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The Impact of Regulations on Agricultural Trade: Evidence from SPS and TBT Agreements

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The Impact of Regulations on Agricultural Trade: Evidence from SPS and TBT Agreements *

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Abstract

According to WTO rules, countries are allowed to adopt regulations under the Sanitary and Phyto-Sanitary (SPS) and Technical Barriers to Trade (TBT) agreements in order to protect human, animal and plant health as well as environment, wildlife and human safety. For agricultural products, however, there is a thin division between SPS and TBT measures and barriers to trade. Our paper offers an analysis of the structure and the importance of these measures in agricultural trade and tries to identify this division. We cover all notifying countries and products at the HS6 digit level. In contrast with previous works, our estimated gravity equation controls for the bilateral applied tariff protection and uses *ad-valorem* equivalents of SPS and TBT measures. Our results first suggest that these measures have on the whole a negative impact on OECD imports. When we consider different groups of exporting countries, we show that OECD exporters are not significantly affected by SPS and TBTs in their exports to other OECD countries while developing and least developed countries' exports are negatively and significantly affected. Furthermore, EU imports seem to be more negatively influenced by tariffs and SPS & TBTs than imports of other OECD countries. Finally, our sectoral analysis suggests an equal distribution of negative and positive impacts of NTBs on agricultural trade.

JEL classification: F13, Q17
Keywords: Agriculture, Sanitary and phyto-sanitary norms, Technical barriers to trade, *Ad-Valorem* Equivalents, Protectionism.

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1 Introduction

Sanitary and Phyto-Sanitary measures (SPS) and Technical Barriers to Trade (TBTs) may play an important role in the conduct of international negotiations: in their July 2006 meeting in St Petersburg, Vladimir Putin and George W. Bush clashed over the accession of Russia to the WTO, apparently as a result of Putin's request to impose phyto-sanitary measures on US exports of beef and pork.[1] The concern over the proliferation of sanitary or environment-related measures for agricultural and food products is not limited to the United States. Developing countries (DCs) protest regularly against the increasing use of NTBs by developed countries. During their meeting on July 13, 2004 in Mauritius, the Trade Ministers from the Alliance of the African, Caribbean and Pacific (ACP) Group of States, the African Union (AU) and the Least Developed Countries (LDCs), commonly known as the G-90 agreed on different elements for a G-90 Consensus on the Doha Development Agenda. One of these elements concerned SPS and TBT measures and asked "WTO members [to] exercise restraint in applying TBT and SPS measures to products of G-90 countries and [to] provide technical and financial assistance for compliance with SPS and TBT requirements for the export of G-90 agricultural commodities".[2] Economists also investigated the effects of SPS and TBTs on trade flows. For example, in their study on exports of Nile perch, Henson and Mitullah (2004) emphasize that stricter food safety requirements in industrialized countries forced Kenyan exporters and the government to restructure and reform (especially in terms of enhancing hygiene standards) this export-oriented supply chain and to diversify their export base away from the European Union.

The purpose of this paper is to study the importance and the structure of these measures in agricultural trade. We investigate two central questions: first, do these measures significantly influence trade flows? Second, is the impact similar for all exporting countries or are there differences (i) between OECD countries and developing (DCs) & least developed (LDCs) ones; and (ii) among DCs between Cairns and non-Cairns members? Previous works (Otsuki et al., 2001; Moenius, 2004) do not control for tariffs faced by exporters in the importing country. Consequently one cannot distinguish the impact of NTBs on trade from that of tariffs. To avoid this bias, we include a bilateral measure of market access in our estimations. We also introduce *ad-valorem* equivalents of SPS and TBT measures in order to allow direct comparison of estimated coefficients on tariff and

[1] `http://www.usembassy.it/pdf/other/RL31979.pdf`
[2] `http://www.gov.mu/portal/sites/ncb/acp/english/doc4.htm`

NTB variables. These equivalents are of course more accurate than the simple dummies or frequency indexes traditionally used in the literature.

Our results first show that, on the whole, SPS and TBT measures negatively influence OECD imports. Our estimations also suggest that SPS and TBTs do not significantly affect bilateral trade between OECD members but significantly reduce DCs and LDCs exports to OECD countries. Within DCs, Cairns and non-Cairns members' exports are similarly affected by SPS and TBTs. Furthermore, EU imports seem to be more negatively influenced by SPS and TBTs than imports of other OECD countries. Lastly, our sectoral analysis shows that SPS and TBT measures could foster trade in some sectors.

The remainder of the paper is structured as follows. The related empirical literature is presented in section 2. In section 3, we describe our data and report the results from the inventory approach. Our econometric specification and estimation results are detailed in section 4. Section 5 concludes.

2 Related empirical literature

Different measures have been suggested in the literature for identifying non-tariff barriers to trade and estimating their impact.[3] We provide here a brief review of them and of their main applications (for a detailed review, see Deardorff and Stern, 1998; Beghin and Bureau, 2001; Bora et al., 2002; or Cipollina and Salvatici, 2006). These measures can be classified into four groups: (i) the frequency and coverage type measures, (ii) the quantity-impact measures, (iii) the price-comparison measures, and finally, (iv) the price effect measures based on import demand elasticities. The first group identifies NTBs, while the second one quantifies their restrictive impact on trade. The two latter groups offer estimations of *ad-valorem* equivalents of NTBs. Quantity or price distortions are difficult to estimate in the case of NTBs (see *infra*), mainly because of the lack of appropriate data.

- *Frequency and coverage type measures.* The frequency index only accounts for the presence or absence of an NTB. This index does not provide any information on the relative value of affected products. This could be acquired through the coverage index. Ideally, the latter would be computed using the value of imports that would have occurred in the absence of

[3]The discussion will be limited to the impact on trade of measures notified under the SPS and TBT agreements. We will not consider their impact on welfare. Furthermore, we will focus on measures used to control imports. Production and export measures will not be studied.

NTBs as weight (Leamer, 1990). This value is however unobservable and imports (home or world imports) are therefore usually used as alternative weights. Nevertheless, this approach suffers from an endogeneity problem. If trade barriers are effective in reducing imports, the coverage ratio is downward-biased. Deardorff and Stern (1998) mention two other limits of coverage and frequency indexes. First, they do not indicate the deterrent effects that NTBs may have on exporters' pricing and quantity decisions. Second, these indexes do not provide information on the possible effects of trade barriers on prices, production and international trade. Last but not least, this approach misses an important issue when applied to SPS and TBTs: in case of incomplete information on traded products, such measures can facilitate trade by signaling that products are safe to the consumer. In their absence, there might be no trade at all. Such issues can be tentatively addressed using the second method detailed below.

Frequency and coverage indexes were used in several studies (Nogués et al., 1986; OECD, 1995 for example). Two of the authors also used them in one previous paper (Fontagné et al., 2005a). Nogués et al. (1986) analyze the impact of NTBs on imports of sixteen industrial countries for the years 1981-1983. The authors point out that NTBs affect more than 27% of all imports and more than 34% of imports from developing countries. Their results also show strong variations in NTB coverage by commodity, type of barrier, importing and exporting countries.

- *Quantity-impact measures.* The method consists here of estimating models of trade flows (mainly gravity equations) in which information on NTBs is introduced as explanatory variables. Comparison between predicted trade flows in the absence of NTBs and actual trade flows then provides some indication of the trade restrictiveness of these barriers. Evaluations of trade barriers included in these models are usually based on frequency or coverage indexes. One exception is Otsuki et al. (2001) who introduce the level of NTBs[4] themselves. This approach suffers two main drawbacks, however. First, the endogeneity problem between trade barriers and imports is usually not addressed (Bora et al., 2002). Besides, Beghin and Bureau (2001) emphasize that predicted trade flows are sensitive to the assumptions made in the models.

[4] Food safety standards in their case.

Leamer (1990) and Harrigan (1993) employ this method to determine the trade impact of NTBs. In both studies, trade barriers data refer to the year 1983. Leamer focuses on barriers applied by 14 major industrialised countries against Latin American exports, while Harrigan estimates the import-reducing effects of trade barriers on flows between OECD countries. Leamer's results show that trade barriers have reduced Latin American exports to these 14 importing countries, while Harrigan's conclusions suggest that trade-reducing effects of tariffs and transport costs between OECD countries were significantly higher than the one observed for NTBs. Moenius (2004) relies on this approach to investigate the trade impact of bilaterally shared and country-specific standards. His analysis covers 471 industries in 12 countries over the period 1980-1995.[5] Estimates display a positive influence of shared standards on trade. For importer-specific standards, results differ across sectors. Their influence seems to be negative for agriculture, while it is positive for manufactured goods. This latter surprising result may be due to the absence of tariff data in the estimations (cf. *infra*). This work is extended in Moenius (2006). The sample includes 80 agricultural industries in 15 countries over the period 1980-1995. This new research confirms the negative impact of importer-specific standards on agricultural trade flows. A negative effect is now obtained for shared standards. Only exporter-specific standards seem to foster trade.

Interestingly, Moenius (2006) shows that results differ for trade between EU members and imports from outsiders. Importer-specific standards do not reduce intra-EU trade, while they affect both significantly and negatively the imports from non-EU members. On the other hand, shared standards promote imports from outsiders but reduce intra-EU trade. The explanation suggested by Moenius is the following: harmonization reduces the adaptation costs faced by non-EU members (and consequently positively influences their exports to the EU), but it also limits the products' variety and thus the trading opportunities between EU members. Focusing on EU harmonization of technical regulations in the food industry, Henry de Frahan and Vancauteren (2006) suggest however that harmonization has contributed to more intra-EU trade. Finally, quantity-impact measures are also used by Fontagné et al. (2005b) for estimating the trade's effect of SPS and TBTs. Their study covers all notifications compiled up to 2001. The authors estimate a censored tobit with random effects and include bilateral

[5] The measure of standards used is the number of documents that specify the details of standards for a particular industry, country and year.

tariffs on the right-hand side of the equation. While their results suggest a predominance of negative impacts of SPS and TBTs on trade of fresh and processed food, they show insignificant or even positive impacts for most of the manufactured products.

