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Asymmetric Trade Costs: Agricultural Trade among Developing and Developed Countries

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Abstract:
In this article, the reasons why developing countries trade fewer agricultural products than developed countries are analyzed. Based on earlier findings that low trade volume in the agricultural sector is due to high trade costs, the focus is on evaluating the extent to which bilateral trade costs in the agricultural sector differ among trading partners. Using a neo-Ricardian trade model, the results show that systematically, asymmetric bilateral trade costs and variation in the level of agricultural productivity across all countries in the sample, are the main barriers to developing countries' agricultural exports. In addition, low-income countries face higher trade costs to export than do high-income countries.

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1 Introduction

Trade in agricultural products is significantly less that in manufacturing products: in 2013 the value of trade in the former was under US$2 trillion as compared to about US$13 trillion in the latter (UNCTAD 2015). Agricultural trade mostly originates from developed countries, with in excess of 60 percent of trade in agricultural products flowing largely from either developed to developed countries (North-North) or from developed to developing (North-South) (UNCTAD 2015).

The main causes of low agricultural trade flows from developing countries are considered to be significant relative productivity differences and high trade costs (Tombe 2015; Xu 2015). Labor productivity variation across countries is also more significant in the agricultural sector than in the non-agricultural sector (Caselli 2005; Restuccia, Yang, and Zhu 2008; Lagakos and Waugh 2013). Gollin, Lagakos, and Waugh (2014) attribute relatively lower labor productivity in the agricultural sector, the so-called "agricultural productivity gap", to the misallocation of labor across sectors, where the gap is even greater in developing countries. Lagakos and Waugh (2013) find that self-selection of heterogeneous workers is a major contributor to cross-sector and cross-country labor productivity differences. They observe that, in developing countries, where a large percent of the workforce is engaged in the agricultural sector, the level of labor productivity in the agricultural sector is lower than that in manufacturing. Conversely, in industrialized countries, they find the opposite relationship holds. Furthermore, Gollin and Rogerson (2014) and Adamopoulos (2011) suggest that high transport frictions also affect low labor productivity in agriculture and distort labor allocations across sectors. Therefore, reduction of transportation costs is expected to improve agricultural productivity as well as general economic welfare.

In this article, the differences in agricultural product trade for developing compared to developed countries are examined using a neo-Ricardian trade model. The multi-country model consists of individual countries specializing in a continuum of products according to their comparative advantage. Countries exhibit a range of productivity levels, where productivity is randomly drawn from a country-specific distribution (Eaton and Kortum 2002; Waugh 2010; Reimer and Li 2010; Xu 2015). Bilateral trade flows in the model are explained by relative unit costs of production, bilateral trade costs, and productivity differences.

The key results are as follows: first, the value of the elasticity of trade for the agricultural sector is estimated, the low value reflecting the range of agricultural productivity across countries, which implies that the degree of comparative advantage has strong potential to counteract resistance due to trade barriers. Second, asymmetric trade costs are found to be the main cause of bilateral agricultural trade share differences between developed (North) and developing (South) countries. In particular, developing countries face relatively higher trade costs in exporting their agricultural products to the North than developed countries incur in exporting their agricultural products to the South.

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In previous research, Reimer and Li (2010) investigate the gains from agricultural trade liberalization by estimating the elasticity of trade. They conclude that the gains are not distributed equally because of differences in trade-openness and productivity. Xu (2015) finds the causes of low trade intensity in the agricultural sector, as compared to manufacturing trade, to be due to high trade costs and the large range in agricultural productivity. However, neither article addresses systematically asymmetric trade costs between developing and developed countries. In this article, following the empirical approach suggested by Waugh (2010), a method for appropriate accounting of systematically asymmetric trade costs is used to analyze why agricultural products are not traded from South to North to the same degree that they are traded from North to South.

The remainder of the article is structured as follows. In Section 2, the theoretical model is outlined, while the data are described in Section 3. The empirical specification, the estimation methodology and the results are presented in Section 4. Finally, in Section 5, the article is summarized and conclusions are drawn.

2 Model

Following Reimer and Li (2010), each country i is assumed to have a tradable agricultural product sector. There is a continuum of agricultural products in the sector, indexed by $j \in [0, 1]$ (Dornbusch, Fischer, and Samuelson 1977). Countries differ in their production efficiency $z_i(j)$. In terms of producing agricultural products in country i, land L_i with a rental rate r_i is used with productivity $z_i(j)$. With constant returns to scale, the unit cost of production is r_i/z_i.

Productivity is assigned by a random draw from a country-specific Fréchet probability distribution (Alvarez and Lucas 2007; Costinot, Donaldson, and Komunjer 2012; Eaton and Kortum 2002; Fieler 2011; Waugh 2010). This probabilistic structure allows each country to have some possibility of producing at a lower cost than others, thereby assigning comparative advantage:

$$F_i(z) = \exp\left\{-T_i {z_i}^{-\theta}\right\}. \tag{1}$$

The location of the distribution is controlled by the parameter $T_i > 0$, a higher value indicating higher average agricultural productivity in country i. The parameter $\theta > 1$, which is common across countries, governs the distribution of agricultural productivity. A lower θ implies higher dispersion of average productivity levels across products and countries, indicating that comparative advantage will have a greater impact on trade patterns, i. e., high-productivity agricultural products will be exported, while low-productivity agricultural products will be imported.

Assume that country i is the exporter and country n is the importer. The delivery of one unit of an agricultural good requires τ_{ni} units produced in country i, where $\tau_{ni} > 1$ and $\tau_{ii} = 1$ for inter and intra-country trade respectively. Assuming markets are perfectly competitive, the price that country n pays for the imported product j from country i is:

$$p_{ni}(j) = \frac{\tau_{ni} r_i}{z_i(j)}. \tag{2}$$

The consumer price in n for product j is the lowest price across all trading partners:

$$p_n(j) = \min\left\{p_{n1}(j), p_{n2}(j), p_{n3}(j), ..., p_{nN}(j)\right\}.$$

A representative consumer has the following constant elasticity of substitution (CES) utility function:

$$U = [\int_0^1 q(j)^{(\sigma-1)/\sigma} dj]^{\sigma/(\sigma-1)},$$

where $q(j)$ indicates the quantity purchased by consumers and σ is the elasticity of substitution across products. Utility maximization is subject to an aggregate (across all buyers in country n) budget constraint X_n, accounting for total spending in country n.

The possibility that country i exports a product to country n is the probability that the price of country i will be the lowest. Due to the product continuum assumption, and identical demand and cost structures, the product index j can be dropped. Using the productivity distribution in (1), Eaton and Kortum (2002) have shown that the probability that country i delivers its product at the lowest price to country n is given by:

$$\Pr[P_{ni}(j) \leqslant P_{nl} \forall l \neq i] = \frac{T_i(r_i \tau_{ni})^{-\theta}}{\sum\limits_{i=1}^{N} T_i(r_i \tau_{ni})^{-\theta}}, \tag{3}$$

where country n's probability of buying from country i decreases with the rental rate in $i(r_i)$, and distance between n and $i(\tau_{ni})$, while it increases with higher average productivity in $i(T_i)$.

