The Effect of Product Standard on Agricultural Exports

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3 authors, including:

Esteban Ferro
World Bank

Tsunehiro Otsuki
Osaka University

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Esteban Ferro
John S. Wilson
Tsunehiro Otsuki

The World Bank
Development Research Group
Trade and International Integration Team
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Abstract

The authors create a standards restrictiveness index using newly available data on maximum residue levels of pesticides for 61 importing countries. The paper analyzes the impact that food safety standards have on international trade of agricultural products. The findings suggest that more restrictive standards are associated, on average, with a lower probability of observing trade. However, after controlling for sample selection and the proportion of exporting firms in a gravity model, the analysis finds that the effect of standards on trade intensity is indistinguishable from zero. This is consistent with the assumption that meeting stringent standards increases primarily the fixed costs of exporting. Once firms enter the market, however, standards do not impact the level of exports. The analysis also finds a greater marginal effect of BRICS (Brazil, Russia, India, China, and South Africa) standards on the probability of trade, relative to other countries' standards, keeping in mind however that on average BRICS standards are less restrictive. The analysis also suggests that exporters in low-income countries are more adversely affected by stricter standards.

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The Effect of Product Standards on Agricultural Exports from Developing Countries[‡]

Esteban Ferro[*], John S. Wilson[†], and Tsunehiro Otsuki[§]

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[*]Consultant, eferro@worldbank.org, [†]Lead Economist, jswilson@worldbank.org,. at DECRG - Trade and International Integration, The World Bank Group. 1818 H St. NW, Mailstop: MC3-303, Washington DC, 20433.
[§]Professor, at Osaka School of International Public Policy, Osaka Universityotsuki@osipp.osaka-u.ac.jp.
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1 Introduction

The continual decline of tariffs as a result of multilateral trade negotiations and the proliferation of regional trade agreements has increased the relative importance of non-tariff measures (NTMs). Import conditions for food products defined by public and private standards continue to differ between countries despite international coordination and the development of multilateral regulations and common conformity assessments by international institutions. Typically, standards prescribe requirements for product characteristics, production processes and/or conformity assessment and are used to address information problems, market failure externalities, or societal concerns. In the context of agricultural trade, standards aim to ensure food safety and animal and plant health, but also extend to other quality and technical aspects of food products. Mandatory and voluntary requirements for imports are formulated by both governments and the private sector. In this paper we first analyze the impact of agricultural regulatory/mandatory standards imposed by importing countries on exports entering those markets. We then analyze whether these effects differ for exports originating in developing or developed countries.

According to WTO rules, countries are allowed to adopt regulations under the Sanitary and Phyto-Sanitary (SPS) and Technical Barriers to Trade (TBT) agreements in order to protect human, animal and plant health as well as environment, wildlife and human safety. One of the TBTs commonly used in agricultural products are the ones that restrict the maximum levels of residues from pesticides. A pesticide residue is a very small trace of pesticide that sometimes remains on the treated crop. A maximum residue level (MRL) is the maximum amount of residue legally permitted on food. Once residues are demonstrated to be safe for consumers, MRLs are set by independent scientists, based on rigorous evaluation of each pesticide legally authorized. They act as an indicator of the correct use of pesticides and ensure compliance with legal requirements for low residues on unprocessed food. MRLs ensure that imported and exported food is safe to eat. In the EU, the default limit is 0.01 part per million (ppm), which means for 100 metric tons of agricultural products, the agricultural chemical residuals cannot exceed 1 gram. Countries choose the products they regulate, the pesticides they regulate for each product, and the MRL for a given product-pesticide pair. In this paper we consider three distinct measures of the restrictiveness of a country's standards regime. First, we look at the extent of their standards, or the number of pesticides that are regulated on a per product basis. Second, we consider the "intensity" of the standards, measured by the MRL limits placed on product imports. Finally, we develop a standards restrictiveness index which combines both the extensiveness of the standards and their intensity.

Higher income countries are generally known for having stricter standards, particularly higher SPS standards. This normally occurs because higher income countries also have higher degrees of societal awareness and concerns about the standards of food they consume. There is evidence in the literature that wealthier households typically consume goods of higher quality.[1] Thus, standards tend to be more restrictive and demanding as a country's income rises. Figure 1 confirms this statement with our data. It shows that the average number of standards per product increases with the GDP per capita of the importer.

There are two broad types of concerns regarding standards. Firstly, standards, especially regulatory standards, are sometimes more prescriptive or restrictive than they need to be to achieve the health and safety goals desired by the community. This limits the type and design of products that can be marketed and reduces incentives for innovation. Secondly, differing requirements between countries can result in substantial additional costs for producers and the exclusion of foreign firms from markets.

The emerging markets of Brazil, Russia, India, and China (also known as BRIC) have become major players in the world economy.[2] BRIC's GDP (based on market exchange rates) is now the third largest in the world after the United States and the European Union. According to IMF projections, BRICs' GDP will surpass that of the Euro area before 2015. The remarkable rise in income of the BRICs has been a blessing for many developing countries as demand for their exports in BRIC markets has surged. BRIC's have nearly doubled their share in world imports over the past two decades and are expected to catch up with the United States within a few years. However, the rise in BRIC income also poses potential threats for other developing countries, particularly the least developed (LDCs), as it is likely that their standards for food will also be tightened with their income, effectively shutting out certain LDC exports from these growing markets.

The increase of SPS notifications has been highlighted in the latest WTO Committee overview of the SPS Agreement. The Committee reported that as of October 2011, the WTO had

[1] See for example Bils and Klenow (2001), Hallak (2006), and Broda and Romalis (2009).
[2] In our analysis we will include South Africa as a BRIC country and refer to the group as BRICS.

been notified of 10,366 regular and emergency SPS measures since January 1995 when the WTO was set up, with another 2,980 additions, alterations or corrections to existing notifications. The US submitted over a quarter of the total of regular notifications since 1995 (2,192), followed by Brazil (775), China (592) and Canada (567). Developing countries (including least-developed countries) now submit more notifications than developed countries. They broke through the 50% share in 2008 and now contribute about two thirds of notifications each year. Furthermore, the volume is rising. The latest update of the WTO Secretariat report says 2010 saw the largest number of notifications in a single year so far, at 1,436.

