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Please cite this paper as:

Cadot, O., J. Gourdon and F. van Tongeren (2018-05-16), “Estimating Ad Valorem Equivalents of Non-Tariff Measures: Combining Price-Based and Quantity-Based Approaches”, *OECD Trade Policy Papers*, No. 215, OECD Publishing, Paris.
http://dx.doi.org/10.1787/f3cd5bdc-en

OECD Trade Policy Papers No. 215

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COMBINING PRICE-BASED AND QUANTITY-BASED APPROACHES

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OECD TRADE AND AGRICULTURE DIRECTORATE

The publication of this paper has been authorised by Ken Ash, Director of the Trade and Agriculture Directorate

This document has been declassified on the responsibility of the Working Party of the Trade Committee under the OECD reference number TAD/TC/WP(2017)12/FINAL.

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Estimating *Ad Valorem* Equivalents of Non-Tariff Measures: Combining Price-Based and Quantity-Based Approaches

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A novel econometric method is used to estimate trade effects of non-tariff measures (NTMs) for roughly 5 000 traded goods and 80 countries. It explicitly distinguishes several types of measures and ascertains their distinct effects on trade volumes and prices. The latter feature allows disentangling trade-cost effects associated with non-tariff measures from possible demand-enhancing effects that come from reducing information asymmetries and strengthening consumer confidence in imported products. The volume-based estimates yield information on how NTMs ultimately affect trade: the trade cost associated with NTMs, as captured by the *ad valorem* estimates, often reduces trade volumes, as expected, but not always. In a number of cases, in particular in the sanitary and phytosanitary (SPS) area, trade is found to expand, even though trade costs rise. This is likely explained by closer regulatory environments between the countries examined, but the trade-enhancing features of such measures merit further study.

Key words: Non-tariff measures; price gaps, regulation

JEL Codes: L51; F13; F15

The authors would like to thank Sebastian Benz, Anne-Célia Disdier and Martin von Lampe for their comments. The authors also wish to thank the members of the OECD Working Party of the Trade Committee for their valuable feedback and direction received in developing and finalising this study. Finally, the authors thank Jacqueline Maher for preparing this document for publication.

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Executive Summary

This study explores approaches to estimate trade effects of non-tariff measures; as such, it is intended for a technical audience and, in particular, to inform future efforts to improve the trade policy database for the OECD METRO model.

The term "non-tariff measures" (NTMs) comprise all policy measures other than tariffs and tariff-rate quotas that have a more or less direct incidence on international trade as they affect the price of traded products, the quantity traded, or both.

A novel method to estimate trade effects of non-tariff measures is presented. It explicitly distinguishes several types of measures and ascertains their distinct effects on trade volumes and prices. The latter feature is particularly important as it allows disentangling trade-cost effects associated with NTMs from possible demand-enhancing effects that come from reducing information asymmetries and strengthening consumer confidence in imported products.

The price-based estimations yield a large set of *ad valorem* equivalents (AVEs) that are specific for bilateral trade between more than 80 countries and roughly 5 000 products. The volume-based estimates yield information on how NTMs ultimately affect trade: the trade cost associated with NTMs, as captured by the AVEs, often reduces trade volumes, as expected, but not always. In a number of cases, in particular in the sanitary and phytosanitary (SPS) area, trade is found to expand even though trade costs rise. This is likely explained by closer regulatory environments between those countries, but the trade-enhancing features of such measures merit further study.

While the estimations as such provide a rich source of information on the cost- and volume-effects of NTMs they are also intended to be incorporated into the repository of trade policy information that underpins the OECD METRO model. The precise way to absorb both the trade costs (as AVEs) and the volume effects in a consistent manner warrants further attention.

1. Introduction

The term "non-tariff measures" (NTMs) covers a diverse set of measures in terms of purpose, legal form and economic effect. The diversity of NTMs makes their quantitative analysis difficult, and they have been the object of substantial academic and policy attention.[1] NTMs comprise all policy measures other than tariffs and tariff-rate quotas that have a more or less direct incidence on international trade as they affect the price of traded products, the quantity traded, or both. Most importantly, domestic regulations may prescribe specific requirements for products to be sold on a given market. Generally, such measures aim to overcome or reduce the impacts of perceived market imperfections, such as those related to negative externalities, risks for human, animal or plant health, or information asymmetries (van Tongeren et al., 2009; Beghin et al., 2012). However, they also tend to increase production and trade costs and may affect, positively or negatively, the development of new technologies or production methods.

Regulations can have adverse effects on imports particularly if they differ significantly from those applied in the exporting country, as foreign suppliers wishing to export to regulated markets generally face additional trade costs. These may be related to identifying and processing the information on relevant requirements in the target market (information costs), the need to adjust the product or production process to the requirements of the importing country (specification costs), to verifying and proving that these requirements are actually met (conformity assessment costs), or a combination of the three (von Lampe et al., 2016, OECD (2017).

Besides using NTMs to assure that imported products meet domestic regulatory requirements, there is a concern that governments might use them as substitutes for diminished tariff protection (Kee et al., 2009; Moore and Zanardi, 2011; Aisbett and Pearson, 2012; Beverelli, Boffa and Keck, 2014; Orefice, 2017). Concerns about substitution of tariffs by NTMs have been fuelled by the observation that in spite of tariff reductions, overall trade costs remain high, in particular for low-income countries (Novy, 2013; Arvis et al., 2016). Indeed, NTMs can become non-tariff barriers to trade if they are introduced as a disguised way to reduce or stop imports from certain exporting countries, or to favour domestic suppliers, or if they impose unnecessary costs and compliance burdens.

Trade costs related to NTMs are particularly burdensome for Small- and Medium-sized Enterprises (SMEs), which may not have the resources to comply. Focusing on measures that were the object of concerns at the World Trade Organization (WTO), Fontagné et al. (2015) show on the basis of firm-level evidence that sanitary and phytosanitary (SPS) measures entail compliance costs that can inhibit market entry. They show that these effects are more important for smaller firms.

Regulatory agencies rarely take trade costs systematically into account in regulatory impact assessments (OECD, 2017). This can result in regulatory heterogeneity between countries, even if regulations address the same objectives, creating a cost for firms selling in multiple markets. Fontagne and Orefice (2018) show that the negative effect of technical barriers to trade (TBT) measures on export participation is magnified for multi-destination firms which can divert their exports towards TBT-free destinations.

Trade costs may have trade effects similar to those of tariffs and are often estimated as tariff equivalents or *ad valorem* equivalents (AVEs) to indicate their trade impeding effects (Box 1) – with some estimates suggesting that the AVE of NTMs is around three-times larger on average

1. A review of some of the literature can be found in Ederington and Ruta (2016) and the review prepared for the Working Party of the Trade Committee (TAD/TC/WP(2017)4). See also Swinnen (2016) for a comprehensive discussion of the trade and development issues.

than that of tariffs. Unlike tariffs, however, an abolition of such measures generally is not optimal due to the correction of market failures they pursue.

The economic effects of NTMs differ in many respects from those of tariffs. NTMs affect market structure through channels that are not equivalent to those of tariffs. For instance, specification costs can be fixed costs, because new investments are needed to comply with the requirements of the destination market, penalizing SMEs more than large ones. Large firms remaining in the market may then have more market power than before, thanks to the exit of smaller competitors (Asprilla et al., 2016). Since NTMs are related to non-trade policy objectives, their benefits are difficult to quantify, even though Regulatory Impact Assessments typically aim at assessing costs and benefits of regulations.

The challenge then is to use these assessments of trade costs to identify whether there are other, less trade restricting ways of achieving the same public policy objectives. Moreover, some regulations can be trade-creating, by helping overcome information asymmetries that would otherwise keep some suppliers out of markets (see below).

This report presents a novel method to estimate trade effects of non-tariff measures. It explicitly distinguishes several types of measures and ascertains their distinct effects on trade volumes and prices. The latter is particularly important as it allows disentangling trade-cost effects associated with NTMs from possible demand-enhancing effects that come from reducing information asymmetries and strengthening consumer confidence in imported products. Estimations are made to assess the effects of regulatory difference between countries, which is arguably amongst the key factors explaining trade costs related to regulations. The paper is thus intended more for a technical audience, and supporting the development of the trade policy database for the OECD METRO model.

Box 1. Measuring AVEs

The conventional approach to the measurement of the trade-restricting effect of NTMs is to estimate *ad valorem* equivalents (AVEs) from the partial correlation between the presence of NTMs at the importer-product level and the value of trade flows.*

In a pioneering paper, Kee et al. (2009) performed the estimation product by product at the HS6 level (5 000 regressions), aggregating imports from all sources. One problem with this approach is that it does not allow for retrieval of country-specific AVEs. The authors address this problem by interacting dummy variables for the presence of NTMs with country characteristics such as GDP per capita or endowments. Coefficients can then be used to yield predicted AVEs at a certain level of GDP per capita or endowments. But these are predicted AVEs on the basis of cross-country information, not country-specific estimates. Another technical problem is that in cross-country regressions, the number of degrees of freedom is low and severely constrains the number of NTM types that can be included as explanatory variables. Finally, the use of trade value raises a specific issue in the case when the elasticity of imports is unity, implying that import values never change, whatever the restrictiveness of NTMs. A recent variant on this classic exercise (Kee and Nicita, 2016) improves the estimation by using gravity-type (bilateral) trade data and trade volumes instead of values.

