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A Study on the Endogenous Process of Implementing International Environmental Standards:
Special Interest Politics Approach

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FOREWORD

The green movement has grown rapidly since the 1980s and emerged as an important political actor in most western democratic countries. The rising profile of the environment in politics is due to growing public concern over ecological crises that threaten human activity including production, consumption, income distribution and competitiveness in international trade.

Given the importance of the environment in politics, each environmental standard adopted to regulate human-induced environmental problems would challenge the interests of each country as well as those of relevant interest groups, especially in view of globalization and international market integration. For every environmental issue, there will be a wide range of institutions, organisations and interest groups seeking to influence the government's policy-making process. Most interest group activities include conventional political activities such as lobbying and education.

This study analyses theoretical aspects of how different interest groups interact when implementing an environmental standard from a political economics point of view. Within the specific factor model in international trade, the study examines the changes in the political equilibrium level of the standard as the various types of interest group politics are reviewed. In addition to the common agency framework which is popularly adopted in recent discussions of relevant papers, the study extensively considers more realistic models that incorporate the important aspect of international interest group politics and the international agreements between the governments under the Kyoto Protocol system. Using simulation, the insightful implications of each outcome from those political models are presented in the later part of the study. Although further refinements or contents for better

exposition may be required, this study is expected to serve as a legitimate contribution for the facilitation of subsequent discussions.

I would like to thank the research staff, Uk Hwang, Seok-Joon Hwang, Mi-Jin Kim and Jangyul Cho for their efforts in completing this study. My gratitude also goes to the reviewers, including Professor Jong-Soo Lim, Professor Ki-Heung Kim, Dr. Sung-Bok Yun, Mr. Han-Seung Kum, Dr. Man-Ok Kang and Dr. Jin-Suk Choi, for their inspiring comments on the structure and content of this study throughout its development.

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ABSTRACT

This study presents the political economics models to explore the political landscape of special interest groups influencing the government's decision making process for implementing international environmental standard. Starting with the popular menu-auction types of lobbying frameworks in the literature, the study extends its researching scope to multi-principal and multi-agency based international interest group politics and its hybrid case in order to bring the interaction of the relevant interest politics to the fore. Within a specific factor model of international trade, we compare the political equilibrium outcomes in different institutional frameworks which can be feasible in the sense of recently growing role of environmental groups. In the benchmark, the two governments do not cooperate and the unilateral implementation leads to environmental standards that are too lax. Cooperation between the two governments can internalize the negative externality associated with unilateral policy making. This framework is more elaborated by incorporating the case of clean technology transfer between countries, which can benefit mutually both the donor and the recipient countries. More importantly, it is shown that cooperation between like-minded interest groups in different countries generates an identical result obtainable in the negotiation between the two governments. It is found that comparative static analysis using simulations provides some supporting evidence for the findings in the political economics models.

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I. Introduction

This paper analyses the influence of interest group politics on environmental standards in an economy in which so-called 'environmentalists' and 'industrialists' have traded-off interests over the given level of standard.[1] Focusing on emission intensity standard, this paper illustrates how a government's environmental standards policy is determined by lobbying on behalf of environmentalist groups and industrialist groups. Environmental standards regulating the ratio of emission per unit output particularly would have significant effects on the welfare of capital owners, the profits of firms, as well as on international trade. Thus, in analyzing what affects the government's policy choice of environmental standards, it is of importance to take into account the role of interest group politics. This paper aims to analyze how an environmental standard is endogenously determined by government policy within the context of a simple specific factor (Ricardo-Viner) model of international trade.

An implication is that governments often adopt environmental standards unilaterally and without regard to wider implications. Unilateral standard choices of sovereign governments may give rise to inefficient outcomes for the global economy, and may even provoke a so-called '*race to the bottom*'. This has raised a need for cooperation between the governments in an attempt to internalize externalities caused by these unilateral actions to enhance mutual benefits. The international standard system set up with reference to global environmental issues is constructed or abrogated by the power relationship of each nation, international community, business, environmental

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1) International environmental standards are the whole rules used to regulate the human's activity affecting the global environment and to protect the environment. Currently the system of environmental standards commonly applied to global dimensions is not yet settled and it is difficult to establish the accurate scope and definition of environmental standards to be settled among the bilateral or multilateral arrangements according to need. International environmental standards may be in a stage of development without completed systems as yet and in process of discussion with the interests of opposition between developed and developing nations in opposition.

group which is the so-called behavior in environmental fields. As concerns for transboundary, global environmental issues, inter-country cooperation is momentous to cope with the externality problems. However, attaining international policy cooperation is a delicate matter of troublesome. The frequent failure of reaching agreements during international negotiations, the brittle weakness of international agreement to free riding problem, for example, as well as the absence of a supra national government that is empowered to implement the coordinated policy for the global society are just a few of the concerns.

In face of the problems related to cooperation between governments, one of the implications captured in this study shows that international cooperation between special interest groups can be an alternative to cooperation between governments.[2] It presents that cooperation between interest groups under an identical political stake in different countries may lead politicians to internalize externalities and cause a globally efficient standard policy outcome,[3] or at least an improvement on non-cooperative outcome. Thus, a question may be raised: Could international interest group politics play an alternative role for international agreements between governments. In contrast to most previous literatures on interest group politics, this paper considers the case of international cooperation between national interest groups. That is, an international interest group encompassing groups with common interests in different countries may form and lobby all relevant governments.

This paper considers a specific factor model with perfect competition to capture the strategic interaction of interest groups representing the interest of specific factor holders as well as the externalities generated by the

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2) Environmental standards would perform the major function and role to settle problems of the international community by preventing and controling environmental pollution as well as minimizing international disputes about it. Then there has been a growing international movement to set up the troubleshooting procedures and institutional mechanisms for environmental issues.

3) Global efficiency is attained, in our context, when the payoffs of all the relevant players (lobby groups (principals) and governments (agents)) in each country are maximised at an equilibrium.

governments' environmental standard policies. The fundamental structure of interaction between the government and interest groups under the political models of campaign spending is that they play a two-stage game: In the first stage, the two interest groups simultaneously and independently choose contribution schedules that list financial payments to the government(s) contingent on every environmental standard option to them. In the second stage, the government legislates a specific level of the environmental standard, which is influenced by the contribution payment plans by the interest groups. It is anticipated that, depending on the interest group politics regime, a different equilibrium environmental standard will be implemented in equilibrium. We investigate the following five cases of special interest politics: [1] domestic interest politics, [2] international negotiation with lump-sum transfer, [3] international negotiation with clean technology transfer (Clean Development Mechanism case), [4] international interest group politics, and [5] asymmetric international interest group politics. The details of each political regime will be clear in the sequel of coming analysis.

The remainder of this paper is planned as follows. Section 2 surveys related literature of this field of studies. Section 3 outlines the essential features of the economic model under a small open economy. Section 4 presents the role of interest politics in the decision process of an environmental standard by considering the five possible occasions of interest group politics, focusing on the characterization of each political equilibrium when making campaign contributions to politicians.[4] In section 5, the equilibria characterized in each political regime are computed and comparative static results are presented. Section 6 concludes the paper.

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4) This study will interchangingly use the term ‘politician’, ‘policy maker’, and ‘government’. All is assumed to be in charge of making environmental standard under consideration.

II. Related Literature

Only a few papers have been studied the political aspect of environmental policy making in formal economic models until recently. However, in accordance with recent developments in economic studies such as game theory, mechanism design, and information economics, political economics has emerged as a growing literature, drawing vast attentions from the most main fields of economics. Particularly, the contribution of political economics to public economics, international trade and monetary economics has been enormously noteworthy during the last decade.[5] Environmental policy making also has became one of the popular field of political economics in this regard. With the publication of menu-auction model by Bernheim and Whinston (1988), interest group politics have been widely adopted as a basic framework to explain endogenous trade and environmental policy decision processes. Since the effects of environmental damage affect different groups of an economy with varying intensity, there are incentives for these groups to compete and lobby for the governments' policy making to their benefit. These political economics linkages between trade and the environment are receiving an increasing attention from related fields of economics literature. Some notable developments on this topic are studies such as Hillman and Ursprung (1992), Bommer (1996), Fredriksson (1997), Fredriksson (1999), Aidt (1998), Bommer and Schulze (1999), Schleich (1999), Schleich and Orden (2000), Yu (2000), Damania (2001), and Conconi (2003).[6] Green lobby was initially examined by Hillman and Ursprung (1992), who found a noticeable implication in a model of endogenous trade policy that "the greens" may or may not lobby for higher tariffs depending on the types of pollution(local or transboundary spillover) so as to reduce contamination. Bommer (1996) and Bommer and Schulze (1999) examined the relationship between changes in endogenous environmental policy and international trade opening.

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5) To review these developments, see Persson and Tabellini (2002).

6) For details, refer to the papers that summarize the major developments of trade and environment literature in recent years such as Anriquez (2002) and Sturm (2003).

The common agency type of political competition in lobbying models includes Fredriksson (1997) for the political determination of pollution tax, Fredriksson (1999) for pollution tax linked with given trade policy, Aidt (1998) for an output tax and a tax on the polluting input, and Schleich (1999) for the endogenous trade and pollution policy with the more general assumption that all suffer from pollution. They typically use specific factor model to clearly highlight interest of factor owners in the face of government's policy changes and assume a small open economy model. Not only that, most papers commented are confined to the analysis of the role of domestic interest groups in illuminating the political aspects of endogenous environmental policy setting.

The assumption of a large open economy is introduced by Schleich and Orden (2000) and Conconi (2003). They extend the framework of common agency model to allow interaction between two large open economies. But the characterization of political equilibrium in their model follows that of the menu auction type originally proposed by Bernheim and Whinston (1988). The recent theoretical contribution by Prat and Rustichini (2003) can enable us to characterize political equilibrium from the political model based on multi-principal and multi-agency framework to investigate the political outlook of international interest group politics. Thus, this study can show how to characterize the political equilibrium not only from a multi-principal and multi-agency but also from the hybrid between a multi-principal and multi-agency and a common agency structure with the help of Prat and Rustichini (2003).[7] Damania (2001) starts with a framework that is similar to that of Fredriksson (1997) and examines the interest of polluters whose political behaviour in making campaign contribution depends on the efficiency of abatement technology available. Contrary to other papers which usually adopt common agency model to explain the endogenous mechanisms of environmental policy making, Yu (2000) elaborates the mechanisms by incorporating the median voter theorem to have an insight into the formation

7) The frameworks under consideration can be found in international interest politics and asymmetric international interest politics which will be introduced in the political models in section 4.

of government environmental policies that involve interest groups with different strengths in their political influence.

Setting the basic general equilibrium model with the consideration of transboundary pollution spillover for this study largely benefits from a series of papers by Copeland and Taylor whose contributions on the topics of trade and environment become a cornerstone of this literature. The study especially adopts the international trade frameworks proposed in Copeland and Taylor (1994, 1995, 1997, and 2003). The major features of technology and abatement cost assumed in this study also follows those of Copeland and Taylor (2003).

Compared to the existing studies reviewed, the position of this study in the emerging fields of political economics of environmental policy making can be identified by specifying that the study ① examines the endogenous mechanisms of international environmental standard that directly regulates emission intensity in a general equilibrium model with specific factors, ② focuses on political economics model of financing campaign contribution by special interest group, extending the role of domestic interest group to that of international interest group due to the theoretical advance by Prat and Rustichini (2003), ③ originally analyses the political model for international negotiation for environmental standard setting between sovereign countries when clean technology transfer with the particular case of CDM under the Kyoto Protocol is taken into account as a tool for facilitating the agreement, and ④ proposes some policy implications derived from the comparative static analysis by a series of simulations, in which changes in the major variables of the model are observed when varying the key parameters.

III. The Economy

This analysis develops a simple general equilibrium model that may suggest implications for international trade and environmental policy issues within a three factor - two good - two country model.[8] According to the general equilibrium model based on the specific factor model of production (Nearly, 1978), this model follows their analysis. In the simple model developed here, a specific factor reward changes with the choice of the policy maker's environmental standard options. This comes from the fact that the environmental standard in this context regulates the emission intensity (e) of the pollution industry in the model. It is widely known that the policy choice such as emission tax, allowable emission limit, or emission quota etc. makes no difference in its consequences. Considering the limited scope of the analysis, we will only focus on the case of emission intensity that is a ratio of emission per unit of output as a policy option available to the policy maker. Thus, the environmental standard under consideration in this study is confined to the emission intensity standard. For simplicity of analysis, the two countries are identical, i.e., they have identical political and economic environments.

1. Technology

The model assumes a world consisting of two small open economies. Each cannot affect current world prices. Each economy is assumed to produce two types of goods; a clean good and a dirty good and only the dirty good to generates polluting emission in the production process. It can be deduced that reward for the specific factor employed to produce the dirty good will be positively affected by the quantity of emission including transboundary

8) In following discussions, country 1 indicates either 'home' or 'less developed' country and country 2 either 'foreign' or 'advanced' country.

emission generated from the neighbour country near the economy. The production functions for clean good and dirty good are denoted by

$$Q_c = F_c(L_c, H) \text{ and } Q_D = F_D(L_D, K), \quad (1)$$

where subscript C denotes '*clean*' and D '*dirty*' sector respectively. It is also assumed that

$$\frac{\partial F_C(0,H)}{\partial L_C} = \frac{\partial F_D(0,K)}{\partial L_D} = \infty$$

for positive H and K. This implies that, for any positive prices, it is desirable to allocate the mobile factor labour to each competing use. That is, all the goods are produced. Full employment in the labour market requires that

$$\overline{L} = L_C + L_D.$$

Technologies exhibit constant returns to scale(CRTS) in each industry. Numeraire production Q_C is assumed to require labour input L_C and specific factor H. Production of clean good(Q_C) and dirty good(Q_D) requires labour and factors that are specific to each industry. It is assumed that the production of clean good requires capital H while dirty good utilizes capital K. In other words, factor H is specific to clean good producing industry whereas factor K is to dirty good producing industry respectively. It is further assumed that there are two economic agents in the economy, each with one unit of labour and a specific production factor, thus, in a competitive equilibrium, the wage rate can be normalized to one (w = 1) with CRTS technology assumption.

