Agricultural Trade Costs in 21st Century: New Evidence

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Agricultural Trade Costs in 21st Century: New Evidence

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The globalization and the liberalization of goods, people, and services have decreased the trade costs across the world for many sectors since the establishment of the WTO in 1995. However,the characteristic and distinct nature of agricultural products raises the question of how agricultural trade costs evolve through time. In this paper, we use an original three-step estimation procedure to estimate ad valorem equivalent trade costs that are directional, heterogeneous, and disaggregated at the SITCR1 4-digit level. We first estimate directional country pair coefficients by using a structural gravity model with only fixed effects. In the second and third step, we estimate product match elasticities and use them to convert country pair coefficients into ad valorem equivalent trade costs. We find that the evolution of agricultural trade costs are heterogeneous among products,regions and income levels. In our last section, we investigate the determinants of trade costs, and find that RTAs, tariffs, and distance, along with common country characteristics, are important components of agricultural trade costs.
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Is the world getting flatter indeed? The world is becoming more connected through globalization and the liberalization of goods, people, and services. Since 1995, countries have been embracing free trade with the establishment of the World Trade Organization (WTO) and an increasing number of regional trade agreements (RTAs). Recent developments in globalization and liberalization of trade have aroused the discussion about whether the world is becoming flatter (Friedman, 2005), in which geographical constraints, such as distance, are no longer trivial to trade. The metaphorical flattening also raises the question whether trade costs are declining in a way that they are no longer perceived as trade barriers. These discussions pave the way for new conversations about the changing dynamics of global trade costs.

The changes in trade costs are significant to the trade all over the world in several aspects. First, the liberalization and decrease in trade costs can lead to convergence between the developing countries and developed countries (Baldwin, Martin and Ottaviano, 2001). Moreover,in terms of the agricultural sector, reduction in trade costs is important to alleviate food insecurity and poverty.

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Recently, scholars have argued that new transportation technologies and communication channels, the expansion of digital trade, and the reduction of tariff and non-tariff measures have lowered the trade costs in the early stages of globalization (Jacks, Meissner and Novy, 2011; Arvis et al., 2016). The average tariff rate applied to agricultural products has decreased in the liberalization process, but the tariff rates are still higher than the other sectors (Jouanjean, Maur and Shepherd, 2011; Gaigné and Gouel, 2022; Guimbard et al., 2012).

However,despite the existing scholarly findings, less is known about the extent to which agricultural trade costs have decreased over the last two decades. This might be due to several reasons. For example, agricultural products encounter more regulations and policy influence (Egger et al., n.d.; Gaigné and Gouel, 2022) than other sectors, as many countries opt for precautionary food regulatory policies to ensure food security. In other cases such as the recent Covid-19 and Russia-Ukraine War, instances have caused distortions in the supply chain, and increased trade restrictions in the agricultural sectors, which is one of the vital sectors for the human entity that could decrease the welfare of many countries and improve food security (Aday and Aday, 2020). Moreover, some agricultural products are perishable and cannot be stored, which may induce higher trade costs. For example, an important part of African trade constitutes perishable goods that suffer from high trade constraints and poor trade facilitation, causing inevitable losses and wastes (Bonuedi, Kamasa and Opoku, 2020), and leading to higher trade costs. Therefore, we offer a new perspective by measuring the evolution of trade costs since the beginning of the 21st century. Our viewpoint provides insights for policymakers to reduce the trade costs (Moïsé and Bris, 2013) and to ensure food security for all countries by sustaining lower trade costs.

This paper proposes a new angle for the estimation and evolution of trade costs in the disaggregated agricultural sectors for the period between 2001 to 2018. Our methodology consists of a three-step estimation procedure. The first step is the estimation of directional trade costs by using a structural gravity model with intranational trade which enables us to obtain theoretically consistent estimation (Olivero and Yotov, 2012; Yotov et al., 2016). We include country pair dummies in our estimation to capture the heterogeneity of bilateral trade costs within the direction of trade. We also include exporter-time and importer-time fixed effects to control for multilateral resistance, supply, and demand characteristics. To estimate this structural gravity model, we develop an original dataset from UN Comtrade and UN Statistics Division Comtrade and the Food and Agricultural Organization (FAO) which includes intranational trade flows at the Standard International Trade Classification Revision 1 (SITCR1) level, using UN Comtrade and FAO production data (Syrengelas, Emlinger and Grant, 2021).In a second step, the estimated coefficients of the country pair dummies are converted into ad valorem equivalents for each product and period, using matched product-specific elasticities. We retrieve these elasticities from the estimation of a second structural gravity framework, including disaggregated tariff from the MacMaps

