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Strategic Environmental and Trade Policies with Corporate Environmentalism

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Abstract

The effects of corporate environmentalism are examined in the framework of strategic environmental and trade policies. An environmentally conscious domestic firm competes with a profit-maximizing foreign firm in a third-country market. When emission taxes and export subsidies are both available, the presence of an environmentally conscious firm does not improve domestic welfare. Such a presence reduces domestic welfare when there is transboundary pollution and strong environmental consciousness. When only emission taxes are available, welfare may fall even if pollution is local. When only export subsidies are available, the presence of an environmentally conscious firm may improve domestic welfare.

Keywords: corporate environmentalism; corporate social responsibility; environmental mixed duopoly; self-regulation; stakeholder approach; strategic environmental and trade policy.

JEL classification: F12; F13; H23; Q28.

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1 Introduction

Corporate environmentalism is growing. Within conventional paradigms, private firms care about the environment only when environmental regulations are implemented. In the real world, however, many private firms voluntarily care about the environment and declare that their products and production processes are environmentally friendly. For example, major Japanese oil companies, such as Cosmo Oil, Nippon Oil, and Showa Shell, implement their own environmental activities. These include the compression of gases associated with oil production in oil fields and their re-injection into the ground, and reductions in emissions at oil refineries.[1] In addition, chemical industry associations in 52 countries currently participate in a voluntary program known as "Responsible Care"®, which aims to improve the industry's environmental, safety, and health performance following the initiative of the International Council of Chemical Associations (ICCA).[2] Under this initiative, chemical industry associations conduct their own environmental activities to reduce emissions and waste and to enhance recycling.

This phenomenon has been analyzed in the framework of *self-regulation* and *voluntary approaches* (Lyon and Maxwell, 2002, 2004; Khanna, 2001; Alberini and Segerson, 2002). Existing studies have shown that profit-maximizing firms that do not really care about the environment voluntarily reduce their emission levels. This is because they

[1] Details of these environmental activities are on the company web sites. Cosmo Oil: http://www.cosmo-oil.co.jp/eng/index.html; Nippon Oil: http://www.eneos.co.jp/; Showa Shell: http://www.showa-shell.co.jp/english/index.html.

[2] Responsible Care® was first established by the Canadian Chemical Producers Association in 1985. The U.S. Chemical Manufacturers Association and the British Chemical Industries Association followed by introducing similar programs in 1989. For details, see the Responsible Care® web site, http://www.responsiblecare.org/.

rationally anticipate the government's introduction or tightening of environmental regulations. Hence, they try to preempt or weaken the future regulations by voluntarily committing to environmentally friendly actions (Lutz *et al.*, 2000; Maxwell *et al.*, 2000; Poyago-Theotoky, 2000; Conrad, 2001; Lyon and Maxwell, 2003).[3] Self-regulation tends to reduce social welfare (Lutz *et al.*, 2000). However, when regulatory and legislative costs are taken into account, self-regulation that preempts or weakens environmental regulation can improve social welfare (Maxwell *et al.*, 2000; Lyon and Maxwell, 2003). Firms also have an incentive to participate in voluntary agreements (VAs) if there are background threats of mandatory control by legislation or cost-sharing subsidies provided by the government (Segerson and Miceli, 1998).[4] Segerson and Miceli (1998) show that a first-best outcome can be achieved under a VA. However, Lyon and Maxwell (2003) demonstrate that, when self-regulation by the industry and the offering of VAs by the government are both considered, public VAs can reduce social welfare by reducing the industry's incentives to engage in self-regulation.

Another channel for corporate environmentalism is the *stakeholder approach* to corporate governance (Freeman, 1984; Blair, 1995; Donaldson and Preston, 1995; Tirole, 2001; Charreaux and Desbrières, 2001). *Stakeholders* are "persons or groups with legitimate interests in procedural and/or substantive aspects of corporate activity" (Donaldson and Preston, 1995: 67), who include creditors, employees, customers, suppliers, public authorities, and shareholders. Pollutees are also included when production generates

[3] An essential feature of this analysis is that firms make decisions before their government implements environmental regulations. Although Petrakis and Xepapadeas (1999) obtain a similar result, they treat the issue as one relating to the credibility of environmental regulations.

