The Effect of Product Standards on Agricultural Exports[‡]

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Abstract

We introduce a standards restrictiveness index to analyze the impact that food safety standards have on international exports of agricultural products. Our new measure of standards restrictiveness is created using maximum residue levels of pesticides for 61 importing countries and 66 different products. The index accounts for both the number of pesticides regulated for each product and the allowable level for those pesticides by each importer. 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 in most cases is indistinguishable from zero. This is consistent with the assumption that meeting stringent standards increases primarily the fixed cost to export to a destination. Once a firm adjusts its production to comply with the standards of a foreign market, those standards do not impact the intensity of exports to that market. Finally, our results suggest that exports from developing countries are particularly constrained by stricter standards.

Keywords: standards, agriculture, international trade, emerging markets
JEL Classification Codes: F14, Q17, O13

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[‡]The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent. This research was supported by World Bank-Netherlands Partnership Program at the World Bank. Without implicating them, we would like to thank Aaditya Mattoo, Ana Fernandes, Caglar Ozden, Maggie Chen, Mariem Malouche, Jose Daniel Reyes, Alberto Portugal-Perez from the World Bank and Melvin Spreij and Marlynne Hopper from the WTO for helpful ideas and comments throughout the preparation of this paper and to participants at the 2012 IATRC Conference. Special thanks to two anonymous referees for their insightful comments and to Fritz Shuster at Agrobase Logigram for providing the data as well as his support with questions regarding the Homologa database.

1 Introduction

The continual decline of tariffs as a result of multilateral trade negotiations and the proliferation of regional trade agreements have 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 analyze the impact of agricultural regulatory/mandatory standards imposed by importing countries on products entering those markets.

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. TBTs commonly used in agricultural products are those 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 pesticides 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 that 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.

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. Alternatively, there are potential opportunities provided by the evolving standards environment and the likelihood that certain developing countries can utilize such opportunities to their competitive advantage. From this perspective, many of the emerging public and private standards are viewed as a necessary bridge between increasingly demanding consumer requirements and the participation of distant (and international) suppliers. Many of these standards provide a common language within the supply chain and promote the confidence for consumers in food product safety. Jaffe and Henson (2004) suggest that compliance with food safety and agricultural health standards may well provide a powerful incentive for the modernization of developing country export supply chains and give greater clarity to the necessary and appropriate management functions of government. We take an agnostic approach and estimate the net effect (i.e., trade cost and demand enhancing effect) of standards on trade.[2]

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 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

[1] See for example Bils and Klenow (2001), Hallak (2006), and Broda and Romalis (2009).

[2] Xiong and Beghin (2014) disentangle these two effects. In this study we only look at the net effect of standards on trade.

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 (2014) 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 (2014) miss an important portion of the heterogeneity in regulations. Third, our analysis includes 66 products and close to 1,500 pesticides being regulated by one or more countries. 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 pairs.[3] Drogué and DeMaria (2012) developed an index of (dis)similarity between importer and exporter countries without limiting their focus to those specified by CODEX, but they only considered standards effects on apples and pears. Moreover, their index is time-invariant, resulting in its confluence with importer-exporter fixed effects.

Our results robustly show that product standards on average negatively affect firms' decisions to export to a given destination market. The evidence in this paper is consistent with the Helpman, Melitz, Rubinstein (2008; henceforth 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 of the impact of standards on the intensive margin are less robust, and in most specifications the effect is indistinguishable from zero.

[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 (2010) 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. And Drogué and DeMaria (2012) analyze the impact of MRLs on apple and pear trade.

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.

Each country not only specifies 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.[5]

[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 standard set for at least 50% of importers.

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

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? Averaging MRLs across pesticides for each country-product pair would generate a misleading measure. Pesticides differ on their degree of toxicity and thus highly toxic pesticides will always tend to have lower MRLs than those that are less toxic. The group of pesticides that a country chooses to regulate for a specific product will determine if the average MRL is high or low without providing any information on the restrictiveness of those measures relative to other countries. Consequently it is imperative to normalize MRLs at the pesticide level to get a true measure of how restrictive a country's MRL is relative to how all other countries are regulating that same pesticide for a given product.

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. We choose to fill in these missing values with the maximum (the least restrictive measure) MRL in all importing countries for each product-pesticide pair.

To address the issues described above we create an index of restrictiveness for each country *i*, product *p*, in year *t*. It is defined as follows:

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

where $\mathrm{MAX}_{p,a,t} = \max_{(i \in I)}\{\mathrm{MRL}_{i,p,a,t}\}$ is the maximum MRL for product *p*, pesticide *a*, and year *t* across all importing countries and $\mathrm{MIN}_{p,a,t} = \min_{(i \in I)}\{\mathrm{MRL}_{i,p,a,t}\}$ is the minimum MRL for product *p*, pesticide *a*, and year *t* across all importing countries. $\mathrm{MRL}_{i,p,a,t}$ is country *i*'s MRL for pesticide *a*, for product *p* in year *t*. This index will be between zero and one, zero being the least restrictive and one the most restrictive.[6] In other words, the operation inside the summation simply normalizes a country's MRL regulation for a product-pesticide pair in year *t* to be between zero and one relative to the maximum and minimum MRLs for that same product-pesticide pair in all other countries. We then take the average of these normalized MRLs across pesticides for each importer-product combination and aggregate them to the importer-product-year level in order to match it to trade data.