Database (CEPII) (Guimbard et al., 2012). Third, we obtain a full dataset of trade costs by product, exporter, importer, and period. In addition to being disaggregated at the SITCR1 product level, and covering a long period, these trade costs have the advantage of being directional (i.e., asymmetric), which means that the trade costs between two trade partners depend on the direction of the trade. All of these allow us to investigate the heterogeneity of the evolution of trade costs through time across products, regions, and country income levels. This is especially important since many trade agreements, and negotiations such as the US and China trade conflict, and the following Phase 1 agreement are discussed at the sectoral level (Moïsé and Bris, 2013), so that they could ensure the food security, increase the well being of their country, and help to alleviate poverty by reducing the trade costs.

We find that the agricultural trade costs decrease at the beginning of the 2000s, but have been increasing since the second period, i.e. 2004-2006, with an important heterogeneity across products and regions. Our results are robust to several checks such as the use of different elasticities and various slices of the data. This heterogeneity can be explained by differences in tariff levels, transportation and communication costs, or non-tariff barriers.Heterogeneity of trade costs evolution in regional and country income group settings indicate the unequal integration of economies in world trade, in particular the lower participation of developing countries in the liberalization and globalization process. Developed regions usually enjoy advanced technology, enhanced communication, integrated infrastructure, and benefits from the economics of scale. On the other hand, developing regions may not have the same level of technology, weak communication channels, insufficient infrastructure, logistic problems, and may suffer from instability. In the last part of the paper, we investigate how policy instruments, such as tariffs, and regional trade agreements have impacted the evolution of agricultural trade costs since the beginning of the 21st century. By proposing an original estimate of trade costs over a long period of time, this paper opens new perspectives and discussions on the unequal effects of globalization, with particular emphasis on the heterogeneity of the effects of liberalization across the agricultural sectors.

I. Trade Costs Estimation

A. Structural Gravity

In the first step, we use theoretically consistent structural gravity model to obtain directional trade costs. Consider following structural gravity model;

$$X_{ij,t} = exp[\alpha_{ij} D_{ij} + \eta_{i,t} + \theta_{j,t}] \times \varepsilon_{ij,t} \tag{1}$$

where $X_{ij,t}$ is trade flow in value from origin i to destination j, and time t. The trade flow includes international and intranational trade flows to obtain unbiased and consistent estimation (Yotov et al., 2016; Santos Silva and Tenreyro, 2011). D_{ij} refers to directional country pair dummies and α_{ij} is the coefficient of trade cost from country pair i to j. $\eta_{i,t}$ and $\theta_{j,t}$ are exporter-time and importer time fixed effects, respectively. The equation (1) is estimated separately for each product k, and period τ using Poisson Pseudo Maximum Likelihood (PPML) by (Santos Silva and Tenreyro, 2011) . We split the data into three years intervals and call each interval as a period to match trade data with the tariff data and investigate the change in trade costs through time. We obtain the country-pair coefficients α_{ij} for each product and period and denote them as $\alpha_{ijk,\tau}$ in the third step. Including exporter-time and importer-time fixed effects in the equation (1) controls for consumer and producers characteristics and capture the directional trade costs in an indirect estimation method. It is important to note that while estimating the structural gravity model with country pair dummies, we use the intranational trade flows as a reference category. This enables us to estimate, evaluate and compare international trade costs, i.e. border effects relative to intranational trade costs.