[4] Manzini and Mariotti (2003) focus on the negotiation process between the industry and the regulator over VAs.

pollution. In the stakeholder approach, managers make decisions on behalf of all the stakeholders (Jensen, 2001). Firms that adopt the stakeholder approach try to engage in corporate social responsibility (CSR) activities (Baron, 2001). CSR is an "ill- and incompletely defined concept" (Baron, 2001: 9). However, firms engaging in CSR voluntarily address social interests by considering their economic, social, and environmental effects on society. Corporate environmentalism is part of CSR.[5]

Tirole (2001) argues that the stakeholder approach is widely accepted in some European countries (such as France and Germany) and Japan, while the traditional shareholder-value approach is prevalent in Anglo-Saxon countries. The empirical analysis of Nakamura *et al.* (2001) suggests that incorporating aspects of the stakeholder approach into standard models of profit-maximizing firms significantly improves the ability of these models to explain differences in environmental protection behavior among Japanese manufacturing firms. Their results indicate that Japanese firms' environmental commitments depend on the environmental values, beliefs, and attitudes of managers, whereas the costs and benefits of voluntary action on environmental issues are also important determinants. A number of empirical studies also find that stakeholder pressure is important in getting North American firms to voluntarily adopt environmental management systems (Anton *et al.*, 2004; Henriques and Sadorsky, 1996; Khanna and Anton, 2002). Moreover, Dowell *et al.* (2000) and Konar and Cohen (2001) find a significantly positive relationship between environmental performance and market value, as measured by Tobin's q, among firms listed on the S&P 500.[6] This result suggests that firms have

[5]CSR may be motivated by morality or by threats from activists or stakeholders. Baron (2001) refers to the latter as *strategic CSR*.

[6]Dowell *et al.* (2000) find that US-based multinational firms that adopt strict global environmental standards have

an incentive to improve environmental performance, even on behalf of their shareholders.

This paper follows the stakeholder approach to corporate environmentalism. The questions addressed in this paper are as follows. (i) How does corporate environmentalism alter the effects of policy instruments when there is strategic interaction between countries? (ii) Does corporate environmentalism improve domestic social welfare? To address these issues, I develop a model in which one firm that considers environmental damage competes with a standard firm that simply maximizes private profits, in the framework of a third-market trade model with strategic environmental and trade policies.[7] The basic set-up of the model follows that of Walz and Wellisch (1997). I extend their model by including in the objective function of one of the two firms global environmental damage caused by its own emissions.[8] The case in which environmental and trade policy instruments are both available is examined along with those in which only one of the two instruments is available.

The model of this paper is related to the *mixed-duopoly* model, in which a welfare-maximizing public firm interacts with a profit-maximizing private firm (e.g., Cremer *et al.*, 1989; De Fraja and Delbono, 1989; Matsumura, 1998). My model differs from the mixed-duopoly model mainly because one firm maximizes the sum of private profits and environmental quality rather than social welfare. I term this firm the *environmentally conscious firm*. The market structure is termed an *environmental mixed duopoly*.

relatively high market values. Konar and Cohen (2001) find that firms that emit large amounts of toxic chemicals have low market values.

[7]The study of strategic trade policy was pioneered by Brander and Spencer (1985). Studies on strategic environmental policy include Conrad (1993), Barrett (1994), Kennedy (1994a, b), Walz and Wellisch (1997), Tanguay (2001), and Burguet and Sempere (2003).

[8]Although Walz and Wellisch (1997) only consider local pollution, my model incorporates transboundary pollution.

The main results are as follows. I show that the effects of the firm's environmentally friendly behavior depend on both the policy instruments that are available and whether pollution is local or transboundary. First, when governments can use both emission taxes and export subsidies, if pollution is purely local, however environmentally conscious a firm is, social welfare and pollution are the same as when both firms maximize their private profits. This is because environmentally friendly actions are completely offset by adjustments to environmental regulations. Second, if pollution is at least partially transboundary and the firm is sufficiently environmentally conscious, welfare falls in the country in which the environmentally conscious firm is located, relative to the case of the standard profit-maximizing firm. The environmentally conscious firm *overinternalizes* the externality and the government cannot fully *externalize* the overinternalized externality. Consequently, the environmentally conscious firm engages in too much abatement activity, which reduces domestic welfare. Third, when governments can only use emission taxes, the presence of an environmentally conscious firm may reduce domestic welfare even if pollution is local. However, when only export subsidies are available, the presence of an environmentally conscious firm can improve domestic welfare. In this case, the presence of an environmentally conscious firm enables the government to implement the first-best policy by using only one policy instrument.

The rest of the paper is organized as follows. Section 2 develops the model. Section 3 analyzes the effects of the presence of an environmentally conscious firm on social welfare when emission taxes and export subsidies are both available. Section 4 investigates the cases in which only one instrument is available. Section 5 concludes the paper.

2 The Model

I examine a model in which a home and a foreign firm export a homogenous good to a third market. An asterisk ($*$) is used to represent foreign variables. The basic set-up of the model follows that of Walz and Wellisch (1997). The production of each unit of output x and x^* generates a constant per unit emission of e. Each firm can reduce emissions by abatement efforts. In order to reduce the fraction $a \in [0,1]$ per emission unit, the firm incurs an abatement cost of $c(a)e$ per unit of output, where $c'(a) > 0$ and $c''(a) > 0$. The home and foreign governments impose emission taxes t and t^*, respectively, on each unit of the remaining emissions and also provide an export subsidy s and s^* per unit of output, respectively.[9] An important assumption is that emission taxes must be non-negative, i.e., $t, t^* \geq 0$. This is because emission *subsidies* are not feasible politically. Export subsidies, on the other hand, can be positive or negative, which means that an export *tax* is not ruled out.