- *Price-comparison measures.* This approach is aimed at detecting the effects of NTBs on domestic prices of imported goods by comparing these prices with some reference prices. It therefore provides AVEs of NTBs which are directly comparable with a tariff (Kee et al. 2006). Besides, these measures can pick up all NTBs effects without constraining to identify what those NTBs are (Deardorff and Stern, 1998). Since the price that would prevail in the absence of barriers is unobservable, the price effect or "price wedge" is commonly computed by simply comparing domestic and world prices in the presence of NTBs. The main drawback of such estimation strategy, however, is that it abstracts from possible quality differences between domestic and imported goods.

  Among papers implementing price wedge measures, three have made important contributions. Bradford (2003) computes AVEs using import prices corrected for transport, taxes and other distribution costs. His sample includes eight OECD countries and results highlight extensive protection of final goods.[6] Andriamananjara et al.'s (2004) paper is the first to retain a large group of countries and products. Furthermore, the authors estimate AVEs directly, using an equation derived from a differentiated products model of retail prices. Finally, Yue et al. (2006) extend the price wedge method in order to account for the heterogeneity between domestic and imported goods.

- *Price effect measures using import demand elasticities.* This new method - which also provides AVEs of NTBs - has been developed by Kee et al. (2006). Using Leamer's (1990) comparative advantage approach, the authors estimate the quantity impact of two broad types of NTBs (core NTBs and agricultural domestic support) on imports at the HS6 digit tariff line. Leamer's approach consists of predicting imports using factor endowments and of observing its deviations in the presence of NTBs. Quantity impact is then converted into an AVE using import demand elasticities. Recent criticisms have been raised against the indirect derivation by Dean et al. (2006). However, the absence of detailed price data for a large number of countries and products

[6] AVE for Japan is 57%, while it ranges from 48% to 55% for European countries. The United States have the lowest one, at 12%.

prevents the development of direct estimations and Kee et al.'s method remains currently the most satisfactory approach. We will rely extensively on it in our empirical application (cf. *infra*).

3 Data

WTO members must notify their non-tariff measures. These notifications are collected and analyzed by the UNCTAD, distinguishing between seven broad categories of measures:

- Para-tariff measures (customs surcharges, additional charges, internal taxes levied on imports);
- Price control measures (administrative pricing, voluntary export restraints, anti-dumping, countervailing measures);
- Finance measures (advance payment requirements, multiple exchange rates, transfer delays, etc.);
- Automatic licensing measures (automatic license, prior surveillance);
- Quantity control measures (non-automatic licensing including prior authorizations, quotas, prohibitions, export restraint arrangements, enterprise specific restrictions);
- Monopolistic measures (single channel for imports, compulsory national services);
- Technical measures (technical regulations, pre-shipment inspection, special custom formalities, obligation to return used products, obligation on recycling).

Our empirical implementation focuses on measures notified under the Sanitary and Phyto-Sanitary and Technical Barriers to Trade agreements. We limit our investigation to agricultural products. These barriers fit into all the above-mentioned categories, except price control measures. Countries can adduce six different motives to impose measures on agricultural trade flows: (i) protection of the environment, (ii) protection of wildlife, (iii) protection of plant health, (iv) protection of animal health, (v) protection of human health, (vi) protection of human safety.

For each notification, the database provides the notifying country (the importer), the affected product (at the six-digit level of the Harmonized System of classification - hereafter HS6), and the classification code of the barrier. 115 measures could be imposed for environment, wildlife, health or safety purposes. However, only 43 of them are effectively enforced. We will therefore focus only on the latter. The list (code and description) is given in table A.1 of the appendix.

Using these data, we will estimate econometrically the impact of SPS and TBT measures on bilateral trade in agricultural products (section 4).

Before doing this, we provide some descriptive statistics and examine which countries make most intensive use of SPS or TBT measures. We also investigate which sectors and exporters are the most affected and whether SPS and TBTs are used in accordance with their original objective or instead used in a protectionist way. The inventory approach is an efficient way of addressing these issues. If a sizeable share of international trade is affected by these barriers, then this would suggest the presence of a wider consensus among importers on the negative impact of the product on the environment, or on the magnitude of risks for health or safety. On the other hand, if only a single or very few countries notify a measure, they can be suspected of protectionism. The boundary between both cases will be of course a matter of arbitrary chosen thresholds. We will adopt the following criteria and divide products into five categories:

- Products for which none of the importers introduce a measure;
- Those for which at least one country imposes a measure;
- Products for which at least 25% of world imports in value are directly affected by SPS and TBT measures (irrespective of the number of importing countries applying such measures). We call them "widely-affected products";
- Products for which at least 25% of importers notify a measure (irrespective of their share in world trade). For importers, these products create a danger to environmental and sanitary security. This category is denominated "sensitive products";
- Finally, if five or less countries enforce a measure on a product, we consider that we are in presence of *protectionism*.

We first merge at the HS6 level information on notifications with trade data of the BACI database developed by the CEPII.[7] As stressed in the introduction, we focus only on agricultural and food

[7] `http://www.cepii.fr/francgraph/bdd/baci.htm`. This database developed by Guillaume Gaulier and Soledad Zignago uses original procedures to harmonise COMTRADE data: evaluation of the quality of country declarations

industry goods (See table A.2 in the appendix for a description of these products). Data on trade are for the year 2004. Notifications are compiled *up to 2004*, but countries are actually not notifying on a regular basis. Our sample includes 154 importing countries, 183 exporting countries and 690 products. EU countries are considered individually. We exclude intra-EU trade flows from our sample. EU member states apply the principle of mutual recognition on SPS and TBT regulations. Therefore, it would be irrelevant to consider that these regulations affect in the same way intra-EU and extra-EU trade.

Among the importing countries, only 92 notify measures under the SPS and TBT agreements. Data on notifications do not have a bilateral dimension. With rare exceptions, measures are enforced unilaterally by importing countries and applicable to all exporting countries. However, as our inventory approach will suggest, exporters will be differently affected by SPS and TBT measures depending on the structure of their exports in terms of products and markets. In our analysis, the value of world imports of products affected by SPS and TBT measures (i.e. HS6 positions for which at least one importer is notifying at least one measure) is denominated "world imports in affected products". Besides, "imports in notifying countries" correspond to the value of imports in affected products by countries having enforced measures. Lastly, the term "coverage ratio" refers to the ratio of imports in notifying countries over world imports in affected products.

Among the 43 different measures described in table A.1, all of them except one ("quota to protect environment" – code 6274) are present in our sample. These measures represent 5,247 notifications.[8] Figure 1 presents the number of affected products and the coverage ratio of each group of SPS and TBT measures included in our sample. If we rank these groups using the number of affected products, "technical barriers", which define specific characteristics for products, is the most frequent measure. We then obtain "authorization" and "technical measure related to testing, inspection or quarantine requirements". Both of them affect the same number of products (677 products). The latter measure is also the one with the highest coverage ratio (19.84%) and the highest amount of imports in notifying countries (USD 77,839 millions). Any obvious link between the number of notifications and the coverage ratio can be seen in our sample. For example, quotas for sensitive products affect 3 products and have a coverage ratio of 1.49%, while surveillance measures affect 610

to average mirror flows, evaluation of CIF rates to reconcile import and export declarations, etc.

[8]An HS6 position can be affected by several notifications. This explains why the number of notifications is higher than the number of "products".

products but with a coverage ratio of only 0.49%. We mentioned previously that six concerns can be adduced by countries to justify these barriers. Figure 2 reports the distribution of the motivations in our sample. The protection of human health is the most frequent concern. Our results also show that this concern is associated with the highest degree of restrictiveness (19.84%). In decreasing order of number of notifications, the other concerns are for animal health, plant health, human safety, wildlife and environment.

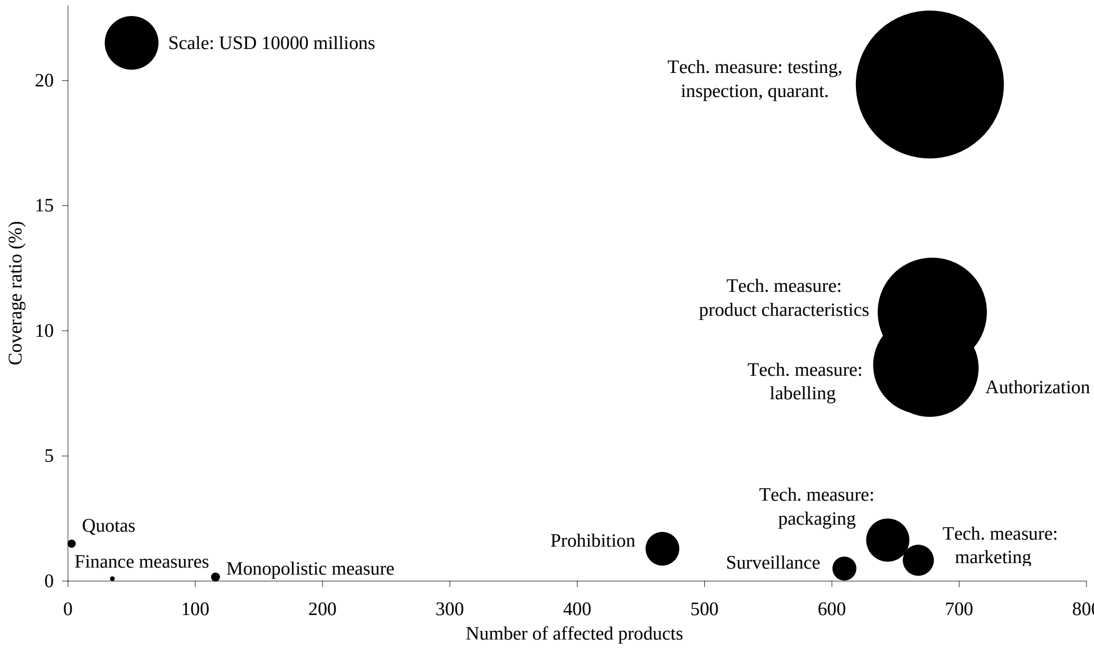

Figure 1: Typology of SPS and TBT measures in agriculture (2004)

