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Abstract

This paper shows that voluntary product standards in EU food and agriculture markets can have significant trade effects. In particular for all countries and for goods that are raw or lightly processed, EU standards can often be trade-inhibiting. However, internationally harmonized EU standards—those that are equivalent to ISO norms—have much weaker trade effects, and in some cases are even trade-promoting. EU standards may have hurt developed countries more than developing countries, but this result is dependent on the sector. At a policy level, the results highlight the importance of dealing with the trade effects of voluntary standards in major markets, not just mandatory public standards.

Keywords

Trade policy; Product standards; International harmonization; Agricultural products; Gravity model.

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1 Introduction

As traditional market access barriers, such as tariffs and quotas, have fallen in many countries over recent decades, attention has increasingly turned to other regulatory measures that have the potential to act as trade barriers. Although rarely designed as explicitly protectionist measures, product standards nonetheless have the potential to keep foreign producers out of domestic markets by imposing fixed and variable adaptation costs—the so called “standards as barriers” view. These costs have the potential to fall particularly heavily on developing country producers, whose adaptability is constrained by technical and financial capacity. Indeed, recent trade theory suggests that fixed cost measures such as product standards might play an important role in explaining the pattern of bilateral trade (Helpman, et al. (2008) and see Tamini, et al. (2010) for an application to trade in agricultural products). On the other hand, foreign standards can also act as a catalyst for production upgrading, as resources shift to producers able to make the required technical adaptations (the “standards as catalysts” view; Maertens and Swinnen (2009), Henson (2008)).

A number of recent contributions to the literature focus on the trade effects of mandatory product standards, including in the agricultural sector. For example, Disdier, et al. (2008) construct an inventory of such measures and use a gravity model to show that they tend to reduce developing countries’ exports to the OECD, but have little effect on intra-OECD trade. By contrast, there is much less work on voluntary product standards, even though they are commercially crucial for developing countries seeking to integrate into agri-food supply chains in developed country markets. Moenius (2004) considers a range of industries across a number of developed country markets. He finds that bilaterally shared voluntary standards tend to be trade promoting, but that country-specific standards tend to inhibit trade in non-manufactured goods such as agriculture. Czubala, et al. (2009) examine the impact of voluntary EU standards on African exports of textiles, clothing, and footwear. They find that EU standards tend to inhibit African exports, except for those standards that are internationally harmonized. Portugal-Perez, et al. (2009) extend that analysis to electrical products (cf.Moenius, 2007), but they do not examine the potential for differential impacts across developing and developed countries. Finally, Shepherd (2007) presents evidence that voluntary product standards and international harmonization affect the extensive margin of trade—particularly in developing countries—which is consistent with a significant role for fixed costs of adaptation.

Although there is considerable anecdotal evidence that similar mechanisms may be at work in the food and agriculture sector, quantitative evidence remains scarce (Henson 2008). Emlinger, et al. (2008) find that even after controlling for tariffs, there is a significant ‘‘border effect’’ in EU fruit and vegetable trade with Mediterranean partners. They interpret this as possible evidence of the effects of non-tariff measures, including standards. Moenius (2004, 2006) finds that voluntary standards in food and agriculture can be trade-inhibiting in a sample of developed countries. More recently, Anders and Caswell (2009) and Tran, et al. (2012) show that stricter food safety standards for seafood have negative impacts on many developing country exporters.

This paper builds on and extends this existing work in four main ways. First, we complement single sector studies such as Anders and Caswell (2009) and Tran, et al. (2012) by covering a wide range of agricultural products from HS Chapters 1-24. In light of differences in the level of product differentiation between manufactured goods sectors, like textiles and clothing (Czubala et al. (2009)), it is important to know whether similar mechanisms are at work in the relatively more homogeneous agricultural sector. Second, we focus on the increasingly important area of voluntary standards, rather than the mandatory standards considered by Disdier, et al. (2008). Third, we allow for standards to have different effects on developing and developed country exporters. Fourth, our dataset allows us to identify agricultural product standards that are internationally harmonized versus those that are not, as in Czubala, et al. (2009) and Portugal-Perez, et al. (2009) for textiles and clothing, and electronic goods, respectively.

Against this background, the paper proceeds as follows. The next section discusses materials and methods, covering the dataset, estimating equation, and basic descriptive results. Section 3 presents results from the econometric model and discusses them. Section 4 provides some illustrative calculations to give an idea of the empirical importance of our results. Finally, section 5 concludes.

2 Material and Methods

Setting product standards is an area of mixed competence in the EU. Each member state has both voluntary and mandatory standards at a national level, while centralized EU bodies also issue standards with transnational application. A mixture of private and public agencies are involved in standard setting within the EU, with private bodies focusing primarily on voluntary standards, while public bodies emphasize mandatory ones. Swann, et al. (1996) and Moenius (2004) examine the trade impacts of voluntary national standards, while Chen and Mattoo (2008) and Baller (2007) focus on transnational mandatory standards (Harmonization Directives). Only Czubala, et al. (2009) and Shepherd (2007) look at the role played by transnational voluntary standards, such as those issued by the European Committee for Standardization (CEN).

However, the empirical literature on the trade effects of private versus public standard on food and agriculture is thin if not non-existent (Henson, 2008).

2.1 EU Standards Database

To conduct the empirical analysis in the next section, we use previously unexploited data from the World Bank's EU Standards Database (EUSDB).[1] EUSDB collates data on voluntary standards in force in the EU over the period 1995-2003, and provides the first catalogue of CEN European standards with mapping to a standard trade classification (HS 2000). These standards are of the same type studied by Swann, et al. (1996) and Moenius (2004), although their jurisdictional reach is different since they apply to all EU member states. To be clear, although these standards are voluntary, not mandatory, they are to be distinguished from private standards used by retailers and distributors that are not catalogued in the sources used to create the dataset used here. EUSDB covers two product clusters of particular interest to developing countries: agriculture, and textiles and clothing. The first product cluster was analysed by Czubala, et al. (2009), who found evidence of significant trade effects. The present paper is the first one to use the agriculture component of EUSDB.

2.1.1 EUSDB Construction

Concretely, EUSDB was constructed by searching the CE-Norm and Perinorm databases for Community-level ('EN') standards, and extracting the relevant information from individual records, then cross-checking. Particular care was taken to ensure that the standard count for each year reflects as accurately as possible the total number of standards in force for that year (referred to as the 'stock' of standards), regardless of whether individual standards were published prior to or during the EUSDB sample period (1995-2003). Only those documents

[1] The description of the EUSDB given here draws heavily on Shepherd (2006), which fully reports the construction of the EUSDB and sets out the techniques used to create the standards variables used in Shepherd (2007), Czubala, et al. (2009), and this paper.

classified as ‘standards’ in Perinorm are included in the count data. An amendment to an existing standard is counted as an additional standard. All draft standards are excluded from the dataset.

Some previous studies have differentiated between harmonized (or shared) standards and ‘idiosyncratic’ standards that are unique to a particular country, e.g., Moenius (2000, 2004). Since EUSDB deals only with Community-level standards, it does not investigate differences in national standards within the EU; that subject is addressed by de Frahan and Vancauteren (2006), who find that harmonization is associated with significant intra-regional trade gains. However, EUSDB does capture information on whether or not a particular EU standard implements a corresponding ISO standard (‘international harmonization’). A binary dummy variable is used to make this distinction, which is based on the presence or absence of an ‘equivalent’ or ‘identical’ tag in the Perinorm record with reference to an ISO standard. Under current data constraints, it is not possible to code an additional variable that identifies shared NonISO standards by country pair, given the broad sample of exporting countries used in this paper.

