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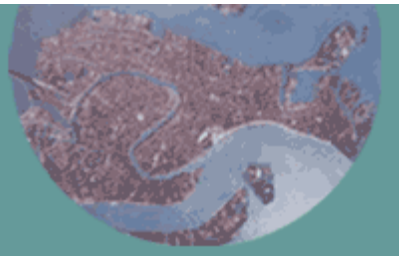

The logic of two-levels games with endogenous lobbying: case of international environmental agreements

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The Logic of Two-Level Games with endogenous lobbying: Case of international environmental agreements

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Abstract:

All works studying the problem of IEAs stability and abatement level have the inconvenient of assuming that governments maximise welfare function. There are political constraints that bind the hands of national governments and influence the international negotiation process. Therefore, the aim of the current paper is to develop an international framework in which the government's decision about IEAs' participation and abatement level (international level) are influenced by pressures of interest groups who make electoral contributions (national level). To this purpose, we present an endogenous lobbying model and we assume that lobbies try to influence the policy choice of governments by offering political contribution in return for policy compromise. Therefore, our work attempts to answer the following questions: What will be the size of stable coalition? How political competitions between lobby groups shape the outcome of international agreements?

Keywords : non-cooperative game theory, Interest group, Coalition theory, International Environmental Policy.
JEL: Q280, D720, D780

1 Introduction

International environmental agreements are increasingly important in a globalised economy. Beyond their specific interest, these agreements are also important in the context of coalition formation theory. The literature on coalition formation in international pollution control has grown immensely within the last decades. It focused on the question of the stability and profitability of international environmental agreements (IEAs). This literature is following two main directions: cooperative game, non-cooperative game.

In the cooperative game theory, the focus of analysis is the coalition of countries and its characteristic function, i.e. the total net benefits the coalition can share (Chander and Tulkens, 1997). Non-cooperative game theory, on the contrary, focuses on individual countries which maximise their own welfare subject to the individual welfare maximising behaviour by other countries. In this theory, game can be repeated (Barrett, 1997) as well as one-shot (Barrett, 1994; Carraro and Siniscalco, 1993; Hoel, 1992). In both cases, the analysis focuses on coalition formation mechanisms, i.e. on the incentives that lead to self-enforcing international environmental agreements and define the number of the signatory countries. Except Chander and Tulkens (1992, 1995), all papers employ stability concepts of non-cooperative game theory. The reason is that IEAs must be self-enforcing because no binding commitments are possible. Basically, the models of Barrett (1994b), Bauer (1992), Carraro and Siniscalco (1992, 1993) and Hoel (1992) employ a stability concept borrowed from the oligopoly literature (D'Aspermont, et al., 1983) where a coalition is said to be stable if no country wants to accede to the coalition (external stability) and no country wants to leave the coalition (internal stability). The equilibrium size is determined as an adjustment process of signatories and non-signatories. This is particularly evident in Barrett (1994a, b), where signatories behave as Stackelberg leaders.

Though the above-mentioned papers do not control free-riding in a strict sense, most models come to the pessimistic conclusion that only two or three countries will form a stable coalition. However, this prediction is rejected by the data. Only Barrett (1994b) finds a coalition of up to N countries in the case of linear marginal abatement and damage costs, symmetric countries, and assuming the signatories to be Stackelberg leaders. The result is confirmed in the supergame version of his model. In our paper we focus on non-cooperative games. We particularly concentrate on one-shot coalition formation game to determine the size of stable coalition and the abatement level of each countries. All works studying the problem of IEAs stability and abatement level have the inconvenient of assuming that governments maximise welfare function. However, recent events in the United States have illustrated the extent to which organised groups condition environmental policy, both at national and multilateral level. Industry and green lobbies have been extremely influential. On some issues, such as multilateral emission cuts, they have held different positions[1].

[1] While green lobbies have exercised "considerable influence on the negotiations" at Ky-

On others, such as the compliance of foreign legislation with American environmental standards, their objectives have often coincided[2]. Thus, we argue that there are political constraints that bind the hands of national governments that participate in the international negotiation process.

The aim of the current paper is to develop an international framework in which the Government's decision about IEAs' participation and abatement level (international level) are influenced by pressures of interest groups who organize a collective action through electoral contributions (national level). It is, therefore, assumed that lobbies try to influence the policy choice of the governments by offering them political contribution in return for policy compromise. Therefore, our work attempts to answer the following questions: With respect to national constraint, what will be the size of stable coalition and how to share the responsabilities to be taken against climate change between signatory governments? To this end, we use the theory of two-level games, which acknowledges the interplay between domestic politics and international relations (Putnam, 1988). This paper is, as well, based on the notion that environmental policy is a product of political self-interest and proceeds to show that political competition between lobby groups constitute a political constraint and pressures, that the governments face at home, and shape the outcome of international agreements.

Since we are mainly concerned with positive analysis of both coalition formation and the size of a stable IEA, we assume that governments pursue their own goals. It cares both about political supports and aggregate social welfare. The two motives are derived from outside the model. The former arises from the fact that contributions can be used to finance political campaigns or because they give the government more direct benefits as with bribes. With a democratic government that cares about re-election, social welfare matters as far as voters are more likely to re-elect a government that, in the past, has provided high level of general welfare. If the government is non-democratic, the motive may arise from fear of riots or coups.

This paper is part of an increasing political economy literature, which examines the influence of interest groups on policy-making. To our knowledge, rare are the studies which are looking at the role of green and industrial lobbies on the IEAs formation and stability. A more recent body of literature, which includes Frederiksson (1997), Aidt (1998) and Conconi (2000a, 2000b, 2001) studied the political economy of environmental policy. These studies adopt the political contribution approach to study the impact of green and producer interest on environmental policy. The former studies treat only environmental policy when the later investigates the joint determination of trade and environmental

oto conference in favour of multilateral reductions in greenhouse emissions (Financial times, December 11, 1997), a broad coalition of corporations, unions and economic lobbies has organised " one of the most intensive campaigns ever mounted on a single political issue, seeking to convince that American curbs on greenhouse gas are unfair and damaging to the economy " (Financial Times, September 10, 1997)

[2]For example, both have demanded compliance of foreign legislation with American environmental standards on incidental catching of dolphins set out in the Marine mammal protection Act.

policy. But none examine the effect of lobbing by green and producer groups on the formation and stability of IEA.

