soybeans), Argentina (soybeans and corn), Malaysia (palm oil) and Indonesia (palm oil). This suggests that China's effects on agricultural exports are particularly important for these countries.

Table 5. Exporter-fixed effects before and after simulation from regressions for year 2006 (Top 20 countries)

	Before	After	Difference	% of "Before"
Brazil	– 0.29	– 0.25	– 0.04	13.60
Argentina	– 0.57	– 0.53	– 0.04	6.75
Hong Kong	– 5.48	– 5.22	– 0.26	4.77
Malaysia	– 2.13	– 2.03	– 0.09	4.46
India	– 2.44	– 2.33	– 0.11	4.44
Indonesia	– 1.90	– 1.81	– 0.08	4.29
China	– 1.10	– 1.06	– 0.04	3.93
Japan	– 3.86	– 3.72	– 0.14	3.69
Australia	– 1.66	– 1.60	– 0.06	3.66
Korea	– 4.39	– 4.23	– 0.16	3.59
New Zealand	– 1.60	– 1.55	– 0.05	3.25
Netherlands	– 1.33	– 1.29	– 0.04	3.00
France	– 1.50	– 1.46	– 0.04	2.65
Germany	– 1.52	– 1.48	– 0.04	2.62
Chile	– 1.48	– 1.45	– 0.04	2.58
Spain	– 1.78	– 1.74	– 0.04	2.28
Singapore	– 3.80	– 3.72	– 0.08	2.18
Italy	– 1.91	– 1.86	– 0.04	2.18
Great Britain	– 1.91	– 1.87	– 0.04	2.05
SACU	– 2.41	– 2.36	– 0.04	1.86

Notes: The first column shows the exporter-fixed effects obtained from estimating Eq. (8) for year 2006. Next are the exporter-fixed effects obtained by minimizing the sum of the squared residuals obtained by taking the costs, expenditures and outputs as given, and reducing China's expenditures on food to its 1995 levels. Following that is a column giving the difference between "Before" and "After." The last column express this difference as a percentage of the original fixed effects. Because we hold output constant, the increases in these fixed effects reflect larger exports to other countries as China reduces its expenditures on food.

Source: Author's elaboration based on regression output

The above-described changes in the importer and exporter price indexes are the changes in prices needed to obtain the *observed* bilateral exports in the presence of China's attenuated demand. However, we can also use them to infer how exports from Southern African countries would change assuming a stagnated demand in China. To this end, using the parameter estimates of Equation (8) and the terms recovered throughout this section, we rewrite a counterfactual version of Equation (9) as:

$$X_{ci} = \frac{Y_i}{\Pi_i^{1-\sigma}} \left[\sum_{j \neq cChina} \left(\frac{t_{ij}^{1-\sigma}}{P_j^{1-\sigma}} \right) E_j + \left(\frac{t_{i,cChina}^{1-\sigma}}{P_{cChina}^{1-\sigma}} \right) \hat{E}_{cChina} \right] \quad (12)$$

(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 noted above, the first-order effect of a stagnation in China's demand is through $\hat{E}_{cChina}$ (i.e., China's relative 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 opposed to counterfactual) $\Pi_i^{1-\sigma}$ and $P_j^{1-\sigma}$. The resulting exports are then subtracted from the exports observed in 2006, and the difference is expressed as a percentage of the latter. The results are shown in the first column of Table 6.

Table 6. Total agricultural exports of selected countries and estimated percentage reduction given a contraction in China's expenditures on food imports

	Export Value	Direct Effect	Direct Effect + Imp. Pr. Effect
Malawi	357	-0.00	-3.46
Mozambique	225	0.00	-3.59
Tanzania	542	-1.40	-5.15
SACU	4,596	-0.45	-4.15
Zambia	157	-0.00	-4.01
Indonesia	9,749	-7.37	-10.52
Malaysia	7,559	-13.13	-16.58
Argentina	19,122	-7.29	-10.48
Brazil	25,949	-8.36	-11.26

Notes: The first column shows total agricultural exports in 2006 (US$ millions). The second column gives the percentage by which exports simulated with China's expenditures held constant differ from the observed exports. The third column shows the percentage by which exports simulated with China's expenditures held constant (and taking into account reductions in the CES import prices for locations other than China) differ from the observed exports. The results assume that the export and import prices remained constant from 1995 to 2006.

Source: Author's elaboration based on regression output

In line with our discussion in Section II, the impact on the countries of Southern Africa is practically null; that is, the difference between observed total exports and simulated exports for Malawi, Mozambique and Zambia is zero, while it is slightly negative for the SACU (-0.4 percent). For Tanzania, the effect is slightly larger; if China's food expenditures had stagnated at their 1995 levels, Tanzania's agricultural exports would be 1.40 percent lower.

Due to the potential effects on world prices, we proposed earlier that there may be indirect effects benefiting Southern African exporters. Our discussion of the importer-fixed effects confirms that China's increased demand for food has been a source of price inflation in a few developed countries; we would therefore expect that Southern African countries exporting to these countries would benefit from higher prices. To asses the relative importance of these indirect effects, we repeat the exercise outlined in the

paragraph above, using $P_{cj}^{1-\sigma}$ (the counterfactual price index) instead of $P_j^{1-\sigma}$. The results are shown in the third column of Table 6. These percentages capture both the first-order effects discussed above, and the indirect effects through changes in global prices (as before, relative to price changes in the US). Notice that the indirect effects are now discernible in the data. The impact of a reduction of China's expenditures in its imports of agricultural goods reduces agricultural exports of Malawi and Mozambique by 3.58 percent. Similar numbers are observed for Tanzania (-5.15 percent), Zambia (-4.01 percent), and the SACU (-4.01 percent). 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 these results may be somewhat artificial. To see this more clearly, let us consider a situation in which China's effects are limited to oilseeds. In the aggregate data, an increase in the price of oilseeds appears as a diluted increase in the price of all food products. Thus, we are valuing the SA exports with this effect, even if Southern African countries do not export oilseeds.