The fact that EUSDB catalogues voluntary, as opposed to mandatory, standards is significant in terms of the interpretation of our results. At the firm level, individual operators remain free to adopt or not adopt voluntary standards, whereas they are required to follow mandatory ones. The use of firm-level data on standards compliance is therefore an interesting avenue for additional research, because it captures different behaviour at a micro-level. However, given the wide sample of developing countries used in the present analysis, it is not possible to proceed using firm-level data. We must therefore rely on country-level data, which are effectively aggregated from the firm-level. Therefore, we can only present aggregate results, and cannot interpret them in terms of the behaviour of individual firms.

2.1.2 The Evolution of Standards

Voluntary standards catalogued in the EUSDB have been growing rapidly over recent years. Summing across all two-digit HS sectors in the agricultural products cluster, the total number of standards increased from less than 50 in 1995 to more than 800 in 2003. This represents an average annual growth rate of just over 40%. From the point of view of exporters to the EU, particularly those from developing countries, the expansion in these voluntary agricultural standards is clearly a dynamic with potentially major cost implications. The available firm-level evidence suggests that foreign standards can indeed impose substantial fixed costs of compliance: Maskus, et al. (2005) report an average of $425,000 per firm, or 4.7% of value added, based on a survey of over 600 firms in 16 developing countries.

Table 1 presents summary statistics from EUSDB for the final year in the sample (2003), broken down by HS Chapter. A small number of product groups stand out for the relatively strong concentration of standards observed: HS Chapters 4 (dairy and eggs), 11 (milling products), 12 (oil seeds), 15 (fats and oils), 19 (preparations of cereals or milk), and 20 (preparations vegetables, fruits or nuts). In each case, more than 50 different combined ISO and NonISO standards were in force at the end of the sample period. However, our results show that these products are not necessarily the most affected by their standards. Considerable heterogeneity exists across sectors in terms of the degree of international harmonization that has taken place. In HS Chapter 23 (food industry residues), for instance, nearly all EU standards are harmonized with ISO norms (96%). The corresponding figure is over 60% for HS Chapters 4 (dairy and eggs) and 15 (animal and vegetable fats and oils), but is much lower in other sectors. For nine of the 18 sectors with at least one standard in force in 2003, the rate of ISO harmonization is zero. On an overall basis, the percentage of ISO-harmonized standards in the total has actually fallen over time: from just less than 70% in 1995 to around 17% in 2003.

<<Insert Table 1 Here>>

Part of the reason for the rapid increase in NonISO standards relative to ISO standards is that some products do not have ISO standards. Table 1 shows, for instance, that HS Chapter 3 (fish and crustaceans) only face NonISO standards. More common in agriculture, though, is that the number of NonISO standards increased at a faster rate than the number of ISO standards. In HS Chapter 12 (oil seeds), for example, at the beginning of the data set the EU only had ISO standards. By the midpoint of the data period, the number of NonISO standards outstripped the ISO standards, so that at the end of the data period of the total of all standards, the percentage of ISO standards was 27% while NonISO standards were 73%.

The overall growth in the number of standards, as well as the realignment that has taken place between the two types of standards, suggest a real shift in the regulatory hurdles that the EU imposes on exporting countries in food and agricultural trade. The next section of the paper develops a gravity model to examine more carefully the trade impacts of these changes.

2.2 The Gravity Model

Anderson and van Wincoop (2003) develop a theory-consistent gravity model based on constant elasticity of substitution (CES) demand in a general equilibrium structure. Using *i*, *j*, *k*, and *t* to index exporters, importers, sectors, and time respectively, the log-linearized version of their model takes the following form:

$$\log\left(X_{ijt}^{k}\right) = \log\left(E_{jt}^{k}\right) + \log\left(Y_{it}^{k}\right) - \log\left(Y_{t}^{k}\right) + \left(1 - s^{k}\right)\log\left(t_{ijt}^{k}\right) - \left(1 - s^{k}\right)\log\left(P_{jt}^{k}\right) - \left(1 - s^{k}\right)\log\left(\Pi_{it}^{k}\right) + e_{ijt}^{k} \qquad (1)$$

where: X_{ijt}^{k} is exports from country i to country j in sector k at time t; E_{jt}^{k} is sector k expenditure in country j; Y_{it}^{k} is sector k production in country i; t_{ijt}^{k} is bilateral trade costs in sector k; s^{k} is the intra-sectoral elasticity of substitution (between varieties within a sector); and e_{ijt}^{k} is a random error term satisfying standard assumptions. The P_{jt}^{k} and Π_{it}^{k} terms represent multilateral resistance, i.e. the fact that trade patterns are determined by the level of bilateral trade costs relative to trade costs elsewhere in the world. Inward multilateral resistance $(P_{jt}^{k})^{(1-s^{k})} = \sum_{i=1}^{N}\left(\Pi_{it}^{k}\right)^{(s^{k}-1)} w_{it}^{k}\left(t_{ijt}^{k}\right)^{(1-s^{k})}$ captures the dependence of country j's imports on trade costs across all suppliers. Outward multilateral resistance $(\Pi_{it}^{k})^{(1-s^{k})} = \sum_{j=1}^{N}\left(P_{jt}^{k}\right)^{(s^{k}-1)} w_{jt}\left(t_{ijt}^{k}\right)^{(1-s^{k})}$ captures the dependence of country i's exports on trade costs across all destination markets. The w_{it} terms are weights equivalent to each country's share in worldwide sectoral expenditure.

2.2.1 Application of Gravity Model to EUSBD

Since the two multilateral resistance terms are unobservable, it is common to estimate (1) using fixed effects. As Baldwin and Taglioni (2007) point out, it is important to ensure as close a correspondence as possible between the theoretical model and the dimensions of the fixed effects when estimating using sectoral data. Ideally, equation (1) would be estimated separately for each sector *k*, with a full set of importer-time and exporter-time fixed effects. Such an approach allows for the proper level of variation in multilateral resistance, and also takes account of the fact that the elasticity of substitution varies across sectors. However, a cost of that methodology in our context is that it would produce a very large number of regression results—one for each four digit product code in the first 24 chapters of the Harmonized System—which makes overall interpretation difficult. In addition, the inclusion of importer-time dummies in product regressions would make it impossible to include measures of CEN standards from EUSDB, which are implemented on an MFN basis: they are constant across all exporters, and would be collinear with the fixed effects.

We therefore adopt a compromise strategy. We estimate (1) separately for each two-digit HS sector, i.e. using data pooled across all four digit products within a sector. We include fixed effects in the exporter, importer, product, and time dimensions. Although conscious that this specification does not exactly mirror the dimensions of the theoretical model, we believe that it represents an appropriate compromise between rigor and feasibility in the context of a model with many countries, sectors, and years, in which the number of fixed effects can quickly become burdensome.