B. *Trade Elasticity Estimation*

In the second step, we use product specific elasticities. Heterogeneous elasticities are more realistic, since one cannot expect the same elasticity of substitution for agricultural products. For example, wheat is one of the essential products that most people consume, however coconut is not as essential as wheat for most people. Therefore, we use product specific elasticities instead of using uniform elasticity of substitution on the contrary to precedent studies (Novy, 2013; Arvis et al., 2016). This enables us to show the heterogeneous trade costs among agricultural products. We run another structural gravity model given in (2) to estimate product specific elasticities.

$$\begin{aligned} X_{ij,t} = & exp[\beta_1 lnTARIFF_{ij,t} + \beta_2 lnDIST_{ij} + \beta_3 CMNCOL_{ij} \\ & + \beta_4 CMNLAN_{ij} + \beta_5 RTA_{ij,t} + e_{i,t} + e_{j,t}] \times \varepsilon_{ij,t} \end{aligned} \tag{2}$$

where $X_{ij,t}$ is trade flow in value from origin i to destination j at time t as it is in the (1). The equation (2) includes covariates of natural logarithm of $(1 + TARIFF)$ rate $(lnTARIFF)$, natural logarithm of distance $(lnDIST)$, common colonizer dummy $(CMNCOL)$, common language index $(CMNLAN)$, regional trade agreements (RTA), and exporter-time, importer-time fixed effects. We estimate the equation (2) separately for each product k. Using the equation (2),we estimate product specific elasticity of tariff and convert our trade costs coefficients into advalorem equivalent trade costs. Trade elasticity is equivalent to $\sigma = 1 - (-\beta_1) = 1 + \beta_1$. Since we estimate trade elasticity by product, we denote the elasticity as σ_k in the third step.

C. *Ad valorem Equivalent Trade Costs*

In the last step, we convert trade costs into advalorem equivalent measure by matching product specific elasticities as follows;

$$TC_{ijk,\tau} = \Big(exp[\hat{\alpha}_{ijk,\tau}]\Big)^{\frac{1}{\sigma_k}} \tag{3}$$

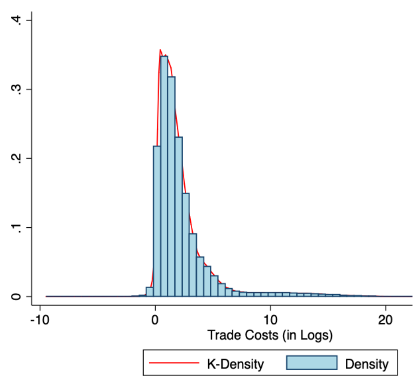
where $TC_{ijk,\tau}$ is advalorem equivalent trade costs from origin i to destination j at period τ, and for product k. And as we mentioned above, σ_k represents individual elasticities for each product. After applying the conversion in (**??**), we finally obtain an original trade costs dataset that is directional, heterogeneous, and disaggregated at the SITCR1 4-digit level.

D. *Data*

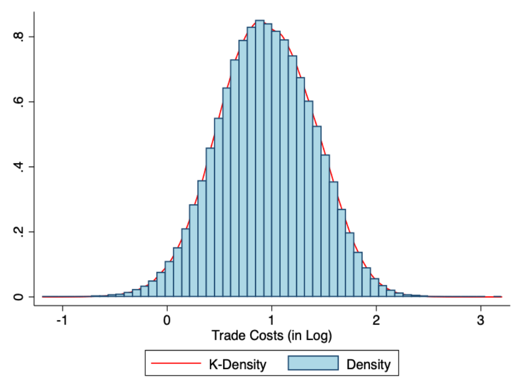
This section describes the dataset, sources and the descriptive statistics.There are three different data sets that we use to estimate the trade costs. In step 1 we estimate the structural gravity model, using international trade costs relative to intranational trade flows. Therefore, we use international and intranational trade flows at the SITCR1 4-digit level, which are obtained from UN Comtrade and FAO production data Syrengelas, Emlinger and Grant (2021). In step 2 additional to trade flows dataset, we use the disaggregated tariff data from the MacMaps Database (CEPII) (Guimbard et al., 2012), and Gravity Database (CEPII) (Head, Mayer and Ries, n.d.; Head and Mayer, 2014) to estimate the product specific elasticities in the second step. The tariff data is available for every three years, and it spans from 2001 to 2016. Therefore, starting from 2001, we divide the data into 6 periods, each of which includes 3 consecutive years. Lastly, there are 158 exporters, 158 importers and 63 products at the 4-digit level of the SITCR1 ranging from 0111 to 4224 in our dataset.

