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Non-Tariff Measures and the Quality of Imported Products

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Abstract

Eight multilateral rounds of negotiations under the General Agreement on Tariffs and Trade (GATT) and international agreements under the World Trade Organisation (WTO) have contributed significantly to the reduction of tariffs among WTO members. However, over the years legitimate reasons for the imposition of non-tariff measures (NTMs) within regulations have triggered their extensive use. Among these measures, technical barriers to trade (TBTs) and sanitary and phytosanitary (SPS) measures allow countries to impose restrictions on the import of low-quality products suspected of harming domestic consumers' health, plant life or the environment. Such trade policy instruments may lead to higher standards in the import market, in addition to improving market efficiency through information requirements such as mandatory labelling. This paper analyses two types of regulative and standard-like NTMs – TBTs and SPS measures – and the quality improvement of traded products that is driven by their imposition, which might be a general underlying motive for the adoption of such regulations. Based on a model framework involving both the supply and the demand side of trade and using four types of measures of these NTMs, this paper assesses the impact of TBTs and SPS measures on the quality of traded products. A dummy variable measuring the existence of these NTMs and a count variable indicating their stringency are used in the analysis. Moreover, two other variables indicate flows of NTMs imposed in each year and stocks of these NTMs accumulated over years. The results indicate that TBTs and SPS measures do indeed imply a higher quality of traded products, which is also consistent with the model when NTMs enter as a specific trade cost. Stringent TBTs with more regulations imposed in each year (i.e. flows of count TBTs) have the largest impact on the quality of traded products. However, for SPS measures only the existence of a regulation (i.e. the dummy variable on flows of SPS measures) on a traded product has the strongest impact on its quality.

Keywords: non-tariff measures, technical barriers to trade, sanitary and phytosanitary measures, quality of products, global bilateral trade

JEL classification: F13, F14, L15

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1. Introduction

Eight multilateral rounds of negotiations under the General Agreement on Tariffs and Trade (GATT) and international agreements under the World Trade Organisation (WTO) have contributed significantly to a reduction of tariffs among WTO members. However, legitimate reasons for the imposition of non-tariff measures (NTMs) within regulations have triggered their extensive use over the years. Aiming at trade liberalisation, protectionist and discriminatory motives for trade policy measures are not permitted by the regulations, while some specific motives are endorsed in good faith by NTMs. Among these measures, technical barriers to trade (TBTs) and sanitary and phytosanitary (SPS) measures allow countries to impose restrictions on the import of low-quality products suspected of harming the health of domestic consumers, the global environment, safety etc. Such trade policy instruments may induce higher standards in the import market, in addition to improving market efficiency via information requirements such as mandatory labelling. In this paper we analyse the quality improvement of the imported products, which might be a general underlying motive for the imposition of different types of NTMs. Applying a monopolistic competition framework involving both the supply and the demand side of trade, we will assess the impact of different types of NTMs on the quality of traded products at the four-digit level of the Standard International Trade Classification (SITC) rev. 2. The analysis modifies and uses the existing information on NTM notifications to the WTO from the Integrated Trade Intelligence Portal (I-TIP) over the period 1995-2011.

According to the MAST[1] classification, *'Non-tariff measures (NTMs) are policy measures, other than ordinary customs tariffs, that can potentially have an economic effect on international trade in goods, changing quantities traded, or prices or both.'* Classifications of NTMs are mostly based on legal international regulations mandated by the WTO and other organisations. In addition, scholars have classified NTMs based on their nature and implications into two broad categories. The first category includes quantitative NTMs such as anti-dumping measures, quantitative restrictions, safeguard measures, etc. Despite having quantitative implications, this broad category of NTMs is sometimes based on some qualitative reasoning (e.g. national legal basis, national security, health and environment issues, market adjustments, etc.). The second category refers to NTMs that have qualitative implications. TBTs and SPS measures are the core NTM category that aims to achieve better regulations and higher standards. Irrespective of the complex motives behind such trade policy measures – i.e. following good faith and legitimate motives, unlike discriminatory motives – they are basically caused by technology, domestic standards and innovations, and qualitative, health and environmental issues (Ghodsi, 2018). Therefore, these core qualitative or regulative NTMs (i.e. TBTs and SPS measures) are considered to also have qualitative upgrading effects on trade flows.

1 As of July 2008 the Multi-Agency Support Team (MAST), established by UNCTAD in 2006 to work on the taxonomy of NTMs, comprised the following institutional members: Food and Agriculture Organisation of the United Nations (FAO), International Monetary Fund (IMF), International Trade Centre UNCTAD/WTO (ITC), Organisation for Economic Cooperation and Development (OECD/TAD), United Nations Conference on Trade and Development (UNCTAD), United Nations Industrial Development Organisation (UNIDO), World Bank (WB), World Trade Organisation (WTO). Observers: European Commission (EC), United States International Trade Commission (USITC), United States Department of Agriculture (USDA). MAST is coordinated jointly by UNCTAD and the World Bank. MAST reports to the Group of Eminent Persons, which is convened by the director general of UNCTAD.

Thus, such core NTMs are aimed at improving the quality of the imported product to align it with domestic standards. Standard-based regulations can potentially improve production procedures or the quality of products (Wilson and Otsuki, 2004; Trienekens and Zuurbier, 2008; Ing and Cadot, 2017). The various impacts of NTMs on trade values and quantities have already been studied (Ronen, 2017A). For instance, using a gravity model on traded HS six-digit products, Essaji (2008) found that the technical regulations imposed by the US result in a huge cost to poor exporting countries with lower capacities. Using the data on TBT notifications to the WTO, Bao and Qiu (2012) found that these regulations reduce the export-extensive margins while increasing the intensive margins. In a computable general equilibrium (CGE) framework Francois et al. (2011) analysed trade liberalisation gains from preferential trade agreements. They found that a reduction in NTMs would have a much larger impact than a tariff reduction. Disdier et al. (2008), Li and Beghin (2012), Yousefi and Liu (2013) and Ghodsi (2019) also found evidence of the negative impact of core NTMs on trade flows while Ronen (2017B) finds a trade-stimulative impact of quality NTMs imposed on virgin olive oil. Several other studies in the literature have analysed the trade restrictiveness of NTMs at the HS six-digit level by estimating the ad-valorem equivalent of NTMs (Kee et al., 2009; Beghin et al., 2015; Cadot and Gourdon, 2016; Ghodsi et al., 2016; Bratt, 2017; Niu et al., 2018; Cadot et al., 2018). While these studies provide evidence of the price equivalence of NTMs to make them comparable to tariffs, the literature regarding the quality impact of core regulative NTMs is still lacking.

Therefore, this paper extends the literature by focusing specifically on the role of two types of qualitative NTMs, i.e. TBTs and SPS measures, notified to the WTO during the period 1995-2011 regarding the quality of products traded bilaterally at the SITC four-digit level. The quality of traded products is measured using the theoretical framework developed by Feenstra and Romalis (2014). It is important to note that the legitimate motive behind the imposition of TBTs and SPS measures is to improve the quality of products traded to a country when these products may harm human health, plant life, environmental quality, consumer safety and protection, etc. Therefore, the results of this analysis may provide a better understanding of whether these regulative NTMs fulfil their intended purpose.

The paper is structured as follows. In the next section we summarise the theoretical model for the calculation of the quality index for products traded bilaterally, as developed by Feenstra and Romalis (2014). This methodology provides a framework to disentangle quantity, price and quality effects of bilateral trade flows from traded values. Section 3 discusses data issues and the econometrics specification. Section 4 provides a discussion of the estimation results, and section 5 concludes.

