

Imai, Haruo; Horie, Mayumi

Working Paper

Pre-negotiation for an international emission reduction game

Nota di Lavoro, No. 106.2002

Provided in Cooperation with:

Fondazione Eni Enrico Mattei (FEEM)

Suggested Citation: Imai, Haruo; Horie, Mayumi (2002) : Pre-negotiation for an international emission reduction game, Nota di Lavoro, No. 106.2002, Fondazione Eni Enrico Mattei (FEEM), Milano

This Version is available at:

<https://hdl.handle.net/10419/119714>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Fondazione Eni Enrico Mattei

**Pre-Negotiation for an
International Emission
Reduction Game**

Haruo Imai and Mayumi Horie

NOTA DI LAVORO 106.2002

DECEMBER 2002

ETA – Economic Theory and Applications

Haruo Imai and Mayumi Horie, *Kyoto University*

This paper can be downloaded without charge at:

The Fondazione Eni Enrico Mattei Note di Lavoro Series Index:
http://www.feem.it/web/activ/_wp.html

Social Science Research Network Electronic Paper Collection:
http://papers.ssrn.com/abstract_id=XXXXXX

The opinions expressed in this paper do not necessarily reflect the position of
Fondazione Eni Enrico Mattei

Pre-Negotiation for an International Emission Reduction Game

Summary

Based on a result due to Ray and Vohra showing the possibility of inefficiency due to a coalition formation in an international emission reduction game, we consider a possibility of negotiation preceding the negotiation stage, and by means of an example, indicate that the efficiency is restored. In the equilibrium obtained, we observe a potential in which different set of coalition arises in the two stages, which could help explain what is going on in the international negotiation.

Keywords: Prenegotiation, coalition formation, international emission reduction game

JEL: C78

This paper has been presented at the Workshop on “Game Practice and the Environment”, jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002.

Address for correspondence:

Haruo Imai
Institute of Economic Research,
Kyoto University, Sakyo, Kyoto
Japan, 606-8501
Phone 81-75-753-7113
Fax 81-75-753-7118
E-mail: imai@kier.kyoto-u.ac.jp

Pre-negotiation for an International Emission Reduction Game

By Haruo Imai and Mayumi Horie

October 2002, Kyoto University

1. Introduction

In understanding the recent development of an international cooperation to cope with global environmental problems, the relevance and importance of the notion of a “coalition” is recognized more and more (e.g. Carraro and Siniscalco (1993), (1998)).

To start with, the international treaty for the prevention of the climate change (such as UNFCCC) itself can be viewed as a cooperative agreement reached within the grand coalition. Further, on some occasion like the scheme envisioned under the Kyoto Protocol, only a group of nations (called Annex I nations) accepted the responsibilities to reduce their GHG emission levels within a certain bound (set based upon the 1990 level) in the period between 2008 and 2012. This arrangement resembles the pattern in an oligopolistic industry where certain firms form a cartel to curtail their production levels in order to keep the price from falling, while the rest of the firms act as outsiders. Moreover, in the negotiation process at an international meeting, nations form groups presumably both for coordinating their environmental policies and for enhancing the effectiveness of their positions in the process (like umbrella groups and EU). The deviation by the USA from the Kyoto Protocol also fits well with the results in the analyses of a coalition formation process.

A variety of arrangements among nations interpreted as coalition or coalition-like phenomena, and also a variety of the definitions of what a coalition can and cannot do in several literatures (like open-end closed-end coalitions, when and how they can dissolve, what they can agree on and enforce, and so on) suggest that one must be careful about what aspects one wishes to shed light on by the concept of a “coalition” in analyzing international environmental problems. (One could further say that the adequacy of solution concepts, like core, strong equilibrium, coalition proof equilibrium, etc. depends upon the exact concept of coalition, chosen.) Among others, in this paper, we like to focus upon the possibility that potentially players may form different “coalitions” when there are distinct opportunities for agreements. In particular, we take upon the case where there is an opportunity to make an agreement prior to another opportunity to make a

final agreement. The latter opportunity corresponds to a usual “coalition” formation game in which nations make a binding agreement on their adoptions of a measure to reduce GHG emissions. The former opportunity is then a “coalition” formation game in which nations make a binding agreement on a course of actions they employ in the coalition formation process. We shall refer to the latter as a negotiation stage whereas the former as a prenegotiation stage.

The motivation behind this setup is based on the observation that there are several groups of nations eminent in international negotiation processes, like China and G77, AOSIS, and environmental integrity groups (consisting of Korea, Mexico, and Switzerland), etc. With a possible exception of AOSIS, these groups are formed more or less for the sake of the negotiation at UN or other international political arena, and its role at the stage of executing climate policies is not clear. To this effect, we may say that “coalition-like” phenomena are equally prevalent at a negotiation stage as at an execution stage. In fact, one of the fields where one finds the most appealing applications of coalition analyses is the political one.

To formulate our idea, we adopt an example shown in Ray and Vohra (2001), where they show in a model of voluntary provisions of public goods (such as reductions of GHG emissions), the realization of the full cooperation could be deterred by coalitional incentives. Below, in their example with 4 players, we add a prenegotiation stage, so that players can form coalitions, each of which binds members’ actions during the negotiation stage subsequent to the prenegotiation stage. As in Ray and Vohra (1997)’s analysis, only a certain set of action plans is eligible as the candidate for “coalitional” contracts, due to “inter-coalitional” incentives. To this end, we propose a concept of a subgame perfect equilibrium under a coalition structure, which is an extension of the earlier concept. With this concept, we show that the full cooperation is viable in this example.

