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Non-tariff measures and competitiveness *

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Abstract

We explore how tariff and standard-like Non-Tariff Measures (NTMs) introduced by the EU affect industry characteristics in the domestic market. While tariffs work as a pure tax on import, standards like NTMs potentially affect costs of both domestic and foreign firms, although likely more the latter. We use the model by Melitz and Ottaviano (2008) to include NTMs. We derive some testable implications on the number of firms selling in the domestic market and average efficiency. We take the model to the data for a group of European countries. The empirical analysis confirms the implication of the theoretical model; NTMs make the number of firms and average efficiency increase in the home country. We also test if NTMs effects differ by firms' size, and we find that the effect is positive on the number of medium-large firms, while negative on that of small firms.

JEL Classification: F13, F14

Keywords: Tariffs, Non-tariff Measures, Heterogeneous firms, International Trade, EU.

1 Introduction

In this paper we analyze the effects of technical standards and other NTM (Non Tariff Measures) potentially restricting international trade on the domestic industries of the countries imposing them. This is a crucial question in light, for example, of the Green Eu program where companies are expected to provide considerable contributions in terms of upgrading their environmental standards. Such measures do affect trade, especially if border adjustment duties for non-compliant extra EU exporters are introduced. But it is not clear what their effect will be on the EU industry. Most contributions discussed in the literature reviewed in the following section below have looked at the effect of NTMs on affected exporting countries, but we are not aware of contributions looking at the effects on imposing countries. We develop a theoretical framework to analyze the effect of the introduction of a new NTM on the number of firms, efficiency and productivity/size distributions and we compare it to the impact of a tariff. We work within the framework of the model by Melitz and Ottaviano (2008) to derive testable implications and take them to the data for the case of the EU. As we adopt a long term framework, we also allow for firm mobility between the two hypothetical countries analyzed, country A (domestic, imposing the barrier) and country B (foreign). The introduction of a unilateral NTM, differently from tariffs, is modeled as inducing an exogenous upward shift in the marginal cost of all the firms that have to satisfy it (domestic firms and foreign exporters).Given that we are interested in NTM potentially affecting trade, perceived as barriers by other countries, we assume that the cost shift be larger for foreign producers than for domestic ones. The idea is that new technical standards are often embedded in the domestic institutional, legal and scientific environment, where local technical support is easily available, that they are consistent with the pre-existing regulation, and tax structure (Goulder et al., 1999). In other words, compliance is less expensive at home, where public institutional, regulatory and technical infrastructures supports individual firms (Maskus et al., 2005). The theoretical analysis predicts that, given the rise in the relative cost of exporting to A, exports from B will be discouraged, yet the number of firms located in A be increased by the standard, hence increasing competitive pressure and efficiency. Note that these long-term outcomes partly contradict short term expected effects, namely with no relocation of production between countries. In this case, the introduction of the NTMs produces anticompetitive effects. It is only the longer term relocation of firms that reverts these effects. The property that standards raise costs uniformly across firms in the domestic country is only a first approximation to model their effects on costs. It is likely that the technological capabilities vary across firms of different characteristics in the same industry. For instance, large firms may have more qualified personnel, research infrastructure and technology to cope with regulatory standards. The smallest firms in an industry may have to buy external resources, or invest anew in non-existing facilities and therefore incur a higher cost of implementing the standard per unit produced. These variations in per-unit costs across firms of different size would not emerge when a tariff is introduced, as it does not affect domestic production costs. In this sense one may expect the effects of standards to differ across firms of different size. We discuss this possibility and test it empirically. The predictions of the model are confirmed by the empirical analysis, based on data for a group of European countries and manufacturing industries. We combine CompNet data for 16 EU countries in 2002-2012, providing information on firms' performance at the industry level and by size class, with the STC WTO-I-TIP database, providing information on Specific Trade Concerns (STC) on NTMs [1] raised at the WTO to the Technical Barriers to Trade (TBT) committee and with the TRAINS database providing information on tariffs. Therefore, we consider only NTMs that are perceived as trade barriers by foreign exporters to the EU. The empirical analysis exploits cross- industry and cross-country heterogeneity in trade. Even though both NTMs concerns raised by foreign trade partners and tariffs are the same for all EU countries, their different trade structures make them heterogeneously affected by NTMs and tariffs. We find that NTMs are positively associated with the number of firms operating in a country-sector and to average efficiency. The same results emerge for tariffs when considering the number of firms, while, by contrast, tariffs are negatively associated with average efficiency and, in particular, results are in this case barely statistically significant. Interestingly enough, our analysis of heterogeneity show that NTMs are negatively related with the number of small firms and positively related with the number of medium-large firms, while the inclusion of a tariff is positively related with the number of firms in both classes. This suggests that the adoption of standards implies investments and higher costs that, as predicted, are especially burdensome for small firms. The effect of tariffs is neutral in this respect. The bottom-line is that we show that such measures do enhance the competitiveness of the domestic industry, although they make life harder especially for small firms. Back to the EU and to the example of the Green EU program, we can draw a comfortable prediction that such policies will

[1] Member Countries can appeal against standards imposed by other WTO members and raise a Specific Trade Concern (STC) at the Technical Barriers to Trade Committee of the WTO, opening a dispute on whether the measure brings about unnecessary restrictions to trade.

make the EU space more attractive to foreign investors and EU companies more competitive. Given the scope of the program, even if they were to be challenged at the WTO on the ground of free trade, such measures are unlikely to be lifted following the pressure of foreign competitors. In what follows we first discuss the background literature (Section 2); we then develop the theoretical model (Section 3) and the empirical analysis (Section 4 and 5). Results are reported in Section 6, while in Section 7 we provide some robustness checks. In section 8 we develop the analysis by considering firms'size heterogeneity. Section 9 concludes.

2 Related Literature

A recent stream of literature investigates the role of standard-like NTMs on trade, competition, and welfare. Among the different types of NTMs (UNCTAD, 2019), the technical measures such as Sanitary and Phytosanitary Standards (SPS) and Technical Barriers to trade (TBT) are the most analyzed practices.[2]

Standard-like NTMs are not introduced with a protectionist aim, at least not explicitly. Their scope is to increase the quality of goods, to reduce informational asymmetries, and promote sustainability (Gourdon, 2014). Nonetheless, these measures could also hide the aim to build a barrier to trade. Moreover, even if these practices are welfare enhancing, restricting trade might be a side outcome, given that the costs of compliance might be different both across countries (between developed and developing countries, Disdier et al., 2008; Marette and Beghin, 2010), and within countries across heterogeneous firms (Fontagné et al., 2015).

For the fact that they are not introduced with protectionist aims, this *per se'* opening room for ambiguities and controversial assessments, standard-like NTMs differ intrinsically from traditional trade barriers (Non-technical measures and tariffs)[3] in their economic implications along several dimensions, by working as potential supply and demand shifters (Beghin et al., 2015b; Fugazza, 2013). When standard-like NTMs imply a cost, e.g. to adapt the production process, to buy higher quality intermediate goods and inputs, to comply with the standard,

[2]SPS are measures affecting areas such as restriction for substances, restriction for non eligible countries' hygienic requirements, or other measures for preventing dissemination of diseases; all conformity assessment measures related to food safety, such as certification, testing and inspection, and quarantine. Examples of SPS may be a requirement limiting the use of hormones and antibiotics in the production of meat or a check for the residual level of pesticides on imported vegetables. TBT are measure such as labelling, marking, packaging, restriction to avoid contamination or other measures protecting the environment, standards on technical specifications and quality requirements. Examples of TBT are restriction on toxins in chemical products used in toys or electricity consumption label for electronic devices (Gourdon, 2014).

[3]Non-technical measures are the subset of measures under categories from D to P in the Unctad classification of NTMs (UNCTAD, 2019) such as intellectual property rights, distribution restrictions, or rule of origin.

typically both domestic and foreign firms bear this cost, while traditional barriers affect foreign firms only. But it could also be the case that this cost is lower for firms in the country introducing the technical measure, which would in this case have potentially discriminatory effects with respect to foreign firms. On the other hand, in a world of heterogeneous firms, the best foreign suppliers might satisfy the standard at a lower cost than domestic ones (Beghin et al., 2015b; Marette and Beghin, 2010): in this second case, the foreign country would not raise an STC given the lack of discrimination between domestic and non-domestic suppliers.

Standard-like NTMs can work as supply shifter by increasing the quality of the good or input, but also by solving technical incompatibilities and/or easing trust in buyer-supplier relationships (Jouanjean, 2012), this increasing matching opportunities. Depending on the measure and on the characteristics of the industry involved, they can help solving information asymmetries, reducing transaction costs in buyer-supplier relationships along the global value chain. They can also increase costs, marginal or fixed, of compliance and/or they shift these costs from buyer to suppliers with potential advantages for large suppliers (Beghin et al., 2015b). The extent of the supply shift will depend on the measure and the industry involved, but also on the size and geographical location of the firm. According to Beghin et al. (2015b) the effect of standard-like NTMs along the global supply chain is country, sector and standard specific, in some cases favouring large suppliers, in some others small firms.

They can also work as (final) demand shifter (Sturm, 2006; Tian, 2003), increasing the willingness to pay of consumers by increasing or certifying the quality or safety of the good (Disdier and Marette, 2010), solving information issues (Liu and Yue, 2009; Xiong and Beghin, 2014). Again, small firms and/or firms located in the South may benefit more than large firms from complying with the standard.

In general, the protectionist effects of standard type NTMs are ambiguous both because of heterogeneity across foreign and domestic producers (Marette and Beghin, 2010), and because they can be instrumental to overcome market failures and reduce negative externalities (Beghin et al., 2015a). The evidence on the effects of standard-like NTMs on trade flows is actually mixed, the results showing both trade enhancing and trade restrictive consequences depending on the country pairs, on the sector and on the measure considered (Beghin et al., 2015a; Cadot and Gourdon, 2016; Carrere and De Melo, 2011).

The introduction of a standard measure can generate contrasting effects on firms' domestic and international activities. Moreover, since these effects are likely to be heterogeneous across firms of different size and productivity, the standard-like NTMs will also affect competition in the domestic market, with consequences on efficiency, prices and varieties availability.

Our work is related to three main stream of literature. The first one is the group of contributions assessing the potential protectionist effect of standard-like NTMs, by analyzing the relationship between NTMs and trade flows (Anders and Caswell, 2007; Disdier et al., 2008; Kee et al., 2009; Wilson and Otsuki, 2004; Xiong and Beghin, 2014).[4] The firm level evidence looking at firms' exporting margins is usually focused on the effects of standard-like NTMs in destination markets on firms' exporting activities. Fontagné et al. (2015), using French custom data and STC on SPS show that both small firms and, to a lesser extent, large firms are negatively affected by NTMs measure in the destination markets (both along the extensive and the intensive margin). The literature looking at the effects of standard-like NTMs in developing countries also reaches mixed results, some of them showing an export enhancing effect for the firms, in particular large exporters, bearing the cost to met the standard (Chen et al., 2008; Henson et al., 2011; Martincus et al., 2010; Otsuki, 2011), others finding a negative effect for firms' exporting activities (Schuster and Maertens, 2015).[5]

A second group of contributions indirectly related to our work investigates the effects of standard-like NTMs on the labour market in the country imposing the standards (Leonardi and Meschi, 2021) or in the country specialized in exporting a good on which a standard has been imposed by trade partners (Colen et al., 2012). In particular, Barba Navaretti et al. (2020) find that protectionism arising from TBT affects the composition of labour force within French exporters increasing white collar workers' share.

Our work is also related to the heterogeneous firms' stream of literature, where the effects of variations in trade policy on firms and productivity depend on the type of trade costs affected and theoretical setup. In the standard CES model with heterogeneous firms (Melitz, 2003), an (symmetric) increase in the iceberg trade costs or fixed costs generate a similar outcome: an increase in the number of domestic producers and a reduction in the aggregate productivity. However empirical evidence suggests that changes in trade costs have heterogenous effects across firms with different size. For example, Nataraj (2011) finds that trade liberalization in India increased the average productivity of the firms at the top of the distribution.[6]

[4]For a comprehensive review on approaches and computation of NTMs see Beghin et al. (2015b) and Carrere and De Melo (2011).

