Product Standards: Do they affect Firms' Export Decisions? *

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Abstract

We estimate the effect that product standards have on firms' decisions to export to foreign destinations. The analysis is anchored in two new datasets. The first covers all exporting firms in 20 developing countries. The second consists of pesticide standards for 203 agricultural and food products in 63 importing countries over the 2006-2010 period. Our analysis shows that product standards do affect foreign market access. More restrictive standards in the importing country, relative to the exporting country, lower the probability of firms export participation. The relative restrictiveness of standards also deters exporting firms from entering new markets and leads to higher exit rates from those markets. Moreover, firm characteristics mediate the effect of product standards on firms' export decisions. Smaller exporters are less likely to enter new markets due to restrictive standards. In addition, the findings suggest that network effects of exporters from the same country do not reduce the burden of importing countries' standards on firms' decisions to enter new product-destination markets.

Keywords: Exporter dynamics, Entry, Exit, Intensive margin, Extensive margin, Non-tariff measures, Product standards.

JEL Classification codes: F14, Q17, O13, L15.

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1. Introduction

The issue of standards and their impact on firms and export success is at the forefront of trade research and debate. Moreover, it is suggested that the access of firms from developing countries to foreign markets depends increasingly on compliance with regulatory measures beyond the realm of traditional trade policies such as tariffs. Tariffs have declined significantly over recent decades, under World Trade Organization (WTO) negotiations and in the context of preferential trade agreements. The fact that tariff liberalization alone has often been insufficient to open up markets for developing countries' exporters has drawn further attention to non-tariff measures (NTMs) as major determinants in restricting market access. NTMs are becoming a key topic of negotiation under new bilateral and regional trade agreements. This includes the ongoing Transatlantic Trade and Investment Partnership (TTIP) negotiations between the United States (US) and European Union (EU). Since tariffs in the EU and US are low, any substantial impact of such an agreement on trade flows for the signatories and for third markets will be driven by changes in NTMs. Understanding the effects of NTMs is essential for the design of effective development strategies. However, analyzing the effect of NTMs on trade is difficult due to the breadth of policies covered as well as to their non-measurability.

In this paper, we use new firm-level data to examine how product standards—a type of NTM—affect trade. -We estimate the effect of standards on pesticide residue limits for agricultural and food products imposed by importing countries on firms' decisions to export, to enter or exit a product-destination, as well as their export values, combining two novel datasets, one covering all exporting firms in 20 developing countries and one covering pesticide standards for 203 agricultural products in 63 importing countries over the 2006-2010 period. Agro-food products are an important component of the export portfolio of the developing countries in our sample, accounting on average for 20 percent of their total exports, and play a critical role for the development of poor rural areas in most developing countries.[1]

Our main findings are as follows. First, product standards affect foreign market access in that more restrictive product standards in the importing country relative to the exporting country lead to a lower probability of firm export participation. Our evidence also shows that the relative restrictiveness of importing countries' standards deters exporting firms from entering a new

[1] The average masks heterogeneity across countries in the share that agro-food products represent in total exports, ranging from 50-60 percent for Kenya, Nicaragua, and Uganda to 5 percent or less for Bangladesh, Botswana, Cambodia, and Mexico.

product-destination market and leads to higher exit rates of exporting firms from product-destination markets (once firm size is controlled for). The effect of product standards on firm export values, however, is indistinguishable from zero. Second, firm characteristics mediate the effect of product standards on firms' export decisions. In particular, smaller exporters are less likely to enter a product-destination market due to restrictive standards. In addition, network effects related to the presence of other exporters from the same country do not reduce the burden that the restrictiveness of importing countries' standards imposes on firms' decisions to enter a product-destination market.

The role of two major types of NTMs - Sanitary and Phyto-Sanitary (SPS) and Technical Barriers to Trade (TBT) measures which address regulatory standards on goods and agricultural and food products, respectively on trade is ambiguous. This is, particularly true in regard to developing countries. On the one hand, regulatory standards can impede trade flows by explicitly banning such flows or by imposing prohibitive costs of compliance—related to upgrading production systems, acquiring special types of processing and storage equipment, and implementing quality control procedures—for firms in developing countries that can undermine the competitiveness of their agro-food exports.[2] The empirical evidence suggests that fixed costs of compliance with product standards are important though recurring costs of compliance tend to be lower.[3] The inability to comply with standards is potentially costly not only for individual firms but also for a country's reputation as it can ultimately result in trade restrictions such as import bans for specific products from specific countries.[4] More broadly, regulatory standards can impede trade if used in a protectionist way, being more stringent than what scientists determine as acceptable.

On the other hand, standards can act as trade facilitators by signaling that products are safe to the consumer (which is valuable under asymmetric information) and by providing the incentives for developing countries to modernize the supply chain structure in their export-

[2] See Henson et al. (2000) on the challenges related to product standards faced by firms in developing countries.

[3] Using firm-level data from the World Bank Technical Barriers to Trade Survey for 16 developing countries, Maskus et al. (2005) show that fixed costs represent on average 425,000 U.S. dollars per firm (or 4.7 percent of value added) but the elasticity of firm variable production costs to standards and technical regulations is only in the 0.06%-0.13% range. Case study evidence for shrimp exports from Nicaragua shows that fixed costs to comply with quality and safety standards represent less than 3% of total annual exports while costs to maintain compliance represent less than 1% of that total (Cato et al., 2005).

[4] For example, the EU ban on fish imports from Kenya decreased the country's export earnings by 37% (Henson et al. 2000).

oriented sectors (e.g., increasing investments in quality assurance), enabling them to improve their competitiveness while also strengthening the standards domestically. Maertens and Swinnen (2009), for example, show that foreign standards acted as a catalyst for production upgrading in Senegal.

Some of the most commonly used SPS standards in agricultural and food products are Maximum Residue Levels (MRLs) which restrict the maximum levels of residues from pesticides legally permitted on unprocessed food.[5] Once pesticides are demonstrated to be safe for consumers, MRLs are set by independent scientists, based on rigorous evaluation of each pesticide. MRLs are mandatory regulations which condition market access in order to ensure that domestically-produced and imported unprocessed food is safe to eat. MRLs act as an indicator of the correct use of pesticides and ensure compliance with legal requirements for low residues on unprocessed food.

Countries choose which products to regulate, which pesticides to regulate for each product, and the MRL for a given product-pesticide pair. In order to meet required MRLs, producers need to be informed about each of their destination markets' regulations to avoid the use of certain pesticides and determine the correct pre-harvest intervals necessary to meet the MRLs. Importantly, an MRL standard could affect producers of the same product differently depending on their location since certain pathogens and pests are endemic to certain regions and thus the pesticides used by producers are determined by where the crops grow. Hence, the cost of meeting a specific MRL will vary by location and by the production process used by each individual producer. Even if the adjustment costs necessary to meet MRLs tend to be fixed, different production processes can result in higher cost schedules due to the need to use more expensive inputs or specialized human capital to deal with pathogens and pests through alternative methods in order to meet international regulations. In the case of non-compliance with an MRL, exporters are likely to lose the full value of the shipment and to be flagged and subject to additional monitoring and testing until multiple shipments successfully cross the border.[6] In extreme cases, MRL violations lead to complete import bans for specific origin countries: e.g., imports of frozen spinach from China were banned by Japan in 2002 due to the finding of a pesticide (Chlorpyrifos) in excess of the allowable MRL.

[5] Residues from pesticides are very small traces of pesticide that sometimes remain on treated crops.

[6] Non-compliant exporters also have to pay the cost of shipment along with storage fees overseas while the complaint is processed, a fee to dispose of the product or re-export it, and potentially a violation fee.

In the context of recent trade models with heterogeneous firms, conforming with regulatory standards in an importing country constitutes a fixed entry cost to penetrate that market, as discussed by Bernard et al. (2011), but may also constitute a variable cost that needs to be incurred every time the firm exports to that market, e.g., if more costly inputs need to be used to meet regulations. The models of Chaney (2008) and Bernard et al. (2011) examine the effects of destination-specific or product-destination-specific fixed trade costs as well as destination-specific variable trade costs on the extensive and the intensive margins of exports. Fixed trade costs affect the extensive margin, i.e., a firm's decision of whether to export to a market, as they do in the seminal model of Melitz (2003). Fixed trade costs, however, do not affect the intensive margin, i.e., the firm's exports to that market, in those models whereas variable trade costs affect both margins of firm exports. Focusing on a simpler model of a single firm making export decisions, Chen et al. (2008) allow compliance with standards to impose additional production costs on firms but also to possibly have a positive effect on demand (in terms of consumers' willingness to pay for the products). The net effect of standards on a firm's choice of optimal scale and export scope depends on the strength of the standards-induced increase in costs versus the strength of the standards-induced increase in demand.

The contribution of our study is three-fold. First, our new research is the first empirical work that examines the relationship between explicit measures of product standards and firms' export decisions at the extensive and intensive margins. This is specifically the case in our work using a large set of developing countries in a panel setting and focusing on agricultural and food products which are crucial to their export baskets. Second, in contrast to most previous empirical studies on standards which rely on a count of standards as the measure of regulatory status, our use of MRLs for pesticides allows us to construct index measures that quantify the absolute stringency of these standards. Third, our study focuses on the differences in the stringency of standards in the importing country versus the exporting country. If the MRL standard is stricter in the importing country than in the exporting country, then firms may need to incur in further production costs to meet the stricter MRL standard in the destination market. If the opposite is true then the importing country's MRL should not constitute a constraint on potential exports by firms in that exporting country. A major reason for considering the *relative* stringency of standards in the importing country with respect to that in the exporting country is that this adds variability to our standards measures and thus enables us to include in the econometric

specifications a stringent set of fixed effects to control for unobserved country-industry factors (such as domestic competition) that could bias the estimated effect of standards. Furthermore, examining differences in standards for country pairs while controlling for all time-variant country-industry factors mitigates any potential endogeneity concerns caused by omitted variables.

Overall, our findings demonstrate a negative effect of the stringency of product standards on the extensive margin of firm exports both in terms of participation and experimentation of new markets but no effect on the intensive margin. A similar pattern of effects was found by Ferro et al. (2013) for aggregate product-destination trade flows, indicating that firm heterogeneity does not alter the aggregate patterns. However, what our results highlight is that beyond the average effects there is important heterogeneity across exporters. Also, our results are consistent with the idea that firms confront not only a fixed cost to export but also additional fixed costs to meet foreign standards in each destination market. Only those firms that are productive enough—and size is a proxy for productivity—will be able to cover those costs and enter a foreign market.