Pollution causes damage, which is experienced by the consumers in each exporting country who have no demand for the good. I extend the Walz and Wellisch (1997) model to allow transboundary pollution. Environmental damage in the home and foreign countries is respectively given by

$$D(E, E^*; \alpha) = \hat{D}(E) + \tilde{D}(\alpha E^*) \qquad \text{and} \qquad D^*(E, E^*; \alpha) = \tilde{D}^*(E^*) + \hat{D}^*(\alpha E),$$

where $E = e(1-a)x$ and $E^* = e(1-a^*)x^*$ are the total emissions generated by the home and foreign firms, respectively, and $\alpha \in [0,1]$ measures how much the local environment is affected by the emissions of the other country. If $\alpha = 0$, pollution is local. If $\alpha = 1$,

[9] In section 4, each government is restricted to use only one of the two instruments.

pollution is completely transboundary. I assume that $\hat{D}'(\cdot) > 0, \hat{D}''(\cdot) \geq 0$, and $\hat{D}(0) = 0$, and that similar properties hold for $\tilde{D}(\cdot), \tilde{D}^*(\cdot)$, and $\hat{D}^*(\cdot)$.

The home firm is *environmentally conscious*. That is, the firm considers (either partially or completely) the global environmental damage caused by emissions from its own production process. Hence, the home firm's objective function is

$$\pi - \theta \left(\hat{D}(E) + \hat{D}^*(\alpha E) \right), \tag{1}$$

where π is private profits and $\theta \in [0, 1]$ represents the home firm's degree of environmental consciousness (which is exogenously given). Although the home firm maximizes (1), it operates as long as its private profits are non-negative, i.e., $\pi \geq 0$. The home firm's objective function is given by (1) because it adopts (partially or completely) the stakeholder approach to corporate governance.[10]

The foreign firm is a standard private profit maximizer and maximizes its private profits π^*.

The structure of the game is as follows. In stage 1, the home and foreign governments simultaneously choose available policies. In stage 2, the two firms simultaneously choose outputs and abatement levels.

[10] It is possible to model explicitly the process for the home firm to internalize its externality by assuming, for example, pressure from stakeholders. Alternatively, the home firm may face pressure from environmental activists. For example, Baron (2001) and Cespa and Cestone (2002) show that in response to a threat from activists, firms voluntarily internalize part of their externalities. However, since it is beyond the scope of this paper to endogenously determine the value of θ, I do not explicitly model the home firm's choice of θ.

3 Emission Taxes and Export Subsidies Are Both Available

3.1 Firm behavior

I start by examining stage 2. The home and foreign firms' private profits are respectively given by

$$\pi = R(x, x^*) - C(x) + \{s - c(a)e - te(1-a)\}x, \tag{2}$$

$$\pi^* = R^*(x, x^*) - C(x^*) + \{s^* - c(a^*)e - t^*e(1-a^*)\}x^*, \tag{3}$$

where $R(x, x^*)$ and $C(x)$ (and $R^*(x, x^*)$ and $C(x^*)$) denote the home (and foreign) firm's revenue and cost functions, respectively. I assume that $R_x > 0$, $R_{x^*} < 0$, $R_{xx} < 0$, and $R_{xx^*} < 0$, where subscripts denote partial derivatives; i.e., $R_x \equiv \partial R(x, x^*)/\partial x$, $R_{xx^*} \equiv \partial^2 R(x, x^*)/\partial x \partial x^*$, and so on. The last inequality implies that the outputs are *strategic substitutes*. I also assume that $C'(\cdot) > 0$ and $C''(\cdot) \geq 0$. I assume analogous conditions for the foreign revenue and cost functions.

Since the home firm maximizes (1), the first-order conditions (FOCs) are given by $\pi_x - \theta\gamma(E;\alpha)E_x = 0$ and $\pi_a - \theta\gamma(E;\alpha)E_a = 0$, where

$$\gamma(E;\alpha) \equiv \hat{D}'(E) + \alpha\hat{D}^{*\prime}(\alpha E) \tag{4}$$

is marginal global damage caused by the home firm's emissions. These FOCs respectively yield

$$R_x - C'(x) + s - c(a)e - te(1-a) - \theta\gamma(E;\alpha)e(1-a) = 0, \tag{5}$$

$$t - c'(a) + \theta\gamma(E;\alpha) = 0. \tag{6}$$

The second-order conditions (SOCs) are satisfied because $\pi_{xx} - \theta\gamma'(E,\alpha)(E_x)^2 - \theta\gamma(E,\alpha)E_{xx} < 0$, where $\gamma'(E,\alpha) \equiv \hat{D}''(E) + \alpha^2\hat{D}^{*\prime\prime}(\alpha E) \geq 0$, and $\pi_{aa} - \theta\gamma'(E,\alpha)(E_a)^2 -$

$\theta\gamma(E,\alpha)E_{aa} < 0$. Since the foreign firm maximizes (3), the FOCs are given by

$$R^*_{x^*} - C'(x^*) + s^* - c(a^*)e - t^*e(1-a^*) = 0, \tag{7}$$

$$t^* - c'(a^*) = 0. \tag{8}$$

Similarly to those of the home firm, SOCs of the foreign firm are satisfied.

