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Hattori, Keisuke

Department of Economics, Osaka University of Economics, JAPAN

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Keisuke Hattori*

Department of Economics, Osaka University of Economics, Japan

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Abstract.

In this paper, we construct a political-economy model of international noncooperative environmental policymaking, and examine the strategic incentives for voters to elect an environmental policymaker in open economies. We show that under several circumstances, citizens have an incentive to deliberately vote for a candidate whose environmental preferences differ from their own. Further, the strategic voting incentives are crucially depend on the environmental policy tools employed by the government, the international market structures, and the degree of product differentiation among firms.

Key words: strategic voting, the race to the bottom, market structure, environmental policy

JEL classifications: F18; D72; D43

1. Introduction

In recent years, the international aspect of environmental policy has been a significant factor

* *E-mail address:* hattori@osaka-ue.ac.jp

in international and national politics. As for the international aspects, the Kyoto Protocol on combating global warming is an archetypal example. Another example is that the negotiations on trade and environmental issues are becoming more prominent in policy discussions constituting a larger part of the World Trade Organization (WTO). With regard to domestic politics, environmental issues often occupy an important position in several policy pledges and elections.[1] Some citizens are interested not only in the national but also the global environment, and expect elected politicians to demonstrate the country's initiative in making environmental policies on international environmental problems.

It is well known that there are considerable strategic relationships among countries for policymaking with regard to global environmental problems. In this context, previous theoretical studies have shown that, taking international trade and transboundary pollution into account, governments may have the following two types of incentives to impose ineffectively less stringent environmental regulations: ecological-dumping and free-riding incentives.[2] The former represents government incentives to relax domestic environmental regulations for the purpose of shifting profits from foreign to domestic firms, and the latter represents them for the purpose of free-riding on a foreign country's efforts to reduce transboundary pollution. Thus, the noncooperative behavior of governments may conceptually lead to a "race to the bottom" in environmental policymaking.

If voters in democratic countries can perceive the above intergovernmental interdependencies and can anticipate how their choice of a policymaker influences the foreign country's policy, then, in some elections, they might strategically elect policymakers who institute environmental policies. This strategic voting of democratic people may change the strategic relationships among governments and hence the behavior of governments. In the context of the relationship between political systems and environmental policies, for example, Congleton (1992) empirically shows that authoritarian regimes will adopt less stringent domestic environmental standards than democratic regimes. Furthermore, Murdoch and Sandler (1997) present evidence that the ex-

tent of political and civil freedoms had a positive impact on reductions in CFC emissions in the late 1980s. These results provide evidence for the relationship between the democratic political system and environmental policies set under it.[3]

What influence does the democratic process have on the strategic relationship with regard to environmental policies among governments? Siqueria (2003) constructs a two-country delegation model where voters in each country elect a policymaker who noncooperatively implements a consumption tax on the emission generating goods at a later stage. In this framework, he shows that the median-voter will tend to prefer a policymaker who lays less emphasis on environmental pollution than he or she does, and overall, the outcome will be inferior to the one derived in the absence of delegation (or election). Subsequently, Buchholz et al. (2005) construct a model where each government that is democratically elected by its citizens decides its outputs of environmentally-harmful products cooperatively or noncooperatively, and compare the outcome under a cooperative policy (an international environmental agreement) with that under a noncooperative policy. They also show that voters strategically choose their policymaker who is less eco-friendly than the voters themselves in both cases. In other words, the strategic voting intensifies the free-riding incentives of governments and hence worsens the situation. Furthermore and surprisingly, they show that the the elected politicians can be greener, pollution can be lower, and the median-voter's payoff can be higher in the case where policies are noncooperatively decided by each government than in the case of international policy cooperation with bargaining. However, since the above literature focuses on the strategic interaction between governments, their investigation does not consider the strategic behavior of firms in an international market. Given that the strategic interaction of firms may affect the above pessimistic results, the democratic political system might worsen the situation.

Recently, Roelfsema (2007) investigated the citizen's incentives for strategic voting in a model with strategic relationships both among governments and among firms.[4] Taking the firms' strategic interaction into consideration, governments conceptually have incentives of "ecological-

dumping" and "free-riding," which leads to a race to the bottom in environmental policymaking, as mentioned above. However, the race to the bottom arguments have little empirical support.[5] Roelfsema (2007) has suggested that the strategic behavior of voters might be a possible explanation for the discrepancy between theory and evidence regarding the race to the bottom. He constructed a two-country model where citizens in each country strategically elect a politician who sets and imposes an emission tax on its domestic firms, and showed that citizens may have an incentive to elect a policymaker who is more concerned about the environment than they are. Contrary to the results of Buchholz et al. (2005), strategic voting may mitigate the race to the bottom in the noncooperative environmental tax setting. However, Roelfsema's analysis only considers the case where firms produce and sell homogenous goods à la Cournot and policymakers implement an emission tax as a means of regulation. Thus, the effects of product differentiations, alternative market structures, and other policy instruments on the strategic voting remain unresolved.