Equilibrium 1. *Price Index*: At the country level, each country n has an aggregate price index. The moment-generating function for the extreme value distribution generates the following price index (Eaton and Kortum 2002):

$$P_n = [\Gamma(\frac{\theta + 1 - \sigma}{\theta})]^{1/(1-\sigma)} [\sum_{i=1}^{N} T_i(r_i \tau_{ni})^{-\theta}]^{-1/\theta}, \tag{4}$$

where $\theta > \sigma - 1$, and $[\Gamma(\frac{\theta+1-\sigma}{\theta})]^{1/(1-\sigma)}$ is the Gamma function. The aggregate price index is expressed as a function of average productivity T_i, the rental rate r_i, and bilateral trade costs τ_{ni}.

Equilibrium 2. *Trade Shares*: Denote X_{ni} as n's total expenditure on imports from i and X_n as n's total spending. The share of n's expenditure on imported products from i relative to n's total expenditure is equal to the probability that country i exports to n at the minimum price. Therefore, the probability that country i exports to country n at the minimum price can be written as its trade share for the agricultural sector in aggregate:

$$\frac{X_{ni}}{X_n} = \frac{T_i(r_i \tau_{ni})^{-\theta}}{\sum\limits_{i=1}^{N} T_i(r_i \tau_{ni})^{-\theta}}. \tag{5}$$

Expression (5) shows that trade shares are a function of relative average productivity (T_i), relative rental rates (r_i), and bilateral trade costs (τ_{ni}) . Using (5), the trade share of country i is then normalized by the share of domestic production in total expenditure of importing country n, which is also a function of relative average productivity (T_i), relative rental rates (r_i), and bilateral trade costs (τ_{ni}):

$$(\frac{X_{ni}/X_n}{X_{nn}/X_n}) = \frac{T_i}{T_n}(\frac{r_i}{r_n})^{-\theta} \tau_{ni}{}^{-\theta}. \tag{6}$$

Equilibrium 3. *Allocation of Land and Rental Rate* :(7) gives the trade balance requirement, i. e., total exports are equal to total imports, while (8) shows that total domestic product equals the sum of country i's exports towards all trading partners, including itself:

$$\sum_{i \neq n} X_{in} = \sum_{i \neq n} X_{ni}, \tag{7}$$

$$Y_i = \sum_{n=1}^{l} X_{ni} = r_i L_i. \tag{8}$$

Optimal land allocation, which is derived from the first-order condition of the producer's problem, is given by: $r_i L_i = \sum\limits_{n=1}^{l} X_{ni}$.

3 Data

Balanced agricultural product trade flow data for a sample of 128 countries were obtained for the year 2013. The total number of observations is 9,709. The countries and descriptive statistics are shown in Table 1 and Table 2 respectively. Zero trade flows are revised to 1/10,000,000 in order not to lose a substantial number of observations.[1] Trade and production data were obtained from the Food and Agriculture Organization of the United Nations (FAO) (2014) database. The observed values for mainland China, Macao, Taiwan, and Hong Kong are aggregated as one country "China". The observed value at the country-level is aggregated trade and production values for agricultural products, the list of observed products being presented in Table 3. Trade cost data were obtained from the Centre d'Études Prospectives et d'Information Internationales (CEPII) (2011;

2015) gravity dataset. The geographic distances between two countries, common border, common language, and common regional trade agreements were used as proxies for impediments to trade. Distance variables consist of six dummies, representing the intervals of the circular distance between country capitals. The criteria for dividing the intervals ([0,375); [375,750); [750, 1500); [1500, 3000); [3000, 6000); and [6000, maximum]) are taken from Eaton and Kortum (2002). Arable land data are obtained from the World Bank's World Development Indicators (2016).

Table 1: Observed countries.

Albania	Burkina Faso	Ethiopia	Japan	Netherlands	Saudi Arabia	USA
Algeria	Burundi	Fiji	Jordan	New Zealand	Senegal	Uruguay
Antigua & Barbuda	Cote d'Ivoire	Finland	Kazakhstan	Nicaragua	Seychelles	Vanuatu
Argentina	Cabo Verde	France	Kenya	Niger	Singapore	Venezuela
Armenia	Cambodia	Gambia	Kyrgyzstan	Nigeria	Slovakia	Vietnam
Australia	Cameroon	Georgia	Latvia	Norway	Slovenia	Yemen
Austria	Canada	Germany	Lebanon	Oman	South Africa	Zambia
Azerbaijan	Chile	Ghana	Lithuania	Pakistan	Spain	Zimbabwe
Bangladesh	China, mainland	Greece	Luxembourg	Panama	Sri Lanka	
Barbados	Colombia	Guinea	Macedonia	Paraguay	Suriname	
			Madagascar			
Belarus	Congo	Guyana	Malawi	Peru	Sweden	
Belgium		Honduras	Malaysia	Philippines	Switzerland	
Belize	Costa Rica	Hungary	Maldives	Poland	Thailand	
Benin	Croatia	Iceland	Mali	Portugal		
	Cyprus	India	Malta		Togo	
Bolivia	Czech Republic	Indonesia	Mauritius	South Korea	Trinidad Tobago	
Bosnia &Herzegovina	Denmark	Iran	Mexico	Moldova	Tunisia	
Botswana	Ecuador	Ireland	Mongolia	Russia	Turkey	
Brazil	Egypt	Israel	Morocco	Rwanda	Ukraine	
Brunei Darussalam	El Salvador	Italy	Namibia	Saint Lucia	United Kingdom	
Bulgaria	Estonia	Jamaica	Nepal	St Vincent & Grenadines	Tanzania	

Table 2: Summary statistics.

Variable	Obs	Mean	Std.	Min	Max	Unit
Import value *ij*	9,709	26.071	346.478	0	21556.97	Million US$
Export value *ij*	9,709	45.616	624.006	0	38860.57	Million US$
RTA *ij*	9,709	0.207	0.405	0	1	
Common border *ij*	9,709	0.035	0.183	0	1	
Common lang *ij*	9,709	0.145	0.352	0	1	
Distance *ij*	9,709	4195.430	2815.637	37.044	12285.96	mile
dist1 *ij*	9,709	0.028	0.166	0	1	
dist2 *ij*	9,709	0.062	0.240	0	1	
dist3 *ij*	9,709	0.130	0.337	0	1	
dist4 *ij*	9,709	0.183	0.387	0	1	
dist5 *ij*	9,709	0.336	0.472	0	1	
dist6 *ij*	9,709	0.261	0.439	0	1	
Total imports *i*	9,709	2974.089	7818.797	0	64624.96	Million US$
Total exports *i*	9,709	2900.187	6730.051	0	45891.53	Million US$

Total prod *i*	9,709	35732.9	124458.6	8.75	1060080	Million US$
Xn *ij*	9,709	35806.8	129682.7	8.75	1117193	
Pini *ij*	9,709	0.861	0.137	0.203	1	
Dep *ij*	9,709	0.003	0.037	0	2.363	
ln dep *ij*	9,709	−17.795	8,169	−29.987	0.860	

Table 3: Observed products.