We do not mean that our tentative result indicated by an example here directly explains the actual behavior of the US in the context of the Kyoto Protocol, or etc. This theoretical experiment rather indicates the necessity of a careful examination of the assumptions to be employed in the analyses of the coalition formations in global environment problems. Of course, even with a tiny exercise here, one can extract a lesson that allowing an opportunity to pre-negotiate prior to a negotiation may have positive effect (and definitely have effects) on the consequence.

2. Emission Reduction Game under International Protocol

Let us start with a simple emission reduction game G considered by Ray and Vohra(2001)(in a strategic form). In this game n countries (players) simultaneously choose levels of emission reductions (or any public goods in general) with linear external effects. Let N be the set of n countries. We shall denote country i 's emission reduction level by $a_i \in \mathbf{R}_+ (= A_i)$ and an action profile by $a \in A (= \times_{i \in N} A_i)$. When a reduction profile $a \in A$ realizes, country i receives the payoff $u_i(a) = \sum_{j \in N} a_j - (1/2) a_i^2$, where the term $(1/2) a_i^2$ expresses country i 's private cost of reducing a_i units of emission.

This game G has a unique Nash equilibrium; where each country chooses to reduce 1 unit of emission. This equilibrium is the strictly dominant strategy equilibrium that is inefficient as a characteristic of these n player prisoners' dilemma games.

Based on this game, for example, Ray and Vohra(2001) considered a possibility of writing a binding agreement on their choices of emission reduction activities. This led them to adopt their coalition formation game [Ray and Vohra (1999)], in which countries sequentially bargain over an agreement along with a coalition formation, i.e. they form a coalition and its members sign a mutually binding agreement. (Thus, we adopt their view that a "coalition" is an enforcing mechanism for the agreement agreed by a group of players.) In addition, we assume that sidepayments are feasible within each "coalition" at the end of the entire game.

(Following our discussion at Introduction, one may question why all the agreements must be reached among mutually disjoint sets of players (i.e. a coalition in the conventional sense). Our primary answer would be that, in this regard, we follow traditional framework so as to concentrate on the inter-temporal aspects. Besides, we may also claim that if there are sets of players mutually overlapping each of which corresponds to a different agreement (which must be consistent to each other, obviously), then it could well be a consequence of a deliberate choice by a large coalition engulfing all the players involved. Since we shall assume away complete information and no cost in writing and enforcing "any" contract in consideration, there shall be no need to explore such a possibility (as seen in the framework of Jackson and Wolinsky(1996)).

The starting point for this analysis is the outcome of emission reduction game given coalitions formed. What we adopt here as a solution is the same as the one adopted in Ray and Vohra (2001). (For somewhat different approach, see Chander and Tulkens(1997), for example.) They use the similar method to generate a partition function in several applications, and one could trace their concept back in Ray and Vohra (1997). In this game, n countries choose their emission reduction levels according to an international agreement, expressed in terms of a coalition structure among n nations, (a partition of N). The member nations in a coalition M can coordinate their

reduction levels and distribute the coalitional payoff among members.

Given a coalition structure among nations $\gamma = [M_1, M_2, \dots, M_k]$ with $|M_j| = m_j$, let $a_M(\rho) \in \mathbf{R}_+^m (= A_M)$ denote an emission reduction profile of a coalition $M \in \gamma$, and let a_{-M} be a reduction profile other than M , that is, $(a_M, a_{-M}) \in A$. When profile $a \in A$ realizes, define a coalitional payoff for M to be $u_M(a(\gamma))$ with $u_M(a(\gamma)) = \sum_{i \in M} u_i(a(\gamma))$. Let us denote this game by $G_\pi(\gamma)$, and let G_π be the collection of such games, $G_\pi = \{G_\pi(\gamma)\}_{\gamma \in \Pi}$, where Π is the set of all partitions of N .

A Nash equilibrium under a coalition structure (NEUCS) embodies the idea that countries cooperate within a coalition but every coalition acts non-cooperatively. Formally, given a coalition structure $\gamma = [M_1, M_2, \dots, M_k]$ with $|M_j| = m_j$, a Nash equilibrium under γ is a reduction profile $a^*(\gamma)$ such that for every $M \in \gamma$, $u_M(a^*(\gamma)) \geq u_M(a_M(\gamma), a_{-M}^*(\gamma))$ for any $a_M(\gamma) \in A_M$.

In a NEUCS of this game G_π , any coalition $M_j \in \gamma$ with m_j is to produce m_j per member, which is the strictly dominant action. Write an optimal action profile $a^*(\gamma)$ under a coalition structure $\gamma = [M_1, M_2, \dots, M_k]$ as $a_i^*(\gamma)$, $i \in M_j$. When $\gamma = [M_1, M_2, \dots, M_k]$ realizes, $u_i(a^*(\gamma)) = \sum_{l=1}^k m_l^2 - (1/2) m_j^2$ for every $i \in M_j$. The following table shows NEUCS where $n = 4$. Since each player's concern is focused on the number of member countries and coalitions, γ is expressed in the form of a numerical coalition structure $[m_1, m_2, \dots, m_k]$ (as utilized in Bloch(1996)).

In the game where γ is the grand coalition, the full cooperation arises and the efficient outcome is achieved.

Table 1

	1	2	3	4
[4]	8 4	8 4	8 4	8 4
[1,3]	9.5 1	5.5 3	5.5 3	5.5 3
[1,1,2]	5.5 1	5.5 1	4 2	4 2
[2,2]	6 2	6 2	6 2	6 2
[1,1,1,1]	3.5 1	3.5 1	3.5 1	3.5 1

In G_π , given the grand coalition, every country chooses the efficient level of emission reduction. However, up to now, we did not question how this international protocol has been determined. Ray and Vohra (1999, 2001) proposed a bargaining game with coalition formations, which described a coalition formation procedure.

