Environmental standards under deep trade agreements

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Abstract

After decades of gradual reductions in global average tariff rates, the focus of trade negotiations has shifted from shallow trade agreements that mainly aim at cutting import tariffs towards deep trade agreements that focus on harmonizing other trade-affecting regulation between countries. We build a theoretical model to analyze how domestic environmental regulation responds to such gradual deepening of trade relations. We show that the optimal domestic policy is less stringent under deep than shallow trade agreements, and that full harmonization of regulation between countries opens up new avenues for strategic behaviour when countries differ in size or in their exposure to the environmental externality. Finally, we will extend the model to analyze whether deep trade integration increases the incentives of special interest groups to exercise their lobbying power.

Keywords: Tariffs; Environmental externality; Product standards; Intra-industry trade; Cournot competition;

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1 Introduction

The multilateral trade rules signed under the WTO/GATT framework have been a major driver of economic integration during the past decades. A key outcome of this process has been the continuous decline in global average tariff rates. However, as import tariffs have gradually diminished, regulatory differences between countries have emerged as the most important barrier to international trade. These non-tariff barriers include all differences between domestic and foreign market regulation that restrict trade and investment, such as gaps in minimum food safety standards or different particle emissions caps for vehicles. These differences in regulation have grown more important relative to the declining tariffs, but erecting such barriers has also become an actively used trade policy tool for governments. According to the Global Trade Alert Database, the number of non-tariff measures in force has soared from less than 400 in 2009 to more than 2400 in 2016.

As the nature of trade barriers has changed, so too have the international trade negotiations. In particular, the focus of trade talks has shifted from multilateral *shallow agreements* that mainly aim at cutting import tariffs towards bilateral *deep agreements* where countries try to harmonize their domestic regulation in any policy areas with a direct link to international trade. The EU has been particularly active in promoting bilateral trade talks, recently signing agreements such as the Comprehensive Economic and Trade agreement (CETA) with Canada and a similar deal with the Latin-American Mercosur-bloc. Whereas in 1990 there were globally 16 deep trade agreements in force, by 2015 the number had increased to 260 (Claudia et al., 2017).

Several factors have contributed to the shift from multilateral shallow trade agreements to bilateral deep agreements. First, international trade has changed drastically since the The General Agreement on Tariffs and Trade (GATT) was signed in 1947. Trade flows are increasingly based on services and intangible goods for which the conventional trade policy tools like import tariffs and export subsidies are harder to implement. Second, since decisions at the WTO are based on a consensus between its more than 160 member countries, agreeing on complex regulatory questions has become increasingly difficult. Indeed, the WTO negotiations have been virtually in a deadlock since the beginning of the Doha negotiation round in 2001. To pursue their objectives

in international trade policy, many countries have seen bilateral talks outside the conventional WTO framework as a promising avenue.

The deep trade integration, however, does not come without concerns. An often stated issue is that the attempt to harmonize regulation between two countries could dilute domestic environmental standards, consumer rights, and labour codes as countries struggle to remain competitive against their foreign rivals (see e.g. Prakash and Potoski (2006)). From the political economy point of view, on the other hand, there is a fear that deep trade integration might increase the influence of lobbyists and special interest groups, who could benefit from the use of domestic regulation as hidden, secondary protectionist measures (Rodrik, 2018). The reason for this is that while tariffs are clearly observable and undeniably protectionist, the stringency of domestic regulation can be adjusted based on more opaque domestic public policy concerns. This makes it difficult to distinguish whether the intention of a policy measure (such as a ban on the imports of hormone-treated beef) is purely protectionist, or based on an actual public policy concern within a given country.

In this paper, we build a theoretical model of international trade to analyze some of these concerns. We first model the shift from shallow towards deep trade agreements under imperfect competition and study how the optimal domestic regulation responds to the changing trade regime. Imperfect competition is an important feature of the model since it gives rise to intra-industry trade even between two perfectly identical countries. Deep trade agreements are frequently signed between highly industrialized countries (e.g. between the EU and Canada), so we can assume the parties of the trade agreement to be symmetrical in many relevant aspects such as their production technology and their exposure to environmental externalities. In our model, two symmetrical countries trade with an exogenously specified tariff rate. Both countries have one policy variable at their disposal: a minimum product standard for all goods consumed within their borders. That is, the policy set by home country determines minimum standards for the domestic market supply of domestic firms, as well as for the export supply of foreign firms.

Finally, we extend our basic model to the question of lobbying. In particular, we are interested in how the deepening trade integration affects firms and profits within

each country, and whether or not the changing trade environment brings about new lobbying opportunities for special interest groups. Although the focus of this paper is mainly on the relationship between international trade agreements and environmental regulation, the approach lends itself to a broader range of topics as well, such as data protection standards and labour market rules.