In this paper, a three-stage game involving firms, elected policymakers, and voters in two countries is developed to address the issue. In particular, the citizens in each country elect a policymaker by means of majority rule in stage 1. In stage 2, the elected policymaker in each country noncooperatively decides on domestic environmental policies (either taxes or standards). In stage 3, given the domestic environmental regulations, the representative firm in each country produces and sells the differentiated goods in a world market a la Cournot or Bertrand. The investigations in this paper differ from the above mentioned previous works in the following aspects. First, by incorporating the notion of product differentiation into Roelfsema's political-economy model, our framework covers all degree of product differentiations between domestic and foreign products. This enables us to examine the relationship between the market competitiveness and the voters' incentives for strategic voting. Second, we consider both the emission tax (price regulation) and the emission standard (quantity regulation) as the elected policymakers' policy tools. Third, this paper also considers alternative market structures, that is, Bertrand as well as

Cournot.

As a result of the investigations, we find that the outcome of strategic voting crucially depends on the policy instruments, market structures, and degree of product differentiations. In particular, we obtain the following results. First, under Cournot competition, citizens in each country deliberately vote for a more (or less) green candidate who employs an emission tax policy as an environmental regulation. Electing a policymaker who has higher (or lower) environmental awareness credibly commits the country to setting a higher (or lower) tax rate, and hence, it affects the foreign tax policy. Taking these factors into account, citizens may strategically vote for a candidate whose environmental preferences differ from their own. In particular, the higher the degree of market competition and environmental externalities, the more likely it is that citizens deliberately choose a tax-setting policymaker who is greener than themselves. In such a case, welfare in each country is improved by the voters' strategic behavior. On the other hand, citizens would definitely vote for a candidate who is less green than themselves when the elected policymakers in both countries employ an emission standard (command-and-control) policy. Such strategic voting incentives reduce welfare in both the countries. Therefore, taking the strategic behavior of voters into consideration, we suggest that a tax (incentive-based) policy is preferable to a standard (command-and-control) policy with respect to global welfare and the environment. Second, voters necessarily elect a tax-setting policymaker who is greener than themselves under Bertrand competition. Finally, if the domestic and foreign products are perfectly differentiated, then citizens in each country vote sincerely for a candidate, regardless of the policy tools that the policymakers employ and the market structure that the firms compete in. This is because the voters' choice of a policymaker is no longer strategic in character.

The remainder of the paper comprises three sections. Section 2 presents the basic model with a Cournot market structure, and then analyzes the voters' incentives to deliberately elect a policymaker who implements an emission tax and standard policies, respectively, in a subgame-perfect equilibrium of the game. Section 3 analyzes the same in the model with a Bertrand

market structure, and concluding remarks are drawn in Section 4.

2. The Model

Consider two democratic countries labeled by i ($i = 1, 2$). In each country, there is one representative firm. Emitting transboundary pollution, each firm i ($i = 1, 2$) produces differentiated products and sells them in the world market à la Cournot. The model has three stages. In stage 1, via an election under majority rule, the citizens in each country elect a policymaker who then sets the domestic environmental policy in stage 2. In stage 3, firms engage in Cournot competition with product differentiation in the world market.

We consider the following two types of environmental policies: emission taxes and standards. First, we investigate the strategic incentives of voters to elect policymakers in the case where each elected policymaker (or government) uses emission taxes as a means of regulating domestic emissions. Second, we investigate them in the case where each government employs emission standards.

2.1. STRATEGIC VOTING FOR A TAX-SETTING GOVERNMENT

Assuming the inverse demand of the world market as $P_i(q_1, q_2; \theta)$, where P_i represents the price of the products of firm i; q_i, the outputs of firm i; and $\theta \in (0, 1]$, the degree of product differentiation. Here, we assume the following:

$$\frac{\partial P_i}{\partial q_i} \equiv P_i' < 0, \quad \frac{\partial P_i}{\partial q_j} = \theta P_i', \quad \frac{\partial^2 P_i}{\partial q_i^2} = \frac{\partial^2 P_i}{\partial q_i \partial q_j} = 0 \qquad \forall i \in \{1, 2\},\ i \neq j.^{6}$$

Larger (smaller) θ impliess that the products are lowly (highly) differentiated. The products are homogenous when $\theta = 1$, which corresponds to the investigation of Roelfsema (2007), and become independent when θ converges to zero.

The model is solved backwards from the last game to the first. In stage 3, each firm simulta-

neously chooses its output, taking as given both the rival's output and the emission tax set by the government. Profits of firm i are given by $\pi_i = P_i q_i - e_i t_i q_i$, where e_i is the emissions per unit of output and t_i is the rate of emission tax or subsidy in country i.[7] The first- and second-order conditions for maximizing profits of firm i are $P_i + P_i' q_i = e_i t_i$ and $-2P_i' < 0$, respectively. Performing comparative statics on the first-order conditions for both firms and arranging them, we obtain

$$\frac{\partial q_i}{\partial t_i} = \frac{2e_i}{(4-\theta^2)P_i'} < 0, \ \frac{\partial q_j}{\partial t_i} = -\frac{\theta e_i}{(4-\theta^2)P_i'} = -\frac{\theta}{2}\frac{\partial q_i}{\partial t_i} > 0,$$

which show that the variables q_i and q_j are strategic substitutes since $\partial q_j / \partial q_i = -\theta/2 \leq 0$.