The remainder of the paper proceeds as follows. Section 2 reviews the existing literature on product standards. Section 3 describes the data while Section 4 presents the empirical framework. Section 5 discusses the main results and Section 6 focuses on the robustness tests. Section 7 concludes.

2. Literature Review

The evidence provided in our study contributes to the literature on product standards and trade. Most studies examine how aggregate trade flows—particularly of agricultural products—are affected by technical regulations in a gravity regression framework.[7] Disdier et al. (2008) show a trade-impeding effect from a higher number of SPS and TBT regulations imposed by OECD countries, in that they significantly reduce exports of developing countries but they do not affect bilateral trade among OECD countries. Anders and Caswell (2009) find a significantly negative impact of stricter food safety standards (through mandatory Hazard Analysis and Critical Control Point —HACCP measures) on U.S. seafood imports, especially from developing countries, while Tran et al. (2011) find a significantly negative impact of a zero tolerance for a

[7] See Cadot and Malouche (2012) for a review of the role of standards and technical regulations for trade.

drug residue standard (chloramphenicol) on crustacean imports by Canada, the EU15, Japan, and the United States from major Asian exporters. Xiong and Beghin (2010) re-examine the effect of the SPS standard (the maximum MRL of the toxic substance aflatoxin) on exports shown to be trade-impeding by Otsuki et al. (2001a, 2001b).[8] The authors find that its tightening in 2002 which limited market access had no effect on African exports of groundnuts, but rather that African domestic supply constraints played a role in determining the volumes of trade and the propensity to trade. Ferro et al. (2013)—who compiled the standards restrictiveness index based on data on MRLs of pesticides imposed by importing countries that we use—show that more restrictive standards are associated with a lower probability of observing a positive trade flow but standards do not affect trade volumes per se. They interpret this finding as indicating that meeting stringent standards increases the aforementioned fixed costs of exporting, but once firms enter the market, standards do not impact their level of exports.[9]

To our knowledge only three studies examine how standards affect firms' trade patterns. Chen et al. (2008) use cross-sectional data from a World Bank survey of firms covering compliance with technical barriers to trade and firm participation in export markets and show that different types of standards exhibit different links with intensive and extensive margins of exports. Quality standards and labeling requirements are positively correlated with firms' average export volume across destinations and products but also with their export scope (number of destinations and products) while certification procedures are linked to a decline in export scope. A clear limitation of that study is its use of subjective responses by surveyed firms of whether their exports have been impacted by different types of standards. Reyes (2012) shows that the harmonization of EU electronics regulations with international standards (whose compliance is not compulsory) led to the entry of new U.S. exporters of electronics products into the EU. Finally, Fontagné et al. (2013) examine the impact of SPS concerns raised in the WTO Committee on SPS on the export behavior of French firms based on customs data. SPS concerns

[8] Otsuki et al. (2001a, 2001b) show lower edible groundnuts exports by African countries resulting from tightening an SPS standard (the maximum MRL of the toxic substance aflatoxin) while Wilson et al. (2003) show lower bovine meat imports in countries imposing more stringent food safety standards (tetracycline).

[9] All studies mentioned focus on mandatory technical regulations—as our pesticides standards are—but other studies focus on voluntary technical regulations. Czubala et al. (2009) show some inhibiting effect of voluntary EU standards on African exports of textiles, clothing, and footwear, except for those standards that are internationally harmonized whereas Shepherd and Wilson (2013) show that voluntary product standards in EU food and agriculture markets are often trade-inhibiting for all countries and for goods that are raw or lightly processed, but internationally harmonized EU standards (equivalent to ISO norms) have much weaker trade effects, and in some cases are even trade-promoting.

have a negative impact on firms' export participation and on the value of exports (extensive and intensive margins of trade) and lead to increases in their export prices. They also find a heterogeneous effect across firms, with the negative effect of SPS concerns being lower for larger firms exporting to several destinations. One limitation of their study is that their variable of interest, SPS concerns, as a measure of importer restrictiveness raises potential endogeneity concerns as only countries whose exports are depressed by an importer's SPS will raise a concern at the WTO and thus we expect greater SPS concerns to be linked through this reverse causality channel to a more negative impact on exports. The authors, however, argue that their data is preferable to the use of WTO notifications or traditional sources of information on the existence of a regulation.

3. Data

3.1 Data on Standards

Our policy variable measures the restrictiveness of mandatory standards imposed on agricultural products based on MRLs of pesticides allowed for agricultural products in several importing countries.[10] The source for our data is the Homologa database obtained from Agrobase-Logigram, a French company that collects information on monthly changes in allowable pesticides for 63 importing countries from each country's relevant ministry and standardizes the information in terms of language, unit, and format for the period 2006-2010.

The Homologa dataset reports only the importing countries' list of regulated pesticides. However, many countries use a 'deferral policy' for pesticides for which it has not set a specific limit. For example in the case of the EU the default MRL is 0.01 parts per million (ppm). Many countries defer to Codex Alimentarius standards, the set of international standards for food safety and consumer protection developed by the Food and Agriculture Organization and the World Health Organization. In fact, many countries, particularly developing countries, do not have a list of regulated pesticides but instead directly defer to Codex standards. For the empirical analysis we will use all the information available for each importing country, including the countries' deferral policies as well as their default MRLs. Appendix Table A.1 provides the list of importing countries for which we have data on pesticide standards and indicates whether each country has its own set of regulations and what is each country's deferral policy.

[10] Note that these standards apply both to domestic production and to imports of the products.

Using Agrobase-Logigram's Homologa data we matched 243 agricultural products to their corresponding harmonized system (HS) codes at the 6-digit level of disaggregation.[11] The products covered are agricultural products belonging to HS Chapters 06-24 with the exception of HS Chapters 15 and 16 (oils and edible preparations of meat and fish).[12] Table 1 displays for each importing country the number of products that are covered by MRL standards in every year. The product coverage is very heterogeneous across countries: e.g., in 2010 pesticide limits were set by Brazil on 73 agricultural products and by the E.U. on 136 agricultural products. However, the product coverage of each country is fairly constant across time. Only 35 products have pesticide limits that are regulated by all countries in the sample, among which we find: potatoes, tomatoes, peas, beans, apples, oranges, wheat, maize, sorghum, and ground nuts.

Table 1 also lists the number of HS 6-digit products specifically regulated by each importing country as well as the number of HS 6-digit products regulated including deferral and default policies. The number of products regulated in total by all importing countries range from 214 in 2006 to 242 in 2010. The importing countries with MRL regulations with the widest coverage of products are the U.S., Canada, and Australia; however, importing countries such as Japan, Canada, and the European Union which have default MRLs are the countries with the widest coverage of products once default MRLs are accounted for. The same is true when we analyze the breadth of MRL regulations regarding the number of pesticides in Appendix Table A.2. In total, the importing countries in our sample regulated 863 pesticides in 2006 whereas by 2010 this number had increased to 964. South Korea, Switzerland, and the European Union have the most extensive coverage of specific pesticides.

Several challenges arise when working with MRL data. A first challenge relates to the two dimensions of restrictiveness that need to be considered: the number of pesticide regulations per product and how strict those regulations are. A second challenge relates to the heterogeneity of pesticides regulated across products and countries which make it difficult to compare restrictiveness across countries. For example, the 96 pesticides regulated in Russia for oranges in 2010 might not be included among the 101 pesticides regulated in Brazil for oranges in the same year. Thus the question arises: how do we compare Russia's and Brazil's restrictiveness in terms

[11] 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 the maximum number of products that were matched to the exporter-level data described in Section 3.2 was 203 products, which correspond to the year 2009.

[12] We will omit HS Chapters 15 and 16 from the analysis because these chapters include animal products for which importing countries also regulate veterinary drug MRLs which are not covered by our dataset.

of pesticide standards 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 in the other. We cannot replace these missing values with zeros, as is commonly done with missing trade values, because in the case of MRLs a lower value signifies a more restrictive standard, thus setting an MRL to zero would be equivalent to banning that pesticide entirely.

For our empirical analysis we will use measures of *relative* restrictiveness of pesticide standards, constructed relying on the restrictiveness of pesticide standards for a product in both the importing country and in the exporting country. We consider three measures:

(i) the difference in the number of pesticides regulated for a given product by each importing country-exporting country pair designated as $Rel\_number_{c,k,d,t}$ for which a larger (positive) value indicates that the importing country has a relatively more restrictive standard (it imposes a larger number of regulations);[13]

(ii) the difference in the average MRL for a given product for each exporting country-importing country pair designated as $Rel\_MRL_{c,k,d,t}$ for which a larger (positive) value indicates that the importing country has a relatively more restrictive standard (it allows relatively smaller MRLs);[14]

(iii) an index of relative restrictiveness designated as $Rel\_restrictiveness_{c,d,k,t}$ which is defined as follows:

$$(1) \quad Rel\_restrictiveness_{c,k,d,t} = \frac{1}{N(a)} \sum_{n(a)=1}^{N(a)} \frac{MRL_{c,k,a,t} - MRL_{d,k,a,t}}{MAX_{k,a,t} - MIN_{k,a,t}}$$

where $MRL_{c,k,a,t}$ and $MRL_{d,k,a,t}$ are the exporting country *c* and the importing country *d*'s MRL for each product *k*-pesticide *a* pair in year *t*, respectively. Thus, $MAX_{k,a,t} = max_d\{MRL_{d,k,a,t}\}$ represents the maximum pesticide standard across all countries while $MIN_{k,a,t} = min_d\{MRL_{d,k,a,t}\}$ represents the minimum pesticide standard across all countries. 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

[13] Specifically, $Rel\_number_{c,k,d,t}$= *ln(1+number_MRLs*$_{d,k,t}$*) – ln(1+number_MRLs*$_{c,k,t}$*).*

[14] Specifically, $Rel\_MRL_{c,k,d,t}$ *=ln(avg_MRL*$_{c,k,t}$*) – ln(avg_MRL*$_{d,k,t}$*).* The average MRLs for a given product in a country is obtained as the simple average across the MRLs for all applicable pesticides for that product in that country.

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.[15] If a country does not set an MRL for a given product-pesticide pair - i.e., $MRL_{c,k,a,t}$ or $MRL_{d,k,a,t}$ are missing - we replace the missing $MRL_{c,k,a,t}$ or $MRL_{d,k,a,t}$ with $\text{MAX}_{\text{k,a,t}}$.[16] Larger values of the index indicate that the importing country has a relatively more restrictive standard.