The impacts of international trade on optimal domestic regulation have been extensively studied, particularly in the environmental economics literature. A common finding is that if a country has firms competing in the international markets, under certain conditions the policymaker has an incentive to cut back domestic environmental regulation as an implicit export subsidy for the domestic producers. Barrett (1994) discusses the issue when the domestic policy tool is a product standard, and Kennedy (1994) finds similar results when the policy tool is a pollution tax. The results are, however, rather sensitive to the model specification on the type of competition, the number of firms assumed in each country, and the type of the externality that is being considered. Ederington and Minier (2003) provide empirical evidence of using domestic environmental policy as a secondary trade barrier.

A common framework to study the impact of trade liberalization is a Cournot-type competition model similar to Brander and Krugman (1983). Burguet and Sempere (2003) use this approach and show two opposite channels through which a bilateral tariff reduction can affect domestic environmental policies for two symmetric countries. First, a cut in tariffs boosts output and decreases prices in both countries, leading to a higher marginal environmental damage. This pushes the domestic government to implement more stringent environmental regulation. Simultaneously, however, a cut in tariff rates also implies lower tariff revenue and lower export costs, which makes exporting relatively more appealing to the policy maker. This creates an incentive to support domestic exporting firms with more lenient environmental rules. Depending on the available domestic environmental policy (tax, quota, or standard), the impact of trade liberalization on welfare and the stringency of regulation remains ambiguous.

In a similar setting with pollution taxes, import tariffs, and monopolistic competition, Tanguay (2001) studies the welfare impacts of trade liberalization and argues that freer trade must be welfare-decreasing. This is because after tariffs are removed,

pollution taxes by themselves are not enough to correct both for the negative pollution externality and the competition inefficiency arising from duopolistic trade. As a result, with fewer policy tools available, welfare with free trade is always lower than under restricted trade. Interestingly, the first-best outcome is then achieved when the countries set positive import tariffs and pollution taxes, cooperatively.

Several authors have also studied how the firm's incentive to collude and form international cartels changes with a bilateral liberalization of trade. Through collusion, firms can extract higher monopoly rents by agreeing not to supply the other country's market. Pinto (1986) is the first to extend the model of Brander and Krugman (1983) into a repeated game version. Their key finding is that with Cournot competition, collusion becomes harder to sustain under free trade because with lower trade costs the gains from invading the foreign market are larger. However, the result has been shown to be sensitive to the assumptions of competition type (Lommerud and Sørgard, 2001) and the degree of product differentiation (Ashournia et al., 2013).

Focusing on product standards as the domestic policy variable, Fischer and Serra (2000) show that the domestic firm can have an incentive to lobby also for more stringent minimum standards, as long as they are stringent enough to push the foreign rival out of the home market. Their model of two countries trading under Cournot competition is very similar to ours, but only focuses on strategic choices in one country. Essaji (2010) extends the paper by Fischer and Serra by adding tariffs as another endogenous policy variable. They show that the motives for the policymaker to adjust domestic regulation strategically with freer trade ultimately depends on the initial level of import tariffs. Finally, building on a Brander and Krugman (1983) -type model, Costinot (2008) compares the performance of two types of international institutions for standard setting: "National treatment" where both domestically produced and imported goods must be treated with similar regulation, and "Mutual recognition" where any good lawfully produced by any trading partner is also accepted to enter the domestic market. Whichever institution performs better ultimately depends on the level of externality related to the good in question.

This paper contributes to the existing literature by analyzing the impacts of trade integration on optimal domestic regulation under a range of possible levels of cooper-

ation, instead of focusing only on the cooperative and non-cooperative solutions. We also tailor our model and trade specifications to match the design and issues of deep trade agreements, which so far haven't received much attention in the literature.

The remainder of this paper is structured as follows. Chapter 2 sets out the modeling framework, and Chapter 3 uses this model to analyze different trade agreement designs. In Chapter 4, we extend the core model to the question of lobbying. Chapter 5 concludes the paper.

2 The Set-up

2.1 The Assumptions

We begin by setting up a simple model of international trade similar to Brander and Krugman (1983).

International trade. Consider two countries A and B. In each country, there are consumers consuming one homogeneous good. This good is produced in both countries. Firms can supply both markets at the same time. The two countries do not initially sign any trade agreements, and each country sets an exogenous tariff rate t_i on foreign imports. The tariff is assumed to be strictly positive in each country. The tariff is a trade-restrictive measure that generates tax revenues for the country that implements it.

Production and consumption. In each country, there is only one firm producing the good and supplying it to both markets. Denote by X_j^i the production by the firm in country i destined to market j and by Q_i be the total amount of goods available in market i. Put differently, $Q_A = X_A^A + X_A^B$ and $Q_B = X_B^B + X_B^A$. Demand in each market is characterized by the inverse demand function. The inverse demand function in country i is assumed to be linear and given by $p_i(Q_i) = a_i - Q_i$, where the demand parameter a_i can be interpreted either as the choke price or the market-size of country i. We assume that firms compete "à la Cournot".