In the case that a country does not set an MRL for a given product-pesticide (i.e., $MRL_{i,p,a,t}$ is missing) we use the default MRL for unlisted pesticides, and if there is not default MRL for the product-pesticide pair we substitute the missing $MRL_{i,p,a,t}$ 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 it normalizes the value of an MRL at the product-pesticide level, allowing us to compared MRLs across countries. A third advantage is that for every product, it includes all pesticides regulated in the world for that specific product; this contrasts to for example Li and Beghin (2014) 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 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).[7] We use the gravity model of trade which has been the workhorse for policy analysis in trade since Anderson (1979) developed its theoretical foundation. The gravity model has been used in studies to test the impact of regional trade blocs, regional trade bias and home country

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

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 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. Chen et al. (2008) examined 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 found 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 (2014) to study the effect of standards relative to CODEX standards in Canada and the US. The authors found that imports by US and Canada are not affected by the stringency of this type of regulation; however, the authors found that exports from Canada see a positive effect in foreign markets.

We specifically apply the 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.[8] 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,

[8] See for example Eaton et al. (2004)

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 uses 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*,

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

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_{ipt} is the importer-product standard regulation, and ϕ_{ij} is a vector of gravity country-pair controls typically found in gravity models. 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:

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

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 applied 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. In some specifications we will additionally include total supply, measured by total exports of product *p* by exporter *j* in year *t*, to control for exporter-product specific supply side effects. Finally we use product-time effects to control for any demand or supply effect 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. Furthermore, to allow possible heterogeneity across agricultural sectors in the self-selection process and to test the robustness of our results with an alternative exclusion restriction, we use the interaction between the sum of the number of documents required by the exporting country to export and the number of documents required by the importing to import with product fixed effects.[9]

[9] Similarly, Xiong and Beghin (2014) interact HS 2 digit chapters with religion to create an exclusion restriction that accounts for heterogeneity across products. We thank an anonymous referee for the suggestion to test the robustness of our results using number of documents as an exclusion restriction.

In order to control for the firm-level heterogeneity we include a cube polynomial of $\hat{\bar{Z}}_{ijpt}$.[10] $\hat{\bar{Z}}_{ijpt}$ 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 are necessary for the correct estimation of the gravity equation, we include country-time effects in the gravity Equation (3) to control for multilateral resistance terms. Even though HMR and Heckman procedures typically suffer from limitations (i.e, fragility of results with respect to heteroskedastic errors and misspecification) it has the advantage that not only it controls for selection, and firm heterogeneity but it also allows to explore the impacts of MRLs on both the extensive and intensive margin of trade separately. In the next section, we show the baseline results and the results from a number of robustness checks, particularly on the estimating strategy, to show the validity of the results.

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). The variable of interest is the restrictiveness index described in equation (1) which measures the restrictiveness of importers' standards of product *p*. 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 second stage OLS regression correcting for firm heterogeneity and sample selection where the dependent variable is the natural logarithm of the trade value.

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

The results displayed on columns 1 and 2 of Table 4 show that more restrictive standards in a destination market result in a lower probability that an exporter will trade with that destination; however, after controlling for firm heterogeneity and sample selection, stricter standards are not statistically different from zero in the trade intensity regression. In this first specification, we mimic HMR and use common language as the exclusion restriction for the first stage. Columns 3 and 4 show the results of the two-stage HMR model that additionally controls for output of product *p* by exporter *j*. As mentioned in the previous section, 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 the size of the exporter's economy is not warranted. We include total supply, measured by total exports of product *p* by exporter *j* in year *t*, to control for exporter-product specific supply side effects.[11] The coefficient of the restrictiveness index in the first stage probit regression remains negative and statistically significant with the inclusion of exporter supply. The restrictiveness index's sign on the intensity regression is, however, reversed but remains statistically insignificant.

Columns 5 and 6 show the results of a two stage HMR model that make use of an alternate exclusion restriction. We use the log of the sum of the number of documents required for imports by the importer country and the number of documents required for exports by the exporter country interacted with product dummies to allow for heterogeneity across agricultural sectors in the self-selection process to exports. The probit results shown in column 5, with the alternative exclusion restriction, are almost identical to those shown in column 3. The results of the intensive margin of trade shown in column 6 slightly differ from those in column 4, with the new exclusion restriction the coefficient on the restrictiveness index is now positive and significant at the 10% level.

Gravity model controls have their expected signs in all regressions displayed in Table 4. 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.

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[11] Exporter-product flows that are destined to only one destination (i.e, total exports = exports to destination *i*) are dropped from the sample.

The two stage HMR model shows that the impact of standards on trade occurs through the proportion of firms being able to trade. The results displayed on Table 4 suggest that standards are important determinants on firms' choice of destination. On average, fewer firms can cover the additional fixed cost associated with meeting high standards in destination markets which in turn results in less trade *via* the lower proportion of exporters.

4.2 Robustness Checks - Endogeneity

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 frequently imported. Also, the levels of imports could influence policymakers' decisions of using NTMs, (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 the 1% level in the probit regressions. Stricter standards are associated, on average, with lower probabilities of observing trade whereas the effect of standards on trade intensity is not statistically different from zero. Again, the results indicate that on average standards deter firms from exporting to markets with stricter standards because of the additional fixed costs necessary to adjust production to comply with international markets.