[5]Cadot and Gourdon (2016) looks instead at the effects of NTMs on the price of imported goods and the role of regional trade agreements as mediating factors in the relationship between NTMs and prices.

[6]Mion and Zhu (2013) show that an increase in the import competition from China in WTO did not reduce

The removal of standard assumptions, such as CES, generates additional insights. Introducing heterogeneous demand elasticities, Spearot (2013) shows that imported varieties with high elasticity are the most harmed by an increase in tariff. [7] Using indirectly additive preferences, Bertoletti et al. (2018) provide evidence that small firms are more harmed by an increase in the iceberg trade cost, compared to large firms.

Heterogeneity arises also from different trade costs (additive or multiplicative). Irarrazabal et al. (2015) provide evidence that the introduction of an additive import tariff is more harmful (in term of welfare and trade) than the corresponding multiplicative tariff.

3 Theoretical Model: Non tariff Measures: Regulatory Standards

3.1 Closed Economy

We use the model in Melitz and Ottaviano (2008)(henceforth M-O). The closed economy is characterized by a continuum of firms, each one producing a single variety of a product, with cost function $C(q) = cq$, where c is specific to each firm, and results after a firm has decided to enter the market, from a random draw by Nature. Firms with c larger than a threshold, in a sense to be specified later, will have to exit after entry. The demand function to each firm is derived by a quasi-linear utility function $U = q_0 + a \int q_i di - \frac{\gamma}{2} \int (q_i)^2 - \frac{\eta}{2} \left(\int q_i di\right)^2$, where all the integrals are defined over the space of available varieties, q_0 is a *numeraire* good, q_i is quantity of variety of a differentiated good with index i, while γ measures the degree of product differentiation among varieties. The inverse demand function is of the form $p_i = a - \gamma q_i - \eta Q^c$, where $Q^c = \int q_i di$. The maximum price $p^{\max}$ is a function of the utility function parameters and of the size of the country - if in autarky - and of the two countries under free trade. The resulting per-firm profit function in a closed economy is $\pi(c) = (L/4\gamma)(c_D - c)^2$ where L is the population size and $c_D = p^{\max}$ is the cut-off cost for surviving firms. Entrants discover their marginal cost after entry, as a draw by Nature from a distribution G(c), which is common knowledge to all firms. The support of c is $[0, M]$, the distribution is assumed to be Pareto, namely $G(c) = (c/M)^k$ over $A = [0, M]$. Let $w \equiv c_D$ be the cut-off cost, then under the assumption of a Pareto distribution, and letting $\omega(L) = kL/(4\gamma M^k)$ the expected profit, $E(\pi)$,

the survival probability of Belgian firms.

[7] Similarly to our model, Spearot (2013) assumes that consumer preferences are quasi-linear as in Melitz and Ottaviano (2008).

from entry is a linear transformation of $\int_0^w (c-w)^2 c^{k-1} dc$, namely,

$$E(\pi) = \omega(L) \int_0^w (w-c)^2 c^{k-1} dc \tag{1}$$

To enter the market a firm has to pay an entry cost, f, which is sunk after entry. Ex-ante, entry is profitable only if expected profit is non-negative and in the long run entry shall occur till the expected profit from entry is zero—no entry is a decision that implies no cost. Let $E(\pi) = f$, then (1) provides the following solution for the cutoff marginal cost:

$$\left(c_D^0\right)^{k+2} \equiv 2(f/L) M^k \gamma (k+2)(k+1). \tag{2}$$

If a technical standard leads to a marginal cost increase equal to s for any firm in the industry, the support of the cost distribution is translated from $A = [0, M]$ to $A\prime = [s, M+s]$. Let $q = c+s$, the cut-off now must satisfy $q = p^{\max}$; or $c_D + s = p^{\max}$. The distribution is $G(q) = ((q-s)/M)^k$ and the zero-profit condition before entry becomes:

$$E(\pi|s) = \omega(L) \int_s^z (z-q)^2 (q-s)^{k-1} dc = \frac{L}{2\gamma M^k} \frac{(z-s)^{k+2}}{(k+2)(k+1)}. \tag{3}$$

Since z is the cutoff in the shifted support then $c_D' = z - s$ is the cut-off in terms of the base (or "identity") variable c. Inspection of (3) reveals that setting $E(\pi|s) = f$ implies a solution such that $z - s = c_D$, where c_D is the original value. Hence the new cost cutoff is equal to the original one [8] plus s. The after-entry profit however is reduced for each firm. This makes entry less attractive ex-ante, leading to a reduction of the number of entrants in the industry. The lower number of entrants allows $p^{\max}$ (and hence the cutoff cost) to increase. Average price is increased so that a lower quantity of the differentiated good is bought at equilibrium - while consumer will buy more of the numeraire good. The number of firms operating in the industry will decrease, as from Eq.16 in M-O, namely $N_s^0 = 2(k+1)(\gamma/\eta)(a - c_D)/c_D$, due to an increase in the cutoff from c_D to $c_D + s$.

It is worth noting here that we are not allowing the standard to increase the parameter a, namely the utility of the differentiated good. In that case, the result on the cut-off and on the *numeraire* would be ambiguous.

[8]The integral in (3) is also equal to $\omega(L) \int_0^{z-s} (z-s-c)^2 (c)^{k-1} dc$

3.2 Open Economy

In an open economy the introduction of a standard will raise costs for the home firms but it will also increase costs to foreign exporters. Country A, where the standard is introduced, will be less attractive as a location for production, but country B now is also affected because exports to A from B are more expensive than before the standard. Therefore the question is whether the increase in the cut-off cost for the home country hurts production and efficiency in A or B, and what are the effects on trade flows. The answer will clearly depend also on the effect of the standard on the cut off cost of country B. Let c_X^A represent the cut off cost for the firms based in A exporting to B. Due to export costs of the iceberg form a unit exported arrives in country B with weight less than 1 hence the cost of a unit carried to country B from A is $\tau_{B.}c$ where $\tau_B > 1$(respectively τ_A for exports in the reverse direction). One can interpret the $\tau' s$ as incorporating tariff and transportation costs. To survive in country B an exporter from A must have cost at most equal to $c_X^A \equiv c_D^B/\tau^B$ (symmetrically $c_X^B \equiv c_D^A/\tau^A$). The zero expected profit condition—see M-O Eq. 21 and 22— before entry for country A in an open economy is:

$$L^A \int_0^{c_D^A} \left(c_D^A - c\right)^2 c^{k-1} dc + L^B \left(\tau_B\right)^2 \int_0^{c_X^A} \left(c_X^A - c\right)^2 c^{k-1} dc = f\left(\frac{4\gamma M^k}{k}\right), \tag{4}$$

or,

$$L_A \left(c_D^A\right)^{k+2} + L_B \left(\tau_B\right)^2 \left(c_X^A\right)^{k+2} = \gamma\phi \tag{5}$$

where $\phi = 2(k+1)(k+2)M^k f$. Then, using the equalities $c_X^i = c_D^J/\tau^J$ and letting $\rho_i = 1/\tau_i$ for $i = A, B$ one obtains a system of two equations in two unknowns:

$$\begin{aligned} L_A \left(c_D^A\right)^{k+2} + L_B \rho_B \left(c_D^B\right)^{k+2} &= \gamma\phi \\ L_B \left(c_D^B\right)^{k+2} + L_A \rho_A \left(c_D^A\right)^{k+2} &= \gamma\phi \end{aligned}$$

whence the solutions c_D^{A0} and c_D^{A0} satisfy:

$$\left(c_D^{A0}\right)^{k+2} = \frac{\gamma\phi}{L_A}\frac{1-\rho_B}{1-\rho_A\rho_B} \text{ and } \left(c_D^{B0}\right)^{k+2} = \frac{\gamma\phi}{L_B}\frac{1-\rho_A}{1-\rho_A\rho_B}.$$

3.3 Technical standards as NTM

Once the technical standard is introduced the shift in cost can differ across the home and foreign country, which could substantiate an STC to the TBT committee by Country B. Denote by α and β (with $0 \leq \alpha \leq \beta \leq 1$) the proportion of the shift (namely of s) that must be borne by a firm in Country A and by a firm in Country B respectively. If $\beta > \alpha$ domestic firms have a lower cost than foreign firms in adopting the standard, for example because their existing technology is already prepared to adjust to a standard while foreign firms have to undertake in depth re-engineering of all their production lines, or because the human capital and research networks in Country A have already built in the capabilities to adjust to the standard requirements.

Let c **in** $[0, M]$ **define the identity cost for firm** c**. The cut-off cost for selling at home by firms in Country A is** $s_A = c_D^A - \alpha s$, while foreigners for foreigners it is $\tau_A^{-1}(c_D^A - \beta s)$.[9]

Rewriting the two equilibrium equations, modified by applying the cost shifts to domestic and foreign firms with generic values for α and β we obtain:

$$L^A \left(c_D^A - \alpha s\right)^{k+2} + L^B \left(\tau_B\right)^{-k} \left(c_D^B\right)^{k+2} = \gamma\phi \tag{6a}$$

$$L^B \left(c_D^B\right)^{k+2} + L^A \left(\tau_A\right)^{-k} \left(c_D^A - \beta s\right)^{k+2} = \gamma\phi \tag{6b}$$

In equations 6a and 6b the varieties sold in the market in Country B can be supplied without any cost shift—since this country does not requires the standard to be satisfied. This implies that firms can produce different varieties without scope economies or diseconomies. We call this case "diversified local supply conditions". Relaxing this assumption is possible but is not essential for the general message of the analysis; in particular one can also assume that domestic firms produce with the standard for the domestic as well as for the foreign market, incurring therefore the same cost shift in both markets; this case of "uniform local supply conditions" is dealt with in Appendix B .

Let $A = \left(c_D^A - \alpha s\right)^{k+1}$, $B = \left(c_D^B\right)^{k+1}$,and $C = \left(c_D^A - \beta s\right)^{k+1}$. Differentiating the two equations one obtains the system

$$\begin{array}{c} L^A A \frac{dc_D^A}{ds} + L^B \tau_B^{-k} B \frac{dc_D^B}{ds} = \alpha L^A A \\ L^A \tau_A^{-k} C \frac{dc_D^A}{ds} + L^B B \frac{dc_D^B}{ds} = \beta \tau_A^{-k} L^A C \end{array}. \tag{7}$$

[9]If we assume that standards modify fixed costs rather than shifting marginal costs, we would obtain the same qualitative results.

Whence, letting $\tau^k = \tau_A^k \tau_B^k$ and $\lambda = L^A/L^B$:

$$\frac{dc_D^A}{ds} = \frac{C\beta - A\alpha\tau^k}{C - A\tau^k} \text{ and } \frac{dc_D^B}{ds} = \frac{A}{B}C\lambda\frac{\tau_B^k(\alpha-\beta)}{C - A\tau^k}$$

Proposition 1 *(a) Diversified local supply conditions. If the technical standard has a lower impact on the marginal cost of domestic firms than that of foreign firms (namely $\beta > \alpha \geq 0$) the cutoff cost decreases (the high cost—and smallest firms—must exit the industry). If $\alpha = \beta$ this effect is null. (b) Uniform local supply conditions. If domestic exporters have to incur the same cost shift implied by the standard also for the variety sold abroad the result in (a) holds as far as α is low enough.*

Proof. The identity cutoff cost in Country A is $\hat{c}_D^A = c_D - \alpha s$ hence it decreases with the cost shift s if $dc_D^A/ds - \alpha < 0$; then, $dc_D^A/ds - \alpha = C(\beta - \alpha)/(C - A\tau^k)$. Since $\tau^k \geq 1$, the denominator $C - A\tau^k$ is negative because $\beta > \alpha$ has been assumed, while $C > 0$. Hence ad far as $\beta > \alpha$ the cutoff cost $\hat{c}_D^A$ in Country A decreases with s. ■

As claimed in part (b), if domestic exporters have to incur the same cost shift implied by the standard also for the variety sold abroad, then the proposition is slightly modified, as it holds only for $\alpha < \tilde{\alpha} < \beta$, namely for α not too close to β. (See Appendix B for a proof).