Wheat	Rapeseed	Tangerines, mandarins	Mata
Barley	Sesame seed	Lemons and limes	Hops
Maize	Mustard seed	Grapefruit	Pepper (piper spp.)
Rye	Poppy seed	Apples	Chillis and peppers
Oats	Cottonseed	Pears	Vanilla
Millet	Linseed	Quinces	Cinnamon (canella)
Sorghum	Oilseeds nes	Apricots	Nutmeg, mace and cardamoms
Buckwheat	Cabbages and other brassicas	Cherries, sour	Anise, badian, fennel, coriander
Triticale	Artichokes	Cherries	Ginger
Canary seed	Asparagus	Peaches and nectarines	Rubber, natural
Grain, mixed	Lettuce and chicory	Plums and sloes	Meat, cattle
Potatoes	Spinach	Strawberries	Milk, whole fresh cow
Sweet potatoes	Tomatoes	Gooseberries	Meat, sheep
Roots and tubers, nes	Cauliflowers and broccoli	Currants	Meat, goat
Sugar beet	Pumpkins, squash and gourds	Blueberries	Meat, pig
Beans, dry	Cucumbers and gherkins	Cranberries	Meat, chicken
Broad beans, horse beans, dry	Eggplants	Grapes	Eggs, hen, in shell
Peas, dry	Chillis and peppers, green	Watermelons	Meat, duck
Chick peas	Onions, shallots, green	Melons, other (inc.cantaloupes)	Meat, goose and guinea fowl
Lentils	Onions, dry	Figs	Meat, turkey
Cashew nuts, with shell	Garlic	Mangoes, mangosteens, guavas	Meat, horse
Chestnut	Leeks, other alliaceous vegetables	Avocados	Meat, rabbit
Walnuts, with shell	Beans, green	Pineapples	Meat, game
Pistachios	Peas, green	Dates	Honey, natural
Kola nuts	Carrots and turnips	Persimmons	
Nuts, nes	Maize, green	Kiwi fruit	
Soybeans	Mushrooms and truffles	Papayas	
Coconuts	Vegetables, fresh nes	Fruit, fresh nes	
Oil, palm	Ba as	Coffee, green	
Olives	Plantains	Cocoa, beans	
Sunflower seed	Oranges	Tea	

4 Empirical Analysis

4.1 Elasticity of Trade

The value of the elasticity of trade is critical to estimating the effect of trade policies on trade (Simonovska and Waugh 2014), and the welfare benefits of trade (Arkolakis, Costinot, and Rodríguez-Clare 2012), because it influences the measurement of trade frictions, the fluctuation of trade flows, and the associated welfare effects of trade liberalization. In this article, estimation of the elasticity of trade parameter follows the approach developed by Eaton and Kortum (2002), who suggest using the second highest price difference among trade partners to measure bilateral trade costs with product-level price data:

$$(\frac{X_{ni}/X_n}{X_{ii}/X_i}) = (\frac{P_i\tau_{ni}}{P_n})^{-\theta}, \tag{9}$$

(9)

(9)

where

$$\ln(\frac{P_i\tau_{ni}}{P_n}) = \frac{\max 2\{\ln P_n(j) - \ln P_i(j)\}}{\frac{1}{J}\sum_{j=1}^{J}(\ln P_n(j) - \ln P_i(j))}. \tag{10}$$

(9) indicates that the trade share of country i in country n relative to i's share at home can be expressed through relative prices and bilateral trade costs. If the relative price in market i with respect to n increases or the distance between country i and n increases, then country i's normalized trade share in n declines. In the theoretical model, a lower θ indicates more variation in average productivity, reflecting strength of comparative advantage – see (1). As θ becomes small, the left-hand side of the equation, representing normalized import share, is less elastic to changes in relative prices and bilateral trade costs τ_{ni}. Therefore, a low elasticity of trade θ means that there are more agricultural productivity outliers that can overcome the effect of relative price differences and bilateral trade costs, and thereby affect trade shares (Eaton and Kortum 2002).

By taking logs of (9) and substituting in the right-hand side from (10), the value of the trade elasticity θ can be recovered by using ordinary least squares (OLS) estimation. The product-level price data come from the FAO price statistics database for each observed country in the year 2013. OLS estimation yields a value of $\theta = 2.536$, lower than the estimated values of θ for agriculture of 4.06 and 4.76 reported by Tombe (2015) and Xu (2015) respectively. However, the value reported in the current article is similar to those reported in Reimer and Li (2010): 2.83 and 2.52, based on their use of generalized method of moments (GMM) and maximum likelihood estimation (MLE) techniques, respectively, for trade in crop products among 23 countries in 2001. Originally, Eaton and Kortum (2002) used a simple method-of-moments technique for the manufacturing sector based on a sample of 19 OECD countries in 1990, reporting a value of $\theta = 8.28$. Simonovska and Waugh (2014) estimate a value for θ of 2.79 to 4.46 based on results from simulated method-of-moments estimation for all sectors in a sample of 123 countries in 2004. The estimates from the latter two studies suggest larger values for θ than the estimates reported in the current article largely because the focus here is limited to agriculture where productivity is more heterogeneous than productivity in the manufacturing sector (Eaton and Kortum 2002; Reimer and Li 2010).

4.2 *Estimation of* S_i

Equation (6) shows that trade share normalized by domestic production is a function of relative average productivity, relative rental rates, and bilateral trade costs. Taking logs of (6) yields a structural "gravity" equation:

$$\begin{aligned} &\ln(\frac{X_{ni}/X_n}{X_{nn}/X_n}) = S_i - S_n - \theta\ln\tau_{ni}, \\ \text{where} \quad &\ln\tau_{ni} = b_{ni} + l_{ni} + RTA_{ni} + \sum_r d_{r_{ni}} + ex_i \ + v_{ni}. \end{aligned} \tag{11}$$

Following, *inter alia*, Eaton and Kortum (2002), Waugh (2010), and Heerman and Sheldon (2017), trade costs τ_{ij} consist of: a common border b_{ni} between countries, a common language l_{ni} between countries, membership of a common regional trade agreement RTA_{ni}, distance between two countries $d_{r_{ni}}$, and exporter fixed effects ex_i, where the distance variable is constructed over the k^{th} distance intervals.

The objective is to estimate the S_i, which are defined as the combination of the average productivity parameter and rental rate, i. e., $S_i \equiv \ln(T_i r_i{}^{-\theta})$. The error term v_{ni} in (11) is assumed to be the sum of the two components, $v_{ni}{}^1 + v_{ni}{}^2$, of which the first component $v_{ni}{}^1$ indicates unobserved one-way trade (with variance $\sigma_1{}^2$), while the second component is country-pair specific affecting two-way trade, so that $v_{ni}{}^2 = v_{in}{}^2$(with variance $\sigma_2{}^2$).[2] Accordingly, the error term has a variance-covariance matrix with the diagonal elements of $E(v_{ni} \cdot v_{ni}) = \sigma_1{}^2 + \sigma_2{}^2$ and the off-diagonal elements of $E(v_{ni} \cdot v_{in}) = \sigma_2{}^2$ (see Eaton and Kortum 2002). The error term, overall, controls for the potential reciprocity in geographic barriers, i. e., the disturbance relating to exports from n to i may be positively correlated to the disturbance relating to exports from i to n (see Reimer and Li 2010):

$$\ln(\frac{X_{ni}/X_n}{X_{nn}/X_n}) = \hat{S}_i - \hat{S}_n - \theta\hat{\tau}_{ni} - \theta v_{ni} = \bar{S}_i - \hat{S}_n - \theta(b_{ni} + l_{ni} + RTA_{ni} + \sum_r d_{r_{ni}} + v_{ni}), \quad \text{where} \quad \bar{S}_i = \hat{S}_i - \theta\hat{e}x_i \ . \tag{12}$$

The exporter fixed effects ex_i measure the additional trade costs for a specific exporter i, which enables identification of the difference between high export costs and S_i. Including the exporter fixed effects in the trade cost equation helps identify the importer and exporter effects separately (Simonovska and Waugh 2014). As shown in (12), the two separate effects, destination country fixed effects $\hat{S}_n$, and source-country fixed effects $\bar{S}_i$, are estimated with dummy variables. Since $\hat{S}_i$ is a common component for countries that are both exporters and importers, the exporter-specific component of trade costs is recovered as the deviation in the importer and exporter fixed effects ($\hat{S}_i - \bar{S}_i = \hat{S}_i - (\hat{S}_i - \theta ex_i) = \theta ex_i$). Accordingly, (12) is estimated using generalized least squares (GLS) with the diagonal elements ($\sigma_1{}^2 + \sigma_2{}^2$) of the variance-covariance matrix (Eaton and Kortum 2002; Reimer and Li 2010; Simonovska and Waugh 2014). In order to avoid the dummy variable trap, two constraints,$\sum^{S_n} = 0$ and $\sum^{e} x_i = 0$, are imposed (Reimer and Li 2010; Simonovska and Waugh 2014).