We now investigate the stage 2 equilibrium where the elected policymaker in each country simultaneously and noncooperatively sets the domestic emission tax rate. We assume that the profits of the domestic firm are equally distributed among country i's inhabitants. We also assume that the policymaker ignores the effect of government policy on domestic consumers since the domestic consumption is sufficiently small in comparison to the world consumption. Thus, the policymaker's utility in country i is given by $V_i^p = \pi_i^n - \lambda_i^p E_i$, where π_i^n is the before tax profits of firm i, λ_i^p is the environmental preference (or awareness) of the policymaker elected in country i, and $E_i = D_i(e_i q_i) + \kappa D_j(e_j q_j)$ is the environmental damages from the pollution of country i. The function $D_i(\cdot)$ is the environmental damage function of country i and has the following properties:

$$\frac{dD(\cdot)}{d(e_i q_i)} \equiv D_i' > 0, \ \frac{d^2 D(\cdot)}{d(e_i q_i)^2} \equiv D_i'' \geq 0 \quad \forall i = \{1, 2\},$$

and D_i'' is a positive constant. The parameter $\kappa \in [0, 1]$ represents the degree of pollution spillovers from emissions in the other country. $\kappa = 1$ ($\kappa = 0$) implies that the pollution is global (perfectly local).

The first- and second-order conditions for maximizing utilities by the policymaker in country

i are as follows:

$$\frac{\partial V_i^p}{\partial t_i} = \frac{\partial q_i}{\partial t_i}\left[\left(1-\frac{\theta^2}{2}\right)P_i' q_i + P_i - \lambda_i^p\left(e_i D_i' - \frac{\kappa\theta}{2}e_j D_j'\right)\right] = 0 \tag{1a}$$

$$\frac{\partial^2 V_i^p}{\partial t_i^2} = \left(\frac{\partial q_i}{\partial t_i}\right)^2\left[\left(2-\theta^2\right)P_i' - \lambda_i^p\left(e_i^2 D_i'' + \frac{\kappa\theta^2}{4}e_j^2 D_j''\right)\right] < 0. \tag{1b}$$

Using the first-order condition for maximizing the profits of firms, we can rewrite (1a) as

$$t_i = \lambda_i^p D_i' - \frac{\theta}{2e_i}\left(\lambda_i^p \kappa e_j D_j' - \theta P_i' q_i\right). \tag{2}$$

The above equation implies that $t_i = \lambda_i^p D_i'$ holds when θ converges to zero. In other words, the optimal (second-best) environmental tax levied on the domestic firm, which is a monopolist in the world market, coincides with the domestic Pigouvian tax rate (i.e. the domestic marginal environmental damage). Further, it is obtained independently from the foreign tax strategy, even if there are negative pollution spillovers. The result of $\theta = 0$ here is consistent with the results of Rauscher (1997).[8]

Furthermore, (2) implies that the policymaker strategically sets t_i so that it is lower than $\lambda_i^p D_i$, and the differences are increasing in θ and κ. These properties are considered as the well-known ecological-dumping and free-riding incentives of the environmental policymakers, as mentioned in the introduction.

Totally differentiating the first-order conditions of both policymakers (1a) and imposing symmetry in equilibrium[9] yields the following:

$$\frac{\partial t_i}{\partial \lambda_i^p} = \frac{1}{\Delta}\left[\underbrace{\frac{\partial^2 V_i^p}{\partial t_i^2}}_{-}\underbrace{\frac{\partial q_i}{\partial t_i}}_{-}\left(1-\frac{\theta\kappa}{2}\right)e\,D'\right] > 0 \tag{3a}$$

$$\frac{\partial t_j}{\partial \lambda_i^p} = -\frac{1}{\Delta}\left[\frac{\partial^2 V_i^p}{\partial t_i \partial t_j}\underbrace{\frac{\partial q_i}{\partial t_i}}_{-}\left(1-\frac{\theta\kappa}{2}\right)e\,D'\right] \gtrless 0 \;\Leftrightarrow\; \frac{\partial^2 V_i^p}{\partial t_i \partial t_j} \gtrless 0 \tag{3b}$$

where the determinant $\Delta = (\partial^2 V_i^p/\partial t_i^2)^2 - (\partial^2 V_i^p/\partial t_i \partial t_j)^2 > 0$ by assumption.

From (3a), we can observe that the stronger preferences for the environment of the policymaker in country i raise t_i, while the effect of changes in λ_i^p on t_j depends on the sign of $\frac{\partial^2 V_i^p}{\partial t_i \partial t_j}$, which

represents the effect of the marginal increase in the foreign tax on the marginal benefit of the domestic tax. Moreover, the sign of $\frac{\partial^2 V_i^p}{\partial t_i \partial t_j}$ represents the strategic relationship between the tax choices. Indeed, t_i and t_j are strategic substitutes when $\frac{\partial^2 V_i^p}{\partial t_i \partial t_j} < 0$. In this case, the foreign tax rates are reduced when the domestic government becomes greener. On the other hand, when t_i and t_j are strategic complements ($\frac{\partial^2 V_i^p}{\partial t_i \partial t_j} > 0$), the foreign tax rates are increased when the domestic government becomes greener, since the foreign policymaker follows a tax increase in the domestic country.