Our study contributes to the literature in a number of aspects. First, we have created a time-series database of MRL import restrictiveness measures for 61 importing countries. To our best knowledge this is the first database of this type. Second, we introduce a measure of restrictiveness that takes into account all published MRLs for each importer-product pair in a given year. The closest measure in the existing literature is Li and Beghin (2012) which measure the deviation of MRLs for each importer-product-pesticide with respect to the CODEX standard. However, as shown in the next section, CODEX only regulates a limited number of product-pesticides pairs compared to individual countries, thus Li and Beghin (2012) miss an important portion of the heterogeneity in regulations. Third, our analysis includes 66 products and close to 1,500 pesticides. This is in contrast to existing studies in the literature which analyze the effects of standards on one product, one pesticide, or one product-pesticide pair or at best, few selected products-pesticides pair.[3]

Our results robustly show that product standards on average negatively affect exporters' decisions to export to a given destination market. The evidence in this paper is consistent with the HMR model where firms face a fixed cost to export. Firms need to comply with importers' standards which impose a fixed cost to firms that need to adjust their production processes in order to meet those foreign standards. Our results also show that the marginal effect of product standards in the BRICS (i.e., Brazil, Russia, India, China, and South Africa) is greater in absolute terms than that of non-BRICS countries. Furthermore, we show that the value of exports from

[3] Otsuki et al. (2001) measure the impact of the EU's aflatoxin standards of cereals, dried fruits and nuts on imports from Africa. Wilson et al. (2003) used the gravity model to examine the impact of Tetracycline standard in beef. Sun et al. (2005) analyze Japan's Chlorpyrifos standard on China's vegetables export to Japan. Most recently, Chen et al. (2008) examines the impact of Chlorpyrifos MRLs standards on China's export of vegetables and the impact of Oxytetracycline MRLs on aquatic products. More recently Xiong and Beghin (2012) re-estimate Otsuki et al. (2001) with ex post data. Winchester et al. (2012) developed bilateral deviations measures of food safety regulations for importer-exporter-product-pesticide groups but their data was highly aggregated and with no time series.

low income countries is negatively affected by product standards more than those of higher income countries.

2 Data

In an effort to measure standards restrictiveness we have collected import markets' maximum residual limits of pesticides. Our source for this data is Agrobase-Logigram's Homologa database. Agrobase-Logigram collects monthly changes in allowable pesticides for approximately 61 importing countries. They obtain their information directly from each country's pertinent ministry and standardize it in terms of language, unit, and format.

Using this dataset we matched 243 agricultural products to their corresponding harmonized system (HS) codes at the six digit of disaggregation.[4] Table 1 displays the number of products that are covered by each importer in every year. We can see that there is a great difference in the coverage of products across countries. For example, in 2011, Brazil set pesticide limits on 75 agricultural products whereas the EU on 140 products. However, the coverage of each country is fairly constant across time. There are only 35 products regulated by all countries in the sample. Among these products we find: potatoes, tomatoes, peas, beans, apples, oranges, wheat, maize, sorghum, and ground nuts, among others.

Table 2 displays the number of pesticides regulated by each importer in our sample. Japan, Switzerland, and the EU are the importers that set standards on the greatest number of pesticides, whereas Thailand and other ASEAN countries only set standards for a limited number of pesticides. Countries greatly differ in the pesticides they regulate for a particular product. Take oranges in 2011 as an example. The EU set limits for 506 pesticides, Brazil for 102, and Russia for only 16. Thus the EU is far more restrictive in terms of number of standards.

Figure 2 displays the average number of pesticides per product in BRICS and non-BRICS countries between 2006 and 2011.[5] We observe several stylized facts. First, BRICS restrict fewer pesticides per product than non-BRICS. Second, non-BRICS countries are significantly increasing the number of standards they set per product going from an average of 25 pesticides in

[4] Homologa's product coverage is greater than 243 products; however we were unable to match all products directly to an HS code. In our analysis we will only use 66 out of the 243 available products because of the excessive number of missing data among the importers. In order to be included in the sample each product had to have a standards set for at least 50% of importers.
[5] EU data is only available starting in 2008 which explains the kinks in Figure 1, 2 and 3 in that year.

2006 to an average of nearly 50 pesticides in 2011. On the other hand, the BRICS, on average, set close to seven standards per product in 2006 compared to eleven in 2011.

Each country not only sets the number of pesticides to restrict per product but also sets the "intensity" of the standards, or the permissible level for each pesticide (the MRL). The higher the MRL, the less restrictive is the standard. Continuing the example from above of oranges in 2011, the average MRL among the 506 pesticides the EU regulates is 0.59 ppm, the average in Brazil for the 102 MRLs is 1.47 ppm, and in Russia the average for the 16 MRLs is 0.17 ppm. Thus in terms of the levels of MRLs, Russia is more restrictive than the EU, and the EU more restrictive than Brazil.[6]

Figure 3 displays the average MRL per product in BRICS and non-BRICS importers. On average, BRICS markets are less restrictive than non-BRICS as their allowable levels of pesticides are higher. BRICS however are becoming more restrictive, particularly between 2006 and 2008. Over the same period, non-BRICS became less restrictive, but since have become slightly more restrictive again.

There are several challenges when working with MRL data. First, there are two dimensions of restrictiveness that need to be considered: the number of regulations per product, and how strict those regulations are. The second challenge is that the heterogeneity of pesticides regulated across products and countries makes it difficult to compare how restrictive one country is compared to another. For example, the 16 pesticides regulated in Russia for oranges in 2011 might not be included among the 102 pesticides that are regulated in Brazil. Thus the question arises: how do we compare Russia's and Brazil's restrictiveness for oranges? A third challenge, closely related to the second, is how to interpret the missing values that originate from a pesticide being regulated in one country but not the other. We cannot replace these missing values with zeros, as is commonly done with missing trade values, because an MRL set to zero is equivalent to banning that pesticide entirely.

In our analysis we use the number of pesticides and the average MRL to assess the restrictiveness of standards for each country-product-year. Furthermore, we created an index of restrictiveness for each country *i*, product *p*, in year *t*. It is defined as follows:

[6] The averages are estimated ignoring missing values as well as whether the same pesticides are restricted in one country compared to the other.

$$(1) \quad \mathrm{restrictiveness}_{i,p,t} = \frac{1}{N(a)} \sum_{n(a)=1}^{N(a)} \frac{\mathrm{MAX}_{p,a,t} - \mathrm{Std}_{i,p,a,t}}{\mathrm{MAX}_{p,a,t} - \mathrm{MIN}_{p,a,t}}$$

where $\mathrm{MAX}_{p,a,t} = \max_i\{\mathrm{Std}_{i,p,a,t}\}$ and $\mathrm{MIN}_{p,a,t} = \min_i\{\mathrm{Std}_{i,p,a,t}\}$. *Std* is country *i*'s MRL for each product-pesticide pair in year *t*. This index will be between zero and one, zero being the least restrictive and one the most restrictive.[7] In the case that a country does not set an MRL for a given product-pesticide (i.e., $Std_{i,p,a,t}$ is missing) we substitute the missing $Std_{i,p,a,t}$ with $MAX_{p,a,t}$. This index combines the number of pesticides restricted as well as the intensity with which they are set into one measure. The second advantage of the index of restrictiveness is that for every product, it includes all pesticides regulated in the world, this contrasts to for example Li and Beghin (2012) which analyze only those product-pesticide pairs regulated by Codex.