Given a partition function (defined through NEUCS in most applications, e.g. Cho, Jewell, and Vohra(2002)), Ray and Vohra (1999, 2001)s' coalition formation game is an adaptation of sequential bargaining game à la Binmore,(1985), Rubinstein (1982), and Chatterjee, et. al. (1993) to this setting.

In our adaptation of their game, given an ordering, a proposer makes an offer including a coalition, actions of the coalition (emission reduction levels), and sidepayments. If a member of the proposed coalition rejects the offer, then that player makes an alternative offer (which may designate a different coalition), whereas every member in the coalition agrees, then the same process continues among remaining players.

Admittedly, this is a very specific rule omitting many realistic aspects, and the rule yields a sharp prediction with stationarity and other restrictions on an equilibrium (for a possible extension, see Konishi and Ray(2002) for example). Furthermore, since we assume the perfect foresight on the side of players, at least, players have chances to consider all the possible coalition structures, and in this sense, their rule would be minimally sufficient.

Ray and Vohra's solution yields the efficient outcome, i.e. the formation of the grand coalition in many cases, but not always. The smallest number of players with which this occurs is $n = 4$. Let us focus on this case.

Although an equilibrium is derived given the (common) discount factor less than 1, it is convenient to express the outcome by the limiting payoff distribution when this factor tends toward 1. Since there is no need to consider a trivial outside option given by a subsequent coalition formation in this game, all the limit payoff distribution is symmetric within each coalition "formed." The efficient and the symmetric division of NEUCS (coalitional) payoffs are given in Table 1 (for each coalition structure).

When $n = 4$, Ray and Vohra (2001) showed that the coalition structure $[\{1\}, \{2, 3, 4\}]$ realizes. To see why, first note that player 1 receives the highest payoff of 9.5 under this coalition structure. Given player 1 leaves the negotiation table by him/herself, the next proposer, player 2, receives the same payoff under the structure $[\{1\}, \{2, 3, 4\}]$ and $[\{1\}, \{2\}, \{3, 4\}]$. However, since we are looking at an equilibrium given a discount factor less than 1, there is an advantage to be a proposer in a coalition with a larger payoff, and hence $[\{1\}, \{2, 3, 4\}]$ results.

With the sort of results shown above, Ray and Vohra (2001) claim the coalitional effect

as a deterrent to the realization of Coase Theorem, although they also note that the magnitude of the efficiency loss may not be that great.

One could blame an oversimplification of the negotiation rule as the culprit. In fact, the observation heavily depends upon the nature of the rule which allows players to commit through a coalition (which may be a singleton). (Renegotiation is one possible remedy (cf. Okada (2000), but one has to redefine the concept of a coalition, employed here.) However, making a rule more complex would introduce a proliferation of solutions. Here, the possibility of “prenegotiation” may serve as one extension which might alleviate the loss of efficiency, due to the coalition effect. (This may correspond to some observation made about the nature of framework agreement to facilitate cooperation in the subsequent negotiation process, e.g. Conconi and Perroni (2002).)

Formally, we write a coalition formation game defined on G_π , $\mathbb{G}[G_\pi]$ with π and a transfer scheme $\{v_M\}$ contingent on the final coalition structure formed. Writing this way, one would find that pre-negotiation is a very natural concept, as $\mathbb{G}_\pi[G_\pi]$ is another non-cooperative game and hence $\mathbb{G}[\mathbb{G}_\pi[G_\pi]]$ is just another coalition formation game. (From this reason, we express dependence on strategic or extensive game explicitly, rather than using partition function game.

For the purpose of defining pre-negotiation, one has to resolve one issue, i.e. defining a counterpart of NEUCS for $\mathbb{G}[\mathbb{G}_\pi[G_\pi]]$. Since $\mathbb{G}[G_\pi]$ is an extensive game (with perfect information), it is natural to think of a subgame perfect equilibrium under a coalition structure (SPEUCS). The definition of this concept involves some problems in its interpretation but we shall use some simple-minded way, below.

As an illustrative example, let us take a look of a prenegotiation game for a finite extensive game, i.e. a sequential version of the emission reduction game.

Example

For illustration, we consider the case with $n = 3$. To define a subgame perfect equilibrium under a coalition structure (SPEUCS) for a game with perfect information one has to consider all the histories as well as coalition structures, so that no player’s strategy is suboptimal. This implies that one has to define optimality of a player’s action on the off-path events. As a first step, here we simply assume that even at an unreachable event, the coalition survives, so that the player tries to maximize the payoff of the coalition the player belongs to (even though some member might have acted quite against the coalition’s interest in the past). With this definition, we have a very simple conclusion that at any history, each player i chooses $a_i = m$ where m is the size of the coalition i belongs to.

Thus, regardless of player’s identity, by representing a coalition structure through the

numerical coalition, payoffs from the SPEUCS is as in Table 2.

[3]	4.5	4.5	4.5
[1, 2]	4.5	3	3
[1, 1, 1]	2.5	2.5	2.5

Table 2.

A coalition formation game à la Ray and Vohra for this extensive form game is essentially the same as the one given above, with suitable adaptations for this case such that strategies for each coalition is dependent upon the coalition structure formed, and must be SPEUCS. It would not be difficult to see that the solution involves that the first player (in a coalition formation game) proposes the entire coalition.