The production technology and the costs. The marginal cost of production is assumed to be constant in output quantity. However, consumption of the good

generates a local negative externality. This externality can be reduced by imposing a minimum product standard $\mu_j \in [0, 1]$, which affects the unit production costs. Note that μ_j equal to 0 means that the production does not generate any externalities to the consumers and the regulation is as stringent as possible. Setting μ_j equal to 1, on the other hand, implies that the firm is required zero efforts to reduce the externality and the externality per unit of consumption is maximal. To be more precise, we assume that the cost function in country i takes the form $c_i(\mu_j) = \lambda - h_i\mu_j$. Intuitively, λ captures the cost of production when the standards are at the maximum level and there are no externalities remaining. On the other hand, h_i captures the marginal cost of improving standards (we assume $\lambda > h_i$ to ensure strictly positive costs). Moreover, in case that the level of regulation differs between the two countries, we assume that there are no additional costs for firms from producing two versions of the good under different levels of standards in order to supply both the domestic and export market simultaneously.

Minimum product standard. We assume that the consumers do not observe the production process and cannot distinguish between two products with different minimum standards. Then, in the absence of a policymaker, the firms will have no incentives to reduce the externality by producing at a higher level of standards. In order to give incentives to firms to reduce consumption externalities, each country implements a standard on the minimum level of externality that the product must satisfy, which is denoted by $\bar{\mu_j}$ for country j. Each country therefore controls the products sold and not the products produced within their borders by setting standards. The assumption that any country can specify the minimum standard for all goods consumed within its territory follows directly from the language employed in existing trade agreements. Here we assume that countries are free to treat imported goods with any regulation deemed necessary for either human or environmental well-being, as long as domestic producers also face the same requirements. Firms wishing to sell to a specific market must comply with the standards of the country involved. Moreover, as we have seen, firms have no incentive to produce better quality than that defined by the standard. Thus, a country's standard defines the production process used by firms selling on this market. We will later relax the assumption that the externality only stems from the consumption of the good and consider the case of a production externality.

Damages and welfare. As described earlier, consumption generates local damages. We assume that the damage function depends linearly on the quantity consumed so that the marginal damage is constant. Letting δ_i denote the constant marginal damage in country i, the damage function of country i is given by $D_i = \delta_i \mu_i Q_i$. Interpreting μ_i for instance as the unit emissions content of consuming a given good, $\mu_i Q_i$ simply gives the level of total emissions in each country. Our implicit assumption is that the marginal damages are relatively similar for the two countries. This implies assuming, for instance, that the consumers in both countries are to a similar degree harmed by small particle emissions from vehicles. Finally, the welfare in each country is assumed to be the sum of consumer surplus, the profits of the domestic firm and tariff revenue, less the damages from consumption. It is formally given by:

$$W_i = CS_i + \pi_i^i + \pi_j^i + t_i X_i^j - D_i, \ i \neq j \tag{1}$$

Timing. We solve the model as a two-stage game. In the first stage, the governments set their minimum standards. In the second stage, firms in both countries simultaneously choose their profit-maximizing output quantities for all markets.

In order to study the role of trade agreements as well as their different possible designs, we analyze and compare the four following scenarios:

1. **Business as usual:** An exogenous tariff is imposed between two trading countries, and both countries set their standards non-cooperatively.

2. **Shallow trade agreement:** Countries agree to eliminate all tariffs, but do not cooperate on standards. That is, countries still set their domestic regulation in isolation.

3. **Deep trade agreement with no regulatory convergence:** In addition to removing all tariffs, countries can also negotiate the stringency of their standards. They set domestic policies maximizing joint welfare, thereby taking into account the export sector in the foreign country.

4. **Deep trade agreement with full regulatory convergence:** In addition to removing all tariffs, there is a perfect harmonization of policies, so that both countries set equal standards maximizing their joint welfare.

2.2 Business as usual

Let us first focus on the business-as-usual case in which trade is allowed but there are no trade agreements in force and countries impose exogenous tariffs to the imports from the foreign country.

As explained above, regulation based on a minimum standard is binding and firms will not improve their products by more than what is required. Importantly, a stricter standard is not directly observed by the consumer and does not therefore affect demand. Therefore, the unit production cost for each firm i only depends on the level of the standard in force in the destination market j, μ_j. Remember that there are no additional costs for firms to produce two versions of the good with different levels of externality in order to supply both the domestic and export market. To conclude, the firm chooses the profit-maximizing output levels for domestic and export markets separately.

The profits of Firm A and Firm B are given by:

$$\pi^A(X_A^A, X_B^A) = [a_A - (X_A^A + X_A^B) - c_A(\mu_A)]X_A^A + [a_B - (X_B^B + X_B^A) - c_A(\mu_B) - t_B]X_B^A \tag{2}$$

$$\pi^B(X_A^B, X_B^B) = [a_A - (X_A^A + X_A^B) - c_B(\mu_A) - t_A]X_A^B + [a_B - (X_B^B + X_B^A) - c_B(\mu_B)]X_B^B \tag{3}$$

Each firm's profits are divided into two parts: (i) the profit made on the domestic market, where the product sold meets the standard imposed on that market, and (ii) the profit made on the export market, where the product sold meets the standard imposed by the foreign country. Firms therefore independently choose production for the domestic and export markets. One possible interpretation of the breakdown of profits is that in each country there is one company specialising in the domestic market and the other specialising in exports.

