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Economic integration and environmental policy coordination*

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Abstract

We analyse the effect of international economic integration on environmental policy incentives when product markets are characterised by imperfect competition and national policy makers act strategically. If traditional trade policy instruments are not available, environmental policies will typically be determined by the interaction of conflicting policy incentives. We find that economic integration – interpreted as a reduction of non-tariff trade costs – will reduce policy distortions in the non-cooperative policy game if the marginal social cost of pollution is increasing at a sufficiently low rate. In this case, it follows that increased integration reduces the need for transnational policy coordination, from an environmentalist perspective.

Keywords: Economic integration; Strategic environmental policy; Policy coordination.

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1 Introduction

One of the most important features of the ongoing process of globalisation is the increased integration of national (or regional) product markets. Elimination of trade barriers through bilateral or multilateral

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free trade agreements are accompanied by reductions of non-tariff trade costs, such as improved infrastructure and reduced bureaucratic barriers to trade. Reduction of non-tariff trade costs is arguably the more important force in the current process of international economic integration, due to the widespread establishment of free trade areas such as the European Economic Area (EEA), the North American Free Trade Agreement (NAFTA) and the Asian Free Trade Area (AFTA). A recent example of an institutional reform that implies non-tariff trade cost reductions is the introduction of the European Monetary Union (EMU).

The process of international economic integration has raised many concerns among environmentalists, who argue that the consequent increase in trade flows will lead to increased pollution, and that increased openness of economies will undermine the effectiveness of national environmental policies. In particular, there seems to be a widespread belief – not only among environmentalists – that international economic integration increases the need for transnational coordination of environmental policies. For instance, in a fairly recent WTO report on the environmental consequences of increased trade, it is argued that

> "...the ongoing dismantling of economic borders reinforces the need to cooperate on environmental matters, especially on transboundary and global environmental problems that are beyond the control of any individual nation." (WTO, 1999, p.1.)

The aim of the present paper is to study precisely the relationship between product market integration and the effect of environmental policy coordination – from an environmentalist perspective – when product markets are characterised by imperfect competition and national policy makers act strategically.

In a world of imperfect competition, national policy makers typically have incentives to use environmental policies strategically to pursue non-environmental goals, for example to use emission taxes, or other environmental policy instruments, as strategic trade policy tools. These incentives are particularly relevant when free trade agreements have eliminated the viability of traditional trade policy instruments such as import tariffs or export subsidies. Thus, in a non-cooperative policy game, the chosen environmental policies will typically be determined by the interaction of conflicting policy incentives, so the environmental effect of policy coordination is a priori not clear. In the present paper we analyse how different policy incentives interact in determining the optimal non-cooperative environmental policies, with a particular focus on how economic integration is likely to affect the environmental gain of transnational policy coordination. Does international economic integration increase or reduce the distortion of environmental policies in the non-cooperative policy game?

The idea that imperfect competition in global markets creates distorted incentives with respect to national environmental policy making is not new. Early contributions to the literature on 'strategic environmental policy' – based on the idea of strategic trade policy in Brander and Spencer (1985) – include Conrad (1993), Barrett (1994), Kennedy (1994), Rauscher (1994) and Ulph (1996). The main insight from this body of literature is that national governments, when being prevented from using export subsidies or other direct trade policy instruments, may have incentives to adopt lax environmental standards in order to promote the competitiveness of domestic firms, a policy that has been termed 'ecological dumping'.[1,2] By applying a model of reciprocal trade – rather than the third-market model of Brander and Spencer (1985) – the present paper adds to this literature by studying how the non-cooperative policy incentives, and the efficient (second-best) policy, depend on the degree of product market integration.

The two papers which relate perhaps most closely to the present study are Kennedy (1994) and Burguet and Sempere (2003). In the former paper, a two-country model with oligopolistic competition is used to analyse how strategic interaction between governments can lead to inefficient distortion of pollution taxes in the non-cooperative policy equilibrium. However, there are no costs of trade in that model, so the issue of product market integration (or trade liberalisation) is not tackled.[3] Burguet and Sempere (B&S), on the other hand, use a related type of framework to analyse how trade liberalisation affects non-cooperative environmental policies and welfare. However, they only focus on the non-cooperative policy game, so the question of how trade liberalisation affects the environmental gain of policy coordination is not an issue in their paper. We show that trade liberalisation – or economic integration – affects not only the non-cooperative policy outcome, but also the efficient solution. Thus, even if increased integration leads to a more lax environmental policy in the non-cooperative policy game, it does not

[1]A related body of literature focus on the *interaction* between trade policy and environmental policy instrument, see, e.g., Walz and Wellisch (1997) and Tanguay (2001).

[2]Incentives for 'ecolocigal dumping' when plant locations are endogenous are analysed by, e.g., Markusen et al. (1993, 1995), Hoel (1997) and Ulph and Valentini (2001). There is also a large body of literature on environmental polices and trade in a *competitive* framework, see, e.g., Copeland and Taylor (1994, 1995).

[3]In a similar type of framework, and still without any trade costs, Duval and Hamilton (2002) study strategic environmental policy when markets are asymmetric.

necessarily follow that the environmental gain of policy coordination increases.

There are also other differences between the two above mentioned papers and the present one. In contrast to B&S, who focus on local pollution exclusively, we also allow for transboundary pollution, which has important implications for policy incentives. Furthermore, whereas B&S analyse trade liberalisation as a bilateral reduction of *tariffs*, we also focus on the effect of non-tariff trade barriers. Finally, in contrast to both Kennedy and B&S, we allow for products to be differentiated, which turns out to play an important role in determining the strength of the different policy incentives.