With the definition of SPEUCS informally indicated in the example above, we can go on to examine the pre-negotiation stage prior to the coalition formation game. In the pre-negotiation stage, each country negotiates over a plan for the actions to be taken in the negotiation stage; i.e. a coalition structure for the negotiation stage and a set of transfer scheme within such coalitions. We shall refer to this coalition structure formed in the pre-negotiation stage as a preliminary coalition structure.

To be concrete, consider the case where $n = 4$. When a preliminary coalition structure $\rho = [\{1\}, \{2,3,4\}]$ is chosen in the pre-negotiation stage, it is possible to form the grand coalition with payoff distribution $(9.5, 7.5, 7.5, 7.5)$, since the grand coalition can afford to pay 9.5 to country 1 so as not to form a singleton coalition. In section 5, it will also be proved that, for every $\rho \in \Pi$, only the grand coalition and $[1, 3]$ appears on the equilibrium path. Therefore, in the pre-negotiation stage the grand coalition will be chosen with payoff distribution $(9.5, 7.5, 7.5, 7.5)$, the efficient outcome with total emission reduction level 16.

In the following sections, we define the pre-negotiation for an international emission reduction game and investigate an equilibrium based on the international protocol formally.

3. Basic Framework

In this section, we give a formal definition for our analysis. Although our aim is to analyze 4-person emission reduction game, we do this for general n person cases. We

start with a strategic form game $G = [N, \{A_i\}_{i \in N}, \{u_i\}_{i \in N}]$ where N is a set of n players, A_i is an action space, $A = \times_{i \in N} A_i$, and $u_i : A \rightarrow \mathbf{R}$, the payoff for i when $a \in A$ is played.

3.1 Coalitional Bargaining under a Coalition Structure

Let π be a partition (a coalition structure) of N , and let Π be the set of all partitions of N . We express π^n as the partition that includes n coalitions, i.e., $\pi^n = [\{1\}, \{2\}, \dots, \{n\}]$.

A coalitional bargaining game under a coalition structure $G_\pi(\rho)$ is the game played by n players, who bargain over a coalition formation and a transfer scheme within every coalition formed, given a preliminary coalition structure ρ and a transfer scheme $\{w_M\}_{M \in \rho}$. As defined in the previous section, let a coalitional game $G_\pi(\Gamma_\pi)$ be a collection of $G_\pi(\gamma)$ ($\Gamma_\pi(\gamma)$) for every $\gamma \in \Pi$ respectively. (The game G_π can be defined on a coalitional strategic game G_π or a coalitional extensive game Γ_π .) When $\rho = \pi^n$, we write $G_\pi(\pi^n)$ just as G . The bargaining game proposed in Ray and Vohra (2001) has this property where G is defined on a public good provision game.

Let $\pi(M)$ be a partition of $M \subset N$ (a coalition structure inside $M \subset N$), and let $\Pi(M)$ be the set of all coalition structures inside M . Also let $\Pi_{\pi(M)}$ denote a set of partitions of N which contain $\pi(M)$, and write $\Pi(N)$ for Π and $\pi(N)$ for π as defined above.

The order of proposal and response for every game in G_π is assumed to be a fixed order $(1, 2, \dots, n)$ as follows:

- 1) player 1 is the initial proposer who begins the stage,
- 2) when i proposes a coalition M , the players in $M - \{i\}$ respond according to the fixed order restricted to $M - \{i\}$,
- 3) in the event that $j \in M$ rejects an offer, then j gets to make the next offer.
- 4) when all the respondents accept the offer, coalition M formed, and all the members in M retire the process. Now, let P be the set of retired players.
- 5) If $M - P \neq \phi$, then the negotiation process continues. A proposer is the next one to the initial proposer in the previous session, (i.e. the proposer after a coalition is formed and a new session starts out with players in M), according to the order restricted to $N - P$. The order of response is the same as in 2).
- 6) If $M - P = \phi$, then the stage ends.

This order depends on the retired player set $P \subset N$ and the proposed coalition $M \subset N$ or $M \in \Pi(N - P)$, as long as no rejection takes place along a path.

In the following description, we consider only the case of an extensive game Γ_π , however, just replacing the set of strategies in Γ_π for an action profile in G_π , would do for

strategic game as well.

Let $x = [M, A_M, V_M]$ be an i 's proposal to the members of a coalition $M (\subset N, i \in M)$, a collection of s_M and a utility allocation scheme V_M contingent on partitions including M , for every $\pi \in \Pi_M$.

This definition is less general in not allowing proposal to depend on any history of the bargaining game. It is based on the premise that G_π is completely characterized by a coalition structure finally formed in every G_π . We further restrict x as below.

Suppose that k coalitions $C = [M_1, M_2, \dots, M_k]$, $0 \leq k \leq n$ were already formed before i 's offer. Let $P = \cup_{j=1}^k M_j$. Then, i 's offer $x = [M, A_M, V_M]$ must satisfy $M \in \Pi(N-P)$, $A_M = \{a_M\}_{\pi \in \Pi_{C \cup [M]}}$, and V_M is a collection of allocation functions $v_M : \Pi_{C \cup [M]} \rightarrow \mathbf{R}^m$ satisfying

$$\sum_{i \in M} v_i(\gamma) = \sum_{i \in M} u_i(a^*(\gamma)). \quad (1)$$

Let us express a collection of such v_M s as V_M . Let X be the set of possible offers.

