

# International Coordination and Domestic Politics\*

Kimiko Terai<sup>†</sup>

## Abstract

We examine how international coordination between countries generates a trend to establish an international institution for the provision of global public goods. In the present model, the forces creating movement to international agreement are a politician's opportunistic motive for re-election, and his optimistic expectation of unanimous consent on agreement between countries. If a politician expects another politician in a neighboring country to signal his good performance to his citizens by participating in the agreement, he also decides to participate in the agreement, which then brings benefit spillovers to his country. Furthermore it is shown that, by dividing political authorities for coordination between the executive and politicians, observed over-compliance in the agreement by participating countries can be explained. Keywords: international environmental agreements; global public goods; re-election pressure; division of authorities

JEL classification: D72, D78, D82, H87, Q58

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\*I am grateful to Amihai Glazer for his guidance of this research agenda and comments on this paper. This paper was written during my visit to the Department of Economics, University of California, Irvine. The generous hospitality of the department is gratefully acknowledged.

<sup>†</sup>Professor, Hosei University, and Visiting Researcher, University of California, Irvine. Correspondence to: Kimiko Terai, Department of Economics, University of California, Irvine, 3151 Social Science Plaza, Irvine, CA 92697, USA. E-mail: terai@hosei.ac.jp

# 1 Introduction

Global public goods refer to public goods which are supplied in a country and generate transnational benefit spillovers. An important instance of global public goods, which has recently become regarded as the most pressing matter, is protection of the environment. If a country implements effective regulations to reduce domestic emission of greenhouse gases, the menace of global warming and extreme weather, which would also harm other countries, may be reduced.

The difference between global public goods, and public goods which are supplied in a region within a nation and generate positive external effects nationwide, lies in whether a third party exists that can enforce the internalization of externalities. As the Coase theorem suggests, when property rights are defined and there is no transaction cost, the agents concerned can bargain over trading externalities and achieve an efficient outcome only if the result of bargaining is enforced by a third party. A democratic national government usually has a judiciary. This is provided by the nation with the power to enforce the contract between the parties concerned, independent of any party's interests.

Consider now global public goods. Each country's decentralized decision-making fails to internalize the externalities generated from its decisions. We have consequently observed attempts to correct the externality problem through international agreements for enhancing the provision of global public goods. The difficulty is that there is no powerful third organization to punish a country's deviation, independent of the interests of participating countries. Barrett (2005) says that "the source of the failure of the international system is sovereignty" (p. 1459).

The present study examines how the domestic political process is related to the success or failure of such an international agreement. In particular, we focus on domestic elections, which will be shown to induce a politician to participate in the agreement and comply with it. The reasons to focus on electoral process are twofold. One is that election is an important process in democracies, through which

citizens choose delegates to represent their interests. Another is that the literature modeling electoral competition is abundant in the field of political economy.

We suppose that there are two countries, and in each country there are four agents: a representative citizen, an incumbent politician and a potential entrant, and the executive. The executive is benevolent in that he cares for the welfare of the citizen. On the other hand, a politician is opportunistic; he acts according to the interests of the citizen in his own country, since it profits him. The ability of any politician can take one of two levels. The politician knows his own ability level, but a citizen, as well as the executive, can only infer it by observing the politician's performance. The citizen tries to select a high-ability politician from the incumbent and an entrant at the election. An election is held after the incumbent sets the level of public good provision in his country.

First, we suppose that only politicians can engage in setting policy. Suppose further that the agreement is established only by unanimous consent of two countries. After deriving the equilibrium by decentralized decision-making, we show the following. If a politician expects that even a low-ability politician in the neighboring country signals his good performance to his citizen, by participating in an international agreement and providing a high level of public goods, then he also decides to participate in the agreement, since it produces more benefit spillovers to his country than the equilibrium without international coordination. Consequently, coordination among countries can generate a trend toward cooperation. Barrett (2003) pointed out that attainment of the minimum number of participating countries required for an agreement to enter into force also induces other countries to behave cooperatively. In our model, the forces creating movement to international agreement are a politician's opportunistic motive for re-election, and his optimistic expectation of unanimous consent on the agreement among countries. This optimistic expectation is in turn generated from the politician's belief that any politician in the other country knows that failure to establish an international institution will

end in the worst situation.

Let us introduce the executives into the model. After two executives in both countries decide cooperatively the level of public goods, a politician in each country chooses to ratify or reject it. The executives' proposal can induce the politician to ratify the agreement, which may internalize externalities. The analysis shows that re-election pressure can work as the substitute of the penalty for non-compliance of the agreement. An interesting finding is that, when the benefit from re-election is not attractive enough for a low-ability politician to pretend to have high ability, the executives can assign a low level of public good provision to each country in order to make a low-ability politician's participation easier. This executives' proposal is also ratified by a high-ability politician, who willingly suppresses public good provision in order to induce a low-ability politician in the neighboring country to participate in the agreement. If the agreement is not binding then, once it is in force, countries with high-ability politicians may implement a higher level of public good provision than required by the agreement; this would not trigger any penalty by the other country because over-compliance by a country benefits the other country. Furthermore, countries with low ability may be forced to follow high-ability countries by re-election pressure. These results can explain Barrett's (2003) observation that many of the countries participating in international environmental agreements have reduced their emissions by much more than required.

Many researchers have worked on enforceability of international agreements, including Carraro and Siniscalco (1993, 1998), Barrett (1994, 2003, 2005), Chander and Tulkens (1995, 1997), and Glazer and Proost (2008). Hoel (1991), Heal (1994, 1999), Barrett (2003, 2005), Copeland and Taylor (2005), and Glazer and Proost (2008) are closely related to the present model, since they examine the interdependence of one country's environmental action with other countries' policy choices.

There also exist works studying the linkage of international agreement to domestic political process. Putnam (1988) and Currarini and Tulkens (1997) described

the interaction between international negotiations leading to a tentative agreement, and the domestic process to ratify it (Putnam (1988) in a conceptual framework, while Currarini and Tulkens (1997) use a formal model). Drazen (2000), Buchholz, Haupt, and Peters (2005), and Roelfsema (2007) examined the representative citizen's incentive to delegate environmental policy making to a politician who has different policy preferences from him. Our study shares the motive with Glazer and Proost (2008) in dealing with interdependence between two countries' action by incorporating domestic politics and asymmetric information. They study how a politician's decision on participating in the international agreement influences citizens' beliefs of the potential benefits of an environmental policy, and consequently strengthens credibility of the policy. On the other hand, in the present model, a citizen has power to make a politician choose positive environmental action, by applying re-election pressure. Thus, citizens' voting behavior in the domestic political process can produce movement toward international cooperation.

This study is also related to a series of papers which examine how the politician's concerns for re-election affect his policy choice. See, e.g., Barro (1973), Ferejohn (1986), Persson and Tabellini (2000), Besley (2006), Besley and Smart (2007), Alesina and Tabellini (2007, 2008), and Terai (2008).

In Section 2, the payoffs of a citizen, an incumbent politician, and the executive are defined, and asymmetry of information between the politician and the other agents is described. Section 3 derives each type of politician's uncoordinated decision-making. In Section 4, each type's choice in the equilibrium with international coordination is derived. Section 5 extends the analysis in Section 4 by incorporating the role of the executive in the domestic political process, and examining the effect of the divided authorities. Section 6 sets out conclusions. Technical details are set out in the Appendix.

## 2 The Basic Framework

We have two countries,  $i = 1, 2$ . There are four agents in each country: a representative citizen, an incumbent politician and a potential entrant, and the executive. The executive is benevolent, in that he cares for the welfare of the citizen in his country. On the other hand, a politician is opportunistic; he acts according to the interests of the citizen in his own country, since his performance may lead to praise or donation from the citizen.