Totally differentiating (5) and (7), and using (6) and (8), yields

$$dx/dt = -e(1-a)dx/ds = e(1-a)\pi^*_{x^*x^*}/\Omega < 0, \tag{9}$$

$$dx/dt^* = -e(1-a^*)dx/ds^* = -e(1-a^*)\pi_{xx^*}/\Omega > 0, \tag{10}$$

$$dx^*/dt = -e(1-a)dx^*/ds = -e(1-a)\pi^*_{x^*x}/\Omega > 0, \tag{11}$$

$$dx^*/dt^* = -e(1-a^*)dx^*/ds^* = e(1-a^*)\pi_{xx}/\Omega < 0, \tag{12}$$

where $\Omega \equiv \pi_{xx}\pi^*_{x^*x^*} - \pi_{xx^*}\pi^*_{x^*x}$ is assumed to be positive for stability. These results confirm those obtained by Walz and Wellisch (1997).

3.2 Strategic environmental and trade policies

I now turn to stage 1. Social welfare in each exporting country comprises the domestic firm's private profits minus domestic environmental damage and the social cost of the export subsidy plus tax revenue from the emission tax. Thus, home welfare is given by

$$W = \pi - D - sx + te(1-a)x.$$

Note that the consumer surplus is not included in W because there is no domestic demand for the good. Foreign welfare is defined analogously. Each government chooses the emission tax and the export subsidy to maximize its domestic social welfare, taking the other country's emission tax and export subsidy as given.

The FOCs for the home government are

$$\frac{dW}{ds} = (\pi_{x^*} - D_{x^*})\frac{dx^*}{ds} - s\frac{dx}{ds} + e(1-a)\frac{dx}{ds}\left\{t - \hat{D}'(E) + \theta\gamma(E;\alpha)\right\} = 0, \quad (13)$$

$$\frac{dW}{dt} = -e(1-a)\frac{dW}{ds} - ex\frac{da}{dt}\left\{t - \hat{D}'(E) + \theta\gamma(E;\alpha)\right\} \leq 0, \quad (14)$$

which make use of (5) and (6). Similarly, the FOCs for the foreign government are given by

$$\frac{dW^*}{ds^*} = (\pi^*_x - D^*_x)\frac{dx}{ds^*} - s^*\frac{dx^*}{ds^*} + e(1-a^*)\frac{dx^*}{ds^*}(t^* - \tilde{D}^{*'}(E^*)) = 0, \quad (15)$$

$$\frac{dW^*}{dt^*} = -e(1-a^*)\frac{dW^*}{ds^*} - ex^*\frac{da^*}{dt^*}(t^* - \tilde{D}^{*'}(E^*)) \leq 0, \quad (16)$$

which make use of (7) and (8). The foreign country's optimal non-cooperative emission tax, $\hat{t}^*$, is obtained by substituting (15) into (16), as follows:

$$\hat{t}^* = \tilde{D}^{*'}(E^*). \quad (17)$$

The foreign country's optimal non-cooperative export subsidy, $\hat{s}^*$, is obtained by substituting (10) and (12) into (15), as follows:

$$\hat{s}^* = -\frac{(\pi^*_x - D^*_x)\pi_{xx^*}}{\pi_{xx}} > 0. \quad (18)$$

These optimal policies are qualitatively the same as those obtained by Walz and Wellisch (1997), except for the effect of transboundary pollution.[11] If pollution is purely local, Eq. (18) becomes $\hat{s}^* = -\pi^*_x\pi_{xx^*}/\pi_{xx}$, which is the same as the corresponding equation in Walz and Wellisch. However, if pollution is at least partially transboundary, a higher export subsidy would be optimal because $\pi^*_x < 0$ and $D^*_x > 0$. This result is straightforward because a higher export subsidy reduces the home firm's output. When pollution is

[11] Note that Walz and Wellisch (1997) consider only local pollution.

transboundary, the subsidy also reduces pollution from the home country. Thus, the foreign government has an additional incentive to raise its export subsidy.