The generic technologies without consideration of pollution externalities to the production process are formally expressed as follows;

$$Q_C = AL_C^a H^{1-a}, \quad Q_D = BL_D^b K^{1-b}. \quad (2)$$

These technologies are not affected by the pollution. We make the alternation in the Ricardo-Viner model to accommodate the environmental factor. From one perspective, pollution is an unwanted by-product or output from offending industrial processes. From another equivalent point of view, the environment is a factor of production, which is used up in industrial and agricultural processes. Being a productive factor, the environment will be used to the point that its value marginal product equals its price, which, in the absence of any standard or regulation, is zero. To reduce environmental deterioration, the environmental factor must be conserved, either indirectly through post-pollution clean up processes, or directly in the industrial process by substituting other valuable factors such as labour or capital for the environmental factor. From this rationale, the environmental factor can be incorporated in this setup by adding the environmental standard, e, as one factor in the production of an industry. As defined in Copeland and Taylor (2003), $e = z/Q_D$, where z can be interpreted as depletion of the environment and is measured in tons or some physical quantity of effluent output. In this analysis, z indicates the emission released in the air, generating negative externalities with harmful pollution. When the emission intensity with regard to externalities due to emission is incorporated to the technologies, the production functions assume to exhibit the following forms;

$$Q_C = AL_C^a H^{1-a}, \quad Q_D = e^{\frac{\alpha}{1-\alpha}} BL_D^b K_D^{1-b}, \tag{3}$$

where the parameter a, b, and α is any real number which belongs to the interval between 0 and 1. And It is assumed that $A = a^{-a}(1-a)^{a-1}$ and $B = b^{-b}(1-b)^{b-1}$. The assumptions taken to describe the pollution externality-driven technologies is that production of the dirty good pollutes the capital need to produce the clean good and pollution abatement requires both labour and the specific factor. Following Copeland and Taylor (2003), to capture the abatement activity in a neat way, suppose it uses the same factor intensities as production of the dirty good. Then, effectively the cost of abatement is to reduce the output of Q_D:

$$Q_D = (1-\theta)F_D(L_D, K),$$

where $F_D(\cdot)$ is a standard CRTS production function and is viewed as the potential(gross) output of the dirty goods when pollution abatement is not required as is defined in (2). That is, a firm allocates a fraction of θ of its inputs to the abatement activity. The pollution abatement cost is assumed to reduce the productivity of producing the good in a neutral way.[9] Then Q_D is the net output with pollution abatement and $\theta F_D(L_D, K)$ is the cost of pollution abatement in units of dirty good to meet a specific level issued by the policy maker.[10] The dirty good industry jointly produces two outputs - good and emissions. Since abatement is possible, and emission intensity is a choice variable. Then emission as a joint production technology is shown as

$$z = \varphi(\theta)F_D = e^{\frac{1}{1-\alpha}}F_D.$$

A specific functional form is selected for simplicity of the analysis:

$$\varphi(\theta) = (1-\theta)^{\frac{1}{\alpha}}. \qquad (4)$$

This is why the production function assumed in (3) is specified in that way. From (3) and (4), it is shown that

$$e = (1-\theta)^{\frac{1-\alpha}{\alpha}}. \qquad (5)$$

All inputs are supplied inelastically at levels $\overline{L} = L_C + L_D$, $\overline{H}$, and $\overline{K}$. In the specific factor model under consideration, the equilibrium factor rewards

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9) This type of pollution abatement costs is parallel to the theory of the iceberg transportation cost initially suggested by Samuelson (1954).

10) In this analysis, the policy maker can be viewed as a typical type of politician in the sense that he(she) is elected in the political campaign and serves as a civil servant to design the environmental standard and to regulate the production activities of voters defined in this model.

$r_C(P_C, e, e^*)$ and $r_D(P_D, e, e^*)$ to the specific factor employed to produce the clean good and the factor employed to produce the dirty good are respectively

$$r_C = P_C^{\frac{1}{1-a}} = 1,\ r_D = e_1^{\frac{\alpha}{1-\alpha}\frac{1}{1-b}} P_D^{\frac{1}{1-b}},$$

where P_C and P_D are fixed international prices for the goods and P_C is normalized to one. Specific factor rewards of the factor for the production of the dirty good is positively related with the changes of emission intensity. This is because the production factor for the dirty good is to be less restricted in its use as the government allows higher emission intensity for that industry. This feature implies that the interests of the owners of a specific factor are aligned with the interests of the industry that employs it. Allowing larger emission intensity benefits the dirty good producers by paying less for pollution abatement facilities when imposing less strict regulation.

The total population is N (= 2) and each individual is assumed to supply one unit of labour as well as a specific factor. There are two kinds of individuals in the economy according to the specific factor they own: one for the '*industrialists*', each of whom owns the specific factor that is used to produce the dirty good and the other for, so called, '*environmentalists*', each of whom owns the specific factor to produce the clean good.[11][12] The dirty good production may be looked upon as one of the traditional manufacturing industry usually generating negative pollution externalities while the clean good production may be looked upon as one of the traditional agricultural industry vulnerable to the intensity of pollution around. All industrialists are organized as a special interest group with a population of N_D (= 1) and all environmentalists are also organized with a population of N_C (= 1).[13] Each group would politically be active in the government's

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11) Otherwise, they may be named as 'physiocrat' rather than as environmentalist according to the specification of the model.

12) As will be clear when analysing political models, the study assumes that each individual with a specific factor organizes an interest group to lobby the government under the process of the environmental standard choice. There is no individual who do not have membership in a lobby group in this analysis.

13) Thus, $N = N_C + N_D$. There are no unorganized individuals as an Interest group in the

decision process of the environmental standard.

2. Individual Preference

It is assumed that all individuals in the economy display identical preference except for different valuations of environmental quality and difference in their income due to the implementation of the environmental standard. Individual i of the environmentalists maximizes a transferable utility function with an additive global pollution externality term subject to a budget constraint;

$$\begin{aligned} &\max_{Q_1^i, Q_2^i, z} U_E^i(Q_C^i, Q_D^i, Z) = Q_C^i + u^i(Q_D^i) - h(Z) \\ &s.t \quad P_C Q_C^i + P_D Q_D^i \leq I_C^i. \end{aligned} \tag{6}$$

An explicit form of the direct utility function of an individual i of environmentalists is assumed;

$$U_E^i(Q_C^i, Q_D^i, Z) = Q_C^i + ln\, Q_D^i - \rho Z,$$

where commodities Q_C^i and Q_D^i have the fixed international prices P_C and P_D, and the individual income is I_C^i. ρ is between 0 and 1($0 < \rho < 1$) and indicates marginal disutility of the environmentalists per unit increase of global pollution. Q_j^i denotes the amount of consumption demand for good j by an individual i. It should be also noted that $Z = z_1 + \phi z_2$. ϕ denotes the fraction of transboundary emission affecting the domestic country ($0 \leq \phi \leq 1$). For example, when ϕ approaches to 0, it can be deduced that global emission pollution is getting to be domestic.

As mentioned in the beginning of this section, we consider a case

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economy.

implementing the environmental standard does not require any cost such as taxes for its provision. The environmental standard under consideration acts as a kind of environmental law or mandated regulation of a public good nature in the sense that no one is excluded from being equally served for. Hence, this leads the individual factor income equal to

$$I_C^i = w + r_C(P_C)H^i = 1 + H^i. \tag{7}$$

For brevity, the amount of labour endowment for each individual was assumed to be unit (L_i = 1) whereas specific factor endowment is assumed to be equally distributed among the holders. Thus, the heterogeneity among individuals comes from the different rewards of the specific factor endowment and its income differences among the individuals in the economy. Accordingly, the indirect utility function V_C^i of individual i is alternatively represented as "*the policy preference of individual* i", which follows the form of

$$V_i^{E_i} = V_i^{E_i}(e_i, e_j) = I_C^i(e_i, e_j) - 1 - lnP_D - \rho Z. \tag{8}$$

For the industrialists, the direct utility function of an individual i also follows a transferable form;

$$U_I^i = U_C^i(Q_C^i, Q_D^i) = Q_C^i + ln\, Q_D^i.$$

It is shown that industrialists do not concern about how much pollution is prevalent around themselves because they rather have more stake in the earning factor income when increasing production. Thus, the policy preference for the individual in this group is

$$V_i^{I_i}(e_i, e_j) = I_D^i(e_i, e_j) - 1 - lnP_D,$$

where $I_D^i(e_i, e_j) = 1 + r_D(P_D, e_i, e_j)K^i = 1 + e_1^{\frac{\alpha}{1-\alpha}\frac{1}{1-b}} P_D^{\frac{1}{1-b}} K^i.$

By comparing the payoff structures of industrialists and environmentalists, it is clear that the interests of both groups are trade-off in that industrialists are in favour of a high environmental standard which makes them earn more factor income while the environmentalists have more interests in lower environmental standard. We will find one of resolution of this conflict of interest in special interest politics, in which the interest groups would compete with each other in making financial contribution to the government who decides on the level of the environmental standard as will be discussed in the following section.

IV. Political Economics Models: Special Interest Group Politics

It is assumed in this paper that capital owners for manufacturing industry(industrialists) not only want to represent their interest in earning factor rewards in production processes, they thus also serve as vocal and weighty interest groups. Likewise, those who are the owners of the capital for clean industry are often organized in environmentalist organizations. It is, therefore, natural to conjecture that environmental policies are significantly influenced by special interest group politics. Particularly, it is assumed that the owners of each specific factor in each country organize interest groups and try to influence on the decision making process of the environmental standard by competitively offering monetary(financial) rewards to the relevant government(s), as in Bernheim and Winston (1986) and Dixit et al. (1997).

The analysis examines five cases for interest group politics. In the first case - domestic interest group politics - environmental standards are decided unilaterally by the two governments and the two interest groups in each country try to influence on that country's policy only by lobbying. In the second case - international negotiations with lump-sum transfer - the two governments coordinate their environmental standards and the interest groups, as in Grossman and Helpman (1995), seek influence on the outcome of the negotiation between the two governments using lump-sum transfer. In the third case - international negotiations with clean technology transfer - clean development mechanism is considered as a tool for facilitating an international agreement between technically less developed country and advanced country. In the fourth case - international interest group politics - each group of specific factor holders organizes an international interest group that through its national subsidiary lobby each of the two governments which, in turn, set its environmental standard unilaterally. The fifth case - asymmetric international interest group politics - studies the same situation but assumes that only the environmentalists organize an international interest

group.

In the following subsections, we characterize the equilibrium environmental standards under each case. In all cases, it is, despite the simplifying assumptions made in the specification of the economic structure, not possible to derive closed form solutions. To keep the analysis tractable, we focus on interior solutions and assume in each case that the relevant second order conditions hold locally. In section 5, we show numerically that these conditions hold for a wide range of parameter values. Furthermore, the concept of cooperation between interest groups was primarily introduced by Conconi (2003). In her model, she only allows green lobbies to act cooperatively, while our model assumes that any lobbies with like-minded can form an international interest group.

1. SIP 1： Domestic Interest Group Politics

We firstly explore the non-cooperative nature of the domestic environmental standard decision process as special interest politics 1 of a country, which may arise in the absence of any international treaty or international institution that have an authority to enforce the environmental standard. The general set-up can be used to illuminate the motivation that influences a policy maker's choice of the standard. We begin our analysis by initially applying the common agency framework to the case for unilateral implementation, through the competition of an environmentalist group and an industrial group as indicated. We characterise the "truthful" equilibrium, in which interest groups compete to contribute up to the point where the marginal benefit of the contribution is exactly the same as the marginal cost of them. The assumption of the differentiability of the contribution schedule is prerequisite for the characterisation of local truthfulness of the equilibrium. The non-cooperative nature of the policy maker's unilateral action implies that he does not care about any externalities generated by his own policy choice. Figure 1 shows domestic lobby case in which interest groups compete with each other in lobbying their own government by making financial

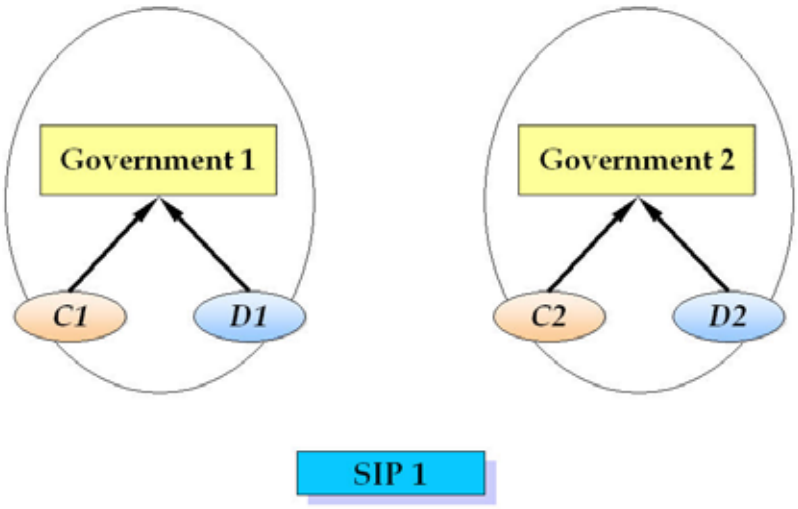

Figure 1. Domestic interest group politics

contribution.[14] We index the domestic interest groups in each country by $l \in \{E, I\}$, where E stands for environmentalists group and I stands for industrialist group lobby. The objective of the two interest groups of country $i = 1, 2$ and $i \neq j$ is to maximize $v_i^l(e_i, e_j) - c_i^l(e_i)$ for $l \in \{E, I\}$, where $c_i^l(e_i)$ is the financial contribution schedule offered by the interest group l in country i to the government of country i.[15] We note that the contributions are contingent on the environmental standard determined by the government in country i only. The two governments care about social welfare and the financial contributions from the interest groups:

$$G_i^1 = c_i^E(e_i) + c_i^I(e_i) + \delta W_i(e_i, e_j), \ i = 1, 2 \text{ and } i \neq j, \qquad (9)$$

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14) In the figure, "SIP" indicates "Special Interest Politics". C_i and D_i also implies the environmentalists group of country i (represented by C in clean) and the industrialists group of country i (represented by D in dirty) respectively.

15) Politicians are assumed to be office-seekers and it is also assumed that in the analysis, the financial contributions from the special interest groups are consumed as an expenditure needed for the election campaign.

where W_i represents social welfare of country i and "1" indicates that we are in case one.

$$W_i(e_i, e_j) = v_i^E(e_i, e_j) + v_i^I(e_i, e_j). \quad (10)$$

The parameter $\delta \geq 0$ is the relative weight attached by the government to the social welfare. It can be interpreted as an inverse measure of corruption.

The strategic interaction between the interest groups in a given country and their government can be represented as a common agency game. The solution to this type of game is well-known (see, e.g., Grossman and Helpman, 1995). The details are provided in the Appendix. It is sufficient to note that the equilibrium environmental standard in the two countries is characterized by the solutions to the following two equations:[16)]

$$\phi_i^1(\hat{e_i}, \hat{e_j}) = \left\{ \frac{\partial v_i^E(\hat{e_i}, \hat{e_j})}{\partial e_i} + \frac{\partial v_i^I(\hat{e_i}, \hat{e_j})}{\partial e_i} \right\} = 0, \ i = 1, 2 \text{ and } i \neq j, \quad (11)$$

where "$\wedge$" is used to denote equilibrium values. Equation (11) shows that the equilibrium environmental standard in each country maximizes, for a given environmental standard implemented in the other country, a weighted social welfare function. The environmental standard of country i is efficient in the sense that it is not possible, for a given environmental standard in country j, to devise another standard that would make government i or one of the two interest groups in country i better off without reducing the welfare of one of the others. More important fact is that the political process in country i does not take into account that e_i affects the welfare of citizens in country j. This externality implies that the outcome under national lobbying is inefficient from a global perspective and motivates why the governments may make an attempt at coordinating their environmental standards within international negotiations.

