Consumption Externalities, Product Quality, and the Role of National Treatment

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Abstract

A main concern of the World Trade Organization (WTO) is non-discrimination among members as there exist incentives for individual countries to impose restrictions on foreign firms to advantage their own firms. To this end, non-discrimination is embodied in two important articles of the WTO: Article I (Most Favored Nation Treatment), which is concerned primarily with tariffs, and Article III (National Treatment), which is concerned with domestic policy. In this paper, we examine the role of Article III in a two-stage, two-country model in which a single firm within each country produces a quality-differentiated good that generates pollution at the consumption stage but the extent of the externality depends on the quality of the good and may be positively or negatively correlated with quality. For each of the two correlation possibilities, we study the environmental policy choices of the two countries (first-stage problem) and quantity and price equilibria in the two product markets (second-stage problem) under Article III and compare them to the environmental policy choices and product market equilibria prevailing in a world in which Article III does not apply. If the high-quality good is more polluting, we find that National Treatment restrictions can lead to a better global environment and higher global welfare, a worse global environment and lower global welfare, or a worse global environment but higher global welfare, depending on the pollution intensity level relative to the quality gap between the two goods. However, if the low-quality good is more polluting, it is not possible for global welfare to increase and global environmental quality to decrease; instead, a new possibility arises which involves a lower global welfare level but a higher global environmental quality level.

Keywords: National Treatment; non-discrimination; environmental damages; consumption externalities; environmental policy; WTO.

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1 Introduction

Non-discrimination is a fundamental principle of the World Trade Organization (WTO) as a response to the incentives of individual countries to impose restrictions on foreign firms in order to give their own firms an advantage. There is a general consensus that protectionist trade policy benefits are "beggar thy neighbor" in nature: gains in one country largely (or exclusively) come at the expense of losses in other countries. To this end, non-discrimination is embodied in two important articles of the WTO (and formerly in the GATT): Article I (Most Favored Nation Treatment) and Article III (National Treatment), with the former concerned with border measures or tariffs and requiring that goods from different countries be treated equally and the latter concerned with domestic policy and requiring that imported goods be treated at least as favourably as "like" domestic goods. To date, Article I (or MFN) has received a great deal of attention in the literature, while Article III (or NT) has been largely ignored in spite of its significance in support of a more critical view of the WTO that stresses the negative implications of restricting countries' freedom to set their domestic policies, particularly when such policies are motivated by legitimate reasons (e.g., protecting the environment).

According to Article III, internal taxes "should not be applied to imported or domestic products so as to afford protection to domestic production" and importing goods "shall not be subject, directly or indirectly, to internal taxes or other internal charges of any kind in excess of those applied, directly or indirectly, to like domestic products." An explanatory note added to the second paragraph of Article III further clarifies that, if the imported and domestic goods are not "like" products, internal taxes cannot be applied "as to afford protection to domestic production" if the goods are "directly competitive or substitutable." Hence, if the imported and domestic goods are "like" products, the internal tax on the imported good cannot be higher than the internal tax on the domestic good; however, if the two goods are "directly competitive or substitutable," the tax rate on the imported good can be higher provided that the tax differential does not exceed some *de minimis*, but yet unspecified, amount. In case law, "like" is a narrower concept than "directly competitive or substitutable" in that the former implies the latter but not the other way around. Loosely speaking, two products are "like" if they share a number of identical or similar characteristics, including but not limited to their end-uses as reflected in the elasticity of

substitution, while two products are "directly competitive or substitutable" if they have common end-uses.[1]

In a world in which trade agreements explicitly specify border measures but cannot and do not specify internal measures, thus leaving the trade parties with unilateral control over the determination of their internal policies, it is hard to argue against the need for provisions that prevent the use of internal regulations to undo agreed upon restrictions regarding border measures to the extent that such undoing is desirable.[2] The NT principle is thus intended to prohibit the application of price discrimination techniques that can interfere with the fair competition between domestically produced and imported goods in the market.[3] As it stands, however, the principle does not allow for any consideration as to the reasons motivating discriminatory taxation, even though its intended role is to prevent the use of domestic policy for protectionist purposes, and thus applies even when there exist legitimate reasons (e.g., out of environmental and health concerns) for discriminatory taxation. Of course, countries can internalize legitimate concerns they may have about imported goods in their tariff negotiations, but the NT obligation holds independently of whether tariff agreements are in place; furthermore, even in the presence of tariff agreements, concerns over imported goods, particularly as they relate to health and the environment, may evolve over time as countries have the opportunity of experiencing the goods and are thus likely to be unknown at the tariff negotiation stage.[4] Yet another complication arises when a country deals with two or more imported products which are similar to the domestic product, so that the NT provision applies, but impose different negative externalities; in negotiating tariffs with the trading partners, the country would be bound by Article I and would thus be unable to tariff discriminate to address the different

[1] See Table 1 for a summary of disputes (from 1995 to 2012) involving the passages in Article III which are of relevance to internal taxation (i.e., Art. III:1, Art. III:2 first sentence, and Art. III:2 second sentence).

[2] Existing formal models of the relationship between trade policy and domestic regulatory policy (e.g., Markusen, 1975; Copeland, 1990; Ederington, 2001; Bagwell and Staiger, 2002, ch. 9) highlight the concern that large countries may circumvent the restrictions of their trade policies by relaxing domestic regulatory standards in import-competing industries, thus forcing foreign suppliers to lower the prices of their products in order to remain globally competitive. The potential for a weakening of regulation (e.g., environmental and labour) to retain global competitiveness after the lowering of trade barriers is referred to in the literature as the (regulatory) race to the bottom hypothesis.

[3] Article XX allows for some exceptions to NT, particularly in relation to health and well-being and the environment. In practice, disputes involving these exceptions have been largely unsuccessful (see Table 2 for a summary of disputes involving Art. XX over the 1995 to 2012 period). In this paper, we assume that the qualities of the domestic and foreign goods are not sufficiently dissimilar to avoid NT provisions.

[4] Although Article XXVIII allows members to renegotiate tariff bindings, renegotiation is constrained in that the member seeking changes must provide compensatory concessions on other products; absent agreement, the affected members can withdraw "substantially equivalent" concessions initially negotiated with the member making the changes. Since the establishment of the WTO in 1995, there have been 39 requests to enter into renegotiations under Article XXVIII, of which 5 have been withdrawn, 22 have been concluded, and 12 are still on-going.

levels of concern associated with the imported goods.

In light of the above considerations, it is important to examine the role of the NT clause more closely and look at its welfare and environmental implications in instances in which the imported and domestically produced goods are "like" from the legislative standpoint but differ in quality which, in turn, determines how consumption affects the environment; hence, in spite of their likeness, the imported and domestic goods have different environmental effects. If, on one hand, there are aggregate gains resulting from trade liberalization (e.g., the promotion of globalization and fair competitiveness that minimize policy-induced market power and bring about a reduction in domestic prices), on the other hand, there are losses resulting from the inability to internalize the quality differences between the imported and domestic goods through discriminatory internal measures. Our paper provides a formal analysis of this trade off both when the consumption externality is increasing in quality (e.g., cars) and when it is decreasing in quality (e.g., organic food and energy-saving appliances) and, for each case, derives conditions under which NT improves the environment and/or welfare (both locally and globally).

While, as noted above, economic analyses in much of the relevant literature has been on the role of MFN, some recent work has examined the relationship between NT and international trade (and trade agreements). One of the earliest analyses (Horn, 2006) considers, for example, the interaction between tariff liberalization and domestic tax setting under a binding NT principle. With constant tariffs, Horn shows that a marginally binding provision increases welfare, but a more restrictive provision may reduce welfare; however, when tariffs are endogenous and countries negotiate their levels before deciding upon their internal sales taxes, NT is welfare-enhancing. Horn's analysis thus supports the position that, even when discrimination against imported goods is justifiable on the basis of a first-best solution argument, non-discrimination can enhance welfare if countries are able to take full account of how tariff agreements affect the setting of internal policy.[5] Our paper differs from Horn's paper in its emphasis on the impact of NT when countries cannot target distortions in the domestic market at the tariff negotiation stage for reasons in line with those above mentioned (e.g., distortions unknown when tariffs are negotiated and re-negotiation is not viable; additional provisions such as MFN restrict extent to which distortions can be internalized in tariff agreements).

[5] For similar arguments, see Horn et al. (2010), which is about trade agreements as endogenously incomplete contracts when contracting is costly, and Staiger and Sykes (2011), which is concerned with the relationship between border instruments and domestic product standards in the presence of a purely domestic externality.

Furthermore, our paper is concerned with a particular type of distortions in the domestic market, which relates to the environmental impact of consumption, and thus considers not only the welfare implications of NT but also its environmental implications.

Another paper on NT of relevance to our analysis is Saggi and Sara (2008) which analyzes the decision of whether to sign a non-discrimination agreement in a two-country world in which the countries provide quality-differentiated products and differ in the size of their markets. When markets are symmetric in size, an NT agreement does not emerge in equilibrium unless the agreement includes international transfers; this result arises because the low-quality country prefers discrimination while the high-quality country prefers non-discrimination but global welfare is higher under NT so that there exist international transfers that would induce the low-producing country to sign the agreement. Under market asymmetry (i.e., the high-quality country's market is larger), on the other hand, it is possible for both countries to prefer NT, provided that the quality gap is not too large, and international transfers are thus unnecessary for an NT agreement to arise. While our paper also considers two countries producing quality-differentiated products, its focus is not on the decision of whether to form a non-discrimination agreement and how asymmetry in market size affects this decision but on the welfare and environmental impacts of the NT provision when there is a negative externality associated with consumption the extent of which depends on quality.

The paper most closely related to ours in terms of objective is Gulati and Roy (2008) which investigates the welfare effects of a non-discrimination clause that governments must satisfy when introducing product standards to control consumption-generated emissions. In a general equilibrium model with two small open economies, Gulati and Roy consider the optimality of non-discrimination under different policy regimes and conclude that NT does not prevent implementation of the optimal outcome under (1) an optimal emission tax on consumers or (2) an optimal consumption tax coupled with product standards when foreign producers do not enjoy a compliance cost advantage; however, if the emission/consumption tax is suboptimal (i.e., cannot be set at the socially efficient level), NT is more likely to prevent implementation of the optimal outcome and, in fact, does not result in welfare losses only if domestic producers' compliance cost advantage is sufficiently large. Although our paper is also concerned with how NT affects countries' ability to optimally regulate environmental externalities arising at the consumption stage, its focus is on domestic taxes within a partial equilibrium model with imperfect competition and asymmetry in external effects rather than

on product standards within a general equilibrium model with perfect competition and asymmetry in compliance costs.

Two other papers that consider NT in the presence of externalities but are quite different from our paper in terms of the questions they address are Costinot (2008) and Horn (2011). The former provides a formal analysis of how the WTO's NT principle as applied to regulatory standards performs in relation to the EU's Mutual Recognition (MR) principle when goods differ in their external effects. Relative to a case of complete contracting, both the NT and MR provisions are inefficient, but NT is preferable to MR when the traded goods impose high externalities. This results arises because, under NT, a country chooses standards on both the domestic and foreign goods and thus tends to set standards that are too high by ignoring the foreign country's profits from exports, while, under MR, the foreign country has control over the standard on its good and thus tends to set standards that are too low by ignoring the environmental effects of its good in the export market.[6] The second paper (Horn, 2011) focuses on the implications of the allocation of the burden of proof in environmental disputes over the application of the NT principle. Using a two-sector model with two symmetric countries producing in both sectors but consuming only in one and facing environmental damages in the importing sector as a result of a negative consumption externality, Horn finds that NT always constrains countries with legitimate environmental concerns but not necessarily countries that use differential taxes for protectionist purposes. If environmental damages are sufficiently large, higher taxes on imports are desirable from a global efficiency point of view but, if imposed, can be challenged. Adjudicators, however, do not know with certainty whether differential taxation is based on legitimate concerns, and thus desirable from a global perspective, and can reasonably make judicial mistakes, allowing discrimination at times when it is not desirable but restricting it at other times when it is desirable. As the allocation of the burden of proof between the complainants (exporting countries) and the respondents (importing countries) influences the propensity to make mistakes, Horn then goes on to examine how shifting the burden of proof in NT disputes affects the environment and welfare through changes in the propensity for environmentally affected countries to prevail in NT disputes (direct effect) and through changes in negotiated tariffs (indirect effect).

[6] The EU's MR principle requires that imported goods be lawfully produced to be admitted into the territory of the importing country; to be lawfully produced means to be produced according to the rules and manufacturing processes in place in the exporting country.

To examine the implications of the NT principle when countries have legitimate reasons for discriminating between domestic and foreign goods which they cannot internalize at the tariff setting stage, our paper considers a two-stage model with two countries producing "like" products that differ, however, in quality and are freely traded. Consumption generates a negative externality which governments control via internal taxation (first stage). As the magnitude of the externality is a function of quality, governments must resort to differential taxation of the two goods to fully account for the external effects of consumption. With the internal policy determined, the two countries engage in a non-cooperative game to determine the equilibrium prices and quantities in the two product markets (second stage). If governments are constrained to adopt non-discriminatory internal measures (i.e., the NT clause applies), it is not always the case that global environmental damages increase or that global welfare decreases. In fact, there exist several possibilities depending on (*i*) the pollution intensity level relative to the quality gap, (*ii*) whether environmental effects are increasing or decreasing in quality, and (*iii*) whether NT is unilaterally or bilaterally binding. In terms of global effects, some interesting differences between the high-quality polluting case (i.e., when pollution generates from consuming the high-quality good as in the car market) and the low-quality polluting case (i.e., when pollution generates from consuming the low-quality good as in the market for energy-saving appliances) are as follows: (*i*) at intermediate pollution intensity levels, welfare increases but the environment worsens in the former case while welfare decreases but the environment improves in the latter case; (*ii*) when NT is only binding for the clean-good country as pollution intensity is relatively high, welfare increases but the environment worsens in the former case while welfare decreases and the environment worsens in the latter case.

We structure the remainder of the paper in several sections. In section 2, we detail the model and derive the welfare-maximizing internal policies with and without a non-discrimination principle. In section 3, we compare the results in terms of market equilibrium (prices, sales, and market coverage), environmental taxes, national and global welfare, and national and global environmental damages. In section 4, we consider instances in which pollution arises from the consumption of the low-quality good as in the organic food market and, more applicable to the unit-consumption assumption of the model, in the market for energy-saving appliances. In section 5, we compare the national and global welfare and environmental damages that prevail in the absence of NT with those that emerge at high pollution intensity levels when NT is only binding for the clean-good country. Finally, in

section 6, we provide concluding remarks and comment on future research questions to consider.

2 The Model

To assess the theoretical implications of the NT clause on environmental policy by comparing outcomes under the NT and non-NT regimes, we adopt a two-stage game framework involving two countries, each with a single firm producing a quality-differentiated good x.[7] For the comparison to make sense, the two goods must generate different externalities, and we thus assume that one good generates pollution (a dirty good) but the other does not generate pollution (a clean good). In the first stage, governments choose taxes to maximize domestic welfare; in the second stage, firms compete in prices, and consumption takes place.[8] Letting s_h and s_l denote the high- and low-quality versions of x, with $s_h > s_l$, we label the country producing the high-quality version as country H and the country producing the low-quality version as country L and, for simplicity, assume that production costs are zero irrespective of which version is produced.

Consumers have preferences over quality, reflected in a non-negative taste parameter θ which is uniformly distributed in each country over $[0, 1]$ with density one. With p_i^j denoting the price of quality i in country j,[9] and assuming that consumers purchase only a single unit of the good if they choose to buy, we can express the utility of a consumer in country j buying quality i as

$$u^j = \theta s_i - p_i^j, \qquad \text{for } i = h, l, \tag{1}$$

and normalize the utility of purchasing neither the high-quality good nor the low-quality good to zero. Hence, the continuum of consumers is potentially segmented into three regions consisting of those who buy nothing, those who buy the low-quality, and those who buy the high-quality. Letting θ_l^j and θ_h^j denote the values of θ for the consumers in country j indifferent between buying nothing, thus receiving zero surplus ($u^j = 0$), and buying the low-quality good and indifferent between buying the low-quality good and the high-quality good, we have that

$$\theta_l^j = \frac{p_l^j}{s_l} \quad \& \quad \theta_h^j = \frac{p_h^j - p_l^j}{s_h - s_l}, \tag{2}$$

[7] In Shaked and Sutton (1982), a duopoly offers only two qualities in equilibrium, provided that entry is sufficiently low cost and the gap between qualities is not overly large (see also Shaked and Sutton, 1984, or Saggi and Sara, 2008).

[8] In many respects, the setup of our model closely follows the national treatment modeling of Saggi and Sara (2008), in which countries differ in market size but goods do not generate externalities.

[9] All prices are gross of taxes throughout the paper.

so that consumers are partitioned into $[0, \theta_l^j)$ buying nothing, $[\theta_l^j, \theta_h^j)$ buying the low-quality version, and $[\theta_h^j, 1]$ buying the high-quality version.

For country j, we can then express the demand faced by the low-quality firm as

$$x_l^j = \theta_h^j - \theta_l^j = \frac{p_h^j - p_l^j}{s_h - s_l} - \frac{p_l^j}{s_l} \tag{3}$$

and the demand faced by the high-quality firm as

$$x_h^j = 1 - \theta_h^j = 1 - \frac{p_h^j - p_l^j}{s_h - s_l}. \tag{4}$$

At given prices, total consumer surplus from the purchases of the low-quality good in country j is equal to

$$cs_l^j = \int_{\theta_l^j}^{\theta_h^j} \left(s_l\theta - p_l^j\right) d\theta = s_l \frac{\theta^2}{2} - p_l^j\theta \Big|_{\theta_l^j}^{\theta_h^j} = \left(\theta_h^j - \theta_l^j\right) \left[\frac{s_l\left(\theta_h^j + \theta_l^j\right)}{2} - p_l^j\right], \tag{5}$$

while the consumer surplus from the purchases of the high-quality good is equal to

$$cs_h^j = \int_{\theta_h^j}^{1} \left(s_h\theta - p_h^j\right) d\theta = s_h \frac{\theta^2}{2} - p_h^j\theta \Big|_{\theta_h^j}^{1} = \left(1 - \theta_h^j\right) \left[\frac{s_h\left(1 + \theta_h^j\right)}{2} - p_h^j\right]. \tag{6}$$

Total consumer surplus in country j is then simply $cs^j = cs_l^j + cs_h^j$.

We assume that the consumption of x generates pollution (a consumption, not production, externality, or "tailpipe" pollution) and that the amount of pollution generated depends on the quality of the good.[10] We could assume that both types of goods are polluting with one generating more pollution per unit than the other; for ease of exposition (and with no loss of generality), we assume instead that one version of the good generates zero pollution while the other creates pollution. Initially, we consider the scenario in which it is the consumption of the high-quality good that generates pollution; later, however, we allow for pollution to arise from the consumption of the low-quality good. For the case considered first, we can think of cars, for which unit consumption is most applicable, as the obvious example. The quality of a car consists of a bundle of characteristics such as engine displacement, acceleration, passenger roominess, and cargo capacity, which tend to be positively correlated with each other and with the size (weight or length) of the car. We can

[10] With production externalities, countries would have competing incentives to use domestic policy to push production out to other countries (to avoid the externality) on one hand and to draw production in (to benefit their local firms) on the other hand. In such a case, domestic policy may not be used to protect local firms, as envisioned in pro-NT arguments, and the impacts of NT would soften.

then use a car's weight or length (or, simply, size) as the one-dimensional variable that appropriately measures the car's quality. But both weight and length are negatively correlated with fuel economy, and we thus have that large (or high-quality) cars are less environmentally friendly or more polluting. If pollution is purely local (i.e., pollution from consumption in country j does not spill over into the other country), we can write pollution damages in country j as an increasing function of the quantity of the high-quality good consumed in that country; specifically, we assume pollution damages in country j to be equal to

$$\varphi^j = \xi \left(x_h^j\right)^2 = \xi \left(1 - \theta_h^j\right)^2, \tag{7}$$

where ξ, a positive parameter, represents the marginal damage of pollution (or the *intensity* of pollution damages).