The analysis presented in this paper considers the relationship between interest groups and policy-makers[3]. Most studies have focused on the role of producer groups in the determination of trade policy[4]. In this area, the political contributions approach of Grossman and Helpman (1994, 1995, 1996) has become something of a workhorse model (see Cadot et al (1997), Rama and Tabellini (1998) and Mitra (1999), among many other). A similar approach originally developed by Stigler (1971) and Peltzman (1976), and first applied to trade policy by Hillman (1982), describes trade policy as being set by an incumbent government seeking to maximize its political support. A third approach developed by Hillman and Ursprung (1988) and Magee et al. (1989), focuses on the electoral competition among political parties. Here, lobbies do not directly affect policy choices, but do rather influence the probability that their favourite party be elected. Alternatively, Austen-Smith (1997) views the policy-making process as being characterized by uncertainty. In his framework, interest groups influence the provision of informational expertise. Most studies on the political economy of trade have disregarded the environmental impact of trade and the role of green lobbies. Two notable exceptions in this respect are Hillman and Ursprung (1992, 1994), who introduce environmental lobby groups in a model of endogenous trade policy.

In the majority of recent literature, lobbying is modelled as a "menu auction" where exogenously given lobby groups offer policy makers contribution schedules, representing binding promises of payment, depending on the chosen policy (Bernheim and Whinston 1986, Besley and Coate 2001, Dixit, Grossman and Helpman 1997, Grossman and Helpman 1994, Grossman and Helpman 1996, Person and Helpman 1998).

In this paper, we propose an alternative model of lobbying where the elected policy-maker chooses the lobbies that participate in the policymaking process. This is in this sense that lobbying is endogenous in our model. As in Grossman and Helpman (1994), we assume that lobbies try to influence environmental policy decision of government by offering contribution. Contrary to Grossman and Helpman, however, we do not model lobbying as menu auction, where all lobbies are (exogenously) assumed to participate in the policy making process. Rather, we assume that given the set of existing lobbies, the government chooses the lobbies with which it will bargain over policy in exchange for contribution.

We organized the remainder of the paper as follows. In section 2, we present the analytical framework. Section 3 sets out the basic model. In section 4, we determine the equilibrium and the size of the stable IEAs and study the effect of taking in account lobby pressures on abatement decision. In section 5, we raise a discussion on coalition size the effect of lobbies support on its stability . Finally, in section 6, we conclude and discuss some interesting extensions of the model.

[3] See Persson and Tabellini (2000), for an extensive review of this literature.

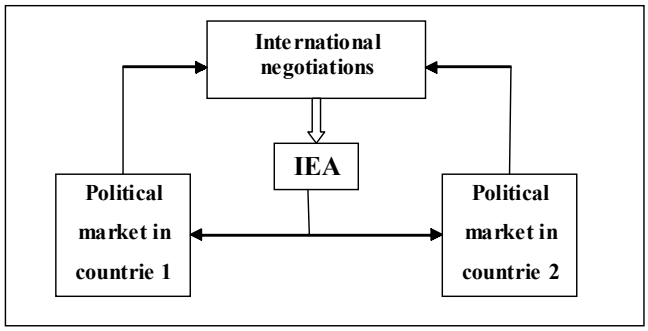
[4] The literature on the political economy is reviewed by Rodrik (1995).

2 An analytical framework

The economic literature on international environmental agreements tends to treat the participant in international negotiations as monolithic and benevolent governments that sincerely represent the common interest of their country (see, eg., Barrett, 1997). While this approach has yielded many important insights, it appears somewhat incomplete and inappropriate for analysing the international environmental agreements' size and stability. In particular, it leaves out the idea that governments often have interests opposed or aligned with those of their domestic constituents, and that it is the incentive embodied in elections and other political control systems that ultimately determine what these governments can and will do at the negotiation table. These ideas have long been recognised by political scientists and public choice scholars, and have been formalised in the theory of two-level games.

In most international bargaining situations, negotiators attempt to find an agreement acceptable not only to the foreign countries with which they are bargaining, but also to the majority of their domestic interests. Negotiators often find themselves simultaneously engaging in domestic and international bargaining. Then the goal of this article is to present a formal model which reveals how domestic and international factors interact to shape international environmental cooperation between nations. This model examines the interaction between international environmental negotiations and a simple domestic political situation; it is a two level game. Such games have been discussed before, and a few studies have attempts to formalize the notion (Schelling, 1960; Walton and McKersie, 1965; Evans, Jacobson and Putman, 1993; Putnam, 1988. Formal models include Iida, 1991 and 1993; Mo 1991; Mayer 1992; Morrow 1991; Lohmann 1993) but rare are those which have studied international environmental negotiations.

As the name of the theory suggests, the game is played at two levels: the international level, where the executives of countries involved in cooperation meet to negotiate the terms of an international environmental agreement, and the national level, where a political market constrains the set of politically acceptable actions available to the national representative during the negotiation at international level. The general structure of this game is illustrated in the following Figure:



Two level game: Putman1988

The national political markets impose constraints on the representatives in many ways. We have the electoral incentives of the executive. Because the electorate is not a direct participant, it cannot directly influence the international bargaining, but it can influence it indirectly through election. Then government, in the international bargaining game has to make a proposal that is acceptable to his domestic constituents (Morrow, 1991). While voters are concerned about many different policy issues, they take a basic interest in the issue of environmental problems, although priority placed on it differs between country (CEU, 1999). Successfully reaching an IEA at the international level is, therefore, important for national politicians who want to demonstrate progress in the implementation of climate policy and, ultimately, for winning election. The adoption of emissions targets involves, as the same time, the benefits and cost perceived by different voters. Voters may well reward politicians for reaching international agreements, even though the "real" benefits of action against climate change are highly uncertain and would, in any case, not materialise until far into the future. On the other hand, greenhouse gas abatement is costly, and the costs are borne by firms and households immediately. Then when governments seek to implement climate policy, they risk losing votes from voters harmed by abatement decision.

Interest groups affect also government decisions (Olson 1965). Special interest groups: green lobby and industrial lobby- in particular Business associations and environmental NGOs- are able to affect the behaviour of politicians by providing information, by financing election campaigns, or by bringing climate change problems to the forefront of the minds of the voter (Grossman and Helpman, 2001).

All these political factors are taken into account when the executives of the countries meet at the international level to decide whether or not they will accept to participate in the IEA, and define the abatement level that individual representatives would consider politically acceptable. The model presented is an example of nested game. We can think of international negotiation as consisting

of domestic and international games that are played simultaneously, that is, players take a single action applicable to both games.

3 Model:

3.1 International level:

The theoretical framework that is used to analyse the feasibility of international environmental agreements is the non-cooperative game theory of coalition formation. Following this approach, countries facing an international environmental problem play a two-stage game. In the first stage-the coalition game- they decide non-cooperatively whether or not to sign the agreement. In the second stage, they play the non-cooperative Nash emission game, where the countries, which sign the agreement, play as a single player and divide the resulting payoff according to a given burden-sharing rule.