16) The detailed derivation process for the solution is in the Appendix.

2. SIP 2： International Negotiation with Lump-sum Transfer

It is well known that the non-cooperative policy action of a government may impose economic inefficiency when the economies are closely integrated. The non-cooperative outcome of special interest group politics 1 implies that each sovereign country would determine its own favourite level of the environmental standard through political competition, taking the other country's environmental standard as given. From the global point of view, the non-cooperative implementation of the environmental standard may provoke a "Race to the bottom", in which governments may be pressured to loosen the environmental standard to take competitive advantages in the trade. This concern could justify especially, an attempt by the countries to coordinate the international environmental standard on entering multilateral negotiating agreements. Hence, our attention will be on a cooperative equilibrium that could eliminate such undesirable costs since international cooperation between governments is needed to promote mutual economic interests. For this political setting, we contrive a bilateral negotiation model for the agreement to achieve a globally efficient level of the standard as a cooperative outcome, for which the governments jointly maximise a weighted average of their welfares. The equilibrium would be Pareto efficient if no alteration in the policy choice for the standard is able to make one country better off, without making the other worse off. Thus, cooperation yields an efficiency, internalising the externalities incurred by such undesirable competitions as described in special interest politics 1. The structure of special interest politics II follows two stages as well; the governments negotiate the division of surplus to coordinate environmental standard in the first stage of game. In the second stage, each domestic interest group compete in making political contribution to its government under the international negotiation.

Figure 2 shows the international negotiation case in which each interest group of a country lobby their government under negotiation (for an international environmental agreement) with the other counterpart country for setting the international environmental standard. '**T**' in the figure 2 denotes lump-sum transfer between country, which would be used to

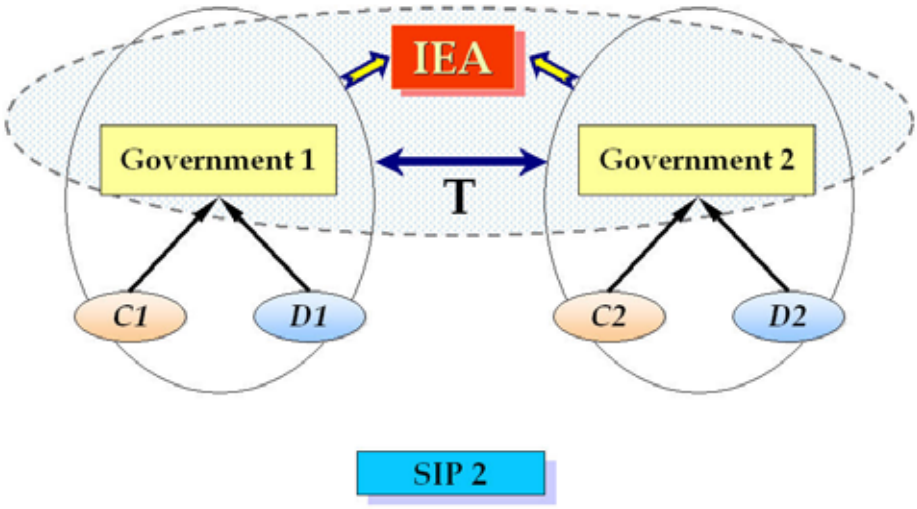

Figure 2. International negotiation with lump-sum transfer

promote the negotiation. The contribution schedule of each interest group depends on the environmental standard of both countries, and we can write the net payoff of the two interest groups in country $i = 1, 2$ and $i \neq j$ as $v_i^l(e_i, e_j) - c_i^l(e_i, e_j)$ for $l \in \{E, I\}$. The objective functions of the two governments are

$$G_1^{II} = \hat{c_1}^E(e_1, e_2) + \hat{c_1}^I(e_1, e_2) + \delta\{W_1(e_1, e_2) + T\}$$
$$G_2^{II} = \hat{c_2}^E(e_2, e_1) + \hat{c_2}^I(e_2, e_1) + \delta\{W_2(e_2, e_1) - T\}. \quad (12)$$

An lump-sum transfer (T) between the countries to promote the international negotiations is assumed in this analysis, but it will be found that this is inconsequential for the results. Social welfare is defined in equation (10). Political competition takes place in two stages. In the first stage, the two interest groups in country i offer contribution schedules to the government of country i with the view of influencing the outcome of the negotiations, i.e., the environmental standards adopted in both countries. In the second stage, the two governments negotiate a set of environmental

standards (e_1, e_2) taken as given the contribution schedules offered by the domestic interest groups. Specifing the details of the bargaining process is not need to describe the political outcome of these negotiations for the purpose of analysis. The agreement maximizes the joint surplus of the two governments is only required and so the negotiated environmental standards (e_1^{II}, e_2^{II}) should satisfy[17]

$$[\hat{e_1}^{II}, \hat{e_2}^{II}] = \arg \max_{e_1, e_2} \sum_{l \in \{E, I\}} [\hat{c_i}^{I}(e_i, e_j) + \hat{c_j}^{I}(e_i, e_j)] + \delta [W_i(e_i, e_j) + W_j(e_j, e_i)]. \tag{13}$$

We adopt Definition 3 from Grossman and Helpman (1995) to characterize the equilibrium policy.[18] The two equilibrium environmental standards must satisfy the following conditions. First, the negotiated environmental standards must maximize the joint surplus of the two governments, as shown in equation (13). Second, the negotiated environmental standards must maximize the joint welfare of each interest group and the two governments when the contribution schedules of the other interest groups are taken as given; if not, the interest groups could change their contribution schedules and increase their payoff. This requirement is presented as

$$[\hat{e_1}^{II}, \hat{e_2}^{II}] = \arg \max_{e_1, e_2} v_1^l(e_1, e_2) - \hat{c_1}^l(e_1, e_2) + \sum_{l \in \{E, I\}} \hat{c_1}^l(e_1, e_2) + \sum_{l \in \{E, I\}} \hat{c_2}^l(e_2, e_1) + \delta [W_1(e_1, e_2) + W_2(e_2, e_1)] \tag{14}$$

for all $m \in \{u, \pi\}$ and

$$[\hat{e_1}^{II}, \hat{e_2}^{II}] = \arg \max_{e_1, e_2} v_2^l(e_2, e_1) - \hat{c_2}^l(e_2, e_1) + \sum_{l \in \{E, I\}} \hat{c_1}^l(e_1, e_2) + \sum_{l \in \{E, I\}} \hat{c_2}^l(e_2, e_1) + \delta [W_1(e_1, e_2) + W_2(e_2, e_1)] \tag{15}$$

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17) The details matter only for the division of the surplus between the two governments.
18) The precise definition is shown in the Appendix

for all $l \in \{E, I\}$. By assuming that the contribution schedules are differentiable around the equilibrium, the first order conditions associated with equations (13), (14) and (15) yield the conditions of local truthfulness:

$$\frac{\partial v_i^l(e_i, e_j)}{\partial e_i} = \frac{\partial \hat{c_i}^l(e_i, e_j)}{\partial e_i} \text{ for each } l = \{E, I\}. \tag{16}$$

$$\frac{\partial v_j^l(e_j, e_i)}{\partial e_i} = \frac{\partial \hat{c_j}^l(e_j, e_i)}{\partial e_i} \text{ for each } l = \{E, I\}. \tag{17}$$

We can combine the local truthfulness conditions for each interest group l in country i with the first order condition associated with equation (13). The equilibrium environmental standards in the two countries are then characterized by the solutions to the following two equations:

$$\phi_i^{II}(\hat{e}^{II}) = \frac{\partial v^E(\hat{e}^{II})}{\partial e_i} + \frac{\partial v^I(\hat{e}^{II})}{\partial e_i} = 0, \; i = 1, 2 \text{ and } i \neq j, \tag{18}$$

where $\hat{e}^{II} = (\hat{e}_1^{II}, \hat{e}_2^{II})$, $v^E(\cdot) = v_1^E(\cdot) + v_2^E(\cdot)$, and $v^I(\cdot) = v_1^I(\cdot) + v_2^I(\cdot)$.

Equation (18) shows that the equilibrium environmental standards internalize the externalities generated when the two governments implement their standards unilaterally: the environmental standard set in a given country reflects the interests of the specific capital owners in both countries. Moreover, the equilibrium environmental standards are *globally efficient* considering that no other set of standards can be devised that would make one of the governments or one of the interest groups better off without harming the welfare of another. A comparison between equations (11) and (18) suggests that domestic interest politics results in a race to the bottom. This is because both the environmentalist group and the industrialist group in country j benefits from a tighter environmental standard in country i and internalization of this positive externality through international negotiations, *ceteris paribus*, leads to stricter standards in the two countries.

Although countries are better off coordinating their environmental standards, international agreement is, in reality, difficult to achieve because of conflicting economic or political objectives or because of free rider incentives. International agreements are, moreover, hard to enforce and, if established, tend to be unstable over time without a strong commitment. These considerations motivate our analysis of international interest group politics as a possible alternative to international negotiations. It can also be shown that domestic interest group politics in the process of international negotiation can generate equilibrium environmental standards as Pareto efficient outcome for the governments.[19]

3. SIP 3 : International Negotiation with Clean Technology Transfer

It is often the case that traditional international trade theories adopt the lump-sum transfer between the countries for facilitating trade agreements. Instead of lump-sum transfer, we alternatively consider a kind of technology transfer case, clean development mechanism(CDM) of which concept was initially introduced in the Kyoto Protocol(1997).[20] In the Protocol, a CDM allows transfer of emission reduction units resulting from emission reduction or removal projects between Annex I and non-Annex I countries. the CDM has two objectives, emission reduction and sustainable development for host non-Annex I countries.

As shown in figure 3, we consider the case that a CDM project is

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19) For the detailed discussion, see Grossman & Helpman (1995) and Mutoo (1999).

20) As a milestone of the efforts on international cooperation for combating global warming, the Protocol sets out that each party included in Annex I to the FCCC shall achieve its quantified emission limitation and reduction commitments inscribed in Annex B under Article 3. The Kyoto Protocol promotes international emissions trading to help high-cost countries to achieve their goals committed in the Protocol. The international emissions trading has three flexible forms as defined in the Kyoto Protocol that Joint Implementation in Article 6, Clean Development Mechanism in Article 12, and Emissions Trading in Article 17 respectively. For detailed story of Kyoto Protocol and CDM, see Munashinghe et al. (2005).

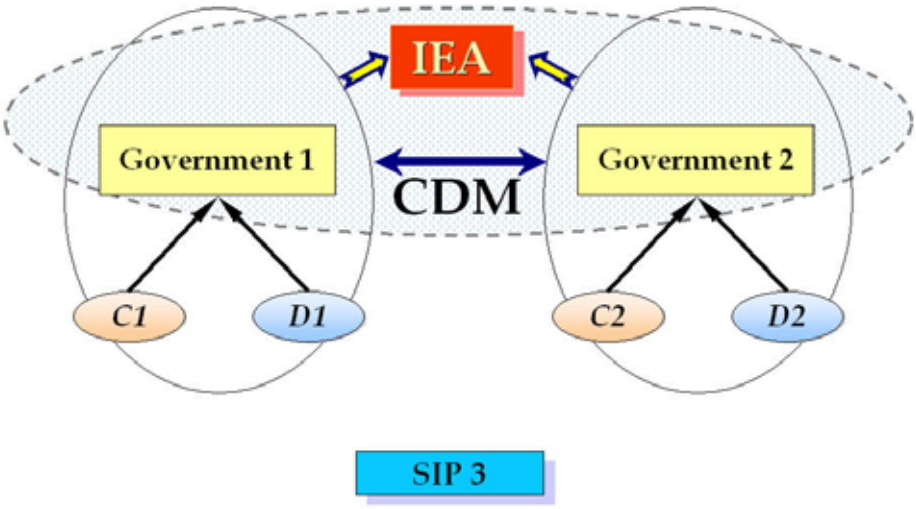

Figure 3. International negotiation with clean technology transfer

implemented to promote the international environmental agreement on the standard. Main point in this subsection is to find out the outcomes of the international environmental negotiation between the countries when the abatement technology is transferred from the advanced country to the less developed country.[21] It is expected that most solution mechanisms in this analysis will also follow the previous case except for the objective functions of the two governments under the CDM project, which are

$$\begin{aligned} G_1^{CDM} &= \hat{c_1}^E(e_1, e_2) + \hat{c_1}^I(e_1, e_2) + \delta[W_1(e_1, e_2) + \Omega_1(e_1, e_2)] \\ G_2^{CDM} &= \hat{c_2}^E(e_2, e_1) + \hat{c_2}^I(e_2, e_1) + \delta[W_2(e_2, e_1) + \Omega_2(e_2, e_1)]. \end{aligned} \tag{19}$$

21) So far, the analysis has kept the assumption that the countries are symmetric in the sense that they have an identical economic and political environment. But, only in this international negotiation case, we rule out the symmetric case and assume that the two countries are asymmetric since they have different abatement technologies. Here, the assumption that country 2 is one of the Annex I countries while country 1 is Non-Annex I. Another assumption is that transferring abatement technology is not costly.

where $\Omega_i(\cdot)$ is defined as the benefit package of country i when it is either donor country (2) or recipient country (1). The benefit package of the CDM project shows that;

$$\Omega_2(e_2, e_1) = CER(e_2, e_1)$$
$$\Omega_1(e_1, e_2) = \Delta Q_{1D}(e_1, e_2) + \Delta z_1(e_1, e_2).$$

Ω_2 includes so-called "certified emission reductions(CER)". The Kyoto Protocol allows donor country to gain CER as a reward of doing the CDM project in recipient country. The real value of CER in this case is equal to $P_D \Delta z_1$, where Δz_1 is calculated from (4). Thus, CER, the amount of emission reduction achieved in the developing country through CDM project, is the credit that can be traded in the international carbon market. Ω_1 in recipient country consists of increasing production of the dirty good ΔQ_{1D} and pollution reduction Δz_1 due to the adoption of advanced abatement technology from the developed country.[22] These benefits from CDM project can be measured as the changes in the dirty good production of recipient country. For example, from (4), it is noted that abatement technology transfer can be characterized as the changes in the technical parameter α. Before transfer, we initially assume that $\alpha_1 > \alpha_2$ so that donor country exhibits more efficient abatement technology. Donor country would then allow the recipient country to achieve the technical improvement through transfer such that

$$\alpha_1 > \alpha^{CDM} \geq \alpha_2.$$[23]

Once the new technical parameter is augmented, then amounts of the emission reduction as well as the increase in the production of pollution generating good due to (4) and (3) can be by stages obtained per given value of θ:

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22) The Number of subscript(1 or 2) indicates the country in this analysis.