Trade data are sourced from the United Nation's Commodity Trade Statistics Database, and tariff data is taken from the Trade Analysis and Information System developed by the United Nations Conference on Trade. Countries' gross domestic products are taken from the World Bank World Development Indicators. Finally, gravity variables such as distance, language, colonial relationship are extracted from Centre d`Etudes Prospectives et d'Informations Internationales (CEPII).

3 Methodology

We first aim to measure the effect of food safety standards on exports of agricultural commodities—mainly products that fall under edible vegetables (HS 07) and edible fruits (HS 08).[8] We then explore whether BRICS import policies have a different impact on LDC exports. We use the gravity model of trade which has been the workhorse for policy analysis in trade. The gravity model has been used in studies to test the impact of regional trade blocs, regional trade bias and home country trade bias. The gravity model has also been the most common method to estimate the impact of product standards and food safety standards on trade flows. Moenius (2000) used the gravity model to provide a framework for estimating the effect of product standards on trade flows. Otsuki et al. (2001) used it to estimate the impact of the EU's new aflatoxin standards on food imports from Africa. The study suggests that the implementation of

[7] In the case where Std=MAX=MIN, the ratio inside the summation takes a value of 1.
[8] The detailed list of the 66 products included in our analysis can be seen in Table 3.

the new standard will have a negative impact on African exports of cereals, dried fruits and nuts to Europe. Wilson et al. (2003) used the gravity model to examine the impact of drug residue standards on trade in beef and found that Tetracycline standard in beef has a negative and significant impact on world trade in beef. The study predicts that if international standards set by CODEX were followed in antibiotics, global trade in beef would rise by over US$3.2 billion. Using the gravity model to examine Japan's stricter pesticide residue limit on vegetables exports from China, Sun et al. (2005) found that Japan's stricter Chlorpyrifos standard has a negative impact on China's vegetables export to Japan. Most recently, Chen et al. (2008) examines the impact of Chlorpyrifos MRLs standards on China's export of vegetables and the impact of Oxytetracycline MRLs on aquatic products. Their results show that food safety standards imposed by importing countries have a negative and statistically significant effect on China's export of agricultural products. Furthermore, the authors find that the trade effect of food safety standards is much larger than that of the import tariff. Finally, Xiong and Beghin (2013) apply the score indices constructed by Li and Beghin (2012) to study the effect of standards relative to CODEX standards in Canada and the US. The authors find that imports by US and Canada are not affect but the stringency of this type of regulation; however, the authors find that exports from Canada see a positive effect in foreign markets.

We specifically apply the Helpman, Melitz and Rubinstein (2008; henceforth HMR) gravity model for our analysis. Based on the Melitz (2003) model, HMR extended the gravity equation of Anderson and van Wincoop (2003) and developed an estimation procedure to obtain the effects of trade barriers on the intensive and extensive margins of trade. The model takes account of the empirical facts that firms in a typical industry are heterogeneous in terms of efficiency, that only a fraction of them export and that exporters tend to be more productive than non-exporters (see i.e., Eaton et al , 2004). Without control for heterogeneity, estimates of the effects of trade barriers on firm level exports will be confounded with their effects on the number of firms that export, and without control for zero bilateral trade flows, estimates will be affected by selection bias. Bilateral trade data at the firm level would optimally be used to empirically estimate the effects on the two margins; however, the authors solve this problem by exploiting the presence of zero trade flows in aggregate bilateral trade data. Nearly half of the potential bilateral trade flows in their data have a value of zero. In our case, nearly 90% of potential trade flows have a value of zero making it imperative to use a methodology that deals with zero trade.

HMR, as a first step, derives an equation for the probability of trade at the firm level based on firms' decisions and use it to estimate effects on the extensive margin. The proportion of firms that are able to export are determined by a country-pair specific fixed cost to export. Only those firms that are productive enough to cover this fixed cost and remain profitable will export.

The selection of firms into export markets is a function of firm-level decisions about the profitability of exporting, which in turn is a function of firm efficiency, fixed and variable costs, trade barriers, demand and the elasticity of substitution between symmetric products. Since the ratio of the profit level relative to the fixed cost at which firms can export is unobserved but is observed positive when trade is positive, the following probit equation can be used to estimate the ρ_{ijpt}, the probability of positive exports between two countries for product *p* at time *t*,

$$(2) \qquad \rho_{ijpt} = \Phi(\gamma_0 + \zeta_{it} + \xi_{jt} + \varsigma_{pt} + \gamma d_{ij} + \rho\tau_{ip} - \kappa\phi_{ij})$$

ξ_{jt} is exporter-time fixed effects, ζ_{it} is an importer-time fixed effect, and ς_{pt} is product-time fixed effect. d_{ij} is the distance between country *i* and country *j*, τ_{ip} is the importer-product standard regulation, and ϕ_{ij} is a country-pair specific fixed trade cost. The predicted ρ_{ijpt} can be used to estimate controls for firm-level heterogeneity and estimate the inverse Mills ratio that corrects for sample selection bias when used in the trade flow gravity regression.