Next, we classify histories of the negotiation stage;

- (1) a *round* begins when i proposes x , where C has already formed up : $H^r(C)$
- (2) *midst* of the round (player $j \in M$ responds to an offer x) : $H^m(C)$
- (3) if $j \in M$ rejects, the round *ends* : $H^e(C)$
- (4) if every member in M accepts, then the next member (according the fixed order defined above) makes the next offer (the next round begins) : $H^r(C')$, where $C' = C \cup [M]$
- (5) if nobody left (a terminal history) : $H^f (= H^r(C), \text{ where } C \in \Pi)$

When all the player made an agreement, players receive their payoffs according to the agreement.

Denoting by $H(i)$, the set of history where player i is to move, i 's strategy in the negotiation game is such that $s_i : H(i) \rightarrow X \cup \{\text{Yes, No}\}$. Denote the set of strategies of player i by S_i , a strategy profile by $s = (s_i)$, and the set of strategy profiles by S . As stated above, we are looking at strategies dependent on some coalition structures constrained by the coalitions already formed. In view of this, we consider the coalitions already formed as a *state* in this game.

Each rejection is costly, with $\delta \in (0,1)$ being the common discount factor, and the impasse yields a payoff of 0.

For prenegotiation stage script[G], the rule of the game is similar to above with following modifications.

Let $s \in S$ be a strategy profile in the negotiation game described above, and let s_M be a

strategy profile of m players in coalition M . In this stage, a proposal consists of $[M, S_M, W_M]$ where obviously $S_M = \{s_M\}_{\pi \in \Pi_{C \cup \{M\}}}$ and W_M is a collection of allocation functions $w_M : \Pi_{C \cup \{M\}} \rightarrow \mathbf{R}^m$.

Adding to this, the strategy schedule in the proposal must satisfy the condition that for each coalition structure, it must comprise a SPEUCS. With the transferable (and linear) utilities, this essentially amounts to require that for each history in the negotiation stage, if $i \in M$ is making a choice, then $s_M \in S_M$ is chosen so that M 's coalitional payoff is maximal. This restriction is based on the supposition that, coalition members sign a "ultra-complete" contract for every contingency, which includes all the off-the-path events, with respect to the payoffs in that contingency. (What motivates members keep acting for the coalition would be some redistribution scheme prepared for each contingency, but we shall leave its specification open.)

Owing to this definition, again we can separate out the strategic choice from distributive matter. Further, we require that one SPEUCS $s^*(\rho)$ is fixed for each ρ . (This is because we do not wish members have power and an opportunity to determine which SPEUCS to come given ρ , through negotiation.) This assumption de facto determines the partition function game, although we do not define it explicitly.

Moreover, for a coalition formation game in G_π , we restrict $s^*(\rho)$ to be a stationary SPEUCS with no rejection. (The additional requirement is necessary because otherwise, when no non-trivial coalition is formed, we may not be able to single out the equilibrium, which Ray and Vohra(2001) obtained.)

A strategy of player i in this prenegotiation stage is defined similarly and is denoted by σ_i .

3.2 Pre-negotiation for Coalitional Bargaining

Finally we define a game which has two coalitional bargaining stages, the negotiation stage and the pre-negotiation stage. In the pre-negotiation game, each player bargains over the formation of a coalition structure for negotiation, strategies in the negotiation stage, and a transfer scheme within the coalition structure for negotiation. The game proposed by Ray and Vohra (2001) is a coalition formation game defined on G_π , represented by $\mathcal{G}[G_\pi]$ by our definition. On the other hand, our negotiation stage is $G_\pi[G_\pi]$ and pre-negotiation stage is G , since the pre-negotiation stage is played independently by n players. Therefore, our entire game is expressed as $\mathcal{G}[G_\pi[G_\pi]]$.

3.3 Equilibrium

To investigate the properties of a class of games defined in the above sections, we shall introduce some notions based on what we may call an equilibrium. Since we focus on alternating-offer type bargaining, we follow Ray and Vohra(1999) to require an equilibrium to satisfy the subgame perfection, stationarity, and no rejection. The most important property is the stationarity under coalition structures.

4. Equilibrium When $n = 4$

In this section, we derive the equilibrium for the case $n = 4$, and establish that the grand coalition forms. For the sake of simplicity, we assume that the ordering in the 2 stages are the same.

As a preliminary, first note that without an effective outside options, the bargaining game employed here yields an equal division of the coalitional payoffs among its members, provided that the coalition formed. In addition, let us introduce two more useful results.

Observation 1 Suppose that four players, $N = \{1,2,3,4\}$ with the common discount factor $\delta \in (0,1)$ bargain over the division of $v > 0$ according to the alternating-offers procedure with outside options. Let c_i be the player i 's continuation value such that $v/4 < c_1 < v$, $c_i \leq v/4$, $i = 2,3,4$, and $c_2 + c_3 \leq v - c_1$. Then, in the limit as $\delta \rightarrow 1$, the subgame perfect equilibrium share converges to

$$(x_1, x_2, x_3, x_4) = \left(c_1, \frac{v - c_1}{3}, \frac{v - c_1}{3}, \frac{v - c_1}{3} \right).$$

Observation 2 Suppose that a proposer's limiting payoffs (as $\delta \rightarrow 1$) is $v_2/2$ in the two-player alternating-offer bargaining game with the common δ , and $v_3/3$ in the three-player game with the common δ , where $v_2/2 = v_3/3$. Then, given a $\delta \in (0,1)$, the payoff in the three-player game is larger than that in the two-player game, i.e., $v_2/(1 + \delta) < v_3/(1 + \delta + \delta^2)$. (It is implied by the fact that $(1 + \delta)/(1 + \delta + \delta^2)$ is strictly decreasing in δ .)