It follows that

$$\frac{\partial^2 V_i^p}{\partial t_i \partial t_j} = - \underbrace{\frac{\partial q_i}{\partial t_i}}_{-} \underbrace{\frac{\partial q_i}{\partial t_j}}_{+} \left[- \frac{\theta^2}{2} |P'| + \lambda^p e^2 (1+\kappa) D'' \right], \tag{4}$$

which implies that whether the tax choices are strategic substitutes or complements depends on the values of λ^p, θ, $|p'|$, e, κ, and D''. The above equation also implies that if θ converges to zero, the strategic relationship between t_i and t_j disappears (i.e. $(4) = 0$) since $\lim_{\theta=0} \partial q_i / \partial t_j = 0$.

The first term in the parentheses, $-\theta^2 |P'|/2$, represents the effect of the marginal increase in the foreign tax on the marginal profits of the domestic tax, that is, $\partial^2 \pi_i^n / \partial t_i \partial t_j$. Since the term is negative, this captures the policymakers' incentive for lowering tax rates in reaction to an increase in the foreign tax rate. We also find that the incentive is larger when the products are more homogenous (large θ) and the price elasticity of demand is less elastic (large $|P'|$). The second term in the parentheses, $\lambda^p e^2 (1+\kappa) D''$, represents the effect of the marginal increase in the foreign tax on the marginal environmental benefits of the domestic tax, that is, $\partial^2 (-\lambda_i^p E_i) / \partial t_i \partial t_j$. Since the term is positive, this captures the policymakers' incentive for raising tax rates in reaction to an increase in the foreign tax rate. This originates from the fact that an increase in foreign tax reduces foreign outputs and raises the domestic outputs and hence the emissions. The incentive is larger when the policymakers are greener (large λ^p) and the environmental damages are more serious (large e, κ, and D''). Thus, we obtain the following lemma.

Lemma 1

The tax choices of each policymaker are strategic complements (substitutes) if the following condition holds:

$$\frac{\theta^2 \left|P'\right|}{2\,e^2\,(1+\kappa)\,\lambda^p\,D''} < (>)\,1. \tag{5}$$

The tax choices are more likely to exhibit strategic complements when (i) the products are more differentiated, (ii) the demands are more elastic, (iii) the emission coefficients are larger, (iv) the degree of pollution spillovers is larger, and (v) the convexity of the environmental damage function is stronger.

Proof: The lemma is directly obtained by equation (4). ■

We finally investigate the stage 1 equilibrium where citizens in each country elect the policymaker by majority voting. The derivations of the equilibrium are based on Besley and Coate (2003) and Roelfsema (2007). We assume that the utility of citizens in country i only differs in terms of their environmental preferences λ_i. Thus, the median-voter theorem can be applied if the citizens' utility is strictly concave in λ_i^p. When selecting a candidate, the median-voters take into account the effects of their choices on the tax rate in the foreign country that is described by (3b). Thus, the median-voters may not select the candidate who has the same environmental preferences for strategic reasons.

The preference of the median-voter i who lives in country i is given by $V_i^m = \pi_i^n - \lambda_i^m E_i$, where λ_i^m is the median-voter i's preferences for the environment. The median-voter i chooses the policymaker's preference for the environment, λ_i^p, so as to maximize his/her own utilities. Taking (1a) and symmetric equilibrium into account, after rearrangement, the first-order condition that describes the preferences of the optimal candidate is as follows:

$$\frac{\partial V_i^m}{\partial \lambda_i^p} = \underbrace{\frac{\partial t_i}{\partial \lambda_i^p}}_{+}\,\underbrace{\frac{\partial q_i}{\partial t_i}}_{-}\left[\left(\lambda^p - \lambda^m\right)\left(1 - \frac{\theta\kappa}{2}\right)eD'\right] + \underbrace{\frac{\partial t_j}{\partial \lambda_i^p}}_{+ \text{ or } -}\,\underbrace{\frac{\partial V_i^m}{\partial t_j}}_{+} = 0. \tag{6}$$

In the above equation, following Roelfsema (2007), we assume $\partial V_i^m/\partial t_j > 0$, which implies that the median-voter is not an extreme environmentalist who wants the other country to lower its tax rate in order to shrink the output of his/her own country.[10] Combining (3b), (5), and (6), we obtain

$$\lambda^p \gtrless \lambda^m \;\Leftrightarrow\; \frac{\partial t_j}{\partial \lambda_i^p} \gtrless 0 \;\Leftrightarrow\; \frac{\partial^2 V_i^p}{\partial t_i \partial t_j} \gtrless 0 \;\Leftrightarrow\; \frac{\theta^2 \left|P'\right|}{2\,e^2\,(1+\kappa)\,\lambda^p\,D''} \lesseqgtr 1. \tag{7}$$

This shows that the voters have incentives to deliberately support greener candidates than the themselves (i.e., $\lambda^p > \lambda^m$) when the tax choices are strategic complements. Thus, we obtain the following proposition and corollary.

Proposition 1

Voters strategically elect tax-setting policymakers who are more (less) green than themselves if the tax choices of governments are strategic complements (substitutes).