The trade intensity equation that gives consistent estimates by correcting for firm heterogeneity and selection bias and estimated in this study is:

$$(3) \qquad \ln M_{ijpt} = \alpha_{it} + \alpha_{jt} + \alpha_{pt} + \beta_1 STD_{ipt} + \beta_2 \ln(1 + tariff_{ijpt}) + \psi Gravity_{ij} + \delta\hat{\bar{Z}}_{ijpt} + \hat{\bar{\eta}}_{ijpt} + \varepsilon_{ijpt}$$

where M_{ijpt} is the imports by importer *i* from exporter *j* of product *p* in year *t* is determined by STD_{ipt}, one of the measures of standards set by the importer on product *p* and the ad-valorem applicable tariff rate ($tariff_{ijpt}$). The importers-time effects, among other things, capture the purchasing power and the market size of the importing country, the demand side effect of the commodity. Exporter-time effects are used to measure the supply side effect. This is an advantage over previous work since applying the logic of the gravity equation to sectoral trade is not entirely straightforward. When looking at sectoral trade flows and particularly agricultural goods, the idea that trade flows between *i* and *j* in a certain product *p* are increasing in GDP is not necessarily warranted. In the monopolistic-competition model, larger countries produce more varieties of goods and that contributes to increasing their trade. That is, they do not necessarily export more of each good but they export more goods. With our specification we overcome some of the issues that arise from other controls of supply side commonly used in the literature, such as total exports, as this covariate is clearly endogenous. Finally we use product-time effects to control for any demand or supply specific to a product in a given year across all producers and importers.

In addition, the baseline estimation includes all the traditional covariates of the gravity model, including distance, contiguity, and colonial relationship. A variable that controls for whether countries share a common language is used as the exclusion restriction. HMR use a measure of common religion and a measure of the cost to start a business as their exclusion restriction; however, they acknowledge that either using "common language" or "colonial relationship" is another option as they found them to be consistently significant in the first stage probit regression and not in the second stage regression. A valid exclusion restriction would affect the fixed cost of exporting and thus the decision to export to a given destination but not its variable cost. In other words, it would have to be significant in the probit regression but not in the second stage regression, just as HMR find with common language, and confirmed in our analysis.

In order to control for the firm-level heterogeneity we include a cube polynomial of $\hat{\bar{Z}}_{ijpt}$.[9] $\hat{\bar{Z}}_{ijpt}$ is an approximation of an arbitrary increasing function of the latent variable Z_{ij}, which is determined by the zero profit condition and determines the cutoff point between exporter and non-exporters.HMR assume a Pareto distribution of firm heterogeneity that gives a non-linear term which makes it necessary to use NLS to estimate Equation 3. However, HMR later drop this assumption and find that a polynomial that approximates any monotonic increasing function of the latent variable Z_{ij} yields very similar results. We use this latter specification for simplicity. We also include the inverse Mills ratio, $\hat{\bar{\eta}}$, which is the standard Heckman correction for sample selection.

Anderson and van Wincoop (2003) determine that multilateral trade resistance terms we necessary for the correct estimation of the gravity equation, we include country-time effects in the gravity Equation (4) to control for multilateral resistance terms.

[9] $\hat{\bar{Z}}_{ij} \equiv \hat{Z}_{ij} + \hat{\bar{\eta}}$ where $\hat{Z}_{ij} = \Phi^{-1}(\hat{\rho}_{ij})$ and $\hat{\bar{\eta}} = \phi(\hat{Z}_{ij})/\Phi(\hat{Z}_{ij})$

4 Results

4.1 Impact of Importer Standards on Trade Flows

Table 4 displays results of the impact of importer standards on agricultural trade, in both the extensive (i.e., equation 2) and intensive margins (i.e., equation 3). There are three different variables that measure the restrictiveness of importers' standards of product *p*: (1) number of regulated pesticides; (2) average MRL for those regulated pesticides; and (3) the restrictiveness measure described in equation (1). All three measures provide evidence that more restrictive standards are associated with lower levels of trade.

For each of the standard restrictiveness measures we estimate the first stage probit and second stage OLS regression correcting for firm heterogeneity and sample selection. The odd numbered columns in Table 4 display the marginal effects for the probit regressions where the dependent variable is zero if there is no trade between two trading partners for a given product and equal to one otherwise. The even numbered columns display results for the OLS regressions where the dependent variable is the natural logarithm of the trade value.

Column 1 in Table 4 shows the marginal effects for the probit regression controlling for the number of pesticides that are regulated for product *p*. The results show that each additional pesticide regulated by the importer, on average, is associated with a 0.1% lower probability of trade. The coefficient displayed in column 2 shows that an additional pesticide will on average be associated with 0.1% lower imports of product *p* from a given source.

The second measure of standard restrictiveness is the average MRL imposed by the importer on a certain product. The results show that higher MRLs[10] (i.e., less restrictive standards) are on average associated to higher probability and intensity of trade.

The last measure of standards is the restrictiveness index. This index incorporates both the number and intensity of MRLs into one measure and thus is our preferred measure of standard restrictiveness. Again, the results show that more restrictive standards in a destination market result, on average in fewer firms exporting into this market (firms are unable or unwilling to overcome the added fixed costs associated with compliance with the stricter standards).

[10] Remember that higher MRLs would allow for a greater residue of pesticides thus a higher average MRL is a less restrictive standard.

The interesting finding is that all three measures of the restrictiveness of standards are only statistically significant in the first stage probit regressions.[11] Given the HMR model, these results indicate that standards are important determinants of whether a firm exports to a given destination or not. Standards appear to be a fixed cost to exporting.

Gravity variables have their expected signs in all regression displayed in Table 3. Higher tariffs and greater distances restrict both the probability of trade as well as trade intensity. Whereas common language, colonial relationship, and sharing a common border all increase the *likelihood* of trade, colonial relationship and sharing a common border increase the *intensity* with which countries trade.

4.2 Robustness Checks

There is the possibility that product standards are endogenously determined by imports. Since one of the determinants of MRLs is consumption, it is possible that higher standards are set on products that are greatly consumed and possibly also highly imported. Also, the levels of imports could influence policymakers' decisions of using NTBs, (i.e., MRLs) as an alternative policy for blocking trade. In order to check the robustness of our results we use one and two lags of the restrictiveness measure. The lag values of the restrictiveness measures are appropriate instrumental variables as the previous standards are highly correlated with current standards; however, the reverse causality is avoided as current trade cannot influence previously determined standards. Columns 1 through 4 of Table 5 display the results. The results are consistent with the previous findings. Both the first and second lags are statistically significant at 1% level in the probit regressions. Stricter standards are associated, on average, with lower probabilities of observing trade whereas standards are not statistically different from zero in the trade intensity regressions. Again, the results indicate that on average standards exert an additional fixed cost on firms to join international markets.