Our preferred measure of pesticide standards will be the index of relative restrictiveness since it combines into one measure the number of pesticides restricted as well as the intensity with which they are set. Another advantage of this index is that for every product, it includes all pesticides regulated in the world; this contrasts to the limited set of product-pesticide pairs regulated by Codex standards considered by Li and Beghin (2012). Finally, given that some pesticides are more toxic than others, the MRLs for those toxic pesticides are more restrictive in all countries. Therefore it becomes all the more important to normalize the MRLs for each pesticide by a common denominator across all countries and thus to rely on the index of relative restrictiveness in order to compare the restrictiveness of MRL standards across countries. More generally, the use of measures of the *relative* restrictiveness of pesticide standards is important because it informs on the dissimilarity in the stringency of regulatory requirements across the importing country and the exporting country and as such allow us to consider whether the presence of stricter pesticide standards in the importing country than in the exporting country imposes additional costs on firms and thus limit their market access.[17]

It is important to highlight that MRL standards are updated frequently; our estimating strategy will take advantage of this variability in time. Product registrations are withdrawn, new registrations and MRLs are established, and existing MRLs change on a regular basis. Codex MRLs for example, are updated annually every July. New Zealand typically publishes two MRL amendments per year and local officials report that they seek to update MRLs every four months.

[15] 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.

[16] 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.

[17] Winchester et al. (2012) examine how the dissimilarity in sanitary, phytosanitary and conformity requirements (including product requirements such as maximum residue limits for pesticides) across the EU and several of its trading partners affect their bilateral trade but do not but consider the stringency of those requirements, as we do in our study. Disdier et al. (2014) study the impact of standards harmonization promoted in North-South trade agreements and show a negative impact on South-South trade as well as on North-South trade when the harmonization is on regional (rather than international) standards but only harmonization is examined, not the stringency of the standards.

However, changes in MRLs are not always towards more restrictive standards, but rather very frequently MRLs are increased thus becoming less restrictive.

3.2 Data on Exporters

Our data on exporter behavior comes from transaction-level customs data for the period 2006-2010 for 20 developing countries across different regions of the world. The sources for the data for each country are detailed in the Annex of Cebeci et al. (2012) and the data was collected by the Trade and Integration Unit of the World Bank Research Department, as part of their efforts to build the Exporter Dynamics Database.[18] Each country's raw dataset covers the universe of exporting firms in the agricultural, mining excluding HS Chapter 27 (hydrocarbons such as oil, petroleum, natural gas, coal, etc.), and manufacturing sectors and provides information at the exporter-product-destination-year level for seven variables: country of origin, exporting firm identifier, country of destination, HS 6-digit product, export value, export quantity, and year.[19] Additional details on the data are provided in the Appendix.

Although for each firm we have information on its exports in all sectors, we define the key outcome variables capturing exporter behavior—firm export value, export quantity, export participation, entry and exit variables—at the exporting country-firm-product-destination-year level *focusing exclusively on agricultural and agro-food products*, i.e., those belonging to HS Chapters 06-24 (with the exception of HS Chapters 15 and 16), which are the products for which our measures of pesticide standards imposed in importing countries are available.

Regarding the intensive margin of trade at the firm level, the outcome variables that we consider are the value and quantity exported by firm *i* from country *c* of product *k* to destination country *d* in year *t* which are given by, respectively, $v_{c,i,k,d,t}$ expressed in current U.S. dollars and $q_{c,i,k,d,t}$ expressed in a specific measurement unit (e.g., kilos). The number of observations in specifications that explain quantities exported will be substantially smaller than those in the

[18] Although the Exporter Dynamics Database's raw dataset span across 35 developing countries with data for (some years in) the period 2006-2010, the selection of 20 countries for our sample here is constrained by their having information on pesticide standards given that we use relative measures of pesticide standards across the importing and exporting country.

[19] Cebeci et al. (2012) show the quality of the data by comparing the total exports obtained from aggregating the transaction-level customs data at the country level with the total exports obtained at the country level from COMTRADE/WITS (World Integrated Trade Solution).

specifications that explain value exported given that 8 of the 20 developing countries in our sample did not include quantity information in their exporter-level customs datasets.[20]

Regarding the extensive margin of trade at the firm level in terms of firms' decisions to export or to enter or exit a product-destination market, we need to expand (or fill in) the initial dataset described above with only positive exports by—adding zeros for exports, export starts or stops not occurring—on some dimensions to be able to define the corresponding outcome variables. If we were to follow the gravity equation literature (particularly studies employing an export participation equation to account for biases in gravity equation estimation) we would expand the initial dataset so as to make it a 'square' matrix where every firm would have an observation (a row) for every product-destination-year combination possible.

Given the large number of exporting firms in our sample of 20 developing countries, such an expanded dataset would be computationally impossible to handle and it would be highly cluttered by zeros as most firms tend to export a single product to a single destination. Moreover, our objective in constructing an expanded dataset is to have observations (rows) that make economic sense, i.e., that indicate plausible choices for firms without requiring major assumptions. Consider as a first example, an observation from the initial dataset in which firm *i* starts to export product *k* to destination *d* in year t. If in the expanded dataset we add an observation with a 0 export value for firm *i* product *k* destination *d* in year *t-1*, that implies that in year *t-1* we are allowing firm *i* to choose whether to export product *k* to destination *d* and the firm chooses not to do so. This seems like a plausible and not overly restrictive assumption.[21] Consider as a second example, firm *i* exporting products *k* and *l* at some point during the sample period in the initial dataset. If in the expanded dataset we add observations with 0 export values for firm *i* for all other possible products (other than *k* and *l*) to any possible destination in any year, this implies that in any year we are allowing firm *i* to choose whether to export any possible agricultural product. This seems like an implausible assumption given that other agricultural products may be completely different from what the firm's capabilities in terms of technology, type of land, and other inputs allow her to produce (e.g., if a firm produces and

[20] Those 8 countries are: Botswana, Chile, the Dominican Republic, Guatemala, Mexico, Macedonia, Pakistan and El Salvador.

[21] The only scenario under which this assumption would be wrong is if the firm only begun to have the capacity (through access to machinery, type of land, other inputs, etc.) to produce product *k* in year *t* not in year *t-1* or if the firm did not exist in year *t-1*.

exports tropical fruits it is unlikely that the firm can also produce and export wheat or maize which require completely different environmental conditions to grow).[22]

Our choice is therefore to expand the initial dataset along a dimension that retains computational feasibility, does not require implausible assumptions about the firms' export choice set, and allows us to exploit an interesting type of variability in the data. We expand the initial dataset so that each firm-product-destination has an observation (a row) in all of that exporting country's sample years, with a 0 export value in a year when exports by the firm-product-destination are not occurring. Setting up the expanded dataset in this way and including a specific type of fixed effects - discussed in Section 4 - allows us to exploit the panel variation in the firms' decisions to export, enter or exit a product-destination market as pesticide standards change over time. Using this expanded dataset, we define:

- a firm export participation dummy $p_{c,i,k,d,t}$ as being equal to 1 in year *t* if firm *i* from country *c* exports a positive value of product *k* to destination *d*, and being equal to 0 otherwise;
- a dummy for firm entry into a product-destination market $e_{c,i,k,d,t}$ as being equal to 1 if firm *i* exports product *k* to destination *d* in year *t* but did not do so in year *t-1*, and being equal to 0 if the firm did not export product *k* to destination *d* in year *t-1* and does not start to do so in year *t*. If the firm continues to export the product-destination market after year *t*, then the entry dummy becomes missing for years greater than *t*;[23]
- a dummy for firm exit from a product-destination market $x_{c,i,k,d,t}$ as being equal to 1 if firm *i* does not export product *k* to destination *d* in year *t* but did so in year *t-1* and being equal to 0 if the firm exported product *k* to destination *d* in year *t-1* and continues to do so in year *t*.

Firms that export to a product-destination market in every year are excluded from the entry analysis since the entry dummy is missing in all of their years) but are included in the analysis of exit and of the intensive margin of trade.[24] If a firm has positive exports to a product-destination market only in the first year of the sample (and has no exports to that product-destination market

[22] Thus we would be allowing a firm in a country to have the choice to export products that might not be feasible to grow in that country due to climate and soil conditions.

[23] We follow Koenig (2009), Koenig et al. (2010), and Mayneris and Poncet (2010) and allow for multiple export entries over the sample period for a given firm-product-destination. Multiple entries occur in cases where the firm starts exporting to a product-destination market, then stops, and then re-starts exporting to the same product-destination market.

[24] In the case of the exit decision, however, the firms that export to a market in every year and thus have a 0 in the dependent variable in every year are effectively dropped in the estimation given the specific fixed effects (exporting country-firm-product-destination) included in our specifications.

in later years of the sample), it is included in the exit analysis but not in the entry analysis because we are unable to determine whether the firm entered the product-destination market in that first year or was already exporting there previously. Alternatively, if a firm has positive exports to a product-destination market only in the last year of the sample (and has no exports to that product-destination market in previous years of the sample) it is included in the entry analysis but not in the exit analysis.

Table 2 shows for each exporting country the number of firms in our initial dataset. Cambodia has the fewest agricultural exporters with an average of 42 firms per year, whereas Mexico has close to 3,800 agricultural exporters each year. Table 2 also shows for each exporting country the number of firms in the expanded dataset, which is similar in every year as by construction each firm that appears at least once in the dataset has the possibility of exporting in every year in the country's sample period. Finally, Table 2 shows the total number of observations in the initial dataset that will be used for the intensive margin specifications and the total number of observations in the expanded dataset that will be used for the extensive margin specifications. Additional summary statistics on the sample of exporting countries are provided in Appendix B.