The basis for our analysis is an international duopoly model of reciprocal trade, in the tradition of Brander and Krugman (1983), where a by-product of the production process is the emission of a pollutant. The analysis rests on the fundamental assumption that free trade agreements prohibit the use of traditional trade policy instruments, so that the available number of policy tools is lower than the number of policy goals, implying that policy makers are operating in a second-best world, at best. Thus, the main part of the analysis is carried out under the assumption that trade costs do not comprise tariffs at all, so that the process of international economic integration is driven by reductions of *non-tariff* trade costs. Furthermore, in order to make the model tractable and simple – while still preserving the relevant trade-offs between different policy incentives – we assume that the only available policy instrument is an emission tax.

In this non-competitive scenario, policy making has to balance three different considerations: first, imperfect competition creates an underprovision problem, so there is an incentive to reduce emission taxes in order to improve product market efficiency. Second, in the non-cooperative policy game there is an incentive to reduce taxes in order to capture oligopoly rents from the foreign country. Third, considerations for environmental damage yield incentives to keep emission taxes high. The strength of these partly conflicting policy incentives, as well as the effect of policy coordination, depend – in different ways – on the degree of product market integration. Stronger integration increases competition, implying that considerations for product market efficiency reduces the downward pressure on emission taxes when national policies are coordinated. The relationship between integration and the coordination effect on the two other policy incentives are, however, ambiguous. Regarding environmental incentives, increased integration actually reduces the upward pressure on emission taxes when policies are coordinated, provided that pollution is predominantly local. In this case, non-cooperative policy making tends to yield excessively high taxes due to incentives for 'pollution-shifting', and these incentives are reinforced when product markets are integrated.

Our main result is that product market integration always *reduces* the need for policy coordination – from an environmentalist perspective – if the marginal social cost of pollution is constant, or if pollution is purely local. Given that policy coordination reduces pollution, this means that the process of economic integration reduces the policy distortions in the non-cooperative policy game and moves the non-cooperative equilibrium closer to the efficient (second-best) solution, in terms of equilibrium emission tax levels. There are two main effects that contribute to this result. In addition to the above mentioned 'pollution-shifting' effect, which applies when pollution is sufficiently local in nature, economic integration also reduces the incentive to keep emission taxes high in the coordination regime in order to curtail the total outlay on trade costs.

However, it turns out that results are crucially dependent on whether the process of product market integration is driven by a reduction of tariff or non-tariff trade costs. In the former case, which we briefly examine towards the end of the paper, economic integration always increases the environmental gain (i.e., the reduction of total emissions) of policy coordination. If trade costs are recouped as tariff revenues, trade liberalisation implies that incentives for both product market efficiency and rent-shifting contribute towards increasing the upward pressure on emission taxes when policies are coordinated. In our model, these two effects are always dominating, even though – somewhat paradoxically – purely environmental incentives might work in the opposite direction.

The rest of the paper is organised as follows. In the next section we present the fundamental ingredients of the model. In Section 3, the non-cooperative equilibrium is derived, and we also consider the effect of economic integration on non-cooperative equilibrium policies. In Section 4 we analyse the environmental effect of a transnational coordination of national policies, and examine under which circumstances policy coordination is likely to reduce total pollution. Section 5 contains the main contribution of the paper. Here we analyse how economic integration affects the environmental gain of transnational policy coordination. In Section 6 we examine how the assumption of non-tariff trade costs affects the results. Finally, some concluding remarks are offered in Section 7.

2 Model

Consider an international duopoly – with firm i located in country i, $i = 1, 2$ – where each firm produces its own variant of a differentiated product. The preferences of a representative consumer in country i is given by a quasi-linear utility function

$$U^i = q_i^i + q_j^i - \frac{1}{2}\left[\left(q_i^i\right)^2 + \left(q_j^i\right)^2 + 2bq_i^iq_j^i\right] + y, \tag{1}$$

where q_j^i is the quantity supplied in country i by firm j, and y is a numeraire good. With a fixed income, utility maximisation then yields the following inverse demand functions:

$$p_i^i = 1 - q_i^i - bq_j^i, \tag{2}$$

$$p_j^i = 1 - q_j^i - bq_i^i, \tag{3}$$

$i, j = 1, 2,\ i \neq j$, where p_j^i is the price of good j (produced by firm j) in country i.[4] The parameter $b \in [0, 1]$ is a measure of the degree of product differentiation, where $b = 1$ implies that the goods are homogeneous.

The firms act as Cournot players, and we also adopt the market segmentation hypothesis, implying that each firms chooses its optimal supply of the good for each market separately. There are no fixed costs, and marginal production costs are assumed to be constant and equal for both firms. Without loss of generality, these costs are set equal to zero. There are also some trade costs associated with exports: we assume that each firm has to pay a per-unit cost t for goods supplied to the foreign market. This cost parameter encompasses all non-tariff costs associated with serving a foreign market, such as transportation costs, red tape and various regulatory requirements that complicate and/or delay the trading process.

Production of the goods causes emissions of a pollutant. Emissions from firm i are given by

$$E_i = k\sum_j q_i^j, \quad i, j = 1, 2, \tag{4}$$

where the parameter $k > 0$ represents the emission rate (or the abatement technology). Given the technology k, no additional abatement is possible, so emissions can only be reduced by reducing production. We follow the specification in Kennedy (1994) and assume that total pollution in country i, Ω^i, is given by

$$\Omega^i = E_i + \alpha E_j, \quad i, j = 1, 2, \quad i \neq j, \tag{5}$$

[4]Regarding notation, the following convention is adopted throughout the paper: subscripts attached to a variable indicate the firm/product, whereas superscripts indicate the country.

where the parameter $\alpha \in (0,1)$ indicates the degree to which pollution is transboundary. If $\alpha = 0$, pollution is purely local, whereas $\alpha = 1$ implies that pollution is completely transboundary.[5]

Pollution causes environmental damage, and the social evaluation of these costs is given by a damage cost function $D^i := D(\Omega^i)$, where $D'(\cdot) > 0$ and $D''(\cdot) \geq 0$. Each national policy maker can influence the total level of emissions by levying an emission tax τ on the domestic firm. We define social welfare in country i as

$$W^i = U^i + \pi_i + \tau_i E_i - D^i, \quad i = 1, 2, \tag{6}$$

where $\tau_i E_i$ is emission tax revenue for the government in country i, and π_i denotes the profits of firm i, given by

$$\pi_i = p_i^i q_i^i + \left(p_i^j - t\right) q_i^j - \tau_i E_i, \quad i, j = 1, 2, \quad i \neq j. \tag{7}$$

The game is played in two stages:

- Stage 1: the governments in the two countries decide – cooperatively or non-cooperatively – on the environmental policy by setting emission taxes.
- Stage 2: the firms compete in Cournot fashion by choosing – non-cooperatively – how much to supply for each market.

