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Bilateral effects of non-tariff measures on international trade

Volume-based panel estimates

Marcelo Dolabella

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Abstract

Seeking to deepen the understanding about the relationship between non-tariff measures (NTMs) and international trade, this work estimates bilateral volume effects of imposing NTMs on international trade, focusing on two of the most observed measures: technical barriers to trade (TBT) and sanitary and phytosanitary (SPS) measures. Estimates were carried out for more than 5,000 products at the 6-digit level of the Harmonized System using a panel for 2001-2015 with NTM data notified by more than 150 member countries of the World Trade Organization (WTO). Values estimated with the gravity model are later aggregated into average volume effects. Empirical results reveal a large dispersion of volume effects across both the positive and the negative range. Average effects indicate more trade restrictive effects coming from TBT measures than SPS measures. On the country dimension, low income and lower-middle income exporters are the most affected when a new TBT is introduced.

Key words: Non-tariff measures, SPS, TBT, gravity model, volume-based estimation, international trade.

Introduction

International trade plays an important role in the economic development of a country. Understanding how different policies can potentially affect international trade is of paramount importance in order to efficiently design and implement better welfare enhancing policies. Historically, customs tariffs have been used as the main trade policy instrument. However, international trade is not only affected by tariffs. Non-tariff measures (NTMs) also play an important role in shaping trade flows across countries and products. UNCTAD (2015) defines NTMs as policy measures other than ordinary custom tariffs that can potentially have an economic effect on international trade in goods, changing quantities traded, prices or both. Such measures can take the form of instruments of commercial policy (e.g. antidumping duties, quantitative restrictions, safeguards measures) or technical measures aimed at achieving different purposes, such as, ensuring food safety, quality of products, protection of the environment, among others (e.g. sanitary and phytosanitary measures, technical barriers to trade). Expanding the understanding on NTM trade effects is crucial in a context where more and more countries are giving increasing importance to such measures in the negotiation of trade agreements, either bilaterally or multilaterally.

This study quantifies and compare the trade volume effects of two of the most frequently used NTMs, namely technical barriers to trade (TBT) and sanitary and phytosanitary (SPS) measures. These measures, also known as technical or standard-like measures are rules generally aimed at regulating the domestic market but which simultaneously affects trade. According to the World Trade Organization (WTO) SPS and TBT Agreements, WTO member countries are required to notify in advance to the institution any new or modified measure which will be imposed. This allows exporters to know what the latest standards are in their prospective markets (WTO, 2019). These notifications, which are recorded in the WTO's Integrated Trade Intelligence Portal (I-TIP), are the source of the NTM data used in this study.[1]

Formerly, NTMs were thought to have an explicit negative trade impact and were commonly denominated as non-tariff barriers (NTBs). However, this must not be always the case, as it will be later shown. While some NTMs are by definition trade restrictive, such as import prohibitions and quotas, other types, especially SPS and TBT, the scope of this study, might promote trade if they are able to reduce information asymmetries between producers and consumers. Important to highlight as well is the difference between NTMs and procedural obstacles. According to ESCAP (2019) procedural obstacles are practical challenges, such as long delays in testing or certification, inadequate facilities, lack of adequate information on regulations, or infrastructural challenges. While not regulations themselves (i.e., not NTMs), they exist because there are NTMs. Although, relevant and sometimes considered more trade restrictive than NTMs themselves, trade effects of procedural obstacles are not the focus of this study.[2]

Another relevant question is how these technical NTMs affect trade across different dimensions. For instance, impacts should not only be allowed to differ according to the measure applied but also depending on the imposing economy or the product regulated by the NTM. One of the unique features of this work is that it uses panel data and allows impact to differ bilaterally, according to each partner country. The intuition behind it is that NTMs, even when imposed multilaterally, might display different trade impact. For example, if a new regulation in a country sets standards for the quality of a particular product which follow the international standards (i.e. those set by International Standard Organization - ISO), producers in countries which already comply with these quality requirements are likely to be beneficiated. On the other hand, countries which previously exported and did not possess these quality certifications, must now incur in additional costs to comply with the new regulation.[3]

Recent advances in the literature stress the importance of segregating price and volume effects while calculating an NTM trade effect.[4] Price-based methods are best suited to capture the compliance costs while volume-based methods focus on the quantity variation arising from imposing NTMs. This study employs the latter method and assesses the bilateral impact of different NTMs across all products of the Harmonized System classification (HS) at the 6-digit level, outputting more than 5,000 regressions across different specifications. In order to capture the bilateral effects of NTMs, an identification strategy similar to the one implemented by Kee and Nicita (2016) is applied. They use import and export market shares of world trade at the product level as proxies for market power and use the estimated parameters to calculate trade effects.

When analyzing countries and country-groups, it does not matter if a country has a low or high coverage ratio (i.e. the percentage of trade under the influence of one or more NTMs) and frequency index (i.e. the percentage of tariff lines under the influence of one or more NTMs). Results here capture the average volume impact of imposing a NTM, regardless if a country applies TBTs

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1 This work uses this data further processed by Ghodsi et al. (2017). More information is made available on section I.

2 For more information on procedural obstacles, see ESCAP (2019) for survey based results for Asian countries and ECLAC (2017) for estimates for Central American countries.

3 This might then lead to either: i) trade diversion, if imports move to those countries already complying with the standards; ii) trade creation, if standards affect import-demand positively; or even iii) trade destruction, if there is inability of foreign producers to comply with the NTM (or if it is substituted by domestic production).

4 See Cadot *et al.* (2018b).

to all of its products or only to a few products. Therefore, this study does not provide a calculation of the potential barrier coming from NTMs.[5] For an estimation of the total barrier coming from NTMs, see Dolabella and Durán (2020).[6]

This work proceeds as follows. Section I discusses some remarks on the diverse trade impacts steaming from the imposition of NTMs, alongside with a brief description of the NTM dataset and a literature review. Section II explains the estimation methodology employed, deliberates about the econometric issues behind the estimation and provides data sources. Section III presents the empirical results including the multilateral, bilateral and sectoral aspects. Section IV brings to light some concluding remarks of this work.

5 If a country has a low coverage ratio (let's say 10% of its trade is regulated by TBTs) with a low frequency index (suppose 20% of its tariff lines are regulated by TBTs), it is likely to display a smaller barrier —compared to a country with high values for these indicators, supposing a similar stringency of the measures in question— but will not necessarily display a less strict volume impact as a result of imposing this TBT.

6 Dolabella and Durán (2020) transform volume effects into ad-valorem equivalents (AVEs) using trade elasticities. These AVEs are then aggregated into different dimensions and compared with the level of protection of ordinary custom tariffs.

I. Heterogeneous effects of non-tariff measures

The broad definition of the term non-tariff measure (NTM) calls for a more specific classification in order to capture the heterogeneity of regulations potentially affecting trade. A Multi-Agency Support Team (MAST) developed the taxonomy of NTMs, categorizing them into 16 chapters (A to P) with several subgroups. This study focuses mainly on the first two chapters of the classification. Those are the two of the most common types of NTMs, namely sanitary and phytosanitary (SPS) and technical barriers to trade (TBT).[7] Since NTMs serve different purposes and may be set up differently, their trade effects are also expected to be asymmetrical. A product quality/safety requirement is likely to affect trade in a different way compared to a minimum requirement or a maximum tolerance limit of a substance in a particular imported product. Allowing the impact to vary, not only across NTMs but also over different dimensions, enriches the analysis.[8]

Additionally, trade effects of NTMs might differ according to multiple reasons other than their type. A second dimension affecting trade is the product one. A testing requirement for SPS reasons on imports of some particular chemical substance might present different quantity effect compared to a similar NTM affecting import of some kind of food or drink. Hence, acknowledging the importance of disaggregated data for retaining the heterogeneity of different import structures, this work assesses the trade impact of different NTMs on all HS 6-digit codes of the 1996 version.

Two further dimensions related to the importer and exporter countries are also taken into account. Trade impact can also vary depending on which country imposed the measure and which

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7 The impact of other NTMs is also briefly analyzed in annex 5. The NTMs analyzed are quantitative restrictions (QR), antidumping investigations (ADPINV), antidumping duties (ADP), countervailing duties (CV), safeguard measures (SG), special safeguard measures (SSG) and two types of specific trade concerns (STC) raised at the SPS and TBT committees of the World Trade Organization (WTO). For the complete classification see UNCTAD (2015), available at: http://unctad.org/en/PublicationsLibrary/ditctab20122_en.pdf .

8 For an overview on the theoretical impact of different NTMs on welfare, prices and quantities see De Melo and Shepherd (2018).

country faced it. For example, a SPS measure such as a registration requirement for importers, imposed by the Ministry of Health of two different countries, is likely to influence imports unevenly. If country A's registration process requires too much and unnecessary information and incur in many additional costs for the importing firm, while country B's process is simpler and almost costless, imports of the latter are likely to be less affected compared to imports of the former country. Furthermore, as argued by Bratt (2017), the same NTM can affect different exporters differently. If for a particular product an importing country implemented a TBT standard identical to the standard of exporting country A but not of exporting country B, this could trigger an increase of imports from the former and a decrease in imports from the latter. For instance, a labeling requirement for TBT reasons (i.e. content advice in toys) might display a greater impact on trade with countries which do not display this information on their products.

Nevertheless, great variance will remain unexplained as it is not possible to differentiate according to the multiple forms of SPS and TBT measures using the I-TIP dataset. For example, a prohibition of imports for SPS reasons will totally constrain traded quantities while a fumigation procedure to eliminate pests in the same product is likely to have a less harsh impact. Therefore what we capture is an average effect across either SPS or TBT measures.[9]

The question of how to capture these diverse effects of NTMs on international trade has evolved rapidly in the trade literature. As previously mentioned in the definition of NTMs, their impact can be through a change in quantities traded or/and prices. Therefore, compliance costs associated to the imposition of a new NTM might affect: i) traded values, ii) prices or/and iii) volume traded. The interaction of the supply and demand curves at the product level (with its respective elasticities) will determine the final equilibrium outcome.

So, when a new NTM is imposed, firms are likely to incur in additional costs to comply with this measure. This is reflected by a shift to the left in the supply curve, initially raising prices and reducing quantities. The magnitude of this shift will vary according to the countries involved, the NTM and product in question as explained above. As a result, trade unit prices are expected to increase. The magnitude of this price increase is determined by the level of pass through, that is, how much of this cost is passed on to consumers.

The import demand curve might also shift in response to the imposition of this NTM, prompting either volume-deterring effects or volume-enhancing effects. Especially standard like measures (SPS and TBT) may lead to a reduction of information asymmetries, an increase in consumer trust and the establishment of minimum quality standards which in turn increase import demand.[10] This increase in demand will soften he impacts on quantity coming from additional compliance costs or even overcome them, making volume traded increase in comparison to the previous equilibrium. On the other hand, if a regulation, such as a TBT labeling requirement, reveals, for example, unhealthy substances in a product or high amounts of sodium, a negative shift in the import demand curve might happen, making traded quantities decrease even further.

Another factor influencing traded quantities and prices is the market structure. Asprilla et al. (2019) argue that NTMs require firms to adapt their production technology, which may crowd out the least efficient ones, whether domestic or foreign. More efficient ones, again irrespective of whether they are

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[9] For a more detailed overview on the differences of each NTM type, see Trade Analysis Information System (TRAINS) NTM dataset made available by UNCTAD.

[10] See for example Bratt (2017), Ghodsi *et al.* (2016), Ronen (2017) and WTO (2012a) for the intuition on trade promoting effects of NTMs.

domestic or foreign, benefit from this change in market structure with expanded market shares. If domestic firms prevail over foreign ones, export supply will decrease. If only a few foreign firms are able to survive in the market an oligopoly or a monopoly might be created, leading to higher prices and a smaller traded quantity.

The final equilibrium of this market will be the result of the interaction between supply and demand effects as well as from the changes in market concentration. If demand and supply are shifted to the left, the new equilibrium will reveal a reduced traded quantity with an increased price. If the demand-enhancing effect dominates the supply-reducing effect, a positive effect on quantities traded is expected. If the supply-reducing effect is larger than the demand-enhancing effect, prices will also increase and quantities will shrink. Also, shifts along the demand and supply curve can occur if the NTM lead to an increased market concentration by foreign firms.

Earlier work used to focus on the NTM impact on trade values, which might have led to misleading results. When using trade values as the dependent variable, either the world price or traded quantities has to remain constant after a change in an independent variable X (e.g. the imposition of a NTM), so that the change in value comes only from the quantity or price $((\partial \ln(pq)) / (\partial \ln(X)))$. Cadot et al. (2018b) build on this saying that when the price elasticity of import demand is unity, trade values do not change whatever the stringency of NTMs (price and quantity effects offset each other), so there is no statistically useable information in the data. Price-based estimates of NTM capture the compliance cost effect, the final impact on prices, while volume-based estimates, such as the one implemented in this work, capture the final effect on traded quantities.

A. Overview on NTMs: data structure and characteristics

Data on NTMs was retrieved from the work of Ghodsi et al. (2017) from The Vienna Institute for International Economic Studies (wiiw).[11] The authors executed an extensive work of processing the information available at the subsection of goods of the WTO’s Integrated Trade Intelligence Portal (I-TIP). Since the original notification database is incomplete and does not always display which HS 6-digit codes are affected by each measure, the authors applied an identification strategy in order to match the missing codes. Therefore, the notifications with missing codes were reduced from around 45% to 22.3%. Some further remarks and weaknesses about the WTO’s I-TIP database are worth pointing out before moving on.

First, only WTO members are listed as reporters, because the database is built on notifications to the WTO by member countries. Therefore, this work excludes from the estimation sample import flows of non-WTO members to WTO members at any point in the sample period. Second, there is still a number of notifications for which no HS06 line was assigned. Third, the database has three types of dates (initiation, in-force and withdrawal) which might have different features according to the type of NTM. For example, TBT and SPS notifications, which comprise most of the NTM notifications, do not have information on the withdrawal date. Although this might be a significant issue for countries applying a temporary measure, these cases are not that frequent, since most of these measures are set on permanent basis. This is further discussed in the estimation section. The fourth point is related to the reporting capacity of different WTO members. According to Ghodsi et al. (2017) high income countries tend to belong to the heaviest users of NTMs. They give two reasons for this, first, these countries ask for higher standards for the products they consume and second, they have a better reporting capacity

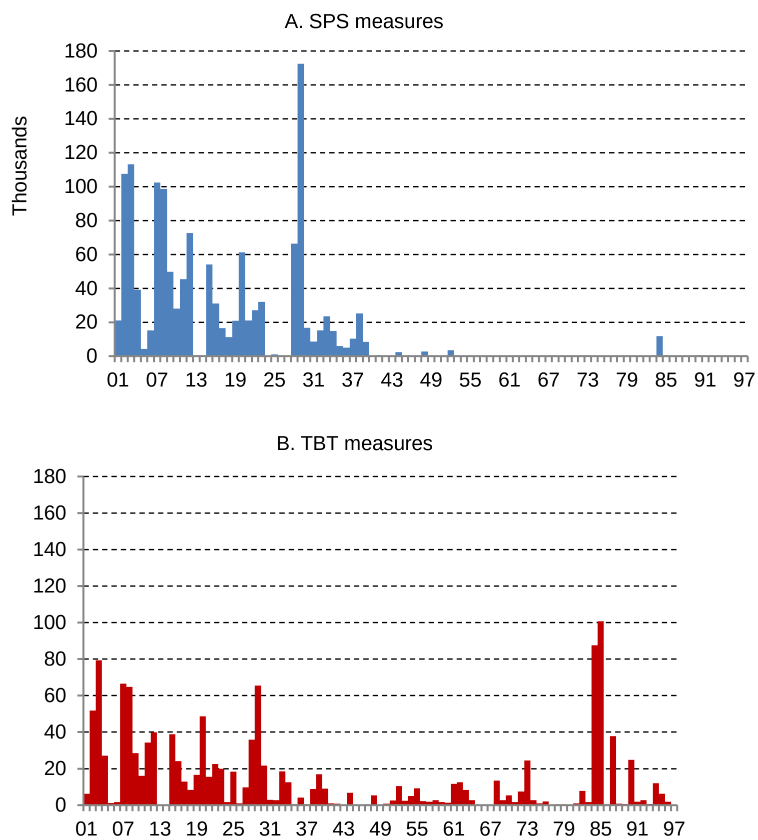
[11] German acronym for: Wiener Institut für Internationale Wirtschaftsvergleiche (wiiw).

when compared to low income countries. Some countries report every NTM applicable, whereas others report only NTMs which depart from international standards. Lastly, according to ESCAP (2019), pre-1995 regulations, since they were not "new" or "amended", are not in the WTO database.

The rest of this section examines the two types of NTMs covered in this paper, giving a broad overview on the definition of SPS and TBT measures, characteristics and incidence on the period of 2000 to 2015. NTMs imposed from 1995 to 1999 were included into the stock of NTMs at the beginning of the analysis.

Generally, SPS and TBT measures, or standard-like measures, are not imposed with a direct trade policy objective, but with an aim to correct market failures, such as reducing information asymmetries and protecting the environment. Precisely, sanitary and phytosanitary measures are applied to protect human, animal or plant life from risks arising from additives, contaminants, toxins, pests and diseases, prevent or limit the spread of pests and to protect biodiversity. On its turn, technical measures (TBT), which serve the purpose of consumer or environmental protection, are regulations on product characteristics or their related processes and production methods. It may also include or deal exclusively with terminology, symbols, packaging, marking or labeling requirements as they apply to a product, process or production method (UNCTAD, 2015).

Figure 1
Incidence of products affected by SPS and TBT measures across HS chapter



Source: Author's calculation based on wiiw's NTM database (Ghodsi *et al.*, 2017).

Considering only the estimation sample, which used information up to the end of 2015, these notifications together, represented around 80% all notifications to the WTO. All TBT notifications and most of the SPS measures (92%) were applied multilaterally. The United States was the country which submitted most SPS and TBT notification, 2,360 altogether. These notifications placed standards into 374,456 products, with product 290516 (Alcohols; saturated monohydric, octanol —octyl alcohol— and isomers thereof) being regulated 321 times. After the United States, China was the second countries with most notifications of these types, 1,698 notifications which affected 218,178 products.[12] They are followed by Canada (1,369 notifications affecting 249,986 products), Brazil (1,266 notifications affecting 98,056 products) and the European Union (979 notifications affecting 120,852 products).

Since the purpose of these measures differs, their sector incidence structure should be different as well. To illustrate this, figure 1 shows the aggregated number of products (HS06) affected by all SPS (left panel) and TBT (right panel) notifications. It can be seen that SPS measures are mostly targeted at the agricultural and chemical sectors, represented by the first codes of the HS02 classification. On the hand, TBT measures are mostly target at manufactured goods, such as machinery, electrical equipment among others.

Most of these notifications did not displayed the date that the measure entered in force. According to ESCAP (2019), while countries are encouraged to publish final regulations as they come in-force, few countries follow this recommendation with all regulations. Following the recommendation of the WTO (2012b) it was assumed that this measured entered into force 180 days after the initiation date. As previously mentioned they also show no termination date.

After excluding bilateral and multilateral notifications with no HS code identified, removing the measures which ended before 2000 and that went in force after 2015 and applying the above-mentioned modification, *wiiw's* database covers more than 3 million products affected by different measures. Table 1 presents the count of HS 6 digit products affected by different notifications by type of NTM and whether these notifications were applied bilaterally or multilaterally. The table presents information on all type of NTMs available in *wiiw's* dataset, including two specific trade concerns, which are questions regarding other WTO members' proposed NTMs or their implementation.