Each firm maximizes its profit by choosing production for the domestic and export markets. By studying the first-order conditions, we determine the best response func-

tions in each market.[1] We then determine Nash's equilibrium in each market.[2] The Cournot-Nash equilibrium quantities are given by:

$$X_A^A = \frac{1}{3}[a_A - 2c_A(\mu_A) + c_B(\mu_A) + t_A] \tag{4}$$

$$X_B^A = \frac{1}{3}[a_B - 2c_A(\mu_B) + c_B(\mu_B) - 2t_B] \tag{5}$$

$$X_A^B = \frac{1}{3}[a_A - 2c_B(\mu_A) + c_A(\mu_A) - 2t_A] \tag{6}$$

$$X_B^B = \frac{1}{3}[a_B - 2c_B(\mu_B) + c_A(\mu_B) + t_B] \tag{7}$$

Equilibrium production is positively dependent on market size a_i. A high tariff benefits the local producer in a market and disadvantages the exporter in that market. However, $\frac{\partial Q_i}{\partial t_i} < 0$, so that an increase in tariffs will lead to a reduction in the overall domestic supply, and also lead to higher prices p_i. Also note that whenever tariffs are below the trade-restricting level $t_i < \frac{1}{2}[a_i - 2c_j(\mu_i) + c_i(\mu_i)]$, both firms will supply both of the markets. Moreover, if the technological disadvantage of the home firm is sufficiently small and $c_i(\mu_i) < c_j(\mu_j) + \frac{t_i}{3}, i \neq j$, the domestic producer will have a larger share of the market.

Next we solve for the optimal domestic standard. Since the countries are perfectly symmetrical, we only present the main results in terms of country A for clarity. Solving for $\frac{\partial W_A}{\partial \mu_A} = 0$ gives the optimal standard:[3]

$$\bar{\mu}_A^{bau} = \frac{2(2h_A + h_B - 3\delta_A)(a_A - \lambda) + (h_A + 2h_B + 3\delta_A)t_A}{6(h_A + h_B)\delta_A - 3h_A^2 - 2h_A h_B - h_B^2} \tag{8}$$

We assume that $a_i - \lambda > 0$. Intuitively, this means that the market demand is higher than the cost of producing at the highest level of standards, so that firms will always

[1] We calculate the second derivatives of the profits which are equal to -2 and then strictly negative.

[2] The uniqueness of the equilibrium follows from the linear demand schedules.

[3] The second-order condition holds whenever $3h_A^2 + 2h_A h_B + h_B^2 < 6\delta_A(h_A + h_B)$, which we assume from here onward. This also gives a lower bound for the relationship between the unit damages δ_i and the marginal production costs h_i, and guarantees the denominator in equation 8 to be positive. An upper bound follows from assuming $2h_A + h_B - 3\delta_A \geq 0$, so that the optimal standard μ_i remains positive under all scenarios.

find it profitable to produce something and there is always some mark-up available in each market.

We use equation 8 to deduce the following lemma.

Lemma 1 *The optimal standards become more lenient with tariffs, i.e.* $\frac{\partial \bar{\mu}_i^{bau}}{\partial t_i} > 0$.

This result is particularly interesting. When tariffs are lowered, countries set more ambitious standards. The total output sold in a market decreases with the tariff. Reducing the tariff implies increasing sales in a market and thus increasing the total externality borne by consumers. Therefore, the regulator has a strict incentive to reduce the standard in order to reduce externalities. The two policy instruments are not directly comparable here because we consider only an exogenous tariff and an optimal standard. However, we consider the case where also an endogenous import tariff is set optimally later on in the section 3.5. Also, it is interesting to note that with purely local consumption externalities, the optimal domestic regulation does not depend on the standards chosen in the foreign country.

The result that the elimination of trade barriers always leads to more stringent domestic regulation is in contrast to some of the findings in the previous literature. This result hinges on model specifications such as the type of the externality, the available domestic policy instruments and the mode of competition. So far, we have only considered product (quality) standards with a purely local consumption externality. For instance in Barrett (1994), with standards on the domestic production *process*, the incentive to distort domestic standards downwards (the "environmental dumping effect") stems from the possibility to cut the domestic production costs and therefore subsidize the home firm relative to the foreign rival. Here, on the other hand, a reduction in domestic standards would also reduce the compliance costs in the rival country, and hence be less effective. The fact that the environmental externality stems from consumption instead of production, means that there is also a rent-shifting effect from foreign to home firms from setting stricter domestic standards.

Another factor at play here is the market failure arising from the imperfect competition. The situation is similar to the one presented in Lai and Hu (2008). A higher tariff barrier will increase domestic prices and reduce consumption, which would amplify the market failures of the duopoly market. One way around this is to cut production costs

by lowering the product standards. This also explains the opposite direction of movement for tariffs and optimal product standards.

We also note that the optimal standard depends negatively on the local marginal damage ($\frac{\partial \mu_i^{bau}}{\partial \delta_i} < 0$), so that higher damages, other things equal, always imply stricter standards. Finally, we consider the impact of production costs on the optimal standard. Intuitively, $\frac{\partial \mu_i^{bau}}{\partial h_i} > 0$, so that higher domestic compliance costs always imply more lenient domestic regulation.