3 The non-cooperative equilibrium

For given national policies (τ_i, τ_j), we can find the equilibrium levels of output for each market by simultaneously solving the firms' profit maximisation problems, yielding

$$q_i^i = \frac{2 - b + bt + bk\tau_j - 2\tau_i k}{4 - b^2}, \tag{8}$$

$$q_i^j = \frac{2 - b - 2t + bk\tau_j - 2\tau_i k}{4 - b^2}, \tag{9}$$

$i, j = 1, 2$, $i \neq j$. We will assume throughout that the equilibrium implies two-way trade. From (9) we see that this requires trade costs to be below a certain prohibitive level.[6]

[5] This is not the only plausible way to model transboundary pollution. An alternative specification could be $\Omega^i = (1 - \alpha) E_i + \alpha E_j$. This would, however, not change our results qualitatively.

[6] From (9) we see that whether or not the equilibrium is characterised by two-way trade also depends on the level of emission taxes. These are, however, endogenously

Anticipating the outcome of the production game, the national policy makers simultaneously and non-cooperatively set emission taxes to maximise (domestic) social welfare. For the subsequent analysis, it will be useful to reformulate the social welfare function in the following way:

$$W^i = U^i + S^i - D^i, \tag{10}$$

where

$$S^i := \left(p_i^j - t\right) q_i^j - p_j^i q_j^i \tag{11}$$

is the net trade surplus for country i. The first-order condition for an optimal tax rate in country i is then given by

$$\frac{\partial W^i(\tau_i, \tau_j)}{\partial \tau_i} = \frac{\partial U^i(\tau_i, \tau_j)}{\partial \tau_i} + \frac{\partial S^i(\tau_i, \tau_j)}{\partial \tau_i} - \frac{\partial D^i(\tau_i, \tau_j)}{\partial \tau_i} = 0. \tag{12}$$

When setting an optimal emission tax rate, each government has to balance three different considerations: product market efficiency, net trade surplus and environmental damage. In order better to grasp the intuition for the main results of the model, we will proceed by taking a more in-depth look at the decomposed effects of the first-order condition, evaluated at the symmetric equilibrium $\tau_1 = \tau_2 = \tau_{nc}$. We assume an interior solution, i.e., $\tau_{nc} > 0$.

Product market efficiency

By inserting the equilibrium expressions from stage two of the game, we derive

$$\frac{\partial U^i(\tau_{nc})}{\partial \tau_i} = -k \frac{(2-b)^2 (1 + \tau_{nc} k (1+b)) + b^3 t}{(2-b)^2 (2+b)^2} < 0. \tag{13}$$

Thus, considerations for product market efficiency pull in the direction of lower emission taxes. This is of course due to the fact that imperfect competition creates an under-provision problem when environmental damages are not taken into account.[7]

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determined in the model. Under the basic assumption that taxes are never set so high that firms do not find it profitable to operate even in their home markets, the assumption of two-way trade boils down to the assumption that trade costs are sufficiently low. For zero emission taxes, two-way trade prevails if $t < 1 - \frac{b}{2}$. For a related discussion in a similiar type of model, see also Naylor (1998, 1999), where production costs of firms are determined by monopoly trade unions.

[7] As observed by Barnett (1980), imperfectly competitive and polluting firms may under-produce from a social perspective if the market power effect outweighs the environmental damages.

Net trade surplus

At the non-cooperative equilibrium we have that

$$\frac{\partial S^i(\tau_{nc})}{\partial \tau_i} = -k\frac{(2-b)(b+2\tau_{nc}k)-tb^2}{(2-b)^2(2+b)} < 0. \tag{14}$$

By increasing taxes for the domestic firm, rents are shifted to the foreign country. Thus, considerations for the net trade surplus – the strategic trade policy incentives – also pull in the direction of a more lax environmental policy.

Environmental damage

Once more, by inserting the equilibrium expression from the production subgame, we derive

$$-\frac{\partial D^i(\tau_{nc})}{\partial \tau_i} = D'(\cdot)\frac{2k^2(2-\alpha b)}{4-b^2} > 0. \tag{15}$$

This illustrates the environmental gains from emission taxation. Increased taxation reduces production and thus pollution. Note that a lower value of α yields incentives for a tougher environmental policy (i.e., higher emission taxes). If pollution is predominantly local, uncoordinated taxation implies that each government has an incentive to use the tax instrument to shift (polluting) production to the other country.[8]

Using (13)-(15), the equilibrium non-cooperative emission tax rate is then characterised by the following equation:

$$-\frac{[4+b^2(1-b-2t)+\tau_{nc}k(2-b)(6+3b-b^2)]}{(2-b)^2(2+b)^2}+D'(\cdot)\frac{2k(2-\alpha b)}{(4-b^2)} = 0. \tag{16}$$

3.1 Economic integration

Before analysing the effects of policy coordination, let us see how economic integration – interpreted as a (marginal) reduction of trade costs – affects the uncoordinated policy equilibrium. Once more, it is useful to start out by discussing the decomposed effects. From (13) we easily see that

$$\frac{\partial}{\partial t}\left(\frac{\partial U^i(\tau_{nc})}{\partial \tau_i}\right) < 0, \tag{17}$$

which implies that economic integration reduces the negative effect of increased taxation on consumer utility. This is due to the fact that

[8]This 'pollution shifting' effect was identified by Kennedy (1994).

economic integration increases the degree of competition, and thus total output, which alleviates the under-provision problem. Ceteris paribus, a reduction of trade costs leads then to a tougher environmental policy.