4. Empirical Framework

To examine the effects of pesticide standards imposed by importing countries on firms' export behavior in developing countries exploiting the panel dimension, we consider the three following specifications each relying on a different measure of standards' restrictiveness:

$$(2)\quad Y^1_{c,i,k,d,t} = \alpha + \beta_1 * Rel\_number_{c,k,d,t} + \gamma * tariff_{c,k,d,t} + \delta * \boldsymbol{Z}_{c,i,k,d,t} + I_{c,i,k,d} + I_t + \varepsilon^{11}_{c,i,k,d,t}$$

$$(3)\quad Y^1_{c,i,k,d,t} = \alpha + \beta_2 * Rel\_MRL_{c,k,d,t} + \gamma * tariff_{c,k,d,t} + \delta * \boldsymbol{Z}_{c,i,k,d,t} + I_{c,i,k,d} + I_t + \varepsilon^{12}_{c,i,k,d,t}$$

$$(4)\quad Y^1_{c,i,k,d,t} = \alpha + \beta_3 * Rel\_restrictiveness_{c,k,d,t} + \gamma * tariff_{c,k,d,t} + \delta * \boldsymbol{Z}_{c,i,k,d,t} + I_{c,i,k,d} + I_t + \varepsilon^{13}_{c,i,k,d,t}$$

where the dependent variable Y^1 is either export participation, entry, or exit at the exporting country-firm-product-destination-year level defined based on the expanded dataset or log export value or log export quantity at the exporting country-firm-product-destination-year level defined

based on the initial dataset. The variables $Rel\_number_{c,k,d,t}$, $Rel\_MRL_{c,k,d,t}$, and $Rel\_restrictiveness_{c,k,d,t}$ are defined in Section 3.2, $\text{tariff}_{\text{c,k,d,t}}$ is the log of 1 plus the bilateral tariff imposed by the importing country on products from the exporting country taken from the WITS-TRAINS database, and ε^{11}, ε^{12}, and ε^{13} are independent and identically distributed (i.i.d.) residuals.[25] The vector $\boldsymbol{Z}_{c,i,k,d,t}$ includes GDP per capita of the exporting country and of the destination country in all specifications and additional firm characteristics and other variables as will be described in Section 5.[26] A key remark on Equations (2)-(4) concerns the stringent exporting country-firm-product-destination fixed effects $I_{c,i,k,d}$ that are included and account for unobserved heterogeneity at that very finely disaggregated level, in addition to the year fixed effects I_t also included. The coefficients of interest β_1, β_2, and β_3 are thus identified based on *within* exporting country-firm-product-destination changes in export participation, export value, export quantity, entry, or exit as pesticide standards change over time in the importing country relative to the exporting country for that product.

In the context of recent trade models with heterogeneous firms, conforming to regulatory standards in an importing country may constitute either a fixed entry cost to penetrate that destination market or a variable trade cost that needs to be incurred every time the firm exports to that market. Those models predict that fixed trade costs affect a firm's decision of whether to export to a destination but do not affect the firm's value of exports to that destination, whereas variable trade costs affect both margins of firm exports.[27] Those models do not indicate what role the stringency of pesticide standards in the exporting country may play but the rest of the literature discussed in Sections 1 and 2 suggest that that the more stringent are the importing country's standards relative to the exporting country's standards, the harder and costlier it will be for exporting firms to meet the foreign standards. Thus, the important hypotheses to test in our empirical framework are whether an increase in the stringency of pesticide standards in an

[25] Simple average applied tariffs are used for importing country-exporting country pairs for each product and year available in the WITS-TRAINS (Trade Analysis and Information System) database. We interpolate observations to fill in missing years. For cases where applied tariff data is not available for a given importing country-exporting country-product-year cell we replace the missing values with Most Favored Nation (MFN) tariffs of the importing country-product-year or with preferential tariffs of the given importing country-exporting country-product-year for importing country-exporting country pairs which have a preferential tariff agreement. In the export participation regression in Section 4.2 we lose approximately 13,600 observations (3%) due to the inclusion of tariffs in the regression as tariff data is missing for 21 agricultural products.

[26] GDP per capita data is obtained for all countries from the World Development Indicators (WDI) database.

[27] These findings are derived in the trade models where firm heterogeneity takes the form of a Pareto distribution for firm productivity.

importing country relative to an exporting country hampers that exporting country's firms' export participation and entry decisions and fosters that exporting country's firms' exit decisions.[28] If relatively more stringent pesticide standards in a destination market increase firms' variable trade costs to that market, then they would in principle lead to a reduction in firms' export values (or quantities). But if higher fixed entry costs ensuing from those standards reduced entry into that destination market, incumbent firms' export values (or quantities) could actually increase. Hence the effect of pesticide standards on the firms' intensive margin of exports is theoretically ambiguous.

Table 3 displays summary statistics for all dependent variables on firm export behavior as well as for our three measures of relative restrictiveness of pesticide standards.

5. Main Results

5.1 Baseline Results on Export Decisions and Pesticide Standards

Tables 4 and 5 present the baseline results from estimating Equations (2)-(4). Inference is based on Huber-White standard errors robust to heteroskedasticity clustered by exporting country-importing country-product-year since the specifications explain firm export behavior with more aggregate pesticide standards measures (Moulton, 1990). For the export participation, export entry and exit decisions a linear probability model is used since traditional probit models cannot be estimated with the panel-type of fixed effects considered and for the export value and export quantity regressions OLS estimation is also used. The use of linear probability models for the export participation, entry, and exit decisions follows the study by Bernard and Jensen (2004) but has the shortcoming that the predicted probabilities may not be meaningful since they can lie outside of the [0,1] range and thus the magnitude of the effects of the regressors on the export decisions cannot be assessed.

Table 4 shows the estimated effects of pesticide standards on the extensive margin of trade, firms' export participation decisions as well as firms' decisions to enter and/or exit specific product-destination markets. The estimates in columns (1)-(3) suggest a lower probability of exporting for a firm when importing country standards are more restrictive than

[28] A corollary is that exporting firms whose countries have more stringent pesticide standards should have easier access to destinations with less stringent standards.

exporting country standards. The coefficients on both *Rel_number* and *Rel_restrictiveness* are negative and statistically significant. The coefficient on *Rel_MRL* is insignificant.

Columns (4)-(6) of Table 4 show that firms' decision to start exporting a product to a new destination market are influenced by the pesticide standards that regulate that market, relative to those that regulate their domestic market. The coefficients on both *Rel_MRL* and *Rel_restrictiveness* are negative and statistically significant. More restrictive standards in the importing country decrease the likelihood that a firm from an exporting country with laxer standards enters that market. There are several reasons why this is the case. First, the asymmetry of information that new exporters to a market suffer from, relative to domestic producers or incumbent exporters, constitutes an additional cost to potential exporters that need to collect the information on the regulations imposed across foreign markets. Second, pesticide standards vary greatly from country to country and producers need to adapt production methods to meet the standards imposed by each destination market. Furthermore, stricter standards are likely to be harder to meet and thus to require a greater investment by producers in order to comply. As our results show, stricter standards in importing countries relative to exporting countries result in fewer producers attempting to enter those importing countries' markets.

Columns (7)-(9) of Table 4 show how pesticide standards affect firms' decisions to stop exporting a product to a destination market. Counterintuitively, our results show that stricter standards in the importing country relative to the exporting country are associated with a lower likelihood that an exporter will exit that market but neither of the coefficients is statistically significant. Our prediction was that as the stringency of standards increases firms would stop exporting to the market as many would not be able to comply with that change in standards. Some potential rationales for our counterintuitive (though insignificant) findings are that incumbent exporters to a market may receive the necessary information regarding changes in regulations in a timely manner so as to be able to adjust their production process in order to comply with the new regulation without having to stop exports or being denied entry at the border for not meeting the adequate standards. It is also possible that because more restrictive standards deter entry, incumbent exporters enjoy lower competition and are able to pass-through the cost of regulatory compliance onto consumers and avoid exit. We will, however, see in Section 6 that this counterintuitive finding is not robust.

Table 5 shows the results for the intensive margin of trade, which should be interpreted as the effect of pesticide standards on exports, conditional on there being positive exports. The estimates in columns (1)-(3) show that more restrictive standards imposed by the importing country relative to the exporting country are associated with higher firm export values, but the coefficients are all insignificant. The estimates in columns (4)-(6) show that stricter importing country standards relative to the exporting country's standards are associated with lower firm export volumes (quantities). The effect of *Rel_number* negative and statistically significant but our preferred *Rel_restrictiveness* measure has an insignificant effect. The opposite effect of pesticide standards on export values compared to export volumes can be explained by standards having a positive effect on price. More stringent standards imposed by the importing country can result in higher quality products being imported, which would be reflected in higher prices and in higher values even though volumes could remain unchanged or even possibly decrease. In unreported regressions, we tested whether such an effect exists on firm unit values (prices) and found that the effect of standards was positive but insignificant.[29]

5.2 Further Results on Export Entry and Pesticide Standards

In this section we explore the mechanisms that may lie behind the effects of product standards on firms' decisions to enter a new product-destination market, focusing on firm characteristics and network effects. Trade models with heterogeneous firms suggest that trade policies or regulations may affect firms' export performance differentially depending on firms' characteristics. The impact of product standards on firm export decisions may depend on firm size, which is likely to be associated with firm productivity, and hence with the firm's ability to overcome additional costs to export. In that case relatively more restrictive importing country product standards could have a greater detrimental impact on small exporters.

Network effects may also play a role, i.e., the presence of other firms from the same exporting country in a given destination may alleviate the negative impact of product standards on export entry. A first network effect may occur as firms from a given exporting country receive information—including on product standards— about possible product-destination markets through firms already established in those markets. A second network effect may occur when foreign buyers or distribution networks in an importing country attempt to expand imports

[29] Those regressions are available from the authors upon request.

to levels that previous exporters alone are unable to meet, and hence new firms are approached to export to that destination. A third possible spillover effect of incumbent exporters on potential entrants is through the availability of inputs in the domestic market, such as replacement pesticides for banned ones or the necessary human capital and/or know-how to implement new production methodologies to meet more stringent foreign standards.

Table 6 shows the results from estimating several variants of Eq. (4) where the measure *Rel_restrictiveness* enters by itself but also interacted with a measure of firm size and with proxies for network effects, and where both firm size and the proxies for network effects also enter by themselves. Column (1) shows the results exploring just the role of firm size, which is measured by the firm's total agricultural exports, $Agro\_exports_{c,i,t-1}$, to all of its destinations including those for which we do not have MRL data and thus are not part of our sample of importing countries.[30] The coefficient on *Rel_restrictiveness* is negative and significant as in Table 4, indicating that stricter pesticide standards in the importing country relative to the exporting country reduce the likelihood of a firm entering that product-destination market, even after controlling for firm size. Also, all else equal larger firms are more likely to enter a new product-destination market than smaller ones. Finally, our main coefficient of interest on the interaction between *Rel_restrictiveness* and firm size is positive and significant indicating that larger exporters are less negatively impacted by the stringency of pesticide standards. This is consistent with the empirical evidence that larger exporters tend to be more productive and thus are able to absorb higher costs related to compliance with foreign product standards. Hence, the size of the firm appears to be a direct channel through which the relative restrictiveness of standards affects a firm's decision to export to a new market.