This result shows that, when two policy instruments are available and the government can commit to policies before firms make decisions, the two policy instruments play separate roles. That is, the emission tax is used to internalize marginal local damage and the positive export subsidy is used to shift rents from the rival firm to its domestic firm and reduce transboundary pollution from abroad.[12] Note that this emission tax is not efficient from a global point of view if pollution is transboundary, since the transboundary externality is ignored.

3.3 Local pollution

To examine the home government's optimal non-cooperative policies, it is useful to distinguish between two cases: (i) pollution is purely local; and (ii) pollution is at least partially transboundary. I first consider the case in which pollution is purely local, i.e., $\alpha = 0$. In this case, the home government's FOCs (13) and (14) together with (9) and (11) yield the following optimal non-cooperative emission tax and export subsidy:

$$\hat{t} = (1-\theta)\hat{D}'(E), \tag{19}$$

$$\hat{s} = -\frac{\pi_{x^*}\pi^*_{x^*x}}{\pi^*_{x^*x^*}} > 0, \tag{20}$$

respectively. Note that, since $\theta \in [0,1]$, then $\hat{t} \in [0, \hat{D}'(E)]$. As seen in the foreign government's policies, the two instruments play distinct roles. The formula of the optimal emission tax (19) differs from its foreign counterpart (17). However, the tax fully

[12] Similar results are obtained by Kennedy (1994b) in the context of emission taxes and production subsidies and by Spencer and Brander (1983) in the context of R&D subsidies and export subsidies.

internalizes the marginal environmental damage, as shown in the following lemma.

Lemma 1 *When $\alpha = 0$, the optimal non-cooperative emission tax in the home country is chosen so that the marginal environmental damage is fully internalized.*

Proof. Substituting the optimal emission tax (19) into the home firm's FOC (6) and setting $\alpha = 0$ yields

$$c'(a) = \hat{D}'(E). \tag{21}$$

That is, abatement effort is chosen so that the marginal abatement cost is equal to the marginal environmental damage. □

This lemma implies that when the firm is environmentally conscious and is willing to voluntarily undertake more abatement activity, the environmental policy is adjusted so that self-regulation by the firm is taken into account. In fact, when the home firm completely internalizes the local environmental damage (when $\theta = 1$) the optimal emission tax is zero.

Since the emission tax is adjusted in the manner specified in Lemma 1, I obtain the following result.

Proposition 1 *When $\alpha = 0$, social welfare and pollution are unaffected by how environmentally conscious is the firm.*

Proof. The home firm's abatement activity level in equilibrium, $\hat{a}$, is determined by (21), which is independent of θ. Substituting $\hat{a}$, the optimal emission tax (19), and the optimal export subsidy (20) into the home firm's other FOC (5) yields

$$R_x(x, x^*) - C'(x) + \hat{s} - c(\hat{a})e - \hat{D}'(e(1-\hat{a})x)e(1-\hat{a}) = 0,$$

which is also independent of θ. Thus, in equilibrium, variables are independent of θ. $\square$

This result implies that when pollution is purely local, the home firm's environmental consciousness only reduces the emission tax and has no effect on environmental damage or social welfare.

3.4 Transboundary pollution

I now consider the case in which pollution is at least partially transboundary. When $\alpha > 0$, the home government's FOCs (13) and (14), together with (9) and (11), yield the optimal non-cooperative emission tax and export subsidy, respectively, as follows:

$$\tilde{t} = \max\left\{\hat{D}'(E) - \theta\gamma(E;\alpha),\ 0\right\}, \tag{22}$$

$$\tilde{s} = -\frac{(\pi_{x^*} - D_{x^*})\pi^*_{x^*x}}{\pi^*_{x^*x^*}} + \max\left\{e(1-a)(\theta\gamma(E;\alpha) - \hat{D}'(E)),\ 0\right\}. \tag{23}$$

The assumption that emission taxes are non-negative is crucial for these optimal policies. The optimal policies depend on whether the home firm's degree of environmental consciousness θ is smaller than the ratio of marginal local damage $\hat{D}'(E)$ to marginal global damage $\gamma(E;\alpha)$. When $\theta \leq \hat{D}'(E)/\gamma(E;\alpha)$, the optimal emission tax is given by an interior solution and the result is qualitatively similar to that in the case of local pollution. That is, there is a clear distinction between the roles of the two instruments and the optimal emission tax is adjusted so that marginal local damage is internalized.

When $\theta > \hat{D}'(E)/\gamma(E;\alpha)$, on the other hand, the optimal emission tax is given by a corner solution, and hence, is equal to zero. In this case, the environmentally conscious home firm *overinternalizes* the externality from the home government's viewpoint. This is because, in the non-cooperative setting, the home government cares about only

local damage from pollution, whereas the environmentally conscious home firm considers global damage. When the home firm overinternalizes the externality, the optimal emissions policy is an *emission subsidy*, which *externalizes* part of the overinternalized externality. However, since an emissions subsidy is not feasible, the home government sets $t = 0$, which is the lowest possible emission tax. At the same time, the home government chooses a higher export subsidy. This is because, in addition to the rent-shifting motive, an export subsidy also contributes to externalizing the pollution.