We also include a second robustness check that addresses 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 for *j* except *i*. *Index_other destinations* is the average restrictiveness index an exporter faces in all possible destinations other than *i*. We expect that an exporter facing 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 Difference in exporter and importer regulation

Even though the benchmark specification and the additional regressions performed in the previous section all include importer-time, exporter-time, and product-time effects there could be concerns about possible endogeneity particularly due to omitted variables. The original specification can be improved by additionally controlling for exporter-country standards or, even better, by the difference in standards between exporter and importer countries—which is what we do in this section and for the remainder of the study. The latter, for example, could influence the level of additional production costs needed for exporting when standards vary between exporter and importer countries. For instance, if the MRL level is stricter in the exporter country than in the importer country, then the latter's MRL standard should have no effect on its imports from the exporter country. Also, by looking instead at the difference in standards between trading partners, we are able to include country-sector-year fixed effects to better control for unobserved country-sector factors—such as domestic competition or other standards that are not directly controlled—that could bias the estimated effect of standards. Furthermore, examining country pairs' differences in standards while controlling for all time-variant country-industry factors mitigates the endogeneity problem. This new specification, however, comes with the loss of observations, as we can only include exporters for which there is data on standards available.

We re-estimate the restrictiveness index to account for the differences in importer and exporter MRLs of pesticide *a* for product *p*, in year *t*. The new index of *relative* restrictiveness is defined as:

$$(4) \quad \text{realtive restrictiveness}_{i,j,p,t} = \frac{1}{N(a)} \sum_{n(a)=1}^{N(a)} \frac{MRL_{j,p,a,t} - MRL_{i,p,a,t}}{MAX_{p,a,t} - MIN_{p,a,t}}$$

The index of *relative* restrictiveness varies between -1 and 1. The index equals 0 when both importing country and exporting country share the same MRLs for a given product, it equals 1 when the importing country has the most restrictive MRLs and the exporting country has the least restrictive MRLs for a product, and it equals -1 when the exporting country has the most restrictive MRLs and the importing country has the least restrictive MRLs for a product.[12] If a country does not set an MRL for a given product-pesticide pair - i.e., $MRL_{i,p,a,t}$ or $MRL_{j,p,a,t}$ are missing - we replace them with $MAX_{p,a,t}$.[13] Larger values of the index indicate that the importing country has a relatively more restrictive standard.

The results displayed on columns 1 and 2 of Table 6, show that the probability of positive trade between importer *i* and exporter *j* decreases when standards in the importer country are more restrictive than the exporter country's standards. The coefficient on the relative restrictiveness measure is positive and statistically significant in the trade intensity regression. The positive relation between stricter standards on higher value of trade could be due to higher unit prices. It is not hard to imagine, that exporters pass-through the additional costs to comply to foreign standards to their foreign consumers which result in higher export values. Xiong and Beghin (2014), for example, show that there is a demand-enhancing effect of standards—complying with foreign standards conveys information to consumers that a product is safe to consume thus increasing the demand for it. The positive net effect on the intensive margin of trade, shown in our regressions, suggests that the demand-enhancing effect is larger than the trade-cost effect.

As mentioned above, analyzing the relative restrictiveness of importers' standards compared to exporters' standards allows us to include importer-product-time effects that control for any additional importer SPS regulation for which we cannot directly control because of lack of data. Columns 3 and 4 of Table 6 show the results. The coefficient on our variable of interest,

[12] If MRL=MAX=MIN, for example when only one of the countries regulates a specific product-pesticide pair, the ratio inside the summation takes a value of 1. A higher value in absolute terms of the index indicates more dissimilar pesticide standards between the importing country and the exporting country.

[13] This assumes that the not setting an MRL for a given product-pesticide pair is equivalent to setting the least restrictive MRL across all countries.

the relative restrictiveness index, remains negative and statistically significant in the selection probit-regression, whereas it is positive and statistically significant in the trade intensity regression. The results, again, suggest that importer's restrictive standards deter countries from exporting with each other. However, when there is positive trade, the value of imports tends to increase with more restrictive importer standards.

Since the exclusion restriction—the log of required documents to trade interacted with the product dummies—varies across importer-exporter-product-time dimension, it allows us to test the robustness of our results to the inclusion of importer-exporter effects.[14] Columns 5 and 6 in Table 6 show the results of such a regression. The results remain robust, showing that more restrictive standards by the importer country relative to the exporter decreases the likelihood that the two countries trade. The second-stage regression shows that after controlling for more encompassing importer-exporter effects, the coefficient on relative restrictiveness remains positive but is not statistically different from zero.

4.4 Robustness Checks - Specifications

HMR and Heckman procedures typically suffer from limitations (i.e., incidental parameters, misspecification, and fragility of results with respect to heteroskedastic errors). In this section we perform several robustness checks using different specifications and estimation procedures to confirm the validity of our results.

Fixed effects do not generally cause any problems in "static" linear models, since they can easily be differenced out to allow consistent estimation of the relevant parameters. However, when considering nonlinear panel data models, we encounter the well-known incidental parameters problem identified by Neyman and Scott (1948). The incidental parameter problem refers to the fact that in nonlinear models with a fixed number of observations for each group, the bias in the estimation of the fixed effects contaminates the estimates of the parameters of interest. Due to concerns about the existence of incidental parameters in the first stage probit regression we re-estimate the first stage using several techniques that overcome this issue including, probit random-effects estimator, Chamberlain-Mundlak correction, and the logit fixed-effects estimator.

[14] Common language, the original exclusion restriction used in section 4.1 as well as in the HMR model would not have allowed for the inclusion of importer-exporter effects in the regression as it would have been absorbed by the fixed effects.