Given the above setup, we look at the two firms' profit-maximizing decisions in market/country j, solving for the equilibrium prices of the two types of good x as functions of qualities and tax rates, the latter being restricted to be identical under NT but allowed to differ under non-NT. Hence, within country j, firm i chooses the price of its i-version of good x (p_i^j) to maximize profits in market j, given the tax rate t_i^j faced, namely,

$$\pi_h^j \left(p_h^j, p_l^j\right) = \left(p_h^j - t_h^j\right) x_h^j \left(p_h^j, p_l^j\right) = \left(p_h^j - t_h^j\right) \left(1 - \frac{p_h^j - p_l^j}{s_h - s_l}\right), \tag{8}$$

if firm i is the high-quality firm, and

$$\pi_l^j \left(p_h^j, p_l^j\right) = \left(p_l^j - t_l^j\right) x_l^j \left(p_h^j, p_l^j\right) = \left(p_l^j - t_h^j\right) \left(\frac{p_h^j - p_l^j}{s_h - s_l} - \frac{p_l^j}{s_l}\right), \tag{9}$$

if firm i is the low-quality firm. From the profit-maximizing conditions, we then obtain the reaction functions of the two firms, namely,

$$p_l^j = \frac{p_h^j s_l + t_l^j s_h}{2 s_h} \quad \& \quad p_h^j = \frac{p_l^j + t_h^j + (s_h - s_l)}{2}, \tag{10}$$

and can solve for the two equilibrium prices as

$$p_l^j = \frac{s_l \left(s_h - s_l\right) + 2 s_h t_l^j + s_l t_h^j}{4 s_h - s_l} \quad \& \quad p_h^j = \frac{s_h \left[2 t_h^j + t_l^j + 2 \left(s_h - s_l\right)\right]}{4 s_h - s_l}. \tag{11}$$

Upon inspection of the above equilibrium conditions in the absence of taxes (i.e., $t_l^j = t_h^j = 0$), we obtain the following:

Lemma 1 *The laissez-faire equilibrium in each country is characterized by (i) the sales of the high-quality good being twice as large as the sales of the low-quality good, (ii) the price of the high-quality good being more than twice as large as the price of the low-quality good ($p_h^j = 2\frac{s_h}{s_l}p_l^j$), and (iii) the market being partially covered (i.e., $\theta_l^j > 0$).*

The laissez-faire equilibrium is inefficient because of underproduction (i.e., market not being fully covered) which results from firms exploiting their market power, as in Saggi and Sara, but not necessarily because of allocative inefficiency. In fact, in the presence of external (environmental) effects that are increasing in quality, allocative efficiency does not require that only the high-quality good be offered in the market; instead, social optimality requires that both goods be provided and that more consumers buy the high-quality good for $\xi < \frac{s_h - s_l}{2}$.[11]

2.1 No National Treatment

When the NT rules do not apply, country j chooses taxes t_l^j and t_h^j to maximize its welfare, defined as the sum of consumer surplus from the domestic consumption of both goods, producer surplus of country j's firm from the sales in the two markets, and tax revenues, less environmental damages, that is,

$$w^j\left(t_l^j, t_h^j\right) = cs^j\left(t_l^j, t_h^j\right) + \pi_d^j\left(t_l^j, t_h^j\right) + \pi_e^j\left(t_l^{-j}, t_h^{-j}\right) + t_h^j x_h^j\left(t_l^j, t_h^j\right) + t_l^j x_l^j\left(t_l^j, t_h^j\right) - \varphi^j\left(t_l^j, t_h^j\right), \quad (12)$$

where $\pi_d^j\left(t_l^j, t_h^j\right)$ and $\pi_e^j\left(t_l^{-j}, t_h^{-j}\right)$ represent the profits of country j's firm in the domestic market and from exports to the other country (i.e., country $-j$).[12] The welfare-maximizing taxes are then

$$t_h^H = \frac{3s_h\left(s_h - s_l\right)\left[2\xi - \left(s_h - s_l\right)\right]}{3s_h\left(s_h - s_l\right) + 2\xi\left(3s_h - 2s_l\right)} \quad \& \quad t_l^H = \frac{2s_l\left(s_h - s_l\right)\xi}{3s_h\left(s_h - s_l\right) + 2\xi\left(3s_h - 2s_l\right)} > 0 \quad (13)$$

in the high-quality country and

$$t_h^L = \frac{\left(s_h - s_l\right)\left(s_h - s_l + 2\xi\right)}{3\left(s_h - s_l\right) + 2\xi} > 0 \quad \& \quad t_l^L = -\frac{2s_l\left(s_h - s_l + \xi\right)\left(s_h - s_l\right)}{s_h\left[3\left(s_h - s_l\right) + 2\xi\right]} < 0 \quad (14)$$

in the low-quality country. We thus obtain the following:

Proposition 1 *Without NT, both countries tax the imported good but, while the low-quality country always subsidizes the locally produced good, the high-quality country's choice of whether to*

[11] In terms of market shares, the socially optimal market share of the high-quality good is higher than the laissez-faire market share for $\xi < \frac{s_h - s_l}{4}$ and lower for $\xi > \frac{s_h - s_l}{4}$.

[12] As in Saggi and Sara, markets are segmented so profits depend only on local taxes.

tax or subsidize the locally produced good depends on the intensity of pollution damages relative to the quality difference between the two versions of the good, with a tax (subsidy) prevailing when the pollution intensity is high (low) relative to the quality difference.

To facilitate the discussion about the various incentives the two countries face in setting their policies, we can express country j's welfare function as

$$\underbrace{\left[1-\left(\vartheta_h^j\right)^2\right]\frac{s_h}{2}}_{GS_h^j}+\underbrace{\left[\left(\vartheta_h^j\right)^2-\left(\vartheta_l^j\right)^2\right]\frac{s_l}{2}}_{GS_l^j}-\underbrace{\left(p_{-i}^j-t_{-i}^j\right)x_{-i}^j}_{NS_{-i}^j}+\underbrace{\left(p_i^{-j}-t_i^{-j}\right)x_i^{-j}}_{NS_i^{-j}}-\underbrace{d\left(x_h^j\right)^2}_{ED}, \tag{15}$$

where i denotes the local good, $-i$ the foreign good, and $-j$ the foreign country. In the above expression, GS_h^j represents the gross surplus from the consumption of the high-quality good, GS_l^j is the gross surplus from the consumption of the low-quality good, NS_{-i}^j is the surplus from country j's consumers of good $-i$ which flows out of country j into country $-j$, NS_i^{-j} is the surplus from country $-j$'s consumers of good i which flows out of country $-j$ into country j, and ED represents damages from pollution. In setting its policies (t_i^j and t_{-i}^j), country j has no control over NS_i^{-j} but can affect the other welfare components, of which NS_{-i}^j and ED are key in explaining policy differences between the two countries, with the latter decreasing in the tax on the high-quality good and increasing in the tax on the low-quality good in both countries and the former increasing (decreasing) in t_h^j and decreasing (increasing) in t_l^j when $j=H$ ($j=L$). While a tax increase in market h and a tax decrease in market l benefit both countries through ED, the increase in t_h^j is beneficial to country L but costly to country H and the increase in t_l^j is beneficial to country H but costly to country L through NS_{-i}^j. As for the policy effects on $GS_h^j+GS_l^j$, we can conveniently express them in terms of the effects on the gross surplus from the consumption of the low-quality good over the entire pool of active consumers, which we refer to as base surplus, and the effects on the incremental gross surplus from the consumption of the high-quality good over the pool of consumers of the high-quality good, namely,

$$\underbrace{-\vartheta_l^j s_l\frac{\partial\vartheta_l^j}{\partial t_i^j}}_{\text{base surplus}}\underbrace{-\vartheta_h^i\left(s_h-s_l\right)\frac{\partial\vartheta_h^j}{\partial t_i^j}}_{\text{incremental surplus}}, \tag{16}$$

for $i=l,h$ and $j=L,H$, where the first term represents the effect of t_i^j on $\int_{\theta_l^j}^1\theta s_l d\theta=\left[1-\left(\theta_l^j\right)^2\right]\frac{s_l}{2}$ and the second term represents the effect of t_i^j on $\int_{\theta_h^H}^1\theta s_h d\theta-\int_{\theta_h^H}^1\theta s_s d\theta=\left[1-\left(\theta_h^H\right)^2\right]\frac{(s_h-s_l)}{2}$.

In both countries, the base surplus is decreasing in both taxes, whereas the incremental surplus decreases with the tax on the high-quality good and increases with the tax on the low-quality good. The effects on the incremental surplus weaken country L's incentives, while strengthening country H's incentives, to subsidize the local good and tax the imported good.

In the low-quality country, local production and environmental concerns thus align in that promoting the consumption of the locally produced good, thus limiting NS_h^L, coincides with producing less pollution. In the high-quality country, on the other hand, greater consumption of the local good to limit NS_l^H comes at the expense of more pollution, and there is thus a trade off between promoting the local good (via a subsidy) and containing pollution damages (via a tax): the more damaging pollution is (i.e., the higher ξ is), the more likely the country is to opt for a tax on the locally produced good. Specifically, the threshold value of ξ, that is, the value above which environmental concerns dominate and a tax prevails (i.e., $\xi = \frac{s_h - s_l}{2}$) depends on the quality difference: the further apart the two versions of good x are, the more damaging the marginal unit of pollution must be before the high-quality country decides to tax the local good. When the quality gap widens, the surplus benefit from the high-quality good over and above the surplus benefit from the low-quality good increases, and taxing the high-quality good thus becomes more costly (or, equivalently, subsidizing the high-quality good becomes less costly) so that, the larger the quality gap is, the larger the ξ value that triggers the country to switch from a subsidy to a tax on the local good. For the imported good, a country has an additional incentive to tax the good produced abroad as, by so doing, it curtails the amount of surplus the foreign producer is able to extract from its consumers in the form of profits which flow out into the other country.

A corollary of the above proposition is that, in the absence of a non-discrimination principle, the low-quality country always opts for preferential treatment of the domestic good in setting its internal policy, unlike the high-quality country which may decide to discriminate against its own good, that is, to tax the domestic good at a higher rate than the foreign good, thus doing away with the need for an NT-type agreement. Interestingly, but not surprisingly, NT requirements would not be binding in the high-quality country at high pollution intensity levels. Using (13), we can readily see that $t_l^H - t_h^H \leq 0$ (i.e., the foreign good is treated at least as favorably as the domestic good) if $\xi \geq \frac{3s_h(s_h - s_l)}{2(3s_h - s_l)}$, a threshold level that is increasing in s_h and decreasing in s_l and thus increasing in the quality gap. Put it differently, the greater the quality gap is, the more damaging pollution

must be before the high-quality country opts for an internal policy that actually favors the foreign good.

Looking more closely at the effects of pollution intensity and quality gap through a comparative static analysis, we can establish the following:

Lemma 2 *Whether the marginal damage of pollution increases or the quality gap increases, the low-quality country responds to the change by implementing an internal policy that treats the domestic good increasingly more favorably than the foreign good. The high-quality country, on the other hand, reduces the extent to which it favors its own good relative to the imported good in response to an increase in the marginal damage of pollution but increases it in response to an increase in the quality gap.*

That the internal policy advantage awarded to the domestic good, absent a non-discrimination principle, increases in the low-quality country but decreases in the high-quality country when pollution intensity increases follows directly from the effects of ξ on domestic policy, that is,

$$\frac{dt_h^L}{d\xi} = \frac{1}{3}\left(\frac{a}{a+\xi}\right)^2 > 0 \quad \& \quad \frac{dt_l^L}{d\xi} = -\frac{s_l}{s_h}\left(\frac{a}{3a+2\xi}\right)^2 < 0 \tag{17}$$

in the low-quality country and

$$\frac{dt_l^H}{d\xi} = \frac{6s_h s_l a^2}{\left[3s_h a + 2\xi\left(s_h + 2a\right)\right]^2} > 0 \quad \& \quad \frac{dt_h^H}{d\xi} = \frac{12s_h\left(2s_h + a\right)a^2}{\left[3s_h a + 2\xi\left(s_h + 2a\right)\right]^2} > 0 \tag{18}$$

in the high-quality country, where $a = s_h - s_l$ which is a notation we use from now onward to denote the quality gap. It is immediate from the above expressions that $t_h^L - t_l^L$ increases while $t_l^H - t_h^H$ decreases when ξ increases. When a unit of pollution becomes more damaging, the marginal (environmental) cost of consuming the less environmentally friendly good increases, and the low-quality country intensifies its efforts to discourage consumption of the foreign good by increasing both the subsidy on the local good and the tax on the foreign good. Consistently with the low-quality country's reaction to a higher ξ, the high-quality country reduces (increases) the subsidy (tax) on the less environmentally sound good (i.e., the local good), but it also increases the tax on the foreign (low-quality) good, which decreases the consumption of the local (high-quality) good, to counter, in essence, the effects of the change in the subsidy/tax on the local good. A higher t_h^H decreases x_h^H, reducing environmental damages and thus the cost of taxing the foreign good, and

increases x_l^H, raising the surplus flowing out into the other country and thus the benefit of taxing the foreign good; the incentive to increase t_l^H from these combined (indirect) changes outweighs the incentive to decrease t_l^H arising out of the increase in the cost of taxing the low-quality good that originates directly from a higher ξ.

The quality gap effects are less straightforward, and we derive them by computing the effects of an increase in s_h, namely,

$$\frac{dt_h^L}{ds_h} = \frac{4\xi\left(a+\xi\right)+3a^2}{\left(3a+2\xi\right)^2} > 0 \quad \& \quad \frac{dt_l^L}{ds_h} = -\frac{2s_l\left[2s_l\left(a+\xi\right)^2 - a^2\left(\xi - s_l\right)\right]}{\left[s_h\left(3a+2\xi\right)\right]^2} < 0 \tag{19}$$

in the low-quality country, that is, the tax on the foreign good and the subsidy on the local good are increasing in the quality gap,[13] and

$$\frac{dt_l^H}{ds_h} = \frac{2\xi s_l\left(2\xi s_l - 3a^2\right)}{\left[3s_h a + 2\xi\left(3s_h - 2s_l\right)\right]^2} \tag{20}$$

and

$$\frac{dt_h^H}{ds_h} = \frac{3\left\{4\left(2a^2+s_h^2\right)\xi^2 - 4a\left[a^2+s_h\left(2s_h-s_l\right)\right]\xi - 3a^2 s_h^2\right\}}{\left[3s_h a + 2\xi\left(3s_h - 2s_l\right)\right]^2} \tag{21}$$

in the high-quality country, that is, the tax on the foreign good is decreasing in the quality gap for $\xi \in \left(0, \frac{3a^2}{2s_l}\right)$ and increasing for $\xi > \frac{3a^2}{2s_l}$, the subsidy on the local good (if $\xi < \frac{a}{2}$) is always increasing in the quality gap, and the tax on the local good (if $\xi > \frac{a}{2}$) is decreasing in the quality gap for $\xi \in \left(\frac{a}{2}, \gamma\frac{a}{2}\right)$ and increasing for $\xi > \gamma\frac{a}{2}$, with $\gamma > 1$.[14] Hence, the low-quality country adjusts to an increase in the quality gap by strengthening the domestic policy advantage of its good relative to the foreign good; on the other hand, the high-quality country's response in terms of preferential tax treatment does not follow directly from the directions of the two effects in (20) and (21) but, upon a formal comparison of the two effects, we can conclude that, if the high-quality country discriminates against the imported good (i.e., $\xi < \xi_c$ so that $t_l^H - t_h^H > 0$), it responds to an increase in the quality gap by implementing a policy that is increasingly more discriminatory.

An increase in the quality gap via an increase in s_h raises the surplus benefit of consuming the high-quality good over and above the benefit of consuming the low-quality good and thus raises

[13] It is possible for the subsidy to be decreasing in s_h, that is, $\frac{dt_l^L}{ds_h} > 0$, but a necessary, although not sufficient, condition for this to happen is for a to be very large ($a \geq 8.901 s_l$). The critical ξ above which $\frac{dt_l^L}{ds_h} > 0$ is in fact equal to $\xi = \frac{a\left[\left(s_h - 5s_l\right) + \sqrt{a^2 - 8s_l s_h}\right]}{4s_l}$, which requires that $a^2 - 8s_l s_h > 0$ or $s_h \geq 9.901 s_l$.

[14] Specifically, $\gamma = \frac{a^2 + s_h\left(2s_h - s_l\right) + \sqrt{\left[a^2 + s_h\left(2s_h - s_l\right)\right]^2 + 3s_h^2\left(2a^2 + s_h^2\right)}}{\left(2a^2 + s_h^2\right)} > 1$. We note here that $\gamma\frac{a}{2} > \xi_c$, $\frac{3a^2}{2s_l} > \xi_c$ if $s_h > \left(\frac{5+\sqrt{13}}{6}\right) s_l \approx 1.4343 s_l$, $\frac{3a^2}{2s_l} > \gamma\frac{a}{2}$ if $s_h > 2s_l$, and $\frac{3a^2}{2s_l} > \frac{a}{2}$ if $s_h > \frac{4}{3}s_l \approx 1.3333 s_l$.

the surplus the producer of the high-quality good can extract from its consumers. As profits in the high-quality market enter the low-quality country's welfare negatively, the change intensifies the country's concern over local production or, equivalently, over the surplus flowing out into the other country, increasing the benefits of subsidizing the domestic (low-quality) good and taxing the imported (high-quality) good; hence, the low-quality country adopts a larger subsidy on the domestic good and a larger tax on the foreign good in response to an increase in the quality gap. For the high-quality country, the additional surplus that a unit of the high-quality good generates stays within the country independently of how it is shared between the consumer and the producer, and, to the extent that taxing the high-quality good negatively affects surplus, the increase in s_h amounts to a higher marginal cost of taxation. The high-quality country thus relaxes its policy in the domestic market, increasing the subsidy or lowering the tax on the domestic good, unless pollution intensity is sufficiently high that environmental concerns, which are associated with the consumption of the high-quality good, dominate and induce the country to increase the tax on the local good in order to curb pollution.[15] To understand the policy change in the foreign market, it is useful to recall that, unlike the low-quality country for which each of the two internal policy instruments addresses both the country's concern over the environment (or environmental motive) and its concern over local production (or protectionist motive), the high-quality country faces a trade off between the two motives in that addressing its environmental concern via taxing the local good comes at the expense of discounting its local production concern. In dealing with this trade off in response to an increase in the quality gap, the country can (i) increase the tax on the foreign good when increasing the tax on the domestic good to offset the latter's negative effect on local production (equivalently, the country can reduce the tax on the foreign good when decreasing the tax or increasing the subsidy on the domestic good as there is less of a need for an offsetting effect) or (ii) increase the tax on the foreign good when decreasing the tax (or increasing the subsidy) on the domestic good to offset the latter's negative effect on the environment. Which option the country chooses depends on the pollution intensity level relative to the quality gap: at low and high pollution intensity levels, the country opts for (i), reducing both taxes at low pollution intensity and increasing both taxes at high pollution intensity; at intermediate pollution intensity levels, the

[15] For this to occur, the country must be taxing its domestic good at a higher rate than the imported good as $\xi > \gamma\frac{a}{2} > \xi_c$.

country opts for (ii). Option (ii) thus prevails when the country starts experiencing the negative welfare effects of the pollution from the additional consumption of the high-quality good that comes about as the country keeps reducing the tax on the domestic good in order to exploit the positive welfare effects of the increase in s_h; at intermediate pollution intensity levels, the country is able to counter the negative pollution-related welfare effects by reducing the amount of surplus flowing out of the country via a tax on the imported good. What defines the ranges of low, intermediate, and high pollution intensity levels does, however, depend on the quality gap in that the gap determines how important the environmental concern is relative to the local production concern; hence, the larger the quality gap is, the higher the pollution intensity levels that fall within the intermediate range.[16]

Using the above welfare-maximizing taxes, we can compute country H's equilibrium prices as

$$p_h^H = \frac{6\xi s_h a}{\Delta_h} \quad \& \quad p_l^H = \frac{4\xi s_h a}{\Delta_l}, \tag{22}$$

with $p_h^H > p_l^H$, and equilibrium sales as

$$x_h^H = \frac{3 s_h a}{\Delta_h} \quad \& \quad x_l^H = \frac{2\xi s_h}{\Delta_h}, \tag{23}$$

with $x_h^H > x_l^H$ if $\xi < \frac{3a}{2}$, where

$$\Delta_h = 3 s_h a + 2\xi\left(3 s_h - 2 s_l\right) > 0 \quad \& \quad \Delta_l = 3a + 2\xi > 0. \tag{24}$$

The corresponding market shares of the two products are then equal to

$$MS_h^H = \frac{3a}{\Delta_l} \quad \& \quad MS_l^H = \frac{2\xi}{\Delta_l}. \tag{25}$$

At low ξ values, the high-quality country subsidizes its own firm and the market share of the high-quality good exceeds that of the low-quality good. However, as ξ increases, the subsidy falls and eventually becomes a tax, so that the market share of the high-quality good falls while the market share of the low-quality good increases. Furthermore, the more differentiated the two products are, the larger the proportion of consumers purchasing the high-quality good is. To complete the equilibrium characterization in country H, we compute the θ values of the consumer indifferent between buying the high-quality good and the low-quality good and the consumer indifferent between

[16] The intermediate range is $\xi \in \left(\frac{3a^2}{2s_l}, \gamma\frac{a}{2}\right)$ if $s_h < 2s_l$ and $\xi \in \left(\gamma\frac{a}{2}, \frac{3a^2}{2s_l}\right)$ if $s_h > 2s_l$. Both bounds are increasing in s_h.

buying the low-quality good and buying nothing as

$$\theta_h^H = \frac{2\xi\,(3s_h - 2s_l)}{\Delta_h} \quad \& \quad \theta_l^H = \frac{4\xi a}{\Delta_h}. \tag{26}$$

The fact that $\theta_l^H > 0$ implies that the market is not completely covered (i.e., some individuals with very low valuations of quality are priced out of the market). Both cutoff values are increasing in ξ but, as the quality gap increases, θ_h^H always decreases while θ_l^H decreases if $\xi \in \left(0, \frac{3a^2}{2s_l}\right)$, that is, when t_l^H is decreasing in s_h, and increases if $\xi > \frac{3a^2}{2s_l}$, that is, when t_l^H is increasing in s_h. The total market covered thus shrinks in response to an increase in ξ but may increase in response to an increase in s_h.