2. The theoretical framework of the quality index

The starting point of the analysis is the model presented in Feenstra and Romalis (2014) – subsequently referred to as F&R (2014) – which provides a framework to disentangle quantity, quality and price effects of exports and imports. Here the intuition of the model is presented allowing for a proper interpretation of results concerning the econometric outcomes of the effects of NTMs.[2]

The model starts from an expenditure function given by

$$E^k = U^k\left[\int_i \left(\frac{p_i^k}{(z_i^k)^{\alpha^k}}\right)^{1-\sigma} di\right]^{\frac{1}{1-\sigma}} = U^k\left[\int_i \left(\frac{p_i^k}{z_i^k}\frac{1}{(z_i^k)^{\alpha^k-1}}\right)^{1-\sigma} di\right]^{\frac{1}{1-\sigma}} \tag{1}$$

(with $\sigma > 1$) implying non-homothetic demand for quality for $\alpha^k(U^k) \geq 1$. The price p_i^k of good i sold in market k is divided by quality z_i^k which allows us to model the consumer decision in quality-adjusted prices and quantities. The quality-adjusted price is denoted by $P_i^k := p_i^k / z_i^{\alpha^k}$ where for brevity we set $(z_i^k)^{\alpha^k} := z_i^{\alpha^k}$. Note that the quality-adjusted price depends on both the level of quality z_i^k and how consumers evaluate quality α^k. Both lead to lower quality-adjusted prices. Correspondingly, quality-adjusted demand is denoted by $Q_i^k := z_i^{\alpha^k} q_i^k$. The validity of the expenditure function is shown in F&R (2014). From the above we can also see that quality-adjusted demand increases with quality.

It is assumed that firms can produce multiple products (one for each market), and that firm h in country r simultaneously chooses quality z_{ih}^{rk} and the f.o.b. price $p_{ih}^{\text{fob},rk}$ to sell in market k. Further, the production function for quality z_{ih}^{rk} is assumed to be Cobb-Douglas given by productivity of labour φ_{ih}^{rk} and amount of labour l_{ih}^{rk} used: $z_{ih}^{rk} = (l_{ih}^{rk}\varphi_{ih}^{rk})^{\theta}$ with $0 < \theta < 1$ reflecting diminishing returns to quality. The wage rate for (the composite) input l_{ih}^{rk} is given by w^r. Factor demand therefore is $l_{ih}^{rk} = (z_{ih}^{rk})^{1/\theta}/\varphi_{ih}^{rk}$ and total per-unit variable costs are $w^r l_{ih}^{rk} = w^r (z_{ih}^{rk})^{1/\theta}/\varphi_{ih}^{rk}$. Further, firms pay fixed costs of exporting given by $f_{ih}^{rk}(\varphi_{ih}^{rk})$, i.e. depending on productivity. Productivity levels are assumed to be Pareto-distributed, with $G_i^r(\varphi_i) = 1 - \left(\frac{\varphi_i}{\varphi_i^r}\right)^{-\gamma_i}$ where $\varphi_i < \varphi_i^r$ (φ_i is the lower bound of productivities in country r).[3]

Concerning trade costs, the assumption is that there are both specific (per-unit) trade costs denoted by T_i^{rk} and ad-valorem trade costs τ_i^{rk}. Tariffs might be included and considered similarly denoted by t_i^{rk}. Likewise, other ad-valorem costs (e.g. AVEs of NTMs) might be part of the specific trade costs or enter as tariff-equivalents. These trade costs are applied to the value including the specific trade costs, giving the c.i.f. price (including tariffs) as [4]

$$p_{ih}^{\text{cif},rk} = (1 + t_i^{rk})(1 + \tau_i^{rk})\left(p_{ih}^{\text{fob},rk} + T_i^{rk}\right) \tag{2}$$

2 The section summarises the model in F&R (2014) with some small changes in notation.

3 The lower bound φ_i^r might vary across countries, though the dispersion parameter λ_i is assumed the same across countries.

4 The c.i.f. price exclusive of tariffs would then be $p_i^{\text{cif},rk}/(1 + t_i^{rk}) = (1 + \tau^{rk})\left(p_i^{\text{fob},rk} + T_i^{rk}\right)$.

The marginal costs are the same as the total costs for producing one unit of a good with quality z_{ih}^{rk}, i.e. $c_{ih}^{rk}(z_{ih}^{rk}, w^r) = w^r l_{ih}^{rk} = w^r (z_{ih}^{rk})^{1/\theta}/\varphi_{ih}^r$. These are thus increasing in the wage rate w^r and the quality z_i^{rk}, and decreasing in productivity φ_{ih}^r. The firm maximisation problem is thus given by

$$\max_{p_{ih}^{\text{fob},rk}, z_{ih}^{rk}} \left[p_{ih}^{\text{fob},rk} - w^r (z_{ih}^{rk})^{1/\theta}/\varphi_i^r\right] \frac{(1+\tau_i^{rk}) q_{ih}^{rk}}{(1+t_i^{rk})} \tag{3}$$

This can be reformulated in quality-adjusted terms and to tariff-exclusive c.i.f. prices, which can be rewritten in quality-adjusted c.i.f. prices net of tariffs (see Appendix)

$$\max_{P_i^{\text{cif},rk}, z_i^{rk}} \left[P_{ih}^{\text{cif},rk} - (1+\tau_i^{rk}) \frac{\left(\frac{w^r (z_{ih}^{rk})^{\frac{1}{\theta}}}{\varphi_{ij}^r} + T_i^{rk} \right)}{(z_{ih}^{rk})^{\alpha_k}} \right] \frac{Q_{ih}^{rk}}{(1+t_i^{rk})} \tag{4}$$

The assumption of a Cobb-Douglas production function and the resulting cost function results in a log-linear form of the optimal quality choice – see F&R (2014) for the derivation

$$z_{ih}^{rk} = \left(\frac{T_i^{rk} \frac{\alpha^k \theta}{1-\alpha^k \theta}}{w^r/\varphi_{ih}^r} \right)^{\theta} \tag{5}$$

Thus, quality is increasing with higher specific trade costs (referred to as the 'Washington apples effect') of which NTMs might be a part, higher productivity and higher parameter values $\alpha^k \theta$ [5]. If α^k is increasing with income, richer countries import higher qualities. If θ (depending on the exporter r) is larger, the returns to quality diminish less quickly and thus quality is increasing. Conversely, quality is decreasing with higher wages, i.e. higher costs of production.

The marginal costs become proportional to the specific trade costs

$$c_{ih}^{rk}(z_{ih}^{rk}, w^r) = \left[\frac{\alpha^k \theta}{1-\alpha^k \theta}\right] T_i^{rk} \tag{6}$$

These are increasing in α^k (as quality increases and therefore marginal costs increase) and the specific trade costs. The assumption of the CES expenditure function and the optimal choice of the f.o.b. price yield the familiar mark-up equation

$$\left(p_{ij}^{\text{fob},r\,k} + T_i^{rk}\right) = \left[c_{ih}^{rk}(z_{ih}^{rk}, w^r) + T_i^{rk}\right]\left(\frac{\sigma}{\sigma-1}\right) \tag{7}$$

Using the proportionality of marginal costs and specific trade costs gives f.o.b. and c.i.f. (inclusive tariffs) prices:

$$p_{ih}^{\text{fob},rk} = T_i^{rk}\left[\left(\frac{\alpha^k \theta}{1-\alpha^k \theta}\right)\left(\frac{\sigma}{\sigma-1}\right) - 1\right] =: \overline{p_\iota^{\text{fob},rk}} \tag{8a}$$

[5] It is assumed that $0 < \alpha^k \theta < 1$.

$$p_{ih}^{\mathrm{cif},rk} = (1+t_i^{rk})(1+\tau_i^{rk})T_i^{rk}\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)\right] =: \overline{p_i^{\mathrm{cif},rk}} \tag{8b}$$

Thus, the prices do not depend on firm productivity, as more efficient firms sell higher-quality products.[6] The implication of these assumptions is that all firms selling to market k charge the same price but only differ with respect to quality.