The fixed effects estimator assumes the existence of an unobserved heterogeneous component that is constant over time and affects each group (exporter-importer-product) of the panel in a different way. By contrast, the random effects model imposes no correlation between the group effects and the regressors, implicitly assuming that the unobserved heterogeneous component is strictly exogenous. Column 1 of Table 7 shows the results of using a random-effects probit in the first stage. The random effects are defined at the exporter-importer-product level and we additionally control for year effects. Just as was previously done, the HMR corrections terms are calculated using the predicted values of the first stage and used in the second stage OLS regression. The results for the second stage OLS regression are shown in column 2 of Table 7. The coefficient on the relative restrictiveness index is negative and statistically significant in the first stage regression which is consistent to the previous results shown. The coefficient for relative restrictiveness in the second stage intensity regression is now negative and statistically different from zero.

The traditional random-effects probit model imposes a strong set of assumptions: strict exogeneity, conditional serial independence, and independence between the group effects and the regressors. Under these assumptions, the coefficient on the regressors and the parameters in the distribution of the group effects are identified and are consistently estimated by full MLE. We can relax the independence between the group effects and the regressors using Chamberlain-Mundlak device under conditional normality. The Chamberlain-Mundlak device estimates random-effects regression models adding within group-means of all independent variables. This technique was proposed by Mundlak (1978) as a way to relax the assumption in the random-effects estimator that the observed variables are uncorrelated with the unobserved variables (also see Wooldridge (2010)). The results in columns 3 and 4 of Table 7 show the results of regressions incorporating Chamberlain-Mundlak method in the first stage. The results again show that the effect of more restrictive importer standards relative to the exporter standards results in a lower likelihood that both countries trade. The second stage regression shows a negative relation between the value of trade and the relative restrictiveness of the importer's standards.

So far we have estimated the first stage selection regression using a probit estimation, as was implemented by HMR. Although they use a probit with importer and exporter fixed effects, one could also similarly use a logit to estimate the parameters for the first stage selection equation. Crozet and Koenig (2010), for example, also use the probability of exporting as a first stage in their empirical strategy. More specifically, the authors use logit estimations with firm and import country-year fixed effects to disentangle the elasticity of trade barriers on the extensive and intensive margins. Similarly, we apply a fixed-effect logit estimation for the first stage selection equation. Estimates are displayed on column 5 of Table 7. We again find that the effect of more restrictive importer's standards relative to the exporter's standards is associated with a lower probability of trade. The results of the second stage trade intensity equations are shown in column 6 of Table 7. The results suggest a negative relation between our variable of interest, the relative restrictiveness index, and the value of trade; however, it is not statistically different from zero.

The HMR model and more generally the gravity model of trade, are commonly criticized because the log-linearization of the variables can lead to biased estimations in the presence of heteroskedasticity as shown by Santos Silva and Tenreyro (2006, 2011). They suggest using the Poisson Maximum Likelihood (PPML) method. To properly account for the full importer-exporter-products effects we instead make use of a fixed-effects Poisson (Quasi-ML) regression. Wooldridge (1999) shows that the fixed effects Poisson estimator produces consistent estimates of the parameters in an unobserved components multiplicative panel data model under very general conditions. In fact, all that is required is an assumption about the conditional mean of the dependent variable. This is useful for two reasons. First, it implies that the fixed effects Poisson estimation is appropriate for any non-negative dependent variable—not just count data that follow a Poisson distribution. Second, the estimator is robust to arbitrary patterns of serial correlation.[15] The only caveat to this estimation strategy is that it cannot disentangle the effects of standards on the extensive and intensive margins of trade. For completeness we show the results using fixed-effects Poisson regression on column 7 of Table 7. The results show a negative effect of more restrictive importer's standards relative to the exporter's standards on the value of trade; the coefficient is, however, indistinguishable from zero.

As a final robustness check to our specification we make use of zero-inflated models to estimate the parameters of interest since nearly 90 percent of observations in our sample are zeros. The excessive zeros can either result from the over-dispersion of the data-generating

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[15] Timothy Simcoe developed a Stata command that allows for the estimation of fixed-effects Poisson with robust standards errors, "xtpqml". http://people.bu.edu/tsimcoe/data.html

process, or the existence of another data-generating process that produces inflated zeros.[16] In order to accommodate those excessive zeros and identify their underlying processes we implement zero-inflated Poisson (ZIP) and zero-inflated negative binomial (ZINB) regressions. The results, displayed on Table 8, show that the relative restrictiveness of standards is a significant positive factor in determining the zeros in trade. The relative restrictiveness of standards on the intensive margin trade is not statistically significant in any of the zero-inflated regressions. The Voung test confirms that zero-inflated regressions are preferred over their ordinary counterparts. [17]

It is important to highlight that only the regressions which include importer-exporter-product, and time effects pass Ramsey's RESET test. The estimation strategies that allow us to include these more encompassing effects, namely: probit random effects, Chamberlain-Mundlak random effects, and logit fixed effects, find that the stricter importer standards relative to the exporter's standards reduce the probability of trade. This result is robust across all specifications shown in this section. In most specifications shown in this subsection we find that the relation between relative standard restrictiveness and the intensive margin of trade is negative; however, is only statistically significant when the HMR correction terms when estimated using a random effect probit regression.