These results are summarized in the following lemma.

Lemma 2 *Suppose that* $\alpha > 0$. *Then, (i) if* $\theta \leq \hat{D}'(E)/\gamma(E;\alpha)$, *the optimal non-cooperative emission tax in the home country is chosen so that the marginal damage is completely internalized. (ii) If* $\theta > \hat{D}'(E)/\gamma(E;\alpha)$, *the optimal non-cooperative emission tax in the home country is zero. At the same time, a higher export subsidy is chosen.*

Proof. For the first part of the lemma, substituting the first element in the bracket in (22) into the home firm's FOC (6) yields

$$c'(a) = \hat{D}'(E).$$

The second part is proved by substituting $\theta > \hat{D}'(E)/\gamma(E;\alpha)$ into (22) and (23). □

Note that when $\theta = \hat{D}'(E)/\gamma(E;\alpha)$, the externality that is internalized by the environmentally conscious home firm is equivalent to the local environmental damage, and hence, the optimal emission tax is zero.

Unlike in the case of local pollution, when pollution is at least partially transboundary, the presence of an environmentally conscious firm may have some effect on the exporting

country's social welfare. In fact, a sufficiently environmentally conscious home firm reduces home welfare, as the following proposition states.

Proposition 2 *Suppose that* $\alpha > 0$. *If* $\theta > \hat{D}'(E)/\gamma(E;\alpha)$, *home welfare is lower when the home firm is environmentally conscious than when it is a profit maximizer.*

Proof. Substituting $\tilde{t} = 0$ into the home firm's FOC (6) yields

$$c'(a) = \theta\gamma(E;\alpha). \tag{24}$$

Let $\tilde{a}$ be the abatement level that satisfies (24). Since $\theta > \hat{D}'(E)/\gamma(E;\alpha)$, it holds that $\theta\gamma(E;\alpha) > \hat{D}'(E)$. Then, since $c''(a) > 0$, it follows that $\tilde{a} > \hat{a}$, where $\hat{a}$ is defined by (21). Now, it follows that

$$dW/da = -(c'(a) - \hat{D}'(E))ex.$$

Then, evaluating dW/da at $a = \tilde{a}$ yields

$$dW/da|_{a=\tilde{a}} = -(\theta\gamma(E;\alpha) - \hat{D}'(E))ex < 0.$$

A lower abatement improves social welfare because $d^2W/da^2 = -c''(a)ex < 0$. □

The welfare loss arises from the home firm's overinvestment in abatement activity. As already discussed, since the environmental policy cannot be used to externalize the externality, the export subsidy plays this role. However, since the export subsidy is a less efficient policy instrument for controlling pollution due to the production of goods, the export subsidy is not a perfect substitute for the emission tax. Hence, replacing a (negative) emission tax with an export subsidy leads to overinvestment in abatement

efforts, and hence, reduces home welfare.[13]

Proposition 2 implies that corporate environmentalism may reduce domestic welfare.

4 Only One Instrument Is Available

In the previous section, I investigated the effects of corporate environmentalism when each government can use both emission taxes and export subsidies. In this section, I examine the cases in which each government can use only one of the two policy instruments.

4.1 Emission taxes only

I first consider the case in which each government can use only an emission tax. Since export subsidies are prohibited under the GATT/WTO rule, this case would be realistic.

In this case, the foreign government's FOC is given by (16) with $s^* = 0$, which yields

$$t^{*e} = \tilde{D}^{*'}(E^*) + \Lambda^*, \tag{25}$$

where

$$\Lambda^* = \frac{(\pi_x^* - D_x^*)(1-a^*)\pi_{xx^*}/\Omega}{e(1-a^*)^2\pi_{xx}/\Omega - x^*(da^*/dt^*)} < 0.$$

Λ^* has a negative sign because $\pi_x^* - D_x^* < 0$, $\pi_{xx^*} < 0$, $\Omega > 0$, $\pi_{xx} < 0$, and $da^*/dt^* > 0$. I assume that $\tilde{D}^{*'}(E^*) > -\Lambda^*$ so that $t^{*e} > 0$. This result implies that if an emission tax is the only available instrument, it is optimal for the foreign government to set the emission tax below the marginal local damage. This is a well-known result from the literature on

[13] Petrakis and Xepapadeas (1999) also show that self-regulation causes overinvestment in abatement activity and reduces social welfare in the framework of a monopoly in a closed economy. In their model, the key determinant of overinvestment is the government's inability to precommit to an emission tax.

strategic environmental policy (Barrett, 1994; Conrad, 1993; Kennedy, 1994a). That is, rent shifting motivates the government to impose a strategically lower emission tax than the environmentally optimal level.