Let us begin by analysing the outcome of the game under alternative strategic combination. First, we assume that countries decide simultaneously in both stages[5]. Second, countries are proposed to sign a single agreement. Hence, those, which do sign, cannot propose a different agreement. From a game theoretical viewpoint, this implies that only one coalition can be formed, the remaining defecting players playing as singletons. We also suppose that when defecting from coalition, each country assumes that the other countries belonging to s remain in it.

Given theses assumptions, as presented by Carraro and Siniscalco (1993) we say that:

- A coalition s is *profitable* when each country i gains from forming the coalition (with respect to its position when no countries cooperate). Formally, a coalition s is profitable iff $U_i^s(s) > U_i^s(\varnothing)$, where $U_i^s(s)$ is country i payoff when coalition s forms.

- A coalition s is *stable* iff:

1. There is no incentive to free-ride, i.e. $U_i^{ns}(s-1) - U_i^s(s) < 0 \ \forall \ i \in s$, where $U_i^{ns}(s/i)$ is country i's payoff when it defects from coalitions,

2. There is no incentive to broaden the coalition, i.e. $U_i^s(s \cup i) - U_i^{ns}(s) < 0$ $i \notin s$[6].

- A profitable and stable coalition s is also Pareto optimal if there exist no other profitable and stable coalition which provides all countries with a payoff larger than $U_i^s(s), \forall i \in s$. Formally, $U_i^s(s) > U_i^s(s^*)$, $\forall i \in s$, and s^* such that

[5] By contrast, Barrett (1994) assumes that the group of signatories is stackelberg leader with respect to non-signatories in the second stage emission game. In Bloch (1997) it is assumed that countries play sequentially in the first stage coalition game.

[6] This definition of stability coincides with the definition of stable cartel provided in the oligopoly literature (D'Aspremeont et al, 1983) and defines the Nash equilibrium of the first stage(the one in which countries decide whether or not to sign the agreement.

$s \in S$ and $s^* \in S$ such that $i \notin s^*$ when S is the set of all stable and profitable coalitions. Note that profitable and stable coalition is also Pareto optimal under the assumption that country i's payoff function increases monotonically with the coalition size.

3.2 National level:

3.2.1 The Economy:

Consider a world of i=1,...,N countries, each of them emits a pollutant that damages a shared environmental resource. i's current abatement benefits are assumed to depend on current total abatement as follows

$$B_i(Q) = \frac{b_1}{2}Q^2$$

Where $B_i(Q)$ denotes abatement benefits, b_1 is positive parameter, and Q is global abatement. b_1 represents the slope of each country's marginal abatement cost curve.

Each country's abatement costs are assumed to depend on its own abatement level and no else's. For country i, the abatement cost function is assumed to be given by

$$C_i(q_i) = \frac{b_2}{2}q_i^2$$

Where $C_i(q_i)$ is i's abatement cost and q_i is i's abatement (in eq. (1), $Q = \sum_i q_i$). The parameter b_2 represents the slope of each country's marginal abatement cost curve.

3.2.2 The Political Process:

As in Grossman and Helpman (1994), we describe interaction between elected governments, voters and special interest groups as follow: government seeks to maximise its own utility, which is the function of aggregate welfare and the total amount of political contributions that it collects. We include aggregate welfare in the governments' objective functions because we believe that an incumbent's chance of being re-elected depends to some extent on the level of welfare of the general electorate. However, contribution also enters the government's utility function because campaign funds can be used for political advertising and because contributions, sometimes, augment the candidates' personal fortunes or provide other political benefits.

In this paper, we propose an alternative model of lobbying where the elected policy-maker chooses the lobbies that participate in the policymaking process. This is the sense in which lobbying is endogenous in our model. As in Grossman

and Helpman (1994), we assume that lobbies try to influence government's environmental policy decision by offering contribution. Contrary to Grossman and Helpman, however, we do not model lobbying as menu auction where all lobbies are (exogenously) assumed to participate in the policy making process. Rather, we assume that given the set of existing lobbies, the government chooses the lobbies with which it will bargain over policy in return for contribution (Felli and Merlo, 2002). We assume that governement choices of lobbies constitute the characteristic that differ it from others. That is, we have N asymmetric countries which participate to the international negiciation process. Each Government's objective function is presented as follow

$$U_i\left(q_i, q_g\right) = \upsilon_i\left(q_i\right) + \sigma \sum_{h \in l_i} c_h \tag{1}$$

Where $\upsilon_i\left(q_i\right) = B_i(Q) - C_i(q_i)$, such that $B_i\left(Q\right) = \frac{b_1}{2}Q^2$ and $C_i\left(q_i\right) = \frac{b_2}{2}q_i^2$, $\sigma > 0$ measures the intensity of each government's preferences over contribution with respect to environmental policy (if σ=0 governments are purely policy-motivated and lobbying is irrelevant, that is the case usually presented in environmental policy literature) and $c_h > 0$ represents the monetary contribution given by lobby h to the government.

We model environmental policy making as the outcome of a political process that involves not only elected government but also non-elected political agents know as lobbies. We assume that there is H lobbies which differ with respect to their policy preferences. Each lobby $h = 1, ..., H$ has a most preferred policy outcome q_h and their net benefits or costs are represented by

$$V_i^h\left(q_i, q_h\right) = \nu_i^h\left(q_i, q_h\right) - \mu\ c_h \tag{2}$$

Where q_h is the most preferred abatement level for the lobby h. $\mu > 0$ measures the intensity of each lobby's preferences over contribution with respect to environmental policy. c_h represents contribution given by group h to the government. To capture the idea that lobbies care relatively more about contribution than government, we assume that $\mu > \sigma$.

Each lobby h is assumed to be able to sign binding contracts on environmental policy choice with government in exchange for contribution transfers. Notice that the government has the option of not signing any contract and of implementing his most preferred policy q_g. We restrict attention to the case where there are two lobbies: Environmental and Industrial lobby groups, labelled E and I with preferred abatement level q_E and q_I respectively. Note that $q_E = 1$ and $q_I = 0$. The environmentalist's current benefit from abatement decision takes the following form:

$$\nu_i^E\left(q_i, q_I\right) = B_i\left(Q\right) - D_i\left(q_i, q_E\right) \tag{3}$$

Where $B_i(Q) = \frac{b_1}{2}Q^2$ and $D_i(q_i, q_E) = \frac{b_1}{2}(q_E - q_i)^2$. Then, environmentalists' preferences depend on the global benefit generated by the total abatement realised by all countries.