In a recent paper, Cadot and Gourdon (2016), avoid the problem with import values by using trade unit values (equivalent to prices) to directly retrieve AVEs from the coefficients in the estimation without the need of import demand elasticity. Grübler et al. (2016) pursue a similar strategy by estimating AVE regressions on trade volumes rather than values and by interacting NTM variables with importer dummies, producing differentiated AVEs by importer (the sum of the coefficients on direct an interacted terms).

This report builds on these new approaches and innovates in a number of dimensions. First, it combines the approaches of Gruber et al. (2016) on volumes and Cadot and Gourdon (2016) on prices in two separate sets of equations. It is shown that price-based estimation directly yields AVEs under the small-country assumption, while quantity-based estimation yields qualitative information on “market-creating” effects. Second, like Kee and Nicita (2016), it uses explicitly the bilateral dimension of trade data, but, in addition, it uses information on “regulatory distance” following the approach of Cadot et al. (2015), also detailed in Knebel and Peters (2018).

* See, for example, Kee et al. (2009); Beghin et al. (2015); Bratt (2014); Cadot and Gourdon (2016).

The report is structured as follows. Section 2 discusses issues related to the interpretation of NTMs. Section 3 discusses data sources and information on frequency of NTMs. Section 4 presents initial results across price AVE, volume and market equilibrium effects, including bilateral aspect and regulatory distance. Section 5 addresses the potential inclusion of these AVEs in the METRO model. Section 6 concludes, and indicates some possible areas for further work. Important technical information on the methodology used in this paper can be found in Annexes 2 and 3.

2. Interpreting NTM AVEs

The *ad valorem* equivalent (AVE) of an NTM is the proportional rise in the domestic price of the goods to which it is applied, relative to a counterfactual where it is not applied. It is often interpreted as measuring the distortion imposed by the NTM to the domestic economy. While this would be true in an economy characterized by pure and perfect competition and the absence of externalities or public goods, it is not true in more general – and realistic – settings.

While the term "non-tariff measures" suggests a simple parallel with tariffs, NTMs take many forms and fulfil in reality a broad range of objectives, trade and non-trade. In order to disentangle these different forms and objectives and how they map into one another, at the broadest level, two different types are usually distinguished. The first type of measures, called "non-technical", includes quantitative restrictions (QRs), price measures, forced logistics or distribution channels, and so on. The second type of measures, called "technical", includes primarily sanitary and phytosanitary (SPS) and technical barriers to trade (TBT) measures.

Technical measures are generally imposed to address market failures such as information asymmetries or negative externalities. For instance, the distribution of counterfeit drugs has a large negative impact on public health. Inspection and testing requirements on imported drugs are NTMs, and depending on how heavy the requirements are, they can have high AVEs on all drugs, including legal ones. Similarly, two-wheelers with two-stroke engines generate toxic smoke with adverse health effects in urban areas. Restrictions on the importation of such products are NTMs; they can be considered, *de facto*, as trade restrictions when the products are not produced locally. However, the measures can be justified as correcting negative externalities, and simply interpreting AVEs as measuring distortions would be severely misleading.

Even if externalities are left aside, interpreting the AVE of a technical measure as a pure trade cost, a tradition that goes back to the work of Otsuki, Wilson and Sewadeh (2001), can be misleading. First, NTMs can alter fixed costs and can thus have different effects on small compared to large firms. For example, a non-discriminatory regulation that induces the exit of small firms, domestic and foreign alike, will alter the market structure. The induced change in market structure may leave non-exiting large firms with more market power than before, and this may apply to foreign as well as domestic firms (Asprilla et al., 2016). In that case, a rise in trade unit values may compound the effects of increased market concentration with NTM compliance costs.

Moreover, an alternative strand of work suggests that NTMs related to standards can work as market-creating "catalysts" in situations of asymmetric information (see e.g. Henson and Jaffee, 2007; Maertens and Swinnen, 2007; Xiong and Beghin, 2014). When the quality of suppliers is heterogeneous and unknown to buyers, regulations can overcome the information deficit and convey a signal that all producers conform to a certain standard, encouraging demand.[2] Good regulations can facilitate trade. In such cases, NTMs affect both the product supply curve through

2. See *inter alia*, Thilmany and Barrett (1997) or Bureau, Marette, and Schiavina, (1998).

the various costs associated with compliance and the demand curve through signalling or "catalyst" effects.

The estimations in this study disentangle demand-enhancing effects from trade costs in order to identify trade-facilitating effects of regulations (and their concomitant NTMs). An illustration of the possible market equilibrium outcomes depending on the relative strengths of the demand-shifting and trade-cost effects of NTMs is in Annex 1. It shows how a separate estimation of the effect of NTMs on prices and quantities makes it possible, in principle, to fully disentangle compliance cost from signalling effects. While the estimations on unit values pick up the compliance cost, the proportional shift in import volumes picks up the signalling effect that is created by the imposition of a technical measure.

3. Data

3.1. A new database

While empirical work on the effect of NTMs has long been hampered by the scarcity of comparable data, since 2011 the United Nations Conference on Trade and Development (UNCTAD), in collaboration with several other agencies, has assembled a large database of NTMs. The dataset contains 121 measures and 86 countries, classified according to The MAST nomenclature (a detailed list of technical and non-technical measures is displayed in Annex 2). The nomenclature is illustrated, at its broadest, as it appears in UNCTAD's MAST booklet in Figure 1.

Figure 1. The MAST 2012 NTM classification

Imports	Technical measures	A	SANITARY AND PHYTOSANITARY MEASURES
		B	TECHNICAL BARRIERS TO TRADE
		C	PRE-SHIPMENT INSPECTION AND OTHER FORMALITIES
	Non technical measures	D	CONTINGENT TRADE-PROTECTIVE MEASURES
		E	NON-AUTOMATIC LICENSING, QUOTAS, PROHIBITIONS AND QUANTITY-CONTROL MEASURES OTHER THAN FOR SPS OR TBT REASONS
		F	PRICE-CONTROL MEASURES, INCLUDING ADDITIONAL TAXES AND CHARGES
		G	FINANCE MEASURES
		H	MEASURES AFFECTING COMPETITION
		I	TRADE-RELATED INVESTMENT MEASURES
		J	DISTRIBUTION RESTRICTIONS
		K	RESTRICTIONS ON POST-SALES SERVICES
		L	SUBSIDIES (EXCLUDING EXPORT SUBSIDIES UNDER P7)
		M	GOVERNMENT PROCUREMENT RESTRICTIONS
		N	INTELLECTUAL PROPERTY
		O	RULES OF ORIGIN
	Exports	P	EXPORT-RELATED MEASURES

Source: UNCTAD, 2012.

The data is typically collected by consultants – e.g. local academic institutions – in collaboration with the country's national authorities. Early waves of data collection by the World Bank involved validation workshops where national authorities had the opportunity to comment on the data; however, this practice has been abandoned in more recent data collection. Once collected by local consultants, the data is screened by a technical team at UNCTAD's Geneva headquarters for consistency (for instance, to ensure that a technical requirement on car seats is not classified as an SPS regulation), and then posted on WITS, the World Bank's trade-data portal.

Once converted to a format appropriate for econometric estimation, for each country the data takes the form of a matrix with products at the HS6 level of disaggregation (about 5 000 products) in lines and measures in columns. Entries are binary: A one if a measure is applied to a product, and a zero otherwise. When estimating the effect of NTMs on a cross-section of importing countries, matrices are stacked on top of each other. In order to fit the data into a gravity framework, one would ideally want to have NTM vectors differentiated by origin, depending on which measure is applied to which origin. However, bilateral NTM data is scant; moreover, most technical measures (say, maximum residual limits on pesticides) are not distinguished by the origin of imports.[3] Consequently, each importer-product line, with its line vector of NTM entries, is merely repeated as many times as a given country has import sources for the product. This means that gravity-based estimation does not add bilateral information on NTMs *per se*. However, this setup effectively filters out confounding influences on trade unit values and volumes through the inclusion of bilateral control variables; in addition, the estimates presented here take advantage of the cross-section design through the use of a measure of "regulatory distance" between countries (see below).

Unlike some of the recent papers in the field, this report does not use dummy variables marking the presence of NTMs as the basic explanatory variable. Instead, it uses the number of NTMs of a certain type imposed by the importing country on each product. The reason for using the count of NTMs is that the cumulative burden of different measures is considered the most burdensome for trade.[4]

3.2. Regulatory distance

Without detailed comparison of regulatory texts, it is impossible to assess precisely the extent to which regulations, and their implementation, differ across counties. As a shortcut to measuring regulatory differences this report uses an approach derived from Cadot et al. (2015) and recently developed in Knebel and Peters (2018) which yields a measure of regulatory distance between any two countries at the HS6 product level.

3. Exceptions include temporary import bans on meat from regions affected by foot-and-mouth disease and other pest-prevention measures. Such temporary bans are not part of the data.

4. For instance, Cass Sunstein, Administrator of the U.S. Office for Information and Regulatory Affairs from 2009 to 2012, noted that
"[a] special problem, and one that makes the project of simplification all the more imperative, is that agencies currently impose high cumulative burdens on the private sector. Requirements may be sensible taken individually, but taken as a whole, they might be redundant, inconsistent, overlapping, and immensely frustrating, even crazy-making (to use the technical term). In fact the problem of cumulative burdens may have been the most common complaint that I heard during my time in government." (Sunstein, 2013, p. 588).