In country L, equilibrium prices are

$$p_h^L = \frac{2a\,(a+\xi)}{\Delta_l} \quad \& \quad p_l^L = 0, \tag{27}$$

equilibrium sales are

$$x_h^L = \frac{a}{\Delta_l} \quad \& \quad x_l^L = \frac{2\,(a+\xi)}{\Delta_l}, \tag{28}$$

and equilibrium cutoff or threshold ϑ values are

$$\theta_h^L = \frac{2\,(a+\xi)}{\Delta_l} \quad \& \quad \theta_l^L = 0, \tag{29}$$

so that the entire market is covered and the equilibrium market shares of the two products coincide with the equilibrium sales. The market share of the high-quality good is then increasing in the quality gap but decreasing in pollution intensity; correspondingly, the market share of the low-quality good is decreasing in the quality gap but increasing in pollution intensity.

2.2 National Treatment

In this sub-section, we consider the case when national treatment rules apply: countries face the constraint that foreign products be treated at least as favorably as domestic products. Under a binding NT, which requires that $\xi < \xi_c = \frac{3s_h a}{2(3s_h - s_l)}$, the constraint becomes that foreign and domestic products be treated equally in policy setting, so that quality-differentiated versions of the same good must be subjected to the same tax rate within each country, although taxes can differ across countries (that is, NT does not require harmonization of domestic policies across borders). To facilitate exposition and be able to separate easily between the non-NT and NT solutions, we

use capital letters to denote choice variables under NT rules (e.g., T^j represents the NT tax in country j).

Under NT, country j chooses a single tax, T^j, to maximize its individual welfare, namely,

$$w^j\left(T^j\right) = cs^j\left(T^j\right) + \pi_d^j\left(T^j\right) + \pi_e^j\left(T^{-j}\right) - \varphi^j\left(T^j\right), \tag{30}$$

where $\pi_d^j\left(T^j\right)$ denotes the domestic firm's profits from domestic sales, which depend only on country j's tax, T^j, and $\pi_e^j\left(T^{-j}\right)$ denotes the domestic firm's profits from foreign sales, which depend only on country $-j$'s tax, T^{-j}. Using the two countries' welfare-maximizing conditions, we obtain the equilibrium taxes as

$$T^H = \frac{4\xi s_h s_l}{\Delta_H} > 0 \quad \& \quad T^L = \frac{4\xi s_h s_l}{\Delta_L} > 0, \tag{31}$$

where

$$\Delta_H = 12s_h^2 - 3s_h s_l + 2\xi s_l > 0 \quad \& \quad \Delta_L = 4s_h^2 + 7s_h s_l - 2s_l^2 + 2\xi s_l > 0. \tag{32}$$

We summarize the results in the following:

Proposition 2 *Under NT, both countries choose to tax the two quality-differentiated products, tightening their policies as pollution intensity increases and/or the quality gap decreases, but the tax in the low-quality country is always larger than the tax in the high-quality country.*

It is straightforward to show that country L opts for more aggressive taxation than country H does as

$$T^L - T^H = \frac{8\xi s_h s_l\left(4s_h - s_l\right)a}{\Delta_H \Delta_L} > 0, \tag{33}$$

that both taxes are always increasing in pollution intensity as

$$\frac{dT^H}{d\xi} = \frac{12s_l s_h^2\left(4s_h - s_l\right)}{\Delta_H^2} > 0 \quad \& \quad \frac{dT^L}{d\xi} = \frac{4s_l s_h\left(s_h + 2s_l\right)\left(4s_h - s_l\right)}{\Delta_L^2} > 0, \tag{34}$$

and that both taxes are decreasing in the quality gap over the relevant range of ξ values as

$$\frac{dT^H}{ds_h} = -\frac{8s_l\xi\left(6s_h^2 - s_l\xi\right)}{\Delta_H^2} < 0 \quad \& \quad \frac{dT^L}{ds_h} = -\frac{8s_l\xi\left(2s_h^2 + s_l^2 - s_l\xi\right)}{\Delta_L^2} < 0. \tag{35}$$

The effects of s_h can be positive at high ξ values but are always negative for $\xi < \xi_c$.

In setting their policies, the two countries face similar incentives: on one hand, a higher tax reduces gross consumer surplus (both base surplus and incremental surplus); on the other hand, it reduces pollution damages and the amount of surplus flowing out into the other country. That

the tax in the low-quality country is always larger than the tax in the high-quality country follows from the fact that, in the absence of taxation, the high-quality good enjoys both a higher price and a larger share of the market than the low-quality good in both countries; as profits from the consumption of the high-quality (low-quality) good represent surplus that flows out of the low-quality (high-quality) country, the benefit of taxation in addressing the local production concern is greater in the low-quality country which thus opts for a stricter policy. When pollution intensity increases, the benefit of taxation through the effect on pollution damages increases in both countries, and both taxes increase; when the quality gap increases, the cost of taxation through the effect on the incremental surplus increases in both countries, and both taxes decrease.

With the equilibrium taxes determined, we can then compute the equilibrium prices as

$$P_h^H = \frac{2s_h\left[3s_h a + 2\xi s_l\right]}{\Delta_H} \quad \& \quad P_h^L = \frac{2s_h\left[\left(s_h + 2s_l\right)a + 2\xi s_l\right]}{\Delta_L} \tag{36}$$

for the high-quality good and

$$P_l^H = \frac{s_l[2\xi\left(s_h + s_l\right) + 3s_h a]}{\Delta_H} \quad \& \quad P_l^L = \frac{s_l[\left(s_h + 2s_l\right)a + 2\xi\left(s_h + s_l\right)]}{\Delta_L} \tag{37}$$

for the low-quality good, and note that $P_h^L > P_h^H$, $P_l^L > P_l^H$, and $P_h^L - P_l^L > P_h^H - P_l^H > 0$. Equilibrium sales are then

$$X_h^H = \frac{6s_h^2}{\Delta_H} \quad \& \quad X_h^L = \frac{2s_h\left(s_h + 2s_l\right)}{\Delta_L} \tag{38}$$

for the high-quality good and

$$X_l^H = \frac{s_h\left(3s_h - 2\xi\right)}{\Delta_H} \quad \& \quad X_l^L = \frac{s_h\left(s_h + 2s_l - 2\xi\right)}{\Delta_L} \tag{39}$$

for the low-quality good, with $X_l^H > 0$ for $\xi < \frac{3s_h}{2} > \xi_c$, $X_l^L > 0$ for $\xi < \frac{s_h+2s_l}{2} > \xi_c$, $X_h^H > X_h^L$, $X_l^H > X_l^L$, and $0 < X_h^H - X_l^H < X_h^L - X_l^L$. Finally, the equilibrium cutoff ϑ values are

$$\Theta_h^H = \frac{3s_h\left(2s_h - s_l\right) + 2\xi s_l}{\Delta_H} \quad \& \quad \Theta_h^L = \frac{2\left(s_h^2 - s_l^2\right) + 3s_h s_l + 2\xi s_l}{\Delta_L} \tag{40}$$

for the consumer indifferent between buying the high-quality good and the low-quality good and

$$\Theta_l^H = \frac{3s_h a + 2\xi\left(s_h + s_l\right)}{\Delta_H} \quad \& \quad \Theta_l^L = \frac{s_h^2 + s_h s_l - 2s_l^2 + 2\xi\left(s_h + s_l\right)}{\Delta_L} \tag{41}$$

for the consumer indifferent between buying the low-quality good and buying nothing, with $\Theta_h^H > \Theta_l^H$ for $\xi < \frac{3s_h}{2} > \xi_c$ and $\Theta_h^L > \Theta_l^L$ for $\xi < \frac{s_h+2s_l}{2} > \xi_c$. Unlike the non-NT case, when NT rules

apply, market coverage in the low-quality country is not only incomplete (i.e., $\Theta_l^L > 0$) but is also less complete than in the high-quality country (i.e., $\Theta_l^H < \Theta_l^L$). Hence, while country H's sales exceed (fall short of) country L's sales in the high-quality (low-quality) market in the absence of NT rules, they are greater in both markets in the presence of NT rules. In both countries, the two critical ϑ values increase with ξ, which implies that, at high pollution intensity levels, more consumers with low valuations of quality are priced out of the market and fewer consumers with high valuations of quality buy the high-quality good.

3 Comparing National Treatment with No National Treatment

In this section, we compare the NT and non-NT cases with respect to environmental taxes, sales of the two products in each country, market coverage, national and global welfare, and national and global environmental damages. As the focus of the paper is on the implications of a binding NT clause, which only excludes preferential treatment of the domestic good, therefore allowing for preferential treatment of the foreign good, we constrain the comparative analysis that follows to situations in which $\xi < \xi_c = \frac{3s_h a}{2(3s_h - s_l)}$; for completeness, however, we do consider the welfare and environmental implications of a unilaterally binding NT (i.e., when NT is only binding for the clean-good country) in a separate section before concluding.

3.1 Environmental Taxes

Proposition 3 *With the adoption of NT, both countries raise the tax on the domestic good and reduce the tax on the foreign good.*

In the high-quality country, the tax effects of switching from NT to non-NT are reflected in

$$T^H - t_h^H = \frac{s_h \left[2\xi \left(3s_h - s_l\right) - 3s_h a\right] \left[2\xi s_l - 3\left(4s_h - s_l\right) a\right]}{\Delta_h \Delta_H}, \tag{42}$$

which is positive for $\xi < \xi_c$, and

$$T^H - t_l^H = \frac{2\xi s_l \left(2s_h - s_l\right) \left[2\xi \left(3s_h - s_l\right) - 3s_h a\right]}{\Delta_h \Delta_H}, \tag{43}$$

which is negative for $\xi < \xi_c$. For the low-quality country, the tax difference in the low-quality market, that is, $T^L - t_l^L$, is always positive as the country opts for a tax under NT but a subsidy under non-NT; the tax difference in the high-quality market, namely,

$$T^L - t_h^L = \frac{\left[2\xi s_l - \left(4s_h - s_l\right) a\right] \left[2\xi \left(s_h + s_l\right) + \left(s_h + 2s_l\right) a\right]}{\Delta_l \Delta_L}, \tag{44}$$

depends on ξ but is negative for $\xi < \xi_c$. Overall, both countries react to the application of NT rules by taxing, as opposed to subsidizing, or increasing the tax on the domestic good while decreasing the tax on the foreign good. To understand the intuition of this result, it may be useful to think of a country's objective under NT as choosing taxes on the two goods in order to maximize its welfare subject to the constraint that the two taxes are equal. Hence, the country's choice is such that the sum of the individual marginal welfare effects of the two taxes is equal to zero and the equality constraint is satisfied. Being restricted to imposing the same tax on the two goods, the country cannot subsidize the domestic good or tax it at a lower rate and must instead choose a tax such that the marginal welfare effect of taxing the foreign good is positive and offsets the negative marginal welfare effect of taxing the domestic good; the NT tax on the foreign good is thus lower than the corresponding non-NT tax.

The extent to which a binding NT clause affects the two tax rates in each country varies with both pollution intensity and the quality gap, and we summarize these relationships in the following:

Lemma 3 *As pollution intensity increases, the impact of NT on the taxation of the foreign good increases (decreases) at low (high) ξ values in both countries, while the impact of NT on the taxation of the domestic good always increases (decreases) in the low-quality (high-quality) country. As the quality gap increases, the impact of NT increases for both goods and in both countries.*

We graph the above results in Figures 1a and 1b. In Figure 1a, we set $s_h = 1.5$ and $s_l = 1$ and look at the tax differences over the relevant range of ξ values, that is, $\xi \in (0, 0.32)$; in Figure 2a, we set $s_l = 1$ and $\xi = 0.25$ and look at the tax differences over the relevant range of s_h, that is, $s_h > 1.38$. In the absence of NT, as environmental pollution becomes more of a concern (as ξ increases), country L curbs the additional environmental damages through increases in both the tax on good h and the subsidy on good l; under NT, country L has no choice but to increase the common tax, balancing the benefit of reducing pollution through a higher tax on good h with the cost of reducing producer's surplus through a higher tax on good l. As the benefit effect is increasing in ξ, country L raises the common tax by a smaller (larger) amount than the non-NT tax on good h at low (high) ξ values; hence, the difference between the NT and non-NT taxes is decreasing (increasing) in ξ at low (high) ξ values for good h and is always increasing for good l given that, independently of the magnitude of the NT tax increase relative to the magnitude of

the non-NT subsidy increase, the difference between the two instruments can only increase. When we consider the comparative effects of a change in the quality gap, we know that an increase in s_h raises country L's concern over local production which, if it is able to discriminate, it addresses by increasing both the subsidy on the local good and the tax on the imported good; under a non-discrimination clause, the country reduces the common tax, balancing the benefit of increasing producer's surplus through a lower tax on good l with the cost of increasing pollution through a lower tax on good h. As the benefit effect is decreasing in s_h, country L lowers the common tax by a smaller amount than the non-NT tax on good l, and the difference between the NT and non-NT taxes is decreasing in s_h for good l but increasing for good h given that the two policy instruments move in opposite direction in response to an increase in s_h.

The story is somewhat different for country H, which, in the absence of NT, raises both the tax on good h (or reduces the subsidy on good h) and the tax on good l when ξ increases but adjust the tax changes to reflect the level of environmental concern through ξ: the more concerned about the environment the country is (i.e., the higher ξ is), the larger the increase in the tax that targets the source of pollution (i.e., good h) relative to the increase in the tax on the clean good. Such an adjustment is not feasible under NT as the tax increase in response to an increase in ξ applies equally to both goods, and the country has to then rely on the offsetting effect of the tax increase in market l to a greater extent than in the absence of NT and increasingly so as pollution becomes more damaging. The implication of the above is that the NT tax increases in response to an increase in ξ by a smaller amount than the non-NT tax for good h, so that the difference between the two taxes is decreasing in ξ. For good l, the NT tax increase is smaller at low ξ values but larger at high ξ when environmental concern becomes more relevant but the country has to rely more on the tax change in market l to make up for the lack of incremental taxation of the source of pollution; the difference between the NT and non-NT taxes in market l is thus declining (raising) at low (high) ξ levels. As for the profiles of the tax differences over s_h, the rationale is in line with that for the profiles over ξ: under NT, the country cannot rely on adjustments of the two tax rates in response to an increase in s_h, decreasing the tax on good h, which represents the source of gain in this case, by more than decreasing the tax on good l, and thus decreases the NT tax by a smaller amount than the non-NT tax for good h, so that their difference declines as s_h increases, and by a larger amount for good l, so that their difference is increasing in s_h.

[Insert Figures 1a and 1b here]

3.2 Prices

Lemma 4 *NT increases the prices of both goods in country H, increases the price of the low-quality good in country L, and may increase or decrease the price of the low-quality good in country L if the quality gap is sufficiently small.*

The price changes resulting from adopting NT rules are

$$P_h^H - p_h^H = \frac{2s_h\left[2\xi\left(3s_h - s_l\right) - 3s_h a\right]\left[\xi s_l - 3s_h a\right]}{\Delta_h \Delta_H} \tag{45}$$

and

$$P_l^H - p_l^H = \frac{s_h s_l\left[2\xi\left(3s_h - s_l\right) - 3s_h a\right]\left(2\xi - 3a\right)}{\Delta_h \Delta_H},$$

both of which are positive for $\xi < \xi_c$, in country H and

$$P_h^L - p_h^L = \frac{\left(\xi s_l - a^2\right)\left[\left(s_h + 2s_l\right)a + 2\xi\left(s_h + s_l\right)\right]}{\Delta_l \Delta_L}, \tag{46}$$

which is always negative at high quality gap levels (i.e., $s_h \geq 1.63 s_l$) but, for $s_h \leq 1.62 s_l$, is negative for $0 < \xi < \frac{a^2}{s_l}$ and positive for $\frac{a^2}{s_l} < \xi < \xi_c$, and

$$P_l^L - p_l^L = \frac{s_l[\left(s_h + 2s_l\right)a + 2\xi\left(s_h + s_l\right)]}{\Delta_L} > 0 \tag{47}$$

in country L.

3.3 Market Coverage and Outputs

Lemma 5 *In the low-quality country, the application of the NT principle results in: (i) fewer consumers buying the good, (ii) more consumers buying the high-quality good, and (iii) fewer consumers buying the low-quality good. In the high-quality country, NT also leads to market coverage shrinkage but with more (fewer) consumers buying the low-quality (high-quality) good.*

In the high-quality country, the quality valuation differences for the consumer indifferent between the two goods and the consumer indifferent between buying the low-quality good and buying nothing are

$$\Theta_h^H - \theta_h^H = \frac{3s_h\left(2s_h - s_l\right)\left[3s_h a - 2\xi\left(3s_h - s_l\right)\right]}{\Delta_h \Delta_H} \tag{48}$$

and

$$\Theta_l^H - \theta_l^H = -\frac{s_h\left[3s_h a - 2\xi\left(3s_h - s_l\right)\right]\left(2\xi - 3a\right)}{\Delta_h \Delta_H}; \tag{49}$$

in country H, the high-quality good market thus shrinks (i.e., $X_h^H - x_h^H = \theta_h^H - \Theta_h^H < 0$) for $\xi < \xi_c$ and market coverage contracts (i.e., $X_h^H + X_l^H - x_h^H - x_l^H = \theta_l^H - \Theta_l^H < 0$) if $\xi < \xi_c < \frac{3a}{2}$. What happens to the size of the low-quality good market also depends on ξ and, in fact, the difference in sales in market l is

$$X_l^H - x_l^H = \frac{s_h\left(3s_h + 2\xi\right)\left[3s_h a - 2\xi\left(3s_h - s_l\right)\right]}{\Delta_h \Delta_H}, \tag{50}$$

which is positive (and thus market l expands) if $\xi < \xi_c$. To sum up, at ξ values such that NT is binding, that is, for $\xi < \xi_c$, market coverage contracts at the expense of market h in that sales of good h decrease while sales of good l increase.

