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Trade Sanctions and Green Trade Liberalization[#]

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Abstract

This paper studies the impact of a WTO withdrawal of trade concessions against countries that fail to respect globally recognized environmental standards. We show that a punishing tariff can be effective when environmental and trade policies are endogenous. When required standards lie within a reasonable range, compliance along with free trade as a reward is the unique equilibrium outcome. A positive optimal tariff in the case of non-compliance prevents pollution-motivated delocation, but only works as a successful credible threat and does not emerge in equilibrium. Results are consistent with broad empirical evidence that disputes the pollution haven hypothesis and suggests capital movements to be non-pollution related.

JEL classifications: F13, F18, F23, H23, Q56, R38

Key words: environmental policy; WTO; delocation; tariffs; credible threat.

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1. Introduction

Rapid unforeseen changes in the climate are driving us towards a new era of environmental protection. With the consequences of global pollution growing more evident in recent years, the link between trade and environment is drawing greater attention from environmentalists, governments, and the private sector alike. More eyes are turning to the WTO with the vision of a global enforcement of environmental standards. Indeed, recent rounds have devoted greater attention to the environment. One particular issue under debate has been the potential use of traditional WTO rights to dispute trade obligations set out in multilateral environmental agreements (MEAs). This has lead to suggestions to authorize trade sanctions against non-signatories, thereby granting economic integration only upon the adoption of tougher standards.[1] Are such tariffs justified, and if so, how do they affect the location of firms and environmental policy?[2]

This paper attempts to answer this question by modeling the above proposal on trade and environment. It endogenizes the decision of firms on location and governments' respective policies on trade and environment to see whether tariffs are effective in implementing environmental standards. It shows that when pollution related costs constitute a plausible fraction of firms' total costs, tariffs can work as a successful credible threat to make environmental upgrading and free trade the unique equilibrium outcome.[3]

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[1] See Neary (2004) for more on the key issues on the Doha development agenda.

[2] Barrett (1997) shows how committing to trade sanctions in a MEA such as the Montreal Protocol can work as a credible threat to deter free-riding and sustain cooperation. Zigic (2000) further shows how punitive tariffs can be used as a credible threat to improve intellectual property rights regime in the same spirit as they are projected to improve environmental standards in the Doha proposal.

[3] Although we examine all levels of pollution tax in the paper, only very low values reflect reality and are of relevance for the results. A wide range of studies such as Noerdstrom and Vaughan (1999) show that pollution related costs only account for a very small proportion of a firm's total costs. These costs only come up to no more than 1% of production costs for an average industry in the North and at most 5% for the worst polluters. Hence, we emphasize the results for low enough levels of emission tax.

Environmentalists argue that the absence of trade policy instruments leads governments to ignore environmental policies in order to improve the competitiveness of their firms.[4] The lack of such policies has also been blamed for the relocation of polluting activities of multinationals to pollution havens. Theoretical literature on environmental policy and the location of firms goes as far back as Markusen, et al. (1993). They look at exogenous trade costs and environmental policies and show the latter to have a very strong impact on a firm's location decision when firms are "footloose". Motta and Thisse (1994) consider a different setting where firms are initially established in their country of origin and do not incur a fixed cost when operating at home. They show that a firm is less likely to relocate as a response to environmental policy because fixed costs of establishing a domestic plant are sunk when the game begins. Hoel (1997) endogenizes environmental policy to demonstrate government motives to choose weak environmental standards to attract firms as long as the disutility from pollution does not promote a 'Not In My Back Yard' policy. Ulph and Valentini (2001) show that environmental dumping is greater when plants are 'not' footloose as this creates strategic rent-shifting incentives for governments. On the empirical side, studies on the issue have largely rejected any link between firm location and environmental policy. Javorcik and Wei (2005), Eskeland and Harrison (2003) and Grether and Melo (2003) are among recent empirical works that find little or no evidence on the pollution haven hypothesis.

Unlike the previous array of literature, this paper integrates environmental standards, trade policy and delocation into a single model to investigate their interaction in shaping environmental policy. By endogenizing the decision of firms on location and governments' policies on trade and environment, we study how punishing tariffs can work as an instrument to instigate 'green' trade liberalization. If standards are not adopted, optimal tariffs are positive and eliminate firms' incentives to relocate their pollutive activities. However, in

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[4] Barrett (1994) for instance shows that in imperfectly competitive international markets, governments may be tempted to impose a weak environmental policy where the marginal cost of abatement is less than the marginal damage from pollution.

accordance with recent empirical findings, the so-called escape to pollution havens never arises in equilibrium and all capital movement tends to occur as a result of non-pollution-related factors. The model can be summarized in the following game: in the first stage, the government of a non-signatory country (South) chooses whether or not to adopt standards taking into consideration that a group of participants to an MEA (North) can impose a tariff against its imports in the second stage upon non-compliance. If the South chooses to harmonize its environmental standards, tariffs are abolished to allow for economic integration as a complement or reward.[5] Governments also anticipate firms' decision on output and location. A Northern firm moves next by choosing location in the third stage and competes in production with a Southern firm in the final stage. The timing of the game is illustrated in figure 1.