23) The intuition of the inequality ($\alpha_1 > \alpha^{CDM} \geq \alpha_2$) implies that donor country would strategically behave in transferring the technology. They may prefer to keep the technological gap between the countries to maintain their competitive position in the markets rather than transfer the whole technology to the recipient country.

$$\Delta z_1(e_1,e_2)=\left[(1-\theta)^{\frac{1}{\alpha_1}}-(1-\theta)^{\frac{1}{\alpha^{CDM}}}\right]F_D(e_1,e_2)$$
$$\Delta Q_{1D}(e_1,e_2)=\left[e_1^{\frac{\alpha^{CDM}}{1-\alpha^{CDM}}}-e_1^{\frac{\alpha_1}{1-\alpha_1}}\right]F_D(e_1,e_2).$$

This is due to $e=(1-\theta)^{(1-\alpha)/\alpha}$ as in (5). The agreement maximizes the joint surplus ($G_1^{CDM}+G_2^{CDM}$) of the two governments with the abatement technology transfer and so the negotiated environmental standards (e_1^{CDM}, e_2^{CDM}) satisfy

$$[\hat{e_1}^{CDM},\hat{e_2}^{CDM}]=\arg\max_{e_1,e_2}\sum_{l\in E,I}[\hat{c_i}^l(e_i,e_j)+\hat{c_j}^l(e_j,e_i)]+ \delta[W_i(e_i,e_j)+W_j(e_j,e_i)+\Omega_i(e_i,e_j)+\Omega_j(e_j,e_i)]. \quad (20)$$

Combining the local truthfulness conditions for each interest group l in country i with the first order condition associated with equation (20). The equilibrium environmental standards in the two countries are then characterized by the solutions to the following two equations:

$$\phi_i^{CDM}(\hat{e}^{CDM})=\delta\left[\frac{\partial\Omega_i(\hat{e}^{CDM})}{\partial e_i}+\frac{\partial\Omega_j(\hat{e}^{CDM})}{\partial e_i}\right]+ (1+\delta)\left[\frac{\partial v^E(\hat{e}^{CDM})}{\partial e_i}+\frac{\partial v^I(\hat{e}^{CDM})}{\partial e_i}\right],$$

where $\phi_i^{CDM}=0$, $e^{CDM}=(e_1^{CDM},e_2^{CDM})$, $v^E(\cdot)=v_1^E(\cdot)+v_2^E(\cdot)$, and $v^I(\cdot)=v_1^I(\cdot)+v_2^I(\cdot)$.

The main implication of this case would be clearer when we compare the social welfare and the amount of emission polluted under each political regime in the comparative static analysis section later. Particularly, results from the comparison of international negotiation regimes under the lump-sum transfer and clean up technology transfer would attract our attention in this study. Also, the cases for international negotiation give some insights into the international environmental agreement in that polluter pay principle may or may not hold depending on the types of transfer.

4. SIP 4 : International Interest Group Politics

Although countries may be better off in cooperating when deciding the environmental standard, coordination between governments is often difficult because of economic or political conflict. In considering the current international community, international cooperation or agreements between sovereign nations are likely to be unstable in the long run. We could easily find such cases through the media. That is why, for instance, some transnational institutional designs or agreements remain controversial as global dilemma. These difficulties in international coordination lead us to look for a more realistic non-cooperative mechanism that could derive an outcome that can alternatively be obtainable by international negotiation. Thus, this analysis is dedicated to the introduction of a new concept for special interest politics in which each interest group under a common interest pledge their international solidarity to systematically exert a more consolidated political influence on the governments' environmental standard choice making. The international solidarity, in this context, implies that the interest groups are tied by the cause of their common interest, and so they cooperate in making a political contribution to each government, competing with the other groups either under international cooperation or of individual domestic interest.

In the third case as shown in figure 4, the two environmentalist group and the two industrialist group, respectively, organize an international interest group that through its national subsidiary offers contributions to each of the two governments which, in turn, set their environmental standard unilaterally. In other words, no cooperation takes place between the two governments; instead interest groups in different countries join forces and coordinate their political strategies through international organizations. We use the index $\tilde{\imath} \in \{\tilde{E}, \tilde{I}\}$ to indicate the international environmentalist group and the international industrialist group, respectively.

Let $v^E(e_1, e_2) = \sum_{i=1}^{2} v_i^E(e_1, e_2)$ and $v^I(e_1, e_2) = \sum_{i=1}^{2} v_i^I(e_1, e_2)$ be the gross payoffs of the two international interest groups. The net payoffs then are

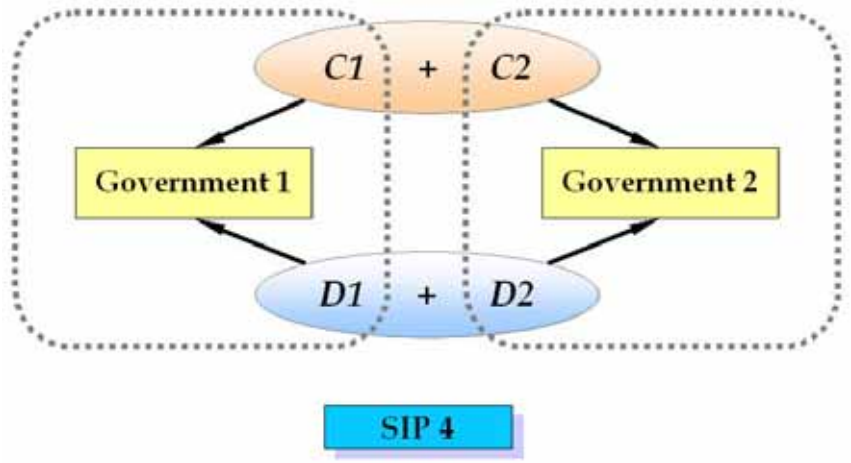

Figure 4. International interest group politics

$v^j(e_1,e_2)-c_1^j(e_1;e_2)-c_2^j(e_2;e_1)$ for $\tilde{l}\in\{\bar{E},\tilde{I}\}$. Each interest group offers two financial contribution schedules $c_i^j(e_i;e_j)$, $i=1,2$ and $i\neq j$; one to each government. The schedule offered to government i is a function of the environmental standard implemented in that country, taking as given the environmental standard of the other country. The objective function of government $i=1,2$ and $i\neq j$ is

$$G_i^{III}=\hat{c_i}^{\bar{E}}(e_i;e_j)+\hat{c_i}^{\tilde{I}}(e_i;e_j)+\delta W_i(e_i,e_j). \quad (21)$$

As before, political competition come about through two stages. First, the two international interest groups simultaneously offer contribution schedules to two governments. Second, the two governments unilaterally implement an environmental standard taking as given the contribution schedules offered by the two international interest groups. Formally, the game between the two governments and the two international interest groups is a multiple agent, a multiple principal problem. Since the solution for this political structure is not popular like that of menu auction type games of case 1 and 2[24], and the theoretical foundation can be found in Prat and Rustichini (2003).

[24] In case 1 and 2, the game is a standard common agency. In case 1, the two interest

They provide an equilibrium characterization that can be adopted to this type of political structure. Contrary to the common agency models which are adopted in the previous cases, Prat and Rustichini (2003) particularly suggest that a multiple agent, a multiple principal problem needs additional condition for complete characterization of the equilibrium, which is called the "cost minimization" condition. The detailed explanation is attached to the Appendix. This condition implicitly suggests that there is either no monetary rewards for the equilibrium policy choice, or, there is another policy which gives an exactly equal payoff to a policy maker, so that a group could not reduce its contribution for the equilibrium standard. SIP 4 may not attain a globally efficient outcome since the model allows direct externalities in the policy maker's preferences, which may cause a coordination failure and thus an inefficient equilibrium thereafter. This why they propose in their paper a modified equilibrium concept called a weakly truthful equilibrium strategy.

From the conditions described in Definition 3 in the Appendix, the equilibrium environmental standards in the two countries are characterized by the solutions to the following two equations:

$$\phi_i^{III}(\hat{e}^{III}) = \left\{ \frac{\partial v^{\bar{E}}(\hat{e}^{III})}{\partial e_i} + \frac{\partial v^{\bar{I}}(\hat{e}^{III})}{\partial e_i} \right\} = 0, \ i = 1, 2 \ \text{and} \ i \neq j, \qquad (22)$$

where $\hat{e}^{III} = (\hat{e_1}^{III}, \hat{e_2}^{III})$.

For the details of derivation of these equations, consult the Appendix. We see that this is the same as equation (18) that determines the equilibrium policy in regime II. Thus, we have

Summary 2 *International interest group politics generates the identical level of environmental standard that is decided through international negotiations, i.e.,*

$$(\hat{e}_1{}^{III}, \hat{e}_2{}^{III}) = (\hat{e}_1{}^{II}, \hat{e}_2{}^{II}).$$

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groups in each country are principals for the government (the agent) in that country. In case 2, all four interest groups are principals for the "mediator" who conduct the negotiations between the two governments.

It is already shown that the efficient outcome in SIP II comes from cooperation between the incumbent governments, whose interest is not only to collect campaign contributions from the domestic interest groups, but also to enhance the welfare of global society. On the contrary, the equivalent globally efficient outcome of SIP III essentially comes from lobbying of the international interest groups. The intuition for this result is as follows. Although the international interest groups behave non-cooperatively with each other when competing in the political market of each country, the contributions offered to each government imply the cooperative efforts to maximise the sum of their net rents. This is why a domestic interest group cooperates with its foreign counterpart when they contribute to each government.

It is, of course, important for this result that both the industrialist group and the environmentalist group cooperate internationally. While the two environmentalist groups have a common interest and would like to see strict environmental standards in both countries, each industrialist group would like to see a lax standard at home. It is, therefore, reasonable to conjecture that it is easier for the two environmentalist groups to form an international interest group than for the two industrialist groups. For this reason, we conclude the analysis by considering this situation, noting that the opposite case - only the environmentalist groups cooperating their lobbying effort internationally - can be analyzed along similar lines.

5. SIP 5 : Asymmetric International Interest Group Politics

In the fifth case, the two environmentalists organize an international interest group that contributes to each of the two governments. The two industrialist groups, on the other hand, do not cooperate but seek influence on their own government separately. This scenario is described in figure 5.

The two governments impose their environmental standard unilaterally. The objective functions of the two separate industrialist interest groups and

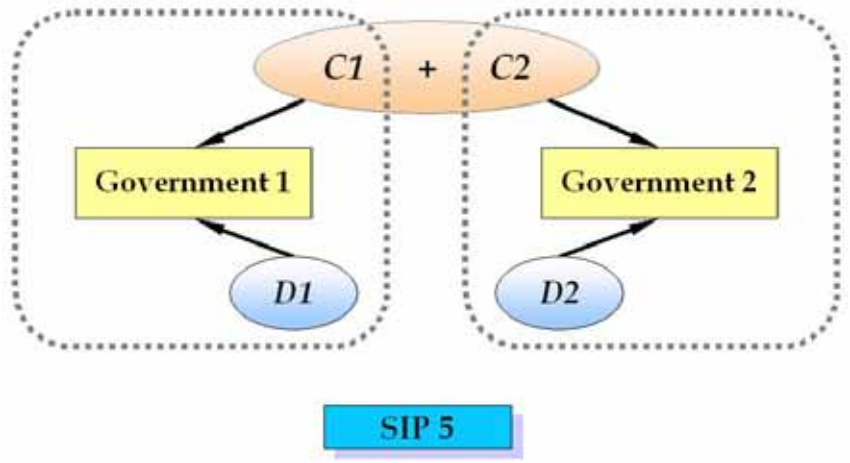

Figure 5. Asymmetric international interest group politics

the international environmentalist group are $v_i^I(e_i, e_j) - c_i^I(e_i)$, $i = 1, 2$ and $i \neq j$ and $v^{\bar{E}}(e_i, e_j) - c_i^{\bar{E}}(e_i; e_j) - c_j^{\bar{E}}(e_j; e_i)$ respectively. The objective function of government i is $G_i^{IV} = \hat{c_i}^I(e_i) + \hat{c_i}^{\bar{E}}(e_i; e_j) + \delta W_i(e_i, e_j)$. To derive the equilibrium environmental standard vector, we need to combine aspects of the analysis of case 1 and III. For a brief explanation, the details of the definition of equilibrium are in the Appendix. At equilibrium, the environmental standard of government i, $\hat{e_i}^{IV}$, must maximize the joint welfare of the international environmentalist group and the two governments, respectively, i.e.,

$$\begin{aligned} \hat{e_i}^{IV} = \arg \max_{e_i} \; & v^{\bar{E}}(e_i, e_j) - \hat{c_i}^{\bar{E}}(e_i; e_j) - \hat{c_j}^{\bar{E}}(e_j; e_i) + \\ & \hat{c_i}^{\bar{E}}(e_i; e_j) + \hat{c_i}^I(e_i) + \delta W_i(e_i, e_j) + \\ & \hat{c_j}^{\bar{E}}(e_j; e_i) + \hat{c_j}^I(e_j) + \delta W_j(e_j, e_i). \end{aligned} \tag{23}$$

At the same time, $\hat{e_i}^{IV}$ must maximize the joint welfare of the industrialist group i and government i:

$$\hat{e_i}^{IV} = \arg \max_{e_i} v_i^I(e_i, e_j) - \hat{c_i}^I(e_i) + \hat{c_i}^E(e_i;e_j) + \hat{c_i}^I(e_i) + \delta W_i(e_i, e_j). \tag{24}$$

The first order conditions associated with equations (41), (45), and (46) generate the following conditions

$$\frac{\partial v^{\tilde{E}}}{\partial e_i} + \frac{\partial \hat{c_i}^{\tilde{E}}}{\partial e_i} + \frac{\partial \hat{c_j}^I}{\partial e_i} + \delta \frac{\partial W_j}{\partial e_i} = 0 \tag{25}$$

$$\frac{\partial v_i^I}{\partial e_i} - \frac{\partial \hat{c_i}^I}{\partial e_i} = 0 \tag{26}$$

for $i = 1, 2$ and $i \neq j$. Using that $\partial \hat{c_j}^I(e_j)/\partial e_i = 0$ and adding up yields

$$\frac{\partial v^{\tilde{E}}}{\partial e_i} - \frac{\partial \hat{c_i}^{\tilde{E}}}{\partial e_i} + \frac{\partial v_i^I}{\partial e_i} - \frac{\partial \hat{c_i}^I}{\partial e_i} + \delta \frac{\partial W_j}{\partial e_i} = 0. \tag{27}$$

Cost minimization implies that

$$\frac{\partial \hat{c_i}^{\tilde{E}}}{\partial e_i} = - \frac{\partial \hat{c_i}^{\tilde{E}}}{\partial e_i} - \delta \frac{\partial W_i}{\partial e_i}. \tag{28}$$

By substituting equation (49) into equation (47), we get

$$\frac{\partial v^{\tilde{E}}}{\partial e_i} + \delta \frac{\partial W_i}{\partial e_i} + \frac{\partial v_i^I}{\partial e_i} + \delta \frac{\partial W_j}{\partial e_i} = 0, \tag{29}$$

which can be written as

$$\phi_i^{IV}(\hat{e}^{IV}) = \delta \frac{\partial v_j^I(\hat{e}^{IV})}{\partial e_i} + (1+\delta)\left\{ \frac{\partial v_i^I(\hat{e}^{IV})}{\partial e_i} + \frac{\partial v^{\tilde{E}}(\hat{e}^{IV})}{\partial e_i} \right\} = 0, \quad i = 1, 2 \text{ and } i \neq j, \tag{30}$$

where $\hat{e}^{IV} = \{\hat{e_1}^{IV}, \hat{e_2}^{IV}\}$. The equilibrium environmental standards in the two countries are then characterized by solving these two equations.