The FOC for the home government is given by (14) with $s = 0$, which yields

$$t^e = \max\{\hat{D}'(E) - \theta\gamma(E;\alpha) + \Lambda,\ 0\}, \tag{26}$$

where

$$\Lambda = \frac{(\pi_{x^*} - D_{x^*})(1-a)\pi^*_{x^*x}/\Omega}{e(1-a)^2\pi^*_{x^*x^*}/\Omega - x(da/dt)} < 0.$$

As in the case of the foreign country, I assume $\hat{D}'(E) > -\Lambda$. When $\theta \geq \hat{D}'(E)/\gamma(E;\alpha)$, the optimal emission tax is $t^e = 0$. This is because a negative t is not feasible.

The welfare effects of corporate environmentalism are most clearly seen when $\alpha = 0$ and $\theta = 1$, as shown in the following proposition.

Proposition 3 *Suppose that each government can use only an emission tax. If $\alpha = 0$ and $\theta = 1$, the optimal emission tax for the home government is $t^e = 0$. In this case, home welfare is lower than when the home firm is a profit maximizer.*

Proof. When $\alpha = 0$ and $\theta = 1$, from (26), it follows that $t^e = 0$ since $\Lambda < 0$. In the home government's FOC (14), $t^e - \hat{D}'(E) + \theta\gamma(E;\alpha) = \Lambda$ for all θ. Thus, (14) is independent of θ. This implies that home welfare when $\theta = 0$ and $t^e = \hat{D}'(E) + \Lambda$ is the same as home welfare when $\theta = 1$ and $t^e = \Lambda$. Thus, home welfare when $\theta = 1$ and $t^e = 0$ is lower than home welfare when $\theta = 0$ and $t^e = \hat{D}'(E) + \Lambda$. □

As in the case where governments can use two instruments, the home firm's environmental consciousness fails to improve home welfare when an emission tax is the govern-

ment's only available policy instrument. As shown in Proposition 3, the home firm's environmental consciousness actually lowers home welfare for some parameter values.

Unlike in Proposition 2, welfare losses could arise even when pollution is local. This is because complete internalization of the local externality is not optimal from the home government's viewpoint. Instead, partial internalization is optimal for strategic purposes. When the home firm commits to complete internalization of the externality, the home government's ability to use strategic environmental policy is restricted, and hence, home welfare is reduced.

4.2 Export subsidies only

I now consider the case in which each government can use only an export subsidy. In practice, it is difficult to introduce emission taxes because interest groups strongly lobby against their introduction. In such a case, the government may not be able to use emission taxes.

In this case, the foreign government's FOC is given by (15) with $t^* = 0$, which yields

$$s^{*x} = -\frac{(\pi^*_x - D^*_x)\pi_{xx^*}}{\pi_{xx}} - e(1-a^*)\tilde{D}^{*\prime}(E^*). \tag{27}$$

This export subsidy is lower than that given by (18). The reason is as follows. When an emission tax is not available, an export subsidy must be used in part to deal with local pollution. Consequently, it is optimal for the foreign government to set an export subsidy that is lower than the pure rent-shifting export subsidy.

The home government's FOC is given by (13) with $t = 0$, which yields

$$s^x = -\frac{(\pi_{x^*} - D_{x^*})\pi^*_{x^*x}}{\pi^*_{x^*x^*}} - e(1-a)\left(\hat{D}'(E) - \theta\gamma(E;\alpha)\right). \tag{28}$$

Unlike in the context of the foreign government's policies, s^x is *higher* than the pure rent-shifting export subsidy when $\theta > \hat{D}'(E)/\gamma(E;\alpha)$, whereas it is lower than the pure rent-shifting export subsidy when $\theta < \hat{D}'(E)/\gamma(E;\alpha)$. A higher export subsidy may be chosen for the reason given in the context of (23). That is, since the home firm overinternalizes the externality and because emission subsidies are not available, the export subsidy is also used for externalizing the overinternalized externality.

A surprising result is that the home firm's environmental consciousness can improve home welfare in this case, as stated in the following proposition.

Proposition 4 *Suppose that each government can use only an export subsidy. If* $\alpha = 0$ *and* $\theta = 1$*, the optimal export subsidy for the home government is given by* $s_1^x = (\pi_{x^*} - D_{x^*})\pi^*_{x^*x}/\pi^*_{x^*x^*}$*. In this case, home welfare is higher than when the home firm is a profit maximizer.*

Proof. See Appendix. □

This result contrasts sharply with that in the case in which two policy instruments are available, and that in the case in which only emission taxes are available. In these cases, the home firm's environmental consciousness fails to improve home welfare. In the current case, the presence of an environmentally conscious firm may actually *improve* home welfare. The intuition is as follows. When the government can only use an export subsidy, it uses the export subsidy both to shift rents and internalize the local externality. However, as is well known from the theory of distortions (Bhagwati, 1971), the first-best policy requires two instruments. Since the export subsidy is a less efficient instrument for dealing with the externality, the export subsidy is only used as a second-best policy in

this situation. By contrast, the home firm's voluntary internalization of the externality plays the role of the policy instrument used to address the distortion (emissions in this case) in the market. Consequently, given an environmentally conscious firm, the home government may be able to implement the first-best policy despite the fact that only one instrument is available.