Corollary 1 *The effects on the cut off-cost in Country B have opposite sign than those in Country A (and are null when those in Country A are also null). The proof is in Appendix B.*

An implication of Proposition 1 and of Corollary 1 is that;

RESULT 1: *The proportion of exporters from the home country increases following the introduction of a technical standard in Country A.*

PROOF: The ratio $G(c_X^A - s)/G(c_D^A - s)$, namely the proportion of exporters in the Home country is the ratio $G\left(\left(c_D^B/\tau_B\right) - s\right)^k / G\left(c_D^A - s\right)^k$. The effect of an increase in s on the numerator is positive while that on the denominator is negative. If $\alpha = \beta$, the effect is null. Q.E.D.

By the same token, the proportion of exporters in the foreign country displays an opposite pattern to that of the home country.

Always referring to the system in (7) The number of firms selling in country A, namely N^A, increases since it is given by $N^A = \frac{2(k+1)\gamma}{\eta}\frac{a-z}{z}$ (and z decreases). By the same token, N^B decreases. The opposite effects on the number of firms hold in the case of a newly imposed

NTM. The number of entrants in country A also increases and is unchanged if $\alpha = \beta$. The number of entrants is given by:

$$N_E^A = \frac{M^k}{1-\rho^A\rho^B}\left[\frac{N^A}{\left(c_D^A - s\right)^k} - \rho^A \frac{N^B}{\left(c_D^B\right)^k}\right],$$

and hence it increases as far as the first ratio in square brackets increases, or $\left(c_D^A - s\right)^k$ decreases, and the second decreases (namely $\left(c_D^B\right)^k$ increases). Finally, the number of firms located in A that survive, $G(c_D^A - s)N_E^A$ increases.

Proposition 2 (summary for effects of a standard in Home): *(a) Under diversified supply conditions, a standard that raises marginal costs - and does not raise the utility of the good - has the following long run effects: the profitability of locating in the home country vis-a-vis the foreign country increases. The cut off cost for firms located in A decreases and hence so does the price in A. The number of firms selling in A increases, the number of firms located in A increases, and so does the proportion of exporting home firms. (b) The same results are obtained under uniform local supply conditions only if α is small enough.*

3.4 Tariffs

A marginal cost increasing standard imposed by country H is different from a tariff because a tariff, t, is paid only by the foreign firms. The profit of the foreign exporter is changed to $\pi_X^B(c,t) = (L^A/4\gamma)\left(\tau_A\right)^2\left(c_D^A - t - c\right)^2$.

Setting $\tau_A = 1$ be the original iceberg cost for A, to simplify, the new iceberg cost τ_A' is such that delivered cost $\tau_A' c = c + t$; then $\tau_A' = \dfrac{t}{c} + 1$ varies inversely with c. This is a slight modification with respect to M-O, who only consider direct changes in τ_B , however this has no consequence on the main results. Then $\rho_X' = \frac{1}{\tau_X}$, for $X = A, B$.

Only firms in B with costs $c < c_D^A - t$ can export to A, hence the population of foreign exporters is, regarding their identity cost, more efficient than before the tariff, but the tariff offsets this cost advantage and their average price increases. The cut-off costs are given by the solutions to:

$$L^A\left(c_D^A\right)^{k+2} + L^B\rho_B\left(c_D^B\right)^{k+2} = (4/k)\gamma M^k f \tag{8a}$$

$$L^B\left(c_D^B\right)^{k+2} + L^A\rho_A\left(c_D^A - t\right)^{k+2} = (4/k)\gamma M^k f. \tag{8b}$$

It is straightforward to show that:

RESULT 2: *The cutoff cost for the home country decreases after a per-unit tariff is unilaterally introduced by the same country.*

An increase in the tariff is equivalent to a decrease in ρ_A. The cut off costs c_D^A is *decreased* since ρ_A is decreased. By contrast the cut off costs c_D^B is increased. Then we can follow M-O without changes. The number of entrants in A increases, while in B decreases.

The number of sellers in country home (A) increases and in B decreases.

RESULT 3: *The proportion of exporters from A to B* $G(c_X^A)/G(c_D^A) = G(c_D^B/\tau_B)/G(c_D^A)$ *increases.*

The number of sellers in country A may increase or decrease: $N^A = G(c_D^A)N_E^A + G(c_X^B)N_E^B$ is a sum of two terms with size depending upon, among other things, the size of the two countries. For the same reason, since the imported products in A will be sold at a higher price than before the tariff, the net effect on average price of goods sold at home is ambiguous.

Proposition 3 (summary for effects of a tariff in Home): *A unit tariff has the following long-run effects in home: the profitability of locating in the home country vis-a-vis the foreign country increases (protectionist effect), hence the number of entrants in the home country increases. The cut off cost for firms located in A decreases and hence so does the price in A. The number of firms selling in A increases, the number of firms located in A increases, and so does the proportion of exporting home firms. The average marginal cost decreases.*

4 Data

To test our theoretical predictions, we combine three major data sources. First, we use a database on specific trade concerns (STC) raised by countries to the TBT committee at WTO to assess the role of non tariff measures. Second, we use the TRAINS database with information on the average import tariff imposed by the importing countries. Finally, we retrieve information on market size and productivity from CompNet database (see Section 4.2 for a detailed description).

4.1 Non Tariff and Tariff Barriers

The main data source on the non tariff trade barriers is grounded on the Integrated Trade Intelligence Portal (I-TIP) which includes, among all trade policy notifications, information on goods' technical standards (i.e., notifications) and specific trade concerns (STC) raised by

WTO members: thus the I-TIP includes all the relevant information from the Technical Barrier to Trade (TBT) committee. Given that I-TIP does not provide information in a ready-to-use format, we employ in our analysis a database developed by Ghodsi et al. (2017) which reports all type of NTM (both notification and concern) occurring between 1995 and 2016 at HS 6-digit level.[10] The TBT committee provides a platform to WTO members to settle disputes related to regulation on product standards. The objective is to avoid that standards became a source of discrimination and an unnecessary obstacles to trade. TBT standards have to be notified to WTO and are applied to both domestically produced and imported goods. WTO notifications apply to existing or in the pipeline norms. If a TBT measure create "an unnecessary obstacles to trade", one ore more WTO member states may raise a concern to the committees in order to ask the change or the removal of the measure. Therefore, when a specific TBT measure is perceived by someone as an obstacle to trade, a concern is raised (see Appendix A for more details).

The NTM database records both countries that raise the concerns, the country which imposes the standard, and the product covered by the measure (i.e., HS 2002 6-digit level). Finally, the NTM database includes the date in which the concern has been raised and whether it has been resolved.[11] For our purposes, a concern suggests that a particular technical standard is perceived by trading partners as discriminatory and consequently a trade barrier. A product is protected by a TBT if a concern has been raised and we consider that specific good covered by a NTM.

It is also worth underlining that if a concern is raised on a TBT, that is to say, the TBT is perceived as a discriminatory practice by the country rising the concern, it is likely that the cost of complying with the requirements is not the same for domestic and foreign firms: otherwise there would be not any potential discrimination. This definition of trade barrier measured by concerns is consistent with the assumptions in our theoretical model where TBT affects exporters' cost.

Concerns on standards are raised continuously during the meetings of the TBT committee. The concern raised by Thailand in 2009 against the EU regulation on chemical products

[10] HS classification according to the 1996 and 2002 versions. The NTM database includes also information from Sanitary and Phyto Sanitary (SPS) committee: SPS measures aims at ensuring food safety, and preventing the spread diseases among animals and plants. Since SPS mainly regards a few sectors, i.e. Food (Nace rev.2 10), Wood (16) and Chemical (20), we conduct our analysis by focusing on TBT measures only.

[11] In most of the TBT cases concerns are closed with a "*gentlemen agreement*" between parts. As a rule of thumb, we consider closed a concern after two years (Fontagné et al., 2015). Results are unaffected if we use a period of three years.

(REACH regulation) is illustrative of the trading partners' aims within these WTO meetings: minimize discrimination for the exporters and reduce production costs. According to the Thai representative, "the complexity of REACH was beyond the capacity of many developing and least developed countries to understand and comply with. Such difficulties were particularly evident for SMEs, which were rapidly being forced to shut down" (TBT minutes G/TBT/M/48).[12]. In other cases, concerns focus on a very narrowly defined technology. Japan complained with the EU proposal to eliminate (among other things) Nanosilver in manufactured nanobject: according to Japan, EU "should provide scientific evidence and data that document the danger to human health and the environment" from Nanosilver (TBT minutes G/TBT/M/52).[13]

In a broad sense, TBTs affects exporters' cost. However in our framework, standards works as shifter for the marginal costs' distribution. Different concerns raised at WTO suggest that TBT change the marginal cost of foreign firms. For example, the EU imposed in 2010 a minimum energy performance requirement for the household dishwashers (notification G/TBT/N/EEC/321). The standard imposed by EU were stricter than the one imposed by other developed economics (the cleaning efficiency index was raised from 0.9 to 1.12). According to China, it was a violation of TBT agreement because the EU law were deviating by international standards (TBT minutes G/TBT/M/52). According to China representative this would affect trade by imposing higher cost to Chinese producers due to change in dishwashers' components. Similarly, EU regulation on chemical products moved some substances, as borates, among dangerous ones (notification G/TBT/N/EEC/151): the US and other countries raised concerns on the fact that this new standard would raise cost for all companies which use borates due to the increase in price of alternative substances and additional cost in labelling and packaging (TBT minutes G/TBT/M/42). With the same perspective, China raised concern on the EU regulation on chemical substances for toys (TBT minutes G/TBT/M/44).[14]

Ideally, information on NTM and TBT can be retrieved also from the WTO-TRAINS database or from the World Bank database on the Ad Valorem Equivalent (AVE) of Non-Tariff Measures. However, these two sources present several drawbacks. In the WTO-TRAINS, NTMs are not updated since 2001 so that this source is not compatible with CompNet (see

[12] In 2006, EU implemented a new regulation for the Registration, Evaluation, Authorization, and restriction on Chemical products (REACH). See also footnote 29

[13] Nanosilver is a trademark by Samsung for an antibacterial technology used in washing machines, refrigerators, air conditioner, etc.

[14] In all the above-mentioned cases, the concerns rely on the fact that EU regulation become stricter than international standards, imposing additional costs to foreign producers.

section 4.2). Second, TRAINS records NTM (only a part of them) without mentioning if a specific regulation is as a barrier to trade or not: such information is retrieved through a survey on exporters' perceptions of obstacles to foreign-market access. In the AVE database, the indicator measures the additional costs that the presence of NTMs has on imports (see Kee et al. (2009) for the methodology). However, AVE database provides time invariant information with a different type of sector classification (GTAP sectors): thus the indicator does not allow to evaluate the time variation in the standards and concerns. For these reasons, we prefer to use WTO-STC database to construct our index of protection from TBT.

The NTM database is merged with tariff data from TRAINS database. The tariff dataset includes information on the effectively applied tariff (AHS) at HS2002-6 digit level for each year and country pairs.[15] Finally, we merge NTM database and tariff data using HS 6 digit classification. To be consistent with our empirical analysis, we consider European Union (both for TBT and tariff data) as the importing country which imposes a tariff or set standard.

4.2 CompNet

Under the coordination of the European Central Bank, 17 national central banks [16] have produced a set of harmonized and comparable sector-year level indicators based on national firm-level samples (Lopez-Garcia and di Mauro, 2014).[17] For each triple NACE rev.2 2-digit sector, country, and year, a battery of indicators are computed using a bottom-up approach from firm-level data.

We use in our analysis the IVth vintage of CompNet. The database has two different version depending on the firms' sample used to develop sectoral statistics. The *"full sample"* is produced from countries' samples based on firms with at least one employee and covers the period 2002-2012, while the *"20E sample"* is restricted to firms with at least 20 employees and covers the period 2002-2012.[18] However, the *"20E sample"* ensures a relatively higher degree of representativeness because the *"full sample"* in some cases do not cover smaller firms (those

[15]The effectively applied tariff is defined as the lowest available tariff. If a preferential tariff exists, it will be used as the effectively applied tariff. Otherwise, the Most Favourite Nation tariff will be used. We use weighted tariff at 6-digit level, namely the average of tariffs weighted by their corresponding trade value across 8-digit products.