The rest of the paper is organized as follows: Section 2 describes the model and solves the final two stages of the game when environmental standards are not enforced in the South. Section 3 introduces the other branch of the game where the South adopts the required environmental policy and solves for output and location under harmonized standards. Section 4 finds the optimal tariff set by the North and the decision by the South whether or not to ratify. Section 5 concludes.

2. Asymmetric Environmental Standards

2.1. The Model

There are two regions in the model: the North and the South. They are assumed symmetric in all aspects aside from their environmental regulation. Production here gives rise to transboundary pollution. The North is assumed to enforce an exogenous level of environmental standards by imposing a pollution tax on emissions released by firms during production. The South in contrast can choose to adopt standards and enjoy trade liberalization

[5] An interesting extension would be to look at a three country model to also consider the case of partial tax harmonization in the merits of Conconi, Perroni and Riezman (2006).

or to keep its weak environmental regulations.[6] The latter option allows local as well as foreign firms operating in the South to produce with no additional charge for causing pollution. There is however a punishing tariff in this case set optimally by the North against *all* dirty imports from the South, including exports by the Northern firm.[7]

There are two firms, one belonging to each country. They produce a homogeneous good and compete in an oligopoly à la Cournot. We assume markets are segmented, thus firms choose the optimal output for each market separately. The Northern firm is a multinational and can decide its production location. It can stay at home and serve both markets from its Northern headquarters. It can also build a subsidiary in the South to serve the Southern market, but maintain production in the North to serve its home interests. Finally, it can close down home production altogether and delocate to serve both markets from the South. The Southern firm has no incentives to relocate in such setting because of fixed moving costs and pollution costs associated with production in the North.

We assume a linear demand function with the familiar form

$$p_i = a - Q_i \qquad for \quad i = N, S \,, \tag{1}$$

where Q_i is the total consumption in region *i*, and subscripts *N* and *S* represent the North and the South. Total consumption in each region is

$$Q_i = q_{Ni} + q_{Si} \,, \tag{2}$$

where q_{ji} indicates the quantity of goods produced in region *j* and consumed in region *i*. Production costs are divided into non-pollution related costs *c* and pollution tax τ paid on emissions released from the production of each unit of output.

The rest of this section looks at the case of no standards in the South. The profit function of the Northern firm when all of its production takes place in the North is

$$\pi_N{}^E = q_{NN}{}^E (a - Q_N^E - c - \tau e_0) + q_{NS}{}^E (a - Q_S^E - c - \tau e_0) \,, \tag{3a}$$

[6] While Southern policy with regards to participating in an environmental agreement is endogenized, the magnitude of the standards required remains exogenous in the model.

[7] Note that the model only considers goods that are directly related to the environmental problem.

where superscript E represents exports. Parameter e_0 represents the unit emission discharged by each firm and can be thought of as the pollution intensity of the industry.[8] In this locational scenario, the Northern firm must pay a pollution tax on its entire production. Alternatively, when it builds a subsidiary in the South to serve each market locally, it must only pays a pollution tax on goods it produces in the North for the domestic market:

$$\pi_N{}^F = q_{NN}{}^F (a - Q_N^F - c - \tau e_0) + q_{SS}{}^F (a - Q_S^F - c) - \Gamma \,. \tag{3b}$$

Superscript F denotes FDI and Γ is the fixed cost of setting up a plant abroad, which is independent of output. If the Northern firm completely delocates to serve both markets from the South, it avoids paying pollution taxes altogether, but is bound to pay tariffs on its exports back to the North:

$$\pi_N{}^D = q_{SN}{}^D (a - Q_N^D - c - t) + q_{SS}{}^D (a - Q_S^D - c) - \Gamma \,, \tag{3c}$$

where D stands for delocation. The profits of the Southern firm are in turn

$$\pi_S{}^k = q_{SN}{}^k (a - Q_N^k - c - t) + q_{SS}{}^k (a - Q_S^k - c) \tag{4}$$

for each scenario $k=E,F,D$ prevailing subsequent to the Northern firm's decision on production location. Recall that there is no environmental tax enforced in the South here, but a tariff is paid on Southern exports to the North.[9] Using backward induction, section 2.2 first solves the problem of firms in the final stage where they compete in output.

