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Exploring 'Non-Tariff Measures Black Box':

Whose Regulative NTMs on Which Products Improve the Imported Quality?

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Whose Regulative NTMs on Which Products Improve the Imported Quality?

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Abstract

Regulative non-tariff measures (NTMs), such as technical barriers to trade (TBTs) and sanitary and phytosanitary (SPS) measures, have frequently been imposed to regulate the quality of imported goods when the market fails to address some issues of concern regarding harmful products with low standards. The impact of NTMs on trade values and trade volumes has been extensively modelled and analysed in the literature, while their quality impact has usually been studied using the unit values of imports. In this paper a monopolistic competition framework is presented, in which firms choose both the quality and the price of their exports subject to the compliance costs of NTMs behind the border and a fixed cost of technological change. Using the solutions of this model including NTMs, the quality of products at the six-digit level of the harmonised system (HS) traded globally and bilaterally during the period 1996–2017 is estimated. Using these estimates, the impacts of TBTs and SPS measures on trade values, volume, unit value and quality are estimated. On average and across all global bilateral trade, TBTs restrict imports while improving quality significantly. SPS measures stimulate trade and improve the average imported quality. Then, by estimating the importer-specific impact of NTMs on traded value, quantity, unit value, quality, and quality-adjusted price for each product, the 'NTM Black Box' is opened and analysed. This provides evidence of whether the quality of traded goods to an importing country has been upgraded despite the trade restrictiveness of NTMs. The complete analysed data that are available in the online appendix and visualised on Tableau will provide insights to scholars, policymakers and trade-dispute settlement cases at the World Trade Organisation (WTO).

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

JEL classification: F13, F14, L15

CONTENTS

TABLES AND FIGURES

Appendix

1. Introduction

Standards and regulations have commonly been implemented by governments to increase the quality of products in a market or to eliminate harmful products and bad production procedures. When such a harm enters the market through imports of products, these standards and regulations are embedded within non-tariff measures (NTMs) to prohibit the entry of the harmful products or to improve the quality of overall imports. Technical barriers to trade (TBTs) and sanitary and phytosanitary (SPS) measures are the major categories of regulative NTMs that regulate import markets using standards and technical regulations. Products that may harm human health and safety, plant life or the global environmental quality may also be targeted by these NTMs to prohibit their trade or even their production. However, NTMs are opaque by nature because their effect on traded values and quantities is not as straightforward as that of other ad-valorem trade policy measures, e.g. traditional tariffs or quantitative measures such as quotas or anti-dumping duties. Therefore, an NTM seems like a 'Black Box' that needs to be opened and its contained components need to be analysed thoroughly to understand its implications for value, quantity, unit value, quality, and quality-adjusted price of traded products. While empirical studies modelling the impact of various types of qualitative and quantitative NTMs on trade values, quantities, and prices are abundant in the literature (Bora et al., 2002; Ferrantino, 2006; Fugazza et al., 2008; Beghin et al., 2015; Cadot and Gourdon, 2016; Cadot et al., 2018; Jafari and Britz, 2018; Liu et al., 2019; Webb et al., 2020; Gourdon et al., 2020), a theoretical framework to estimate these effects comprehensively by taking into consideration the quality impact on traded products is very rare. This paper provides a model to estimate the importer-specific impact of regulative NTMs on the quality of imported goods as well as their volumes and values. This allows us to understand which NTMs imposed by which countries on which products achieve their qualitative objectives, given their implication on traded volumes and values.

When a regulative NTM is imposed on a given product, the exporter of that product must comply with the regulation to enter the regulated market. This may impose an additional compliance cost on the exporter to fill in the check list showing when the product is produced and exported in compliance with the relevant regulation and standards. This cost could be in terms of specific trade costs per each unit of the exported goods or an ad-valorem trade cost. However, when the product is not initially produced in compliance with the relevant regulation, the exporter may need to incur an additional fixed cost to completely change its production procedure. When the exporter is more productive, both compliance costs and the fixed cost on technological change may become easier and more efficient (Fontagné et al., 2015), leading to an immediate surge in the volume of exports of high-quality products. Due to this compliance with the regulation, the overall quality of imported goods should be higher than before the imposition of the regulation.

Disdier et al. (2020) used the conceptual framework of Akerlof (1978) to allow this quality improvement to be defined in a mechanism through which the imposed standards oblige the existing supplying firms to signal their high quality to consumers. This operates in an environment where producers of bad-quality products have exited the market and the market has failed to provide enough information to a concerned consumer to be convinced of the high quality of existing goods in the market. Therefore, the theoretical framework allows the NTMs to correct for the asymmetric information in the market. However, in this article the theoretical framework assumes that a firm can export only when its productivity is high enough to comply with the NTMs in the import market, thus ensuring an automatic filtering of bad-quality products. Through its compliance the firm ensures the higher quality of traded goods.

The quality of a traded product has been an important issue in the literature, where empirical evidence and theoretical foundations have evolved over time. The unit value of traded products has usually been used as an indicator of the quality of traded products. Using product-level US trade data, Schott (2004) shows that traded unit values are not necessarily showing the cost of goods, which should be inversely associated with firms' productivity. But firms' higher productivity can result in the higher quality of products, which is reflected in larger traded unit values. Hummels and Klenow (2005) insert the quality of a traded product in a utility function of differentiated products and compare export margins based on a few theoretical models of trade theory (Armington, 1969; Acemoglu and Ventura, 2002; Krugman, 1979, 1980, 1981). Incorporating Feenstra's (1994) methodology, Hummels and Klenow (2005) estimate the intensive and extensive margins of trade by considering how the quality of varieties within a certain sector can increase the utility and intensive margin. Then, using the data on trade of six-digit products in 1995, it is concluded that larger economies export higher volumes of goods, a wider variety of goods, and a higher quality of goods. Investigating the demand-side of trade at the three-digit level of SITC, Hallak (2006) provides empirical evidence that richer countries demand products with higher unit values. This is rooted in the fact that the consumption of higher-quality goods yields higher utility, therefore consumers with higher incomes demand products with higher quality. Khandelwal (2010) estimates the quality of imported products to the US by assigning higher quality to products with larger unit values conditional on their US market share. In other words, it is assumed that products with higher quality have larger intensive margins too. Trenczek and Wacker (2021) also find that the product-country-specific innovation residual of export quality is biased in favour of richer countries. While these models have conceptualised the quality of a traded product based on the demand-side of trade, Feenstra and Romalis (2014) extend these frameworks to also include the supply-side of trade.

Using the conceptual framework of Feenstra and Romalis (2014), it is possible to present a model with endogenous quality choice by firms to comply with NTMs in the destination market in addition to other factors. Within the firm heterogeneity model of Melitz (2003), only firms whose productivity exceeds a certain threshold and which are meeting the zero-cut-off profit (ZCP) condition would manage to comply with the regulations in the destination market and export to that destination. However, after the imposition of NTMs, and when the demand has increased, less efficient firms may also meet this condition and enter the market after compliance. Therefore, this paper is built on the framework presented by Feenstra and Romalis (2014) and extends that model by incorporating NTMs into the model. Using this framework and following the generalised methods of moments (GMM) by Feenstra (1994), this paper disentangles the quality and quality-adjusted price of globally traded products at the six-digit level of the Harmonised System (HS) during the period 1996-2017 by taking the impact of TBTs and SPS measures into account. In so doing, some modifications to the theoretical framework are made to estimate the parameters of the model at the HS six-digit level.

According to the agreements of the World Trade Organisation (WTO), governments are legally allowed to implement regulative NTMs in good faith to prevent harm and to improve safety, human life, plant life and environmental quality, which are not automatically controlled for in the free and open markets. Despite this good faith, and precisely because of their nature, regulative NTMs have been often been referred to as opaque trade policy measures by scholars and policymakers. One can consider this as an 'NTM Black Box', which cannot be easily understood unless the components it contains are extracted and analysed. This is, first, because the immediate consequences of NTMs on trade values and volumes are often neither clear nor evident. Second, it is because the mechanism through which the quality of traded product is affected is not clear. While the first reason has been studied by many scholars in the literature, reasonable and sound empirical evidence for the second reason is still missing. For instance, earlier studies have analysed the trade implications of NTMs (Essaji, 2008; Bao and Qiu, 2012; Ronen, 2017; Disdier et al., 2008; Li and Beghin, 2012; Yousefi and Liu, 2013; Ghodsi, 2019), or some others estimated the ad-valorem equivalents 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). These studies find a heterogeneous impact of NTMs on traded values, quantities and unit values that are importer-specific, which sheds light on some components of the 'NTM Black Box'. However, the main reason why the affected quality of traded goods induces either trade promotion or trade restriction has not been fully clarified. This has also led to numerous dispute settlement cases at the WTO to find out whether regulative NTMs have been implemented in good faith or whether they have merely been imposed to restrict trade in a discriminatory manner. For instance, if the quality of trade is significantly improved by the imposition of a product regulations despite its enormous trade restrictiveness, then it would be easier for the dispute settlement bodies of the WTO to prepare their verdicts. Moreover, Singh and Chanda (2021) find that restrictive TBTs imposed by a developing country, on which specific trade concerns are raised by other WTO members have negative impact on the performance of firms that are importing their intermediate inputs in that developing country. Therefore, regulative NTMs may have heterogeneous impact on importing countries. Thus, after the estimation of the bilateral traded quality, the importer-specific impact of NTMs on traded quantity, value, unit value, quality, and quality-adjusted price will be provided in this analysis to open the 'NTM Black Box' of each country for each product. These importer-specific estimates along with other estimations of the parameters in the theoretical framework will be available in the online appendix of this paper[1], which may provide better insights to both policymakers and scholars.

Therefore, the contributions of this paper can be divided into four major categories. First, it extends the model proposed by Feenstra and Romalis (2014) by incorporating the impact of TBTs and SPS measures. Excluding these NTMs from the model estimating the quality of traded goods may have omitted variables bias. The estimated traded quality including NTMs suggests that there is an overestimation of quality in the model excluding TBTs when their quality impact on the imported product is not controlled for. And there is an underestimation of quality in the model excluding SPS measures. Second, this paper estimates the parameters of the model at the more disaggregated six-digit level of HS and to a more recent period 1996-2017, whereas Feenstra and Romalis (2014) calculated quality of traded products during the period 1984-2011 at the four-digit level of Standard International Trade Classification (SITC) rev. 2. Third, this paper estimates the parameter of the Pareto distribution for the US economy using firm-level data that are concorded to the six-digit level of the HS, while in Feenstra and Romalis (2014) the parameter was borrowed from an earlier work by Chaney (2008) at the SITC three-digit level. Fourth, using the parameters of the model, bilateral trade values will be disentangled into quality, quality-adjusted prices and quantities at the HS six-digit level. Fifth, the importer-specific impact of NTMs on these trade outcomes will be provided to open the 'NTM Black Box' of each country on each product. According to the author's knowledge, these estimates are the first in the literature that

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1 The whole data in the online appendix are available upon request.

are adjusted with the quality impact of NTMs in addition to their trade-impeding impact. The model allows for the estimates to vary across products and importers.[2]

The rest of the paper is structured as follows. In the next section the extension to the theoretical model proposed by Feenstra and Romalis (2014) is illustrated, in which the NTMs are also implemented. Section 3 discusses data issues and the econometric specifications for the estimation of parameters of the model. Section 4 provides a discussion of the estimated results, and section 5 concludes.

2 The results of this paper are based on 1,877,601 estimations.

2. The theoretical framework of the quality index

As mentioned above, the theoretical framework here builds on the model proposed by Feenstra and Romalis (2014). NTMs will be added to this framework as ad-valorem trade cost, specific trade cost and fixed cost of exporting. The latter is following the ZCP condition of exporting à la Melitz (2003). To incorporate both sides of trade, i.e., supply and demand, the framework uses an expenditure function which rises with the quality of the product. This is in line with earlier studies, which found a positive relationship between demand for quality and income. Assuming constant elasticity of substitution (CES), the model starts from an expenditure function given by:

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

$$\alpha^k = h(U^k) = 1 + \lambda \ln U^k \tag{1b}$$

where σ is the elasticity of substitution across products and is assumed to be larger than unity to ensure a non-homothetic demand for quality; p_i^k is the price of good i sold in market k; z_i^k is the quality of that good that is raised to the power of α^k that is also assumed to be larger than unity; as it is defined in equation (1b), α^k is an explicit function of utility in country that country U^k, which can be a function of the gross domestic product (GDP) per capita of that country. Moreover, as α^k is the power of quality in this CES expenditure function, it also proxies the perception of consumers in market k on the valuation of the quality of a product. This perception could be modified and shaped, with the product regulations embedded within NTMs that ensure minimum standards on the quality of the existing products. As equation (1b) shows, such a perception is closely related to the per-capita income of a country that is also related to the imposition of higher standards. The expenditure function is valid only when it is increasing in utility and non-decreasing in price. As is mathematically argued by Feenstra and Romalis (2014), it is valid with small values of lambda. Assuming that the quality-adjusted price is denoted by $P_i^k := p_i^k / z_i^{\alpha^k}$, equation (1a) suggests that a consumer can spend more on products with a higher quality when her income increases. This also suggests that the consumer maximisation problem is in terms of quality-adjusted price and quantity. Therefore, both z_i^k and α^k lead to lower quality-adjusted prices. In addition, the quality-adjusted demand increases with quality, which is denoted by $Q_i^k := z_i^{\alpha^k} q_i^k$.

Using the above expenditure function, one can derive the demanded quantity q_i^k by differentiating E^k with respect to price p_i^k, while quality-adjusted quantity Q_i^k can be derived by differentiating E^k with respect to quality-adjusted price P_i^k:

$$q_i^k = \frac{\partial E^k}{\partial p_i^k} = \frac{\partial E^k}{\partial P_i^k} \frac{1}{z_i^{\alpha^k}}, \qquad Q_i^k = \frac{\partial E^k}{\partial P_i^k} \tag{2}$$

For the production side of the model, one can implement NTMs as firm h in country r maximises its profits à la Meltiz (2003) to choose a specific quality z_{ih}^{rk} for product i to be sold in market k with f.o.b. price $p_{ih}^{\text{fob},rk}$. Therefore, the choice of quality is pretty much dependent on the use of minimum standards and regulations in each destination market, which is internalised at the very firm level depending on the productivity φ_{ih}^{rk} of that firm. It is assumed that this specific quality z_{ih}^{rk} is produced in a Cobb-Douglas production function using composite input labour l_{ih}^{rk}: $z_{ih}^{rk} = (l_{ih}^{rk}\varphi_{ih}^{rk})^{\theta}$ with $0 < \theta < 1$ to ensure a profit-maximisation solution via a concave production function meeting the diminishing returns to quality. Moreover, θ is the elasticity of marginal cost with respect to quality that suggests higher quality of output is produced by higher quality of input.

Following Melitz (2003), a Pareto distribution of productivity across firms in a country is assumed with a distribution function of $G_i^r(\varphi) = 1 - \left(\frac{\varphi}{\varphi_i^r}\right)^{-\gamma_i}$ where $\varphi_i^{rk} \leq \varphi$ is the lower bound of productivities in country r that can export. Following Eaton and Kortum (2002), it is assumed that the dispersion parameter γ_i is identical across countries for a given product i, while the lower bound of productivities can differ across countries. Furthermore, the factor income of the composite input l_{ih}^{rk} is given by w^r. Therefore, by maximising the production function of quality with respect to quality, the marginal cost of production of a good with quality z_{ih}^{rk} is simply as:

$$c_{ih}(z_{ih}^{rk}, w^r) = w^r l_{ih}^{rk} = w^r (z_{ih}^{rk})^{1/\theta} / \varphi_{ih}^{rk} \tag{3}$$

And the demand for the composite input is thus: $l_{ih}^{rk} = (z_{ih}^{rk})^{1/\theta} / \varphi_{ih}^{rk}$.

2.1. THE ROLE OF TRADE POLICY MEASURES

This section presents how the model used by Feenstra and Romalis (2014) is extended so that it incorporates NTMs. Firms are maximising their production function with respect not only to quality z_{ih}^{rk} but also to the f.o.b. price $p_{ih}^{\text{fob},rk}$ that depends on the c.i.f. price $p_{ih}^{\text{cif},rk}$ in the destination market, which is a function of trade costs to that destination k. In addition to the traditional trade costs that were implemented in the model proposed by Feenstra and Romalis (2014), in this model the trade costs related to regulative NTMs – i.e. TBTs and SPS measures – are also implemented. To analyse the 'NTM Black Box', one needs to understand how NTMs affect the trade cost at the firm-level. There are two types of trade costs induced by NTMs, which will be explained below.

2.1.1. Cost of compliance with regulative NTMs behind borders

One type of trade cost is associated with compliance behind borders for exported products with a high quality that can meet the required standards. This could increase either the ad-valorem (one plus iceberg) trade cost denoted by τ_i^{rk} or the specific (per-unit) trade costs denoted by T_i^{rk}. Tariffs as the traditional trade policy measures are similarly included as an ad-valorem trade cost denoted by tar_i^{rk} (i.e. tariff in percentage points plus one). Thus it is assumed that the net-of-tariffs c.i.f. price is equal to $p_{ih}^{\text{cif},rk} / tar_i^{rk}$. Ad-valorem trade costs associated with the compliance of regulative NTMs could increase the iceberg cost plus one that is denoted by $\tau_i^{NTM_k}$. Therefore, the tariff-inclusive c.i.f. price of traded goods could be defined as a function of f.o.b. prices and other trade costs as follows:

$$p_{ih}^{\text{cif},rk} = \tau_i^{rk}.(p_{ih}^{\text{fob},rk} + T_i^{rk}), \qquad \tau_i^{rk}(\tau_i^{TBT_k}, \tau_i^{SPS_k}, tar_i^{rk}) \geq 0, \qquad T_i^{rk}(TBT_{ki}, SPS_{ki}) \geq 0 \tag{4}$$

Note that the iceberg cost is not necessarily larger than one. This is mainly because regulative NTMs have been proved to have also a trade-promoting impact, which is like a negative tariff equivalent of

NTMs. This is evident for many traded products as a negative ad-valorem equivalent of NTMs in the empirical literature, e.g., Beghin et al. (2015), Cadot and Gourdon (2016), Ghodsi et al. (2016), Bratt (2017) and Niu et al. (2018). As shown in equation (3), the marginal cost of exporting is increasing in the wage rate w^r and the quality z_{ih}^{rk}, and decreasing in productivity φ_{ih}^{r}. Therefore, the firm maximisation problem can be written as:

$$\max_{p_{ih}^{\text{fob},rk},z_{ih}^{rk}}\left[p_{ih}^{\text{fob},rk}-w^r(z_{ih}^{rk})^{1/\theta}/\varphi_i^r\right]\frac{\tau_i^{rk}q_{ih}^{rk}}{tar_i^{rk}}=\max_{P_i^{\text{cif},rk},z_i^{rk}}\left[P_{ih}^{\text{cif},rk}-\tau_i^{rk}.\frac{\left(\frac{w^r(z_{ih}^{rk})^{\frac{1}{\theta}}}{\varphi_{ij}^{r}}+T_i^{rk}\right)}{(z_{ih}^{rk})^{\alpha_k}}\right]\frac{Q_{ih}^{rk}}{tar_i^{rk}} \quad (5)$$

This profit maximisation setting allows firms to optimise the quality-adjusted quantity with respect to the tariff-inclusive c.i.f. price that is specific to each destination k which implements its own product regulations affecting trade costs. This quality optimisation is equivalent to minimising the average variable cost per unit of quality $\tilde{c}_{ih}(z_{ih}^{rk},w^r,T_i^{rk})=\left(c_{ih}(z_{ih}^{rk},w^r)+T_i^{rk}\right)\Big/(z_{ih}^{rk})^{\alpha_k}$. The second order condition of minimising the average variable cost with respect to quality should be positive $\frac{\partial\tilde{c}_{ih}\left(z_{ih}^{rk},w^r,T_i^{rk}\right)}{\partial z_{ih}^{rk}}>0$. This suggests that $0<\alpha_k\theta<1$. Then, the optimisation problem gives the solution for quality taking ad-valorem and specific trade costs into account as follows:

$$z_{ih}^{rk}=\left(\frac{T_i^{rk}\dfrac{\alpha^k\theta}{1-\alpha^k\theta}}{w^r/\varphi_{ih}^{r}}\right)^{\theta} \quad (6)$$

This suggests that the optimal quality of traded goods is positively related to the valuation of quality α^k, which will depend on the income of the consumer as it was shown in equation (1b). Moreover, quality is increased with specific trade costs T_i^{rk}, which we assume can be affected by several factors noted above, including traditional trade costs such as distance and the cost of compliance with regulative NTMs and general standards and regulations in destination k. Thus, when a regulative NTM is imposed to exclude imported products whose quality is below threshold $z_h^{NTM_k}$, those firms which are meeting these regulations already have products with a quality above the threshold $z_{ih}^{rk}>z_i^{NTM_k}$ that do not need further investment on quality upgrading. Therefore they may need to pay only the specific trade cost T_i^{rk}, or the ad-valorem cost $\tau_i^{NTM_k}$ behind the border to enter the market.

Furthermore, the exported quality is increased by the cost efficiency of the exporting firm w^r/φ_{ih}^{r}, which is in line with the empirical evidence in the literature (Fontagné et al., 2015). After replacing this solution of the quality optimised by the firm in equation (3), one can find that the marginal cost of exporting $c_{ih}^{rk}(z_{ih}^{rk},w^r)=\left[\frac{\alpha^k\theta}{1-\alpha^k\theta}\right]T_i^{rk}$ is also proportional to the specific trade cost but is no longer a function of firms' productivity. The reason is that firms with higher productivity export products with higher quality $z_{ih}^{rk}>z_i^{NTM_k}$ while they compete with the same price in each sector i in the destination market k. The larger the per-unit cost of compliance with regulative NTMs, the larger would be the marginal cost of exporting. Therefore, with CES expenditure function in (1a) and the optimal choice of the f.o.b. price, one can achieve the demanded price in the destination as a function of firms' mark-up, specific trade costs induced by NTMs and marginal cost as follows:

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

Using the proportionality of marginal costs and specific trade costs f.o.b. and c.i.f. (inclusive tariffs), prices are derived as follows:

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

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

As noted above, these equations indicate that firms exporting in sector i to the destination market k compete with a constant price, but more productive firms produce products with a higher quality. After combining equation (8a) with equation (6), the optimal choice of quality could be represented as a function of the f.o.b. price as follows:

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

with $\kappa_1^k\equiv\frac{\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}$.

From this, one can derive the quality-adjusted price $P_i^k:=p_i^k/z_i^{\alpha^k}$ as follows:

$$P_{ih}^{rk}=p_{ih}^{rk}\left(\frac{\kappa_1^k\overline{p_i^{\mathrm{fob},rk}}}{w^r/\varphi_{ih}^r}\right)^{-\alpha^k\theta} \tag{10}$$

Thus, the adjusted-quality price is decreasing with productivity of the exporting firm. This suggests that firms competing with the quality of their products in a destination market have lower costs net of quality when their productivity is larger.

2.1.2. Fixed cost of exporting

From equation (7), and taking profit in equation (4) into consideration, one can arrive at firm h's profit π_{ih}^{rk} of exporting product i from country r to destination market k as follows:

$$\pi_{ih}^{rk}=\frac{P_{ih}^{rk}Q_{ih}^{rk}}{tar_i^{rk}\sigma}=\frac{X_{ih}^{rk}}{tar_i^{rk}\sigma} \tag{11}$$

where X_{ih}^{rk} is the total export revenue of firm h exporting product i from country r to country k. Moreover, the optimal quality of a traded product i from country r to country k on the left hand-side of equation (10) is for each firm h exporting that good, which is related to the productivity of that firm on the right-hand side. However, the available data to be used in this analysis are at the bilateral product level, and we are interested in calculating this average quality of products traded bilaterally at the six-digit level of the HS when information on exports at the firm level is not available. Therefore, using the ZCP condition à la

Melitz (2003), this equation can be transformed from the firm level to the six-digit sector level. In so doing, it is necessary to define the ZCP productivity level by incorporating the fixed cost of exporting to a certain destination in the model. This fixed cost is assumed to be dependent on the well-known gravity variables such as bilateral distance or similar characteristics between the two trading partners, e.g. language.

Additionally, after the imposition of the quality NTM, products with quality above a certain threshold can be imported if they meet this condition: $z_{ih}^{rk} > z_i^{NTM_k}$. To comply with such a regulation embedded within the regulative NTMs, firms need to incur a technological fixed cost to modify their production procedure for that destination to meet its standards, or else they simply invest in quality upgrading. Therefore, firms need to pay fixed costs of exporting given by $f_{ih}^{rk}(\varphi_{ih}^{rk})$ that depend on the cost efficiency of firm $\frac{w^r}{\varphi_{ih}^{rk}}$, destination's real expenditure $\frac{Y^k}{p_i^k}$, similar language F_{Lan}^{rk}, similar colonial history F_{Col}^{rk}, and regulative NTMs $F_i^{NTM_k}$ as follows:

$$f_i^{rk}(\varphi_i^{rk}) = \left(\frac{w^r}{\varphi_{ih}^{rk}}\right)\left(\frac{Y^k}{p^k}\right)^{\beta_0} \mathrm{e}^{\beta' F_{Lan}^{rk}} \mathrm{e}^{\beta' F_{Col}^{rk}} \mathrm{e}^{\beta' F_i^{NTM_k}} \tag{12}$$

It is then possible to calculate the productivity of a representative marginal exporter $\hat{\varphi}_i^{rk}$ that is meeting the ZCP condition as follows[3]:

$$\frac{\hat{P}_{ih}^{rk}\hat{Q}_{ih}^{rk}}{t_i^{rk}\sigma} = \frac{\hat{X}_{ih}^{rk}}{t_i^{rk}\sigma} = f_i^{rk}(\hat{\varphi}_i^{rk}) \tag{13}$$

Firms with productivity lower than $\hat{\varphi}_i^{rk}$ make losses, and they cannot incur the fixed costs of exporting. After imposing the product regulations within the regulative NTMs, the induced fixed cost of quality upgrading will reduce profits, and some firms with productivity lower than $\hat{\varphi}_i^{rk}$ will exit the market. With the imposition of NTMs, the perception of consumers of the quality of products α^k may also improve, as consumers may have better information regarding the quality and safety of imports and their demand may increase (Disdier et al., 2020). In this model, it is reflected in an increase in the quality-adjusted quantity of exports. Afterwards, with rising profits, firms with productivity lower than $\hat{\varphi}_i^{rk}$ may enter the market, while the less productive firm can afford the fixed cost of producing higher quality with a larger quality-adjusted quantity demanded in the destination.

2.2. EXPORTS FROM FIRM LEVEL TO SECTOR LEVEL

From the assumptions of the CES demand $\hat{X}_i^{rk} = \hat{P}_i^{\mathrm{cif},rk^{(1-\sigma)}} Y^k / P^{k^{(1-\sigma)}}$, one can arrive at the relative firm revenue X_{ih}^{rk} to the exports of the marginal firms $\hat{X}_{ih}^{rk}$ that are exporting to the same destination k as follows:

$$\frac{X_{ih}^{rk}}{\hat{X}_i^{rk}} = \left(\frac{p_{ih}^{\mathrm{cif},rk}}{\hat{P}_i^{\mathrm{cif},rk}}\right)^{(1-\sigma)}, \qquad \frac{Q_{ih}^{rk}}{\hat{Q}_i^{rk}} = \left(\frac{p_{ih}^{\mathrm{cif},rk}}{\hat{P}_i^{\mathrm{cif},rk}}\right)^{-\sigma} \tag{14}$$

3 Note that from here onwards the variables v of the marginal exporter that is meeting the ZCP condition are presented by hat $\hat{v}$.