The politician in country  $i$  is characterized by his ability level  $\alpha_i$ , which is determined by Nature. It takes one of two levels  $\{\alpha_h, \alpha_l\}$ ,  $0 < \alpha_l < \alpha_h$ , with the respective prior probabilities  $\pi_h$  and  $\pi_l (= 1 - \pi_h)$ ,  $0 < \pi_h < 1$ . In our model, the term *ability* refers to the politician's ability to enact effective policies associated with public good provision. We call a politician with  $\alpha_k$  *type*  $k$ ,  $k \in T = \{h, l\}$ . Each incumbent politician  $i$  knows his own type, but the citizens and the executives in both countries and an incumbent politician in country  $j$  do not know the ability level of the incumbent politician in country  $i$ ; they can only infer it.

Let  $g_i (\geq 0)$  denote the total quantity of public goods produced in country  $i$ . It costs  $\frac{g_i^2}{2}$  to produce the quantity  $g_i$ . This assumption means that the marginal cost of supplying  $g_i$ , which is equal to  $g_i$ , is strictly increasing in the quantity of public goods. The cost is imposed upon the citizen. Thus, the welfare of the citizen in country  $i$  is given by

$$w_i = -\frac{g_i^2}{2} + \alpha_i g_i + \beta g_j, \quad (1)$$

where  $\beta (> 0)$  represents the extent to which effects spill from public goods supplied in the neighboring country  $j$ ; its exact value is known to all agents. Thus, the welfare of the citizen depends on the relative magnitude of the cost of supplying public goods in his country, and the benefit from public goods in his country and the neighboring country.

The executives in both countries cooperate to implement a policy which con-

tributes to the total welfare of their citizens. Each executive  $i$ 's payoff is given by

$$v_i = w_i + w_j. \quad (2)$$

A pair of policies  $(g_1, g_2)$  which maximizes (2) attains social optimum, and the welfare of the citizen in each country is also maximized, as a result of symmetry between the two countries.

The payoff of each incumbent politician  $i$  is given by

$$r_i = w_i + p_i R, \quad (3)$$

where  $p_i$  denotes the probability that the incumbent politician in country  $i$  is re-elected;  $R(> 0)$  denotes political rent which the politician can enjoy in office in the second period. The discount factor is supposed to be 1.

At the beginning of the second period, an election is held between two candidates: the incumbent, and another politician who has the same prior distribution of ability as the incumbent. The citizen in country  $i$  sets the probability of re-electing the incumbent according to the rule

$$p_i = \begin{cases} 1, & \text{if } \tilde{\alpha}_i \geq \alpha_m; \\ 0, & \text{if } \tilde{\alpha}_i < \alpha_m, \end{cases} \quad (4)$$

where  $\tilde{\alpha}_i$  represents the citizen's rational expectation of the incumbent  $i$ 's ability  $\alpha_i$ , and  $\alpha_m \equiv \pi_h \alpha_h + \pi_l \alpha_l$ . Given the citizen's welfare in (1), choosing a politician who has a higher ability is consistent with the citizen's rationality; a politician with a higher ability can choose a higher level of public good provision, and it generates a higher welfare of the citizen, as we will show in the following section. Advantage of the incumbent over an entrant is assumed in (4); if the citizen is indifferent between the incumbent and an entrant, he selects the incumbent.

### 3 Politician's Decentralized Decision-making

First, examine a politician's decision-making, assuming that there exist no executives and no chance for international coordination. The timing of this game is defined as follows. In period 1,

1. Nature draws an incumbent politician  $i$ 's ability  $\alpha_i$  from its distribution;
2. the incumbent politician  $i$  chooses  $g_i$ .

In period 2, voting occurs, and the winner of the election is determined. Through the analysis, we use the concept of Perfect Bayesian Nash equilibrium to solve the games.

Let us examine the incumbent  $i$ 's choice of  $g_i$  when his choice does not affect his probability of re-election  $p_i$ . The maximizer of  $r_i$  in (3) then coincides with the maximizer of  $w_i$  in (1). Given  $g_j$ , the first-order condition with regard to  $g_i$  is

$$g_i = \alpha_i. \tag{5}$$

Given  $g_j$  and with (5), the citizen's welfare is calculated as  $w_i = \frac{\alpha_i^2}{2} + \beta g_j$ , which is higher for higher  $\alpha_i$ .

The citizen's voting rule (4) suggests that a type  $l$  incumbent may be re-elected by manipulating his choice of a policy, and accordingly the citizen's inference. If the gain from re-election exceeds the cost of pretending to be a high-ability politician, he behaves as if he was type  $h$  by selecting  $g_i = \alpha_h$  instead of  $g_i = \alpha_l$ , and succeeds in being re-elected. Such behavior benefits him iff

$$-\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + \beta g_j + R \geq \frac{\alpha_l^2}{2} + \beta g_j,$$

i.e., iff

$$R \geq \frac{\Delta^2}{2}, \tag{6}$$

where  $\Delta \equiv \alpha_h - \alpha_l$ . We assume that type  $l$  selects mimicking type  $h$ , where (6) holds with equality. This assumption reflects the fact that election is important

for politicians. Thus, when  $R \geq \frac{\Delta^2}{2}$ , the citizen assigns  $p_i = 1$  to the politician in country  $i$  who selected  $g_i = \alpha_h$ , since  $\tilde{\alpha}_i = \alpha_m$ . Let us represent a choice of  $g_i$  by type  $k$  as  $g_{ik}$ , and similarly for the other variables. We mark an equilibrium under a decentralized decision-making system by a superscript  $+$ . The following proposition shows equilibrium without international coordination  $\{g_{ih}^+, g_{il}^+\}$ ,  $i = 1, 2$ .

*Proposition 1.* Suppose that there are no executives and no chance of international coordination. Then,

$$g_{ih}^+ = \alpha_h,$$

$$g_{il}^+ = \begin{cases} \alpha_l, & \text{if } R < \frac{\Delta^2}{2}; \\ \alpha_h, & \text{if } R \geq \frac{\Delta^2}{2}, \end{cases}$$

for  $i = 1, 2$ .

Thus, the equilibrium of this game is derived independent of the other country's choice, due to linearity in the politician's payoff function in (3). This proposition also suggests that type  $h$  need not care about his re-election, whereas type  $l$ 's optimal choice depends on how attractive re-election is to him. The candidates of type  $l$ 's best choice are confined to  $\alpha_l$  and  $\alpha_h$ , given that type  $h$  always selects  $\alpha_h$ . When the benefit from remaining in office  $R$  is small relative to the cost of mimicking type  $h$ , which is measured by  $\frac{\Delta^2}{2}$ , type  $l$  does not copy type  $h$ 's behavior. Then only type  $h$  is re-elected. When that benefit is great, type  $l$  is induced to mimic type  $h$  and is consequently re-elected. Thus,  $p_{ih}^+ = 1$  and  $p_{il}^+ = 0$  if  $R < \frac{\Delta^2}{2}$ ;  $p_{ih}^+ = p_{il}^+ = 1$  if  $R \geq \frac{\Delta^2}{2}$ ,  $i = 1, 2$ .

## 4 Politician's Decision-making about an International Agreement

Now introduce international coordination into the model. We still assume that there are no executives; only politicians in both countries are engaged in making international agreements. Let a superscript  $c$  stand for international coordination. The timing of this game is modified as follows. In period 1,

1. Nature draws an incumbent politician  $i$ 's ability  $\alpha_i$  from its distribution;
2. the incumbent politician  $i$  in each country simultaneously and independently determines whether to agree to establish an institution for international cooperation;
3. if both countries agree to establish an institution, it is established and a public good level  $g_i^c$  is determined simultaneously and independently by the incumbent politician in each country  $i$ ; if at least one country disagrees over establishing an institution, it is not established.