Asymmetric international interest group politics may not be able to implement globally efficient environmental standards. Particularly, the fact that the two industrialist groups do not cooperate in lobbying each government may cause implementation of more stringent environmental standards in both countries. This is because the two industrialist groups favor lax environmental standard at home and in the absence of cooperation between the two industrialist groups, this effect is not reflected in planning contribution schedules offered to the government and thus not taken standard choice into consideration. The equilibrium environmental standard imposed under asymmetric international interest group politics can be, typically stricter than the equilibrium standard imposed under domestic interest group politics.

V. The Comparative Statics Analysis

In this section, we examine how the environmental intensity standards as well as the welfare of an environmentalist group, industrialist group, the amount of pollution emission, and social welfare are affected by changes in the key parameters of the model in each of the cases. This is done numerically through a sequence of simulations.[25] The key parameters considered in this analysis include α(efficiency in the abatement technology of less-advanced country), ρ(marginal disutility of the environmentalists on the global pollution), and ϕ(the fraction of transboundary emission affecting the domestic country). The range over which each parameter is varied is carefully chosen so as to insure that interior solutions are attainable in each case and that all relevant conditions needed in the system are satisfied. In the baseline specification, the following parameters are assumed to have the fixed values initially such that P_D = 0.8, α = 0.6, β = 0.2, ϕ = 1, θ = 0.2, ρ = 1, b = 0.4, δ = 1, K = 2, and H = 2.[26] The details of the comparative statics analysis are presented in the tables.[27] The economic and political environment of the two countries depicted in the analysis is exactly identical except for the difference in efficiencies of the abatement technologies. This may generate asymmetric results in the simulation.

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25) The simulation was performed using Mathematica programme.

26) This selection implies that the technologies are specific factor intensive; that dirty goods are less expensive that clean good; that the environmentalists are directly affected by level of global pollution; and that there is a technology gap in the abatement efficiency performance between the two countries.

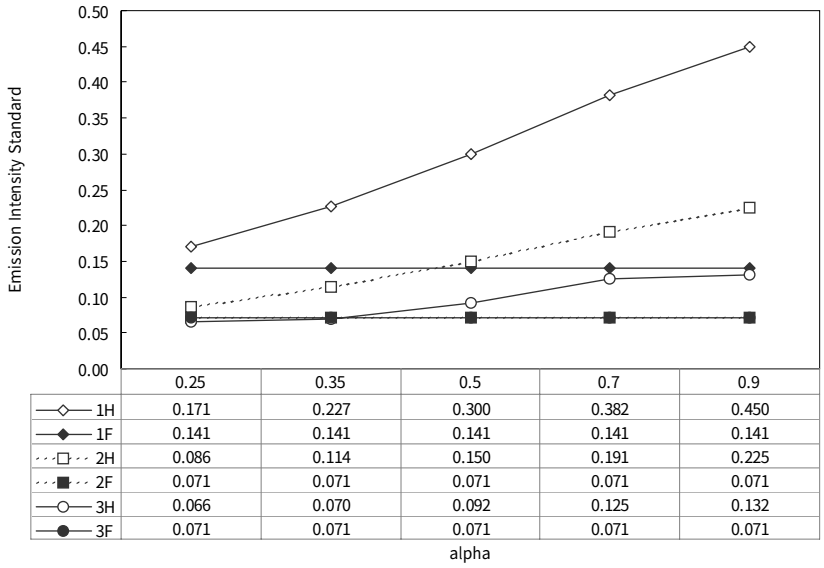
27) The notations adopted in the tables are iH and iF, where $i = 1, 2 \text{ and } 3$. This indicates that home(H) country in case 1(domestic politics), in case 2(international negotiation with lump-sum transfer, international interest politics, and asymmetric international interest politics), and in case 3(international negotiation with CDM project). Identical implication is also applied to foreign(F) country case.

1. Efficiency of the Abatement Technology

In the sequel of simulation, changes in the environmental standard, social welfare, global pollution, and dirty good production due to changes in efficiency parameter(α) of the home country are examined.

1.1. Changes in Emission Intensity Standard

Figure 6 shows that emission intensity standards embodied in the five cases of political arena are listed.[28] It is shown that the standard($1H$) decided in the domestic politics is the highest level as it is expected in the theoretical analysis. Particularly, the standards attained through international negotiation between the relevant governments allow the lowest level of the standard whether lump-sum transfer or clean technology transfer(here, CDM case) is used to facilitate the negotiation, resulting in the lowest pollution



	0.25	0.35	0.5	0.7	0.9
1H	0.171	0.227	0.300	0.382	0.450
1F	0.141	0.141	0.141	0.141	0.141
2H	0.086	0.114	0.150	0.191	0.225
2F	0.071	0.071	0.071	0.071	0.071
3H	0.066	0.070	0.092	0.125	0.132
3F	0.071	0.071	0.071	0.071	0.071

Figure 6. Changes in emission intensity standard w.r.t. α

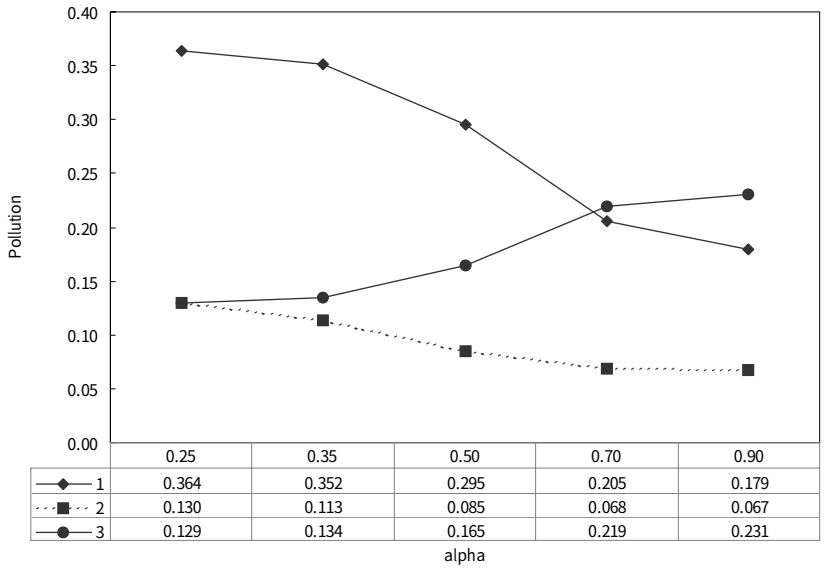
28) "w.r.t." in the title of the figure denotes "with regard to".

level in each country under negotiation. It is also noticed that, as the efficiency gap in the abatement technology gets small, differences in the standard in each case gets small accordingly. It is particularly noteworthy that the lowest level of the standard results when there is international negotiation with clean technology transfer. The major rationale of this result may be found in the main feature of the CDM project itself since both donor and recipient countries would gain when transferring clean technology given the existing production level. Particularly the recipient country would be required to implement a stricter standard. These findings will be again confirmed in the results from the changes in global pollution and dirty good production hereafter.

1.2. Changes in Global Pollution

The following figure 7 presents trends of change in global pollution as the efficiency of the abatement technology of the less-developed country gets close to that of the advanced country. The efficiency parameter α is assumed to be varied from 0.9 to 0.25 as indicated in the lower end of figure 7.

Except for an extreme case such as α = 0.9, global pollution level resulting from the domestic politics appears the highest level of all the cases considered. It should be noted that global pollution level generated from case 1 and 2 gets larger when the efficiency in the abatement technology for the less developed country improved. The CDM case is intuitive since both countries benefit from making mutual efforts to reduce the global pollution level through clean technology transfer. However, changes in the pollution level due to case 1 and 2 displayed in figure 7 seem to be counter-intuitive in the sense that global pollution gets intense, although the degree of efficiency in the abatement technology gets close to each other($\alpha \Rightarrow 0.25$; $\beta \Rightarrow 0.2$). A probable insight to this phenomenon may be found in the international competitiveness of each country. Considering that the only difference between the countries lies in the efficiency of the abatement technology, the advanced country would suffer from losing competitiveness in the international market as the less developed country can access to more



	0.25	0.35	0.50	0.70	0.90
1	0.364	0.352	0.295	0.205	0.179
2	0.130	0.113	0.085	0.068	0.067
3	0.129	0.134	0.165	0.219	0.231

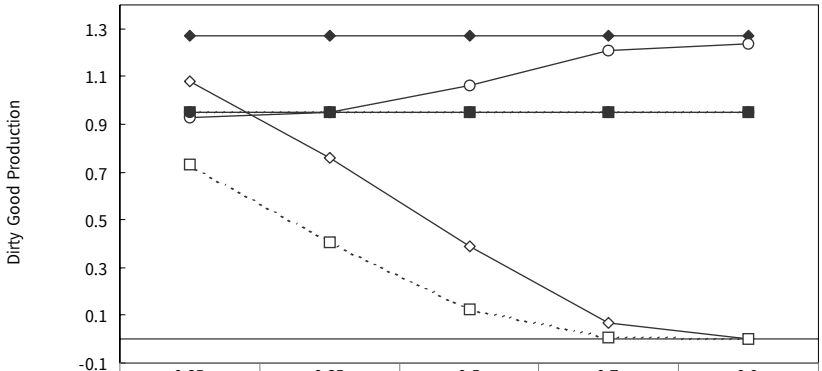
Figure 7. Changes in global pollution w.r.t. α

efficient technology. This could, on the contrary, lead to an intense trade conflict between the countries by increasing the dirty good production to secure their own stake in the market. The following section may support this explanation.

1.3. Changes in Pollution Generating Production

Figure 8 presents a change in the production of pollution generating good as the values of efficiency in the abatement technology of the less-developed country vary.

The counter intuitive results raised in the prior discussion are supported by the fact that an increase in the production of a dirty good appears in case 1 and 2 in figure 8. Thus, figure 7 and 8 reveal consistent findings in the simulation. Without changes in efficiency in the abatement technology, dirty good production of the advanced country remains constant whatever tools of transfer is taken into account in the international negotiation. But



	0.25	0.35	0.5	0.7	0.9
1H	1.078	0.759	0.386	0.068	0.000
1F	1.271	1.271	1.271	1.271	1.271
2H	0.734	0.408	0.122	0.005	0.000
2F	0.952	0.952	0.952	0.952	0.952
3H	0.927	0.951	1.064	1.209	1.237
3F	0.952	0.952	0.952	0.952	0.952

alpha

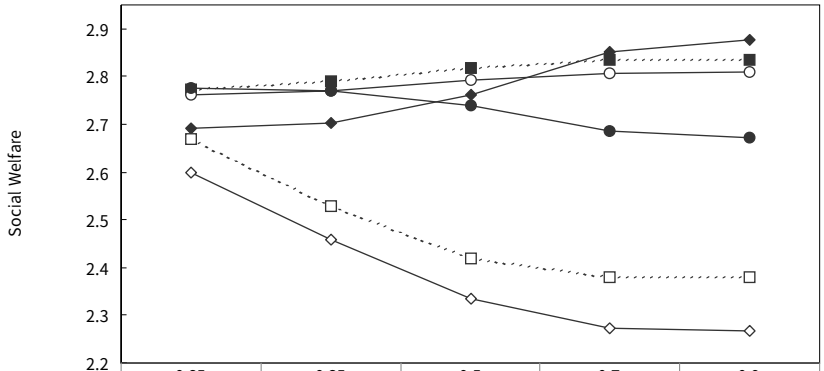
Figure 8. Changes in dirty good production w.r.t. α

the CDM case has a different implication in that the dirty good production level of the less-developed country gradually decreases even when it can significantly improve efficiency of the abatement technology. Let us consider that efficiency improvement in the abatement technology is decomposed into two effects; production increase by efficiency gains on the one hand and the strict environmental standard on the other. The observation that the effect of implementing the tightest emission intensity standard surpasses the effect of production increase happens to our context in the simulation.

1.4. Changes in Social Welfare

The figure 9 presents a change in the social welfare when the values denoting efficiency of the abatement technology of the less-developed country change.

Implications displayed in the figure suggest that social welfare attained in case 2 and 3 is mostly superior to that attained in case 1. The extreme



	0.25	0.35	0.5	0.7	0.9
1H	2.600	2.459	2.336	2.274	2.267
1F	2.692	2.704	2.761	2.851	2.877
2H	2.668	2.528	2.419	2.380	2.379
2F	2.773	2.790	2.818	2.835	2.836
3H	2.763	2.769	2.792	2.808	2.809
3F	2.775	2.769	2.738	2.685	2.672

alpha

Figure 9. Changes in social welfare w.r.t. α

case in which the technology gap is very large reveals counter implication. It means that the technically advanced country may enjoy the highest welfare because not only it has absolute advantage over the production technology with a given level of the standard, but it also needs not care about the negative externality it generates.[29] However, the social welfare of the less-developed country in political case 1 and 2 would rise with clean technology while that of the advanced country would decline by a gradual slope. This may be obvious, since supremacy over the clean technology for the efficient production enjoyed by the advanced country weakens when the less-developed country gradually procures better clean technology. The figure also suggests that a country would be better off by reaching an agreement through international negotiation even in the face of a technology gap. Social welfare attained by the CDM case also displays a relatively higher level as

29) This may serve as an example that some advanced countries with those conditions are still tempted to deviate from or are reluctant to sign an international environmental agreement such as the Kyoto protocol.

conjectured. But, it needs to pay attention to the fact that the donor country can be better than the recipient country when the technology gap gets smaller. Conversely, it says that the recipient country can be better than the donor country as the gap widens. This may indicate that the marginal benefit of transferring clean technology is significantly larger when the donor country allows only a tiny bit of its entire technology set to the recipient country.

2. Marginal Effect of Foreign Emission to Transboundary Pollution

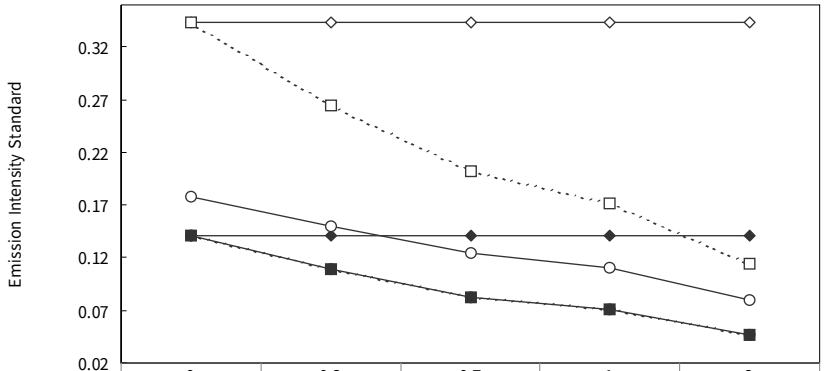
In this subsection, the following simulations contribute to the analysis for changes in the environmental standard, social welfare, global pollution, and dirty good production due to changes in the fraction of transboundary emission affecting the domestic country($\phi \geq 0$). Simulations allow the values of ϕ to have 0, 0.3, 0.7, 1, and 2 as shown in the top raw of the table attached to the figure.