Finally, it can be shown that the quality index is related to the log f.o.b. price

$$z_{ih}^{rk} = \left(\frac{\kappa_1^k \overline{p_i^{\mathrm{fob},rk}}}{w^r/\varphi_{ih}^r}\right)^\theta = \left(\frac{\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}T_i^{rk}\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)-1\right]}{w^r/\varphi_{ih}^r}\right)^\theta \tag{9}$$

with $\kappa_1^k = \frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}$. Thus, quality is increasing with the specific trade costs (which might include the costs of NTMs) and productivity.

Let $\hat{\varphi}_i^{rk}$ denote the cutoff-productivity of the marginal exporter (i.e. the firm just covering the fixed costs of exporting). The c.i.f. (including tariffs) quality-adjusted price for the marginal exporter is defined as $\hat{P}_i^{\mathrm{cif},rk} := \frac{p_i^{\mathrm{cif},rk}}{(z_i^{rk}(\hat{\varphi}_i^{rk}))^{\alpha^k}}$ which after inserting yields

$$\hat{P}_i^{\mathrm{cif},rk} = \frac{p_i^{\mathrm{cif},rk}}{(z_i^{rk}(\hat{\varphi}_i^{rk}))^{\alpha^k}} = \frac{p_i^{\mathrm{cif},rk}}{\left(\left(\frac{\kappa_1^k \overline{p_i^{\mathrm{fob},rk}}}{w^r/\hat{\varphi}_i^{rk}}\right)^\theta\right)^{\alpha^k}} = p_i^{\mathrm{cif},rk}\left(\frac{w^r/\hat{\varphi}_i^r}{\kappa_1^k \overline{p_i^{\mathrm{fob},rk}}}\right)^{\alpha^k\theta} \tag{10}$$

which includes tariffs. $\hat{X}_i^{rk} = \hat{P}_i^{\mathrm{cif},rk}\hat{Q}_i^{rk}$ is the (tariff-inclusive) export revenue. Firm profits are given by

$$\frac{\hat{X}_i^{rk}}{(1+t_i^{rk})}\frac{1}{\sigma} = f_i^{rk}(\hat{\varphi}_i^{rk}) \tag{11}$$

which covers fixed costs. Assuming a special function for fixed costs as argued in F&R (2014)

$$f_i^{rk}(\hat{\varphi}_i^{rk}) = \left(\frac{w^r}{\hat{\varphi}_i^{rk}}\right)\left(\frac{Y^k}{p^k}\right)^{\beta_0}\exp(\beta' F_i^{rk}) \tag{12}$$

(with $\beta_0 > 0$) allows us to derive the quality-adjusted c.i.f. price (tariff-inclusive) (under the assumption of homogeneous firms)

$$\hat{P}_i^{\mathrm{cif},rk} = \left[\frac{\overline{p_i^{\mathrm{cif},rk}}}{\left(\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}\overline{p_i^{\mathrm{fob},rk}}\right)^{\alpha^\kappa\theta}}\right]\left[\frac{X_i^{rk}}{\sigma(1+t_i^{rk})N_i^r}\left(\frac{Y^k}{p^k}\right)^{-\beta_0}\exp(-\beta' F^{rk})\right]^{\alpha^\kappa\theta} \tag{13}$$

which after some manipulations (see Appendix) can be written as

6 As F&R (2014) describe it, this is a razor-edge case.

$$\hat{P}_i^{\mathrm{cif},rk} = \left[\frac{(1+t_i^{rk})^{1-\alpha^\kappa\theta}(1+\tau_i^{rk})\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)\right](T_i^{rk})^{1-\alpha^\kappa\theta}}{\left(\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)-1\right]\right)^{\alpha^\kappa\theta}} \right] \left[\frac{X_i^{rk}}{\sigma N_i^r}\left(\frac{Y^k}{p^k}\right)^{-\beta_0} \exp(-\beta' F^{rk}) \right]^{\alpha^\kappa\theta} \qquad (14)$$

The quality-adjusted price is decreasing with κ_1^k (which is increasing in its arguments), a larger f.o.b. price, and increasing with a larger c.i.f. price. In the second term it is decreasing with tariffs, σ, and the number of exporters. It is further decreasing with the size of the market and the fixed costs. The value of exports X_i^{rk} and the quality-adjusted price $\hat{P}_i^{\mathrm{cif},rk}$ are positively related – in contrast to the demand-side interpretation. A similar equation holds in the case of heterogeneous firms (see Apppendix).

From the CES demand it would follow that

$$\hat{X}_i^{rk} = \frac{X_i^{rk}}{N_i^r} = \left(\frac{\hat{P}_i^{\mathrm{cif},rk}}{P^k}\right)^{-(\sigma-1)} Y^k \qquad (15)$$

i.e. a higher quality-adjusted price results in lower export values. Using supply-side information results in an export equation that is close to a gravity equation.

$$\frac{X_i^{rk}}{M_i^r\,(\frac{\varphi_i^r}{w^r})^\gamma} = \left(\frac{\overline{P_i^{\mathrm{cif},rk}}}{P^k}\right)^{-(\sigma-1)(1+\gamma)} (Y^k)^{1+\gamma}\left(\sigma\kappa_2^k(1+t_i^{rk})\left(\frac{Y^k}{p^k}\right)^{\beta_0} \exp(\beta' F_i^k)\right)^{-\gamma} \qquad (16)$$

F&R (2014) used equation (16) for two representative countries r and j exporting to market k, which could equally be used for two different markets k and l as export destinations for a representative country i. Therefore equation (16) is modified to be estimated using GMM to calculate the unknown parameters of the model. With the estimated parameters we can further calculate the quality index in equation (9). For the sake of simplicity, the quality preference parameter of the US is assumed to be equal to 1, and other countries' preferences are then calculated relative to the US with iterated estimations.

Further, the model suggests that NTMs (TBTs or SPS measures) impact positively on the quality of traded products if these enter as specific trade costs.