4.5 Differences in Standards' Effects between High and Low Income Countries

As a final exercise, we explore if standards affect exports of higher and lower income countries differently depending on whether the destination is a high or low income country.[18] Table 9 shows the results. Column 1 and 2 show the effects of relative restrictiveness of standards on High-High trade. The results suggest that the effect of relative restrictiveness of standards on exports from high income countries to other high income countries is positive both in the intensive and extensive margin; however, these effects are not statistically significant. In the case of exports of high income countries to low income countries (columns 3 and 4), more restrictive standards by the importer relative to the exporter appear to increase the likelihood that high income countries export to low income ones, and the effect on the value of trade is also

[16] See for example Greene (1994) and Burger et al. (2009).

[17] Notice that the fixed effects used in the zero-inflated regressions are not as restrictive as the importer-exporter-product effects used in the other robustness tests as to allow the system to converge.

[18] The list of high income countries in our sample is as follows: AUS, CAN, CHE, CHL, EU27, ISR, JPN, KOR, NOR, NZL, RUS, SGP, and USA. All other countries whether low or middle income are labeled as low income.

positive and statistically significant. On the other hand, columns 5 and 7 of Table 9 show that exports of low income countries to both high and low income countries are less likely to occur when the importer standards are relatively more restrictive than that of the exporter. The effect of more restrictive standards by the importer relative to the exporter on the intensive margin of trade is a positive in Low-High trade and negative in Low-Low trade; however, both of these effects are not statistically significant (see columns 6 and 8 of Table 9).

The results follow the intuition that less developed countries struggle to meet stricter import requirements from developed countries because of supply side constraints such as the lack of financial and technological resources to comply with these standards. On the other hand, exporters from high-income countries have the resources and technology available to meet foreign standards even when these standards are higher than those in their local market. Furthermore, exporters from high income countries benefit when they face stricter standards in the low income countries, possibly at the expense of low income exporters that cannot meet those standards.

5 Conclusions

Our results robustly show that 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 more likely export to the country with lower product standards. The results presented are consistent with the HMR model where firms face a fixed cost to export. Exporting firms need to adjust their production process to comply with their trading partners' standards. This process increases the fixed cost to export. The result that more restrictive standards hinder the likelihood of trade is resilient to a number of robustness tests presented throughout this report. The results of the effect of standards on the intensive margin of trade are, however, less robust but mainly suggest that the effect is indistinguishable from zero. We also found that exporters from low income countries are the ones that are particularly restrained from exporting to destinations where standards are more restrictive than in their local markets. These results are in contrast to those found by Xiong and Beghin (2014) who suggest that the net effect of stricter MRLs enhance OECD member imports of plant products. However, both studies' results coincide that exporters from the less and least developed countries are more constrained by stricter standards than their competitors from the developed world. Similarly to Drogué and

DeMaria we find that dissimilarity of regulations hinder trade; however, we find that this effect happens through the extensive margin whereas they find that the negative effect of dissimilarity of regulations is channeled through the intensive margin.

Growing incomes and increased demand in emerging markets such as China, Brazil, Russia, and India provide important opportunities for other developing countries so long as their products are able to access these markets. However, as tariffs become less of a market-entry barrier for developing countries, NTMs are becoming increasingly important. In general, it is more difficult to analyze the effect of NTMs 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. From a development perspective, our results suggest that in order for developing countries to take advantage of new opportunities, they need to be aware of foreign regulations such as product standards and of their domestic supply side constraints that prevent them from meeting these regulations. The results also suggest that further coordination and adherence to the established international standards by developed and developing countries could boost exports from developing countries as the fixed costs to exporting would decline; firms would only need to meet one international standard rather than several specific importers' standards.

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 for firm level data; however, a more detailed analysis with firm-level data would provide additional and more detailed insight. Understanding which firms are able to meet standards, which divert trade to other destinations, and which cannot survive changes to standards are important issues to understand for effective policy making and an interesting piece of the puzzle left for future work.

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Figure 1 – Importers' Income and Standards