To make (1) operational, we need to specify the content of the trade costs function t_{ijt}^{k}:

$$\begin{aligned} \log(t_{ijt}^{k}) = {} & b_1 \log(ISO_t^k) + b_2 \log(ISO_t^k) * Developing + \\ & b_3 \log(NonISO_t^k) + b_4 \log(NonISO_t^k) * Developing + \\ & b_5 Developing + b_6 \log(Distance_{ij}) + b_7 Colony_{ij} + \\ & b_8 Language_{ij} + b_9 Border_{ij} + b_{10} RTA_{ijt} \end{aligned} \tag{2}$$

In line with the gravity model literature, we use distance ($Distance_{ij}$) as a proxy for international transport costs. We also include dummy variables for countries that were previously in a colonial relationship, those that share a common official language, those that are geographically contiguous, and those that are both members of the same regional trade agreement. (For a full description of variables and data sources, see Table 2.)

Our main variables of interests are two counts of product standards drawn from EUSDB. The first one (ISO_t^k) counts the number of ISO-harmonized CEN standards in force for a given product-year combination, and the second ($NonISO_t^k$) counts the number of NonISO-harmonized

CEN standards.[2] The reason for entering them separately into the trade costs function is that based on the results of Shepherd (2007), and Czubala, et al. (2009), we expect the cost impacts of these two types of standards to be different, and thus their trade impacts to differ. Since internationally harmonized standards make it possible for firms to enter multiple markets upon payment of a single product adaptation cost, we expect them to be less burdensome to foreign exporters than non-harmonized standards. Concretely, we expect $b_1 > b_3$ in terms of equation (2). Finally, we also interact the two standards variables with a dummy variable equal to unity for developing country exporters. We define developing countries as all non-high-income countries, according to the World Bank country classification (World Bank (2009)). The reason for the interaction term is to take account of the possibility arising from the previous literature that standards might have different impacts on developed and developing country exporters. In order to obtain consistent estimates of the interaction parameter, we also enter the developing country dummy variable directly into the regression specification, with the expectation that it will return a negatively signed coefficient, in line with the lesser observed exports of developing countries to the EU relative to developed country exporters with larger home markets.

Combining (1) and (2), adding reduced form coefficients, and removing variables that are accounted for by fixed effects gives our final estimating equation:

[2] Some sector-year combinations have a zero count for one or other of these variables. To deal with this problem, we add 0.00001 to the number of standards prior to taking the logarithm. Absent this adjustment, those observations would be dropped from the dataset.

$$
\begin{aligned}
&\log\left(X_{ijt}^{k}\right) = \\
&\sum \mathrm{dum}_{\mathrm{i}}^{\mathrm{k}} + \sum \mathrm{dum}_{\mathrm{j}} + \sum \mathrm{dum}_{\mathrm{t}} + \mathrm{b}_1(1 - s^k)\log(\mathrm{ISO}_{\mathrm{t-1}}^{\mathrm{k}}) + \mathrm{b}_2(1 - \\
&s^k)\log(\mathrm{ISO}_{\mathrm{t-1}}^{\mathrm{k}}) * \mathrm{Developing} + \mathrm{b}_3(1 - s^k)\log\left(\mathrm{NonISO}_{\mathrm{t-1}}^{\mathrm{k}}\right) + \mathrm{b}_4(1 - \\
&s^k)\log\left(\mathrm{NonISO}_{\mathrm{t-1}}^{\mathrm{k}}\right) * \mathrm{Developing} + \mathrm{b}_5\mathrm{Developing} + \mathrm{b}_6(1 - \\
&s^k)\log\left(\mathrm{Distance}_{\mathrm{ij}}\right) + \mathrm{b}_7(1 - s^k)\mathrm{Colony}_{\mathrm{ij}} + \mathrm{b}_8(1 - s^k)\mathrm{Language}_{\mathrm{ij}} + \\
&\mathrm{b}_9(1 - s^k)\mathrm{Border}_{\mathrm{ij}} + \mathrm{b}_{10}(1 - s^k)\mathrm{RTA}_{\mathrm{ijt}} + e_{ijtk}
\end{aligned}
\tag{3}
$$

where dum under a summation operator indicates a full set of dummy variables (fixed effects) in the listed dimension.

2.2.2 Estimation Method

We estimate (3) using the Poisson pseudo-maximum likelihood estimator (PPML) (Santos Silva and Tenreyro, 2006)) with fixed effects. The PPML model has two main advantages over OLS as a workhorse estimator for the gravity model. First, estimating a log-linear gravity model like (3) using OLS makes it necessary to drop observations in which the dependent variable is equal to zero in levels, since log (0) is undefined. Poisson does not suffer from this limitation, and zeros can be included in the dataset in the same way as observations with any other value. Second, Santos Silva and Tenreyro (2006) argue that in the presence of a certain type of heteroskedasticity, OLS can in fact produce biased parameter estimates in addition to the usual biased standard errors. They show empirically that there is good reason to believe that this type of heteroskedasticity is present in typical gravity model samples. The PPML model, however, is consistent under much weaker assumptions, and is thus more likely to give robust results than OLS in this context.

One potential issue in models such as the one we are estimating is that standards might be endogenous, thus creating bias in the estimates. This possibility has recently been explored by Vigani et al. (2012), who find, however, that their core results are robust to possible endogeneity issues. As one way of dealing with this issue, we lag all standards variables by one period in the regressions (see equation 3), in order to reduce the likelihood of endogeneity. There is less of a risk that lagged standards are endogenous to current trade flows, so this solution should at least provide some level of confidence that our results are not plagued by endogeneity concerns.

2.3 Data

Data for the gravity model are drawn from standard sources over the period 1995-2003 (Table 2). Our trade data come from the European Union's Eurostat trade database (Eurostat, 2010). We use import value data at the four-digit level of the Harmonized System. See the Appendix for a list of countries included as exporters. For common geographical and historical control variables used in gravity modelling, such as distance, contiguity, colonial links, and common language, we use CEPII's distance database (CEPII, 2009). Finally, we included a dummy variable for countries having signed a RTA with the EU (Shepherd, 2007), based on information taken from online databases (WorldTradeLaw.net, 2007).

<<Insert Table 2 Here>>

3 Results and Discussion

The results of the models and calculations suggest that in general NonISO standards have a negative effect on trade, while ISO standards have mixed effects on trade. This story has a number of nuances depending on the level of development of the exporter and the sector. These differences add richness and complexity to the story of standards as catalysts or barriers to trade. The model results illustrate these nuances through the direct effects of the standards and the marginal effects which incorporate differences in developing and developed country effects. At the margin, developing countries are not as negatively affected by standards for some products as developed countries.

In Table 3, we present the estimates of the PPML fixed effects model. We consider only sectors in which there is at least one EU standard in force, and suppress the fixed effects coefficients for brevity. In addition, HS Chapter 7 (vegetables) is not reported due to concerns over data reliability. Most of the typical gravity model coefficients are statistically significant and have the correct sign. For example, $\log(\text{Distance}_{ij})$ is negative and statistically significant in 11 of the 17 regressions. For HS Chapters 9 (coffee, tea, mate and spices), 12 (oil seeds), 15 (fats and oils), 18 (cocoa and cocoa preparations), 19 (preparations of cereals, flour), and 20 (preparations of vegetables, fruits and nuts), the distance coefficient is not statistically significant. This result is unusual in gravity modelling and undoubtedly reflects the specific characteristics of these agricultural sectors. It is also perhaps due to the strong negative correlation (-0.5 in HS Chapter 9) between distance and the RTA dummy variable, which arises because countries tend to sign RTAs with neighbours rather than distant trading partners.