Table 4 shows the estimation results for (12) based on using 9,709 observations for 128 countries. Most of the coefficients are statistically significant with an adjusted R^2 of 0.523. Panel A indicates the estimated coefficients of the geographic barriers and Panel B presents the estimated S_i terms and recovered exporter effects. The coefficients for the geographic barriers imply that the trade share increases in common border, common language, and common regional trade agreements. The coefficients are positive and statistically significant at the 1 percent level. At the same time, the normalized trade share decreases in distance between the countries. In detail, the coefficient on the first distance dummy is −13.75 and this is the smallest in magnitude relative to the further distance dummies. The magnitudes of all distance variables in absolute values are larger than that of any other variables, suggesting that transport costs are the main impediment to agricultural trade.

Table 4: Estimation of $S_{i.}$

Panel A									
Dist1 (−θd1)	−13.75	***	(0.437)						
Dist2 (−θd2)	−15.38	***	(0.299)						
Dist3 (−θd3)	−18.21	***	(0.208)						
Dist4 (−θd4)	−20.18	***	(0.161)						
Dist5 (−θd5)	−21.83	***	(0.106)						
Dist6 (−θd6)	−22.41	***	(0.153)						
Border (−θb)	1.74	***	(0.456)						
Lang (−θl)	0.823	***	(0.215)						
RTA (−θrta)	3.286	***	(0.225)						
Panel B	Destination country (S_n)		Source country (θex_i)			Destination country (S_n)		Source country (θex_i)	
	Coeff	SE	Coeff	SE		Coeff	SE	Coeff	SE
Armenia	1.700	(0.75)	−2.608	(0.52)	Lebanon	2.956	(0.75)	1.100	(0.65)
Albania	1.449	(0.38)	−0.174	(0.63)	Lithuania	1.613	(0.44)	1.603	(0.84)
Algeria	−0.039	(0.49)	−5.177	(0.58)	Madagascar	−0.165	(0.59)	1.220	(0.84)
Antigua and Barbuda	2.124	(1.08)	−2.599	(0.38)	Malawi	−1.549	(0.97)	−2.930	(0.79)
Argentina	−0.927	(0.30)	9.951	(0.52)	Malaysia	2.403	(0.69)	3.470	(0.58)
Australia	0.800	(0.35)	9.043	(0.67)	Mali	−9.052	(0.66)	−12.933	(0.52)
Austria	0.850	(0.29)	3.479	(0.52)	Malta	1.479	(0.53)	−4.659	(0.67)
Barbados	1.060	(0.80)	−3.663	(0.55)	Mauritius	3.200	(0.62)	−0.711	(0.56)

Bangladesh	−7.689	(0.61)	−8.239	(0.64)	Mexico	0.077	(0.67)	4.689	(0.68)
Bolivia	−3.169	(0.64)	−2.768	(0.79)	Mongolia	−6.797	(1.18)	−10.218	(0.48)
Botswana	0.897	(2.24)	−4.569	(0.89)	Morocco	0.477	(0.48)	−0.077	(0.62)
Brazil	−1.777	(0.53)	7.913	(0.65)	Moldova	2.159	(0.51)	3.280	(0.80)
Belize	−0.199	(0.76)	−3.806	(0.44)	Namibia	2.172	(0.71)	0.159	(0.66)
Brunei Darussalam	3.701	(1.04)	−1.999	(0.64)	Nepal	−2.462	(1.02)	−6.115	(0.40)
Bulgaria	1.603	(0.31)	3.681	(0.55)	Netherlands	3.057	(0.44)	9.964	(0.45)
Burundi	0.380	(1.34)	−2.864	(0.74)	Macedonia	0.996	(0.51)	1.677	(0.72)
Cameroon	−6.175	(0.82)	−8.297	(0.69)	Vanuatu	−5.207	(1.16)	−9.224	(1.61)
Canada	3.377	(0.56)	12.692	(0.56)	New Zealand	1.035	(0.55)	7.954	(0.66)
Cabo Verde	3.687	(0.87)	−0.778	(0.49)	Nicaragua	−0.228	(0.95)	−2.121	(0.67)
Sri Lanka	1.520	(0.44)	4.927	(0.81)	Niger	0.993	(1.18)	−3.274	(0.57)
Chile	−0.489	(0.35)	7.926	(0.54)	Nigeria	−8.447	(0.96)	−9.553	(0.60)
China	3.511	(0.79)	14.453	(0.52)	Norway	1.830	(0.46)	−3.058	(0.53)
Colombia	−0.757	(0.55)	−0.786	(0.50)	Pakistan	−0.375	(0.47)	−0.476	(0.53)
Congo	4.400	(0.92)	−0.134	(0.29)	Panama	0.499	(0.92)	−2.034	(0.51)
Costa Rica	−0.745	(0.69)	−0.009	(0.68)	Czech Republic	0.502	(0.35)	1.090	(0.67)
Cyprus	2.051	(0.45)	0.839	(0.56)	Paraguay	−2.630	(0.68)	1.248	(0.93)
Azerbaijan	−0.078	(0.72)	−4.380	(0.48)	Peru	−0.847	(0.62)	4.604	(0.69)
Benin	−3.264	(1.24)	−8.904	(0.59)	Philippines	0.373	(0.44)	1.674	(0.63)
Denmark	0.298	(0.30)	4.161	(0.57)	Poland	−0.732	(0.33)	2.373	(0.57)
Belarus	1.548	(0.62)	−3.184	(0.74)	Portugal	1.146	(0.43)	2.388	(0.56)
Ecuador	−1.887	(0.67)	−1.798	(0.63)	Zimbabwe	0.137	(0.92)	−4.316	(0.47)
Egypt	0.404	(0.50)	4.520	(0.56)	Rwanda	−3.004	(0.95)	−5.611	(0.72)
El Salvador	0.492	(1.74)	−2.232	(0.56)	Russian Federation	3.694	(0.73)	8.865	(0.77)
Estonia	0.106	(0.56)	−1.795	(0.75)	Saint Lucia	−3.101	(0.71)	−8.397	(0.57)
Fiji	1.725	(1.04)	−1.111	(0.83)	Saint Vincent	−3.752	(1.16)	−8.682	(0.42)
Finland	−0.642	(0.47)	−1.701	(0.61)	Saudi Arabia	1.344	(0.60)	0.150	(0.56)
France	1.038	(0.42)	9.048	(0.48)	Senegal	0.573	(0.78)	−0.970	(0.73)
Georgia	3.154	(0.55)	−0.946	(0.57)	Seychelles	−0.421	(1.22)	−5.505	(0.83)
Gambia	1.042	(1.68)	−4.332	(0.54)	Slovenia	1.882	(0.37)	1.114	(0.68)
Germany	1.009	(0.39)	8.623	(0.40)	Slovakia	0.502	(0.49)	−0.599	(0.74)
Bosnia and Herzegovina	2.481	(0.45)	−0.313	(0.79)	Singapore	5.613	(0.51)	1.901	(0.52)
Ghana	0.145	(0.67)	−2.094	(0.58)	South Africa	1.267	(0.38)	8.051	(0.61)
Greece	0.988	(0.62	2.389	(0.50	Spain	2.572	(0.58)	9.804	(0.45)
Guinea	−6.510	(0.65)	−10.780	(0.35)	Suriname	−5.849	(1.06)	−10.082	(0.45)
Guyana	−1.156	(1.00)	−6.405	(0.40)	Sweden	1.039	(0.35)	0.203	(0.55)
Honduras	−5.296	(0.75)	−5.304	(0.59)	Switzerland	1.496	(0.41)	−0.600	(0.59)