Table 1 reports results on the distribution of measures by number of notifying countries. Over the 690 agricultural and food industry products, only 4 do not face any barrier in any importing country (HS6: 150510 - Wool grease, crude; HS6: 151560 - Jojoba oil or fractions not chemically modified; HS6: 430140 - Raw beaver furskins, whole; HS6: 430150 - Raw musk-rat furskins, whole). For the remaining 686 products, measures are notified by at least one importer. For these products, the amount of imports in notifying countries is 176,598.07 millions of US dollars and the average coverage ratio is 45% (=176,598.07/392,445.14). For 20 products (2.90% of all products), one can suspect a protectionist use of barriers, identified as cases where only five or less countries enforce a measure on a product. The associated value of imports in notifying countries is 7.46 millions of

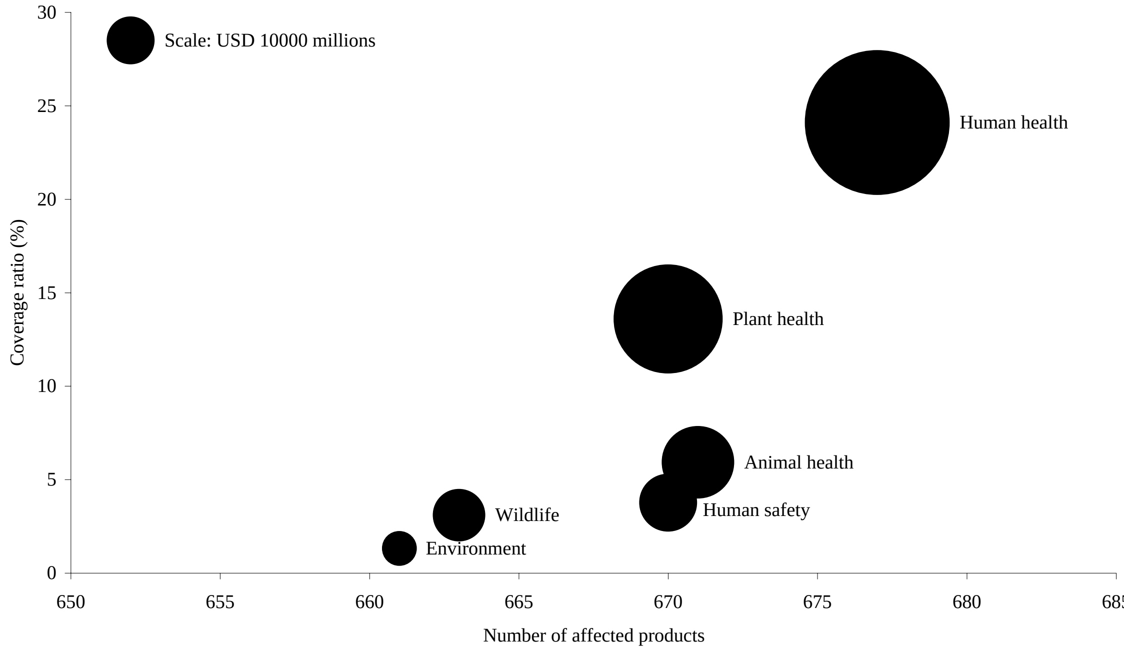

Figure 2: Motivations for SPS and TBT measures in agriculture (2004)

dollars, compared with a value of world imports of 45.87 millions. If the scope of the analysis is restricted to cases where only one country notifies a measure, the number of affected products is then 6, corresponding to US$ 5.75 millions imports of which only 14.90% are effectively affected by the notification. The very low amount of imports for these products could be another indication of the effective restrictiveness of the measure.

We previously defined "sensitive products" as products for which at least 25% of importing countries notify a measure. Our sample includes 154 importers. Thus, a product is sensitive if more than 39 countries notify a measure. The results reported in the two last rows of table 1 suggest that 366 products of our sample are sensitive. The coverage ratio for these products is 50%.

Table 2 presents results on barriers' coverage ratio. In our sample, 260 (37.68%) agricultural and food industry products have a coverage ratio above 50%. Also, 502 (72.75%) products could be viewed as "widely-affected" products. At least 25% of world imports in value of these products are indeed directly affected by SPS and TBT barriers. The coverage ratio for them is 55.36%.

We now investigate which products are the most affected by these measures. We rank products according to the following three criteria: (i) number of notifying countries, (ii) coverage ratio and

Table 1: Distribution of SPS and TBT measures by number of notifying countries

Nb. of notifying countries	Nb. of affected products	Imports in notifying countries (millions USD)	World imports in affected products (millions USD)	Coverage ratio (%)
0	4	0	0.54	0
1	6	0.86	5.75	14.90
[1 – 5]	20	7.46	45.87	16.27
[6 – 10]	13	138.87	1589.20	8.74
[11 – 20]	54	1271.24	6038.98	21.05
[21 – 30]	100	7043.30	25078.05	28.09
[31 – 40]	154	23137.19	72732.10	31.81
[41 – 50]	244	69503.82	163890.00	42.41
[51 – 60]	63	44735.46	77945.55	57.39
[61 – 70]	32	19177.59	30379.79	63.13
[71 – 80]	6	11583.14	14745.06	78.56
≤ 39	324	28906.05	97039.92	29.79
> 39	366	147692.00	295405.20	50.00

Notes : Authors' calculations.

Table 2: Coverage ratio of SPS and TBT measures

Percentage of world imports subject to SPS or TBT (%)	Nb. of affected products	Imports in notifying countries (millions USD)	World imports in affected products (millions USD)	Coverage ratio (%)
]90 – 100]	18	4512.29	4739.61	95.20
]80 – 90]	38	14961.69	17739.26	84.34
]70 – 80]	54	35735.70	48115.48	74.27
]60 – 70]	57	23076.74	35986.97	64.13
]50 – 60]	93	36396.78	65581.73	55.50
]40 – 50]	106	24584.24	55057.94	44.65
]30 – 40]	101	14933.50	42890.65	34.82
]20 – 30]	92	14845.64	60678.66	24.47
]10 – 20]	86	6549.53	48736.58	13.44
]0 – 10]	41	1001.99	12917.70	7.76
0	4	0	0.54	0
≤ 25	188	17916.96	105831.60	16.93
> 25	502	158681.10	286613.50	55.36

Notes : Authors' calculations.

(iii) imports in notifying countries. In each case, the 10 most affected products are retained. Results are depicted in table 3. These criteria strongly influence the ranking of products. Products are indeed mostly different in each ranking. In other words, the top 10 affected products in terms of number of notifying countries are not those for which the coverage ratio is the highest. Similarly, for 7 of the most affected products in terms of notified imports (last part of the table), the number of notifying countries is below the one observed when this latter criterion is used to rank products (1^{st} part of the table). Lastly, our results suggest that the total value of notified imports for the top 10 affected products in terms of number of notifying countries is more than five times higher than the one observed in terms of coverage ratio: 17,014.83 millions of dollars in the first case versus 3,302.28 millions of dollars in the second one.

The next step is to analyze the use of SPS and TBTs by importing countries: this will in particular shed light on the possible obstacle raised against LDCs' exports. Table 4 presents a comparison of measures notified by OECD countries (excluding Luxembourg). These importers are the ones we will consider in our econometrical application (section 4). One result of interest is the variance observed between OECD countries. Five of them (Australia, Mexico, New Zealand, Norway, and the United States) have a coverage ratio above 50%. By comparison, the coverage ratio is only 23.52% for Japan. The coverage ratio for EU is 11.75%. Note that the variations in terms of coverage ratio and numbers of affected products between EU members result from differences in countries' import structures. For example, five EU countries (Denmark, Finland, Hungary, Slovakia and Sweden) do not import the product "HS6: 010420 - Live Goats", on which EU members notify a SPS. Lastly, we should mention that the three members of the Cairns group[9] included in our sample - Australia, Canada and New Zealand - have a higher coverage ratio than the one observed for each EU country.

The inventory approach can also be used to analyze which exporting countries are the most affected by SPS and TBT notifications. Export flows are here calculated using mirror flows. Results are described in table 5. Top 10 affected exporting countries are defined using two different rankings. The first one uses the coverage ratio and the second one refers to the number of affected products. The choice of the criterion strongly affects the results. One interesting finding is that the most affected exporters in terms of coverage ratio are developing countries. On the other hand, 7 of

[9] This group is a coalition of 18 agricultural exporting countries which account for over 25% of the world's agricultural exports. These countries support trade liberalization in agriculture.