Colony, Language, Border, and RTA have positively signed coefficients that are statistically significant in the majority of sectors. The dummy for developing country exporters is negative and statistically significant in all sectors except HS Chapter 9 (coffee and tea), which indicates, in line with expectations, that developing countries tend to export less to the EU, due in part, to smaller domestic market size.

3.1 The Direct Effects of ISO and NonISO Standards

Our variables of primary interest are the two standards counts—ISO and NonISO—and the interaction terms with the developing country exporter dummy. Strikingly, NonISO standards have a negative and statistically significant impact on trade in 14 of the 17 regressions. Our results, therefore, confirm the view that in relation to agricultural goods, national standards tend to act as barriers to other countries' exports, although sectoral differences must be kept in mind: the effect of NonISO standards is statistically insignificant in two cases (HS Chapters 10 and 17) and positive in one case (HS Chapter 22). The "standards as barriers" argument dominates, but this result depends on the specificities of each sector.

The evidence for ISO standards is more mixed. In three cases (HS Chapters 4, 12, and 23), ISO standards have a positive and statistically significant impact on trade, consistent with the "standards as catalysts" view. In two cases, however, they have a negative and statistically significant impact on trade (HS Chapters 10 and 11). While in three cases, ISO standards are statistically insignificant (HS Chapters 15, 19, and 21). The contrast between the results for ISO and NonISO standards is notable; however, ISO standards sometime act as barriers and sometime as catalysts, whereas NonISO standards tend to act as barriers. The parameter estimates for ISO standards tend to be larger (and in some cases more positive) than the parameters for NonISO, supporting our hypothesis $b_1 > b_3$.

<<Insert Table 3 Here>>

<<Insert Table 3 Cntd. Here>>

3.2 The Marginal Effects of ISO and NonISO Standards

The marginal effects of the standards over time (cf. Figures 2 and 3) support the idea that ISO standards tend to be less negative (or positive) relative to NonISO standards. The marginal effect is the percentage change in trade given an additional lagged standard for each year. With the PPML specification, the coefficients are the estimated elasticities. The marginal effect for the ISO standards are generally in the range of -0.036 to 0.-078, with the notable exception of HS

Chapter 4 (dairy and eggs), which has a marginal effect that is as low as -0.62. The marginal effects of NonISO standards generally range from -0.3 to 0.06, with the notable exception HS Chapter 3 (fish and crustaceans), which has a marginal effect that is as low as -0.76. The contrasting effects of the ISO and NonISO standards sits well with previous work such as Czubala et al. (2009) for textiles, where it was found that ISO standards are generally less trade distorting than NonISO standards.

<<Insert Figure 1 Here>>

<<Insert Figure 2 Here>>

As discussed above, an important issue in the standards literature is the potential for differential effects on developed and developing country exporters. Our prior is that the “standards as barriers” case is more likely to apply to developing country exporters: due to the significant difficulties they face in terms of human and financial capacity in terms of upgrading production to meet the requirements of new standards regimes. From equation 3, the effect of the standard for developing countries includes the direct effect of the standard and the interaction term of the developing country dummy. Thus, based on our prior, empirically a negative effect of the standard becomes more negative if the interaction term is also negative.

However, the data paint a picture that is more complex. For NonISO standards, the interaction term is only negatively signed and statistically significant—in line with our expectations—in one regression (HS Chapter 22). In fact, it is positively signed and statistically significant in five regressions (HS Chapters 3, 4, 12 15, and 23). This result indicates that the negative effects of standards on trade are in fact felt relatively less strongly in developing countries. For HS Chapters 15 and 23, the interaction term with developing and NonISO outweighs the direct NonISO standard effect so as to make the aggregate effect of NonISO standards for developing countries positive. This surprising result could be due to the importance of quality norms and information costs in the agricultural setting, where they are potentially more serious than in the textiles and clothing market considered by Czubala et al. (2009). Compliance with standards cannot only be a way of signalling product safety, quality, and conformity with consumers' expectations, but can also be an important prerequisite for joining agricultural value chains. As a result, it may be that the potential role of standards as barriers is reduced in the agricultural sector relative to other parts of the economy. Nevertheless, the overall impact on trade is still negative.

The interaction term of developing country and ISO standards also produces surprising results. It is negatively signed and statistically significant in three regressions (HS Chapters 4, 21 and 23), which is consistent with our prior, but positively signed and statistically significant in three other regressions (HS Chapters 10, 12 and 19).

In the cases where the interaction term is negative, the aggregate effect of ISO standards for developing countries is negative because $|b_1| < |b_2|$. However, in the cases where the ISO interaction term is positive, we see three different effects: For HS Chapter 10, developing countries are less negatively affected by ISO standards in aggregate than developed countries. However the effect is still negative. For HS Chapter 12, the positive effect of ISO standards is increased for developing countries relative to developed countries. For HS Chapter 19, ISO standards have no significant impact on trade in general, but they have a positive impact for developing countries. These last two findings are in line with previous work, such as Czubala et al. (2009), which highlights the important trade-promoting role that international harmonization can play for developing countries. Taking these results together, we conclude that the effects of ISO standards are also highly sector-specific, but that they can act, in some circumstances, act as catalysts for agricultural trade, especially for developing countries, which is in line with previous results for other sectors, such as textiles and clothing (Czubala et al., 2009).

In table 1 and figures 1 and 2, we divide the chapters into two groups: raw and lightly processed (HS Chapters 2, 3, 4, 8, 9, 10, 11, and 12) and processed products (HS Chapters 15, 16, 18, 19, 20, 21, 22, and 24). Our prior is that raw and lightly processed products tend to be either highly perishable or products more readily exported by developing countries because of the low level of processing. Generally, standards tend to have more negative effects on the raw and lightly processed products, such as HS Chapter 2 (meat) and HS Chapter 3 (fish and crustaceans), than on processed products, such as HS Chapter 15 (fats and oils). This result holds generally for ISO and NonISO standards and for developed and developing countries. For HS Chapters 15 and 23 (fats and oils, and residues and waste), the NonISO standards are positive at the margin for developing countries, which further makes the point that more processed products are less negatively affected (in this case positively affected) by the standards than raw and lightly processed products. The notable exceptions are the ISO standards for HS Chapter 12 (oil seeds) with relatively large and positive effects on trade and the NonISO standards for HS Chapters16 and 18 (preparation of meat and fish and cocoa and cocoa preparations), which at the four-digit product level look less processed than other products in the processed category.[3] Also for developing countries the ISO standards for HS Chapter 22 (beverages, spirits and vinegar) has a negative effect, though ISO standards have a positive effect for developed countries. Despite the exceptions, we generally see differential marginal effects of the standards depending on the level of processing and perishability of the product.

[3] Further inspection at the four-digit level reveals a number of raw or lightly processed and highly perishable products in these two categories. For example HS Chapter 16 includes sausages, extracts and juices from meat or fish products, caviar, and prepared and preserved crustaceans and mollusks. HS Chapter 18 includes all products related to cocoa from the raw bean to chocolate.