In period 2, voting occurs, and the winner of the election is determined.

The institution is successfully established iff both countries unanimously say, "*I agree.*" We require unanimity because frequently international treaties require ratification by a minimum number of countries in order to enter into force. If establishment fails,  $g_i^+$  will be implemented in each country  $i$  since it constitutes an equilibrium in the game under a decentralized decision-making system. We carry the analysis at first by supposing that the agreement on  $g_i^c$  is enforceable thanks to rigid punishment of non-compliance; we shall later investigate this supposition.

Let  $s_{ik}$  be the probability for type  $k$  in country  $i$  to agree on establishment of the institution for international cooperation. Let  $T_j^c = \{k' \in T | s_{jk'} = 1\}$  and  $T_j^d = \{k' \in T | s_{jk'} = 0\}$ . Note that  $T_j^c \cap T_j^d = \emptyset$  and  $T_j^c \cup T_j^d = T$ , since we do not

allow a mixed strategy in this model. Then type  $k$  in country  $i$  chooses  $s_{ik} = 1$  iff

$$\sum_{k' \in T_j^c} \pi_{k'} r_{ik}^c(k') + \sum_{k' \in T_j^d} \pi_{k'} r_{ik}^+(k') \geq \sum_{k' \in T} \pi_{k'} r_{ik}^+(k'),$$

that is, from (3),

$$\begin{aligned} & \sum_{k' \in T_j^c} \pi_{k'} \left( -\frac{(g_{ik}^c)^2}{2} + \alpha_k g_{ik}^c + \beta g_{jk'}^c + p_{ik}^c R \right) \\ & + \sum_{k' \in T_j^d} \pi_{k'} \left( -\frac{(g_{ik}^+)^2}{2} + \alpha_k g_{ik}^+ + \beta g_{jk'}^+ + p_{ik}^+ R \right) \\ & \geq \sum_{k' \in T} \pi_{k'} \left( -\frac{(g_{ik}^+)^2}{2} + \alpha_k g_{ik}^+ + \beta g_{jk'}^+ + p_{ik}^+ R \right), \end{aligned} \quad (7)$$

and he chooses  $s_{ik} = 0$  otherwise. Condition (7) is a politician's participation constraint. It indicates that making expectations on the neighboring country's decision, a politician agrees on the establishment of the international institution if his expected payoff by agreeing is equal to or greater than his expected payoff by disagreeing about it.<sup>1</sup> A pair of  $T_j^c$ ,  $j = 1, 2$ , which satisfies (7) constitutes a Perfect Bayesian Nash equilibrium. We mark an equilibrium with international coordination by a superscript  $*$ . We represent an equilibrium of this game by  $\{T_i^{c*}; \{g_{ik}^{c*}\}, k \in T_i^{c*}\}$  for  $i = 1, 2$ .

It follows immediately from the symmetry between the countries and (7) that  $T_i^{c*} \neq \emptyset$  for  $i = 1, 2$ . The following reduced form of the participation constraint (7) is useful in deriving an equilibrium:

$$\begin{aligned} & \sum_{k' \in T_j^c} \pi_{k'} \left( -\frac{(g_{ik}^c)^2}{2} + \alpha_k g_{ik}^c + \beta g_{jk'}^c + p_{ik}^c R \right) \\ & \geq \sum_{k' \in T_j^c} \pi_{k'} \left( -\frac{(g_{ik}^+)^2}{2} + \alpha_k g_{ik}^+ + \beta g_{jk'}^+ + p_{ik}^+ R \right). \end{aligned} \quad (8)$$

We can infer that each type of politician selects  $g_{ik}^c = \alpha_k$  without any strategic manipulation. Type  $l$  may choose  $g_{il}^c$ , which is divergent from  $\alpha_l$ , when he attempts

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<sup>1</sup>This formulation is consistent with Carraro and Siniscalco's (1993) idea of *profitability* of an agreement. They assert that countries would not participate in an agreement if it made them worse off than in the equilibrium without international coordination.

to remain in office for another term by manipulating his citizen's recognition of his ability. These discussions lead us to explore two kinds of equilibrium: a separating equilibrium in which only a single type agrees on the cooperative institution, and a citizen can correctly recognize his true ability by observing his performance; and a pooling equilibrium in which either type can agree on the cooperative institution, choose the same level of public good provision, and consequently be re-elected according to citizen's voting rule (4). In fact there exists another trivial equilibrium in which each type agrees on the cooperative institution but does not necessarily select the same policy. It is straightforward to show that each type proposes  $g_{ik}^{c*} = g_{ik}^+$  in this equilibrium; we will not discuss it further.

**Separating equilibrium.** We first examine a separating equilibrium with only type  $h$  agreeing on establishment of the institution. From Proposition 1 and (8), in equilibrium,  $g_{ih}^c$  for  $i = 1, 2$ , satisfies the following participation constraint for type  $h$ :

$$\pi_h \left( -\frac{(g_{ih}^c)^2}{2} + \alpha_h g_{ih}^c + \beta g_{jh}^c + R \right) \geq \pi_h \left( \frac{\alpha_h^2}{2} + \beta \alpha_h + R \right), \quad (9)$$

where

$$g_{ih}^c = \arg \max_z -\frac{z^2}{2} + \alpha_h z + \beta g_{jh}^c + R. \quad (10)$$

Condition (10) represents country  $i$  type  $h$ 's optimal decision, given his expectation that in country  $j$ , only type  $h$  agrees on the cooperative institution, and proposes  $g_{jh}^c$ , which actually constitutes an equilibrium. These two conditions (9) and (10) also imply that type  $h$  is re-elected, as he anticipates by himself, by being correctly recognized as a high-ability politician by his citizen, with or without international coordination.

Proposition 1 and condition (8) also give us the following incentive-compatibility constraint for type  $l$ :

$$\pi_h \left( -\frac{(g_{ih}^c)^2}{2} + \alpha_l g_{ih}^c + \beta g_{jh}^c + R \right) < \pi_h \left( -\frac{(g_{il}^+)^2}{2} + \alpha_l g_{il}^+ + \beta \alpha_h + p_{il}^+ R \right). \quad (11)$$

Thus, (11) shows that in equilibrium, type  $l$  in country  $i$  is not induced to behave as if he had high ability by agreeing on the cooperative institution and proposing  $g_{ih}^c$ .

It follows from (10) that  $g_{ih}^c = \alpha_h$ . From symmetry between the countries we also derive  $g_{jh}^c = \alpha_h$ . Notice that (9) holds with these results. Furthermore, (11) reduces to

$$\begin{aligned} & \pi_h \left( -\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R \right) \\ < & \begin{cases} \pi_h \left( \frac{\alpha_l^2}{2} + \beta \alpha_h \right), & \text{if } R < \frac{\Delta^2}{2}; \\ \pi_h \left( -\frac{\alpha_l^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R \right), & \text{if } R \geq \frac{\Delta^2}{2}, \end{cases} \end{aligned} \quad (12)$$

and it follows immediately that (12) holds only for  $R < \frac{\Delta^2}{2}$ .

*Lemma 1.* Suppose that no executives exist. Then there exists a separating equilibrium such that  $\{T_i^{c*}, \{g_{ik}^{c*}\}, k \in T_i^{c*}\} = \{\{h\}; \{\alpha_h\}\}$ ,  $i = 1, 2$ , iff  $R < \frac{\Delta^2}{2}$ .

Thus, in the separating equilibrium with type  $h$ 's participation, type  $h$  selects the same policy as chosen without international coordination, since he does not need any additional effort to be re-elected. A separating equilibrium with type  $l$ 's participation is derived in the same manner. We display here only the result (for a detailed derivation, see the Appendix).