Therefore, assuming that the mass of firms in country r that meet the ZCP condition to export product i to market k have productivity greater than $\hat{\varphi}_i^{rk}$ is equal to $M_i^r[1-G(\hat{\varphi}_i^{rk})]$ and considering a Pareto distribution of firms' productivity, the total bilateral exports of product i from country r to country k would be as follows:

$$X_i^{rk} = M_i^r \int_{\hat{\varphi}_i^{rk}}^{\infty} X_{ih}^{rk}\, G_i^r(\varphi) d\varphi = M_i^r \int_{\hat{\varphi}_i^{rk}}^{\infty} \hat{X}_i^{rk} \left(\frac{p_{ih}^{\mathrm{cif},rk}}{\hat{P}_i^{\mathrm{cif},rk}}\right)^{(1-\sigma)} G_i^r(\varphi) d\varphi = M_i^r \hat{X}_i^{rk} \int_{\hat{\varphi}_i^{rk}}^{\infty} \left(\frac{\hat{\varphi}_i^{rk}}{\varphi}\right)^{\alpha^k \theta(1-\sigma)} G_i^r(\varphi) d\varphi$$
$$= M_i^r \hat{X}_i^{rk} \left(\frac{\hat{\varphi}_i^{rk}}{\varphi}\right)^{-\gamma} \kappa_2^k \tag{15}$$

By inserting $\hat{X}_i^{rk}$ from equation (15) into the ZCP condition (13), one can calculate the cost efficiency of the marginal exporter as follows:

$$\left(\frac{w^r}{\hat{\varphi}_i^{rk}}\right)^{1+\gamma} = \frac{X_i^{rk}}{\sigma \kappa_2^k tar_i^{rk} M_i^r \left(\frac{\varphi_i^{rk}}{w^r}\right)^{\gamma} \left(\frac{Y^k}{p^k}\right)^{\beta_0} \mathrm{e}^{\beta' F_{Lan}^{rk}} \mathrm{e}^{\beta' F_{Col}^{rk}} \mathrm{e}^{\beta' F_i^{NTM_k}}} \tag{16}$$

This cost efficiency will be used in the optimal quality in equation (9) that is derived from the supply-side of trade. The tariff-inclusive c.i.f. quality-adjusted price for the marginal exporter is thus defined as $\hat{P}_i^{\mathrm{cif},rk} := \frac{\overline{p_i^{\mathrm{cif},rk}}}{(z_i^{rk}(\hat{\varphi}_i^{rk}))^{\alpha^k}}$. After inserting the optimal value of quality from equation (9), in which the cost efficiency is replaced by equation (16), the average quality-adjusted price for imports to destination k is:

$$\overline{P_i^{\mathrm{cif},rk}} = \left[\frac{\overline{p_i^{\mathrm{cif},rk}}}{\left(\kappa_1^k \overline{p_i^{\mathrm{fob},rk}}\right)^{\alpha^k \theta}}\right] \left[\frac{X_i^{rk}}{\kappa_2^k tar_i^{rk} M_i^r \left(\frac{\hat{\varphi}_i^{rk}}{w^r}\right)^{\gamma}} \left(\frac{Y^k}{p^k}\right)^{-\beta_0} \mathrm{e}^{-\beta' F_{Lan}^{rk}} \mathrm{e}^{-\beta' F_{Col}^{rk}} \mathrm{e}^{-\beta' F_i^{NTM_k}}\right]^{\frac{\alpha^k \theta}{1+\gamma}} (\kappa_2^k)^{\frac{1}{1-\sigma}} \tag{17}$$

With $\kappa_1^k \equiv \frac{\alpha^k \theta(\sigma-1)}{1+\alpha^k \theta(\sigma-1)}$ and $\kappa_2^k \equiv \frac{\gamma}{[\gamma-\alpha^k \theta(\sigma-1)]} > 1$

From this **supply-side equation** one can observe that the average quality-adjusted c.i.f. price is decreasing with a f.o.b. price and increasing with a larger c.i.f. price. Moreover, it is decreasing with tariffs, the mass of exporters, and fixed costs of exports. As explained earlier, an increase in demand may allow less productive firms to enter the market, allowing the mass of exporters to increase, which results in a lower quality-adjusted price. The value of exports X_i^{rk} is positively related to the average quality-adjusted price $\overline{P_i^{\mathrm{cif},rk}}$.

Moreover, the quality-adjusted price $\overline{P_i^{\mathrm{cif},rk}}$ could be expressed as a function of the ZCP condition price $\hat{P}_i^{\mathrm{cif},rk}$. This is similar to Melitz (2003) that is a model of international trade without quality of products:

$$\overline{P_i^{\mathrm{cif},rk}} = \left[\int_{\hat{\varphi}_i^{rk}}^{\infty} P_{ih}^{rk}(\varphi)^{(1-\sigma)} \frac{G_i^r(\varphi)}{1-G_i^r(\hat{\varphi}_i^{rk})} d\varphi\right]^{\frac{1}{1-\sigma}} = (\kappa_2^k)^{\frac{1}{1-\sigma}} \hat{P}_i^{\mathrm{cif},rk} \tag{18}$$

2.2.1. Gravity equation

The CES demand for a marginal exporter $\hat{X}_i^{rk} = \hat{P}_i^{\text{cif},rk^{(1-\sigma)}} Y^k / P^{k^{(1-\sigma)}}$ could be used to calculate the total bilateral exports in the sector using the equations derived above. In particular, one can insert $\hat{X}_i^{rk}$ from (15) and $\hat{P}_i^{\text{cif},rk}$ from (18) into this demand equation to have the aggregate export X_i^{rk} as follows:

$$X_i^{rk} = \left(\frac{\overline{P_i^{\text{cif},rk}}}{P^k}\right)^{-(\sigma-1)(1+\gamma)} (Y^k)^{1+\gamma} \left(\sigma\kappa_2^k tar_i^{rk} \left(\frac{Y^k}{p^k}\right)^{\beta_o} \mathrm{e}^{\beta' F_{Lan}^{rk}} \mathrm{e}^{\beta' F_{Col}^{rk}} \mathrm{e}^{\beta' F_i^{NTM_k}}\right)^{-\gamma} M_i^r (\frac{\varphi_i^r}{w^r})^{\gamma} \tag{19}$$

One can immediately observe from this **demand-side equation** that bilateral export is a function of quality-adjusted price in the sector relative to the price level in the destination with an elasticity equal to $-(\sigma-1)(1+\gamma)$, which suggests that both elasticity of substitution in the CES expenditure function in the destination and the shape parameter of the distribution of firms' productivity in the origin matter for the extensive margin of substitution. Furthermore, the destination's income, mass of exporters, tariffs and fixed costs of exporting in terms of gravity variables and NTMs also matter.

2.3. DEMAND AND SUPPLY EQUATIONS

By inserting the bilateral exports from demand-side equation (19) into the supply-side equation (17), the mass of firms M_i^r will cancel out. Then, such an equation can be represented for two countries r and j exporting to the same destination market k to derive the relative average quality-adjusted export prices as follows:

$$\frac{\overline{P_i^{\text{cif},rk}}}{\overline{P_i^{\text{cif},jk}}} = \left(\frac{\overline{p_i^{\text{cif},rk}} \Big/ \left(tar_i^{rk}\overline{p_i^{\text{fob},rk}} \mathrm{e}^{\beta' F_{Lan}^{rk}} \mathrm{e}^{\beta' F_{Col}^{rk}} \mathrm{e}^{\beta' F_i^{NTM_k}}\right)^{\alpha^{\kappa}\theta}}{\overline{p_i^{\text{cif},jk}} \Big/ \left(tar_i^{jk}\overline{p_i^{\text{fob},jk}} \mathrm{e}^{\beta' F_{Lan}^{jk}} \mathrm{e}^{\beta' F_{Col}^{jk}} \mathrm{e}^{\beta' F_i^{NTM_k}}\right)^{\alpha^{\kappa}\theta}}\right)^{\frac{1}{1+\alpha^k\theta(\sigma-1)}} \tag{20}$$

Equation (20) can be representative of the export quality-adjusted prices as two different exporting countries export to a single destination. Therefore, to achieve that, and because different exporting countries have a different mass of exporting firms, one should have combined equations (19) and (17). However, one can compute the relative import quality-adjusted prices only from equation (17) by considering a single country r that is exporting to two different destinations k and l as follows:

$$\frac{\overline{P_i^{\text{cif},rk}}}{\overline{P_i^{\text{cif},rl}}} = \left(\frac{\overline{p_i^{\text{cif},rk}} / \left(\kappa_1^k \overline{p_i^{\text{fob},rk}}\right)^{\alpha^{\kappa}\theta}}{\overline{p_i^{\text{cif},rl}} / \left(\kappa_1^l \overline{p_i^{\text{fob},rl}}\right)^{\alpha^{l}\theta}}\right) \left[\frac{X_i^{rk} / \kappa_2^k tar_i^{rk} \left(\frac{Y^k}{p^k}\right)^{\beta_0} \mathrm{e}^{\beta' F_{Lan}^{rk}} \mathrm{e}^{\beta' F_{Col}^{rk}} \mathrm{e}^{\beta' F_i^{NTM_k}}}{X_i^{rl} / \kappa_2^l tar_i^{rl} \left(\frac{Y^l}{p^l}\right)^{\beta_0} \mathrm{e}^{\beta' F_{Lan}^{rl}} \mathrm{e}^{\beta' F_{Col}^{rl}} \mathrm{e}^{\beta' F_i^{NTM_l}}}\right]^{\frac{\alpha^k\theta}{1+\gamma}} \left(\frac{\kappa_2^k}{\kappa_2^l}\right)^{\frac{1}{1-\sigma}} \tag{21}$$

Like the quality-adjusted export prices in equation (20), quality-adjusted import prices are also a function of the relative c.i.f.-f.o.b. prices ratio with a different multiplier and power. It is also a function of real expenditure in the destination, the bilateral exports, and the fixed costs of exporting. Thus, it is feasible to calculate the quality of imports and exports from these two equations when all parameters of the model are available and when the quality-adjusted prices are also available. In so doing, one can first estimate parameters from an equation without quality-adjusted prices. This can happen by transforming the demand-side equation (19) into two countries r and j exporting to a single destination k, while replacing the relative import prices (21) in its terms as follows:

$$\frac{X_i^{rk}}{X_i^{jk}} = \left(\frac{\overline{p_i^{\text{cif},rk}}/\left(\overline{p_i^{\text{fob},rk}}\right)^{\alpha^\kappa\theta}}{\overline{p_i^{\text{cif},jk}}/\left(\overline{p_i^{\text{fob},jk}}\right)^{\alpha^\kappa\theta}}\right)^{-A_i^k} \left(\frac{\left(tar_i^{rk}\mathrm{e}^{\beta' F_{Lan}^{rk}}\mathrm{e}^{\beta' F_{Col}^{rk}}\mathrm{e}^{\beta' F_i^{NTM_k}}\right)}{\left(tar_i^{jk}\mathrm{e}^{\beta' F_{Lan}^{jk}}\mathrm{e}^{\beta' F_{Col}^{jk}}\mathrm{e}^{\beta' F_i^{NTM_k}}\right)}\right)^{-B_i^k} \frac{M_i^r\left(\frac{\varphi_i^r}{w^r}\right)^\gamma}{M_i^j\left(\frac{\varphi_i^j}{w^j}\right)^\gamma} \tag{22}$$

with $A_i^k = \frac{(\sigma-1)(1+\gamma)}{1+\alpha^k\theta(\sigma-1)}$, $B_i^k = \frac{\gamma-\alpha^k\theta(\sigma-1)}{1+\alpha^k\theta(\sigma-1)}$

This equation can be estimated for each six-digit product to find out the parameters of the model. Perception of consumers in the destination of the quality of production and its evaluation in the preferences α^κ, elasticity of substitution in the expenditure function σ, elasticity of quality with respect to the composite input at the firm θ, and fixed cost parameters $\beta' F_{Lan}^{rk}$, $\beta' F_{Col}^{rk}$, $\beta' F_i^{NTM_k}$ are to be estimated in this paper. β_0 is borrowed from Eaton et al. (2011) that is obtained from French firms. Following Feenstra (1994), these parameters are estimated in several steps and in a GMM system of equations for each six-digit product. The next section explains how these systems of equations are specified. The distribution parameter of firms' productivity γ is estimated using the US firms whose methodology is elaborated in the next section.

3. Estimations specifications and data

3.1. ESTIMATION FRAMEWORK

The analysis is conducted for a sample of countries over the period 1996-2017. The sample includes 170 importers and 237 exporters, and 5,130 HS six-digit products that are bilaterally traded. The data on bilateral trade flows are downloaded from the UN Comtrade database. The data on export flows are reported by the exporting countries as free on board (f.o.b.), and the data on imports flows are reported by the importing countries as c.i.f. (including the costs of shipping and insurance). Since the prices of exports $\overline{p_{it}^{\text{fob},rk}}$ from (8a) and imports from (8b) $\overline{p_{it}^{\text{cif},rk}}$ are not observable, they are proxied by unit values. By dividing the bilateral traded values X_{it}^{rk} by traded quantities q_{it}^{rk}, unit values of exports $uv_{it}^{\text{fob},rk}$ and unit values of imports $uv_{it}^{\text{cif},rk}$ of product i traded from country r to country k are calculated and measured as non-observable prices of the model as follows:

$$\ln uv_{it}^{\text{fob},rk} = \ln \overline{p_{it}^{\text{fob},rk}} + u_{it}^{fob,rk} \tag{23a}$$

$$\ln uv_{it}^{\text{cif},rk} = \ln \left(\overline{p_{it}^{\text{cif},rk}}/tar_i^{rk}\right) + u_{it}^{cif,rk} \tag{23b}$$

Since the econometric analysis covers a panel database of bilateral products over years, subscript t for each year is added from here onwards. It is important to note that $uv_{it}^{\text{cif},rk}$ is calculated by dividing the import values by import quantities. This means that $uv_{it}^{\text{cif},rk}$ does not include tariffs in the trade data. Therefore, as is shown in equation (23b), to calculate $\overline{p_{it}^{\text{cif},rk}}$, $uv_{it}^{\text{cif},rk}$ should be multiplied by tar_i^{rk}. From (8a) and (8b) it is observed that prices depend on the ad-valorem and specific trade costs. As noted in the previous section, both these costs could depend on NTMs, and excluding them from the model would give omitted-variable bias. Therefore, including the NTMs allows us to model the two trade costs as follows:

$$\ln \tau_{it}^{rk} = \eta_0 + \eta_1 \ln tar_{it}^{rk} + \eta_2 \ln TBT_{it}^{rk} + \eta_3 \ln SPS_{it}^{rk} + \eta_4 \ln dist^{rk} + \eta_5 \ln(q_{it}^{rk}) + \xi_{1it}^{rk} \tag{24a}$$

$$\ln T_{it}^{rk} = \chi_0 + \chi_2 \ln TBT_{it}^{rk} + \chi_3 \ln SPS_{it}^{rk} + \chi_4 \ln dist^{rk} + \chi_5 \ln(q_{it}^{rk}) + \xi_{2it}^{rk} \tag{24b}$$

where TBT_{it}^{rk} and SPS_{it}^{rk} are respectively the natural logarithm[4] of total accumulated stocks of TBTs and SPS measures that are in force (from earlier) and imposed by the destination country k against the imports of product i from country r at time t; $dist^{rk}$ is the geographical distance between the two countries; ξ_{1it}^{rk} and ξ_{2it}^{rk} are the error terms. Both types of trade costs are modelled as a function of volume of trade q_{it}^{rk} to account for economies of scale and transport congestion. This is also added to allow us to reach a final solution incorporating these equations into equation (22) as it is written in few equations below. Furthermore, one can log-linearise a modification of equation (8a) and equation (8b) as follows:

$$\theta \ln \overline{p_{\imath}^{\text{fob},rk}} = \theta \ln T_i^{rk} + \theta \ln\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)-1\right] \tag{25a}$$

$$\ln \overline{p_{\imath h}^{\text{cif},rk}} = \ln \tau_{it}^{rk} + \ln T_i^{rk} + \ln\left[\left(\frac{\alpha^k\theta}{1-\alpha^k\theta}\right)\left(\frac{\sigma}{\sigma-1}\right)\right] \tag{25b}$$

By deducting equation (25b) from equation (25a) and by showing the relative prices from two exporting countries r and j to a single destination country k to remove the closed brackets one can derive:

$$\left(\ln \overline{p_{\imath h}^{\text{cif},rk}} - \ln \overline{p_{\imath h}^{\text{cif},jk}}\right) - \theta\left(\ln \overline{p_{\imath h}^{\text{fob},rk}} - \ln \overline{p_{\imath h}^{\text{fob},jk}}\right) = \left(\ln \tau_{it}^{rk} - \ln \tau_{it}^{jk}\right) + (1-\theta)\left[\ln T_i^{rk} - \ln T_i^{jk}\right] \tag{26}$$

Note that without modification of (8a), the difference in relative c.i.f. price from relative f.o.b. price would be simply the ad-valorem trade cost plus the specific trade cost, which is referred to as c.i.f.-f.o.b. margin of trade in the literature (Miao and Fortanier, 2017). However, this modification is done to make the final estimated equation that will be presented in few equations below easier. Then, one can insert the modelled equations of unit values from equations (23a) and (23b) and those of the ad-valorem and specific trade costs from equations (24a) and (24b) into equation (26) to achieve:

$$\begin{aligned}
&\left(\ln uv_{it}^{\text{cif},rk} - \ln uv_{it}^{\text{cif},jk}\right) - \theta\left(\ln uv_{it}^{\text{fob},rk} - \ln uv_{it}^{\text{fob},jk}\right) \\
&= (\eta_1 - 1)\left(\ln tar_{it}^{rk} - \ln tar_{it}^{jk}\right) + (\eta_2 + (1-\theta)\chi_2)\left[\ln TBT_{it}^{rk} - \ln TBT_{it}^{jk}\right] \\
&+ (\eta_3 + (1-\theta)\chi_3)\left[\ln SPS_{it}^{rk} - \ln SPS_{it}^{jk}\right] + (\eta_4 + (1-\theta)\chi_4)\left[\ln dist_i^{rk} - \ln dist_i^{jk}\right] \\
&+ (\eta_5 + (1-\theta)\chi_5)\left[\ln q_{it}^{rk} - \ln q_{it}^{jk}\right] + u_{it}^{cif,rk} - \theta u_{it}^{fob,rk} + \xi_{1it}^{rk} + (1-\theta)\xi_{2it}^{rk}
\end{aligned} \tag{27}$$

As noted above, one can disentangle unit values uv_{it}^{rk} and export values X_{it}^{rk} from volume of trade q_{it}^{rk}. Then, this equation could be reformulated by moving all trade variables to the left-hand side to have them as a function of parameters and trade costs. One can also log-linearise the gravity equation (22) and reformulate it by taking all its trade variables to the left-hand side. Afterwards, the product of that equation with the reformulation of equation (27) could give us the following equation for estimation:

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[4] Since NTM variables have many zero values, to transform the number of NTMs to the logarithmic form and to remain consistent with the log-transformation of tariffs and iceberg cost, the logarithm of the number of NTMs plus one is calculated. The results presented here would give us similar results as if the log-transformation were done using inverse hyperbolic (arcsine) transformation.

$$
\begin{aligned}
&\left(\ln uv_{it}^{\mathrm{cif},rk} - \ln uv_{it}^{\mathrm{cif},jk}\right)^2 \\
&= \left(\alpha^k\theta + \frac{\theta}{1+\omega}\right)\left(\ln uv_{it}^{\mathrm{cif},rk} - \ln uv_{it}^{\mathrm{cif},jk}\right)\left(\ln uv_{it}^{\mathrm{fob},rk} - \ln uv_{it}^{\mathrm{fob},jk}\right) \\
&- \frac{\alpha^k\theta}{1+\omega}\left(\ln uv_{it}^{\mathrm{fob},rk} - \ln uv_{it}^{\mathrm{fob},jk}\right)^2 + \frac{\omega}{A_i^k(1+\omega)}\left(\ln X_{it}^{rk} - \ln X_{it}^{jk}\right)^2 \\
&+ \left(\frac{\omega}{1+\omega} - \frac{1}{A_i^k}\right)\left(\ln X_{it}^{rk} - \ln X_{it}^{jk}\right)\left(\ln uv_{it}^{\mathrm{cif},rk} - \ln uv_{it}^{\mathrm{cif},jk}\right) \\
&+ \left(\frac{\theta}{A_i^k(1+\omega)} - \frac{\alpha^k\theta\omega}{1+\omega}\right)\left(\ln X_{it}^{rk} - \ln X_{it}^{jk}\right)\left(\ln uv_{it}^{\mathrm{fob},rk} - \ln uv_{it}^{\mathrm{fob},jk}\right) \\
&+ \frac{1}{A_i^k(1+\omega)}\left[(\eta_1 - 1)\left(\ln tar_{it}^{rk} - \ln tar_{it}^{jk}\right) + (\eta_2 + (1-\theta)\chi_2)\left(\ln TBT_{it}^{rk} - \ln TBT_{it}^{jk}\right)\right. \\
&\left.+ (\eta_3 + (1-\theta)\chi_3)\left(\ln SPS_{it}^{rk} - \ln SPS_{it}^{jk}\right) + (\eta_4 + (1-\theta)\chi_4)\left(\ln dist_i^{rk} - \ln dist_i^{jk}\right)\right] \\
&\times \left[\delta_0\left(L_{it}^r - L_{it}^j\right) + \delta_i^r - \delta_i^j - B_i^k\beta'\left(F_{Lan}^{rk} - F_{Lan}^{jk}\right) - B_i^k\beta'\left(F_{Col}^{rk} - F_{Col}^{jk}\right)\right. \\
&\left.- B_i^k\beta'\left(F_{NTM}^{rk} - F_{NTM}^{jk}\right) - C_i^k\left(\ln tar_{it}^{rk} - \ln tar_{it}^{jk}\right)\right] \\
&+ \frac{\left(\tilde{\xi}_{2it}^{rk} - \tilde{\xi}_{2it}^{jk}\right)}{A_i^k(1+\omega)}\left[\delta_0\left(L_{it}^r - L_{it}^j\right) + \delta_i^r - \delta_i^j - B_i^k\beta'\left(F_{Lan}^{rk} - F_{Lan}^{jk}\right) - B_i^k\beta'\left(F_{Col}^{rk} - F_{Col}^{jk}\right)\right. \\
&\left.- B_i^k\beta'\left(F_{NTM}^{rk} - F_{NTM}^{jk}\right) + \tilde{\varepsilon}_{it}^{rk} - \tilde{\varepsilon}_{it}^{jk}\right] \\
&+ \frac{\tilde{\varepsilon}_{it}^{rk} - \tilde{\varepsilon}_{it}^{jk}}{A_i^k(1+\omega)}\left[(\eta_1 - 1)\left(\ln tar_{it}^{rk} - \ln tar_{it}^{jk}\right) + (\eta_2 + (1-\theta)\chi_2)\left(\ln TBT_{it}^{rk} - \ln TBT_{it}^{jk}\right)\right. \\
&\left.+ (\eta_3 + (1-\theta)\chi_3)\left(\ln SPS_{it}^{rk} - \ln SPS_{it}^{jk}\right) + (\eta_4 + (1-\theta)\chi_4)\left(\ln dist_i^{rk} - \ln dist_i^{jk}\right)\right]
\end{aligned} \tag{28}
$$

with $\omega = (\eta_5 + (1-\theta)\chi_5)$; and mass of exporters are estimated as: $\ln M_i^r(\frac{\varphi_i^r}{w^r})^\gamma = \delta_0 \ln L_{it}^r + \delta_i^r + \varepsilon_{it}^{rk}$, where L_{it}^r is calculated as the population of country r at time t multiplied by the exporting country r's exports of good i divided by its GDP; $C_i^k = B_i^k + A_i^k$; $\tilde{\xi}_{2it}^{jk} = u_{it}^{cif,rk} - \theta u_{it}^{fob,rk} + \xi_{1it}^{rk} + (1-\theta)\xi_{2it}^{rk}$; $\tilde{\varepsilon}_{it}^{rk} = \varepsilon_{it}^{rk} + A_i^k u_{it}^{cif,k} - A_i^k \alpha^k \theta u_{it}^{fob,k}$; This equation is estimated using the non-linear least squares (NLS) to retrieve the parameters θ and σ that are hidden in A_i^k, B_i^k and C_i^k. However, two other parameters γ and α^k are estimated separately. While data on γ are available from another set of estimations discussed below, α^k will be estimated after obtaining the parameters from the estimation of equation (28). Therefore, the first time that this equation is estimated, this parameter is set to be equal to one, i.e., $\alpha^k = 1$. Then, the parameters will be used to estimate α^k. After retrieving α^k and replacing its estimated parameter into the new data, equation (28) will be estimated again. This procedure will be iterated more than ten times to achieve convergence in the distribution of parameters. The period-averaged variables are used to estimate equation (28). Furthermore, equation (28) is estimated in two NLS stages following the GMM of Feenstra (1994). The second stage will be done by dividing all variables by the residual retrieved from the first stage. Each NLS stage may have to be iterated more than 1,500 times to achieve convergence.

3.1.1. Estimation of γ

Following Chaney (2008), $\frac{1}{\gamma_i}$ indicates the heterogeneity of productivity in sector i. Therefore, firm productivity should have a standard deviation equal to γ_i in that sector. This also means that sectors with a small γ_i have more output distributed among the more productive firms. Chaney (2008) calculates the marginal effect of fixed costs on total exports to be equal to $\frac{\gamma_i}{\sigma-1} - 1$ in his model. In his model $\zeta_i = \frac{\gamma_i}{\sigma-1}$ is estimated using firm-level data of manufacturing firms in the US. However, in the model represented here the fixed cost of exporting is a function of productivity, the marginal cost with the elasticity of θ; and according to equation (10) price depends on productivity with the elasticity of $\alpha^k\theta$. When $\alpha^k\theta$ approaches to one $\alpha^k\theta \rightarrow 1$, the model represented here has the same elasticity of exports to fixed costs as the one in Chaney (2008). Thus, by estimating the parameter ζ_i for the US and assigning $\alpha^k = 1$ for the US, one can also estimate the parameter γ_i for each industry and country as $\gamma_i = \zeta_i\theta(\sigma - 1)$.

The data of all US firms are downloaded from the Orbis databank provided by Bureau van Dijk. Operating revenue (turnover) in US dollars in the period 2016-2018 and core activity of firms classified in classification of economic activities (NACE) rev. 2 are retrieved from Orbis. Then, a concordance table from four-digit NACE rev. 2 to six-digit HS is constructed with weights indicating the appearance of each HS six-digit product in each four-digit NACE sector. This allows us to categorise firms active in each NACE four-digit sector that produce several HS six-digit products. Then, for each six-digit product i the size of firm measured by their period-averaged turnover y_{ih}^{US} is estimated against its size rank n_{is}^{US} in each six-digit sector. Following Gabaix and Ibragimov (2011), the equation to be estimated is as follows:

$$\ln(n_{ih}^{US} + 0.5) = \alpha_i - \zeta_i^{US} \ln y_{ih}^{US} + \mu_{ih}^{US} \qquad (29)$$

where the ranking of firm size is added to 0.5 to reduce the bias on small samples discussed by Gabaix and Ibragimov (2011); α_i is a constant term, μ_{ih}^{US} is the error term, and this equation is estimated using normal ordinary least square (OLS).

3.1.2. Estimation of α_i^k

Parameter α_i^k measures the perception of consumers in country k in the valuation of the quality of product i in their preferences. This parameter is modelled using the real GDP per capita as presented in equation (1b). Rewriting the log-linearised version of equation (8a) and inserting the specific trade cost from equation (24b) and parameter α_i^k from equation (1b) one can derive:

$$\ln uv_{it}^{\text{fob},rk} = \chi_{it}^r + \chi_2 \ln TBT_{it}^{rk} + \chi_3 \ln SPS_{it}^{rk} + \chi_4 \ln dist^{rk} + ln\left[\left(\frac{1}{1-\left[1+\lambda_i \ln\left(\frac{GDPpc_t^k}{GDPpc_t^{US}}\right)\right]\tilde{\theta}}\right)\left(\frac{\tilde{\sigma}}{\tilde{\sigma}-1}\right) - 1\right] + u_{it}^{fob,rk} \qquad (30)$$

where exporter-time fixed effects χ_{it}^r are replaced by the constant term χ_0 in equation (24b), and preferences parameter λ_i is estimated against the relative income per capita of the importing country k with respect to that of the US. As discussed above, the other parameters $\tilde{\theta}$ and $\tilde{\sigma}$ are estimated in the first stage, where λ_i was set to zero and α^k was set to one. After retrieving the parameters from the NLS estimation of equation (30), the NLS estimations of equation (28) are run again. This procedure is done more than ten times until there is convergence in the distribution of parameters.