2.2. Production

In the export case, production by each firm turns out to be

$$q_{NN}{}^E = \frac{1 + t - 2\tau e_0}{3}\,,\; q_{NS}{}^E = \frac{1 - 2\tau e_0}{3}\,,\; q_{SS}^*{}^E = \frac{1 + \tau e_0}{3}\,,\; q_{SN}^*{}^E = \frac{1 - 2t + \tau e_0}{3}\,, \tag{5}$$

[8] Naghavi (2007) studies how green tariffs may result in lower emissions than environmental harmonization by strategically inducing a higher level of pollution abatement R&D. In this paper, we abstract from the R&D effect of tariffs on unit emission, but endogenize and find the optimal trade policy of the North and environmental policy of the South from a welfare perspective.

[9] Tariffs and pollution taxes have been normalized to the market size to allow for the elimination of *(a-c)* from all upcoming equations.

where the asterisk denotes production by the Southern firm. In this case, the direct effect of tariffs is to increase local production in the North and reduce imports from the South. Stricter standards per se have the reverse effect of reducing Northern production and encouraging production by the Southern firm. Inequality $t \geq 2\tau e_0 - 1$ is a constraint for $q_{NN}^E \geq 0$ to hold so that the Northern firm continues to serve its home market through local production.[10] Also, $t \leq \frac{1+\tau e_0}{2}$ is a necessary condition for the Southern firm to maintain its exports to the North, i.e. for $q^*_{SN}{}^E \geq 0$. This tariff rates denote a complete ban on imports from the South making values of t above this level irrelevant for the analysis.

In the case of FDI, $q_{NN}^F = q_{NN}^E$ and $q^*_{SN}{}^F = q^*_{SN}{}^E$ as the Northern firm maintains local production for the home market and competes with imports from the South. However, it builds a subsidiary in the South to serve the latter locally, making output aimed at the Southern market

$$q_{SS}{}^F = q^*_{SS}{}^F = \frac{1}{3} \qquad (6)$$

for both firms. As under FDI both firms produce in the South for the Southern market where no pollution tax exists, the optimal quantity produced by both firms resembles that in a typical Cournot case. In addition, τ affects the entire production by both firms in the exports case, whereas with FDI only goods targeted at the Northern market are influenced.

When the Northern firm delocates, production by both firms for the Southern market remains $q_{SS}{}^D = q_{SS}{}^F$. The Northern firm produces in the South also for its domestic market and re-exports back to the North, making production by both firms aimed at the North

$$q_{SN}{}^D = q^*_{SN}{}^D = \frac{1-t}{3}. \qquad (7)$$

If the Northern firm completely closes down production in the North and establishes a plant in the South to serve both markets, pollution tax becomes irrelevant and tariffs reduce exports of

[10] It will be seen that this constraint is never binding as it coincides with the scenario of complete delocation, where the Northern firm does not produce at home and no longer pays an emission tax.

both firms to the North. Market segmentation allows us to drop the superscripts of output by the Northern firm throughout the rest of the paper.

2.3. Location

In the third stage of the game, the Northern multinational must choose where to locate to serve each market. By substituting the optimal output back into the Northern firm's profit function and comparing the profits for each case, we can find the location outcome that yields the most profits. Northern profits for each scenario are simply

$$\pi_N^E = q_{NN}^{\ 2} + q_{NS}^{\ 2}, \tag{8a}$$

$$\pi_N^F = q_{NN}^{\ 2} + q_{SS}^{\ 2} - \Gamma, \tag{8b}$$

$$\pi_N^D = q_{SN}^{\ 2} + q_{SS}^{\ 2} - \Gamma. \tag{8c}$$

Looking first at profits of keeping all production in the North against establishing an extra plant in the South, we can see that in the absence of relocation costs *Γ*, a firm would always be better off by serving each market through a local subsidiary.[11] The critical level of fixed costs that gives $\pi_N^E = \pi_N^F$ is

$$\overline{\Gamma} = \frac{4}{9}\tau e_0 (1 - \tau e_0). \tag{9}$$

When fixed costs are below this level, costs of relocation are sufficiently low making FDI the preferable scenario. Otherwise, relocation is too costly and the Northern firm keeps all production at home, leaving no concern for the influence of environmental policy on firm location. This scenario could reflect a situation where very high plant-specific fixed costs, or inflexible foreign investment laws and political instability in the host country deter relocation.

[11] This also reflects the branch of literature on environment and firms' location pioneered by Markusen et al. (1993) that assumes firms to be footloose. Thus, there are no extra costs for relocation as they incur a plant specific fixed cost regardless of whether they build a plant at home or in the other region. The number of plants would however matter in determining the total fixed costs in this case.

As we are interested in studying the location of firms, we reduce the analysis to a situation with sufficiently low fixed costs of relocation, where the latter is an option.[12]

Next, we compare profits under FDI and delocation to distinguish between the standard form of capital movement and delocation for pollution-motivated reasons. The threshold tariff rate below which the Northern firm delocates all production is the t that makes profits under the two options equal ($\pi_N^F = \pi_N^D$):

$$\bar{t} = \tau e_0 . \tag{10}$$

Figure 2 shows the Northern firm's choice on location in a space of τ and t for an emission level $e_0=1$. It is easy to see that a higher pollution tax in the North makes delocation more attractive. This implies that tougher standards require a higher tariff on dirty goods from the South to impede delocation. As tariffs rise, delocation becomes less attractive for a larger range of Northern pollution tax. The shaded area shows the region where tariffs halt trade.