Annex 2 presents further information on dates by NTMs type. For a complete and detailed analysis of the database and its dispersion over products, imposing and affected countries and year see Ghodsi et al. (2017).

[12] Since each notification might affect many products, these figures represent the cumulative number of products affected by all notifications.

Table 1
Number of notifications and affected products by different NTMs notifications

NTMs	Number of notifications				Sum of all products affected by all notifications	
	Total	in %	Bilateral	Multilateral	Total	in %
Antidumping measures (ADP)	4 023	12.9	4 023	0	18 530	0.6
Antidumping investigation (ADPINV)					23 552	0.8
Countervailing duties (CV)	177	0.6	177	0	1 611	0.1
Quantitative restrictions (QR)	978	3.1	40	938	194 087	6.5
Safeguard (SG)	147	0.5	0	147	1 116	0.04
Sanitary and Phytosanitary (SPS)	11 264	36.0	857	10 407	1 372 314	45.7
Specific Trade Concerns of SPS (SPS STC)	160	0.5	160	0	17 357	0.6
Special Safeguard (SSG)	628	2.0	0	628	774	0.03
Technical Barriers to Trade (TBT)	13 667	43.7	0	13 667	1 298 566	43.2
Specific Trade Concerns of TBT (TBT STC)	230	0.7	230	0	76 520	2.5
Total	31 274	100.0	5 487	25 787	3 004 427	100.0
			17.5%	82.5%		

Source: Author's calculation based on wiiw's NTM database (Ghodsi et al.; 2017).

B. Literature review: how NTMs impact trade?

A few studies have set to analyze the impact of NTMs on international trade. The best estimates of NTM effects should be crafted with detailed knowledge of products and markets, one product and country at a time, controlling for time-varying forces that might affect each product and country pair differently. Ferrantino (2010) argues that in order to compare these estimates, policymakers need these estimates' identification strategy to have certain level of homogeneity. This leads to a tradeoff between "handicraft" and "mass-produced" estimates of NTM effects. This section reviews studies which set to quantify "mass-produced" estimates NTMs effects, that is, those studies assessing trade on all tariff lines (HS06).[13]

Kee et al. (2009) were among the first to dive into the product level in order to access the impact of NTMs. They estimate the effect of NTMs on trade values and then transform them into AVEs using import elasticities, estimated externally. They allow them to have an importer specific impact that depends on the interaction of an NTM dummy with country's specific factor endowments. They argue that, for example, an SSG (a NTM on agricultural products) is likely to be less restrictive in countries with low agricultural land over GDP. With this assumption they bootstrap their cross-sectional dataset 200 times and estimate standard errors for each AVE. They restrict the impact to be explicitly negative and differentiate between two types of NTMs: a core NTM category (including price control measures, quantity restrictions, monopolistic measures and technical regulations) and agricultural domestic support. Across the majority of tariff lines their results are

[13] This section focuses more on studies which used trade values or quantities as a dependent variable. For readers interested in price-based estimates, see Cadot and Gourdon (2016), Cadot et al. (2018a) and ESCAP (2019). For those interested in examples of "handicraft" estimates of NTMs trade effects see Ronen (2017) and Cadot et al. (2018b).

not statistically different from zero.[14] Overall, they find a very large variation across products and across countries. Agricultural products displayed a higher average than manufacturing goods. Across importing countries, the countries with highest AVEs of core NTMs were mostly low income African countries and some middle income countries. Their average AVE for core NTMs is 45% using a simple average and 32% using an import weight average for cases where countries imposed at least one NTM. When considering only significant AVEs this value increases to 95%.

Bratt (2017) also acknowledges that an NTM can impact trade diversely across trading partners. With this goal in mind, he modifies the identification strategy of Kee et al. (2009) by adding a NTM interaction term with the factor endowments of the partner country. This allowed him to estimate product specific bilateral AVEs for his cross-sectional data.[15] He analyzes the impact of NTMs on trade values and finds positive and negative effects of NTM on trade even though most of the negative effects are not significant. All in all, a large share of the estimated AVEs is not statistically significant at any conventional level. Therefore, he uses a 20% significance level and finds that 31.1% of the estimated AVEs are significant. Based on this sample of AVEs, his results support that the impact of the same NTM on exporters can differ considerably. His AVEs estimates ranged from a minimum of —100% up to a maximum of 904.6%, with a mean of 82.3%. Additionally, low-income countries were found to impose and face more trade-restrictive NTMs than middle and high-income countries. As his work does not differentiate among types of NTMs, part of this result might be linked to the high frequency of bans imposed by low income countries.

Analyzing NTM effects on actual volume traded, Ghodsi et al. (2017) apply a different identification strategy in order to get multilateral product volume effects. Using a panel data covering the period of 1995-2014 they interact a country dummy the number of NTMs to estimate importer specific impact of different measures on trade for all tariff lines. Taking into account only their significant results (around 53%), they show that around 67% of NTMs have negative trade effects. Their results vary a lot according to which importer-product pair is being analyzed. On a country average, the trade effects also display a large variation according to the country in question, for example, SPS measures imposed by Nepal and India increased trade in 111% and 4.5% respectively, while measures imposed by Swaziland and the United States reduced trade by 95.9% and 1.03%. When analyzing the measures, quantitative restrictions and countervailing duties were on average the most trade-restrictive ones. Geographically, the greatest import-restricting effects were found for Sub-Saharan Africa. When evaluating products, they find NTMs to be most trade-restrictive for luxury products, minerals as well as arms and ammunition, followed by products of the agri-food sector.

Using a smaller sample of countries (34 importing and 96 exporting countries) and focusing on SPS and TBT measures Kee and Nicita (2016) estimate bilateral product specific AVEs as an input to analyze reasons for large discrepancies of detailed product trading between importing and exporting countries. Deploying 50 bootstraps of different models for their cross sectional tariff line data they find the average AVE to be of 11.5%. Using the same methodology, but with a larger sample specially for exporting countries, the authors published updated results in chapter 4 of a UNCTAD-World Bank (2018) report. Their results pointed to an AVE of 11% for technical measures

[14] Table 3 in page 189 of Kee et al. (2009) show that the country with most significant tariff lines for core NTMs was the European Union with only 28.3% and the least Mali with 4.1%. For agricultural domestic support Poland was the country with most binding effects (13% of tariff lines) and a few countries showed no significant tariff lines.

[15] The estimation was bootstrapped 50 times to retrieve standard errors.

and 9% for non-technical measures, with higher AVEs of technical NTMs being imposed by high income countries and higher AVEs of non-technical NTMs (all the remaining) being imposed by low income countries. On the exporter side, they argued that AVEs tended to be higher for countries with lower per capita GDP.

Cadot et al. (2018a) innovate by bringing together NTM quantity and price effects into the spotlight. They use variation in prices to retrieve AVEs and variation in volumes to assess the strength of market-creating effects relative to compliance costs. Concerning the volume regressions, they use a similar identification strategy to this work: import and export shares in world trade in order to identify bilateral relationships. Their cross-sectional samples of 80 countries indicate that in a number of cases, in particular in the SPS area, trade volume is found to expand, even though trade costs rise.

II. Gravity model specification, econometric issues and data source

This section briefly explains the strategy applied in order to estimate the impact of NTMs on trade at a product level. This paper makes use of the quantity based methodology (volume-based estimation), which uses the variation on trade volumes to identify the trade effects of NTMs, using a fixed effects Poisson Pseudo Maximum Likelihood (PPML) estimator.[16] Following the common practice in the literature, a gravity framework was selected for assessing the impact of NTMs on trade. The effort of considering all the dimensions previously mentioned, precludes estimation of a single equation due to the large computing power and time required. Therefore, the solution applied was to split the database by products. Thus, using disaggregated trade data at a HS 6 digit level, gravity equations were estimated for each one of the 5,111 HS 6 digit level tariff lines.[17] The panel range spans over the period of 2001 to 2015.[18] [19] The TiVA database provides information on 64 countries, including 7 Latin American economies (Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico and Peru), and 34 sectors (including 16 manufacturing industries and 14 service activities). The contribution of services to Latin American manufacturing exports is compared here with that

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16 Annex 1 explains the method of estimation by pseudo maximum likelihood using a Poisson distribution and derives a fixed effects estimator for a panel framework. For a review on different methodologies to quantify the trade effects of non-tariff measures see Ferrantino (2010), UNCTAD (2013) or Cadot et al. (2018b).

17 Strategy previously implemented by Kee et al. (2009), Bratt (2017), Ghodsi et al. (2016), Kee and Nicita (2016), Ghodsi et al. (2017), Cadot et al. (2018a) among others.

18 An additional specification was implemented in order to check the robustness of results. For this specification some variables were not available for 2015 and therefore the estimation containing more controls was performed using data up to 2014. See annex 4.

19 Data for 2000 was also gathered since the specification uses lagged values as proxies for some variables.

observed in 10 Asian emerging economies (8 ASEAN countries (Brunei Darussalam, Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam), China and India).

The following equation presents a baseline specification of gravity model in its multiplicative version:

$$E\left(Q_{ijt}^{k}\middle|\boldsymbol{x}_{ijt}\right) = \exp\left(\alpha_{ij}^{k} + \beta_{1ijt}tar_{ijt-1}^{k} + \sum_{n=1}^{10}\beta_{2nijt}NTM_{nijt-1}^{k} + \beta_{3}expsh_{it-1}^{k} + \beta_{4}impsh_{jt-1}^{k} + \beta_{5}lnY_{it} + \beta_{6}lnY_{jt} + \beta_{7}PTA_{ijt} + \beta_{8}WTO_{ijt} + \sum_{t}\theta_{t}T_{t}\right) \quad (1)$$

where Q_{ijt}^{k} represents the quantity in tons imported by country *j* of product k from country i in year *t*; tar_{ijt}^{k} stands for the tariff imposed by country *j* on country i at the product level; NTM_{nijt-}^{k} represents a count variable of the number of measures applied by country *j* on country i for the NTM type *n*, presented in section I. The variables $expsh_{it}^{k}$ and lnY_{it} are the share of the exporter country in the world trade's value of product *k* and the logarithm of its GDP. Similarly, $impsh_{jt}^{k}$ and lnY_{jt}represent the same variables from the importing economy. The remaining controls are time fixed effects (T_t) and two dummies; one dummy indicating the existence of a preferential trade agreement between countries i and j (PTA_{ijt}), and one indicating if both countries were members of the WTO at year t WTO_{ijt}. Lastly, ε_{ijt}^{k} represent the residual. Even though no variation is found at the product dimension *k*, the subscript is included to differentiate the variables measured at the product level from the ones measured at national level (multilateral or bilateral).

The next challenge concerns how to formulate the gravity model so as to capture the potential bilateral forces previously mentioned. This work follows Kee and Nicita (2016) and interacts NTMs to importer and exporter specific variables: the share of the exporter in the world trade of this HS 6 product, and the share of the importer in the world trade of this HS 6 product, both for each year in the dataset. This can be viewed as a proxy of importer's and exporter's market power for each particular product. The intuition behind it is that the cost of complying with a new NTM should be lower for exporters with a large share in the world trade of the product since they are more likely to have spare resources to comply with new measures, resulting in smaller negative or larger positive trade effect. On the other hand, the bigger the exporter's market power, the easier it is for them to divert their exports to another third country, which could also imply in a larger negative or smaller positive impact for the bilateral trade. Similarly, the importer's market share also plays a role in this narrative. When imposing a new NTM, a large importing country's market power could mean higher compliance cost for exporting countries and a larger negative trade impact since they do not have much other options to export to. However, if a specific country concentrates most of the world demand for a product and imposes of an NTM, it is more difficult for exporting countries to divert their products to other markets, leading to bigger effort to comply with the NTM and a potential smaller negative or larger positive trade effect. That being said, the intuition of how market shares of importer and exporter in the world market will affect trade with an imposition of a new a NTM presents contradictory forces. In the end, which trade effect will stand out for each particular product is an empirical question, which will be determined by the data for each product and NTM type. As argued by Kee and Nicita (2016), a similar argument can be made for tariff and the resulting bilateral import elasticities.

For this reason, the following formula is to be replaced in (1) in order to attain the bilateral coefficients:

$$\beta_{1ijt} = \beta_1 + \beta_{11} expsh_{it}^k + \beta_{12} impsh_{jt}^k ,$$

$$\beta_{2ijt}^n = \beta_2^n + \beta_{21}^n expsh_{it}^k + \beta_{22}^n impsh_{jt}^k. \quad (2)$$

Some remarks on endogeneity are worth pointing out before moving on. To begin with, the simple fact that estimations are carried at the very specific product level already eliminates the possibility of unobserved product specific invariant factors being correlated with the NTMs. Secondly, the chosen estimator, PPML panel fixed effects, controls for country-pair time invariant characteristics and also explores the within country-pair dimension so as to estimate the parameters.[20] So, the effect of traditional gravity variables such as distance, dummies of common language, common border, and common colonizer, among others cannot be estimated, but are fully taken into account and cannot bias other estimates. Thirdly, this paper chose not to include exporter-time and importer-time dummies because non-discriminatory trade policies, the ones applied multilaterally such as safeguards and special safeguards would be perfectly collinear with the number of imposed NTMs. This would preclude estimation of β_1 and β_2^n in equation (2). However, we include time dummies to capture the time-varying heterogeneity that is common among the country pairs. On the other hand, the choice for panel data makes simple bootstrapping methods invalid, since observations are no longer i.i.d. Therefore, this work drives apart from those studies which used bootstrapping methods and exploited the cross sectional dimension of the data (Kee et al., 2009; Kee and Nicita, 2016; Bratt, 2017). On the other hand, it resembles the estimation strategy implemented by Cadot et al. (2018a).

In addition, the variables of interest of this study are lagged by one period. As argued by Ghodsi et al. (2016) there are two reasons for this. First, demand takes time to react to policy changes, which seems particularly reasonable for intermediate products. Second, for some NTMs, reverse causality should be a barrier to the estimation of the true NTM effect. Sometimes, NTMs are the cause imports grow or reduce, so not only trade reacts to the imposition of a NTM but also a NTM might be implemented to promote or reduce imports. The lagged value of an NTM is expected to lessen this problem.

Such bilateral identification approach has been used before by the literature but not free of criticism. For instance, Cadot et al. (2018b) say that it does not describe a particular country's estimated trade impact; instead, they simulate what the estimated trade impact ought to be at that country's level of trade share. The real impact could only be captured by interactions with import and export dummies. In my case, estimation of bilateral parameters using country dummies would be feasible since the data contains the time dimension providing additional degrees of freedom. However, the chosen estimator PPML, required for gravity estimations with many zero trade flows, presented computing problems in the presence of large numbers of dummies and therefore estimation with country specific dummies was not possible. This problem was also described by Cadot et al. (2018b). Also important are the remarks of Cadot et al. (2018a) regarding the interpretation of country specific AVE effects. Consider the case of technical regulations (SPS and TBT), and suppose that two importing countries share the same body of

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[20] Another reason for this model's selection was its desirable features of robustness to the presence of heteroskedasticity in the residuals and the fact that it does not exclude the zeros from the estimation sample (Santos Silva and Tenreyro; 2006). See annex 1 for more information.

regulations (e.g. two EU countries) but the first imports more from countries with weak SPS infrastructures (assuming also alike product import structures). While identical with those of the second importing country, its regulations will require more adaptation from origin producers, and might be related to a more restrictive volume impact. Likewise, product-composition effects will also affect trade weighted averages of NTMs trade effects. For example, a country importing more highly sensitive products will have a mechanically higher average AVE for SPS measures than a county that imports less sensitive products.

Data has been collected from different sources. As previously mentioned, the variable of interest of this paper was retrieved from wiiw's NTM database with all notifications member countries imposed (both multilaterally and bilaterally) and its affected HS 6-digit code (Ghodsi et al., 2017). Trade flows, measured in quantities, were retrieved from the CEPII's BACI database elaborated by Gaulier and Zignago (2010) with data from UN-Comtrade.[21] The authors harmonize export and import data using an estimation of CIF (cost, insurance and freight) and a measure of reporter reliability. The HS version of 1996 was selected to perform a match with the *wiiw* dataset. Tariff data comes from the Trade Analysis Information System (TRAINS) and the WTO Integrated Data Base (IDB) via the World Integrated Trade Solutions (WITS). Bilateral preferential tariff data were considered first and when no data was available for this tariff type the Most Favored Nation (MFN) tariff was used. Annex 2 leads the interested reader though a general explanation on tariffs, how this variable was constructed and the assumptions made along the way. Currently, 163 countries plus the European Union are members of the WTO. Since the NTM data only covers reporters which are WTO members, observations concerning nonmember's imports are not taken into account. Data on member countries, their ascension year and the preferential trade agreements between different country pairs are made available by the WTO. For an additional specification (see annex 4) factor endowments, namely labor (number of persons engaged multiplied by a human capital index) and capital (stock measured at constant national prices), were taken from the Penn World Table (PWT 9.0) by Feenstra et al. (2015).[22] The third factor endowment, agricultural land (sq. km), was retrieved from the World Bank's World Development Indicators (WDI). Gross domestic product at constant prices of 2010 was also taken from this source.

This work did an effort to include as many countries possible in the analysis. The numbers of importers included in the analysis were 153, which comprise only WTO members present in the BACI database. Countries were included in the panel from their WTO's entrance date onwards, in case they joined the organization after the year 2001. The affected country sample contained additional countries and reached the count of 182. See annex 2 for a complete list of countries included in the analysis.

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[21] French acronyms for: Base pour l'analyse du commerce international (BACI) and Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

[22] By the time the analysis started, Penn World Table 9.0 with data up to 2014 was the most complete data source for factor endowments.

III. Trade volume effects of NTMs

Even though quantity trade effects were estimated from a nonlinear model, interpretation of coefficients in percentage changes is not arduous. For the purpose of analyzing the trade effects of NTMs, the discrete change in the expected trade quantity from equations (1) and (2) is calculated and then divided by the expected quantity without this additional measure.[23] This allows the interpretation of the results not to depend on the level of the expected trade quantity. The following equation (3) shows how NTMs trade effects (in percentage changes) were obtained from the coefficients estimated in (2):

$$100 * \frac{\Delta E(Q_{ijt}|\boldsymbol{x}_{ijt})}{\Delta NTM_{ijt}^{n}} / E(Q_{ijt}|\boldsymbol{x}_{ijt}) = 100 * \left[\exp(\beta_2^n + \beta_{21}^n * impsh_{ikt} + \beta_{22}^n * expsh_{jkt}) - 1\right] \quad (3)$$

Additionally, for the calculation of trade effects of NTMs, this paper assumes that the impact is different from zero when the at least one of the NTM coefficients $(\beta_2^n, \beta_{21}^n, \beta_{22}^n)$ is significant at the 10% level. This will generate a mix of multilateral and bilateral impacts at the HS06 level. These values are averaged using simple and trade weighted averages over different dimensions.

This section presents results coming from two different specifications. The difference between them is the form chosen for the NTM variable: count or a dummy variable. In the first specification, NTMs are placed as count variable and in the second as a dummy variable. When the NTM is inserted in equation (1) as a count variable, its accompanying parameter captures the mean effect of imposing one additional NTM to the already existing stock of NTMs applied in the bilateral relationship. When a dummy variable is considered (specification 2), the parameter captures the trade protection/promotion related to the existence of this NTM type in products that at least one

23 See annex 1 for the detailed development of the formula.

NTM was applied. Quantity trade effects are expected to be smaller when the NTM variable is entered as a count of measures.