In the low-quality country, the same quality valuation differences are

$$\Theta_h^L - \theta_h^L = -\frac{\left(2s_h + s_l\right)\left[2\xi\left(s_h + s_l\right) + a\left(s_h + 2s_l\right)\right]}{\Delta_l \Delta_L} < 0 \tag{51}$$

and

$$\Theta_l^L - \theta_l^L = \frac{\left[2\xi\left(s_h + s_l\right) + a\left(s_h + 2s_l\right)\right]}{\Delta_L} > 0; \tag{52}$$

in country L, independently of the ξ value, the high-quality good market grows (i.e., $X_h^L - x_h^L > 0$) and market coverage contracts (i.e., $X_h^L + X_l^L < x_h^L + x_l^L$) so that the low-quality good market shrinks (i.e., $X_l^L - x_l^L < 0$). While the impact of a binding NT clause on market coverage is qualitatively the same in both countries, more consumers are completely driven out of the market in country L than in country H as $\Theta_l^L - \theta_l^L > \Theta_l^H - \theta_l^H$.

3.4 Welfare

Proposition 4 *With the adoption of NT, welfare in the low-quality country decreases while welfare in the high-quality country increases. The positive welfare change in country H tends to outweigh the negative welfare change in country L, so that world welfare increases, but it is possible for global welfare to decrease at combinations of low pollution intensity and quality gap values.*

In the absence of NT rules, equilibrium welfare, which includes domestic welfare (i.e., the sum of consumer surplus, local profits, and tax revenues minus environmental damages) and profits from sales in the foreign market, is

$$w^L = w_l^L + \pi_l^H = \frac{\left(s_h + 2s_l\right)a + 2\xi s_l}{2\Delta_l} + \frac{4\xi^2 s_h s_l a}{\Delta_h^2} \tag{53}$$

in country L and

$$w^H = w_h^H + \pi_h^L = \frac{s_h\left[3s_h a + 2\xi s_l\right]}{2\Delta_h} + \frac{a^3}{\Delta_l^2} \tag{54}$$

in country H. Under NT rules, equilibrium welfare is instead

$$W^L = W_l^L + \Pi_l^H = \frac{s_h\left(s_h + 2s_l - 2\xi\right)\left(s_h + 2s_l\right)}{2\Delta_L} + \frac{s_h s_l a(2\xi - 3s_h)^2}{\Delta_H^2} \tag{55}$$

in country L and

$$W^H = W_h^H + \Pi_h^L = \frac{3s_h^2\left(3s_h - 2\xi\right)}{2\Delta_H} + \frac{4s_h^2\left(s_h + 2s_l\right)^2 a}{\Delta_L^2} \tag{56}$$

in country H.

We can then show, with more details available in the Appendix, that

$$w^L - W^L = \underbrace{w_l^L - W_l^L}_{>0} + \underbrace{\pi_l^H - \Pi_l^H}_{\lesseqgtr 0} > 0, \tag{57}$$

that is, country L's welfare is always lower under NT. For country L, by preventing discrimination against the competing firm, NT also prevents discrimination against the polluting good; however, NT also prevents the foreign country (i.e., country H) from discriminating against its non-domestic good (i.e., good l), which means that country L's firm's profits from sales in the foreign market increase at low ξ levels, for a given quality gap, when the foreign country's NT tax on good l falls short of the non-NT tax. As we show in the Appendix, when we remove NT rules, the increase in domestic welfare always outweighs the decrease in profits from the foreign market so that, overall, country L's welfare is always larger in the absence of NT rules.

In country H, we also have an increase in domestic welfare but profits from foreign sales always decrease when we move away from NT, that is,

$$w^H - W^H = \underbrace{w_h^H - W_h^H}_{>0} + \underbrace{\pi_h^L - \Pi_h^L}_{<0}. \tag{58}$$

As country L imposes a lower tax on the foreign good under NT for a wider range of ξ values than country H does, the increase in profits from foreign sales that the adoption of NT rules brings about is more sustainable, and turns out to hold over the entire range of feasible ξ values, in country H, although the incremental profits decline at high ξ values when country L's NT tax on good h increases above the non-NT level. The stronger effect on profits from foreign sales serves to more than offset the negative effect on domestic welfare so that country H's welfare is greater under NT.

In Figure 2, we illustrate the possible global welfare changes by means of two isovalue curves: a zero-welfare isovalue curve and a zero-tax isovalue curve. The zero welfare isovalue curve $s\left(\xi|_{w^W-W^W}\right)$, which we draw only partially for (ξ, s_h) ranging from $(0,1)$ to $(0.45, 1.73)$,[17] gives combinations of ξ and s_h (for $s_l = 1$) such that global welfare is zero, that is, $w^W - W^W = w^H - W^H + w^L - W^L = 0$. The positive slope of this curve reflects the negative effect of pollution intensity and the positive effect of the quality gap on NT welfare relatively to non-NT welfare: for a given quality gap as reflected in s_h under normalization of s_l to unity, NT welfare decreases relatively to non-NT welfare when pollution becomes more damaging since NT rules prevent discrimination against the polluting good; for a given pollution intensity, NT welfare decreases relatively to non-NT welfare when the quality gap increases since NT rules prevent countries from capitalizing on the quality differences between the two goods via differential taxes. The zero isovalue curve $s\left(\xi|_{t_h^H - t_l^H}\right)$ gives, instead, combinations of ξ and s_h (for $s_l = 1$) such that non-NT taxes in country H are equal, that is, $t_l^H - t_h^H = 0$; this curve thus bounds from below the area relevant for our analysis of the impacts of the NT clause, with the area below this curve representing combinations of ξ and s_h for which NT is not binding for both countries. In the area above $s\left(\xi|_{w^W-W^W}\right)$, welfare under NT is always lower in country L but higher in country H; as for global welfare, it is positive in area B_1 but negative in area B_2.

[Insert Figure 2 here]

3.5 Environmental Damages

Proposition 5 *NT results in greater environmental damages in country L but leads to lower damages in country H. Globally, the environment improves (worsens) with the implementation of NT at low (high) pollution intensity levels.*

The difference in environmental damages between the NT and the non-NT regimes in country H is

$$\varphi^H - \Phi^H = \frac{9\xi s_h^2\left(a^2\Delta_H^2 - 4s_h^2\Delta_h^2\right)}{\Delta_h^2\Delta_H^2}, \tag{59}$$

which is positive if $(s_h - s_l)\Delta_H - 2s_h\Delta_h = (2s_h - s_l)\left[3s_h(s_h - s_l) - 2\xi(3s_h - s_l)\right] > 0$ or, in terms

[17] We omit the section of the curve that lies in the non-binding NT region.

of ξ, if $\xi < \xi_c$; the corresponding difference in country L is

$$\varphi^L - \Phi^L = \frac{\xi\left[a^2\Delta_L^2 - 4s_h^2\left(s_h + 2s_l\right)^2\Delta_l^2\right]}{\Delta_l^2\Delta_L^2}, \tag{60}$$

which is always negative as

$$a\Delta_L - 2s_h\left(s_h + 2s_l\right)\Delta_l = -\left(2s_h + s_l\right)\left[a\left(s_h + 2s_l\right) + 2\xi\left(s_h + s_l\right)\right] < 0. \tag{61}$$

Under NT rules, the low-quality country cannot differentiate between the polluting good and the non-polluting good and cannot use domestic policy to increase the competitiveness of its own product in its own market. Hence, the market share of the polluting good produced abroad increases, thus causing pollution to increase as consumption shifts away from the clean good produced domestically. The high-quality country, on the other hand, experiences a decrease in the local market share of the domestically produced polluting good, which decreases pollution. Hence, environmental damages increase in country L but decrease in country H.

In Figure 4, we illustrate changes in environmental damages. In area C_1, NT decreases damages in country H by inducing the country to raise its tax on its own dirty good while lowering the tax on the clean good; these gains more than offset the extra damages in country L, where NT results in a lower tax on the dirty good, and world damages thus decrease. However, as pollution intensity increases for a given quality gap (i.e., area C_2), country H's savings in environmental damages shrink so that, although pollution under NT remains below its non-NT level in country H, global pollution is higher under NT.

[Insert Figure 3 here]

Overall, then, with a high-quality polluting good, NT can lead to an increase in world welfare and a cleaner world environment when pollution intensity is low relative to the quality gap (area D_1 in Figure 4), can improve world welfare but at the cost of a dirtier environment at intermediate ξ values for a given quality gap (area D_2 in Figure 4), or can reduce world welfare and lead to a dirtier environment when pollution intensity is high (area D_3 in Figure 4).

[Insert Figure 4 here]

4 Low-Quality Polluting Goods

In the above analysis, we consider situations in which the consumption of the high-quality good imposes a negative environmental externality as in the car market. But what if one of the dimensions encompassed in the quality parameter is environmental friendliness so that consuming the high-quality good is better for the environment? Under the existing pressures to reduce pollution, firms have increasingly been incorporating environmental considerations in their products' design and consumers have increasingly become more sensitive to the environmental attributes of what they consume, partly because of health considerations (e.g., organic products). While there may be instances in which environmental friendliness may not be positively correlated with the other dimensions captured in the quality parameter and we may thus need a multidimensional measure of quality, we confine our attention to instances in which such correlation does exist or, more narrowly, to instances in which goods differ in their environmental friendliness/quality and individuals prefer more to less environmental friendliness (e.g., energy-saving appliances).

A key difference between the previous case, where pollution arises out of consuming the high-quality good, and the case in this section, where pollution arises out of consuming the low-quality good, is the absence in the latter case of the trade off between pollution and quality that characterizes the former case. In fact, when it is the consumption of good l that generates pollution, consumers prefer good h because it is of higher quality, and governments prefer, ceteris paribus, the same good because it produces less pollution.

The problem of the firms remains the same as in the previous case, with (11) representing the equilibrium prices, for given taxes and cut-off quality parameters. With pollution damages arising from the consumption of the low-quality good and thus equal to

$$\tilde{\varphi}^i = \xi \left(x_l^i\right)^2 = \xi \left(\theta_h^i - \theta_l^i\right)^2, \tag{62}$$

the non-NT optimal taxes in the low-quality country are

$$\tilde{t}_h^L = \frac{a\left(2\xi s_h + s_l a\right)}{\tilde{\Delta}_l} > 0 \quad \& \quad \tilde{t}_l^L = \frac{2s_l a\left(2\xi s_h - s_l a\right)}{s_h \tilde{\Delta}_l}, \tag{63}$$

where

$$\tilde{\Delta}_l = 3s_l a + 2\xi\left(3s_h - 2s_l\right) > 0. \tag{64}$$

Like the high-quality country in the previous case, country L always taxes the clean good produced abroad and subsidizes its own dirty good provided that the marginal damage of pollution is sufficiently low relative to the quality gap, that is, if $\xi < \frac{s_l a}{2s_h}$, which is smaller than the threshold ξ value below which country H subsidizes its own good in the previous case; in other words, the incentive to subsidize the domestically produced dirty good is stronger when pollution generates from consuming the high-quality good. From closer inspection of (63), we also note that, when the low-quality country chooses to tax its own good and the quality gap is sufficiently small, it is possible for the tax on the foreign good to fall short of the tax on the domestic good, in which case the NT clause would not be binding; specifically, if $s_h \geq 2s_l$, the country always treats its own good more favorably, but, if $s_l < s_h < 2s_l$, favorable treatment of the domestic good requires that $\xi < \tilde{\xi}_c = \frac{s_l a(s_h+2s_l)}{2s_h(2s_l-s_h)}$. In comparing the incentives to subsidize the domestic good and to discriminate against the foreign good between the two cases (i.e., when pollution generates from the consumption of the high-quality good and when it results from the consumption of the low-quality good), we arrive at the following:

Lemma 6 *The dirty-good country is less likely to subsidize the local good, but is also less likely to tax the local good at a higher rate than the imported good so that the need for a non-discrimination clause is more likely to arise, when external effects are associated with the consumption of the low-quality good.*

That subsidization of the local good is more likely to result when country L produces the dirty good follows from a comparison of the threshold values of ξ below which subsidization takes place: $\frac{s_l a}{2s_h}$, which is the threshold value of ξ when good l is the dirty good, falls short of $\frac{a}{2}$, which is the threshold value of ξ when good h is the dirty good, and we thus have that, for given values of s_l and s_h, the range of ξ values that support subsidization is wider when pollution generates from consuming the high-quality good. As for the second part of the lemma, if we take the range of ξ values such that NT is binding as a measure of the need for a non-discrimination cause, we have that, when $s_l < s_h < 2s_l$, the critical ξ value above which NT is not binding for the dirty-good country is larger if the low-quality good is polluting, $\tilde{\xi}_c = \frac{s_l a(s_h+2s_l)}{2s_h(2s_l-s_h)} > \xi_c = \frac{3s_h a}{2(3s_h-s_l)}$, which implies that the need for NT is greater in the low-quality polluting good case; when $s_h \geq 2s_l$, there is a always a need for NT in the low-quality polluting good case but not in high-quality polluting good

case. Hence, NT is more likely to be binding when pollution generates from the consumption of the low-quality good.

In the case at hand, both policy instruments are increasing in the extent of the externality as

$$\frac{d\tilde{t}_h^L}{d\xi} = \frac{4s_l^2a^2}{\tilde{\Delta}_l^2} > 0 \quad \& \quad \frac{d\tilde{t}_l^L}{d\xi} = \frac{8s_l^2a^2\left(3s_h - s_l\right)}{s_h\tilde{\Delta}_l^2} > 0, \tag{65}$$

but, while the tax on the high-quality good is also increasing in the quality gap as

$$\frac{d\tilde{t}_h^L}{ds_h} = \frac{4\xi^2\left(s_h^2 + 2a^2\right) + 4s_l\left(3s_h - 2s_l\right)a\xi + 3as_l^2}{\tilde{\Delta}_l^2} > 0, \tag{66}$$

the tax on the low-quality good may decrease or increase in response to an increase in s_h as

$$\frac{d\tilde{t}_l^L}{ds_h} = \frac{2s_l^2\left[4\xi^2s_h^2 - 4\xi as_l\left(2s_h - s_l\right) - 3a^2s_l^2\right]}{s_h^2\tilde{\Delta}_l^2}, \tag{67}$$

which is negative for $\xi < \frac{as_l}{2s_h^2}\left[\left(2s_h - s_l\right) + \sqrt{3s_h^2 + \left(2s_h - s_l\right)^2}\right] > \frac{2as_l\left(2s_h - s_l\right)}{2s_h^2} > \frac{s_la}{2s_h}$. Hence, the more quality differentiated the two goods are, the stronger country L's incentive to subsidize (tax) its domestic good at low (high) pollution intensity levels (at intermediate pollution intensity levels, that is, for $\frac{s_la}{2s_h} < \xi < \frac{as_l}{2s_h^2}\left[\left(2s_h - s_l\right) + \sqrt{3s_h^2 + \left(2s_h - s_l\right)^2}\right]$, country L's incentive to tax its dirty good thus weakens).[18]

In the absence of NT rules, the high-quality country, on the other hand, always finds it optimal to subsidize the domestic good to the point of driving the low-quality good out of the market, so that consumers purchase only the clean, locally produced, high-quality good. To achieve this, country H sets the optimal tax on its good to be

$$\tilde{t}_h^H = -a, \tag{68}$$

that is, it chooses a subsidy equal to the quality gap; the subsidy is thus independent of the marginal damage of pollution and increasing in the quality gap.[19]

Equilibrium prices are then

$$\tilde{p}_h^L = \frac{2a\left(2\xi s_h + s_la\right)}{\tilde{\Delta}_l} \quad \& \quad \tilde{p}_l^L = \frac{4\xi s_la}{\tilde{\Delta}_l} \tag{69}$$

[18] For $s_h < 2s_l$, $\frac{as_l}{2s_h^2}\left[\left(2s_h - s_l\right) + \sqrt{3s_h^2 + \left(2s_h - s_l\right)^2}\right] < \tilde{\xi}_c$.

[19] There is no need to tax good l as consumers do not buy it ($t_l^H = 0$). While a high tax on good l could achieve the same outcome (i.e., no consumption of good l), country H also wants its consumers to buy the high-quality good and must thus choose to subsidize its own firm.

in country L and

$$\tilde{p}_l^H = \tilde{p}_h^H = 0 \tag{70}$$

in country H. As both goods are priced at the same level in country H, consumers choose to purchase only the high-quality good, and, at least in this market, there is allocative efficiency. In terms of sales, the equilibrium consists of

$$\tilde{x}_h^L = \frac{2\xi s_h + s_l a}{\tilde{\Delta}_l} \quad \& \quad \tilde{x}_l^L = \frac{2 s_l a}{\tilde{\Delta}_l} \tag{71}$$

in country L and

$$\tilde{x}_h^H = 1 \quad \& \quad \tilde{x}_l^H = 0 \tag{72}$$

in country H. As $\theta_l^H = \theta_h^H = 0$, the market in country H is completely covered, with every consumer buying good h, and remains completely covered for any change in pollution intensity or quality gap. In country L, however, there are consumers who are priced out of the market as $\theta_l^L = \frac{\tilde{p}_l^L}{s_l} > 0$, and the overall market size is decreasing in both ξ and s_h, but more consumers buy the high-quality good as ξ increases while more consumers buy the low-quality good as s_h increases, that is,

$$\frac{d\tilde{x}_h^L}{d\xi} = \frac{4 s_l^2 a}{\tilde{\Delta}_l^2} > 0 \quad \& \quad \frac{d\tilde{x}_l^L}{d\xi} = -\frac{4 s_l a \left(3 s_h - 2 s_l\right)}{\tilde{\Delta}_l^2} < 0, \tag{73}$$

with $\frac{d\tilde{x}_h^L}{d\xi} + \frac{d\tilde{x}_l^L}{d\xi} < 0$, and

$$\frac{d\tilde{x}_h^L}{ds_h} = -\frac{4\xi s_l \left(s_l + 2\xi\right)}{\tilde{\Delta}_l^2} < 0 \quad \& \quad \frac{d\tilde{x}_l^L}{ds_h} = \frac{4\xi s_l^2}{\tilde{\Delta}_l^2} > 0, \tag{74}$$

with $\frac{d\tilde{x}_h^L}{ds_h} + \frac{d\tilde{x}_l^L}{ds_h} < 0$.