4.1 Equilibrium Coalition Structures in the Negotiation Stage

In this subsection, we use player's index $i, j, k, l \in \{1, 2, 3, 4\}$, $i \neq j \neq k \neq l$ to illustrate any particular coalitional structure with a symmetric payoff structure. As we mentioned earlier, to represent outcomes (equilibrium offers and allocations), we look at the limit payoffs as $\delta \rightarrow 1$.

Now we propose candidates for optimal w_M and v_M . Note that, in each stage, v_M or w_M might be varying among every possible $\pi(N-P-M)$ in general. However, as shown in the following claims, for every subgame with state such that $P \neq \emptyset$ the optimal strategy does not depend on $\pi(N-P-M)$, and so we do not have to consider those possibilities.

Suppose that, in the pre-negotiation stage G , all the players reached an agreement for negotiation $[\rho, \{s_M\}_{M \in \rho}, \{w_M\}_{M \in \rho}]$.

We write the equilibrium payoff distribution by means of w_M^* such that for every $M \in \rho$ with $|M| = m$ and for any $s' \in S$ and $a' \in A$;

1) if $\rho = [N]$, then $w(\rho) = (19/64) \sum v(s^*(\rho))$

$$w_1^*(\rho) = \frac{19}{64} \sum_{i \in N} v_i(s^*(\rho))$$

$$w_r^*(\rho) = \frac{15}{64} \sum_{i \in N} v_i(s^*(\rho)), \quad r \neq 1$$

2) if $\rho = [M_1, M_2] = [\{i, j\}, \{k, l\}]$ and $i = 1$, then

$$w_1^*(\rho) = \frac{19}{34} \sum_{i \in M_1} v_i(s^*(\rho))$$

$$w_j^*(\rho) = \frac{15}{34} \sum_{i \in M_1} v_i(s^*(\rho))$$

$$w_r^*(\rho) = \frac{1}{2} \sum_{i \in M_2} v_i(s^*(\rho)), \quad r = k, l$$

3) if $\rho \neq [N]$ and $\rho \neq [\{i, j\}, \{k, l\}]$, then for every $M \in \rho$,

$$w_r^*(\rho) = \frac{1}{m} \sum_{i \in M} v_i(s^*(\rho)) \quad \text{for every } r \in M.$$

Write $w_M^*(\rho)$ for $\{w_i^*\}_{i \in M}$ and w^* for $\{w^*(\rho)\}_{\rho \in \Pi}$.

Suppose that, in the negotiation stage, the final coalition structure γ is going to be formed. Let us consider the transfer scheme v^* as follows:

For any $a \in A$ and any $M \subset N$ such that $|M| = m$,

1) if $\gamma = [N]$ with proposer i , then

$$v_i^*(\gamma) = \frac{19}{64} \sum_{i \in N} u_i(a^*(\gamma)),$$

$$v_r^*(\gamma) = \frac{15}{64} \sum_{i \in N} u_i(a^*(\gamma)), \quad r = j, k, l$$

2) for the other γ ,

$$v_i^*(\gamma) = \frac{1}{m} \sum_{i \in N} u_i(a^*(\gamma)) \quad \text{for every } i \in M.$$

Write $v_M^*(\gamma)$ for $\{v_i^*\}_{i \in M}$ and let v^* for $\{v^*(\gamma)\}_{\gamma \in \Pi}$.

As stated above, we seek for NEUCS of G_π , hence, in game G_π after γ was chosen, $a = a^*(\gamma)$ is played. Therefore, v^* is completely characterized by γ , and we may write v_M^* for $v_M^*(a^*(\gamma))$.

Now, we investigate a stationary subgame perfect equilibrium with no rejection in the negotiation game. As noted above, we need to find an optimal strategy for every state and every preliminary coalition structure. It follows that there are a lot of subgames to be examined for any combination of states and coalition structures.

The following three claims deal with the cases where $P \neq \phi$, and show that, in every case, the optimal strategy does not depend on ρ nor $\pi(P)$.

Claim 4.1 Suppose that $P = \{i, j, k\}$ and that, according to the agreement reached in the pre-negotiation stage, s_l^* is to form $M = \{l\}$ and choose $a_l^* = 1$. Then, for any $\rho \in \Pi$ and any $\pi(P) \in \Pi(P)$, s_l^* is optimal for player l .

Proof.

This immediately follows from the fact that $a_l^* = 1$ is the strictly dominant reduction level.

Claim 4.2 Suppose that $P = \{i, j\}$ and that, according to the pre-negotiation agreement, s_M^* induces a history $h^f(s_M^*, s_P)$ such that proposer p makes an offer $x^* = [M, a_M^*, v_M^*]$ with $M = \{k, l\}$ and $a_\iota^* = 2$ for every $\iota \in M$, which is accepted without delay. Then, for any $\rho \in \Pi$ and any $\pi(P) \in \Pi(P)$, s_M^* is optimal.

Proof.

In case of $\pi(P) = [\{i\}, \{j\}]$, $v_\iota^*(a_\iota^*) = 4$, $\iota = k, l$, which is strictly better than their payoffs from their separation (3.5 each), when every player chooses a reduction level 1, on the one hand. On the other hand, in case of $\pi(P) = [\{i, j\}]$, $v_\iota^*(a_\iota^*) = 6$, $\iota = i, j, k, l$. However, their separation leads to $v_\iota^*(a_\iota^*) = 6$, $\iota = k, l$ and causes the other players' payoffs to become 4.

All the players are worse off compared to the case of their playing s_M^* , implying that for any $\rho \in \Pi$ every coalitional payoff under ρ definitely decreases.