Columns (2) and (3) show the results exploring the role of the network effects, proxied either by the number of firms from the same country as firm *i* that export (any) agricultural products to each destination in year *t-1*, $Number\_agro\_firms_{c,d,t-1}$ in column (2) or by the number of firms from the same country exporting the same HS 6-digit product *k* to the same destination as firm *i* in year *t-1*, $Number\_prod\_firms_{c,d,k,t-1}$ in column (3).[31] The estimates show that firms are

[30] Firm size is obtained as the sum of total agricultural exports in HS chapters 06-24 with the exception of chapters 15 and 16. Specifically, the variable that enters the regressions is $ln(Agro\_exports_{c,i,t-1})$ where the one-year lag of firm size is used to allow for a firm's past performance to affect current export decisions. In unreported results we measured firm size as the sum of exports in all HS chapters and obtained qualitatively similar results.

[31] Specifically, the variables that enter the regressions are $ln(1+Number\_agro\_firms_{c,d,t-1})$ and $ln(1+Number\_prod\_firms_{c,d,k,t-1})$.

more likely to enter a new destination where more firms are already selling agricultural products or where more firms are selling the exact same product (though only the latter coefficient is statistically significant). The coefficient on *Rel_restrictiveness* is negative significant in column (3). The coefficient on interaction term between *Rel_restrictiveness* and *Number_agro_firms* is negative in column (2) suggesting that the greater the number of exporters of agricultural products to a given destination the more negative is the effect of restrictive standards of the importing country on entry into that destination. The interaction term between *Rel_restrictiveness* and *Number_prod_firms* in column (3) shows that the effect of stricter standards on the likelihood of entry into a new market does not vary significantly with the number of exporters of the same product to the same destination. These results provide evidence of positive network effects for a firm's decision to start exporting to a new destination but that the network effect does not appear to be a channel that helps firms overcome the regulatory impediments of restrictive standards in a new destination market. Even after controlling for network effects the stringency of an importing country's product standards continues to significantly hinder the entry of new exporters into that market.

5.3 Further Results on Export Exit and Pesticide Standards

In this section we explore whether product standards impact the decision of a firm to stop exporting to a destination where it previously sold its agricultural products differentially depending on firm size, the product's importance for firm total exports, or the destination's importance for firm total exports. The rationale behind the consideration of the product's importance is that a firm which derives most of its export revenue from one product is more likely to incur in the costs necessary to comply with changes in standards in order to sustain its main source of revenue. In contrast, a firm which sells multiple products is more likely to stop exporting a product that is not important for its overall export portfolio if it is more costly to comply with changes in standards due to the small scale of production. A similar rationale applies to the destination market's importance in the firm's total exports.

Table 7 shows the results from estimating several variants of Eq. (4) where the measure *Rel_restrictiveness* enters by itself but also interacted with the measure of firm size, $Agro\_exports_{c,i,t-1}$, and measures of the importance in the firm's total agricultural exports of the

product, $Product\_share_{i,k,t-1}$, or the destination, $Destination\_share_{c,i,d,t-1}$, and where both firm size as well as the measures of the importance of the product and destination in total exports also enter by themselves. Column (1) explores the role of firm size for the decision to exit a product-destination market. In contrast to what was shown in the baseline estimates in Table 4, once firm size is controlled for, the coefficient on *Rel_restrictiveness* is positive and significant, indicating that firms are more likely to stop exporting a product to a destination that has relatively more restrictive standards than their domestic market. The coefficient on firm size shows that larger firms are less likely to exit their export markets. The interaction term between *Rel_restrictiveness* and firm size has a negative and significant coefficient indicating that larger firms are less likely to exit a product-destination market due to the relative restrictiveness of that importing country's pesticide standards.

Column (2) explores the importance of the product in the firm's total agricultural exports. Our estimates show that firms are less likely to stop exporting a product to a given destination if the product accounts for a larger share of their export portfolio. The interaction term between *Rel_restrictiveness* and *Product_share* has a negative and significant coefficient, suggesting that the exit-inducing effect of more stringent pesticide standards is less severe for the agricultural products that account for a larger share of firms' export portfolios.

Column (3) explores the importance of the destination in the firm's total agricultural exports. The results suggest that the more important is a given destination to a firm, the less likely is the firm to stop exporting to that market. The interaction term between *Rel_restrictiveness* and *Destination_share* has a negative and significant coefficient and the coefficient on *Rel_restrictiveness* remains positive and significant.

Column (4) presents the results from a specification which controls for firm size, product share, destination share, as well as the interaction between each of these variables and the *Rel_restrictiveness* measure. The coefficient on *Rel_restrictiveness* is positive and significant and that on firm size is negative and significant, indicating that larger firms are less likely to exit. The importance of the product or the destination market for firms' total agricultural exports continue to be negatively linked to the firms' decision to exit. Firm size as well as the importance of the product or destination are all channels by which the relative importing country restrictiveness of pesticide standards affects the firms' decision to exit.

6. Robustness Results

In this section we describe a number of robustness checks to our results. We re-estimate the export participation, entry, and exit regressions including interactions with firm size for three variants of the sample. The first set of regressions whose results are shown in columns (1)-(3) of Table 8 restricts the sample of importing countries and exporting countries to be only those countries that draft specific MRL regulations, that is, the sample excludes the countries that use solely Codex standards as their own regulations. The effect of the importing country's relative restrictiveness of standards on firm export participation and entry into new destinations is negative and significant while the effect on firm export exit is positive and significant. The coefficient on the interaction between *Rel_restrictiveness* and firm size is significant in all specifications suggesting that the effect of pesticide standards on a firm's export decisions depends on firm size. Smaller firms are more negatively affected by the relative stringency of importing country standards than larger firms. The second set of regressions whose results are shown in columns (4)-(6) of Table 8 restricts the sample in terms of the years covered, keeping only the years 2006-2009 and thus addressing the fact that only 8 out of 20 countries in our sample have data for year 2010, as seen in Table 2. Again, the results show that the relative restrictiveness of standards of the importing country negatively impacts a firm's decision to export and firm size determines how much the standards affect the firm's decision. The third set of regressions whose results are shown in columns (7)-(9) of Table 8 restricts the sample of products to those belonging to HS chapters 7 and 8 (edible vegetable and edible fruits). The match on MRL standards obtained from Homologa database was better for these two HS chapters. Again the results are qualitatively maintained.

Table 9 shows the results of another set of robustness checks using newly constructed relative restrictiveness index measures that use only the MRLs for which countries have specific regulations, that is, that ignore any MRLs that are used as a deferral or a default MRL. The results are consistent with those in Section 5. Columns (1) and (2) show that restrictive importing country standards relative to exporting country standards according to the new *Rel_restrictiveness* are associated with both a significantly lower probability of observing positive firm exports as well as with significantly lower entry of firms into new markets. In both regressions the interaction term between the new *Rel_restrictiveness* and firm size has a positive and significant coefficient suggesting that the importing country's relative restrictiveness is less

of a hurdle for entry for larger exporters than it is for smaller exporters. Column (5) shows that relatively more stringent importing country standards according to the new *Rel_restrictiveness* are associated with a higher likelihood of firm exit. The results again suggest that smaller exporters are at a disadvantage as they are more likely to exit a market than larger exporters due to the stringency of standards regulations. Finally, columns (1) and (2) show that the effect of the new *Rel_restrictiveness* measure is negative but insignificant on the intensive margin of firm exports.

We conduct one final robustness check in which we exploit the variability across destinations rather than the variability across time as in the main results and previous robustness checks. For this purpose we construct a different version of the expanded dataset so that each firm-product-year has an observation (a row) in all destinations possible (i.e., those with pesticide standards data to which some firm in the sample exports) with a 0 export value in the destinations to which exports by the firm-product-year are not occurring. This expanded dataset allows us to exploit the cross-destination variation in the firms' decisions to export a product as pesticide standards differ across destinations, relative to the pesticide standards in the exporting country. The important difference in the specifications considered for this expanded dataset — relative to those in Equations (2)-(4) — is the set of fixed effects considered. Here we include exporting country-firm-product-year fixed effects thus the coefficients on pesticide standards are identified based on *within* exporting country-product-year differences in export participation as pesticide standards differ across destination countries, relative to the exporting country. Table 10 presents the results from the regressions with standard errors robust to heteroskedasticity clustered by exporting country-importing country-product-year.[32] The regressions control for exporting-country-importing country fixed effects as a flexible way of accounting for bilateral gravity-type country characteristics. The coefficient on the *Relative_restrictiveness* measure is negative and statistically significant in the firm export participation regression as identified in our main results, whereas the coefficients are not statistically significant in the firm intensive margin regressions.[33]

[32] The measures of the restrictiveness of pesticide standards used in these regressions are the same as used in the baseline specifications.

[33] In unreported results where we include instead of the exporting-country-importing country fixed effects traditional gravity controls (such as distance, whether two countries share a border, have the same official language, had a former colonial relationship and are signatories to a preferential trade agreement) we obtain qualitatively similar (though weaker) results.

7. Conclusion

This paper examines the importance of standards' regulations in influencing the ability of firms in developing countries to exploit export opportunities for agricultural and food products in foreign markets. Our evidence shows that the relative restrictiveness of importing country pesticide standards restricts market access for exporting firms from developing countries. Importantly, our findings suggest an insignificant effect of restrictive importing country standards on the firm intensive margin of exports but we find that standards significantly depress the firm extensive margin. Our results are consistent with recent trade models which predict that only the most productive firms are able to overcome the fixed costs of exporting. Obtaining information on foreign regulations and adjusting production processes in order to comply with foreign standards are likely to increase the fixed costs to reach foreign markets. This is why the negative effect of the importing country's relative standards restrictiveness on firm entry is specially felt on smaller firms.

The international community has attempted to overcome the trade-distortive effects of standards through the WTO SPS Agreement and other trade tools. This has included decades of discussion about the benefits of harmonization of standards, use of international consensus standards through international bodies such as Codex, and potential cost of domestic standards that deviate from international norms. Limited progress has been made, however in these various steps to mitigate the negative affect of discriminatory or duplicative national standards. Moreover, a number of developing countries lack access to compliance resources, including scientific and technical expertise, information and finance to exploit the opportunities offered in various trade agreements.

Looking ahead, it is important that new trade talks consider and address the channels through which NTMs affect trade. SPS standards, including MRLs, continue to be developed by national governments, in some cases. Furthermore, the development of new and deeper trade agreements in which NTMs are included—which is likely to be the case of a US-EU agreement—will greatly impact third-country firms that cannot meet the new agreed-upon standards.

New research on standards and trade can deepen the understanding of the effects NTMs on trade, including expanding analysis into the manufacturing sector using measures that account not only for the number of standards but also for their stringency, as we have in this

paper with standards for agricultural products. In addition, while our work here has focused on the impact of "de jure" regulations, the implementation of these regulations at ports and border crossing points may or may not be fully enforced by the importing country's authorities. This question is outside the scope of the current analysis and is left for future work.