3. Environmental Harmonization and Trade Liberalization

This section investigates the consequences of the global enforcement of environmental regulations. This can be interpreted as a policy to only grant trade concessions to WTO members that are also parties to a globally recognized MEA. Here, this entails that the South upgrades its standards to the level imposed in the North, namely τ, and enjoys free trade as a reward, i.e. tariff t is abolished.

There is only one possible scenario in the case of harmonized standards as liberalized trade and symmetry in environmental policies make firms indifferent about location. There are no incentives to relocate in this situation, as the smallest form of relocation fixed costs would cause firms to remain in their home region. Both firms now pay the pollution tax τ on the emissions release during production, while trade is liberalized. Profit functions of the two firms become

[12] The dividing line between the export and the FDI case has been studied in Motta and Thisse (1994). It plays a more important role in their analysis, as they also look at differences in the market size between regions and changes in fixed costs of establishing a plant.

$$\pi_N^H = q_{jN}(a - Q_N^H - c - \tau e_0) + q_{jS}(a - Q_S^H - c - \tau e_0) \qquad for \quad i = N, S\,, \tag{11}$$

where superscript *H* stands for harmonized environmental standards. In this case, the quantity produced by each firm for the domestic and the foreign market is identical:

$$q_{NN}{}^H = q_{NS}{}^H = q_{SN}^{*}{}^H = q_{SS}^{*}{}^H = \frac{1 - \tau e_0}{3}\,. \tag{12}$$

Profits are equal for both firm under harmonized standards and are

$$\pi_j^H = q_{jN}^{H}{}^2 + q_{jS}^{H}{}^2 \qquad for \quad j = N, S\,. \tag{13}$$

Profits are lower the more stringent are standards required in an MEA. We now turn to the first two stages of the game where the South decides whether or not to enforce environmental regulations and the North chooses an optimal tariff in the case of non-compliance.

As for location, by choosing to adopt standards the South makes relocation redundant for the Northern firm and forces the latter to keep all production at home. On the other hand, when the South fails to adopt standards, the Northern firm can decide whether to undertake FDI or completely delocate production using the approach explained in section 2.3.

4. Optimal Policy by Governments

4.1. Welfare

This section introduces the components of welfare in the North and the South under each scenario. Economic welfare in this setting is the sum of consumer surplus and producer surplus minus the disutility caused by pollution, plus the tariff and emission tax revenues.

Consumer surplus is the area under the demand curve and can be written as half of the total output intended for each region squared:

$$CS_i^k = \frac{Q_i^{k\,2}}{2} \qquad for \quad i = N, S, \quad k = F, D. \tag{14a}$$

Consumer surplus in the North and the South when the latter does not adopt standards is

$$CS_N^F = \frac{(2 - t - \tau e_0)^2}{18}, CS_S^F = \frac{2}{9},\ CS_N^D = \frac{2}{9}(1 - t)^2, CS_S^D = \frac{2}{9}\,, \tag{14b}$$

for FDI and delocation respectively. When standards are adopted, consumer surplus turns to

$$CS_i^H = \frac{2}{9}(1-\tau e_0)^2 \qquad for \quad i = N, S \,. \tag{14c}$$

Producer surplus with no standards in the North is profits in (8b) and (8c) for FDI and delocation respectively. Producer surplus in the South equals Southern profits from (4) using the appropriate output from (5)-(7) for each case:

$$\pi_S^k = {q_{SN}^k}^2 + {q_{SS}^k}^2 \quad for \quad k = F, D \,. \tag{15}$$

Equation (13) represents producer surplus in both regions with harmonized standards.

The third component of welfare is the disutility caused by pollution in each region. This is parameterized as Δ_i and contains total emissions in each region and a parameter d_i, which measures the concern of the population over pollution:

$$\Delta_i^k = d_i E_i^k \qquad for \quad i = N, S; \quad k = E, F, D \,. \tag{16}$$

Another interpretation for parameter d_i is the relative importance of the disutility caused by emissions against utility gains from other components of welfare.[13]

Pollution is assumed to be of the transboundary type.[14] Total world pollution depends on whether the non-signatory joins the MEA, the trade obligations of an MEA, and the location of the Northern firm. Looking at the case with no standards, total world emission is

$$E^F = \frac{1}{3} e_0 (4 - t - \tau e_0) \,, \tag{17a}$$

$$E^D = \frac{2}{3} e_0 (2 - t) \,, \tag{17b}$$

when the multinational has a local subsidiary in each country and when it completely delocates respectively. Under harmonized standards, total emission becomes

$$E^H = \frac{4}{3} e_0 (1 - \tau e_0) \,. \tag{17c}$$

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[13] Disutility here increases monotonically with pollution. Other functional forms can be used to describe disutility, but the merits of the results remain the same.