*Lemma 2.* Suppose that no executives exist. Then there exists a separating equilibrium such that  $\{T_i^{c*}, \{g_{ik}^{c*}\}, k \in T_i^{c*}\} = \{\{l\}; \{\alpha_l\}\}$ ,  $i = 1, 2$ , iff  $R < \frac{\Delta^2}{2}$ .

The result demonstrated in Lemma 2 corresponds to the result in Proposition 1. When the benefit from re-election is lower than the cost for type  $l$  to manipulate citizen's recognition, he chooses a policy which straightforwardly delivers information on his true type to his citizen.

**Pooling equilibrium.** Suppose that there exists an equilibrium in which either type decides to agree on a cooperative institution and provides the identical level of public goods  $g_i^c = g_{ih}^c = g_{il}^c$ ,  $i = 1, 2$ . From (8) and Proposition 1, this equilibrium should satisfy the following participation constraint for type  $h$ :

$$\begin{aligned} & -\frac{(g_i^c)^2}{2} + \alpha_h g_i^c + \beta g_j^c + R \\ \geq & \pi_h \left( \frac{\alpha_h^2}{2} + \beta \alpha_h + R \right) + \pi_l \left( \frac{\alpha_h^2}{2} + \beta g_{jl}^+ + R \right), \end{aligned} \quad (13)$$

where

$$g_i^c = \arg \max_z -\frac{z^2}{2} + \alpha_h z + \beta g_j^c + R, \quad (14)$$

as well as type  $l$ 's participation constraint

$$\begin{aligned} & -\frac{(g_i^c)^2}{2} + \alpha_l g_i^c + \beta g_j^c + R \\ \geq & \pi_h \left( -\frac{(g_{il}^+)^2}{2} + \alpha_l g_{il}^+ + \beta \alpha_h + p_{il}^+ R \right) \\ & + \pi_l \left( -\frac{(g_{il}^+)^2}{2} + \alpha_l g_{il}^+ + \beta g_{jl}^+ + p_{il}^+ R \right). \end{aligned} \quad (15)$$

Notice that (14) shows that, given  $g_j^c$ , type  $h$ 's payoff is maximized by the equilibrium policy choice; otherwise, he could have chosen the other policy. Furthermore, (13) and (15) imply that either type is re-elected in equilibrium, since the citizen cannot recognize the true ability of the incumbent politician, and either type gains at least the same level of payoff as in the equilibrium with decentralized decision-making.

We derive  $g_i^c (= g_j^c) = \alpha_h$  from (14). With these results, (13) becomes

$$\frac{\alpha_h^2}{2} + \beta \alpha_h + R \geq \begin{cases} \frac{\alpha_h^2}{2} + \beta \alpha_m + R, & \text{if } R < \frac{\Delta^2}{2}; \\ \frac{\alpha_h^2}{2} + \beta \alpha_h + R, & \text{if } R \geq \frac{\Delta^2}{2}, \end{cases} \quad (16)$$

which holds for either case of  $R < \frac{\Delta^2}{2}$  or  $R \geq \frac{\Delta^2}{2}$ . In particular, (16) holds with strict inequality for  $R < \frac{\Delta^2}{2}$ , which implies that this pooling equilibrium can assure

type  $h$  of higher spillovers from the neighboring country than the equilibrium by decentralized decision-making. Furthermore, (15) becomes

$$\begin{aligned}
& -\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R \\
\geq & \begin{cases} \frac{\alpha_l^2}{2} + \beta \alpha_m, & \text{if } R < \frac{\Delta^2}{2}; \\ -\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R, & \text{if } R \geq \frac{\Delta^2}{2}. \end{cases} \quad (17)
\end{aligned}$$

Notice that (17) holds when  $-\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R \geq \frac{\alpha_l^2}{2} + \beta \alpha_m$  and  $R < \frac{\Delta^2}{2}$ , i.e.,  $\frac{\Delta^2}{2} - \beta \pi_l \Delta \leq R < \frac{\Delta^2}{2}$ , as well as when  $R \geq \frac{\Delta^2}{2}$ . We can derive the following lemma from these results.

*Lemma 3.* Suppose that no executives exist. Then there exists a pooling equilibrium such that  $\{T_i^{c*}; \{g_{ik}^{c*}\}, k \in T_i^{c*}\} = \{\{h, l\}; \{\alpha_h, \alpha_h\}\}$ ,  $i = 1, 2$ , iff  $R \geq \frac{\Delta^2}{2} - \beta \pi_l \Delta$ .

Recall that the outcomes predicted by Lemmas 1 and 2 are the same as the outcomes displayed in Proposition 1. When  $R < \frac{\Delta^2}{2}$ , i.e., the benefit from re-election is lower than the cost for pretending to be type  $h$ , type  $l$  supplies public goods at a level  $\alpha_l$ , while type  $h$  supplies them at  $\alpha_h$ , whether or not an international institution for cooperation is established. The outcomes predicted in Lemma 3 are distinct from the outcomes in Proposition 1, however. According to Lemma 3, type  $l$  in each country may pretend to be type  $h$  by choosing  $\alpha_h$  even for  $\frac{\Delta^2}{2} - \beta \pi_l \Delta \leq R < \frac{\Delta^2}{2}$ . Without international coordination, type  $l$  never chooses  $\alpha_h$ , since

$$-\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + R < \frac{\alpha_l^2}{2}, \quad (18)$$

for this range of  $R$ . Consequently, choosing  $\alpha_l$  is a dominant strategy against any policy choice by the neighboring country.

Let us investigate the factors generating different outcomes. When type  $l$  in country  $i$  knows that type  $h$  in any country chooses  $\alpha_h$  for the agreement, and he also anticipates that only type  $h$  agrees on the cooperative institution in the neighboring country  $j$ , as we have already shown in (12), the following incentive-

compatibility constraint holds for type  $l$  for  $\frac{\Delta^2}{2} - \beta\pi_l\Delta \leq R < \frac{\Delta^2}{2}$ :

$$\begin{aligned} & \pi_h \left( -\frac{\alpha_h^2}{2} + \alpha_l\alpha_h + \beta\alpha_h + R \right) + \pi_l \left( \frac{\alpha_l^2}{2} + \beta\alpha_l \right) \\ < & \pi_h \left( \frac{\alpha_l^2}{2} + \beta\alpha_h \right) + \pi_l \left( \frac{\alpha_l^2}{2} + \beta\alpha_l \right), \end{aligned} \quad (19)$$

since (18) holds. On the other hand, if type  $l$  in country  $i$  knows that type  $h$  in any country chooses  $\alpha_h$  for the agreement, and if he anticipates that either type may decide participation in the agreement in the other country  $j$ , then the following participation constraint holds for him for the corresponding range of  $R$ , as already shown in (17):

$$\begin{aligned} & \pi_h \left( -\frac{\alpha_h^2}{2} + \alpha_l\alpha_h + \beta\alpha_h + R \right) + \pi_l \left( -\frac{\alpha_h^2}{2} + \alpha_l\alpha_h + \beta\alpha_h + R \right) \\ \geq & \pi_h \left( \frac{\alpha_l^2}{2} + \beta\alpha_h \right) + \pi_l \left( \frac{\alpha_l^2}{2} + \beta\alpha_l \right). \end{aligned} \quad (20)$$

Notice that (20) holds in spite of (18) being satisfied. Indeed, (19) and (20) suggest that type  $l$ 's different expectations generate the different outcomes for the same range of  $R$ . If he expects that even a low-ability politician in the neighboring country signals his good performance to his citizen by participating in an international agreement and providing a high level of public goods, he also decides to participate in the agreement, since it brings plentiful spillover benefit to his country.