We also include a second robustness check that deals with the possible endogenous decision of policy makers in setting standards on imports. In this second robustness check we analyze how exports of product *p* from country *j* to country *i* are affected by the standards set in all other possible destinations except *i*'s. *Index_other destinations* is the average restrictiveness index an exporter faces in all possible destinations other than *i*. We expect that an exporter facing

[11] With the exception of the average MRL that is only statistically significant at the 10% level.

restrictive standards in the rest of the world would likely export more to *i* and *vice versa*. In other words, we expect to find a trade diversion effect. And indeed, that is what our results show in columns 5 and 6 of Table 5. We find that the coefficient on *Index_other destinations* is positive and statistically significant in the probit regression, implying that the more restrictive the standards in destinations other than *i* the higher the likelihood that *j* exports to *i*. Again we find that the effect of standards on the intensive margin of trade is not statistically different from zero except through the effects of firm heterogeneity.

To confirm product standards' trade diversion effect found in columns 5 and 6 of Table 5, we create one additional variable by taking the difference between the *restrictiveness index* in country *i* and the average restrictiveness index an exporter faces in all possible destinations other than *i* (i.e., *index_other destinations*). If importer *i*'s standards are more restrictive than in other destination markets then we would expect to see lower exports to *i*. Our results confirm the idea that restrictive standards cause trade diversion into other destinations; particularly through exporting firms' choice of destination.

4.3 Impact of BRICs Standard on Low Income Countries' Exports

In this section we analyze the impact of importers' product standards on exports of countries by their income groups (i.e. low income, lower middle income, higher middle income, and high income). We want to identify whether standards, even though applied as a most favored nation (MFN) barrier have different effects on the different income groups. Intuitively, exporters in less developed countries will most likely have lower product standards to meet in their local market than producers in higher income countries. Thus, adapting production to meet stricter foreign standards will likely be more expensive in lower income countries. Ideally we would like to analyze the difference between exporters' standards and importers' standards; however, most low income countries do not report or do not have any standards information. As a second best test, we simply analyze importer's standards impact on group exports by income.[12] The results are displayed on Table 6.

[12] Since we want to identify the exporter group effect we cannot include importer-exporter group effects and there are no covariates that will be able to control for typical gravity variables. Since our variable of interest is of the type importer-product-year, we control for importer-year, product-year and exporter effects. We use the standards measure as the exclusion restriction. This is consistent with the findings previously reported as product standards are only statistically significant in the probit regressions.

Columns 1 and 2 show the selection and intensity regressions for the sample of all importers. Again, importer standards have a negative and statistically significant coefficient in the probit regression indicating that higher standards are associated with a lower probability of having positive trade. The restrictiveness index is omitted in the second stage OLS regression as it is used as the exclusion restriction in the two stage HMR model. The coefficients on the exporters' income groups have the expected signs and magnitudes; they are increasing in income, in other words, higher income countries export more. The omitted control is the group of high income countries and thus the negative coefficients on the income groups' coefficients. The interaction terms between income groups and the restrictiveness index are all statistically indifferent from zero, except for the interaction between product standards and low income countries in the intensity regression which is negative and statistically significant. The results indicate that on average, stricter product standards are associated with a lower likelihood that exporters will target a given destination no matter from what income group. However, the results also show that stricter standards could be associated with fewer exports from low income countries. This result could partially be explained by import rejections at the border due to standards requirements not being met which would affect the intensive margin of trade. Even though most exporting countries inspect products prior to shipment, many developing countries have financial constraints which limit the effectiveness of these procedures and in many cases testing and inspection facilities are inadequate. Border agencies in the importing country can reject the entrance of any shipment not meeting the required standards.

Columns 3 and 4 of Table 6 display the results for the estimations of the HMR model on the restricted sample of exports only to BRICS markets. The results show that the marginal effect of BRICS standards on trade is greater in absolute terms than those imposed by other importing countries.[13] The coefficient for the standards restrictiveness index for the BRICS sample is statistically greater than the one for non-BRICS countries displayed in Column 5. The interaction terms between the standards restrictiveness index and the four income groups are not statistically different from zero. The income group effects have the expected sign and their magnitudes are increasing in income. The source for the negative effect on the intensity of trade from low

[13] The average BRICS restrictiveness measure is 0.0323 whereas the non-BRICS average restrictiveness measure is 0.0889. The BRICS marginal effect is greater but the average standard is lower than for non-BRICS. The resulting average effect of standards is still greater for the BRICS but not that much greater as the marginal effect would suggest.

income countries, displayed in column 2 of table 6, seems to be the non-BRICS countries, as the interaction term in column 6 is negative and statistically significant.

5 Conclusions

Our results robustly show that an on average product standards negatively affect exporters' decision to sell into a given destination market. *Cetiris paribus*, an exporter facing two possible destination markets will most likely export to the country with lower product standards. The evidence in this paper is consistent with the HMR model where firms face a fixed cost to export. Firms need to comply with importers' standards which impose a fixed cost to firms which need to adjust their production process in order to meet those foreign standards. However, once the fixed costs to comply with standards are covered there appears there are no additional variable costs to comply with standards that affect the intensity of trade.

Our work also shows that the marginal effect of BRICS standards on the decision of firms to export is greater in absolute terms than that of non-BRICS countries. Furthermore, it appears that exports from low income countries are more negatively affected by product standards than those from higher income countries. We find that an interaction term between our measure of standards restrictiveness and a dummy variable controlling for low income countries is statistically significant and negative in the intensity regressions. This hints at the considerable problems that developing countries have in meeting basic food hygiene requirements, let alone requirements for which more sophisticated (and costly) monitoring and testing procedures, such as limits on pesticide residues, are required. Finally, it is understandable that exporters would self select out of certain destination markets as the cost of rejection at the border, including loss of product value, transport and other export costs, and product re-export or destruction costs, can be considerable.

Growing incomes and increased demand in the BRICS will provide important opportunities for developing countries so long as the products are able to access these markets. However, as tariffs become less of a market-entry barrier for developing countries, NTBs are becoming increasingly important. In general, it is more difficult to analyze the effect of NTBs on trade because of the breadth of policies as well as their non-measurability. In this case, MRLs provide an important product specific scenario to study these effects. What we find is that in order for developing countries to take advantage of new opportunities, developing countries need to be aware of their supply side constraints including their infrastructure and institutions in order not to be shut out of these markets.

Moving forward, there are a number of important topics to be examined regarding the impact of standards on trade that were not analyzed in this paper. First of all, it would be important to understand the impact of standards on actual firms. The framework used here analyzes firm decisions without the need of firm level data; however, a more detail analysis with firm data would provide additional and more detailed insight. Understanding which firms are able to meet standards, or divert trade to other destinations is an important issue to understand for policy makers.