When environmentalists gain from the increases in total (global) abatement effort, this means that an environmentalist group in a country j will support its own government even though abatement effort has been made in some country i. This means that government will be rewarded by its environmentalist group for having incited other government to participate to the collective abatement effort. But, global benefit isn't sufficient to explain why an environmentalist group is supporting its own government. We assume that it will only do so, when its own government undertakes additional abatement effort. To introduce this condition, we suppose that environmentalists are harmed by the damage caused by the non-abated emissions consisting in the difference between their ideal point (q_E) and their country current abatement level. This damage allows environmentalist group to sanction their government both when it doesn't take any abatement decisions and when its abatement decision is lower than environmentalist ideal abatement level (q_E). Then the more the government abatement level is closed to the environmentalist group ideal point, the more it will be supported.

Industrialist groups are always harmed by their government abatement decisions and their abatement cost is assumed to depend on its own abatement level and nor one else's and it takes the following form:

$$\nu_i^I(q_i, q_I) = -C_i(q_i, q_I) \tag{4}$$

Where $C_i(q_i, q_I) = \frac{b_2}{2}(q_I - qi)^2$and $q_I = 0$. Then industrialist group abatement cost is no else than its country's abatement costs.

We denote $\Lambda = \{I, E\}$ the set of lobbies. Let

$$\Delta = \{\{\emptyset\}, \{I\}, \{E\}, \{I, E\}\}$$

be the collection of all possible coalition of lobbies with whom government may choose to participate to the IEA and to bargain over abatement policy and contribution.

We model lobbying as a two stage bargaining game, in the first stage, each possible coalition $l_i \in \Delta$ is associated with a willingness to pay, $\omega_{l_i}(q_i, q_g)$, for any policy q_i the government may choose to implement instead of his most preferred policy q_g;

$$\omega_{l_i}(q_i, q_g) = \sum_{h \in l_i} c_h(q_i, q_g) \tag{5}$$

Such that $\omega_\emptyset(q_i, q_g) = 0$.

Given the preferences of a lobby specified is equation (2) above, the willingness to pay of lobby $h \in l_i$ for any abatement policy q_i implemented by government is

$$c_h\left(q_i, q_g\right) = \frac{\left[\nu_i^h\left(q_i, q_h\right) - \nu_i^h\left(q_g, q_h\right)\right]}{\mu} \tag{6}$$

This is the monetary value of utility gains (or loss) with respect to the status quo that lobby h obtains if government choice abatement level qi.

The status quo is here defined to be government decision in absence of any lobbying, q_g. Then

$$\omega_{l_i}(q_i, q_g) = \sum_{h \in l_i} \frac{\left[\nu_i^h\left(q_i, q_h\right) - \nu^h\left(q_g, q_h\right)\right]}{\mu} \tag{7}$$

In the second stage of the bargaining game, government, fist, chooses an optimal policy $q^*(l)$ for any potential coalition $l_i \in \Delta$ such that

$$q^*(l_i) \in \arg\max_{qi}\ \upsilon_i\left(q_i, q_g\right) + \rho\omega_{l_i}(qi, qg) \tag{8}$$

where $\rho = \frac{\sigma}{\mu}$
and then chooses a coalition l_i^* such that

$$l_i^* \in \arg\max_{l_i}\ \upsilon_i\left(q_i, q_g\right) + \rho\omega_l(qi, qg) \tag{9}$$

The outcome of bargaining between government is l_i^* and $q^*(l_i^*)$ and $\omega_{l_i}^*(q^*(l_i^*), qg)$.

4 The equilibrium:

We use a feedback resolution to resolve our two level non cooperative game. We begin by the determination of signatories and non signatory countries abatement. We suppose that there are two groups of countries.We assume that s identical governments sign an agreement and $N - s$ do not. Let Q^s denotes the abatement level of the coalition, and q_i^s denotes the abatement of any individual signatory, such that $Q^s = s.q_i^s$. In a similar manner, each non-signatory government's abatement is q_i^{ns} yielding a total abatement of all non signatories $Q^{ns} = (N - s)q_i^{ns}$.

Following the approach of the non-cooperative game theory of coalition formation, countries facing an international environmental problem play a two-stage game. We assume that countries decide simultaneously in both stages. In the first stage-*the coalition game*- they decide non-cooperatively whether or not to sign the agreement. In the second stage, they play the non-cooperative *Nash emission game*, where the countries, which sign the agreement, play as a single player and divide the resulting payoff according to a given burden-sharing rule.

The equilibrium number of countries participating in an IEA is derived by applying the notions of internal and external stability of a coalition originally developed by D'Aspremont et al. (1983). We assume that countries decide simultaneously in both stages. The non-signatories behave non-cooperatively when signatories choose their abatement level by maximizing their collective political support function. That is, signatories choose Qs by solving the following maximization problem.

$$\sum_{s_i} U_i^s(q_i^s, q_g) = \frac{b1}{2}(Q)^2 - \frac{b_2}{2}(q_i^s)^2 + \rho \sum_{h \in l_i} \frac{\nu_i^h\left(q_i^s, q_h\right) - \nu_i^h\left(q_g, q_h\right)}{\mu} \tag{10}$$

Their maximization problem results to a best response function of the form presented earlier. However, now only $N - s$ governments stay outside of the emission reduction agreement abating Q^{ns}, while the rest s countries abate in total Q^s, that is, $Q = (N-s)q^{ns} + s.q_i^s$. Non-signatory governments choose their abatement level playing the non-cooperative Nash emission game. That is, each government chooses q_i^{ns} to maximize

$$U_i^{ns}(q_i^s, q_g) = \frac{b1}{2}(Q)^2 - \frac{b_2}{2}(q_i^{ns})^2 + \rho \sum_{h \in l_i} \frac{\nu_i^h\left(q_i^{ns}, q_h\right) - \nu_i^h\left(q_g, q_h\right)}{\mu} \tag{11}$$

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Their maximization problem results to a best response function of the form presented earlier.

The first order conditions yield the aggregate abatement of signatories

$$Q^s = \rho \frac{s[(\chi^s - (N-s)^2)S_2^{ns} + s(N-s)S_2^s]}{(\chi^s - (N-s)^2)\chi^{ns} - s^2\chi^s} \tag{12}$$

Where $S_2 = \sum_{h \in l_i} \frac{b_h}{b_1} q_h$, $\chi = S_1 + \lambda$, $S_1 = \sum_{h \in l_i} \frac{b_h}{b_1}$ and $\lambda = \frac{b_2}{b_1}$. If $l_i = l_s$ then $\chi = \chi^s$, $S_1 = S_1^s$and $S_2 = S_2^s$ and inversely if $l_i = l_{ns}$. The individual government's abatement level is $q^s = \rho \frac{(\chi^s - (N-s)^2)S_2^{ns} + s(N-s)S_2^s}{(\chi^s - (N-s)^2)\chi^{ns} - s^2\chi^s}$