Table 3: Most affected products

HS6 code	Description	Imports in notifying countries (millions USD)	Coverage ratio (%)	Nb. of notifying countries
By nb. of notifying countries				
010600	Animals, live, except farm animals	292.34	83.64	78
060310	Cut flowers and flower buds for bouquets, etc., fresh	1768.75	76.87	73
020230	Bovine cuts boneless, frozen	4297.87	72.57	73
060210	Unrooted cuttings and slips	217.88	88.28	72
160420	Fish prepared or preserved, except whole, in pieces	677.51	83.41	72
020329	Swine cuts, frozen nes	4328.80	84.66	71
190110	Infant foods of cereals, flour, starch or milk, retail	715.32	55.60	69
060290	Other live plants, cuttings and slips; mushroom spawn	824.80	75.46	68
020130	Bovine cuts boneless, fresh or chilled	3487.27	71.98	68
010119	Horses, live except pure-bred breeding	404.29	62.10	68
By coverage ratio				
020312	Swine hams, shoulders & cuts bone in, fresh or chilled	487.47	98.21	49
020630	Swine edible offal, fresh or chilled	49.23	97.76	32
020319	Swine cuts, fresh or chilled nes	1602.24	97.11	63
080131	Cashew nuts, in shell dried	370.84	96.61	24
020820	Frog legs, fresh, chilled or frozen	31.08	96.20	32
021012	Bellies (streaky) of swine, salted, dried or smoked	174.51	95.25	50
020210	Bovine carcasses and half carcasses, frozen	199.95	95.03	36
160242	Swine shoulders & cuts thereof, prepared or preserved	89.69	94.98	37
020680	Sheep, goat, ass, mule, hinnie offal, fresh or chilled	6.36	94.41	27
110423	Maize (corn), hulled, pearled, sliced or kibbled	290.91	93.62	39
By imports in notifying countries				
100190	Wheat except durum wheat, and meslin	9235.90	73.73	53
120100	Soya beans	8921.85	58.14	45
210690	Food preparations nes	5078.15	57.41	52
020329	Swine cuts, frozen nes	4328.80	84.66	71
020230	Bovine cuts boneless, frozen	4297.87	72.57	73
100590	Maize except seed corn	3857.46	42.35	52
020130	Bovine cuts boneless, fresh or chilled	3487.27	71.98	68
150710	Soya-bean oil crude, whether or not degummed	3195.76	79.88	37
100630	Rice, semi-milled or wholly milled	2690.66	53.96	58
151190	Palm oil or fractions simply refined	2557.60	38.48	43

Notes : Authors' calculations.

Table 4: Comparison between OECD importers

Country	Coverage ratio (%)	Nb. of affected products	Country	Coverage ratio (%)	Nb. of affected products
EU members			*Other OECD countries*		
Denmark	18.34	99	Australia	97.07	568
Greece	14.45	94	Mexico	96.27	594
Italy	13.85	111	New Zealand	82.24	526
Sweden	12.66	79	Norway	81.16	486
Poland	12.39	87	United States	58.27	410
Great Britain	12.32	108	Switzerland	48.18	346
Germany	12.02	112	Canada	42.53	380
Netherlands	11.94	104	Iceland	27.42	143
France	11.62	109	Japan	23.52	87
Finland	10.51	79	South Korea	0	0
Ireland	9.91	75	Turkey	0	0
Belgium	9.86	94			
Austria	9.44	90			
Czech Republic	9.19	77			
Portugal	9.18	73			
Spain	8.42	102			
Slovakia	8.07	67			
Hungary	6.57	70			
All EU members	*11.75*	*118*			

Notes : Authors' calculations.

the 10 most affected exporting countries regarding the number of affected products are developed countries. This last result could be easily explained by the fact that these countries are big. They therefore export more products and face more SPS and TBT measures. The biggest contrast between both groups of countries is probably the difference between the number of affected products and the coverage ratio. For example, Bhutan has a coverage ratio of 98.41% but only 21 affected products, while the United States have a coverage ratio of 46.91% and 663 of their products are submitted to notifications on at least one destination market.

Table 5: Most affected exporting countries

Country	Coverage ratio (%)	Exports of affected products (millions USD)	Total exports (millions USD)	Nb. of affected products
By coverage ratio				
Guinea-Bissau	98.71	61.93	62.74	3
Bhutan	98.41	9.06	9.212	21
New Caledonia	96.75	79.66	82.33	60
Nepal	88.93	74.07	83.29	130
Belarus	88.54	1068.31	1206.64	337
Afghanistan	86.67	92.07	106.23	85
Bolivia	86.18	560.70	650.61	173
Myanmar	84.53	251.30	297.27	137
Cambodia	84.23	42.55	50.51	78
Armenia	79.04	63.40	80.21	92
By nb. of affected products				
United States	46.91	30977.72	66040.78	663
France	38.43	4710.37	12257.90	641
Germany	48.92	3610.17	7380.17	633
The Netherlands	45.49	4318.60	9494.18	612
Australia	38.89	7260.41	18669.47	610
China	33.86	6563.78	19382.39	607
India	43.19	3475.07	8046.25	601
Italy	35.63	2614.47	7338.48	590
South Africa	24.55	1149.51	4681.73	583
Spain	54.05	2256.92	4175.28	574

Notes : Authors' calculations. Export flows are obtained using the mirror flows.

4 Empirical application

4.1 Econometric specification

In this section, we quantify the impact of NTBs on bilateral trade. Gravity equation provides an appropriate framework for this analysis. This equation can be seen as a reduced form of the theoretical trade flow prediction. Our theoretical foundation for trade patterns is the standard new trade monopolistic competition-CES demand-Iceberg costs model introduced by Krugman (1980).[10] Producers in each country operate under increasing returns to scale and produce differentiated varieties. These varieties are shipped with a cost to consumers in all countries. Following Redding and Venables (2004), the total value of exports from country i to country j can be written as follows:

$$x_{ij} = n_i p_i^{1-\sigma} (T_{ij})^{1-\sigma} E_j G_j^{\sigma-1} \tag{1}$$

with n_i and p_i the number of varieties and prices in country i, E_j and G_j being the expenditure and price index of country j. T_{ij} represents the iceberg transport costs.

Trade data are available at the 6-digit level. Thus, a key issue here is to choose an aggregation level detailed enough in order to keep variance among groups of products, but aggregated enough in order to avoid the endogeneity bias. At the most detailed level of the product, estimating the impact of NTBs may simply reveal that NTBs are imposed where imports have to be kept under control in absence of sizeable tariffs. We therefore decided to aggregate products according to the HS nomenclature with 4 positions, and measure the tightness of NTBs within each of these categories by relying on our information at the 6-digit level.

Two empirical specifications could be used to estimate this equation. First, exporting country's supply capacities and importing country's market capacities could be proxied by the GDPs of both countries. However, the robustness of this specification has been recently questioned in the trade literature. Note that this is especially so both in the case of agricultural goods and when one is modeling trade at the detailed level of the products or groups of products. A more theoretically consistent approach consists in using fixed effects for each exporting and importing country (see Feenstra, 2004). These fixed effects indeed include the size effects, but also the price and number of

[10] As shown by Deardorff (1998), the gravity equation can also be derived from the Heckscher-Ohlin theory.

varieties of the exporting country for each sector and the size of demand and the price index of the importing partner. Since we use sector-level trade data, we interact HS 2-digit sector- and country fixed effects to fully capture the unobserved price indexes at the sector-level. Transport costs are measured with the bilateral distance between both partners. These distances are extracted from the CEPII database[11] and are calculated as the sum of the distances between the biggest cities of both countries, weighted by the share of the population living in each city. We also include a dummy variable "Common border" (*cbord*) that equals one if both countries share a border.

Bilateral trade can be fostered by countries' cultural proximity. Similarity in culture can indeed increase the quality of the match between varieties produced in country i and tastes of consumers in country j. We therefore control for this proximity by introducing two dummies, respectively equal to one if a language is spoken by at least 9% of the population in both countries (*clang*)[12] or if both partners have had a colonial relationship (*col*). Data come from the previously mentioned CEPII database.

The next step is to introduce tariff barriers in the gravity equation. Previous works (see for example Otsuki et al., 2001; Moenius, 2004) do not include the tariffs faced by country i's exporters in j in the estimations.[13] Consequently *one cannot distinguish the impact of NTBs on trade from that of tariffs*. To avoid this bias, we include a *bilateral* measure of market access in our estimations. Data are extracted from the Market Access Map (MAcMap) database jointly developed by the ITC (UNCTAD-WTO) and the CEPII.[14] This database incorporates not only the applied tariff but also specific duties, tariff quotas and anti-dumping duties. All these barriers are converted into an *ad valorem* equivalent and summarized in one measure. This measure is computed initially at the HS6 level. Since we conduct our analysis at the HS4 level we need to average tariff data. Since the traditional import-weighted average is flawed by the problem of endogeneity between trade flows and tariffs, we will rely on the Reference Group method used in MAcMap.[15]

Our focus in this paper is on the trade impact of measures notified by importing countries under

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[11] `http://www.cepii.fr/anglaisgraph/bdd/distances.htm`

[12] Several studies control for the share of a common official language. However in countries with several official languages, some of them are spoken by a very small share of the population and are not used for trade. We therefore prefer to consider any language spoken by a large share of the population in both countries.

[13] One exception is Fontagné et al. (2005b).