These discussions imply that coordination between countries can generate a trend to cooperation. Barrett (2003) pointed out that the minimum number of participating countries required for an agreement to enter into force creates a *bandwagon*; achievement of this requirement induces other countries to behave cooperatively. In our model, forces for international agreement are a politician's opportunistic motive for re-election, and his optimistic expectation of unanimous agreement among countries; in turn, this optimistic expectation is generated from the politician's belief that any politician in the other country knows that failure to establish an international institution will lead to the worst situation. We summarize these results in the following proposition.

*Proposition 2.* Suppose that no executives exist. Suppose also that an international agreement is enforceable. Then decision-making by opportunistic politicians through international coordination generates the same outcomes as in the equilibrium without international coordination, except for  $\frac{\Delta^2}{2} - \beta\pi_l\Delta \leq R < \frac{\Delta^2}{2}$ . For this range of  $R$  there exist multiple equilibria  $\{T_i^{c*}; \{g_{ik}^{c*}\}, k \in T_i^{c*}\} = \{\{h\}; \{\alpha_h\}\}$ ,  $\{\{l\}; \{\alpha_l\}\}$ , and  $\{\{h, l\}; \{\alpha_h, \alpha_h\}\}$ ,  $i = 1, 2$ , and in the third equilibrium, type  $l$  chooses a policy  $\alpha_h$  which is different from his uncoordinated equilibrium choice.

Thus, in a certain circumstance, we have multiple equilibria, and one of them may generate greater spillover effects than by decentralized decision-making. These effects may become overwhelming with a larger scale of  $\beta\pi_l\Delta$ , i.e., with a larger difference in expected spillover effects between international coordination and its absence. In the other circumstance, however, international coordination does not affect the two countries' public good provision, since a politician, who is solely interested in approval by the citizen in his own country, monopolizes the authority to decide a policy in each country. In the following section, we shall examine domestic policy procedure in more detail, where the authority to negotiate with the other countries and ratify the agreement achieved through negotiations is divided between two agents.

Consider now our supposition that the international agreement is enforceable. Our focus is the time-inconsistency problem. After agreeing on the international institution, an incumbent politician may change his mind and deviate from the agreement, e.g., by legislating domestic regulation laws which do not impose sufficient cost on citizens or interest groups to satisfy the demands of the agreement. International institutions frequently specify the treatment of countries for non-compliance, e.g., reinforced requirement of emission reduction in the Kyoto Protocol, but it is unlikely that the international institution itself constitutes a powerful third organization that can punish a country's deviation independently of the interests of participating countries. If the agreement is perfectly enforceable by punishing ev-

ery deviation with strict penalties, the outcomes demonstrated in Proposition 2 are realized. If there is no penalty for non-compliance, opportunistic politicians will deviate to the policy  $g_{ik}^+$ . Reality seems to be intermediate between these two extremes.

We shall examine how and to what extent a politician's non-compliance can be deterred. Represent the level of the penalty for deviating from  $g_{ik}^{c*}$  to  $g'$  by  $\gamma(\geq 0)$ . We suppose that the deviation to  $g'$  such that  $g' \geq g_{ik}^{c*}$  is not punished ( $\gamma = 0$ ), because this deviation benefits the neighboring country. Denote the probabilities of re-election for a type  $k$  incumbent politician in country  $i$ , complying with or deviating from the agreement, by  $p_{ik}^{cc}$  or  $p'_{ik}$  respectively. Then he is adhered to  $g_{ik}^{c*}$  iff for any  $g'$ ,

$$-\frac{(g')^2}{2} + \alpha_k g' + p'_{ik} R - \gamma \leq -\frac{(g_{ik}^{c*})^2}{2} + \alpha_k g_{ik}^{c*} + p_{ik}^{cc} R,$$

that is,

$$\psi_{ik}(g') \equiv (g' - g_{ik}^{c*}) \left( \alpha_k - \frac{g' + g_{ik}^{c*}}{2} \right) + (p'_{ik} - p_{ik}^{cc}) R \leq \gamma. \quad (21)$$

With  $g_{ik}^{c*}$  being fixed,  $(g' - g_{ik}^{c*}) \left( \alpha_k - \frac{g' + g_{ik}^{c*}}{2} \right)$  is maximized by choosing  $g' = \alpha_k$ , i.e., by deviating to type  $k$ 's best uncoordinated policy.

From our discussions, type  $h$  never deceives the partner country in the equilibria  $\{T_i^{c*}; \{g_{ik}^{c*}\}, k \in T_i^{c*}\} = \{\{h\}, \{\alpha_h\}\}, \{\{h, l\}, \{\alpha_h, \alpha_h\}\}$ , which have been derived in Lemmas 1 and 3. Now examine type  $l$ 's choice. In equilibrium  $\{T_i^{c*}; \{g_{ik}^{c*}\}, k \in T_i^{c*}\} = \{\{l\}, \{\alpha_l\}\}$ , which has been demonstrated in Lemma 2, type  $l$  keeps his promise, since he has been correctly recognized by citizen as type  $l$  at the stage of agreement, and he can no longer change citizen's recognition. Consider now the equilibrium  $\{T_i^{c*}; \{g_{ik}^{c*}\}, k \in T_i^{c*}\} = \{\{h, l\}, \{\alpha_h, \alpha_h\}\}$  in Lemma 3. When  $R \geq \frac{\Delta^2}{2}$ , type  $l$  keeps his promise and does not deviate to  $\alpha_l$ , since  $\psi_{il}(\alpha_l) = \frac{\Delta^2}{2} - R \leq 0$  in (21); the citizen knows that type  $h$  never deviates, so that by observing the incumbent politician's non-compliance the citizen correctly makes inference of  $\tilde{\alpha}_i = \alpha_l$  and updates the probability of re-electing him to  $p'_{il} = 0$  according to (4). When

$\frac{\Delta^2}{2} - \beta\pi_l\Delta \leq R < \frac{\Delta^2}{2}$ , however,  $\psi_{il}(\alpha_l) = \frac{\Delta^2}{2} - R > 0$  in (21), and hence type  $l$  deceives the partner country without penalty, in spite of the citizen's severe reaction.

*Proposition 3.* Suppose that no executives exist. Any  $g_{ik}^{c*}$ ,  $k \in T_i^{c*}$ , which has been shown in Lemmas 1 to 3, is adhered to with no penalty, except  $g_{il}^{c*}$  in *Lemma 3* for  $\frac{\Delta^2}{2} - \beta\pi_l\Delta \leq R < \frac{\Delta^2}{2}$ . This agreement is adhered to if  $\gamma + R \geq \frac{\Delta^2}{2}$ ; otherwise, a type  $l$  incumbent politician deviates from  $g_{il}^{c*} = \alpha_h$  to  $g_{il}^+ = \alpha_l$ .

Thus, a high level of public good provision agreed by an optimistic type  $l$  politician may not be enforceable without sufficiently strict penalty, since the benefit from re-election  $R$ , which will be lost by his deviation, is not sufficiently attractive to deter him from deviation. Thus, re-election pressure works as a substitute for penalty.

## 5 Divided Authorities

As Barrett (2003, pp. 138–152) observes, agreement on international cooperation has frequently been accomplished through the procedure of negotiation and signing by the executives of participating countries, ratification by the congress in each country, and implementation by legislating domestic laws for regulation. Let us examine the effects of dividing domestic authorities between the executive and the congress (a politician). Without knowing the incumbent politicians' type, the executives in both countries cooperatively choose the level of public goods  $g^c$  which maximizes their payoff (2) and is applied to both countries. Given  $g^c$  by the executives, each politician's strategy set includes two strategies: ratifying it and rejecting it. A citizen computes each type's reaction, and sets the probability of re-electing the incumbent according to (4) after observing his performance. This implies that the citizen re-elects the type  $l$  incumbent when he acts as if he was type  $h$ .