II. Evolution of Trade Costs

In this section we present our main findings. We start with the descriptive statistics on newly estimated trade costs. Figure 1 shows the kernal density estimates and the histogram for trade costs data . In panel a, trade costs are skewed to right and the density is higher around 0.5 to 1. This indicates that higher trade costs imply lower trade flows in our dataset. On the other hand, panel b looks like symmetric distribution that resembles normal distribution. The difference between the panel a and the panel b is that, after obtaining the pair coefficients in the step 1, we use two different elasticities to calculate the trade costs. The Figure 1 shows that the unit elasticities deprived us from seeing the heteroskedasticity of trade costs. Hence, it is more convenient and realistic to use product-matched elasticities. From now on, we use product-matched elasticities if not specified otherwise.



(a) elasticity:σ_k



(b) elasticity:$\sigma = 8$

Figure 1. : Kernal Density and Histogram of Trade Costs

A. Evolution Within Time

We now turn into another descriptive graph to measure the trade costs. Figure 2 demonstrates the kernal density estimates for different time periods of the dataset. The left and right tail have been limited at $(-1, 10)$ to increase the visibility of differences among the kernal densities. In the first period i.e., 2001-2003, the distribution has lower densities for lower trade costs, however it is getting wider than the others after some point. The second period, i.e., 2004-2006, shows that the distributions have become tighter comparing the previous period, implying that the trade costs have decreased. However, after the second period, the distributions are getting flatter, hence they suggest increasing trade costs in these periods.

We evaluate the evolution of trade costs with a regression of period dummies, and exporter-sector and importer-sector fixed effects on logarithm of trade costs. This helps to compare how trade costs evolve for different sub-samples of our trade costs dataset. Figure 3, Figure 4 and Figure 5 shows coefficient plots for product type, regions and income group.

B. Heterogeneity Across Sectors

In Figure 3, we use BICO classification for sample of products that belong to bulk, consumer oriented, intermediate, or agriculture related commodities defined

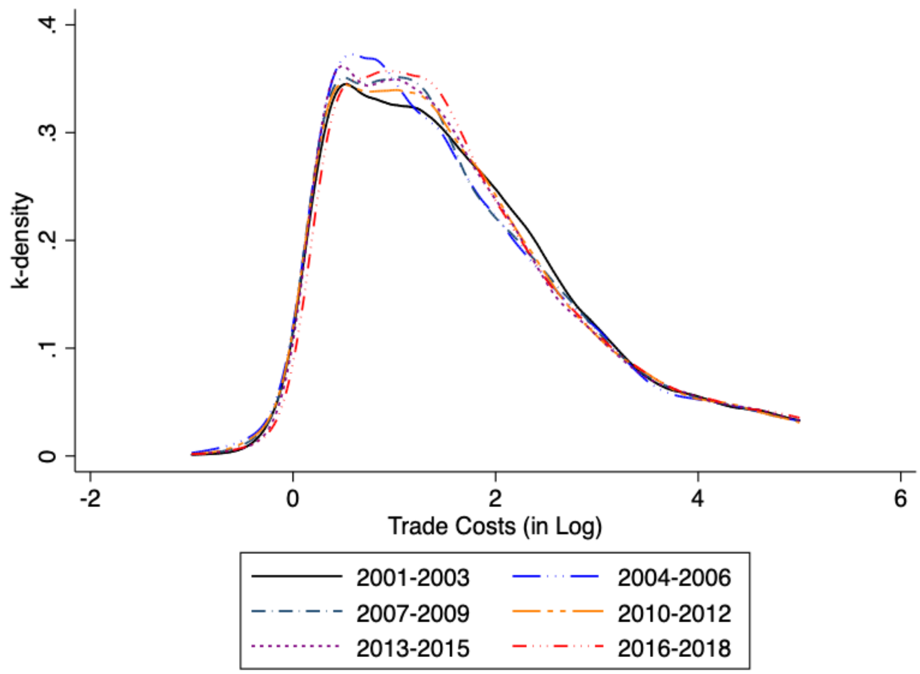


Figure 2. : Kernal Density of Trade Costs with Periods

by Foreign Agricultural Serive (FAS) of U.S. Department of Agriculture (USDA).