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Table 1. Number of Products Regulated by Pesticide Standards by Importing Country

	Number of Specific Products Regulated					Number of Products Regulated or With Default MRL				
	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
Argentina	102	110	110	110	115	214	219	232	240	242
ASEAN	-	-	102	102	102	-	-	147	148	149
Australia	139	154	155	152	152	139	154	155	152	152
Brazil	59	66	66	72	73	147	152	141	145	149
Canada	118	142	157	160	161	214	219	232	240	242
Chile	146	149	136	136	138	146	149	136	137	142
China	87	87	87	43	43	87	87	87	43	43
Codex	146	149	136	137	140	146	149	136	137	140
Colombia	-	136	136	136	136	-	149	136	137	140
Dominican Republic	146	149	136	137	140	183	192	191	191	192
Egypt	-	-	-	136	136	-	-	-	240	242
European Union	-	-	125	135	136	-	-	232	240	242
Honduras	146	149	136	137	140	183	192	191	191	192
India	-	134	149	105	105	-	149	150	151	151
Israel	93	87	87	87	87	149	152	139	140	143
Japan	129	117	115	119	116	214	219	232	240	242
South Korea	92	92	100	98	100	92	92	100	98	100
Malaysia	42	86	86	84	84	214	219	232	240	242
Mexico	66	66	72	67	67	167	184	182	180	181
Morocco	146	149	136	137	140	146	149	171	175	177
New Zealand	142	109	99	86	86	214	219	232	240	242
Panama	146	149	136	137	140	183	192	203	205	206
Russia	32	95	113	112	113	32	95	113	112	113
Singapore	-	-	125	125	125	-	-	150	151	151
South Africa	89	99	99	99	99	214	219	232	240	242
Switzerland	125	127	133	133	145	125	127	147	150	146
Taiwan	68	68	75	77	77	68	68	75	77	77
Thailand	102	102	102	102	102	154	157	149	150	153
Turkey	103	103	103	98	137	103	103	134	137	138
Ukraine	-	-	-	114	114	-	-	-	114	114
United States	166	183	180	180	181	166	183	180	180	181
Total	214	219	232	240	242	214	219	232	240	242

Note: - indicates that the country does not have data for that particular year.

Table 2. Number of Firms and Observations by Exporting Country

	Number of Exporting Firms by Exporting Country-Year					Number of Observations		
	Initial Dataset					Initial Dataset	Time-Series Expanded Dataset	
	2006	2007	2008	2009	2010	Across All Years	Per Year	Across All Years
Burkina Faso	95	133	138	111	129	1315	339	4060
Bangladesh	390	324	413	349	363	4807	1,148	14,332
Botswana	101	108	118	133	125	1783	292	4616
Chile	986	1,001	1,053	1,067	-	27901	1,685	40,530
Cameroon	119	116	213	163	-	1369	446	3270
Colombia	-	832	777	728	-	7793	1,266	14,178
Dominican Republic	350	722	522	614	-	14451	1,324	28,452
Ecuador	434	463	496	555	-	6981	886	11655
Kenya	811	614	665	706	-	7067	1,579	13,905
Cambodia	35	45	39	49	-	326	125	795
Morocco	635	641	643	663	691	11586	1,399	24,080
Mexico	4,242	3,595	3,681	3,792	-	43125	7,815	74,853
Nicaragua	219	220	253	250	255	4037	587	10020
Pakistan	1,119	1,137	1,252	1,516	1,551	18,844	3,084	45,744
Peru	1,008	1,028	1,083	1,150	-	15871	2,047	28,194
Senegal	129	128	118	122	133	1442	294	3884
El Salvador	200	194	202	227	-	2628	336	4020
Tanzania	205	211	232	273	-	2529	493	5016
Uganda	-	194	180	187	250	2358	413	6008
South Africa	1,439	1,428	1,475	1,473	-	58133	2,839	94,338
Total	12,517	13,134	13,553	14,128	3,497	234,346	28,397	431,950

Note: - indicates that the exporting country does not have data for that particular year.

Table 3. Summary Statistics

	Number of Observations	Mean	Std. Dev.	Minimum	Maximum
Export Participation Dummy	740,155	0.41	0.49	0	1
Entry Dummy	336,630	0.33	0.47	0	1
Exit Dummy	225,148	0.47	0.50	0	1
Log Export Value	304,910	9.00	3.36	-4.61	21.01
Log Export Quantity	172,957	8.16	3.71	-6.91	20.20
Rel_number	447,179	-0.42	2.42	-6.59	6.44
Rel_MRL	276,550	-0.24	1.78	-9.80	10.13
Rel_restrictiveness	447,179	-0.07	0.47	-1	1

Note: log export value or quantity are at the exporting country-firm-product-destination-year level defined based on the initial dataset whereas export participation, entry, or exit are at the exporting country-firm-product-destination-year level based on the expanded dataset.

Table 4. Results from Estimation of Firm Export Participation, Entry, and Exit Specifications

	Dependent Variable:								
	Export Participation Dummy$_{c,i,k,d,t}$	Export Participation Dummy$_{c,i,k,d,t}$	Export Participation Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rel_number$_{c,k,d,t}$	-0.003			-0.003			-0.003		
	[0.001]***			[0.003]			[0.002]		
Rel_MRL$_{c,k,d,t}$		0.000			-0.02			-0.012	
		[0.003]			[0.008]**			[0.007]	
Rel_restrictiveness$_{c,k,d,t}$			-0.026			-0.031			-0.014
			[0.008]***			[0.016]**			[0.015]
Tariff$_{c,k,d,t}$	-0.01	-0.012	-0.01	-0.018	-0.023	-0.018	0.016	0.013	0.016
	[0.004]**	[0.004]***	[0.004]**	[0.010]*	[0.013]*	[0.010]*	[0.009]*	[0.013]	[0.009]*
GDP per capita$_{d,t}$	0.042	0.002	0.039	0.071	-0.204	0.07	-0.192	-0.355	-0.188
	[0.021]**	[0.027]	[0.020]*	[0.059]	[0.087]**	[0.058]	[0.056]***	[0.083]***	[0.056]***
GDP per capita$_{c,t}$	0.093	0.104	0.094	-0.341	-0.216	-0.338	-0.219	-0.248	-0.227
	[0.025]***	[0.030]***	[0.024]***	[0.073]***	[0.106]**	[0.071]***	[0.082]***	[0.113]**	[0.081]***
Exporting Country-Firm-Importing Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Efects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	427,685	264,891	427,685	189,388	123,831	189,388	135,126	89,608	135,126
R-squared	0.305	0.366	0.305	0.36	0.437	0.36	0.801	0.82	0.801

Notes: Robust standard errors in parentheses, clustered at the exporting country-importing country-product-year level. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. Dependent variables are defined as follows: export participation equals one if there is positive trade between countries or zero otherwise; entry equals to one if firm *i* exports product *k* to destination *d* in year *t* but did not do so in year *t-1* and being equal to zero if the firm did not export product *k* to destination *d* in year *t-1* and does not start to do so in year *t*. Similarly, exit equals to one if firm *i* does not export product *k* to destination *d* in year *t* but did so in year *t-1* and equals zero if the firm exported product *k* to destination *d* in year *t-1* and continues to do so in year *t*. Tariffs enter as the log of 1 plus the tariff rate and GDP per capita of the exporting country and of the destination country also enter in logs.

Table 5. Results from Estimation of Firm Export Value and Quantity Specifications

	Dependent Variable:					
	Log Export Value$_{c,i,k,d,t}$	Log Export Value$_{c,i,k,d,t}$	Log Export Value$_{c,i,k,d,t}$	Log Export Quantity$_{c,i,k,d,t}$	Log Export Quantity$_{c,i,k,d,t}$	Log Export Quantity$_{c,i,k,d,t}$
	(1)	(2)	(3)	(4)	(5)	(6)
Rel_number$_{c,k,d,t}$	0.006			-0.012		
	[0.005]			[0.005]**		
Rel_MRL$_{c,k,d,t}$		0.012			-0.003	
		[0.016]			[0.017]	
Rel_restrictiveness$_{c,k,d,t}$			0.047			-0.025
			[0.032]			[0.034]
Tariff$_{c,k,d,t}$	-0.033	-0.011	-0.033	-0.035	-0.037	-0.031
	[0.018]*	[0.026]	[0.018]*	[0.023]	[0.033]	[0.023]
GDP per capita$_{d,t}$	0.406	0.462	0.409	-0.274	-0.249	-0.232
	[0.119]***	[0.168]***	[0.119]***	[0.132]**	[0.196]	[0.130]*
GDP per capita$_{c,t}$	0.045	0.129	0.05	-0.754	-0.675	-0.831
	[0.138]	[0.190]	[0.136]	[0.152]***	[0.241]***	[0.149]***
Exporting Country-Firm-Importing Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,076	112,612	181,076	99,242	54,181	99,242
R-squared	0.951	0.957	0.951	0.958	0.966	0.958

Note: Robust standard errors in parentheses, clustered at the exporting country-importing country-product-year level. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. Tariffs enter as the log of 1 plus the tariff rate and GDP per capita of the exporting country and of the destination country also enter in logs.

Table 6. Results from Estimation of Firm Size and Network Effects in Firm Export Entry Specifications

	Dependent Variable:		
	Export Entry Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$
	(1)	(2)	(3)
Rel_restrictiveness$_{c,k,d,t}$	-0.284	-0.092	-0.316
	[0.050]***	[0.082]	[0.054]***
Agro_exports$_{c,i,t-1}$	0.065	0.065	0.064
	[0.003]***	[0.003]***	[0.003]***
Rel_restrictiveness$_{c,k,d,t}$ X Agro_exports$_{c,i,t-1}$	0.019	0.018	0.019
	[0.004]***	[0.004]***	[0.004]***
Number_agro_firms$_{c,d,t-1}$		0.029	
		[0.027]	
Rel_restrictiveness$_{c,k,d,t}$ X Num_agro_firms$_{c,d,t-1}$		-0.032	
		[0.011]***	
Number_product_firms$_{c,d,\ k,\ t-1}$			0.081
			[0.011]***
Rel_restrictiveness$_{c,k,d,t}$ X Num_product_firms$_{c,d,k,t-1}$			0.011
			[0.010]
Tariff$_{c,k,d,t}$	-0.014	-0.015	-0.012
	[0.011]	[0.011]	[0.011]
GDP per capita$_{d,t}$	0.209	0.188	0.203
	[0.061]***	[0.061]***	[0.060]***
GDP per capita$_{c,t}$	-0.302	-0.327	-0.316
	[0.081]***	[0.082]***	[0.081]***
Exporting Country-Firm-Importing Country Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Observations	105,961	105,961	105,961
R-squared	0.452	0.452	0.453

Notes: Robust standard errors in parentheses, clustered at the exporting country-importing country-product-year level. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The dependent variable is defined as follows: entry equals to one if firm *i* exports product *k* to destination *d* in year *t* but did not do so in year *t-1* and being equal to zero if the firm did not export product *k* to destination *d* in year *t-1* and does not start to do so in year *t*. Tariffs enter as the log of 1 plus the tariff rate and GDP per capita of the exporting country and of the destination country as well as firm *i* total agricultural exports, the number of firms from country *c* that export (any) agricultural products to destination *d*, and the number of firms from country *c* that export product *k* to destination *d* also enter in logs.