The timing of this game is summarized as follows. In period 1,

1. Nature draws an incumbent politician  $i$ 's ability  $\alpha_i$  from its distribution;
2. the executives in both countries decide public good provision level in each country  $g^c$ ;
3. the incumbent politician in each country  $i$  simultaneously and independently determines whether to ratify or reject  $g^c$ ;
4. if the incumbent politicians in both countries ratify  $g^c$ , the institution for international cooperation is established and  $g^c$  is obligatory in each country; otherwise, it fails to be established.

In period 2, voting occurs, and the winner of the election is determined.

We represent equilibrium in this game by  $\{g^{c*}; T_i^{c*}\}$ ,  $i = 1, 2$ . The game can be solved backwards. We first examine each type of politician's reaction to the executives' decision.

**Type  $h$ 's reaction.** From (9) and Proposition 1, given  $g^c$  from the executives, if type  $h$  in country  $i$  anticipates that only type  $h$  ratifies  $g^c$  in the other country  $j$ , he ratifies it iff

$$-\frac{(g^c)^2}{2} + \alpha_h g^c + \beta g^c + R \geq \frac{\alpha_h^2}{2} + \beta \alpha_h + R. \quad (22)$$

Notice that  $-\frac{(g^c)^2}{2} + \alpha_k g^c + \beta g^c$  strictly increases in  $g^c$  if  $g^c \leq \alpha_k + \beta$ , and strictly decreases in  $g^c$  if  $g^c \geq \alpha_k + \beta$ . It thus takes the maximum with  $\alpha_k + \beta$ , and is symmetric around  $\alpha_k + \beta$ . Consequently, (22) holds only for  $g^c \in [\alpha_h, \alpha_h + 2\beta]$ .

Similarly, from (13) and Proposition 1, if type  $h$  anticipates that both types ratify  $g^c$  in the other country, he ratifies it iff

$$\begin{aligned} -\frac{(g^c)^2}{2} + \alpha_h g^c + \beta g^c + R &\geq \frac{\alpha_h^2}{2} + \beta(\pi_h \alpha_h + \pi_l g_{jl}^+) + R \\ &= \begin{cases} \frac{\alpha_h^2}{2} + \beta \alpha_m + R, & \text{if } R < \frac{\Delta^2}{2}; \\ \frac{\alpha_h^2}{2} + \beta \alpha_h + R, & \text{if } R \geq \frac{\Delta^2}{2}. \end{cases} \end{aligned} \quad (23)$$

For  $R \geq \frac{\Delta^2}{2}$ , this condition holds with  $g^c \in [\alpha_h, \alpha_h + 2\beta]$  as in (22). For  $R < \frac{\Delta^2}{2}$ , we can find a proposal  $g^c < \alpha_h$  which is included in the set of type  $h$ 's admissible agreements. When  $R$  is low, so that re-election is not attractive to type  $l$ , type  $l$  in the neighboring country supplies a low level of public goods without international coordination. Knowing this, type  $h$  is more likely to agree on the establishment of the cooperative institution, which may induce type  $l$  in the neighboring country to supply a higher level of public goods.

If type  $h$  anticipates that only type  $l$  ratifies  $g^c$  in the other country, he ratifies it iff

$$\begin{aligned} -\frac{(g^c)^2}{2} + \alpha_h g^c + \beta g^c + R &\geq \frac{\alpha_h^2}{2} + \beta g_{jl}^+ + R \\ &= \begin{cases} \frac{\alpha_l^2}{2} + \beta \alpha_l + R, & \text{if } R < \frac{\Delta^2}{2}; \\ \frac{\alpha_h^2}{2} + \beta \alpha_h + R, & \text{if } R \geq \frac{\Delta^2}{2}. \end{cases} \end{aligned} \quad (24)$$

Thus, equations (22) to (24) suggest that a type  $h$  politician's expectation of the choice of the politician in the other country has no influence on his choice when  $R \geq \frac{\Delta^2}{2}$ . When  $R < \frac{\Delta^2}{2}$ , i.e., when re-election pressure does not work on type  $l$  under a decentralized decision-making system, a type  $h$  politician's decision depends on his expectation of the ability of the politician in the neighboring country who ratifies the agreement. When the expected ability is lower, type  $h$ 's participation constraint is more slack, since establishment of the institution for international cooperation is more profitable to him. Thus, international coordination gives opportunistic politicians an incentive to behave cooperatively.

**Type  $l$ 's reaction.** We can derive type  $l$ 's reaction to the executives' decision  $g^c$  in a similar manner to the derivation of type  $h$ 's reaction. With the anticipation of only type  $h$  ratifying  $g^c$  in the other country, type  $l$  ratifies it iff

$$\begin{aligned} -\frac{(g^c)^2}{2} + \alpha_l g^c + \beta g^c + p_{il} R &\geq -\frac{(g_{il}^+)^2}{2} + \alpha_l g_{il}^+ + \beta \alpha_h + p_{il}^+ R \\ &= \begin{cases} \frac{\alpha_l^2}{2} + \beta \alpha_h, & \text{if } R < \frac{\Delta^2}{2}; \\ -\frac{\alpha_l^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R, & \text{if } R \geq \frac{\Delta^2}{2}. \end{cases} \end{aligned} \quad (25)$$

If type  $l$  anticipates that both types ratify  $g^c$  in the other country, his participation constraint is

$$\begin{aligned}
& -\frac{(g^c)^2}{2} + \alpha_l g^c + \beta g^c + p_{il} R \\
\geq & -\frac{(g_{il}^+)^2}{2} + \alpha_l g_{il}^+ + \beta(\pi_h \alpha_h + \pi_l g_{jl}^+) + p_{il}^+ R \\
= & \begin{cases} \frac{\alpha_l^2}{2} + \beta \alpha_m, & \text{if } R < \frac{\Delta^2}{2}; \\ -\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R, & \text{if } R \geq \frac{\Delta^2}{2}. \end{cases} \tag{26}
\end{aligned}$$

Finally, when type  $l$  anticipates that only type  $l$  ratifies  $g^c$  in the neighboring country, his participation constraint is

$$\begin{aligned}
& -\frac{(g^c)^2}{2} + \alpha_l g^c + \beta g^c + p_{il} R \\
\geq & -\frac{(g_{il}^+)^2}{2} + \alpha_l g_{il}^+ + \beta g_{jl}^+ + p_{il}^+ R \\
= & \begin{cases} \frac{\alpha_l^2}{2} + \beta \alpha_l, & \text{if } R < \frac{\Delta^2}{2}; \\ -\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R, & \text{if } R \geq \frac{\Delta^2}{2}. \end{cases} \tag{27}
\end{aligned}$$

These results, (25) to (27), have similar implications to the results (22) to (24). When  $R < \frac{\Delta^2}{2}$ , type  $l$ 's participation constraint is more slack, with a lower expected ability of the ratifying politician in the neighboring country. When  $R \geq \frac{\Delta^2}{2}$ , his ratification is independent of his expectation.

**The executives' decision.** Consider first the case of  $R \geq \frac{\Delta^2}{2}$ . As (22) to (27) already imply, equilibrium can be solved independently of the politician's expectation on the cooperating partner's type. It follows from (22), (23), and (24) that type  $h$  in country  $i$  ratifies  $g^c$  iff  $|\alpha_h + \beta - g^c| \leq \beta$ . That is, he ratifies  $g^c \in [\alpha_h, \alpha_h + 2\beta]$ ; he rejects any other level of  $g^c$ . Also, from (25), (26), and (27), expecting  $p_{il} = 1$ , type  $l$  ratifies  $g^c$  iff  $|\alpha_l + \beta - g^c| \leq |\alpha_l + \beta - \alpha_h|$ . That is, he ratifies  $g^c \in [\alpha_h, 2(\alpha_l + \beta) - \alpha_h]$  when  $\beta \geq \Delta$ ; and he ratifies  $g^c \in [2(\alpha_l + \beta) - \alpha_h, \alpha_h]$  when  $\beta < \Delta$ . We derive from these inferences the following lemma on the executives' decision which leads to both types' ratification and their re-election.