The Figure 3 suggests that trade costs decrease in the second period, i.e. 2004-2006, compared to the first period. After the second period, there is an increasing trend in trade agricultural trade costs. Furthermore, the trade costs do not evolve in the same way in different sector classifications. Trade costs for the intermediate commodities such as live animal, animal fats and oils have increased about 14.4% compared to the first periods. The bulk classification includes commodities such as wheat, soybean, corn rice and cotton, and it also follows the similar pattern with the intermediate commodities. The trade costs for bulk commodities are 10.8% higher than the first period. However, even though there is an increasing trend for consumer oriented and agriculture related commodities, the trade costs for these commodity groups are still lower than the reference period.

C. Heterogeneity Across by Regions and Income Levels

We have seen that there is heterogeneity in trade costs evolution among product groups. In the Figure 4 and the Figure 5 we investigate the trade costs evolution by exporter region, importer regions, exporter income group and importer income

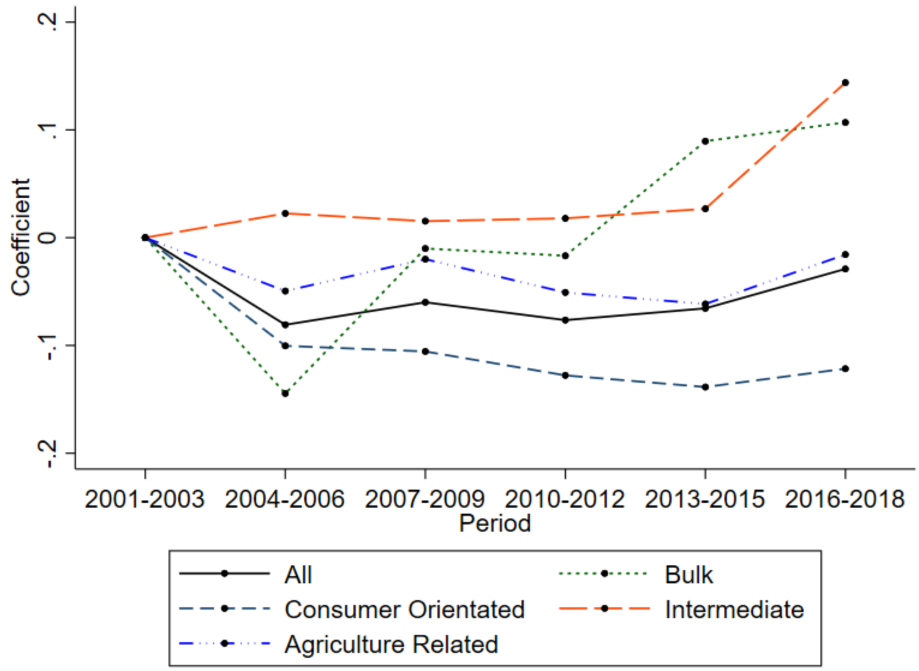
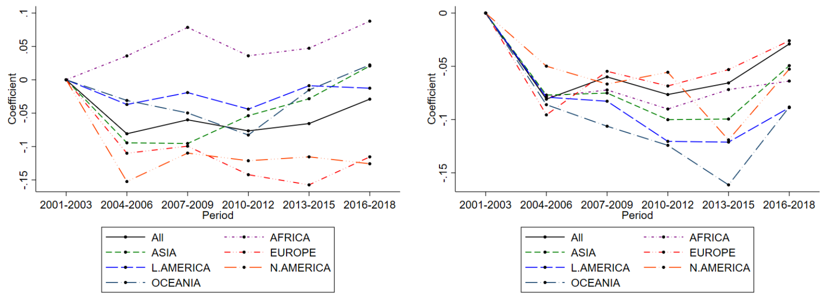


Figure 3. : Trade Costs Evolution

group. We use FAO's definition for regions and country income groups. In both of the graphs, the reference category is the first period. Hence, the coefficients imply trade costs changes relative to the first period. We investigate the unequal globalization of trade by comparing the evolution of trade costs among regions and country income groups.