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Figure 1 – Importers' Income and Standards

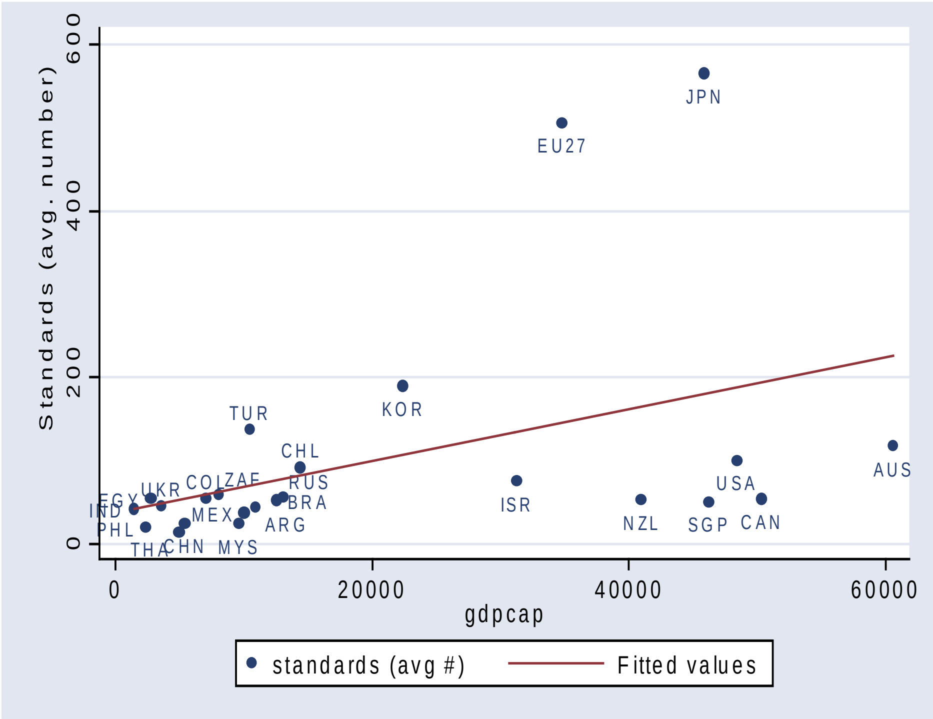

Figure 2. Average Number of Regulated Pesticides per Product

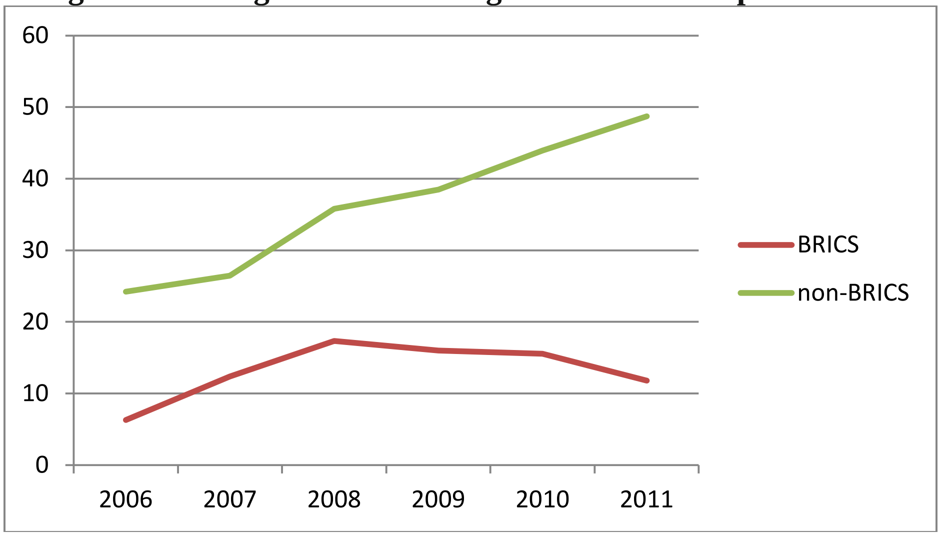

Figure 3. Average MRL per Product

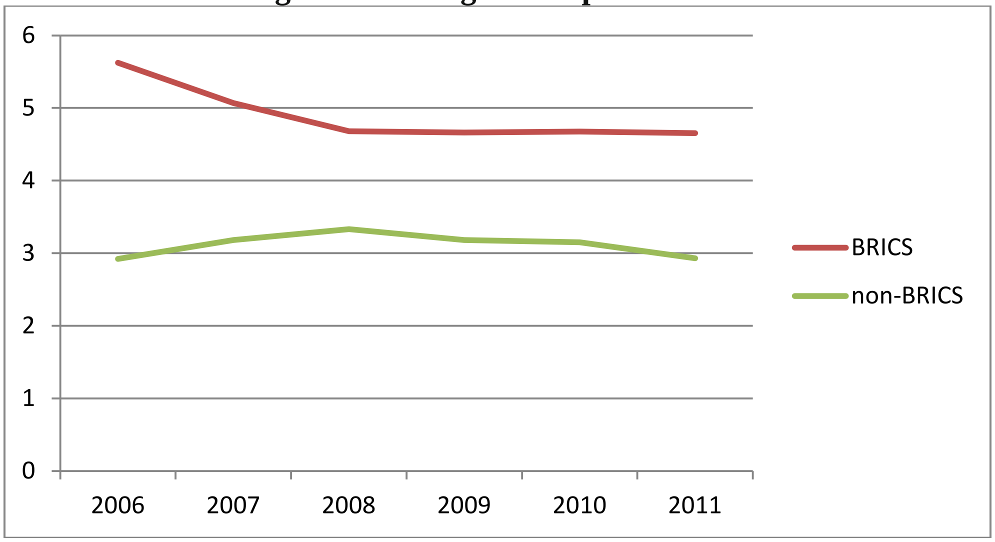

Figure 4. Average Restrictiveness Index per Product

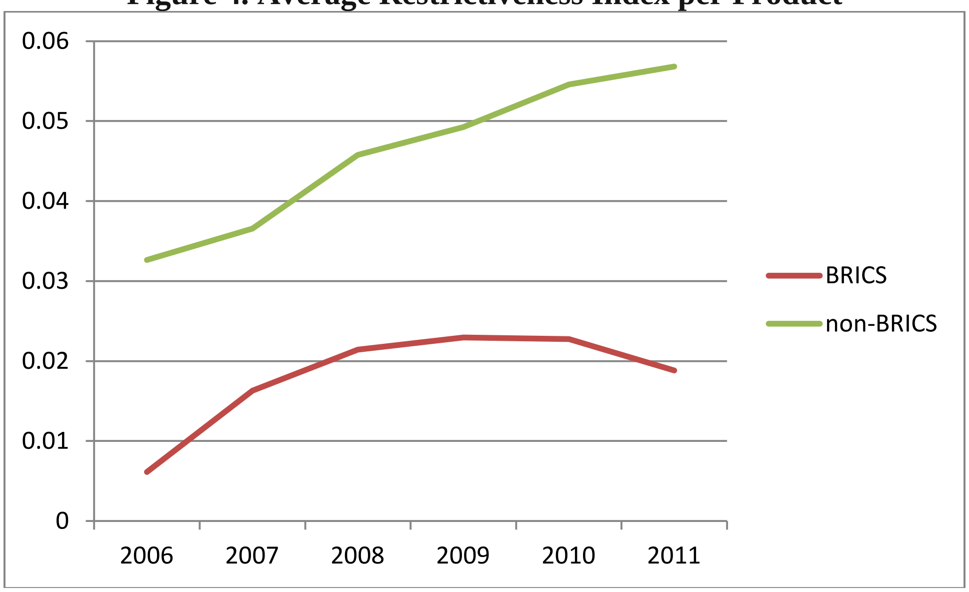

Table 1- Number of regulated products (all pesticides)

	2006	2007	2008	2009	2010	2011
ARGENTINA	103	111	111	111	116	110
ASEAN	-	-	104	104	104	104
AUSTRALIA	141	159	160	157	157	157
BRAZIL	60	67	67	74	75	75
CANADA	120	145	161	164	165	168
CHILE	148	151	138	138	142	89
CHINA	88	88	88	43	43	44
CODEX	148	151	138	139	142	143
COLOMBIA	-	138	138	138	138	138
EGYPT	-	-	-	138	138	138
EU	-	-	129	139	140	140
INDIA	-	136	152	108	108	108
ISRAEL	95	89	89	89	89	89
JAPAN	130	117	115	119	116	116
KOREA-SOUTH	94	94	102	100	102	103
MALAYSIA	42	89	89	87	87	87
MEXICO	67	67	73	68	68	68
NEW ZEALAND	146	111	101	88	88	88
RUSSIAN FED	32	97	115	114	115	113
SINGAPORE	-	-	128	128	128	128
SOUTH-AFRICA	91	101	101	101	101	101
SWITZERLAND	127	129	136	136	149	145
TAIWAN, CHINA	70	70	77	79	79	101
THAILAND	103	103	103	103	103	103
TURKEY	105	105	105	100	141	138
UKRAINE	-	-	-	117	117	117
USA	172	189	185	185	186	187
All	220	225	239	248	250	250

Table 2 – Number of regulated pesticides (all products)						
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
ARGENTINA	258	263	254	254	291	291
ASEAN	-	-	61	61	63	63
AUSTRALIA	320	366	373	367	370	373
BRAZIL	290	293	299	299	303	303
CANADA	172	191	200	205	209	240
CHILE	289	293	171	171	180	112
CHINA	123	124	124	147	147	147
CODEX	289	293	171	179	184	193
COLOMBIA	-	161	171	171	171	171
EGYPT	-	-	-	171	171	171
EU	-	-	475	482	473	506
INDIA	-	163	239	149	149	151
ISRAEL	287	278	280	287	291	297
JAPAN	607	615	611	616	606	618
KOREA-SOUTH	361	362	396	415	419	426
MALAYSIA	58	173	173	170	170	170
MEXICO	217	218	260	231	231	231
NEW ZEALAND	188	203	206	186	197	202
RUSSIAN FED	36	329	349	357	362	352
SINGAPORE	-	-	105	105	105	105