Under National Treatment, the optimal taxes are instead

$$\tilde{T}^L = \frac{4\xi s_l s_h^2}{\tilde{\Delta}_L} > 0 \tag{75}$$

in country L, where

$$\tilde{\Delta}_L = s_h \left(8\xi s_h + 4 s_h s_l + 7 s_l^2\right) - 2 s_l^3, \tag{76}$$

and

$$\tilde{T}^H = \frac{4\xi s_l s_h}{\tilde{\Delta}_H} > 0 \tag{77}$$

in country H, where

$$\tilde{\Delta}_H = 8\xi s_h + 12 s_h s_l - 3 s_l^2, \tag{78}$$

with

$$\tilde{T}^L - \tilde{T}^H = \frac{8s_h s_l^2 \xi \left(4s_h - s_l\right) a}{\tilde{\Delta}_L \tilde{\Delta}_H} > 0. \tag{79}$$

Country L's tax is increasing in both ξ and s_h, that is,

$$\frac{d\tilde{T}^L}{d\xi} = \frac{4s_l^2 s_h^2 \left(s_h + 2s_l\right)\left(4s_h - s_l\right)}{\tilde{\Delta}_L^2} > 0 \quad \& \quad \frac{d\tilde{T}^L}{ds_h} = \frac{4\xi s_l^3 s_h \left(7s_h - 4s_l\right)}{\tilde{\Delta}_L^2} > 0; \tag{80}$$

country H's tax is instead increasing in ξ but decreasing in s_h, that is,

$$\frac{d\tilde{T}^H}{d\xi} = \frac{12s_l^2 s_h \left(4s_h - s_l\right)}{\tilde{\Delta}_H^2} > 0 \quad \& \quad \frac{d\tilde{T}^H}{ds_h} = -\frac{12\xi s_l^3}{\tilde{\Delta}_H^2} < 0. \tag{81}$$

Equilibrium sales are thus

$$\tilde{X}_h^L = \frac{2s_h\left(2\xi s_h + s_h s_l + 2s_l^2\right)}{\tilde{\Delta}_L} \quad \& \quad \tilde{X}_l^L = \frac{s_l s_h \left(s_h + 2s_l\right)}{\tilde{\Delta}_L} \tag{82}$$

in country L and

$$\tilde{X}_h^H = \frac{2s_h\left(3s_l + 2\xi\right)}{\tilde{\Delta}_H} \quad \& \quad \tilde{X}_l^H = \frac{3s_h s_l}{\tilde{\Delta}_H} \tag{83}$$

in country H. Under NT, neither country opts for full market coverage, but country H prices out of the market fewer consumers than country L as $0 < \tilde{X}_h^L + \tilde{X}_l^L < \tilde{X}_h^H + \tilde{X}_l^H < 1$. Both countries respond to an increase in ξ or an increase in s_h by reducing market coverage, driving more consumers out of the market, and pricing more consumers out of purchasing the high-quality good in favour of the low-quality good; the relevant effects are

$$\frac{d\tilde{X}_l^H}{d\xi} = -\frac{24s_l s_h^2}{\tilde{\Delta}_H^2} < \frac{d\tilde{X}_h^H}{d\xi} = -\frac{12s_l^2 s_h}{\tilde{\Delta}_H^2} < 0 \tag{84}$$

and

$$\frac{d\tilde{X}_h^H}{ds_h} = -\frac{6s_l^2\left(3s_l + 2\xi\right)}{\tilde{\Delta}_H^2} < \frac{d\tilde{X}_l^H}{ds_h} = -\frac{9s_l^3}{\tilde{\Delta}_H^2} < 0 \tag{85}$$

in country H and

$$\frac{d\tilde{X}_l^L}{d\xi} = -\frac{8s_l s_h^3\left(s_h + 2s_l\right)}{\tilde{\Delta}_L^2} < \frac{d\tilde{X}_h^L}{d\xi} = -\frac{4s_l^2 s_h^2\left(s_h + 2s_l\right)}{\tilde{\Delta}_L^2} < 0, \tag{86}$$

$$\frac{d\tilde{X}_h^L}{ds_h} = -\frac{2s_l^2\left[s_l\left(s_h + 2s_l\right)^2 + 2\xi s_h\left(s_h + 4s_l\right)\right]}{\tilde{\Delta}_L^2} < 0, \tag{87}$$

and

$$\frac{d\tilde{X}_l^L}{ds_h} = -\frac{s_l^2\left[s_l\left(s_h + 2s_l\right)^2 + 16\xi s_h^2\right]}{\tilde{\Delta}_L^2} < 0, \tag{88}$$

in country L, with $\frac{d\tilde{X}_h^L}{ds_h} < \frac{d\tilde{X}_l^L}{ds_h}$ if $s_h < \frac{7+\sqrt{21}}{7} \approx 1.6547$ but, for $s_h > \frac{7+\sqrt{21}}{7}$, $\frac{d\tilde{X}_h^L}{da} < \frac{d\tilde{X}_l^L}{da}$ if $\xi < \frac{s_l(s_h+2s_l)^2}{4s_h(3s_h-4s_l)}$ and $\frac{d\tilde{X}_h^L}{da} > \frac{d\tilde{X}_l^L}{da}$ otherwise. Before moving on to comparing taxes, welfare, and environmental damages under the two policy regimes, it is worthwhile underscoring the effects of NT on sales and market coverage: in country H, these effects are clear from the above analysis and amount to a contraction of the market accompanied by a decrease in the sales of good h and an increase in the sales of good l; in country L, the effects are also straightforward once we report the differences, namely,

$$\tilde{x}_h^L - \tilde{X}_h^L = -\frac{[4s_h\xi + s_h(2s_h + s_l)]\,[2s_h(s_h - 2s_l)\,\xi + s_l a(s_h + 2s_l)]}{\tilde{\Delta}_l}, \tag{89}$$

which is always negative under a bilaterally binding NT (i.e., for $s_h \geq 2s_l$ or for $s_h < 2s_l$ and $\xi < \tilde{\xi}_c$),

$$\tilde{x}_l^L - \tilde{X}_l^L = \frac{s_l(5s_h - 2s_l)\,[2s_h(s_h - 2s_l)\,\xi + s_l a(s_h + 2s_l)]}{\tilde{\Delta}_L}, \tag{90}$$

which is always positive under a bilaterally binding NT, and

$$\tilde{x}_h^L + \tilde{x}_l^L - \left(\tilde{X}_h^L + \tilde{X}_l^L\right) = -\frac{[2s_h(s_h - 2s_l)\,\xi + s_l a(s_h + 2s_l)]\,(4s_h\xi - 3s_l a)}{\tilde{\Delta}_l\tilde{\Delta}_L}, \tag{91}$$

which is positive for $\xi < \frac{3s_l a}{4s_h}$ and negative otherwise.

In comparison to the non-NT policy, the NT policy is always stricter in country H but can be laxer in country L; the relevant tax differences are in fact

$$\tilde{t}_h^L - \tilde{T}^L = \frac{a\,[4\xi s_h + s_l(4s_h - s_l)]\,[s_l a(2s_l + s_h) - 2\xi s_h(2s_l - s_h)]}{\tilde{\Delta}_l\tilde{\Delta}_L} \tag{92}$$

and

$$\tilde{t}_l^L - \tilde{T}^L = \frac{2s_l\left[2\xi s_h^2 - s_l a(4s_h - s_l)\right][s_l a(2s_l + s_h) - 2\xi s_h(2s_l - s_h)]}{s_h\tilde{\Delta}_l\tilde{\Delta}_L}, \tag{93}$$

which can be negative or positive depending on the value of ξ relative to the values of s_h and s_l. If $s_h \geq 2s_l$, the NT tax on good h is always smaller and the NT tax on good l is smaller if $\xi > \frac{s_l a(4s_h - s_l)}{2s_h^2} > \frac{s_l a}{2s_h}$. If $s_h < 2s_l$, both NT taxes are smaller for $\frac{s_l a(4s_h - s_l)}{2s_h^2} < \xi < \tilde{\xi}_c = \frac{s_l a(2s_l + s_h)}{2s_h(2s_l - s_h)}$ but the NT tax on good h is smaller and the NT tax on good l is larger for $\xi < \frac{s_l a(4s_h - s_l)}{2s_h^2}$. We summarize and illustrate the above possibilities in Figure 5; for a given quality gap, we thus have that the tax on the foreign good decreases while the tax on the domestic good increases at low pollution intensity levels (area E_1) and both taxes decrease at intermediate pollution intensity levels if $s_h < 2s_l$ and at high pollution intensity levels if $s_h \geq s_l$ (area E_2).

[Insert Figure 5 here]

4.1 NT versus non-NT: Welfare and Environmental Damages

When pollution generates from the consumption of the low-quality good, country H suffers unambiguously from higher pollution damages under NT (damages are zero in the non-NT case), in spite of higher taxes on both goods.[20] In the absence of NT, every consumer in country H participates in the market but buys only good h; under NT rules, consumers with the lowest valuations of quality withdraw from the market and only consumers with the highest valuations of quality buy the high-quality good, so that a segment of the market purchases the low-quality good; hence, with the adoption of NT rules, consumption of the clean good (i.e., good h) decreases while consumption of the dirty good (i.e., good l) increases in country H, and the environment thus worsens. Welfare, however, does not necessarily decrease in country H following the NT adoption: as long as the marginal damage of pollution is sufficiently small and the quality gap sufficiently high, NT increases country H's welfare. This increase comes about as a result of the increased profits from greater sales of good h and lower taxes in country L which outweighs the reduction in domestic welfare upon entry of good l into country H.[21]

Environmental damages and welfare in country L depend on pollution intensity and the quality gap but in different ways than in country H. Damages are lower in country L when pollution intensity is low relative to the quality gap and higher otherwise; in particular, damages are higher when the NT tax falls short of both non-NT taxes (area E_1 in Figure 5) and lower otherwise. When pollution intensity is low, allowing additional sales of good h through common taxation reduces the market size of the dirty good, and damages thus fall. As pollution intensity increases, NT can cause an increase in the market size of the dirty good, which increases pollution. Welfare, on the other hand, is higher in country L under NT if (i) the quality gap is sufficiently high and pollution intensity is sufficiently low or (ii) the quality gap is sufficiently low and pollution intensity is sufficiently high. For intermediate values of both pollution intensity and the quality gap, NT

[20] In the absence of NT rules, country H always prices the low-quality good out of the market through a subsidy on good h, and there is thus no tax on good l. We could then say that country H can choose *any* tax on good l without affecting the equilibrium. In this sense, we could argue that the tax on good l does not increase. We take the view that requiring "no tax" implies a zero tax.

[21] If NT did not reduce domestic welfare, country H would be able to increase its welfare by choosing the NT tax even in the absence of NT rules. As country H does not choose a common tax, it must be that domestic welfare is lower.

reduces country L's welfare. We illustrate these effects in Figures 6a and 6b (welfare) and Figure 7 (world damages) but we also summarize them in the following proposition:

Proposition 6 *When pollution generates from the consumption of the low-quality good, NT results in*

(i) *unambiguously higher environmental damages in country H but leads to lower (higher) damages in country L when ξ is sufficiently low (high) relative to the quality gap*

(ii) *higher welfare in country H when ξ is sufficiently low and the quality gap is sufficiently high but higher welfare in country L only if damages are neither too low nor too high relative to the quality gap.*

[Insert Figures 6a, 6b, and 7 here]

From Figures 6a and 6b,[22] we can see that country H prefers NT when the quality gap is high relative to pollution intensity, as its high-quality good enjoys greater protection in the foreign market and the inability to discriminate against the dirty good does not generate significant negative external effects. For the most part, country L prefers the opposite: NT raises the welfare of country L at low relative values of the quality gap, as consumers perceive less of a difference between its good and the high-quality good and NT prevents discrimination against its dirty product. It is now possible, though, that both countries gain from NT (area F_3 in Figure 5), when the externality is small and the quality gap is moderate, a possibility which does not arise when pollution results from the consumption of the high-quality good. When the quality gap is very small relative to pollution intensity, country L wants to discriminate against its own good but NT prevents it from doing so, and both countries are thus worse off under NT.

Figure 7 illustrates the effects of NT on both world welfare and world environmental damages. When pollution is not very damaging (area G_1), the inability to discriminate against dirty goods does not have important effects, and NT raises world welfare and improves the world environment. Unlike the high-quality polluting case when governments have incentives to temper their discrimination against the dirty good (since consumers prefer the high-quality good), such moderating

[22] For Figure 6a, we have that $s_h < 2s_l$, and we thus need to include the condition for binding NT, namely, $s_h\left(\xi|_{\tilde{t}_h^L=\tilde{t}_l^L}\right)$, to the right of which NT is not binding. For Figure 6b, we have that $s_h \geq 2s_l$, and NT is always binding.

incentives are not present when the environmental externality arises out of consuming the low-quality good. Accordingly, NT often leads to a decrease in world welfare (areas G_2 and G_3), as equal treatment implies that countries take relatively larger quantities of both the low-quality good and the dirty good (which are the same good). At intermediate values of the quality gap relative to pollution intensity (area G_2), environmental improvements in country L can more than offset the increased damages in country H, leading to a possibility that does not arise in the high-quality good polluting case: NT lowers world welfare but improves the world environment. At relatively very high pollution intensity values (area G_3), NT decreases world welfare and results in a worsening of the world environment.

5 A Unilaterally Binding NT

In this section, we consider instances in which NT is only binding for the country producing the clean good. As we show in the previous sections, in the absence of NT, the country producing the dirty good may choose to tax the domestic good at a higher rate than the imported good if pollution intensity is high. Specifically, we derive that, when pollution arises from the consumption of the high-quality good, country H discriminates against its own good if $\xi > \xi_c = \frac{3s_h a}{2(3s_h - s_l)}$; alternatively, when pollution arises from the consumption of the low-quality good, country L discriminates against its own good if $\xi > \tilde{\xi}_c = \frac{s_l a(s_h + 2s_l)}{2s_h(2s_l - s_h)}$. In such cases, NT is not binding for the country producing the dirty good; hence, under NT, the clean-good country chooses the NT tax while the dirty-good country chooses the non-NT taxes.

Under a unilaterally binding NT, national welfare, which we denote as W_{ub}^j when good h is dirty and $\tilde{W}_{ub}^j$ when good l is dirty, for $j = H, L$, is equal to the non-NT domestic welfare plus the (bilaterally binding) NT profits from foreign consumption for the country producing the dirty good and is equal to the NT domestic welfare plus the non-NT profits from foreign consumption for the country producing the clean good. The national welfare differences between non-NT and a unilaterally binding NT are then equal to

$$w^H - W_{nb}^H = \left(w_h^H + \pi_h^L\right) - \left(w_h^H + \Pi_h^L\right) = \pi_h^L - \Pi_h^L < 0 \tag{94}$$

and

$$w^H - W_{nb}^H = \left(w_l^L + \pi_l^H\right) - \left(W_l^L + \pi_l^H\right) = w_l^L - W_l^L > 0 \tag{95}$$

when good h is polluting, with $w_l^L - W_l^L + \pi_h^L - \Pi_h^L < 0$, and equal to

$$\tilde{w}^H - \tilde{W}_{nb}^H = \left(\tilde{w}_h^H + \tilde{\pi}_h^L\right) - \left(\tilde{W}_{nb}^H + \tilde{\pi}_h^L\right) = \tilde{w}_h^H - \tilde{W}_h^H > 0 \tag{96}$$

and

$$\tilde{w}^L - \tilde{W}_{nb}^L = \left(\tilde{w}_l^L + \tilde{\pi}_l^H\right) - \left(\tilde{w}_l^L + \tilde{\Pi}_l^H\right) = \tilde{\pi}_l^H - \tilde{\Pi}_l^H < 0 \tag{97}$$

when good l is polluting, with $\tilde{\pi}_l^H - \tilde{\Pi}_l^H + \tilde{w}_h^H - \tilde{W}_h^H > 0$ (see Appendix). Globally, a unilaterally binding NT increases global welfare when good h is polluting but decreases it when good l is polluting.

The level of environmental pollution under a unilaterally binding NT, which we denote as Φ_{ub}^j and $\tilde{\Phi}_{ub}^j$ for $j = H, L$ depending on which good is dirty, is the same as the non-NT level for the dirty-good country and the same as the (bilaterally binding) NT level for the clean-good country. Global environmental damages under a unilaterally binding NT (Φ_{ub}^W) are then equal to $\varphi^H + \Phi^L$ when good h is polluting and $\tilde{\Phi}^H + \tilde{\varphi}^L$ when good l is polluting, and it thus follows that the difference in global pollution between non-NT and a unilaterally binding NT corresponds to the difference in country L's environmental damages as in (60) in the former case and to the difference in country H's environmental damages (i.e., $-\tilde{\Phi}^H$) in the latter case.

We illustrate the welfare and environmental effects of moving to a unilaterally binding NT when pollution originates from consuming good h, under normalization of s_l to unity, in Figure 2 with the area B_3 where welfare decreases in country L, increases in country H, and increases globally, in Figure 3 with the area C_3 where pollution increases in country L, does not change in country H, and increases globally, and in Figure 4 with the area D_4 where both global welfare and global pollution increase. We sum up the results for the low-quality polluting case in Figure 6a with the area F_5 where welfare increases in country L and decreases in country H and in Figure 7 with the area G_4 where global welfare decreases and global pollution increases.

6 Conclusion

Previous work on externalities and National Treatment have primarily focused on the costs of achieving an environmental standard and the role of the burden of proof in NT disputes. In this paper, we propose a model in which countries produce a product with differing qualities and pollution is generated at the consumption level in order to provide countries with incentives to

impose differential taxes (that is, to discriminate in the absence of National Treatment rules). In this way, we can analyze the impact of NT on a variety of variables, including taxes, product prices, market shares, market coverage, and individual and global welfare levels and environmental damages.

As the amount of pollution generated at the consumption stage depends on the quality of the product, we consider two plausible ways of linking pollution to quality. In one case, pollution generates as a by-product of the consumption of the high-quality good; this correlation possibility applies most notably to cars in that better (e.g., more powerful) cars tend to be worse for the environment. In the other case, pollution originates from the consumption of the low-quality good; this correlation possibility arises when environmental friendliness is itself a dimension of quality that consumers value (e.g., organic food and energy-saving appliances).

When pollution increases with quality and NT is binding for both countries, the domestic taxes increase and the foreign taxes decrease with the adoption of NT rules. These tax effects result in fewer consumers buying either version of the good but more consumers buying the imported good. The low-quality country ends up with a worse environment and lower welfare and the high-quality country with a better environment and higher welfare. Globally, both environmental damages and welfare can increase or decrease, and we have three possible outcomes: lower environmental damages and higher global welfare if pollution intensity is sufficiently low; higher environmental damages and higher welfare at intermediate pollution intensity levels, and higher environmental damages and lower welfare if pollution intensity is sufficiently high.

When pollution decreases with quality and NT is binding for both countries, the adoption of NT always leads to a stricter policy in the high-quality country but may decrease both taxes or increase the tax on the domestic good and decrease the tax on the foreign good in low-quality country. These tax effects amount to fewer consumers buying the domestic good and more consumers buying the imported good, with market coverage contracting in the high-quality country but expanding in the low-quality country at low pollution intensity levels. In terms of environmental damages, NT results in a worse environment in the high-quality country and, provided that pollution intensity is sufficiently high, in the low-quality country. In terms of national welfare, the set of possible changes is richer than when pollution generates from the consumption of the high-quality good: both country can experience a welfare decrease upon adoption of NT, a welfare increase, or one

country can gain while the other loses and vice versa, depending on the pollution intensity level relative to the quality gap. Globally, welfare can increase or decrease as environmental damages can increase or decrease. However, unlike in the high-quality pollution good case, it is no longer possible for NT to increase global welfare but worsen the world environment. Instead, a new possibility arises: NT can lower world welfare but improve the world environment.[23]

In both cases, it is possible for the country producing the dirty good to become so concerned about the damaging effects of pollution to decide to tax its good at a higher rate than the imported good, and NT is thus only binding for the country producing the clean good. The level of environmental concern triggering the switch from less to more stringent policy in the domestic market is however not independent of how differentiated the two goods are, with greater differentiation requiring pollution to be more damaging before the dirty country engages in policy discrimination against its own product. As the surplus benefit of greater quality differentiation does not fall evenly on the two countries but favours the high-quality country which retains the surplus the producer of the high-quality good is able to extract from consumers, the positive relationship between the quality gap and the threshold pollution intensity level above which the dirty country taxes its good at a higher rate than the imported good always holds when the high-quality country is the producer of the dirty good but ceases to hold at a sufficiently high quality gap when the low-quality country is the producer of the dirty good. Two important implications then follow: (i) there is greater need for a non-discrimination clause in internal policy setting when pollution is associated with the consumption of the low-quality good; (ii) global welfare is more likely to fall, independently of whether NT is binding for both countries or only for the clean country, when pollution is associated with the consumption of the low-quality good.

More generally, an important conclusion of this paper, which is novel in the literature examining the welfare implications of NT in the presence of differing environmental effects that give rise to legitimate internal policy discrimination incentives, is that NT needs not lower global welfare even when environmental concerns are quite pressing and, more importantly, even when there is no opportunity for countries to internalize discriminatory motives at the tariff setting stage. However, as we note above, the applicability of this result rests upon the link between the environmental externality that consumption generates and quality and, to the extent that this link is different

[23] We provide a summary of the key results in the two cases in Table 3.

for different consumption goods (e.g., cars versus energy-saving appliances), is likely to vary across sectors. While our choice of a quality model with unit consumption may seem restrictive, it is a choice that most effectively, and with no loss on the reality front, allows us to characterize a world in which NT applies, with products that, in spite of being differentiated, are like, at a minimum by virtue of sharing their end uses, and in which consumption externalities can differ as they can be tied to quality differences creating legitimate (non-protectionist) incentives for discriminatory internal policies. The quality model we adopt is thus an ideal framework to study the welfare implications of NT when discrimination is arguably justifiable on the basis of environmental considerations.