From (14) it is also easily seen that

$$\frac{\partial}{\partial t}\left(\frac{\partial S^i(\tau_{nc})}{\partial \tau_i}\right) > 0, \tag{18}$$

which implies that economic integration increases incentives for rent-shifting activity by the governments. The reason is simply that lower trade costs make it easier to capture rents from the foreign market. Ceteris paribus, this means that trade cost reductions encourage a more lax environmental policy.

Finally, from (15) we can derive

$$\frac{\partial}{\partial t}\left(-\frac{\partial D^i(\tau_{nc})}{\partial \tau_i}\right) = -D''(\cdot)\frac{2k^3(1+\alpha)(2-\alpha b)}{(2+b)(4-b^2)} \leq 0. \tag{19}$$

Lower trade costs increase total production and thus pollution. This is the so-called 'scale effect' of product market integration. If the damage cost function is strictly convex, this means that the social benefit of reducing pollution increases as a result of reduced trade costs. Thus, environmental considerations call for a tougher environmental policy when product markets become more integrated, as long as the marginal social cost of pollution is increasing.

Total differentiation of (16) yields

$$\frac{\partial \tau_{nc}}{\partial t} = \frac{2\left(\left(\frac{b^2}{2-b}\right) - D''(\cdot)k^2(1+\alpha)(2-b\alpha)\right)}{k\left(6+3b-b^2+4k^2D''(\cdot)(1+\alpha)(2-b\alpha)\right)}. \tag{20}$$

The following result follows immediately:

Proposition 1 *In the non-cooperative equilibrium, economic integration always leads to a more lax environmental policy if the marginal social cost of pollution is constant. With a strictly convex damage cost function, economic integration leads to a tougher environmental policy if products are sufficiently differentiated, or if the emission rate (k) is sufficiently high.*

If the damage cost function is linear, trade cost reduction does not influence how environmental considerations affect the optimal policy; only incentives for rent-shifting and for improving product market efficiency are affected. It turns out that the rent-shifting effect dominates, implying that economic integration leads to lower emission taxes, because incentives for rent-shifting are sufficiently strengthened. The strength of both effects are, however, determined by the degree of product differentiation. For instance, the higher the degree of product differentiation the more difficult it is to capture rents from the foreign country by lowering emission taxes. Thus, with increasing marginal costs of pollution, environmental considerations will dominate if products are sufficiently differentiated, implying that product market integration leads to higher taxes.

4 Transnational policy coordination

In the coordinated policy regime, the two governments (or a transnational governmental body) optimally set emission taxes to maximise joint welfare. Thus, the maximisation problem is given by:

$$max_{\tau_i,\tau_j}\left(W^i+W^j\right)=\left(U^i+U^j\right)+\left(S^i+S^j\right)-\left(D^i+D^j\right). \quad (21)$$

Performing our usual decomposition of policy incentives, and evaluating at the symmetric cooperative equilibrium $\tau_1=\tau_2=\tau_c$, we can now derive

$$\frac{\partial\left[U^i\left(\tau_c\right)+U^j\left(\tau_c\right)\right]}{\partial\tau_i}=-k\frac{2+\left(1+b\right)\left(t+2\tau_c k\right)}{\left(b+2\right)^2}<0, \quad (22)$$

$$\frac{\partial\left[S^i\left(\tau_c\right)+S^j\left(\tau_c\right)\right]}{\partial\tau_i}=\frac{tk}{2+b}>0, \quad (23)$$

$$\frac{\partial\left[D^i\left(\tau_c\right)+D^j\left(\tau_c\right)\right]}{\partial\tau_i}=D'\left(\cdot\right)\frac{2k^2\left(1+\alpha\right)}{2+b}>0. \quad (24)$$

Comparing with the non-cooperative solution, there are two important aspects to note. First, incentives for rent-shifting are now eliminated. Instead, the countries have a common incentive to increase taxes in order to reduce costly trade, as illustrated by (23). Second, the marginal environmental benefit of emission taxation is now increasing in α, since 'pollution shifting' incentives are eliminated by policy coordination.

Using (22)-(24), the optimal emission tax rate in the coordinated equilibrium is given by the solution to

$$-\frac{\left(2+\tau_c 2k\left(1+b\right)-t\right)}{\left(2+b\right)^2}+D'\left(\cdot\right)\frac{2\left(1+\alpha\right)k}{2+b}=0. \quad (25)$$

In the following subsection we present a more detailed comparison of the two policy regimes.

4.1 When does transnational policy coordination reduce environmental pollution?

In order to analyse how policy coordination affects equilibrium emission taxes, we once more start out by investigating the decomposed effects. We do so by by evaluating the changes in policy incentives at the non-cooperative equilibrium. In other words, we are looking for the decomposed expression for $\frac{\partial\left[W^i(\tau_{nc})+W^j(\tau_{nc})\right]}{\partial\tau_i} - \frac{\partial W^i(\tau_{nc})}{\partial\tau_i}$, which reduces to $\frac{\partial W^j(\tau_{nc})}{\partial\tau_i}$. It follows that policy coordination leads to a tougher environmental policy (i.e., higher emission taxes) if $\frac{\partial W^j(\tau_{nc})}{\partial\tau_i} = \frac{\partial U^j(\tau_{nc})}{\partial\tau_i} + \frac{\partial S^j(\tau_{nc})}{\partial\tau_i} - \frac{\partial D^j(\tau_{nc})}{\partial\tau_i} > 0$.

Regarding considerations for product market efficiency, we find that

$$\frac{\partial U^j(\tau_{nc})}{\partial\tau_i} = -k\frac{(2-b)^2(1+\tau_{nc}k(1+b))+t(4-3b^2)}{(2-b)^2(2+b)^2} < 0, \tag{26}$$

which implies that coordination yields incentives for lower taxes. In the non-coordination regime, each policy maker does not care about the share of domestic production that is consumed by foreigners, so the full extent of the under-provision problem is not taken into account. When national policies are coordinated, though, this effect is internalised.