The essence of the approach is as follows. Consider a product, say HS 840731 ("spark ignition reciprocating piston engines of a kind used for the propulsion of vehicles of Ch.87, of a cylinder capacity not >50cc"). Suppose that country *i* imposes an NTM coded in the MAST classification as B840 (inspection requirements) on that product. If country *j* imposes the same NTM on the same product, for that given NTM-product pair, the two countries are considered "similar" and the regulatory-distance measure is zero. If, by contrast, one of the two countries imposes NTM B840 on product HS 840731 but the other does not, the regulatory distance variable is set to one. This comparison is repeated for all NTMs in the NTM-trade database applied to product HS 840731 by either *i* or *j*, and all the resulting ones and zeroes are added up. The sum is then divided by the total number of NTMs applied to HS 840731 by any of the two countries.

This procedure yields a single number between zero and one (the proportion of NTMs applied to HS 840731 by both countries simultaneously), for each origin-destination-product tuple, that indicates the regulatory distance between the two countries for that product (a value closer to one means that the countries are more different in their regulatory patterns). This is a rough approximation to regulatory differences between countries and should ideally be complemented by a measure differences in the stringency of NTMs. But measures of stringency are not generally available, except in cases where a precise metric exists, as for example maximum residue levels of toxic chemicals (Annex 6).

3.3. Descriptive statistics

The incidence of NTMs varies substantially across sectors for both technical and economic reasons. While some products, such as agriculture, electric machinery, weapons, are highly regulated because of consumers and environmental protection and technical standards, other goods are, by their nature, less subject to laws and regulation. Table 1 below reports frequencies indices for six broad categories of NTMs and 21 HS sections across 86 countries. Frequency indices simply report the percentage of products in a sector to which one or more NTMs of a given type are applied. Frequency indices do not reflect the relative value of the affected products and thus cannot give any indication of the importance of the NTMs on overall imports. Key observations on the frequency of measures include:

- The use of *SPS measures* is largely limited to agricultural sectors and products from animal origin, as their control is essential for ensuring the health and well-being of consumers and the protection of the environment. As a result, more than 60% of food-related products are found to be affected by at least one form of SPS measure.
- By contrast, *TBT measures* can cover a much wider set of products and are found to be more uniformly applied across economic sectors with peaks in textiles, footwear, processed food, and chemicals.
- Measures involving *border control measures* are widely distributed across economic sectors but concern a more limited number of products: agricultural products, wooden products, textiles and footwear.
- Finally, *quantity restrictions* are applied more or less uniformly across economic sectors with peaks on agricultural goods, animal products, motor vehicles, and chemical products. They are sectors particularly sensitive products are often regulated by non-automatic licenses, quotas, and sometimes outright prohibitions.

Table 1. NTM Frequency index, by HS section

	Sanitary and phyto sanitary	Technical barriers to trade	Border control measures	Quantitative restrictions
HS Sections	**SPS**	**TBT**	**PSI**	**QRs**
Animals	91.0%	72.8%	34.2%	21.3%
Vegetables	87.4%	69.2%	34.9%	17.8%
Fats & oils	84.8%	78.0%	31.5%	15.7%
Beverages & tobacco	84.2%	74.5%	29.5%	17.3%
Minerals	8.1%	44.6%	18.6%	20.0%
Chemicals	21.7%	56.0%	18.9%	18.7%
Plastics	17.1%	37.1%	20.3%	12.2%
Leather	32.3%	40.7%	19.2%	13.8%
Wood products	41.2%	36.9%	25.9%	14.4%
Paper	10.9%	32.2%	18.4%	12.2%
Textile and clothing	11.4%	43.5%	27.5%	13.7%
Footwear	10.7%	41.9%	23.2%	12.1%
Stone & glass	9.3%	33.4%	19.2%	11.6%
Pearls	5.3%	33.3%	19.6%	17.8%
Metals	9.2%	33.2%	20.5%	14.9%
Machinery	9.7%	51.9%	20.4%	18.2%
Vehicles	9.8%	50.6%	23.2%	23.0%
Optical & med. Instr.	10.2%	41.3%	20.2%	14.9%
Miscellaneous	10.0%	35.2%	20.2%	12.0%

Source: OECD calculations based on MAST and UNCOMTRADE.

4. Results

This section presents the estimation approach and results, first using CIF import prices as the dependent variable, then using import volumes as the dependent variable.

4.1. Estimation approach

Both price-based and volume-based estimations use the number of NTMs as the explanatory variable of interest. Both use bilateral trade data and control for conventional gravity determinants of trade unit values and volumes. When there is no trade in a certain product between two countries, the price is not defined; so zero-trade observations can only be ignored; accordingly, for price equations, we use the OLS estimator. By contrast, import volumes are well defined in the absence of trade (they are just zero) and zero-trade observations should not be ignored in the estimation. Accordingly, for volume equations, the PPML (Pseudo Maximum Likelihood) estimator is used (details are provided in Annex 3).

AVEs are calculated directly by taking the exponential of the estimated coefficients in price-based OLS regressions. As is shown in the Annex 3, using import prices instead of import values as the dependent variable makes it possible to retrieve AVEs directly, without using the price elasticity of import demand.

Volume effects are not transformed into AVEs, and they are directly captured by the estimated coefficients without further algebraic transformation.

4.2. Price-based estimates

Price-based AVE estimates are shown in Table 2, by HS section, averaged over all countries. Since SPS measures are more widely applied to the agri-food sector than to manufacturing. Table 2 also shows that the variability of AVEs for SPS measures in the agri-food sector is higher than that of TBT measures in manufacturing. Since those estimates are primarily aimed to be used for the METRO model, Annex 5 displays price-based AVE estimates by GTAP sector.

Technical measures (SPS and TBT) are those for which the interpretation of AVEs as compliance costs is the most straightforward. However, higher AVEs do not necessarily reflect more severe distortions to economic welfare – in fact, the opposite interpretation is equally plausible: High AVEs imply that producers must alter substantially the design of their products or upgrade the quality, suggesting that the unregulated market equilibrium might be far away from the social optimum. This is clearly the case in foodstuffs, in particular live animals, where consumer safety hazards are arguably high.

Table 2. Baseline AVE estimates on unit value, by HS section

	Frequency weighted AVE					Unweighted AVE			
HS Section	SPS	TBT	BCM	QRs		SPS	TBT	BCM	QRs
Live animals	3.0%	14.8%	1.5%	0.9%	20.3%	4.6%	16.5%	2.8%	4.4%
Vegetable products	4.1%	10.0%	1.5%	0.3%	15.8%	5.5%	17.1%	6.9%	3.0%
Fats and Oil	10.8%	7.1%	0.8%	1.4%	20.0%	17.7%	9.1%	4.6%	4.6%
Processed food	14.8%	12.0%	0.3%	1.6%	28.7%	13.5%	12.1%	1.3%	6.6%
Chemical products	1.6%	5.8%	0.3%	0.7%	8.5%	5.8%	9.3%	1.9%	5.6%
Rubber Plastics	3.6%	4.5%	1.2%	0.6%	9.9%	10.5%	6.8%	13.0%	11.5%
Raw hide skins	0.1%	7.7%	0.7%	1.9%	10.4%	0.4%	6.0%	5.0%	14.4%
Wood	7.9%	13.9%	0.3%	4.7%	26.8%	25.0%	30.2%	0.5%	10.3%
Paper	2.1%	4.0%	0.1%	1.5%	7.7%	8.6%	10.4%	0.2%	4.8%
Textile	0.6%	10.8%	0.6%	0.9%	12.9%	11.4%	15.1%	3.3%	5.4%
Footwear	0.2%	0.9%	1.2%	6.0%	8.3%	5.1%	1.5%	4.4%	24.0%
Stone Cement	1.1%	6.8%	0.1%	0.4%	8.4%	11.2%	12.2%	0.7%	10.9%
Precious stones	0.4%	5.5%	0.9%	2.7%	9.5%	15.9%	16.1%	7.2%	18.9%
Base Metals	0.0%	4.4%	0.6%	1.3%	6.4%		9.1%	3.0%	13.4%
Machinery & Electrical Equipment	0.0%	4.8%	0.4%	0.9%	6.1%		10.1%	1.4%	7.9%
Motor Vehicles	0.0%	15.9%	0.7%	5.7%	22.3%		20.4%	1.5%	23.4%
Optical Medicals	0.0%	5.1%	1.1%	1.5%	7.7%		8.6%	4.2%	13.5%
Miscellaneous	0.0%	7.5%	0.0%	1.0%	8.6%		8.9%	2.1%	6.3%

Note: SPS is Sanitary and Phytosanitary measures, TBT is Technical barriers (standards), BCM is Border control measures and QRs is Quantitative restrictions.
For unweighted series the cases for products in a country with no NTM are not taken into account in calculating the average, while in the frequency weighted series the AVE in such cases are set to zero. Therefore unweighted AVEs capture the restrictiveness of an NTM when it is applied while frequency-weighting captures the average effect of NTMs when accounting for their incidence.
Source: OECD estimates.