[16]Austria, Belgium, Croatia, Estonia, Finland, France, Germany, Hungary, Italy, Malta, Lithuania, Poland, Portugal, Romania, Slovakia, Slovenia, and Spain. We are going to use in the current analysis the fourth release.

[17]The unit of analysis is the firm. Self-employed (physical persons with economic activity) are generally not included.

[18]Both samples are slightly unbalanced: for example, Portugal data begin in 2006, while Belgian ones end in 2011.

with less than 10 employees in Poland, less than 20 employees in Slovakia, less than 750,000 euros of turnover in France), and in the other cases tend to be biased towards medium and large firms (such a bias is severe for Austria and Germany). To improve representativeness and homogeneity across countries, the *"20E sample"* has been enriched by a weighting scheme based on the total number of firms by country-year-sector-size class taken from Eurostat Structural Business Statistics (SBS). Thus, *"20E sample"* is the most appropriate database for cross-country analysis.

Finally, in order to merge information from tariff and TBT data (HS classification) with CompNet data (NACE rev.2), we need to define system of concordance. For this reason, we collect trade policy data using the HS 2002 classification at 6 digit and we create n:1 concordance with HS 2007. Then, the HS 2007 is related with CPA 2008 classification and the 6 digit CPA are associated with NACE rev.2 classification at 2 digit (more details in Appendix A).

4.3 Protection Indexes

Our theoretical model relates protection arising from standards with firms' population size. Thus, we need to asses for each country, sector, and year the intensity of protection from EU trade policy (both TBT and tariff). Given that trade policies are defined at EU-level [19], we need to asses to what extent a geographical area (country) and a sector is exposed to the policy. In the same spirit of Autor et al. (2013), we measure the 'exposure' of a country-sector to a given policy using shift-share variables.

Index 1 definition - In order to compute the degree of protection (from tariff or TBT) for each CompNet country c and sector s, we proceed in two steps. Firstly, we compute the protection for the EU country c and sector s from a given source j

$$T^{c}_{jst} = \sum_{p(s)=1}^{P(s)} t^{EU}_{jpt} \frac{import^{c2000}_{jp}}{import^{c2000}_{js}} \quad \forall\, p \,\in\, s, \tag{9}$$

where j is the exporting country (outside EU), s is the NACE rev2-2 digit sector, p is the product (HS-6 digit) that belongs to the NACE rev2, c is a CompNet country, and t^{EU}_{jpt} is the policy imposed by EU to product p from country j (tariff or a STC raised by country j against EU for a product p) at time t.[20] The second term in Eq.9 are weights which represent, for year

[19] Some of the concerns in the NTM database are registered as imposed by a specific EU country. We do not use this piece of information. This type of NTM accounts for the 0.13% of concerns against EU (all from France), in the period of analysis.

[20] Notice that, with the specific trade concern on TBT, the term t^{EU}_{jp} takes value of one if a concern has been

2000, the quota of import in product p from source j to total imports in sector s from j, for the EU country c (e.g., Italian imports of socks from China to total Italian imports in textile from China).[21]

Thus, Eq.9 apportions across CompNet countries c the relevance of trade policy in product p from origin j, using specific country weights. Through the import share, we measure if a good p accounts for a large quota of imports from origin j in sector s.[22]

To measure the exposure to a EU trade policy (due to tariff or TBT) for the country c in sector s, in the second step we aggregate protection from different source countries as follows

$$ProtectionIndex_{st}^{c} = \sum_{j=1}^{J} T_{jst}^{c} \frac{import_{js}^{c2000}}{import_{tot,s}^{c2000}}, \tag{10}$$

where T_{jst}^{c} is defined as in Eq. 9. Similarly to Eq. 9, we redistribute for each CompNet country the intensity of protection across different source of imports using as weights the relative share of imports from origin j to total imports for a given sector $s$for a Compnet country c (in 2000)(e.g. Italian import in textile from China to total Italian import in Textile).[23]

Index 2 (share) definition - Given that TBT entails a binary choice (protected vs non protect products), we define an alternative measure for the degree of protection originated by TBT using the quota of protected products within each NACE sectors. First, we compute, for each sector s, the quota of products p sourced by country of origin j under TBT protection (i.e., for which country j raised a concern):

$$\lambda_{sjt} = \frac{1}{N.Products(s)} \sum_{p(s)=1}^{P(s)} TBT_{jpt}^{EU}, \tag{12}$$

where TBT may takes value zero if a concern is raised by j in t (or $t-1$) and zero otherwise

raised by country j versus the EU in product p, otherwise it is zero.

[21] Weights are taken in year 2000, out of the estimation sample, and constant over time in order to minimize endogeneity concerns arising from reverse causality. For a more detailed discussion on identification strategy see Section 5.

[22] Imports data are from BACI database. Imports are collected at HS 6-digit level. We use the same aggregation procedure for trade data (from HS 2002 to HS2007 to CPA 2008 to NACE rev.2). See Appendix A for more details.

[23] Notice that TBT or tariff protection index can be written as

$$ProtectionIndex_{st}^{c} = \sum_{j=1}^{J} \sum_{p(s)=1}^{P(s)} t_{jpt}^{EU} \frac{import_{jp}^{c2000}}{import_{tot,s}^{c2000}} \tag{11}$$

combining Eq. 9 and Eq. 10. It is straightforward to observe that Eq. 11 ranges from 0 to 1. If zero, none of the products p are recorded with a concern. If one, all the products p are under concerns. The effect of trade policy varies across EU countries c and sectors s in function of the importance of product p imports from country j on total imports in NACE sector s.

and $N.Products_s$ is the number of six digit product that belongs to NACE sector s.[24] Therefore, variable λ is the quota of all TBT concerns raised by country j for the products p which belong to sector s. It measures to what extent a country j is targeted by TBT in sector s. In order to redistribute TBT concerns from source j, we define TBT protection for EU country c in sector s as

$$TBT(quota)_{cst} = \sum_{j=1}^{J} \lambda_{sjt} \frac{import_{j,s}^{c2000}}{import_{tot,s}^{c2000}} \tag{13}$$

where the weights are defined as above in Eq. 10.[25]

4.4 Descriptive Statistics

Consistently with the time coverage of CompNet IVth vintage, our analysis focus on the period 2002-2012. In this period 10,521 TBT concerns were raised against European Union (almost the 13% of total concerns raised at WTO committees in the same period).[26]. We compute three indices to measure the average trade protection through tariff and TBT: Tariff and TBT built as the Protection Index in Eq. 10 by using information on tariffs and TBT concerns respectively, and the TBT(quota) as in Eq. 13 (see Section 4.3).

Table 1 reports the average protection index by sector for both Tariff (Eq. 11), TBT (Eq. 11) and TBT(quota)(Eq. 13). First, we notice that the most protect sectors by TBT are Machinery (28), Motor Vehicles (29), and Other Manufacturing (32) while tariff are used to protect textile sectors (13, 14, and 15). Second, protection index from TBT is lower compared to tariff given that only a tiny share of product within sector is subject to concerns.[27] On average, 485 TBT concerns are raised every year against the European Union, with a peak in 2008, 2009, and 2012 and none in 2005 and 2007.

Table 2 shows how the average trade protection for CompNet countries has evolved over

[24]More precisely, $N.Products$ is the number of CPA 2008 6-digit products that are included in each NACE rev.2 2-digit sector by Eurostat: this information is country and time invariant. The concordance between CPA 2008 products and the HS2002 products is explained in Appendix A.

[25]We can write $TBT(quota)_{cst}$ combining Eq. 12 and Eq. 13 namely,

$$TBT(quota)_{cst} = \frac{1}{N.Products(s)} \sum_{j=1}^{J} \sum_{p(s)=1}^{P(s)} TBT_{jpt}^{EU} \frac{import_{js}^{c2000}}{import_{tot,s}^{c2000}}.$$

[26]These numbers refers to all the concerns (agriculture and manufacturing) including those concerns for whom we have not information on the complaining country. In that case, we exclude the concern from our analysis

[27]Notice that goods under concerns (i.e., goods protected by standards) are a sub-sample of products for whom a TBT notification exists. Notifications are a sub-sample of all existing products.

Table 1: Sector average protection ‡

Sector	Nace rev.2 code	Tariff	TBT	TBTquota
Food	10	1.7134	0.0067	0.0036
Beverages	11	1.1666	0.0080	0.0030
Tobacco	12	0.1643	0.0000	0.0000
Textile	13	3.7671	0.0026	0.0005
Wearing Apparel	14	6.6400	0.0000	0.0000
Leather	15	3.3266	0.0000	0.0000
Wood	16	0.6771	0.0000	0.0000
Paper	17	0.0730	0.0000	0.0000
Printing	18	0.5031	0.0104	0.0104
Coke/Petroleum	19	0.0968	0.0000	0.0000
Chemicals	20	2.2779	0.0093	0.0031
Pharmaceuticals	21	0.1712	0.0045	0.0037
Rubber/Plastic	22	1.7368	0.0033	0.0003
Non Metallic Minerals	23	2.2155	0.0007	0.0003
Basic Metals	24	1.3236	0.0000	0.0000
Fabricated Metals	25	1.6052	0.0005	0.0024
Computer/Electronics	26	1.0203	0.0038	0.0007
Electrical Equipment	27	1.0183	0.0016	0.0028
Machinery	28	0.8103	0.0120	0.0103
Motor Veichles	29	4.8104	0.0202	0.0123
Other Transport	30	1.6176	0.0005	0.0003
Furniture	31	0.1179	0.0000	0.0000
Other Manufacturing	32	0.9354	0.0292	0.0223
Total		1.6430	0.0049	0.0033

‡ Source: Our calculation from TRAINS and NTM database. Tariff and TBT computed as in Eq.11. TBTquota computed as in Eq.13.

time. In particular, TBT protection has risen during the period 2008-2012.[28] In that years EU introduced several new regulations and standards which have been notified to the WTO committees. For example, in December 2006, EU introduced the new regulation on chemicals products and created the European Chemicals Agency [29], while the "Classification, Labelling and Packaging" regulation (CLP), to harmonize European system of labelling for chemicals products, has been declared in December 2008.[30] These new regulations aim to protect human health and environment through a more detailed analysis of chemicals substances used in all types of products (not only pure chemicals products).

In light of these objectives, the regulation has been notified to WTO and trade partners. In 2008, 1029 concerns were raised against EU in chemical sector (almost 1600 for all sectors).[31] In

[28]Similar patterns have been observed by Fontagné et al. (2015).

[29]See Regulation (EC) No 1907/2006, which defined the "Registration, Evaluation, Authorisation and Restriction of Chemicals" (REACH).The REACH entered into force on 1 June 2007, with a phased implementation over the next decade. The aim of the regulation is to protect human health and environment, consistently with TBT agreement at WTO. The regulation also established the European Chemicals Agency, which manages the technical, scientific and administrative aspects of REACH. .

[30]See Regulation (EC) No 1272/2008.

[31]Notice that most of the concerns have been raised against the only REACH regulation. Usually EU revises

addition, in 2007 and 2008 it has been introduced new regulations in food and wine labelling in particular for organic products [32] We may observe a similar pattern for the TBT(quota) index.

Table 2: Yearly average protection ‡

Year	Tariff	TBT	TBTquota
2002	1.6012	0.00036	0.00040
2003	1.5688	0.00037	0.00044
2004	1.4518	0.00538	0.00320
2005	1.6007	0.00429	0.00275
2006	1.6037	0.00023	0.00011
2007	1.9578	0.00021	0.00009
2008	1.6035	0.00729	0.00450
2009	1.6678	0.00876	0.00531
2010	1.7641	0.00233	0.00175
2011	1.5991	0.00883	0.00812
2012	1.6542	0.01605	0.00976
Total	1.6430	0.00492	0.00331

‡ Source: Our calculation from TRAINS and NTM database. Tariff and TBT computed as in Eq.11. TBTquota computed as in Eq.13.