SOUTH-AFRICA	324	327	327	327	327	329
SWITZERLAND	371	380	426	433	502	481
TAIWAN, CHINA	330	333	353	333	333	353
THAILAND	20	20	20	20	20	20
TURKEY	354	356	351	339	430	415
UKRAINE	-	-	-	313	313	313
USA	342	381	368	367	372	381
All	863	922	945	962	964	989

Table 3 – List of Products

hscode	productdescription		hscode	productdescription
70190	Potatoes		80510	Oranges
70200	Tomatoes, fresh or chilled.		80520	Mandarins (including tangerines and
70310	Onions and shallots		80530	Lemons (Citrus limon, Citrus limonu
70320	Garlic		80540	Grapefruit
70390	Leeks and other alliaceous vegetabl		80710	Melons (including watermelons) :--
70410	Cauliflowers and headed broccoli		80810	Apples
70420	Brussels sprouts		80820	Pears and quinces
70490	Other		80910	Apricots
70511	Lettuce :-- Cabbage lettuce (head l		80920	Cherries
70519	Lettuce :-- Other		80930	Peaches, including nectarines
70521	Chicory :-- Witloof chicory (Cichor		80940	Plums and sloes
70529	Chicory :-- Other		81010	Strawberries
70610	Carrots and turnips		81020	Raspberries, blackberries, mulberri
70690	Other		81040	Cranberries, bilberries and other f
70700	Cucumbers and gherkins, fresh or ch		81050	Kiwifruit
70810	Peas (Pisum sativum)		81090	Other
70820	Beans (Vigna spp., Phaseolus spp.)		81110	Strawberries
70920	Asparagus		81120	Raspberries, blackberries, mulberrie
70930	Aubergines (egg-plants)		91099	Other spices :-- Other
70951	Mushrooms and truffles :-- Mushroom		100110	Durum wheat
70960	Fruits of the genus Capsicum or of		100190	Other
70970	Spinach, New Zealand spinach and or		100200	Rye.
70990	Other		100300	Barley.
71420	Sweet potatoes		100400	Oats.
80130	Cashew nuts :-- Shelled		100590	Other
80130	Cashew nuts :-- In shell		100630	Semi-milled or wholly milled rice,
80290	Other		100700	Grain sorghum.
80300	Bananas, including plantains, fresh		100820	Millet
80410	Dates		120100	Soya beans, whether or not broken.
80420	Figs		120210	In shell
80430	Pineapples		120600	Sunflower seeds, whether or not
80440	Avocados		121490	Other
80450	Guavas, mangoes and mangosteens		200560	Asparagus