3.1.3. Estimation of trade costs

After retrieving all parameters, the fixed costs of exporting and ad-valorem trade costs with respect to distance and NTMs are estimated as discussed in Feenstra and Romalis (2014). In fact, the ad-valorem trade costs are estimated using the relative c.i.f.-f.o.b. prices in equations (8b) over (8a), respectively, and their modelled forms in (23b) and (23a), and the trade costs in equations (24a) and (24b), which will give the equation below:

$$\ln\left(\frac{uv_{it}^{\text{cif},rk}}{uv_{it}^{\text{fob},rk}}\right) - \ln\frac{\left(\frac{\tilde{\alpha}^k\theta}{1-\tilde{\alpha}^k\theta}\right)\left(\frac{\tilde{\sigma}}{\tilde{\sigma}-1}\right)}{\left(\frac{\tilde{\alpha}^k\theta}{1-\tilde{\alpha}^k\theta}\right)\left(\frac{\tilde{\sigma}}{\tilde{\sigma}-1}\right)-1} = \rho_i + \rho_{i1}\ln TBT_{it}^{rk} + \rho_{i2}\ln SPS_{it}^{rk} + \rho_{i3}\ln dist^{rk} + \rho_t + u_{it}^{cif,rk} - u_{it}^{fob,rk} \quad (31)$$

where ρ_i is a constant term and ρ_t is year-fixed effect. After retrieving the parameters of this equation, it is possible to calculate the ad-valorem trade cost for NTMs using the multiplication of the estimated parameter with the NTM. Therefore, the total ad-valorem bilateral trade cost should be as follows:

$$\ln\tilde{\tau}_{it}^{rk} = \ln\frac{\left(\frac{\tilde{\alpha}^k\theta}{1-\tilde{\alpha}^k\theta}\right)\left(\frac{\tilde{\sigma}}{\tilde{\sigma}-1}\right)}{\left(\frac{\tilde{\alpha}^k\theta}{1-\tilde{\alpha}^k\theta}\right)\left(\frac{\tilde{\sigma}}{\tilde{\sigma}-1}\right)-1} + \tilde{\rho}_{i1}\ln TBT_{it}^{rk} + \tilde{\rho}_{i2}\ln SPS_{it}^{rk} + \tilde{\rho}_{i3}\ln dist^{rk} + \tilde{\rho}_t \quad (32)$$

where parameters with tilde $\tilde{\rho}_{i1}$, $\tilde{\rho}_{i2}$, $\tilde{\rho}_{i3}$, $\tilde{\rho}_t$ are the point estimates obtained from equation (31) using a median regression to control for the errors in prices that appeared in (31). The ad-valorem trade costs are provided in the online appendix.

The fixed costs of exporting could be estimated in a simpler version of equation (28), which is represented as follows:

$$\ln X_{it}^{rk} + \tilde{A}_i^k\left(\ln uv_{it}^{\text{cif},rk} - \tilde{\alpha}^k\tilde{\theta}\ln uv_{it}^{\text{fob},rk}\right) + \tilde{C}_i^k\ln tar_{it}^{rk} = \delta_t^k + \delta_i^r + \delta_0^k L_{it}^r + \delta_{i1}\ln TBT_{it}^{rk} + \delta_{i2}\ln SPS_{it}^{rk} + \delta_{i3}Lan^{rk} + \delta_{i4}Col^{rk} + \varepsilon_{it}^{rk} \quad (33)$$

where δ_t^k and δ_i^r are the importer-time and exporter fixed effects, respectively; Lan^{rk} is a dummy variable indicating whether the two countries have common ethnic languages; Col^{rk} is a dummy variable indicating whether both countries share a colonial history, ε_{it}^{rk} is the error term. This equation is estimated using normal OLS. After retrieving the estimated parameters, they are exponentiated by the right-hand side variables which are net of fixed effects δ_t^k and δ_i^r, tariffs $\ln t_{it}^{rk}$, and labour share L_{it}^r effects. This means that these net effects are the residual of the estimations of these right-hand side variables against fixed effects δ_t^k and δ_i^r, tariffs $\ln tar_{it}^{rk}$, and labour share L_{it}^r. After exponentiating the estimated parameters from equation (33) with their respective variables, the total fixed costs of exporting is calculated using their multiplications. The fixed costs of exporting with respect to NTMs and total fixed costs are provided in the online appendix.

3.1.4. Calculation of quality

First, calculation of price index P_t^k using the Fisher and Shell (1972) approach discussed in Feenstra and Romalis (2014) is implemented. At the final stage, the quality of imports and exports is calculated. The quality of exports and imports is derived from the quality-adjusted prices in equations (20) and (21), respectively. The quality-adjusted export price and import price will respectively be calculated using the estimated parameters as follows:

$$\ln \overline{z_i^{\mathrm{fob},rk}} = \frac{\widetilde{\alpha}_i^{\kappa}\widetilde{\theta}_i}{1+\widetilde{\alpha}_i^{\kappa}\widetilde{\theta}_i(\tilde{\sigma}_i-1)}\Big[(\tilde{\sigma}_i-1)\ln uv_{it}^{cif,rk} + \ln uv_{it}^{fob,rk} + \widetilde{\beta}_i^{'} F_{Lan}^{rk} + \widetilde{\beta}_i^{'} F_{Col}^{rk} + \widetilde{\beta}_i^{'} F_{i,TBT}^{rk} + \widetilde{\beta}_i^{'} F_{i,SPS}^{rk} + \tilde{\sigma}_i \ln tar_{it}^{rk}\Big] \quad (34a)$$

$$\ln \overline{z_i^{\mathrm{cif},rk}} = \frac{\overline{\widetilde{\alpha}_i^{\kappa}}\widetilde{\theta}_i}{1+\gamma_i}\left[(1+\tilde{\gamma}_i)\ln \tilde{\kappa}_{1i} uv_{it}^{fob,rk} - \ln\frac{X_{it}^{fob,rk}}{\ln tar_{it}^{rk}} + \beta_0 \frac{Y_t^k}{P_t^k} + \widetilde{\beta}_i^{'} F_{Lan}^{rk} + \widetilde{\beta}_i^{'} F_{Col}^{rk} + \widetilde{\beta}_i^{'} F_{i,TBT}^{rk} + \widetilde{\beta}_i^{'} F_{i,SPS}^{rk}\right] + \left[\frac{\overline{\alpha_i^{\kappa}}\theta_i}{1+\tilde{\gamma}_i} + \frac{1}{\tilde{\sigma}_i-1}\right]\ln \tilde{\kappa}_{2i} \quad (34b)$$

where $\overline{\tilde{\alpha}_i^{\kappa}}$ is the period-averaged of $\tilde{\alpha}_i^{\kappa}$; β_0 is borrowed from Eaton et al. (2011), which is equal to 0.65; and the definitions of other estimated parameters and variables remain as explained above.

3.2. DATA

As noted above, the main database used in the analysis comprises about 120 million observations on bilateral trade values and quantities of 5,130 six-digit products at the HS revision 1 trade during the period 1996-2017 between 170 importers and 230 exporters. These data are downloaded from the UN Comtrade database. While the output data are based on this full and large database, the estimated data are filtered for outliers. In fact, traded values below USD 5,000 are deflated by the global consumer price index (CPI) with 2011 as the base year. This CPI is calculated using the GDP weighted average of all countries' CPI. The CPI of all countries in the sample is downloaded from World Development Indicator (WDI) of the World Bank. When the CPI is not based on 2011, adjustments are made to convert all countries' CPI so that their base year is 2011. Moreover, the CPIs for some countries that are not available in the WDI are downloaded from their national sources. Data on real GDP, employed persons, population size and exchange rates are downloaded from the Penn World Table (PWT 9.1) provided by Feenstra et al. (2015). When the data for some countries and some years are missing, data from the WDI or national sources are used after adjustments to be comparable with the PWT data.

Furthermore, bilateral trade flows that have import to export unit value ratios smaller than 0.1 and larger than 10 are excluded. This means that those observations for which data on mirror flows are available are kept in the estimation of parameters. After the full estimation of parameters the observations that were excluded from the estimations are then included to calculate their respective data on mirror flows which were missing in the raw data and their respective quality. The former is done using equations (31) and (32). In fact, a missing c.i.f. unit value is calculated by its existing f.o.b. unit value multiplied by the ad-valorem trade cost calculated from (32), or vice versa. After calculations of fixed and ad-valorem trade costs, there are some extreme outliers. Therefore, the estimated trade costs across the whole sample are filtered and truncated by 1-2% of their two sides of the distribution.

Tariff data are collected from the World Integrated Trade Solution (WITS) database.[5] Two sources – the United Nations Conference on Trade and Development (UNCTAD) Trade Analysis Information System (TRAINS) and the WTO's Integrated Data Base (IDB) – are the providers of tariffs to this source. Applied tariff rates based on preferential (PRF) agreements where applicable, most-favoured nation (MFN) where applicable and other applied tariffs are used to enrich the data with preference over the lowest tariff rate as indicated in the agreements. Tariffs imposed on trade between the Member States of the European Union (EU) are set to zero.

Data on TBTs and SPS measures are collected from the Integrated Trade Intelligence Portal (I-TIP) of the WTO, which reports the official notifications of WTO members to the WTO. These notifications have sometimes misreported their targeted HS codes. Therefore, the updated and improved version of the data provided by Ghodsi et al. (2017) is used in this analysis. EU Member States can impose their independent NTMs, while such NTMs cannot impede intra-EU trade, consistent with the mutual recognition of the single market of the EU. Therefore, while their number of NTMs in force may differ, the bilateral intra-EU NTMs are set to zero due to both the mutual recognition and the harmonisation of standards. Stocks of NTMs are used in this analysis, i.e. the accumulated number of past and current NTMs that have not yet been withdrawn from the WTO notifications. There are only some cases of withdrawal for SPS measures, while no TBT has ever been withdrawn. Therefore, the larger number of NTMs imposed on a given product may indicate the more stringent regulations and standards. The natural logarithm of NTMs is used in the analysis. Since there are zero values for NTMs, the natural logarithm is taken from the NTMs plus one.

5 https://wits.worldbank.org/

4. Results

In this section the estimated parameters of the model are presented and discussed. One set of results is obtained from a model which excludes NTMs and the other set is from a model which includes NTMs. The model used in Feenstra and Romalis (2014) does not include NTMs. Therefore, the first sub-section presents the estimated parameters using the model which includes NTMs. The second sub-section then shows how NTMs are correlated with the outcome variables of the model, i.e., trade values, quantities, qualities, unit values, quality-adjusted price, and quality-adjusted quantity. In the third sub-section the estimated results obtained from the model including NTMs are compared with the ones excluding NTMs obtained from the model used in Feenstra and Romalis (2014).

4.1. PARAMETERS OF THE MODEL

The density plots of estimated parameters of the model are presented in the panels of figure 1. Panel A depicts the density plot of the estimated $\tilde{\zeta}_i$ from a sample of US manufacturing firms. The average zeta estimated in this sample is 0.57, the maximum and minimum values for this parameter are respectively 14.46 and 0.29. As is shown in Panel A of figure 1, the density is higher around the median, which is equal to 0.52.

Then, the estimated $\tilde{\theta}_i$ is depicted in Panel B of figure 1. This graph shows a very similar distribution pattern to the estimated parameter at the SITC four-digit level presented by Feenstra and Romalis (2014). The average and the median values of this parameter across all 5,130 HS six-digit products are very close to each other and equal to about 0.59. This is very close to the findings of Crozet et al. (2012), who experimented on the firm-level data of champaign exports, in which the f.o.b.-proportional cost of exports for producers of the highest quality to the lowest quality was 0.68. The maximum and minimum values of this parameter are 0.98 and 0.007, respectively. This indicates that diminishing return to quality holds for all products.

The elasticity of the substitution parameter $\tilde{\sigma}_i$ of all products is depicted in panel C of figure 1. The maximum and minimum values of this parameter are 1.93 and 4,548.65, respectively. Due to very large sigma values, the mean of the parameter across all 5,130 products is about 39. The elasticity of substitution of about 15% of products is larger than this average. After replacing the extreme values larger than twice the mean and truncating the distribution at twice the mean, it is evident in panel C that the density of around 78 is above 0.03, which comprises 15% of the products. In Figure II of Feenstra and Romalis (2014) this truncation is at 25, covering about 0.12 of the density of all sectors. The elasticity of substitution is much larger in this paper than in Feenstra and Romalis (2014), as the products are at the six-digit level and are more disaggregated than at the SITC four-digit level. Therefore, the differentiation of products is higher, and more differentiated products are substitutable for each other. For instance, a search for ‘Footwear’ in the list of products by SITC rev 2. classification at the four-digit level yields only two products, namely Footwear (sector 8510) and Parts of footwear (6123). However, one can find 29 products at the six-digit level of HS rev. 1 when searching for

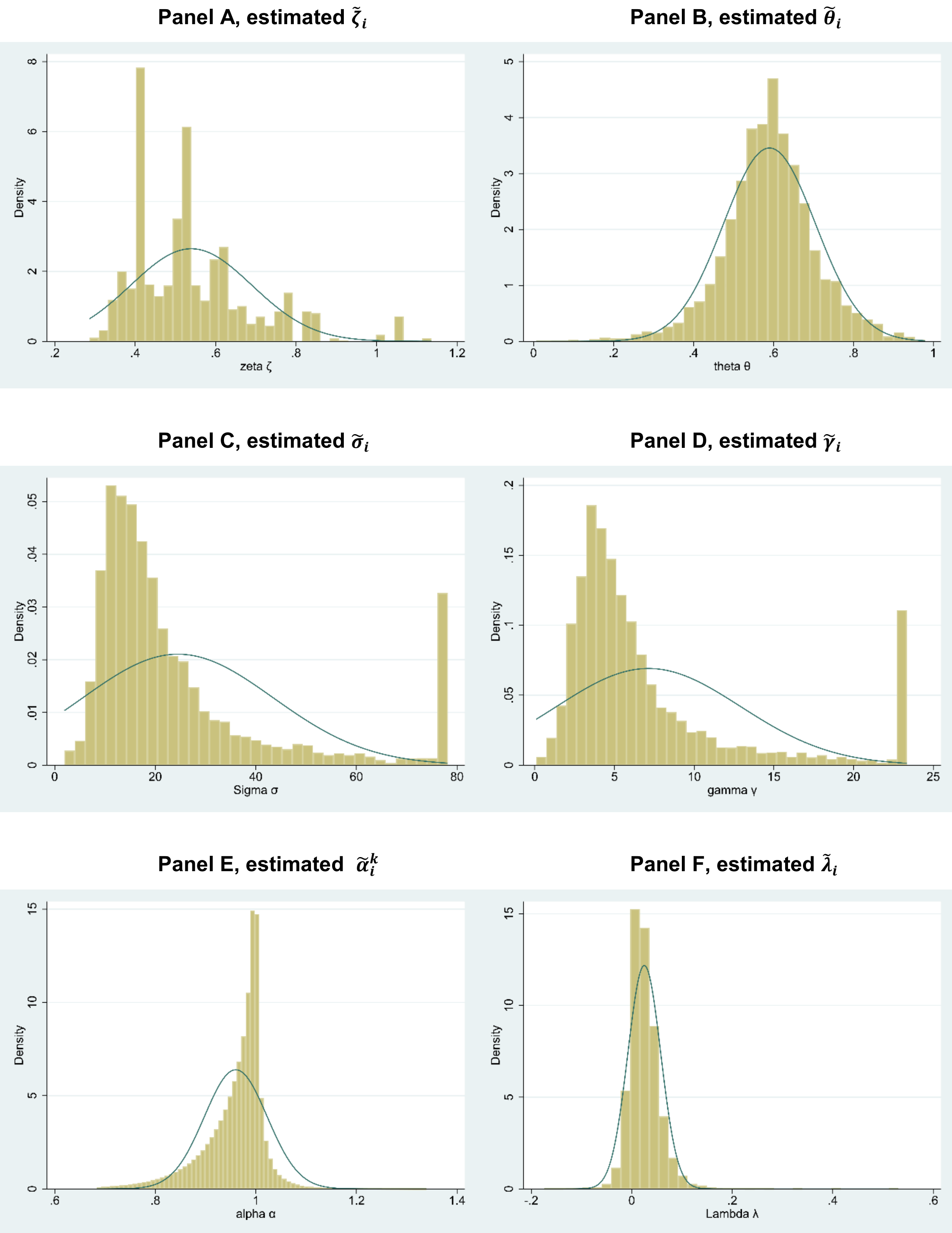
'Footwear'. The largest elasticity of 4,548.65 is for the product 'Other footwear with outer soles of leather, Other' with HS code 640359, for which a consumer can find many other substitutable products.

The heterogeneity parameter $\tilde{\gamma}_i$ is calculated using $\tilde{\zeta}_i$, $\tilde{\theta}_i$, and $\tilde{\sigma}_i$ as noted earlier. This parameter in Feenstra and Romalis (2014) is obtained from Chaney (2008) that is estimated for each three-digit SITC sector, which is much more aggregated than the one used in this analysis. The largest density in that paper has values between 5 and 10. However, as depicted in panel D of figure 1 in this paper, the largest density of the parameter lies somewhere that is smaller than 5. This again suggests that using the more disaggregated data would render heterogeneity parameter smaller. The average of the parameter in this sample is about 11.67, while the median stands at 5.07. The maximum value of this parameter is 1,445.47 for 'Other footwear with outer soles of leather, Other' with HS code 640359. This suggests that more output is concentrated among firms with the lowest productivity, which could reflect the huge number of tailors and textile firms across an economy. The minimum value of this parameter is 0.09 for the product 'Cement copper (precipitated copper)' with HS code 740120. This means that more output is concentrated among highly productive firms in this sector, which usually have large capital expenditures and fixed costs of entry.

The distribution of estimated parameter $\tilde{\alpha}_i^{\kappa}$ is depicted in panel E of figure 1. This graph is depicted using more than 20 million importer-product-year observations. Therefore, this variable explains the perception of consumers in each importing country regarding the valuation of quality of each product in their preferences over years. For instance, the maximum value of this parameter is 1.91 and the 100 largest values of this parameter are for the product 'Copra' with HS code 120300, i.e. the dried kernels of coconut imported into many African countries. This indicates that the consumers in these countries attach great importance to the quality of this specific product. The product 'Cement copper (precipitated copper)' with HS code 740120 has the smallest value of this parameter and is the smallest for many African importers. Again, this suggests that the import of this product has a small weight for its quality in the preferences of its importers. The density of the parameter is highest around 1 as its median is about 0.98, and its mean is about 0.96, which all suggests that a large portion of imported products has weights around unity for quality in preferences of consumers across the globe.

The distribution of the estimated parameter $\tilde{\gamma}_i$ is depicted in panel F of figure 1, which measures the elasticity of quality perception of product i with respect to the real per-capita income relative to that of the US. As depicted by Feenstra and Romalis (2014) in their Appendix Figure 4, the largest density of this parameter is between zero and 0.1 here as well. About 17% of products have negative income elasticity of quality. The product 'Copra' with HS code 120300 again appears here as the lowest lambda value, which suggests why the lowest-income countries should have larger preferences for the quality of imports of these goods. The product 'Cinematographic film, exposed and developed, whether or not incorporating soundtrack or consisting only of soundtrack, of width smaller than 35 mm' with HS code 370610 has the largest value of this parameter, while the product 'Cement copper (precipitated copper)' with HS code 740120 again appears to have the second-largest value of this parameter. This suggests why lower per-capita income is associated with lower perception of quality for such an imported product. The mean and median of this parameter are both positive and close to 0.02, which suggests that countries with higher income per capita assign a greater weight to the quality of the imports of many products.

Figure 1 / Density plots of estimated parameters of the model including NTMs



Source: Author's estimations. Some figures are truncated on their right only for presentation purposes.

4.2. IMPACT OF NTMS ON TRADE OUTCOMES

To understand how NTMs are correlated with trade variables, this sub-section estimates how NTMs affect the trade outcomes, namely imports value $\mathrm{X}_{it}^{cif,rk}$, imported quantity $\mathrm{q}_{it}^{cif,rk}$, imported unit values $\mathrm{uv}_{it}^{cif,rk}$, imported quality $\mathrm{z}_{it}^{cif,rk}$, quality-adjusted import prices $\overline{\mathrm{P}_{it}^{cif,rk}}$, and quality-adjusted import quantities $\mathrm{Q}_{it}^{cif,rk}$. These variables are estimated against NTMs controlling for tariffs t_{it}^{rk}, income of both trading partners, and per-capita income of both trading partners as follows:

$$\begin{aligned}\ln \Upsilon_{it}^{rk} = {} & \varsigma_0 + \varsigma_1 \ln TBT_{it}^{rk} + \varsigma_2 \ln SPS_{it}^{rk} + \varsigma_3 \ln tar_{it}^{rk} + \varsigma_4 \ln Pop_t^k + \varsigma_5 \ln Pop_t^r + \varsigma_6 \ln GDPpc_t^k \\ & + \varsigma_7 \ln GDPpc_t^r + \varsigma_8 \ln dist_i^{rk} + \varsigma_9 Lan^{rk} + \varsigma_{10} Col^{rk} + \varsigma_{11}\, \mathrm{R} \ln TBT_{it}^{rk} + \varsigma_{12}\, \mathrm{R} \ln SPS_{it}^{rk} \\ & + \varsigma_{13}\, \mathrm{R} \ln tar_{it}^{rk} + \varsigma_{12}\, \mathrm{R} \ln dist_i^{rk} + \varsigma_{13}\, \mathrm{R}\, Lan^{rk} + \varsigma_{14}\, \mathrm{R}\, Col^{rk} + \varsigma_t + \psi_{2it}^{rk}\end{aligned} \tag{35}$$

where $\ln \Upsilon_{it}^{rk}$ is the log of the trade outcome variables mentioned above; Pop_t^k and Pop_t^r are the population of importing and exporting countries, respectively; Lan^{rk} is a dummy variable indicating whether both countries have similar ethnic languages; Col^{rk} is a dummy variable indicating whether both countries have a similar colonial history; ς_0 is the constant term; ς_t is the time fixed effect; and ψ_{2it}^{rk} is the robust standard error. This equation is estimated over all available bilateral trade flows for which all observations for all dependent variables are non-missing. Since we are interested in all the available results to have equal numbers of observations across columns, zero trade flows are not included in these models and the estimations are run using normal OLS. The reason is that there is no meaningful explanation for zero prices and zero quality when a bilateral trade flow does not exist. Usually a very expensive product is not in demand because of its uncompetitive price, while a product with the lowest price should largely be in demand. Moreover, the estimation of a sample including all zero and non-zero trade flows is not feasible due to the very large size of its data.

Following Chaney (2008) and Baier and Bergstrand (2009), and in order to control for multilateral resistances of all trade costs, a remoteness index $\mathrm{R}\,\Phi_{\varrho,it}^{rk}$ from the rest of the world is included for each trade policy measure and gravity trade cost in equation (35), which is calculated as follows:

$$\mathrm{R}\,\Phi_{\varrho,it}^{rk} = \left[\sum_{l=1}^{N} \text{Ʊ}_{kt} \Phi_{\varrho,it}^{rl}\right] + \left[\sum_{j=1}^{N} \text{Ʊ}_{mt} \Phi_{\varrho,it}^{\mathrm{jk}}\right] - \left[\sum_{l=1}^{N}\sum_{j=1}^{N} \text{Ʊ}_{kt}\text{Ʊ}_{mt} \Phi_{\varrho,it}^{\mathrm{jl}}\right], \qquad \text{Ʊ}_{\daleth t} = \frac{GDP_{\daleth t}}{\sum_{\daleth}^{N} GDP_{\daleth t}}, \tag{36}$$

$$\forall \daleth \in \{1, j, k, m, l\ \dots, N\}, \qquad \varrho \in \{\ln TBT, \ln SPS, \ln tar, \ln dist, Lan, Col\}$$

where N is the total number of countries in the world and $\text{Ʊ}_{\daleth t}$ is the share of country $\daleth$'s GDP in total world GDP in a given year. Holding the bilateral trade cost ϱ constant in equation (35), bilateral trade from r to k should increase in these multilateral resistance terms. To give robust results controlling for omitted-variable bias, these models, whose results are presented in Table 1, include bilateral product fixed effects ς_i^{rk}. After including these fixed effects, time-invariant bilateral variables including distance, colony and language are excluded. In general, all models have relatively large explanatory power, as shown by the R-squared statistics. Another specification excluding bilateral product fixed effects ς_i^{rk} is also estimated, and its results are presented in Table A1 in the appendix. The signs and significance of the estimated coefficients of trade policy measures in Table A1 are comparable to those of the coefficients in Table 1. Therefore, the interpretation of the results in Table 1 is discussed here.

Table 1 / Estimation results on the trade outcome

Dependent variable:	$\ln X_{it}^{cif,rk}$	$\ln q_{it}^{cif,rk}$	$\ln uv_{it}^{cif,rk}$	$\ln z_{it}^{cif,rk}$	$\ln \overline{P_{it}^{cif,rk}}$	$\ln Q_{it}^{cif,rk}$
$\ln TBT_{it}^{rk}$	-0.050***	-0.070***	0.020***	0.012***	0.0079***	-0.058***
	(0.00054)	(0.00059)	(0.00022)	(0.00014)	(0.00019)	(0.00053)
$\ln SPS_{it}^{rk}$	0.064***	0.046***	0.019***	0.0016***	0.017***	0.047***
	(0.00069)	(0.00075)	(0.00027)	(0.00018)	(0.00022)	(0.00067)
$\ln tar_{it}^{rk}$	-0.77***	-0.69***	-0.087***	0.038***	-0.12***	-0.65***
	(0.0044)	(0.0047)	(0.0017)	(0.0011)	(0.0014)	(0.0042)
$\ln Pop_t^r$	-0.095***	0.022***	-0.12***	-0.091***	-0.026***	-0.068***
	(0.0037)	(0.0040)	(0.0016)	(0.00099)	(0.0011)	(0.0035)
$\ln Pop_t^k$	0.28***	0.43***	-0.16***	0.0036***	-0.16***	0.44***
	(0.0028)	(0.0031)	(0.0013)	(0.00078)	(0.0011)	(0.0028)
$\ln GDPpc_t^r$	0.95***	0.93***	0.016***	-0.057***	0.073***	0.88***
	(0.0015)	(0.0016)	(0.00060)	(0.00039)	(0.00048)	(0.0015)
$\ln GDPpc_t^k$	0.79***	0.67***	0.12***	0.0035***	0.12***	0.67***
	(0.0013)	(0.0014)	(0.00057)	(0.00036)	(0.00048)	(0.0013)
$R\,tar_{it}^{rk}$	-0.015***	-0.019***	0.0034***	0.00081***	0.0026***	-0.018***
	(0.00013)	(0.00015)	(0.000049)	(0.000030)	(0.000041)	(0.00013)
$R\,TBT_{it}^{rk}$	0.043***	0.045***	-0.0025***	-0.0066***	0.0041***	0.039***
	(0.00036)	(0.00039)	(0.00015)	(0.000097)	(0.00012)	(0.00035)
$R\,SPS_{it}^{rk}$	-0.017***	-0.014***	-0.0034***	0.0042***	-0.0076***	-0.0097***
	(0.00035)	(0.00038)	(0.00014)	(0.000092)	(0.00011)	(0.00034)
Constant: ς_0	-7.68***	-9.54***	1.87***	1.60***	0.27***	-7.95***
	(0.025)	(0.027)	(0.010)	(0.0065)	(0.0083)	(0.024)
Observations	112877289	112877289	112877289	112877289	112877289	112877289
R-squared	0.764	0.799	0.853	0.890	0.649	0.769
Adjusted R-squared	0.733	0.773	0.834	0.876	0.603	0.739
Bilateral product FE: ς_i^{rk}	Yes	Yes	Yes	Yes	Yes	Yes
Year FE: ς_t	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01

The interesting result to point out is that since the multiplication of unit values $uv_{it}^{cif,rk}$ and traded quantity $q_{it}^{cif,rk}$ is simply equal to traded value $X_{it}^{cif,rk}$, the coefficients of each variable for the traded value model should be equal to the summation of that variable's coefficient in the model of traded unit value and that in the model of traded quantity. For instance, TBTs increase the traded unit value by the elasticity of 0.02, and they affect the traded quantity by the elasticity of -0.07; therefore, they affect the traded value by the elasticity of -0.05. This suggests that TBTs reduce trade by inducing larger prices. Then, observing the coefficient of TBTs on the estimated quality, one can easily observe that 60% of this price increase is due to the quality upgrading. In fact, TBTs induce higher quality by an elasticity of about 0.016. The rest of the TBT-induced increase in prices of traded product is due to the higher quality-adjusted price. The impact of TBTs on quality-adjusted price has the elasticity of 0.0079. Moreover, one can also observe that because of the TBTs quality-adjusted quantities are also reduced by the elasticity of 0.058, which is slightly smaller than the impact on traded quantity. This smaller magnitude is simply because TBTs induce higher traded quality rather than traded cost, which is hidden in the quality-adjusted price.