Claim 4.3 Suppose that $P = \{i\}$ and that, according to the pre-negotiation agreement, s_M^* induces a history $h^f(s_M^*, s_P)$ such that proposer p makes an offer $x^* = [M, a_M^*, V_M^*]$ with $M = \{j, k, l\}$ and $a_i^* = 3$ for every $i \in M$, which is accepted without delay. Then, for any $\rho \in \Pi$, s_M^* is optimal.

Proof.

By the same argument as in Claims 4.1 and 4.2, the largest coalition yields the best payoff.

Remaining claims cover the cases where $P = \emptyset$, and show that optimal strategies varies among every $\rho \in \Pi$. However, the resulting coalition structure is [4] or [1,3] (in terms of numerical coalition structures).

Claim 4.4 Suppose that a preliminary coalition structure is $\rho = [N]$ and that $P = \emptyset$. Suppose also that, according to the pre-negotiation agreement, s_M^* induces a history $h^f(s_M^*)$ such that a proposer p makes an offer $x^* = [M, a_M^*, v_M^*]$ with $M = N$ and $a_i^* = 4$ for every $i \in M$, which is accepted without delay. Then, this s_M^* is optimal.

Proof.

If s_M^* is played, the coalitional payoff under ρ is the largest, i.e. 32 in total. Therefore, no responding players reject the offer.

Claim 4.5 Suppose that a preliminary coalition structure is $\rho = [\{i\}, \{j, k, l\}]$ (i.e. including a coalition with $m = 3$) and that $P = \emptyset$. Suppose also that, according to the pre-negotiation agreement, s_M^* induces a history $h^f(s_M^*)$ such that a proposer p makes an offer $x^* = [M, a_M^*, v_M^*]$ with $M = \{1, 2, 3, 4\}$ and $a_i^* = 4$ for every $i \in M$, which is accepted without delay. Then, this s_M^* is optimal.

Proof.

For x^* to be accepted, player i has to receive a payoff as much as 9.5, and also $\{j, k, l\}$ needs to receive 20.5 in total, since the best deviation for $\{j, k, l\}$ will be $[\{j\}, \{k, l, i\}]$, for instance. Only the grand coalition can afford such payoffs. The remaining issue is the way how to divide the total payoff, 32, subject to $v_i \geq 9.5$ and $v_j + v_k + v_l \geq 20.5$. By the same argument as in Observation 1, $v_i \geq 9.5$ is the only binding restriction. It follows that $(v_i^*, v_j^*, v_k^*, v_l^*) = (9.5, 7.5, 7.5, 7.5)$. As for the optimality of x^* , note that i prefers to belong to the larger coalition, as indicated by Observation 2.

Claim 4.6 Suppose that a preliminary coalition structure is $\rho = [\{i, j\}, \{k, l\}]$ (i.e. including two coalitions with $m = 2$) and that $P = \phi$. Suppose also that, according to the pre-negotiation agreement, s_M^* induces a history $h^f(s_M^*)$ such that an initial proposer i makes an offer $x^* = [M, a_M^*, v_M^*]$ with $M = \{1, 2, 3, 4\}$ and $a_i^* = 4$ for every $i \in M$, which is accepted without delay. Then, this s_M^* is optimal.

Proof.

For x^* to be accepted, $\{i, j\}$ and $\{k, l\}$ have to be given as much as 15 each, since the best deviation for $\{i, j\}$ will be $[\{i\}, \{j, k, l\}]$, for instance. Only the grand coalition can afford such payoffs. However, in this case, $v_i + v_j \geq 15$ is not binding. It follows that $(v_i^*, v_j^*, v_k^*, v_l^*) = (8, 8, 8, 8)$. Again, any deviation results in a smaller size of pie. As for the optimality of x^* , note that any player could not achieve higher payoff from the other coalition structures.

Claim 4.7 Suppose that a preliminary coalition structure is $\rho = [\{i, j\}, \{k\}, \{l\}]$ (i.e. including a coalition with $m = 2$ and two singular coalitions) and that $P = \phi$. Suppose also that, according to the pre-negotiation agreement, s_M^* induces a history $h^f(s_M^*, s_{-M}^*)$ such that any proposer $p = i, j, k$, or l makes an offer $x^* = [M, a_M^*, V_M^*]$ with $M = \{p\}$ and $a_p^* = 1$. Then, this s_M^* is optimal.

Proof.

- (1) At first, suppose that, under $\rho = [\{i, j\}, \{k\}, \{l\}]$, p proposes the grand coalition (with an adequate transfer scheme). Under the condition that the grand coalition is not feasible, the maximum coalitional payoff for $\{i, j\}$ is achieved when either i or j forms a singleton coalition $\{i\}$, or $\{j\}$ and they earn 15 in total, from the argument in Claim 4.3. In addition, k or l also gets the payoff 9.5 by forming a singleton

coalition $\{k\}$ or $\{l\}$, which is the most profitable for them. The optimal offer agreeable for all the players must yield $15 + 9.5 + 9.5 = 34$, however even the grand coalition cannot satisfy these demands.

- (2) Secondly, suppose that, under $\rho = [\{i, j\}, \{k\}, \{l\}]$, p proposes a three-person coalition (with an adequate transfer scheme). From Claim 4.1, this coalition shall achieve a payoff level 16.5. However, the coalition necessarily includes either k or l , or both. Therefore, the optimal and acceptable offer has to have the surplus of $9.5 + 15 = 9.5 + 9.5 + 5.5 = 24.5$, whichever coalition p belongs to.
- (3) Suppose now that, under $\rho = [\{i, j\}, \{k\}, \{l\}]$, p proposes a two-person coalition (with an adequate transfer scheme). From Claim 4.2, the maximum coalitional payoff for this coalition is 12. The coalition $\{i, j\}$ offered by $p = i$ or j is definitely rejected by the other members, since they will earn more (i.e. 15) from the numerical structure [1, 3]. Now, the coalition necessarily includes either k or l , or both. However, the optimal and acceptable offer has to yield the payoffs as much as $9.5 + 15 = 9.5 + 9.5 + 5.5 = 24.5$, whichever coalition p belongs to. Again, this is impossible.
- (4) From the arguments in (1) through (3), we conclude that p acts as a solo and the remaining players form a coalition as is indicated by Claim 4.3.