The effect of policy coordination on rent-shifting incentives is given by

$$\frac{\partial S^j(\tau_{nc})}{\partial\tau_i} = k\frac{(2-b)(b+2k\tau_{nc})+4t(1-b)}{(2-b)^2(2+b)} > 0. \tag{27}$$

From a comparison of (14) and (23), this effect is obvious. By eliminating rent-shifting incentives, policy coordination yields – all else equal – incentives for a tougher environmental policy.

Finally, the change in policy incentives that is related to environmental considerations is given by

$$-\frac{\partial D^j(\tau_{nc})}{\partial\tau_i} = -D'(\cdot)\frac{\partial\Omega^j(\tau_{nc})}{\partial\tau_i} = D'(\cdot)\left(\frac{2k^2(2\alpha-b)}{4-b^2}\right). \tag{28}$$

We see that

$$-\frac{\partial D^j(\tau_{nc})}{\partial\tau_i} > (<)\, 0$$

if

$$\alpha > (<)\, \frac{b}{2}.$$

In words, policy coordination always increases the marginal environmental benefit of emission taxes – implying, all else equal, that taxes are increased – if $\alpha > \frac{1}{2}$ or if products are unrelated ($b = 0$), whereas the opposite is true if pollution is purely local ($\alpha = 0$). When pollution is highly transboundary, non-coordinated policies imply too low taxes – from an environmental perspective – because the negative externality on the other country's environment is not taken into account. However, when pollution is predominantly local, non-coordinated policies imply *excessively high* taxes – still from an environmental perspective – because each local policy maker is trying to shift polluting production to the other country. This last effect is more pronounced the less differentiated the products are.

Based on the above discussion, we can already conclude that the more transboundary pollution is, the more likely it is that transnational policy coordination benefits the environment. For the special case of homogeneous products, we are also able to derive the following result:

Proposition 2 *In the case of homogeneous goods, a sufficient condition for transnational policy coordination to reduce environmental pollution is* $\alpha > \frac{1}{2}$.

Proof. Policy coordination yields higher emission taxes, and thus reduces pollution, if $\frac{\partial W^j(\tau_{nc})}{\partial \tau_i} = \frac{\partial U^j(\tau_{nc})}{\partial \tau_i} + \frac{\partial S^j(\tau_{nc})}{\partial \tau_i} - \frac{\partial D^j(\tau_{nc})}{\partial \tau_i} > 0$. For $b = 1$ we find that $\frac{\partial U^j(\tau_{nc})}{\partial \tau_i} + \frac{\partial S^j(\tau_{nc})}{\partial \tau_i} = \frac{1}{9}k\left(2 + 4k\tau_{nc} - t\right) > 0$. Furthermore, from (28) we know that, in this case, $-\frac{\partial D^j(\tau_{nc})}{\partial \tau_i} > 0$ if $\alpha > \frac{1}{2}$. ■

This result is explained by two different effects. First, we know that rent-shifting incentives in the non-cooperative regime are stronger the less differentiated the products are. Thus, in the case of homogeneous goods, the elimination of rent-shifting incentives dominates the increased incentives for alleviating the under-provision problem when national policies are coordinated. If, in addition, pollution is transboundary to a sufficient degree, environmental considerations also imply that policy coordination leads to higher taxes. On the other hand, if products are sufficiently differentiated, or if pollution is predominantly local, the environmental effect of policy coordination is generally ambiguous.[9]

[9] In a setting of imperfect competition and strategic environmental policy, Greaker (2003) also observes the possibility that policy coordination could lead to lower emission taxes, but for different reasons. In his model, the possibility that higher emission taxes could *reduce* the marginal cost of production (emissions as an 'inferior input' to production) implies that taxes will be set excessively high in the non-cooperative equilibrium.

5 Does economic integration increase the environmental gain from policy coordination?

The degree of product market integration – interpreted as the level of trade costs – is influential in determining the effect of policy coordination. Our focus is on whether or not the process of economic integration increases the need for policy coordination, as viewed from an environmental perspective. In other words: assuming that policy coordination yields a tougher environmental policy, will product market integration move the non-cooperative emission tax level further away from the efficient (second-best) level?

Since the marginal effect of taxation on total emissions is independent of trade costs, it follows from our previous analysis that integration will increase the environmental gain (or reduce the loss) from policy coordination if $\frac{\partial}{\partial t}\left(\frac{\partial W^j(\tau_{nc})}{\partial \tau_i}\right) < 0$. Again, we proceed by considering the decomposed effects.

From (26) we have that

$$\frac{\partial}{\partial t}\left(\frac{\partial U^j(\tau_{nc})}{\partial \tau_i}\right) = -k\frac{4-3b^2+k(1+b)(2-b)^2\frac{\partial \tau_{nc}}{\partial t}}{(2-b)^2(b+2)^2}. \tag{29}$$

By inserting the expression for $\frac{\partial \tau_{nc}}{\partial t}$ from (20) we derive

$$\frac{\partial}{\partial t}\left(\frac{\partial U^j(\tau_{nc})}{\partial \tau_i}\right) \tag{30}$$
$$= -k\frac{12-9b^2+b^3+2D''(\cdot)k^2(1+\alpha)(2+b)(1-b)(2-b\alpha)}{(2+b)(6+3b-b^2+4D''(\cdot)k^2(1+\alpha)(2-b\alpha))(2-b)^2} < 0.$$

Since $\frac{\partial U^j(\tau_{nc})}{\partial \tau_i} < 0$, it follows from (30) that product market integration reduces the coordination effect on efficiency incentives. This result is explained simply by the fact that lower trade costs leads to increased competition. The subsequent decrease in consumer prices reduces the inefficiency caused by imperfect competition in the first place. Ceteris paribus, this means that integration increases the probability that policy coordination results in higher emission taxes.