3 The different designs of trade agreements

Let us detail and discuss the different designs of trade agreements. We start from a shallow (conventional) trade agreement where countries agree to cut tariff rates but do not cooperate on domestic regulation. Then we move to deep trade agreements in which countries set standards maximizing the joint-welfare. Two cases of deep agreements are also considered, one where the standards remain distinct between countries and one the countries set the same standard.

3.1 Shallow trade agreement

The first trade agreement scenario follows directly from the business as usual setting outlined in section 2.2. The difference between these two scenarios is simply that countries agree to exogenously remove their tariff barriers. The timing for the shallow trade agreement is as follows:

> **First stage:** Both governments set their optimal minimum standards maximizing their own welfare, as specified in equation 1.
>
> **Second stage:** Governments agree to remove tariff barriers and set $t_i = 0$ for $i = A, B$.
>
> **Third stage:** Firms in both countries simultaneously choose their profit-maximizing output quantities for all markets.

Solving for the optimal standard gives:

$$\bar{\mu}_A^{shallow} = \frac{2(2h_A + h_B - 3\delta_A)(a_A - \lambda)}{6(h_A + h_B)\delta_A - 3h_A^2 - 2h_A h_B - h_B^2} \tag{9}$$

Comparing equations 8 and 9, we immediately notice that $\bar{\mu}_A^{shallow} < \bar{\mu}_A^{bau}$ and deduce the following lemma.

Lemma 2 *The optimal minimum standard is more stringent under the shallow trade agreement than under business-as-usual.*

The optimal standard is more stringent under the (conventional) free trade agreement than under the baseline with no trade agreement in place. This follows directly from the substitutability between tariffs and standards: as shown in the business-as-usual setting, lower tariffs always imply stricter standards.

An important thing to note is that in this model of imperfect competition, even a cooperatively set tariff rate that maximizes joint welfare is not necessarily zero, as is often the case for perfectly competitive general equilibrium models. A positive tariff rate can be used by the policymaker not only to collect tax revenue but also to uphold the monopoly power of the domestic firm in home markets. However, a welfare-maximizing government might also choose to set negative tariffs in order to subsidize imports and thereby remedy the market failure that stems from imperfect competition.

3.2 Deep trade agreement with no regulatory convergence

Our second trade scenario models a deep trade agreement where countries also negotiate on their minimum product standards. Let us consider the joint welfare, which is the sum of the welfare of the two countries, and given by

$$W = W_A + W_B = CS_A + CS_B + \pi_A^A + \pi_B^A + \pi_B^B + \pi_A^B - D_A - D_B. \tag{10}$$

The timing of this game is as follows:

First stage: Both governments set their optimal minimum standards maximizing their joint welfare.

Second stage: Governments agree to remove tariff barriers and set $t_i = 0$ for $i = A, B$.

Third stage: Firms in both countries simultaneously choose their profit-maximizing output quantities for all markets.

What changes relative to the shallow trade agreement in the previous section is that the domestic policymaker now also takes into account the profits made by the foreign exporter, and how the domestic minimum standard affects the foreign profits. We again solve for $\frac{\partial W}{\partial \mu_i} = 0$, which gives:

$$\bar{\mu}_A^{deep} = \frac{2(2h_A + h_B - 3\delta_A)(a_A - \lambda)}{6(h_A + h_B)\delta_A - 3h_A^2 - 2h_A h_B - 3h_B^2} \tag{11}$$

Indeed, comparing equations, 9 and equation 11, we see that they only differ in terms of how sensitive the optimal standard is to the foreign production costs. We use this result to deduce the following lemma.

Lemma 3 *If the initial tariffs are sufficiently low, the optimal standard is less stringent under deep trade agreement with no regulatory convergence than under the business-as-usual setting. However, if the tariffs are sufficiently high, the optimal standard under deep trade agreement will be more stringent than under the business-as-usual.*
Proof. *See Appendix A.* ■

The intuition follows again directly from the substitutability between tariffs and standards as policy instruments. In the non-cooperative business-as-usual scenario, a country with high initial tariffs will choose lenient product standards. In a deep trade agreement, the relative strength of the standard depends on how much the standards tighten as a response to the removal of tariffs, and how much they are loosened when taking into account the foreign export sector profits.

3.3 Deep trade agreement with full regulatory convergence

In our third and final trade policy scenario, we consider a situation where the domestic standards are perfectly harmonized between the two countries. More precisely, we consider the following setup:

First stage: Both governments set the same product standard $\mu_A = \mu_B = \mu$ maximizing their joint welfare, as given in equation 10.

Second stage: Governments still agree to remove all tariff barriers and set $t_i = 0$ for $i = A, B$.

Third stage: Firms in both countries simultaneously choose their profit-maximizing output quantities for all markets.