Hungary	0.304	(0.33)	4.651	(0.48)	Tanzania	−2.438	(0.58)	−4.849	(0.78)
Croatia	1.926	(0.36)	0.255	(0.69)	Thailand	1.390	(0.44)	6.312	(0.57)
Iceland	0.927	(0.70)	−3.164	(0.68)	Togo	−0.419	(0.95)	−4.760	(0.51)
India	0.329	(0.67)	6.694	(0.61)	Trinidad and Tobago	−4.033	(0.59)	−7.944	(0.56)
Indonesia	0.555	(0.67)	2.308	(0.62)	Tunisia	0.239	(0.63)	−2.375	(0.67)
Iran	−8.234	(0.75)	−7.290	(0.54)	Turkey	1.252	(0.74)	6.335	(0.53)
Ireland	−1.005	(0.46)	−0.898	(0.64)	United Kingdom	1.930	(0.47)	7.083	(0.46)
Israel	0.257	(0.44)	3.166	(0.67)	Ukraine	1.026	(0.42)	6.308	(0.64)
Italy	0.772	(0.39)	7.395	(0.45)	USA	5.212	(0.76)	17.146	(0.51)
Cote d'Ivoire	−0.238	(0.63)	−2.414	(0.56)	Burkina Faso	−2.083	(1.05)	−5.617	(0.80)
Kazakhstan	2.864	(0.61)	4.098	(0.90)	Uruguay	0.227	(0.40)	5.045	(0.71)
Jamaica	0.367	(0.90)	−2.590	(0.40)	Venezuela	−2.320	(0.70)	−5.357	(0.46)
Japan	2.493	(0.83)	3.729	(0.49)	Vietnam	3.013	(0.69)	5.963	(0.64)
Jordan	2.266	(0.51)	0.201	(0.57)	Ethiopia	−0.713	(0.53)	3.272	(0.70)
Kyrgyzstan	−5.616	(1.06)	−3.865	(0.99)	Yemen	1.819	(0.69)	−1.636	(0.38)
Kenya	0.692	(0.49)	2.141	(0.66)	Zambia	−2.325	(1.03)	−3.364	(1.22)
Cambodia	−0.565	(0.98)	−2.307	(1.38)	Belgium	2.264	(0.36)	6.898	(0.46)
South Korea	0.912	(0.54)	1.935	(0.51)	Luxembourg	−3.543	(0.96)	−8.157	(0.80)
Latvia	1.290	(0.55)	−0.680	(0.76)					
Observations	9,709								
Groups	128 countries								
F stat	846.36								
R^2	0.536								
Adj R^2	0.523								

Notes: Estimated by generalized least squares. The specification is given in eq. (11). Standard errors are in parentheses. * p < 10 percent, ** p < 5 percent, *** p < 1 percent.

The estimated destination country effects S_i, and the exporter effects θex_i are reported in Panel B of Table 4. S_i, which is equivalent toln$(T_i r_i{}^{-\theta})$, is interpreted as the average productivity level adjusted by the unit production cost of country *i*. In other words, for a country with an average level of productivity, S_i is a decreasing function of the unit costs of production. However, in Figure 1, it can be seen that the estimated S_i do not vary with GDP per capita, the latter being defined as $Y_i/L_i = r_i$. In other words, countries in the North and South are similar in terms of their unit production costs r_i. By using exporter fixed effects, the model precisely reflects that tradeable products have similar aggregate prices across countries in the data (Waugh 2010).[3]

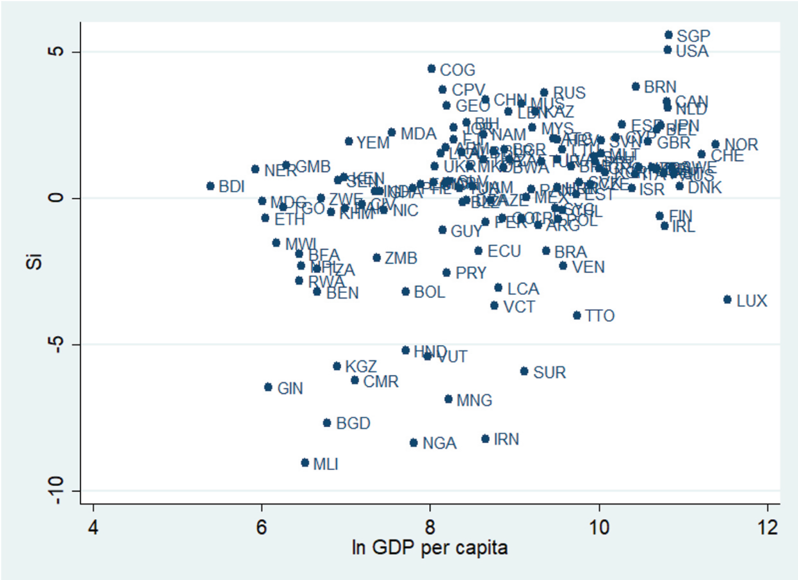

Figure 1: Destination country effects (S_i) and GDP per capita.

4.3 Trade Costs

Given the estimated value of θ, in Table 5 results are reported showing the implied effects on trade costs, which are estimated by $(e^{(-1/\theta)*b} - 1)$ with $\theta = 2.5$. In Panel A, the effects of geographic barriers on trade costs are estimated. While common border, common language, and common regional trade agreement reduce trade costs, the distance variables increase trade costs. The effect of geographic distance is much larger for distance than that of the shared border, shared language, and shared regional trade agreement. A distance of less than 375 miles requires at least an additional 243.59 units of agricultural products to be traded. Other geographic barriers (common border, common language, and common regional trade agreement) reduce trade costs by at least an additional 0.28 ~ 0.73 units of traded agricultural products.

Table 5: Estimation of the effects on trade costs.