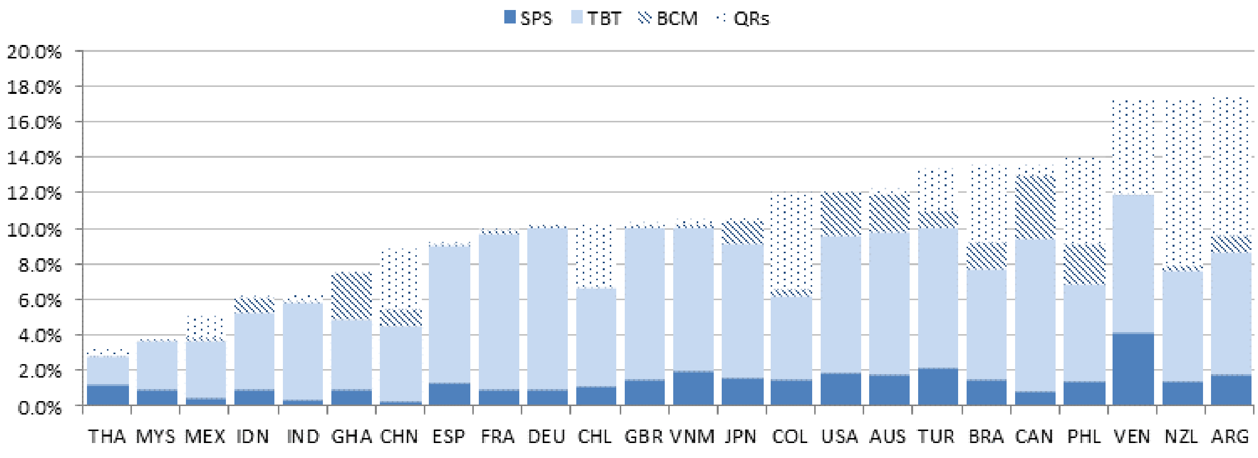
In some other cases, like fats and oil, anecdotal evidence suggests that high AVEs may also reflect policy interference with the smooth functioning of markets in some countries. In chemicals, given the sensitivity of the products for consumer and environmental safety, an average 10.1% AVE for TBT measures can be considered moderate. Generally, the size of the estimated AVEs and their relative importance across products are in line with those of Cadot and Gourdon (2016) or Cadot et al. (2015) who use the same data but with different empirical approaches.

Turning to country-specific estimates, Figure 2 shows average (cross-sectoral) AVEs, by broad type of measure, for selected importers in the database. These estimates should be interpreted very cautiously and should in no case be used to rank countries, for a number of reasons. Consider first the case of technical regulations (SPS and TBT), and suppose that two importing countries share the same body of regulations (e.g. two EU countries) but the first imports more from countries with weak SPS infrastructures. While identical with those of the second importing country, its regulations will require more adaptation from origin producers, and hence will entail higher AVEs.

This origin-composition effect is one reason why EU countries can have different average AVEs, even though they apply the same regulations. Likewise, product-composition effects will affect average AVEs. For example, a country importing more highly sensitive products, e.g. shrimp, will have a mechanically higher average AVE for SPS measures than a county that imports less sensitive products. The case of non-technical measures, say quantitative restrictions provides another illustration where a simple comparison of the height the AVEs between countries may be misleading. A country allowing some rent-sharing between exporters and importers in the allocation of limited quantities will have a higher AVE compared to the case where all quota rents accrue to exporters, although this does not mean that it distorts trade more.

Thus, a naive interpretation of the average numbers in Figure 2 as a rank order where lower AVEs imply, in some sense, better compliance with world trade rules or lower distortions would be severely misleading. Rather, they should be construed as a "reality check" on the estimation procedure inasmuch as they do not show any country except perhaps Venezuela as a clear outlier, all numbers falling in a non-prohibitive range.

Figure 2. Distribution of AVEs by Importer

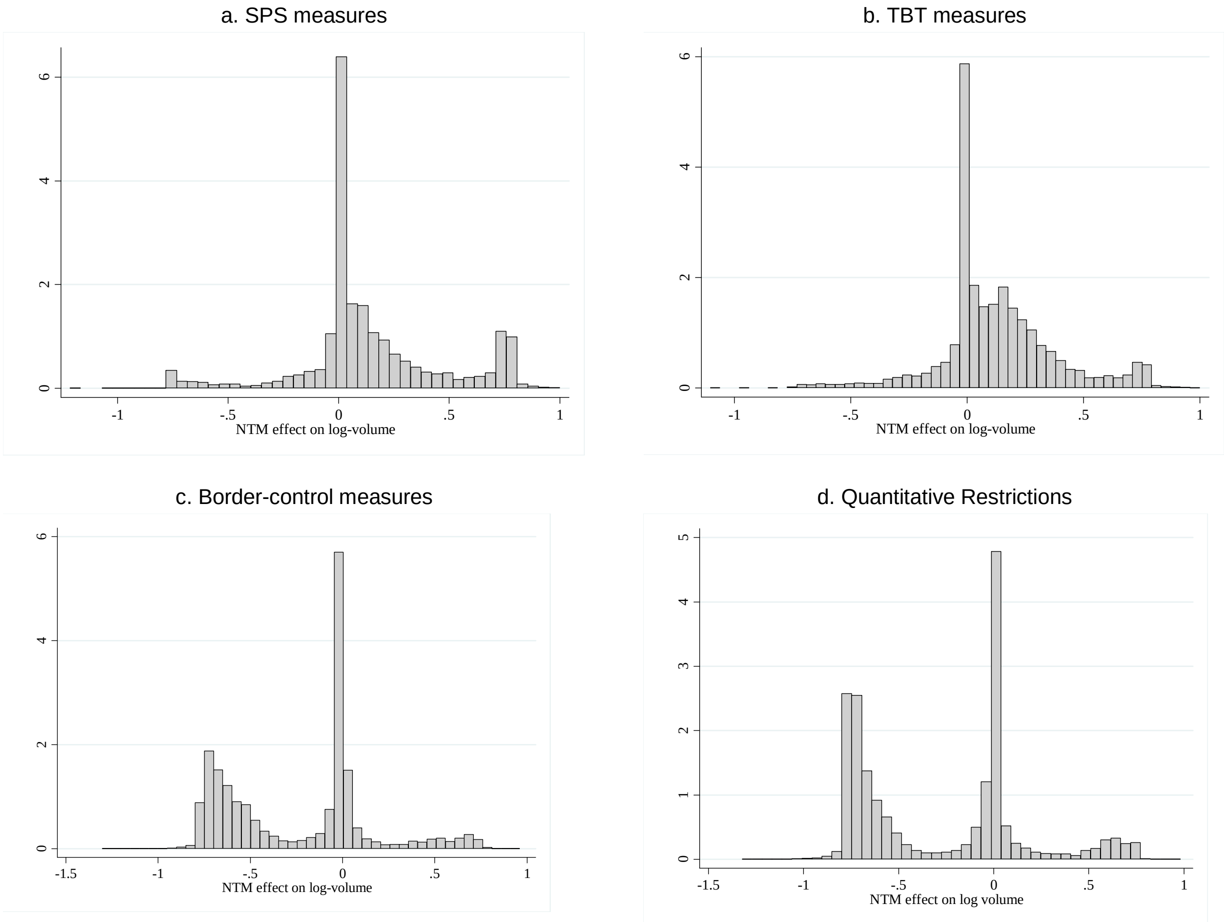


Note: SPS is Sanitary and Phytosanitary measures, TBT is Technical barriers (standards), BCM is Border control measures and QRs is Quantitative restrictions.
Source: OECD estimates.

4.3. Volume effects

As illustrated in Figure A1 in Annex 2, the effect of NTMs on unit values is expected to be positive for all technical measures, reflecting essentially various forms of compliance costs This this is clearly seen in the graphs in Annex 4. However the volume effects can go either way, depending on the relative strength of compliance-cost versus demand-enhancing effects. Figure 3 shows their distribution over the whole sample (all importers and all products), by one-digit NTM. As volume changes give only qualitative information on market-creating effects -positive if they outweigh compliance-cost effects, negative otherwise- the main interest is in their sign and not in their magnitude, as this has no direct interpretation. Thus, they are not transformed into AVEs.

Figure 3. Distribution of changes in trade volumes at country-product level, by type of measure



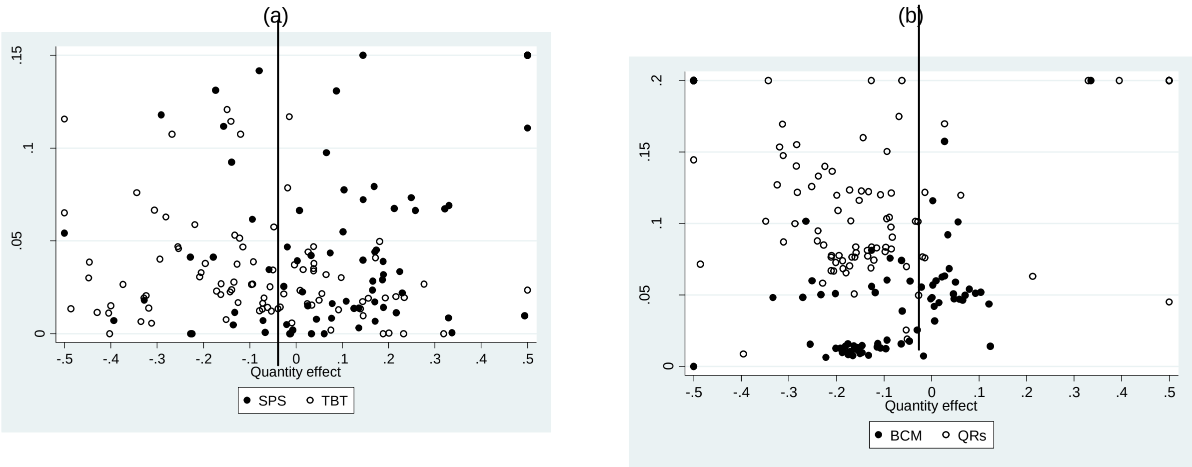
Source: OECD estimates.