[14] `http://www.cepii.fr/anglaisgraph/bdd/macmap.htm`

[15] This methodology uses a weighting scheme based on reference groups of countries (for more details, see Bouët et al., 2004). We thank David Laborde for extracting the data from the MAcMap database.

the SPS and TBT agreements. The last step is therefore to specify these barriers. We consider three different variables: (i) a dummy variable equal to one if the importing country notifies at least one barrier at the 6-digit level of the HS classification, (ii) a frequency index and (iii) an *ad-valorem* equivalent. The third variable is of course more accurate than the other two and is directly comparable with the tariff variable. It will be our preferred measure. The frequency index is defined as the proportion of HS6 product items notified by the importing country within a HS4 product category. Values belong to the [0;1] interval.[16] Data on *ad-valorem* equivalents come from Kee et al. (2006). The authors construct price effect measures using import demand elasticities. They first introduce a dummy variable indicating the presence of a NTB in a specification based on Leamer's comparative advantage approach. The estimated coefficient of this variable captures the quantitative impact of the NTB on imports. It is then translated into a price equivalent using import demand elasticity.[17] By merging their database and our information on notifications under SPS and TBT agreements, we can isolate AVEs of SPS and TBT measures. For example, in Kee et al.'s sample, the US impose a NTB on the HS6 code 020120, and its AVE is 0.826. The UNCTAD database also indicates the presence of a notification by the US on this HS6 code. We therefore pick up the AVE calculated by Kee et al. (2006) for this observation. However, Kee et al. consider various NTBs. Therefore, if a NTB is included in their sample but not in the UNCTAD one, we assume that this NTB is not a SPS or TBT measure and do not use the AVE they compute. For our estimations, we calculate average AVEs at the HS4 level using the reference group method. If we focus on OECD countries, the average AVE is 0.313, with a standard error of 0.397. For EU importers (without Luxembourg), the mean is 0.347 and the standard error is 0.397. By comparison, Australia, Canada and New Zealand - which are Cairns members - have an average AVE of 0.320 (standard error: 0.435) and for other OECD importers which are not EU or Cairns members, the average AVE is 0.233 (standard error: 0.359).

After taking logs and introducing all the explanatory variables, our preferred estimated equation

[16]For example, the product category "0102 - Live bovine animals" includes 2 product items: "010210 - Pure-bred breeding animals" and "010290 - Other". If an importing country imposes a barrier on the first product item, then its frequency index is 0.5 (1/2).

[17]SPS and TBTs represent only two types of the NTBs covered by Kee et al. (2006). If more than one type of NTBs is imposed by the importing country at the tariff line level, the dummy variable included in the regression captures the quantitative impact of all these NTBs and its effect is higher. Thus, the estimated price equivalent is biased. However, we assume that most NTBs notified on agricultural products are SPS and TBT measures and therefore ignore this potential bias in our estimations.

is:

$$\ln x_{ij}^{s_{hs4}} = \mu_i \text{fe}_i^{s_{hs2}} + \lambda_j \text{fe}_j^{s_{hs2}} + \delta_1 \ln d_{ij} + \delta_2 \text{cbord}_{ij} + \delta_3 \text{clang}_{ij} + \delta_4 \text{col}_{ij}$$
$$+ \delta_5 \text{tar}_{ij}^{s_{hs4}} + \delta_6 \text{NTB}_{ij}^{s_{hs4}} + u_{ij}^{s_{hs4}}. \quad (2)$$

For our dependent variable, we choose bilateral import data of country j from country i. The source is the BACI database, already used in the inventory approach (see section 3), a database which provides us with harmonized trade data. Notifications are compiled up to 2004 in our sample (we take the latest year available for every reporter), and tariff data are for 2004. We therefore use cross-section data for 2004. We use cluster regressions to deal with the problem of clustering of errors.

4.2 Results

We now present our estimation results. The database is hardly satisfactory with regards to the notifications made by non-OECD countries. Some sets of notifications have not been updated for years; other have been updated - or recorded by UNCTAD - without checking their consistency (e.g. countries imposing NTBs on all products); lastly, certain developing economies may actually enforce such barriers without having notified them. Tariffs applied by non-OECD countries also present some inconsistencies. Facing such evidence of poor quality data concerning developing countries as importers, we decided to restrict our sample of importers to OECD countries.

Table 6 presents an overview of the results. The first two columns report results with a simple gravity estimation. Fixed effects estimation results are presented in columns (3) to (7). Technical and degree of freedom constraints forced us to limit the number of fixed effect variables in our estimations. We therefore include only HS 2-digit sector-specific exporter fixed effects and do not interact importer fixed effects with sector dummies.[18] Column (1) uses the import-weighted average methodology to aggregate the bilateral tariffs from the tariff line to the HS4 level. In the other columns, the reference group approach is applied. To allow comparisons, we restrict our sample in column (1) to observations for which bilateral tariffs using the reference group approach are available. Similarly, we re-estimate model (3) restricting the sample to observations for which we have the AVE

[18] Our estimations will therefore include 6039 sector-specific exporter fixed effects (183 exporter fixed effects × 33 sector fixed effects) and 29 importer fixed effects.

of NTBs: results are shown in column (4). We also impose this constraint in columns (5) and (6).

The overall fit of regressions is consistent with what is found in the literature. The comparison between columns (1) and (2) shows that the coefficient magnitude on the tariff variable is not significantly affected by the choice of the aggregation procedure. Regarding traditional covariates, distance negatively influences bilateral imports. As expected, trade flows are fostered by the share of a border. A common border raises trade by a factor of 2.05 (exp[0.72]), everything else held constant (column 1). If we focus now on cultural proximity variables, we can see that imports are higher if both countries share a language or have had a colonial relationship in the past. This last variable is however significant only at the 10% level.

Comparing results from simple gravity and fixed effects estimations (columns 2, 3 and 4), we see that the value of coefficients varies but the sign of the influence is unchanged. Besides, the levels of significance of common border and colonial links variables improve. The one of common language variable decreases from the 0.01 level to the 0.05 level in column (3). Nonetheless, it finds its 0.01 level significance again in column (4) when we restrict our sample to observations for which AVEs of NTBs are available. Before we discuss the results obtained for NTBs notified under SPS and TBT agreements, we should mention that the influence of all the other explanatory variables is stable in the fixed effects specifications (columns 4 to 7).

Concerning NTB measures, columns (5), (6) and (7) include respectively a simple dummy variable equal to one if the importing country notifies at least one barrier at the HS6 level, a frequency index and finally an *ad-valorem* equivalent based on Kee et al. (2006) (cf. *supra* for more details on these variables). The estimated coefficient on NTBs is always negative and significant. The introduction of a simple dummy variable (column 5) provides a coefficient equal to -0.15 while the use of a frequency index (column 6) gives a coefficient equal to -0.21. Both coefficients are significant at the 1% level. When an AVE of NTBs is introduced (column 7), the estimated coefficient on NTBs is -0.06 ($p < 0.05$). Furthermore, in this last estimation, the Wald test shows that coefficients on tariffs and on SPS and TBTs are not significantly different (the two coefficients can be compared since we rely on AVE for the former). This last estimation is our preferred one.

Table 7 goes further in the analysis and presents the influence of tariffs and NTBs for different subsamples of *importers*. In this table, SPS and TBTs are measured in terms of *ad-valorem* equivalents. In the first three columns, all OECD countries are included in our sample of importers. Note that

Table 6: Influence of NTBs - General Overview

Dep. variable:	Ln (imports)						
Model :	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Importers:	OECD Countries						
Exporters:	All Countries						
ln GDP exporter	0.15^a	0.15^a					
	(0.01)	(0.01)					
ln GDP importer	0.11^a	0.11^a					
	(0.01)	(0.01)					
ln distance	-0.29^a	-0.29^a	-0.68^a	-0.77^a	-0.77^a	-0.77^a	-0.78^a
	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
common border	0.72^b	0.72^b	0.94^a	0.92^a	0.92^a	0.92^a	0.92^a
	(0.32)	(0.32)	(0.16)	(0.17)	(0.17)	(0.17)	(0.17)
common language	0.34^a	0.34^a	0.13^b	0.22^a	0.22^a	0.22^a	0.22^a
	(0.09)	(0.09)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
colonial links	0.19^c	0.19^c	0.20^a	0.28^a	0.27^a	0.27^a	0.28^a
	(0.10)	(0.10)	(0.07)	(0.08)	(0.08)	(0.08)	(0.08)
bilateral tariff (import-weighted)	-0.05^b						
	(0.02)						
bilateral tariff (ref. group) [I]		-0.06^a	-0.06^a	-0.08^a	-0.08^a	-0.08^a	-0.08^a
		(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
= 1 if at least one NTB at the HS6 level					-0.15^a		
					(0.03)		
frequency index of NTBs						-0.21^a	
						(0.03)	
AVE of NTBs (ref. group) [II]							-0.06^b
							(0.03)
Wald test [I]=[II]							0.31
Nb. Obs.	90783	90783	90783	68956	68956	68956	68956
R^2	0.699	0.699	0.778	0.795	0.795	0.795	0.795
RMSE	2.626	2.626	2.308	2.258	2.258	2.258	2.258

Note: Standard errors (importing country-exporting country clustered) in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Specifications (1) and (2) include sector fixed effects. Specifications (3) to (7) include importer and sector-specific exporter fixed effects.

column (1) replicates column (6) of table 6 for convenience. The last three columns now focus only on EU member states (excluding Luxembourg). The overall quality of the fit remains high and is comparable to that obtained in the previous table.

A second objective in this table is to study potential differences in the influence of tariffs and NTBs between *exporting* countries. The first distinction we make is between OECD exporters on one hand, and DCs & LDCs on the other hand. Consequently, in columns (2) and (5), we interact tariffs and NTBs with two indicator variables respectively equal to one if exporters are OECD countries and DCs or LDCs. For comparison, columns (1) and (4) do not include any distinction between exporting countries.