Panel A			effect on cost		
			$\theta = 2.5$		
Dist1 (-θd1)	−13.75	***	243.59		
Dist2 (-θd2)	−15.38	***	468.07		
Dist3 (-θd3)	−18.21	***	1455.20		
Dist4 (-θd4)	−20.18	***	3205.25		
Dist5 (-θd5)	−21.83	***	6197.16		
Dist6 (-θd6)	−22.41	***	7831.21		
Border (-θb)	1.74	***	−0.50		
Lang (-θl)	0.823	***	−0.28		
RTA (-θrta)	3.286	***	−0.73		
Panel B	θex_i	effect on cost		θex_i	effect on cost
	Coeff	$\theta = 2.5$		Coeff	$\theta = 2.5$
Armenia	−2.61	1.84	Lebanon	1.10	−0.36
Albania	−0.17	0.07	Lithuania	1.60	−0.47
Algeria	−5.18	6.93	Madagascar	1.22	−0.39
Antigua and Barbuda	−2.60	1.83	Malawi	−2.93	2.23
Argentina	9.95	−0.98	Malaysia	3.47	−0.75
Australia	9.04	−0.97	Mali	−12.93	175.47
Austria	3.48	−0.75	Malta	−4.66	5.45
Barbados	−3.66	3.33	Mauritius	−0.71	0.33
Bangladesh	−8.24	25.99	Mexico	4.69	−0.85
Bolivia	−2.77	2.03	Mongolia	−10.22	58.56
Botswana	−4.57	5.22	Morocco	−0.08	0.03
Brazil	7.91	−0.96	Moldova	3.28	−0.73

Belize	−3.81	3.58	Namibia	0.16	−0.06
Brunei Darussalam	−2.00	1.22	Nepal	−6.11	10.54
Bulgaria	3.68	−0.77	Netherlands	9.96	−0.98
Burundi	−2.86	2.14	Macedonia	1.68	−0.49
Cameroon	−8.30	26.63	Vanuatu	−9.22	39.03
Canada	12.69	−0.99	New Zealand	7.95	−0.96
Cabo Verde	−0.78	0.37	Nicaragua	−2.12	1.34
Sri Lanka	4.93	−0.86	Niger	−3.27	2.71
Chile	7.93	−0.96	Nigeria	−9.55	44.66
China	14.45	−1.00	Norway	−3.06	2.40
Colombia	−0.79	0.37	Pakistan	−0.48	0.21
Congo	−0.13	0.06	Panama	−2.03	1.26
Costa Rica	−0.01	0.00	Czech Republic	1.09	−0.35
Cyprus	0.84	−0.29	Paraguay	1.25	−0.39
Azerbaijan	−4.38	4.77	Peru	4.60	−0.84
Benin	−8.90	34.23	Philippines	1.67	−0.49
Denmark	4.16	−0.81	Poland	2.37	−0.61
Belarus	−3.18	2.57	Portugal	2.39	−0.62
Ecuador	−1.80	1.05	Zimbabwe	−4.32	4.62
Egypt	4.52	−0.84	Rwanda	−5.61	8.43
El Salvador	−2.23	1.44	Russian Federation	8.87	−0.97
Estonia	−1.79	1.05	Saint Lucia	−8.40	27.76
Fiji	−1.11	0.56	Saint Vincent	−8.68	31.23
Finland	−1.70	0.97	Saudi Arabia	0.15	−0.06
France	9.05	−0.97	Senegal	−0.97	0.47
Georgia	−0.95	0.46	Seychelles	−5.50	8.04
Gambia	−4.33	4.66	Slovenia	1.11	−0.36
Germany	8.62	−0.97	Slovakia	−0.60	0.27
Bosnia and Herzegovina	−0.31	0.13	Singapore	1.90	−0.53
Ghana	−2.09	1.31	South Africa	8.05	−0.96
Greece	2.39	−0.62	Spain	9.80	−0.98
Guinea	−10.78	73.57	Suriname	−10.08	55.41
Guyana	−6.41	11.96	Sweden	0.20	−0.08
Honduras	−5.30	7.35	Switzerland	−0.60	0.27
Hungary	4.65	−0.84	Tanzania	−4.85	5.96
Croatia	0.26	−0.10	Thailand	6.31	−0.92
Iceland	−3.16	2.54	Togo	−4.76	5.71
India	6.69	−0.93	Trinidad and Tobago	−7.94	22.99
Indonesia	2.31	−0.60	Tunisia	−2.37	1.59
Iran	−7.29	17.47	Turkey	6.33	−0.92
Ireland	−0.90	0.43	United Kingdom	7.08	−0.94
Israel	3.17	−0.72	Ukraine	6.31	−0.92
Italy	7.39	−0.95	USA	17.15	−1.00
Cote d'Ivoire	−2.41	1.63	Burkina Faso	−5.62	8.46
Kazakhstan	4.10	−0.81	Uruguay	5.05	−0.87
Jamaica	−2.59	1.82	Venezuela	−5.36	7.52
Japan	3.73	−0.78	Vietnam	5.96	−0.91
Jordan	0.20	−0.08	Ethiopia	3.27	−0.73
Kyrgyzstan	−3.86	3.69	Yemen	−1.64	0.92
Kenya	2.14	−0.58	Zambia	−3.36	2.84
Cambodia	−2.31	1.52	Belgium	6.90	−0.94
South Korea	1.93	−0.54	Luxembourg	−8.16	25.12
Latvia	−0.68	0.31			

In Panel B, it can be seen that the costs of exporting agricultural products from the US are lower by an additional one unit of the product as compared to products exported from the average country. Similarly, it costs less to export agricultural products from Argentina, China, Chile, and Brazil than from the average country – about 0.97 units. On the other hand, an agricultural product exported from Nigeria costs about 44.66 units more than the average, while agricultural products exported from Mali, Mongolia, Guinea and Surinam cost more than an additional 50 units than the average country. Therefore, as shown in Figure 2, it costs less for the relatively open and developed countries to export.

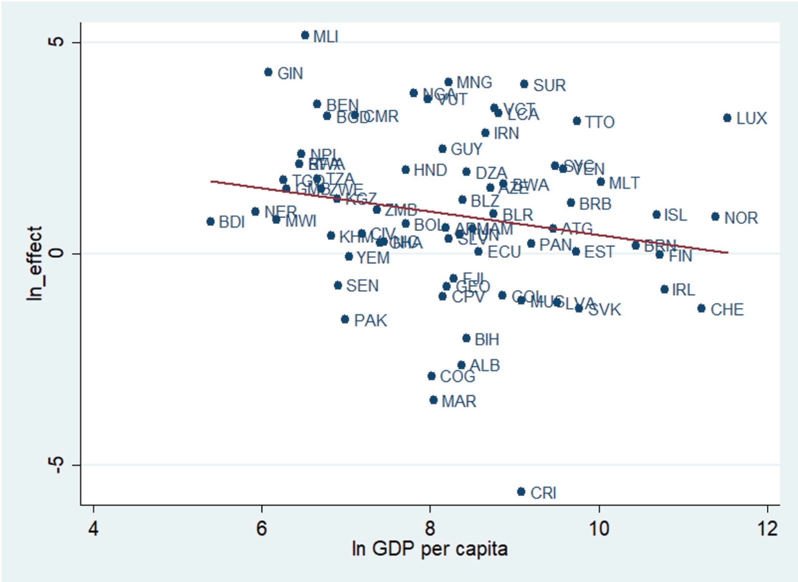

Figure 2: Effect on trade costs and GDP per capita.

4.4 Productivity Estimates

As noted earlier, the results indicate that the unit costs of production for countries with average productivity T_i are equivalent across countries. Therefore, differences in S_i are assumed to be caused by differences in agricultural productivity. Average productivity is recovered using the definition of S_i:

$$\ln T_i \equiv \hat{S}_i + \theta \ln r_i,$$

where r_i is estimated using the exporter's agricultural output per hectare of arable land (Heerman and Sheldon 2017). From this, a country's average productivity level T_i can be separated from its competitiveness S_i. As shown in Figure 3, more productive countries also have higher levels of income, the relationship between the log of estimated average productivity T_i and the log of GDP per capita being positive. The conclusion to be drawn is that the North and South differ in terms of average productivity levels.