7 Appendix

7.1 No National Treatment (High-Quality Polluting Good)

The welfare-maximizing conditions in country j are

$$\frac{dw^j\left(t_l^j,t_h^j\right)}{dt_i^j}=-\left(s_h-s_l\right)\vartheta_h^j\frac{d\vartheta_h^j}{dt_i^j}-s_l\vartheta_l^j\frac{d\vartheta_l^j}{dt_i^j}-\left(p_{-i}^j-t_{-i}^j\right)\frac{dx_{-i}^j}{dt_i^j}-x_{-i}^j\frac{dp_{-i}^j}{dt_i^j}-2\xi x_h^j\frac{dx_h^j}{dt_i^j}=0$$

for the tax on the domestic good (i.e., for $i=h$ and $-i=l$ when $j=H$ or $i=l$ and $-i=h$ when $j=L$) and

$$\frac{dw^j\left(t_l^j,t_h^j\right)}{dt_i^j}=-\left(s_h-s_l\right)\vartheta_h^j\frac{d\vartheta_h^j}{dt_i^j}-s_l\vartheta_l^j\frac{d\vartheta_l^j}{dt_i^j}-\left(p_i^j-t_i^j\right)\frac{dx_i^j}{dt_i^j}-\underbrace{x_i^j\left(\frac{dp_i^j}{dt_i^j}-1\right)}_{<0}-2\xi x_h^j\frac{dx_h^j}{dt_i^j}=0$$

for the tax on the foreign good (i.e., for $i=l$ when $j=H$ and $i=h$ when $j=L$), where

$$\frac{d\vartheta_h^j}{dt_h^j}=-\frac{dx_h^j}{dt_h^j}=\frac{2s_h-s_l}{\left(s_h-s_l\right)\left(4s_h-s_l\right)}>0,\quad \frac{d\vartheta_h^j}{dt_l^j}=-\frac{dx_h^j}{dt_l^j}=-\frac{s_h}{\left(s_h-s_l\right)\left(4s_h-s_l\right)}<0,$$

$$\frac{d\vartheta_l^j}{dt_h^j}=\frac{1}{s_l}\frac{dp_l^j}{dt_h^j}=\frac{1}{s_l}\left(\frac{s_l}{4s_h-s_l}\right)>0,\quad \frac{d\vartheta_l^j}{dt_l^j}=\frac{1}{s_l}\frac{dp_l^j}{dt_l^j}=\frac{1}{s_l}\left(\frac{2s_h}{4s_h-s_l}\right)>0,$$

$$\frac{dp_h^j}{dt_h^j}=\frac{2s_h}{4s_h-s_l}>0,\quad \frac{dp_h^j}{dt_l^j}=\frac{s_h}{4s_h-s_l}>0,$$

$$\frac{dx_l^j}{dt_h^j}=\frac{s_h}{\left(s_h-s_l\right)\left(4s_h-s_l\right)}>0,\quad \&\quad \frac{dx_l^j}{dt_l^j}=\frac{s_h\left(s_l-2s_h\right)}{s_l\left(s_h-s_l\right)\left(4s_h-s_l\right)}<0.$$

7.2 National Treatment (High-Quality Polluting Good)

The welfare-maximizing condition in country j is

$$\frac{dw^j\left(T^j\right)}{dT^j} = -\left(s_h - s_l\right)\Theta_h^j\frac{d\Theta_h^j}{dT^j} - s_l\Theta_l^j\frac{d\Theta_l^j}{dT^j} - \left(P_i^j - T^j\right)\frac{dX_i^j}{dT^j} - \underbrace{X_i^j\left(\frac{dP_i^j}{dT^j} - 1\right)}_{<0} - 2\xi X_h^j\frac{dX_h^j}{dT^j} = 0,$$

for $i = l$ when $j = H$ and $i = h$ when $j = L$, where

$$\frac{d\Theta_h^j}{dT^j} = -\frac{dX_h^j}{dT^j} = \frac{1}{4s_h - s_l} > 0, \quad \frac{d\Theta_l^j}{dT^j} = \frac{1}{s_l}\frac{dP_l^j}{dT^j} = \frac{1}{s_l}\left(\frac{2s_h + s_l}{4s_h - s_l}\right) > 0,$$

$$\frac{dP_h^j}{dT^j} = \frac{3s_h}{4s_h - s_l}, \quad \& \quad \frac{dX_l^j}{dT^j} = -\frac{1}{s_l}\left(\frac{2s_h}{4s_h - s_l}\right) < 0.$$

7.3 Welfare and Environmental Damage Comparisons

In comparing the NT regime with the non-NT regime in terms of welfare and environmental damages, we consider here not only the range of ξ values such that NT is binding for both countries but also instances in which NT is only binding for the clean-good country. We begin with the analysis of the high-quality polluting good case when NT is binding for both countries if $\xi < \xi_c = \frac{3s_h(s_h - s_l)}{2(3s_h - s_l)}$ and NT is binding only for country L otherwise.

7.3.1 High-Quality Polluting Good

In country L,

$$w^L - W^L = \underbrace{w_l^L - W_l^L}_{>0} + \underbrace{\pi_l^H - \Pi_l^H}_{\lesseqgtr 0} > 0,$$

where

$$w_l^L - W_l^L = \frac{\left[\left(s_h - s_l\right)\left(s_h + 2s_l\right) + 2\xi\left(s_h + s_l\right)\right]^2}{2\Delta_l\Delta_L} > 0$$

and

$$\pi_l^H - \Pi_l^H = -\frac{3s_h s_l\left(s_h - s_l\right)\left(3s_h + 2\xi\right)M_1 M_2}{\Delta_h^2\Delta_H^2},$$

with

$$M_1 = -3s_h\left(s_h - s_l\right) + 2\xi\left(3s_h - s_l\right),$$

which is negative for $\xi < \xi_c$, and

$$M_2 = -3s_h^2\left(s_h - s_l\right) + 4\xi^2\left(s_h - s_l\right) - 4s_h\xi\left(3s_h - s_l\right),$$

which is negative for $\xi < \frac{s_h\left(3s_h - s_l + 2\sqrt{3s_h^2 - 3s_h s_l + s_l^2}\right)}{2(s_h - s_l)} > \xi_c$ so that $\pi_l^H - \Pi_l^H < 0$. Using that $\frac{d\left(\pi_l^H - \Pi_l^H\right)}{d\xi} > 0$ for $\xi < \xi_c$ and $\frac{d\left(w_l^L - W_l^L\right)}{d\xi} > 0$ for any ξ value, we know that $\pi_l^H - \Pi_l^H$ reaches its lowest (negative) level and $w_l^L - W_l^L$ reaches its lowest (positive) level when $\xi = 0$; we can then conclude that $w^L - W^L > 0$ for any feasible ξ value by showing that the welfare difference is positive when $\xi = 0$, that is,

$$w^L - W^L = \frac{(s_h - s_l)\left(4s_h^2 - 2s_l^2 + s_h s_l\right)}{6\left(4s_h - s_l\right)^2} > 0.$$

In country H,

$$w^H - W^H = \underbrace{w_h^H - W_h^H}_{>0} + \underbrace{\pi_h^L - \Pi_h^L}_{<0} < 0,$$

where

$$w_h^H - W_h^H = \frac{\left[-3s_h\left(s_h - s_l\right) + 2\xi\left(3s_h - s_l\right)\right]^2}{2\Delta_h \Delta_H} > 0,$$

and

$$\pi_h^L - \Pi_h^L = -\frac{\left(s_h - s_l\right)\left(2s_h + s_l\right) N_1 N_2}{\Delta_l^2 \Delta_L^2} < 0,$$

with

$$N_1 = \left(s_h - s_l\right)\left(s_h + 2s_l\right) + 2\xi\left(s_h + s_l\right) > 0$$

and

$$N_2 = \left(s_h - s_l\right)\left(10s_h - s_l\right)\left(s_h + 2s_l\right) + \xi\left[s_l\left(10s_h - s_l\right) + \left(4s_h^2 - s_l^2\right)\right] > 0.$$

Using that (i) both $w_h^H - W_h^H$ and $\pi_h^L - \Pi_h^L$ are convex functions of ξ, with the former difference reaching its lowest level when $\xi = \xi_c$ and the latter at some $\xi > \xi_c$, (ii) the relevant range of ξ values being $(0, \xi_c)$, and (iii) $w^H - W^H < 0$ when $\xi = 0$, we conclude that $w^H - W^H$ is negative for any feasible ξ value.

When $\xi > \xi_c$, the welfare differences are

$$\left(w_l^L + \pi_l^H\right) - \left(W_l^L + \pi_l^H\right) = w_l^L - W_l^L > 0$$

in country L and

$$\left(w_h^H + \pi_h^L\right) - \left(w_h^H + \Pi_h^L\right) = \pi_h^L - \Pi_h^L < 0$$

in country H. The difference in global welfare is

$$w_l^L - W_l^L + \pi_h^L - \Pi_h^L = -\frac{N_1\left[2\left(s_h - s_l\right)\left(2s_h + s_l\right) N_2 - N_1 \Delta_l \Delta_L\right]}{2\Delta_l^2 \Delta_L^2},$$

which is negative as $2(s_h - s_l)(2s_h + s_l)N_2 - N_1\Delta_l\Delta_L$ is increasing in ξ and positive for $\xi = \xi_c$, while the difference in global environmental damages corresponds to the difference in country L's environmental damages as in (60), which is negative.

7.3.2 Low-Quality Polluting Case

In both countries, domestic welfare worsens as

$$\tilde{w}_h^H - \tilde{W}_h^H = \frac{1}{2}\frac{s_h\left[3s_l(s_h - s_l) + 2\xi s_h\right]}{\tilde{\Delta}_H} > 0$$

and

$$\tilde{w}_l^L - \tilde{W}_l^L = \frac{1}{2}\frac{\left[-2s_l\left(s_l^2 + 2\xi s_h\right) + s_l s_h\left(s_l + s_h^2 + 2\xi s_h\right)\right]^2}{\tilde{\Delta}_l\tilde{\Delta}_L} > 0,$$

but profits from exports increase as

$$\tilde{\pi}_h^L - \tilde{\Pi}_h^L = -\frac{(s_h - s_l)\left[2s_l(s_h + s_l) + 2\xi s_h\right]R_1R_2}{\tilde{\Delta}_l^2\tilde{\Delta}_L^2},$$

where

$$R_1 = 2s_h(s_h - 2s_l)\xi + s_l(s_h - s_l)(s_h + 2s_l),$$

which is positive for $\xi < \tilde{\xi}_c = -\frac{s_l(s_h - s_l)(s_h + 2s_l)}{2s_h(s_h - 2s_l)}$, and

$$R_2 = 8s_h^2(5s_h - 2s_l)\xi^2 + 10s_l s_h\left(4s_h^2 - 2s_l^2 + s_l s_h\right)\xi + s_l^2(s_h - s_l)(s_h + 2s_l)(10s_h - s_l) > 0,$$

and

$$\tilde{\pi}_l^H - \tilde{\Pi}_l^H = -\frac{9s_l^3 s_h(s_h - s_l)}{\tilde{\Delta}_H^2} < 0.$$

Environmental damages decrease in country L and increase in country H as

$$\tilde{\varphi}^L - \tilde{\Phi}^L = \frac{s_l^2(5s_h - 2s_l)\xi\left[2s_h\left(11s_h^2 - 4s_l s_h - 4s_l^2\right)\xi + s_l(s_h - s_l)(s_h + 2s_l)\right]R_1}{\tilde{\Delta}_l^2\tilde{\Delta}_L^2} > 0$$

and

$$\tilde{\varphi}^H - \tilde{\Phi}^H = -\frac{9s_l^2 s_h^2\xi}{\tilde{\Delta}_H^2} < 0.$$

When $s_h < 2s_l$ and $\xi > \tilde{\xi}_c$, the welfare differences are

$$\left(\tilde{w}_l^L + \tilde{\pi}_l^H\right) - \left(\tilde{w}_l^L + \tilde{\Pi}_l^H\right) = \tilde{\pi}_l^H - \tilde{\Pi}_l^H < 0$$

in country L and

$$\left(\tilde{w}_h^H + \tilde{\pi}_h^L\right) - \left(\tilde{W}_h^H + \tilde{\pi}_h^L\right) = \tilde{w}_h^H - \tilde{W}_h^H > 0$$

in country H. The difference in global welfare is

$$\tilde{w}_h^H - \tilde{W}_h^H + \tilde{\pi}_l^H - \tilde{\Pi}_l^H = \frac{s_h \left\{ \left[3s_l \left(s_h - s_l \right) + 2\xi s_h \right] \tilde{\Delta}_H - 18 s_l^3 \left(s_h - s_l \right) \right\}}{2\tilde{\Delta}_H^2},$$

which is positive as $\left[3s_l \left(s_h - s_l \right) + 2\xi s_h \right] \tilde{\Delta}_H - 18 s_l^3 \left(s_h - s_l \right)$ is increasing in ξ and positive for $\xi = \xi_c$, while the difference in global environmental damages corresponds to the difference in country H's environmental damages.

References

[1] Bagwell, K., and R.W. Staiger (2001). "Domestic Policies, National Sovereignty, and International Economic Institutions," *Quarterly Journal of Economics* 116(2), 519–62.

[2] Bagwell, K., and R.W. Staiger. *The Economics of the World Trading System* (Cambridge, Massachusetts: MIT Press, 2002).

[3] Copeland, B.R. (1990). "Strategic Interaction among Nations: Negotiable and Non-negotiable Trade Barriers," *Canadian Journal of Economics* 23(1), 84–108.

[4] Costinot, A. (2008). "A Comparative Institutional Analysis of Agreements on Product Standards," *Journal of International Economics* 75(1), 197–213.

[5] Ederington, J. (2001). "International Coordination of Trade and Domestic Policies," *American Economic Review* 91(5), 1580–93.

[6] Ganslandt, M., and J.R. Markusen (2001). "Standards and Related Regulations in International Trade: A Modeling Approach," NBER Working Papers 8346.

[7] Gulati, S., and D. Roy (2008). "National Treatment and the Optimal Regulation of Environmental Externalities," *Canadian Journal of Economics* 41(4), 1445–1471.

[8] Horn, H. (2006). "National Treatment in the GATT," *American Economic Review* 96(1), 394-404.

[9] Horn, H. (2011). "The Burden of Proof in Trade Disputes and the Environment," *Journal of Environmental Economics and Management* 62(1), 15–29.

[10] Horn, H., G. Maggi, and R.W. Staiger (2010). "Trade Agreements as Endogenously Incomplete Contracts," *American Economic Review* 100(1), 394–419.

[11] Fischer, R., and P. Serra (2000), "Standards and Protection," *Journal of International Economics* 52(2), 377-400.

[12] Janeba, E. (1998). "Tax Competition in Imperfectly Competitive Markets," *Journal of International Economics* 44 (1), 135–53.

[13] Markusen, J.R. (1975). "International Externalities and Optimal Tax Structures," *Journal of International Economics* 5(1), 15–29.

[14] McAusland, C. (2004), "Environmental Regulation as Export Promotion: Product Standards for Dirty Intermediate Goods," *B.E. Journal of Economic Analysis & Policy: Contributions* 3(2), 1–17.

[15] Saggi, K., and N. Sara (2008). "National Treatment at the WTO: The Role of Product and Country Heterogeneity," *International Economic Review* 49(4), 1365–1394.

[16] Shaked, A., and J. Sutton (1982). "Relaxing Price Competition through Product Differentiation," *Review of Economic Studies* 49(1), 3–13.

[17] Shaked, A., and J. Sutton. "Natural Oligopolies and International Trade," in H. Kierzkowski, ed., *Monopolisitic Competition and International Trade* (Oxford: Oxford University Press, 1984).

[18] Staiger, R.W., and A.O. Sykes (2011). "International Trade, National Treatment, and Domestic Regulation," *Journal of Legal Studies* 40(1), 149–203.

TABLE 1. Summary of Article III (GATT) Disputes from 1995 to 2012.

DISPUTE Short Title (Year) (Dispute No.)	**MEASURE AT ISSUE**	**KEY FINDINGS**
Japan – Alcoholic Beverages II (1995) (DS8, 10, 11)	Japanese Liquor Tax Law that established a system of internal taxes applicable to all liquors at different tax rates depending on which category they fell within. The tax law at issue taxed shochu at a lower rate than the other products.	The Appellate Body upheld the Panel's findings that • vodka was taxed in excess of shochu, in violation of Art. III:2, first sentence; • shochu and whisky, brandy, rum, gin, genever, and liqueurs were not similarly taxed so as to afford protection to domestic production, in violation of Art. III:2, second sentence.
US – Gasoline (1995) (DS2)	The Gasoline Rule under the US Clean Air Act that set out the rules for establishing baseline figures for gasoline sold on the US market (different methods for domestic and imported gasoline), with the purpose of regulating the composition and emission effects of gasoline to prevent air pollution.	The Panel considered it unnecessary to examine the consistency of the Gasoline Rule with Art. III:1, given that a finding of violation of Art III:4 (i.e., more specific provision than Art. III:1) had already been made.
Canada – Periodicals (1996) (DS31)	(i) Tariff Code 9958, which prohibited the importation into Canada of any periodical that was a "special edition"; (ii) the Excise Tax Act, which imposed, in respect of each split-run edition of a periodical, a tax equal to 80 per cent of the value of all the advertisements contained in the split-run edition; (iii) the postal rate scheme under which different postal rates were applied to domestic and foreign periodicals.	The Appellate Body reversed the Panel's finding that imported split-run periodicals and domestic non-split run periodicals were "like products" (Art. III:2, first sentence). The Appellate Body concluded that the Excise Tax Act was inconsistent with Art. III:2, second sentence, because • imported split-run periodicals were "directly competitive or substitutable" with domestic non-split-run periodicals; • imported and domestic products were not similarly taxed; • the tax was applied so as to afford protection to domestic products.
Indonesia – Autos (1997) (DS54, 55, 59, 64)	(i) "The 1993 Programme" that provided import duty reductions or exemptions on imports of automotive parts based on the local content percent; (ii) "The 1996 National Car Programme" that provided various benefits such as luxury tax exemption or import duty exemption to qualifying (local content and etc.) cars or Indonesian car companies.	The Panel found that the sales tax benefits under the measures violated both Art. III:2, first and second sentences. The Panel noted that, under the Indonesian car programmes, • an imported motor vehicle would be taxed at a higher rate than a like domestic vehicle; • any imported vehicle would not be taxed similarly to a directly competitive or substitutable domestic car.
Korea – Alcoholic Beverages (1997) (DS75, 84)	Korea's tax regime for alcoholic beverages, which imposed different tax rates for various categories of distilled spirits.	The Appellate Body upheld the Panel's conclusion that Korean tax measures at issue were inconsistent with Art. III:2, second sentence. More specifically, the Appellate Body upheld the Panel's findings that, within the meaning of Art. III:2, second sentence, • the products at issue were "directly competitive or substitutable"; • Korea's tax measures on alcoholic beverages were applied "so as to afford protection" to domestic production.
Chile – Alcoholic Beverages (1998) (DS87, 110)	Chile's tax measures that imposed an excise tax at different rates – depending on the type of product (pisco, whisky, etc.) under the "Transitional System" and according to the degree of alcohol content (35°, 36°,...,39°) under the "New Chilean System".	The Appellate Body upheld the Panel's finding that Chile's new tax regime for alcoholic beverages violated the national treatment principle under Art. III:2, second sentence. The Appellate Body agreed with the Panel that imported distilled spirits and Chilean pisco, as directly competitive and substitutable products, were not similarly taxed since the tax burden (47 per cent) on most of imported products (95 per cent of imports) would be heavier than the tax burden (27 per cent) on most of the domestic products (75 per cent of domestic production).
Argentina – Hides and Leather (1999) (DS155)	(i) Argentine regulations by which representatives of the Argentine leather tanning industry were present during the customs clearance process for bovine hides export; (ii) advance tax payments that allegedly imposed a higher tax burden on imports.	The Panel concluded that the requirements were in violation of Art. III:2, first sentence, as advance tax payment requirements were financial burdens that taxed imports in excess of domestic products, in the form of an opportunity cost (interest lost) and a debt financing (interest paid).
Mexico – Taxes on Soft Drinks (2004) (DS308)	Mexico's tax measures under which soft drinks using non-cane sugar sweeteners were subject to 20 per cent taxes on (i) their transfer and importation and (ii) specific services provided for the purpose of transferring soft drinks and bookkeeping requirements.	The Panel found that • the tax measures for soft drinks sweetened with HFCS were inconsistent with Art. III:2, first sentence, as these drinks were subject to internal taxes (20 per cent transfer and services taxes) in excess of taxes imposed on like domestic products (i.e., soft drinks sweetened with cane sugar); • the tax measures for non-cane sugar sweeteners such as HFCS were inconsistent with Art. III:2, second sentence, as "the dissimilar taxation (i.e., 20 per cent transfer and services taxes)" imposed on "directly competitive or substitutable imports (HFCS) and domestic products (cane sugar)" was applied in a way that afforded protection to domestic production.
China – Auto Parts (2006) (DS339, 340, 342)	Three legal instruments enacted by China which impose a 25% "charge" on imported auto parts "characterized as complete motor vehicles" based on specified criteria and prescribe administrative procedures associated with the imposition of that charge.	The Appellate Body upheld the Panel's findings that the measures violated Art. III:2 because they imposed an internal charge on imported auto parts that was not imposed on like domestic auto parts.
Thailand – Cigarettes	Thailand's customs and tax measures.	The Appellate Body upheld the Panel's finding that Thailand acted inconsistently with Art. III:2, first sentence. Thailand's measure subjected resellers of imported cigarettes to VAT if they did not satisfy conditions for

(Philippines) (2008) (DS371)		obtaining input tax credits necessary to achieve zero VAT liability; resellers of like domestic cigarettes were not subject to VAT liability by reason of a complete exemption from VAT. The fact that resellers of imported cigarettes could take action to achieve zero VAT liability under Thailand's measure did not preclude a finding of inconsistency.
Philippines – Distilled Spirits (2010) (DS396, 403)	Philippines excise tax on distilled spirits, which imposed different tax rates depending on the raw material used to make the spirit.	The Appellate Body upheld the Panel's findings that • each type of imported distilled spirit at issue in this dispute (gin, brandy, vodka, whisky, and tequila) made from non-designated raw materials was "like" the same type of domestic distilled spirit made from designated raw materials, within the meaning of Art. III:2, first sentence; • the Philippines, through its excise tax, had subjected specific types of imported distilled spirits to internal taxes in excess of those applied to like domestic spirits of the same type made from designated raw materials in violation of Art. III:2, first sentence; • the Philippines, through its excise tax, had applied dissimilar internal taxes on domestic and imported distilled spirits in a manner so as to afford protection to the domestic production of distilled spirits in violation of Art. III:2, second sentence (domestic distilled spirits made from designated raw materials and imported distilled spirits made from other raw materials were found to constitute directly competitive or substitutable products).