Conversely, tariff protection is more constant over time with the exclusion of a small peak in 2007 mainly due to Textile and Wearing Apparel sector. This increase in tariff protection occurs after several year of stunning growth in Chines textile exports after the expiry of Multifiber agreement (Bloom et al., 2016).[33] For example, between 2006 and 2007, the average tariff from China for the cotton sector (HS-50) has increased in Europe by 15% while after 2008, this short term measures for trade has expired.

Finally, we can observe from Table 3 that there exists a certain degree of heterogeneity in term of protection across countries. Even if trade policy is common between European countries, the degree of protection varies across countries in function of the trade instrument (tariff or TBT) relevance described by weights (Eq. 11). Moreover, different trade instruments generates different level of protection between countries (Figure 1).

Tariff and TBT generate different level of protection across countries and sectors (Figure 1). For example, Finland is the country with the higher protection in Textile (13) both from TBT and tariff, while France, Portugal, and Italy are mostly protected by tariff rather than TBT. We can observe similar patters of heterogeneity across countries and type of trade instruments

regularly its regulation (also as consequence of concerns). New concerns are often related to new revisions of regulation.

[32] Council Regulation (EC) No 834/2007 and No 1235/2008. 650 concerns were raised in 2009 in food sector.

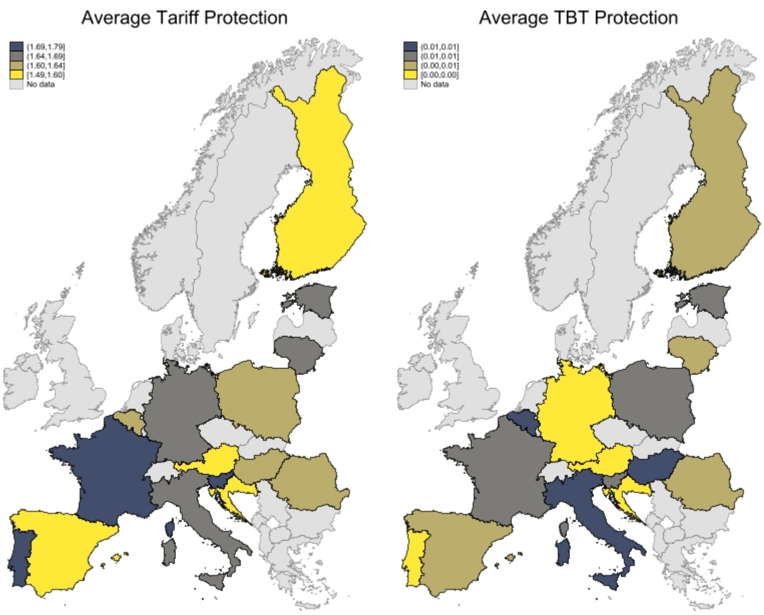
[33] Given the definition of protection index, tariff is a weighted mean of a percent tariff. So it ranges (on average) from 1.6% to 1.9%.

Table 3: Country average protection ‡

Country	Tariff	TBT	TBTquota
Austria	1.5995	0.0039	0.0034
Belgium	1.6378	0.0072	0.0030
Croatia	1.5591	0.0043	0.0029
Estonia	1.6661	0.0055	0.0030
Finland	1.4945	0.0045	0.0030
France	1.7897	0.0058	0.0037
Germany	1.6819	0.0031	0.0032
Hungary	1.6096	0.0059	0.0040
Italy	1.6553	0.0061	0.0029
Lithuania	1.6912	0.0050	0.0035
Poland	1.6405	0.0052	0.0034
Portugal	1.7012	0.0040	0.0035
Romania	1.6316	0.0043	0.0027
Slovakia	1.6325	0.0037	0.0035
Slovenia	1.7035	0.0051	0.0039
Spain	1.5933	0.0051	0.0034
Total	1.6430	0.0049	0.0033

‡ Source: Our calculation from TRAINS and NTM database. Tariff and TBT computed as in Eq.11. TBTquota computed as in Eq.13.

Figure 1: Country Protection

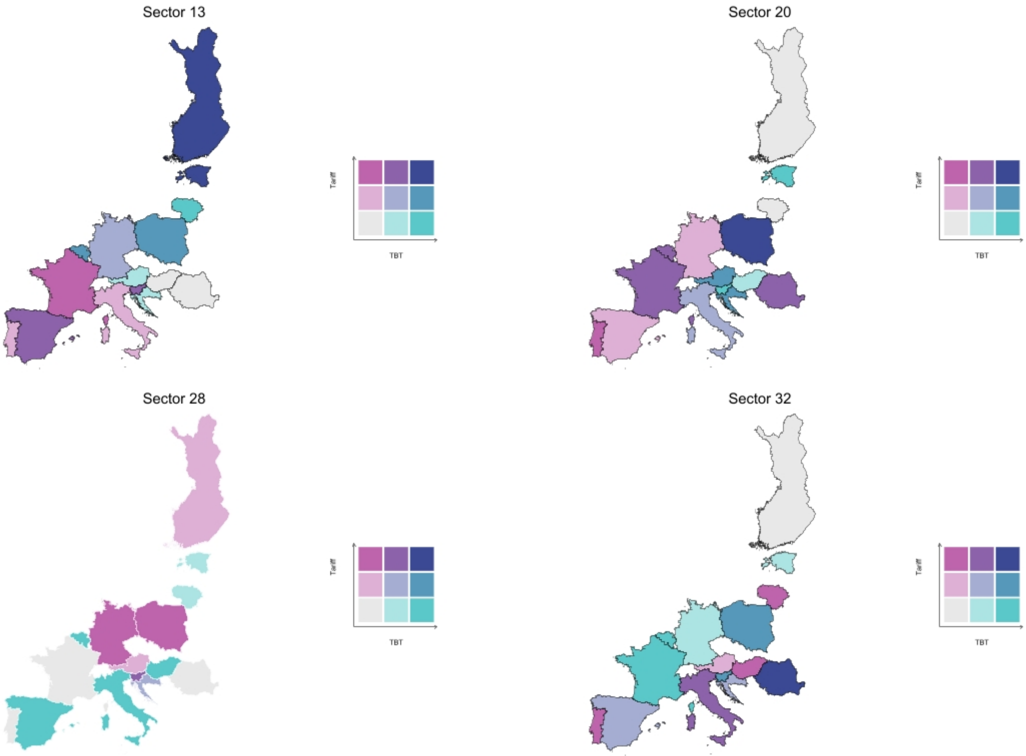


Source: Our calculation from TRAINS and NTM database. Averages across sectors and years

also for other sectors such as Chemical (20), Motor Vehicles (29), and Other Manufacturing (32).

In Appendix C, Table 8 reports information on the CompNet sample and in particular the number of firms and the average productivity by countries. Number of firms, our main dependent variable, is the total number of firms, with whom CompNet statistics have been

Figure 2: Country Protection - Sector Heterogeneity



Source: Our calculation from TRAINS and NTM database. Averages across years

computed. Given that we use the *"20E sample"* is representative for the population of firms with more than 20 employees.

5 Empirical strategy

By using the trade concerns data on TBT for NTM protection measures as described in Section 4.3, we investigate the relationship between NTMs and tariffs and market size in the EU countries imposing the measures. In particular, we consider the relationship between these measures and the total number of firms in the domestic markets and the average productivity. According to the theoretical model developed in Section 3, we expect the (unilateral) introduction of a tariff to be positively associated with the number of domestic firms and higher average productivity. As for NTMs, the theory predicts that a standard raising the marginal costs will increase the number of firms located in the country imposing the standard and decrease the price since the profitability of locating in the home country increases in the long run. This is true if the cost shift implied by the standard is larger for foreign firms than for domestic firms.[34]The latter case is consistent with the definition of a discriminatory TBT which is identified by a concern versus a new standard notified at WTO. As we have mentioned in Section 4 above, otherwise, there would be no reason for other countries to rise 'concern' to WTO about the measure potentially being discriminatory. Like for tariffs, we therefore should observe a positive relationship between NTMs, the number of firms and the average productivity.

We investigate these relationships considering empirical models in which tariffs and NTM are considered separately and then a model in which they are included together.[35]

We therefore start by estimating the following equations:

$$\mathsf{Y_{cst}} = a_0 + a_1 \mathsf{tariff_{cst-1}} + a_2 \mathsf{X_{cst-1}} + u_c + u_s + u_t + \epsilon_{cst} \tag{14}$$

$$\mathsf{Y_{cst}} = a_0 + a_1 \mathsf{NTM_{cst-1}} + a_2 \mathsf{X_{cst-1}} + u_c + u_s + u_t + \epsilon_{cst} \tag{15}$$

$$\mathsf{Y_{cst}} = a_0 + a_1 \mathsf{tariff_{cst-1}} + a_2 \mathsf{NTM_{cst-1}} + a_3 \mathsf{X_{cst}} + u_c + u_s + u_t + \epsilon_{cst} \tag{16}$$

where Y_{cst}, the dependent variables, are alternatively, the number of domestic firms or the average labour productivity of country c in sector s at time t; $tariff_{cst-1}$ is the tariff barrier imposed by country c in sector s at time $t-1$ as in Eq. 11 and NTM_{cst-1} are indicators of NTMs barriers,i.e. trade concerns on TBT, alternatively, TBT as in Eq. 11 and TBT(quota) as in Eq. 13; X_{cst-1} is a vector of other potential control variables; in particular, we include in all specifications the imports from EU27, in order to control for the effect of import competition within EU on firms' population size. We add to our empirical models also country, sector, and year fixed effects (u_c, u_s, and u_t, respectively). The inclusion of country fixed effects allow us to control for all the unobservable country-specific persistent characteristics which might simultaneously affect the industrial structure, i.e. number of firms, the share of exporters, efficiency, and the level of barriers, like quality of institutions, cultural inheritance and attitude towards competitiveness, geographical characteristics and resource endowments. The inclusion of sector

[34]Consistently with the model, we define our protection index as a continuous variable for both tariff and the TBT. In particular, Eq. 9 and 10 transform the binary variable TBT (defined at HS 6 digit level) in a continuous variable (with lower bound equal to zero) which measures the intensity of protection, in country-sector pairs, arising from standards.

[35]If we try to measure the effect of TBT without considering tariffs, we would clearly incur in an omitted variable problem given that some sectors (at the two-digit level) might be protected with a coordination of tariff and TBT, or TBT can be a substitute of tariff (Orefice, 2017).

fixed effects is useful in a framework where both the dependent and the explanatory variables are strongly related to both the demand side and the supply side industry characteristics; while year fixed effects allow us to control for both the EU business cycle and those macroeconomic events that might have happened in the period considered affecting simultaneously all EU countries (e.g, end of Multifiber agreement or global economic shocks). Finally, ϵ_{cst} is the usual i.i.d. error term.

In all specifications both the dependent variable and the explanatory variables are in logarithm, and therefore the estimated coefficients can be interpreted as elasticities. We cluster standard errors at the country level and year.

6 Results

6.1 Tariffs, NTMs and the number of domestic firms

Table 4, where the dependent variable is the number of domestic firms in logarithm, shows the estimates of the models in Eq. 14 (column 1), in Eq. 15 (column 2 and 4,), and in Eq. 16 (in column 3 and 5). The results show a positive association, statistically significant at the 1% level, between the tariff and the number of domestic firms in all the specifications, in line with what expected. In particular, an increase of 1% in the tariff is associated with an increase of 0.017% in the number of firms. These results are in line with the implication of the theoretical model, where firms relocate production in the country protected by the tariff.

Turning the attention to the NTM, we see that the coefficients of both the TBT indexes, i.e. TBT and TBT(quota) are in line with those of the tariff, the results showing a positive and significant (at 1%) relationship with the number of domestic firms, the TBT(quota) showing a larger elasticity (0.004%) with respect to the TBT index (0.001%). Both the coefficients are nevertheless of a smaller magnitude with respect to those of the tariff.