Apart from the differences in interpretation, both specifications have their pros and cons. Using count variable keeps the richness of the data and differentiate when countries impose only a few measures from those that apply innumerous measures. As argued by Cadot et al. (2018b), one advantage of this approach is that it takes into account the cumulative burden of NTMs piled up by various bureaucracies on a given product, something that often surfaces in private-sector complaints. Additionally, estimation based on counts has proved somewhat more stable than estimation based on binary markers. However, for this benefit to achieved, the dependent variable should represent the real stock of NTMs, which might not always true since NTMs from the I-TIP database carry some noise. As previously mentioned, NTM data do not have withdrawal dates for some types of NTM (including TBT and SPS). By using a count variable, some measures that are imposed temporarily will not quit the stock of NTM and inflate the variable. Therefore, one advantage of using the dummy NTM is that it reduces the probability of measurement error from our NTM variable. Although the problem is not completely eliminated when the dummy is used, it should be reduced. In the sequence both effects are analyzed.

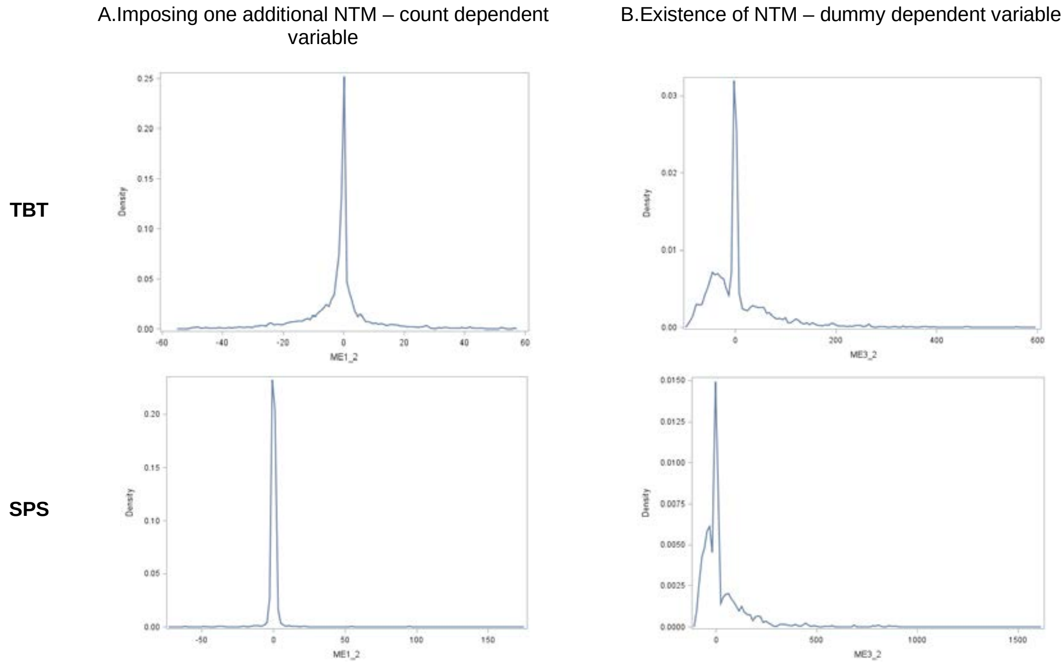
In regard to the way results are presented, one last remark is worth highlighting. Since estimations were executed at the HS6 digit level the issue of how to aggregate these AVEs into a few values arises. Both simple average and trade-weighted averages have strengths and weaknesses. As Kee et al. (2009) notice, when calculating trade-weighted averages, imports subject to high protection rates are likely to be small and therefore will be attributed small weights, which would underestimate the restrictiveness of those tariffs. In the extreme case, goods subject to prohibitively high tariffs have the same weight as goods subject to zero tariffs: a zero weight. Similarly, when computing simple average tariffs, very low tariffs on economically meaningless goods would bias this measure of trade restrictiveness downward. For the sake of completeness, the analysis will focus on both measures (trade weighted and simple average) as well as its distribution.

Additionally, this work chooses to drop the extreme values in order to reduce the influence of outliers. Hence, values under the 1% percentile and above the 99% percentile of the entire distribution were not taken into account. Since there is no upper limit for the estimated values, as there is for the lower values, averages might be sensible if large values are included in the central values 98% of the distribution.[24]

Whenever the parameters were found to be different from zero at 10% significance level, the chosen identification strategy allowed the calculation of NTM trade effects for all years and countries, independent if they applied or not an NTM and if they traded or not at this specific product level. This work will focus the analysis of results in those combinations of product-exporter-importer-year in which at least one NTM was imposed, making results represent the impact of existing NTMs. When analyzing the impact of specification 2 (binary NTM variable), the trade effects shall not be interpreted as an overall protection/ promotion effect for a particular country/group since products not covered by NTMs are not considered into the averages.

[24] Given the multiplicative form of the gravity equation, negative values cannot be smaller than —100%, in other words, traded quantities cannot drop beyond zero.

Figure 2
Distribution of estimated SPS and TBT trade effects



Source: Author's calculation.

After eliminating this part of the sample, trade effects were calculated using the structure of trade for all product, countries (importers and exporters) and years of the remaining sample. A first glimpse on the results unveils a large dispersion of the results for the same NTM (see Figure 2). NTMs are shown to have both positive and negative trade effects depending on the dimension analyzed. For TBTs, specification 1 showed that 61.7% of the volume effects were negative while the remaining 38.3% was positive. The second specification rendered 57.5% of the volume effects on the negative side of the distribution while the remaining 42.5% were on the positive side. The picture for SPS was similar for volume effects calculated using specification 2. Concerning specification 1, SPS trade quantity effects were more evenly distributed with 49.1% of all calculated effects being trade promoting and the remaining 50.9%, trade reducing. Analyzing results from specification 1, partners with positive trade were associated with less restrictive volume effects for TBT, with a simple average of -1.25% while those country-pairs with no trade displayed an estimated average effect of -2.00%. The picture changed for SPS measures, with those country-pairs which did not trade among themselves displaying a simple average of 0.76% while the others which traded displaying an average of 0.6% per new measure.

A first conclusion from results is that TBT measures seem to be more restrictive than SPS measures, either when considering the imposition of a new measure or the existence of measures at all. This can be seen by analyzing the averages and percentiles as shown in Table 2. If a country imposes an additional TBT measure it is associated with a reduction of 1.94% in trade when a simple average is applied to aggregate results and with a reduction of 1.42% when trade weights are used. SPS measures were found to be trade promoting on average although half of the distribution lies on the negative side. On average (both simple and trade weighted) imposing a new SPS had a positive effect on trade of around 0.8%. Also important to notice is that the distribution of SPS effects is more equidispersed around zero than the distribution of TBT trade effects. These results go in line with Cadot et al. (2018a) findings on the volume increasing effects of SPS and restrictive effects of TBTs.

Table 2
Summary of volume effects of NTMs (SPS and TBT)
(Volume effects in percentages)

Observations		Simple average[a]	Trade weighted average[a]	Percentage of trade covered[b]	Distribution of volume effects (Percentiles)						
					1st	10th	25th	50th	75th	90th	99th
Imposing one additional NTM (count dependent variable)											
TBT	218 922 324	-1.94	-1.42	90.7%	-54.24	-16.09	-4.91	-0.16	0.60	8.18	56.35
SPS	94 560 531	0.76	0.81	89.1%	-71.52	-1.60	-0.54	0.00	0.57	1.44	173.0
Existence of NTM (dummy dependent variable)											
TBT	217 018 136	8.52	-5.32	85.9%	-93.20	-57.52	-33.85	-0.42	17.03	90.83	590.3
SPS	93 631 225	30.90	14.14	82.4%	-98.06	-66.69	-38.56	-0.69	49.11	166.3	1 602

Source: Author's calculation.
[a] Averages were calculated by eliminating the bottom 1% and top 1% of the complete distribution, that is, eliminating values lower than the 1st and higher than the 99th percentile columns.
[b] This column shows the percentage of trade of the entire distribution that was considered while calculating the trade weighted average.

The second part of the table 2 shows the impact of imposing NTMs on trade (second specification with NTM as a dummy variable). As expected, there is much more variation on these results as it can also be seen in figure 2. For SPS, both averages were positive indicating trade inducing effect of this kind of measure. On the other hand, TBT measures displayed a negative trade weighted average (-5.32%) and a positive simple average (8.52%). This means that imposing TBTs are associated with a positive effect but when its trade structure is taken into account, the impact turns negative. Since this specification estimates larger parameters, the sample considered for the calculation of averages includes more extreme values, which are more likely to influence averages.[25] Therefore, for this specification, the analysis of the distribution and its quartiles give a more reliable understanding of the effects. The median of both distributions lie on the negative side, meaning that more than half of the product-country pairs-year combinations were estimated to have a negative trade effect. For TBT trade effects the inter-quartile range goes from -33.85% up to 17.03%, while for SPS these values are -38.56% and 49.11%. This gives further support to the more trade restrictiveness characteristic of TBTs while compared to SPS measures.

In the sequence different dimension are analyzed and the impact is split by importer's and exporter's level of development and by chapters of the HS classification.

A. Multilateral effects by income group

The breakdown of results by income level of the imposing and affected economy is presented in this section. The World Bank income classification of 2015 is used to rank countries into the four groups. Table 3 and 4 examine the impacts multilaterally: the impact of a measure imposed by a high income country on all partners and the impact received by a high income country from all partners.

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25 These averages should be analyzed with caution because they might be sensible to strategy chosen to remove outliers.

Table 3
Summary of trade effects of TBT by income group
(Volume effects in percentages)

	Observations	Simple Averag.	Trade Weighted Average	% of trade consid.[a]	Distribution (percentiles)				
					1st	25th	50th	75th	99th
Imposing one additional NTM (count dependent variable)									
By Imposing countries									
High income	127 026 568	-2.01	-1.07	91%	-55.8	-5.3	-0.3	0.7	56.3
Upper mid. income	59 156 881	-1.99	-2.30	89%	-55.0	-5.0	-0.1	0.6	57.2
Lower mid. income	29 834 916	-1.61	-1.96	91%	-48.9	-3.1	0.0	0.3	52.3
Low income	2 903 959	-1.60	-2.23	95%	-48.6	-3.5	0.0	0.2	48.3
By Affected countries									
High income	61 346 601	-1.77	-1.31	91%	-51.1	-4.2	-0.1	0.5	54.9
Upper mid. income	64 017 025	-1.95	-1.36	92%	-54.7	-4.9	-0.2	0.5	56.3
Lower mid. income	58 698 956	-2.02	-2.58	87%	-55.0	-5.2	-0.2	0.6	56.3
Low income	34 859 742	-2.11	-2.24	68%	-55.8	-5.7	-0.4	0.8	57.8
Existence of NTM (dummy dependent variable)									
By Imposing Countries									
High income	125 197 230	8.68	-4.76	84%	-94.9	-34.2	-0.7	19.8	694.3
Upper mid. income	58 575 300	8.46	-8.92	91%	-92.2	-33.2	-0.3	14.0	530.4
Lower mid. income	30 289 279	7.91	6.75	92%	-88.2	-32.7	-0.2	7.7	437.1
Low income	2 956 327	9.05	-3.08	95%	-89.9	-35.8	0.0	20.2	386.1
By Affected countries									
High income	60 750 587	8.16	-4.70	85%	-92.9	-31.8	-0.3	13.4	557.3
Upper mid. income	63 336 725	8.51	-5.27	88%	-93.2	-33.7	-0.4	16.6	584.9
Lower mid. income	58 223 121	8.65	-10.05	86%	-93.5	-34.4	-0.5	18.7	626.8
Low income	34 707 703	8.93	-3.23	66%	-93.8	-35.7	-0.7	22.4	682.5

Source: Author's calculation.
Note: Averages were calculated by eliminating the bottom 1% and top 1% of the complete distribution (shown in table 2).
[a] This column shows the percentage of trade of the distribution that was considered while calculating the trade weighted average.

Decomposing TBT effects by income groups reveals more insights. When analyzing simple averages of impacts over the imposing economies a new TBT from a high income country (hereafter referred to as HI) reduces trade by 2.01%, while a TBT imposed by a low income (referred to as LI) economy reduces it by 1.60%. More developed nations appear to impose the most trade restrictive TBTs, followed by upper-middle income (UMI). This is also supported by analyzing the median impact of imposing one additional TBT, although these values are close to zero. This may be due to the higher level of stringency required by measures imposed by these HI nations. The picture is reversed when the affected economy is analyzed. TBTs affect the least developed economies the hardest. Considering simple averages, a TBT affecting low income economies reduces volume by 2.11%, and high income countries by 1.77%. When trade weights are taken into account the picture changes slightly. Now, lower middle income (LMI) countries are the most affected group, with the imposition of a new NTM representing a reduction of 2.58% in traded quantities. Exporters from richer countries seem to be less affected by a new TBT, showing less difficulty in handling/adapting to a new regulation/process. On the other hand, poor nations seem to be most affected in volume terms. Another takeaway from table 3 is that the number of measures imposed by HI countries outnumbers by far the measures applied by other groups, with LI groups applying fewest measures. This goes in line with what was explained above about the higher reporting capacity of developed economies.

Analyzing results from specification 2 shows outcomes somehow aligned with specification 1. Median values show the same picture, with more developed countries imposing harsher and receiving blander TBTs. The first quartile displayed an impact smaller than -30% for all country groups while the third quartile showed a positive impact higher than 7.7% for all country groups. Simple averages were again positive range while most of trade weighted averages displayed negative values, except for measures imposed by lower middle income countries. These values represent that if a high income country imposes one or more TBTs its traded quantity is associated with a reduction of 4.76% on average, weighting traded products and partners more heavily.[26]

Table 4
Summary of trade effects of SPS by income group
(Volume effects in percentages)

	Observations	Simple Average	Trade Weighted Average	% of trade consid.[a]	Distribution (percentiles)				
					1st	25th	50th	75th	99th
Imposing one additional NTM (count dependent variable)									
By Imposing Countries									
High income	59 949 901	0.90	0.79	88%	-76.7	-0.5	0.0	0.6	183.6
Upper mid. income	19 756 311	0.66	0.86	93%	-43.3	-0.6	0.0	0.5	136.2
Lower mid. income	13 357 233	0.21	0.86	88%	-67.8	-0.6	0.0	0.5	90.7
Low income	1 497 086	1.18	2.38	88%	-11.5	-0.7	0.0	0.4	183.6
By Affected countries									
High income	25 966 430	0.66	0.95	92%	-64.3	-0.5	0.0	0.5	140.7
Upper mid. income	27 839 641	0.78	1.08	88%	-72.0	-0.5	0.0	0.6	176.1
Lower mid. income	25 522 394	0.79	-0.97	76%	-72.3	-0.5	0.0	0.6	183.1
Low income	1 532 066	0.81	0.18	83%	-73.0	-0.6	0.0	0.6	183.6
Existence of NTM (dummy dependent variable)									
By Imposing Countries									
High income	59 201 866	29.67	16.54	84%	-98.5	-39.4	-1.3	48.7	2,871
Upper mid. income	19 688 307	31.65	9.82	77%	-95.8	-35.7	-0.5	48.5	863.3
Lower mid. income	13 262 065	33.83	1.60	86%	-95.8	-35.8	-0.2	51.0	863.3
Low income	1 478 987	43.52	-14.13	87%	-87.5	-36.7	0.0	72.3	805.5
By Affected countries									
High income	25 525 554	30.00	10.33	85%	-98.1	-36.6	-0.4	45.6	1 418
Upper mid. income	27 513 381	30.79	24.03	80%	-98.1	-38.5	-0.7	49.0	1 602
Lower mid. income	25 350 460	31.19	10.90	71%	-98.1	-38.9	-0.8	50.3	1 602
Low income	15 241 830	32.16	27.53	74%	-98.1	-39.5	-1.1	54.1	1 644

Source: Author's calculation. Note: Averages were calculated by eliminating the bottom 1% and top 1% of the complete distribution (shown in table 2).
[a] This column shows the percentage of trade of the distribution that was considered while calculating the trade weighted average.

Turning to SPS measures the picture changes in some way. Adding a new SPS has an almost null impact for the median country independent of their income level.[27] The central 50% of observations, analyzed by the quartiles of the distribution, show not much variation. This means that for all country-groups, volume effects observations are similarly distributed and may have positive and negative impact on traded quantity. For countries imposing SPS, both simple and trade weighted averages of SPS displayed positive trade effects below unity, except for the LI group, which displayed the highest averages. However, such results might again be influenced by extreme

[26] Again, these values do not represent an overall protection due to TBTs because those products for which no NTM was imposed were not taken into account.
[27] Only non-zero values are taken into account while calculating the dispersion of trade effects. The median values are rounded to two decimals and therefore display a null value.

values.[28] Additionally, these average values are not robust to a change in specification, as shown in annex 4. Still, analyzing the relative position of income groups, LMI country exporters appear to be the most affected by a new SPS.

When the whole structure of SPS is considered (specification 2), the outline is more similar to TBT measures: richer economies imposed SPS with smaller trade effects (when compared to poorer economies), while these same economies were less affected by a SPS imposed by other countries. This can be inferred by analyzing the centre of the distribution as well as its quartiles. Simple and trade weights displayed positive figures, probably still influenced by some outliers.

Finally, it is important to underline again that these results display large dispersion what was taken as a conclusion for the group will not hold for all countries-product-year combinations.

B. Bilateral effects by income group

Acknowledging the great dispersion of the estimated trade effects at the bilateral product level, this sub-section dives into the bilateral data seeking a better understanding of how trade effects change according to the importer's and the exporter's level of income. Figure 3 and 4 are organized as follow: the graphs on the left column show the impact of applying one additional NTM to the existing stock while the graphs on the right show the impact of applying one or more NTMs. The first row of graphs represents the impact of NTMs imposed by a high income country, with each bar in a graph representing the distribution related to the income level of the affected economy. The bar represents the centre of the distribution, that is, the distance from the first to the third quartile, with values on the bottom displaying the 1st quartile value and on the top the 3rd quartile. The red line represents the median, the yellow the simple average and the blue the trade weighted average. The second row of charts represents the distribution of volume effects of measures imposed by an upper-middle income nation, the third row by a lower-middle income and the four and last by a low income nation. Y-axis was fixed within a range according to the type of impact so as to facilitate comparison.

In light of this, figure 3 depicts the impact for TBT measures. The first bar of top right graph shows trade effects of imposing one additional TBT by HI countries to other HI countries. The central fifty percent of the estimated trade effects lie above -4.50% and 0.63%, with a median of -0.16%. Averages pointed also to a trade restrictive impact. The following bars concerning the impact of a HI country TBT on UMI, LMI and LI countries show a more negative 1st quartile, median and simple average as we move to the right of the graph. This means that a measure imposed by a HI country reduces more trade of the least developed economies, which probably do not have the standards of HI economies and must incur in an additional cost in order to export, since this cost might be prohibitive for some exporters, trade quantities are likely to reduce. Trade weighted average shows the same pattern except for measures applied to LI countries which showed a positive effect of magnitude 0.24%. Measures applied by UMI countries on countries from different income levels show a similar distribution of effects when compared to measures applied by HI nations. Countries with lower level of development were the most affected by UMI nations TBTs. Adding a new TBT by this income group reduced trade with HI nations in the order of 1.85%, with other UMI nations by the

[28] Since the lower cutoff threshold, -71.5 (1st percentile from the original distribution), is more twice times larger than the upper cutoff threshold, -173.0 (99th percentile from the original distribution), averages might be upward biased.