*__Relevant Sections of Article III__: **Art. III:1** – "The contracting parties recognize that internal taxes and other internal charges, and laws, regulations and requirements affecting the internal sale, offering for sale, purchase, transportation, distribution or use of products, and internal quantitative regulations requiring the mixture, processing or use of products in specified amounts or proportions, should not be applied to imported or domestic products so as to afford protection to domestic production." **Art. III: 2 1st** (first sentence) – "The products of the territory of any contracting party imported into the territory of any other contracting party shall not be subject, directly or indirectly, to internal taxes or other internal charges of any kind in excess of those applied, directly or indirectly, to like domestic products." **Art. III: 2 2nd** (second sentence) – "Moreover, no contracting party shall otherwise apply internal taxes or other internal charges to imported or domestic products in a manner contrary to the principles set forth in paragraph 1."

__Sources__: (**1**) http://www.wto.org/english/res_e/booksp_e/gatt_ai_e/art3_e.pdf; (**2**) http://www.wto.org/english/res_e/booksp_e/dispu_settl_1995_2012_e.pdf.

TABLE 2. Summary of Article XX (GATT) Disputes from 1995 to 2012.

DISPUTE Short Title (Year) (Dispute No.)	**MEASURE AT ISSUE**	**KEY FINDINGS**
US – Gasoline (1995) (DS2)	The "Gasoline Rule" under the US Clean Air Act that set out the rules for establishing baseline figures for gasoline sold on the US market (different methods for domestic and imported gasoline), with the purpose of regulating the composition and emission effects of gasoline to prevent air pollution.	The Appellate Body modified the Panel's reasoning and found that the measure was "related to" (i.e., "primarily aimed at") the "conservation of exhaustible natural resources" and thus fell within the scope of Art. XX(g). However, the measure was still not justified by Art. XX because the discriminatory aspect of the measure constituted "unjustifiable discrimination" and a "disguised restriction on international trade" under the chapeau of Art. XX.
Canada – Periodicals (1996) (DS31)	(i) Tariff Code 9958, which prohibited the importation into Canada of any periodical that was a "special edition"; (ii) the Excise Tax Act, which imposed, in respect of each split-run edition of a periodical, a tax equal to 80 per cent of the value of all the advertisements contained in the split-run edition; (iii) the postal rate scheme under which different postal rates were applied to domestic and foreign periodicals.	The Panel found that Tariff Code 9958, which prohibited the importation of certain periodicals, violated Art. XI, and was not justified under Art. XX(d) because it could not be regarded as a measure to secure compliance with Canada's Income Tax Act.
US – Shrimp; US – Shrimp (1997) (DS58)	US import prohibition of shrimp and shrimp products from non-certified countries (i.e., countries that had not used a certain net in catching shrimp).	The Appellate Body held that, although the US import ban was related to the conservation of exhaustible natural resources and, thus, covered by Art. XX(g) exception, it could not be justified under Art. XX because the ban constituted "arbitrary and unjustifiable" discrimination under the chapeau of Art. XX.
EC – Asbestos (1998) (DS135)	France's ban on asbestos (Decree No. 96-1133).	The Appellate Body agreed with the Panel that the measure protected "human life or health" and that "no reasonably available alternative measure" existed and upheld the finding that the ban was justified as an exception under Art. XX(b). The Panel also found that the measure satisfied the conditions of the Art. XX chapeau, as the measure neither led to arbitrary or unjustifiable discrimination nor constituted a disguised restriction on international trade.
Argentina – Hikes and Leather (1999) (DS155)	(i) Argentine regulations by which representatives of the Argentine leather tanning industry were present during the customs clearance process for bovine hides export; (ii) advance tax payments that allegedly imposed a higher tax burden on imports.	Although the Panel found that the measures were necessary to secure compliance with Argentina's tax law and, thus, fell within the terms of Art. XX(d), it concluded that they could not be justified because they resulted in "unjustifiable discrimination" under the chapeau of Art. XX when they were not "unavoidable" for the operation of Argentina's tax law and when there were several alternative measures available.
Korea – Various Measures on Beef (1999) (DS161, 169)	(i) Korea's measures affecting the importation, distribution, and sale of beef; (ii) Korea's "dual retail system" for sale of domestic imported beef; (iii) Korea's agricultural domestic support programmes.	The Appellate Body upheld the Panel's finding that the dual retail system was not justified as a measure necessary to secure compliance with Korea's Unfair Competition Act because the dual retail system was not "necessary" within the meaning of Art. XX(d). The Appellate Body agreed with the Panel that Korea failed to demonstrate that it could not achieve its desired level of enforcement using alternative measures.
US – Shrimp (Article 21.5 Malaysia) (2000) *(DS58)*	Revised Guidelines for the Implementation of Section 609, under which certain countries were exempt from the import prohibition on shrimp pursuant to the criteria provided therein.	The Appellate Body upheld the Panel's finding that Section 609, as implemented by the revised guidelines and as applied by the United States, was justified under Art. XX(g) as (i) it related to the conservation of exhaustible natural resources as set out in Art. XX(g) and (ii) it met the conditions of the chapeau of Art. XX when applied in a manner that no longer constituted a means of arbitrary discrimination as a result of (i) the serious, good faith efforts made by the United States to negotiate an international agreement and (ii) the new measure allowing "sufficient flexibility" by requiring that other Members' programmes simply be "comparable in effectiveness" to the US programme, as opposed to the previous standard that they be "essentially the same". In this regard, the Appellate Body rejected Malaysia's contention and agreed with the Panel that the United States had only an obligation to make best efforts to negotiate an international agreement regarding the protection of sea turtles, not an obligation to actually conclude such an agreement because all that was required of the United States to avoid "arbitrary or unjustifiable discrimination" under the chapeau was to provide all exporting countries "similar opportunities to negotiate" an international agreement.
Canada – Wheat Exports and Grain Imports (2003) (DS276)	Canadian Wheat Board ("CWB") Export Regime and requirements related to the import of grain into Canada.	The Panel found that Sections 57(c) and 56(1) of the Canada Grain Act were inconsistent with Art. III:4 and were not justified under Art. XX(d) as a measure necessary to secure compliance with Canada's laws and regulations.
Dominican Republic – Import and Sale of Cigarettes (2004)	Dominican Republic's general measures relating to import charges and fees and other measures specific to import and sale of cigarettes.	The Appellate Body upheld the Panel's finding that the tax stamp requirement was not "necessary" within the meaning of Art. XX(d) and was thus not justified under the provision.

(DS302)		
Mexico – Taxes on Soft Drinks (2004) (DS308)	Mexico's tax measures under which soft drinks using non-cane sugar sweeteners were subject to 20 per cent taxes on (i) their transfer and importation and (ii) specific services provided for the purpose of transferring soft drinks and bookkeeping requirements.	The Appellate Body upheld the Panel's finding that Mexico's measures, which sought to secure compliance by the United States with its obligations under the NAFTA, did not constitute measures "to secure compliance with laws or regulations" within the meaning of Art. XX(d).
Brazil – Retreated Tires (2005) (DS332)	(i) Brazil's import prohibition on retreaded tyres ("Import Ban"); (ii) fines on importing, marketing, transportation, storage, keeping or warehousing of retreaded tyres; (iii) Brazilian state law restrictions on the marketing of imported retreaded tyres; (iv) exemptions of retreaded tyres imported from Mercosur countries from the Import Ban and fines ("MERCOSUR exemption").	The Appellate Body upheld the Panel's findings that the Import Ban was provisionally justified as "necessary" within the meaning of Art. XX(b) and that none of the less trade-restrictive alternatives suggested by the European Communities constituted "reasonably available" alternatives to the Import Ban. The Appellate Body reversed the Panel's findings that the MERCOSUR exemption and imports of used tyres through court injunctions (i) would not result in the Import Ban being applied in a manner that constituted "arbitrary discrimination" and (ii) would lead to "unjustifiable discrimination" and a "disguised restriction on international trade" only to the extent that they resulted in import volumes that would significantly undermine the achievement of the objective of the Import Ban. The Appellate Body found that the MERCOSUR exemption, as well as the imports of used tyres under court injunctions, had resulted in the Import Ban being applied in a manner that constituted arbitrary or unjustifiable discrimination and a disguised restriction on international trade within the meaning of the chapeau of Art. XX. The Appellate Body thus upheld, albeit for different reasons, the Panel's finding that the Import Ban was not justified under Art. XX. Having found that the Import Ban could not be justified by Art. XX(b), the Panel also found that the fines could not be justified under Art. XX(d) since they did not fall within the scope of measures that were designed to secure compliance with "laws or regulations that are *not themselves inconsistent* with" some provision of the GATT.
China – Auto Parts (2006) (DS339, 340, 342)	Three legal instruments enacted by China which impose a 25% "charge" on imported auto parts "characterized as complete motor vehicles" based on specified criteria and prescribe administrative procedures associated with the imposition of that charge.	The Panel rejected China's defence of its measures under Art. XX(d) because China had not proven that the measures were "necessary to secure compliance" with its Schedule.
US – Shrimp (Thailand), US – Custom Bond Directive (2006) (DS343, 345)	The enhanced continuous bond requirement (the "EBR").	The Appellate Body upheld the Panel's finding that the EBR was not "necessary" to secure compliance with certain United States "laws and regulations" governing the final collection of anti-dumping duties since the United States had not demonstrated that the margins of dumping were likely to increase resulting in significant additional unsecured liability. Consequently, the Appellate Body did not find it necessary to express a view whether a defence under Art. XX(d) was available in respect of a measure that had been found to be inconsistent with ADA Art. 18.1 and GATT Ad Art. VI, paras. 2 and 3.
China – Publications and Audiovisual Products (2007) (DS363)	A series of Chinese measures regulating activities relating to the importation and distribution of certain publications and audiovisual entertainment products.	The Appellate Body found that, by virtue of the introductory clause of para. 5.1 of China's Accession Protocol, China could, in this dispute, invoke Art. XX(a) to justify provisions found to be inconsistent with China's trading rights commitments under its Accession Protocol and Working Party Report. The Appellate Body upheld the Panel's conclusion that China had not demonstrated that the relevant provisions were "necessary" to protect public morals and that, as a result, China had not established that these provisions were justified under Art. XX(a).
China – Raw Materials (2009) (DS394, 395, 398)	Export restraints imposed on the different raw materials: (i) export duties; (ii) export quotas; (iii) export quotas management; (iv) minimum export price requirements; (v) export licensing requirements; (vi) administration and publication of trade regulations. The complainants identified 40 specific Chinese measures in connection with their claims.	The Appellate Body upheld the Panel's finding that there was no basis in China's Accession Protocol to allow the application of Art. XX to China's obligations under para. 11.3 of the Protocol. The Panel had concluded that China's export restraints were not justified pursuant to Arts. XX(b) and (g).

*__Relenant Sections of Article XX__: **Art. XX (Chapeau, a, b, d, and g)** – "Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade, nothing in this Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures: (a) necessary to protect public morals; (b) necessary to protect human, animal or plant life or health; (d) necessary to secure compliance with laws or regulations which are not inconsistent with the provisions of this Agreement, including those relating to customs enforcement, the enforcement of monopolies operated under paragraph 4 of Article II and Article XVII, the protection of patents, trade-marks and copyrights, and the prevention of deceptive practices; (g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption;"

__Sources__: (**1**) http://www.wto.org/english/res_e/booksp_e/gatt_ai_e/art20_e.pdf; (**2**) http://www.wto.org/english/res_e/booksp_e/dispu_settl_1995_2012_e.pdf.

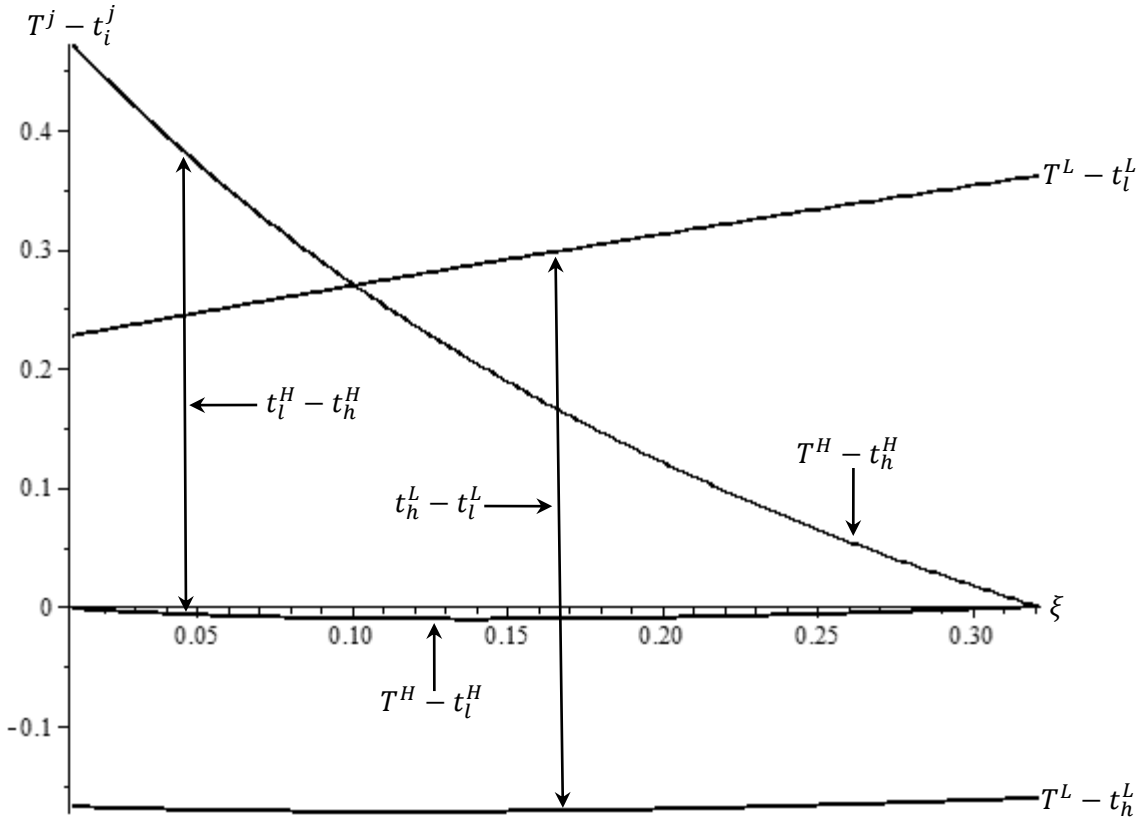

Figure 1a. Taxes: NT versus No NT (high-quality polluting case), $s_l = 1$ and $s_h = 1.5$.

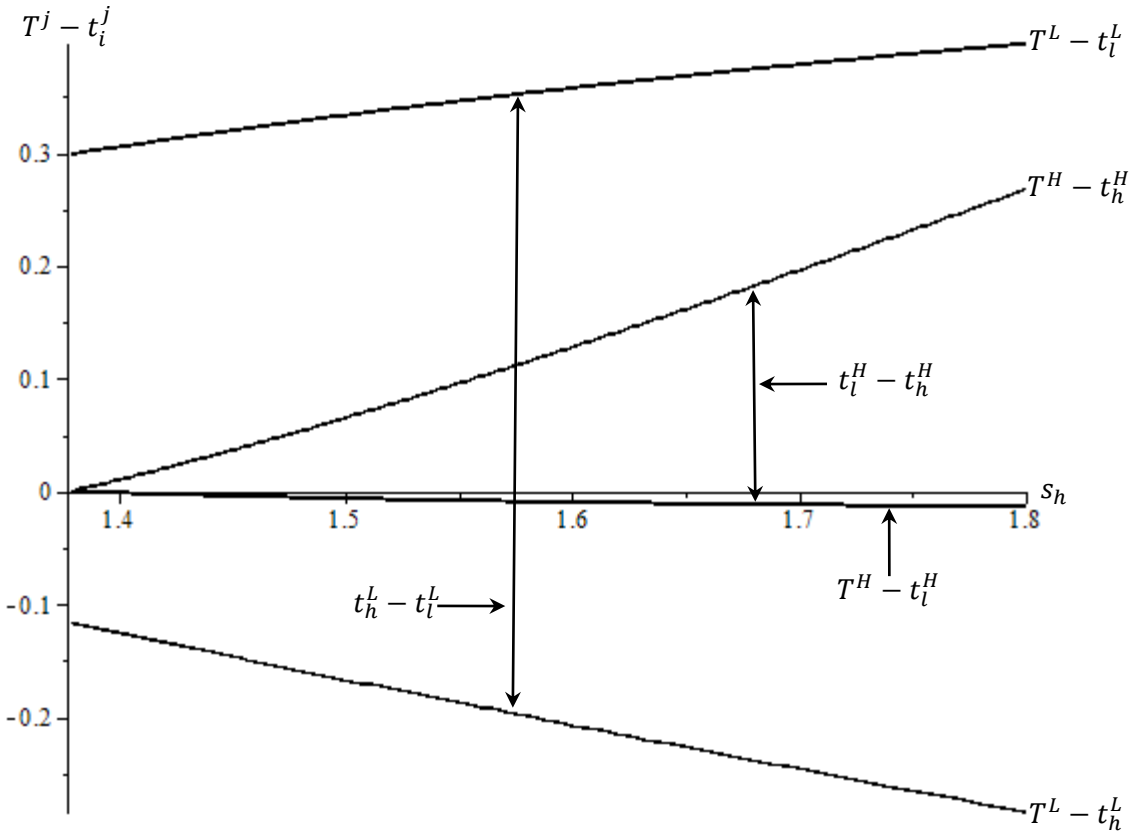

Figure 1b. Taxes: NT versus No NT (high-quality polluting case), $s_l = 1$ and $\xi = 0.25$.