6.2 Tariffs and NTMs: implications for efficiency

In this Section we turn the attention to the average efficiency, proxied by the labour productivity. Results are reported in Table 5, where we see that the average productivity is positively and significantly associated with both the NTM measures as expected from our theoretical model. An increase of 1% in the TBT(quota) measure is associated with an increase of 0.006% in the average productivity (statistically significant at 1%). The positive sign is confirmed when

Table 4: tariffs, NTMs and number of domestic firms‡

VARIABLES	(1) N firms	(2) N firms	(3) N firms	(4) N firms	(5) N firms
Tariff (ln)	0.017***		0.017***		0.017***
	(0.002)		(0.002)		(0.002)
TBTquota(ln)				0.004***	0.004***
				(0.000)	(0.000)
TBT(ln)		0.001***	0.001***		
		(0.000)	(0.000)		
Observations	2,963	2,964	2,963	2,964	2,963
R-squared	0.887	0.888	0.887	0.888	0.888
Industry FE	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

‡ Dependent variable: number of domestic firms. All models include fixed effects at the country, sector and year level and control for the level of import from EU27 (coefficients not reported). Standard errors (in parenthesis) clustered at the country and year level. Sectors with $nfirms < 10$ are excluded. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.

looking at the other measure, the TBT(quota), even if the magnitude of the coefficient is lower and barely significant. Therefore we expect them to increase the competition at the aggregate level showing a positive association with the average efficiency. In contrast with what predicted by our model in the long run, the relationship between tariff and average efficiency is negative and barely significant (at 10% level).[36]

The low effect on productivity (and the negative sign in the case of a tariff) can be explained by the indicator we use. Labor productivity (i.e., value added per worker) or TFP include both pure technical efficiency and firm market power (see among others De Loecker et al. (2016); Forlani et al. (2016)). The former is a key variable of our model (efficiency is the inverse of marginal cost c), while the latter measures the firm ability to charge a higher price for a given demand. Therefore, trade liberalization (as a reduction in tariff) may generate a decrease in the average technical efficiency, according to the theory, but, on the other hand, tariff reduction increases domestic firms' mark-up due to reduced competition. Given that our productivity measures include both terms, the net effect could cancel out, or even the second one could prevail, inverting the sign of the relationship, as in the case of the tariff.

Summarizing, our results are in line with the implications of the theory, with respect to the number of firms. Both tariffs and NTMs are positively associated with the number of firms operating in a country-sector, with a coefficient of a smaller magnitude in the case of NTMs.

[36]It is worth noting that in the robustness check that we carry out in Section 7 the relationship is not statistically significant, except for the TBT(quota) measure.

Table 5: tariffs, NTMs and the average efficiency‡

VARIABLES	(1) lprod	(2) lprod	(3) lprod	(4) lprod	(5) lprod
Tariff (ln)	-0.019*		-0.019*		-0.019*
	(0.010)		(0.010)		(0.010)
TBTquota(ln)				0.006***	0.006***
				(0.001)	(0.001)
TBT(ln)		0.003*	0.003*		
		(0.002)	(0.002)		
Observations	2,961	2,962	2,961	2,962	2,961
R-squared	0.881	0.880	0.881	0.881	0.881
Industry FE	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

‡ Dependent variable: average labour productivity. All models include fixed effects at the country, sector and year level and control for the level of import from EU27 (coefficients not reported). Standard errors (in parenthesis) clustered at the country and year level. Significance level: *0.10>p-value **0.05>p-value ***0.01>p-value.

By contrast, tariffs and NTMs show opposite signs when considering average efficiency and, in particular, results are in this case barely statistically significant. Overall, these results suggest that the average relationship may hide a composition effect, i.e. there might be heterogeneous effects, which we will explore in Section 8.

7 Robustness

The empirical model in Section 5 may produce biased estimates because it is plagued by different sources of endogeneity such as reverse causality or omitted variables. First, the EU trade policy may depend on the firms' population size across sectors: the larger the sector, the stronger is the incentive for protection (or vice-versa). Second, tariffs and NTM measures may be related to some unobserved sectoral characteristics (R&D expenditure, innovation, market power) that determine both the market's outcomes (the number of firms or the average efficiency) as well as and the adoption of protectionist measures. Finally, we may experience a combination of reverse causality and omitted variable bias: the lobbyist activity, which may depends on market's size and outcomes, influences EU trade policy over a variety of goods aiming at protecting the sectors of affiliates.

However, omitted variable bias concerns may be attenuated by different levels of aggregation. Tariffs and NTM data, which are set at the HS6 level for the whole EU (namely, τ^{EU}_{jpt} in Eq. 11), are not likely to be affected by country-sector (c, s) characteristics unless some sectors are dominated by only a few firms in a few countries.[37] If it is the case, it would be necessary to control for firms' distribution at the sector level, which in our strategy is captured by sector fixed effect. [38]

Still, the empirical model in Section 5 may suffer from endogeneity issues if the tariff or the NTM measure is related to omitted variables which vary at country-year or sector-year level, (i.e., asymmetric business cycle shocks or sector specific shocks). Thus, as robustness check we also estimate the same equation as in Eq. 16 by including different combinations of fixed effects.

Results are presented in Table 9 and Table 10 in Appendix C.2, for the number of firms and average efficiency, respectively. In both Tables, columns 1, 3, 5 include the TBT and columns 2, 4, 6 the TBT(quota) index.[39] Columns 1 and 2 show the robustness including country-year and sector fixed effects, allowing us to capture all those observable and unobservable factors varying at the country-year level, like for instance GDP per capita, population, trade openness, or country asymmetric business cycle. Columns 3 and 4 report results when country and sector-year fixed effects are included. This combination of fixed effects controls for asymmetric sectoral shocks (e.g., end of Multifiber agreement or the introduction of a specific sectoral EU policy). Finally, in columns 5 and 6, country-industry and year fixed effects are considered, so that our trade policy indexes exploits within country-sector variation.

As for the number of firms, results in Table 9 generally confirm those in the baseline specification, with two exceptions. The relationship between tariff and number of firms does not survive the inclusion of country-industry fixed effects (columns 5 and 6). With this combination of fixed effects, the tariff index exploits time variation within each country-sector unit. The lack of statistical significance may depend on the fact that the tariff index do not vary enough over time (between 2002-2012) within the unit of analysis; in addition, the weights of the protection index are country-sector specific and time invariant (see Eq. 9 and 10). Therefore, no more variability is left to the tariff index for the identification, once country-sector fixed effects are considered.

Second, the relationship between the TBT and the number of firms is not robust to the si-

[37]Moreover, different lobbies within the same broad sector may have different and contrasting interests (i.e., in favour or against globalization (Dür et al., 2020).

[38]However, it is important to underline that the EU trade policy is a common policy for all the EU countries. Differently from the US, we have not only producers' lobbying but also countries' interests. These interests may be in contrast between them, so a specific policy for product j is the results of mediation between countries. The conflict of interest between countries and sectors attenuate endogeneity bias concerns.

[39]These results should be compared with those in Tables 4 and 5, in columns 3 and 5, for the TBT and the TBT(quota) index respectively.

multaneous inclusion of industry-year and country fixed effects (column 3).[40]. The comparison with the results in column 1 suggests that the identification of TBT mostly relies on variation across sectors, within each country-year observations. Conversely, in column 3. the only variation left for identification is cross-country variation within each sector-year pair. Thus compared to TBT(quota) index, TBT seems to not vary across countries while TBT(quota) index remains positive and statistically significant suggesting a greater variation across country for the index.

As for the relationship between our measures and average efficiency, again results shown in Table 10 are in general in line with those of the baseline model, that is to say that the relationship is positive and statistically significant in the case of the TBT(quota) index measure only, while barely or not statistically significant for both the tariff and the TBT.

As a further check we estimate the same equation as in Eq. 16, i.e. our baseline analysis, by including another control variable beyond the import from EU27, a multilateral resistance term, computed from the estimation of a gravity model over the period 2002-2012 for a sample of 50 countries (Fally, 2015).[41] Ideally, we want to control to what extent a country-sector is integrated in the global economy. The Outward term is a weighted sum of trade cost paid by exporting country to all destinations. The Inward term accounts for all trade costs (from all sourcing countries) paid by consumers in the importing country (Anderson et al., 2018). In addition, this variables should capture the potential effects that trade relationships among third countries may have on a country's number of firms and average efficiency at the sectoral level. Results are reported in Table 11 in Appendix C.2. In columns 1 and 2 the dependent variable is the number of firms and in columns 3 and 4 is the average efficiency. Results are in line with those of our baseline, with coefficients of a larger magnitude in the case of number of firms as dependent variable.

[40]The inclusion of both country-year and sector-year fixed effects produce the same qualitative results as those reported in column 3 and 4

[41]For each Nace rev.2 2-digit sector, we estimate a gravity model of bilateral trade using a Poisson estimator. Bilateral trade cost are proxied by distance, common border, common language, and regional trade agreement (time variant information). Using a Poisson estimator for each sector level gravity, exporter-year and importer-year fixed effects correspond to the outward and inward multilateral resistance term as defined by Anderson and Van Wincoop (2003).

8 Further explorations: heterogeneity by size class

Tariffs are costs which are likely to be homogeneous across firms, in particular across firms of different size. Therefore we expect that the implications of the imposition of a tariff, as derived in Section 3.4, should not differ across firms' size classes. This might not be the case of the costs implied by the imposition of NTMs.

A question that arises in empirical analyses is whether the cost shift implied by a standard be uniform across firms *within* the home country. In particular, there are reasons to believe that large firms precede regulators in setting technical standards. Also, large firms are most likely better equipped with labs and technical support to cope with new standards; they can arrange contracts with suppliers involved with the fulfilment of the new requirements, so as to dampen the cost impact of a standard. These considerations can support the hypothesis that the cost shift implied by a standard differs across firms according to their size.

As a further step we investigate whether the effects of non-tariffs barriers might be heterogeneous depending on firms' size. This analysis should provide insights on the potential mechanisms working behind the average relationships, shedding light in particular on the magnitude of the coefficients and the opposite signs of tariffs and NTMs emerging in the analysis of average efficiency.

When going to the data one goes from a theoretical construct where each single firm (and each countable set of firms) is of zero measure to a factual analysis where the set of firms is countable and each firm has a non-negligible size. The two supports of the distribution of marginal costs are not equivalent therefore. Suppose then that, for any reason, some of the less efficient/smaller firms in the population that enter the market are then exiting the market when the standard is introduced. It is impossible to give an analytical treatment of this decrease in *numbers* in a model where any finite number of firms is of zero measure. Nevertheless we may try to envisage the implications of a differential impact of a standard on 'small' and 'large' firms by explaining why and how the distribution of costs would change in a model with a continuum of firms if the survival rate is dependent on the pre-standard marginal cost of a firm.

Each firm j could be classified by both: the marginal cost level and by the ability to cope with a changing regulatory environment. In line with the modelization so far adopted, both elements are the result of a joint random draw by Nature. The resulting pair, (c_j, α_j), determines the marginal cost and the proportion of the shift (α_j) borne by a firm.

Assume again that c_j is distributed as Pareto over $[0, M]$ while α_j, is distributed as uniform over $[0, \bar{\alpha}c_j]$. The two random variables therefore are not independent and firms with higher costs incur higher expected cost shifts due to the standard and higher variance—the cost after the standard[42] to firm j is $\hat{c}_j = c_j + \alpha_j c_j s$, ranging form $\hat{c}_j = \mathbf{c}_j$ to $\hat{c}_j = c_j + \bar{\alpha} c_j s$; while in the analysis of the "uniform" case we had $\hat{c} = c_j + \alpha s$.

Once entered, firms with a low realization of c_j will survive for a larger range of realization of α_j than firms with a high value of c_j. This mechanism implies that the probability of surviving after entry decreases with c_j. Obviously, this will affect the equilibrium cut-off identity cost c_D^A for any given mass of firms that entered the market (because the proportion of large firms becomes larger than with a uniform cost shift across firms). All equilibrium values shall be affected.

The model becomes clumsy to be solved and analytically intractable; however it is quite obvious that the likely effect of an idiosyncratic shock to the cost shift, for any level of prices and for any mass of entrants, will always be that after entry the cumulative distribution of costs will change to one with a fatter tail in the proximity of $c = 0$. The case where $\alpha = 0$ for all domestic firms cannot apply anymore if the cost shift is heterogeneous across firms within the home country, but can be seen as an approximation to the case where domestic firms incur on average lower adaptation costs that the foreign rivals (one can set $\bar{\alpha}$ close to zero). The effect on the cut-off point for c_D^A cannot be easily predicted though, since a lower number of firms pushes the maximum price in the upward direction, while an increase in the proportion of low cost firms pushes it in the opposite direction.[43]

To take these intuitions to the data, we investigate the previous relationships by interacting the barriers, both NTMs and tariffs, with a categorical variable obtained by splitting firms into two different size classes on the basis of the employment level.