The economic intuitions behind the proposition are as follows. From (3b), we find that if the tax choices of policymakers are strategic complements, then the domestic citizens can raise the foreign tax as well as the domestic tax by electing a greener policymaker. Since the noncooperative rate of emission tax is suboptimally low due to the ecological-dumping and free-riding incentives in our setting, increases in the tax rates of both the countries are beneficial for the welfare of both countries. On the other hand, if the tax choices of policymakers are strategic substitutes, then the citizens can raise the foreign tax rate by electing a domestic policymaker who has lower λ. Thus, in this case, voters in both countries strategically choose a less green government in order to free-ride the foreign tax contributions and heighten the strategic position of domestic firms.

By considering the result of Lemma 1, we find that citizens are more likely to choose a government greener than themselves when (i) the products are more differentiated, (ii) the demands are more elastic, (iii) the emission coefficients are larger, (iv) the degree of pollution spillovers is

larger, and (v) the convexity of the environmental damage function is stronger. Intuitively, voters tend to delegate to environment "lovers" when the market is more competitive ((i) and (ii)) and/or the environmental externalities are stronger ((iii), (iv), and (v)). The results generalize and correct the results of Roelfsema (2007).[11]

In addition, since $\lim_{\theta=0}(\partial t_j/\partial \lambda_i^p) = 0$, we find that citizens choose a politician who has the same preference for the environment that they do when θ is close to zero. In other words, voters sincerely vote for the politician when the domestic and foreign products are perfectly differentiated.

2.2. STRATEGIC VOTING FOR A STANDARD-SETTING GOVERNMENT

In this subsection, we investigate the strategic incentives for voters in the case where policymakers in both countries employ emission standards as a policy tool. The emission standards are defined as direct regulations on the total allowable volume of emissions, i.e., $e_i q_i$ by policymaker i. Since our model includes neither emission abatement activities nor environmental R&D by firms, we define the emission standard (ceiling) as the policy by which the policymakers directly choose the amount (or upper bound) of the domestic outputs denoted by $\bar{q}_i$. Thus, the policy can be also considered as a command-and-control instrument.

Given that the utilities of the policymaker in country i are $V_i^p = \pi_i^n - \lambda_i^p E_i$, the first- and second-order conditions for maximizing utilities of country i's policymaker are

$$\frac{\partial V_i^p}{\partial \bar{q}_i} = P_i' \bar{q}_i + P_i - \lambda_i^p \, e_i \, D_i' = 0, \tag{8a}$$

$$\frac{\partial^2 V_i^p}{\partial \bar{q}_i^2} = 2P_i' - \lambda_i^p \, e_i^2 \, D_i'' < 0, \tag{8b}$$

where (8a) implies that the policymaker chooses the output (emission) ceiling so as to equate the marginal revenues of production with the marginal domestic environmental damages evaluated

by him.[12] Totally differentiating the first-order conditions yields

$$\frac{\partial \bar{q}_i}{\partial \lambda_i^p} = \frac{1}{\Theta}\Big[(2P_i' - \lambda_i^p\, e_i^2\, D_i'')e_i\, D_i'\Big] < 0 \tag{9a}$$

$$\frac{\partial \bar{q}_j}{\partial \lambda_i^p} = -\frac{1}{\Theta}(\theta\, P_i'\, e_i\, D_i'') > 0, \tag{9b}$$

where the determinant $\Theta > 0$.[13] Equations (9a) and (9b) imply that the stronger environmental preferences of the domestic policymaker tighten domestic emission control but relax foreign emission control. Notice also that (9b) becomes zero when θ converges to zero.

Next, we derive an equilibrium where median-voters in each country simultaneously elect their policymaker. Using (8a), we obtain the first-order condition that describes the preferences of the optimal candidates:

$$\frac{\partial V_i^m}{\partial \lambda_i^p} = \underbrace{\frac{\partial \bar{q}_i}{\partial \lambda_i^p}}_{-}\Big[\big(\lambda^p - \lambda^m\big)\, e\, D'\Big] + \underbrace{\frac{\partial \bar{q}_j}{\partial \lambda_i^p}}_{+}\underbrace{\frac{\partial V_i^m}{\partial \bar{q}_j}}_{-} = 0. \tag{10}$$

Since $\partial V_i^m/\partial \bar{q}_j = \theta P_i' \bar{q}_i - \lambda_i^m \kappa e_j D_j' < 0$, we find that $\lambda^p < \lambda^m$ necessarily holds.

Proposition 2

Voters strategically elect standard-setting policymakers who are less green than themselves.

In contrast to the previous case where policymakers employ an emission tax policy, median-voters in each country necessarily elect policymakers who are less green than themselves when each elected policymaker employs emission standard policies. Intuitively, electing a policymaker who has low preferences for the environment serves as a commitment to a lax environmental regulation. Since the foreign policymaker observes the commitment before he implements the standard policy, the commitment tightens the regulation in the foreign country and is beneficial for its own welfare. Thus, in the symmetric equilibrium, both voters deliberately choose a less green policymaker.

The proposition is closely related to the result of "isolatinist" scenario in Buchholz et al. (2005). In the scenario where governments noncooperatively determine their output of domestic

products, they show that strategic voting results in a government that assigns less weight to the environment than the median voter. Our Proposition 2 also shows that a quantity-regulating policy leads to the same outcome even when there are strategic interactions among firms in a product market.