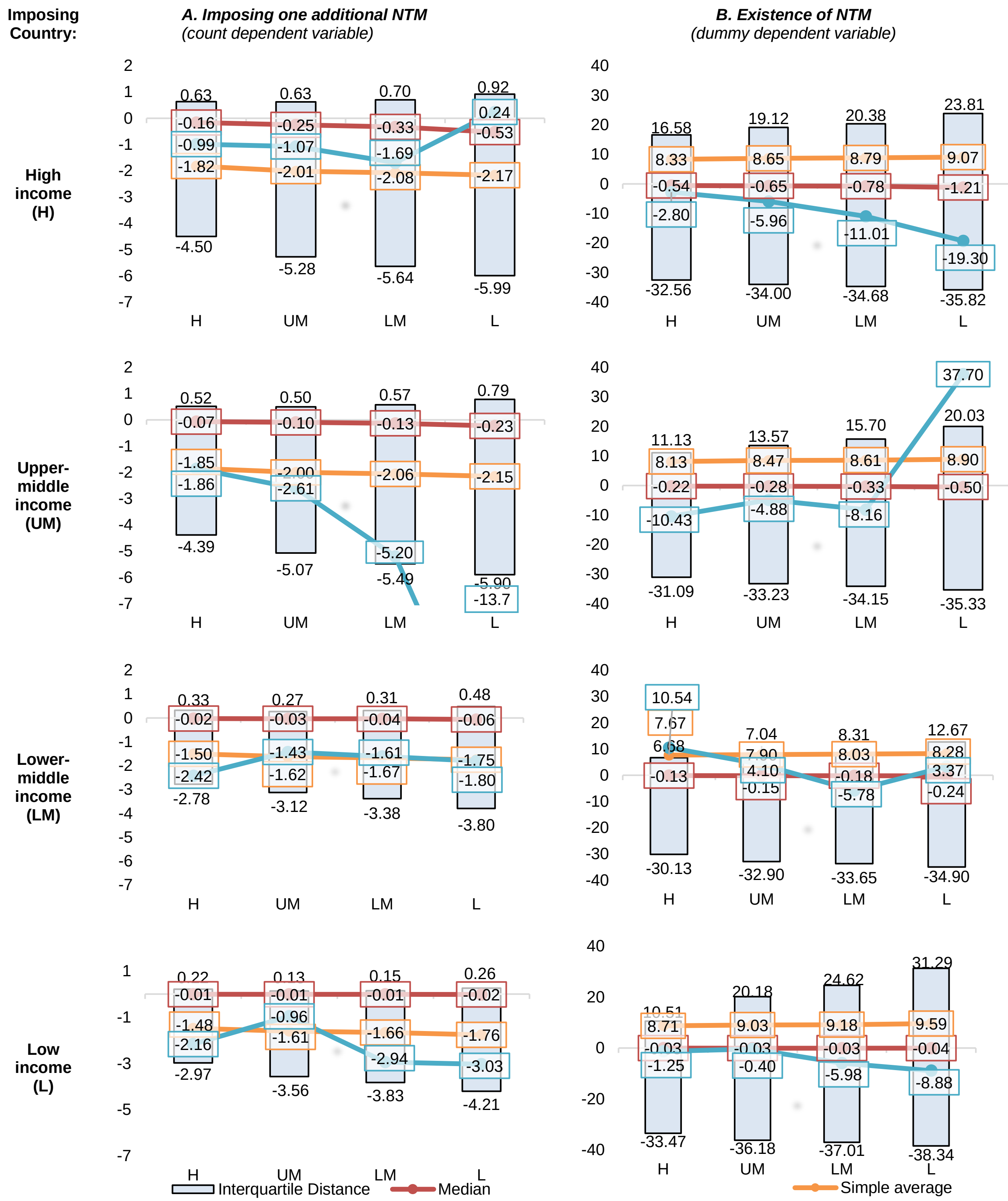
order of 2,00%, lower-middle income countries, 2.06% and LI countries 2.15% on a simple average basis. Weighting measures by trade magnified the impact, with more extreme values being observed. The next two rows of graphs showing the impact imposed by LMI and LI countries tell a similar story. The lower the income group of the affected country the more restrictive imposing a new measure appears to be. Also, values seem be less dispersed, with a smaller inter-quartile range independent of the affected country group. Before moving on, as mentioned above, few low income countries report the imposition of NTMs to the I-TIP database and this group is likely to be sub-represented.

The graphs to the right in figure 3 show the impact of imposing one or more TBTs. An overview reveals confirms what was concluded before: most part of the distribution lie on the negative side and trade effects is larger in magnitude, with quartiles reaching beyond -30% and 20%. Also, as seen in the bottom of table 3, simple averages are also positive oscillating mainly between 8% and 9% and might be subject to the influenced of more extreme values on the positive side (1st percentile was -93.2%, while the 99th was 590.3%, see table 2).

The top right graph shows that when HI countries impose TBTs on other HI countries trade is reduced by 2.8% on a trade weighted average. This value is even more trade deterring for the other groups with the most affected being the least developed ones: LI (-19.3%), LMI (-11.03%) and UMI countries (-5.96%). However, measures imposed by HI countries also show a bigger dispersion as we move to groups with low economic development, with the standard deviation increasing from 72.9 (HI-HI) to 76.1 (HI-LI), meaning that there are also cases where the imposition of a TBT by an HI country on a LI country might impulse trade. When analyzing TBTs imposed by UMI countries, one result stands out as contradictory in comparison to the analysis using the count dependent variable. What UMI apply to LI countries on a trade average represent a trade boost of around 37%, while applying one additional measure reduced trade in around 14%. Two probable sources might have driven this conflicting result. One is the simple fact that estimations come from different models and might be subject to endogeneity in the parameters. The other is the lack of trade considered for the calculation of this trade weighted average. Since a relevant part of these groups' trade was under the influence of outliers and were not considered, this lowers the robustness of these particular results.[29] TBT measures applied by LMI and LI show a slightly decreasing median value as the income group moves from high to low income. For measures imposed by LMI, trade weighted averages are as simple average in most cases positive. Another pattern observed across specification 2 was the increase of the variance of results when the lower income group were considered, suggesting that some countries were able to use TBTs to promote trade in certain products.

[29] Only 55% (for specification 1) and 63% (specification 2) of trade was used to calculate the trade weighted average (the lowest values of all bilateral country-group results). The trade weighted average for a TBT imposed by a UMI nation on the other income groups took into account at least 85% of trade.

Figure 3
Estimated TBT trade effects by income group of imposing and affected country
(Volume effects in percentages)

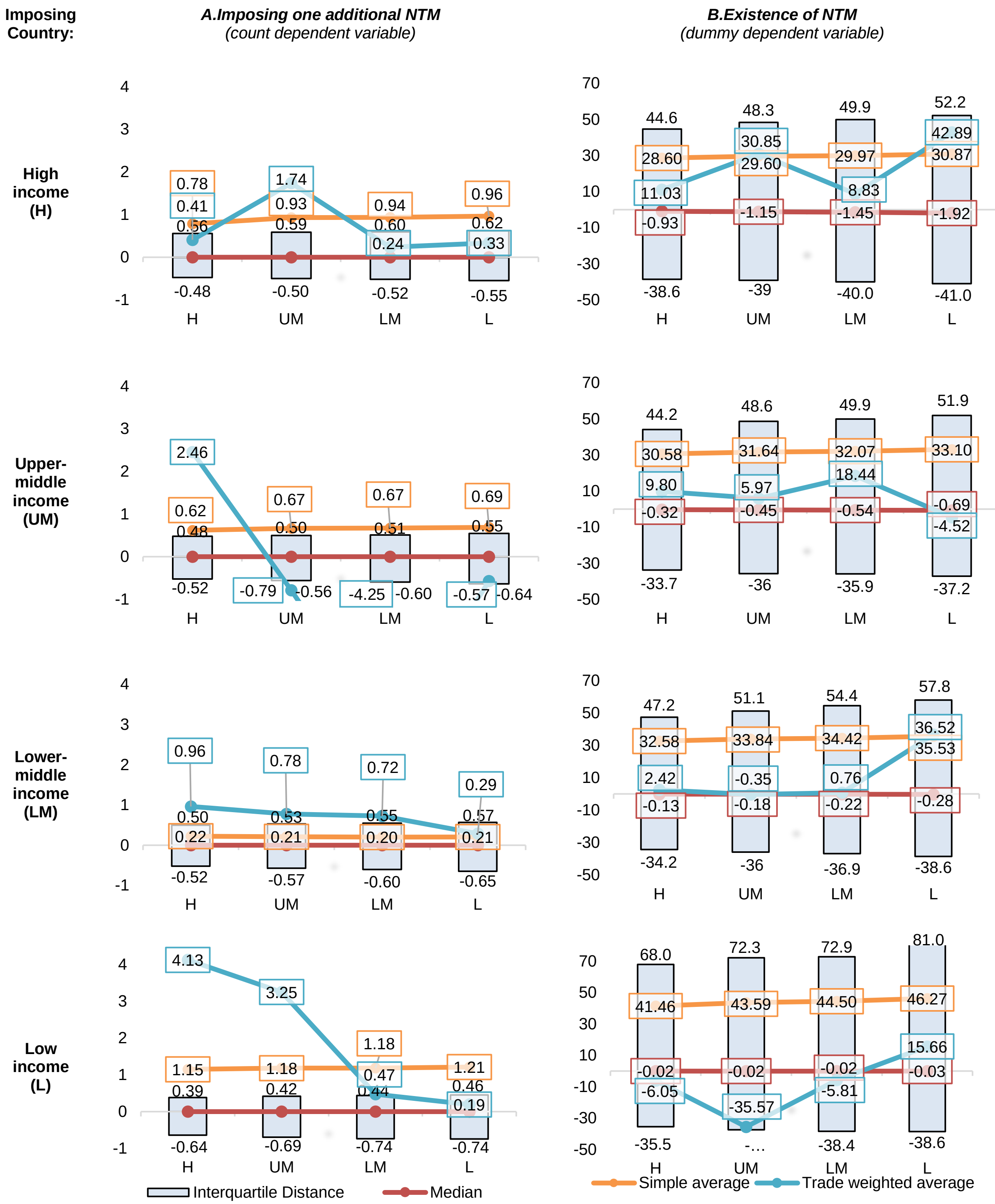


Source: Author's calculation.
Note: the letters at the bottom of each graph represent the affected country income level: H (high income), UM (upper-middle income), LM (lower-middle income) and L (low income).

As previously observed in table 2 and 4, the trade effects of SPS analyzed by importer-exporter income groups show that for all group combinations the impacts of imposing one additional measure present a more symmetric dispersion with less dispersed values compared to the same impact of TBT measures. Medians were all equal to zero when rounded to two decimals. The centre of the distribution of volume effects does not show much variation across exporter or the importer dimension. The top left graph examines the impact of measures imposed by HI countries. Although SPS volume effects are all positive, as previously mentioned, averages are again not robust to a change in specification. SPS imposed by UMI nations are trade restrictive especially for UMI, LMI, with trade promoting effects only for exporters of HI countries. The impact of SPS imposed by LMI economies is the smallest and presented the lowest variance. Simple averages reveal that measures imposed by LMI across income groups' exporters showed the smallest volume effects when compared with measures imposed by other income groups. Robustness checks, presented in annex 4, show conflicting results concerning the direction of the impact. While here average effects, are positive, indicating trade promotion, the other specification argue for a slightly negative impact on volume. For SPS measures imposed by LI nations, a robust pattern for trade weighted averages was observed, supporting that exporters from more developed countries were the most beneficiated by new SPS regulation. Here HI country being associated with a 4.13% increase in volume while a SPS applied to a LI country boosting trade only by 0.19% (see figure 4).

Moving to the graphs of the right which capture the central dispersion of trade effects of imposing one or more SPS, one can notice the abovementioned high variance across all exporter and importers income group combinations. As observed before for TBT NTMs, the variance almost always increases as exporters move into a least developed income group. The hypothesis that exporters from low income countries are the most affected by an NTM is not supported by analyzing the averages of this specification. This holds only for SPS imposed by UMI economies on exporters of LI economies, where the existence of SPS was linked to a reduction of 4.52% in the volume traded. Median values on the other hand, show that most of the observations are associated with trade reduction as a response of imposing one or more SPS and support that these measures affect most the least developed economies. As mentioned before, the upper quartile dispersion and a high 1% cutoff threshold (1,602%) might be influencing averages (see table 2).

Figure 4
Estimated SPS trade effects by income group of imposing and affected country
(Volume effects in percentages)



Source: Author's calculation.
Note: the letters at the bottom of each graph represent the affected country income level: H (high income), UM (upper-middle income), LM (lower-middle income) and L (low income). Medians labels were suppressed when all values were equal to zero.

C. Sectorial effects (HS sections)

This part analyzes the volume impact of imposing NTMs over all HS sections. First, sections with most significant impacts were those with higher frequency indexes. In regard to TBTs, the HS sections with most of the significant impact of NTMs were “Machinery and electrical equipment” (sec. XVI), “Textile and articles” (sec. XI), “Chemical products” (sec. VI) and “Vegetable products” (sec. II). Together these four HS sections represented almost 60% of all significantly imposed TBTs (for both specifications). In relation to SPS, “Products Chemical products” (sec. VI) followed by “Vegetable products” (sec. II), “Prepared foodstuff; beverages, vinegar; tobacco” (sec. IV) and “Live animals; animal products” (sec. I) were the sections with most significant identified. The detailed percentage of the number of NTMs considered for calculating volume effects in each section are detailed in tables 5 and 6.

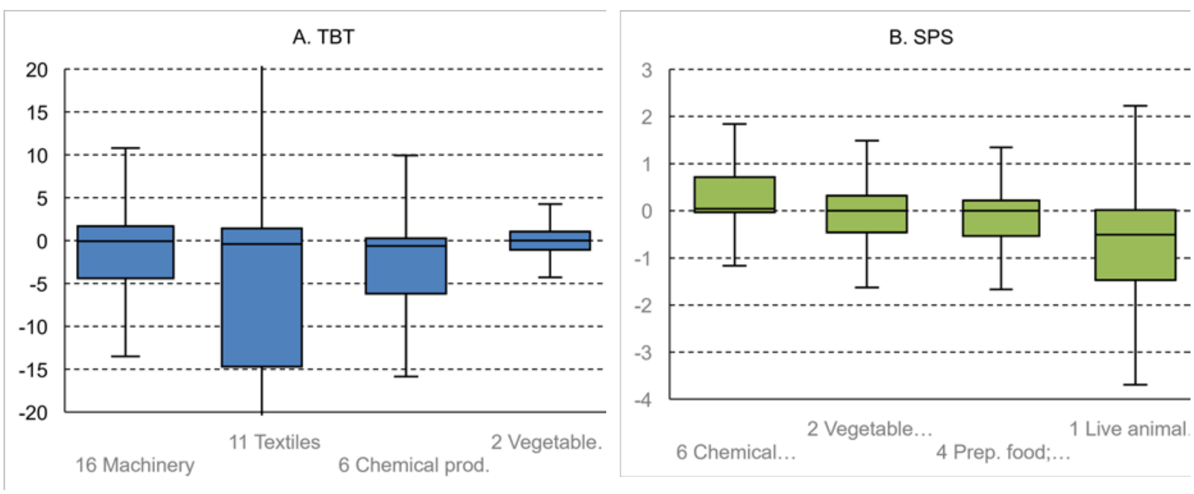
A first look into the product dimension reveals that agri-food products (sections I to IV) were less affected by an additional TBT than industrial products (sections V-XXI). The former group of products a negative averages close to -0.65% while the latter a negative effect of -1.21% using trade weights and -2.36% using simple averages. The SPS disaggregation into big sectors shows the contrary: SPS tended to reduce volume for agri-food products while it had the opposite effect on industrial products. SPS imposed on agri-food products had a negative impact on volume of magnitude -0.38% and -0.04% for simple and trade weighted averages. Therefore, most of the trade creating force of SPS appears to be coming from measures applied on the industrial sectors, which are mainly regulating section VI of chemical and related products. The volume promoting features of SPS in industrial products lack robustness, as shown in annex 4.

Figure 5 displays the distribution of the four HS sections with most significant measures for the first specification. TBTs imposed on machinery and electrical equipment products showed mostly a negative impact on traded quantities, with the inter-quartile range of imposing a new measure lying between an a -4.4% impact and a 1.7% trade creating impact. The second HS section with most significant TBTs was section XI – textile and articles thereof. These products displayed a more disperse distribution with more NTMs being associated with more restrictive trade impacts. Similarly, to machinery, chemical products showed a smaller dispersion, with great part of the distribution lying on the negative side. Vegetable products regulated by TBTs were more equidispersed with the central 80% observations of the distribution lying between a volume effect of -2.6% and 2.4%.

From an initial assessment of panel B in Figure 5, a smaller volume effect of SPS compared to TBT can be identified. The largest trade-enhancing effects of SPS appear to be coming from chemical products, with the third quartile of the distribution representing a 0.71% increase in volume. “Vegetable products” and “prepared foodstuff; beverages, vinegar; tobacco” have a more similar distribution with median values of both HS sections’ distribution displaying values close to zero. From these main sectors “live animals and animal products” exhibited the most negative trade effects, with the median effect of imposing a new measure representing a 0.51% fall in traded quantities.

The analysis of simple average (SA) volume impacts give a notion of protection/promotion associated with the products of this section. Differently, trade weighted averages (TWA) represent the reduction/increase associated with a new NTM in the most economically important goods and bilateral trade relationships. Taking this into account, it can be seen that for sections most affected by TBTs, the simple average impact is larger than trade weighted average. For textile products for example, a new TBT is linked to a 3.63% reduction in volume, while a new TBT in country-pairs with relevant trade in textiles is related to a 0.29% increase in the quantity traded. This pattern is also observed for "live animals and products", "prepared foodstuff; beverages, vinegar; tobacco", "chemical products" and "Instruments, clocks, recorders and reproducers". For "vegetable products" and "machinery and electrical equipment", SA effects were larger than TWA, with the former showing a negative TWA (-0.60%) and a positive SA (0.04%) and latter showing negative values for both TWA (-2.48%) and SA (-1.08%). Median values of TBT impacts from each HS section seem to be mostly on the negative side of the distribution. Moving SPS measures, it can be seen from 7th column in Table 5 (% of SPS) that the four main affected sections represent around 85% of all significant volume effects calculated. For both "live animals and products", "vegetable products" SA showed a more restrictive impact than TWA. The other two main sections affected by SPS showed the reversed pattern (TWA larger than SA) with volume effects of "prepared foodstuff; beverages, vinegar; tobacco" being both negative and those of "chemical products" being trade promoting. Some extreme values were observed for SPS of the three last HS sections. This might be a consequence of the low frequency indexes displayed by these sectors, which might have led to more unstable results in such products.

Figure 5
Distribution of estimated volume effects of imposing one additional measure by main HS sections
(HS sections with most measures —specification 1— in percentages points)



Source: Author's calculation.
Note: Upper and lower adjacent values of the box plot were calculated according to Tukey (1977). The upper adjacent is calculated by adding 1.5 times the inter-quartile range (IQR) to the 3rd quartile and the lower adjacent value by subtracting 1.5 times the IQR to 1st quartile of the distribution.