The individual government's abatement level is $q^{ns} = \rho \frac{(\chi^{ns} - s^2)S_2^s + s(N-s)S_2^{ns}}{(\chi^s - (N-s)^2)\chi^{ns} - s^2\chi^s}$. The aggregate abatement of non-signatories is

$$Q^{ns} = \rho \frac{(N-s)[(\chi^{ns} - s^2)S_2^s + s(N-s)S_2^{ns}]}{(\chi^s - (N-s)^2)\chi^{ns} - s^2\chi^s} \tag{13}$$

The aggregate abatement level $Q = Qs + Qns$ is,

$$Q = \rho \frac{s\ S_2^{ns}\chi^s + (N-s)\ S_2^s\chi^{ns}}{(\chi^s - (N-s)^2)\chi^{ns} - s^2\chi^s} \tag{14}$$

The equilibrium number of countries participating in an IEA is derived by applying the notions of internal and external stability of a coalition originally developed by D'Aspremont et al. (1983). Then, we have to determine $U_i^{ns}(s)$ and $U_i^s(s)$ to verify the following self-enforcing condition of an IEA consisting of s signatories:

$$U_i^s(s) > U_i^{ns}(s-1) \text{ and } U_i^s(s+1) < U_i^{ns}(s) \tag{15}$$

If (15) holds, no signatories will want to withdraw unilaterally from the agreement; such withdrawal would reduce the signatory's abatement level, and hence its costs, but its defection from the IEA would weaken the agreement, and the resulting loss in benefits would more than offset the reduction in costs gained by withdrawal. Similarly,no nonsignatory acting alone would want to acceed to the IEA; although the recruit's benefits would rise, its abatement costs would rise even more.

Before determinig the size of stable coalition, we try to check the following conditions: $q_s > 0$, $q_{ns} > 0$ and $q_s > q_{ns}$. To this end, we begin by considering the case of identical countries. That is, we supposed that all governements have the same choice about lobbies they will bargain over policy in return for contributions. Then we have:

Lemma 1 ** if $\lambda < 1$, $q^s > 0$ for all $s \leq \frac{N}{2}$, $q^{ns} > 0$ for all $s \geq \frac{N}{2}$ and $q^s > q^{ns}$ for $s \leq \frac{N}{2}$.*

**if $\lambda > 1$, $q^s > 0$ for s very small such that $s \leq \frac{N}{2}$ or for none, $q^{ns} > 0$ for s very large such that $s \geq \frac{N}{2}$ or none and $q^s > q^{ns}$ for $s \leq \frac{N}{2}$*

Lemma 1 can restrict the interval of s. In fact, the size of stable coalition depends on $\lambda = \frac{b_2}{b_1}$. If $b_2 > b_1$ that is on $\lambda = \frac{b_2}{b_1}$.If abatement decision envolves more benefits than costs ($b_1 > b_2$) then our stable coalition, if it exists, can be large. But if environmental decision generates more costs than benefits, few countries will be attracted by the paticipation to the IEA.

The last stage consists in analysing all possible coalition of lobbies with whom government may choose to participate to the IEA and to bargain over abatement policy and contributions. Unfortunately, for the here stated functional specification, a full characterization of solution cannot be obtained analytically . However, simulation reveals a very simple and compelling relationship between λ,the equilibrium possible coalition of lobbies and the size of stable international coalition.

5 Simulation:

Table1 presents solution s^* for, as well, values of b_1 and b_2 and the size of national political coalition, for N=100, $q_g = 0.5$ and $\rho = 0.5$ [7]. It is clear from the simulation that the number of signatories to the self-enforcing IEA depends on governement's choice of the supporting lobbies . It is encouraging to find that a self enforcing IEA can consist of many signatories, if $\lambda \leq 1$ and if signatories accept the support of environmental lobbies or both lobbies. Simulations show that , in this case, we can have two sorts of solutions. Globally, s^* can be small (2 or 3)or large (51), but small size of coalition can't be stable because $DIF(s) = U^s(s) - U^{ns}(s-1) > 0$,though lemma 1 demonstrated that if $\lambda \leq 1$, to have $q^s > 0$, $q^{ns} > 0$ and $q^s > q^{ns}$, s must be equal to $\frac{N}{2}$

Table 1: Number of signatories out of 100 for various values of b_1 *and* b_2 and different form of national political coalition such that $l_{ns} = \{\{E\}\{E, I\}\}$

$\{\emptyset, E\}$

b_2 \ b_1	0.01	1	100
0.01	3	3	3
1	3	3	2
100	$\forall s\ dif(s) > 0$	3	2

$\{\emptyset, \{E, I\}$

b_2 \ b_1	0.01	1	100
0.01	3	2	3
1	$2, dif(s) < 0$	3	2
100	$2, dif(s) < 0$	$2, dif(s) < 0$	2

$\{I, E\}$

b_2 \ b_1	0.01	1	100
0.01	3	$\forall s\ dif(s) > 0$	3
1	$\forall s\ dif(s) > 0$	3^*	3
100	$\forall s\ dif(s) > 0$	$\forall s\ dif(s) > 0$	3

$\{I, \{E, I\}\}$

b_2 \ b_1	0.01	1	100
0.01	$\forall s\ dif(s) > 0$	$\forall s\ dif(s) > 0$	3
1	$\forall s\ dif(s) > 0$	$\forall s\ dif(s) > 0$	3
100	$3, dif = 0$	$\forall s\ dif(s) > 0$	$\forall s\ dif(s) > 0$

[7] This assumption seems natural in light of the fact that lobbies are corporations *in se* and *per se*. Our analysis can be easily extended to the case where $\mu < \sigma$ without changing the main thrust of our results.

{E,E}

b_2 \ b_1	0.01	1	100
0.01	$3-51$	51	51
1	$3-51$	$3-51$	$3^{(1)}-51$
100	52	$3^{(1)}-51$	$3-51$

$\{E,\{E,I\}\}$

b_2 \ b_1	0.01	1	100
0.01	$3-44^{(2)}$	51	51
1	$\forall s\ dif(s)<0$	$3-44^{(2)}$	51
100	$\forall s\ dif(s)<0$	$\forall s\ dif(s)<0$	$3-51$

$\{\{E,I\},E\}$

b_2 \ b_1	0.01	1	100
0.01	$3-58^{(3)}$	51	51
1	$dif(s)>0$	$3-58^{(3)}$	$3^{(1)}-51$
100	$dif(s)>0$	$dif(s)>0$	$3-58$

$\{\{E,I\},\{E,I\}\}$

b_2 \ b_1	0.01	1	100
0.01	$3-51^{(4)}$	51	51
1	51	$3-51^{(4)}$	$3^{(1)}-51$
100	$3, dif=0$	$3, dif=0$	$3-51$