We estimate the following equations:

$$\mathsf{Y}_{\mathsf{cst}} = a_0 + a_1 \mathsf{szclass}_{\mathsf{cst}} + a_2 \mathsf{tariff}_{\mathsf{cst}} + a_3 \mathsf{szclass}_{\mathsf{cst}} * \mathsf{tariff}_{\mathsf{cst}} + a_4 \mathsf{X}_{\mathsf{cst}} + u_c + u_s + u_t + \epsilon_{cst} \quad (17)$$

[42]Hence, *ex-post* this shift is not uniform even across firms with "the same cost c"

[43]In autarky standards lead to a decrease in the number of firms in the sector. If furthermore firms that are assigned a high marginal cost by Nature also have a higher probability of incurring a high cost of adaptation to the standard then the distribution of the surviving firms will change and show a lower number of high cost firms than if the impact of the standard is independent of the 'original' marginal cost of production.

$$\mathsf{Y_{cst}} = a_0 + a_1 \mathsf{szclass2_{cst-1}} + a_2 \mathsf{NTM_{cst-1}} + a_3 \mathsf{szclass2_{cst-1}} * \mathsf{NTM_{cst-1}} + a_4 \mathsf{X_{cst-1}} + u_c + u_s + u_t + \epsilon_{cst} \quad (18)$$

$$\mathsf{Y_{cst}} = a_0 + a_1 \mathsf{szclass2_{cst-1}} + a_2 \mathsf{tariff_{cst-1}} + a_3 \mathsf{szclass2_{cst-1}} * \mathsf{tariff_{cst-1}} + a_4 \mathsf{NTM_{cst-1}} + a_5 \mathsf{szclass2_{cst-1}} * \mathsf{NTM_{cst-1}} + a_6 \mathsf{X_{cst-1}} + u_c + u_s + u_t + \epsilon_{cst} \quad (19)$$

where $szclass_{cst}$ is the categorical variable built by splitting firms in two groups on the basis of their employment, namely: szclass1 (10-49), small firms, and szclass2 (>50), including medium and large firms. The excluded group is szclass1, i.e. smaller firms.

Since we do not have information for labour productivity by size, in this analysis we can consider only the number of firms as dependent variable. Moreover, we do not have information by size class for some countries, namely Austria, Germany and Spain. Therefore, before going into the heterogeneity analysis, we have done the baseline estimations as in Table 4 and Table 5 on the restricted sub-sample excluding these countries. Results for the number of firms and average efficiency are reported in Table 12 and Table 13 (in Appendix C.3), respectively. They confirm the findings emerging from the analyses on the large sample and they should be the reference results for interpreting the decomposition by firms size that we implement in this Section.

Table 6 reports the results on the association between NTMs and the number of firms when taking into account the firm size class. As before, column 1 shows the results of the estimates of the model in Eq. 17, columns 2 and 4 those of the model in Eq. 18, while estimations of the model in Eq. 19 are reported in columns 3 and 5. The coefficient of the not-interacted term capture the effect for small firms, since that of small firms is the excluded category. The coefficients of medium and large firms result from the sum of the coefficient of the not-interacted term and the interacted one. For the sake of clarity, in Table 7 we summarize the relevant coefficients for small and medium-large firms together with their level of statistical significance.

In all models, i.e. both when considered alone (column 1) and when included with either TBT (column 3) or with TBT-share (column 5), the inclusion of a tariff is positively and significantly related (at 1%) with the number of firms in both the small size class and in the medium-large class, with a larger coefficient in the latter. In particular, an increase of 1% in the tariff corresponds to an increase of 0.015% in the number of small firms in all the models and an increase of 0.03% in the number of medium-large firms.

Columns 2 and 3 show results for the TBT measure. Interestingly enough, we see that both TBT measures are negatively and significantly related with the number of small firms, while they are positively correlated with the number of medium-large firms. The positive relationship is statistically significant when considering the TBT(quota) index of NTM.

These results, in particular the difference between tariffs and NTMs, are in line with the theoretical insights. Tariffs have a pro-competitive effect in the long-run for all firms, even if differences in the magnitude of the effect emerge, probably due to the fact that re-location is more likely to occur for larger firms than for smaller ones. By contrast, NTMs measures tend to penalize small firms. In our first theoretical speculations, reported above in this Section, this could be due to the fixed cost component of the NTMs, i.e. the ability to cope with the requirements implied by the standard. [44]

It is also worth noting that the heterogeneity across size classes of the relationship of NTM with the number of firms, showing opposite signs depending on whether small or large firms are considered, helps explain the small magnitude of the coefficients for NTMs (and larger for tariffs) in the results reported in Table 12 in Appendix C.3 when size heterogeneity is not taken into account. Results by size class show that all these measures are associated with the number of firms in the country imposing the measure, but since these associations go in opposite directions in the different size classes for the NTMs, they partially offset each other when the class dimension is not considered. At the same time, these results could help in explaining the negative and barely significant relationship between tariffs and efficiency and the positive and statistically significant (at the 1% level) relationship of NTMs and efficiency reported in Table 13 in Appendix C.3, when heterogeneity is not taken into account. By having a pro-competitive effect for both small and medium-large firms, the relationship between tariffs and efficiency is in principle ambiguous and actually turns to be negative even if small and barely significant. By increasing the number of medium-large firms to the detriment of small firms, NTMs display indeed a positive relationship with average efficiency.

[44]Blanga-Gubbay et al. (2020) show that large and international US firms lobby in favour of the ratification of Free Trade Agreements, which include also standards harmonization. These findings reassure us that our results are not capturing the effect of large firms' lobbying in favour of TBT.

Table 6: Tariffs, NTMs and the number of firms by size class‡

VARIABLES	(1)	(2)	(3)	(4)	(5)
szclass2	0.033	0.225**	0.219**	0.223**	0.216**
	(0.098)	(0.093)	(0.090)	(0.096)	(0.093)
Tariff (ln)	0.014***		0.015**		0.015***
	(0.003)		(0.005)		(0.004)
szclass2Xtariff	0.020		0.017		0.017
	(0.014)		(0.015)		(0.015)
TBTquota(ln)				-0.005**	-0.005*
				(0.002)	(0.002)
szclass2XTBTquota				0.016**	0.015**
				(0.005)	(0.005)
TBT(ln)		-0.006***	-0.006**		
		(0.001)	(0.002)		
szclass2XTBT		0.016**	0.015**		
		(0.005)	(0.005)		
Observations	3,772	3,772	3,772	3,772	3,772
R-squared	0.846	0.846	0.846	0.846	0.846
Industry FE	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

‡ Dependent variable: number of domestic firms. $szclass2_{cst}$ is the categorical variable built by splitting firms in two groups on the basis of their employment, namely, szclass2 includes medium and large firms (>50). The excluded group is szclass1, i.e. smaller firms (10-49). All models include fixed effects at the country, sector and year level and control for the level of import from EU27 (coefficients not reported). Standard errors (in parenthesis) clustered at the country and year level. Sectors with $nfirms < 10$ are excluded. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.

Table 7: Effects for medium and large firm

	(1)	(2)	(3)	(4)	(5)
Tariff (small)	0.014***		0.015**		0.015***
	(0.003)		(0.005)		(0.004)
Tariff+szclass2 (medium-large)	0.031**		0.030**		0.030**
	(0.009)		(0.010)		(0.009)
TBT (small)		-0.006***	-0.006**		
		(0.001)	(0.002)		
TBT+szclass2 (medium-large)		0.006	0.006		
		(0.005)	(0.005)		
TBT(quota) (small)				-0.005**	-0.005*
				(0.002)	(0.002)
TBT(quota)+szclass (medium-large)				0.009**	0.008**
				(0.003)	(0.003)

Significance level: * 0.10>p-value ** 0.05>p-value *** 0.01>p-value.

9 Conclusions

In this paper we investigate, both theoretically and empirically, the relationship between tariff and standard-like Non-Tariff Measures (NTMs) imposed by the EU and market conditions in domestic EU markets, in terms of number of firms and average productivity. We also explore whether and to what extent these effects are heterogeneous across firms, and therefore also affect firms' distribution. We develop a theoretical framework to analyze (i) the introduction of a tariff, (ii) the adoption of a NTM by domestic firms and foreign exporters. We work within the framework of the model by Melitz and Ottaviano (2008), Section 3. We derive some testable implications relating NTMs to the number of firms located in the domestic market and average efficiency. We take the model to the data for a group of European countries and manufacturing industries. We combine CompNet data for 16 EU countries in 2002-2012, providing information on firms' performance at the industry level and by size class, with the STC WTO-I-TIP database, providing information on Specific Trade Concerns (STC) raised at the WTO on NTMs, in particular on Technical Barriers to Trade (TBT), and with the TRAINS database providing information on Tariffs. Results are in line with the implication of the theoretical model, where firms relocate production in the country imposing the standard. Here, the number of firms increases, especially medium-large firms, while small firms decrease, and also average efficiency increases.

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A Technical Barriers to Trade (TBT) and sector concordance

In order to guarantee the production and consumption of "safe" products without creating unnecessary barriers to trade, WTO countries defined a set of rules under which regulate Technical Barriers to Trade (TBT).

TBT agreement aims at regulating technical standards or products requirements which are imposed by states with the objective of protecting human health or environment. However, the existence of many standards may make difficult the actives of exporting firms. TBT agreement aims to facilitate trade and to solve countries dispute on production standards. On the one hand, TBT agreement recognizes countries' rights to adopt the standards they consider appropriate. On the other hand, the TBT agreement try to simplify exporting activities across the multitude of regulations. It is achieved in different ways. First, TBT agreement encourages countries to use international standards in order to uniform regulation. Second, countries should notify to a specific committee, TBT committee, the existing and future regulations on products standards.[45] According to the agreement, standards have to be fair and equitable[46], and any discriminatory practices between domestic produced and foreign good is discouraged.

Usually in response to notifications, countries may use the TBT Committee to discuss specific trade concerns (STCs) related to regulations or procedures of other countries that affect trade. Raised concerns are related to regulations that may be beyond the purpose of public safety and impose a discrimination between domestic and foreign producers. Concerns may be raised on both existing and forthcoming regulation (both should be notified to WTO).

[45] Transparency is a fundamental point of TBT agreement. Notification, with establishment of enquiry points, and publication requirements are the three key points.

[46] It is encouraged also the recognition of other countries' assessment procedures.

Differently from TBT, **SPS agreement** aims to protect the safety of food and to prevent the spread of diseases among animals and plants. Moreover, SPS measures cannot be used as protection for domestic producers. In particular such regulation cannot be used to discriminate between countries with similar prevailing conditions. In order to export, it is necessary to demonstrate that the exporting country achieve the same level of protection as in the importing country. Similarly to TBT, governments have to provide in advance notification on new or changed sanitary and phyto-sanitary regulations to SPS committee. As for TBT, WTO members can raise concerns on SPS to the SPS committee.

Sector concordance - In order to perform our empirical analysis, we need that protection index (computed from NTM and Tariff database) could be merged with from CompNet (NACE rev2.). Thus to harmonize nomenclatures, we use correspondence tables from the World Integrated Trade Solutions (WITS) and RAMON-Eurostat databases. To identify HS-6 digit products within each Nace rev.2-2 digit, we proceed as follows. First we consider HS2002 revision for NTM and tariff database.[47] Second, we use correspondence tables between HS2002 and HS2007, and between HS2007 and CPA2008. Once we have the correspondence between HS2002 and CPA2008, we could aggregate all HS2002-6 digit within the first two digits of CPA2008: the first two digit of CPA 2008 corresponds to NACE rev. 2-2 digit.