Table 7. Results from Estimation of Firm Size and Network Effects in Firm Export Exit Specifications

	Dependent Variable:			
	Export Exit Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$
	(1)	(2)	(3)	(4)
Rel_restrictiveness$_{c,k,d,t}$	0.416	0.390	0.436	0.410
	[0.056]***	[0.058]***	[0.057]***	[0.058]***
Agro_exports$_{c,i,t-1}$	-0.082	-0.084	-0.084	-0.086
	[0.004]***	[0.004]***	[0.004]***	[0.004]***
Rel_restrictiveness$_{c,k,d,t}$ X Agro_exports$_{c,i,t-1}$	-0.031	-0.031	-0.033	-0.033
	[0.004]***	[0.004]***	[0.004]***	[0.004]***
Product_share$_{c,i,k,t-1}$		-0.030		-0.028
		[0.003]***		[0.003]***
Rel_restrictiveness$_{c,k,d,t}$ X Product_share$_{c,i,k,t-1}$		-0.006		-0.006
		[0.003]*		[0.003]*
Destination_share$_{c,i,d,t-1}$			-0.034	-0.030
			[0.004]***	[0.005]***
Rel_restrictiveness$_{c,k,d,t}$ X Destination_share$_{c,i,d,t-1}$			-0.010	-0.009
			[0.005]*	[0.005]*
Tariff$_{c,k,d,t}$	0.014	0.013	0.012	0.012
	[0.009]	[0.009]	[0.009]	[0.009]
GDP per capita$_{d,t}$	-0.178	-0.17	-0.207	-0.203
	[0.055]***	[0.054]***	[0.057]***	[0.056]***
GDP per capita$_{c,t}$	-0.202	-0.195	-0.277	-0.278
	[0.080]**	[0.081]**	[0.092]***	[0.092]***
Exporting Country-Firm-Importing Country Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	135,126	135,126	135,126	135,126
R-squared	0.806	0.807	0.807	0.808

Notes: Robust standard errors in parentheses, clustered at the exporting country-importing country-product-year level. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The dependent variable is defined as follows: exit equals to one if firm *i* does not export product *k* to destination *d* in year *t* but did so in year *t-1* and equals zero if the firm exported product *k* to destination *d* in year *t-1* and continues to do so in year *t*. Tariffs enter as the log of 1 plus the tariff rate and GDP per capita of the exporting country and of the destination country as well as firm *i* total agricultural exports, the share of product *k* in firm *i* total agricultural exports and the share of destination *d* in firm *i* total agricultural exports also enter in logs.

Table 8. Results from Robustness Checks – Restricted Samples

	Dependent Variable:								
	Export Participation Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$	Export Participation Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$	Export Participation Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$
	Destination-Restricted Sample			Year-Restricted Sample			Product-Restricted Sample		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Rel_restrictiveness$_{c,k,d,t}$	-0.112	-0.318	0.441	-0.142	-0.292	0.45	-0.136	-0.274	0.449
	[0.029]***	[0.078]***	[0.054]***	[0.022]***	[0.048]***	[0.045]***	[0.031]***	[0.069]***	[0.057]***
Agro_exports$_{c,i,\ t-1}$	0.027	0.068	-0.073	0.033	0.069	-0.085	0.033	0.068	-0.084
	[0.003]***	[0.006]***	[0.004]***	[0.002]***	[0.004]***	[0.004]***	[0.003]***	[0.005]***	[0.004]***
Rel_restrictiveness$_{c,k,d,t}$ X Agro_exports$_{c,i,t-1}$	0.008	0.022	-0.035	0.009	0.02	-0.033	0.008	0.018	-0.033
	[0.002]***	[0.006]***	[0.004]***	[0.002]***	[0.004]***	[0.003]***	[0.002]***	[0.005]***	[0.004]***
Tariff$_{c,k,d,t}$	0.006	0.02	0.02	-0.004	-0.007	0.017	-0.004	-0.005	0.022
	[0.008]	[0.026]	[0.018]	[0.005]	[0.012]	[0.009]*	[0.006]	[0.016]	[0.014]
GDP per capita$_{d,t}$	0.427	0.239	-0.399	0.277	0.157	-0.2	0.252	0.128	-0.115
	[0.044]***	[0.101]**	[0.072]***	[0.032]***	[0.065]**	[0.056]***	[0.046]***	[0.100]	[0.082]
GDP per capita$_{c,t}$	0.228	-0.302	-0.256	0.224	-0.246	-0.142	0.288	-0.254	-0.195
	[0.050]***	[0.154]*	[0.100]**	[0.038]***	[0.088]***	[0.083]*	[0.053]***	[0.149]*	[0.122]
Exporting Country-Firm-Importing Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	122,855	47,258	75,597	230,300	100,477	129,823	118,750	47,998	70,752
R-squared	0.532	0.462	0.807	0.521	0.478	0.813	0.531	0.466	0.805

Notes: Robust standard errors in parentheses, clustered at the exporting country-importing country-product-year level. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. Dependent variables are defined as follows: export participation equals one if there is positive trade between countries or zero otherwise; entry equals to one if firm *i* exports product *k* to destination *d* in year *t* but did not do so in year *t-1* and being equal to zero if the firm did not export product *k* to destination *d* in year *t-1* and does not start to do so in year *t*. Similarly, exit equals to one if firm *i* does not export product *k* to destination *d* in year *t* but did so in year *t-1* and equals zero if the firm exported product *k* to destination *d* in year *t-1* and continues to do so in year *t*. Tariffs enter as the log of 1 plus the tariff rate and GDP per capita of the exporting country and of the destination country as well as firm *i* total agricultural exports also enter in logs.

Table 9. Results from Robustness Checks – Only Listed MRLs

	Dependent Variable:				
	Export Participation Dummy$_{c,i,k,d,t}$	Export Entry Dummy$_{c,i,k,d,t}$	Export Exit Dummy$_{c,i,k,d,t}$	Log Export Value$_{c,i,k,d,t}$	Log Export Quantity$_{c,i,k,d,t}$
	(1)	(2)	(3)	(4)	(5)
Rel_restrictiveness$_{c,k,d,t}$	-0.431	-0.77	0.834	-0.288	-0.097
	[0.055]***	[0.130]***	[0.116]***	[0.377]	[0.453]
Agro_exports$_{c,i,\ t-1}$	0.031	0.061	-0.079	0.024	0.053
	[0.002]***	[0.003]***	[0.004]***	[0.014]*	[0.018]***
Rel_restrictiveness$_{c,k,d,t}$ X Agro_exports$_{c,i,t-1}$	0.026	0.051	-0.061	0.015	-0.006
	[0.004]***	[0.010]***	[0.008]***	[0.027]	[0.033]
Tariff$_{c,k,d,t}$	-0.006	-0.012	0.014	-0.029	-0.026
	[0.005]	[0.011]	[0.009]	[0.019]	[0.024]
GDP per capita$_{d,t}$	0.269	0.186	-0.168	0.516	0.129
	[0.031]***	[0.062]***	[0.056]***	[0.143]***	[0.169]
GDP per capita$_{c,t}$	0.262	-0.254	-0.208	0.092	-0.93
	[0.037]***	[0.085]***	[0.082]**	[0.160]	[0.204]***
Exporting Country-Firm-Importing Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	238,463	104,739	133,724	115,473	64,875
R-squared	0.512	0.454	0.807	0.962	0.967

Notes: Robust standard errors in parentheses, clustered at the exporting country-importing country-product-year level. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The dependent variables in columns (1)-(3) are defined as follows: export participation equals one if there is positive trade between countries or zero otherwise; entry equals to one if firm *i* exports product *k* to destination *d* in year *t* but did not do so in year *t-1* and being equal to zero if the firm did not export product *k* to destination *d* in year *t-1* and does not start to do so in year *t*. Similarly, exit equals to one if firm *i* does not export product *k* to destination *d* in year *t* but did so in year *t-1* and equals zero if the firm exported product *k* to destination *d* in year *t-1* and continues to do so in year *t*. The restrictiveness index measure is calculated for each importing country and for each exporting country using only the MRLs for which countries have specific regulations, that is, ignoring any MRLs that are used as a deferral or a default MRL. Tariffs enter as the log of 1 plus the tariff rate and GDP per capita of the exporting country and of the destination country as well as firm *i* total agricultural exports also enter in logs.

Table 10. Results from Robustness Checks – Dataset Expanded on Destinations

	Dependent Variable:		
	Export Participation Dummy$_{c,i,k,d,t}$	Log Export Value$_{c,i,k,d,t}$	Log Export Quantity$_{c,i,k,d,t}$
	(1)	(2)	(3)
Rel_restrictiveness$_{c,k,d,t}$	-0.004	-0.046	-0.096
	[0.002]**	[0.134]	[0.149]
Tariff$_{c,k,d,t}$	-0.002	-0.041	-0.026
	[0.000]***	[0.025]*	[0.030]
GDP per capita$_{d,t}$	0.001	0.178	-0.082
	[0.002]	[0.256]	[0.305]
Exporting Country-Firm-Product-Year Fixed Effects	Yes	Yes	Yes
Exporting Country-Importing Country Fixed Effects	Yes	Yes	Yes
Observations	6,024,762	166,331	88,789
R-squared	0.336	0.924	0.927

Notes: Robust standard errors in parentheses, clustered at the exporting country-importing country-product-year level. ***, **, and * indicate significance at 1%, 5%, and 10% confidence levels, respectively. The dependent variable in column (1) is defined as follows: export participation equals one if there is positive trade between countries or zero otherwise; entry equals to one if firm *i* exports product *k* to destination *d* in year *t* but did not do so in year *t-1* and being equal to zero if the firm did not export product *k* to destination *d* in year *t-1* and does not start to do so in year *t*. Similarly, exit equals to one if firm *i* does not export product *k* to destination *d* in year *t* but did so in year *t-1* and equals zero if the firm exported product *k* to destination *d* in year *t-1* and continues to do so in year *t*. Tariffs enter as the log of 1 plus the tariff rate and GDP per capita of the destination country also enter in logs.