* : $s=15\ if\ q_g=0.1, and\ if\ q_g=0.9\ then\ \forall s,\ dif(s)>0$
$^{(1)}$: $exists\ only\ if\ q_g=0.9\ or\ 0.1,$
$^{(2)}$: $if\ q_g=0.9\ then\ \forall s\ dif(s)<0, and\ if\ q_g=0.1$ then s can only be large

$^{(3)}$: $if\ q_g=0.9\ then\ \forall s\ dif(s)>0, and\ if\ q_g=0.1$ then s can only be large,
$^{(4)}$: $if\ q_g=0.9$ or 0.1 then s can only be large

We have to indicate that the q_g value can affect the equilibrium size of the self-enforcing international envionmental agreement and its stability. This result is particualry interesting when signatory or non-signatory governments prefer to be supported by environmentalist lobbies or the both existing lobbies such that governments have different choices. In fact, when q_g =0.1 and $\lambda \leq 1$, we have only one equilibrium equal to the largest one, particulary, when b_1 and b_2 are both small. When q_g =0.9, and under the same circumstances the IEA, if it exists, cannot be stable ($\forall s, dif > 0$) or can not be signed by any governments. If governements are symmetric and choice to be supporting either by environmental lobby or both existing lobbies, then the self-enforcing IEA will be signed by a lot of countries.

Table 2: Number of signatories out of 100 for various values of b_1 *and* b_2 and different form of national political coalition such that $l_{ns} = \{\{\emptyset\}\{I\}\}$

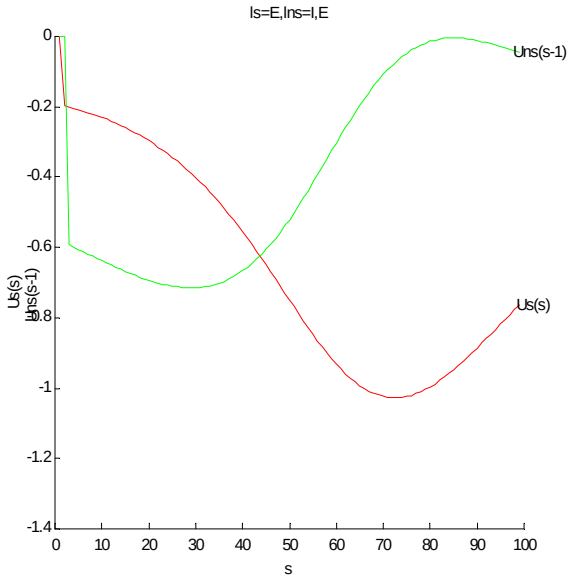
l_{ns} \ l_s	$\emptyset$	$\{E\}$	$\{I\}$	$\{I,E\}$
$\emptyset$	$\forall s, DIF=0$	$\forall s, DIF<0$	$\forall s, DIF>0$	$\forall s, DIF<0^{(1)}$
$\{I\}$	$2,\ DIF<0$	$\forall s, DIF<0$	$3, DIF=0$	$\forall s, DIF<0^{(2)}$

$^{(1)}$: if $\lambda>1, \forall s\ DIF>0,^{(2)}$ if $\lambda>1$, $s^{*}=3\ and\ DIF=0$

Table 2 shows that for any values of b_1 and b_2 the size of international coalition can be large but not stable if the non-signatories' supporting lobby is the industrial lobby. The result is the same if non-signatories do not accept the support of any lobbies. This can be explained by the fact that signatories decide taking into account the possibility that non-signatories can offset actions against climate change adopted by participants to the IEA. This result can explain normative works which have demonstrated that the size of self-enforcing IEA on climate change cannot but be of a small size.

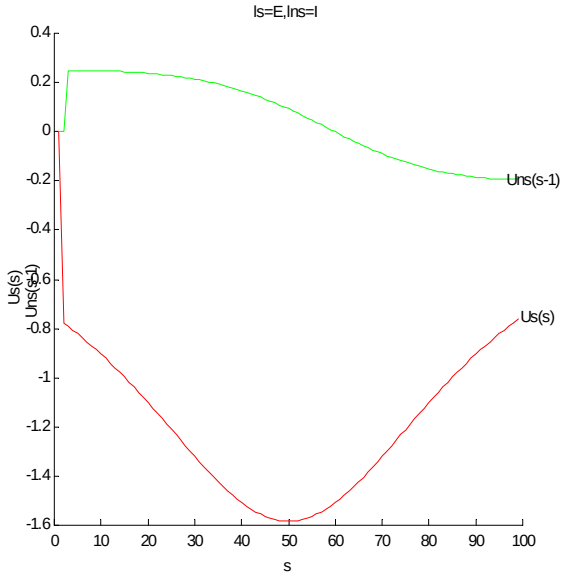
Proposition 2 *For global environmental problems characterized by eq(1), the self-enforcing IEA will be signed by a lot of countries when* $\lambda \leq 1$ *and signatory and non-signatory governements prefer to be supported by environmental lobby or the both existing lobbies. However, when signatory governement are incited by contributions of industrial lobbies or none, then under these circumstances the self-enforcing IEA cannot sustain a large number of signatories. If non-signatory governements take into consideration the support of industrial lobbies or prefer not to be suppoted, then coalition cant' be stable for all* λ.

The equilibrium size could be either small or large, depending on the values of λ as well as on the national political coalition supporting each government. In reality, there exist two equilibrium sizes being, in the majority of cases, 3 and 51. The former, corresponds to the size predicted by normative literature. The latter, occurs when signatories accept either environmental lobbies contributions or the support of both existing lobbies. Thus, the stable size of the self-enforcing IEA is very large. More particularly, when λ=1, the size of the coalition could even equal 58. Nevertheless, the current research results have shown that this previous size (3) is not, actually, a stable one. In fact, it corresponds either to the situation where non-signatory governments or signatory governments have the support of industrial lobbies or none.



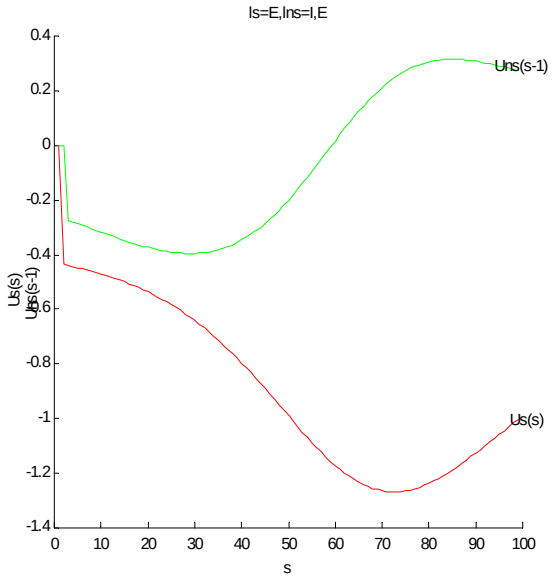
Self-enforcing IEA size when ls={E}and lns={I,E}such that $\lambda = 1$,

We can, as well, observe this same result when governments take into account the support of environmental lobbies or both. This result is observed, in particular, when $\lambda = 1$. The previous results are, in fact, based on our intuition that when non signatories decide to accept the support of industrial lobbies (Fig.2); this may signal to the signatories that their counterparts could be incited to offset their actions against climate change. As a result, they would decide not to remain in the coalition. However, when participants observe that non-signatories benefit of the support of environmental lobbies or both; this may indicate that they are less incited to offset signatories abatement decisions. In such a case, the signatory governments would, consequently, be more motivated to participate in the IEA and to remain in the coalition (Fig.1).