B Proofs Section3

Proof of part (b2) of Proposition 1. The model with domestic firms incurring the same cost shift for production at home and abroad implies the two equilibrium equations:

$$\begin{aligned} L^A \left(c_D^A - \alpha s\right)^{k+2} + L^B \left(\tau_B\right)^{-k} \left(c_D^B - \alpha s\right)^{k+2} &= \gamma\phi \qquad (a) \\ L^B \left(c_D^B\right)^{k+2} + L^A \left(\tau_A\right)^{-k} \left(c_D^A - \beta s\right)^{k+2} &= \gamma\phi \qquad (b) \end{aligned} \tag{20}$$

Letting $A = \left(c_D^A - \alpha s\right)^{k+1}$, $B = (c_D^B - \alpha s)^{k+1}$, $C = \left(c_D^A - \beta s\right)^{k+1}$, $D = \left(c_D^B\right)^{k+1}$ (remark the different definition of B with respect to the text) and fully differentiating one obtains the system:

$$\begin{pmatrix} \lambda A & \tau_B^{-k} B \\ \lambda \tau_A^{-k} C & D \end{pmatrix} \begin{pmatrix} \frac{dc_D^A}{ds} \\ \frac{dc_D^B}{ds} \end{pmatrix} = \begin{pmatrix} \lambda\alpha A + \alpha\tau_B^{-k} B \\ \lambda\tau_A^{-k}\beta A \end{pmatrix}$$

So that :

[47] In particular, HS2002 allows us to have the largest set of information for the period 2002-2012 (CompNet) both in terms of tariff, TBT, and imports from a unique data source

$$\begin{pmatrix} \frac{dc_D^A}{ds} \\ \frac{dc_D^B}{ds} \end{pmatrix} = \begin{pmatrix} -\frac{\left(B\alpha\tau_A^k D - AB\beta\lambda + A\alpha\lambda\tau_A^k\tau_B^k D\right)}{\lambda\left(BC - A\tau_A^k\tau_B^k D\right)} \\ \frac{\left(BC\alpha - A^2\beta\lambda\tau_B^k + AC\alpha\lambda\tau_B^k\right)}{BC - A\tau_A^k\tau_B^k D} \end{pmatrix}$$

then

$$\frac{dc_D^A}{ds} = -\frac{B\alpha\tau_A^k D - AB\lambda\beta + A\lambda\alpha\tau_A^k\tau_B^k D}{\lambda\left(BC - A\tau_A^k\tau_B^k D\right)}$$

then $A > C$ and $D > B$ imply $\left(BC - AD\tau_A^k\tau_B^k\right) < AD(1 - \tau_A^k\tau_B^k) < 0$ hence the sign of $\frac{dc_D^A}{ds}$ equals that of $j(\alpha, \beta) = B\alpha\tau_A^k D - AB\beta\lambda + AD\lambda\alpha\tau_A^k\tau_B^k$

Then, $\alpha = 0$ implies $j(0, \beta) = A\lambda\left(-B\beta\right) < 0$ whence the procompettive effect when the NTM is extended to foreign firms but is already adopted by home firms is confirmed.

Let $\alpha = \beta$ then $j(\alpha, \alpha) = \alpha\left(BD\tau_A^k + A\lambda\left(D\tau_A^k\tau_B^k - B\right)\right)$ which is positive because by definition one has $B < D$. Furthermore, the effect is anticompetitive if $\frac{dc_D^A}{ds} > \alpha$ or

$$-\frac{B\alpha\tau_A^k D - AB\lambda\beta + A\lambda\alpha\tau_A^k\tau_B^k D}{\lambda\left(BC - A\tau_A^k\tau_B^k D\right)} > \alpha$$

letting $\beta = \alpha$ one has $A = C$ and the denominator is negative. So that the condition becomes $-\left(B\alpha\tau_A^k D - AB\lambda\alpha + A\lambda\alpha\tau_A^k\tau_B^k D\right) < \alpha\left(\lambda A\left(B - \tau_A^k\tau_B^k D\right)\right)$ or$B\tau_A^k D\alpha > 0$ which is true for

$\alpha > 0$.

Proof of Corollary 1.

We take the two equations in (6a and (6a) to analyze the effects in Country B. One has :

$$\frac{dc_D^B}{ds} = -\frac{A}{B}\lambda\tau_B^k\frac{A\beta - C\alpha}{C - A\tau_A^k\tau_B^k}$$

then the denominator is negative; hence the sign of $\frac{dc_D^B}{ds}$ equals that of $A\beta - \alpha C$. For $\alpha = 0$ this is clearly positive, hence for already adopted NTM the effect in country B is anticompetitive. And $A\beta - \alpha C = 0$ for $\alpha = \beta$ hence there is no effect.

Assume now that domestic firms incur the same cost shift abroad as at home as in equation (20). Then:

$$\frac{dc_D^B}{ds} = \frac{BC\alpha - A^2\beta\lambda\tau_B^k + AC\alpha\lambda\tau_B^k}{BC - A\tau_A^k\tau_B^k D}. \tag{21}$$

Since the denominator is negative then the sign of $\frac{dc_D^B}{ds}$ is the opposite of that of the numerator in (21). For $\alpha = 0$ the numerator reduces to $-A^2\beta\lambda\tau_B^k < 0$, hence $\frac{dc_D^B}{ds} > 0$ if $\alpha = 0$. By contrast, if $\alpha = \beta$ the $A = C$ and the numerator reduces to $AB\alpha > 0$. Hence $\frac{dc_D^B}{ds} < 0$ if $\alpha = \beta$.

Proof of Result 4. An increase in the tariff is equivalent to a decrease in ρ_A hence look at $sign[-\frac{d}{dt}(G(c_D^B/\tau_B)]$ as equivalent to $sign[-\frac{d}{d\rho_A}(G(c_D^B/\tau_B)] = sign\left[-\frac{d}{d\rho_A}(c_D^B)\right] = (+)$ while $sign[-\frac{d}{d\rho_A}(G(c_D^A)] = (-)$ hence the numerator in $G(c_D^B/\tau_B)/G(c_D^A)$ increases while the denominator decreases. Q.E.D.

C Additional Tables

C.1 Descriptive Statistics

Table 8: Descriptive Statistics - CompNet‡

Country	Stat	Firms	Labor Productivity
Austria	Mean	54.90	89.73
	St.Dev	46.24	43.26
Belgium	Mean	160.30	64.29
	St.Dev	154.80	31.23
Croatia	Mean	80.32	12.92
	St.Dev	74.59	8.17
Estonia	Mean	48.81	12.83
	St.Dev	45.96	7.32
Finland	Mean	102.02	64.64
	St.Dev	97.18	40.72
France	Mean	856.42	66.88
	St.Dev	789.96	25.88
Germany	Mean	634.36	97.76
	St.Dev	614.14	36.55
Hungary	Mean	216.25	7.51
	St.Dev	200.19	6.63
Italy	Mean	1285.81	39.37
	St.Dev	1068.81	17.16
Lithuania	Mean	88.77	9.01
	St.Dev	92.46	4.63
Poland	Mean	482.45	15.24
	St.Dev	479.24	13.56
Portugal	Mean	319.05	22.96
	St.Dev	310.55	11.31
Romania	Mean	431.50	5.22
	St.Dev	438.29	3.39
Slovakia	Mean	90.67	11.11
	St.Dev	74.16	6.99
Slovenia	Mean	53.04	13.10
	St.Dev	39.76	7.54
Spain	Mean	579.62	35.13
	St.Dev	502.28	11.36
Total	Mean	363.37	37.59
	St.Dev	577.23	38.15

‡ Source: Our calculation from CompNet, sample 20E. Sector-Year averages. Labor Productivity: value added per worker.

C.2 Robustness

Table 9: tariffs, NTMs and number of domestic firms‡

VARIABLES	(1) nfirms	(2) nfirms	(3) nfirms	(4) nfirms	(5) nfirms	(6) nfirms
Tariff (ln)	0.018***	0.018***	0.024***	0.024***	0.004	0.003
	(0.001)	(0.001)	(0.007)	(0.005)	(0.003)	(0.003)
TBTquota(ln)		0.003***		0.008***		0.003**
		(0.000)		(0.001)		(0.001)
TBT(ln)	0.001***		-0.007		0.003**	
	(0.000)		(0.005)		(0.001)	
Observations	2,963	2,963	2,960	2,960	2,961	2,961
R-squared	0.891	0.892	0.889	0.889	0.990	0.990
Industry FE	Y	Y	N	N	N	N
Country FE	N	N	Y	Y	N	N
Year FE	N	N	N	N	Y	Y
Country-Year	Y	Y	N	N	N	N
Industry-Year	N	N	Y	Y	N	N
Country-Industry	N	N	N	N	Y	Y

‡ Dependent variable: number of domestic firms. All models control for the level of import from EU27. Standard errors (in parenthesis) clustered at the country and year level. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.

Table 10: tariffs, NTMs and the average efficiency‡

VARIABLES	(1) lprod	(2) lprod	(3) lprod	(4) lprod	(5) lprod	(6) lprod
Tariff (ln)	-0.016	-0.017	-0.015	-0.016	-0.008*	-0.009*
	(0.011)	(0.010)	(0.011)	(0.010)	(0.004)	(0.004)
TBTquota(ln)		0.006***		0.021**		0.004*
		(0.001)		(0.007)		(0.002)
TBT(ln)	0.003*		-0.006		0.002	
	(0.002)		(0.007)		(0.002)	
Observations	2,961	2,961	2,958	2,958	2,959	2,959
R-squared	0.885	0.886	0.884	0.884	0.986	0.986
Industry FE	Y	Y	N	N	N	N
Country FE	N	N	Y	Y	N	N
Year FE	N	N	N	N	Y	Y
Country-Year	Y	Y	N	N	N	N
Industry-Year	N	N	Y	Y	N	N
Country-Industry	N	N	N	N	Y	Y

‡ Dependent variable: average labour productivity. All models include fixed effects at the country by year and sector level and control for the level of import from EU27. Standard errors (in parenthesis) clustered at the country and year level. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.

C.3 Reduced sample

Table 11: MLR term‡

VARIABLES	(1) nfirms	(2) nfirms	(3) lprod	(4) lprod
Tariff (ln)	0.025***	0.024***	-0.015	-0.016
	(0.006)	(0.006)	(0.010)	(0.009)
TBTquota(ln)		0.004***		0.006***
		(0.000)		(0.002)
TBT(ln)	0.002**		0.004	
	(0.001)		(0.002)	
Observations	2,776	2,776	2,774	2,774
R-squared	0.888	0.888	0.885	0.885
Industry FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

‡ Dependent variables: number of firms (columns 1 and 2), average labour productivity (columns 3 and 4). All models include fixed effects at the country by year and sector level and control for the level of import from EU27. Standard errors (in parenthesis) clustered at the country and year level. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.

Table 12: Reduced sample (no Austria, Germany, Spain). Number of firms.‡

VARIABLES	(1) nfirms	(2) nfirms	(3) nfirms	(4) nfirms	(5) nfirms
Tariff (ln)	0.016***		0.016***		0.016***
	(0.004)		(0.004)		(0.004)
TBTquota(ln)				0.004***	0.004***
				(0.000)	(0.000)
TBT(ln)		0.002***	0.002**		
		(0.000)	(0.001)		
Observations	2,354	2,355	2,354	2,355	2,354
R-squared	0.900	0.900	0.900	0.900	0.900
Industry FE	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

‡ Dependent variable: number of firms. All models include fixed effects at the country by year and sector level and control for the level of import from EU27. Standard errors (in parenthesis) clustered at the country and year level. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.

Table 13: Reduced sample (no Austria, Germany, Spain). Average efficiency‡

VARIABLES	(1) lprod	(2) lprod	(3) lprod	(4) lprod	(5) lprod
Tariff (ln)	-0.021*		-0.021*		-0.021*
	(0.010)		(0.011)		(0.010)
TBTquota(ln)				0.008***	0.008***
				(0.000)	(0.000)
TBT(ln)		0.004***	0.004**		
		(0.001)	(0.001)		
Observations	2,352	2,353	2,352	2,353	2,352
R-squared	0.862	0.862	0.862	0.862	0.863
Industry FE	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

‡ Dependent variable: average labour productivity. All models include fixed effects at the country by year and sector level and control for the level of import from EU27. Standard errors (in parenthesis) clustered at the country and year level. Significance level: *0.10>p-value ** 0.05>p-value*** 0.01>p-value.