We first analyze the results for all OECD importers and then compare them with those for EU countries. As previously mentioned, OECD imports are similarly affected by SPS & TBTs and tariffs (column 1). Results on interaction variables are particularly interesting (column 2). First, our results suggest that OECD exporters are more affected than DCs and LDCs exporters by tariffs (-0.14^a vs. -0.04^b): this result is easy to interpret if one keeps in mind that we are considering agricultural and agro-food products, where tariffs are sizeable. Also, developing exporters are specialized in tropical products that are less protected by tariffs or benefit from tariff preferences. More interestingly, NTBs have an *insignificant* impact on OECD exports (0.08) but a negative one on DCs and LDCs exports (-0.14^a). We are confronted here with the dual effect of SPS and TBTs in agriculture: they can have no impact on trade or even facilitate it as they carry information and confidence on the imported products, assuming that exporters can cope with the associated technical requirements and paperwork; but they can also be a barrier to trade. Our conclusion is that SPS and TBTs can be considered as green protectionism by developing countries' exporters. Combining the previous remarks, we can check that DCs and LDCs are more affected by NTBs than by tariffs (-0.14^a vs. -0.04^b).

Regarding the sub-sample restricted to EU imports (columns 4 and 5), the magnitude of estimated coefficients on tariffs is higher than the one observed for all OECD imports, a conclusion in line with the concerns of exporters with market access in the EU for agricultural products. Another difference should also be mentioned. The SPS and TBTs now influence negatively ($p < 0.10$) exports of other OECD countries (column 5).[19]

[19] Results on traditional gravity variables also show some differences in the determinants of OECD and EU imports. The influence of common border is smaller and less significant whereas the impact of colonial links and distance is

Table 7: Influence of NTBs - Various samples.

Dep. variable:	Ln (imports)					
Model :	(1)	(2)	(3)	(4)	(5)	(6)
Importers:	OECD Countries			EU Countries		
Exporters:	All Countries					
ln distance	-0.78[a]	-0.78[a]	-0.78[a]	-0.96[a]	-0.96[a]	-0.96[a]
	(0.04)	(0.04)	(0.04)	(0.12)	(0.12)	(0.12)
common border	0.92[a]	0.92[a]	0.92[a]	0.43[b]	0.43[b]	0.43[b]
	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)	(0.18)
common language	0.22[a]	0.22[a]	0.22[a]	0.19[b]	0.19[b]	0.19[b]
	(0.06)	(0.06)	(0.06)	(0.09)	(0.09)	(0.09)
colonial links	0.28[a]	0.27[a]	0.27[a]	0.35[a]	0.35[a]	0.35[a]
	(0.08)	(0.08)	(0.08)	(0.10)	(0.10)	(0.10)
bil. tariff [I]	-0.08[a]			-0.28[a]		
	(0.02)			(0.06)		
bil. tariff × OECD countries		-0.14[a]	-0.14[a]		-0.74[a]	-0.74[a]
		(0.03)	(0.03)		(0.09)	(0.09)
bil. tariff × DCs and LDCs		-0.04[b]			-0.08	
		(0.02)			(0.07)	
bil. tariff × DCs and Cairns members			-0.03			0.03
			(0.04)			(0.10)
bil. tariff × DCs and LDCs but non-Cairns members			-0.05[b]			-0.19[b]
			(0.02)			(0.10)
AVE of NTBs [II]	-0.06[b]			-0.26[a]		
	(0.03)			(0.04)		
AVE of NTBs × OECD countries		0.08	0.08		-0.13[c]	-0.13[c]
		(0.05)	(0.05)		(0.07)	(0.07)
AVE of NTBs × DCs and LDCs		-0.14[a]			-0.31[a]	
		(0.03)			(0.05)	
AVE of NTBs × DCs and Cairns members [III]			-0.13[a]			-0.30[a]
			(0.03)			(0.08)
AVE of NTBs × DCs and LDCs but non-Cairns members [IV]			-0.16[a]			-0.31[a]
			(0.04)			(0.05)
Wald test [I] =[II]	0.31			0.10		
Wald test [III] =[IV]			0.28			0.01
Nb. Obs.	68956	68956	68956	35980	35980	35980
R^2	0.796	0.795	0.795	0.787	0.787	0.787
RMSE	2.258	2.258	2.258	2.236	2.235	2.235

Note: Standard errors (importing country-exporting country clustered) in parentheses with [a], [b] and [c] respectively denoting significance at the 1%, 5% and 10% levels. Importer and sector-specific exporter fixed effects are included in all our estimations.

Another potentially useful distinction is within DCs between Cairns and non-Cairns exporters. In columns (3) and (6), tariffs and NTBs are therefore interacted with three dummies that respectively take the value of 1 if exporters are (i) OECD countries, (ii) DCs and Cairns members, and (iii) DCs and LDCs but non-Cairns members. Our analysis shows that, within DCs and LDCs, the most affected by tariffs are non-Cairns members. This conclusion holds for both OECD (column 3) as well as EU imports (column 6). If we now focus on NTBs, Wald tests suggest that Cairns and non-Cairns DCs and LDCs are similarly affected by SPS and TBT measures in their exports to the OECD countries (column 3) and to the EU market (column 6). Furthermore, estimated coefficients on AVE of NTBs for EU imports are again higher than the ones obtained for OECD flows. Table 7 seems therefore to suggest that tariffs as well as SPS and TBT measures applied by EU countries make it harder for foreign countries to export their agricultural goods to the European market than to other OECD countries' markets. This result is close to the one obtained by Moenius (2006).

Now, we would like to know in which agricultural sub-sectors the protectionist impact of SPS and TBTs is the most stringent. Table 8 reports the estimated coefficient on the NTB variable for each sub-sector at the HS2 level. We run two different estimations. First, we interacted the NTB variable with sectoral dummies. Results are presented in column (1). The second strategy we adopted consisted in estimating our equation for each sector separately (column 2). One advantage of this approach is to allow coefficients on all other explanatory variables to differ across sectors. Column (1) includes importer and sector-specific exporter fixed effects while column (2) includes importer and exporter fixed effects. Due to the small number of observations, we do not report results for the three following sectors: HS29 "Organic chemicals", HS38 "Miscellaneous chemical products", and HS50 "Silk".

Results in both columns are relatively similar. Some coefficients are significant in only one estimation but none of them have a positive and significant influence in one estimation and a negative and significant impact in the other. For 8 sectors, estimated coefficients are *negative* and significant in both columns. The impact is particularly strong in sectors HS06 "Live trees, plants, bulbs, roots, cut flowers ", HS13 "Lac, gums, resins, vegetable saps & extracts nes ", HS22 "Beverages, spirits & vinegar", and HS24 "Tobacco & manufactured tobacco substitutes". Note that the influence of NTBs on trade is also negative for the sector HS17 "Sugars & sugar confectionery", which is largely

higher for EU.

Table 8: NTB Coefficients for each sector HS2

Estimated coefficient on:	AVE of NTBs			
Model :	(1)	(2)		
Specification:	All other coeff. constrained	Regressions sector by sector	Nb. obs.	R^2
HS01 - Live animals	-0.02	0.32	619	0.866
HS02 - Meat & edible meat offal	-0.40	-0.76[a]	1549	0.827
HS04 - Dairy products, eggs, honey, edible animal pduct. nes	0.61[a]	0.99[a]	1485	0.817
HS05 - Products of animal origin, nes	0.82[a]	0.97[a]	1429	0.767
HS06 - Live trees, plants, bulbs, roots, cut flowers	-2.03[a]	-1.72[a]	2715	0.815
HS07 - Edible vegetables & certain roots & tubers	0.11	0.11	6009	0.765
HS08 - Edible fruit, nuts, peel of citrus fruit, melons	-0.12[c]	-0.19[a]	6590	0.793
HS09 - Coffee, tea, mate & spices	0.35[a]	0.44[a]	4865	0.775
HS10 - Cereals	1.80[a]	2.91[a]	1386	0.803
HS11 - Milling products, malt, starches, inulin, wheat gluten	0.24[c]	0.35[b]	2069	0.751
HS12 - Oil seed, oleagic fruits, grain, seed, fruit, nes	-0.11	0.03	4340	0.798
HS13 - Lac, gums, resins, vegetable saps & extracts nes	-1.90[a]	-2.29[a]	1338	0.877
HS14 - Vegetable plaiting materials, vegetable products nes	-0.15	-0.17	1083	0.786
HS15 - Animal,vegetable fats & oils, cleavage products	0.001	-0.05	3660	0.771
HS16 - Meat, fish & seafood food preparations nes	0.52	-0.42	452	0.883
HS17 - Sugars & sugar confectionery	-0.67[a]	-0.88[a]	2521	0.789
HS18 - Cocoa & cocoa preparations	-0.75[a]	0.52	1089	0.858
HS19 - Cereal, flour, starch, milk preparations & products	-0.46[a]	-0.49[a]	3198	0.841
HS20 - Vegetable, fruit, nut, food preparations	-0.72[a]	-1.20[a]	5985	0.811
HS21 - Miscellaneous edible preparations	0.51[a]	0.77[a]	4037	0.825
HS22 - Beverages, spirits & vinegar	-1.13[a]	-1.28[a]	4058	0.790
HS23 - Residues, wastes of food industry, animal fodder	0.37	0.20	1732	0.813
HS24 - Tobacco & manufactured tobacco substitutes	-2.07[a]	-3.19[a]	1753	0.847
HS33 - Essential oils, perfumes, cosmetics, toileteries	-0.87[b]	-1.54	1035	0.918
HS35 - Albuminoids, modified starches, glues, enzymes	1.72[b]	0.57	853	0.846
HS41 - Raw hides & skins (other than furskins) & leather	0.28	1.46[b]	1206	0.839
HS43 - Furskins & artificial fur, manufactures thereof	-0.61	1.63	295	0.887
HS51 - Wool, animal hair, horsehair yarn & fabric thereof	1.26[b]	3.15[a]	687	0.872
HS52 - Cotton	0.27	0.61	380	0.913
HS53 - Vegetable textile fibres nes, paper yarn, woven fabric	0.02	0.17	210	0.855
Nb. obs.	68956	See column (3)		
R^2	0.797	See column (4)		

Note: Standard errors (importing country-exporting country clustered) in parentheses with [a], [b] and [c] respectively denoting significance at the 1%, 5% and 10% levels. Specification (1) includes importer and sector-specific exporter fixed effects. Specification (2) includes importer and exporter fixed effects.

protected by numerous OECD importers.