4 Calculation

For illustrative purposes, Table 4 presents simulations of the trade effects of ISO and NonISO standards on five products derived from animals at different levels of processing: HS Chapters 2, 3, 4, 15 and 16 (meat, fish and crustaceans, dairy and eggs, fats and oils[4], and preparation of meat and fish). We chose to focus on products derived from animals because of the various food safety, sanitary, and animal welfare standards that influence animal trade. Additionally, regulations of plant products, especially from the developing world have received a great deal of attention over the last several years (e.g. vegetables and flowers from Kenya). Given that the estimates are over the years 1996 to 2003 and over the four-digit products of the two-digit HS Chapters, we simulate the effects at the midpoint of the data set 1999 with the 1998 standards and for the two-digit products. In the simulation, we consider the trade effects of one additional lagged standard. We calculated the marginal effect of one additional standard based on the estimated elasticity and the trade and lagged number of standards for developed and developing countries in 1999. Based on those marginal effects, we simulated the effects of an additional lagged standard on trade and the resulting market shares of developing and developed countries' exports to the EU. The number of lagged standards ranged from seven to 16. Therefore, an additional NonISO standard would have represented an increase of 6.67% to 14.29% in the number of standards. For the five products in 1999, only HS Chapter 4 (dairy and eggs) had ISO standards.

The largest, aggregate effect of an additional standard is for HS Chapter 3 (fish and crustaceans, molluscs and other aquatic invertebrates). One additional standard would have caused a -29.17% change in total imports. The estimated effect was larger, in absolute terms, for developed countries (-29.20%) than for developing countries (-29.12%). The effect on market

[4] Twelve of the 22 products at the four-digit level are animal products.

share is that developing countries increase market share from 38.87% to 38.90%, while the market share for developed countries falls from 61.13% to 61.10%. The gain for developing countries is small, but the gain suggests that HS Chapter 3 and similar products, such as NonISO standards for HS Chapters 4 and 15 (dairy and eggs, and fats and oils), must be more sensitive to the kinds of information costs that standards can help overcome, and standards actually act as catalysts in those cases, but the net effect is a loss in trade.

This point is even clearer for NonISO standards for HS Chapter 15. An additional standard would have generated an increase of 0.13% in trade from developing countries while developed countries would have lost -0.10% of trade in 1999. The net effect is negative, despite the gains for developing countries. The NonISO standards for HS Chapter 15 also reflects the general result that standards for processed products are less negatively affected by an additional standard as compared to less processed products.

The ISO standards for HS Chapter 4 present the result most commonly assumed about increasing standards effect on developing countries, though it contradicts the prior about harmonized standards. The elasticity of ISO standards is -0.23 for developing countries and 0.0015 for developed countries. An additional ISO standard would have reduced developing country trade by -3.29% while developed countries would have gained 0.021%. The net effect on total trade would have been very small (0.17%), which supports the thought that harmonized standards increase trade. However, the negative effect on developing countries contradicts the harmonization story. While ISO standards on HS Chapter 4 have a net positive effect, developing countries are hurt and lose market share. Here is an example where the standards erode the competitiveness of developing countries.

For HS Chapters 2 and 16 (meat and edible meat offal and preparations of meat, of fish or of crustaceans), the marginal increase in the number of NonISO standards would have a negative effect on trade for developing and developed countries. The percentage trade effects would have been the same, so the market shares would not have changed. Additionally, the simulations for these products reflect the idea that less processed products (-11.30% change in trade) are more negatively affected than less process products (-9.10%).

In summary these simulations support the model estimates that the effect of standards are highly dependent on the sector and country type. However, ISO standards tend to have less negative effects on trade relative to NonISO. Standards tend to limit trade of lightly processed products more than highly processed products. The effects of standards on developing versus developed countries depend on the product and the standard; however, we find that, at the margin, standards tend to lower the trade of developed countries a little more than developing countries. Our simulations suggest that greater subtlety exists in the discourse on standards.

<<Insert Table 4 Here>>

5 Conclusion

This paper has provided some of the first empirical evidence on the trade impacts of voluntary food and agriculture standards in the EU. Our results highlight the fact that the effects of standards, and in particular their character as barriers or catalysts, is highly sector specific. In some cases, we find—in line with previous work—that internationally harmonized EU standards tend to have weak, or even slightly positive, trade impacts, whereas non-harmonized standards—those that are unique to the EU—tend to be trade inhibiting. This result is similar to findings that regulatory similarity is trade enhancing (Vigani, et al. 2012). However, the opposite also applies in some sectors. It may be the case in those sectors that standards impart valuable market information to exporters, and thus can help promote, rather than inhibit, trade. Standards can thus act as either barriers or catalysts depending on sector specificities, as well as the degree of international harmonization present, and the per capita income level of the exporter. The trade impacts of non-harmonized EU standards tend to be particularly negative for products that are raw or lightly processed. More highly processed goods are less affected by EU standards, even though the total number of standards is considerably larger in processed goods sectors. In addition, we find that for less processed products, non-harmonized standards tend to have a larger effect on developing country exporters than on developed country exporters. These results provide important nuances to the simple standards as barriers or catalysts debate in the literature.

From a policy point of view, at least two implications flow from our results. The first is that discussions on product standards at the WTO and elsewhere need to be broadened to take account of the important role that voluntary standards play in influencing global trade patterns in food and agriculture markets. Most policy-level discussion is limited to dealing with mandatory standards, such as food safety regulations. However, our results show that in a context of increasingly globalized supply chains, voluntary standards also matter.

Second, our results highlight the way in which, particularly for developing countries, product standards can effectively make market access gains conditional: Malawi has duty and quota free access to the EU market under the Everything But Arms initiative, but if its exporting firms actually want to sell products in the European market, then they need to comply with the prevailing standards (See Henson (2008) and Jaffee and Henson (2004) for further discussion). Adapting products and production methods to deal with overseas standards raises serious issues of technical and financial capacity for many developing countries. But as our results show, the trade impacts of EU standards can sometimes be negative for developing countries in the sectors that are of most current export interest to them: perishable goods and lightly processed commodities. There is clearly a case to be made for increased technical assistance and capacity building in this area, as part of the broader Aid for Trade agenda.