Table 4 - Impact of Standards on Trade

VARIABLES	(1) selection	(2) intensity	(3) selection	(4) intensity	(5) selection	(6) intensity
number of MRLs	-0.001	-0.001				
	[0.000]***	[0.001]				
average MRL			0.000	0.008		
			[0.000]	[0.004]*		
Restrictiveness Index					-0.011	-0.223
					[0.004]***	[0.916]
Ln(1+tariff)	-0.001	-0.382	-0.001	-0.375	-0.001	-0.382
	[0.000]***	[0.067]***	[0.000]***	[0.067]***	[0.000]***	[0.067]***
Contiguity [d]	0.006	0.563	0.006	0.571	0.006	0.564
	[0.001]***	[0.173]***	[0.001]***	[0.175]***	[0.001]***	[0.173]***
Colony [d]	0.004	0.445	0.004	0.424	0.004	0.439
	[0.001]***	[0.161]***	[0.001]***	[0.163]***	[0.001]***	[0.161]***
Ln(distance)	-0.007	-0.913	-0.007	-0.914	-0.007	-0.909
	[0.000]***	[0.278]***	[0.000]***	[0.279]***	[0.000]***	[0.278]***
Common language [d]	0.002		0.002		0.002	
	[0.000]***		[0.000]***		[0.000]***	
zeta		3.683		3.835		3.700
		[1.553]**		[1.556]**		[1.565]**
zeta_sq		-0.339		-0.407		-0.356
		[0.837]		[0.837]		[0.843]
zeta_cb		-0.051		-0.042		-0.048
		[0.155]		[0.154]		[0.155]
mills		1.462		1.482		1.455
		[0.476]***		[0.471]***		[0.476]***
Observations	2,109,457	98,065	2,055,256	95,047	2,109,457	98,065
R-squared		0.320		0.322		0.320

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1. Dependent variable in the selection equation equals one if there is positive trade between countries or zero otherwise. The dependent variable in the intensity equation is the natural logarithm of the value of trade. Importer-time, exporter-time, and product-time effects also included in all regressions. Error terms clustered by importer-product-year groups. Superscript [d] is for dummy variables.

Table 5 – Robustness Checks

VARIABLES	(1) selection	(2) intensity	(3) selection	(4) intensity	(5) selection	(6) intensity	(7) selection	(8) intensity
Restrictiveness $_{t-1}$	-0.013	-0.957						
	[0.004]***	[1.078]						
Restrictiveness $_{t-2}$			-0.015	-2.058				
			[0.004]***	[1.241]*				
Index_other dest					0.007	-1.670		
					[0.003]***	[1.576]		
Restrictiveness - index_other dest							-0.011	-0.156
							[0.001]***	[0.338]
Common language [d]	0.002		0.002		0.002		0.002	
	[0.000]***		[0.000]***		[0.000]***		[0.000]***	
Ln(1+tariff)	-0.001	-0.400	-0.001	-0.432	-0.001	-0.384	-0.001	-0.382
	[0.000]***	[0.068]***	[0.000]***	[0.072]***	[0.000]***	[0.029]***	[0.000]***	[0.029]***
Zeta		3.442		2.681		3.899		3.695
		[1.607]**		[1.698]		[0.754]***		[0.753]***
zeta_sq		-0.294		0.010		-0.450		-0.353
		[0.852]		[0.884]		[0.410]		[0.408]
zeta_cb		-0.060		-0.116		-0.033		-0.048
		[0.155]		[0.160]		[0.075]		[0.074]
Mills		1.604		1.764		1.489		1.455
		[0.496]***		[0.543]***		[0.236]***		[0.236]***
Observations	1,724,491	80,121	1,336,085	61,404	2,109,457	98,065	2,109,457	98,065
R-squared		0.319		0.322		0.321		0.320

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1. Dependent variable in the selection equation equals one if there is positive trade between countries or zero otherwise. The dependent variable in the intensity equation is the natural logarithm of the value of trade. Gravity controls for contiguity, colonial relationship, and distance have their expected sign and statistically significant but were omitted from the table due to space constraints. Importer-time, exporter-time, and product-time effects also included in all regressions. Error terms clustered by importer-product-year groups. Superscript [d] is for dummy variables.

Table 6 – Impact of BRICS Standards						
SAMPLE	All Importers		BRICS Only		Non-BRICS importers	
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	selection	intensity	selection	intensity	selection	intensity
Restrictiveness Index	-0.875		-2.179		-0.739	
	[0.187]***		[0.798]***		[0.185]***	
low income X restr. Index	0.040	-2.980	0.198	4.457	0.181	-2.381
	[0.097]	[0.812]***	[0.981]	[6.857]	[0.097]*	[0.849]***
lower middle X restr. Index	0.016	-1.405	2.166	-0.694	-0.008	-0.976
	[0.089]	[0.645]**	[0.904]**	[6.751]	[0.089]	[0.658]
upper middle X restr. Index	-0.113	-1.429	-0.287	-5.683	-0.172	-0.946
	[0.078]	[0.576]**	[0.951]	[4.901]	[0.079]**	[0.651]
Low income [d]	-0.614	-1.390	-0.580	-1.270	-0.625	-1.348
	[0.008]***	[1.126]	[0.040]***	[1.801]	[0.008]***	[1.407]
Lower middle [d]	-0.393	-0.475	-0.519	-0.162	-0.386	-0.442
	[0.010]***	[0.609]	[0.038]***	[1.531]	[0.010]***	[0.718]
Upper middle [d]	-0.042	0.435	-0.143	1.056	-0.027	0.341
	[0.012]***	[0.095]***	[0.045]***	[0.416]**	[0.013]**	[0.092]***
ln_tariff	0.005	-0.403	0.010	-0.098	0.004	-0.418
	[0.006]	[0.062]***	[0.019]	[0.167]	[0.006]	[0.067]***
zeta		6.328		7.406		5.792
		[1.204]***		[4.575]		[1.302]***
zeta_sq		-1.502		-2.254		-1.211
		[0.419]***		[1.794]		[0.445]***
zeta_cb		0.112		0.217		0.076
		[0.049]**		[0.234]		[0.053]
mills		1.946		2.586		1.633
		[0.678]***		[1.557]*		[0.782]**
Observations	73,752	36,414	6,988	3,946	66,764	32,468
R-squared		0.430		0.391		0.443

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1. Dependent variable in the selection equation equals one if there is positive trade between countries or zero otherwise. The dependent variable in the intensity equation is the natural logarithm of the value of trade. Importer-time, and product-time effects also included in all regressions. Error terms clustered by importer-product-year groups. Superscript [d] is for dummy variables.