3. Data and specification

3.1. REGRESSION FRAMEWORK

The analysis is conducted for a sample of countries over the period 1995-2011. The sample includes all 151 countries that were WTO members in 2011, mainly because the NTM database includes the notifications of the WTO members. The primary data source on product quality is the index quality of exports derived in F&R (2014), which are downloadable from their website.[7] These data provide information for bilateral flows of goods at the four-digit SITC rev. 2 (782 products) over the period 1984-2011. Based on the theoretical framework outlined in F&R (2014) discussed above, GMM estimations are performed for each of the 712 products to estimate the relevant elasticities with other parameters partly taken from the literature. The quality index is thus disentangled from quality-adjusted prices and quality-adjusted quantities in the values of trade.

$$ln\, z_{ht}^{rk} = \alpha_0 + \alpha_1\, ln(1 + t_{ht}^{rk}) + \alpha_2 TBT_{ht}^{rk} + \alpha_3 SPS_{ht}^{rk} + \alpha_4 WTO_t^{rk} + \epsilon_{St}^{r} + \epsilon_{St}^{k} + \epsilon_h^{rk} + \varepsilon_{ht}^{rk} \tag{17}$$

where $ln\, z_{ht}^{rk}$ is the log of the average quality index of (all exporting firms) exporting product h from country r to importing country k in year t; $ln(1 + t_{ht}^{rk})$ is the log of tariffs plus one; TBT_{ht}^{rk} and SPS_{ht}^{rk} represent four different proxies for TBTs and SPS measures included in the analysis (see discussion below) imposed by the importing country on the export of the product in that year; WTO_t^{rk} is a dummy variable indicating whether the two countries are members of the WTO in that year; in order to control for the technological change across firms in the same sector and in the production side of the exporting country, exporter-sector-time fixed effects (FE) ϵ_{St}^{r} with S as a three-digit sector are included; moreover, importer-sector-time FE ϵ_{St}^{k} are included to control for demand-side characteristics. Thus, using these two sets of FE, time-varying country-level characteristics such as size, capital and factor endowments of the economy are controlled for. Furthermore, ϵ_h^{rk} is bilateral-product FE that controls for any time-invariant characteristics inherent in the bilateral trade flows at the four-digit product level in addition to other gravity variables such as distance, common border and historical relations. The whole set of fixed effects controls for multilateral resistance terms elaborated in the gravity framework (Anderson and Van Wincoop, 2003); moreover, ε_{ht}^{rk} is the error term.

The estimation is run using the Ordinary Least Squares (OLS) on the whole sample of bilateral products over the period 1995-2011. Estimators are robust against heteroscedasticity in the error term. Since qualitative NTMs may have a heterogenous impact on the quality of products in different sectors, the sample of estimations is also separated in ten one-digit SITC sectors, including all bilateral flows of four-digit products, and the estimations are run separately for each sector. As a robustness test, the analysis is run on first-lagged independent variables to control for the endogeneity bias due to the reverse causality, which is available on request.

7 See http://www.robertfeenstra.info/data/

3.2. MEASUREMENT OF QUALITATIVE NTMS

Four types of measurement of TBTs and SPS measures are used in this analysis in four separate models. In **Model 1** the simplest measure, which is often used in several studies in the literature (e.g. Kee et al., 2009; Beghin et al., 2015; Bratt, 2017; Niu et al., 2018), uses a dummy variable that takes the value of 1 when an importing country k imposes any qualitative NTMs against the import of product h from exporting country r in year t. Thus, this is a dummy variable on the ***flows*** of NTMs, and for TBTs and SPS measures it is shown respectively as TBT_{rkht}^{DF} and SPS_{rkht}^{DF}.

However, previous studies in the literature relied on cross-sectional data analysis, whereas we apply a panel-data analysis here. Thus, it matters whether an NTM which was imposed in previous years is still in force and has not been withdrawn. Therefore, as the second measure of NTMs and in **Model 2** we use a dummy variable on *stocks* of qualitative NTMs that takes the value of 1 when there exists any qualitative NTM that was in force until year t and has not yet been withdrawn, which was notified by the importing country k against the exports of product h from exporting country r. Thus, the dummy variables on the ***stock*** of TBTs and SPS measures are shown respectively as TBT_{rkht}^{DS} and SPS_{rkht}^{DS}.

To make standards and regulations more stringent, authorities may impose several NTMs on a given product to achieve the highest quality (Ing and Cadot, 2017; Cadot et al., 2018). To expand the impact of the existence of any qualitative NTMs on the product quality to the impact of stringency of these NTMs on quality, in **Model 3** we use the count measures of NTMs. Therefore, we expand the dummy variable on flows of NTMs to the count variable of ***flows*** of the total number of NTMs notified in a given year t by the importing country k reporting the product h. The variable for TBTs and SPS measures is thus included as TBT_{rkht}^{CF} and SPS_{rkht}^{CF}, respectively.

It might be the case that it takes time to adjust the quality of a product to ensure that it complies with the new regulative NTMs imposed in each year. Therefore, the count variable of ***stocks*** of the total number of NTMs might indicate a stronger impact on the average quality of the products at the sector level than the count ***flows*** variable might have. Consequently, as the benchmark measure in **Model 4** we use the count variable of ***stocks*** of the existing number of NTMs that is calculated as the accumulated number of NTMs that came into force until year t and have still not been withdrawn, which were notified by the importing country k against the exports of products h. This count variable of ***stocks*** for TBTs and SPS measures is included as TBT_{rkht}^{CS} and SPS_{rkht}^{CS}, respectively. This variable has been used in earlier studies, such as Ghodsi et al., (2016, 2017), Ghodsi and Stehrer (2019), and Ghodsi (2019, 2020).

Finally, EU Member States can impose unilateral NTMs that affect third-party countries. However, because of the mutual recognition clause of the single market agreement these regulations cannot affect intra-EU trade but can only affect extra-EU trade. Therefore, due to both the harmonisation and the mutual recognition of trade policy measures, regulations and standards within the EU, bilateral tariffs and non-tariff measures imposed against intra-EU trade are set to zero.

3.3. DATA

The quality framework presented above considers both the demand and the supply side of markets, which improves the former frameworks proposed by Hallak and Schott (2008) and Khandelwal (2010). The following analysis is based on the quality of imported products measured by the framework discussed above.

The data on explanatory variables are collected from various sources. The data on tariffs are taken from F&R (2014), which include preferential rates and Most-Favoured Nations (MFN) tariffs wherever applicable. Two types of NTMs are included: TBTs and SPS measures allow countries to impose restrictions on imports of low-quality products suspected to harm domestic consumers' health, plant life, the environment, etc. It is expected that these core NTMs induce higher standards in the import market, in addition to improving market efficiency via information requirements such as mandatory labelling. TBTs and SPS measures are usually imposed unilaterally on the imports from all other countries in the world. The data on NTMs are collected from the WTO I-TIP database. The data have many missing HS codes, which are improved, harmonised, and matched to the trade data using the approach in Ghodsi et al. (2017).

4. Results

In this section we present the results of the econometric analysis. First, we start with the overall results, which includes bilateral trade flows of all products in the regressions. In the second sub-section we present the results of estimations for each one-digit SITC group encompassing all its bilateral four-digit products.

4.1. THE WHOLE SAMPLE

The estimation results for the whole sample are presented in Table 1. Overall, the regressions perform quite well, indicated by a high R-squared. The Akaike information criterion (AIC) and Bayesian information criterion (BIC) both indicate that Model 2 has the best fit. This model includes dummy variables on stocks of TBTs and SPS measures. Based on both AIC and BIC, Model 4 is the second-best. This model includes count variables on *stocks* of TBT and SPS measures. In all models, control variables on tariffs and WTO membership have statistically insignificant coefficients.

In all models, the TBT measure strongly affects the quality of traded products. This impact is statistically significant at the 1% level. According to the estimation results of Model 2, the existence of a TBT on a product traded bilaterally can increase its quality by 1.3%, though according to the results obtained from Model 4 an additional TBT imposed on a product traded bilaterally can increase its quality by 0.09% only. In this respect it is worth noting that the average number of *stocks* of TBTs imposed on bilaterally traded products in the sample is about 1.78, and the maximum number of *stocks* of TBTs imposed on a bilateral four-digit SITC product is 155 (see Table A1 in the Appendix). However, the average value of the dummy variable on *stocks* of TBTs shows that only about 30% of all products traded bilaterally report an existing TBT. This comparison indicates that regulative TBTs on one-third of observations are very stringent, which gives a statistically significant coefficient of TBTs in Model 4. This could also explain the much smaller effect on quality (i.e. 1.3% compared with 0.09%).