4.4. Equilibrium changes

Figure 4 combines information obtained from price-based estimation with that obtained from volume-based estimation in the form of scatter plots to give a visual rendering of the average equilibrium changes induced by the imposition of NTMs, by country and HS section. In panel a, SPS measures are shown as full black dots, while TBT measures are shown as empty dots. In both cases, about half the sample lies to the right of the vertical line, implying that import volumes are higher with the measures than without them. This suggests that the demand-enhancing effect of technical measures is substantial; in other words, the findings substantiate the presumption that

NTMs can correct pre-existing market failures, and well-designed regulations can have a trade-facilitating effect although they raise prices. Non-technical measures (BCM and QRs in panel b), in contrast, raise prices while reducing volumes (except for some few border control measures), as they involve no market-creating effect.

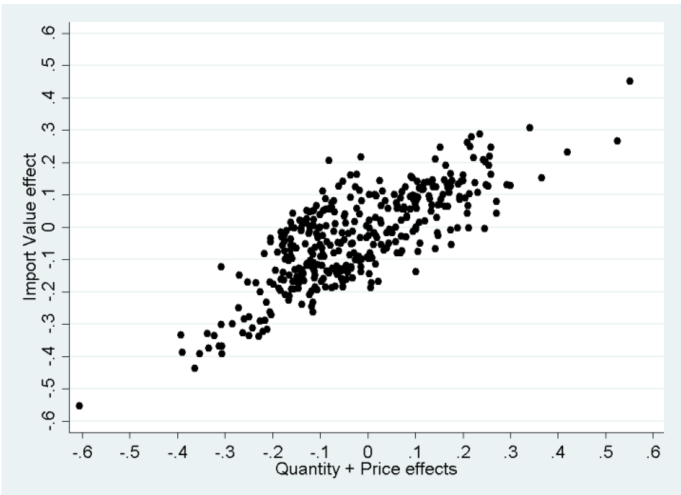
Figure 4. Estimated equilibrium changes, by country-HS section



Note: Figures show a scatterplot of log-changes in prices (on the vertical axis) against log-changes in volumes (horizontal axis),
Source: OECD estimates.

As a consistency check, Figure 5 shows log-changes in the dollar value of trade against the sum of log-changes in trade volumes and unit values. All points should be on the diagonal if the estimates were fully consistent. While this is not the case, the amount of noise is limited. Figure 5 also illustrates an important point: many observations lie around a region where the variation in the dollar value of trade is around zero, corresponding to cases where the price elasticity of import demand is around unity. In such cases, AVEs estimated from changes in the dollar value of trade are not retrievable in a consistent manner, and hence the separate estimates of volumes and unit values as dependent variables yield more robust results.

Figure 5. Value changes against price & quantity changes



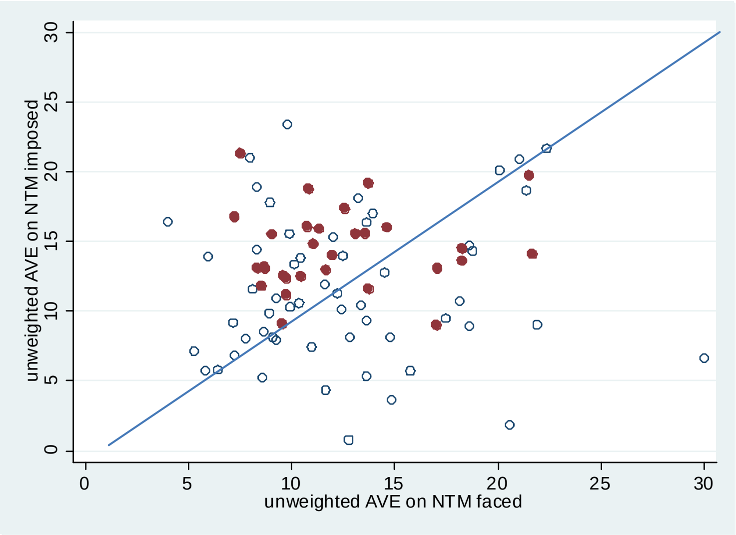
Note: Figures show a scatterplot of log-changes in value (on the vertical axis) against log-changes in volumes summed with log-changes in price (horizontal axis),
Source: OECD estimates.

4.5. Bilateral dimension

One of the novelties of this report is to calculate bilateral AVE for NTM, i.e. on a same market the impact of NTMs on bilateral trade unit value (an trade flows) are likely to vary across exporting countries, due to compliance costs and other importing, exporting country specificities (including regulatory distance). Figure 6 presents averages of the AVEs imposed by countries on their imports (summing all type of NTMs) and of the AVEs they face on their exports.[5]

AVEs imposed by OECD countries, shown as full dots, are generally higher than the ones they face on their exports. This is partly explained by a trade composition effect but it also reflects the lower cost due to NTMs that non OECD countries face on the export markets (OECD and non OECD).

Figure 6. AVE imposed vs AVE faced, by country



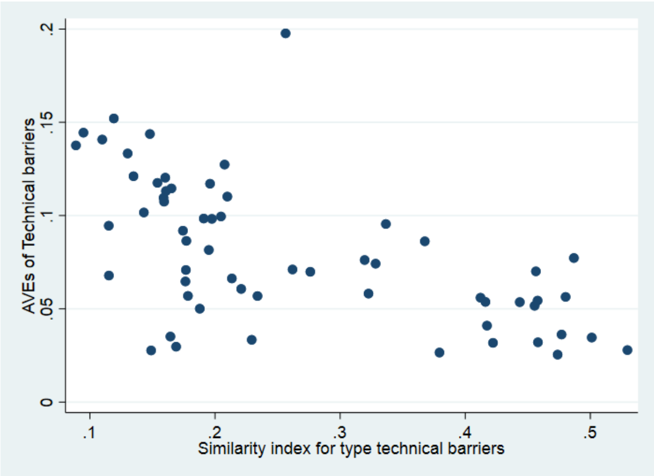
Note: Red dots represent OECD countries, and blue dots are non-OECD countries.
Source: OECD estimates.

A growing body of evidence suggests that regulatory convergence – or reducing regulatory heterogeneity – reduces trade costs. In order to ascertain this effect, a measure of bilateral regulatory distance between the two trading countries is calculated as detailed in Annex 6.[6] Figure 7 shows the result for the technical measures (sum of SPS and TBT). It clearly shows the negative correlation between greater similarity (moving to the right hand side) and the size of the bilateral AVEs, adding to the evidence that regulatory differences are a key contributor to trade costs related to NTMs..

5. In the spirit of the OTRI and MA-OTRI of Kee et al. (2009).

6. Regulatory distance between two countries is calculated at the HS6 level and then aggregated by simple average to the country level.

Figure 7. Price effect versus regulatory distance with partners, by country



Source: OECD estimates.

5. Incorporation of those equilibrium change in the METRO model

The OECD METRO model is widely used to assess the sectoral and economy-wide effects of trade policy reforms. Incorporating the price and volume estimates of NTMs into this model will allow for a more comprehensive assessment on a sound empirical basis. Earlier model developments have incorporated the notion of demand shift effects in the import equations to model trade facilitation (OECD, 2016). The price effects can be implemented straightforwardly by incorporating them into the equations for price of foreign goods, along with additional cost such as tariff. However, splitting out price and volume effects in applied work and incorporating them into the multi-level import demand structure of METRO requires more attention. The 'Willingness to Pay' approach used in that context essentially captures the mechanics of the volume effects that are identified in the present report (Granslandt and Markusen, 2001).

6. Concluding remarks and further development

This report presents a novel method to estimate trade effects of non-tariff measures. It explicitly distinguishes several types of measures and ascertains their distinct effects on trade volumes and prices. The latter feature is particularly important as it allows disentangling trade-cost effects associated with NTMs from possible demand enhancing effects that come from reducing information asymmetries and strengthening consumer confidence in imported products.

The price-based estimations yield a large set of *ad valorem* tariffs (AVEs) that are specific for bilateral trade between more than 80 countries and roughly 5 000 products. The volume-based estimates yield information on how NTMs ultimately affect trade: the trade cost associated with NTMs (as captured by the AVEs) often reduces trade volumes, as is typically expected, but not always. In a number of cases, in particular in the SPS area, trade is found to expand, even though trade costs rise. The trade-enhancing features of such measures merit further study, and are likely related to closer regulatory proximity between countries. While the trade-enhancing features of such measures can be beneficial to large businesses, the impact of NTMs on trade participation by SMEs merits further study.