The relationship between trade costs and the coordination effect on rent-shifting incentives is derived from (27), yielding

$$\frac{\partial}{\partial t}\left(\frac{\partial S^j(\tau_{nc})}{\partial \tau_i}\right) = 2k\frac{2(1-b)+k(2-b)\frac{\partial \tau_{nc}}{\partial t}}{(2-b)^2(2+b)}, \tag{31}$$

from which, when inserting for $\frac{\partial \tau_{nc}}{\partial t}$, we derive

$$\frac{\partial}{\partial t}\left(\frac{\partial S^j(\tau_{nc})}{\partial \tau_i}\right) \tag{32}$$
$$= \frac{4k\left(6-3b-3b^2+b^3+D''(\cdot)\,k^2(1+\alpha)(2-3b)(2-b\alpha)\right)}{(2+b)\left(6+3b-b^2+4D''(\cdot)\,k^2(1+\alpha)(2-b\alpha)\right)(2-b)^2}.$$

A closer inspection of (32) shows that sufficient conditions for economic integration to reduce the coordination effect on rent-shifting incentives, i.e., $\frac{\partial}{\partial t}\left(\frac{\partial S^j(\tau_{nc})}{\partial \tau_i}\right) > 0$, are $b < \frac{2}{3}$ or $D''(\cdot) = 0$. However, with strictly convex damage costs and a sufficiently low degree of product differentiation, the opposite result might hold true. The intuition is somewhat intricate, but still tractable. For a given level of emission taxes, integration implies that incentives for rent-shifting activity in the non-cooperative regime are increased – cf. (18). However, lower trade costs also reduce incentives for using environmental policy to reduce the amount of two-way trade in the coordination regime – cf. (23). For $b < 1$, it turns out that the second effect dominates, implying that product market integration reduces the coordination effect on rent-shifting incentives, and more so the higher the degree of product differentiation, because rent-shifting incentives are then less sensitive to the level of trade costs in the non-cooperative regime. These are the direct effects. However, we are evaluating the coordination effects at the non-coordinated equilibrium, so a reduction of trade costs also implies that τ_{nc} changes. If $\frac{\partial \tau_{nc}}{\partial t}$ is positive, product market integration means that τ_{nc} goes down, which reduces the incentives for rent-shifting in the non-coordinated regime. This reinforces the result that economic integration reduces the coordination effect on rent-shifting incentives.

If $\frac{\partial}{\partial t}\left(\frac{\partial S^j(\tau_{nc})}{\partial \tau_i}\right) > 0$, efficiency and rent-shifting incentives work in opposite directions with respect to the environmental gain of policy coordination when product markets become more integrated. Concerns for product market efficiency put a downward pressure on environmental taxes when national policies are coordinated, but this pressure is reduced when trade costs are lowered. Conversely, the elimination of rent-shifting incentives through policy coordination puts an upward pressure on emission taxes, but this effect is also reduced by economic integration. In this case, the sum of these two effects are generally ambiguous.

Finally, then, let us see how the degree of product market integration determines the coordination effect on environmental incentives. From

(28) we have that

$$\frac{\partial}{\partial t}\left(-\frac{\partial D^j(\tau_{nc})}{\partial \tau_i}\right) = D''(\cdot)\left(\frac{\partial \Omega^j(\tau_{nc})}{\partial \tau_i}\frac{\partial \tau_{nc}}{\partial t} + \frac{\partial \Omega^j(\tau_{nc})}{\partial t}\right)\left(\frac{2k^2(2\alpha - b)}{4-b^2}\right). \tag{33}$$

By inserting for $\frac{\partial \Omega^j(\tau_{nc})}{\partial \tau_i}$, $\frac{\partial \Omega^j(\tau_{nc})}{\partial t}$ and $\frac{\partial \tau_{nc}}{\partial t}$ we derive

$$\begin{aligned} &\frac{\partial}{\partial t}\left(-\frac{\partial D^j(\tau_{nc})}{\partial \tau_i}\right) \\ &= \frac{2k^3 D''(\cdot)(b-2\alpha)\left[\Phi + 4D''(\cdot)k^2(1+\alpha)(2-b)(2-b\alpha)^2\right]}{(2-b)^3(2+b)^2\left[6+3b-b^2+4k^2D''(\cdot)(1+\alpha)(2-b\alpha)\right]}, \end{aligned} \tag{34}$$

where

$$\Phi := 12(1+\alpha)(2-b) - b^2\left(10 - 3b + b^2 + 2\alpha + b^2\alpha - 7b\alpha\right) > 0$$

We can first note that $\frac{\partial}{\partial t}\left(-\frac{\partial D^j(\tau_{nc})}{\partial \tau_i}\right) = 0$ if the marginal social cost of pollution is constant. Since the marginal effect of taxation on total pollution is independent of trade costs, product market integration does not influence the coordination effect on environmental incentives if marginal damage costs are independent of the *level* of pollution. For strictly convex damage costs, however, we see that $\frac{\partial}{\partial t}\left(-\frac{\partial D^j(\tau_{nc})}{\partial \tau_i}\right) > 0$ if $\alpha < \frac{b}{2}$. In this case – when pollution is predominantly local – environmental incentives put a *downward* pressure on emission taxes when national policies are coordinated, due to the elimination of 'pollution-shifting' incentives.[10] A reduction of trade costs implies that total production increases, with an equivalent increase in total emissions. Due to convexity of the damage cost function, higher emissions increase the incentives to shift polluting production to the other country by setting high taxes in the non-coordinated regime. Consequently, lower trade costs imply that the coordination effect increases. All else equal, product market integration then increases the probability – due to purely environmental considerations – that coordination leads to *lower* emission taxes! The 'inverse intuition' applies when $\alpha > \frac{b}{2}$.