The estimation results of Model 1 and Model 3 including *flows* of TBTs also show that when TBTs are imposed in each year, a higher quality of traded product is expected in that same year too. The impact of TBTs in Model 1 is smaller than in Model 2, which suggests that the existence of *stocks* of TBTs that have remained in force over time has a stronger impact on the quality of traded products than the newly imposed *flows* of TBTs in each year. However, the impact of TBTs in Model 3 is stronger than in Model 4. This indicates that the stringency of a regulative TBT on a traded product has the strongest impact in the year in which it is imposed, rather than when the regulative TBT remains in force and gets accumulated over time.

Table 1 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011

Dependent var.: $\boldsymbol{ln\, z_{ht}^{rk}}$	Model 1	Model 2	Model 3	Model 4
Tariffs	0.0040	0.0057	0.0042	0.0055
	(0.0081)	(0.0081)	(0.0081)	(0.0081)
TBT	0.0033***	0.013***	0.0020***	0.00090***
	(0.0012)	(0.0013)	(0.00031)	(0.000088)
SPS	0.010***	0.0043**	0.00034*	0.000051
	(0.0016)	(0.0018)	(0.00020)	(0.000066)
WTO	0.0060	0.0054	0.0060	0.0055
	(0.0041)	(0.0041)	(0.0041)	(0.0041)
Constant	-2.57***	-2.57***	-2.57***	-2.57***
	(0.0039)	(0.0039)	(0.0039)	(0.0039)
Observations	14651320	14651320	14651320	14651320
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.888	0.888	0.888	0.888
Adjusted R-squared	0.867	0.867	0.867	0.867
AIC	21955249.5	21955134.8	21955243.3	21955158.8
BIC	21955322.0	21955207.3	21955315.8	21955231.3

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Sources: Authors' estimation of equation (17) on quality index compiled from F&R (2014); NTMs data from Ghodsi et al. (2017).

The results also indicate a positive impact of SPS measures on the quality of traded products. While SPS coefficients are positive, the estimation results indicate that the level of significance of SPS coefficients is strongest in Model 1, that it is gradually weakened through Models 2 and 3, and that it becomes statistically insignificant in Model 4. This indicates that the existence of an SPS measure has the strongest positive impact on the quality of a traded product in the year in which it is imposed. The existence of SPS measures which were imposed until a specific year that is measured as a *stock* dummy variable also has a positive impact on the quality of traded products, but this impact is statistically significant at a 5% level only. Using the number of *flows* of SPS measures as an indicator of stringency of these standard-like measures in Model 3 has a weakly significant effect on the quality of a traded product. Therefore, these findings point to the fact that the existence of an SPS measure that protects human health and safety is the most important factor for the quality improvement of traded products, while the impact over time (i.e. proxied in *stock* measure) and stringency (i.e. proxied in count measure) on the quality of traded products fades.

4.2. HETEROGENEOUS QUALITY IMPACT OF REGULATIVE NTMS ACROSS SECTORS

This sub-section provides an overview of the estimation results on the quality of traded products at the four-digit level of SITC in each sample of one-digit SITC sector. These results are presented in Table A2 to Table A11 in the Appendix.

According to the estimation results presented in Table A2, both TBTs and SPS measures in almost all four models affect the quality of traded products in the 'Food and live animals chiefly for food' industry positively and statistically significantly. The TBT coefficient is statistically insignificant only in Model 2, which includes a dummy on the *stocks* of TBT. Therefore, it can be argued that the existence of a new TBT in a year can improve the quality of traded products, while the existence of TBTs that have accumulated from previous periods have no further statistically significantly effects on the quality of these products. However, the stringency of TBTs imposed in one year and those accumulated up to that year affect the quality of traded products in these industries positively.

However, this does not appear to be the case for all other sectors. In fact, the impact of these NTMs in models represented for the table of each sector has a different pattern. For the sample of the 'Beverages and tobacco' industry, TBTs have a positive coefficient in Model 2 and Model 3, which are statistically significant at the 5% level (Table A3). By contrast, in Model 4 TBTs show to be negatively affecting the quality of traded products at the 5% level of significance, but the positive impact of stocks of SPS measures is shown to be strong and statistically significant at 1%. This shows the importance of SPS measures for the quality of traded products in this industry.

For traded products in the 'Crude materials, inedible, except fuels' industry, TBTs show to be positively affecting the quality in three models (Table A4). However, the existence of SPS measures that are imposed until a specified year have a statistically negative impact on the quality of traded products. In contrast, the stringency of SPS measures that are calculated using stocks of these measures show to have a positive impact on the traded quality in this industry.

The sample of 'Mineral fuels, lubricants and related materials' is the least affected by regulative NTMs (Table A5). Only in Model 4 does the count of *stocks* of TBTs show to be positively affecting the traded quality at the 5% level of significance.

Based on the results in Table A6, in the sector 'Animal and vegetable oils, fats and waxes' TBTs have positive coefficients in all models. These are statistically significant at the 1% level, whereas SPS measures do not affect the traded quality of these products at all.

According to Table A7, TBTs also positively affect the quality of traded products in the 'Chemicals and related products, n.e.s.' industry. However, SPS measures affect the quality of traded products in this sector only when they are used as a dummy variable. This indicates that only the existence of SPS measures imposed on the imports of this sector matters for quality improvement.

In the sector 'Manufactured goods classified chiefly by material' the coefficients of NTMs in each model have contradicting results with another model (Table A8). In Model 1 and Model 4 a TBT has statistically significant negative coefficients, while it has a positive statistically significant coefficient in Model 3. An SPS measure in Model 1 has a statistically significant coefficient that is positive in Model 1 but negative in Model 2. According to Table A9, TBT and SPS measures have statistically significant and positive coefficients in almost all models on products in the 'Machinery and transport equipment' sector. This is the largest sample for a one-digit sector that includes manufacturing machinery and transport equipment such as automobiles. It is not surprising that regulative measures imposed globally enhance the quality of traded products in this sector. In contrast, according to Table A10 TBTs and SPS measures have statistically significant and negative coefficients in almost all models for the sector 'Miscellaneous manufactured articles'. It is surprising that the quality of other manufacturing products is on average negatively affected by regulative measures. The results from these three tables (Tables A8, A9 and A10) indicate that TBTs and SPS measures have a very heterogeneous quality impact across manufacturing products.

The smallest sample sector is 'Commodities and transactions not classified elsewhere in the SITC', whose quality estimation results are represented in Table A11. The existence of TBT measures at the time of imposition has a positive impact on the quality of traded products in this sector. However, the coefficient of SPS measures is negative, which is statistically significant at 1% in Model 4 and statistically significant at 10% in Model 2. This indicates that it is the number of SPS measures that plays a negative role in the quality of these products.

5. Summary and concluding remarks

Following the establishment of GATT and the WTO and the subsequent fall in tariffs, NTMs have increasingly been used as a trade policy tool. However, the various causes and motivations behind the imposition of NTMs make their implications hard to interpret. The complex and opaque nature of these trade policy instruments has been emphasised in the literature. Despite the trade-impeding consequences of NTMs on the quantity of traded products, the quality improvement of these products can point to the direction of legitimate motives behind them. The discriminatory behaviour and trade restrictiveness of these trade policy instruments have been studied extensively in the literature. However, a visible gap has remained regarding the analysis of the impact of these complex measures on the quality of traded products. This study aims to contribute to the literature by filling this gap.