Note that when pollution is transboundary and the home firm's environmental consciousness is high, the result in Proposition 4 no longer holds. Since the home firm overinternalizes the externality in that case, the home government must use an export subsidy to both shift rents and externalize the overinternalized externality (see (ii) in Lemma 2), which reduces welfare.

5 Conclusions

In this paper, I have examined the effects of environmentally friendly behavior by firms in the framework of strategic environmental and trade policies. I have assumed that an environmentally conscious firm is located in the home country and a profit-maximizing firm is located in the foreign country and that these firms compete in a third-country market. I have examined the case in which emission taxes and export subsidies are both available, and also the cases in which only one of the two instruments is available.

In the case in which both policy instruments are available, I have shown that when pollution is purely local, or when the home firm has a low degree of environmental consciousness, the optimal non-cooperative emission tax in the home country is adjusted so that the marginal local environmental damage is completely internalized. As a result,

the home firm's environmental consciousness has no effect on social welfare or pollution.

However, when pollution is at least partially transboundary and the home firm is sufficiently environmentally conscious, social welfare in the home country is reduced by the presence of an environmentally conscious firm. This is because the environmentally conscious home firm overinternalizes the externality and the home government cannot completely externalize the overinternalized externality. For this, emission subsidies are required but are not feasible. Export subsidies are used instead. However, since export subsidies are less efficient in controlling pollution, the home firm overinvests in abatement, which reduces home welfare.

When governments can only use export subsidies, the presence of an environmentally conscious firm may improve home welfare. This is because when the home firm voluntarily internalizes the externality, the home government may be able to implement the first-best policy by using only one policy instrument tool. This is not possible when the firm maximizes profits.

The results in this paper suggest that corporate environmentalism may strengthen or weaken the effects of environmental and trade policies. Their effects depend on various factors such as the availability of policy instruments and the nature of pollution. Thus, in the presence of corporate environmentalism, it is important for policy makers to take into account private firms' voluntary actions.

Corporate environmentalism may also alter the effects of other public policies. My future task is to investigate the effects of corporate environmentalism in other contexts.

A Appendix: Proof of Proposition 4

The optimal export subsidy with $\alpha = 0$ and $\theta = 1$, which is denoted as s_1^x, is obtained by substituting $\alpha = 0$ and $\theta = 1$ into (28). With $\alpha = 0$ and $\theta = 1$, evaluating the home government's FOCs (13) and (14) at $t = 0$ and $s = s_1^x$ yields

$$\begin{aligned} \left.\frac{dW}{ds}\right|_{t=0,\ s=s_1^x} &= (\pi_{x^*} - D_{x^*})\frac{dx^*}{ds} - s_1^x\frac{dx}{ds} = 0, \\ \left.\frac{dW}{dt}\right|_{t=0,\ s=s_1^x} &= -e(1-a)\left.\frac{dW}{ds}\right|_{t=0,\ s=s_1^x} = 0. \end{aligned}$$

Thus, setting $s = s_1^x$ with $\alpha = 0$, $\theta = 1$, and $t = 0$ is equivalent to optimally choosing both t and s for any θ.

Substituting $\alpha = 0$ and $\theta = 0$ into (28) reveals that the optimal export subsidy with $\alpha = 0$ and $\theta = 0$ is given by

$$s_0^x = -\frac{(\pi_{x^*} - D_{x^*})\pi^*_{x^*x}}{\pi^*_{x^*x^*}} - e(1-a)\hat{D}'(E)$$

With $\theta = 0$, from (14), it follows that

$$\frac{dW}{dt} = -e(1-a)\frac{dW}{ds} - ex\frac{da}{dt}(t - \hat{D}'(E)).$$

Evaluating dW/dt at $t = 0$ and $s = s_0^x$ yields

$$\begin{aligned} \left.\frac{dW}{dt}\right|_{t=0,\ s=s_0^x} &= -e(1-a)\left.\frac{dW}{ds}\right|_{t=0,\ s=s_0^x} + ex\hat{D}'(E)\frac{da}{dt} \\ &= ex\hat{D}'(E)\frac{da}{dt} > 0. \end{aligned}$$

This implies that for $s = s_0^x$, $t > 0$ is optimal.

Home welfare must be higher when t and s are optimally chosen than when they are not. Therefore, provided that the home government optimally chooses its export subsidy, home welfare is higher when $\theta = 1$ than when $\theta = 0$. □

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