Table 5
Volume effects of TBT and SPS by HS section: imposing one additional NTM
(simple averages, SA; trade weighted averages, TWA; and medians in percentages)

HS Section		TBT				SPS			
		% of TBT[a]	SA	TWA	Median	% of SPS[a]	SA	TWA	Median
Sec. I	Live animals; animal products	5.7%	-1.43	-0.05	-0.11	17.1%	-0.62	0.06	-0.51
Sec. II	Vegetable products	8.4%	0.04	-0.60	0.00	18.9%	-0.31	0.10	0.00
Sec. III	Animal and vegetable fats, oils and waxes	1.5%	-0.70	-2.28	-0.02	2.7%	0.10	0.24	0.00
Sec. IV	Prepared foodstuff; beverages, vinegar; tobacco	7.6%	-0.79	-0.61	-0.40	12.3%	-0.25	-0.30	0.00
Sec. V	Mineral products	2.4%	-4.12	-4.72	-0.09	2.7%	20.24	7.35	2.03
Sec. VI	Products of the chemical or allied industries	15.1%	-1.63	-1.10	-0.62	37.3%	0.30	0.12	0.04
Sec. VII	Plastics, Ruber and articles thereof	3.8%	-2.70	-2.70	-1.05	2.0%	1.72	2.42	0.00
Sec. VIII	Hides, skins & art. saddlery/travel goods	0.5%	-9.20	0.93	-16.14	1.3%	6.80	2.04	0.00
Sec. IX	Wood, cork and articles; basketware	0.8%	4.79	-4.79	1.46	1.4%	21.86	-4.19	0.00
Sec. X	Paper, paperboard and articles	1.3%	-1.70	-2.75	-1.34	0.6%	2.35	3.16	0.06
Sec. XI	Textiles and articles	16.6%	-3.63	0.29	-0.38	1.1%	-1.11	6.85	-0.24
Sec. XII	Footwear, headgear; feathers, artif. flowers, fans	0.4%	-1.43	-6.96	-0.02	0.0%	-1.37	-7.09	-3.58
Sec. XIII	Articles of stone, plaster; ceramic prod.; glass	2.0%	-0.32	0.17	-0.03	0.2%	5.37	27.06	0.57
Sec. XIV	Pearls, precious stones and metals; coin	0.3%	-3.06	13.46	0.03	0.0%	-	-	-
Sec. XV	Base metals and articles	5.6%	-3.34	-1.77	-0.40	0.2%	9.04	6.08	6.50
Sec. XVI	Machinery and electrical equipment	17.5%	-1.08	-2.48	-0.06	1.6%	0.18	-5.56	-0.08
Sec. XVII	Vehicles, aircraft and vessels	2.8%	-0.88	0.09	-0.04	0.2%	4.93	25.23	-1.41
Sec.XVIII	Instruments, clocks, recorders and reproducers	5.2%	-3.14	2.25	-1.22	0.2%	5.84	2.68	-6.51
Sec. XIX	Arms and ammunition	0.1%	-7.16	-2.98	-0.25	0.0%	15.87	69.97	1.05
Sec. XX	Miscellaneous manufactured articles	2.2%	-6.45	2.60	-0.23	0.2%	4.93	27.25	0.43
Sec. XXI	Works of art and antiques	0.0%	-1.13	-20.92	-0.01	0.0%	23.20	-1.52	305.79
	Total	100%	-1.94	-1.42	-0.16	100%	0.76	0.81	0.00

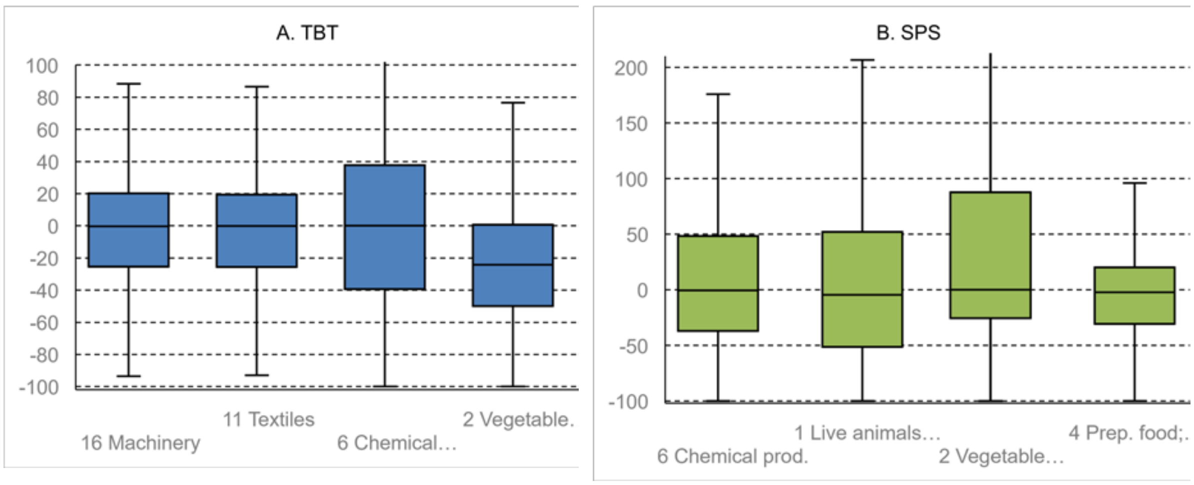
Source: Author's calculation.
[a] This value represents the percentage that NTMs from each HS section represent of all significant NTMs imposed.

The same analysis, but now for specification 2 on the impact of one or more NTMs on volume reveal additional insights. Analyzing the four main affected HS section shows that, first, these four main HS section with most TBT and SPS impacts identified were the same as from specification 1 (see figure 6). Second, except for "vegetable products" for which almost three quarters of the distribution lie on the negative side, TBT volume effects showed a large distribution of the calculated trade effects with almost the same amount of observations in the negative and in the positive side. Machinery and textiles showed a similar inter-quartile range with the existence of a TBT being approximately associated with a 20% increase or 20% reduction in volume traded. For chemical products this range was twice as large. In regard to SPS measures, contrary to the previous specification, SPS volume effects were more dispersed than TBT's. These values were more dispersed on the positive side than on the negative side, with the third quartile larger than the second quartile. Among the main HS sections, "Prepared foodstuff; beverages, vinegar; tobacco" displayed the lowest dispersion, with the IQR of volume effects going from -31% to 20%.

Taking a closer look at median values reveals negative values for most of the HS sections, implying that for most of the country-pairs-product-year the impact was volume restrictive. "Pearls, precious stones and metals; coin" (-48.8%), followed by "vegetable products" (-24.2%), "animal and vegetable fats, oils and waxes" (-5.9%) and "plastics, Rubber and articles thereof" (-5.1%) displayed the most negative medians for volume effects of imposing TBTs. When simple averages were analyzed the pictured changed, with most values showing a positive trade effect, except for sections II, III, XII, X and XXI. Trade weighted averages, on the other hand, were mostly negative. For SPS, "instruments, clocks, recorders and reproducers" (-27.3%)

and "machinery and electrical equipment" (-21.4%) were the sections with most negative medians. Simple and trade weighted averages were mainly positive for both measures.[30]

Figure 6
Distribution of estimated volume effects of imposing NTMs by main HS sections
(HS sections with most measures —specification 2— in percentages points)



Source: Author's calculation.
Note: Upper and lower adjacent values of the box plot were calculated according to Tukey (1977). The upper adjacent is calculated by adding 1.5 times the inter-quartile range (IQR) to the 3rd quartile and the lower adjacent value by subtracting 1.5 times the IQR to 1st quartile of the distribution.

Table 6
Volume effects of TBT and SPS by HS section: existence of NTM
(simple averages, SA; trade weighted averages, TWA; and medians in percentages)

HS Section		TBT				SPS			
		% of TBT[a]	SA	TWA	Median	% of SPS[a]	SA	TWA	Median
Sec. I	Live animals; animal products	7.1%	6.93	2.26	-1.46	19.6%	33.51	27.01	-4.58
Sec. II	Vegetable products	9.1%	-10.92	-8.57	-24.15	19.1%	47.22	-7.48	0.00
Sec. III	Animal and vegetable fats, oils and waxes	1.4%	-15.05	-6.92	-5.93	2.8%	-4.52	-27.56	-8.54
Sec. IV	Prepared foodstuff; beverages, vinegar; tobacco	6.5%	1.89	10.59	-1.33	12.2%	22.64	12.93	-2.46
Sec. V	Mineral products	2.4%	33.34	-18.86	0.28	2.6%	85.44	37.10	0.44
Sec. VI	Products of the chemical or allied industries	13.4%	19.13	23.78	0.00	34.1%	22.80	1.68	-0.65
Sec. VII	Plastics, Rubber and articles thereof	3.5%	-2.54	-9.36	-5.11	2.5%	2.04	104.46	-4.49
Sec. VIII	Hides, skins & art. saddlery /travel goods	0.5%	11.62	18.19	-0.69	1.4%	32.25	13.98	0.00
Sec. IX	Wood, cork and articles; basketware	0.9%	17.14	26.27	0.51	1.1%	44.30	48.70	0.01

30 Comparing values in tables 5 and 6 disclose some supportive as well as contradictory evidence. Median values for 16 HS sections show the same sign for both specifications. The conflicting results appear when analyzing averages especially simple averages, where only 5 HS sections show the same direction of average volume effects. Considering TWAs, this number increase for eleven out of twenty-one. These conflicting results, which were more frequently observed for TBTs, might be explained by the larger dispersion of volume effects from specification 2. This in turn is likely to have affected the mean value upwards.

HS Section		TBT				SPS			
		% of TBT[a]	SA	TWA	Median	% of SPS[a]	SA	TWA	Median
Sec. X	Paper, paperboard and articles	1.2%	-8.81	1.55	-4.98	0.6%	10.16	-46.96	-7.07
Sec. XI	Textiles and articles	16.5%	7.71	9.36	-0.14	1.2%	95.57	6.02	0.50
Sec. XII	Footwear, headgear; feathers, artif. flowers, fans	0.5%	8.37	-48.88	-0.53	0.0%	25.58	-4.62	-8.68
Sec. XIII	Articles of stone, plaster; ceramic prod.; glass	2.3%	7.04	-1.02	-0.01	0.2%	-11.67	13.46	-12.61
Sec. XIV	Pearls, precious stones and metals; coin	0.3%	13.58	136.73	-48.79	0.0%	0.00	0.00	0.00
Sec. XV	Base metals and articles	5.9%	6.67	6.89	0.00	0.2%	9.23	-9.90	-0.36
Sec. XVI	Machinery and electrical equipment	18.5%	13.87	-10.62	-0.41	1.8%	9.87	-1.19	-21.37
Sec. XVII	Vehicles, aircraft and vessels	3.3%	17.26	-17.88	-0.79	0.2%	85.81	70.86	7.60
Sec.XVIII	Instruments, clocks, recorders and reproducers	4.3%	14.95	-2.50	-1.18	0.2%	74.08	12.27	-27.27
Sec. XIX	Arms and ammunition	0.1%	10.07	-29.99	0.36	0.0%	11.76	107.88	0.78
Sec. XX	Miscellaneous manufactured articles	2.4%	1.26	7.69	-0.13	0.2%	5.99	50.72	0.18
Sec. XXI	Works of art and antiques	0.0%	-6.23	115.88	0.03	0.0%	347.41	62.87	92.20
	Total	100%	8.52	-5.32	-0.42	100%	30.90	14.14	-0.69

Source: Author's calculation.

[a] This value represents the percentage that NTMs from each HS section represent of all significant NTMs imposed.

To conclude, these findings should be taken with caution because of the abovementioned reasons. The first reason concerns the NTM data source used, WTO's I-TIP. Despite efforts to improve the data quality, still some aforementioned weaknesses remain. Second, results show great diversity and average effects, which although give a general idea on the impact, are not representative for a whole group.

IV. Conclusions

This work contributes to the literature by using panel data methods to calculate bilateral volume effects of NTMs, contemplating especially Technical Barriers to Trade (TBT) and Sanitary and Phytosanitary (SPS) measures. Since even multilateral NTMs are likely to impact exporters unevenly, effort was made to quantify the bilateral aspect of the NTM which would give indications to which group of countries is likely to come out winning or losing. Regressions were performed at the product level (HS 6 digit) for more than 5,000 products using data from more than 150 importers and exporters spread over the period of 2001-2015. Different specifications assessed the robustness of results.

All in all, volume effects of both SPS and TBT showed a large dispersion both over the negative and the positive axis, which means that, these measures not only restrict trade quantities but also promote it in many occasions. This suggests that well designed measures as well as convergence of regulation can unleash trade promoting effects in terms of quantity while still achieving the pre-defined goals initially set by these technical measures. The comparison of the direction and magnitude between the volume effects of both measures, suggest that TBT measures are more restrictive than SPS measures.

With respect to TBT measures, average effects showed a trade restrictive feature, with most of the distribution of estimated volume effects lying on the negative side. Higher compliance costs or a negative import-demand shift after a new TBT is imposed are associated with a -1.42% decrease in volume. A TBT imposed by a high-income country reduces more trade of the least developed economies, which probably do not have the standards of high-income economies and must incur in an additional cost in order to export. Since this cost might be prohibitive for some exporters, trade quantities are likely to fall. When a low-income country imposes a TBT, other low income countries appear to be the most affected, maybe due to the inability or difficulty to comply with the new regulation. Exporters from least developed countries seem to be the most affected. From the sectoral perspective, a new TBT measure applied on industrial products appeared to reduce more trade than agri-food products.

The picture is somehow different for SPS measures. First, the volume impact of these measures were more equally distributed around zero. A large portion of the distribution lies on the positive side, indicating a market creating effect of imposing these measures. This result reinforces the potential of such measures in correcting market failures and reducing asymmetric information. Assuring local consumers of the quality and safety of imported goods was shown to increase trade in many cases. Analyzing the product dimension revealed that imposing a new SPS measure on agri-food products shows a negative impact of around -0.38%. This impact on industrial products was less robust, although for chemical products the impact appears to be small and positive. The analysis of the importer-exporter dimension did not reveal much variation when compared to the whole distribution. For SPS measures imposed by low income countries, trade-weighted averages supported that exporters from more developed countries were the most beneffited by this new regulation. An intuition for such results is that exporters from more developed countries were better able/equipped to comply with these new measures or they already possessed the standards required by the NTM in question.

Finally, as stated by other works such as Cadot et al. (2018b), mass-produced estimates, such as the one implemented here, are useful in assessing the impact of NTMs over a large number of products and countries and generating comparable figures. However, when individual countries want to implement a specific policy affecting a particular product or group of products, a handicraft estimation method, taking into account the particularities of the country-product in question, is better suited.

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Annexes

Annex 1
Econometric and Theoretical issues of the Gravity Model of Trade

This extra section guides the most interested reader through a more detailed explanation on the reasons why this paper has chosen this particular model and which are the assumptions behind it. Initially, some historical background on the gravity framework is presented by exposing the recent advances of the empirical literature. In the sequence, the chosen model is explained in further details, going from the parameter estimation method up to the assumptions and distributional forms underlying it.

Identification strategy

Following the common practice in the literature, a gravity framework was selected for assessing the impact of NTMs on trade. The gravity model of international trade, inspired from Newton's law of gravitation, states that trade between two countries is explained by the product of the size of their economy divided by the trade costs. So, the bigger the size of the economy of the trade partners the bigger will be the value traded between them, while the bigger the trade costs between them, the smaller the amount traded. Along the last decades, this naïve specification has been improved to correct for some estimation issues and support the model with theoretical background.

Particularly important has been Anderson and Van Wincoop (2003) contribution where they show that controlling for relative trade costs is crucial for a well-specified gravity model.[31] Their theoretical results show that bilateral trade is determined by relative trade costs, i.e. the propensity of country *j* to import from country *i* is determined by country *j's* trade cost toward *i* relative to its overall "resistance" to imports (weighted average trade costs) and to the average "resistance" facing exporters in country *i*; not simply by the absolute trade costs between countries *i* and *j* (Bacchetta et al., 2012). These are called "multilateral trade resistance" (MTR) terms. Shepherd (2016) claims that because the traditional model does not include these multilateral resistance variables but they are, by construction, correlated with trade costs, there is a classic case of omitted variables bias.

The literature argues that one of the best ways to control for the multilateral resistance terms is to include as many fixed effect as possible, that is, controlling for country-pair, product, importer-time and exporter-time fixed effects and performing a so-called structural gravity estimation (Yotov et al., 2016; Shepherd, 2016; Bacchetta et al., 2012). As mentioned before, importer-time and exporter-time dummies were not included due to the collinearity issues with non-discriminatory trade policy. Instead this work includes further multilateral controls as a way of controlling for the MRTs.

Another advance by the empirical trade literature refers to how to estimate the gravity in order to correct for two important issues: endogeneity steaming from the selection bias and the heteroskedasticity of the residuals. Failure to include observations with no trade may bias the estimation parameters. The fact that many countries do not trade among themselves or that some trade statistics are rounded to zero due to their low value forces a log-log OLS estimation to drop those observations of the sample because the logarithm of zero is undefined. This gives rise to concerns about sample selection bias. The sample from which the regression function is estimated is not drawn randomly from the population (all trade flows), but only consists of those trade flows

[31] For an extensive explanation on the abovementioned model see Anderson and Van Wincoop (2003) and Shepherd (2016).

which are strictly positive. One way of thinking of this problem is that the probability of being selected for the estimation sample is an omitted variable in the standard gravity model. To the extent that that variable is correlated with any of the variables included in the model —which it certainly is, since the probability of trading no doubt depends on trade costs— then a classic case of omitted variable bias arises (Shepherd, 2016).

Furthermore, Santos Silva and Tenreyro (2006) highlight that in the presence of heteroskedastic errors in the multiplicative form of the gravity model, the linearized version will yield biased coefficients. To see why this is so, notice that the expected value of the logarithm of a random variable depends both on its mean and on the higher-order moments of the distribution. Hence, for example, if the variance of the multiplicative error term is a function of the regressors, the expected value of ln of this multiplicative error, will also depend on the regressors, violating the condition for consistency of OLS. In order to solve the problems, the authors suggest estimating the gravity using Poisson Pseudo Maximum Likelihood (PPML), which does not drop zero trade observations because no transformation of the dependent variable is required and because it is robust to different patterns of heteroskedasticity in the residuals.

Poisson Pseudo Maximum Likelihood (PPML)

In a seminar paper Santos Silva and Tenreyro (2006) suggested estimating the gravity model with a maximum likelihood estimator (MLE) coming from a misspecified Poisson distribution. This section will explain briefly the maximum likelihood estimation applied to the gravity model within a panel setup.