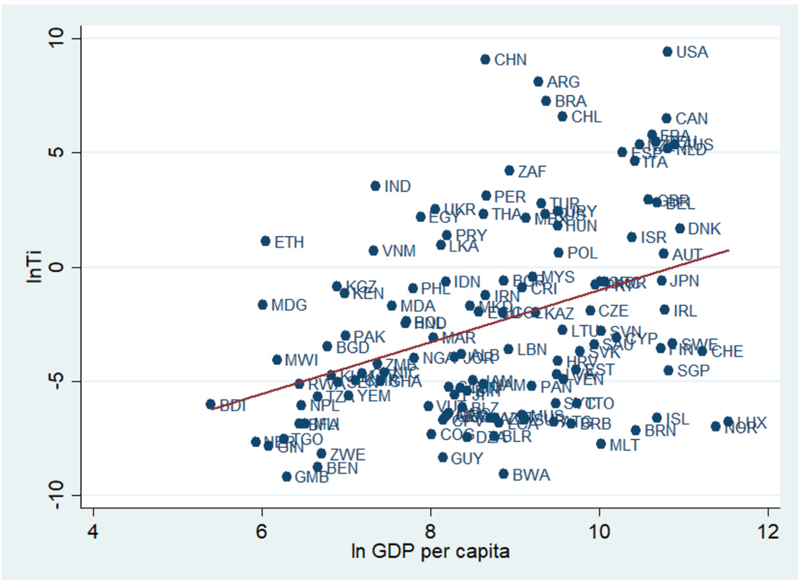

Figure 3: Productivity (T_i) and GDP per capita.

In Table 6, the normalized average productivity level is shown by calculating the value relative to the US value $(\frac{T_i}{T_{us}})^{1/\theta}$. The US, China, Argentina, Brazil, and Chile are recorded as the top five high-productivity countries in the agricultural sector whereas Gambia, Botswana, Benin, Guyana, and Zimbabwe are recorded as the bottom five countries. Also, the normalized average productivity level is interpreted as the agricultural productivity level of a country adjusted by its rental rate. For instance, Australia (9.042) is more competitive than France (9.048) and Germany (8.623) (see Table 4), but it is ranked below France and Germany in terms of agricultural productivity (see Table 6). It is assumed that the competitive edge is due to lower rental rates rather than the level of productivity. Similarly, a low productivity estimate for Belgium (ranked 24th) is the consequence of a high rental rate (ranked 19th).

Table 6: Estimation of productivity.

Country	$(\frac{T_i}{T_{us}})^{-1/\theta}$	Country	$(\frac{T_i}{T_{us}})^{-1/\theta}$
United States of America	1.0000	Switzerland	0.0053
China, mainland	0.8783	Slovakia	0.0053
Argentina	0.5938	Albania	0.0050
Brazil	0.4242	Jordan	0.0047
Chile	0.3226	Nigeria	0.0047
Canada	0.3111	Malawi	0.0045
France	0.2326	Croatia	0.0044
Germany	0.2075	Zambia	0.0042
Australia	0.1982	Estonia	0.0038
New Zealand	0.1952	Singapore	0.0038
Netherlands	0.1829	Nicaragua	0.0036
Spain	0.1707	Cote d'Ivoire	0.0035
Italy	0.1463	Latvia	0.0035
South Africa	0.1237	Cambodia	0.0034
India	0.0952	Venezuela	0.0032
Peru	0.0800	Cameroon	0.0032
United Kingdom	0.0749	Jamaica	0.0032
Belgium	0.0707	Ghana	0.0031
Turkey	0.0704	Senegal	0.0031
Ukraine	0.0633	Rwanda	0.0030
Uruguay	0.0616	Namibia	0.0029
Thailand	0.0584	Panama	0.0029
Russian Federation	0.0581	El Salvador	0.0028
Egypt	0.0557	Tunisia	0.0028
Mexico	0.0542	Bosnia and Herzegovina	0.0026
Hungary	0.0476	Fiji	0.0025
Denmark	0.0455	Yemen	0.0024
Paraguay	0.0404	United Republic of Tanzania	0.0024
Israel	0.0388	Seychelles	0.0021
Ethiopia	0.0361	Trinidad and Tobago	0.0021
Sri Lanka	0.0338	Burundi	0.0021
Vietnam	0.0306	Nepal	0.0020
Poland	0.0297	Vanuatu	0.0020
Austria	0.0289	Belize	0.0020
Malaysia	0.0195	Mongolia	0.0018
Japan	0.0181	Georgia	0.0017
Bulgaria	0.0181	Mauritius	0.0017
Indonesia	0.0178	Armenia	0.0017
Republic of Korea	0.0177	Saint Vincent and the Grenadines	0.0016
Greece	0.0177	Azerbaijan	0.0016
Portugal	0.0169	Iceland	0.0016
Kyrgyzstan	0.0165	Suriname	0.0016
Costa Rica	0.0160	Cabo Verde	0.0016
Philippines	0.0158	Antigua and Barbuda	0.0015
Kenya	0.0146	Luxembourg	0.0015
Iran	0.0140	Saint Lucia	0.0015
Madagascar	0.0119	Barbados	0.0015
Republic of Moldova	0.0117	Mali	0.0015
Macedonia	0.0116	Burkina Faso	0.0015
Ireland	0.0108	Norway	0.0014
Czech Republic	0.0108	Brunei Darussalam	0.0013
Ecuador	0.0105	Congo	0.0012
Colombia	0.0104	Belarus	0.0012
Kazakhstan	0.0103	Algeria	0.0012

Bolivia	0.0088	Togo	0.0011
Honduras	0.0086	Niger	0.0011
Lithuania	0.0076	Malta	0.0010
Slovenia	0.0075	Guinea	0.0010
Pakistan	0.0069	Zimbabwe	0.0009
Morocco	0.0067	Guyana	0.0008
Cyprus	0.0067	Benin	0.0007
Sweden	0.0060	Botswana	0.0006
Saudi Arabia	0.0060	Gambia	0.0006
Bangladesh	0.0057		
Finland	0.0055		
Lebanon	0.0054		

4.5 *Recovering Asymmetric Trade Costs*, τ_{ij}

Using the estimates from the previous section, bilateral trade costs from the structural model are estimated. Equation (11) is used to derive asymmetric trade costs:

$$\tau_{ni} = \exp(-\hat{b}_{ni}/\theta) * \exp(-\hat{l}_{ni}/\theta) * \exp(-r\hat{ta}_{ni}/\theta) * \exp(-\sum_{r} \hat{d}_{r_{ni}}/\theta) * \exp(\hat{ex}_i/\theta).$$

Trade costs for selected countries are presented in Table 7. The rows indicate exporters and the columns indicate destination markets. Trade costs to export τ_{ni} follow the standard iceberg assumption, in that they refer to transportation costs or costs necessary to overcome geographic barriers. They also include unobserved related barriers, which are the asymmetric components.

Table 7: Asymmetric trade costs for selected countries.