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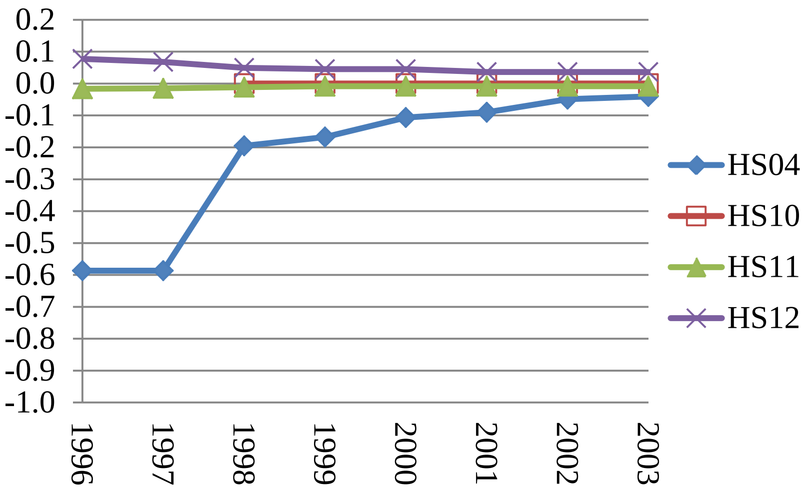
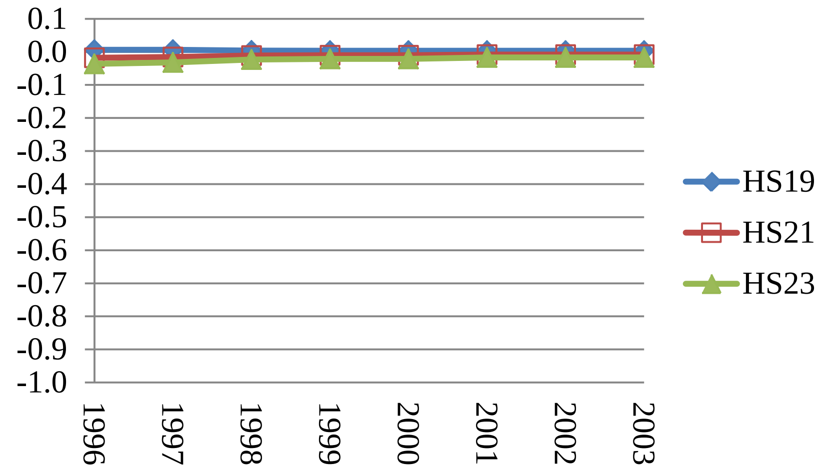
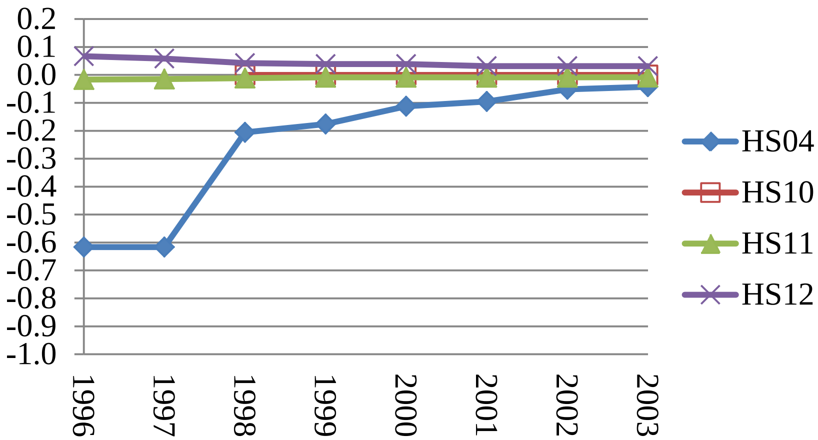
Figure 1. Marginal Effect of ISO Standards 1996-2003



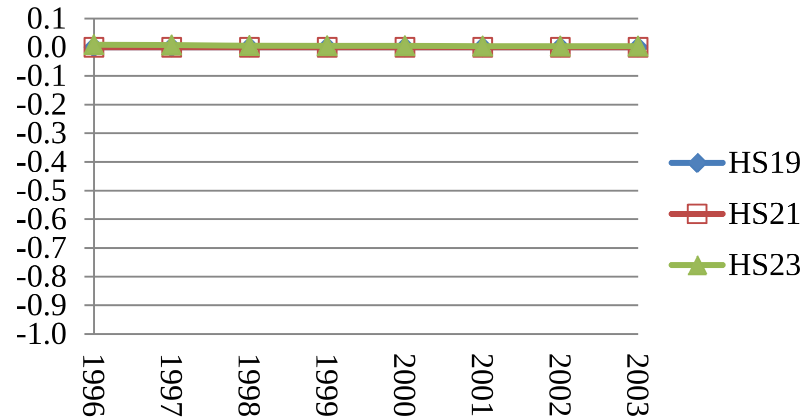
(a) Developing Country Raw or Lightly Processed Products



(b) Developing Country Processed Products



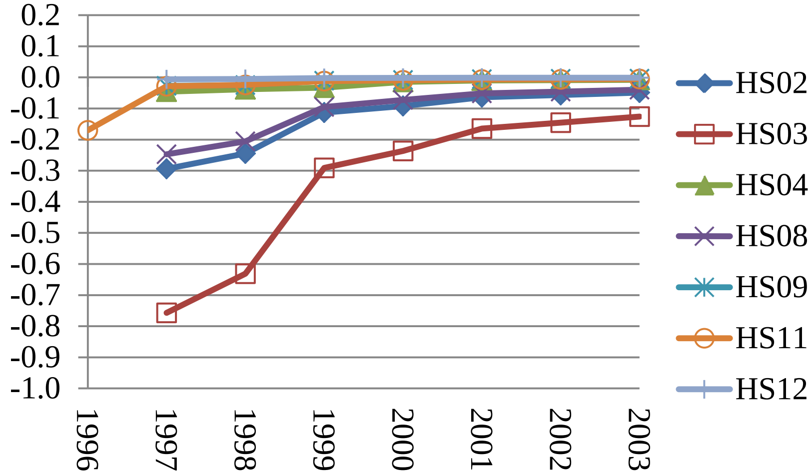
(c) Developed Country Raw or Lightly Processed Products



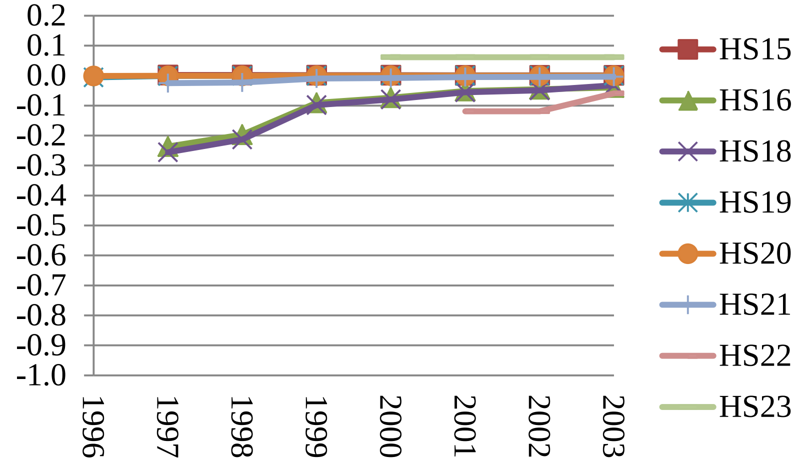
(d) Developed Country Processed Products

Note: The marginal effects reflect the percentage change in trade given one additional standard, based on elasticity estimates from table 3.