2.1. Changes in Emission Intensity Standard

The environmental standard in each case decreases as the marginal impact of foreign emission to transboundary pollution affecting a country gets larger to the exclusion of the standard determined in the domestic politics case. Countries under the domestic politics would behave as if they are not affected because a policy maker does not at all take into account the negative externality the country discharges into the another country. The figure 10 shows that the advanced country under either case 2 or CDM case would identically enforce the toughest level of the standard.

2.2. Changes in Global Pollution

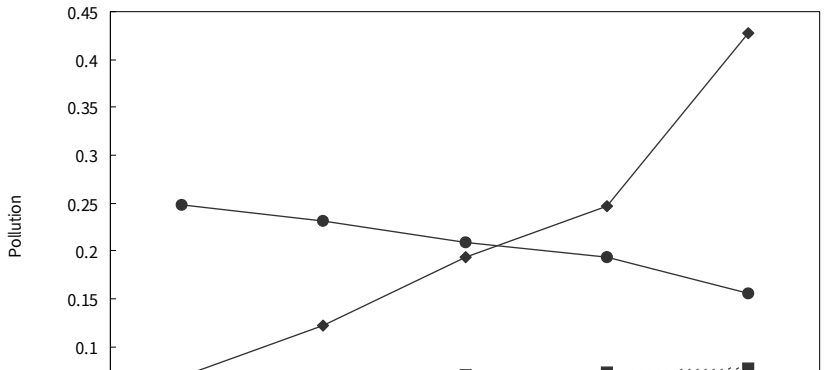
It would be natural to find out that the global pollution level uncovered in a country under case 1 and 2 is identically low when pollution is confined the domestic($\phi = 0$) in figure 11. Global pollution from those politics increases



	0	0.3	0.7	1	2
1H	0.343	0.343	0.343	0.343	0.343
1F	0.141	0.141	0.141	0.141	0.141
2H	0.343	0.264	0.202	0.171	0.114
2F	0.141	0.109	0.083	0.071	0.047
3H	0.178	0.150	0.124	0.110	0.080
3F	0.141	0.109	0.083	0.071	0.047

phi

Figure 10. Changes in emission intensity standard w.r.t. ϕ



	0	0.3	0.70	1.00	2.00
1	0.068	0.122	0.193	0.247	0.427
2	0.068	0.064	0.070	0.073	0.077
3	0.248	0.232	0.209	0.193	0.156

phi

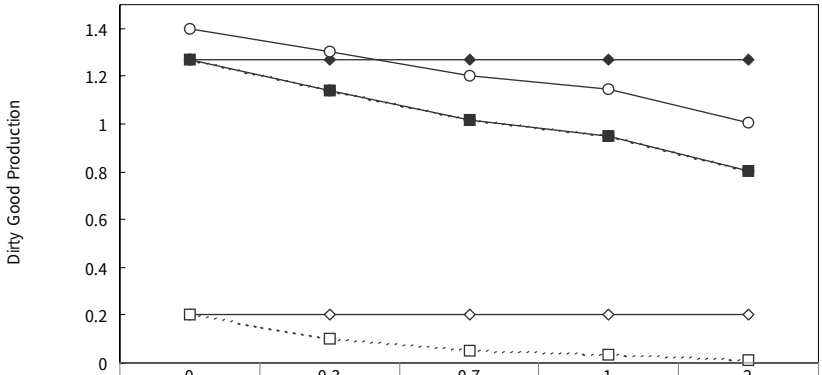
Figure 11. Changes in global pollution w.r.t. ϕ

as the impact of foreign emission intensifies. But global pollution through domestic politics increases more rapidly. Global pollution through international negotiation with clean technology transfer, on the contrary, decreases with an increase in ϕ. This indicates that a CDM project may be more effective when countries are seriously influenced by foreign emission.

2.3. Changes in Pollution Generating Production

The following figure 12 presents a change in the production of pollution generating good as the value of ϕ varies.

Though the emission intensity standard of the less developed country was relatively lax compared to that of the advanced country under the domestic politics, the actual level of dirty good production is adversely higher in the advanced country. This is because, in the advanced country, the effect of production increase with efficient production technology is larger than when implementing the stricter standard. The figure also shows that ① the production of pollution generating good is larger in the case of the domestic



	0	0.3	0.7	1	2
1H	0.200	0.200	0.200	0.200	0.200
1F	1.271	1.271	1.271	1.271	1.271
2H	0.200	0.103	0.052	0.035	0.013
2F	1.271	1.139	1.019	0.952	0.804
3H	1.398	1.302	1.204	1.145	1.005
3F	1.271	1.139	1.019	0.952	0.804

phi

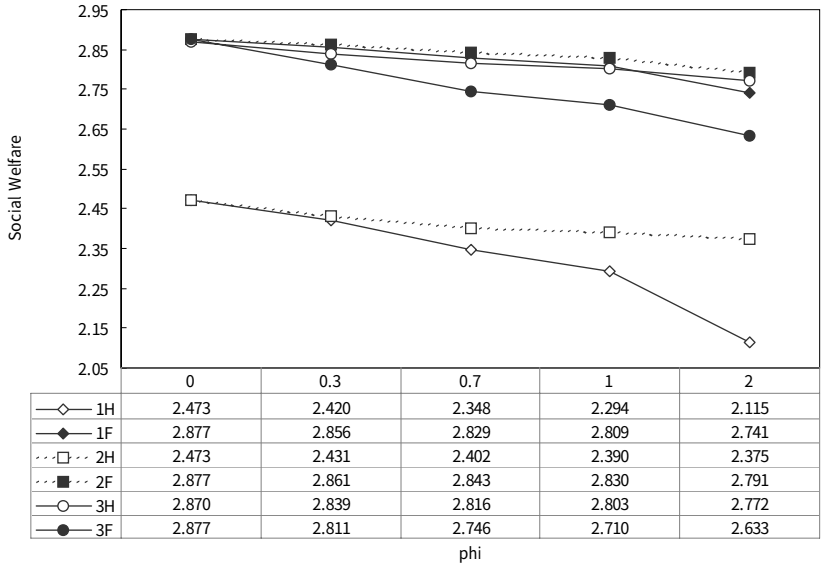
Figure 12. Changes in dirty good production w.r.t. ϕ

politics than international negotiation with lump-sum transfer in each country and ② the production level remains constant in any country under the domestic politics because of a unilateral action of a policy maker in that case. Production of the dirty good under the clean technology transfer case moderately decreases as the marginal influence of the foreign emission is amplified as elucidated in the figure. This also confirms that the CDM project can be an appropriate mutually beneficial policy for mitigating transboundary pollution by reducing the production of the dirty good especially when the effect of foreign emission is intensifies.

2.4. Changes in Social Welfare

The following figure 13 presents a change in the social welfare when the values designated marginal impact of foreign emission to transboundary pollution changes.

Basically, social welfare under any political case decreases as the marginal effect of foreign emission to transboundary pollution increases. Social welfare



	0	0.3	0.7	1	2
1H	2.473	2.420	2.348	2.294	2.115
1F	2.877	2.856	2.829	2.809	2.741
2H	2.473	2.431	2.402	2.390	2.375
2F	2.877	2.861	2.843	2.830	2.791
3H	2.870	2.839	2.816	2.803	2.772
3F	2.877	2.811	2.746	2.710	2.633

Figure 13. Changes in social welfare w.r.t. ϕ

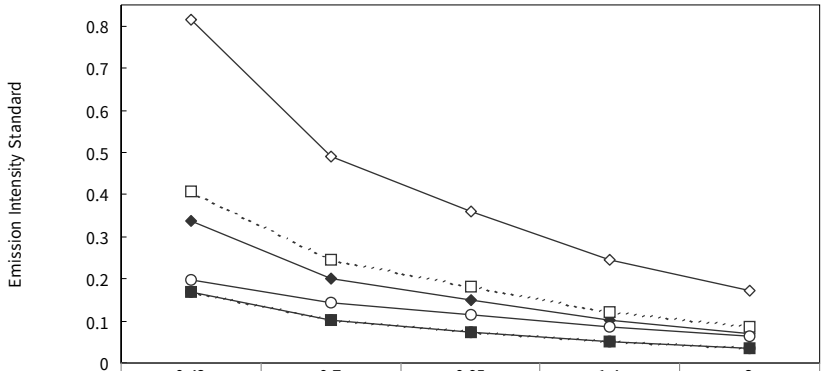
of a country attained through international negotiation or international interest politics is shown to be higher than that attained in domestic politics. It also clearly shows that social welfare of the advanced country is higher than that of the less developed country regardless of their being in a political arena. These are quite natural results as is identified in the theoretical analysis. The clean technology transfer also can attain relatively high social welfare in each country, implying that aggregate social welfare from a global perspective is the highest.

3. Marginal Disutility of the Environmentalists on the Transboundary Pollution

In this subsection, the following simulations are related to the evaluation of changes in the environmental standard, social welfare, global pollution, and dirty good production induced by changes in the marginal disutility of the environmentalist on the transboundary pollution($\rho \geq 0$). The typical values adopted in the simulations are 0.42, 0.7, 0.95, 1.4 and 2 as shown in the top raw of the table attached to the figure.

3.1. Changes in Emission Intensity Standard

Figure 14 shows that an emission intensity standard of any country becomes stricter as the marginal disutility of the environmentalist increases. That is, more efforts in lobbying would be made by the environmentalists when they have much stronger preferences over clean environment. The standard decided when two countries negotiate by use of the clean technology transfer notably exhibits the strictest level. This could be appropriate considering that the environmentalist in the advanced country may lead the industrialist to agree to implementing a more strict standard since the industrialists are rewarded with their emission reduction efforts in the less-developed country. As well for the environmentalists in the less-advanced country, their influence through lobbying can persuasively induce



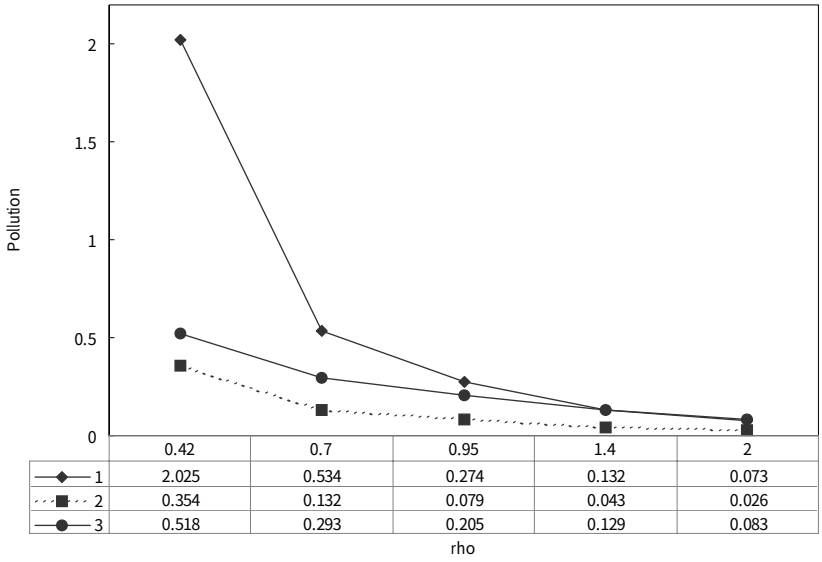
	0.42	0.7	0.95	1.4	2
1H	0.816	0.490	0.361	0.245	0.171
1F	0.336	0.202	0.149	0.101	0.071
2H	0.408	0.245	0.180	0.122	0.086
2F	0.168	0.101	0.074	0.050	0.035
3H	0.197	0.142	0.114	0.085	0.064
3F	0.168	0.101	0.074	0.050	0.035

Figure 14. Changes in emission intensity standard w.r.t. ρ

the policy maker to choose the relatively strict standard in the sense that the industrialists are now able to produce dirty goods with less costly abatement technology as a result of clean technology transfer from the advanced country.

3.2. Changes in Global Pollution

Following figure 15 presents how the transboundary pollution would be affected when the environmentalists have an increasingly strong distaste for pollution(0.42 $\Rightarrow$ 2). It is noted that lobbying through international negotiation or the international interest politics can give rise to the lowest global pollution in this setting for simulation. The unilateral decision through the domestic politics leads to the highest global pollution level all the way. The clean technology transfer case also shows relatively restrained pollution level. It is worthy to note that the transboundary pollution levels decided in any political arena get closer to each other as the environmentalists show an



	0.42	0.7	0.95	1.4	2
1	2.025	0.534	0.274	0.132	0.073
2	0.354	0.132	0.079	0.043	0.026
3	0.518	0.293	0.205	0.129	0.083

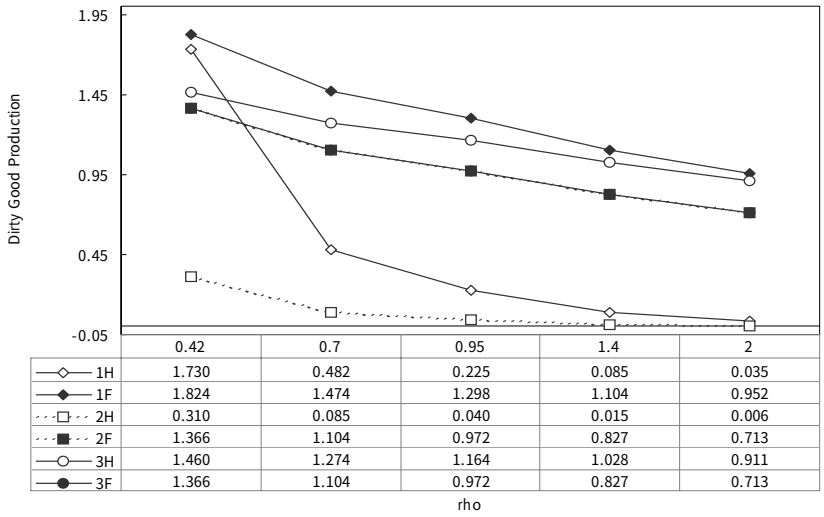
Figure 15. Changes in global pollution w.r.t. ρ

extreme preference for a green environment.

3.3. Changes in Pollution Generating Production

Figure 16 addresses the ways in which the production of pollution generating good is affected by the changes in the preference of environmentalists over transboundary pollution.