Ex\Im	Argentina	China	France	Guyana	Italy	Japan	Morocco	Nicaragua	Peru	Zimbabwe	South Africa	Spain	UK	US	Vietnam	Ethiopia
Argentina	1	146	146	60	146	146	116	83	43	116	116	105	146	116	146	146
China	24	1	19	24	19	4	24	24	24	24	24	19	19	24	2	19
France	210	166	1	166	2	210	8	166	210	166	45	2	2	166	166	166
Guyana	41564	101534	80350	1	80350	101534					57812	80350	57812	29906		
Italy	407	322	3	322	1	407	20	407	407	322	86	20	20	322	322	167
Japan	1762	328	1762		1762	1	1762		1762	1762	1762	1762	1394	1762	721	
Morocco	6391	8076	290		403	8076	1		6391	6391	6391	130	403	1717	8076	6391
Nicaragua	10417	18294	14478		18294	18294		1	5388			10417		2012	18294	18294
Peru	366	1242	1242		1242	1242	983	366	1		1242	707	1242	983	1242	1242
Zimbabwe	34835	44019	34835		34835	44019		44019	44019	1	789	34835	25064	31672	34835	12965
South Africa	248	313	66	178	66	313	248	313	313	6	1	66	60	225	313	178
Spain	112	123	1	123	8	155	2	88	88	123	33	1	8	123	155	123
UK	461	365	4	262	23	365	23	365	461	262	89	23	1	262	365	262
US	7	8	7	2	7	8	2	1	7	6	6	7	5	1	8	6
Vietnam	721	67	571		571	295	721	721	721	571	721	721	571	721	1	571
Ethiopia	2116	1674	1674		866	2116	1674	2116	2116	623	1205	1674	1205	1522	1674	1

For rich countries, e. g., China, France, Japan, the UK, the US, and so on, the costs of exporting to the South, which are represented in the upper diagonal, are less than the costs of the South exporting to the North, as represented in the lower diagonal. For example, trade costs for the US exporting to Zimbabwe (6) are considerably smaller than those for Zimbabwe exporting to the US (31,672). In addition, the trade cost of Ethiopia exporting to France is more than twice the cost of France exporting agricultural products to Ethiopia. Accordingly, asymmetric trade costs imply that countries in the South trading with the North, face relatively more difficulty in exporting their products than importing products from the North.

In Figure 5, the relationship between τ_{in} and τ_{ni} is shown, where n is trading partner and i is the US. Trade cost from the US towards country n is relatively smaller than that of country n's trade costs towards the US market. Developing countries are located in the upper part of the figure, indicating that they have a relatively higher trade cost than that of the US. In Figure 4 the relationship between asymmetric trade costs and GDP per capita is illustrated. Most countries have a positive deviation of trade costs, meaning that their trade costs towards the US market are higher than the US trade costs towards their markets. The relationship between GDP per capita and the deviation is negative. Thus, countries with a higher deviation of export trade cost towards the US also have a lower GDP per capita. An important conclusion is that low-income countries in the South pay relatively higher trade costs to export agricultural products as compared to the US.

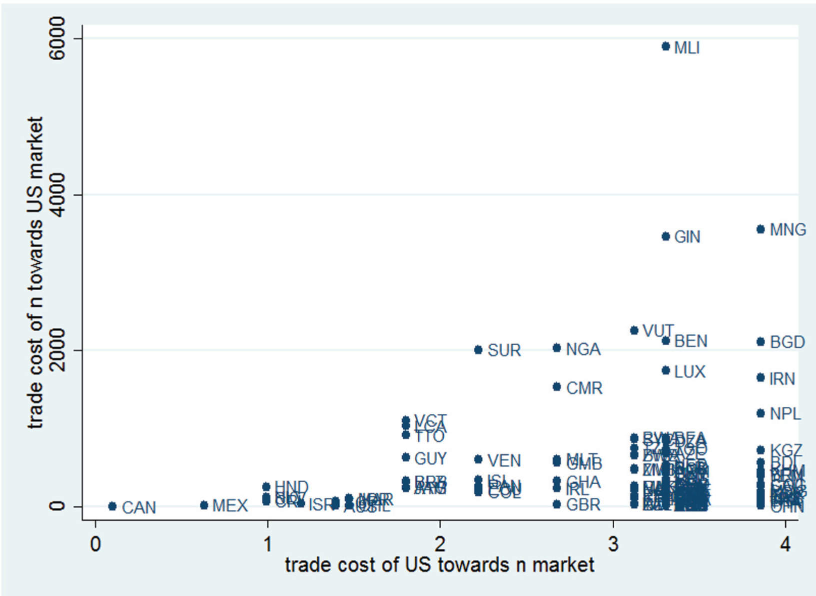

Figure 4: Asymmetric trade costs.

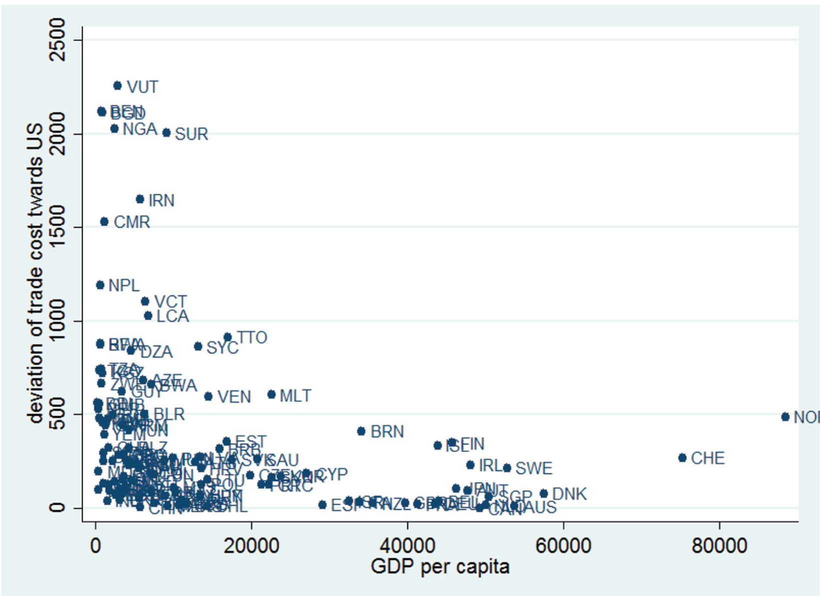

Figure 5: Asymmetric trade costs and GDP per capita.

5 Summary and Conclusion

Trade flows in the agricultural sector are significantly less than those in manufacturing. In this article, the extent to which low agricultural trade flows are due to either relative average productivity differences and/or bilateral trade costs are examined. Based on a neo-Ricardian model, trade shares are expressed as a function of relative average productivity, relative rental rates, and bilateral trade costs. Using trade data for 128 countries for 2013, the value of the elasticity of trade is estimated, the value being relatively lower than the value reported in other studies for the manufacturing sector. The low value for the elasticity of trade reveals that there is large heterogeneity in productivity in the agricultural sector, implying that the role of comparative advantage in countering trade costs should be strong.

Furthermore, large trade frictions restrict agricultural trade flows. In particular, asymmetric trade costs account for the low agricultural trade of developing countries in that the South faces relatively higher trade costs than does the North. Based on the estimation results, the trade costs incurred by the South are much higher than those incurred by the North, while domestic unit costs and the price of tradeable products are equivalent between the North and the South. In conclusion, relatively higher trade costs, as well as differences in productivity are suggested as the main causes for why the South trades fewer agricultural products, a result that compares to the earlier findings of Waugh (2010) for trade in the manufacturing sector.

Notes

1 If zero trade flows were dropped, the number of observations decreases to 4,928 with 116 countries.
2 Simonovska and Waugh (2014) use both specifications with the error term in (9), interpreting the error term as a measurement error and structural shock to trade barriers, respectively. According to their results, the estimates are nearly identical.
3 The interpretation of S_i is different from Eaton and Kortum (2002) who use importer fixed effects. A model with importer fixed effects allows for a larger import share as a result of the lower unit cost of production. If two countries import a similar share of products, then the model predicts that an increase in trade costs will generate similar trade shares.

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