In order to derive somewhat more clear-cut answers to the question we pose in this section of the paper, we now proceed by considering a more specific environmental damage cost function, given by $D^i = \frac{d}{2}(\Omega^i)^2$, $d > 0$. With this quadratic cost function, we can derive explicit solutions for equilibrium emission taxes in the two different policy regimes. These are given by

$$\tau_{nc} = \frac{2dk^2(1+\alpha)(2-b)(2-\alpha b)(2-t) - 4 - b^2(1-b-2t)}{(12-5b^2+b^3+4dk^2(1+\alpha)(2-b)(2-\alpha b))k} \tag{35}$$

[10]Remember that $-\frac{\partial D^j(\tau_{nc})}{\partial \tau_i} < 0$ when $\alpha < \frac{b}{2}$.

and

$$\tau_c = \frac{2d(1+\alpha)^2 k^2 (2-t) - 2 + t}{2k\left(1+b+2d(1+\alpha)^2 k^2\right)}. \tag{36}$$

The relationship between the degree of product market integration and the environmental effect of transnational policy coordination can now be summarised as follows

Proposition 3 *(i) With a constant marginal social cost of pollution, product market integration reduces the environmental gain of policy coordination if products are differentiated. (ii) With a quadratic damage cost function, product market integration reduces the environmental gain from policy coordination if*

1. *Pollution is purely local ($\alpha = 0$) and products are differentiated, or*

2. *$\alpha < 1/3$ and products are sufficiently differentiated.*

Proof. (i) Setting $D''(\cdot) = 0$ in (30), (32) and (34) we find that $\frac{\partial}{\partial t}\left(\frac{\partial W^j(\tau_{nc})}{\partial \tau_i}\right) = \frac{3k(1-b)}{(2-b)(6+3b-b^2)} > 0$ iff $b < 1$.

(ii) Using (35) and (36) we find that

$$\frac{\partial(\tau_c - \tau_{nc})}{\partial t}$$
$$= \frac{(2+b)^2\left(3(1-b) + 2dk^2(1+\alpha)(1-b-\alpha(3-b))\right)}{2k(2-b)\left(6+3b-b^2+4dk^2(1+\alpha)(2-\alpha b)\right)\left(1+b+2d(1+\alpha)^2 k^2\right)}.$$

It follows that $\frac{\partial(\tau_c - \tau_{nc})}{\partial t} > 0$ if $b < \overline{b} := \frac{3+2dk^2(1+\alpha)(1-3\alpha)}{3+2dk^2(1+\alpha)(1-\alpha)}$. It is easily verified that $\overline{b} = 1$ if $\alpha = 0$ and $\overline{b} \in (0,1)$ for $\alpha \in (0, 1/3)$. ■

From an environmental perspective, it appears that the process of increased product market integration between countries does not necessarily imply an increased need for transnational policy coordination. This is actually never the case when the social marginal cost of pollution is constant, so that the 'scale effect' of increased integration does not affect the marginal incentives for reducing pollution.[11] But even with a strictly convex damage cost function, increased integration reduces the environmental gain from policy coordination if products are sufficiently differentiated and pollution is predominantly local in nature.

As the above analysis indicates, two different effects contribute to this result. First, lower trade costs reduce the incentives to keep taxes high

[11] Furthermore, since $\frac{\partial \Omega^i(\tau_{nc})}{\partial t} < 0$ (due to the 'scale effect' of integration) it follows that product market integration reduces the *relative* environmental gain from policy coordination even more.

in the coordination regime in order to reduce total outlay on trade costs. Secondly, and perhaps most noteworthy, product market integration increases the incentives for 'pollution-shifting' in the non-coordinated regime if α is sufficiently low, and these incentives are eliminated through policy coordination. Thus, if pollution is predominantly local, product market integration could lower the environmental gain from policy coordination due to purely environmental considerations.

6 Tariffs

We have conducted our analysis under the assumption that product market integration implies a reduction of non-tariff trade costs, which is arguably the most important aspect of economic integration for many industries, at least within free-trade areas such as the EEA. In this section, though, we also want to look briefly into the situation where trade costs also comprise tariffs. We now make the exaggerated assumption that the cost of trade is solely due to tariffs, which are equal for both countries (and given by t). Product market integration (or trade liberalisation) is taken to mean a bilateral reduction of tariffs.

The assumption of trade-costs-as-tariffs changes the analysis through one specific channel, namely the net trade surplus, which is now given by

$$S^i := p_i^j q_i^j - p_j^i q_j^i + t\left(q_j^i - q_i^j\right), \tag{37}$$

the important implication being that $S^i + S^j = 0$. When policies are coordinated, there are no longer any incentives to reduce total trade volumes because all trade costs are recouped as tariff revenues. This has, of course, implications for the effect of policy coordination on rent-shifting incentives. Regarding the impact of trade liberalisation on the environmental effect of coordination, the important difference from the analysis in Section 5 is that efficiency and rent-shifting incentives now work in the same direction. From the first-order condition of the non-cooperative policy game we can show that[12]

$$\frac{\partial}{\partial t}\left(\frac{\partial S^j}{\partial \tau_i}\right) = -2k\frac{b + 2D''(\cdot)\,k^2(2-\alpha b)(1+\alpha)}{\left(6+3b-b^2+4D''(\cdot)\,k^2(2-\alpha b)(1+\alpha)\right)(2-b)^2} < 0 \tag{38}$$

This is highly intuitive. Trade liberalisation increases incentives for rent-shifting in the non-cooperative policy regime, which implies that policy coordination then causes – all else equal – a stronger upward pressure on taxes. At the same time, tariff reductions also reduce the product

[12] To save space, the details of the derivations are not explicitly shown, but the procedure is completely equivalent to the previous analysis, with the re-specification of S^i.

market inefficiency caused by imperfect competition, which implies that policy coordination causes – all else equal – a lower downward pressure on taxes. Consequently, both efficiency and rent-shifting incentives pull in the direction of increasing the environmental gain of coordination when tariffs are reduced. The overall effect of tariff reductions depends thus on the strength of environmental incentives.