While the estimations as such provide a rich source of information on the cost- and volume effects of NTMs they are also intended to be incorporated into the repository of trade policy information that underpins analysis with the METRO model. The precise way to absorb both the trade costs (as AVEs) and the volume effects in a consistent manner needs further attention.

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Annex 1.
List of Non-tariff Measures in MAST

A	Sanitary and Phytosanitary	B	Technical Barriers to Trade
A1	Prohibitions/restrictions of imports for SPS reasons	B1	Prohibitions/restrictions of imports for objectives set out in the TBT agreement
A11	Temporary geographic prohibitions for SPS reasons	B11	Prohibition for TBT reasons
A12	Geographical restrictions on eligibility	B14	Authorization requirement for TBT reasons
A13	Systems approach	B15	Registration requirement for importers for TBT reasons
A14	Special authorization requirement for SPS reasons	B19	Prohibitions/restrictions of imports for objectives set out in the TBT agreement, n.e.s.
A15	Registration requirements for importers	B2	Tolerance limits for residues and restricted use of substances
A19	Prohibitions/restrictions of imports for SPS reasons, not elsewhere specified (n.e.s.)	B21	Tolerance limits for residues of or contamination by certain substances
A2	Tolerance limits for residues and restricted use of substances	B22	Restricted use of certain substances
A21	Tolerance limits for residues of or contamination by certain (non-microbiological) substances	B3	Labelling, Marking and Packaging requirements
A22	Restricted use of certain substances in foods and feeds and their contact materials	B31	Labelling requirements
A3	Labelling, Marking and Packaging requirements	B32	Marking requirements
A31	Labelling requirements	B33	Packaging requirements
A32	Marking requirements	B4	Production or Post-Production requirements
A33	Packaging requirements	B41	TBT regulations on production processes
A4	Hygienic requirements	B42	TBT regulations on transport and storage
A41	Microbiological criteria of the FInal product	B49	Production or post-production requirements, n.e.s.
A42	Hygienic practices during production	B6	Product identity requirement
A49	Hygienic requirements, n.e.s.	B7	Product quality or performance requirement
A5	Treatment for elimination of plant and animal pests and disease-causing organisms in the final product (e.g. Post-harvest treatment)	B8	Conformity assessment related to TBT
A51	Cold/heat treatment	B81	Product registration requirement
A52	Irradiation	B82	Testing requirement
A53	Fumigation	B83	Certification requirement
A59	Treatment for elimination of plant and animal pests and disease-causing organisms in the (nal product, n.e.s.	B84	Inspection requirement
A6	Other requirements on production or post-production processes	B85	Traceability information requirements
A61	Plant-growth processes	*B851*	Origin of materials and parts
A62	Animal-raising or -catching processes	*B852*	Processing history
A63	Food and feed processing	*B853*	Distribution and location of products after delivery
A64	Storage and transport conditions	*B859*	Traceability requirements, n.e.s.
A69	Other requirements on production or post-production processes, n.e.s	B89	Conformity assessment related to TBT, n.e.s.
A8	Conformity assessment related to SPS	B9	TBT Measures n.e.s.
A81	Product registration requirement		
A82	Testing requirement	**C**	**Border Control measures**
A83	Certification requirement	C1	Pre-shipment inspection
A84	Inspection requirement	C2	Direct consignment requirement
A85	Traceability requirements	C3	Requirement to pass through specified port of customs
A851	Origin of materials and parts	C4	Import monitoring and surveillance requirements and other automatic licensing measures
A852	Processing history	C9	Other formalities, n.e.s.
A853	Distribution and location of products after delivery	E3	Prohibitions other than for SPS and TBT reasons
A859	Traceability requirements, n.e.s.	E31	Prohibition for economic reasons

A86	Quarantine requirement	*E311*	Full prohibition (import ban)
A89	Conformity assessment related to SPS, n.e.s.	*E312*	Seasonal prohibition
A9	SPS measures n.e.s.	*E313*	Temporary prohibition, including suspension of issuance of licences
E	**Quantity control measures**	*E314*	Prohibition of importation in bulk
E1	Non-automatic import licensing procedures other than authorizations for SPS or TBT reasons	*E315*	Prohibition of products infringing patents or other intellectual property rights
E11	Licensing for economic reasons	*E316*	Prohibition of used, repaired or remanufactured goods
E111	Licensing procedure with no specific ex ante criteria	*E319*	Prohibition for economic reasons, n.e.s.
E112	Licensing for specified use	E32	Prohibition for non-economic reasons
E113	Licensing linked with local production	*E321*	Prohibition for religious, moral or cultural reasons
E119	Licensing for economic reasons, n.e.s.	*E322*	Prohibition for political reasons (embargo)
E12	Licensing for non-economic reasons	*E329*	Prohibition for non-economic reasons, n.e.s.
E2	Quotas	E5	Export restraint arrangement
E21	Permanent	E51	Voluntary export-restraint arrangements (VERs)
E211	Global allocation	*E511*	Quota agreement
E212	Country allocation	*E512*	Consultation agreement
E22	Seasonal quotas	*E513*	Administrative cooperation agreement
E221	Global allocation	E6	Tariff Rate Quotas
E222	Country allocation	E61	WTO-bound TRQs, included in WTO schedules (concessions and commitments under WTO negotiations)
E23	Temporary	E62	Other TRQs included in other trade agreements.
E231	Global allocation	*E621*	Global allocation
E232	Country allocation	*E622*	Country allocation
		E9	Quantity control measures n.e.s.

Source: UNCTAD (2012).

Annex 2.
Equilibrium changes from the imposition of an NTM

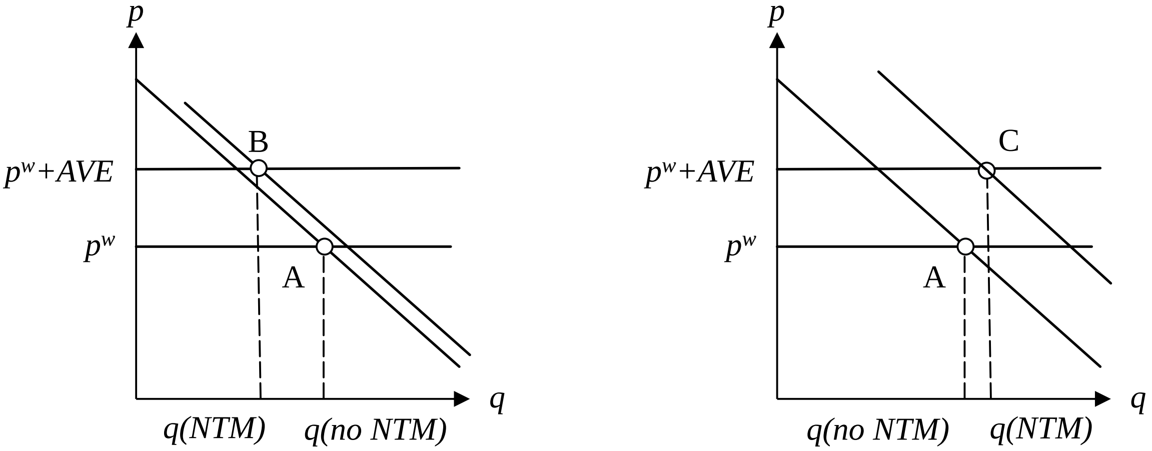
The price- and volume effects are illustrated in Figure A1., where the vertical axis measures CIF import prices and the horizontal one measures import volumes. In both panels, p^w is the world price in the absence of the importing country's NTM. The difference between the two horizontal lines is the NTM's AVE, which reflects the various types of costs (adaptation, information, and conformity assessment), which are assumed to be passed through entirely to importers.[7] The difference between the two demand curves reflects the NTM's market-creating effects discussed above. In panel a, they are weak, so the market equilibrium shifts from A to B and import volumes go down; in panel b, they are strong, so the market equilibrium shifts from A to C and import volumes go up in spite of the demand-inhibiting effect of the AVE.

Thus, variation in prices can be used to retrieve AVEs, while variation in volumes can be used to assess, qualitatively, the strength of market-creating effects (although it does not yield a precise quantitative estimate for them). When the AVE is positive and import volumes go up, we can conclude that the NTM's market-creating effects outweigh its business costs, and conversely when import volumes go down. When the AVE is zero (or statistically insignificant) and import volumes do not change, we can conclude that the NTM is ineffective; when the AVE is positive and import volumes do not change, the correct interpretation of the NTM's effect is not that it is ineffective, but that its compliance costs are just offset by its market-creating effects. Thus, our approach can disentangle a number of configurations that previous approaches could not.

Figure A1. NTM compliance costs *vs*. market-creating effects

Case a: Weak market-creating effect

Case b: Strong market-creating effect



7. The literature on pass-through suggests values close to unity on average; see Asprilla et al. (2016).

The measurement approach takes advantage of this decomposition through two separate sets of estimations, one using CIF import prices as the dependent variable (shifts along the vertical axis in Figure A1), and one using import volumes as the dependent variable (shifts along the horizontal axis in Figure A1). Note that this decomposition is correct only under the small-country assumption (horizontal supply curves); this is a reasonable assumption for the bulk of our 86-country sample, but obviously it should be taken cautiously for the US and EU, for which the small-country assumption is unlikely to hold true.