Appendix

A. Standards Database

Appendix Table A.1 - Country Standards and MRL Deferral Policies

Country	MRL Regulation	Default/Deferral Policy
AGO	CODEX	no default
ARG	own	Defers to Codex when national MRL not established. When there is no established national or Codex MRL, a default MRL of 0.01 ppm is applied.
AUS	own	no default
BEN	CODEX	no default
BFA*	CODEX	no default
BGD*	CODEX	no default
BRA	own	Defers to Codex when national MRL not established.
BWA*	CODEX	no default
CAN	own	Default MRL = 0.1
CHE	own	Switzerland defers to specified EU MRL regulations.
CHL*	own	Defers to Codex when national MRL not established.
CHN	own	no default
CIV	CODEX	no default
CMR*	CODEX	no default
COL*	own	Defers to Codex when national MRL not established.
DOM*	CODEX	Defers to US when CODEX MRL not established.
DZA	CODEX	no default
ECU*	CODEX	no default
EGY	own	Defers first to Codex, then applies EU MRLs including the 0.01 ppm default MRL if applicable. If there are no Codex or EU MRLs, then US MRLs are applied.
ETH	CODEX	no default
EU27	own	Default MRL = 0.01
GHA	CODEX	no default
GMB	CODEX	no default
HND	CODEX	Defers to US when CODEX MRL not established.
IDN	ASEAN	Defers to Codex when national MRL not established.
IND	own	Defers to Codex when national MRL not established.
ISR	own	Defers to Codex when national MRL not established.
JPN	own	Default MRL = 0.01
KEN*	CODEX	no default
KHM*	ASEAN	Defers to Codex when national MRL not established.
KOR	own	no default
LAO	ASEAN	Defers to Codex when national MRL not established.
LBY	CODEX	no default
MAR*	CODEX	Defers to EU MRLs. When there is no established Codex or EU MRL, a default MRL of 0.01 ppm is applied.
MEX*	own	U.S. MRLs are accepted in practice
MLI	CODEX	no default
MMR	ASEAN	Defers to Codex when national MRL not established.
MOZ	CODEX	no default

Appendix Table A1 - continued		
MWI	CODEX	no default
MYS	own	Defers to Codex when national MRL not established. A default MRL of 0.01 ppm applies when no national or Codex MRLs are established.
NAM	CODEX	no default
NGA	CODEX	no default
NIC*	CODEX	no default
NZL	own	Default MRL = 0.1
PAK*	CODEX	no default
PAN	CODEX	Defers fully to Codex. When there is no established Codex MRL, US and EU MRLs are compared and the lowest MRL value is accepted.
PER*	CODEX	no default
PHL	ASEAN	Defers to Codex when national MRL not established.
RUS	own	no default
SEN*	CODEX	no default
SGP	own	Defers to Codex when national MRL not established.
SLV*	CODEX	no default
THA	own	Defers to Codex when national MRL not established.
TUN	CODEX	no default
TUR	own	Defers to EU when national MRL not established.
TWN	own	no default
TZA*	CODEX	no default
UGA	CODEX	no default
UKR	own	no default
USA*	own	no default
VEN	CODEX	no default
VNM	ASEAN	Defers to Codex when national MRL not established.
ZAF*	own	Defers first to the less restrictive value established in the EU and Codex regulations. If no value exists, national South African MRLs apply. Finally, a default MRL of 0.01 ppm is accepted when no MRL is applicable.

Note: * denotes a country that is covered by our exporter-level dataset and whose exporters of agricultural and food products will be used in our empirical analysis.

Appendix Table A.2 – Number of Pesticides Regulated

	Number of Specific Pesticides Regulated					Number of Pesticides Regulated or With Default MRL				
	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
Argentina	258	263	254	254	291	863	922	945	962	964
ASEAN	-	-	61	61	63	-	-	173	181	189
Australia	320	366	373	367	370	320	366	373	367	370
Brazil	290	293	299	299	303	425	428	354	356	357
Canada	172	191	200	205	209	863	922	945	962	964
Chile	289	293	171	171	180	289	293	171	179	193
China	123	124	124	147	147	123	124	124	147	147
Codex	289	293	171	179	184	289	293	171	179	184
Colombia	-	161	171	171	171	-	293	171	179	192
Dominican Republic	289	293	171	179	184	462	490	412	414	416
Egypt	-	-	-	171	171	-	-	-	962	964
European Union	-	-	475	482	473	-	-	945	962	964
Honduras	289	293	171	179	184	462	490	412	414	416
India	-	163	239	149	149	-	293	244	248	257
Israel	287	278	280	287	291	406	401	322	332	338
Japan	607	615	611	616	606	863	922	945	962	964
South Korea	361	362	396	415	419	361	362	396	415	419
Malaysia	58	173	173	170	170	863	922	945	962	964
Mexico	217	218	260	231	231	387	418	418	404	408
Morocco	289	293	171	179	184	289	293	483	490	485
New Zealand	188	203	206	186	197	863	922	945	962	964
Panama	289	293	171	179	184	462	490	578	581	579
Russia	36	329	349	357	362	36	329	349	357	362
Singapore	-	-	105	105	105	-	-	198	206	215
South Africa	324	327	327	327	327	863	922	945	962	964
Switzerland	371	380	426	433	502	371	380	550	557	533
Taiwan	330	333	353	333	333	330	333	353	333	333
Thailand	20	20	20	20	20	289	293	172	180	187
Turkey	354	356	351	339	430	354	356	543	543	561
Ukraine	-	-	-	313	313	-	-	-	313	313
United States	342	381	368	367	372	342	381	368	367	372
Total	863	922	945	962	964	863	922	945	962	964

B. Exporter-Level Database

Each country's raw exporter-level dataset was subjected to uniform reformatting and to a series of cleaning procedures detailed in Cebeci et al. (2012). Firms are identified by their actual names, their tax identification number, or an artificial unique code randomly created by the local customs agency which allows us to create a panel of firms for each country. Regarding product nomenclatures, we use a time-consistent consolidated Harmonized System (HS) classification at the 6-digit level that concords and harmonized product codes across the HS 1996, 2002, and 2007 versions (used in the raw exporter-level datasets). Export values are Freight on Board (FOB) figures measured in USD converted from local currency to USD when necessary using exchange rates taken from the IMF's International Financial Statistics.

Appendix Table B.1 – Firm Product and Destination Diversification, Year 2009

	Exporting Firms' Number of HS 6-Digit Products				Exporting Firms' Number of Destinations			
	Mean	Median	Minimum	Maximum	Mean	Median	Minimum	Maximum
Burkina Faso	2.37	1	1	35	1.43	1	1	7
Bangladesh	2.6	1	1	27	1.24	1	1	17
Botswana	3.77	2	1	60	1.06	1	1	2
Chile	2.98	2	1	53	3.49	2	1	26
Cameroon	2.13	1	1	18	1.23	1	1	10
Colombia	2.32	1	1	35	2.07	1	1	28
Dominican Republic	5.27	3	1	39	1.48	1	1	6
Ecuador	2.74	1	1	35	2.27	1	1	18
Kenya	2.19	1	1	27	1.64	1	1	12
Cambodia	1.71	1	1	28	1.31	1	1	5
Morocco	3.33	2	1	58	1.6	1	1	17
Mexico	2.78	1	1	69	1.36	1	1	34
Nicaragua	3.23	1	1	63	1.72	1	1	9
Pakistan	2.63	1	1	60	1.64	1	1	24
Peru	2.99	1	1	76	2.14	1	1	25
Senegal	2.85	1	1	28	1.41	1	1	4
El Salvador	2.74	1	1	30	1.92	1	1	7
Tanzania	2.38	1	1	73	1.79	1	1	17
Uganda	2.79	1	1	48	1.73	1	1	12
South Africa	6.34	2	1	200	2.24	1	1	30

Appendix Table B.2 – Number of Observations with Positive Entry

	Number of Observations with Entry = 1				
	2007	2008	2009	2010	Total per country
Burkina Faso	227	207	149	202	785
Bangladesh	286	570	722	647	2,225
Botswana	208	251	311	201	971
Chile	2,382	2,639	2,576	-	7,597
Cameroon	260	321	258	-	839
Colombia	-	991	1,017	-	2,008
Dominican Republic	3,338	2,059	2,147	-	7,544
Ecuador	690	830	963	-	2,483
Kenya	1,030	830	978	-	2,838
Cambodia	92	55	53	-	200
Morocco	1,063	1,031	1,105	1,123	4,322
Mexico	5,059	4,939	5,114	-	15,112
Nicaragua	396	462	398	389	1,645
Pakistan	2,219	1,809	2,202	2,138	8,368
Peru	1,999	1,997	2,270	-	6,266
Senegal	232	143	172	190	737
El Salvador	224	262	340	-	826
Tanzania	375	390	416	-	1,181
Uganda	-	270	316	488	1,074
South Africa	6,926	6,046	6,109	-	19,081
Total	27,006	26,102	27,616	5,378	86,102

Appendix Table B.3 – Number of Observations with Positive Exit

	Number of Observations with Exit = 1				
	2007	2008	2009	2010	Total per country
Burkina Faso	189	236	210	135	770
Bangladesh	578	378	523	556	2,035
Botswana	187	206	215	274	882
Chile	2,202	2,464	2,589	-	7,255
Cameroon	263	141	292	-	696
Colombia	-	1331	1,016	-	2,347
Dominican Republic	1,056	3,087	1,982	-	6,125
Ecuador	660	655	802	-	2,117
Kenya	1,346	826	779	-	2,951
Cambodia	65	71	48	-	184
Morocco	886	1,025	1,057	1,004	3,972
Mexico	4,614	4,825	5,096	0	14,535
Nicaragua	375	387	463	341	1,566
Pakistan	2,209	2,249	1,710	1,993	8,161
Peru	1,647	1,849	1,807	-	5,303
Senegal	166	227	164	171	728
El Salvador	226	215	184	-	625
Tanzania	328	334	412	-	1,074
Uganda	-	292	262	300	854
South Africa	6,068	6,505	6,064	-	18,637
Total	23,065	27,303	25,675	4,774	80,817