Using the rich database of NTM notifications by WTO members, we have analysed the diverse impacts of two types of regulative and standard-like NTMs on the quality of traded products at the four-digit level of the SITC during the period 1995-2011. For this, we borrowed the quality index from a demand-supply theoretical framework proposed by Feenstra and Romalis (2014) and used four different proxies of TBTs and SPS measures in the analysis. The results of our analysis for the whole sample of traded products indicate a positive impact of TBTs and SPS measures on the quality of a traded good. However, the results differ quantitatively for the various proxies. The positive impact of TBTs is strongest when we use a dummy variable on the *stocks* of TBTs that are imposed before a given year and are still in force in a year. Using a count variable on the *stocks* of TBTs, we find that an additional TBT imposed on a product traded bilaterally can improve the quality of that product by 0.09%. The positive impact of an SPS measure is strongest when we include it as a dummy variable on the *flows* of SPS measures that are imposed each year. When we include SPS measures as a count measure on stocks of existing SPS measures up to date, then the positive impact on quality becomes statistically insignificant.

As NTMs may have a heterogeneous impact across products and sectors, we have also run regressions on the sample of traded products for each one-digit SITC sector. The positive impact of TBTs on traded quality remains strong and statistically significant in many sectors, such as ‘Food and live animals chiefly for food’, ‘Beverages and tobacco’, ‘Crude materials, inedible, except fuels’, ‘Mineral fuels, lubricants and related materials’, ‘Animal and vegetable oils, fats and waxes’, ‘Chemicals and related products, n.e.s.’, and ‘Machinery and transport equipment’. We also find a strong positive impact of SPS measures on the quality of traded products in many sectors, such as ‘Food and live animals chiefly for food’, ‘Beverages and tobacco’, ‘Chemicals and related products, n.e.s.’, and ‘Machinery and transport equipment’.

Overall, our results suggest that the imposition of TBTs or SPS measures is conducive to the quality of the imported products. This quality-enhancing effect has to be taken into account when discussing the effects of such NTMs on the quantity of traded products. This is also consistent with the model outlined in Feenstra and Romalis (2014) when NTMs enter as specific trade costs.

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Technical Appendix

Equation (3)

This can be reformulated in quality-adjusted terms as

$$\max_{p_{ij}^{\text{fob},rk}, z_{ij}^{rk}} \left[\frac{p_{ij}^{\text{fob},rk}}{\left(z_{ij}^{rk}\right)^{\alpha_k}} - \frac{w^r (z_{ij}^{rk})^{1/\theta} / \varphi_{ij}^r}{\left(z_{ij}^{rk}\right)^{\alpha_k}} \right] \frac{(1+\tau_i^{rk}) Q_{ij}^{rk}}{(1+t_i^{rk})}$$

(as $Q_{ij}^{rk} = q_{ij}^{rk} \left(z_{ij}^{rk}\right)^{\alpha_k}$) and to tariff-exclusive c.i.f. prices

$$\max_{p_{ij}^{\text{fob},rk}, z_{ij}^{rk}} \left[(1+\tau_i^{rk}) \frac{p_{ij}^{\text{fob},rk} + T_i^{rk}}{\left(z_{ij}^{rk}\right)^{\alpha_k}} - (1+\tau_i^{rk}) \frac{\left(\frac{w^r \left(z_{ij}^{rk}\right)^{\frac{1}{\theta}}}{\varphi_i^r} + T_i^{rk} \right)}{\left(z_{ij}^{rk}\right)^{\alpha_k}} \right] \frac{Q_{ij}^{rk}}{(1+t_i^{rk})}$$

which can be rewritten in quality-adjusted c.i.f. prices (net of tariffs)

$$\max_{P_i^{\text{cif},rk}, z_i^{rk}} \left[P_{ij}^{\text{cif},rk} - (1+\tau_i^{rk}) \frac{\left(\frac{w^r \left(z_{ij}^{rk}\right)^{\frac{1}{\theta}}}{\varphi_{ij}^r} + T_i^{rk} \right)}{\left(z_{ij}^{rk}\right)^{\alpha_k}} \right] \frac{Q_{ij}^{rk}}{(1+t_i^{rk})} \tag{3}$$

From equations (5a) and (5b) the c.i.f./f.o.b. margin can be derived: Denote $\mu^k := \left(\frac{\alpha^k \theta}{1-\alpha^k \theta}\right)\left(\frac{\sigma}{\sigma-1}\right)$, then the c.i.f./f.o.b.-margin (c.i.f. price including tariffs) is given by

$$\frac{\overline{p_i^{\text{cif},r\,k}}}{p_i^{\text{fob},r\,k}} = \frac{(1+t_i^{rk})(1+\tau_i^{rk}) T_i^{rk} \mu}{T_i^{rk} [\mu - 1]} = (1+t_i^{rk})(1+\tau_i^{rk}) \frac{\mu^k}{\mu^k - 1}$$

Equation (8)

Including the expressions for c.i.f. and f.o.b. prices one gets

$$\hat{P}_i^{\text{cif},rk} = \left[\frac{(1+t_i^{rk})(1+\tau_i^{rk}) T_i^{rk} \left[\left(\frac{\alpha^k \theta}{1-\alpha^k \theta}\right)\left(\frac{\sigma}{\sigma-1}\right) \right]}{\left(\frac{\alpha^k \theta(\sigma-1)}{1+\alpha^k \theta(\sigma-1)} T_i^{rk} \left[\left(\frac{\alpha^k \theta}{1-\alpha^k \theta}\right)\left(\frac{\sigma}{\sigma-1}\right) - 1 \right] \right)^{\alpha^\kappa \theta}} \right] \left[\frac{X_i^{rk}}{\sigma(1+t_i^{rk}) N_i^r} \left(\frac{Y^k}{p^k}\right)^{-\beta_0} \exp(-\beta' F^{rk}) \right]^{\alpha^\kappa \theta}$$

which can be rearranged to

$$\hat{P}_i^{\mathrm{cif},rk} = \left[\frac{(1+t_i^{rk})^{1-\alpha^\kappa\theta}(1+\tau_i^{rk})\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)\right]\left(T_i^{rk}\right)^{1-\alpha^\kappa\theta}}{\left(\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)-1\right]\right)^{\alpha^\kappa\theta}}\right]\left[\frac{X_i^{rk}}{\sigma N_i^r}\left(\frac{Y^k}{p^k}\right)^{-\beta_0}\exp(-\beta' F^{rk})\right]^{\alpha^\kappa\theta} \tag{8}$$

In the case of heterogenous firms this equation becomes

$$\overline{P_\iota^{\mathrm{cif},rk}} = \left[\frac{\overline{p_\iota^{\mathrm{cif},rk}}}{\left(\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}\overline{p_\iota^{\mathrm{fob},r\,k}}\right)^{\alpha^\kappa\theta}}\right]\left[\frac{X_i^{rk}/\kappa_2^k(1+t_i^{rk})}{M_i^r(\varphi^r/w^r)^\gamma}\left(\frac{Y^k}{p^k}\right)^{-\beta_0}\exp(-\beta' F^{rk})\right]^{\frac{\alpha^\kappa\theta}{1+\gamma}}(\kappa_2^k)^{\frac{1}{1-\sigma}}$$

with $\kappa_2^k = \frac{\gamma}{\gamma-\alpha^k\theta(\sigma-1)} > 1$.