Self-enforcing IEA size when ls={E}and lns={I}such that $\lambda = 1$,

Finally, the size of self-enforcing international agreement depends on the nature of negotiating governments (Fig.3). This is observed when governments prefer to be supported by environmental lobby or the both existing lobbies and have different choices concerning their supporting lobbies. Under these circumstances, if governments present at the status quo ecological preferences then coalition can either not be reached or if it exists, can not be stable. Under the same circumstances, if governments present moderate preferences or poorly ecological preferences then self-enforcing IEA can sustain a large number of signatories. The nature of negotiating governments doesn't change results when signatories and non signatories take into consideration the support of industrial lobbies or prefer not to be supported. That is, for different governments' preferences at the status quo, the size of stable coalition if it exists is small.



Self-enforcing IEA size when ls={E}and lns={I,E}such that $\lambda = 1$ and $q_g = 0.9$

The basis conclusion that emerge from the analysis of politically motivated coalition formation decision depends not only on values taken by λ but also on government choices concerning its supporting lobbies and governments preferences. To resume our find, the international environmental coalition has, if it exists, small size if signatories, non signatories or both prefer to be supported by industrial lobbies or none. The same result is observed if governments are symmetric though they prefer to be supported by environmental lobby or both existing lobbies. This result doesn't depend on the values taken by λ or each government preferences at the status quo. Contrary, when signatories and non signatories take into consideration environmental lobby or both lobbies supports and have different choices then the size of stable coalition depends on λ and government preferences. For λ <1, governements ecological preferences can not be sufficient to guarantee a self-enforcing IEA. Contrary, when governments have poor ecological preferences or moderate preferences, that is in this case that IEA can sustain a large number of signatories.

Simulation results show that, in most international bargaining situations, negotiators attempts to find an agreement acceptable not only to the foreign country with whom they are bargaining, but also to the majority of its domestic interests. Negotiators often find themselves simultaneously engaging in domestic and international bargaining. Focusing on Putnam's (1988) conjecture that greater domestic constraints can be a bargaining advantage in international negotiations, this article developed a formal bargaining model of the interplay between domestic and international bargaining. Simulation results show that

a self-enforcing IEA can sustain a large number of participants when signatory governments have moderate preferences ($q_g = 0.5$)or poorly ecological preferences ($q_g = 0.1$) though they have small relative cost envolved by environmental policy ($\lambda \leq 1$) and prefer to be supported by environmental lobby or both existing lobbies.

6 Conclusion:

The paper studies the size of stable coalitions that ratify IEAs concerning transboundary environmental problems. A coalition is considered stable when no signatories wish to withdraw while no more countries which to participate. Within this framework we show that, contrary to the general perception in the literature, the size of stable coalition isn't necessary very small , it depends of the competition between lobby groups.

To prove this result, we have employed a political economy model in which green and producer lobbies participate in the determination of environmental policy. In contrast to the existing literature, in this paper, the international environmental negotiation has been considered beginning from the premise that authorities will choose abatement levels on the basis of political support motives. So not perceptions of social justice, but rather the authorities' perceptions of their own political self-interest determine the environmental policy. To portray politically motivated interventionist behavior, we have adopted an endogenous lobbying model originally presented in Felli and Merlo model.

In our model, we have supposed that government decisions at the international level are determined by his choice concerning national supporting lobbies. In fact, government can chooses not to be suppoted or to be supported and in the latter case, it can chooses lobby or a coalition of lobbies with which it can bargain. That is in this sense that we endogenize lobbying in the international environmental negociation. This specification of government political support motives permitted us to study the stable size of IEA.

The equilibrium size could be either small or large, depending on the values of λ as well as on the national political coalition supportying each government. In realiy, there exists two equilibrium sizes being, in the majority of cases, 3 and 51 ($\frac{N}{2}$). Contrary to the normative literature which predict a small size of self-enforcing IEA, our results show that this size can rarely be stable. In fact, it corresponds either to the situation where non-signatory governments or signatory governments have the support of industrial lobbies or none. We can, as well, observe a large size of international coalition. This results when governments take into account the support of environmental lobbies or both. The previous results are, in fact, based on our belief that when non signatories decide to accept the support of industrial lobbies ; this may signal to the signatories that their counterparts could be incited to offset their actions against climate change. As a result, they would decide not to remain in the coalition. However, when participants observe that non-signatories benefit of the support of envi-

ronmental lobbies or both; this may represent a guarantee for them. In such a case, the signatory governments could trust the non-signatories and would, consequently, be more motivated to participate in the IEA.

The basis conclusion that emerge from the analysis of politically motivated coalition formation decision depends not only on values taken by λ but also on governmente choics concerning its supporting lobbies and governments preferences. Focusing on Putnam's (1988) conjecture that greater domestic constraints can be a bargaining advantage in international negotiations, this article shows that, though signatories have small relative cost envolved by environmental policy ($\lambda \leq 1$) and prefer to be supported by environmental lobby or both existing lobbies, a self-enforcing IEA can sustain a large number of particpants only when they have moderate preferences ($q_g = 0.5$)or poorly ecological preferences ($q_g = 0.1$).

Regarding future research we propose three main extensions: First, we can choose others specifications of government political support function to verify our result. Second, we can employ a voting game theoretic model to characterize the stability of such agreements when each country's participation is conditioned upon a domestic ratification vote. Third, our analysis could be extended to cover other instruments, e.g., tradable permits, taxes. It would be interesting to find which instrument will emerge from the negotiation process leading to an IEA.

7 bibliography:

References

[1] Aidt, T. S. (1998). "Political Internalization of Economic Externalities and Environmental Policy", *Journal of Public Economics*. 69, 1-16.

[2] Austen-Smith, D. (1997). "Endogenous Informational Lobbying", *Fondazione ENI Enrico Mattei, Nota di Lavoro* 27/97.

[3] Barrett, S. (1994a), "The Biodiversity Super game", *Environmental and Resource Economics*, 4, 111-122. Game Theory and International Environmental Cooperation 87

[4] Barrett, S. (1994b), "Self-Enforcing International Environmental Agreements", *Oxford Economic Papers*, 46, 804-878.