The most interesting result concerns the coefficients of SPS measures, which are positive across all models. However, when bilateral product fixed effects are excluded, the results in Table A1 do not show positive coefficients of SPS in all models. These measures usually deal with the hygiene and safety aspect of imported products that may harm human health. The imposition of these measures not only improves the average traded quality of products but also stimulates the quantity of trade. Consumers who feel safer about the quality of imported products will demand more of the safe products after the SPS measures are imposed. This is in line with the other study by Disdier et al. (2020). Furthermore, the positive impact of TBTs and SPS measures on quality was also evident as reported in Ghodsi and Stehrer (2020), who found a positive impact of TBTs and SPS measures on the quality of traded products estimated by Feenstra and Romalis (2014) at the four-digit level of SITC rev. 2. Those estimations used country-sector-time fixed effects to control for the multilateral resistances. The results still hold using these new estimates at the HS six-digit level and using a slightly different gravity specification.

Tariffs used as a traditional trade policy measure reduce the quantity and value of trade as expected. The quality of imports is increased by tariffs while the quality-adjusted price is decreased. The reason behind this is that an exporter who faces higher tariffs compared with another exporter who enjoys lower tariffs, for instance through preferential tariff rates, should offer a higher-quality product at a lower quality-adjusted price to be able to compete with the exporter who enjoys the favourable tariff treatment.

Population as an indicator of market size does not have meaningful coefficients in Table 1. However, using the traditional gravity framework without bilateral product fixed effects, whose results are presented in Table A1, indicates that the market size stimulates volume and value of trade. Moreover, according to the results presented in Table 1, one can easily observe a positive relationship between the traded quality and real GDP per capita of both importers and exporters. The positive relationship between an exporting country's GDP per capita and its exported quality is also presented in figure VI of Feenstra and Romalis (2014), whose specification is very similar to the model without bilateral product fixed effects, whose results are presented in Table A1. Using the product bilateral fixed effects, the results in Table 1 show that real GDP per capita of the exporting country has a negative impact on the quality of the traded product. However, countries with higher GDP per capita import products with higher quality in both specifications.

4.3. COMPARISON WITH FEENSTRA AND ROMALIS (2014)

In this sub-section, two sets of estimated outcomes are compared with each other. One set of estimated outcomes is obtained from the model presented above that includes NTMs. The other one is obtained from the model excluding NTMs, which is equivalent to that presented in Feenstra and Romalis (2014). Therefore, some regressions are run as follows:

$$\mathrm{d}\Upsilon_{it}^{rk} = \upsilon_0 + \upsilon_1 \ln TBT_{it}^{rk} + \upsilon_2 \ln SPS_{it}^{rk} + \upsilon_3 \ln tar_{it}^{rk} + \upsilon_4 \ln GDPpc_t^k + \upsilon_5 \ln GDPpc_t^r + \upsilon_i^{rk} + \upsilon_t + \psi_{1it}^{rk} \quad (37)$$

where $\mathrm{d}\Upsilon_{it}^{rk}$ is the difference in the output variable of the model excluding NTMs from that of the model including NTMs; this variable takes the difference in import quality $d\ln \overline{z_\iota^{\mathrm{cif},rk}}$ of both models, difference in quality-adjusted price of imports $d\ln \overline{P_\iota^{\mathrm{cif},rk}}$ of both models, difference in ad-valorem trade costs $d\ln \tilde{\tau}_{it}^{rk}$ of both models, and difference in fixed costs of exporting $d\ln \tilde{f}_{it}^{rk}$ of both models; υ_0 is a constant term; υ_i^{rk} and υ_t are respectively bilateral product and time fixed effects; and ψ_{1it}^{rk} is the error term. This model is estimated using normal OLS. Robust estimator is used to render unbiased results.

Table 2 presents the estimation results on the differences in the output variables obtained from the two models. As stated in the table note, the dependent variable is calculated as the variable of interest obtained from the model excluding NTMs (i.e. via Feenstra and Romalis, 2014) minus the variable obtained from the model including NTMs. As is observed in large R-squared statistics, the variables used in these estimations explain major changes in the dependent variables. While import tariffs and real GDP per capita of both countries are included as control variables, the main variables of interest that differ between these two models are NTMs.

Table 2 / Comparing the results obtained from the model excluding NTMs and the model including NTMs

Dependent variable:	$d\ln\overline{z_t^{cif,rk}}$	$d\ln\overline{P_t^{cif,rk}}$	$d\ln\tilde{\tau}_{it}^{rk}$	$d\ln\tilde{f}_{it}^{rk}$
$\ln TBT_{it}^{rk}$	0.0035***	-0.0042***	-0.025***	-0.045***
	(0.000016)	(0.000017)	(0.0000092)	(0.00020)
$\ln SPS_{it}^{rk}$	-0.0019***	0.0024***	0.0042***	-0.0070***
	(0.000021)	(0.000023)	(0.000019)	(0.00023)
$\ln tar_{it}^{rk}$	0.0011***	-0.00074***	-0.00019***	0.026***
	(0.00013)	(0.00013)	(0.000046)	(0.0012)
$\ln GDPpc_t^k$	0.0014***	-0.0014***	-0.0021***	0.0027***
	(0.000035)	(0.000035)	(0.000014)	(0.00036)
$\ln GDPpc_t^r$	0.00021***	-0.000061	-0.00080***	-0.00078*
	(0.000041)	(0.000042)	(0.000019)	(0.00044)
Constant: υ_0	-0.018***	0.016***	0.043***	-0.12***
	(0.00053)	(0.00053)	(0.00022)	(0.0055)
Observation	112877289	112877289	116511304	116511304
R-squared	0.942	0.941	0.816	0.556
Adjusted R-squared	0.934	0.933	0.791	0.498
Bilateral product FE: υ_i^{rk}	Yes	Yes	Yes	Yes
Year FE: υ_t	Yes	Yes	Yes	Yes

Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01
Note: The dependent variables are calculated as the output variable obtained from the model excluding NTMs minus the output variable obtained from the model including NTMs.

A positive and strongly significant coefficient of TBTs in the first column to the left indicates that the model that excludes TBTs gives higher quality of imports than the model that includes TBTs. This means that the difference becomes larger when TBTs increase. Therefore, there is an overestimation of quality in the model excluding TBTs when their quality impact on the imported product is not controlled for. While TBTs are imposed by countries in reality, in the model presented by Feenstra and Romalis (2014) these important regulative measures are not included, which results in a significant omitted-variable bias. Thus, after the model controls for the regulative TBTs, the estimated quality of imports should become smaller as the higher quality was due to these TBTs, which were not taken into account. This is also reflected in a negative and statistically significant coefficient in the second column of quality-adjusted prices of imports. In a model in which TBTs are included, the quality-adjusted import price is significantly larger than in a model in which TBTs are excluded. Furthermore, TBTs reduce the gap between the trade costs estimated in both models. In other words, one can interpret the negative coefficient of TBTs in the two trade cost columns in a way that the trade costs retrieved from the model excluding TBTs are smaller than the trade costs from the model including TBTs.

The pattern observed for TBTs is not observed for the SPS measures. Including SPS measures in the model would give a higher quality of imports and larger fixed costs of exports. However, including SPS measures in the model results in smaller quality-adjusted import prices and ad-valorem trade costs. Overall, it can be argued that inclusion of NTMs in the model matters because they change the results retrieved from the model statistically significantly.

5. The 'NTM Black Box'

In the previous sub-section the econometric results show the average impact of NTMs on various traded outcomes across all countries and products in the world. However, regulative NTMs across countries have diverse implications depending on the type of product. Kee et al. (2009), Ghodsi et al. (2016, 2017), Bratt (2017) and Niu et al. (2018) provide evidence that NTMs have a heterogeneous impact on trade flows that varies across importers, products and exporters. This could also depend on the technological content of the regulative measures embedded within NTMs. For example, when an advanced country that is at the forefront of pharmaceutical production imposes a TBT or an SPS measure on imported medicines to restrict low-quality imports, the producers in that country may already be in compliance with the relevant regulation. However, it is very difficult for exporters in less advanced or developing countries to adjust their production procedures to be able to meet such high standards. As shown above, that may need a fixed cost of exporting, which may be enormous when the productivity of firms in the exporting country is very low. Although the average quality of imported products to this advanced economy is increased, the total imports may have been significantly hampered. This, however, may be interpreted as good faith behind the imposition of the regulative NTMs. Moreover, the same country can impose NTMs on the imports of food products that may have a completely different implication. For instance, to eliminate the risk of lethal allergic reactions to peanuts, an SPS measure could set the maximum level of aflatoxin in peanuts imported to a country. At the same time, it may also impose a TBT measure to require the labelling of the product to contain enough information regarding the SPS measure. The SPS measure may prohibit the import of peanuts from certain producers from low-income countries (Otsuki et al., 2001), leading to an average higher quality of imports to that country. However, the TBT measure may additionally stimulate the import of products from safe countries, while it may have no significant impact on the average quality of imports. This suggests that NTMs in general may look like a 'Black Box', whose implications for the outside variables may depend on the information they contain inside as their embedded regulations and standards. Some of the NTMs imposed by countries may pursue a quality upgrading objective. To achieve such an objective, trade may be hampered or stimulated. However, such a quality upgrading objective may not necessarily be achieved, but trade may be unnecessarily hampered. While in the previous section a general effect of TBTs and SPS measures on traded value, quantity and quality was analysed, in this section these effects are analysed across countries and products.

Therefore, by analysing the impact of NTMs imposed by each country against the import of a given product on the quantity, value, unit value, quality, and quality-adjusted price of imports, one can better understand whether the quality upgrading objective is achieved, despite its implications for trade. Thus, the motivations behind such a regulative NTM become clearer and the 'NTM Black Box' is opened and analysed. In so doing, while equation (35) was estimated across all available global bilateral trade flows, the following equation needs to be estimated for each HS six-digit product i separately:

$$\ln \Upsilon_{it}^{rk} = \varsigma_{i\Upsilon 0} + \sum_{k=1}^{N} \varsigma_{i\Upsilon 1}\varsigma^{k} \ln TBT_{it}^{rk} + \sum_{k=1}^{N} \varsigma_{i\Upsilon 2}\varsigma^{k} \ln SPS_{it}^{rk} + \varsigma_{i\Upsilon 3} \ln tar_{it}^{rk} + \varsigma_{i\Upsilon 4} \ln Pop_{t}^{k} + \varsigma_{i\Upsilon 5} \ln Pop_{t}^{r}$$
$$+ \varsigma_{i\Upsilon 6} \ln GDPpc_{t}^{k} + \varsigma_{i\Upsilon 7} \ln GDPpc_{t}^{r} + \varsigma_{i\Upsilon 8} \mathrm{R} \ln TBT_{it}^{rk} + \varsigma_{i\Upsilon 9} \mathrm{R} \ln SPS_{it}^{rk} \qquad (38)$$
$$+ \varsigma_{i\Upsilon 10} \mathrm{R} \ln tar_{it}^{rk} + \varsigma_{\Upsilon t} + \varsigma_{i\Upsilon}^{rk} + \psi_{2i\Upsilon t}^{rk}, \qquad \Upsilon \in (X, q, uv, z, P)$$

where $\ln \Upsilon_{it}^{rk}$ could include the bilateral import value $\mathrm{X}_{it}^{cif,rk}$, the quantity of bilateral trade $\mathrm{q}_{it}^{cif,rk}$, the imported unit value $\mathrm{uv}_{it}^{cif,rk}$, the quality of the imported product $\mathrm{z}_{it}^{cif,rk}$, or the quality-adjusted import price $\overline{\mathrm{P}_{it}^{cif,rk}}$ as the dependent variables in separate specifications; ς^{k} is the importer fixed effects multiplied by the NTM; then, the coefficient $\varsigma_{i\Upsilon 1}\varsigma^{k}$ indicates the importer-specific impact of a TBT on the dependent variable $\ln \Upsilon_{it}^{rk}$, and the coefficient $\varsigma_{i\Upsilon 2}\varsigma^{k}$ indicates the importer-specific impact of a SPS measure on the dependent variable $\ln \Upsilon_{it}^{rk}$; $\varsigma_{i\Upsilon}^{rk}$ controls for bilateral fixed effects for each product i, and therefore the time-invariant variables are excluded from the estimation, which also achieves better fit of the model; the definition of other variables remains as discussed before. Because the inclusion of all interactions of importer dummies with $\varsigma_{i\Upsilon 1}$ and $\varsigma_{i\Upsilon 2}$ for the two types of NTMs may exhaust the degree of freedom of each estimation, two estimations are run separately for each NTM interacted with importer dummies, while the variable for the other type of NTM is included in the estimation as a control variable. As robustness checks, another model is also estimated using the lagged independent variables to eliminate the reverse causality bias; and in a further model the bilateral fixed effects are removed and time-invariant variables are included instead. The results of these robustness checks are available on request. In another specification, following Ghodsi (2019), an instrumental variable approach is used to control for the endogeneity bias of the NTMs, which is combined with a Heckman (1979) selection procedure to control for zero trade flows. This specification follows a three-stage procedure that will be used as the benchmark model. The first stage estimates the probability of having non-zero trade with a full balanced panel data, which is as follows:

$$\Pr\left(\mathrm{X}_{it}^{cif,rk} > 0\right) = \varsigma_{iX^{+}0} + \varsigma_{iX^{+}1} \ln TBT_{it}^{rk} + \varsigma_{iX^{+}2} \ln SPS_{it}^{rk} + \varsigma_{iX^{+}3} \ln tar_{it}^{rk} + \varsigma_{iX^{+}4} \ln Pop_{t}^{k}$$
$$+ \varsigma_{iX^{+}5} \ln Pop_{t}^{r} + \varsigma_{iX^{+}6} \ln GDPpc_{t}^{k} + \varsigma_{iX^{+}7} \ln GDPpc_{t}^{r} + \varsigma_{iX^{+}8} \mathrm{R} \ln TBT_{it}^{rk}$$
$$+ \varsigma_{iX^{+}9} \mathrm{R} \ln SPS_{it}^{rk} + \varsigma_{iX^{+}10} \mathrm{R} \ln tar_{it}^{rk} + \varsigma_{iX^{+}11} \ln dist_{i}^{rk} + \varsigma_{iX^{+}12} Lan^{rk} \qquad (39)$$
$$+ \varsigma_{iX^{+}13} Col^{rk} + \varsigma_{iX^{+}14} WTO_{t}^{rk} + \varsigma_{iX^{+}t} + \psi_{2iX^{+}t}^{rk}$$

where $\Pr\left(\mathrm{X}_{it}^{cif,rk} > 0\right)$ is the probability of positive trade; $\varsigma_{iX^{+}0}$ is the constant term, $\varsigma_{iX^{+}t}$ is the time fixed effect, and $\psi_{2iX^{+}t}^{rk}$ is the error term; WTO_{t}^{rk} is a dummy variable indicating whether both trading countries are members of the WTO at the time. This variable is used as the exclusion restriction of Heckman; it is argued that this variable affects the extensive margin of trade rather than the intensive margin. This is evident for countries which have joined the WTO since 1995, such as China in 2001 or Russia in 2012. Equation (39) is estimated using a probit estimator. After the estimation is run, the inverse Mills ratio is calculated as the inverse probability of trade multiplied by its density. This inverse Mills ratio is then used in the third stage of regression elaborated below.

The second-stage regression is instrumenting NTM variables with appropriate instruments following Ghodsi (2019). Reverse causality, measurement errors and omitted variables bias are the three sources of endogeneity when estimating trade flows with respect to NTMs. Reverse causality stems from the fact that after a surge in trade policymakers may impose regulative NTMs to regulate imports. This suggests that trade flow (i.e. value or quantity) as the dependent variable affects NTMs as the explanatory variables, which causes simultaneity bias. Moreover, the measurement error could be due to the misreporting of NTMs to the WTO by member states. While these two sources of endogeneity are corrected using exogenous instruments, the omitted variable bias is corrected using the multilateral resistance terms in the third-stage equation. The exogenous instruments should be correlated with the endogenous NTM variables, while they should not be correlated with the dependent variables. Two instruments that do not affect the bilateral import to country k but which may affect the imposition of regulative NTMs by that country k could be the regulative NTMs imposed world-wide and those imposed by the trading partner r. The price of traded products could be affected by regulative NTMs as a sign of regulative quality upgrading. In fact, it can be argued that the increasing level of regulative standards by trading partners and the world would lead countries to implement new regulative measures to adjust their sets of standards with sets of standards in other countries. Therefore, the second stage is estimated as follows:

$$\begin{aligned}\ln NTM_{\varrho,it}^{rk} = {} & \varsigma_{i\varrho 0} + \varsigma_{i\varrho' 1} \ln NTM_{\varrho' it}^{rk} + \sum_{\varrho} \varsigma_{i\varrho k2} \ln \overline{NTM}_{\varrho,it}^{rk,uv} + \sum_{\varrho} \varsigma_{i\varrho w2} \ln \overline{NTM}_{\varrho,it}^{rw,uv} + \varsigma_{i\varrho 3} \ln tar_{it}^{rk} \\ & + \varsigma_{i\varrho 4} \ln Pop_t^k + \varsigma_{i\varrho 5} \ln Pop_t^r + \varsigma_{i\varrho 6} \ln GDPpc_t^k + \varsigma_{i\varrho 7} \ln GDPpc_t^r + \varsigma_{i\varrho 8} \mathrm{R} \ln TBT_{it}^{rk} \\ & + \varsigma_{i\varrho 9} \mathrm{R} \ln SPS_{it}^{rk} + \varsigma_{i\varrho 10} \mathrm{R} \ln tar_{it}^{rk} + \varsigma_{i\varrho}^{rk} + \varsigma_{i\varrho t} + \psi_{2iX^+t}^{rk}, \quad \varrho, \varrho' \in (TBT, SPS), \varrho \neq \varrho'\end{aligned} \tag{40a}$$

$$\ln \overline{NTM}_{\varrho,it}^{rk,uv} = \sum_{l} \frac{\mathrm{uv}_{it}^{cif,lr}}{\sum_l \mathrm{uv}_{it}^{cif,lr}} NTM_{\varrho,it}^{lr}, r \neq k \wedge l \neq k \wedge l \neq r, \forall \varrho \in \{TBT, SPS\} \tag{40b}$$

$$\ln \overline{NTM}_{\varrho,it}^{rw,uv} = \sum_{r} \sum_{l} \frac{\mathrm{uv}_{it}^{cif,lr}}{\sum_l \mathrm{uv}_{it}^{cif,lr}} NTM_{\varrho,it}^{lr}, r \neq k \wedge l \neq k \wedge l \neq r, \forall \varrho \in \{TBT, SPS\} \tag{40c}$$

where $\overline{NTM}_{\varrho,it}^{rk,uv}$ is the unit-value weighted average of NTMs of type ϱ imposed by the partner country r against imports from all countries except k; $\overline{NTM}_{\varrho,it}^{rw,uv}$ is the unit-value weighted average of NTMs of type ϱ imposed by all countries except the importing country k against imports from all countries except k; in equation (40a) the time-invariant variables are excluded due to the inclusion of bilateral fixed effect $\varsigma_{i\varrho}^{rk}$; other variables are also included in this stage, and their definitions remain as before. This specification is the generalised version of the instrumental specification used in Kee and Nicita (2016), where the NTMs are instrumented using the NTMs imposed by the third-closest countries to a given country. After estimation of each type of NTM in equation (40a), their fitted values (i.e., $\widehat{TBT}_{it}^{rk}$ and $\widehat{SPS}_{it}^{rk}$) are used in the third stage as follows:

$$\begin{aligned}\ln \Upsilon_{it}^{rk} = {} & \varsigma_{i\Upsilon 0} + \sum_{k=1}^{N} \varsigma_{i\Upsilon 1} \varsigma^k \ln \widehat{TBT}_{it}^{rk} + \sum_{k=1}^{N} \varsigma_{i\Upsilon 2} \varsigma^k \ln \widehat{SPS}_{it}^{rk} + \varsigma_{i\Upsilon 3} \ln tar_{it}^{rk} + \varsigma_{i\Upsilon 4} \ln Pop_t^k + \varsigma_{i\Upsilon 5} \ln Pop_t^r \\ & + \varsigma_{i\Upsilon 6} \ln GDPpc_t^k + \varsigma_{i\Upsilon 7} \ln GDPpc_t^r + \varsigma_{i\Upsilon 8} \mathrm{R} \ln TBT_{it}^{rk} + \varsigma_{i\Upsilon 9} \mathrm{R} \ln SPS_{it}^{rk} \\ & + \varsigma_{i\Upsilon 10} \mathrm{R} \ln tar_{it}^{rk} + \varsigma_{i\Upsilon 11} IMR_{it}^{rk} + \varsigma_{\Upsilon t} + \varsigma_{i\Upsilon}^{rk} + \psi_{2i\Upsilon t}^{rk}, \qquad \Upsilon \in (X, q, uv, z, P)\end{aligned} \tag{41}$$

where IMR_{it}^{rk} is the inverse Mills ratio obtained from equation (39) using a sample including zero trade values; $\ln \widehat{TBT}_{it}^{rk}$ and $\ln \widehat{SPS}_{it}^{rk}$ are the logarithmic forms of fitted values of TBTs and SPS measures obtained from equation (40a), respectively; and the definition of other variables remains as stated above.

This equation can be simultaneously estimated with equation (40a) in a GMM model when importer dummies are not interacted with the instrumented variables. The Sargan-Hansen J statistic of these GMM estimations is available on request. However, when interacting the NTMs, the estimation of equation (41) simultaneously with equation (40a) in a GMM setting is not feasible. Since bootstrapping is also not feasible in a multi-dimensional fixed effect estimation, the robust standard errors are used.

5.1. RESULTS

A short summary of the estimated importer-specific results is presented here, while all the estimated data are available on request. Tables A2 through to A5 present summary statistics of affected imported quantities, and Tables A6 through to A9 present the summary statistics of affected imported quality. Tables A2 through to A5 present the estimated coefficients of TBTs and SPS measures on quantity and quality of imports per each importer, separated by the impacts that are positive or negative. For instance, Table A2 presents only the statistics for the estimated importer-specific TBT parameters across all 5,130 products that are positive for a given importer. Thus, it reports how many products are positively affected by the TBTs implemented by each importer, and how much the average of the estimated parameter is.

According to Table A2, the number of products positively affected by TBTs ranges from one in Cambodia to 1,067 in Jamaica. TBTs imposed by Jamaica have the largest number of stimulated import flows at 1,067. The average of the estimated parameters of all these stimulative Jamaican TBTs is about 28.53. This suggests that the import quantities of these products to Jamaica increased on average by about 28.5% when the TBTs were increased by 1%. However, these Jamaican TBTs contributed to the quality improvement of only 144 of these products, with an average elasticity of 13.75. On the other hand, the import quantities of these 144 products are stimulated by 53.46% with respect to a 1% increase in imposed TBTs. Quality degrading as a result of TBTs is evident in 568 stimulated import flows. In fact, the import quality of 568 products is downgraded by about 8.7% with a 1% increase in TBTs.

Table A3 presents summary statistics of a number of products whose import quantities have been restricted by TBTs at a 10% level of significance. The number of products negatively affected by TBTs ranges from one product respectively in Nepal and Mali to 1,685 products in Hungary. In many EU Member States the number of imported products restricted by TBTs is higher than in many other countries. For instance, 1,685 six-digit products imported to Hungary are negatively affected by TBTs with an average significant coefficient of -2.36. This suggests that during the period of analysis a 1% increase in TBTs – which Hungary imposed alone or the EU imposed after Hungary's accession to the EU in 2004 – has reduced the volume of trade by about 2.36%. However, very few of these affected products have experienced quality downgrading. Only 53 products whose imports to Hungary are restricted by TBTs have had a statistically significantly lower quality due to TBTs. In contrast, a very large portion of these restricted imports has been experiencing upgraded quality, with 1,051 imported products that are restricted by TBTs enjoying higher quality. While a 1% additional TBT imposed by Hungary during the period has resulted in -2.67% lower volume of trade on 1,051 products, each of these TBTs has also contributed to an improvement of the product by about 0.58%, as shown by its average coefficient. A similar story could be told of countries whose TBTs have been restricting more products than those of other countries. In fact, most of these countries are advanced or emerging economies whose TBTs have improved the quality of imported goods despite restricting their volume of imports.

Table A4 presents summary statistics of a number of products affected by SPS measures whose imported quantities to respective countries have been stimulated by these SPS measures. The number of imported quantities positively affected by SPS measures ranges from one product in Tanzania to 1,060 products in Nepal, which has the largest number of stimulated imports. With 1,060 six-digit products imported, Nepal has registered larger import quantities as a result of imposed SPS measures with an average elasticity of 143.62 across all these affected lines. However, the average coefficient of the SPS measures on imported quality for Nepal is negative and equal to -20.04. Only 152 of these affected imports to Nepal have a higher quality following the imposition of SPS measure, while 629 of these stimulated imported goods have a lower quality due to SPS measures with an average coefficient of -43.22. After Nepal, New Zealand has the second-largest number of stimulated imported goods whose quality is downgraded by an average elasticity of only -0.22. Armenia is the third country whose imported goods imports have been stimulated by SPS measures. Imports of 742 Armenian products are stimulated, while their quality is upgraded by an average elasticity of 1.73.

Table A5 presents summary statistics of a number of products affected by SPS measures, with their imported quantities to the respective importing countries statistically significantly restricted. The number of imported quantities restricted by SPS measures ranges from two products respectively in Uganda and Botswana to 1,539 products in Nepal and 1,396 products in Egypt. The US, Armenia, the Kyrgyz Republic, New Zealand, Hungary and Ireland are among the countries with the greatest number of restricted products. It is interesting to note that the average of the parameters of SPS measures on the quality of imported goods on these affected products for these countries is positive. For instance, 1,539 of imported goods to Nepal are imported in smaller quantities as a result of SPS measures. The quality of 777 of these products is significantly upgraded statistically with an average elasticity of 3.81, while the quality of only 208 products is downgraded by SPS measures imposed by Nepal.

5.2. DISENTANGLING THE AD-VALOREM EQUIVALENT OF NTMS: QUALITY VERSUS QUALITY-ADJUSTED PRICE

Traditionally, unit values of trade are used as proxies of traded goods (see the most recent work by Trenczek and Wacker, 2021). Moreover, Cadot and Gourdon (2016) among many others use unit values of traded products to estimate the ad-valorem equivalents of NTMs. This study assesses the impact of NTMs on unit values, and the data on the importer-specific impact of NTMs on unit values are available in the online appendix. However, the impact of NTMs on unit values is also disentangled between quality and quality-adjusted price, and the relevant summary statistics are briefly presented here.

Tables A6 through to A9 show the number of products whose quality or quality-adjusted prices are affected by NTMs. For instance, Table A6 shows the number of products whose imported quality is upgraded by TBTs across all importers. The number of imported products whose quality is upgraded ranges from one for Seychelles and Iceland, respectively, to 1,496 products for Poland. In fact, the quality of these imported products to Poland is positively affected by an average elasticity of 0.6. The quality-adjusted price of 713 out of these 1,496 products imported to Poland has also increased due to the imposition of TBTs by an average elasticity of 0.61. However, the quality of about 72 imported products to Poland has been upgraded by an average elasticity of 2.75, while their quality-adjusted price is reduced by TBTs with an average elasticity of -2.82. On average the summation of the two effects contribute to a -0.07 reduction in the unit values of these 72 traded goods. This average effect on unit values is similar to that obtained in Cadot and Gourdon (2016), which is here disentangled into its two components of quality and quality-adjusted price. This contradicting effect of TBTs on the two components of unit values of traded goods is an interesting result that is evident across numerous products in many countries.

Table A7 presents the summary statistics of a number of products whose imported quality is downgraded by TBTs across all importers. The number of imported products whose quality is downgraded by TBTs ranges from one product, respectively, in Burundi, Benin and Mali to 1,000 products in Uganda. Among the 1,000 imported goods in Uganda whose quality is downgraded due to TBTs with an average elasticity of -0.56, the quality-adjusted price of 402 products has been reduced significantly by TBTs with an elasticity of -0.78. The quality-adjusted price of 110 of those products imported to Uganda is significantly increased with an average elasticity of 1.99. The quality of these 110 imported products is downgraded with an average elasticity of -0.8, which is much smaller in magnitude than the increased quality-adjusted price. This again suggests that while the price of 110 products imported to Uganda is increased due to TBTs, their quality is downgraded and their quality-adjusted price is significantly increased.