*Lemma 4.* Let  $R \geq \frac{\Delta^2}{2}$ . If  $\beta \geq \Delta$  and a pooling equilibrium exists in which both types in each country ratify the executives' decision, then  $g^{c*} \in [\alpha_h, 2(\alpha_l + \beta) - \alpha_h]$ . If  $\beta < \Delta$  and a pooling equilibrium exists, then  $g^{c*} = \alpha_h$ .

Lemma 4 shows that, when  $\beta \geq \Delta$  and hence the effect spilling from the public goods in the neighboring country is prominent, the executives can induce either type of politician to ratify whichever public good provision level is higher than his uncoordinated decision.

The executives select  $g^c$  which maximizes their payoff (2). They may select a policy which is ratifiable by both types, or a policy ratifiable by only a single type. We state here the effect of their equilibrium decision on citizens' total welfare, which is equal to the executives' payoff.

*Proposition 4.* Let  $R \geq \frac{\Delta^2}{2}$ . Suppose that an international agreement is enforceable. Then an equilibrium such that the executives' decision  $g^{c*}$  satisfies at least one type's participation constraint with strict inequality Pareto-dominates the equilibrium without international coordination, in view of citizens' *ex ante* welfare.

Proposition 4 is derived from (7). Note that  $T_i^{c*} \neq \emptyset$  as already shown. Furthermore,  $p_{ih}^+ = p_{il}^+ = 1$  for  $R \geq \frac{\Delta^2}{2}$ . In equilibrium, where (7) holds with strict inequality for some  $k \in T_i^{c*}$  and  $p_{ik}^{c*} \leq p_{ik}^+$  for all  $k \in T_i^{c*}$ , citizens' total welfare, which does not involve  $R$ , is higher than without international coordination, in the *ex ante* sense. This Pareto-dominance, of the equilibrium with benevolent and cooperative agents over the equilibrium without them, holds with opportunistic agents involved in international coordination process.

Consider now whether a politician implements the agreement after he ratifies it. In a separating equilibrium in which only a single type  $k$  ratifies the executives' decision, his true type has been revealed at the ratification stage so that  $p_{ik}^{cc} = p'_{ik}$  in (21) (where  $g_{ik}^{c*}$  should be replaced by  $g^{c*}$ ). It follows from (21) that

the politician deviates *ex post* to his most preferred uncoordinated policy  $\alpha_k$  iff  $\psi_{ik}(\alpha_k) = \frac{(\alpha_k - g^{c*})^2}{2} > \gamma$ .

Consider now a pooling equilibrium in which both types can ratify the executives' decision. From Lemma 4,  $g^{c*} \geq \alpha_h$  in a pooling equilibrium. Type  $h$  deviates to  $\alpha_h$  iff  $\psi_{ih}(\alpha_h) = \frac{(\alpha_h - g^{c*})^2}{2} > \gamma$ . Then, knowing this, type  $l$  should select from either following type  $h$  or reverting to his uncoordinated choice; in either case he has to pay the penalty. It immediately follows that he also deviates to  $\alpha_h$ , since  $R \geq \frac{\Delta^2}{2}$ . When  $\psi_{ih}(\alpha_h) \leq \gamma$ , type  $h$  sticks to the agreement, so that type  $l$ 's best choice is to keep the agreement or to revert to his uncoordinated policy choice. This case is solved using (21).

*Proposition 5.* Let  $R \geq \frac{\Delta^2}{2}$ . In a separating equilibrium in which only a single type  $k$  ratifies the executives' decision  $g^{c*}$ , he complies with the agreement if  $\gamma \geq \frac{(\alpha_k - g^{c*})^2}{2}$ ; otherwise, he deviates from  $g^{c*}$  to  $\alpha_k$ . In a pooling equilibrium with  $\gamma \geq \frac{(\alpha_h - g^{c*})^2}{2}$ , type  $h$  complies with the agreement, while type  $l$  complies with it if  $\gamma + R \geq \frac{(\alpha_l - g^{c*})^2}{2}$ ; otherwise, he deviates from  $g^{c*}$  to  $\alpha_l$ . In a pooling equilibrium with  $\gamma < \frac{(\alpha_h - g^{c*})^2}{2}$ , both types deviate from  $g^{c*}$  to  $\alpha_h$ .

Proposition 5 shows that a higher penalty is required to make the politician comply with a higher level of agreement  $g^{c*}$ . In a pooling equilibrium, however, type  $l$ 's fear of losing an election deters his deviation by the extent of  $R$ .

Let us examine the case  $R < \frac{\Delta^2}{2}$ , focusing on implementability of the international agreement. From (23), anticipating that both types in the neighboring country ratify the executives' decision, type  $h$  ratifies it iff

$$g^c \in X_h = [\alpha_h + \beta - \sqrt{\beta^2 + 2\beta\pi_l\Delta}, \alpha_h + \beta + \sqrt{\beta^2 + 2\beta\pi_l\Delta}]. \quad (28)$$

From (26), when type  $l$  anticipates both types' ratification in the neighboring country and  $p_{il} = 1$ , he also ratifies it iff  $\beta^2 - 2\beta\pi_h\Delta + 2R \geq 0$  and

$$g^c \in X_l = [\alpha_l + \beta - \sqrt{\beta^2 - 2\beta\pi_h\Delta + 2R}, \alpha_l + \beta + \sqrt{\beta^2 - 2\beta\pi_h\Delta + 2R}]. \quad (29)$$

If a pooling equilibrium exists such that both types ratify the executives' decision in each country, then  $X_h \cap X_l \neq \emptyset$  holds. Recall that the midpoint of  $X_k$  is  $\alpha_k + \beta$ , and hence the distance between the midpoints of  $X_h$  and  $X_l$  is equal to  $\Delta$ . The necessary condition for the existence of a pooling equilibrium is then

$$\sqrt{\beta^2 + 2\beta\pi_l\Delta} + \sqrt{\beta^2 - 2\beta\pi_h\Delta + 2R} \geq \Delta. \quad (30)$$

*Lemma 5.* Let  $R < \frac{\Delta^2}{2}$ . If a pooling equilibrium exists, then the conditions  $\beta^2 - 2\beta\pi_h\Delta + 2R \geq 0$  and  $\sqrt{\beta^2 + 2\beta\pi_l\Delta} + \sqrt{\beta^2 - 2\beta\pi_h\Delta + 2R} \geq \Delta$  should hold.

Lemma 5 shows that, according to the distribution of the two types and the magnitude of the rent in office, a third agent proposing the common requirement to each country may induce a type  $l$  politician to ratify the agreement and to provide a higher level of public goods than his decentralized policy choice. The necessary condition for a pooling equilibrium stated in Lemma 5 is more likely to be satisfied with a higher  $\pi_l$ , as well as a higher  $R$ . As (28) and (29) show, either type in a country is more ready to participate in an agreement in which a low-ability politician in the neighboring country is more likely to participate. Furthermore, (28) shows that the executives' decision  $g^c$  which is lower than type  $h$ 's self-interested policy choice  $\alpha_h$  is ratified by type  $h$ . A type  $h$  politician in a country willingly suppresses the provision of public goods in order to induce a type  $l$  politician in the neighboring country to participate in the agreement.

The following proposition demonstrates the virtue of divided authorities on citizens' welfare in a separating equilibrium.

*Proposition 6.* Let  $R < \frac{\Delta^2}{2}$ . Suppose that an international agreement is enforceable. Then a separating equilibrium in which the executives' decision  $g^{c*}$  satisfies a single type's participation constraint with strict inequality Pareto-dominates the equilibrium without international coordination, in view of citizens' *ex ante* welfare.