[5] Barrett, S. (1997), "Toward a Theory of International Environmental Cooperation", in Carlo Carraro and Dominico Siniscalco (eds), *New Directions in the Economic Theory of the Environment*, Cambridge, UK: Cambridge University Press, pp. 239-280.

[6] Bauer, A. (1992), International Cooperation over Greenhouse Gas Abatement, Munich, Germany: Mimeo of the Seminar f\UNICODE{0xfc} empirische Wirtschaftsforschung, University of Munich.

[7] Bernheim, B., and M. Whinston (1986): "Menu Auctions, Resource Allocation, and Economic Infuence," *Quarterly Journal of Economics*, 101, 1-31.

[8] Besley, T., and S. Coate (1997): "An Economic Model of Representative Democracy," Quarterly Journal of Economics, 108, 85-114.

[9] Besley, T., and S. Coate (2001): "Lobbying and Welfare in a Representative Democracy," Review of Economic Studies, 68, 67-82.

[10] Cadot, O., de Melo, J. and Olarreaga, M. (1997). "Lobbying and the Structure of Protection", CEPR Discussion Paper No. 1574.

[11] Carraro, C. and Siniscalco, D. (1992), international dimension of environmental policy. European Economic Review 36 :379-387.

[12] Carraro, C. and Siniscalco, D. (1993), 'Strategies for the International Protection of the Environment', Journal of Public Economics, 52, 309-328.

[13] Chander, P. and Tulkens, H. (1992), "Theoretical Foundations Of Negotiations And Cost Sharing In Transfrontier Pollution Problems. European Economic Review 36 :388-398.

[14] Chander, P. and Tulkens, H. (1995), 'A Core-Theoretic Solution for the Design of Cooperative Agreements on Transfrontier Pollution", International Tax and Public Finance, 2, 279-293.

[15] Conconi, P. (2000). "Can Green Lobbies Replace a World Environmental Organization-?", Fondazione Eni Enrico Mattei Note di Lavoro: 56/2000.

[16] Conconi, P. (2000). "Green and Producer Lobbies: Enemies or Allies?", Working Paper No: 570. Warwick University.

[17] Conconi, P. (2001). "Green Lobbies, Transboundary pollution, and International Trade", Submitted to EPCS annual meeting, in Paris.

[18] D'Aspremont, C.A., Jacquemin, J., Gabszeweiz, J., and Weymark, J.A (1983), "On the stability of collusive price leadership", *Canadian Journal of Economics*, 16, 17-25.

[19] Diermeier, D., and A. Merlo (2000): "Government Turnover in Parliamentary Democracies," *Journal of Economic Theory*, 94, 46-79.

[20] Dixit, A., G. Grossman, and E. Helpman (1997): "Common Agency and Coordi-nation: General Theory and Application to Government Policy Making," *Review of Economic Studies*, 105, 752-69

[21] Evans, P., Jacobson, H. and Putman, R.(1993). "Double-Edged Diplomacy: Domestic Politics And International Relations. Berkeley, Ca: University Of California Press.

[22] Felli, L., and A. Merlo (2002): " Endogenous Lobbying" Working paper presented in EPCS Rome.

[23] Fredriksson, P. (1997). "The Political Economy of Pollution Taxes in a Small Open Economy", *Journal of Environmental Economics and Management.* 33, 44-58.

[24] Grossman, G. M. and Helpman, E. (1994). "Protection for Sale", *American Economic Review.* 84, 833-850.

[25] Grossman, G. M. and Helpman, E. (1995). "Trade Wars and Trade Talks", *Journal of Political Economy* 103, 675-708.

[26] Grossman, G. M. and Helpman, E. (1996). "Electoral Competition and Special Interest Politics", *Review of Economic Studies* 63, 265-286.

[27] Grossman, G., and E. Helpman (2001): Special Interest Politics. Cambridge: M.I.T. Press.

[28] Hillman, A. L. (1982). "Declining Industries and Political-Support Protectionist Motives, *American Economic Review* 72, 1180-1187.

[29] Hillman, A. L., and Ursprung, H. W. (1988). "Domestic Politics, Foreign Interest and International Trade Policy", *American Economic Review* 78, 729-745.

[30] Hillman, A. L., and Ursprung, H. W. (1992). "The Influence of Environmental Concerns on the Political Determination of Trade Policy,"\ in K. Anderson, and R. Blackhurst (eds.), The Greening of World Trade Issues. Harvester Wheatcheaf, New York.

[31] Hillman, A. L., and Ursprung, H. W. (1994). "Greens, Super greens, and International Trade Policy: Environmental Concerns and Protectionism", in C. Carraro (ed.), *Trade, Innovation, Environment.* Kluwer Academic, Dordrecht.

[32] Hoel, M. (1992), 'International Environment Conventions: The Case of Uniform Reductions of Emissions", *Environmental and Resource Economics*, 2, 141-159.

[33] Iida, K. (1991). "Do Negotiations Matter? The Second Image Reversed In Two Level Game" Manuscript.

[34] Iida, K. (1993). "When And How Domestic Constraints Matter?" *Journal Of Conflict Revolution* 37, 404-426.

[35] Lohman, S. (1993). "Electoral Cycle And International Policy Coordination". *European Economic Review* 37, 1373- 1391.

[36] Mitra, D. (1999). "Endogenous Lobby Formation and Endogenous Protection: A Long-Run Model of Trade Policy Determination", *American Economic Review* 89, 1116-1134.

[37] Mo, J. (1991). "International Bargaining And Domestic Political Competition".Manuscript.

[38] Morrow, J. (1991). "Electoral And Congressional Incentives And Arm Control". *Journal Of Conflict Revolution* 35, 245- 265.

[39] Olson, M., (1965), The Logic of Collective Action. Harvard University Press, Cambridge, MA.

[40] Peltzman, S. (1976). "Toward a More General Theory of Regulation", *Journal of Law and Economics* 19, 211-240.

[41] Persson, T. and G. Tabellini (2000). "Political Economics and Economic Policy". MIT Press, Cambridge, MA.

[42] Putnam, R. (1988), "Diplomacy and domestic politics: the logic of two level games". *International Organization* 42(3), 427- 460.

[43] Rama, M., and G. Tabellini (1998). "Lobbying by Capital and Labor over Trade and Labor Market Policies", *European Economic Review* 42, 1295-1316.

[44] Schelling, T. (1960). " The Strategy Of Conflict. Cambridge, Ma: Harvard University Press.

[45] Walton, R. and McKersie, R. (1965). "A Bihavioral Theory Of Labor Negotiation. Ny: Mcgraw-Hill.