[14] Note that most international environmental agreements deal with transboundary or global issues. If pollution is local, there is no role for an MEA or the WTO.

The first order conditions of emissions released with respect to pollution tax and tariffs show how the environment is affected through government policies. These derivatives are trivially negative with respect to t and τ implying that tariffs and emission taxes per se are beneficial for the environment. When delocation is binding ($t < \tau e_0$), pollution is always lower when global standards are enforced. When FDI is the outcome on the other hand, pollution is only lower in a sub-region where $t < 3\tau e_0$; higher tariffs reduce production by so much that pollution is actually lower than the harmonization case.

The question that needs to be answered here is whether environmental policy can be implemented in isolation or only in conjunction with trade sanctions, taking into consideration the consequences of government policy on firm location, output, and hence total welfare. Total welfare for each country can now be summarized to

$$\begin{aligned} W_N{}^k &= \pi_N^k + CS_N^k - \Delta_N^k + T + I \\ W_S{}^k &= \pi_S^k + CS_S^k - \Delta_S^k + I \end{aligned} \quad (18)$$

for $j=F,D,H$ using the corresponding values found above for each component of welfare. T is the tariff revenue and is equal to the unit tariff rate times the total quantity exported to the North tq_{SN} ; I is the income from domestic environmental taxation and is equal to τe_0 times output.

4.2. Optimal Northern Tariff

We can now use the welfare function derived in the previous section to see if the North finds it optimal to impose a punishing tariff on the South when the latter refuses to adopt the required standards. The Northern government sets an optimal tariff that maximizes its welfare in the second stage for each location scenario. It then compares Northern welfare for FDI and delocation using the respective optimal tariffs. Taking the decision of its firm on location into consideration, it chooses the optimal tariff that results in higher Northern welfare.[15]

[15] Recall that the tariff is set before the decision of the firm about location; therefore, there are no profit-shifting incentives present in the model.

The optimal tariff for each case can be found by differentiating Northern welfare in (18) with respect to t using the appropriate components from the previous sections to get

$$t^{*F} = \frac{1 + e_0(d_N + \tau)}{3}, \tag{19a}$$

$$t^{*D} = e_0 d_N , \tag{19b}$$

for FDI and delocation respectively. The optimal tariff is non-negative for all levels of environmental standards and is increasing with higher pollution concern in the North. Note from (19b) and (10) that a level of concern $d_N > \tau$ implies a tariff rate $t^{*D} > \bar{t}$, which is out of the delocation region. Therefore, t^{*D} is only feasible for $d_N \leq \tau$ making $\bar{t}$ the maximum imposable tariff for $d_N > \tau$. Yet, the latter is never binding as $W_N^F(t^{*F}) \geq W_N^D(\bar{t})$ always holds (see appendix for proof). Given the optimal tariffs and the above constraint, the Northern government prefers a FDI situation to delocation in terms of welfare as long as τ is less than

$$\hat{\tau} = \frac{\sqrt{6}(1 - d_N e_0) - (1 - 2d_N e_0)}{e_0}, \tag{20}$$

which gives $W_N^F(t^{*F}) > W_N^D(t^{*D})$. This makes t^{*F} the relevant tariff for modest values of τ, which are of interest in our investigation (see appendix for more detail on the critical values of τ). The Northern optimal tariff is illustrated in figure 3 for $d_N=0.1$ along the applicable range of τ. The thick line illustrates the optimal tariff used, which is t^{*F} for the FDI and t^{*D} for the delocation region. The optimal level of tariffs results in a FDI scenario in the region of interest implying that FDI for motives other than pollution is the only form of capital movement to the South. Even upon non-compliance by the South, delocation of production and pollution to such 'export platform' does not occur due to sufficiently high optimal tariffs. This reinforces empirical studies that have found weak or no evidence for the pollution haven hypothesis. Delocation is shown to be a pure theoretical outcome that only arises when pollution-related costs amount to an unrealistically high fraction of total costs.

Result 1

A positive optimal Northern tariff makes FDI the equilibrium location outcome if the South deviates and does not ratify, deterring pollution-related delocation for a plausible range of τ. Taking the Northern optimal punishing tariff into account, the Southern government commits to its optimal environmental policy in the first stage.