In addition, from (9b) and (10), it follows that $\lambda^p = \lambda^m$ if θ converges to zero. Combining the result obtained in the previous subsection, we find that citizens sincerely vote for a candidate who has the same preference for the environment as the voters themselves when the domestic and foreign products are perfectly differentiated, regardless of the policy instruments employed by the policymakers and the degree of transboundary pollution. It is interesting to compare these results with those of Siqueria (2003). He showed that the median-voter will choose a policymaker who places the same amount of weight on an externality as he/she does only if the externality is unidirectional (that is, not reciprocal). In contrast, our results indicate that if the domestic and foreign products are perfectly differentiated, such a "sincere voting" result may arise even if the externality is reciprocal in nature. Although these results appear to be conflicting, their rationales are exactly similar: The strategic interaction between policymakers disappears due to the unidirectional externality in Siqueria's model, whereas it disappears due to the perfect differentiation of products in our model.

3. Under Price Competition

In this supplementary section, we consider the case where firms compete in their prices in the international product market, and investigate the strategic incentives of median-voters for electing tax-setting policymakers.[14]

Assume the world market demand as $Q_i(p_i, p_j; \phi)$, where Q_i is the quantity demanded, p_i is the price of good i, and $\phi \in (0.1]$ is the degree of product differentiation. Here, we assume the

following:

$$\frac{\partial Q_i}{\partial p_i} \equiv Q_i' < 0, \quad \frac{\partial Q_i}{\partial p_j} = -\phi\, Q_i' > 0, \quad \frac{\partial^2 Q_i}{\partial p_i^2} = \frac{\partial^2 Q_i}{\partial p_i \partial p_j} = 0 \qquad \forall i \in \{1,2\},\ i \neq j.$$

Larger (smaller) ϕ implies that the products are lowly (highly) differentiated.[15]

We first derive the equilibrium in stage 3. Given the profits of firm i by $\pi_i = Q_i(p_i, p_j; \phi)[p_i - e_i t_i]$, the first-order condition for maximizing the profits of firm i is obtained as $Q_i'[p_i - e_i t_i] + Q_i = 0\ \forall i \in \{1,2\}$. Total differentiation of the first-order conditions yields the following:

$$\frac{\partial p_i}{\partial t_i} = \frac{2e_i}{4-\phi^2} > 0, \ \frac{\partial p_j}{\partial t_i} = \frac{\phi e_i}{4-\phi^2} = \frac{\phi}{2}\frac{\partial p_i}{\partial t_i} > 0.$$

These comparative static results also imply that the price choices by firms are strategic complements (i.e., $dp_i/dp_j > 0$), which is different from the case of the Cournot competition.

In stage 2, each policymaker i simultaneously and noncooperatively chooses the domestic rate of emission taxes so as to maximize $V_i^p = \pi_i^n - \lambda_i^p E_i$, where $E_i = D\big(e_i Q_i(p_i, p_j; \phi)\big) + \kappa D\big(e_j Q_j(p_i, p_j; \phi)\big)$. The first- and second-order conditions are

$$\begin{aligned} \frac{\partial V_i^p}{\partial t_i} &= \frac{\partial p_i}{\partial t_i}\left[\left(1-\frac{\phi^2}{2}\right)Q_i'\, p_i + Q_i - \lambda_i^p\left(\left(1-\frac{\phi^2}{2}\right)e_i Q_i' D_i' - \frac{\phi\kappa}{2} e_j Q_j'\, D_j'\right)\right] = 0, \qquad (11)\\ \frac{\partial^2 V_i^p}{\partial t_i^2} &= \left(\frac{\partial p_i}{\partial t_i}\right)^2\left[(2-\phi^2)Q_i' - \lambda_i^p\left(\left(1-\frac{\phi^2}{2}\right)^2 e_i^2 (Q_i')^2\, D_i' + \frac{\phi^2\kappa}{4} e_j^2 (Q_j')^2 D_j'\right)\right] < 0. \end{aligned}$$

Obviously, $t_i = \lambda_i^p D_i'$ holds when ϕ converges to 0, which implies that the second-best tax rates that the price-setting firm faces are equal to the domestic marginal environmental damage when the domestic and foreign products are perfectly differentiated.

By totally differentiating (11) and imposing symmetry in equilibrium, we obtain the following comparative static results for $i, j = 1, 2$, $i \neq j$.

$$\frac{\partial t_i}{\partial \lambda_i^p} = \frac{1}{\Omega}\left[\frac{\partial^2 V_i^p}{\partial t_i^2}\left(1-\frac{\phi}{2}(\phi+\kappa)\right)eQ'D'\right] > 0, \qquad (12a)$$

$$\frac{\partial t_j}{\partial \lambda_i^p} = -\frac{1}{\Omega}\left[\frac{\partial^2 V_i^p}{\partial t_i \partial t_j}\left(1-\frac{\phi}{2}(\phi+\kappa)\right)eQ'D'\right] > 0, \qquad (12b)$$

where the determinant $\Omega \equiv (\partial^2 V_i^p/\partial t_i^2)^2 - (\partial^2 V_i^p/\partial t_i \partial t_j)^2 > 0$ by assumption, and

$$\frac{\partial^2 V_i^p}{\partial t_i \partial t_j} = \frac{\partial p_i}{\partial t_i}\frac{\partial p_i}{\partial t_j}\left[-\frac{\phi^2}{2}Q' + \lambda^p\left(1-\frac{\phi^2}{2}\right)e^2 (Q')^2 D''\big(1+\kappa\big)\right] > 0. \qquad (13)$$