However, the AVE estimates have sharply different interpretations for technical vs. non-technical measures. For technical measures, compliance costs (adaptation, information, and conformity-assessment) can be assumed to be incurred by producers and passed on to consumers through higher CIF prices (trade unit values). Thus, AVEs estimated from trade unit values for SPS and TBT measures can be safely assumed to reflect compliance costs accurately.

However, for non-technical measures, say quantitative restrictions (QRs), the effect on trade unit values depends on the exact form of the measures. Quotas with import licenses distributed (or auctioned out) to domestic importers will raise domestic prices, but their effect on trade unit values is indeterminate. It is possible that license holders will be conferred market power not only on the selling side, but on the buying side as well, leading to lower CIF prices. This is excluded by assumption in Figure A1, where the importing country is small, but there may be perverse cases in reality where QRs lead to lower trade unit values. By contrast, voluntary export restraints (VERs) will lead to higher trade unit values, and QRs may generally give rise to some rent-sharing between exporters and importers, leading to higher unit values. Likewise, in the case of antidumping measures, price undertakings will lead to higher trade unit values, but the imposition of duties may not. Finally, border measures may create wedges between domestic wholesale prices and CIF import prices that will not be picked up by variation in trade unit values. Thus, price-based AVEs must be interpreted cautiously in the case of non-technical measures.

AVEs are calculated directly from exponentiated coefficients estimated in price-based OLS regressions. Specifically, if β is the coefficient on the number of NTMs per product in a given HS chapter (for which the estimation is carried out),

$$AVE = e^{\beta} - 1$$

That is, using import prices instead of import values as the dependent variable makes it possible to retrieve AVEs directly, without using the price elasticity of import demand.

Volume effects are not transformed into AVEs, so we display simply the raw coefficients rather than the algebraic transformation above. Suppose that γ is, again, the coefficient on the number of NTMs per product in a given HS chapter (for which the estimation is carried out). Then if $\gamma > 0$, market-creating effects outweigh compliance costs (a shift from A to C in Figure A1), if $\gamma < 0$, they do not (a shift from A to B in Figure A1).

Annex 3.
AVE Estimation issues

Underlying framework

The econometric estimations are based on a relatively traditional trade modelling framework. Demand for products assumes substitutability between domestic and foreign sources, with constant elasticities of substitution. Products are supplied to both domestic and foreign destinations, with the composition governed by constant elasticities of transformation. The modelling approach follows closely that of Xiong and Beghin (2014), in particular by acknowledging that NTMs can have both demand-enhancing and cost-raising effects.

Let *i* and *j* designate respectively the origin and destination countries of a trade flow, and *k* a product (at the HS6 level of disaggregation). Let p_{ijk} and q_{ijk} be respectively the CIF unit value and quantity of product *k* exported from *i* to *j*, and $v_{ijk} = p_{ijk}q_{ijk}$ the money value of the trade flow. Let $\varepsilon > 1$ and $\eta > 1$ be the constant elasticities of substitution and transformation respectively.

A product-specific demand-shifting parameter in the destination's CES aggregator is denoted δ_{jk}. For simplicity it is assumed that the sole determinant of δ_{jk} is the imposition of an NTM by destination *j* on product *k*. As discussed above, NTMs are not bilateral, so δ_{jk} is destination- and product-specific but not origin-specific. To incorporate NTMs, a binary variable is introduced:

$$I_{jkm} = \begin{cases} 1 & \text{if } j \text{ imposes an NTM of type } m \text{ on product } k \\ 0 & \text{otherwise.} \end{cases} \quad (1)$$

That is, I_{jkm} is the basic entry in the NTM data. Then

$$\delta_{jk} = \exp\left(\sum_m I_{jkm}\right). \quad (2)$$

The vector of typical determinants of trade volumes and CIF unit values is denoted $\mathbf{G}_{ij}$. Elements of this vector include tariffs, the log of distance between origin and destination countries, and other standard determinants of trade costs. Let τ_{ijk} be a bilateral iceberg trade cost, a function of $\mathbf{G}_{ij}$ and NTM compliance cost:

$$\tau_{ijk} = \exp\left(\mathbf{G}_{ij}^{'}\boldsymbol{\beta}_1 + \sum_m \beta_{2m} I_{jkm}\right) \quad (3)$$

Note that the identification of signalling effects and compliance costs relies on the same explanatory variable, I_{jkm}. Thus, estimation cannot yield distinct parameters identifying signalling effects and compliance costs in a single equation. Instead, as illustrated in Figure A.1, these effects will be identified from the estimates of "twin" parameters in two separate equations, one for prices and one for quantities.

Let Y_j and Q_i be respectively the income and output constraints of *i* and *j*, and Π_j and Ψ_i their price indices. All aggregate magnitudes can be re-interpreted as pertaining to a particular sector in a two-stage budgeting framework, but this is inconsequential for the estimation. Solving for equilibrium prices and values, Xiong and Beghin (2014) show that the value of bilateral trade in product *k* becomes:

$$v_{ijk} = \left(\frac{Y_j}{\Pi_j}\right)^{\frac{1-\eta}{\varepsilon-\eta}} \left(\frac{Q_i}{\Psi_i}\right)^{\frac{\varepsilon-1}{\varepsilon-\eta}} \delta_{jk}^{\frac{(\varepsilon-1)(1-\eta)}{\varepsilon-\eta}} \tau_{ijk}^{\frac{(1-\varepsilon)(1-\eta)}{\varepsilon-\eta}} \quad (4)$$

And $$p_{ijk} = \left(\frac{Y_j}{\Pi_j}\right)^{\frac{1}{\varepsilon-\eta}} \left(\frac{Q_i}{\Psi_i}\right)^{\frac{-1}{\varepsilon-\eta}} \delta_{jk}^{\frac{\varepsilon-1}{\varepsilon-\eta}} \tau_{ijk}^{\frac{1-\eta}{\varepsilon-\eta}}. \quad (5)$$

Combining (4) and (5),

$$q_{ijk} = \left(\frac{Y_j}{\Pi_j}\right)^{\frac{\eta}{\varepsilon-\eta}} \left(\frac{Q_i}{\Psi_i}\right)^{\frac{-\varepsilon}{\varepsilon-\eta}} \delta_{jk}^{\frac{\eta(\varepsilon-1)}{\varepsilon-\eta}} \tau_{ijk}^{\frac{\varepsilon(1-\eta)}{\varepsilon-\eta}} \quad (6)$$

Rather than estimating a conventional gravity equation on trade values using (4), this study uses (5) and (6) to estimate separately the effect of NTMs on equilibrium prices and quantities.

Indirect (country characteristics) approach

The basic unit of observation is an (*i*,*j*,*k*) triplet. The NTM index *m* is defined at the one-letter level of the MAST classification (A, B, C, and E). Time is not indexed as there is only a single year of data, so the data is cross-sectional rather than a panel). Variables pertaining to *i* and *j*, like GDP and GDP per capita are included for exporter and importer, let δ_j and δ_k be those importer and exporter characteristics respectively and $\mathbf{G}_{ij}$ being the traditional gravity variables (distance, contiguity, common language and RTA). Let n_{jkm} be the number of measures of NTMs belonging to the MAST's "one- letter+3 digit (A110, etc.) category applied by importing country j on product k. In addition, denote the importer's share in world trade of product k by s_{jk} and s_{ik} the share of exporter *i* in world trade of product *k*.

As discussed in the text, the indirect approach does not rely on interactions between NTM variables and a vector of importer dummies, but rather on interactions between NTM variables and a single importer characteristic, namely the importer's share in world trade of product k, s_{jk}. To obtain bilateral AVEs, i.e. specific to the partner, we follow Kee and Nicita (2016) and we interact NTM variables with a single exporter characteristic, namely the exporter's share in world trade of product k, s_{ik}. Thus, exporters and importers are treated symmetrically. Formally,

$$\begin{aligned} \ln p_{ijk} &= \mathbf{G}_{ij}^{'} \cdot \boldsymbol{\beta}_1 + \sum\nolimits_m \beta_{2m} n_{jkm} + \sum\nolimits_m \beta_{3jm} \left(n_{jkm} s_{jk}\right) + \sum\nolimits_m \beta_{4m} \left(n_{jkm} s_{ik}\right) \\ &+ \sum\nolimits_i \delta_i + \sum\nolimits_j \delta_j + \sum\nolimits_k \delta_k + u_{ijk} \end{aligned} \quad (7)$$

As zero trade flows have no price, equation (7) is estimated by OLS ignoring zero trade flows. Results should therefore be interpreted as pertaining to the intensive margin only. In order to control for endogeneity issues, we instrument the number of NTMs of type *m* imposed by importing country *j* on product *k* using the number of NTMs of type *m* imposed on product *k* by all of *j*'s overland neighbours.

Price-based AVEs, estimated at exporter share $\bar{s}_{ik}$ and importer share $\bar{s}_{jk}$, AVEs are given by

$$AVE_{ijm}^{C(k)} = \exp\left(\beta_{2m} + \bar{s}_{jk}\beta_{3m} + \bar{s}_{ik}\beta_{4m}\right) - 1 \quad (8)$$

with all coefficients with p-values above 0.1set equal to zero and section-level AVEs reported in the text are import-weighted averages of chapter-level AVEs.