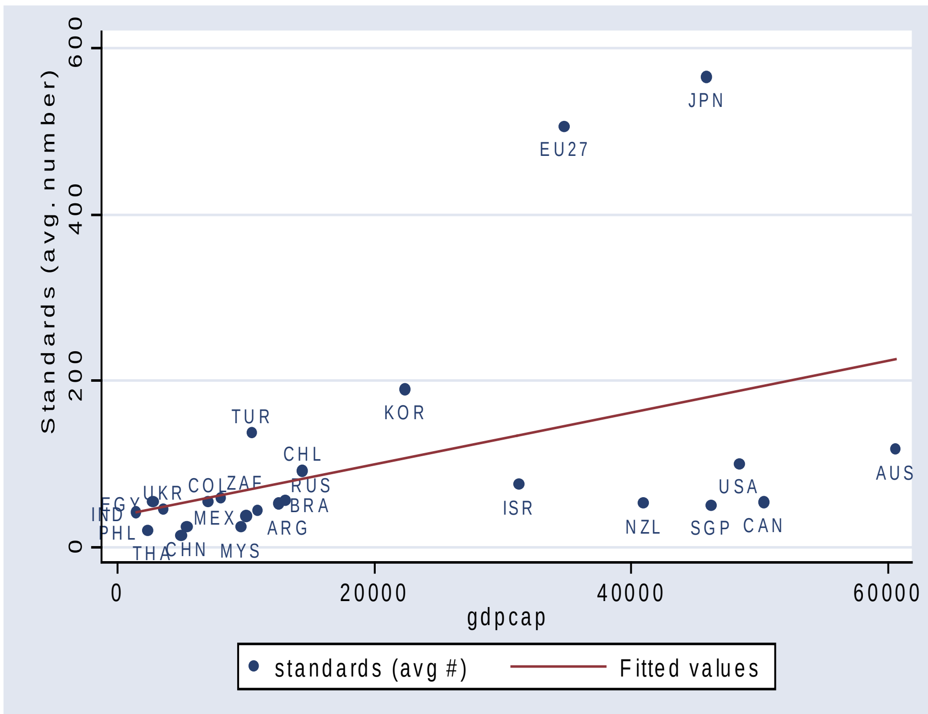

Table 1- Number of regulated products

	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

	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 – Sample of Products

hscode	productdescription	hscode	productdescription
70190	Potatoes	80510	Oranges
70200	Tomatoes, fresh or chilled.	80520	Mandarins (including tangerines)
70310	Onions and shallots	80530	Lemons
70320	Garlic	80540	Grapefruit
70390	Leeks and other alliaceous veg.	80710	Melons (including watermelons)
70410	Cauliflowers and headed broccoli	80810	Apples
70420	Brussels sprouts	80820	Pears and quinces
70490	Cabbage	80910	Apricots
70511	Lettuce :-- Head lettuce	80920	Cherries
70519	Lettuce :-- Other	80930	Peaches, including nectarines
70521	Chicory :-- Witloof chicory	80940	Plums and sloes
70529	Chicory :-- Other	81010	Strawberries fresh
70610	Carrots and turnips	81020	Raspberries, blackberries, fresh
70690	Other edible roots	81040	Cranberries, bilberries fresh
70700	Cucumbers and gherkins, fresh or chill	81050	Kiwifruit
70810	Peas (Pisum sativum)	81090	Other berries tamarinds
70820	Beans (Vigna spp., Phaseolus spp.)	81110	Strawberries frozen
70920	Asparagus	81120	Raspberries, blackberries, frozen
70930	Aubergines (egg-plants)	91099	Other spices :-- Other
70951	Mushrooms and truffles :-- Mushroom	100110	Durum wheat
70960	Fruits of the genus Capsicum	100190	Meslin
70970	Spinach, New Zealand spinach	100200	Rye.
70990	Other vegetables fresh or chilled	100300	Barley
71420	Sweet potatoes	100400	Oats.
80130	Cashew nuts :-- Shelled	100590	Maize other than seed
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	Rutabagas - Other
80450	Guavas, mangoes and mangosteens	200560	Asparagus preserved

Table 4 - Impact of Standards on Trade

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	selection	intensity	selection	intensity	selection	intensity
Restrictiveness Index	-0.011	-0.223	-0.036	0.335	-0.038	0.740
	[0.004]***	[0.916]	[0.007]***	[0.428]	[0.007]***	[0.395]*
Ln(1+tariff)	-0.001	-0.382	-0.004	-0.227	-0.004	-0.181
	[0.000]***	[0.067]***	[0.000]***	[0.027]***	[0.000]***	[0.020]***
Ln(distance)	-0.007	-0.909	-0.023	-0.699	-0.023	-0.399
	[0.000]***	[0.278]***	[0.000]***	[0.130]***	[0.000]***	[0.089]***
Contiguity [d]	0.006	0.564	0.022	0.224	0.020	0.065
	[0.001]***	[0.173]***	[0.001]***	[0.090]**	[0.001]***	[0.067]
Colony [d]	0.004	0.439	0.015	0.249	0.015	0.105
	[0.001]***	[0.161]***	[0.001]***	[0.085]***	[0.001]***	[0.063]*
Common language [d]	0.002		0.006		0.006	-0.065
	[0.000]***		[0.000]***		[0.000]***	[0.036]*
Ln(supply)			0.005	0.561	0.005	0.496
			[0.000]***	[0.027]***	[0.000]***	[0.019]***
zeta		3.700		9.589		9.779
		[1.565]**		[0.586]***		[0.497]***
$zeta^2$		-0.356		-2.979		-2.874
		[0.843]		[0.290]***		[0.254]***
$zeta^3$		-0.048		0.348		0.334
		[0.155]		[0.049]***		[0.041]***
Inverse mills		1.455		1.537		1.033
		[0.476]***		[0.200]***		[0.152]***
Observations	2,109,457	98,065	1,165,305	97,631	1,133,528	96,607
R-squared		0.320		0.527		0.528

Robust standard errors clustered by importer-product-year groups 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. Superscript [d] is for dummy variables. The exclusion restriction used for the first stage regressions displayed in columns 1 and 3 is common language. The exclusion restriction used for the first stage regression displayed in column 5 is the log of the sum of the number of documents required to export by the exporting country and the number of documents required to import by the importing country interacted with product dummies.

Table 5 – Robustness Checks (Endogeneity)