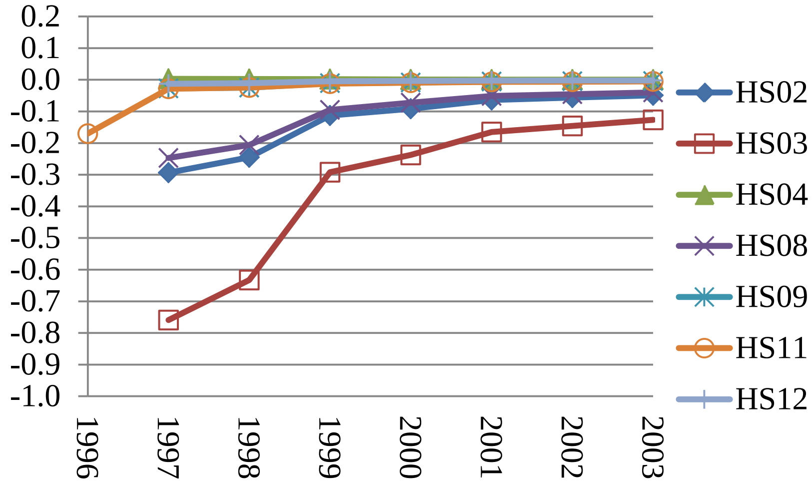
Figure 2: Marginal Effect of NonISO Standards 1996-2003



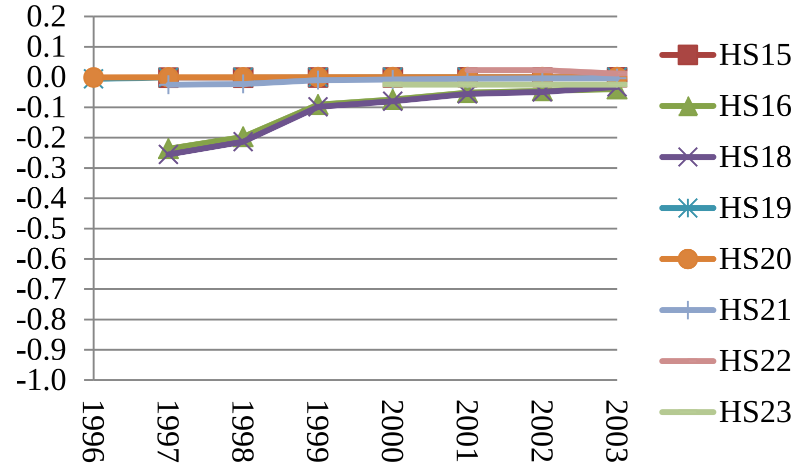
(a) Developing Country Raw or Lightly Processed Products



(b) Developing Country Processed Products



(c) Developed Country Raw or Lightly Processed Products



(d) Developed Country Processed Products

Note: The marginal effects reflect the percentage change in trade given one additional standard, based on elasticity estimates from table 3.

Table 1: Count data on the number of EU standards in force in 2003, by HS Chapter.

HS Chapter	Description	ISO	NonISO
	Raw or Lightly Processed Products		
01	Live animals	0	0
02	Meat and edible meat offal	0	39
03	Fish and crustaceans, molluscs and other aquatic invertebrates	0	40
04	Dairy produce; birds' eggs; natural honey;	34	39
05	Products of animal origin, not elsewhere specified	0	0
06	Live trees and other plants;	0	0
07	Edible vegetables and certain roots and tubers	0	41
08	Edible fruit and nuts; peel of citrus fruit or melons	0	41
09	Coffee, tea, maté and spices	0	41
10	Cereals	2	42
11	Products of the milling industry; malt; starches; inulin	22	41
12	Oil seeds and oleaginous fruits	15	41
13	Lac; gums, resins and other vegetable saps and extracts	0	0
14	Vegetable plaiting materials; vegetable products nes	0	0
	Processed Products		
15	Animal or vegetable fats and oils	30	44
16	Preparations of meat, of fish or of crustaceans	0	39
17	Sugars and sugar confectionery	1	40
18	Cocoa and cocoa preparations	0	39
19	Preparations of cereals, flour, starch or milk; bakers' wares	13	41
20	Preparations of vegetables, fruit or nuts	0	74
21	Miscellaneous edible preparations	2	39
22	Beverages, spirits and vinegar	0	3
23	Residues and waste from the food industries	25	1
24	Tobacco and manufactured tobacco substitutes	0	0

Source: EUSDB.

Table 2: Data and sources.

Variable	Definition	Year	Source
Distance	The physical distance between national capitals for country pairs.	n/a	CEPII
Border	Dummy variable equal to unity for exporting and importing countries with a common land border.	n/a	CEPII
Colony	Dummy variable equal to unity when the exporter and importer were once in a colonial relationship.	n/a	CEPII
Developing	Dummy variable equal to unity for economies that are not part of the World Bank's high income group.	2009	World Bank
Exports	Value of exports from the exporter to the importer, measured at the HS four-digit level.	1995-2003	EUROSTAT
ISO	Count of the number of ISO-harmonized CEN standards, by HS four-digit product.	1995-2003	EUSDB
Language	Dummy variable equal to unity for exporting and importing countries with a common language (official basis).	n/a	CEPII
NonISO	Count of the number of NonISO-harmonized CEN standards, by HS four-digit product.	1995-2003	EUSDB
RTA	Dummy variable equal to unity for country pairs that belong to the same regional trade agreement.	1995-2003	Shepherd (2007)

Table 3: Poisson pseudo-maximum likelihood (PPML) fixed-effects model estimates, aggregated from four-digit HS products

	HS2	HS3	HS4	HS8	HS9	HS10	HS11	HS12	HS15
log(Distance)	-0.330**	-0.916***	-0.501***	-0.325**	-0.181	-0.706***	-0.537***	-0.205	-0.049
	(0.034)	(0.000)	(0.006)	(0.046)	(0.456)	(0.000)	(0.000)	(0.235)	(0.840)
log(ISO)			0.015***			-1.742***	-0.018***	0.468**	-0.027
			(0.000)			(0.000)	(0.001)	(0.015)	(0.360)
log(ISO)*Developing			-0.245***			0.059***	-0.047	0.075***	0.006
			(0.000)			(0.000)	(0.147)	(0.005)	(0.824)
log(NonISO)	-1.469***	-3.796***	-1.233***	-1.235***	-1.360***	-0.234	-0.017*	-0.063***	-0.015**
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.218)	(0.064)	(0.000)	(0.023)
log(NonISO)*Developing	0.018	0.011**	0.060***	-0.003	-0.006	-0.019	0.049	0.032***	0.034***
	(0.109)	(0.019)	(0.001)	(0.607)	(0.501)	(0.162)	(0.232)	(0.001)	(0.000)
Developing	-1.213*	-6.239***	-9.765***	-3.518***	0.567	-6.595***	-11.612***	-6.903***	-12.139***
	(0.053)	(0.000)	(0.000)	(0.000)	(0.239)	(0.000)	(0.000)	(0.000)	(0.000)
Colony	0.514**	0.129	0.995***	1.000***	0.545**	0.516**	0.036	0.190	-1.070**
	(0.048)	(0.575)	(0.009)	(0.000)	(0.023)	(0.017)	(0.912)	(0.439)	(0.033)
Language	0.360*	0.490**	0.422	0.078	0.530*	0.446**	0.675**	0.236	2.356***
	(0.069)	(0.024)	(0.145)	(0.713)	(0.064)	(0.011)	(0.018)	(0.321)	(0.000)
Border	0.545***	0.477**	0.524	0.494*	0.855***	0.556***	1.221***	0.340	-0.299
	(0.001)	(0.017)	(0.132)	(0.052)	(0.005)	(0.009)	(0.000)	(0.191)	(0.510)
RTA	0.542**	0.116	0.906***	0.031	0.081	-0.386	0.995***	0.184*	-0.638***
	(0.019)	(0.172)	(0.000)	(0.684)	(0.441)	(0.688)	(0.005)	(0.072)	(0.000)
N	328320	321408	321840	554148	393120	255744	283824	550368	762048
R^2	0.452	0.317	0.562	0.320	0.616	0.629	0.431	0.597	0.131

The p-values based on robust standard errors, adjusted for clustering by country-pair, are in parentheses. Statistical significance is indicated by: * (10%), **(5%), and *** (1%). All models include fixed effects by importer, exporter, HS 4-digit product, and year.