Again inserting and re-arranging yields

$$\overline{P_\iota^{\mathrm{cif},rk}} = \left[\frac{\left(1+t_i^{rk}\right)\left(1+\tau_i^{rk}\right)T_i^{rk}\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)\right]}{\left(\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}\left(\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}T_i^{rk}\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)-1\right]\right)\right)^{\alpha^\kappa\theta}}\right] \mathrm{x}$$

$$\left[\frac{X_i^{rk}/\kappa_2^k(1+t_i^{rk})}{M_i^r(\varphi^r/w^r)^\gamma}\left(\frac{Y^k}{p^k}\right)^{-\beta_0}\exp(-\beta' F^{rk})\right]^{\frac{\alpha^\kappa\theta}{1+\gamma}}(\kappa_2^k)^{\frac{1}{1-\sigma}}$$

which can be simplified to

$$\overline{P_\iota^{\mathrm{cif},rk}} = \left[\frac{(1+t_i^{rk})^{1-\frac{\alpha^\kappa\theta}{1+\gamma}}(1+\tau_i^{rk})\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)\right](T_i^{rk})^{1-\alpha^\kappa\theta}}{\left(\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}\left(\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)-1\right]\right)\right)^{\alpha^\kappa\theta}}\right] x \left[\frac{X_i^{rk}/\kappa_2^k}{M_i^r(\varphi^r/w^r)^\gamma}\left(\frac{Y^k}{p^k}\right)^{-\beta_0}\exp(-\beta' F^{rk})\right]^{\frac{\alpha^\kappa\theta}{1+\gamma}}(\kappa_2^k)^{\frac{1}{1-\sigma}}$$

Appendix Tables

Table A1 / Summary statistics of the variables used in the estimation of the whole sample

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
$\ln z_{ht}^{rk}$	14,651,320	-4.075901	2.130734	-13.57556	11.99032
$\ln(1+t_{ht}^{rk})$	14,651,320	0.0587812	0.0875754	0	1.504077
TBT_{rkht}^{DF}	14,651,320	0.1113595	0.3145768	0	1
SPS_{rkht}^{DF}	14,651,320	0.0550029	0.2279859	0	1
TBT_{rkht}^{DS}	14,651,320	0.3022631	0.4592386	0	1
SPS_{rkht}^{DS}	14,651,320	0.1104469	0.313446	0	1
TBT_{rkht}^{CF}	14,651,320	0.2596966	1.133496	0	69
SPS_{rkht}^{CF}	14,651,320	0.2461005	2.414951	0	99
TBT_{rkht}^{CS}	14,651,320	1.782203	5.46031	0	155
SPS_{rkht}^{CS}	14,651,320	1.698759	13.92374	0	374
WTO_{t}^{rk}	14,651,320	0.9245489	0.2641178	0	1

Source: Authors' elaboration, quality index and tariffs compiled from F&R (2014), NTMs data from Ghodsi et al. (2017), WTO variable compiled from the WTO website.

Table A2 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 0 – Food and live animals chiefly for food

Dependent var.: $\ln z_{ht}^{rk}$	Model 1	Model 2	Model 3	Model 4
Tariffs	0.019*	0.017	0.021**	0.020*
	(0.011)	(0.011)	(0.011)	(0.011)
TBT	0.015***	0.0012	0.0038***	0.00100***
	(0.0021)	(0.0041)	(0.00031)	(0.00011)
SPS	0.0053**	0.021***	0.0015***	0.00039***
	(0.0021)	(0.0040)	(0.00030)	(0.000083)
WTO	0.0055	0.0051	0.0048	0.0036
	(0.0065)	(0.0065)	(0.0065)	(0.0065)
Constant	-3.39***	-3.39***	-3.39***	-3.39***
	(0.0061)	(0.0062)	(0.0061)	(0.0061)
Observations	1421459	1421459	1421459	1421459
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.936	0.936	0.936	0.936
Adjusted R-squared	0.922	0.922	0.922	0.922
AIC	-40829.3	-40851.6	-40935.2	-40975.3
BIC	-40768.5	-40790.8	-40874.4	-40914.6

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A3 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 1 – Beverages and tobacco

Dependent var.: $\ln z_{ht}^{rk}$	Model 1	Model 2	Model 3	Model 4
Tariffs	-0.13***	-0.14***	-0.13***	-0.13***
	(0.026)	(0.026)	(0.026)	(0.026)
TBT	0.011	0.036**	0.0065**	-0.0024**
	(0.012)	(0.015)	(0.0027)	(0.0011)
SPS	0.0087	-0.00070	-0.0077	0.015***
	(0.014)	(0.016)	(0.0084)	(0.0033)
WTO	0.18***	0.18***	0.18***	0.18***
	(0.048)	(0.048)	(0.048)	(0.048)
Constant	-1.70***	-1.71***	-1.69***	-1.73***
	(0.045)	(0.045)	(0.045)	(0.046)
Observations	199160	199160	199160	199160
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.941	0.941	0.941	0.941
Adjusted R-squared	0.927	0.927	0.927	0.927
AIC	282639.1	282631.8	282631.5	282601.0
BIC	282690.1	282682.8	282682.5	282652.0

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A4 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 2 – Crude materials, inedible, except fuels

Dependent var.: $\ln z_{ht}^{rk}$	Model 1	Model 2	Model 3	Model 4
Tariffs	0.016	0.015	0.012	0.015
	(0.028)	(0.028)	(0.028)	(0.028)
TBT	0.0094**	-0.0017	0.0097***	0.0024***
	(0.0048)	(0.0057)	(0.0013)	(0.00043)
SPS	0.0063	-0.017***	0.0032***	0.00034*
	(0.0050)	(0.0066)	(0.00063)	(0.00020)
WTO	-0.050***	-0.049***	-0.050***	-0.051***
	(0.015)	(0.015)	(0.015)	(0.015)
Constant	-3.80***	-3.80***	-3.81***	-3.81***
	(0.014)	(0.014)	(0.014)	(0.014)
Observations	775692	775692	775692	775692
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.928	0.928	0.928	0.928
Adjusted R-squared	0.908	0.908	0.908	0.908
AIC	750589.7	750583.7	750473.5	750518.9
BIC	750647.5	750641.5	750531.3	750576.8

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A 5 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 3 – Mineral fuels, lubricants and related materials

Dependent var.: $\boldsymbol{ln\, z_{ht}^{rk}}$	Model 1	Model 2	Model 3	Model 4
Tariffs	-0.14	-0.14	-0.14	-0.14
	(0.10)	(0.10)	(0.10)	(0.10)
TBT	-0.0079	0.0049	-0.000023	0.0022**
	(0.0100)	(0.0095)	(0.0036)	(0.0011)
SPS	0.024	0.012	0.0013	0.00031
	(0.019)	(0.013)	(0.00100)	(0.00040)
WTO	-0.055*	-0.056*	-0.055*	-0.056*
	(0.030)	(0.030)	(0.030)	(0.030)
Constant	-3.54***	-3.54***	-3.54***	-3.54***
	(0.027)	(0.027)	(0.027)	(0.027)
Observations	134203	134203	134203	134203
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.942	0.942	0.942	0.942
Adjusted R-squared	0.921	0.921	0.921	0.921
AIC	5983.7	5985.1	5983.9	5981.3
BIC	6032.7	6034.1	6033.0	6030.4

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A6 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 4 – Animal and vegetable oils, fats and waxes

Dependent var.: $\boldsymbol{ln\, z_{ht}^{rk}}$	Model 1	Model 2	Model 3	Model 4
Tariffs	0.026	0.023	0.029	0.030
	(0.029)	(0.029)	(0.029)	(0.029)
TBT	0.025***	0.060***	0.0038***	0.0012***
	(0.0081)	(0.014)	(0.0013)	(0.00041)
SPS	0.0095	0.017	0.00042	0.00011
	(0.0066)	(0.012)	(0.00069)	(0.00017)
WTO	-0.074***	-0.075***	-0.074***	-0.075***
	(0.025)	(0.025)	(0.025)	(0.025)
Constant	-3.28***	-3.30***	-3.27***	-3.27***
	(0.023)	(0.024)	(0.023)	(0.023)
Observations	138571	138571	138571	138571
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.942	0.942	0.942	0.942
Adjusted R-squared	0.926	0.926	0.926	0.926
AIC	-20545.8	-20605.1	-20540.3	-20542.2
BIC	-20496.6	-20555.9	-20491.1	-20493.0

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A7 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 5 – Chemicals and related products, n.e.s.