Condition (12a) captures the positive impacts of λ_i^p on t_i. This implies that the greener policymaker sets a higher rate of domestic tax. Condition (12b) captures the impacts of λ_i^p on t_j. Unlike the case with Cournot competition, the stronger preferences of policymaker i for the environment also raise the foreign tax rates because the policy choices are strategic complements, as shown by (13). In other words, electing a candidate who has a higher λ^p induces a higher rate of emission taxes in the home and foreign countries.[16]

We finally derive an equilibrium in stage 1 where the voters in each country simultaneously elect a policymaker so as to maximize their utilities: $V_i^m = \pi_i^n - \lambda_i^m E_i$. The first-order condition for choosing λ_i^p of a median-voter living in country i is

$$\frac{\partial V_i^m}{\partial \lambda_i^p} = \underbrace{\frac{\partial t_i}{\partial \lambda_i^p}\frac{\partial p_i}{\partial t_i}}_{+}\left[\left(\lambda^p - \lambda^m\right)\underbrace{\left(1 - \frac{\phi}{2}(\phi+\kappa)\right)eQ'D'}_{-}\right] + \underbrace{\frac{\partial t_j}{\partial \lambda_i^p}}_{+}\underbrace{\frac{\partial V_i^m}{\partial t_j}}_{+} = 0. \tag{14}$$

Given that $\partial V_i^m/\partial t_j > 0$,[17] we find that $\lambda^p > \lambda^m$ holds necessarily, which implies that the citizens vote for a candidate who is more concerned about the environment than they are.

Proposition 3

Under the Bertrand structure of the international market, voters strategically elect tax-setting policymakers who are more green than themselves.

Unlike the previous case with Cournot competition, voters necessarily choose a candidate who has stronger preferences for the environment than themselves under Bertrand market structures. The reason is that citizens can earn higher industry profits and lower environmental damages if they can commit to setting a higher rate of emission tax because the commitment can raise t_j and hence p_j as well as p_i. This is because the prices and taxes are both strategic complements.[18] Thus, in the symmetric equilibrium, voters in both countries elect a greener policymaker. Furthermore, we find that under Bertrand competition, the perfect differentiation between the domestic and foreign products leads to sincere voting in both countries because $\partial t_j/\partial \lambda_i^p = 0$ when ϕ converges to zero.

4. Concluding Remarks

Environmental policies, as well as all other policy decisions, are products of political processes. If voters consider strategic interdependencies among governments in international trade-environment arguments, they may strategically choose a politician who implements domestic environmental policies. In this paper, we construct a political-economy model of international noncooperative environmental policymaking, and examine the strategic incentives for voters to elect an environmental policymaker in open economies. We show that under several circumstances, citizens have an incentive to deliberately vote for a candidate whose environmental preferences differ from their own. Further, the strategic voting incentives are closely related to the environmental policy tools employed by the government and the international market structures.

Under the situation where each country's firms engage in Cournot competition in the world market, citizens in each country strategically elect a tax-setting policymaker who is more (or less) green than themselves. In particular, they are more likely to choose a greener government than themselves when competition among firms and/or environmental externalities are more severe. Since the noncooperative rate of emission tax is inefficiently low, such strategic voting in both countries enhances welfare of both countries. In addition, if firms compete in prices (Bertrand) rather than quantities (Cournot), voters have an incentive to elect a tax-setting policymaker who is greener than themselves. On the other hand, they elect a standard-setting policymaker who is less green than themselves. Since the second-best emission standards (ceilings) are strategic substitutes, citizens elect a less green candidate and commit to lax regulation in order to induce stringent regulation in the other country. Such strategic voting in both countries reduces their welfare because the level of emission control noncooperatively set by each policymaker is inefficiently low. Thus, from the viewpoint of strategic voting, emission tax may induce a higher welfare gain than an emission standard. This may confirm the advantage of "incentive-basede" instruments over "command-and-control" instruments in international relations.[19] Finally, in any case, sincere voting arises in each country if products are perfectly differentiated, regardless

of the degree of environmental externalities.

Our analysis can be extended in several important ways. One conceivable extension of our analysis is to allow for asymmetricity between the policies employed by each policymaker. Differences in the policies adopted across countries can change the strategic relationship between policymakers and hence affect citizens' incentives for strategic voting. Another extension would be to incorporate the voters' choice of policy instruments into our model. In this paper, we assume that voters can only choose a type of policymaker, taking the type of policy instruments employed by the elected policymaker as given.[20] The endogenous choice of policy instruments through political processes may elucidate the relationship between voters' preferences for the environment and those for policy instruments. These matters await future investigation.

Acknowledgments

Notes

1 For example, in several northern European nations, green interest groups have organized their own political parties and have become part of a governing majority.

2 For further details on international trade and strategic environmental policy, see, for example, Ulph (1992, 1996), Barrett (1994), Kennedy (1994), Conrad (1996), and Rauscher (1997, 2005), among many others.