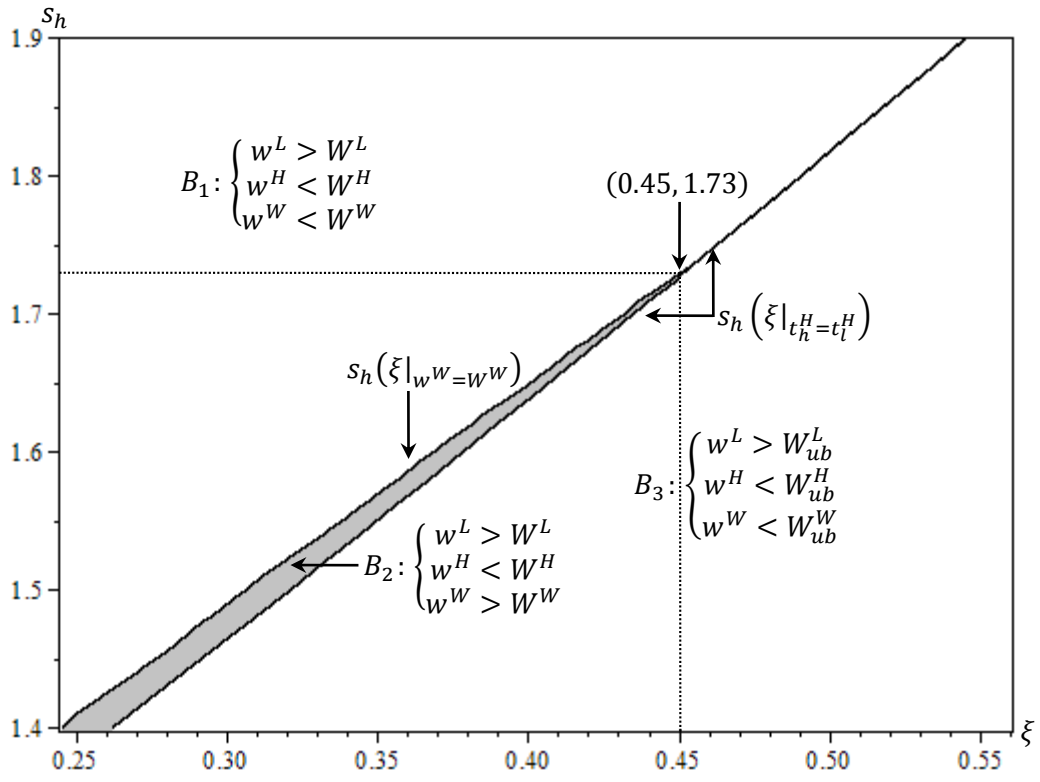

Figure 2. Welfare: NT versus No NT (high-quality polluting case), $s_l = 1$.

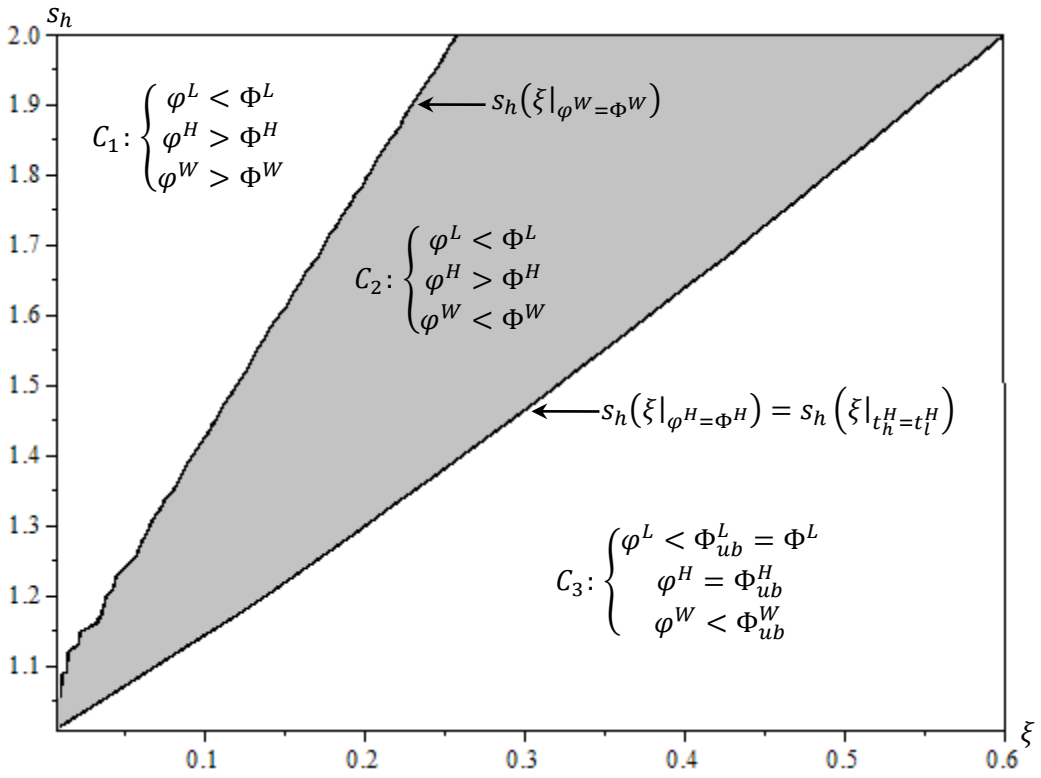

Figure 3. Environmental Damages: NT versus No NT (high-quality polluting case), $s_l = 1$.

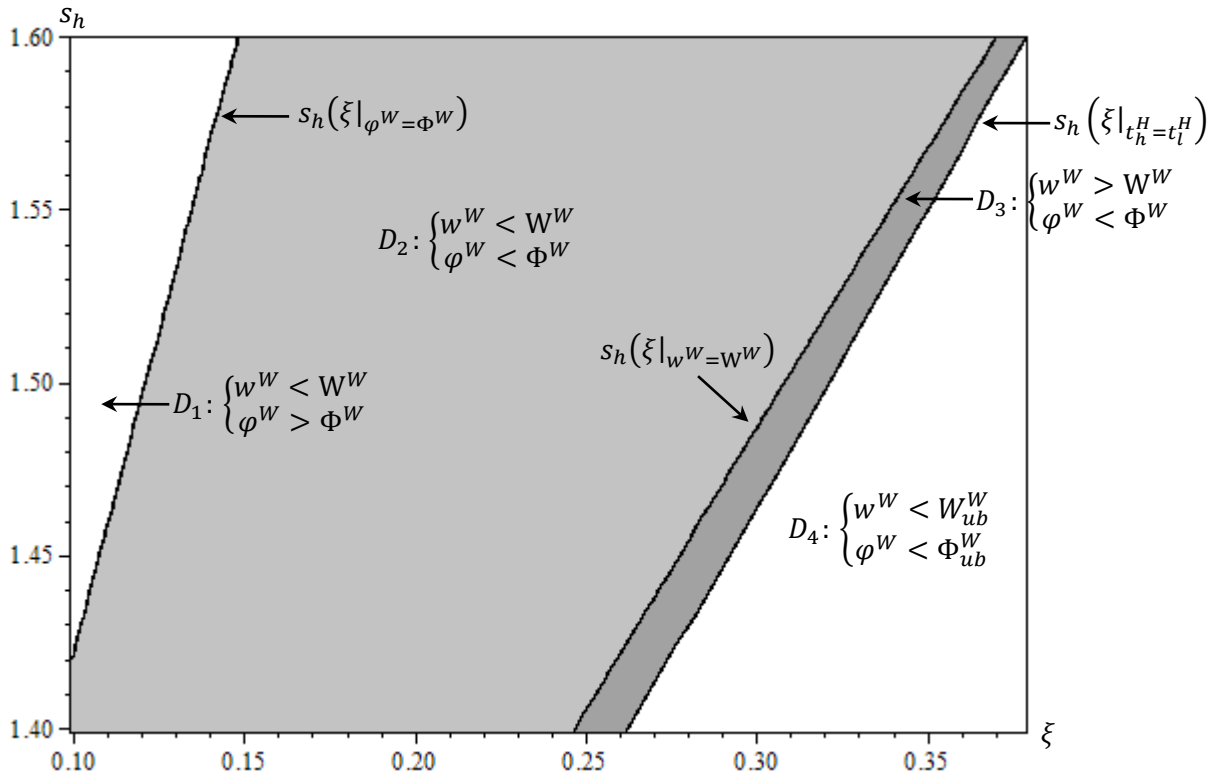

Figure 4. Global Welfare and Environmental Damages: NT versus No NT (high-quality polluting case), $s_l = 1$.

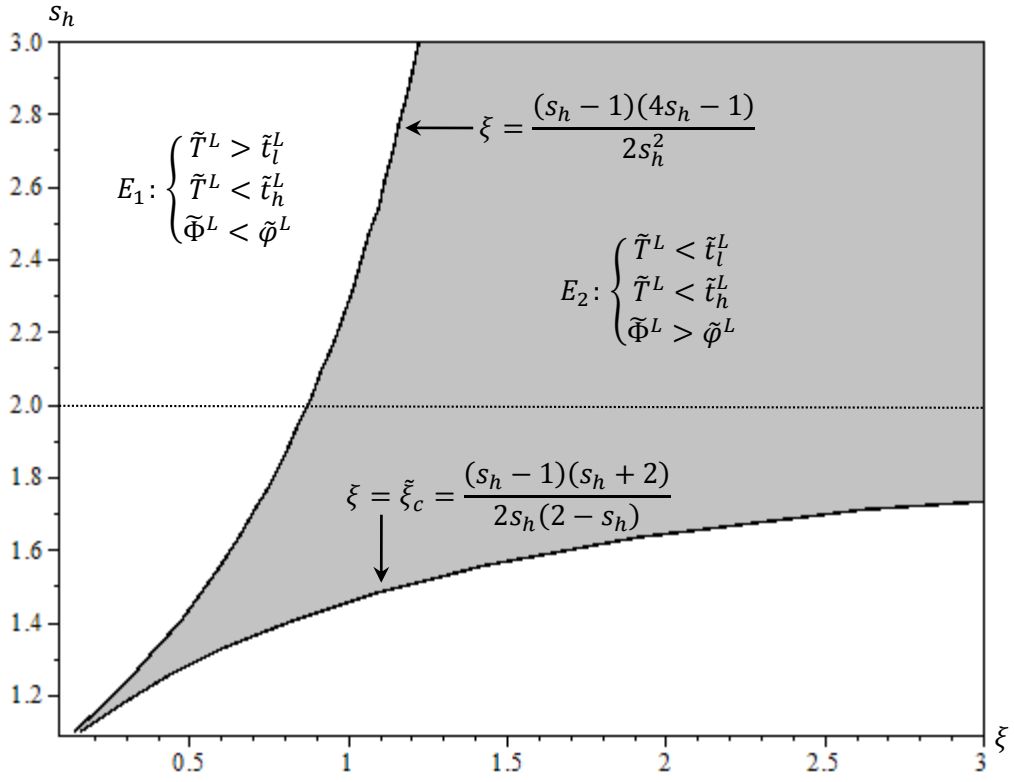

Figure 5. Taxes: NT versus No NT (low-quality polluting case), $s_l = 1$ ($\tilde{T}^H > \tilde{t}_l^H > \tilde{t}_h^H$ everywhere).

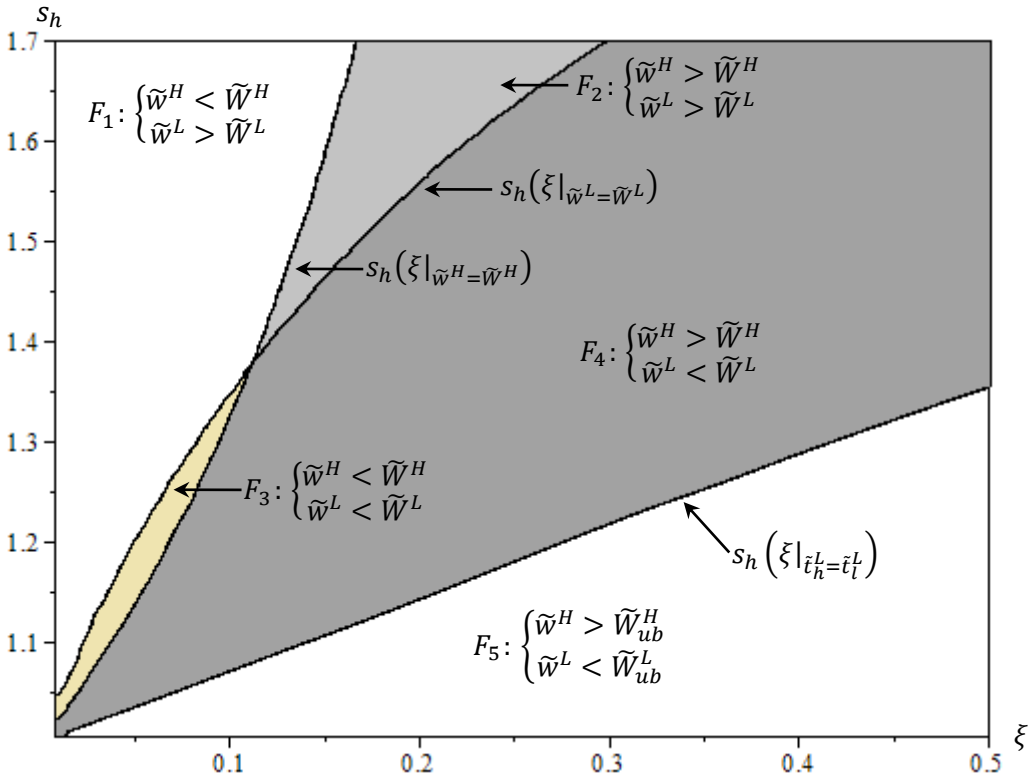

Figure 6a. Welfare: NT versus No NT (low-quality polluting case), $s_l = 1$ and $s_h < 2s_l$.

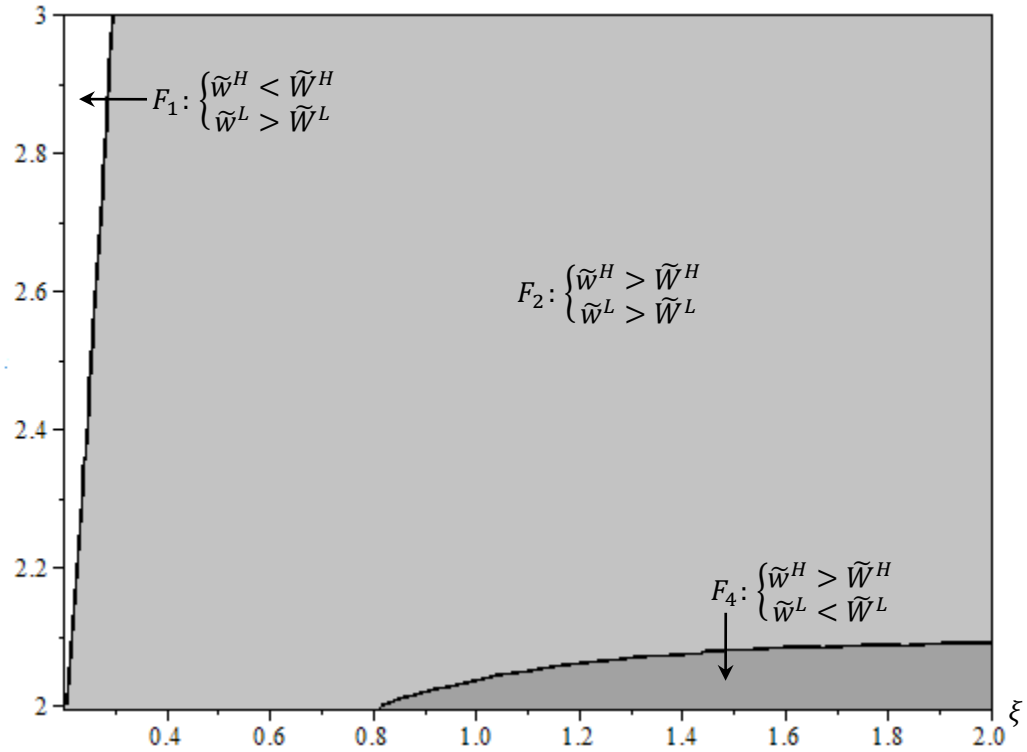

Figure 6b. Welfare: NT versus No NT (low-quality polluting case), $s_l = 1$ and $s_h \geq 2s_l$.

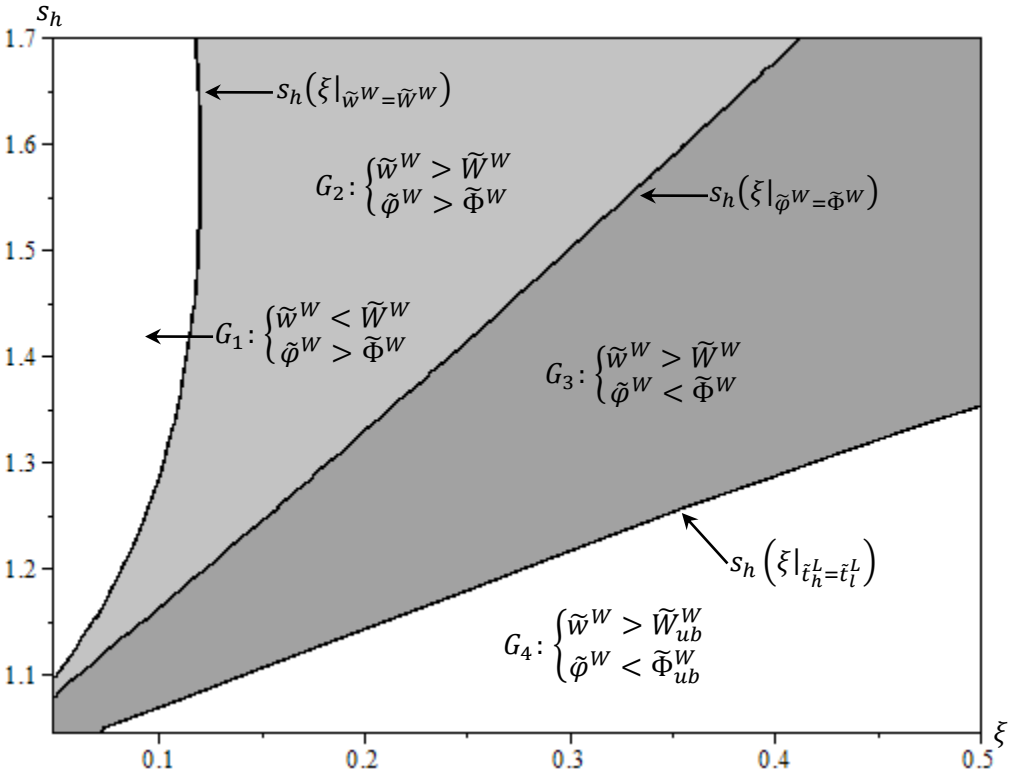

Figure 7. Global Welfare and Environmental Damages: NT versus No NT (low-quality polluting case), $s_l = 1$.

TABLE 3. Summary of the Effects of National Treatment.

		good *h* is dirty	**good *l* is dirty**
tax on good *h*	country *H*	+	+
tax on good *l*		–	+
market coverage		–	–
sales of good *h*		–	–
sales of good *l*		+	+
welfare		+	+ at low ξ; – otherwise
environmental damages		–	+
tax on good *h*	country *L*	–	+
tax on good *l*		+	+ at low ξ; – otherwise
market coverage		–	+ at low ξ; – otherwise
sales of good *h*		+	+
sales of good *l*		–	–
welfare		–	+ at intermediate ξ; – otherwise
environmental damages		+	– at low ξ; + otherwise
welfare	world	+ at low ξ; – at high ξ	+ at low ξ; – at high ξ
environmental damages		– at low ξ; + at high ξ	– at low ξ; + at high ξ
welfare (*W*) & environment (*E*)		• both improve at low ξ • both worsen at high ξ • *W* improves while *E* worsens at intermediate ξ • *W* improves while *E* worsens at high ξ under partially binding NT	• both improve at low ξ • both worsen at high ξ • *W* worsens while *E* improves at intermediate ξ • both worsen at high ξ under partially binding NT