Table A8 presents the summary statistics of the number of products whose imported quality is upgraded by SPS measures across all importers. The number of imported products whose quality is upgraded by SPS measures ranges from two products, respectively, in Tunisia, Tanzania and Botswana to 1,217 products in Nepal. While the average elasticity quality with respect to SPS measures for these products imported to Nepal is positive and equal to 15.37, the average elasticity of the quality-adjusted price of the products with respect to SPS measure is equal to -1.87. This suggests that the impact of SPS measures on the unit value of these products imported to Nepal is positive on average, while the impact on the two components of unit values is different.

Table A9 present the summary statistics of the number of products whose imported quality is downgraded due to SPS measures by the importing countries. The number of imported products whose quality is upgraded by SPS measures ranges from three in Seychelles to 1,182 in Nepal. Again, the impact of SPS measures imposed by Nepal on the quality of these products is the opposite of the impact on the quality-adjusted prices of these products. Similarly in the US, with the second-largest number of products whose quality is downgraded by SPS measures, the average elasticity of quality is the opposite of the average elasticity of the quality-adjusted price for 855 products. A similar pattern could be found for many other importing countries in the sample.

An analysis such as the one discussed here can go deeper into each product and country. Since the results provided in this part of the analysis – which are all useful for policymakers and researchers – are too numerous, they are available in full in the online appendix. Therefore, in order to understand whose restrictive NTMs on which products have a positive impact on quality, or to find out which NTMs of which countries have opposing impacts on quality and quality-adjusted prices, the relevant data are available in the online appendix. Moreover, a comprehensive visualisation of the estimated importer-specific parameters of TBTs and SPS measures on traded value, quantity and quality are available on Tableau.[6]

[6] These graphs have been designed by Payam Elhami.

6. Summary and concluding remarks

This paper presents a theoretical framework for estimating the endogenous quality of traded products. The model, which takes the regulative NTMs into account, is based on the model proposed by Feenstra and Romalis (2014). The costs of compliance with regulative TBTs and SPS measures behind the border are considered as ad-valorem and specific trade costs in the model, while investment in technological change in the production procedures to upgrade the quality of manufactured goods is considered as a fixed cost of exporting in the model. Solutions presented in the model indicate that, according to these assumptions, the average quality of imported goods to a certain market that imposes regulative NTMs should improve. With the solutions of the parameters of the model presented here, equations were derived to estimate the quality of traded products using the available trade data at the six-digit level of the HS revision 1 during the period 1996-2017.

Quality is estimated in two separate models. The first is the same as that proposed by Feenstra and Romalis (2014), which does not include NTMs. The second model includes NTMs according to the assumptions. The paper then draws a comparison between the estimated quality of these two models. The comparison suggests that the model excluding NTMs suffers from omitted-variable bias because it does not consider regulative NTMs, which have been in force for decades across the globe and which have statistically contributed to the quality of traded goods. The model excluding TBTs overestimates the quality of imported goods, while the model excluding SPS measures underestimates the quality of imported goods. This is mainly due to the different nature of TBTs and SPS measures. TBTs embed regulations and standards that are imposed on all manufacturing goods, whereas SPS measures deal with hygiene and health concerns. A TBT which prohibits the import of polluting cars should lead to higher-quality imported cars with higher prices. A technological change may be needed to improve the quality at the factory level. Having SPS measures in force will remove a harmful product from the market and send a signal to a representative consumer regarding the safety of existing products. Thus, it may not necessarily improve the quality of the produced goods when its compliance cost or its related technological investments are taken into the model. It may therefore be better to provide a theoretical framework on the qualitative implication of SPS measures following the other strand of the literature, such as Disdier et al. (2020), while TBTs can be better implemented in a model like the one presented here.

After estimating the quality of traded products at the six-digit level, this paper analysed whether the trade implications of regulative NTMs follow their good faith in improving the quality of imported goods. First, the average impact of TBTs and SPS measures on trade outcomes of the model on the whole sample of global bilateral trade at the six-digit level of HS was estimated. It was found that TBTs are in general trade-restrictive, but they improve the quality of traded goods significantly. However, SPS measures stimulate the imported values and volumes, while they also improve the average quality of imported goods significantly. However, the 'NTM Black Box' is very product-country-specific and is difficult to open using these average results. Therefore, as different types of NTMs imposed by different countries on different products have heterogeneous consequences on trade flows and traded quality, the analysis is then extended to each single product to estimate the importer-specific impact of TBTs and SPS measures on traded volume, value, unit value, quality, and quality-adjusted price. Thus, the 'NTM Black Box' is opened fully and analysed. Many studies in the literature use unit values as proxies for quality, and some other studies use unit values to estimate the ad-valorem equivalents of NTMs. The results of this analysis show that NTMs can have the opposite impact on the components of unit values, namely quality and quality-adjusted price. The analysis has produced many interesting results and data for each importing country that could provide insights to policymakers and scholars. It is important to note that NTMs have caused numerous trade disputes at the WTO, as the true motives behind their imposition and potential implications are opaque. Thus, the results of this analysis, which are available in the online appendix and are visually available on Tableau, may shed a light on some of these dispute-settlement cases.

The results in this paper stem from the assumptions of the model presented to estimate the quality of traded products. Egger et al. (2020) find empirical evidence that assumptions made on the location, scale and shape parameters of the productivity distribution of firms in each country may induce different results and elasticities. When the firm-level data on all countries included in the sample are available, these parameters can be estimated using stronger assumptions on the distribution of firms. Furthermore, a model that considers capital and material inputs in the production of quality can better explain the differences in the average quality produced by each country relative to their endowments on factors of production.

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Appendix

Table A1 / Estimation results on the traded outcomes

Dependent variable:	$X_{it}^{cif,rk}$	$q_{it}^{cif,rk}$	$uv_{it}^{cif,rk}$	$z_{it}^{cif,rk}$	$\overline{P_{it}^{cif,rk}}$	$Q_{it}^{cif,rk}$
$\ln TBT_{it}^{rk}$	-0.068***	-0.25***	0.18***	0.12***	0.059***	-0.13***
	(0.00046)	(0.00054)	(0.00024)	(0.00018)	(0.00014)	(0.00045)
$\ln SPS_{it}^{rk}$	0.19***	0.60***	-0.41***	-0.25***	-0.16***	0.35***
	(0.00054)	(0.00062)	(0.00027)	(0.00020)	(0.00016)	(0.00053)
$\ln tar_{it}^{rk}$	-2.66***	-2.42***	-0.23***	0.029***	-0.26***	-2.39***
	(0.0045)	(0.0049)	(0.0018)	(0.0013)	(0.0011)	(0.0043)
$\ln Pop_t^r$	0.60***	0.64***	-0.035***	-0.073***	0.037***	0.57***
	(0.00018)	(0.00021)	(0.000095)	(0.000071)	(0.000055)	(0.00018)
$\ln Pop_t^k$	0.58***	0.59***	-0.011***	-0.045***	0.035***	0.54***
	(0.00016)	(0.00019)	(0.000083)	(0.000062)	(0.000049)	(0.00016)
$\ln GDPpc_t^r$	0.70***	0.49***	0.22***	0.087***	0.13***	0.57***
	(0.00035)	(0.00041)	(0.00018)	(0.00013)	(0.00010)	(0.00034)
$\ln GDPpc_t^k$	0.67***	0.50***	0.18***	0.051***	0.13***	0.55***
	(0.00030)	(0.00036)	(0.00016)	(0.00012)	(0.000094)	(0.00030)
$\ln dist_i^{rk}$	-0.64***	-0.77***	0.13***	0.14***	-0.0086***	-0.63***
	(0.00027)	(0.00032)	(0.00015)	(0.00011)	(0.000086)	(0.00027)
Lan^{rk}	0.33***	0.45***	-0.12***	-0.094***	-0.025***	0.36***
	(0.00068)	(0.00080)	(0.00037)	(0.00027)	(0.00022)	(0.00067)
Col^{rk}	0.24***	0.22***	0.024***	0.0045***	0.019***	0.22***
	(0.0011)	(0.0013)	(0.00060)	(0.00044)	(0.00036)	(0.0011)
$R\,tar_{it}^{rk}$	0.042***	0.022***	0.020***	0.018***	0.0026***	0.039***
	(0.000089)	(0.00010)	(0.000043)	(0.000030)	(0.000026)	(0.000089)
$R\,TBT_{it}^{rk}$	-0.0024***	0.084***	-0.087***	-0.067***	-0.020***	0.018***
	(0.00036)	(0.00043)	(0.00021)	(0.00016)	(0.00012)	(0.00036)
$R\,SPS_{it}^{rk}$	-0.052***	-0.26***	0.21***	0.14***	0.070***	-0.12***
	(0.00031)	(0.00037)	(0.00019)	(0.00014)	(0.00010)	(0.00031)
$R\ln dist_i^{rk}$	-0.0019***	0.00074***	-0.0026***	-0.0018***	-0.00082***	-0.0011***
	(0.0000017)	(0.0000020)	(0.00000097)	(0.00000070)	(0.00000055)	(0.0000017)
$R\,Lan^{rk}$	-0.0061***	-0.081***	0.075***	0.052***	0.023***	-0.029***
	(0.000042)	(0.000049)	(0.000024)	(0.000017)	(0.000013)	(0.000041)
$R\,Col^{rk}$	0.022***	0.081***	-0.059***	-0.048***	-0.011***	0.033***
	(0.000093)	(0.00011)	(0.000053)	(0.000038)	(0.000030)	(0.000093)
Constant: ς_0	-3.67***	-0.97***	-2.70***	-1.61***	-1.10***	-2.58***
	(0.0053)	(0.0063)	(0.0028)	(0.0021)	(0.0016)	(0.0053)
Observations	118240981	118240981	118240981	118240981	118240981	118240981
R-squared	0.216	0.193	0.226	0.203	0.099	0.194
Adjusted R-squared	0.216	0.193	0.226	0.203	0.099	0.194
Year FE: ς_t	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01

Table A2 / Summary statistics of trade-promoting TBTs (i.e., $\varsigma_{iq1}\varsigma^k > 0$) by importers and their related quality impact

Condition:	$\varsigma_{iq1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k > 0;\ \varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k > 0;\ \varsigma_{iz1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$
Jamaica	1067	28.53	-2.78	144	53.46	13.75	568	32.48	-8.70
Uganda	1002	2.62	-0.28	64	9.96	0.85	515	2.61	-0.66
Colombia	909	6.31	-0.56	32	22.60	2.66	392	5.51	-1.52
Japan	904	3.36	-0.42	31	2.87	1.88	359	4.99	-1.23
India	901	9.16	-1.02	15	15.22	3.29	428	11.29	-2.25
Vietnam	846	7.36	-0.66	61	31.14	2.01	231	14.35	-2.93
China	800	1.72	-0.06	82	0.67	0.16	253	1.50	-0.25
Thailand	789	15.46	-2.10	20	71.83	19.62	318	23.66	-6.45
Mongolia	739	4.35	-0.32	88	2.28	0.64	364	3.75	-0.81
Saudi Arabia	724	2.26	-0.49	69	0.57	0.16	194	6.40	-1.88
Italy	704	1.98	-0.30	25	1.09	0.26	284	2.48	-0.77
Canada	672	1.97	-0.25	26	1.18	0.22	233	2.79	-0.74
United States	669	1.63	-0.15	31	0.74	0.17	217	2.26	-0.50
Luxembourg	646	20.26	-7.88	57	13.09	4.07	398	28.52	-13.38
Slovak Republic	638	7.08	-0.81	15	9.02	7.81	304	9.05	-2.08
Poland	618	4.58	-0.68	48	1.98	1.10	287	7.27	-1.65
El Salvador	606	18.85	-2.82	45	18.51	9.37	294	28.02	-7.25
South Korea	602	1.41	-0.12	25	1.01	0.27	230	1.70	-0.34
Kenya	600	2.82	-0.40	40	2.32	0.36	242	4.10	-1.05
South Africa	569	3.06	-0.29	25	2.22	0.38	184	6.52	-0.96
Ukraine	564	7.25	-2.87	28	13.97	5.40	232	13.72	-7.62
Sweden	553	4.76	-0.82	33	2.11	0.45	277	7.01	-1.68
Dominican Republic	552	3.25	-0.34	32	4.70	0.70	236	4.57	-0.89
Bulgaria	551	4.39	-1.46	32	5.04	0.90	264	7.10	-3.15
Slovenia	551	11.13	-1.64	32	2.57	0.85	266	19.28	-3.49
Czech Republic	548	10.46	-2.41	29	1.57	0.41	190	24.31	-7.01
Belgium	543	27.46	-4.92	32	20.66	5.57	271	41.84	-10.52
Greece	527	6.50	-0.44	43	18.03	1.28	263	4.90	-1.10
United Arab Emirates	522	1.80	-0.15	22	0.73	0.19	131	3.18	-0.62
Denmark	518	9.21	-1.05	32	20.67	3.65	282	10.34	-2.35
Brazil	517	4.51	-0.84	14	1.30	0.21	214	8.16	-2.04
Germany	505	1.58	-0.14	24	1.10	0.45	192	1.68	-0.43
Spain	493	7.32	-0.76	23	5.98	1.15	238	10.15	-1.69
Argentina	485	47.73	-9.86	26	45.39	10.54	255	74.32	-19.83
Kuwait	473	2.95	-0.29	32	1.76	0.46	122	6.08	-1.26
Paraguay	466	5.72	-0.60	50	11.56	2.53	164	10.13	-2.47
Malaysia	463	4.31	0.04	25	21.68	10.66	129	4.98	-1.94
Australia	458	6.72	-0.21	19	43.72	3.10	144	5.71	-1.07
Portugal	448	4.42	-0.91	33	2.70	0.59	238	5.86	-1.80
Netherlands	444	13.08	-2.00	29	16.04	3.32	218	20.87	-4.52
Norway	441	7.51	-0.14	24	30.93	14.32	168	11.08	-2.42
Estonia	437	7.35	-0.72	35	6.61	1.34	238	8.69	-1.51
Israel	434	2.94	-0.46	22	1.06	0.24	136	5.80	-1.49
Egypt	421	18.66	-0.45	15	212.06	16.29	206	20.27	-2.11
Mexico	418	3.27	-0.18	37	3.23	0.59	136	4.10	-0.70
Qatar	418	6.58	-0.94	26	9.44	3.11	120	11.02	-3.97

contd.

Table A2 / Contd.

Condition:	$\varsigma_{iq1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k > 0;\ \varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k > 0;\ \varsigma_{iz1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$
Finland	417	8.26	-1.08	25	39.27	5.61	225	7.70	-2.63
United Kingdom	417	1.96	-0.19	12	1.39	0.84	166	2.21	-0.53
Zambia	408	14.29	-1.78	32	7.29	2.00	230	22.60	-3.44
Cyprus	400	4.26	-0.75	26	8.81	1.03	263	4.64	-1.25
Malta	393	10.30	-1.84	52	11.89	3.36	240	12.84	-3.75
Austria	376	4.13	-0.68	21	1.58	0.33	165	7.44	-1.58
Lithuania	374	12.94	-1.75	26	10.33	2.04	232	16.76	-3.05
Latvia	369	13.05	0.00	36	23.04	19.49	203	17.57	-3.45
Costa Rica	367	14.61	-1.52	22	4.73	0.76	176	28.33	-3.26
Hungary	364	6.01	-1.12	17	7.66	2.91	173	9.13	-2.65
Chile	362	3.27	-0.24	12	1.11	0.24	153	5.28	-0.58
Switzerland	362	3.15	-0.74	11	1.71	0.52	109	6.26	-2.51
New Zealand	358	3.55	-0.10	10	47.46	11.13	180	2.80	-0.82
Ireland	338	14.04	-1.38	26	34.84	3.55	203	16.48	-2.76
Oman	336	16.31	-1.31	14	29.53	17.48	148	19.84	-4.64
Taiwan	331	3.55	-0.65	25	3.10	0.75	118	6.95	-1.99
Turkey	326	1.49	-0.17	5	4.08	0.49	166	1.58	-0.35
Nicaragua	304	24.72	-6.32	41	7.86	2.60	134	42.82	-15.13
Panama	301	6.98	-0.52	32	11.84	4.78	158	9.06	-1.96
Trinidad and Tobago	296	16.98	-3.89	28	9.49	2.14	166	26.68	-7.29
Russia	294	1.79	-0.14	19	1.51	0.45	86	2.60	-0.56
Albania	289	5.37	-0.95	21	2.63	0.87	147	8.10	-2.00
Croatia	288	21.97	-1.87	22	2.98	0.90	169	36.18	-3.30
Philippines	286	2.63	-0.13	18	3.61	0.95	92	3.76	-0.59
Romania	277	5.12	-0.89	21	5.02	1.04	138	7.72	-1.95
Kyrgyz Republic	268	19.13	-4.10	25	21.35	2.76	130	31.10	-8.97
Guatemala	266	4.17	-0.51	15	2.70	0.40	130	6.62	-1.09
Uruguay	261	8.24	-1.21	14	6.23	6.39	130	10.89	-3.12
Ecuador	260	4.61	-1.44	24	1.72	0.42	91	9.19	-4.24
Rwanda	254	8.11	-0.82	36	7.13	1.40	98	15.19	-2.63
Ghana	249	30.13	10.61	9	375.95	374.15	107	24.21	-6.79
Indonesia	243	1.67	-0.09	28	2.31	0.33	71	2.06	-0.43
France	234	3.93	-0.45	14	1.07	0.28	79	6.90	-1.38
Cameroon	227	2.69	-0.44	7	7.32	1.27	106	3.28	-1.02
Peru	215	4.50	-1.01	11	1.21	0.44	95	8.46	-2.35
Macedonia	214	6.89	-1.87	11	4.73	0.62	119	10.81	-3.42
Moldova	213	5.65	-0.55	18	12.35	1.71	68	7.67	-2.18
Bahrain	210	4.56	-0.69	18	2.52	0.84	72	9.50	-2.23
Honduras	209	21.19	-0.98	12	178.57	7.97	93	16.73	-3.22
Armenia	201	60.75	-6.82	13	30.50	1.16	90	121.84	-15.40
Pakistan	194	18.91	-3.34	23	74.64	16.80	73	23.85	-14.16
Georgia	193	12.03	0.88	10	68.59	47.40	103	13.51	-2.95
Sri Lanka	162	183.52	-47.01	11	2.96	0.47	81	363.19	-94.08
Botswana	137	6.88	-0.10	9	80.84	3.29	76	1.87	-0.57
Tanzania	132	1.75	-0.14	10	1.83	0.43	46	1.91	-0.49
Hong Kong	129	3.00	-0.14	11	2.00	1.23	35	6.54	-0.89
Saint Lucia	118	3.43	-1.12	8	10.28	2.48	73	3.56	-2.08

contd.

Table A2 / Contd.

Condition:	$\varsigma_{iq1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k > 0;\ \varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k > 0;\ \varsigma_{iz1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{\iota q1}\varsigma^k}$	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota q1}\varsigma^k}$	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota q1}\varsigma^k}$	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$
Venezuela	118	5.68	-0.38	11	2.94	0.96	43	9.73	-1.29
Bolivia	85	12.96	-2.54	7	18.97	3.72	46	16.02	-5.27
Brunei	80	34.85	-1.58	5	24.24	4.87	48	50.93	-3.15
Singapore	75	2.52	-0.18	1	9.30	2.98	35	3.78	-0.47
Kazakhstan	69	3.48	-0.49	1	2.03	0.74	28	4.54	-1.23
Jordan	68	4.64	-0.52	3	6.13	1.87	25	8.27	-1.63
Tunisia	68	112.12	-13.17	11	37.48	7.73	34	206.78	-28.84
Grenada	66	13.81	-2.74	8	12.40	4.86	50	15.46	-4.39
Barbados	54	8.75	-0.68	6	47.77	8.52	23	6.13	-3.81
Mauritius	38	4.46	-0.65	1	0.81	0.66	22	4.81	-1.16
Yemen	32	4.50	-0.50	4	4.93	0.66	15	6.03	-1.24
Belize	31	1.93	-0.49	0			18	2.27	-0.84
Central African Republic	31	8.90	-0.59	6	6.55	2.44	18	10.14	-1.83
Mozambique	28	2.00	-0.18	0			9	2.22	-0.56
Saint Vincent and the Grenadines	22	2.20	-0.39	2	2.01	0.27	11	3.22	-0.83
Morocco	20	2.28	-0.23	0			7	4.54	-0.66
Macau	18	16.13	-1.75	3	7.51	1.79	10	23.12	-3.69
Senegal	14	10.77	-2.88	0			8	16.07	-5.03
Montenegro	11	4.09	0.38	2	12.23	3.58	4	2.53	-0.75
Malawi	9	1.38	-0.09	1	1.22	0.21	5	1.41	-0.21
Benin	6	11.81	0.51	1	9.77	3.84	1	14.49	-0.78
Nigeria	3	2.53	-0.80	0			2	2.78	-1.20
Seychelles	3	7.25	-1.58	0			3	7.25	-1.58
Cambodia	1	1.04	0.00	0			0		

Note: statistics show the number of products whose imported quantities to an importer is stimulated by TBT. Therefore, the estimated elasticity of TBT for that importer k and product i is positive $\varsigma_{iq1}\varsigma^k > 0$ in this table and is statistically significant at 10% level. $\widetilde{\varsigma_{\iota q1}\varsigma^k}$ and $\widetilde{\varsigma_{\iota z1}\varsigma^k}$ are the average of the estimated TBT elasticises of traded quantity and traded quality, respectively, which both meet the conditions in each column of the table and are statistically significant at 10%. Coefficients that are not statistically significant at 10% are simply removed from this table.
Table is sorted by the largest number of affected products whose import quantities are stimulated by TBTs at 10% level of significance.
Source: Author's estimation of equation (38) on global bilateral trade flows of each product at six-digit level of the HS rev. 1.

Table A3 / Summary statistics of trade-restrictive TBTs (i.e., $\varsigma_{iq1}\varsigma^k < 0$) by importers and their related quality impact

Condition:	$\varsigma_{iq1}\varsigma^k < 0$			$\varsigma_{iq1}\varsigma^k < 0;\ \varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k < 0;\ \varsigma_{iz1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$
Hungary	1685	-2.36	0.35	1051	-2.67	0.58	53	-4.27	-0.48
Ireland	1622	-4.40	-0.17	818	-4.96	1.16	69	-22.24	-17.71
Argentina	1470	-21.94	8.72	805	-34.37	16.21	36	-41.21	-6.65
Romania	1466	-1.89	0.25	826	-2.31	0.47	64	-1.42	-0.30
Latvia	1456	-4.89	0.94	799	-6.38	1.86	97	-4.44	-1.30
Lithuania	1422	-3.55	0.39	783	-4.15	0.88	64	-4.40	-2.04
Croatia	1418	-2.91	0.49	823	-2.70	0.88	63	-1.61	-0.41
France	1364	-1.73	0.22	866	-1.72	0.35	28	-0.95	-0.21
Netherlands	1334	-2.55	0.27	807	-2.82	0.54	38	-3.58	-1.78
Denmark	1333	-6.84	1.41	713	-8.88	2.69	44	-5.13	-0.90
Cyprus	1263	-10.43	2.48	661	-17.23	4.88	108	-6.85	-0.86
Belgium	1238	-14.13	1.90	637	-22.13	3.93	42	-22.72	-3.46
Malta	1207	-9.22	3.32	659	-14.72	6.18	79	-4.74	-0.84
Jamaica	1163	-39.03	6.55	673	-49.95	13.35	126	-51.63	-10.81
Taiwan	1160	-2.37	0.26	630	-1.86	0.56	24	-10.48	-2.04
Portugal	1157	-3.53	0.75	632	-4.69	1.42	45	-2.49	-0.69
Estonia	1130	-4.37	0.50	663	-4.76	1.12	52	-11.07	-3.48
Spain	1114	-4.24	0.64	603	-5.70	1.25	38	-2.47	-0.94
Finland	1094	-2.56	0.34	596	-3.11	0.67	44	-3.27	-0.56
Austria	1090	-1.83	0.27	697	-1.98	0.44	19	-1.26	-0.52
South Korea	1076	-1.41	0.15	604	-1.36	0.28	20	-2.09	-0.53
El Salvador	1071	-22.31	5.19	539	-39.17	11.40	54	-16.37	-10.93
Ukraine	1066	-2.21	0.73	528	-3.03	1.49	28	-1.56	-0.33
Sweden	1057	-3.89	0.75	557	-5.73	1.48	51	-2.59	-0.67
Norway	1032	-6.20	0.54	447	-10.87	1.59	23	-16.83	-6.82
Greece	1031	-3.44	0.40	557	-4.35	0.98	47	-4.92	-2.76
United Kingdom	991	-1.48	0.24	604	-1.51	0.41	30	-1.02	-0.19
Germany	977	-1.34	0.23	658	-1.42	0.35	35	-1.12	-0.28
China	938	-1.70	0.20	581	-1.64	0.33	16	-1.93	-0.40
Poland	936	-2.72	0.49	721	-2.43	0.75	16	-20.02	-5.09
Mexico	891	-2.11	0.33	628	-2.13	0.48	14	-2.61	-0.65
Bulgaria	883	-2.37	0.46	495	-2.89	0.88	25	-2.48	-1.20
Brazil	870	-6.99	0.74	481	-10.90	1.38	22	-5.49	-0.77
Slovenia	864	-6.23	2.27	483	-8.31	4.15	34	-9.70	-1.12
Czech Republic	822	-3.18	0.31	479	-3.11	0.55	24	-2.50	-0.54
Egypt	790	-15.61	-0.02	357	-10.87	1.69	30	-247.29	-20.51
Slovak Republic	775	-6.83	-0.66	422	-8.24	1.47	30	-26.00	-37.75
Italy	771	-2.92	0.60	470	-3.93	1.04	32	-2.70	-0.93
Japan	755	-5.39	0.04	348	-2.44	0.66	28	-95.12	-7.07
Luxembourg	726	-13.64	1.10	416	-18.97	3.15	83	-15.42	-6.17
United Arab Emirates	713	-2.85	0.32	385	-3.90	0.61	10	-2.87	-0.89
Nicaragua	709	-5.86	0.71	388	-8.10	1.37	30	-7.14	-0.83
Colombia	701	-9.70	1.56	346	-15.10	3.29	34	-14.24	-1.27
Thailand	701	-11.72	1.38	296	-18.32	3.86	18	-27.40	-9.86
Mongolia	693	-3.45	0.36	381	-3.55	0.85	72	-7.00	-1.05
United States	674	-13.58	0.23	382	-2.07	0.41	15	-2.09	-0.24

contd.

Table A3 / Contd.