4.3. Optimal Southern Environmental Policy

We turn to the first stage of the game to find the Southern government's optimal choice, namely whether to adopt standards and enjoy trade liberalization or ignore environmental standards and endure punishing tariffs. We do this by looking at Southern welfare in (18) for each case by substituting for its components from the appropriate equations. Comparing (14a) and (14b) with (14c), we can see that Southern consumer surplus is always lower when environmental standards are harmonized. Southern producer surplus also falls with the adoption of standards if delocation prevails under no standards ($t < \tau e_0$). If FDI is the outcome under no compliance, there is a threshold tax level $\tilde{\tau} < \frac{3 - 2t \pm \sqrt{8t^2 - 16t + 9}}{e_0}$ under which the Southern firm benefits from the adoption of standards. This is due to tariff savings that arise from a move to free trade. Yet, this advantage only materializes for low values of τ, where switching policy results in higher total production and thus a stronger market position enjoyed by the Southern firm. In summary, $\tilde{\tau}$ depicts the threshold value where the penalty imposed by the North is equal to its benefits to the Southern firm. Furthermore, $\pi_S^D > \pi_S^F$ for $t > \bar{t}$ implies that the interests of the Southern firm are always in conflict with the Northern firm's preferences on location.

In the rest of this section, we focus on the case where only the North is concerned about pollution ($d_S=0$).[16] In a delocation scenario, the South never finds it optimal to ratify an MEA as it is strictly better off with no standards. On the other hand, when FDI prevails under no standards, there is a critical level of τ below which the South finds it optimal to participate. This level of pollution tax solves $W_S^F = W_S^H$ and is

[16] While this makes the notation much easier to follow, all results hold for positive values of d_S.

$$\bar{\tau} = \frac{2[1 - t \pm \sqrt{(1-t)(1+2t)}\,]}{3e_0}. \tag{21}$$

The hyperbola in figure 3 shows the locus where Southern welfare under ratification is equal to that with FDI and no standards. The area to the left of the curve is the region where the South prefers to adopt standards. Gains from producer surplus, tax revenues and tariff savings outweigh consumer surplus losses in this region. Anticipating Northern optimal tariffs from the second stage t^{*F}, the South ratifies the international environmental agreement as a tariff makes the Southern policy choice fall in the region where compliance is optimal. This is true as long as

$$\tau < \bar{\tau}^* = \frac{2[d_N e_0 - 5 + 3\sqrt{7 + d_N e_0 - 2d_N{}^2 e_0^2}\,]}{19e_0}, \tag{21'}$$

where we have substituted the optimal tariff t^{*F} from (19a) for t in (21). This is the point where t^{*F} meets the hyperbola $\bar{\tau}$ in figure 3. In sum, environmental harmonization is the unique equilibrium outcome if (1) the North prefers FDI upon non-compliance by the South, (2) the South finds it optimal to ratify. This requires τ to lie within a reasonable range of as $\tau < Min\{\hat{\tau}, \bar{\tau}^*\}$. Here tariffs work successfully as a credible threat to motivate participation in an MEA without actually being put into practice in equilibrium. The proposed trade sanctions can hence be deemed effective for modest values of τ consistent with data, and ratification by the South is the equilibrium outcome. Only in the unlikely case of very high τ, standards would not be adopted, tariffs are positive, and the equilibrium outcome is delocation.

Result 2

A punishing tariff works as a credible threat to persuade the South to adopt environmental standards. It is hence an effective green instrument as global environmental standards and free trade is the unique equilibrium outcome for a modest range of τ.

5. Conclusion

This paper studies the potential role of trade sanctions for a successful implementation of globally recognized environmental standards alongside trade liberalization. In particular, it analyzes conditional consent for economic integration upon ratification of environmental agreements. This allows for punishing tariffs if a country with weak environmental standards does not cooperate. For a modest range of environmental obligations, it is optimal for a non-signatory to upgrade its environmental regulation. Punishing tariffs work *only* as a credible threat to paradoxically motivate green trade liberalization. Even if the Southern government deviates, Northern optimal tariffs are positive and high enough to deter pollution-related delocation.

It can be deduced from the results that unlike conventional environmental policy recommendations, a successful policy to control pollution could be optimal in combination with other complementary measures. When a pollution tax in isolation may not work as an effective policy tool, trade measures could be considered when reaching out for environmental targets. If trade sanctions can serve as a successful threat against delocation or eco-dumping policies, they may at times be the only means for successful international environmental negotiations. With regard to the detrimental effects of tariffs, the paper shows that a positive tariff never arises in equilibrium.

The model in the paper is only a cornerstone to highlight the basic role of tariffs and the potential need for trade sanctions in achieving environmental goals. It can easily be extended to investigate whether an optimal emission tax rate for each region, or a world optimal tariff through an international body could induce participation in an MEA when the latter is globally optimal. It is interesting to study the effects of such tariffs and/or emission tax on the R&D effort by firms to abate pollution. It is also important to look into more direct measures of improving the environment such as abatement R&D subsidies to avoid creating a distortion. It must however be taken into account that such subsidies must also be financed from costly taxation. Extending the model to include more countries is a next step to see the impact of the number of signatories on the decision of a non-signatory to join. Another interesting line of research is to study the issue in a more general multi-firm multi-sector framework, where firms/sectors have different pollution intensities.