The Figure 4 has two panels. Panel a and Panel b show trade costs evolution for exporter regions and importer regions separately. The Panel a shows that agricultural trade costs, for exports from EUROPE and North America (N.AMERICA), have experienced 11.5% and 12.6% reduction compared to the first period. However, other regions have experienced higher trade costs in the last period when compared to the first period. The scenario is different in Panel b. Exporter regions, which have experienced high trade costs reductions compared to the first period, i.e. EUROPE and N.AMERICA, have experienced lower trade costs reduction for imports. This demonstrates the unequal globalization effect on agricultural trade costs.

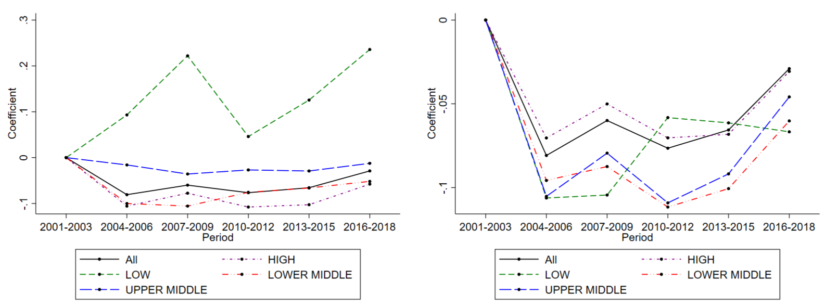
The Figure 5 is a similar graph with the previous one, where we use sub-samples of data with respect to country income groups. The Figure 5 suggests that in the export direction, high income countries experience the higher reductions in the trade costs, and the lower-middle income countries follow them. However,



(a) By Exporter Region (b) By Importer Region

Figure 4. : Regional Differences in Trade Costs Evolution

there is still an increasing trend in the last 3-4 periods. All income groups, except low income group, have lower trade costs in the last period compared to the first period. This illustrates that the low income countries struggle to reduce trade costs benefit from globalization. In the import direction, all income groups nearly follow a similar pattern with different magnitudes. As in the previous case, countries that experience lower trade costs reductions have experienced lower trade costs reductions in the import direction. This also contributes to the fact that high income countries benefit more from the globalization and the reduction in trade costs than the low income countries.



(a) By Exporter Income Group (b) By Importer Income Group

Figure 5. : Income Group Differences in Trade Costs Evolution

III. Determinants of Trade Costs

A. Specification

After measuring the evolution of trade costs, we investigate ways in which trade costs are affected. Consider the following model;

$$\begin{aligned} ln(TC_{ijk,\tau}) = \alpha + \beta_1 lnDIST_{ij} + \beta_2 CMNREL_{ij} + \beta_3 CMNLAN_{ij} + \\ \beta_4 CONTIG_{ij} + \beta_5 DRTA_{ij,\tau} + \beta_6 lnTARIFF_{ijk,\tau} + e_{ipk} + e_{jpk} + \varepsilon_{ijk,\tau} \end{aligned} \tag{4}$$

where $lnDIST_{ij}$ is natural logarithm of distance between the two countries, $DRTA_{ij\tau}$ is a dummy variable for existence of RTAs between i and j at period τ, $lnTARIFF_{ij\tau}$ is $(1 + TARIFF)$ rate for exporting to j at period τ, $CMNREL_{ij}$ is common religion index and $CMNLAN_{ij}$ is common language dummy, $CONTIG_{ij}$ is contiguity, e_{ipk} and e_{jpk} are exporter-period-product and importer-period-product fixed effects. It is useful to note that we have only one trade cost for each ijk, τ. Therefore, we need to adjust the yearly data into the period form. For this reason, when the variable is continuous and time varying, we take the time average for the given period and pairs. However, for time varying binary variables, such as RTA, we use a different method. If there are RTAs for at least two out of 3 years in a given period between the pairs, we assume that there is an RTA in that time period. Otherwise if there is only one RTA for a specific period, it is assumed that there is no RTA in that time period. This is based on intuition that trade flows might not immediately response to policy changes (Yotov et al., 2016).