Condition:	$\varsigma_{iq1}\varsigma^k < 0$			$\varsigma_{iq1}\varsigma^k < 0;\ \varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k < 0;\ \varsigma_{iz1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$
Canada	658	-3.86	0.34	437	-4.85	0.52	8	-0.89	-0.19
Costa Rica	654	-5.95	2.56	348	-9.47	4.89	28	-3.85	-0.95
Venezuela	652	-2.68	0.37	323	-3.50	0.76	14	-2.77	-0.44
Trinidad and Tobago	635	-7.95	1.78	289	-12.00	4.58	53	-15.55	-3.63
India	609	-11.99	1.22	275	-12.80	2.92	17	-18.27	-3.67
Ecuador	605	-3.30	0.47	433	-3.22	0.68	12	-2.73	-0.67
Switzerland	596	-2.29	0.30	296	-2.53	0.62	13	-1.11	-0.28
Panama	583	-5.57	0.69	273	-8.46	1.84	42	-2.84	-2.39
Saudi Arabia	581	-1.99	0.21	317	-2.84	0.39	21	-0.84	-0.20
Sri Lanka	578	-3.45	0.39	309	-4.37	0.83	12	-9.84	-2.63
Uganda	574	-2.25	0.22	239	-2.69	0.72	67	-2.42	-0.72
Chile	572	-3.05	0.31	304	-3.18	0.71	17	-4.43	-2.28
Kenya	570	-6.24	2.82	255	-12.05	6.39	33	-2.19	-0.70
Israel	535	-1.55	0.18	286	-1.46	0.35	10	-1.12	-0.22
Philippines	522	-19.72	1.06	258	-18.24	4.97	17	-300.07	-42.91
Rwanda	507	-10.02	1.10	364	-9.92	2.21	24	-46.15	-10.26
Pakistan	498	-5.08	0.52	317	-7.12	0.90	19	-3.49	-1.25
Albania	493	-5.78	1.04	281	-5.86	2.02	30	-6.32	-1.83
South Africa	491	-2.95	0.28	236	-4.07	0.75	15	-8.81	-2.63
Vietnam	482	-4.85	1.14	244	-7.97	2.44	17	-3.41	-2.51
Honduras	479	-21.24	-0.47	249	-4.69	0.83	27	-315.53	-15.96
Malaysia	462	-2.72	0.67	249	-3.65	1.25	8	-1.46	-0.33
Qatar	449	-6.61	0.11	227	-3.18	0.80	17	-104.85	-7.77
Uruguay	428	-8.21	1.05	212	-12.31	2.84	30	-15.42	-5.14
Russia	409	-1.73	0.22	242	-1.73	0.39	7	-1.40	-0.55
Dominican Republic	404	-4.12	0.30	186	-4.15	0.77	23	-16.31	-0.89
Turkey	401	-2.06	0.07	158	-1.74	0.36	11	-19.33	-2.78
Zambia	400	-12.55	0.83	184	-20.32	5.23	36	-21.98	-17.49
Oman	377	-4.64	0.68	189	-5.45	1.39	21	-1.56	-0.34
Hong Kong	372	-2.27	0.31	233	-2.41	0.52	10	-2.96	-0.60
Indonesia	369	-1.74	0.24	249	-1.59	0.38	7	-2.78	-0.72
Paraguay	350	-11.08	2.47	220	-14.48	4.21	18	-15.77	-3.35
Bahrain	336	-6.30	1.11	194	-7.47	2.49	18	-15.02	-6.12
Jordan	319	-2.38	0.65	129	-4.14	1.62	5	-1.40	-0.39
Kuwait	306	-2.59	1.05	171	-3.19	1.92	9	-1.87	-0.65
New Zealand	291	-2.63	0.34	170	-3.29	0.60	7	-1.48	-0.30
Armenia	278	-7.05	0.30	150	-5.90	1.15	26	-29.40	-3.46
Guatemala	274	-2.39	0.35	143	-2.81	0.71	13	-3.03	-0.43
Singapore	262	-3.06	0.13	140	-3.04	0.65	5	-26.94	-11.58
Tanzania	261	-2.80	0.40	114	-3.90	1.00	13	-2.28	-0.62
Australia	237	-2.55	0.55	115	-3.30	1.29	9	-5.96	-1.94
Kyrgyz Republic	230	-18.79	3.13	134	-19.89	5.91	27	-43.71	-2.69
Georgia	226	-5.26	0.76	108	-8.87	1.68	11	-4.92	-0.84
Macedonia	212	-6.46	1.63	102	-7.97	3.68	17	-5.17	-1.80
Mauritius	211	-2.99	0.17	120	-2.72	0.78	6	-17.07	-9.70
Moldova	198	-6.56	0.92	95	-8.84	2.24	10	-18.28	-2.97
Grenada	182	-6.34	-0.24	72	-6.56	1.19	30	-17.76	-4.31

contd.

Table A3 / Contd.

Condition:	$\varsigma_{iq1}\varsigma^k < 0$			$\varsigma_{iq1}\varsigma^k < 0;\ \varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iq1}\varsigma^k < 0;\ \varsigma_{iz1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq1}\varsigma^k}$	$\widetilde{\varsigma_{iz1}\varsigma^k}$
Botswana	172	-2.46	-0.04	56	-3.87	0.59	29	-2.91	-1.41
Peru	167	-4.57	0.88	79	-7.25	1.92	11	-5.08	-0.39
Brunei	156	-23.65	5.16	70	-45.79	11.76	10	-12.92	-1.83
Saint Lucia	131	-5.09	1.01	57	-9.59	2.45	13	-1.24	-0.60
Ghana	125	-72.33	14.00	66	-130.39	26.86	3	-23.16	-7.65
Bolivia	105	-3.71	0.58	61	-4.35	1.03	6	-2.54	-0.38
Tunisia	94	-9.52	0.78	47	-7.84	2.39	7	-41.94	-5.50
Kazakhstan	93	-2.77	0.46	42	-3.89	1.10	3	-1.41	-1.04
Nigeria	90	-4.55	0.67	39	-7.98	1.56	4	-1.84	-0.19
Yemen	83	-2.84	0.26	47	-3.38	0.52	7	-3.00	-0.43
Morocco	56	-1.57	0.16	17	-1.67	0.55	1	-0.71	-0.15
Cameroon	47	-23.93	5.18	23	-46.72	10.75	3	-1.71	-1.29
Barbados	42	-4.70	0.76	19	-8.15	1.75	3	-2.76	-0.43
Macau	39	-18.72	9.79	16	-35.73	24.07	4	-8.72	-0.87
Saint Vincent and the Grenadines	37	-2.63	0.84	23	-3.55	1.36	0		
Central African Republic	20	-17.95	4.06	13	-24.94	6.49	3	-3.13	-1.09
Malawi	10	-3.67	0.63	6	-4.81	1.05	0		
Senegal	7	-250.06	0.41	4	-7.96	0.71	0		
Swaziland	6	-3.54	0.50	5	-3.04	0.61	0		
Belize	5	-3.69	0.37	3	-3.55	0.61	0		
Benin	3	-18.56	4.20	1	-30.50	12.61	0		
Mozambique	3	-2.49	0.00	0			0		
Seychelles	2	-3.65	0.18	1	-3.96	0.36	0		
Mali	1	-1.54	0.00	0			0		
Nepal	1	-1.35	0.00	0			0		

Note: statistics show the number of products whose imported quantities to an importer is restricted by TBT. Therefore, the estimated elasticity of TBT for that importer k and product i is negative $\varsigma_{iq1}\varsigma^k < 0$ in this table and is statistically significant at 10% level. $\widetilde{\varsigma_{iq1}\varsigma^k}$ and $\widetilde{\varsigma_{iz1}\varsigma^k}$ are the average of the estimated TBT elasticises of traded quantity and traded quality, respectively, which both meet the conditions in each column of the table and are statistically significant at 10%. Coefficients that are not statistically significant at 10% are simply removed from this table.
Table is sorted by the largest number of affected products whose import quantities are restricted by TBTs at 10% level of significance.
Source: Author's estimation of equation (38) on global bilateral trade flows of each product at six-digit level of the HS rev. 1.

Table A4 / Summary statistics of trade-promoting SPS measures (i.e., $\varsigma_{iq2}\varsigma^k > 0$) by importers and their related quality impact

Condition:	$\varsigma_{iq2}\varsigma^k > 0$			$\varsigma_{iq2}\varsigma^k > 0;\ \varsigma_{iz2}\varsigma^k > 0$			$\varsigma_{iq2}\varsigma^k > 0;\ \varsigma_{iz2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$
Nepal	1060	143.62	-20.04	152	64.18	39.11	629	209.63	-43.22
New Zealand	753	3.47	-0.22	37	7.25	2.83	362	3.29	-0.74
Armenia	742	75.83	1.73	101	324.25	72.53	317	66.89	-19.06
United States	670	1.58	-0.17	52	1.06	0.28	307	1.92	-0.42
Egypt	567	26.17	-2.46	37	83.32	11.82	285	27.50	-6.42
Kyrgyz Republic	519	20.52	-4.59	45	30.72	5.92	288	29.81	-9.19
Italy	381	2.19	-0.21	18	3.07	1.32	213	2.04	-0.49
Poland	363	11.65	-3.16	18	5.44	1.00	195	18.63	-5.98
Chile	352	5.51	-0.64	26	3.76	0.54	169	8.73	-1.41
Greece	316	5.56	-0.88	22	4.93	1.59	198	6.60	-1.58
Guatemala	306	21.61	-2.68	22	9.83	5.09	160	37.43	-5.82
Dominican Republic	304	2.37	-0.22	23	4.64	0.63	160	2.53	-0.51
Germany	289	1.97	-0.27	13	0.85	0.26	138	2.32	-0.59
Portugal	287	13.20	-5.42	24	4.37	1.26	178	19.45	-8.90
Slovak Republic	287	13.68	-2.87	13	12.91	3.22	169	20.54	-5.12
Vietnam	279	1.81	-0.21	13	1.54	0.38	109	2.41	-0.59
Bulgaria	277	15.24	-3.20	11	15.70	2.19	159	24.27	-5.73
United Kingdom	277	6.68	-0.74	7	1.15	1.06	158	3.05	-1.34
Brazil	275	4.14	-0.55	10	6.60	0.79	154	5.93	-1.04
Belgium	272	4.11	-0.40	14	14.61	3.10	162	4.01	-0.94
Spain	268	4.34	-0.89	7	4.02	0.95	152	5.80	-1.62
Finland	258	220.37	-17.75	16	57.56	64.50	157	354.35	-35.74
Sweden	254	8.78	-0.58	14	26.26	17.83	146	10.01	-2.72
Luxembourg	252	66.26	-23.96	32	9.64	3.99	162	64.10	-38.06
Colombia	250	3.56	-0.46	9	3.86	0.77	142	4.58	-0.85
Cyprus	250	19.12	-4.22	18	8.86	1.63	163	27.32	-6.65
Costa Rica	247	11.04	-2.77	12	3.67	0.51	144	15.51	-4.80
Ireland	244	17.53	-3.19	23	8.63	1.23	148	25.68	-5.46
Netherlands	243	6.35	-0.97	7	4.61	2.23	129	8.73	-1.94
Denmark	238	19.10	-2.88	12	31.59	17.12	161	21.24	-5.53
Nicaragua	238	32.80	-10.34	13	35.24	3.09	131	52.56	-19.10
Estonia	235	30.24	-2.58	25	142.03	8.08	154	21.84	-5.25
Slovenia	235	8.14	-2.24	10	2.35	0.53	128	11.68	-4.15
China	231	1.79	-0.17	15	1.04	0.24	88	2.37	-0.48
Latvia	231	22.16	-2.73	11	33.46	30.32	137	31.55	-7.05
Czech Republic	225	10.45	-1.69	14	2.04	0.48	123	15.52	-3.15
Australia	220	3.33	-0.42	11	2.75	1.03	104	4.59	-1.00
Austria	210	3.24	-0.50	7	5.04	0.63	107	3.69	-1.03
Japan	208	1.67	-0.25	9	1.21	0.40	99	2.07	-0.57
El Salvador	207	14.26	-3.38	8	1.89	1.22	114	14.39	-6.23
Lithuania	204	15.89	-2.03	10	5.82	1.24	131	17.51	-3.25
Peru	203	6.03	-0.44	14	5.61	2.68	106	9.14	-1.19
Georgia	201	32.80	-6.38	12	36.19	6.22	118	37.46	-11.50
Honduras	196	6.74	-0.86	15	3.25	0.73	113	8.27	-1.58
South Korea	193	1.91	-0.29	8	0.81	0.24	105	2.22	-0.56
India	190	16.89	0.30	10	280.24	10.23	94	2.18	-0.47

contd.

Table A4 / Contd.

Condition:	$\varsigma_{iq2}\varsigma^k > 0$			$\varsigma_{iq2}\varsigma^k > 0;\ \varsigma_{iz2}\varsigma^k > 0$			$\varsigma_{iq2}\varsigma^k > 0;\ \varsigma_{iz2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$
Malta	187	21.26	-5.75	26	7.39	1.66	121	29.89	-9.24
Hungary	175	8.50	-1.21	10	10.79	1.15	104	8.78	-2.14
Romania	169	6.01	-0.94	11	16.70	4.32	116	6.36	-1.77
France	166	4.67	-0.69	8	6.38	2.41	91	5.28	-1.46
Croatia	164	149.89	-108.26	14	7.96	2.29	106	230.20	-167.81
Panama	158	14.35	-2.90	9	4.26	1.23	90	20.46	-5.22
Argentina	150	3.24	-0.42	7	1.55	0.96	85	4.36	-0.83
Russia	142	2.02	-0.13	6	1.63	0.57	52	2.78	-0.42
Mexico	138	2.39	-0.33	9	2.80	0.67	78	2.71	-0.65
Mongolia	138	99.42	-22.22	14	26.50	3.94	79	154.89	-39.52
Switzerland	135	1.84	-0.29	6	1.11	0.33	72	2.07	-0.56
Indonesia	131	3.50	-0.16	17	1.40	0.45	55	2.59	-0.51
Albania	128	2.50	-0.29	8	1.92	0.37	77	2.96	-0.53
Taiwan	126	2.05	-0.24	5	0.65	0.12	54	2.26	-0.57
Ukraine	125	1.90	-0.19	4	7.18	0.56	64	1.76	-0.41
Canada	122	3.18	-0.36	6	1.00	0.21	57	5.05	-0.78
Thailand	121	4.67	-1.15	5	6.36	1.12	65	6.75	-2.23
Fiji	119	10.28	-0.92	13	20.93	1.38	43	18.52	-2.96
Kuwait	119	1.43	-0.13	9	1.08	0.20	41	1.80	-0.42
Laos	115	212.47	-18.85	19	86.77	40.08	70	283.23	-41.84
Malaysia	115	1.81	-0.25	4	1.02	0.19	47	2.36	-0.62
Oman	112	2.77	-0.66	6	1.79	0.33	51	3.67	-1.48
Saudi Arabia	109	1.28	-0.13	8	0.88	0.28	57	1.46	-0.30
Qatar	108	1.78	-0.20	15	0.99	0.25	33	2.43	-0.75
Hong Kong	97	3.70	-0.49	4	2.95	0.78	48	5.76	-1.05
Norway	95	2.49	-0.22	5	1.28	0.38	48	2.45	-0.47
United Arab Emirates	93	1.54	-0.15	3	1.05	0.17	38	1.66	-0.37
Philippines	87	11.12	2.16	10	74.65	22.49	37	3.63	-1.00
Turkey	84	2.38	-0.32	5	1.49	0.28	44	3.15	-0.65
Antigua and Barbuda	83	264.68	-118.61	13	14.04	6.32	54	402.12	-183.82
Nigeria	81	9.29	-1.66	6	28.83	2.11	53	9.95	-2.78
South Africa	81	4.25	-0.06	2	48.97	12.01	42	3.63	-0.69
Burundi	75	26.93	-9.14	10	1.94	0.59	46	37.65	-15.03
Mali	75	10.83	-0.81	17	7.13	2.06	36	16.79	-2.66
Morocco	75	5.04	-0.70	8	11.19	1.42	51	5.12	-1.25
Singapore	71	8.53	-2.31	3	1.09	0.31	30	17.83	-5.49
Bahrain	69	2.56	-0.01	7	5.13	2.92	32	2.98	-0.66
Ecuador	67	3.01	-0.38	5	1.96	0.40	43	3.77	-0.64
Kazakhstan	67	11.88	-1.08	8	3.95	0.43	41	17.64	-1.85
Swaziland	66	8.00	-1.59	6	1.72	0.40	58	8.74	-1.85
Sri Lanka	61	9.01	-1.09	3	18.40	4.06	38	9.50	-2.07
Cote d'Ivoire	59	1.83	-0.25	0			34	2.10	-0.43
Gambia	58	19.84	-4.19	11	7.05	8.00	33	31.50	-10.02
Madagascar	58	12.20	0.05	9	45.65	6.66	31	8.12	-1.84
Zambia	45	31.88	-3.73	4	9.04	5.36	24	44.87	-7.89
Macau	43	4.78	-0.75	9	1.36	0.24	13	12.40	-2.66
Belize	41	11.93	-0.05	9	15.22	3.79	24	5.43	-1.50

contd.

Table A4 / Contd.

Condition:	$\varsigma_{iq2}\varsigma^k > 0$			$\varsigma_{iq2}\varsigma^k > 0;\ \varsigma_{iz2}\varsigma^k > 0$			$\varsigma_{iq2}\varsigma^k > 0;\ \varsigma_{iz2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$
Jamaica	41	7.25	-0.81	4	28.79	4.03	27	6.06	-1.82
Togo	41	4.97	-0.86	8	4.46	0.96	29	5.30	-1.47
Cape Verde	38	3.64	-0.82	1	1.43	0.22	23	5.08	-1.37
Moldova	38	3.70	-0.32	2	3.77	0.26	19	5.31	-0.68
Saint Vincent and the Grenadines	35	2.80	0.55	5	5.06	5.20	16	2.70	-0.41
Macedonia	34	11.23	-0.77	2	6.92	1.47	21	14.40	-1.38
Malawi	28	5.11	-0.45	5	9.33	1.67	19	4.41	-1.10
Congo	27	26.23	-2.36	5	10.57	1.17	12	30.49	-5.79
Ghana	27	4.61	-0.82	0			17	6.07	-1.31
Barbados	25	24.29	-1.63	2	1.69	0.31	17	34.67	-2.44
Jordan	24	3.46	-0.31	4	1.69	0.27	9	5.26	-0.94
Brunei	22	10.56	-1.53	3	1.96	2.92	14	12.51	-3.02
Uruguay	21	3.79	-0.68	0			14	4.61	-1.02
Mauritius	17	3.57	-0.24	1	5.60	1.82	8	3.79	-0.73
Burkina Faso	16	2.42	-0.36	1	1.66	0.49	9	3.04	-0.69
Guinea	16	37.73	-6.04	1	2.71	2.48	10	56.28	-9.91
Iceland	15	10.87	-1.19	1	1.11	0.37	13	12.36	-1.40
Central African Republic	14	21.18	-3.51	1	2.76	0.58	8	18.25	-6.21
Venezuela	13	3.53	-0.25	3	1.86	0.40	7	3.62	-0.64
Trinidad and Tobago	12	13.55	-2.28	1	4.64	0.41	7	18.71	-3.97
Uganda	12	3.28	-0.20	2	1.67	0.61	5	3.77	-0.73
Benin	11	11.21	-3.43	2	1.34	0.74	6	14.63	-6.54
Bolivia	11	12.46	-0.99	1	44.98	4.02	7	12.15	-2.13
Israel	11	4.93	-0.54	0			5	3.43	-1.19
Zimbabwe	10	3.39	-0.51	1	2.08	0.21	6	4.42	-0.89
Paraguay	8	22.41	-12.13	0			6	29.04	-16.17
Mozambique	7	10.25	-1.62	1	2.24	0.10	5	11.42	-2.28
Senegal	7	81.51	-7.08	0			5	40.91	-9.91
Kenya	6	7.59	0.73	1	6.92	5.24	1	1.32	-0.84
Pakistan	6	11.28	-1.74	0			5	11.76	-2.09
Tunisia	4	2.02	-0.25	0			1	2.15	-0.98
Seychelles	2	9.77	-2.10	0			2	9.77	-2.10
Tanzania	1	7.41	0.17	1	7.41	0.17	0		

Note: statistics show the number of products whose imported quantities to an importer is stimulated by SPS measures. Therefore, the estimated elasticity of SPS measure for that importer k and product i is positive $\varsigma_{iq2}\varsigma^k > 0$ in this table and is statistically significant at 10% level. $\widetilde{\varsigma_{iq2}\varsigma^k}$ and $\widetilde{\varsigma_{iz2}\varsigma^k}$ are the average of the estimated SPS elasticises of traded quantity and traded quality, respectively, which both meet the conditions in each column of the table and are statistically significant at 10%. Coefficients that are not statistically significant at 10% are simply removed from this table.
Table is sorted by the largest number of affected products whose import quantities are stimulated by SPS measures at 10% level of significance.
Source: Author's estimation of equation (38) on global bilateral trade flows of each product at six-digit level of the HS rev. 1.

Table A5 / Summary statistics of trade-restrictive SPS measures (i.e., $\varsigma_{iq2\varsigma}^{k} < 0$) by importers and their related quality impact

Condition:	$\varsigma_{iq2\varsigma}^{k} < 0$			$\varsigma_{iq2\varsigma}^{k} < 0;\ \varsigma_{iz2\varsigma}^{k} > 0$			$\varsigma_{iq2\varsigma}^{k} < 0;\ \varsigma_{iz2\varsigma}^{k} < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq2\varsigma}^{k}}$	$\widetilde{\varsigma_{iz2\varsigma}^{k}}$	**No. Products**	$\widetilde{\varsigma_{iq2\varsigma}^{k}}$	$\widetilde{\varsigma_{iz2\varsigma}^{k}}$	**No. Products**	$\widetilde{\varsigma_{iq2\varsigma}^{k}}$	$\widetilde{\varsigma_{iz2\varsigma}^{k}}$
Nepal	1539	-49.01	3.81	777	-56.34	14.33	208	-78.11	-25.32
Egypt	1396	-13.31	3.00	573	-25.03	7.72	75	-16.77	-3.15
United States	1204	-1.62	0.18	616	-1.63	0.37	53	-1.26	-0.30
Armenia	890	-31.04	3.99	539	-35.39	7.62	60	-30.29	-9.25
Kyrgyz Republic	852	-16.65	0.00	368	-12.48	2.07	79	-93.67	-9.59
New Zealand	816	-2.63	0.25	360	-2.75	0.61	30	-2.06	-0.49
Hungary	561	-3.58	0.71	275	-4.75	1.58	33	-4.25	-1.10
Ireland	531	-11.21	1.01	240	-20.12	2.68	40	-8.23	-2.65
Nicaragua	494	-7.71	0.46	242	-7.78	1.22	38	-9.69	-1.80
Romania	473	-4.55	0.58	217	-6.54	1.34	33	-2.25	-0.46
Netherlands	444	-10.20	1.82	178	-20.75	4.74	21	-3.78	-1.62
Denmark	443	-7.93	0.93	224	-7.88	2.12	24	-16.02	-2.63
Lithuania	437	-5.95	0.64	216	-7.67	1.99	30	-9.57	-5.04
Guatemala	433	-5.35	0.88	187	-9.64	2.09	28	-2.85	-0.33
Estonia	417	-5.03	0.31	206	-5.53	1.40	22	-16.82	-7.17
Latvia	416	-17.56	1.19	214	-16.38	4.48	32	-71.31	-14.57
Finland	401	-6.95	1.66	186	-10.64	3.85	27	-11.18	-1.86
Taiwan	399	-1.66	0.18	172	-1.91	0.45	12	-1.28	-0.46
Malta	393	-14.58	4.52	204	-23.75	9.13	42	-13.99	-2.11
South Korea	388	-1.51	0.14	165	-1.70	0.35	7	-1.08	-0.18
Portugal	383	-7.18	0.83	199	-9.34	1.80	22	-17.11	-1.83
Honduras	375	-5.39	0.42	186	-7.94	1.77	23	-10.16	-7.47
Slovak Republic	372	-5.91	0.79	209	-7.32	1.50	23	-7.61	-0.82
Sweden	368	-3.11	0.23	142	-3.81	0.87	26	-6.37	-1.57
Croatia	365	-4.62	1.28	162	-7.32	2.94	21	-2.19	-0.40
El Salvador	359	-3.73	0.85	180	-5.16	1.76	21	-2.69	-0.49
Austria	358	-7.76	0.91	162	-12.54	2.12	18	-4.06	-1.03
China	350	-1.95	0.21	160	-2.10	0.47	6	-1.55	-0.17
Cyprus	349	-7.34	1.42	161	-12.02	3.30	39	-3.79	-0.88
Brazil	333	-2.61	0.63	147	-4.20	1.44	15	-1.15	-0.25
Luxembourg	330	-14.69	1.40	197	-19.35	2.83	34	-8.17	-2.76
France	329	-2.54	0.29	128	-3.65	0.76	15	-0.95	-0.17
Belgium	325	-3.46	0.44	142	-4.88	1.17	13	-8.00	-1.86
Mexico	325	-3.09	0.56	152	-3.62	1.23	14	-1.67	-0.25
Bulgaria	323	-5.40	1.32	155	-7.74	2.79	17	-1.38	-0.36
Czech Republic	322	-7.96	1.73	150	-13.24	4.18	12	-12.31	-5.79
Chile	321	-4.80	-0.52	143	-2.68	0.57	18	-45.89	-13.89
Russia	319	-2.36	0.12	159	-2.03	0.39	9	-21.86	-2.72
Greece	315	-4.76	0.68	145	-4.78	1.56	25	-1.68	-0.46
Slovenia	310	-6.84	0.76	130	-7.80	2.28	23	-13.53	-2.61
Spain	304	-2.87	0.26	110	-3.77	0.76	12	-2.35	-0.45
United Kingdom	278	-4.81	0.72	108	-9.57	1.89	12	-1.40	-0.31
Poland	275	-7.24	1.89	179	-9.51	2.99	7	-9.46	-2.37
Costa Rica	236	-4.30	0.38	110	-6.40	0.96	14	-4.58	-1.08
Nigeria	231	-15.68	1.03	113	-15.54	2.17	12	-2.79	-0.52
Germany	226	-2.72	0.51	97	-4.54	1.19	9	-0.74	-0.13

contd.

Table A5 / Contd.

Condition:	$\varsigma_{iq2}\varsigma^k < 0$			$\varsigma_{iq2}\varsigma^k < 0;\ \varsigma_{iz2}\varsigma^k > 0$			$\varsigma_{iq2}\varsigma^k < 0;\ \varsigma_{iz2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$
Indonesia	226	-27.89	2.59	123	-27.36	5.75	7	-392.22	-17.39
Canada	218	-1.35	0.13	97	-1.55	0.31	9	-0.69	-0.14
Singapore	216	-4.75	0.95	76	-8.44	2.71	3	-1.08	-0.14
Argentina	205	-4.72	0.26	95	-5.85	0.71	10	-20.02	-1.44
Dominican Republic	203	-8.33	0.53	85	-17.29	1.33	12	-2.10	-0.38
Panama	201	-50.30	2.94	83	-113.71	9.73	24	-16.84	-9.06
Sri Lanka	186	-2.33	0.22	81	-3.31	0.57	10	-1.66	-0.50
Morocco	184	-3.83	0.29	79	-6.23	0.86	11	-3.23	-1.28
Colombia	178	-5.34	0.16	74	-3.89	0.61	22	-3.05	-0.75
Switzerland	172	-2.38	0.24	65	-3.36	0.68	5	-1.83	-0.55
Italy	168	-3.71	0.66	81	-5.53	1.46	4	-5.48	-1.97
Georgia	167	-33.22	8.58	93	-45.30	20.22	17	-52.26	-26.39
Ukraine	167	-3.30	0.20	80	-2.42	0.44	8	-1.60	-0.26
Japan	162	-2.32	0.38	48	-5.01	1.36	15	-0.85	-0.21
Antigua and Barbuda	160	-22.35	6.73	87	-34.61	14.00	21	-9.90	-6.77
Peru	157	-385.46	-6.91	69	-13.16	3.95	12	-4954.60	-113.13
India	154	-6.72	0.95	67	-12.07	2.23	10	-1.84	-0.24
Hong Kong	152	-5.36	1.09	75	-8.47	2.35	6	-9.56	-1.61
Vietnam	151	-1.77	0.21	64	-2.03	0.49	1	-2.57	-0.55
Norway	148	-2.45	0.21	57	-3.22	0.56	3	-8.31	-0.57
Fiji	146	-71.37	8.08	77	-133.59	15.35	3	-2.51	-0.56
Bahrain	144	-1.31	0.14	65	-1.52	0.31	4	-0.77	-0.19
Oman	142	-6.55	1.14	41	-19.31	3.99	3	-1.33	-0.29
Mongolia	139	-24.42	1.62	86	-22.55	3.70	14	-56.35	-6.66
Qatar	139	-1.67	0.14	69	-1.69	0.32	5	-3.03	-0.56
Burundi	132	-22.97	1.81	67	-28.29	5.46	18	-56.77	-7.04
South Africa	127	-3.62	0.38	54	-6.17	0.96	5	-1.84	-0.65
Gambia	124	-12.82	2.15	51	-21.81	6.34	16	-16.80	-3.58
Turkey	123	-1.52	0.11	48	-1.91	0.33	8	-1.15	-0.32
Macau	121	-1.62	0.43	66	-2.10	0.79	1	-1.45	-0.23
Albania	119	-5.37	0.47	69	-6.10	0.87	8	-3.45	-0.58
Madagascar	119	-4.21	1.80	50	-7.63	4.36	5	-4.36	-0.71
Philippines	117	-4.69	-0.74	52	-2.72	0.53	5	-49.14	-22.83
Laos	108	-200.99	1.31	61	-264.90	19.76	22	-187.97	-48.37
Malaysia	106	-1.43	0.10	41	-1.62	0.28	5	-1.41	-0.19
Mali	102	-63.78	7.98	62	-94.85	13.57	11	-28.57	-2.52
Thailand	94	-1.69	0.14	45	-2.08	0.33	3	-1.32	-0.68
Saudi Arabia	93	-1.11	0.09	34	-1.37	0.29	6	-1.48	-0.23
Jamaica	89	-4.28	0.48	43	-5.42	1.18	11	-3.92	-0.76
Australia	87	-3.56	0.73	45	-5.32	1.42	1	-0.43	-0.12
Cote d'Ivoire	87	-1.57	0.09	30	-1.87	0.34	8	-1.16	-0.29
United Arab Emirates	81	-2.86	0.14	26	-2.26	0.42	0		
Swaziland	79	-4.65	0.19	36	-4.60	0.67	17	-6.41	-0.52
Kuwait	68	-1.50	0.19	46	-1.42	0.31	1	-2.00	-1.28
Togo	60	-34.39	3.53	37	-50.93	5.75	3	-1.48	-0.30
Ecuador	59	-2.65	0.22	28	-3.75	0.57	5	-1.83	-0.61
Kazakhstan	59	-2.50	0.30	25	-3.11	0.73	3	-2.68	-0.19

contd.