Dependent var.: $\boldsymbol{ln\, z_{ht}^{rk}}$	Model 1	Model 2	Model 3	Model 4
Tariffs	0.072***	0.076***	0.072***	0.073***
	(0.019)	(0.019)	(0.019)	(0.019)
TBT	0.0086***	0.0047*	0.0039***	0.0012***
	(0.0023)	(0.0026)	(0.00055)	(0.00012)
SPS	0.0078***	0.017***	-0.00038	-0.00012
	(0.0025)	(0.0028)	(0.00038)	(0.00015)
WTO	0.0033	0.0022	0.0034	0.0029
	(0.0067)	(0.0067)	(0.0067)	(0.0067)
Constant	-3.43***	-3.43***	-3.43***	-3.43***
	(0.0063)	(0.0063)	(0.0063)	(0.0063)
Observations	2029294	2029294	2029294	2029294
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.898	0.898	0.898	0.898
Adjusted R-squared	0.881	0.881	0.881	0.881
AIC	1340605.5	1340555.6	1340564.0	1340493.6
BIC	1340668.1	1340618.2	1340626.6	1340556.2

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A8 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 6 – Manufactured goods classified chiefly by material

Dependent var.: $\boldsymbol{ln\, z_{ht}^{rk}}$	Model 1	Model 2	Model 3	Model 4
Tariffs	-0.030*	-0.031*	-0.031*	-0.036**
	(0.017)	(0.017)	(0.017)	(0.017)
TBT	-0.012***	0.00095	0.0048***	-0.0028***
	(0.0022)	(0.0021)	(0.0011)	(0.00031)
SPS	0.017**	-0.020***	-0.0013	-0.000025
	(0.0070)	(0.0047)	(0.00079)	(0.00022)
WTO	0.020***	0.020***	0.020***	0.021***
	(0.0068)	(0.0068)	(0.0068)	(0.0068)
Constant	-2.92***	-2.92***	-2.92***	-2.92***
	(0.0063)	(0.0064)	(0.0063)	(0.0063)
Observations	3777945	3777945	3777945	3777945
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.880	0.880	0.880	0.880
Adjusted R-squared	0.859	0.859	0.859	0.859
AIC	4426260.7	4426282.5	4426263.0	4426175.8
BIC	4426326.4	4426348.2	4426328.7	4426241.5

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A9 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 7 – Machinery and transport equipment

Dependent var.: $\boldsymbol{ln\, z_{ht}^{rk}}$	Model 1	Model 2	Model 3	Model 4
Tariffs	0.053*	0.068**	0.050*	0.064**
	(0.029)	(0.029)	(0.029)	(0.029)
TBT	0.019***	0.049***	0.00031	0.0037***
	(0.0029)	(0.0032)	(0.0010)	(0.00031)
SPS	0.058***	0.10***	0.013***	0.0060***
	(0.017)	(0.014)	(0.0049)	(0.0013)
WTO	0.019	0.017	0.019	0.018
	(0.013)	(0.013)	(0.013)	(0.013)
Constant	-1.55***	-1.56***	-1.54***	-1.55***
	(0.012)	(0.012)	(0.012)	(0.012)
Observations	3839257	3839257	3839257	3839257
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.777	0.777	0.777	0.777
Adjusted R-squared	0.738	0.738	0.738	0.738
AIC	8883620.6	8883318.4	8883663.5	8883418.4
BIC	8883686.4	8883384.2	8883729.3	8883484.2

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A10 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 8 – Miscellaneous manufactured articles

Dependent var.: $\boldsymbol{ln\, z_{ht}^{rk}}$	Model 1	Model 2	Model 3	Model 4
Tariffs	0.013	0.0078	0.014	0.0074
	(0.016)	(0.016)	(0.016)	(0.016)
TBT	-0.015***	-0.021***	-0.0040***	-0.0020***
	(0.0020)	(0.0022)	(0.00052)	(0.00017)
SPS	0.0017	-0.029***	-0.00086***	-0.00043***
	(0.0042)	(0.0040)	(0.00025)	(0.00011)
WTO	-0.027***	-0.026***	-0.027***	-0.026***
	(0.0086)	(0.0086)	(0.0086)	(0.0086)
Constant	-2.04***	-2.04***	-2.04***	-2.04***
	(0.0080)	(0.0080)	(0.0080)	(0.0080)
Observations	2310455	2310455	2310455	2310455
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.845	0.845	0.845	0.845
Adjusted R-squared	0.819	0.819	0.819	0.819
AIC	2217826.6	2217698.6	2217822.7	2217660.8
BIC	2217889.9	2217761.9	2217885.9	2217724.1

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

Table A11 / Estimation results on quality of SITC products traded bilaterally during the period 1995–2011; Sector: SITC 9 – Commodities and transactions not classified elsewhere in the SITC

Dependent var.: $\boldsymbol{ln\, z_{ht}^{rk}}$	Model 1	Model 2	Model 3	Model 4
Tariffs	0.77**	0.79**	0.80**	0.67*
	(0.39)	(0.39)	(0.39)	(0.39)
TBT	0.10***	-0.00094	0.0091	0.0020
	(0.036)	(0.050)	(0.0098)	(0.0032)
SPS	0.020	-0.17*	0.0092	-0.028***
	(0.055)	(0.091)	(0.027)	(0.0050)
WTO	-0.12	-0.12	-0.12	-0.12
	(0.13)	(0.13)	(0.13)	(0.13)
Constant	-0.39***	-0.35***	-0.38***	-0.31**
	(0.13)	(0.13)	(0.13)	(0.13)
Observations	39983	39983	39983	39983
Importer-sector-time FE	Yes	Yes	Yes	Yes
Exporter-sector-time FE	Yes	Yes	Yes	Yes
Importer-exporter-product FE	Yes	Yes	Yes	Yes
R-squared	0.959	0.959	0.959	0.959
Adjusted R-squared	0.938	0.938	0.938	0.938
AIC	32222.1	32232.0	32239.1	32182.3
BIC	32265.1	32275.0	32282.1	32225.3

Standard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Model 1 includes dummy variables of *flows* of NTMs; **Model 2** includes dummy variables of *stocks* of NTMs; **Model 3** includes count variables of *flows* of NTMs; **Model 4** includes count variables of *stocks* of NTMs as the benchmark specification.
Source: Authors' estimation of equation (17) on quality index compiled from F&R (2014), NTMs data from Ghodsi et al. (2017).

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