On the other hand, estimated coefficients are *not significant* in both specifications for 10 sectors and *positive* and significant in both specifications for 7 sectors. The largest effects are observed in sectors HS10 "Cereals" and HS51 "Wool, animal hair, horsehair yarn & fabric thereof". This reinforces the conclusion that not all SPS and TBTs in agriculture are protectionist devices.

Our results largely confirm the findings of previous studies. Moenius (2004) finds that country-specific product and process standards of importers reduce imports in the agricultural sector. Fontagné et al. (2005b) focus on SPS and TBT measures. Like us, they show that those measures negatively influence bilateral trade of cut flowers and of processed food like beverages (HS22).

We now provide some robustness checks for the results obtained so far. Estimations for different sub-samples of importers and exporters are presented in tables A.3 and A.4 of the appendix. Results of the sectoral analysis are not reported in order to save space (but are available from the authors upon request).

A possible bias in our results could stem from the presence of zero trade flows. Such flows are not reported in the trade database BACI and are treated as missing observations. However, for some products and importers, we have notifications under SPS and TBT agreements but no observations on the imports of these products by these countries. One can assume that the degree of restrictiveness of some SPS and TBT measures is very high and prevents imports. We therefore proceed as follows: if, in the case of a product (at the HS6 digit level) and an exporter, we observe on one hand some exports different from zero to non-notifying countries and, on the other hand, a missing export flow to a country that notifies a SPS or a TBT measure, then we replace the missing value by zero. After these replacements, about 4.3% of bilateral imports of OECD countries included in our sample are equal to zero. If we focus on imports of EU countries, this percentage is only about 2.1%. Then in our regressions, we use $\ln(1 + x_{ij}^{s_{hs4}})$ as the dependent variable. This approach is one of the most common ways to tackle the problem of zero flows. For high values of trade, $\ln(1+x_{ij}^{s_{hs4}}) \simeq \ln(x_{ij}^{s_{hs4}})$ and for $x_{ij}^{s_{hs4}} = 0$, $\ln(1+x_{ij}^{s_{hs4}}) = 0$. Results are presented in table A.3 of the appendix. Previous main conclusions remain unchanged and our results do not show strong differences in terms of magnitude and ranking between exporters. The sectoral analysis also confirms previous results.

Our second robustness check consists in replacing tariffs and NTBs by zero for intra-EU trade flows and in including these trade flows in our estimations. Results are reported in the appendix (table A.4). The comparison between tables 7 and A.4 shows that main conclusions are still valid. The sectoral analysis suggests that our results are less robust for some sectors. For sector HS18 "Cocoa & cocoa preparations", estimated coefficients are significant in both specifications but take different signs. For HS11 "Milling products, malt, starches, inulin, wheat gluten", both coefficients become insignificant. However, a strong negative impact of SPS and TBTs is still present in sectors HS06 "Live trees, plants, bulbs, roots, cut flowers", HS13 "Lac, gums, resins, vegetable saps & extracts nes", HS17 "Sugars & sugar confectionery", HS22 "Beverages, spirits & vinegar", and HS24 "Tobacco & manufactured tobacco substitutes" and a positive one in sectors HS10 "Cereals" and HS51 "Wool, animal hair, horsehair yarn & fabric thereof".

5 Conclusion

This paper analyzes the impact of measures notified by importing countries under the SPS and TBT agreements on bilateral trade flows. Our empirical application focuses on OECD imports and uses inter alia *ad-valorem* equivalents of SPS and TBT regulations. Our results first suggest that SPS and TBT measures have on the whole a negative impact on trade in agricultural products. We also show that OECD exporters are not significantly affected by these measures in their exports to other OECD members. On the other hand, exports of developing and least developed countries to OECD countries are significantly reduced by these regulations. Besides, the negative impact of SPS and TBTs is higher if we focus only on exports to the EU market. Our results are robust to different samples and specifications.

Our analysis suggests that much remains to be done to improve the position of developing and least developed countries in the international agricultural trade. As stressed by Josling et al. (2004), technical and financial assistance to these countries to help them match the requirements imposed by SPS and TBT measures and increase their participation in the international standards organizations should be a priority within the global food system.

References

Andriamananjara, S., J.M. Dean, R. Feinberg, M.J. Ferrantino, R. Ludema and M. Tsigas, 2004, "The Effects of Non-Tariff Measures on Prices, Trade, and Welfare: CGE Implementation of Policy-Based Price Comparisons", U.S. International Trade Commission, Office of Economics Working Paper # 2004–04.

Beghin, J.C. and J-C. Bureau, 2001, "Quantitative Policy Analysis of Sanitary, Phytosanitary and Technical Barriers to Trade", *Economie Internationale*, 87: 107–130.

Bora, B., A. Kuwahara and S. Laird, 2002, "Quantification of Non-Tariff Measures", United Nations Policy Issues in International Trade and Commodities Study Series # 18.

Bouët, A., Y. Decreux, L. Fontagné, S. Jean and D. Laborde, 2004, "A consistent, *ad-valorem* equivalent measure of applied protection across the world: The MAcMap-HS6 database", CEPII Working Paper # 2004–22.

Bradford, S., 2003, "Paying the price: final goods protection in OECD countries", *Review of Economics and Statistics*, 85(1): 24–37.

Cipollina, M. and L. Salvatici, 2006, Measuring protection: mission impossible? TradeAG, Working Paper # 06/07.

Dean, J. M., R. Feinberg, J. E. Signoret, M. Ferrantino and R. Ludema, 2006, "Estimating the Price Effects of Non-Tariff Measures", U.S. International Trade Commission, Office of Economics Working Paper # 2006–06.

Deardorff A. V., 1998, "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World", in J.A. Frankel (Ed.), *The Regionalization of the World Economy*, The University of Chicago Press, National Bureau of Economic Research Project Report, Chicago, IL, 7–22.

Deardorff, A. V. and R. M. Stern, 1998, *Measurement of Nontariff Barriers*, The University of Michigan Press, Ann Arbor, MI.

Feenstra, R. C., 2004, *Advanced International Trade*, Princeton University Press, Princeton, NJ.

Fontagné, L., F. von Kirchbach and M. Mimouni, 2005a, "An Assessment of Environmentally-Related Non-Tariff Measures", *World Economy*, 28(10): 1417–1439.

Fontagné, L., M. Mimouni and J-M. Pasteels, 2005b, "Estimating the Impact of Environmental SPS and TBT on International Trade", *Integration and Trade Journal*, 22: 7–37.

Harrigan, J., 1993, "OECD imports and trade barriers in 1983", *Journal of International Economics*, 35: 91–111.

Henry de Frahan, B. and M. Vancauteren, 2006, "Harmonization of food regulations and trade in the Single Market: evidence from disaggregated data", *European Review of Agricultural Economics*, 33(3): 337–360.

Henson S. and W. Mitullah, 2004, "Kenyan Exports of Nile Perch: The Impact of Food Safety Standards on an Export-Oriented Supply Chain", World Bank Policy Research Working Paper # 3349.

Josling T., D. Roberts and D. Orden, 2004, *Food Regulation and Trade: Toward a Safe and Open Global System*, Institute for International Economics, Washington, DC.

Kee, H.L., A. Nicita and M. Olarreaga, 2006, "Estimating Trade Restrictiveness Indices", World Bank Policy Research Working Paper # 3840.

Krugman, P.R., 1980, "Scale economies, product differentiation and the pattern of trade," *American Economic Review*, 70(5): 950–959.

Leamer, E.E, 1990, "Latin America as a Target of Trade Barriers Erected by the Major Developed Countries in 1983", *Journal of Development Economics*, 32: 337–368.

Moenius, J., 2004, "Information versus Product Adaptation: The Role of Standards in Trade", International Business & Markets Research Center Working Paper # 1, Northwestern University.

Moenius, J., 2006, "The Good, the Bad and the Ambiguous: Standards and Trade in Agricultural Products", Paper presented at the IATRC Summer symposium "Food Regulation and Trade: Institutional Framework, Concepts of Analysis and Empirical Evidence", Bonn, Germany, May 28-30, 2006.

Nogués, J., A. Olechowski and L.A. Winters, 1986, "Extend of non-tariff barriers to industrial countries' imports", *World Bank Economic Review*, 1: 181–199.

OECD, 1995, "Patterns and Pervasiveness of Tariff and Non-Tariff Barriers to Trade in OECD Member Countries", Working Party No. 1 of the Economic Policy Committee Ad Hoc Group of Experts on Indicators of Government Assistance, ECO/CPE/WP1/GE(96)3.

Otsuki, T., J.S. Wilson and M. Sewadeh, 2001, "What Price Precaution? European Harmonisation of Aflatoxin Regulations and African Groundnut Exports", *European Review of Agricultural Economics*, 28(3): 263–283.

Redding, S. and A.J. Venables, 2004, "Economic geography and international inequality", *Journal of International Economics*, 62(1): 53–82.

Yue, C., J.C. Beghin and H.H. Jensen, 2006, "Tariff Equivalent of Technical Barriers to Trade with Imperfect Substitution and Trade Costs", *American Journal of Agricultural Economics*, 88(4): 947–960.