Table A5 / Contd.

Condition:	$\varsigma_{iq2}\varsigma^k < 0$			$\varsigma_{iq2}\varsigma^k < 0;\ \varsigma_{iz2}\varsigma^k > 0$			$\varsigma_{iq2}\varsigma^k < 0;\ \varsigma_{iz2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iq2}\varsigma^k}$	$\widetilde{\varsigma_{iz2}\varsigma^k}$
Mauritius	55	-13.19	2.67	27	-22.95	5.50	1	-5.62	-1.42
Macedonia	49	-4.63	0.57	18	-9.77	1.64	5	-1.29	-0.31
Burkina Faso	46	-8.97	2.42	24	-15.21	4.79	10	-1.82	-0.38
Jordan	45	-5.15	-1.78	18	-4.75	1.46	3	-29.47	-35.48
Zambia	42	-52.65	3.65	28	-45.44	6.89	7	-124.60	-5.64
Malawi	39	-4.95	0.26	20	-4.25	0.71	6	-4.47	-0.65
Belize	38	-12.07	-0.06	25	-6.33	0.74	6	-12.13	-3.48
Barbados	35	-4.02	1.79	10	-8.52	6.40	3	-3.45	-0.50
Cape Verde	34	-5.34	-0.06	12	-1.52	0.44	2	-66.13	-3.67
Venezuela	34	-6.35	0.36	17	-9.71	0.81	3	-3.82	-0.49
Moldova	28	-3.68	0.33	16	-5.04	0.71	5	-2.29	-0.41
Brunei	27	-34.50	2.59	20	-38.74	4.72	3	-44.90	-8.17
Ghana	26	-2.62	0.15	10	-3.99	0.68	6	-1.57	-0.48
Congo	25	-11.53	1.48	13	-12.10	3.38	3	-31.54	-2.27
Iceland	21	-9.75	-1.64	9	-5.24	0.88	2	-57.66	-21.22
Paraguay	21	-16.97	-0.52	11	-4.49	1.48	3	-28.80	-9.06
Saint Vincent and the Grenadines	20	-4.28	0.48	13	-4.40	0.75	0		
Bolivia	17	-6.74	2.54	2	-30.43	22.47	3	-3.60	-0.59
Senegal	14	-70.06	4.99	4	-106.85	23.08	4	-20.20	-5.61
Trinidad and Tobago	13	-39.67	1.33	5	-89.31	3.90	3	-20.85	-0.74
Guinea	11	-23.50	-0.63	5	-18.65	2.11	3	-34.77	-5.83
Israel	11	-4.95	0.33	5	-4.73	0.72	0		
Mozambique	9	-16.25	-1.02	5	-7.86	0.45	2	-49.70	-5.70
Benin	8	-10.57	0.26	5	-9.34	1.20	1	-22.35	-3.95
Tunisia	8	-2.31	0.47	1	-2.48	4.14	1	-1.29	-0.37
Uruguay	8	-1.82	0.43	4	-2.51	0.87	0		
Zimbabwe	7	-4.22	0.69	7	-4.22	0.69	0		
Kenya	5	-14.10	2.76	4	-17.46	3.49	1	-0.63	-0.18
Central African Republic	4	-11.61	0.45	2	-11.36	1.03	1	-2.65	-0.28
Pakistan	4	-52.42	-0.34	1	-91.36	1.69	1	-3.84	-3.05
Botswana	2	-6.00	0.50	1	-6.69	0.99	0		
Uganda	2	-1.29	0.00	0			0		

Note: statistics show the number of products whose imported quantities to an importer is restricted by SPS measures. Therefore, the estimated elasticity of SPS measure for that importer k and product i is negative $\varsigma_{iq2}\varsigma^k < 0$ in this table and is statistically significant at 10% level. $\widetilde{\varsigma_{iq2}\varsigma^k}$ and $\widetilde{\varsigma_{iz2}\varsigma^k}$ are the average of the estimated SPS elasticises of traded quantity and traded quality, respectively, which both meet the conditions in each column of the table and are statistically significant at 10%. Coefficients that are not statistically significant at 10% are simply removed from this table.
Table is sorted by the largest number of affected products whose import quantities are restricted by SPS measures at 10% level of significance.
Source: Author's estimation of equation (38) on global bilateral trade flows of each product at six-digit level of the HS rev. 1.

Table A6 / Summary statistics of quality-upgrading TBTs (i.e., $\varsigma_{iz1}\varsigma^k > 0$) by importers and their related quality-adjusted price impact

Condition:	$\varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k > 0;\ \varsigma_{i\bar{P}1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k > 0;\ \varsigma_{i\bar{P}1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$
Poland	1496	0.60	0.16	713	0.66	0.61	72	2.75	-2.82
Hungary	1431	0.57	0.16	250	1.22	1.47	265	0.59	-0.53
France	1382	0.34	0.00	202	0.51	0.43	181	0.42	-0.47
China	1317	0.26	0.08	532	0.20	0.29	125	0.42	-0.39
Austria	1282	0.37	0.07	406	0.38	0.37	110	0.53	-0.53
Germany	1274	0.32	0.03	275	0.38	0.32	139	0.37	-0.39
Netherlands	1255	0.65	0.18	157	1.25	2.94	359	0.61	-0.65
Jamaica	1219	10.74	4.20	530	17.69	15.40	252	8.18	-12.08
Argentina	1213	12.05	8.44	302	42.34	40.06	131	9.44	-14.16
Romania	1189	0.44	-0.05	201	0.59	0.54	193	0.79	-0.86
Denmark	1181	2.02	-0.05	231	3.10	3.06	182	5.74	-4.18
Latvia	1163	2.09	0.82	248	6.67	5.18	202	1.46	-1.63
Ireland	1149	1.02	0.09	268	1.79	1.84	226	1.52	-1.71
Spain	1141	1.83	-0.98	166	2.27	2.06	198	5.95	-7.36
United Kingdom	1118	0.45	0.15	144	1.53	1.55	187	0.30	-0.28
South Korea	1098	0.27	0.01	206	0.22	0.29	123	0.40	-0.42
Lithuania	1092	0.79	0.12	219	1.94	1.29	194	0.81	-0.76
Croatia	1074	0.81	0.09	198	2.55	1.50	255	0.65	-0.80
Taiwan	1072	0.46	0.18	206	0.86	1.49	124	0.85	-0.89
Belgium	1064	2.87	-1.01	124	10.52	15.31	315	3.67	-9.42
Mexico	1064	0.46	0.17	511	0.33	0.53	82	1.37	-1.07
Sweden	1050	0.98	-0.39	178	0.85	1.28	297	2.09	-2.14
Estonia	1048	1.15	0.18	248	2.28	1.76	145	2.39	-1.72
Portugal	1035	1.03	0.06	195	2.61	1.35	195	1.12	-1.01
Czech Republic	1017	0.84	0.46	317	1.47	1.88	69	1.55	-1.90
Italy	1016	0.63	-0.07	261	0.44	0.36	104	2.50	-1.62
Finland	995	0.68	-0.70	170	1.31	1.17	194	1.15	-4.61
Greece	965	0.84	0.09	171	2.26	1.80	170	0.70	-1.30
Malta	964	4.54	1.96	279	13.12	9.01	193	2.19	-3.26
Canada	939	0.40	0.06	386	0.37	0.42	93	0.97	-1.14
Ukraine	929	1.66	1.04	259	2.60	4.56	101	1.88	-2.17
El Salvador	922	8.29	4.00	256	20.92	20.33	195	6.55	-7.76
Bulgaria	920	0.64	0.06	174	1.08	1.10	170	0.88	-0.81
Slovenia	890	2.47	1.86	234	7.72	7.66	105	1.22	-1.30
Cyprus	885	3.74	1.72	210	13.66	8.18	150	0.60	-1.29
United States	884	0.34	0.00	143	0.46	0.57	170	0.37	-0.47
Brazil	836	0.98	0.29	195	2.84	1.79	95	0.68	-1.16
Slovak Republic	821	1.22	-0.40	194	1.47	1.49	94	4.05	-6.56
Norway	813	2.36	1.54	222	5.77	6.91	67	4.13	-4.24
United Arab Emirates	807	0.44	0.02	334	0.26	0.41	34	2.62	-3.53
Saudi Arabia	799	0.28	-0.09	244	0.18	0.27	84	1.02	-1.59
Mongolia	789	0.70	0.15	353	0.74	0.75	137	0.75	-1.07
Colombia	776	1.84	0.58	229	2.92	3.52	87	3.58	-4.13
Japan	768	0.64	0.12	147	1.28	1.41	111	1.05	-1.06
Ecuador	730	0.54	0.18	451	0.37	0.52	26	5.07	-3.90
Luxembourg	688	2.52	-0.39	251	2.62	2.43	157	4.60	-5.57

contd.

Table A6 / Contd.

Condition:	$\varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k > 0;\ \varsigma_{i\bar{P}1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k > 0;\ \varsigma_{i\bar{P}1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$
Rwanda	683	1.46	1.19	415	2.00	2.07	35	1.56	-1.41
Vietnam	683	1.29	-1.26	73	1.43	1.06	249	2.70	-3.77
Thailand	662	3.30	0.78	106	9.29	9.12	121	3.80	-3.74
Israel	650	0.32	0.03	165	0.30	0.38	115	0.41	-0.39
Nicaragua	645	1.15	0.53	210	1.85	2.51	76	2.11	-2.43
Costa Rica	628	2.93	0.49	130	11.63	4.19	120	1.26	-1.96
Switzerland	621	0.58	-0.12	154	0.29	0.35	50	2.58	-2.59
Malaysia	605	1.35	1.03	146	3.67	4.76	100	0.62	-0.73
South Africa	596	0.48	0.01	136	0.49	0.63	82	0.54	-0.96
Egypt	565	1.65	4.23	266	2.74	9.36	89	0.87	-1.10
Chile	555	5.81	9.24	153	19.11	34.14	51	3.34	-1.88
India	550	2.66	-0.10	96	5.30	4.04	107	2.44	-4.12
Kenya	548	3.16	2.68	117	13.40	13.20	107	0.50	-0.68
Indonesia	541	0.31	0.11	220	0.26	0.34	31	0.46	-0.44
Paraguay	535	2.42	-1.45	263	1.37	1.63	51	16.31	-23.58
Uganda	534	0.61	0.21	155	0.95	1.26	104	0.60	-0.78
Russia	517	0.35	0.11	208	0.28	0.42	49	0.52	-0.57
Philippines	510	2.80	0.70	119	10.11	3.48	66	1.02	-0.84
Pakistan	499	1.44	0.43	200	2.67	1.85	74	1.43	-2.13
Sri Lanka	499	0.72	0.03	105	1.05	1.09	101	0.95	-1.00
Qatar	486	0.90	0.75	296	0.98	1.33	17	1.43	-1.74
Venezuela	466	0.70	0.21	142	0.76	0.98	45	0.75	-0.87
Albania	462	1.49	0.51	206	2.22	1.45	52	1.36	-1.26
Kuwait	448	0.98	0.62	247	1.41	1.29	16	0.60	-2.67
Panama	446	2.09	0.69	104	5.38	4.84	130	1.39	-1.51
Trinidad and Tobago	440	3.46	0.06	97	10.62	4.73	135	2.30	-3.19
Honduras	425	0.85	0.55	162	1.42	1.89	61	0.70	-1.16
Dominican Republic	423	0.51	-0.30	51	0.30	0.33	141	1.02	-1.01
Bahrain	405	1.42	0.92	172	2.45	2.45	40	1.56	-1.21
Uruguay	389	2.08	0.16	122	2.05	1.48	47	2.68	-2.53
Hong Kong	375	0.46	0.00	73	0.54	0.60	78	0.60	-0.57
Armenia	351	0.86	0.46	173	0.90	1.57	29	2.39	-3.85
New Zealand	346	0.82	-1.39	99	0.48	0.97	63	2.67	-9.15
Oman	345	1.73	0.81	126	3.80	2.46	34	0.62	-0.96
Zambia	321	3.59	-3.27	131	2.31	2.65	61	11.97	-22.90
Australia	315	0.89	-2.42	58	2.06	2.70	60	1.49	-15.30
Turkey	304	0.33	0.07	85	0.30	0.43	32	0.44	-0.50
Guatemala	281	0.52	0.08	66	0.89	0.88	47	0.67	-0.76
Kyrgyz Republic	281	3.64	0.95	127	2.72	2.99	39	2.04	-2.88
Singapore	241	0.51	-0.15	43	0.34	0.42	64	1.13	-0.84
Moldova	217	1.39	0.58	77	2.59	2.12	18	1.80	-2.07
Jordan	193	1.19	0.46	57	2.86	1.95	18	2.02	-1.24
Tanzania	191	0.78	0.36	49	1.68	1.90	27	0.55	-0.91
Georgia	190	3.65	4.60	60	8.83	15.36	28	4.03	-1.72
Peru	182	1.02	0.52	54	2.15	2.09	27	0.55	-0.65
Macedonia	175	2.52	1.78	40	9.28	8.41	30	0.63	-0.83
Mauritius	167	1.11	0.71	42	2.88	3.14	33	0.42	-0.42

contd.

Table A6 / Contd.

Condition:	$\varsigma_{iz1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k > 0;\ \varsigma_{i\bar{P}1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k > 0;\ \varsigma_{i\bar{P}1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$
Ghana	155	34.67	41.13	77	67.95	83.16	20	1.06	-1.41
Brunei	112	7.84	2.42	39	20.17	8.98	24	2.22	-3.32
Botswana	106	0.70	2.44	26	1.89	10.82	30	0.39	-0.75
Tunisia	104	2.69	-0.39	29	4.08	4.52	24	4.32	-7.15
Bolivia	99	1.06	0.52	44	1.22	1.43	5	4.48	-2.29
Saint Lucia	95	1.84	0.48	34	3.89	2.20	28	0.76	-1.03
Grenada	94	1.51	0.16	43	1.70	1.80	22	2.27	-2.84
Yemen	92	0.48	0.35	46	0.51	0.75	4	0.75	-0.66
Kazakhstan	84	0.83	0.10	21	0.76	0.74	9	0.92	-0.84
Cameroon	54	6.18	1.57	25	4.26	4.90	5	41.63	-7.53
Nigeria	46	1.44	0.60	20	2.61	1.59	6	0.85	-0.73
Barbados	39	2.26	3.41	15	5.05	9.02	5	0.39	-0.49
Morocco	35	0.47	-0.02	8	0.18	0.25	5	0.57	-0.54
Saint Vincent and the Grenadines	34	1.02	1.06	9	3.16	4.17	4	0.22	-0.38
Macau	30	13.52	20.06	8	46.89	76.30	4	1.31	-2.11
Central African Republic	23	4.49	2.89	14	5.58	5.67	5	3.81	-2.58
Malawi	23	0.65	0.11	9	0.43	0.56	3	1.35	-0.86
Mozambique	8	0.44	0.14	2	0.40	0.81	1	0.40	-0.50
Senegal	7	2.10	1.25	1	5.60	10.42	2	0.29	-0.84
Belize	6	0.59	0.34	4	0.77	0.59	1	0.26	-0.30
Swaziland	6	0.56	-0.90	0			5	0.62	-1.08
Montenegro	4	2.14	1.13	1	6.58	4.54	0		
Benin	3	16.55	-9.11	1	33.21	4.36	1	12.61	-31.70
Iceland	1	0.43	-0.47	0			1	0.43	-0.47
Seychelles	1	0.36	0.00	0			0		

Note: statistics show the number of products whose imported quantities to an importer is stimulated by TBT. Therefore, the estimated elasticity of TBT for that importer k and product i is positive $\varsigma_{iq1}\varsigma^k > 0$ in this table and is statistically significant at 10% level. $\widetilde{\varsigma_{\iota q1}\varsigma^k}$ and $\widetilde{\varsigma_{\iota z1}\varsigma^k}$ are the average of the estimated TBT elasticises of traded quantity and traded quality, respectively, which both meet the conditions in each column of the table and are statistically significant at 10%. Coefficients that are not statistically significant at 10% are simply removed from this table.
Table is sorted by the largest number of affected products whose imported quality are upgraded by TBTs at 10% level of significance.
Source: Author's estimation of equation (38) on global bilateral trade flows of each product at six-digit level of the HS rev. 1.

Table A7 / Summary statistics of quality-downgrading TBTs (i.e., $\varsigma_{iz1}\varsigma^k < 0$) by importers and their related quality-adjusted price impact

Condition:	$\varsigma_{iz1}\varsigma^k < 0$			$\varsigma_{iz1}\varsigma^k < 0;\ \varsigma_{i\bar{P}1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k < 0;\ \varsigma_{i\bar{P}1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$
Uganda	1000	-0.56	-0.10	110	-0.80	1.99	402	-0.65	-0.78
Jamaica	986	-7.41	-4.58	213	-5.42	10.31	448	-10.88	-14.99
Luxembourg	796	-7.77	-2.39	139	-3.95	4.28	351	-14.87	-7.11
India	744	-1.98	-0.55	107	-2.26	3.12	194	-2.53	-3.85
Japan	723	-1.18	2.43	208	-1.83	9.24	60	-3.06	-2.77
Colombia	720	-1.26	-0.49	144	-0.90	1.03	133	-2.29	-3.75
Denmark	719	-1.41	-0.07	177	-1.85	1.84	144	-2.47	-2.60
Sweden	719	-1.00	-0.24	145	-1.20	1.77	196	-1.52	-2.20
Belgium	690	-5.15	-1.35	172	-3.31	4.05	128	-12.84	-12.73
Spain	678	-1.12	0.00	186	-1.07	1.23	95	-2.06	-2.45
El Salvador	669	-5.00	-1.20	123	-5.65	7.84	224	-6.54	-7.90
Cyprus	663	-1.00	-0.67	135	-0.63	0.66	251	-1.75	-2.12
Slovenia	634	-1.80	-1.43	139	-1.84	1.43	136	-4.87	-8.15
Thailand	633	-6.29	-1.68	96	-3.28	4.48	141	-15.22	-10.58
Mongolia	604	-0.77	-0.17	165	-0.67	0.94	214	-1.05	-1.19
Italy	602	-0.56	0.08	208	-0.45	0.57	49	-2.26	-1.42
Greece	587	-0.90	-0.18	172	-0.77	0.94	105	-2.12	-2.52
Ireland	587	-3.25	-4.42	140	-1.31	1.42	157	-9.69	-17.80
Slovak Republic	587	-3.40	-0.89	124	-8.02	5.34	116	-6.04	-10.21
Bulgaria	568	-1.68	0.67	128	-4.45	4.63	143	-1.57	-1.49
Argentina	566	-9.93	-1.29	112	-3.99	3.49	107	-9.90	-10.45
Portugal	558	-1.19	-0.19	159	-1.23	1.37	121	-2.71	-2.68
Estonia	553	-1.25	-0.42	102	-2.30	1.96	182	-1.73	-2.38
Finland	546	-1.36	-0.49	135	-0.89	1.03	110	-4.07	-3.72
Germany	539	-0.34	0.06	168	-0.35	0.44	58	-0.48	-0.70
Netherlands	532	-2.21	-0.37	120	-1.90	2.17	105	-4.95	-4.38
United Kingdom	527	-0.47	-0.07	136	-0.38	0.42	56	-1.18	-1.72
Malta	523	-2.45	-1.17	106	-1.55	1.24	223	-4.46	-3.33
Lithuania	518	-1.89	-0.05	137	-2.43	2.67	148	-2.17	-2.64
Ukraine	514	-3.66	-0.02	104	-0.42	0.54	80	-0.74	-0.82
South Korea	509	-0.45	0.00	112	-0.37	0.41	78	-0.42	-0.59
Kenya	506	-0.75	-0.14	70	-0.78	0.88	128	-1.54	-1.03
Latvia	505	-2.07	-0.17	132	-3.12	2.37	157	-2.85	-2.54
Brazil	469	-1.36	0.33	79	-3.88	3.53	90	-2.22	-1.37
Poland	466	-1.68	0.19	152	-2.28	2.07	69	-2.50	-3.29
Croatia	463	-1.53	-0.64	112	-1.38	2.83	132	-3.66	-4.65
Austria	461	-0.87	-0.19	138	-0.58	1.13	65	-2.73	-3.71
United States	461	-0.42	0.06	104	-0.55	0.62	58	-0.39	-0.63
Romania	452	-0.85	0.00	111	-1.00	0.86	100	-1.62	-0.97
Czech Republic	438	-15.04	10.41	135	-42.69	36.95	51	-13.20	-8.39
China	437	-0.26	0.10	150	-0.29	0.41	63	-0.17	-0.29
Zambia	436	-3.47	1.15	62	-17.31	13.29	204	-1.53	-1.57
Norway	432	-3.57	-2.49	96	-1.60	1.89	56	-19.47	-22.48
Dominican Republic	431	-0.68	0.20	181	-0.63	0.63	27	-0.97	-1.09
Hungary	423	-1.59	-0.72	95	-0.61	0.79	104	-4.13	-3.63
Canada	417	-0.65	-0.21	76	-0.37	0.51	102	-1.27	-1.24

contd.

Table A7 / Contd.

Condition:	$\varsigma_{iz1}\varsigma^k < 0$			$\varsigma_{iz1}\varsigma^k < 0;\ \varsigma_{i\bar{P}1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k < 0;\ \varsigma_{i\bar{P}1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz1}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}1}\varsigma^k}$
Vietnam	407	-1.90	0.81	132	-3.31	2.68	46	-0.62	-0.54
Saudi Arabia	400	-1.05	-0.27	126	-0.23	0.39	47	-7.15	-3.37
Trinidad and Tobago	392	-4.00	-1.72	75	-2.26	2.66	156	-7.01	-5.60
Egypt	389	-3.16	6.44	82	-5.76	38.14	168	-3.59	-3.72
Turkey	373	-0.41	0.27	91	-0.73	1.35	53	-0.36	-0.44
Costa Rica	360	-2.07	0.45	86	-4.44	5.32	83	-2.12	-3.58
France	359	-0.75	-0.05	120	-0.38	0.44	25	-2.41	-2.90
Chile	353	-0.73	-0.31	81	-1.68	1.95	71	-0.56	-3.76
Panama	345	-1.56	-0.66	64	-1.65	1.88	126	-2.79	-2.77
New Zealand	339	-0.60	-0.30	57	-0.50	0.54	158	-0.79	-0.84
South Africa	339	-0.81	0.15	72	-1.11	1.43	69	-0.96	-0.74
Oman	329	-2.51	0.29	55	-5.70	10.10	83	-5.10	-5.54
Albania	320	-1.43	-0.65	64	-0.89	1.02	123	-2.14	-2.22
Taiwan	307	-1.37	-0.54	73	-0.65	0.95	45	-2.16	-5.24
Switzerland	297	-1.27	-0.11	79	-0.52	0.52	28	-3.11	-2.63
Nicaragua	294	-7.97	-3.82	68	-3.05	4.82	91	-19.86	-15.95
Mexico	288	-0.57	0.05	96	-0.61	0.89	39	-1.13	-1.84
Uruguay	278	-4.29	-1.14	64	-1.18	1.36	72	-4.71	-5.62
Israel	263	-1.24	0.63	107	-1.69	2.38	24	-3.37	-3.76
Malaysia	263	-1.47	0.35	66	-2.57	2.77	44	-2.55	-2.07
Australia	257	-0.82	1.19	70	-1.50	4.79	39	-0.60	-0.79
Guatemala	254	-0.72	-0.19	38	-0.81	0.79	104	-0.72	-0.74
Paraguay	254	-2.13	0.15	85	-3.08	3.28	66	-3.34	-3.65
Kyrgyz Republic	247	-5.26	-2.83	53	-3.48	6.10	107	-10.01	-9.56
United Arab Emirates	233	-0.57	0.16	80	-0.62	0.78	31	-0.80	-0.82
Macedonia	227	-2.10	-0.46	28	-1.45	1.75	68	-3.93	-2.24
Philippines	221	-4.33	0.83	51	-3.15	10.55	41	-17.49	-8.63
Botswana	211	-0.62	-0.12	29	-1.66	0.93	86	-0.54	-0.62
Russia	206	-0.49	0.05	67	-0.55	0.63	22	-0.68	-1.42
Qatar	205	-3.42	-2.62	63	-1.51	2.53	54	-9.50	-12.91
Kuwait	203	-0.98	0.06	73	-0.38	0.58	31	-0.98	-0.94
Honduras	197	-3.84	-6.10	57	-1.16	1.02	66	-10.04	-19.09
Ghana	194	-4.36	-1.28	15	-25.07	18.10	81	-4.64	-6.42
Saint Lucia	193	-1.06	-0.46	19	-0.61	0.95	103	-1.57	-1.04
Armenia	189	-8.32	0.27	43	-18.76	12.07	71	-8.51	-6.60
Georgia	189	-1.88	0.44	44	-2.33	2.83	44	-0.99	-0.94
Rwanda	186	-2.97	0.46	34	-8.76	8.22	66	-2.93	-2.94
Sri Lanka	176	-43.73	-2.69	31	-1.79	2.82	56	-129.52	-10.02
Bahrain	172	-1.83	1.27	46	-3.94	6.05	51	-1.98	-1.19
Peru	172	-1.50	-1.76	45	-1.84	0.98	34	-3.86	-10.21
Ecuador	164	-3.14	0.98	58	-7.03	4.15	25	-2.68	-3.18
Moldova	151	-1.79	-0.63	21	-2.37	1.59	49	-2.62	-2.62
Cameroon	150	-0.90	-0.02	9	-5.57	4.44	46	-0.86	-0.93
Pakistan	144	-7.67	-3.46	59	-0.56	0.78	29	-34.89	-18.77
Grenada	134	-2.92	-2.76	15	-1.75	4.91	87	-3.85	-5.10
Indonesia	124	-0.40	0.14	48	-0.28	0.49	9	-0.62	-0.63
Tanzania	117	-0.49	0.00	25	-0.52	0.72	29	-0.62	-0.63

contd.

Table A7 / Contd.

Condition:	$\varsigma_{iz1}\varsigma^k < 0$			$\varsigma_{iz1}\varsigma^k < 0;\ \varsigma_{i\bar{P}1}\varsigma^k > 0$			$\varsigma_{iz1}\varsigma^k < 0;\ \varsigma_{i\bar{P}1}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota z1}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}1}\varsigma^k}$
Brunei	102	-2.22	0.03	14	-8.36	9.73	51	-1.63	-2.61
Venezuela	99	-0.81	0.14	36	-0.80	1.62	23	-0.88	-1.94
Singapore	85	-1.11	-0.44	27	-1.87	1.64	12	-1.84	-6.80
Hong Kong	81	-0.89	0.05	26	-0.47	0.97	11	-0.81	-1.95
Bolivia	80	-3.32	1.07	25	-4.39	5.80	26	-3.75	-2.29
Tunisia	76	-13.70	-3.00	13	-1.44	5.12	23	-13.70	-12.81
Jordan	69	-0.78	-0.81	14	-0.21	0.31	16	-2.26	-3.78
Mauritius	58	-1.78	0.80	9	-6.96	6.18	11	-1.45	-0.84
Kazakhstan	56	-0.98	-0.27	7	-1.03	0.93	15	-1.54	-1.45
Barbados	55	-1.78	1.08	7	-11.40	10.01	22	-0.36	-0.48
Morocco	29	-0.67	0.08	5	-0.82	1.78	6	-0.99	-1.11
Yemen	29	-0.87	0.00	12	-0.39	1.02	8	-1.75	-1.51
Belize	25	-0.75	-0.37	6	-0.55	0.54	14	-0.77	-0.89
Central African Republic	25	-1.56	0.03	9	-1.64	2.84	14	-1.66	-1.77
Saint Vincent and the Grenadines	19	-0.68	0.04	3	-0.86	0.69	4	-0.79	-0.34
Macau	15	-2.90	-0.04	3	-4.41	7.30	7	-3.54	-3.22
Mozambique	15	-0.62	0.25	5	-0.81	1.30	4	-0.54	-0.69
Nigeria	14	-0.38	-0.02	1	-0.25	0.50	2	-0.15	-0.39
Malawi	11	-0.24	0.29	6	-0.25	0.72	3	-0.22	-0.40
Senegal	11	-3.85	0.06	3	-1.12	0.79	2	-0.64	-0.84
Montenegro	6	-0.74	-0.07	0			1	-0.81	-0.40
Seychelles	3	-1.58	-0.57	0			2	-1.62	-0.86
Benin	1	-0.78	9.45	1	-0.78	9.45	0		
Burundi	1	-0.70	0.00	0			0		

Note: statistics show the number of products whose imported quantities to an importer is restricted by TBT. Therefore, the estimated elasticity of TBT for that importer k and product i is negative $\varsigma_{iq1}\varsigma^k < 0$ in this table and is statistically significant at 10% level. $\widetilde{\varsigma_{\iota q1}\varsigma^k}$ and $\widetilde{\varsigma_{\iota z1}\varsigma^k}$ are the average of the estimated TBT elasticises of traded quantity and traded quality, respectively, which both meet the conditions in each column of the table and are statistically significant at 10%. Coefficients that are not statistically significant at 10% are simply removed from this table.
Table is sorted by the largest number of affected products whose imported quality are downgraded by TBTs at 10% level of significance.
Source: Author's estimation of equation (38) on global bilateral trade flows of each product at six-digit level of the HS rev. 1.