Appendix: The Evaluation of Welfare

Using (5), (6), (8b), (14b), (16), (17a), and t^{*F} from (19a), Northern welfare in the case of FDI can be written in its final form as

$$W_N^F(t^{*F}) = \frac{9 - 4\tau e_0 + d_N{}^2 e_0{}^2 - 22 d_N e_0 + 8 d_N \tau e_0{}^2 - 2\tau^2 e_0{}^2}{18}. \tag{A1}$$

Similarly, Northern welfare in the case of delocation can be rewritten using (6), (7), (8c), (16), (17b), and t^{*F} from (19b):

$$W_N^D(t^{*D}) = \frac{4 + 3 d_N{}^2 e_0{}^2 - 12 d_N e_0}{9}. \tag{A2}$$

When instead $\bar{t}$ from (10) is used as tariffs under delocation, we have

$$W_N^D(\bar{t}) = \frac{4 - 3\tau^2 e_0{}^2 + 6 d_N \tau e_0{}^2 - 12 d_N e_0}{9}. \tag{A3}$$

Note that fixed costs of relocation have been eliminated from profits for the sake of exposition, as they are not involved in welfare comparisons relevant for our analysis. The tax rate that gives $W_N^F(t^{*F}) = W(\bar{t})$ is $\tau = \frac{1 + d_N e_0}{2e_0}$. However, the two welfare curves are tangent at this point, with $W_N^F(t^{*F}) > W_N^D(\bar{t})$ for all other values of τ. Also recall from the main text that $W_N^F(t^{*F}) > W_N^D(t^{*D})$ holds for emission tax rates of $\tau < \hat{\tau}$.

We also do not address the question whether or not the North finds it optimal to have the South included in the treaty, as a call for the global enforcement of environmental standards has been taken as given here. Otherwise, the North may at times find it optimal to exclude the South from an MEA in order to exploit tariff revenues. We abstract from such cases as they would clearly misrepresent the nature of trade obligations under investigation here. 'Optimal tariffs' are merely looked at to examine their credibility.

Southern welfare is in turn

$$W_S^F(t^{*F}) = \frac{28 - 4 d_N e_0 + 2\tau e_0 + 4 d_N{}^2 e_0{}^2 - 4 d_N e_0{}^2 + \tau^2 e_0{}^2}{81}, \tag{A4}$$

$$W_S^D(t^{*D}) = \frac{4 - 2 d_N e_0 + d_N{}^2 e_0{}^2}{9}, \tag{A5}$$

using (6), (7), (14b), (15), and t^{*F} from (19a) for FDI and t^{*D} from (19b) for delocation. When the South chooses to adopt standards, welfare can be rewritten using (12), (13) and (14c):

$$W_S^H = \frac{2(1-\tau e_0)(2+\tau e_0)}{9}. \tag{A6}$$

It is easy to see that $W_N^H > W_S^D(t^{*D})$ is always true, therefore a tariff would only be effective if it moves the equilibrium location from delocation to FDI. Then comparing $W_S^F(t^{*F})$ and W_N^H we saw from the text that $W_N^H > W_S^F(t^{*F})$ holds as long as $\tau < \bar{\tau}^*$.

We can conclude that the optimal tariff chosen by the North is credible and leads to ratification by the South for as long as $\tau < Min\{\hat{\tau}, \bar{\tau}^*\}$. In other words, $\bar{\tau}^*$ is the relevant threshold as long as the North prefers FDI when there are no standards in the South and chooses the optimal tariff rate t^{*F}. In the contrary case, when the Northern welfare is higher with delocation upon non-ratification by the South ($\tau \geq \hat{\tau}$), the optimal tariff rate is t^{*D} making the relevant critical emission tax rate $\hat{\tau}$. Examining (20) and (21') shows that both values are strictly positive and sufficiently high to validate our results. For instance, for $e_0=1$, threshold $\bar{\tau}^* \approx 0.33$ is true at all times, while $\hat{\tau}$ is just above 0.2 for $d_N=0$ and increasing as Northern concern for pollution rises.