The figure evinces a situation in which the production of the dirty good under any type of political process would altogether be diminished in the face of a growing fear of global pollution by the environmentalists. As with results in the prior simulations, the clean technology transfer case leads to a relatively higher level of dirty good production. This also suggests that efficiency gains from the technology transfer enables the industrialists in the recipient country to increase production under a given level of abatement cost as well as the ones in the donor country to benefit by the CER(certified emission reductions) that was given as an incentive to transfer the efficient



	0.42	0.7	0.95	1.4	2
1H	1.730	0.482	0.225	0.085	0.035
1F	1.824	1.474	1.298	1.104	0.952
2H	0.310	0.085	0.040	0.015	0.006
2F	1.366	1.104	0.972	0.827	0.713
3H	1.460	1.274	1.164	1.028	0.911
3F	1.366	1.104	0.972	0.827	0.713

rho

Figure 16. Changes in dirty good production w.r.t. ρ

clean technology.[30] This is why the dirty good production of each country is relatively high in case of the international negotiation through clean technology transfer such as the CDMs. Needless to say, an aggregate level of the production of dirty good records the highest in all three cases.

3.4. Changes in Social Welfare

Next figure 17 finally introduces a change in the social welfare when the values of marginal disutility of the environmentalists over the transboundary pollution vary.

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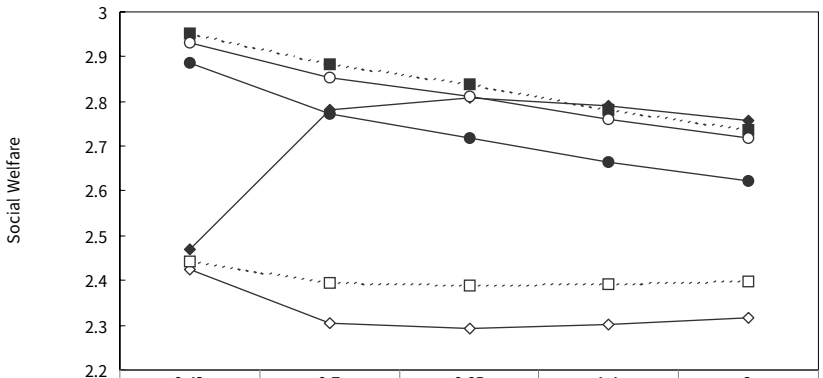
30) Note that CER can be used by an advanced country to meet their reduction commitments under the Kyoto Protocol. Under the emissions trading scheme set by the 1997 landmark agreement, CERs can be traded and thus help to combat climate change in the most cost-effective way. A CER amounts to one tonne of CO2 equivalent. The value of CER in the context of this analysis can be viewed as an opportunity cost, which was otherwise to be produced as consumption goods(here, dirty goods). For details of the Kyoto Protocol and CER, see the UNFCCC website (http://cdm.unfccc.int/CDMNews/).



	0.42	0.7	0.95	1.4	2
1H	2.426	2.304	2.294	2.302	2.317
1F	2.471	2.780	2.809	2.791	2.757
2H	2.444	2.395	2.390	2.393	2.398
2F	2.953	2.884	2.838	2.782	2.737
3H	2.930	2.853	2.810	2.759	2.717
3F	2.885	2.771	2.718	2.663	2.622

rho

Figure 17. Changes of social welfare w.r.t. ρ

Careful inspection of the figure indicates that the difference in social welfare between the less-developed country under domestic politics and under either international negotiation or international interest politics, gets somewhat wider. On the other hand, the difference in social welfare of the advanced country case gets closer to each other as the environmentalists have an increasing distaste for transboundary pollution(ρ : 0.42 $\Rightarrow$ 2). These findings may stem from the assumption in the simulation that there is an efficiency gap in the technology for the dirty good production. This is why the advanced country can be accessible to a higher level of social welfare than the less-developed country. Further, the extremely growing concern over transboundary pollution by the environmentalists may generate different effects on the political behaviour of both the advanced and the less-developed countries: equipped with efficient production technology and faced with extreme preference for the environmentalists, the advanced country may sense that it would be more profitable to appeal to unilateral standard policy decision by the government as shown in domestic politics rather than being

in favour of international negotiation or of international interest politics. Faced with an opposite stance, the less-developed country could have an opposite attitude over the choice of the political decision process so as to maximise its social welfare. It could be better off in case 2 rather than in case 1 since domestic politics may bring about even worse consequences when it is technically inferior to the advanced country, losing international competitiveness by not cooperating with the advanced country. This is supported by the fact that social welfare of the less-developed country is clearly higher when it cooperates (under case 2) than it is under case 1. But we can find a converse implication from the advanced country. Finally, it is also confirmed that the aggregate level of social welfare is the highest when the countries cooperate through CDM since they are mutually beneficial through the clean technology transfer even in face of increasing concern over the transboundary pollution by the environmentalists in each country.

Ⅵ. Concluding Remarks

This study provides the comparative models for special interest politics with campaign contribution to highlight a stream of the green political movement which reflects the rising profiles of the environment in politics in the face of the latest growing global concern about a large-scale ecological crisis. Considering that environmental interest groups are presumably the most distinguishable expression of current environmental concern, particular emphasis of this study is put into the examination of political influence of the relevant interest groups in the process of governments' environmental policy making under the national and international perspective. With the help of the theoretical contributions by Bernheim and Whinston (1988), Dixit et al. (1997), Grossman and Helpman (1995), and Prat and Rustichini (2003), this study adopts those frameworks in analyzing the political competition between interest groups. It is pointed out in this study that political competition between interest groups making financial contribution to policy makers embodies political equilibria for the decision of international environmental standard under various types of interest politics. The main findings of the political model suggests that ① domestic politics usually generates the laxest environmental standard due to the unilateral adoption of sovereign governments, which may give rise to negative externalities across borders, ② the equilibrium environmental standard implemented through international cooperation between the like-minded national interest groups is identical to that implemented through the cooperation between the governments under international negotiation, ③ asymmetric international interest politics can also implement a higher environmental standard than the equilibrium standard obtained with domestic interest group politics. Main implication of this results is that, since perfect coordination between interest groups may not be feasible in practice, a combination of agreements between governments along with international interest group politics would be more appropriate steps to be taken to ensure that equilibrium environmental standards internalize cross national externalities.

Moreover, an analytical framework for clean technology transfer to readily come to an agreement in the international negotiation is designed and analysed in the study. It seems that implementing CDM as a policy instrument for the reduction of global pollution can be mutually beneficial to both donor and recipient countries in static sense. In the same instant, genuine effect of CDM in dynamic perspective may be open to dispute as long as global technology gap due to the strategic motivation of donor country is maintained. This remains as a future research issue to be scrupulously analysed under the Kyoto Protocol.

These findings in the theoretical analysis are numerically verified through a series of simulations in which trends of main variables such as the emission intensity standard, global pollution, the production level of the dirty sector, and social welfare in each political model are explored in response to changes in key parameters of the model. It is assumed that, apart from the difference in efficiency of the clean technologies, the two countries are essentially identical in the economic and political structure. The essential features of the results from the simulation can be summarized as; ① domestic politics usually generates the most lax environmental standard compared to the standards resulted from the international negotiation and the international interest group politics, ② wide differences in the standards from the various types of politics get smaller as the efficiency gap of the clean technology between countries gradually decreases, ③ CDM case provides an intuitive observation that global pollution increases when the efficiency gap of the clean technology increases, ④ wide difference in the levels of social welfare of each country gets smaller as either the efficiency increases or the fraction of transboundary emission affecting domestic country decreases, and ⑤ the standards gets strict (the global pollution and dirty good production decreases) as the environmentalists group puts a more negative weight on the problem of transboundary pollution, however, at the cost of decrease in the social welfare, especially of the advanced country.

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Appendix

1. Definition and characterization of equilibrium of SIP 1

In case of special interest group politics 1, political competition in each country take place in two stages. First, the two domestic interest groups simultaneously offer contribution schedules to their government. Second, the government selects an environmental standard $e_i \in [0,1]$ taken as given the contribution schedules as well as the environmental standard of the other country. We begin by defining an equilibrium response of country i to an equilibrium policy implementation of the other country as follows.

Definition 1 *Following from Grossman and Helpman(1995), let e_j be an arbitrary level of the environmental standard set by country j. Then a set of feasible non-negative contribution function $\{\hat{c_i^l}\}$ and an environmental standard $\hat{e_i^1} \in \Psi_i$ are an equilibrium response to e_j if (a)*

$$\hat{e_i^1} = \arg \max_{e_i} \sum_{m_i} \hat{c_i^l}(e_i;e_j) + \delta W_i(e_i,e_j) \qquad (31)$$

where $W_i(e_i,e_j)$ is given in (10). (b) for every interest group in country i, there cannot be a feasible contribution function $c_i^l(e_i;e_j)$ and an environmental standard e_i^l such that (i)

$$e_i^l = \arg \max_{e_i} c_i^l(e_i;e_j) + \hat{c_i^{-l}}(e_i;e_j) + \delta W_i(e_i;e_j)$$

and (ii)

$$v_i^l(e_i^l,e_j) - c_i^l(e_i^l;e_j) > v_i^l(\hat{e_i^l},e_j) - \hat{c_i^l}(\hat{e_i^l};e_j) \qquad (32)$$

where if $l = E$(or I), then $-l = I$ (or E). First, the equilibrium environmental

standard must maximize the welfare of government i in (31). Second, it must maximize the joint welfare of each of the two interest groups in that country and the government:

$$\hat{e_i}^1 = \arg \max_{e_i} v_i^l(e_i, e_j) - \hat{c_i}^l(e_i;e_j) + \hat{c_i}^l(e_i;e_j) + \hat{c_i}^{-l}(e_i;e_j) + \delta W_i(e_i, e_j)$$

for every l and $-l$. By assuming that the contribution functions are differentiable around the equilibrium, the first order conditions of (31) and (32) generate the so-called "local truthfulness" condition[31], i.e.,

$$\frac{\partial v_i^l(\hat{e_i}, e_j)}{\partial e_i} = \frac{\partial \hat{c_i}^l(\hat{e_i};e_j)}{\partial e_i} \quad \textit{for each } l. \qquad (33)$$

By summing the conditions of local truthfulness up and substituting the result into the first order condition of equation (31), then the equilibrium environmental standards in the two countries are characterized by the solutions to the two equations expressed in (11):

2. Definition and characterization of equilibrium of SIP 2

To characterize the equilibrium policy, we adopt the following definition from Grossman and Helpman (1995).

Definition 2 *Following Grossman and Helpman 1995, an international environmental standard agreed in the negotiation consists of sets of financial contribution functions $\{\hat{c_1}^{l_1}\}_{l_1 \in \{E_1, I_1\}}$ and $\{\hat{c_2}^{l_2}\}_{l_2 \in \{E_2, I_2\}}$ and a pair of environmental standards $\hat{e_1}^{II}$ and $\hat{e_2}^{II}$ and is an equilibrium if (a)*

31) See Grossman and Helpman (1994).

$$\{\hat{e_1}^{II}, \hat{e_2}^{II}\} = \arg \max_{e_1, e_2} \sum_{l_i} \hat{c_i}^{l_i}(e_i, e_j) + \sum_{l_j} \hat{c_j}^{l_j}(e_j, e_i) + \delta[W_i(e_i, e_j) + W_j(e_j, e_i)]$$

where $i, j = 1, 2$ *and* $i \neq j$.

(b) $\forall$ *interest group* l_1 *in country 1,* $\nexists$ *a feasible contribution function* $c_1^{l_1}(e_1, e_2)$ *and a pair of standard vectors* $(e_1^{l_1}, e_2^{l_1})$ *such that (i)*

$$\{e_1^{l_1}, e_2^{l_1}\} = \arg \max_{e_1, e_2} [c_1^{l_1}(e_1, e_2) + \hat{c_1}^{-l_1}(e_1, e_2)] + \sum_{l_2} \hat{c_2}^{l_2}(e_2, e_1) + \delta[W_1(e_1, e_2) + W_2(e_2, e_1)]$$

where $l_1 = E_1$ *(or* I_1*) and* $-l_1 = I_1$*(or* E_1*)*

and (ii)

$$v_1^{l_1}(e_1^{l_1}, e_2^{l_1}) - c_1^{l_1}(e_1^{l_1}, e_2^{l_1}) > v_1^{l_1}(\hat{e_1}^{II}, \hat{e_2}^{II}) - \hat{c_1}^{l_1}(\hat{e_1}^{II}, \hat{e_2}^{II}),$$

and (c) $\forall$ *interest group* l_2 *in country 2,* $\nexists$ *a feasible contribution function* $c_2^{l_2}(e_2, e_1)$ *and a pair of standard vectors* $(e_1^{l_2}, e_2^{l_2})$ *such that (i)*

$$\{e_1^{l_2}, e_2^{l_2}\} = \arg \max_{e_1, e_2} \sum_{e_1} \hat{c_1}^{l_1}(e_1, e_2) + [c_2^{l_2}(e_2, e_1) + \hat{c_2}^{-l_2}(e_2, e_1)] + \delta[W_1(e_1, e_2) + W_2(e_2, e_1)]$$

where $l_2 = E_2$ *(or* I_2*) and* $-l_2 = I_2$*(or* E_2*)*

and (ii)

$$v_2^{l_2}(e_2^{l_2}, e_1^{l_2}) - c_2^{l_2}(e_2^{l_2}, e_1^{l_2}) > v_2^{l_2}(\hat{e_2}^{II}, \hat{e_1}^{II}) - \hat{c_2}^{l_2}(\hat{e_2}^{II}, \hat{e_1}^{II}).$$

Condition (a) indicates that the equilibrium international environmental standard should maximise the joint payoff of the two governments under international negotiation. Condition (b) rules out the case in which an interest group (l_1) in country 1 can benefit from by re-formulating its contribution

schedule, inducing a change in the agreement between the governments (from $(\hat{e_1^{II}}, \hat{e_2^{II}})$ to (e_1^h, e_2^h)).

3. Definition and characterization of equilibrium of SIP 4

To characterize a pure strategy equilibrium, we formally define the equilibrium concept of the environmental standard policy adopt the following definition from Prat and Rustichini (2003).

Definition 3 *(Adopted from Prat and Rustichini, 2003) Let e_j be an arbitrary level of the environmental standard set by country j and let e be a set of environmental standards $\{e_1, e_2\}$. Then a set of feasible non-negative contribution schedules $\{\hat{c}_i^l\}$ and an environmental standard $e_i^{III} \in [0, 1]$ constitute a pure strategy equilibrium if and only if the following conditions are satisfied*

(a) For every country and feasible environmental standard,

$$\hat{c_i^l}(\hat{e}_i;\hat{e}_j) + \delta W_i(\hat{e}_i;\hat{e}_j) \geq \hat{c_i^{\tilde{l}}}(e_i;e_j) + \delta W_i(e_i, e_j), \qquad (34)$$

where $W_i(e_i, e_j)$ is given in equation (10).

(b) For every international interest group $\tilde{l} \in \{\tilde{E}, \tilde{I}\}$ and environmental standard, there cannot be a feasible contribution schedule $c_i^l(e_i;e_j)$ and an environmental standard e_i^l such that [i]

$$v^{\tilde{l}}(\hat{e}_i;\hat{e}_j) + \sum_i \hat{c_i^{\tilde{l}}}(\hat{e}_i;\hat{e}_j) + \delta W_i(\hat{e}_i;\hat{e}_j) \geq$$

$$v^{\tilde{l}}(e_i;e_j) + \sum_i \hat{c_i^{\tilde{l}}}(e_i;e_j) + \delta W_i(e_i;e_j),$$

where if $\tilde{l} = E$ (or I), then $-\tilde{l} = \tilde{I}$ (or $\tilde{E}$).