Solving for $\frac{\partial W}{\partial \mu} = 0$ gives:

$$\bar{\mu}^{full} = \frac{[2h_A + 2h_B - 3\delta_A](a_A - \lambda) + [2h_A + 2h_B - 3\delta_B](a_B - \lambda)}{3(h_A + h_B)(\delta_A + \delta_B) - 3h_A^2 - 3h_B^2 - 2h_A h_B} \tag{12}$$

Interestingly enough, in this modeling framework, the deep trade agreement with full regulatory harmonization is the only scenario where the home country takes also the foreign damages δ_j into account. We then compare equations 8 and 12 and deduce the following lemma.

Lemma 4 *The optimal product standard is less stringent under a deep trade agreement with full regulatory convergence than under business-as-usual if either the initial tariffs are sufficiently low, the demand in home country relative to the foreign country is sufficiently high, or if the domestic environmental externality relative to the foreign externality is sufficiently low.*

3.4 Comparison of the different trade agreement designs

Next, we turn to the comparison of the different trade environments. In particular, we are interested in how the domestic welfare and the stringency of the standards change under different trade regimes.

Let us first focus on the stringency of the standards. We have already seen in Lemma 2 that moving from the business-as-usual to a shallow trade agreement makes the optimal standards more stringent. Next, we will compare equations 9 and 11 to compare the standards under the shallow trade agreement and the deep trade agreement with no regulatory convergence. The only change that takes place is the multiplier of the negative term for foreign production technology in the denominator. This gives us the straight-forward result that standards are less strict under deep than shallow types of trade agreements. That is, more formally, $\mu_i^{shallow} < \mu_i^{deep}$. The intuition behind

this result is clear: when moving from a shallow to a deep trade agreement, the only additional term that the domestic policymaker takes into consideration is the profits made by the foreign exporter, which depend on standards imposed in the home market. Thus, other things equal, these additional profits then makes the optimal standards less demanding.

Next we will turn to the comparison of the two types of deep trade agreements: the one where both countries set their own optimal domestic standards, and the one where standards are perfectly harmonized between the two countries. First note that when the countries are identical in demand and damages ($a_A = a_B = a$ and $\delta_A = \delta_B = \delta$), equations 11 and 12 perfectly coincide, and the optimal standards will be equal in the two versions of a deep trade agreement. Intuitively, this case would be equal to comparing the two scenarios for a single large country. For more heterogeneous countries, however, the shift towards perfect regulatory harmonization opens up new avenues for strategic behaviour.

First, we allow the demand parameters a_i to differ between the countries, but continue assuming that the marginal damages between the countries are equalized. In this case, we have that $\bar{\mu}_i^{deep} < \bar{\mu}^{full} < \bar{\mu}_j^{deep}$ for $a_i < a_j$. Intuitively, what this result says is that the country with a higher demand will want to make its domestic standards more stringent when moving towards the full harmonization of standards. Similarly, the country with a lower demand will end up loosening its domestic regulation. The reason for this is that the country with a stronger domestic demand can shift more burden of the regulatory hike to its trading partner, and be therefore relatively better off with a more stringent standard.

Then, we will analyze the outcome for countries that have identical demand parameters a, but differ in their marginal damages δ_i. Interestingly, the country with a smaller marginal damage will end up with a tighter regulation when moving towards the perfect harmonization of standards. In other words, $\bar{\mu}_i^{deep} < \bar{\mu}^{full} < \bar{\mu}_j^{deep}$ for $\delta_j < \delta_i$. The reason is intuitive. As discussed earlier in section 2.2, higher marginal damages δ_i always imply a stricter minimum standard μ_i. Then, other things equal, the country with higher marginal damages will have imposed stricter standards in the business-as-usual, for the shallow trade agreement as well as for the deep trade agreement with no

regulatory convergence. For the deep agreement with policy harmonization, however, countries will set a common standard that is between the values that the countries would set under no policy convergence. As a result, the standard for the country with low damages will get stricter, and the standard for the country with high damages will become more lenient.

To summarize our findings, we compare equations 9, 11 and 12 and deduce the following propositions.

Proposition 1 *The optimal standards are always more stringent under the shallow trade agreement than under the deep trade agreement with no regulatory convergence. On the other hand, the optimal standard for the deep agreement with full convergence can be either between the standards that the countries would impose for a deep agreement with no convergence, or it may be more stringent than either of the standards under deep agreement with no regulatory convergence.*

Proposition 2 *The welfare in both countries is always higher under a deep trade agreement with no regulatory convergence than under a shallow trade agreement. On the other hand, the welfare in both countries will be lower under the deep trade agreement with full regulatory convergence than under a deep trade agreement with no convergence.*

3.5 Discussion and robustness checks

We can now analyze the robustness of our results.