The intuition behind maximum likelihood estimation is simple. Given the observed data of the dependent variable, trade quantities, the model estimates parameters for the independent variables that give the highest probability (likelihood) of observing these trade quantities. Therefore, to find this highest probability, one needs to assume a probability density function (PDF) which has the feature of resembling the distribution trade quantities. Frequently, the trade literature considers for each observation of the dependent variable a Poisson PDF because it predicts only non-negative values:

$$Pr(Q_{ct}|\boldsymbol{x}_{ct}, \alpha_c, \beta) = \frac{\exp(-\mu_{ct})\, {\mu_{ct}}^{Q_{ct}}}{Q_{ct}!} \tag{A1}$$

where $\mu_{ct} > 0$ is the parameter defining the distribution and specified as:

$$\mu_{ct} \ = \ E(Q_{ct}|\boldsymbol{x}_{ct}, \alpha_c, \beta) = \ \exp(\alpha_c + \boldsymbol{x}'_{ct}\beta) \tag{A2}$$

with α_c being the country-pair fixed effect. For simplicity exporter and importer subscripts were combined into a single country-pair subscript c. Under the assumption of independence of individual observations of Q_{ct},, the joint density probability can be expressed as a multiplication of PDFs for individual observations

$$Pr(Q_{ct}|\boldsymbol{x}_{ct}, \alpha_c, \beta) = \prod_{c=1}^{C}\prod_{t=1}^{T} Pr(Q_{ct}|\boldsymbol{x}_{ct}, \alpha_c, \beta) \tag{A3}$$

where C and T represent respectively the total number of country-pairs and years. This function shows the probability of finding this data, given some fixed parameters and the explanatory variables. However, the values of the parameters are unknown and therefore the relationship cannot be identified. It is then necessary to invert the relationship and look for the probability of finding the parameters, for the observed sample. The likelihood function is then determined:

$$L(\beta, \alpha_c | Q_{ct}, \boldsymbol{x}_{ijt}) = \prod_{c=1}^{C} \prod_{t=1}^{T} Pr(Q_{ct} | \boldsymbol{x}_{ijt}, \alpha_c, \beta) \,. \quad \text{(A4)}$$

Equation (A4) gives the probability of obtaining a specific parameter given the sample.[32] Once the function is obtained, parameters are chosen so as to maximize the probability of occurrence of the sample. For computational convenience the MLE estimate is obtained by maximizing the log-likelihood function. For existence of an MLE, the first derivative with respect to the parameters should be zero and the second should be negative, representing a maximum (Myung, 2003). If the probability function of (A4) is Poisson, as in (A1), the model is termed Poisson maximum likelihood estimator.

The assumption of a Poisson distribution is stronger than necessary for statistical inference based on β. The only requirement needed for a consistent estimation of β from (A4) is the correct specification of the conditional mean, that is, $E(Q_{ct} | \boldsymbol{x}_{ct}, \alpha_c, \beta)$. Given this robustness to distributional assumptions, β can be used even if the data generating process for Q_{ct} is misspecified and it is not the Poisson. If an alternative data generating process is entertained, the estimator defined by the Poisson maximum likelihood first-order conditions of equation (A4) is called a Poisson pseudo maximum likelihood (PPML) estimator. Here, the Poisson mean is assumed but the Poisson restriction of equidispersion is relaxed, allowing for overdispersion or underdispersion in the disaggregated trade data. Also, there is no restriction on the dependence between Q_{ct} and Q_{cr}, $t \neq r$. Furthermore, the data does not have to be integer even though the estimator is mainly used for count data (Cameron and Trivedi, 1998; Santos Silva and Tenreyro, 2006; Wooldridge, 2010).

Fixed Effects Panel PPML estimation

Since country-pair fixed effects, α_c, will generally be correlated with the explanatory variables, random effects estimation will be inconsistent (Westerlund and Wilhelmsson, 2011). Therefore, there is the need to separate these fixed effects from the residuals so that no omitted variable bias arises. The approach used in this work was proposed by Hausman, Hall and Griliches (1984) where they eliminate the term α_c by using a conditional maximum likelihood methodology. In other words, an estimator that is not a function of the fixed effects is found by obtaining the joint distribution of $(Q_{c1}, Q_{c2}, \dots, Q_{cT})$ conditional on the sum of the quantities across time (Greene, 2003). As Cameron and Trivedi (1998) explain this joint distribution of $(Q_{c1}, Q_{c2}, \dots, Q_{cT})$ takes the form of a multinomial distribution and is given by:

$$Pr\left(Q_{c1}, \dots, Q_{cT} | \sum_{t}^{T} Q_{ct}, \boldsymbol{x}_{ct}\right) = \frac{Pr(Q_{c1}, \dots, Q_{cT} | \sum_t^T Q_{ct}, \boldsymbol{x}_{ct})}{Pr(\sum_t^T Q_{ct} \, | \boldsymbol{x}_{ct})} \,. \quad \text{(A5)}$$

Following equation (A3) the joint density probability for the c'th country-pair is equal to the multiplication of this country-pair's PDFs for each year, that is,

$$Pr(Q_{c1}, \dots, Q_{cT} | \boldsymbol{x}_{ct}) = \prod_{t=1}^{T} \frac{\exp(-\exp(\alpha_c + \boldsymbol{x}'_{ct}\beta))\exp(\alpha_c + \boldsymbol{x}'_{ct}\beta)^{Q_{ct}}}{Q_{ct}!} \,, \quad \text{(A6)}$$

$$Pr(Q_{c1}, \dots, Q_{cT} | \boldsymbol{x}_{ct}) = \prod_{t=1}^{T} \frac{\exp(-\exp(\alpha_c)\exp(\boldsymbol{x}'_{ct}\beta) + \alpha_c Q_{ct})\exp(\boldsymbol{x}'_{ct}\beta)^{Q_{ct}}}{Q_{ct}!} \,, \quad \text{(A7)}$$

32 From here on the notation of parameters in the probability functions were suppressed for simplicity.

$$Pr(Q_{c1},\dots,Q_{cT}|x_{ct}) = \left(\prod_{t=1}^{T} \frac{exp(x'_{ct}\beta)^{Q_{ct}}}{Q_{ct}!}\right) exp\left(-exp(\alpha_c)\sum_{t=1}^{T} exp(x'_{ct}\beta) + \alpha_c \sum_{t=1}^{T} Q_{ct}\right). \quad \text{(A8)}$$

Since the denominator of equation (A5) is given by

$$Pr\left(\sum_{t}^{T} Q_{ct}\,|\boldsymbol{x}_{ct}\right) = \frac{1}{(\sum_t^T Q_{ct})!}\exp\left(-\exp(\alpha_c)\sum_{t=1}^{T}\exp(\boldsymbol{x}'_{ct}\beta) + \alpha_c\sum_{t=1}^{T} Q_{ct}\right)\left(\sum_{t=1}^{T}\exp(\boldsymbol{x}'_{ct}\beta)\right)^{\sum_t^T Q_{ct}}, \quad \text{(A9)}$$

one can apply (A8) and (A9) to (A5) and simplify the equation.[33] Note that the resulting equation is not dependent on the fixed effects (α_c):

$$Pr\left(Q_{c1},\dots,Q_{cT}|\boldsymbol{x}_{ct},\sum_{t}^{T} Q_{ct}\right) = \frac{\left[\prod_{t=1}^{T}\frac{\exp(\boldsymbol{x}'_{ct}\beta)^{Q_{ct}}}{Q_{ct}!}\right]\exp[-\exp(\alpha_c)\sum_{t=1}^{T}\exp(\boldsymbol{x}'_{ct}\beta) + \alpha_c\sum_{t=1}^{T}Q_{ct}]}{\frac{1}{(\sum_t^T Q_{ct})!}\exp[-\exp(\alpha_c)\sum_{t=1}^{T}\exp(\boldsymbol{x}'_{ct}\beta) + \alpha_c\sum_{t=1}^{T}Q_{ct}][\sum_{t=1}^{T}\exp(\boldsymbol{x}'_{ct}\beta)]^{\sum_t^T Q_{ct}}} \quad \text{(A10)}$$

$$Pr\left(Q_{c1},\dots,Q_{cT}|\boldsymbol{x}_{ct},\sum_{t}^{T} Q_{ct}\right) = \left[\prod_{t=1}^{T}\frac{\exp(\boldsymbol{x}'_{ct}\beta)^{Q_{ct}}}{Q_{ct}!}\right]\frac{(\sum_t^T Q_{ct})!}{[\sum_{t=1}^{T}\exp(\boldsymbol{x}'_{ct}\beta)]^{\sum_t^T Q_{ct}}} \quad \text{(A11)}$$

$$Pr\left(Q_{c1},\dots,Q_{cT}|\boldsymbol{x}_{ct},\sum_{t}^{T} Q_{ct}\right) = \frac{(\sum_t^T Q_{ct})!}{\prod_t^T Q_{ct}!}\prod_{t=1}^{T}\frac{\exp(\boldsymbol{x}'_{ct}\beta)^{Q_{ct}}}{[\sum_{s=1}^{T}\exp(\boldsymbol{x}'_{cs}\beta)]^{Q_{ct}}} \quad \text{(A12)}$$

The next step is to multiply equation (A12) for all country-pairs in order to get the joint density function covering the country-pair and time of dimension. As Cameron and Trivedi (1998) show, taking the logs of this function results in the conditional log likelihood function:

$$\ln L = ln\prod_{c=1}^{C}\left\{\frac{(\sum_t^T Q_{ct})!}{\prod_t^T Q_{ct}!}\prod_{t=1}^{T}\frac{\exp(\boldsymbol{x}'_{ct}\beta)^{Q_{ct}}}{[\sum_{s=1}^{T}\exp(\boldsymbol{x}'_{cs}\beta)]^{Q_{ct}}}\right\} \quad \text{(A14)}$$

$$\ln L = \sum_{c=1}^{C}\left[\ln\left(\sum_{t=1}^{T}Q_{ct}\right)! - \sum_{t=1}^{T}\ln(Q_{ct}!) + \sum_{t=1}^{T}Q_{ct}\ln\left(\frac{\exp(\boldsymbol{x}'_{ct}\beta)}{\sum_{s=1}^{T}\exp(\boldsymbol{x}'_{cs}\beta)}\right)\right] \quad \text{(A15)}$$

Finally, parameters β^{MLE} are obtained by maximizing this function with respect to β. As Wooldridge (2010) explains whenever $\sum_t^T Q_{ct} = \mathbf{0}$, the cross section observation i does not contribute to the estimation. Thus, there is no selection bias problem because the observations that are dropped are not informative about the parameters of interest. For more information on this estimator and other ways to derive it, see Cameron and Trivedi (1998, 2005), Greene (2003), Hausman et al. (1984) and StataCorp (2013) and Wooldridge (2010).

Post estimation test: RESET test

After estimating the parameters of all equations, the RESET (Regression Equation Specification Error Test) was used to test the overall fit of regressions. So as to conduct the test, the regressions for all

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33 Although the right hand side of (A8) has a different notation from the nominator of (A5), they are considered the same because as Cameron and Trivedi (2005) explain, the knowledge of $\sum_{t=1}^{T} Q_t$ adds nothing given the knowledge of $Q_{c1},\dots,Q_{cT}$.

products were re-estimated but this time including the squared fitted values as an additional regressor. This parameter significance was assessed and whenever this coefficient was statistically significant the model was considered as misspecified. This work used the significance level of 1%. This test was meant to assess the overall acceptance of the specification and was not taken as a criterion to exclude HS06 lines from the analysis. The results from these tests are displayed in Annex 3.

Calculation of Volume Effects

Long and Freese (2014) show that a discrete change in the expected value of models for count outcomes using a Poisson distribution is given by the difference in the expected values, as shown in the first equation line. The following rearrangements show, step-by-step, how equation (3) was derived. For simplicity, product subscripts *k* was dropped and all other variables except for the NTM type *n* were group into a vector $\boldsymbol{x}_{ijt}$. The term $\boldsymbol{x}'_{ijt}\beta$ stands for the multiplication of the transposed vector of variables by its respective vector of parameters.

$$\frac{\Delta E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right)}{\Delta NTM_{ijt}^{n}} = E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}+1\right) - E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right) \quad \text{(A16)}$$

$$\frac{\Delta E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right)}{\Delta NTM_{ijt}^{n}} = \exp\left[\beta_{2ijt}^{n}\left(NTM_{ijt}^{n}+1\right) + \boldsymbol{x}'_{ijt}\beta\right] - \exp\left(\beta_{2ijt}^{n}NTM_{ijt}^{n} + \boldsymbol{x}'_{ijt}\beta\right) \quad \text{(A17)}$$

$$\frac{\Delta E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right)}{\Delta NTM_{ijt}^{n}} = \exp\left(\beta_{2ijt}^{n}NTM_{ijt}^{n} + \boldsymbol{x}'_{ijt}\beta\right) * \exp\left(\beta_{2ijt}^{n}\right) - \exp\left(\beta_{2ijt}^{n}NTM_{ijt}^{n} + \boldsymbol{x}'_{ijt}\beta\right) \quad \text{(A18)}$$

$$\frac{\Delta E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right)}{\Delta NTM_{ijt}^{n}} = \exp\left(\beta_{2ijt}^{n}NTM_{ijt}^{n} + \boldsymbol{x}'_{ijt}\beta\right) * \left[\exp\left(\beta_{2ijt}^{n}\right) - 1\right] \quad \text{(A19)}$$

$$\frac{\Delta E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right)}{\Delta NTM_{ijt}^{n}} \Big/ E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right) = \frac{\exp\left(\beta_{2ijt}^{n}NTM_{ijt}^{n} + \boldsymbol{x}'_{ijt}\beta\right) * \left[\exp\left(\beta_{2ijt}^{n}\right) - 1\right]}{\exp\left(\beta_{2ijt}^{n}NTM_{ijt}^{n} + \boldsymbol{x}'_{ijt}\beta\right)} \quad \text{(A20)}$$

$$\frac{\Delta E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right)}{\Delta NTM_{ijt}^{n}} \Big/ E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right) = \exp\left(\beta_{2ijt}^{n}\right) - 1 \quad \text{(A21)}$$

$$\frac{\Delta E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right)}{\Delta NTM_{ijt}^{n}} \Big/ E\left(Q_{ijt}\middle|\boldsymbol{x}_{ijt}, NTM_{ijt}^{n}\right) = \exp\left(\beta_{2}^{n} + \beta_{21}^{n} * impsh_{ikt} + \beta_{22}^{n} * expsh_{jkt}\right) - 1 \quad \text{(A22)}$$

As mentioned above, the resulting formula (A22), which is the same as equation (3), allows the interpretation of the results not to depend on the level of the expected trade quantity.

Annex 2
Further Dataset Description

The research undertaken in this paper involved assessing and processing a great amount of data spread from different sources. This annex reveals the particularities of data as well as some assumptions made while organizing the dataset.

Note on Non-Tariff Measures

Departing from the full dataset made available by Ghodsi et al. (2017), notifications with no HS code identified and with neither an in-force date nor an initiation date were excluded. Furthermore, notifications of Import Licenses were removed because no information on the date of initiation or in force was available. NTM such as export subsidies (XS), tariff-rate quotas (TRQ), state trading enterprises (STE) were also excluded because they were mostly applied in the period previous to the creation of the WTO. This output a database covering the period starting in 1979 until 23 March 2016 over more than 3 million products affected by different measures. Table A1 shows the incidence of products affected by all NTMs notifications in the wiiw database by type and start/end date.

Table A1
Number of affected products NTMs Notifications by Type

NTM description	Total	Start Date (b+c+d=a)			End Date (e+f=a)	
	(a)	Only Initiation date (b)	Only in force date (c)	Both in force & initiation dates (d)	No termination date (e)	With terminatio n date (f)
Sanitary and Phytosanitary (SPS)	1 396 143	1 233 721	0	162 422	1 396 143	0
Technical Barriers to Trade (TBT)	1 353 907	1 206 525	0	147 382	1 353 907	0
Quantitative restrictions (QR)	194 087	0	194 087	0	194 087	0
Specific Trade Concerns of TBT (TBT STC)	76 520	0	76 520	0	76 520	0
Antidumping measures (ADP)	27 411	8 881	628	17 902	6 203	21 208
Specific Trade Concerns of SPS (SPS STC)	18 658	0	18 658	0	6 741	11 917
Safeguard (SG)	2 880	1 764	0	1 116	2 880	0
Countervailing duties (CV)	2 242	631	0	1 611	1 042	1 200
Special Safeguard (SSG)	774	0	0	774	774	0
Total	3 072 622	2 451 522	289 893	331 207	3 038 297	34 325

Source: Author's calculation based on wiiw's NTM database (Ghodsi et al.; 2017).

Notification id 41,889 for a TBT measure on all countries on different products had an in force year of 5015. This was set to missing and the date 6 months after the initiation date was input as the new in force date. The numbers in table B1 do not match exactly the statistics on section 1 because they represent a rawer version of the dataset, without the changes described in section 1 (i.e., adjustment of SPS and TBT measures in-force date, exclusion of SG and CV measures with no initiation date, separation of antidumping measures into duty and investigations and drop of observations terminated before the year 2000 and that went in force after 2015).

Note on Products

The wiiw NTM dataset reported notifications affecting some specific codes which on the other hand displayed no trade figures in the BACI dataset. Therefore, these codes were excluded from the analysis. Most of them represented UN special codes related to petroleum oils. Not taking these codes into account, the results from this paper were built upon the remaining 5,111 HS 6-digit codes from the 1996 revision. The complete list of removed codes is displayed on the sequence.

Table A2
HS Codes excluded

271011	Aviation spirit **LEGACY NON-WCO CODE**
271012	Petroleum spirit for motor vehicles **LEGACY NON-WCO CODE**
271013	Petroleum spirit except aviation or motor fuel **LEGACY NON-WCO CODE**
271014	Petroleum spirit-type fuel **LEGACY NON-WCO CODE**
271015	White spirit **LEGACY NON-WCO CODE**
271016	Petroleum naphtha **LEGACY NON-WCO CODE**
271019	Light petroleum distillates nes **LEGACY NON-WCO CODE**
271021	Kerosene jet fuel **LEGACY NON-WCO CODE**
271022	Kerosene, for furnaces **LEGACY NON-WCO CODE**
271025	Kerosene lamp oil, motor kerosene, light diesel, etc **LEGACY NON-WCO CODE**
271026	Gas oils - bunker oil, No.1 furnace, motor diesel **LEGACY NON-WCO CODE**
271027	Diesel oils- No.2 furnace, marine diesel **LEGACY NON-WCO CODE**
271029	Fuel oils nes, heavy distillates **LEGACY NON-WCO CODE**
271091	Heavy furnace oil (heating or motor fuel) <1% sulphur **LEGACY NON-WCO CODE**
271093	Heavy furnace oil nes **LEGACY NON-WCO CODE**
271094	Petroleum oil used in road building **LEGACY NON-WCO CODE**
271095	Petroleum lubricating oils **LEGACY NON-WCO CODE**
271096	Petroleum lubricating greases **LEGACY NON-WCO CODE**
271099	Petroleum oils and products nes **LEGACY NON-WCO CODE**
710820	Gold, monetary
711890	Coin; other than coin of item no. 7118.10

Source: Author, based on the UN Comtrade Commodity Classifications.

Note on countries

Countries were selected into the analysis based on data availability and selection bias issues. As in standard gravity estimations, an observation is comprised of a country pair i-j, with *i* being an importer and *j* an exporter.

Up to the present time 163 countries and the European Union are members of the WTO. Of these members three were not considered in the analysis because of they entered the WTO after the estimation period (Kazakhstan, Nov. 2015; Liberia and Afghanistan, Jul. 2016). Six additional members were dropped out of the sample due to its absence in the BACI dataset (Botswana, Liechtenstein, Lesotho, Namibia, Swaziland and Taiwan). Finally, again following the state of art of BACI, Luxemburg and Belgium were considered a single country. This left the group i with 153 countries.

Group *j* included all countries from group *i* plus other 29 countries, including dependencies or other territories. This resulted in a total of 182 countries, excluding those nations with no trade data in BACI. The interaction of both groups left the analysis with a maximum of 27,693 country-pairs (*ij*-*i*). In particular specifications some country-pairs were dropped due to data availability. Table A3 list all the countries included in the analysis.