Proposition 6 is derived in the same way as Proposition 4. When only a single type satisfies the participation constraint (7), with strict inequality, then citizens' *ex ante* welfare is improved in this separating equilibrium relative to the equilibrium without international coordination, since  $p_{ik}^+ = p_{ik}^{c^*}$ ,  $k \in T_i^{c^*}$ . It is difficult to discuss superiority of a pooling equilibrium over the equilibrium without international coordination, however. Since  $p_{il}^+ = 0$  for  $R < \frac{\Delta^2}{2}$  increases to  $p_{il}^{c^*} = 1$  by participation, type  $l$  may clear the participation constraint, taking the rent from re-election into account, which does not contribute to citizens' welfare.

Consider now whether the agreement is complied with after ratification. The discussion concerning the derivation of Proposition 5, which examines time-inconsistency of the agreement when  $R \geq \frac{\Delta^2}{2}$ , applies to the equilibrium when  $R < \frac{\Delta^2}{2}$ , except when  $g^{c^*} < \alpha_h$  which constitutes a pooling equilibrium. Consider  $g^{c^*} < \alpha_h$  which constitutes a pooling equilibrium. As assumed, type  $h$ 's deviation from  $g^{c^*}$  to a higher level  $\alpha_h$  does not appear to be punished, because this deviation is preferred by the neighboring country. Type  $h$  then deviates to  $\alpha_h$  with no penalty imposed on him. If type  $l$  stuck to the agreement, he would be given zero probability of re-election. His best choice is therefore to revert to his decentralized choice  $\alpha_l$ , or to behave as if he was type  $h$  by deviating to  $\alpha_h$ . He deviates to  $\alpha_h$ , not to  $\alpha_l$ , iff  $-\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + R \geq \frac{\alpha_l^2}{2} - \gamma$ , i.e.,  $\gamma + R \geq \frac{\Delta^2}{2}$ .

*Proposition 7.* Let  $R < \frac{\Delta^2}{2}$ . In a separating equilibrium in which only a single type  $k$  ratifies the executives' decision  $g^{c^*}$ , he complies with the agreement if  $\gamma \geq \frac{(\alpha_k - g^{c^*})^2}{2}$ ; otherwise, he deviates from  $g^{c^*}$  to  $\alpha_k$ . In a pooling equilibrium with  $g^{c^*} \geq \alpha_h$  and  $\gamma \geq \frac{(\alpha_h - g^{c^*})^2}{2}$ , type  $h$  complies with the agreement, while type  $l$  complies with it if  $\gamma + R \geq \frac{(\alpha_l - g^{c^*})^2}{2}$ ; otherwise, he deviates from  $g^{c^*}$  to  $\alpha_l$ . In a pooling equilibrium with  $g^{c^*} \geq \alpha_h$  and  $\gamma < \frac{(\alpha_h - g^{c^*})^2}{2}$ , each type  $k$  deviates from  $g^{c^*}$  to  $\alpha_k$ . In a pooling equilibrium with  $g^{c^*} < \alpha_h$ , type  $h$  deviates from  $g^{c^*}$  to  $\alpha_h$ , whereas type  $l$  deviates from  $g^{c^*}$  to  $\alpha_h$  if  $\gamma + R \geq \frac{\Delta^2}{2}$ ; otherwise, he deviates to  $\alpha_l$ .

Proposition 7 may explain the observation of Barrett (2003): international environmental agreements have frequently been over-complied with, and many participating countries have reduced their emissions by more than required (see Figure 1.2 for the Helsinki Protocol and Figure 1.3 for the Oslo Protocol). The agreement negotiated by the executives can set a low target intentionally, to make participation easier. Once the treaty comes into force, countries with high ability to conform may implement a higher scale of reduction, since they “had a strong incentive to reduce their emissions unilaterally,” as Barrett (2003, p. 10) said. Furthermore, countries with low ability to conform may be forced to follow the high-ability countries by re-election pressure.

## 6 Concluding Remarks

This paper has examined how interaction between countries leads to international cooperation. Previous studies considered the participation of leading countries in international agreements (Barrett 2003, 2005), the change in cost and benefit in association with public good provision caused by other countries’ actions (Heal 1994, 1999), or politicians’ and citizens’ beliefs on potential benefits of an environmental policy (Glazer and Proost 2008) as the causes of strategic complementarity in environmental action by countries. In our model, the forces for movement toward international agreement are a politician’s opportunistic motive for re-election, as well as his beliefs concerning the other country’s participation. It was further shown that re-election pressure can work as a substitute penalty upon deviation of participating countries from the agreement.

Our results encompass both optimistic and pessimistic views. Re-election pressure can induce a low-ability politician to provide more public goods than by his uncoordinated choice. Thus, one of the roles of the international agreement is to change the behavior of the countries that would otherwise be reluctant to make

more efforts without it. On the other hand, the optimal agreement negotiated by executives may not be complied with by a high-ability politician, since citizens reelect him even if he deceives partner countries. Indeed, this non-compliance of the international agreement also profits citizens in his own country, given the other countries' compliance of the agreement. A possible extension of our study is to incorporate more detailed descriptions of citizens' voting and of politicians' motive for policy choice.

## A Appendix

### A.1 Separating equilibrium with type $l$ 's agreement

From Proposition 1 and (8), in this equilibrium,  $g_{il}^c$  for  $i = 1, 2$ , satisfies the following conditions:

$$\pi_l \left( -\frac{(g_{il}^c)^2}{2} + \alpha_l g_{il}^c + \beta g_{jl}^c \right) \geq \pi_l \left( -\frac{(g_{il}^+)^2}{2} + \alpha_l g_{il}^+ + \beta g_{jl}^+ + p_{il}^+ R \right), \quad (\text{A1})$$

$$g_{il}^c = \arg \max_z -\frac{z^2}{2} + \alpha_l z + \beta g_{jl}^c, \quad (\text{A2})$$

$$\pi_l \left( -\frac{(g_{il}^c)^2}{2} + \alpha_h g_{il}^c + \beta g_{jl}^c \right) < \pi_l \left( \frac{\alpha_h^2}{2} + \beta g_{jl}^+ + R \right). \quad (\text{A3})$$

Conditions (A1) and (A3) imply that a politician who chooses  $g_{il}^c$  is regarded as having low ability by a citizen and loses an election. It follows from (A2) that  $g_{il}^c (= g_{jl}^c) = \alpha_l$  in equilibrium. Consequently, (A1) is arranged as

$$\pi_l \left( \frac{\alpha_l^2}{2} + \beta \alpha_l \right) \geq \begin{cases} \pi_l \left( \frac{\alpha_h^2}{2} + \beta \alpha_l \right), & \text{if } R < \frac{\Delta^2}{2}; \\ \pi_l \left( -\frac{\alpha_h^2}{2} + \alpha_l \alpha_h + \beta \alpha_h + R \right), & \text{if } R \geq \frac{\Delta^2}{2}, \end{cases} \quad (\text{A4})$$

which holds iff  $R < \frac{\Delta^2}{2}$ . Furthermore, (A3) becomes

$$\pi_l \left( -\frac{\alpha_l^2}{2} + \alpha_h \alpha_l + \beta \alpha_l \right) < \begin{cases} \pi_l \left( \frac{\alpha_h^2}{2} + \beta \alpha_l + R \right), & \text{if } R < \frac{\Delta^2}{2}; \\ \pi_l \left( \frac{\alpha_h^2}{2} + \beta \alpha_h + R \right), & \text{if } R \geq \frac{\Delta^2}{2}, \end{cases} \quad (\text{A5})$$

which holds for both cases since  $-\frac{z^2}{2} + \alpha_h z$  is maximized by  $z = \alpha_h$ . These results lead us to Lemma 2.

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