Endogeneous tariffs. Until now, we have assumed that each government fixes optimally the minimum product standard and that tariffs are exogenous. We relax this assumption and consider that each government fixes optimally the tariffs and the minimum product standard. The detailed calculations are presented in Appendix B. Relaxing this assumption does not qualitatively change the results. First, we note that under many parameter configurations, the results reproduce the gradual decrease in tariffs as the countries shift from the business-as-usual with no trade agreement in force towards the deeper versions of trade agreements. Interestingly, the optimal tariff for both of

the deep trade agreements are on the boundary of zero, as we assume tariffs to be non-negative. This is because the two governments maximizing joint welfare would prefer to set negative tariffs to subsidize imports, in order to curb the market failure stemming from the imperfect competition. The optimal standards follow the same pattern as seen before in the main part. In the business-as-usual scenario, both governments will set high tariffs which, as explained above, directly implies more lenient product standards. As tariffs are reduced to the shallow agreement, both countries will also strengthen their minimum product standard. However, in the deep trade agreements, as countries also consider the impact of domestic standards on foreign producers, the standards will be more lenient in deep trade agreements than under a shallow trade agreement.

Transportation costs. So far, we have assumed the existence of exogenous tariffs that generate tax revenues for countries. We now consider the presence of either transport costs or non-tariff restrictions. Governments are no longer able to collect tariff revenue, but that exporting to the foreign market still remains relatively more expensive for the firms than merely producing for the domestic markets. This change only affects the business-as-usual scenario, since in all of the trade agreement scenarios, the tariff rate was considered to be effectively zero. Repeating the calculation in section 2.2, the optimal minimum standard is then given by

$$\mu_A = \frac{2(h_A + h_B - 3\delta_A)(aA - \lambda) + t_A(h_A - h_B + 3\delta_A)}{6(h_A + h_B)\delta_A - 3h_A^2 - 2h_A h_B} \tag{13}$$

Comparing equations 8 and 13, we immediately notice that the minimum product standard is more stringent under the case where the government is not able to impose tariffs. The intuition is as follows: if a country can no longer impose tariffs, it will shift some of its trade policy goals to the environmental policy. Therefore, it will use the standard as a way of restricting the market entry of the foreign firms, and therefore set more stringent standards relative to the case where it is also able to use tariffs directly.

4 Extension: Lobbying

Next, we extend the model to study the question of lobbying. More precisely, we are interested in studying if the deepening trade integration increases the incentives for special interest groups to use their lobbying power, compared to the business-as-usual and the conventional shallow agreements. For now, we focus only on industrial lobbies that care about firm profits, but the analysis could also be extended to the viewpoint of, say, environmental lobbies.

Ex-ante, industrial lobbies could have several reasons for actively trying to influence the policymaker. They might want to lobby for more lenient standards to boost the profits of the firms, or they might try to lobby for stricter domestic policies to shut the foreign competitor out of the domestic market. Another reason might be reducing uncertainty over cost: in the current model setting, the costs of exporting are solely determined by a foreign policymaker. In order to reduce to volatility of production costs, firms might indeed prefer the full harmonization of policies, even if it makes the regulation more strict and therefore cuts profits.

First, it is useful to have a closer look at the total profits made by the firm in country i, which is the sum of profits made from the sales in domestic markets and the profits from exporting to the foreign market. Combined, the equilibrium profits of firm i are given by:

$$\frac{1}{9}[(a_i - \lambda + h_i\mu_i + t_i)^2 + (a_j - \lambda + h_i\mu_j - 2t_j)^2] \tag{14}$$

We note that domestic profits monotonically decrease in domestic and foreign standards as well as foreign tariffs, but monotonically increase in domestic tariffs. If we take changes in firm profits as a proxy for lobbying incentives, this already gives us some intuition on how the lobbies will behave under different trade environments.

The first thing to note is that although the shift from the business-as-usual to the shallow trade agreement increases welfare, it might well be detrimental to profits. Following the elimination of domestic tariffs and the tightening of domestic standards that follow, the profits made by the home firm in domestic markets will be strictly lower under the shallow trade agreement than under business-as-usual. The net impact on

export profits is positive only if the profit increase from decreasing foreign tariffs outweighs the cost increase from stricter foreign standards. If this is not the case, then profits will always be strictly lower under the shallow trade agreement relative to the business-as-usual, and firms will devote resources to have the policymaker not signing the trade agreement.

Next we will consider the movement from a shallow trade agreement to a deep trade agreement with no regulatory convergence. Since all tariffs are set to zero in both scenarios, the comparison of profits becomes straight-forward. That is, as the minimum product standards are relaxed in both markets, the profits made by the firms will be strictly higher, so firms will always prefer the deep trade agreement to the shallow agreement alternative.

5 Conclusion

Following the gradual reduction in global average tariff rates, other types of trade barriers (such as differences in minimum product standards across countries) have emerged as the most important barrier to international trade. This has also had an impact on the content of modern trade agreements. Whereas the focus of conventional *shallow* trade agreements has traditionally been on cutting import tariffs, the current *deep* trade agreements are aimed at smoothing out any regulatory differences that have a negative impact on trade.

We have constructed a theoretical model to analyze how domestic environmental standards respond to such changes in international trade policy regime. Our main findings are as follows: under a shallow trade agreement, countries have an incentive to use inefficiently strict environmental policies as a secondary trade barrier against foreign firms. A deep trade agreement where countries also negotiate on their environmental policies can ameliorate this issue. A full harmonization of standards, however, is likely to be welfare-decreasing as countries restrict themselves to using fewer policy instruments. Finally, we identify situations where firms and other special interest groups might use their lobbying power in order to impact the trade negotiations.