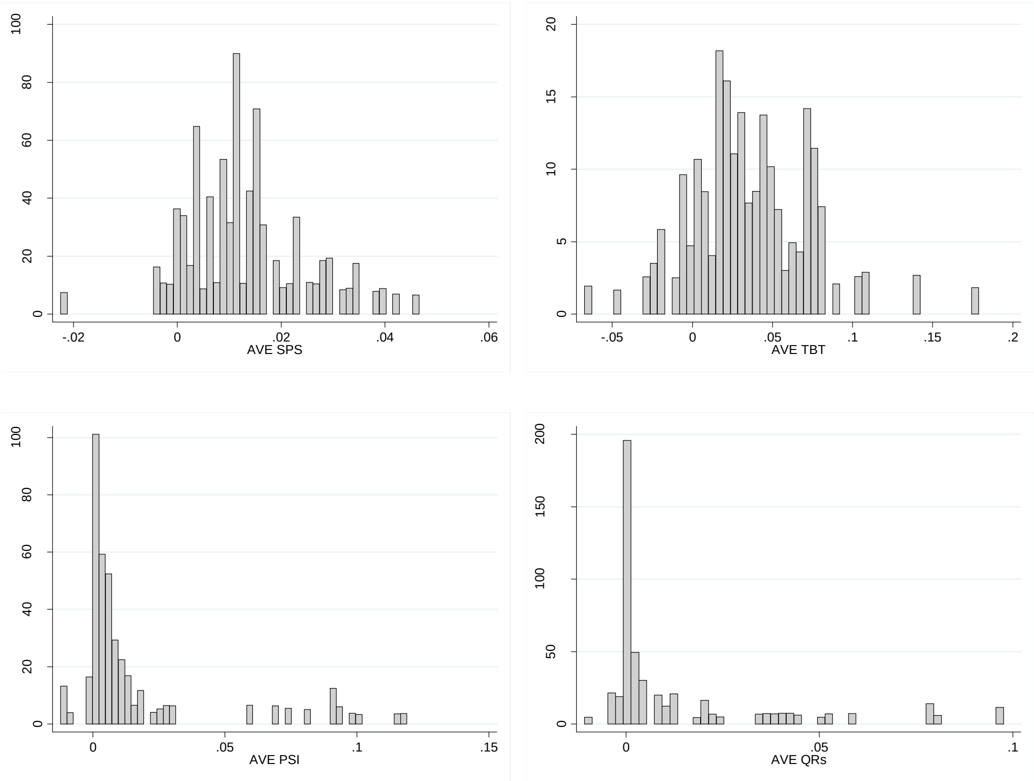
Volume regressions

Import-volume regressions have the same structure, except that the estimator used is PPML (Poisson Pseudo Maximum Likelihood), and directly estimating the non-linear equations without logarithmic transformation. With this approach zero trade flows can be taken into account in the estimation. As Xiong and Beghin (2014) point out, including the zero trade observations allows exploring the extensive margin of trade –the creation of new bilateral trade relations, including new trade links as a result of lower trade barriers, In contrast, discarding zero-flow observations limits estimates to trade that is already observed –the intensive margin of trade. The volume equation to estimate with PPML becomes:

$$\begin{aligned} q_{ijk} = {} & \mathbf{G}_{ij}^{'} \cdot \boldsymbol{\beta}_1 + \sum\nolimits_m \beta_{2m} n_{jkm} + \sum\nolimits_m \beta_{3jm}\left(n_{jkm} s_{jk}\right) + \sum\nolimits_m \beta_{4m}\left(n_{jkm} s_{ik}\right) \\ & + \sum\nolimits_i \delta_i + \sum\nolimits_j \delta_j + \sum\nolimits_k \delta_k + u_{ijk} \end{aligned} \quad (9)$$

Annex 4. Distribution of changes in trade unit value

Figure A2. Distribution of log-changes in trade unit value at country-product level, by type of measure



Annex 5.
Price-based AVE estimates for GTAP sectors

	Frequency weighted AVE				
GTAP sector	**SPS**	**TBT**	**BCM**	**QRs**	
PDR - Paddy rice	7.4%	0.0%	14.9%	0.0%	22.3%
WHT - Wheat	0.0%	0.0%	0.0%	0.0%	0.0%
GRO - Cereal grains n.e.c.	30.9%	20.4%	0.0%	0.0%	51.4%
V_F - Vegetables, fruit, nuts	3.6%	18.2%	0.5%	0.7%	23.0%
OSD - Oil seeds	5.7%	0.1%	3.1%	0.9%	9.8%
C_B - Sugar cane, sugar beet	0.0%	93.4%	0.0%	0.0%	93.4%
PFB - Plant-based fibers	0.0%	0.2%	0.0%	0.0%	0.2%
OCR - Crops n.e.c.	4.1%	9.7%	0.5%	0.2%	14.6%
CTL - Bovine cattle, sheep and goats, horses	7.9%	0.0%	0.0%	0.0%	7.9%
OAP - Animal products n.e.c.	2.9%	1.5%	0.5%	2.3%	7.3%
WOL - Wool, silk-worm cocoons	0.0%	14.3%	5.5%	0.0%	19.9%
FRS - Forestry	7.6%	0.5%	0.0%	0.9%	9.0%
FSH - Fishing	6.6%	3.6%	0.3%	2.1%	12.6%
OMN - Minerals n.e.c.	0.0%	0.3%	0.0%	1.8%	2.1%
CMT - Bovine meat prods	2.2%	13.1%	0.6%	0.2%	16.0%
OMT - Meat products n.e.c.	24.3%	18.7%	4.8%	0.2%	48.0%
VOL - Vegetable oils and fats	8.4%	5.4%	0.6%	1.8%	16.2%
MIL - Dairy products	2.6%	23.8%	0.0%	1.7%	28.2%
PCR - Processed rice	0.0%	2.7%	0.0%	0.0%	2.7%
SGR - Sugar	0.2%	0.0%	0.0%	0.0%	0.2%
OFD - Food products n.e.c.	13.2%	17.3%	0.4%	1.2%	32.1%
B_T - Beverages and tobacco products	10.3%	4.2%	2.8%	4.7%	22.0%
TEX - Textiles	0.9%	7.2%	0.6%	0.9%	9.7%
WAP - Wearing apparel	0.4%	15.8%	0.6%	1.0%	17.9%
LEA - Leather products	0.1%	2.6%	0.8%	5.6%	9.2%
LUM - Wood products	3.1%	15.2%	0.2%	3.4%	21.9%
PPP - Paper products, publishing	2.1%	4.0%	0.1%	1.5%	7.6%
CRP - Chemical, rubber, plastic products	2.4%	5.2%	0.6%	0.7%	8.9%
NMM - Mineral products n.e.c.	1.0%	6.7%	0.1%	0.4%	8.2%
I_S - Ferrous metals	0.0%	6.2%	0.9%	1.8%	8.9%
NFM - Metals n.e.c.	0.0%	1.6%	0.1%	0.7%	2.5%
FMP - Metal products	0.0%	4.5%	0.2%	1.3%	5.9%
MVH - Motor vehicles and parts	0.0%	17.3%	0.8%	6.8%	24.8%
OTN - Transport equipment n.e.c.	0.0%	4.1%	0.4%	0.5%	5.1%
ELE - Electronic equipment	0.0%	4.5%	0.6%	0.1%	5.2%
OME - Machinery and equipment n.e.c.	0.0%	5.8%	0.5%	1.3%	7.6%
OMF - Manufactures n.e.c.	0.2%	4.1%	0.6%	1.0%	5.9%

Note: SPS is Sanitary and Phytosanitary measures, TBT is Technical barriers (standards), BCM is Border control measures and QRs is Quantitative restrictions.

Annex 6. Measure of regulatory distance

This approach is derived from Cadot et al. (2015) which gives a measure of regulatory distance between any two countries at the HS6 product level by calculating a similarity index in regulation

The essence of the approach is as follows. Consider a product, say HS 840731 ("spark ignition reciprocating piston engines of a kind used for the propulsion of vehicles of Ch.87, of a cylinder capacity not >50cc"). Suppose that country *i* imposes an NTM coded in the MAST classification as B840 (inspection requirements) on that product. If country *j* imposes the same NTM on the same product, for that given NTM-product pair, the two countries are considered "similar" with no regulatory-distance and the similarity index is one. If, by contrast, one of the two countries imposes NTM B840 on product HS 840731 but the other does not, the regulatory distance is one and the similarity index is set to zero. This comparison is repeated for all NTMs in the NTM-trade database applied to product HS 840731 by either *i* or *j*, and all the resulting ones and zeroes are added up. The sum is then divided by the total number of NTMs applied to HS 840731 by any of the two countries.

This procedure yields a single number between zero and one (the proportion of NTMs applied to HS 840731 by both countries simultaneously), for each origin-destination-product, that indicates the regulatory distance between the two countries for that product (a value closer to one means that the countries are more similar in their regulatory patterns). This is a rough approximation to regulatory differences between countries and should ideally be complemented by a measure differences in the stringency of NTMs (say, maximum residue level of toxic chemicals), but the data for such comparisons is very patchy and does not lend itself to the construction of a consistent database.

Figure A3 below displays of this proximity in regulation, it shows that for agricultural products and chemical product OECD countries often share the same type of regulation, 30% on average of common regulation, compared to other pairs of partners.

Figure A3. Similarity index in regulation for products, average by country group and HS section