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Figure 1: R&D investment by the Northern Firm

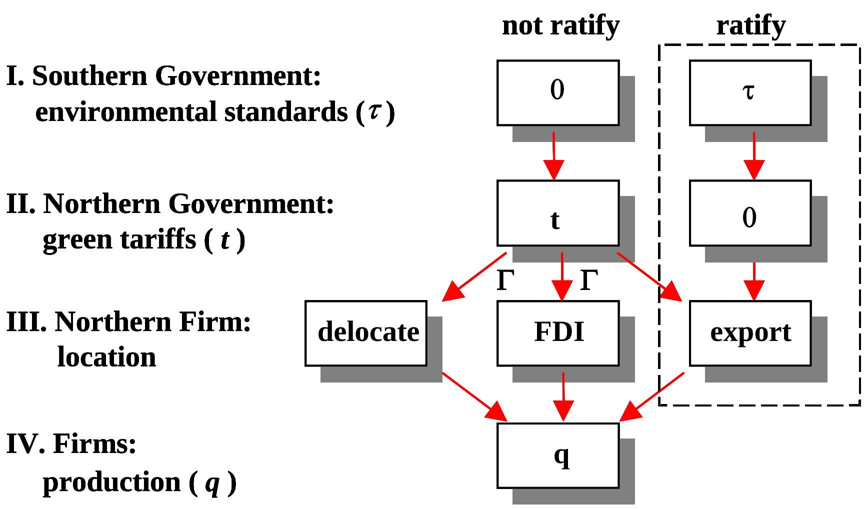


Figure 2: Location of the Northern Firm

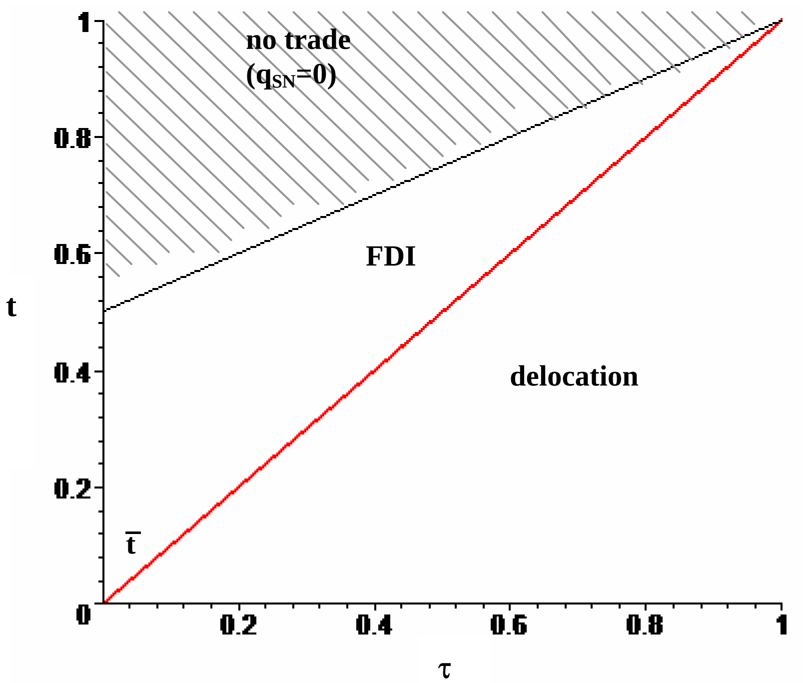
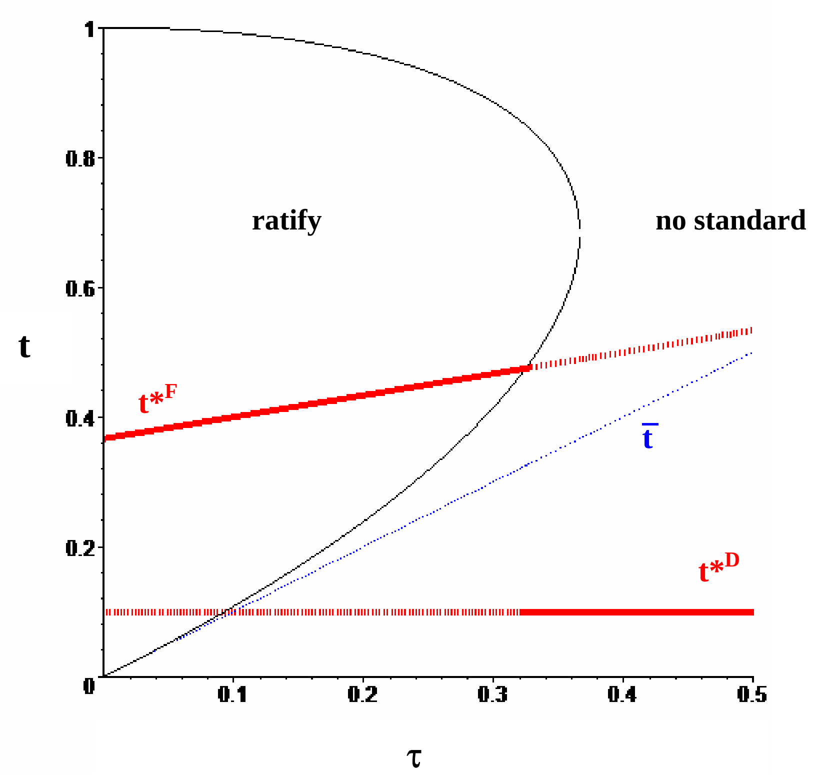


Figure 3: Optimal Government Policies



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