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A Proofs

Proof of Lemma 3

$\mu_i^{BAU} < \mu_i^{DEEP}$ if

$$t_i < \frac{2h_B[2h_A(h_B+3\delta_A)+h_B^2-3h_A^2](a_A-\lambda)}{(h_A+2h_B+3\delta_A)[6(h_A+h_B)\delta_A-3h_A^2-3h_B^2-2h_Ah_B]}$$

and $\mu_i^{BAU} > \mu_i^{DEEP}$ if

$$t_i > \frac{2h_B[2h_A(h_B+3\delta_A)+h_B^2-3h_A^2](a_A-\lambda)}{(h_A+2h_B+3\delta_A)[6(h_A+h_B)\delta_A-3h_A^2-3h_B^2-2h_Ah_B]}$$

For countries with identical production technology $h_A = h_B = h$, the above conditions simplify to

$$\mu_i^{BAU} < \mu_i^{DEEP} \text{ if } t_i < \frac{h\delta_i(a_i-\lambda)}{(h+\delta_i)(3\delta_i-2h)}$$

and

$$\mu_i^{BAU} > \mu_i^{DEEP} \text{ if } t_i > \frac{h\delta_i(a_i-\lambda)}{(h+\delta_i)(3\delta_i-2h)}$$

B Endogenous tariffs

Here we will consider a specification of our model where the policymaker in each country has two endogenous policy variables at disposal: import tariff t_i and a minimum product standard μ_i.

B.1 Business-as-usual

In the non-cooperative business-as-usual case, the domestic policymaker in each country sets optimal tariffs and product standards simultaneously. Formally, they solve: $\max W_i$ w.r.t. μ_i and t_i. This yields:

$$\mu_i = \frac{(5\delta - 7h)(a_i - \lambda)}{7h^2 + \delta^2 - 10\delta h} \qquad t_i = \frac{2\delta(\delta - 2h)(a_i - \lambda)}{7h^2 + \delta^2 - 10\delta h} \tag{15}$$

In the business-as-usual case with endogenous tariffs, the policymaker will then set both the trade policy variable and the minimum product standard to a strictly positive level.

B.2 Shallow trade agreement

The optimal trade and environmental policies under the Shallow agreement are determined in two steps. In this case, we assume that the countries cooperate only on the trade policy, but not on the environmental policy. In other words, countries first negotiate tariffs so as to solve $\max W$ w.r.t t_i. Then, countries set their standards maximizing their own welfare, $\max W_i$ w.r.t μ_i. The optimal policies are solved with backward induction, to capture the fact that countries negotiate their optimal tariffs knowing that they can modify the game in the second step using their environmental policy. This gives an optimal tariff of:

$$t_i = \frac{\delta(h^2 - 8\delta h + 6\delta^2)(a_i - \lambda)}{2h^3 + h^2\delta - 7h\delta^2 + 3\delta^3} \tag{16}$$

and an optimal domestic minimum standard of:

$$\mu_i = \frac{(9\delta^2 - 4h^2 - 7\delta h)(a_i - \lambda)}{2h(2h^3 + h^2\delta - 7h\delta^2 + 3\delta^3)} \tag{17}$$

In many parameter configuration, this replicates the results shown in the main part of the paper. That is, the shallow trade agreement makes optimal tariffs lower, but also the domestic minimum standard more stringent. However, the tariff in this case remains strictly positive.

B.3 Deep trade agreement with no regulatory convergence

For this trade agreement scenario, countries now maximize their joint welfare by setting their optimal domestic tariffs and minimum standards simultaneously. More formally, both countries simultaneously solve $\max W$ w.r.t. t_i and mu_i. This gives:

$$\mu_i = \frac{(3\delta - 4h)(a_i - \lambda)}{2h(2h - 3\delta)} \qquad t_i = 0 \tag{18}$$

An important thing to note is that in our model we assume tariffs t_i to be non-negative, and the result above is on the boundary. This follows from the imperfectly competitive markets, where each government would want to subsidize imports by a negative tariff, and thereby ameliorate the market imperfections and the too low home market supply.

B.4 Deep trade agreement with full regulatory convergence

Finally, we consider the trade agreement scenario where both available policies are fully harmonized between the countries, and both governments maximize welfare cooperatively. That is, $\mu_A = \mu_B = \mu$ and $t_A = t_B = t$. Then:

$$\mu_i = \frac{(3\delta - 4h)(a_B b_A + a_A b_B - \lambda(b_A + b_B))}{2h(2h - 3\delta)(b_A + b_B)} \qquad t_i = 0 \tag{19}$$

This produced the same result than the one presented in the main part of the paper, namely that when $a_A = a_B = a$, then $\mu_i^{FULL} = \mu_i^{DEEP}$. The solution for the optimal tariff still lies on the boundary, as it did in the case with no regulatory convergence.