Two countries split during the sample period and were considered different countries after the separation. In May 2006 Serbia & Montenegro split into two countries. Three observations were considered in this case: (i) Serbia & Montenegro with trade values up to 2004 and missing observations for later years of the panel; (ii) Serbia with observations from 2006 onwards and (iii) Montenegro with the same pattern (observations from 2006) onwards. The transition year of 2005 was dropped. In July 2011 South Sudan got its independence from Sudan. Therefore, these countries were considered three different observations: (i) the unified Sudan (with observations until 2011); (ii) South Sudan and (iii) Sudan after the independence, both with observations from 2012 onwards.

Table A3
Countries included in the analysis

List of countries in group *i* (153).
Albania, Angola, Antigua and Barbuda, Argentina, Armenia, Australia, Austria, Bahrain, Bangladesh, Barbados, Belgium- Luxembourg, Belize, Benin, Bolivia, Brazil, Brunei, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Congo (Dem. Rep.), Congo (Rep.), Costa Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt (Arab Rep.), El Salvador, Estonia, European Union, Fiji, Finland, France, Gabon, Gambia (The), Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong (China), Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea (Rep.), Kuwait, Kyrgyz Republic, Lao PDR, Latvia, Lithuania, Macao (China), Macedonia (FYR), Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Rwanda, Samoa, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Slovak Republic, Slovenia, Solomon Islands, South Africa, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Vanuatu, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.
Additional countries included in group *j* (182).
Afghanistan, Algeria, Aruba, Azerbaijan, Bahamas (the), Belarus, Bermuda, Bhutan, Bosnia and Herzegovina, Comoros (the), Equatorial Guinea, Eritrea, Ethiopia, Iran (Islamic Republic of), Iraq, Kazakhstan, Lebanon, Liberia, Libya, Palestine (State of), Sao Tome and Principe, Serbia, Serbia and Montenegro, South Sudan, Sudan (before 2012), Sudan (after 2012), Syrian Arab Republic, Turkmenistan, Uzbekistan.

Source: Author.

Note on Tariffs

Most-Favored Nation (MFN) tariffs are what countries promise to impose on imports from other members of the WTO, unless the country is part of a preferential trade agreement (such as a free trade area or customs union). This means that, in practice, MFN rates are the highest (most restrictive) that WTO members charge one another member (WITS, 2010a). When countries negotiate and agree to give another country's products lower tariffs than their MFN rate, this is called a preferential tariff. These agreements can be bilateral (both countries lowering their tariffs) or unilateral (for example when a developed country lowers its tariffs for a developing country's exports). This study calculated tariffs taking into account the preferential tariffs when available and applicable and if not, the MFN tariff.

Countries generally base their tariff schedules on the World Customs Organization's Harmonized System (HS) nomenclature. Tariff data is available in the HS level as reported by each country. For any particular year different countries might report their tariff structure under different versions of the HS classifications. This calls for a harmonization of the reported HS codes for a times series analysis. The conversion used in this work was retrieved from the UN Statistics department (UNSTAT, 2017). With the implementation of a new HS version, if an old code was split into multiple new codes, the average of these new codes was taken as the tariff of the old one. When an HS code from the 1996 version disappeared in later versions of the conversion/concordance table, this study assessed the information on the correlation table to match this missing code with new codes and then assigned the average of the correlated codes as the tariff of this HS 1996 code. Therefore, no database was left with missing tariff values because of the inexistence of a counterpart in the conversion table.[34]

Countries might set their tariffs at a more disaggregated level than the HS 6-digit level. While computing average tariffs for products that changed over HS revisions, this study weights each product according to the number of valid lines, that is, if a product contains more national tariff lines it will have more weight in the new tariff. When there was no tariff data for all national tariff lines, the weighted average was calculated taking into account only the available lines.

Although most of the tariff data is measured on an ad-valorem tariff basis, meaning that the customs duty are calculated as a percentage of the value of the product, there are some tariff lines which do not follow this method. Tariff schedule can depend, for example, on the physical quantity of the imported good (specific tariffs), on combination of an ad-valorem tariff and a specific component (compound tariffs) among others.[35] For these cases, ad-valorem equivalents of non ad-valorem tariffs are made available for some countries and some years by the TRAINS database. They are estimated using the UNCTAD 1 methodology.[36]

Tariff data was retrieved from the WITS platform, which has tariffs from two different sources: the TRAINS and WTO-IDB database. The WTO database had only values concerning MFN tariffs. Taking into account a sample period from 2000 to 2015 and including the estimation of AVE of non ad-valorem tariffs, the TRAINS database contained 10,258,526 while the WTO-IDB contained 8,887,715 tariffs from different products country and years, of which 8,182,747 were common entries to both databases. Table A4 shows that there is a small fraction of the common entries that presented conflicting information.

Table A4
MFN tariff comparison across database

Comparison of TRAINS and WTO-IDB	Number of Tariff observations	Percentage of Total
Different tariffs	349 852	4.1
Equal tariffs	8 182 747	95.9
Total	8 532 599	100

Source: Author's calculation based on data retrieved from WITS.

This called for a strategy to deal with the different values. This study opted for a four step harmonization process. The steps are described in the sequence:

i) Preference for AVE estimated values. Out of the conflicting values, 11.44% (40,010) displayed AVE estimation. This was chosen as the first criteria for consistency issues, once there were around 170,000 estimated AVEs tariffs that were not in the WTO-IDB database.

ii) Completeness of the number of lines with tariff data by HS 6-digit code. The ratio of the number of available lines over the total of lines of each HS 6-digit code was not

[34] For more information on the difference between the conversion and correlation see the methodological notes of UNSTAT (2017).

[35] See WITS (2010a) available at https://wits.worldbank.org/wits/wits/witshelp/Content/Data_Retrieval/P/Intro/C2.Forms_of_Import_Tariffs.htm.

[36] See WITS (2010b) available at https://wits.worldbank.org/wits/wits/witshelp/Content/Data_Retrieval/P/Intro/C2.Ad_valorem_Equivalents.htm.

necessarily equal across databases. Here, I chose to replace the tariff according to its most complete database, that is, the one displaying the higher ratio. This replaced 1.54% (5,373) of the different values.

iii) Substitution of extreme values by analyzing the time series of that tariff by product and country. The remaining values that did not have AVE estimations and that had the same completeness ratio (304,469) were listed according its difference in absolute value from one database to the other. A pattern of error was identified analyzing country by country that showed an absolute difference bigger than 50%. This strategy allowed substituting other 0.40% (1,409) tariff lines. Table A5 and A6 give a more detailed picture of the identification procedure.

iv) Choice for TRAINS tariffs. Lastly, as the TRAINS database contained more values, whenever a divergent value was detected, tariffs from TRAINS were considered. This represented 82.63% (303,060) of the conflicting values.

Table A5
MFN tariff comparison: country patterns identification

Country	Number of divergent values	Observation	Database choice
Burundi	609	In the year of 2002, WTO-IDB displayed a tariff of 100 while TRAINS of 40 percent for 609 different products. According to the WTO (2003), Burundi's tariff structure remained unchanged between 1993 and 1 January 2003, when the maximum rates were lowered from 100 to 40 per cent. Therefore the value of the WTO was preferred.	WTO-IDB
Dominica	90	For multiple products the TRAINS database displayed a high variance within the tariff line for Dominica. This pattern repeated across products with the year of 2000 presenting a very low tariff compared to the subsequent years and the years of 2011 and 2013 presenting a high tariff with a low tariff between them. WTO-IDB on the other hand showed less volatile tariffs across the years and was therefore preferred.	WTO-IDB
Egypt	16	The TRAINS's tariffs for 2002 for Egypt displayed some values that were probably an imputation error. Different codes starting with 2203 to 2208 there were found tariff values of 3 percent while for the all other values of these products the value was 3000. The WTO-IDB database showed constant values of 3,000 percent for all these years. Therefore, the later was preferred.	WTO-IDB
Malaysia	42	Tariffs for multiple products in the year of 2002 and 2003 appear to be underestimated by the TRAINS database. These values were constant in the neighboring years in the WTO-IDB database.	WTO-IDB
Moldova	183	Tariffs for multiple products in the year of 2013 appear to be missing the decimal point, making many series increase for this particular year from 5.5 to 55 and then return to 5.5 in the next year. Values are constant in the WTO-IDB database	WTO-IDB
Mexico	28	Tariffs for multiple products in the year of 2006 appear to be underestimated by the TRAINS database by more than 100% most of the time. These values were constant in the neighboring years in the WTO-IDB database.	WTO-IDB
Tunisia	382	For Tunisia extreme outliers (100% and 150%) were identified for the year of 2006 in the WTO-IDB database departing from the mean of period for different products. For this country TRAINS values were selected.	TRAINS
Multiple countries	43	Extreme value(s) displayed by the TRAINS database: CPV (852520 in 2005), ISL (330741 in 2001), KOR (350520 in 2002), MWI (271000 in 2006), NGA (23 products in 2002), THA (11 products in 2013) and ZWE (5 products in 2002)	WTO-IDB

Country	Number of divergent values	Observation	Database choice
Multiple countries	16	Extreme value(s) displayed by the WTO-IDB database: CMR (721119 in 2005), DOM (11 products in 2007), GTM (630510 in 2012), ISR (40221 in 2004), JOR (961310 in 2000) and QAT (220720 in 2005).	TRAINS
No pattern	434	No pattern identified in the extreme differences: BDI(4) BGD(2), BHR(9), BHS(6), BLZ (23), BRB(154), COL(3), DMA(3), ECU(4), EGY(4), EST(10), GIN(1), GUY(17), IND(45), JAM(12), KAZ(3), KNA(2), LCA(2) MAR(22), MUS(7), NGA(26), NOR(4), NPL(8) OMN(33), POL(2), RWA(4), SLV(2), SYC(1), TUN(9), TUR(6), VEN(3) and VUT(3)	TRAINS
Total	1 843		100%

Source: Author's calculation based on data retrieved from WITS.

Annex 3
General overview on Regressions

This additional section gives general statistics on the regressions, exposing what in underneath section's III results. First, products for which many observations (country-pairs-year) presented missing volume data at the product level were not considered. This work eliminated 1% of the product-lines (51) with most missing quantities in terms of traded value. This was performed, because if considered, a relevant part of the volume traded would have been dropped and parameters would have been estimated without an important share of trade. Thus, products for which the missing quantities for the whole panel represented 19% or more of this product's traded value were not taken into account. Among the most relevant products excluded are Non-industrial Diamonds (710231, 710239) and some types of vessels (890190, 890590 and 890520). This excluded HS lines represented 1.7% of the world's trade value during the years analyzed.

Out of the 5,111 PPML regressions at the HS06 level, around 93% of them converged and coefficients could be obtained as shown in the table below. After eliminating products based on missing quantities, regressions were performed on the remaining lines, with some HS06 estimations presenting some kind of estimation error.[37] Hence, around 4,745 regressions were estimated at the product level (see table A7). Results are presented for three specifications, the two previously mentioned in section III and an additional one which is performed for assessing robustness. Results from this latter specification are presented in annex 4.

Table A6
PPML Regressions Statistics
(In number of Hso6 lines)

	Number of models estimated				RESET test			
Model Specif.	Total HS06 (a)	HS lines with missing volume (b)	Estimation error (c)	Estimated models (d)=(a)-(b+c)	RESET test performed (e)=(f)+(g)	Do not Reject H0 (f)	Reject H0 (g)	Binding ratio (h)=(f)/(e)
1	5 111	51	315	4 745	4 540	3 660	880	80.6%
2	5 111	51	320	4 740	4 523	3 695	828	81.7%
3	5 111	51	316	4 744	4 605	3 848	757	83.6%

Source: Author's calculation.

The RESET test was undertaken for almost all HS06 products in which the regression initially converged —due to convergence issues the test could not be performed to all of them— values in column (e) are smaller than column (d). The last two columns of table A7 give the number of HS06 lines for which the test was performed and the percentage of times that the test was not rejected at 1% of significance (null hypothesis of model well specified). This additional check was meant to assess the overall acceptance of the specification and was not taken as a criterion to exclude HS06 lines from the analysis.

[37] Three types of errors were identified: I) the PPML function did not converge after innumerous iterations, II) a discontinuous region was found in the PPML function and therefore an improvement could not be computed or III) the variance matrix was non-symmetric or highly singular precluding the calculation of standard errors.

Next, table A8 shows significance results of all NTMs. As previously mentioned, a volume effect was calculated whenever one of the three parameters of equation (2) was found to be significant at the 10% level. The number of HS06 lines for which at least one parameter was significant is shown in the first column of each specification in table A8. The following column displays the percentage of HS06 for which at least one significant parameter of this NTM was estimated out of the total of HS06 for which parameters were estimated (for this NTM type). This analysis is presented for the three model specification and all NTMs, including some types that are presented in annex 5.

One first insight from this data is that the number of lines significant does not vary much across specification, with most of the cases a same product showing a significant impact for all specifications. The percentage of binding effects, especially for SPS and TBT measures, revealed that around 33% and 43% of products, respectively, regulated by at least one of these measures do not appear to have a significant impact on trade volume. This also gives a clearer picture on the number of products which were used to calculate average effects presented in section III and that will be presented in the coming annexes.

Table A7
PPML Regression Statistics-Significance

	Specification 1		Specification 2		Specification 3	
	Numb. of sig. HS06	Percentage of sig. lines	Numb. of sig. HS06	Percentage of sig. lines	Numb. of sig. HS06	Percentage of sig. lines
Main NTMs						
SPS	2 261	66.3%	2 239	65.6%	2 281	66.7%
TBT	2 740	57.7%	2 661	56.1%	2 786	58.7%
Other NTMs						
ADP	2 550	80.6%	2 558	80.9%	2 518	79.8%
ADPINV	2 133	82.5%	2 133	82.5%	2 106	81.9%
CV	429	82.2%	433	82.6%	418	80.4%
QR	2 838	59.8%	2 878	60.7%	2 830	59.7%
SPSSTC	381	65.6%	374	64.5%	381	65.4%
SG	344	69.6%	335	68.1%	336	67.9%
SSG	110	70.5%	116	74.8%	114	71.7%
TBTSTC	3 219	68.6%	3 237	69.1%	3 204	68.4%

Source: Author’s calculation.

Annex 4
Robustness checks of SPS and TBT volume impact

For the sake of completeness, this annex compares the results from specification 1 presented in section III with results from a different specification, also using count NTMs. This specification is named specification 3. Additional controls were included to the baseline specification (equation 1) in order to assess those result's robustness. The following term, C_{ijt}^{k}, was introduced lagged in one period to equation (1):

$$\boldsymbol{C}_{ijt} = \beta_{c1}\left[\left(\frac{Ypc_{it}^2}{\left(Ypc_{it}+Ypc_{jt}\right)^2}+\frac{Ypc_{jt}^2}{\left(Ypc_{it}+Ypc_{jt}\right)^2}\right)-\frac{1}{2}\right]+\sum\nolimits_{f=L,K,A}\beta_{c2\_f}\left[ln\left(\frac{f_{jt}}{Y_{jt}}\right)-ln\left(\frac{f_{it}}{Y_{it}}\right)\right]+\beta_{c3}lnNER_{it}+\beta_{c4}lnNER_{jt}\,, \quad \text{(A23)}$$

where Ypc represents the per capita GDP, f each one of the three factor endowments considered; labor (L), capital (K) and agricultural land (A) and $lnNER$ the logarithm of the nominal exchange rate. Following Ghodsi *et al.* (2017), the first term, captured by the parameter β_{c1}, accounts for the differences between trading partners with respect to real GDP per capita. The following terms, captured by the parameter β_{c2_f}, account for (dis)similarities of trading partners with respect to three factor endowments. Lastly, as in Bacchetta et al. (2012), the logarithm of the nominal exchange rate of both countries with respect to the US dollar was included.[38] Lastly, for this specification, the GDPs variables were replaced by a single variable, that is, the sum of both partners GDPs.[39]

Comparing figures are displayed in the following tables. Table A9 shows TBT volume effects pointing to the same direction and displaying similar patterns. The quantity impact of adding a new TBT in this specification was equal to -1.11% using simple average and -1.21% using trade weighted averages. These overall results reflect well the difference between both model specifications. Including additional controls supported the findings that TBTs are on average trade harmful in terms of volume but were also found to be less negative than results from specification 1. The whole distribution appears to be shifted to the right, with all quartiles being slightly greater than their respective quartiles in the first specification. The multilateral dimension confirms that high income country group impose more trade restrictive TBTs and that exporters from this group (HI) face less trade restrictive TBTs. These results are confirmed by simple averages and median values. Trade weighted averages show some conflicting results but are largely in accordance with previous results. The bilateral dimension, shows a positive and high correlation when the aggregated figures are compared, with simple averages displaying a 0.92 correlation, median 0.99 and trade weighted averages a 0.25. This low correlation of trade weighted average is highly influenced by this outlier average of volume effect of a TBT imposed by UMI to LI countries (-13.7%). Specification 3 renders an average effect of -1.02%, which confirms the negative impact but reveals a great difference in magnitude. The lack of robustness of volume effects for these income groups requires further analysis. The analysis of the section dimension gives further insights about which sectors this difference in magnitude is coming from. Agri-food products showed a -0.54% TBT volume impact (SA) and a -0.32% (TWA) compared to an impact of -0.64% and -0.65%, respectively for specification 1. This reveals industrial products showed a less trade restrictive impact, with the SA

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38 One of these terms was dropped if both countries were using US dollars as the official currency.

39 Data restrictions implied in the drop of the panel's last year for this additional specification.

effect representing a -1.32% compared to -2.36% in specification 1. The simple average was particularly influenced by section XVI (machinery and electrical equipment). This specification resulted in a SA effect of 0.34% while the first specification showed a value of -1.08%. Trade weighted averages were more consistent and displayed and average of effect of -2.5% for both specifications.