If the social cost of pollution is constant, it follows immediately that tariff reductions will increase the environmental gain of policy coordination. With strictly convex damage costs, a general characterisation is hard to obtain, so, once more, we consider the special case of a quadratic damage cost function. In this case it is straightforward to calculate

$$\frac{\partial\left(\tau_c-\tau_{nc}\right)}{\partial t}=-\frac{\left(3-b\right)\left(2+b\right)^2}{2k\left(2-b\right)\left(6+3b-b^2+4k^2d\left(1+\alpha\right)\left(2-b\alpha\right)\right)}<0. \tag{39}$$

Thus, with quadratic damage costs, a tariff reduction always increase the environmental benefit of policy coordination. In other words, if the non-cooperative equilibrium tax rate is below the efficient (second-best) level, trade liberalisation will move the non-cooperative equilibrium outcome further away from the efficient policy. Note that if pollution is predominantly local, so that incentives for pollution-shifting are high in the non-cooperative policy game, trade liberalisation increases the environmental gain of policy coordination *not* because of environmental incentives, but because the other policy incentives (rent-shifting and product market efficiency) increase the upward pressure on emission taxes when national policies are coordinated.

7 Concluding remarks

It is often claimed that the process of international economic integration contributes towards undermining national environmental policy making and increasing incentives for 'eco-dumping'. The obvious response is to call for environmental policies to be transnationally coordinated. In this paper we have studied how the degree of economic integration affects the environmental gain of policy coordination in a context of imperfect competition and reciprocal trade. The analysis rests on the key assumption that – due to free trade agreements – there are more policy goals than instruments. To make things fairly simple, we have focused on an emission tax as the only available policy instruments. However, the important underlying assumptions are that traditional trade policy instruments are prohibited, and that polices aimed at reducing pollution increases the marginal production costs of firms.

Due to the often complex interaction of different policy incentives, there is no clear-cut relationship between the degree of product market integration and the need for environmental policy coordination. In fact, we find that – in many cases – economic integration will actually reduce the environmental gain of policy coordination. This could be the case even if pollution is completely transboundary, provided that the marginal social cost of pollution is increasing at a sufficiently low rate. However, the results are crucially dependent on the assumption that increased economic integration is caused by reductions of non-tariff trade costs.

Even in a fairly stylised modelling set-up there is a lot of strategic interaction, but, obviously, our model is only able to capture a few of the numerous factors that might be relevant in explaining the effect of economic integration on environmental policy incentives. For example, we have conducted our analysis under the assumptions that both the locations of firms (plants), as well as their technologies, are given exogenously. Although outside the scope of the present study, a more comprehensive analysis of the environmental policy implications of increased economic integration should also take these dimensions into account. This is left for further work.

References

[1] Barnett, A.H., 1980. The Pigouvian tax rule under monopoly. American Economic Review 70, 1037-1041.

[2] Barrett, S., 1994. Strategic environmental policy and international trade. Journal of Public Economics, 54, 325-338.

[3] Brander, J.A. and P. Krugman, 1983. A 'reciprocal dumping' model of international trade. Journal of International Economics 15, 313-321.

[4] Brander, J.A. and B.J. Spencer, 1985. Export subsidies and international market share rivalry. Journal of International Economics 18, 83-100.

[5] Burguet, R. and J. Sempere, 2003. Trade liberalization, environmental policy, and welfare. Journal of Environmental Economics and Management 46, 25-37.

[6] Conrad, K., 1993. Taxes and subsidies for pollution-intensive industries as trade policy. Journal of Environmental Economics and Management 25, 121-135.

[7] Copeland, B.R. and M.S. Taylor, 1994. North-south trade and the environment. Quarterly Journal of Economics 109, 755-787.

[8] Copeland, B.R. and M.S. Taylor, 1995. Trade and transboundary pollution. American Economic Review 85, 717-737.

[9] Duval, Y. and S. Hamilton, 2002. Strategic environmental policy and

international trade in asymmetric oligopoly markets. International Tax and Public Finance 9, 259-271.

[10] Greaker, M., 2003. Strategic environmental policy; eco-dumping or a green strategy? Journal of Environmental Economics and Management 45, 692-707.

[11] Hoel, M., 1997. Environmental policy with endogenous plant locations. Scandinavian Journal of Economics 99, 241-259.

[12] Kennedy, P.W., 1994. Equilibrium pollution taxes in open economies with imperfect competition. Journal of Environmental Economics and Management 27, 49-63.

[13] Markusen, J.R., E.R. Morey and N. Olewiler, 1993. Environmental policy when market structure and plant locations are endogenous. Journal of Environmental Economics and Management 24, 69-86.

[14] Markusen, J.R., E.R. Morey and N. Olewiler, 1995. Competition in regional environmental policies when plant locations are endogenous. Journal of Public Economics 56, 55-78.

[15] Naylor, R.A., 1998. International trade and economic integration when labour markets are generally unionised. European Economic Review 42, 1251-1267.

[16] Naylor, R.A., 1999. Union wage strategies and international trade. Economic Journal 109, 102-125.

[17] Rauscher, M., 1994. On ecological dumping. Oxford Economic Papers 46, 822-840.

[18] Tanguay, G.A., 2001. Strategic environmental policies under international duopolistic competition. International Tax and Public Finance 8, 793-811.

[19] Ulph, A., 1996. Environmental policy and international trade when governments and producers act strategically. Journal of Environmental Economics and Management 30, 265-281.

[20] Ulph, A. and L. Valentini, 2001. Is environmental dumping greater when plants are footloose? Scandinavian Journal of Economics 103, 673-688.

[21] Walz, U. and D. Wellisch, 1997. Is free trade in the interest of exporting countries when there is ecological dumping? Journal of Public Economics 66, 275-291.

[22] WTO, 1999. Trade and environment. Special Studies 4, World Trade Organization. WTO Publications, Geneva. (Available from www.wto.org)