For comparison, Table 6 shows the simulated exports of other developing countries in Asia and Latin America. For instance, considering only a contraction in China's expenditures, Indonesia's simulated agricultural exports are 7.37 percent lower than those actually observed in 2006. When we consider the indirect effect of China on world supply prices, the stagnation of China's expenditures results in a 10.52 percent decrease in exports compared to observed levels. The results for Malaysia are similar. In Latin America, the contraction of exports ranges from 7.29 percent in Argentina to 9.64 percent in Peru. As seen elsewhere, indirect effects account for an additional diminution in export values (~3.5 percent). This comparison shows that our present analysis, using available data and the methods described by Anderson and van Wincoop, can effectively capture the effects of changes in China's expenditures.

When interpreting the results shown in Table 6, it should be noted (as described above) that these findings assume that all prices indexes are relative to those in the US. Thus, our framework does not detect the price effects of China on the US. How important is the assumption of constant prices in the US for the sensitivity of our results? Considering the US as an importer, for our results to be changed in a sensible way, the African countries would have to export to the US the same sort of products that the agricultural exporters in Table 6 are exporting to China (i.e. mostly oilseeds). On the exporting side, the US is a large exporter, meaning that its exporter-fixed effects will increase following attenuation of China's demand (as did the fixed effects of Argentina and Brazil; Table 5). Under our framework, the consequence of an increase in the multilateral resistance term (exporter-fixed effect) is to further reduce the CES prices in the importing countries; thus, we are likely to have underestimated the inflationary effects of China's demand growth and thus the indirect effects on the exports of the Southern African countries in Table 6. However, and given that the US is a large exporter of oilseeds, which predominate among China's imports, most of the bias in the indirect effects is probably going to affect exporters of these products which means that having a larger measured indirect effect is not a sign of larger exports in the countries of Southern Africa.

6. CONCLUSION

The objective of this paper was to answer a simple question: Does China's growth stimulates more agricultural exports in Southern Africa? Our exploration of the import and export structure of China and the countries in Southern Africa reveals that there is little overlap between China's import demand and the Southern Africa countries' export supply, and therefore the direct effect of China on Southern Africa's exports is limited. However, China is a large country and there is a possibility that its increases in demand could affect world prices. In this context, it is possible for African exporters to benefit from price increases induced by demand from China, even if the countries in question do not sell their products directly to China. This would require that the African countries specialize in products demanded by China. We found little evidence that this is the case. However, we did find evidence in favor of a third possibility, namely that China's pressure on agricultural supplies may have a generalized effect on food prices, regardless of whether or not China directly imports from a given country.

The chosen framework for capturing and separating the direct and indirect effects of China is the gravity model proposed by Anderson and van Wincoop (2003), but herein 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 1995-2006, we use the model to trace the evolution of China's relative expenditures over the last decade. Then, for each of our focus countries, we simulate the exports that would have prevailed if China's demand for food had not grown since 1995.

Our results suggest that China has been a source of aggregated mild price inflation in the largest developed economies that occupy the first ranks of food importers. This is probably related to a more intense pressure on world food supplies. When we look at the counterfactual exports of Southern African countries, we find that the effects are null. However, when we take into account the indirect effects, we find that if China had not grown the way it did over the last decade, Southern African agricultural exports would have been larger; we are, however, cautious about these results given the level of aggregation in the data and the small volume of exports from Southern Africa going to China. When we contrast our results for SA with those of other developing countries that export oilseeds, oil meals, and grains, we see that the direct effects of China's increased expenditures are significant and can be detected in the data. These elements suggest that China's growth has not stimulated SA agricultural exports

APPENDIX

Derivation of the gravity equation

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

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

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:

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

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

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

i.e., at 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) into (B):

$$Y_i^k = \sum_j (\frac{p_i^k t_{ij}^k}{P_j^k})^{1-\sigma_k} E_j^k = p_i^{k\,1-\sigma_k} \sum_j (\frac{t_{ij}^k}{P_j^k})^{1-\sigma_k} E_j^k \tag{C}$$

to obtain:

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

This equilibrium supply price is substituted back in expression(A):

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

yielding Anderson and van Wincoop's gravity Equation:

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

where:

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

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

Modification of the system described by Anderson and van Wincoop

Our objective is to slightly modify the system of Anderson and van Wincoop 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. We start with the system proposed by Anderson and van Wincoop (Equations 5, 6 and 7 in Anderson and van Wincoop, p. 708), which is given as:

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

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 country i to country 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), $\widetilde{P}_j^k$ and $\widetilde{\Pi}_i^k$ are the CES price indexes in countries i and j respectively, and σ_k is the elasticity of substitution among origins.

We then 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 indexes purged of Y_k as $\widetilde{\Pi}_i$ and $\widetilde{P}_j$, and then rewrite the system as:

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

subject to:

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

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

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

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