3 For a review and assessment of the extensive literature on the political determination of environmental regulation, see Oates and Portney (2003). Furthermore, using the modern tools of economics and public choice, Congleton (1996) examines the political and economic factors that generate environmental policy.

4 See Frederikson (1997, 1999), Rauscher (1997), Ulph (1998), and Schleich (1999) for alternative political-economy models relating to trade-environmet arguments.

5 With regard to this point, see List and Gerking (2000), World Bank (2000), Antweiler and Copeland (2001), Fredriksson and Millimet (2002), and Millimet (2003), among many others.

6 For example, an inverse demand such as $P_i = a - b(q_i + \theta q_j)$ has the properties we assume here.

7 For the sake of simplicity, we assume that there are no production costs.

8 In Rauscher (1997), constructing the model of monopolistic behavior, he showed that the optimal environmental policy vis-à-vis a domestic firm, which is a monopolist in the foreign market, is to use a Pigouvian emission tax (Proposition 6.2 in Rauscher (1997)).

9 Throughout the paper, variables without subscripts denote those in a symmetric equilibrium.

10 In symmetric equilibrium, we obtain

$$\frac{\partial V_i^m}{\partial t_j} = \frac{1}{2}\frac{\partial q_j}{\partial t_j}\Big[\theta(p'\,q - p) - \lambda^m e D'(2\kappa - \theta)\Big].$$

From the above equation, we confirm that a sufficient condition for holding the assumption of $\partial V_i^m/\partial t_j > 0$ is $2\kappa \geq \theta$. Even when $2\kappa < \theta$, the assumption almost holds unless voters are extreme environmentalists. To see why, consider an extreme case with $\kappa = 0$ and $\theta = 1$. In this case, $\partial V_i^m/\partial t_j < 0$ holds only if $\lambda^m e D' > P - P'\,q$, that is, the marginal environmental damages that the median-voter evaluates are much greater than the price of goods.

11 Roelfsema (2007) indicated that both median-voters are more likely to delegate to environmental lovers when the pollution spillovers κ are *smaller* and the demand is *less* elastic. These are incorrectly derived from equation (7) in his paper. For further details on these corrections and intuitions, see Hattori (2007).

12 Differentiating (8a) in $\bar{q}_j$, we obtain $\partial^2 V_i^p/\partial\bar{q}_i\partial\bar{q}_j = \theta\,P_i' < 0$. Thus, we find that $\bar{q}_i$ and $\bar{q}_j$ are strategic substitutes.

13 In detail, $\Theta = \left(\frac{\partial^2 V_i^p}{\partial t_i^2}\right)^2 - \left(\frac{\partial^2 V_i^p}{\partial t_i \partial t_j}\right)^2 = (4-\theta^2)(P_i')^2 + \lambda_i^p e_i^2 D_i''(\lambda_i^p e_i^2 D_i'' - 4P_i') > 0$.

14 In this paper, we do not consider the case where firms compete in their prices and governments use an emission standard because of the complexities of investigations. However, we can imagine that the results of such a case are identical to those of the investigations in section 2.2. This is because emission controls here are considered as a quantity precommitment before Bertrand competition, which may yield Cournot (emission control) outcomes as shown by Kreps and Scheinkman (1983).

15 For example, a demand function such as $Q_i = \bar{a} - \bar{b}(p_i - \phi\, p_j)$, where $\bar{a}$ and $\bar{b}$ are positive constants, has the same properties that we assume here.

16 Since Ω is positive by assumption, it holds that $\frac{\partial t_i}{\partial \lambda_i^p} > \frac{\partial t_j}{\partial \lambda_i^p}$, that is, the effect of a change in the policymaker's preferences for the environment on the domestic tax rate should be greater than that on the foreign tax rate.

17 The assumption implies that the median-voter is not an extreme environmentalist. In particular, we obtain

$$\frac{\partial V_i^m}{\partial t_j} = \frac{1}{2}\underbrace{\frac{\partial p_j}{\partial t_j}}_{+}\Big[\phi(Q - p\,Q') - \lambda^m e D_i' Q' \big\{\kappa(2-\phi^2) - \phi\big\}\Big],$$

which indicates that a sufficient condition for holding the assumption of $\partial V_i^m/\partial t_j > 0$ is $\kappa > \frac{\phi}{(2-\phi^2)}$. Even when $\kappa < \frac{\phi}{(2-\phi^2)}$, the assumption almost holds unless voters are extremely environmentalists in nature. To check this, consider a case with $\kappa = 0$ and $\theta = 1$. In that case, $\partial V_i^m/\partial t_j < 0$ holds only if $-\lambda^m e D_i' Q' > (Q + p\,Q') - 2pQ'$, that is, the marginal environmental damages brought about by a decrease in price are much greater than the marginal revenues of price.

18 The result is similar to Barrett's (1994) seminal analysis of environmental standards. He shows that if firms compete in prices, countries have an incentive to unilaterally impose strong standards.

19 Notice that the advantage of the tax against the standard does not imply that *one* country should employ tax regulations, because our analysis only considers the symmetric situation. Our results simply imply that strategic voting may lead to a better outcome when *all* countries employ taxes than when they employ standards.

20 For the question pertaining to the choice of environmental policy instruments in the context of a model of strategic international trade, see, for example, Ulph (1992, 1996).

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