Table A8
Robustness checks: TBT volume effects of imposing one additional measure
(Comparing results from two different specifications)

		Specification 1 - Baseline						Specification 3 – Baseline plus additional controls					
			Averages		percentiles				Averages		percentiles		
		Obs.	SA	TWA	25th	50th	75th	Obs.	SA	TWA	25th	50th	75th
All Countries		218 922 324	-1.94	-1.42	-4.91	-0.16	0.60	224 764 585	-1.11	-1.21	-3.73	-0.07	1.16
By imposing country income group													
H		127 026 568	-2.01	-1.07	-5.26	-0.27	0.69	130 122 109	-1.27	-0.73	-4.15	-0.14	1.16
UM		59 156 881	-1.99	-2.30	-5.04	-0.10	0.56	60 818 145	-1.04	-2.47	-3.74	-0.04	1.19
LM		29 834 916	-1.61	-1.96	-3.10	-0.03	0.32	30 795 391	-0.66	-1.18	-2.37	-0.01	1.05
L		2 903 959	-1.60	-2.23	-3.54	-0.01	0.18	3 028 940	-0.60	-1.25	-2.38	0.00	1.28
By affected country income group													
	H	61 346 601	-1.77	-1.31	-4.21	-0.09	0.54	63 024 678	-0.98	-1.51	-3.20	-0.04	1.05
	UM	64 017 025	-1.95	-1.36	-4.93	-0.15	0.54	65 648 623	-1.13	-0.60	-3.74	-0.07	1.14
	LM	58 698 956	-2.02	-2.58	-5.15	-0.20	0.62	60 239 582	-1.17	-1.77	-3.92	-0.09	1.19
	L	34 859 742	-2.11	-2.24	-5.70	-0.36	0.84	35 851 702	-1.22	0.61	-4.28	-0.13	1.36
Imposing Countries	Affected Countries												
H	H	31 925 600	-1.82	-0.99	-4.50	-0.16	0.63	32 726 964	-1.12	-0.96	-3.62	-0.09	1.06
H	UM	38 506 518	-2.01	-1.07	-5.28	-0.25	0.63	39 394 600	-1.29	-0.31	-4.15	-0.13	1.14
H	LM	35 537 419	-2.08	-1.69	-5.64	-0.33	0.70	36 389 505	-1.33	-1.15	-4.37	-0.17	1.19
H	L	21 057 031	-2.17	0.24	-5.99	-0.53	0.92	21 611 040	-1.38	1.52	-4.80	-0.24	1.35
UM	H	18 740 153	-1.85	-1.86	-4.39	-0.07	0.52	19 269 016	-0.95	-2.58	-3.24	-0.03	1.07
UM	UM	16 365 569	-2.00	-2.61	-5.07	-0.10	0.50	16 815 090	-1.05	-1.84	-3.75	-0.04	1.16
UM	LM	15 103 070	-2.06	-5.20	-5.49	-0.13	0.57	15 523 337	-1.08	-3.50	-3.91	-0.05	1.28
UM	L	8 948 089	-2.15	-13.7	-5.90	-0.23	0.79	9 210 702	-1.12	-1.02	-4.28	-0.07	1.45
LM	H	9 727 549	-1.50	-2.42	-2.78	-0.02	0.33	10 033 925	-0.61	-1.77	-2.16	-0.01	0.97
LM	UM	8 334 593	-1.62	-1.43	-3.12	-0.03	0.27	8 594 710	-0.66	-0.35	-2.38	-0.01	1.02
LM	LM	7 332 505	-1.67	-1.61	-3.38	-0.04	0.31	7 569 802	-0.69	-1.09	-2.49	-0.02	1.12
LM	L	4 440 269	-1.75	-1.80	-3.80	-0.06	0.48	4 596 954	-0.72	-2.59	-2.63	-0.02	1.28
L	H	953 299	-1.48	-2.16	-2.97	-0.01	0.22	994 773	-0.55	-1.40	-2.06	0.00	1.05
L	UM	810 345	-1.61	-0.96	-3.56	-0.01	0.13	844 223	-0.61	0.03	-2.40	0.00	1.28
L	LM	725 962	-1.66	-2.94	-3.83	-0.01	0.15	756 938	-0.63	-1.96	-2.53	0.00	1.34
L	L	414 353	-1.76	-3.03	-4.21	-0.02	0.26	433 006	-0.67	-0.64	-2.74	0.00	1.63

Source: Author's calculation. Note: Simple averages (SA) and trade weighted averages (TWA) were calculated by eliminating the bottom 1% and top 1% of the complete distribution (shown in table 2). Income groups considered: H (high income), UM (upper-middle income), LM (lower-middle income) and L (low income).

SPS average volume effects from specification 3 show a similar central distribution to values estimated with specification 1. Median values across all country groups divisions were close to zero (rounded to two digits) representing a null impact whenever the median country imposed one additional SPS to its stock. The features of a similar distribution can be seen by analyzing quartiles of the table A10, not only from the distribution of all volume effects but also across different country groups. This confirms that roughly half of the impacts are positive and the other half is negative.

Table A9

Robustness checks: SPS volume effects of imposing one aditional measure

(Comparing results from two different specifications)

		Specification 1 - Baseline						Specification 3 – Baseline plus additional controls					
			Averages		Percentiles				Averages		Percentiles		
		Obs.	SA	TWA	25th	50th	75th	Obs.	SA	TWA	25th	50th	75th
All Countries		94 560 531	0.76	0.81	-0.54	0.00	0.57	94 151 329	-0.10	-0.42	-0.52	0.00	0.59
By imposing country income group													
H		59 949 901	0.90	0.79	-0.51	0.00	0.59	59 650 111	-0.14	-0.13	-0.51	0.00	0.62
UM		19 756 311	0.66	0.86	-0.57	0.00	0.50	19 657 939	0.08	-1.65	-0.52	0.00	0.56
LM		13 357 233	0.21	0.86	-0.57	0.00	0.53	13 354 260	-0.23	0.56	-0.52	0.00	0.59
L		1 497 086	1.18	2.38	-0.69	0.00	0.42	1 489 019	0.02	1.60	-0.71	0.00	0.48
By affected country income group													
	H	25 966 430	0.66	0.95	-0.51	0.00	0.53	25 968 575	-0.08	-0.08	-0.46	0.00	0.56
	UM	27 839 641	0.78	1.08	-0.52	0.00	0.57	27 759 049	-0.11	-0.63	-0.51	0.00	0.59
	LM	25 522 394	0.79	-0.97	-0.55	0.00	0.57	25 364 287	-0.11	-2.05	-0.53	0.00	0.62
	L	15 232 066	0.81	0.18	-0.58	0.00	0.59	15 059 418	-0.12	0.99	-0.59	0.00	0.63
Imposing Countries	Affected countries												
H	H	14 923 114	0.78	0.41	-0.48	0.00	0.56	14 903 796	-0.12	-0.02	-0.46	0.00	0.57
H	UM	18 228 341	0.93	1.74	-0.50	0.00	0.59	18 166 355	-0.14	-0.30	-0.49	0.00	0.62
H	LM	16 801 444	0.94	0.24	-0.52	0.00	0.60	16 695 018	-0.15	-0.40	-0.52	0.00	0.63
H	L	9 997 002	0.96	0.33	-0.55	0.00	0.62	9 884 942	-0.16	1.38	-0.57	0.00	0.65
UM	H	6 185 244	0.62	2.46	-0.52	0.00	0.48	6 186 636	0.11	-0.39	-0.48	0.00	0.50
UM	UM	5 476 642	0.67	-0.79	-0.56	0.00	0.50	5 455 643	0.08	-2.41	-0.52	0.00	0.56
UM	LM	5 070 972	0.67	-4.25	-0.60	0.00	0.51	5 032 639	0.07	-6.90	-0.57	0.00	0.57
UM	L	3 023 453	0.69	-0.57	-0.64	0.00	0.55	2 983 021	0.07	-0.24	-0.65	0.00	0.59
LM	H	4 366 126	0.22	0.96	-0.52	0.00	0.50	4 385 329	-0.19	0.62	-0.44	0.00	0.56
LM	UM	3 718 213	0.21	0.78	-0.57	0.00	0.53	3 722 301	-0.23	0.50	-0.52	0.00	0.59
LM	LM	3 275 773	0.20	0.72	-0.60	0.00	0.55	3 266 143	-0.25	0.49	-0.58	0.00	0.61
LM	L	1 997 121	0.21	0.29	-0.65	0.00	0.57	1 980 487	-0.27	0.87	-0.65	0.00	0.63
L	H	491 946	1.15	4.13	-0.64	0.00	0.39	492 814	0.02	2.69	-0.65	0.00	0.45
L	UM	416 445	1.18	3.25	-0.69	0.00	0.42	414 750	0.03	2.43	-0.71	0.00	0.48
L	LM	374 205	1.18	0.47	-0.74	0.00	0.44	370 487	0.03	0.21	-0.75	0.00	0.49
L	L	214 490	1.21	0.19	-0.74	0.00	0.46	210 968	0.03	-0.05	-0.77	0.00	0.50

Source: Author's calculation. Note: Simple averages (SA) and trade weighted averages (TWA) were calculated by eliminating the bottom 1% and top 1% of the complete distribution (shown in table 2). Income groups considered: H (high income), UM (upper-middle income), LM (lower-middle income) and L (low income).

Contrary to what was observed in TBT effects, SPS average volume effects showed a change in the direction of volume effects, with specification 1 rendering positive averages and specification 3 rendering negative ones. Simple average of all volume effects was now smaller and negative with magnitude of -0.10% while trade weighted averages equaled -0.46%. This could have been influenced also by the lowest cutoff threshold of the 99th percentile for this measure, which was 122.21%. The same figure for specification 1 as shown in table 2 was a trade volume effect of 172.98%.

Analyzing the relative difference across income country-groups, shows that LMI country exporters are the most affected in almost all cases. However, results from this new specification show that low income exporters appear to be benefited by SPS measures. Apart from this country-group, other groups' exporters face less trade restrictive as their income group increases.

A sectoral analysis corroborates the results for the most relevant HS sections, that is, the HS sections with most affected products. Agri-food products and the chemical sector showed very similar volume effects. Agri-food products displayed a SA of -0.31% for specification 3, compared to -0.38% for specification 1. TWA, on the other hand were close to zero in specification 3, with an additional effect of -0.001%, compared to -0.05% in specification 1. Chemical products had also a similar impact in both specifications.[40] Therefore, the difference is coming from other industrial products, namely for HS sections V (mineral products), VIII (hides, skins and articles…), XIII (articles of stone plaster, ceramic…), XVII (vehicles, aircraft and vessels) and XVIII (instruments, clocks, recorders and reproducers) when simple average is analyzed and specially for HS sections V (mineral products), IX (Wood and articles of wood…) and XIII (articles of stone plaster, ceramic…). A more detailed sectoral analysis would need to be carried to better understand these impacts.

This annex confirms the negative impacts of TBT measures and appears to support the findings that exporters from least developed nations are the most affected by a new TBT and that high income countries impose the most restrictive measures. On the SPS side, aggregated results show less supporting evidence, especially on the income country group relationship. Although, distribution of effects is similar and centered in zero, averages are now on the negative side. Agri-food products display a small and negative trade volume effect but other sectors, with fewer significant NTMs, show more volatile results which might be influencing the resulting average.

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[40] Volume effects for HS section VI (chemical products and allied industries): Specification 1, 0.30% (SA) and 0.12% (TWA); specification 2, 0.33% (SA) and 0.07% (TWA).

Annex 5
Volume effects of other NTMs

Other measures found in the I-TIP dataset were included in the analysis but not displayed in the main text for several reasons. The NTMs analyzed here are quantitative restrictions (QR), antidumping investigations (ADPINV), antidumping duties (ADP), countervailing duties (CV), safeguard measures (SG), special safeguard measures (SSG) and two types of specific trade concerns (STC) raised at the SPS and TBT committees of the World Trade Organization (WTO). First, the inexistence of withdraw dates for most of the measures is a more severe issue when the above-mentioned measures are analyzed. Since most of non-technical measures are placed temporarily, if a measure was placed for one year in the beginning of the panel, it will not leave the dataset and this will lead to a measurement error in our variable of interest. Since most for SPS and TBT are expected to be set permanently this problem should be less frequent when technical measures are concerned. Second, the intuition of using import and export shares as proxies is better suited for analyzing the compliance costs related to a regulation, would not make much sense of using with it with quotas or antidumping or countervailing duties. Third, most of these measures are expected to have a negative trade effect, so the potential trade promoting effects allowed by the identification strategy chosen are hard to explain intuitively. Lastly, even for those NTMs which display termination dates Cadot et al. (2018b) advise against using such specification. They argue that if a country cuts the compliance cost of a given NTM on a given type of products by half through, say, better regulatory design, estimation using the interaction of NTM variables with trade shares will not pick up any change if the country's trade share does not change. Therefore, the change over time of volume effects is not analyzed. That said and for the sake of completeness, this annex first presents a short explanation on the measures analyzed alongside with a brief data description and then report overall impacts of these measures.

Quantitative Restrictions (QR). These measures are import prohibitions, quotas (global or bilateral), non-automatic license among others. Some examples of NTMs of this type are: prohibition to import pork meat; quota for the import of fish; non-automatic license for the import of guns and ammunition, etc. They can be placed bilaterally, targeting only one country, or multilaterally. Although these measures represented only 3.1% of all notifications they reached 6.5% of the sum of all products affected by all measures. Australia (with 116 notifications), Hong Kong (103) and Thailand (102) notified to the WTO more than one third of the QRs of the sample. Even though Japan placed only 38 restrictions, each of its restrictions affected on average around 1,098 products, placing Japan's imports as the most regulated under this type of NTM. All notifications of QRs only displayed in-force dates and no termination or withdrawal date.

Specific Trade Concerns (STC) of TBT and SPS. Following Ghodsi et al. (2017) we also consider two kinds of specific trade concerns raised at the SPS and TBT committees of the WTO. They explain that member countries can raise questions regarding other WTO members' proposed NTMs or their implementation. As explained in their paper not all STC could be matched with an underlying SPS or TBT. Both STC of SPS and STC of TBT displayed in-force dates. Around 64% of the SPS STC were resolved and display a termination date. STC of TBT did not show any termination date. European Union (101) and the United States (66) were the members which raised more concerns. The members receiving more complaints were the European Union (88) and China (40).

Antidumping duties (ADP) and Antidumping investigations (ADPINV). According to the UNCTAD (2015) dumping takes place when a product is introduced into the commerce of an importing country at less than its normal value, generally where the export price of the product is less than the comparable price, in the ordinary course of trade, for the like product when destined for consumption in the exporting country. These dumped imports might cause injury to the domestic industry producing a like product, or to third countries' exporters of that product. Importing country authorities might start an investigation to determine whether dumping of a product is occurring and injuring national producers. The investigation may take only a couple of days or even years. Normally after the investigation, a decision is made if an antidumping duty should be imposed or not.

The date of initiation for anti-dumping measures represents the start of an investigation while the date in force exposes the date when the measure was indeed imposed. That noted it is important to highlight that not all investigations will lead to the imposition of measures. Thus, based on the intuition that an investigation might impact trade differently from a duty itself, this paper tries to make a distinction between them.[41] For this purpose the following steps were taken: i) ADP notifications with no in-force date were classified under investigations; ii) ADP notifications with only in-force dates were classified under duties and; iii) ADP notifications with both initiation date and in-force date were duplicated and considered to be both, that is, from the initiation date up to the in-force date it was considered an antidumping investigation and from the in-force date up to the withdrawal date (when available) a antidumping duty. Withdrawal dates were available for these measures.

As an illustrative example, on April 21st 2007 Chile started an investigation on meat of fowls (products 020711, 020712, 020713 and 020714) imported from its neighbor Argentina. After almost a year, on April 19th 2008, the investigation was dropped and no duties were applied.[42] Whenever the investigation or the duty were initiated/imposed in the same year as it was concluded/removed, no measure was recorded on the panel.

Countervailing duties (CV). These NTMs are applied to imports of a product to offset any direct or indirect subsidy granted by authorities in an exporting country where subsidized imports of that product from that country are causing injury to the domestic industry in the importing country (UNCTAD, 2015). Countervailing measures are normally also subject an ex-ante investigation before the application of the measure. However, due to the small incidence of the measures representing an investigation (observations with only an initiation date and no in-force date) on the dataset, this work excluded these observations from the analysis.[43] Termination dates were available for CVs.

Safeguard (SG) and Special Safeguard (SSG) measures. A safeguard measure is temporary border measure imposed on imports of a product to prevent or remedy serious injury caused by increased imports of that product and to facilitate adjustment. Safeguard measures can take various forms, including increased duties, quantitative restrictions, and others (e.g. tariff-rate quotas, price-based measures, special levies, etc.) and are normally preceded by an investigation. Special safeguard allows the imposition of an additional tariff to agricultural products in response to a surge in imports or a fall in import prices (UNCTAD, 2015). For SG measures notifications with only an initiation date and no in-force date were dropped of the analysis (those observations concerning

41 According to the UNCTAD NTM classification, an antidumping investigation is covered in the field D11 while an antidumping duty is under D12 (UNCTAD, 2015).

42 The information was retrieved from WTO documents: G/ADP/N/158/CHL of 31 August 2007 and G/ADP/N/173/CHL of 30 July 2008.

43 There were only 631 CV notifications with only an initiation date. The full description of notification's dates is available in annex 2.

an investigation) in order to reduce the heterogeneity of the same measure.[44] No end date was available for these measures as well.

Table A11 shows the percentiles of the distribution of volume effects across the remaining NTMs and the two specific trade concerns. Percentiles and the number of observations in each distribution are displayed for all three specification presented in this paper, the first two presented in section III and specification 3 introduced in annex 4.

First, a larger dispersion was identified for these measures, while almost all median values were negative, a relevant share of volume effects was positive. This is somehow counterintuitive since these measures are supposed to restrict trade and the specific trade concerns are also supposed to be the more restrictive technical measures.

Table A10
Distribution of volume effects of other NTMs
(Volume effects in percentages)

		Distribution of volume effects (percentiles)								
	Obs.	1st	5th	10th	25th	50th	75th	90th	95th	99th
ADP										
Specification 1	237 472	-100	-100	-95.5	-63.1	-5.56	86.1	604.6	2 803.9	2.66E+08
Specification 2	240 043	-100	-100	-94.7	-64.9	-4.25	95.2	638.7	2 795.1	1.96E+08
Specification 3	231 707	-100	-100	-95.5	-62.4	-5.45	85.0	564.2	2 552.6	2.56E+08
ADPINV										
Specification 1	40 518	-100	-100	-97.6	-66.7	-8.74	56.2	305.9	1 026.6	2.69E+06
Specification 2	40 654	-100	-100	-97.5	-66.1	-6.97	70.1	343.7	1 200.8	5.53E+08
Specification 3	40 056	-100	-100	-97.3	-67.3	-8.06	48.7	306.2	882.9	1.39E+07
CV										
Specification 1	20 240	-100	-99.7	-96.4	-63.2	-4.70	95.9	823.8	24 499	2.32E+13
Specification 2	20 861	-100	-99.6	-95.0	-68.3	-3.07	131.7	1275	6 569	4.7E+13
Specification 3	19 266	-100	-99.7	-96.6	-63.6	-1.23	120.7	925.0	53 901	1.45E+14
QR										
Specification 1	37 124 629	-100	-53.6	-32.8	-14.9	-0.83	5.2	20.6	33.2	87.9
Specification 2	38 912 293	-100	-96.3	-81.2	-57.2	-16.2	5.5	102.1	213.3	1 250.0
Specification 3	37 320 998	-100	-51.8	-30.9	-13.8	-0.35	7.2	23.9	39.4	112.8
SG										
Specification 1	830 238	-100	-94.7	-84.1	-52.9	-0.01	82.4	350.8	868.8	528 558.8
Specification 2	797 857	-100	-97.4	-84.2	-47.6	0.05	102.9	411.7	1 769.1	19 582.5
Specification 3	801 637	-100	-96.5	-84.5	-51.8	0.00	85.6	371.1	713.5	34 556.2
SSG										
Specification 1	590 967	-97.6	-76.2	-56.5	-43.0	-4.94	4.2	66.7	247.6	1 637.6
Specification 2	642 766	-99.9	-92.3	-79.7	-51.4	-0.66	70.3	221.5	382.2	5 956.7
Specification 3	689 490	-94.6	-74.2	-61.8	-42.0	-5.99	24.7	102.4	176.5	1 497.2
SPSSTC										
Specification 1	901 298	-99.1	-87.6	-75.4	-24.1	0.64	64.1	202.6	396.5	119 047.8
Specification 2	873 848	-99.0	-91.8	-75.1	-28.1	0.77	104.9	275.9	645.4	8.99E+07
Specification 3	904 080	-99.4	-86.7	-77.4	-25.1	2.05	70.9	182.0	360.2	178 649.9
TBTSTC										
Specification 1	4 431 820	-100	-95.4	-83.7	-49.1	-0.06	62.7	423.2	1 658.1	1.69E+08
Specification 2	4 454 021	-100	-96.7	-88.1	-62.2	-0.61	90.6	535.2	2 053.7	2.23E+08
Specification 3	4 317 122	-100	-95.5	-83.4	-46.9	0.01	68.2	470.3	1 843.6	3.35E+08

Source: Author's calculation.

44 1,764 SG notifications were not considered. See annex 2.

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