Table A8 / Summary statistics of quality-upgrading SPS measures (i.e., $\varsigma_{iz2}\varsigma^k > 0$) by importers and their related quality-adjusted price impact

Condition:	$\varsigma_{iz2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k > 0;\ \varsigma_{i\bar{P}2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k > 0;\ \varsigma_{i\bar{P}2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$
Nepal	1217	15.37	-1.78	347	27.55	20.38	460	13.48	-20.07
Armenia	1207	10.83	7.37	504	19.82	21.79	161	11.21	-12.96
United States	1178	0.34	-0.04	144	0.31	0.41	254	0.39	-0.42
Egypt	873	6.88	-0.76	307	8.06	7.16	186	9.75	-15.38
New Zealand	752	0.64	-0.18	131	0.61	0.70	230	0.88	-0.99
Kyrgyz Republic	674	2.69	0.75	124	10.12	12.52	191	2.00	-5.47
Poland	400	1.82	0.37	110	3.44	3.03	63	2.03	-2.94
Hungary	389	2.07	1.03	57	11.08	8.78	130	0.65	-0.78
Nicaragua	385	1.21	0.18	92	1.93	1.69	90	1.48	-0.94
Ireland	380	2.12	1.87	82	5.89	12.19	127	1.55	-2.28
Denmark	369	2.12	-0.94	67	2.61	2.12	124	3.36	-3.93
Netherlands	351	2.86	0.28	38	15.16	10.15	109	1.96	-2.63
Estonia	345	1.75	4.25	88	4.75	17.38	100	0.75	-0.63
Guatemala	343	1.65	-0.03	75	3.99	2.63	94	1.47	-2.21
Latvia	336	4.41	-3.44	73	5.30	4.33	114	7.92	-12.90
Romania	330	1.32	-0.09	41	4.52	2.88	115	1.31	-1.30
Slovak Republic	328	1.39	0.19	60	3.39	3.40	105	1.08	-1.36
Lithuania	326	1.60	0.54	67	3.62	3.92	118	0.75	-0.72
Austria	321	1.35	0.02	63	1.16	1.31	71	0.68	-1.09
Portugal	319	1.76	0.12	68	3.69	3.47	108	1.79	-1.82
Chile	316	0.51	0.04	55	0.78	0.90	71	0.50	-0.51
Sweden	309	1.70	0.51	43	6.80	9.39	119	0.95	-2.08
Finland	308	5.89	1.90	56	25.91	14.74	98	2.16	-2.47
Czech Republic	299	2.60	0.99	35	14.12	10.00	82	0.91	-0.67
France	299	14.65	-13.40	29	1.31	0.82	83	51.16	-48.57
Honduras	299	1.52	0.49	89	3.55	2.28	68	0.73	-0.85
Malta	298	6.51	4.54	122	13.80	13.54	72	2.07	-4.14
South Korea	297	0.31	-0.08	23	0.49	0.53	95	0.29	-0.36
Russia	296	0.60	0.47	92	1.07	1.68	32	0.40	-0.46
El Salvador	293	1.32	-0.26	53	1.40	1.44	69	3.14	-2.23
Brazil	291	1.03	0.28	38	2.37	3.21	74	0.80	-0.55
Taiwan	290	0.39	-0.10	27	0.61	0.67	86	0.45	-0.56
China	289	0.39	0.05	80	0.36	0.44	51	0.40	-0.43
Greece	288	1.18	0.12	42	3.58	3.60	111	0.92	-1.06
Luxembourg	284	2.77	-0.90	86	3.43	2.26	100	2.90	-4.51
Bulgaria	272	1.89	1.01	44	3.02	11.49	85	2.90	-2.73
Slovenia	271	1.33	0.17	51	3.34	2.33	95	0.99	-0.76
Belgium	266	1.08	0.20	21	3.29	9.85	113	1.31	-1.36
Indonesia	265	2.90	-4.45	67	0.89	1.87	39	15.67	-33.48
Germany	262	0.69	-0.13	24	0.78	0.69	83	0.42	-0.61
Croatia	261	2.18	-3.27	35	3.61	2.63	101	3.80	-9.36
United Kingdom	260	1.15	-0.13	25	6.24	1.79	91	0.75	-0.87
Mexico	259	2.03	0.76	88	3.79	3.14	31	4.14	-2.54
Cyprus	253	2.57	0.58	73	2.63	3.08	78	1.28	-0.99
Spain	238	19.04	30.37	22	200.60	331.52	85	0.62	-0.77
Italy	230	0.96	-0.21	26	1.42	1.09	79	0.88	-0.97

contd.

Table A8 / Contd.

Condition:	$\varsigma_{iz2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k > 0;\ \varsigma_{i\bar{P}2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k > 0;\ \varsigma_{i\bar{P}2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$
Canada	209	0.30	-0.04	36	0.43	0.47	65	0.28	-0.38
Costa Rica	196	0.86	-0.92	41	1.12	1.40	66	0.99	-3.62
Dominican Republic	186	0.84	-0.16	25	3.25	1.50	107	0.49	-0.62
Vietnam	176	0.38	-0.25	12	0.34	0.59	81	0.48	-0.62
Georgia	170	12.92	-3.03	68	20.96	10.32	29	14.25	-41.99
Fiji	165	7.55	31.58	37	32.22	142.13	62	0.47	-0.77
Colombia	159	0.52	0.06	30	1.05	1.22	46	0.47	-0.60
Ukraine	157	0.39	0.02	34	0.55	0.72	39	0.42	-0.55
Macau	156	0.47	0.21	51	0.88	0.80	21	0.32	-0.40
Nigeria	156	2.15	-1.19	48	1.65	1.29	45	4.77	-5.49
Peru	156	2.24	3.57	37	7.33	16.23	47	0.97	-0.92
Kuwait	153	0.27	0.09	54	0.28	0.40	19	0.35	-0.42
Argentina	152	0.63	-0.27	18	0.91	1.09	54	0.78	-1.14
Qatar	147	0.29	0.08	62	0.27	0.32	17	0.41	-0.53
Panama	142	6.24	0.40	27	8.37	9.38	50	3.14	-3.93
Bahrain	139	0.53	-0.14	19	1.22	1.07	38	0.77	-1.06
Switzerland	139	0.62	0.11	12	2.46	3.56	48	0.44	-0.57
Mongolia	137	3.82	1.42	61	3.47	5.42	31	3.68	-4.39
India	136	2.06	-7.40	24	5.48	2.53	40	2.98	-26.70
Morocco	135	0.79	0.09	42	1.03	1.37	35	0.90	-1.30
Philippines	135	2.31	-0.31	32	0.53	1.02	27	1.87	-2.75
Antigua and Barbuda	134	9.97	2.62	57	21.57	7.34	27	2.14	-2.50
Hong Kong	130	1.54	-0.17	11	2.00	2.93	55	0.89	-0.98
Japan	121	0.74	0.01	7	3.87	3.87	53	0.34	-0.48
Sri Lanka	121	0.57	0.18	17	2.13	2.61	48	0.36	-0.47
Singapore	120	1.84	-0.45	10	1.50	1.08	40	4.62	-1.62
Australia	118	0.82	-0.18	15	2.01	2.10	52	0.84	-1.02
Albania	116	0.67	0.17	42	0.62	0.91	25	0.74	-0.75
South Africa	112	0.93	-0.18	16	2.22	2.18	34	1.16	-1.63
Norway	110	0.48	0.02	21	0.55	0.75	24	0.49	-0.58
Malaysia	109	0.28	-0.09	15	0.24	0.39	29	0.38	-0.53
Mali	106	8.36	0.54	29	26.49	13.54	47	1.96	-7.15
United Arab Emirates	104	0.37	0.06	11	0.75	1.32	21	0.33	-0.38
Burundi	101	3.82	-0.71	36	5.77	3.53	30	5.29	-6.63
Thailand	101	0.35	0.00	15	0.82	0.93	36	0.31	-0.40
Madagascar	99	2.96	0.66	26	2.68	4.20	26	3.80	-1.68
Laos	98	22.46	-22.09	14	8.59	11.70	68	29.20	-34.25
Saudi Arabia	91	0.27	-0.11	6	0.47	0.57	35	0.27	-0.39
Turkey	89	0.31	-0.14	7	0.21	0.27	33	0.44	-0.45
Oman	83	2.15	0.88	12	12.90	7.04	24	0.31	-0.49
Gambia	75	6.14	3.06	22	16.86	17.70	25	2.22	-6.39
Jamaica	61	1.28	0.77	19	2.93	3.80	27	0.56	-0.94
Cote d'Ivoire	53	0.35	-0.15	3	0.35	0.20	17	0.41	-0.51
Togo	52	4.39	-4.85	19	1.40	2.98	19	10.23	-16.24
Zambia	52	5.35	4.45	28	4.84	9.62	6	5.63	-6.32
Ecuador	49	0.54	0.24	19	0.48	1.23	18	0.54	-0.65
Kazakhstan	48	0.62	-0.10	11	0.88	0.98	14	0.77	-1.10

contd.

Table A8 / Contd.

Condition:	$\varsigma_{iz2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k > 0;\ \varsigma_{i\bar{P}2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k > 0;\ \varsigma_{i\bar{P}2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{\iota z2}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota z2}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{\iota z2}\varsigma^k}$	$\widetilde{\varsigma_{\iota\bar{P}2}\varsigma^k}$
Swaziland	48	0.60	0.01	21	0.66	0.61	15	0.67	-0.83
Mauritius	47	3.40	0.42	17	2.76	3.24	13	7.85	-2.73
Jordan	44	0.79	0.03	8	1.99	2.26	12	0.78	-1.38
Belize	42	1.37	-0.29	15	0.73	0.72	19	2.00	-1.20
Malawi	42	0.70	-0.07	14	0.86	1.02	16	0.51	-1.06
Burkina Faso	33	3.57	2.11	6	18.05	14.02	18	0.34	-0.80
Macedonia	33	1.12	0.19	10	1.74	1.14	4	0.94	-1.26
Saint Vincent and the Grenadines	31	1.35	0.92	16	2.21	1.84	3	0.29	-0.36
Venezuela	31	0.70	-0.67	6	0.62	0.70	11	0.85	-2.27
Moldova	29	0.63	0.17	11	0.74	0.74	6	0.62	-0.56
Brunei	27	4.10	0.43	12	4.11	3.02	10	2.26	-2.47
Cape Verde	27	0.33	0.00	6	0.64	0.68	9	0.22	-0.46
Congo	26	2.06	3.58	10	3.87	10.84	4	1.57	-3.83
Paraguay	25	1.31	1.37	14	1.85	2.72	4	0.74	-0.96
Barbados	17	3.97	-1.89	6	0.63	2.09	4	13.82	-11.18
Ghana	13	0.60	0.13	3	1.41	0.82	2	0.44	-0.36
Iceland	13	7.46	9.64	4	23.11	31.73	3	0.31	-0.52
Guinea	11	1.76	1.33	8	1.69	2.11	1	3.00	-2.17
Zimbabwe	11	0.54	-0.40	0			8	0.45	-0.54
Benin	8	1.88	-0.62	1	7.60	8.05	3	1.90	-4.34
Trinidad and Tobago	8	2.74	-4.45	3	1.15	1.63	3	6.04	-13.49
Israel	7	0.62	-0.23	2	0.38	0.62	1	2.35	-2.89
Mozambique	7	0.57	-1.04	1	0.31	1.78	4	0.78	-2.27
Bolivia	6	9.13	-2.12	3	3.10	8.80	2	22.62	-19.56
Kenya	6	3.30	1.23	2	6.80	3.94	2	0.35	-0.27
Senegal	6	18.21	10.72	4	9.32	16.08	0		
Uruguay	5	0.86	-0.09	2	1.74	0.22	2	0.24	-0.45
Pakistan	4	0.93	-0.42	1	1.17	2.63	2	1.08	-2.16
Uganda	4	0.53	0.77	2	0.69	1.67	1	0.25	-0.27
Central African Republic	3	0.88	-1.09	1	0.58	0.85	1	1.79	-4.11
Botswana	2	0.86	-2.29	0			2	0.86	-2.29
Tanzania	2	0.22	-0.24	0			1	0.17	-0.47
Tunisia	2	2.87	1.11	2	2.87	1.11	0		

Note: statistics show the number of products whose imported quantities to an importer is stimulated by SPS measures. Therefore, the estimated elasticity of SPS measure for that importer k and product i is positive $\varsigma_{iq2}\varsigma^k > 0$ in this table and is statistically significant at 10% level. $\widetilde{\varsigma_{\iota q2}\varsigma^k}$ and $\widetilde{\varsigma_{\iota z2}\varsigma^k}$ are the average of the estimated SPS elasticises of traded quantity and traded quality, respectively, which both meet the conditions in each column of the table and are statistically significant at 10%. Coefficients that are not statistically significant at 10% are simply removed from this table.
Table is sorted by the largest number of affected products whose imported quality are upgraded by SPS measures at 10% level of significance.
Source: Author’s estimation of equation (38) on global bilateral trade flows of each product at six-digit level of the HS rev. 1.

Table A9 / Summary statistics of quality-downgrading SPS measures (i.e., $\varsigma_{iz2}\varsigma^k < 0$) by importers and their related quality-adjusted price impact

Condition:	$\varsigma_{iz2}\varsigma^k < 0$			$\varsigma_{iz2}\varsigma^k < 0;\ \varsigma_{i\bar{P}2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k < 0;\ \varsigma_{i\bar{P}2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$
Nepal	1182	-29.15	18.02	460	-48.80	62.70	352	-20.47	-21.44
United States	855	-0.36	0.10	298	-0.37	0.47	95	-0.41	-0.58
New Zealand	764	-0.63	-0.06	160	-0.74	0.87	223	-0.69	-0.85
Egypt	718	-3.45	-1.21	176	-2.85	3.33	273	-5.81	-5.34
Kyrgyz Republic	669	-5.58	2.39	172	-13.37	16.37	186	-6.27	-6.52
Armenia	615	-12.84	-2.25	172	-12.92	12.79	206	-23.67	-17.40
Italy	446	-0.66	0.27	94	-1.20	1.81	59	-0.80	-0.86
United Kingdom	403	-0.76	-0.44	66	-0.61	0.57	65	-2.21	-3.30
Brazil	393	-0.60	-0.04	65	-0.87	0.71	85	-0.55	-0.72
Belgium	392	-0.71	-0.16	67	-1.25	1.07	82	-0.97	-1.65
Sweden	392	-1.80	0.76	80	-6.03	4.68	84	-0.87	-0.92
Greece	389	-1.06	0.01	97	-1.71	1.06	79	-1.51	-1.24
Guatemala	380	-2.68	-0.56	70	-1.73	1.62	105	-7.80	-3.11
Portugal	377	-4.79	-0.48	90	-2.80	3.80	98	-14.01	-5.33
Chile	371	-1.51	0.81	82	-4.13	4.40	75	-0.90	-0.80
Spain	370	-0.91	0.13	59	-1.79	1.94	59	-1.56	-1.15
Cyprus	369	-3.36	-0.12	61	-2.59	2.49	142	-1.97	-1.37
Denmark	363	-3.01	0.11	76	-5.04	4.75	97	-5.24	-3.33
Finland	363	-15.91	11.97	74	-72.71	61.51	104	-2.69	-1.98
Bulgaria	361	-6.52	-1.78	67	-9.91	12.98	91	-10.90	-16.60
Netherlands	354	-1.10	0.07	57	-2.39	2.26	68	-1.65	-1.54
Ireland	353	-3.01	0.88	92	-6.57	7.64	111	-2.91	-3.53
Slovak Republic	341	-2.78	-0.13	69	-2.37	2.40	85	-2.27	-2.49
Estonia	335	-3.20	-0.13	54	-5.35	4.39	122	-5.16	-2.31
Slovenia	334	-2.00	-0.65	64	-2.14	1.39	84	-4.92	-3.64
Poland	331	-3.93	1.90	101	-8.20	8.03	54	-6.76	-3.35
Germany	323	-0.47	0.01	57	-0.50	0.53	61	-0.41	-0.43
Lithuania	315	-2.09	0.02	65	-3.53	3.92	108	-3.11	-2.31
Czech Republic	312	-1.87	0.22	61	-4.62	3.75	68	-2.68	-2.35
Colombia	307	-0.63	-0.22	48	-0.77	0.83	67	-1.04	-1.59
Nicaragua	307	-8.73	2.67	62	-33.71	19.30	102	-3.67	-3.71
Latvia	305	-5.30	10.73	75	-12.36	50.32	89	-6.37	-5.63
Austria	304	-0.70	0.05	64	-0.72	0.86	45	-1.04	-0.86
Romania	300	-0.96	-0.25	52	-1.28	1.12	87	-1.38	-1.54
France	299	-0.76	0.02	58	-0.75	0.71	49	-0.85	-0.74
Dominican Republic	297	-0.41	0.05	80	-0.58	0.46	49	-0.39	-0.44
Luxembourg	297	-21.70	-29.68	56	-8.01	9.88	129	-45.27	-72.61
South Korea	291	-0.40	0.05	50	-0.59	0.84	48	-0.43	-0.57
Hungary	289	-1.16	0.34	52	-2.78	3.80	86	-1.39	-1.15
El Salvador	283	-2.81	-0.28	44	-1.53	1.50	94	-1.22	-1.56
Croatia	277	-64.41	-49.95	39	-4.05	1.57	96	-183.73	-144.76
Costa Rica	274	-3.04	-0.87	46	-2.93	1.48	85	-5.37	-3.61
Malta	268	-4.70	-1.08	54	-1.87	3.12	116	-9.36	-3.95
Japan	250	-0.47	-0.03	35	-0.44	0.36	47	-0.58	-0.42
Honduras	237	-1.78	-0.80	46	-2.13	3.60	78	-3.14	-4.57
Vietnam	233	-0.49	0.13	52	-0.76	0.72	25	-0.26	-0.33

contd.

Table A9 / Contd.

Condition:	$\varsigma_{iz2}\varsigma^k < 0$			$\varsigma_{iz2}\varsigma^k < 0;\ \varsigma_{i\bar{P}2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k < 0;\ \varsigma_{i\bar{P}2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$
China	218	-0.37	0.13	73	-0.40	0.51	21	-0.28	-0.36
Mexico	218	-0.54	-0.11	62	-0.61	0.79	36	-0.94	-2.05
Australia	211	-0.65	0.12	24	-2.26	2.61	62	-0.42	-0.60
India	209	-0.48	-0.17	29	-0.55	0.86	83	-0.52	-0.72
Taiwan	209	-0.36	0.04	35	-0.65	0.64	26	-0.43	-0.51
Panama	208	-3.76	-1.78	33	-1.34	3.24	95	-6.85	-5.02
Georgia	207	-9.65	-3.10	53	-8.46	7.57	73	-15.93	-14.29
Switzerland	197	-0.46	-0.04	24	-0.48	0.45	37	-0.38	-0.50
Argentina	183	-0.66	-0.52	37	-1.11	0.89	36	-0.72	-3.57
Peru	170	-8.96	0.61	28	-2.68	5.17	40	-0.63	-1.01
Ukraine	168	-0.40	0.01	29	-0.38	0.47	29	-0.26	-0.41
Russia	164	-0.47	-0.23	53	-0.32	0.49	29	-1.11	-2.21
Thailand	158	-1.05	-0.30	23	-0.38	0.45	36	-3.64	-1.59
Canada	157	-0.42	0.02	26	-0.45	0.48	24	-0.29	-0.39
Turkey	154	-0.34	-0.23	28	-0.40	0.40	50	-0.47	-0.92
Albania	137	-0.44	0.01	39	-0.49	0.59	38	-0.52	-0.58
Oman	136	-1.34	-0.91	18	-0.62	0.77	54	-2.66	-2.55
Saudi Arabia	130	-0.25	0.03	21	-0.42	0.49	24	-0.19	-0.28
Mongolia	128	-25.97	0.33	35	-82.48	15.04	41	-7.65	-11.80
Indonesia	126	-1.33	-0.64	42	-0.41	0.70	19	-6.85	-5.76
Antigua and Barbuda	115	-88.21	56.57	17	-530.59	411.23	64	-5.78	-7.58
Norway	114	-0.36	-0.07	14	-0.47	0.44	30	-0.41	-0.48
Nigeria	112	-1.88	0.29	29	-4.04	3.30	37	-1.52	-1.72
Singapore	111	-1.69	1.14	18	-8.61	7.62	28	-0.20	-0.36
Hong Kong	109	-0.77	0.52	13	-3.69	5.05	27	-0.21	-0.33
Laos	109	-38.65	33.14	68	-55.08	61.60	20	-15.61	-28.84
South Africa	108	-0.45	0.11	17	-0.45	1.60	27	-0.35	-0.58
Morocco	102	-1.00	-0.80	15	-0.68	0.85	34	-1.55	-2.78
Sri Lanka	99	-1.48	-1.40	13	-0.77	1.13	42	-2.42	-3.65
Bahrain	93	-0.39	-0.04	21	-0.45	0.54	15	-0.80	-0.98
Fiji	92	-1.66	-2.98	10	-5.16	5.36	44	-1.85	-7.44
Malaysia	92	-0.53	0.00	20	-0.66	0.61	17	-0.67	-0.70
United Arab Emirates	91	-0.34	0.04	22	-0.33	0.41	10	-0.43	-0.50
Burundi	88	-9.48	-1.85	20	-23.56	7.98	46	-6.74	-7.01
Swaziland	88	-1.44	-1.65	9	-2.95	1.24	64	-1.44	-2.44
Philippines	85	-2.12	-1.25	20	-0.81	1.46	21	-7.01	-6.47
Gambia	84	-5.42	-5.42	11	-3.79	7.82	55	-7.23	-9.84
Cote d'Ivoire	82	-0.37	-0.12	8	-0.55	0.39	27	-0.33	-0.47
Kuwait	80	-0.38	0.06	18	-0.46	0.56	10	-0.53	-0.50
Jamaica	78	-0.92	-0.43	10	-0.96	1.46	41	-0.96	-1.17
Kazakhstan	74	-1.18	0.27	13	-4.54	3.01	25	-0.46	-0.77
Madagascar	74	-1.02	-0.53	6	-1.54	1.37	32	-1.31	-1.49
Mali	73	-3.10	3.34	12	-7.25	32.36	36	-3.02	-4.01
Qatar	68	-0.54	-0.05	20	-0.44	0.73	17	-0.92	-1.07
Ecuador	64	-0.55	-0.53	20	-0.58	0.69	27	-0.54	-1.77
Cape Verde	55	-0.83	-0.30	11	-1.69	2.00	25	-0.91	-1.53
Macedonia	52	-0.72	-0.47	0			28	-0.67	-0.87

contd.

Table A9 / Contd.

Condition:	$\varsigma_{iz2}\varsigma^k < 0$			$\varsigma_{iz2}\varsigma^k < 0;\ \varsigma_{i\bar{P}2}\varsigma^k > 0$			$\varsigma_{iz2}\varsigma^k < 0;\ \varsigma_{i\bar{P}2}\varsigma^k < 0$		
Statistics:	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$	**No. Products**	$\widetilde{\varsigma_{iz2}\varsigma^k}$	$\widetilde{\varsigma_{i\bar{P}2}\varsigma^k}$
Togo	49	-1.12	-0.07	10	-0.49	0.73	18	-0.62	-0.59
Belize	47	-1.40	-1.89	1	-0.22	0.16	44	-1.46	-2.02
Barbados	46	-1.33	-4.04	4	-0.83	1.51	24	-2.14	-8.00
Zambia	46	-6.48	-5.45	10	-4.31	5.69	24	-9.15	-12.81
Ghana	45	-0.82	-0.38	3	-4.68	3.98	29	-0.53	-1.01
Malawi	40	-0.76	-0.76	12	-0.52	0.72	18	-1.11	-2.17
Moldova	40	-0.49	-0.43	7	-0.27	0.66	17	-0.71	-1.29
Mauritius	31	-0.76	-0.35	3	-0.92	0.81	10	-0.84	-1.34
Macau	29	-1.33	4.31	7	-4.62	18.35	6	-0.51	-0.58
Jordan	28	-4.59	3.86	8	-13.85	14.39	6	-0.77	-1.18
Saint Vincent and the Grenadines	25	-0.36	-0.25	2	-0.24	0.25	14	-0.30	-0.49
Congo	24	-3.50	-5.71	3	-0.60	1.37	13	-5.79	-10.86
Iceland	24	-2.62	-3.25	2	-0.39	0.61	11	-4.96	-7.20
Burkina Faso	23	-0.51	-0.06	5	-0.44	0.74	10	-0.36	-0.51
Bolivia	19	-1.11	-1.12	2	-0.25	0.47	10	-1.67	-2.23
Brunei	19	-3.70	-1.52	6	-1.98	4.95	12	-4.86	-4.87
Venezuela	19	-0.93	0.48	6	-0.61	1.90	3	-0.41	-0.79
Guinea	16	-8.38	-7.61	6	-8.61	9.99	8	-8.04	-22.72
Uruguay	16	-0.94	0.16	5	-0.85	0.81	5	-0.43	-0.31
Paraguay	14	-8.97	-9.27	3	-4.89	2.79	5	-21.71	-27.63
Central African Republic	13	-3.94	-3.36	1	-0.81	0.27	7	-6.99	-6.27
Trinidad and Tobago	13	-2.40	-0.75	2	-4.43	1.69	7	-1.01	-1.87
Senegal	12	-6.73	-2.89	1	-2.01	3.56	5	-6.20	-7.64
Benin	11	-5.21	-1.98	2	-4.82	7.44	5	-7.82	-7.34
Zimbabwe	11	-0.70	0.04	3	-1.25	0.40	3	-0.36	-0.27
Mozambique	7	-3.26	-6.70	2	-3.25	2.23	5	-3.26	-10.27
Pakistan	7	-2.31	2.58	5	-2.61	3.87	1	-2.71	-1.32
Tunisia	7	-0.74	-0.04	1	-0.31	0.39	1	-0.49	-0.67
Israel	6	-1.03	0.20	1	-1.25	1.97	2	-0.58	-0.38
Uganda	6	-0.69	0.01	4	-0.45	0.49	1	-1.66	-1.88
Kenya	5	-0.31	-0.30	0			3	-0.43	-0.51
Seychelles	3	-1.71	0.41	1	-3.98	2.55	1	-0.93	-1.31

Note: statistics show the number of products whose imported quantities to an importer is restricted by SPS measures. Therefore, the estimated elasticity of SPS measure for that importer k and product i is negative $\varsigma_{iq2}\varsigma^k < 0$ in this table and is statistically significant at 10% level. $\widetilde{\varsigma_{iq2}\varsigma^k}$ and $\widetilde{\varsigma_{iz2}\varsigma^k}$ are the average of the estimated SPS elasticises of traded quantity and traded quality, respectively, which both meet the conditions in each column of the table and are statistically significant at 10%. Coefficients that are not statistically significant at 10% are simply removed from this table.
Table is sorted by the largest number of affected products whose imported quality are downgraded by SPS measures at 10% level of significance.
Source: Author's estimation of equation (38) on global bilateral trade flows of each product at six-digit level of the HS rev. 1.

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