VARIABLES	(1) selection	(2) intensity	(3) selection	(4) intensity	(5) selection	(6) intensity	(7) selection	(8) intensity
Restrictiveness $_{t-1}$	-0.043	0.420						
	[0.008]***	[0.507]						
Restrictiveness $_{t-2}$			-0.048	-0.016				
			[0.009]***	[0.633]				
Restrictiveness other destinations					0.251*	9.222		
					[0.217]	[14.871]		
Restrictiveness (I–other destinations)							-0.037	0.710
							[0.006]***	[0.388]
Ln(1+tariff)	-0.003	-0.192	-0.003	-0.200	-0.004	-0.184	-0.004	-0.181
	[0.000]***	[0.022]***	[0.000]***	[0.025]***	[0.000]***	[0.020]***	[0.000]***	[0.020]***
Ln(supply)	0.005	0.503	0.005	0.505	0.005	0.500	0.005	0.496
	[0.000]***	[0.020]***	[0.000]***	[0.024]***	[0.000]***	[0.019]***	[0.000]***	[0.019]***
zeta		9.799		9.782		9.667		9.777
		[0.543]***		[0.624]***		[0.495]***		[0.497]***
$zeta^2$		-2.889		-2.862		-2.826		-2.873
		[0.277]***		[0.318]***		[0.254]***		[0.254]***
$zeta^3$		0.334		0.328		0.327		0.334
		[0.044]***		[0.051]***		[0.041]***		[0.041]***
Inverse mills		1.081		1.059		1.055		1.034
		[0.165]***		[0.194]***		[0.152]***		[0.152]***
Observations	928,409	78,840	721,305	60,354	1,133,528	96,607	1,133,528	96,607
R-squared		0.527		0.529		0.528		0.528

Robust standard errors clustered by importer-product-year groups 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, common language, 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. The exclusion restriction used for the first stage regressions is the log of the sum of the number of documents required to export by the exporting country and the number of documents required to import by the importing country interacted with product dummies.

Table 6 – Effects of Relative Restrictiveness of Standards on Trade

VARIABLES	(1) selection	(2) intensity	(3) selection	(4) intensity	(5) selection	(6) intensity
Relative Restrictiveness Index	-0.081	1.087	-0.038	0.213	-0.083	0.065
	[0.007]***	[0.362]***	[0.003]***	[0.181]	[0.007]***	[0.216]
Ln(1+tariff)	-0.004	-0.234	-0.005	-0.203	-0.005	-0.207
	[0.000]***	[0.021]***	[0.000]***	[0.014]***	[0.001]***	[0.021]***
Ln(supply)	0.008	0.533	0.007	0.596	0.017	0.524
	[0.000]***	[0.022]***	[0.000]***	[0.010]***	[0.000]***	[0.024]***
Ln(imp_gdppc)					0.015	0.970
					[0.007]**	[0.191]***
Ln(distance)	-0.041	-0.538	-0.037	-0.909		
	[0.000]***	[0.108]***	[0.000]***	[0.045]***		
Contiguity [d]	0.027	0.236	0.026	0.389		
	[0.002]***	[0.071]***	[0.001]***	[0.051]***		
Colony [d]	0.009	0.143	0.008	0.298		
	[0.002]***	[0.063]**	[0.001]***	[0.058]***		
Common language [d]	0.006	-0.047	0.006	-0.001		
	[0.001]***	[0.036]	[0.000]***	[0.032]		
zeta		10.008		8.756		8.868
		[0.520]***		[0.456]***		[0.597]***
$zeta^2$		-3.179		-2.664		-2.601
		[0.250]***		[0.229]***		[0.293]***
$zeta^3$		0.382		0.308		0.282
		[0.039]***		[0.036]***		[0.047]***
Inverse mills		1.371		1.978		1.562
		[0.169]***		[0.093]***		[0.175]***
m-t, x-t, p-t	yes	yes	no	no	no	no
m-p-t, x-t	no	no	yes	yes	no	no
x-m, p-t	no	no	no	no	yes	yes
Observations	650,629	73,529	647,908	73,529	460,121	72,729
R-squared		0.528		0.558		0.589

Robust standard errors clustered by importer-product-year groups 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. Superscript [d] is for dummy variables. The exclusion restriction used for the first stage regressions is the log of the sum of the number of documents required to export by the exporting country and the number of documents required to import by the importing country interacted with product dummies.

Table 7 – Robustness Checks (Estimation Methods)

	probit-RE		Chamberlain		logit-FE		xtpqml
VARIABLES	selection	intensity	selection	intensity	selection	intensity	intensity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Relative Restrictiveness	-0.212	-0.292	-0.29	-0.657	-0.524	-0.121	-0.103
Index	[0.048]***	[0.116]**	[0.070]***	[0.206]***	[0.130]***	[0.320]	[0.211]
Ln(1+tariff)	-0.294	-0.357	-0.02	-0.038	-0.043	-0.055	-0.023
	[0.007]***	[0.191]*	[0.018]	[0.024]	[0.037]	[0.059]	[0.019]
Ln(supply)	0.248	0.682	0.062	0.449	0.118	0.292	0.8
	[0.002]***	[0.175]***	[0.004]***	[0.039]***	[0.007]***	[0.036]***	[0.039]***
Ln(imp_gdppc)	0.41	1.687	-0.01	1.099	0.573	1.054	0.541
	[0.007]***	[0.313]***	[0.054]	[0.084]***	[0.102]***	[0.278]***	[0.114]***
zeta		-10.752		-6.879		0.025	
		[4.239]**		[4.001]*		[0.415]	
$zeta^2$		8.002		3.333		0.019	
		[4.741]*		[2.731]		[0.039]	
$zeta^3$		-2.991		-0.766		-0.001	
		[1.805]*		[0.614]		[0.001]	
Inverse mills		0.595		0.481		-0.745	
		[0.675]		[0.634]		[0.306]**	
Observations	650,629	73,529	650,629	73,529	75,170	30,183	118,867
R-squared		0.921		0.921		0.844	
Ramsey RESET test	F(1, 48414) = 0.68		F(1, 48414) = 22.33		F(1, 14749) = 1.97		Chi2(1) = 0.51
	Prob > F = 0.4106		Prob > F = 0.0000		Prob > F = 0.1605		Prob > chi2 = 0.4755

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, with the exception of column 7 where the dependent variable is the value of trade including zero values. Importer-exporter-product effects and time effects also included in all regressions. The exclusion restriction used for the first stage regressions is the log of the sum of the number of documents required to export by the exporting country and the number of documents required to import by the importing country interacted with product dummies.