B. Results

We use equation 4 and obtain Table 1 for different specifications and samples of our trade costs dataset. The table 1 suggests that RTAs and tariffs are key factors to reduce trade costs in agricultural sectors. Considering the column 1, country pairs with RTA have 15.3% lower trade costs than the case where trade partners do not have an RTA, and 1% increase in tariff rates are expected to increase the trade costs around 72.3%. However, we do not control for exporter-period-product and importer-period-product fixed effects in Column 1. Then, we control for these fixed effects in Column 2 and rest of the table since it is our preferred specification. Column 2 suggest that having an RTA, i.e. (DRTA=1), lowers the trade costs by 9.2%, and 1% increase in tariff rates increases the trade costs by 18.3% in agricultural sector. Furthermore, the RTAs effect ranges from 4.54% to 11% indifferent bulk commodity classification. And, more interestingly, positive effect of tariff rate on trade is much more heterogeneous than the RTAs effect. 1% increase in tariff rate is expected to increase the trade costs by 7% in bulk commodities, and 19.7% in consumer oriented commodities, 37% in intermediate commodities, and 44.8% in agriculture related commodities. Moreover, other country characteristics are also important factors, affecting the trade costs. The distance effect is significant, and it positively affects the trade costs. Having a common border between the two trade partners reduces the agricultural trade costs by 25.8%, and 1% increase in distance increases the trade costs by 0.27%. Furthermore, Table 1 suggests that having similar country characteristics with the trade partner, such as common language, common religion, and common colonizer reduces trade costs. Finally, we observe that policy instruments, and even the country characteristics have heterogeneous effects on different products. For example, the distance has higher effects on consumer orientated products, which includes perishables items such as meat products, fresh vegetables, and dairy products. On the other hand, having an RTA decreases the trade costs around 10% to 11% on consumer and bulk commodities. However, RTA effects are much lower in intermediate and consumer related commodities.

These findings confirm that there is huge heterogeneity among agricultural products and they should be evaluated at disaggregated level. We find that trade costs evolution is heterogeneous across sectors, regions, and income levels. Furthermore, heterogeneous trade costs evolution suggest that the there is unequal globalization where developing and low income countries struggles to reduce trade costs and benefit from the globalization.

Table 1—: Determinants of Trade Costs

	(1)	(2)	(3)	(4)	(5)	(6)
lnDIST	0.147***	0.270***	0.284***	0.155***	0.311***	0.212***
	(0.00475)	(0.00233)	(0.00964)	(0.00396)	(0.00295)	(0.00336)
CMNLAN	−0.0564***	−0.0915***	−0.0956***	−0.0662***	−0.0981***	−0.0707***
	(0.0104)	(0.00452)	(0.0185)	(0.00756)	(0.00570)	(0.00668)
CMNREL	−0.160***	−0.121***	0.0484	−0.111***	−0.158***	−0.147***
	(0.0143)	(0.00719)	(0.0299)	(0.0121)	(0.00913)	(0.0101)
CMNCOL	−0.162***	−0.116***	−0.111***	−0.0500***	−0.131***	−0.148***
	(0.0156)	(0.00718)	(0.0297)	(0.0117)	(0.00931)	(0.00962)
CONTIG	−0.241***	−0.258***	−0.346***	−0.178***	−0.283***	−0.120***
	(0.0142)	(0.00550)	(0.0206)	(0.00842)	(0.00711)	(0.00961)
DRTA	−0.153***	−0.0920***	−0.106***	−0.0442***	−0.110***	−0.0454***
	(0.00955)	(0.00394)	(0.0158)	(0.00682)	(0.00499)	(0.00586)
lnTARIFF	0.723***	0.183***	0.0705**	0.370***	0.197***	0.448***
	(0.0106)	(0.00953)	(0.0270)	(0.0253)	(0.0115)	(0.0515)
Constant	0.368***	−0.0432	0.775***	−0.264***	−0.215***	−0.483***
	(0.0431)	(0.0225)	(0.0887)	(0.0422)	(0.0282)	(0.0614)
Sample	All	All	Bulk	Intermediate	Consumer	Agriculture Related
IPK FE	NO	YES	YES	YES	YES	YES
JPK FE	NO	YES	YES	YES	YES	YES
Observations	439206	428674	68717	71728	238031	50198
Adjusted R^2	0.027	0.906	0.853	0.877	0.925	0.837
p	0	0	0	0	0	0

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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