(c) Each international interest group $\tilde{l}$ should offer the cost minimizing contribution schedule to each government i, i.e., for $\forall \tilde{l} \in \{\tilde{E}, \tilde{I}\}$ and $i \in \{1,2\}$,

$$\sum_{\tilde{l}} \hat{c_i^{\tilde{l}}}(\hat{e_i}; e_j) + \delta W_i(\hat{e_i}, e_j) = \max_{e_i} \left(\hat{c_i^{\tilde{l}}}(e_i; e_j) + \delta W_i(e_i, e_j)\right). \qquad (35)$$

Condition (a) defines the usual agent maximisation problem. Given the campaign financial contributions offered by the international interest groups, a government (a policy maker) would determine a particular level of the environmental standard which gives it the highest payoff. Condition (b) explains that the cost of a deviation must be greater than the benefit of a deviation if an international interest group deviates from the equilibrium environmental standard $e(\hat{e}_i, \hat{e}_j)$, which is called the incentive compatibility condition. This condition is satisfied when the choice of the pure equilibrium environmental standard maximises the joint payoffs of governments to which an international interest group has proposed financial contribution schedules and of the group itself. And condition (c) denoted as cost minimization condition indicates that there is no way in which an international interest group reduces the equilibrium transfers without deviating from e.

It has been assumed that the financial contribution plan designed by an international interest group to a government is only contingent on the environmental standard policy choices by that policy maker given the environmental standard implementation of foreign country j. This is because there exists a basically non-cooperative nature between the international interest groups which compete in making contributions to both governments to exercise their influence over the policy making process of each government.

It is already mention in the text that a globally efficient outcome may not be possible and this is why Prat and Rustichini (2003) propose a modified equilibrium concept called a weakly truthful equilibrium strategy in their paper.

Definition 4 *(Adopted from Prat and Rustichini, 2003) For an international interest group $\tilde{l}$, $\{\hat{c_i^{\tilde{l}}}\}_{i \in \{1,2\}}$ is weakly truthful relative to $(\hat{e}_i, \hat{e}_j)$, if*

$\forall e_i \in \Psi_i (\equiv [0,1])$,

$$v^{\bar{l}}(\hat{e}_i;\hat{e}_j) + \sum_i \hat{c}_i^{\bar{l}}(\hat{e}_i;\hat{e}_j) \geq v^{\bar{l}}(e_i;e_j) + \sum_i \hat{c}_i^{\bar{l}}(e_i;e_j). \qquad (36)$$

A weakly truthful strategy equilibrium eliminates inefficient outcomes caused from coordination problems.[32)]

Then a pure strategy equilibrium of the international interest group politics can be characterized as follows. The agent maximization condition is necessary and sufficient for the equilibrium outcome $\hat{e}$ to be a best response of a government given the financial contributions made by the international interest groups. The best response of an international interest group $\bar{l}$ to the given equilibrium strategy of the other $-\bar{l}$ can be characterized in the following way. An international interest group can induce government i to implement any outcome e provided that it proposes to government i a contribution which is greater than

$$\left\{\max_{a \in e_i} T_i^{\bar{l}}(a)\right\} - T_i^{\bar{l}}(e_i),$$

where $T_i^{\bar{l}}(e_i) = \hat{c}_i^{-\bar{l}}(e_i) + \delta W_i(e)$. Thus, the international interest group will implement that level of the environmental standard if the outcome $\hat{e}$ solves

$$\max_{a \in e} v^{\bar{l}}(e) - \sum_i \left[\left\{\max_{a \in e_i} T_i^{\bar{l}}(a)\right\} - T_i^{\bar{l}}(e_i)\right]. \qquad (37)$$

It is noticed that $\max_{a \in e_i} T_i^{\bar{l}}(a)$ is constant. Thus, $\hat{e}$ solves the international interest group's problem (37) if and only if it meets incentive compatibility condition (b). The cost minimization condition implies that, at the equilibrium outcome $\hat{e}$, the international interest group l solves

32) For details, see Prat and Rustichini (2003).

$$\min_{\hat{c}^l} \sum_i \hat{c}_i^{\bar{l}}(\hat{e}_i) \quad s.t. \quad G_i^{III}(\hat{e}) \geq G_i^{III}(e) \quad \forall i .$$

Then, $\exists$ the solution $\hat{c}_i^{\bar{l}}(\hat{e}_i) \geq 0$, when $\hat{e}$ is implemented, such that:

$$\hat{c}_i^{\bar{l}}(\hat{e}_i) = \left\{ \max_{a \in e_i} \hat{T}_i^{\bar{l}}(a) \right\} - \hat{T}_i^{\bar{l}}(\hat{e}_i) \tag{38}$$

at $\hat{s}$ and

$$\hat{c}_i^{\bar{l}}(e_i) \leq \left\{ \max_{a \in e_i} \hat{T}_i^{\bar{l}}(a) \right\} - \hat{T}_i^{\bar{l}}(e_i) \tag{39}$$

for $\forall e \neq \hat{e}$. Since (38) and (34) leads to (39), the cost minimization condition is confirmed. Then, it should be proved that these conditions are satisfied for the equilibrium pair $(\hat{c}, \hat{e})$ under the weakly truthful strategy. First of all, by summing (34) over i and adding it to (36), the following condition would show the result:

$$v^{\bar{l}}(\hat{e}) + \sum_i \hat{c}_i^{-\bar{l}}(\hat{e}_i) + \delta \sum_i W_i(\hat{e}) \geq v^{\bar{l}}(e) + \sum_i \hat{c}_i^{-\bar{l}}(e_i) + \delta \sum_i W_i(e)$$

for any l. This is identical to the incentive compatibility condition in (b), implying sufficiency is proved. This follows that the necessities for the agent maximisation in (a) and the cost minimisation condition in (c) in the definition are obvious according to the above presentation. Hence, weak truthfulness is necessary. To characterise the equilibrium in SIP III, we will briefly examine the process for derivation of the best response function of country i using the weakly truthful strategy. First of all, summing the weak truthfulness conditions (36) over $\bar{l}$ is

$$\sum_{\bar{l}} v^{\bar{l}}(\hat{e}) - \sum_i \sum_{\bar{l}} \hat{c}_i^{\bar{l}}(\hat{e}_i) \geq \sum_{\bar{l}} v^{\bar{l}}(e) - \sum_i \sum_{\bar{l}} \hat{c}_i^{\bar{l}}(e_i).$$

And summing the agent maxamisation conditions (34) over i shows

$$\delta\sum_i W_i(\hat{e}) + \sum_i\sum_l \hat{c_i^l}(\hat{e_i}) \geq \delta\sum_i W_i(e) + \sum_i\sum_l \hat{c_i^l}(e_i).$$

Adding the two resulting inequality yields

$$\sum_l v^l(\hat{e}) + \delta\sum_i W_i(\hat{e}) \geq \sum_l v^l(e) + \delta\sum_i W_i(e). \qquad (40)$$

Therefore, SIP III attains a globally efficient outcome identical to that shown in SIP III. If the first order condition with regard to e_i around equilibrium point $(\hat{e})$ is also taken, then the resulting expression would be consequently equal to the equation shown in (22).

4. Definition and characterization of equilibrium of SIP 5

A pure strategy equilibrium of the asymmetric international interest group politics can be characterized as follows.

Definition 5 *Following Bernheim and Whinston (1986), Grossman and Helpman (1995) and Prat and Rustichini (2003), a set of feasible contribution functions* $\{\hat{c_i^E}, \hat{c_i^I}\}_{i=1,2}$ *and a environmental standard policy* $\hat{e_i^{IV}}$ *is an equilibrium response to the standard* e_j *taken by the other government* j *if the following conditions are satisfied: (a)* $\forall i$ *and* $e_i \in \Psi_i$,

$$\hat{c_i^I}(\hat{e_i}) + \hat{c_i^E}(\hat{e_i}) + \delta W_i(\hat{e}) \geq \hat{c_i^I}(e_i) + \hat{c_i^E}(e_i) + \delta W_i(e). \qquad (41)$$

(b) for every interest group in country i*, there cannot be a feasible function* $c_i^I(e_i;e_j)$ *and* $c_i^{\tilde{E}}(e_i;e_j)$ *and environmental standards* $(e_i^I, e_i^{\tilde{E}})$ *such that (i)* $\forall e \in \Psi$ *and for the international environmentalists group,*

$$e_i^{\bar{E}} = \arg \max_{e_i} \hat{c}_i^{I}(e_i;e_j) + \hat{c}_i^{\bar{E}}(e_i;e_j) + \delta W_i(e) \text{ and}$$
$$v^{\bar{E}}(e_i^E,e_j) - \sum_i c_i^{\bar{E}}(e_i^E;e_j) > v^{\bar{E}}(\hat{e}_i^{IV},e_j) - \sum_i \hat{c}_i^{\bar{E}}(\hat{e}_i^{IV};e_j). \quad (42)$$

(ii) $\forall e \in \Psi$ and for the domestic industrialists group of country i,

$$e_i^I = \arg \max_{e_i} c_i^I(e_i;e_j) + \hat{c}_i^{\tilde{E}}(e_i;e_j) + \delta W_i(e) \text{ and}$$
$$v_i^I(e_i^I,e_j) - c_i^I(e_i^I;e_j) > v_i^I(\hat{e}_i^{IV},e_j) - \hat{c}_i^{I}(\hat{e}_i^{IV};e_j). \quad (43)$$

(c) international environmentalists interest group $\tilde{E}$ should offer the cost-minimising contribution to each government i such that

$$\sum_{\bar{E}} \hat{c}_i^{\bar{E}}(\hat{e}_i) + \delta W_i(\hat{e}) = \max_{e_i} (\hat{c}_i^{-\bar{E}}(e_i) + \delta W_i(e)). \quad (44)$$

According to theorem 1 in Prat and Rustichini (2003), the equilibrium environmental standard in country i must maximise the joint welfare of the international environmentalists interest group and the two governments such that

$$\{\hat{e}_i^{IV},\hat{e}_j^{IV}\} = \arg \max_{e_i,e_j} v^{\bar{E}}(e_i,e_j) - \hat{c}_i^{\bar{E}}(e_i;e_j) - \hat{c}_j^{\bar{E}}(e_j;e_i) + \hat{c}_i^{\bar{E}}(e_i;e_j) + \hat{c}_i^{I}(e_i;e_j) + \delta W_i(e_i,e_j) + \hat{c}_j^{\bar{E}}(e_j;e_i) + \hat{c}_j^{I}(e_j;e_i) + \delta W_j(e_j,e_i). \quad (45)$$

The similar conditions applied for the industrialists interest group and the government of country i is

$$\hat{e}_i^{IV} = \arg \max_{e_i} v_i^I(e_i,e_j) - \hat{c}_i^{I}(e_i;e_j) + \hat{c}_i^{\bar{E}}(e_i;e_j) + \hat{c}_i^{I}(e_i;e_j) + \delta W_i(e_i,e_j). \quad (46)$$

The first order conditions associated with eq. (41), (45), and (46) and the condition that $\partial \hat{c_j}^{\pi}(s_j;s_i)/\partial s_i = 0$ lead to generate the following two conditions, i.e.,

$$\frac{\partial v^{\bar{E}}}{\partial e_i} - \frac{\partial \hat{c_i}^{\bar{E}}}{\partial e_i} + \frac{\partial v_i^I}{\partial e_i} - \frac{\partial \hat{c_i}^I}{\partial e_i} + \delta \frac{\partial W_j}{\partial e_i} = 0. \tag{47}$$

Condition (c) states that the international environmentalists interest group's contribution functions must be cost minimising:

$$\hat{c_i}^{\bar{E}}(\hat{e_i}^{IV};e_j) = \max_{a \in \Psi_i} \hat{T_i}^{\bar{E}}(a) - \hat{T_i}^{\bar{E}}(\hat{e}^{IV}).$$

The marginal contribution of the international environmentalists interest group with regard to e_i is

$$\frac{\partial \hat{c_i}^{\bar{E}}}{\partial e_i} = - \frac{\partial \hat{c_i}^I}{\partial e_i} - \delta \frac{\partial W_i}{\partial e_i}. \tag{48}$$

By inserting condition (48) into (47), we get:

$$\frac{\partial v^{\bar{E}}}{\partial e_i} + \delta \frac{\partial W_i}{\partial e_i} + \frac{\partial v_i^I}{\partial e_i} + \delta \frac{\partial W_j}{\partial e_i} = 0,$$

which is equivalently shown as in (30).

국문요약 (Abstract in Korean)

본 연구서는 정부의 국제환경규범 결정과정에 영향을 줄 수 있는 특수이익집단들의 정치적 행동을 조감하는데 필요한 정치경제학 모델을 제시한다. 복잡하고 다양한 이익집단 정치경제 모델을 분석하기 위해서, 본 연구는 특별히 이 분야 선행 연구들 중에서 최근 유행하는 메뉴 옥션 유형의 선거비용 기부 모델로부터 시작하여 다수 조정자 - 다수 대리인 이론에 근거하는 국제 이익집단 정치와 더불어 공동 대리인 모델과 다수 조정자 - 다수 대리인 모델이 혼재되어 있는 경우까지 확대된다. 국제무역이론에 있어 특정생산요소 모델의 틀 안에서 다양한 이익집단 정치경제모델에서 결정되는 국제환경규범의 정치적 결과들을 분석하여 근래 점증하는 환경주의자 집단의 정치적 역할의 영향 등을 가늠하도록 한다.

개방된 소국 두 나라 체제를 기본으로 하는 본 연구는 각 국에서의 일방적인 환경규범입안이 매우 완화된 수준에서 이루어질 것이며 이 때문에 초래되는 부정적 외부효과의 내재화는 두 나라의 공조를 통해 가능함을 보인다. 이는 국제무역이론의 정치경제학적 모델에서 자주 원용되는 결과와 같은 맥락이므로, 본 연구에서는 정부 간 협조 모델을 더욱 현실적으로 발전시켜 정부 간의 협조가 교토 프로토콜(The Kyoto Protocol)체제 안에서 고안된 청정개발체제(Clean Development Mechanism)를 통하여 동기 유발되어 촉진될 수 있는 경우를 고려하여 분석하였다. 뿐만 아니라, 정부 간의 협력을 통하여 입안될 수 있는 국제환경규범의 수준이 동일한 이익을 추구하는 각 국의 이익집단간의 협력을 통해서도 가능함을 지적하였다. 마지막으로 본 연구에서는 모델을 구성하고 있는 주요 파라미터 값들의 변화가 이러한 정치경제 모델로부터 도출된 국제환경규범, 전 지구적 오염, 오염유발산업의 생산량 그리고 사회후생수준과 같은 균형 값들에게 어떠한 영향을 줄 수 있는지, 또한 그로부터 어떠한 정책적 시사점들이 유추될 수 있는지 논의된다.