Table 8 – Robustness Checks (Estimation Methods - Zero Inflation)

VARIABLES	ZIP		ZINB		ZINB	
	inflate	Trade value	inflate	Trade value	inflate	Trade value
	(1)	(2)	(3)	(4)	(5)	(6)
Relative Restrictiveness Index	1.586	0.794	2.559	-0.019	5.116	0.454
	[0.134]***	[0.543]	[0.177]***	[0.200]	[0.372]***	[0.264]
Ln(1+tariff)	0.130	-0.271	0.071	-0.261	0.066	-0.284
	[0.009]***	[0.040]***	[0.016]***	[0.014]***	[0.016]***	[0.014]***
Ln(supply)	-0.204	0.902	-0.160	0.895	-0.162	0.905
	[0.008]***	[0.020]***	[0.005]***	[0.004]***	[0.005]***	[0.004]***
Ln(imp_gdppc)	-0.149	0.585	-0.090	0.491		
	[0.118]	[0.558]	[0.158]	[0.178]***		
Ln(distance)	1.239	-0.899	1.954	-0.871	1.951	-0.955
	[0.014]***	[0.063]***	[0.029]***	[0.027]***	[0.030]***	[0.024]***
Contiguity [d]	-0.596	0.198	-1.123	0.710	-1.129	0.711
	[0.029]***	[0.095]**	[0.087]***	[0.051]***	[0.087]***	[0.048]***
Colony [d]	-0.144	0.272	-0.873	-0.388	-0.922	-0.412
	[0.046]***	[0.122]**	[0.087]***	[0.057]***	[0.093]***	[0.057]***
Common language [d]	-0.202	-0.040	-0.322	0.163	-0.336	0.193
	[0.018]***	[0.073]	[0.030]***	[0.036]***	[0.031]***	[0.033]***
Constant	-9.427	0.232	-21.077	0.130	-19.729	5.203
	[1.352]***	[5.071]	[1.787]***	[1.611]	[1.357]***	[0.510]***
Dispersion				2.093		2.074
				[0.016]***		[0.016]***
Exclusion ln(docs)xprod	yes	no	yes	no	yes	no
x, m, p, t	yes	yes	yes	yes	no	no
xt, mt, pt	no	no	no	no	yes	yes
Observations	650,629	650,629	650,629	650,629	653,097	653,097

Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is the value of trade including trade values equal to zero. The exclusion restriction used for the zero inflation equation is the log of the sum of the number of documents required to export by the exporting country and the number of documents required to import by the importing country interacted with product dummies. The first-stage "inflate" regression results are logit coefficients predicting excess zeros. Voung statistics are statistically significant and confirm that zero-inflated models are preferred.

Table 9 – Differentiating Effects of Standards on Trade between High Income and Low Income Countries

	High to High		High to Low		Low to High		Low to Low	
	selection	intensity	selection	intensity	selection	intensity	selection	intensity
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Relative Restrictiveness	0.082	0.713	0.901	1.487	-0.785	0.215	-1.149	-1.127
Index	[0.409]	[0.753]	[0.294]***	[0.811]*	[0.307]**	[0.578]	[0.270]***	[0.729]
Ln(1+tariff)	0.036	0.059	0.157	-0.047	-0.176	-0.003	-0.117	-0.068
	[0.120]	[0.194]	[0.076]**	[0.124]	[0.086]**	[0.113]	[0.055]**	[0.110]
Ln(supply)	1.59	2.09	0.026	0.833	0.876	1.232	0.645	0.15
	[0.324]***	[0.672]***	[0.195]	[0.503]*	[0.234]***	[0.523]**	[0.176]***	[0.471]
Ln(imp_gdppc)	0.155	0.282	0.137	0.374	0.111	0.311	0.113	0.255
	[0.021]***	[0.058]***	[0.019]***	[0.073]***	[0.011]***	[0.041]***	[0.010]***	[0.045]***
zeta		0.033		0.141		-0.052		1.017
		[0.362]		[1.091]		[0.497]		[0.600]*
$zeta^2$		0.002		-0.001		0.003		-0.063
		[0.014]		[0.109]		[0.021]		[0.059]
$zeta^3$		0		0		0		0.002
		[0.000]		[0.003]		[0.000]		[0.002]
Inverse mills		-0.919		-0.151		-0.096		-0.988
		[0.333]***		[0.332]		[0.314]		[0.462]**
Observations	9,659	4,138	19,768	7,709	18,248	7,876	27,495	10,395
R-squared		0.811		0.859		0.823		0.858
Ramsey RESET test	F(1, 2237) = 2.29		F(1, 3637) = 0.94		F(1, 4017) = 0.41		F(1, 4791) = 0.56	
	Prob > F = 0.1302		Prob > F = 0.3330		Prob > F = 0.5243		Prob > F = 0.4523	

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. All first stage –selection regressions are estimated using fixed effects logit estimator. The dependent variable in the intensity equation is the natural logarithm of the value of trade. Importer-exporter-product effects and time effects also included in all regressions. The exclusion restriction used for the first stage regressions is the log of the sum of the number of documents required to export by the exporting country and the number of documents required to import by the importing country interacted with product dummies.