Source: Authors' Estimates.

Table 3 (cntd): Poisson pseudo-maximum likelihood (PPML) fixed-effects model estimates, aggregated from four-digit HS products

	HS16	HS17	HS18	HS19	HS20	HS21	HS22	HS23
log(Distance)	-0.528***	-0.342***	0.092	-0.039	-0.147	-0.651***	-0.527***	-0.383***
	(0.001)	(0.000)	(0.680)	(0.860)	(0.296)	(0.000)	(0.000)	(0.002)
log(ISO)				-0.008		0.009		0.060***
				(0.274)		(0.115)		(0.000)
log(ISO)*Developing				0.045**		-0.124***		-0.313***
				(0.011)		(0.000)		(0.000)
log(NonISO)	-1.183***	0.004	-1.278***	-0.006*	-0.015***	-1.265***	0.023***	-0.025***
	(0.000)	(0.750)	(0.000)	(0.093)	(0.000)	(0.000)	(0.000)	(0.000)
log(NonISO)*Developing	0.005	0.000	0.005	-0.032	0.007	-0.006	-0.142***	0.086***
	(0.500)	(0.967)	(0.629)	(0.204)	(0.684)	(0.649)	(0.000)	(0.000)
Developing	-3.109***	-5.460***	-5.733***	-10.162***	-4.205***	-10.948***	-6.262***	-10.763***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Colony	1.067***	0.232	0.605**	-1.333	0.884***	-0.224	0.300	0.320
	(0.000)	(0.109)	(0.026)	(0.141)	(0.001)	(0.363)	(0.177)	(0.255)
Language	0.914***	0.398***	0.106	2.407***	0.152	0.706***	1.072***	0.420*
	(0.000)	(0.006)	(0.654)	(0.000)	(0.600)	(0.001)	(0.000)	(0.082)
Border	0.841***	0.423***	1.316***	-0.189	0.690***	0.394*	0.147	1.118***
	(0.000)	(0.000)	(0.000)	(0.631)	(0.000)	(0.051)	(0.492)	(0.000)
RTA	0.185**	-0.108	0.005	0.527***	-0.253***	0.329**	-0.162	0.194
	(0.011)	(0.189)	(0.987)	(0.000)	(0.007)	(0.033)	(0.109)	(0.345)
N	174960	137312	203472	170640	359640	221616	353952	295488
R^2	0.434	0.880	0.442	0.551	0.449	0.487	0.529	0.497

The p-values based on robust standard errors, adjusted for clustering by country-pair, are in parentheses. Statistical significance is indicated by: * (10%), **(5%), and *** (1%). All models include fixed effects by importer, exporter, HS 4-digit product, and year.
Source: Authors' Estimates.

Table 4: Simulations of Trade Effects from One Additional Standard on Products Derived from Animals

Source of Exports	1999 Market Conditions		Simulated Results			
	Trade (in mil. €)	**Market Share**	**Estimated Elasticity**	**Trade (in mil. €)**	**Percent Change**	**Market Share**
	HS Chapter 02 Meat and edible meat offal with 16 NonISO standards in 1998					
Developing Countries	1,227.21	7.38%	-1.45	1,088.54	-11.30%	7.38%
Developed Countries	15,392.20	92.62%	-1.45	13,652.88	-11.30%	92.62%
Total	16,619.41	100.00%		14,841.42	-11.30%	100.00%
	HS Chapter 03 Fish and crustaceans, molluscs and other aquatic invertebrates with 13 NonISO in 1998					
Developing Countries	5,169.44	38.87%	-3.785	3,664.33	-29.12%	38.90%
Developed Countries	8,129.48	61.13%	-3.796	5,755.67	-29.20%	61.10%
Total	13,298.92	100.00%		9,420.01	-29.17%	100.00%
	HS Chapter 04 Dairy produce, birds eggs and natural honey with 7 ISO standards in 1998					
Developing Countries	204.74	1.26%	-0.23	198.01	-3.29%	1.21%
Developed Countries	16,086.09	98.74%	0.015	16,120.56	0.21%	98.79%
Total	16,290.83	100.00%		16,318.57	0.17%	100.00%
	HS Chapter 04 Dairy produce, birds eggs and natural honey with 7 NonISO standards in 1998					
Developing Countries	204.74	1.26%	-1.17	204.74	-16.76%	1.27%
Developed Countries	16,086.09	98.74%	-1.23	16,086.09	-17.61%	98.79%
Total	16,290.83	100.00%		16,290.83	-17.60%	100.00%

Source: Authors' Calculations. From equation 3, the elasticities are the coefficients from the regression.

Table 4: Simulations of Trade Effects from One Additional Standard on Products Derived from Animals (continued)

Source of Exports	1999 Market Conditions		Simulated Results			
	Trade (in mil. €)	Market Share	Estimated Elasticity	Trade (in mil. €)	Percent Change	Market Share
	HS Chapter 15 Animal or vegetable fats and oils with 12 NonISO standards in 1998					
Developing Countries	2,444.43	30.68%	0.019	2,447.53	0.13%	30.72%
Developed Countries	5,524.06	69.32%	-0.015	5,518.54	-0.10%	69.28%
Total	7,968.49	100.00%		7,966.06	-0.031%	100.00%
	HS Chapter 16 Preparations of meat, of fish or of crustaceans with 13 NonISO standards in 1998					
Developing Countries	1,761.20	27.02%	-1.18	1,761.20	-9.10%	27.02%
Developed Countries	4,756.70	72.98%	-1.18	4,756.70	-9.10%	72.98%
Total	6,517.90	100.00%		6,517.90	-9.10%	100.00%

Source: Authors' Calculations. The elasticities are calculated based on average trade for developed and developing countries. The standards simulation are based on the total trade.

Appendix: List of Exporters in the Gravity Model Database

Italics indicate developing countries according to the paper's definition

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Argentina
Armenia
Aruba
Australia
Azerbaijan
Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin
Bermuda
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Canada
Cape Verde
Cayman Islands
Chad
Chile
China
Colombia
Comoros
Congo

Congo Democratic Republic
Costa Rica
Cote d'ivoire
Croatia
Cuba
Cyprus
Czech Republic
Denmark
Djibouti
Dominica
Dominican Republic
Ecuador
Egypt
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Faroe Islands
Fiji
Finland
France
French Polynesia
Gabon
Gambia
Georgia
Germany
Ghana
Greece
Greenland
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia

Iran
Iraq
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Kiribati
Korea Republic
Kuwait
Kyrgyzstan
Lao PDR
Latvia
Lebanon
Lesotho
Liberia
Libya
Lithuania
Luxembourg
Macao
Macedonia
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico
Micronesia
Moldova
Mongolia
Morocco
Mozambique
Nepal
Netherlands
Netherlands Antilles
New Caledonia

New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Palau
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Romania
Russian Federation
Rwanda
Samoa
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Serbia
Seychelles
Sierra Leone
Singapore
Slovenia
Solomon Islands
South Africa
Spain
Sri Lanka
St Kitts and Nevis
St Lucia
St Vincent and the Grenadines
Sudan
Suriname
Swaziland
Sweden
Switzerland
Syrian Arab Republic

Tajikistan
Tanzania
Thailand
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Uzbekistan
Vanuatu
Venezuela
Vietnam
Yemen
Zambia
Zimbabwe