Appendix

Table A.1: Classification of barriers by the UNCTAD

Description	Code
Finance measures	
Refundable deposit for sensitive product to protect environment	4174
Surveillance	
Prior surveillance to protect human health	5271
Prior surveillance to protect environment	5274
Authorisation	
Authorisation to protect human health	6171
Authorisation to protect animal health	6172
Authorisation to protect plant health	6173
Authorisation to protect environment	6174
Authorisation to protect wildlife	6175
Authorisation to ensure human safety	6177
Quotas for sensitive product	
Quota to protect human health	6271
Quota to protect environment (Montreal Protocol)	6274
Prohibition	
Prohibition to protect human health	6371
Prohibition to protect animal health and life	6372
Prohibition to protect plant health	6373
Prohibition to protect environment	6374
Prohibition to protect wildlife	6375
Prohibition to ensure human safety	6377
Monopolistic measures	
Single channel for imports to protect human health	7171
Technical measures (related to product characteristics requirements)	
Product characteristics requirements to protect human health	8111
Product characteristics requirements to protect animal health and life	8112
Product characteristics requirements to protect plant health	8113
Product characteristics requirements to protect environment	8114
Product characteristics requirements to protect wildlife	8115
Product characteristics requirements to ensure human safety	8117
Technical measures (related to marketing requirements)	
Marketing requirements to protect human health	8121
Marketing requirements to protect plant health	8123
Marketing requirements to protect environment	8124
Marketing requirements to ensure human safety	8127
Technical measures (related to labelling requirements)	
Labelling requirements to protect human health	8131
Labelling requirements to protect animal health and life	8132

Continued on next page

Continued from previous page	
Description	Code
Labelling requirements to protect plant health	8133
Labelling requirements to protect environment	8134
Labelling requirements to protect wildlife	8135
Labelling requirements to ensure human safety	8137
Technical measures (related to packaging requirements)	
Packaging requirements to protect human health	8141
Packaging requirements to protect animal health and life	8142
Packaging requirements to ensure human safety	8147
Technical measures (related to testing, inspection or quarantine requirements)	
Testing, inspection or quarantine requirements to protect human health	8151
Testing, inspection or quarantine requirements to protect animal health and life	8152
Testing, inspection or quarantine requirements to protect plant health	8153
Testing, inspection or quarantine requirements to protect environment	8154
Testing, inspection or quarantine requirements to protect wildlife	8155
Testing, inspection or quarantine requirements to ensure human safety	8157

Source: Trains.

Table A.2: List of agricultural and food industry products included in our database

HS Chapter	Restrictions	Designation
01		Live animals
02		Meat & edible meat offal
04		Dairy products, eggs, honey, edible animal pduct. nes
05		Products of animal origin, nes
06		Live trees, plants, bulbs, roots, cut flowers
07		Edible vegetables & certain roots & tubers
08		Edible fruit, nuts, peel of citrus fruit, melons
09		Coffee, tea, mate & spices
10		Cereals
11		Milling products, malt, starches, inulin, wheat gluten
12		Oil seed, oleagic fruits, grain, seed, fruit, nes
13		Lac, gums, resins, vegetable saps & extracts nes
14		Vegetable plaiting materials, vegetable products nes
15		Animal,vegetable fats & oils, cleavage products
16		Meat, fish & seafood food preparations nes
17		Sugars & sugar confectionery
18		Cocoa & cocoa preparations
19		Cereal, flour, starch, milk preparations & products
20		Vegetable, fruit, nut, food preparations
21		Miscellaneous edible preparations
22		Beverages, spirits & vinegar
23		Residues, wastes of food industry, animal fodder
24		Tobacco & manufactured tobacco substitutes
29	only 290543 and 290544	Organic chemicals
33	only 3301	Essential oils, perfumes, cosmetics, toileteries preparations
35	only 3501 to 3505	Albuminoids, modified starches, glues, enzymes
38	only 380910 and 382460	Miscellaneous chemical products
41	only 4101 to 4103	Raw hides & skins (other than furskins) & leather
43	only 4301	Furskins & artificial fur, manufactures thereof
50	only 5001 to 5003	Silk
51	only 5101 to 5103	Wool, animal hair, horsehair yarn & fabric thereof
52	only 5201 to 5203	Cotton
53	only 5301 and 5302	Vegetable textile fibres nes, paper yarn, woven fabric

This list follows the definition established in the WTO's Agriculture Agreement.

Table A.3: Influence of NTBs - Various samples - Zero flows included.

Dep. variable:	Ln (1 + imports)					
Model :	(1)	(2)	(3)	(4)	(5)	(6)
Importers:	OECD Countries			EU Countries		
Exporters:	All Countries					
ln distance	-0.79^a	-0.80^a	-0.80^a	-0.93^a	-0.93^a	-0.93^a
	(0.04)	(0.04)	(0.04)	(0.11)	(0.11)	(0.11)
common border	0.92^a	0.91^a	0.91^a	0.47^a	0.46^a	0.46^a
	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)	(0.17)
common language	0.23^a	0.23^a	0.23^a	0.18^b	0.18^b	0.18^b
	(0.06)	(0.06)	(0.06)	(0.08)	(0.08)	(0.08)
colonial links	0.25^a	0.25^a	0.25^a	0.32^a	0.32^a	0.32^a
	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)
bil. tariff [I]	-0.06^a			-0.24^a		
	(0.01)			(0.06)		
bil. tariff × OECD countries		-0.11^a	-0.11^a		-0.71^a	-0.71^a
		(0.02)	(0.02)		(0.09)	(0.09)
bil. tariff × DCs & LDCs		-0.02			-0.04	
		(0.02)			(0.07)	
bil. tariff × DCs and Cairns members			-0.01			0.05
			(0.03)			(0.09)
bil. tariff × DCs & LDCs but non-Cairns members			-0.04^c			-0.13
			(0.02)			(0.09)
AVE of NTBs [II]	-0.10^a			-0.25^a		
	(0.03)			(0.04)		
AVE of NTBs × OECD countries		0.02	0.02		-0.15^b	-0.15^b
		(0.05)	(0.05)		(0.07)	(0.07)
AVE of NTBs × DCs & LDCs		-0.16^a			-0.29^a	
		(0.03)			(0.04)	
AVE of NTBs × DCs and Cairns members [III]			-0.10^c			-0.27^a
			(0.06)			(0.07)
AVE of NTBs × DCs & LDCs but non-Cairns members [IV]			-0.19^a			-0.29^a
			(0.04)			(0.05)
Wald test [I] =[II]	1.70			0.01		
Wald test [III] =[IV]			1.76			0.04
Nb. Obs.	72028	72028	72028	36739	36739	36739
R^2	0.813	0.813	0.813	0.814	0.815	0.815
RMSE	2.117	2.117	2.117	2.073	2.072	2.072

Note: Standard errors (importing country-exporting country clustered) in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Importer and sector-specific exporter fixed effects are included in all our estimations.

Table A.4: Influence of NTBs - Various samples - Intra-EU trade flows included.

Dep. variable:	Ln (imports)					
Model :	(1)	(2)	(3)	(4)	(5)	(6)
Importers:	OECD Countries			EU Countries		
Exporters:	All Countries					
ln distance	-0.85[a]	-0.86[a]	-0.85[a]	-1.01[a]	-1.01[a]	-1.01[a]
	(0.03)	(0.03)	(0.03)	(0.08)	(0.08)	(0.08)
common border	0.87[a]	0.87[a]	0.87[a]	0.68[a]	0.68[a]	0.68[a]
	(0.08)	(0.08)	(0.08)	(0.10)	(0.10)	(0.10)
common language	0.21[a]	0.21[a]	0.21[a]	0.21[b]	0.21[b]	0.21[b]
	(0.06)	(0.06)	(0.06)	(0.10)	(0.10)	(0.10)
colonial links	0.15[c]	0.15[c]	0.15[c]	0.17[c]	0.17[c]	0.17[c]
	(0.08)	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)
bil. tariff [I]	-0.11[a]			-0.28[a]		
	(0.02)			(0.06)		
bil. tariff × OECD countries		-0.20[a]	-0.20[a]		-0.74[a]	-0.74[a]
		(0.03)	(0.03)		(0.09)	(0.09)
bil. tariff × DCs & LDCs		-0.04[b]			-0.07	
		(0.02)			(0.07)	
bil. tariff × DCs and Cairns members			-0.03			0.03
			(0.03)			(0.09)
bil. tariff × DCs & LDCs but non-Cairns members			-0.05[b]			-0.20[b]
			(0.02)			(0.09)
AVE of NTBs [II]	-0.12[a]			-0.27[a]		
	(0.03)			(0.04)		
AVE of NTBs × OECD countries		-0.03	-0.03		-0.15[b]	-0.15[b]
		(0.06)	(0.06)		(0.07)	(0.07)
AVE of NTBs × DCs & LDCs		-0.16[a]			-0.32[a]	
		(0.03)			(0.05)	
AVE of NTBs × DCs and Cairns members [III]			-0.12[b]			-0.32[a]
			(0.06)			(0.08)
AVE of NTBs × DCs & LDCs but non-Cairns members [IV]			-0.18[a]			-0.32[a]
			(0.04)			(0.05)
Wald test [I] =[II]	0.06			0.02		
Wald test [III] =[IV]			0.77			0.00
Nb. Obs.	109524	109524	109524	76548	76548	76548
R^2	0.820	0.821	0.821	0.830	0.830	0.830
RMSE	2.287	2.286	2.286	2.277	2.276	2.276

Note: Standard errors (importing country-exporting country clustered) in parentheses with [a], [b] and [c] respectively denoting significance at the 1%, 5% and 10% levels. Importer and sector-specific exporter fixed effects are included in all our estimations.