Claim 4.8 Suppose that a preliminary coalition structure is $\rho = [\{i\}, \{j\}, \{k\}, \{l\}]$ and that $P = \emptyset$. Suppose also that, according to the agreement reached in the pre-negotiation stage, s_M^* induces a history $h^f(s_M^*, s_{-M}^*)$ such that any proposer $p = i, j, k$, or l makes an offer $x^* = [M, a_M^*, V_M^*]$ with $M = \{p\}$ and $a_p^* = 1$. Then, this s_M^* is optimal.

Proof.

From the essentially similar discussion to the one given above, for p 's offer with an n person coalition ($n > 1$) to be optimal and accepted, that coalition must yield at least $9.5 \times n$, which is impossible. After p goes as a solo, remaining players form a singleton coalition, as is indicated by Claim 4.3.

Denote a perfect equilibrium in $G_\pi(\rho)$ by $s^*(\rho)$, and also write $s^* = \{s^*(\rho)\}_{\rho \in \Pi}$.

4.2 Equilibrium Coalition Structures in the Pre-negotiation Stage

In the previous section, we examined the equilibrium strategies in every subgame $G_\pi(\rho)$ for any $\rho \in \Pi$ and any state. In the pre-negotiation stage, 4 countries negotiate over an international protocol in the negotiation stage, $[\rho, \{s_M\}_{M \in \rho}, \{w_M\}_{M \in \rho}]$. However, the subgame perfection under coalition structures demands that, if ρ and $\{w_M\}_{M \in \rho}$ are optimal, then $s^*(\rho)$ must be played in $G_\pi(\rho)$.

Consider the following strategy profile σ^* which is a candidate of SPEUCS.

- (1) $P = \{i, j, k\}$ --- For any $\pi(P) \in \Pi(P)$, player i forms a single coalition.
- (2) $P = \{i, j\}$ --- For any $\pi(P) \in \Pi(P)$,
 - (2a) proposer k always offers $M = \{k, l\}$, and
 - (2b) player l accepts k 's offer only if l 's share satisfies $w_l^* \geq v_l^*$.
- (3) $P = \{i\}$
 - If $i = 1$,
 - (3a) proposer j always offers $M = \{j, k, l\}$, and
 - (3b) player k (l) accept j 's offer only if k 's (l 's) share satisfies $w_k^* \geq v_k^*$ ($w_l^* \geq v_l^*$).
 - If $i \neq 1$,
 - (3c) proposer $j = 1$ always offers $\{j, k\}$, and
 - (3d) player k accept j 's offer only if k 's share satisfies $w_k^* \geq v_k^*$.
 - If $i \neq 1$,
 - (3e) proposer $j \neq 1$ always offers $\{j, 1\}$, and
 - (3f) player 1 accepts j 's offer only if 1 's share satisfies $w_1^* \geq v_1^*$.
- (4) $P = \emptyset$
 - (4a) proposer i always offers $M = N$, and
 - (4b) player j , k , or l accepts i 's offer only if his/her share satisfies $w_j^* \geq v_j^*$, $w_k^* \geq v_k^*$, or $w_l^* \geq v_l^*$, respectively.

Lemma 4.1 σ^* constitutes a SPEUCS in the pre-negotiation stage. On the equilibrium path, the initial proposer offers the grand coalition and asymmetric payoff profiles $w_M^* = (9.5, 7.5, 7.5, 7.5)$ (in the limit as $\delta \rightarrow 1$) which is accepted without any rejections.

Proof.

We show that every strategy in σ^* is never profitable via the one-shot type deviation.

- (1) For Case(1), there is no other choice, so it is definitely optimal.
- (2) For Case(2), σ^* induces $\rho = [\{i, j\}, \{k, l\}]$, $\gamma = [N]$ and final payoffs $(w_1^*, w_2^*, w_3^*, w_4^*) = (9.5, 7.5, 7.5, 7.5)$.

(i) Suppose first that $\pi(P) = [\{i\}, \{j\}]$. If proposer k forms $\{k\}$, then, by (1), the preliminary coalition structure shall be $\rho = [\{i\}, \{j\}, \{k\}, \{l\}]$. Then, by Claim 4.8, on the equilibrium path in the subgame, $\gamma = [\{1\}, \{2, 3, 4\}]$ shall realize with payoffs $(v_1^*, v_2^*, v_3^*, v_4^*) = (9.5, 5.5, 5.5, 5.5)$, and it yields k the same payoff (in terms of the limiting payoff when $\delta \rightarrow 1$) as $\{k, l\}$. However, by Observation 2, k prefers to be in the larger coalition.

(ii) Suppose now that $\pi(P) = [\{i, j\}]$. If proposer k forms $\{k\}$, then, by (1), the preliminary coalition structure shall be $\rho = [\{i, j\}, \{k\}, \{l\}]$. Then, by Claim 4.7, on the equilibrium path in the subgame, $\gamma = [\{1\}, \{2, 3, 4\}]$ shall realize with payoffs $(w_1^*, w_2^*, w_3^*, w_4^*) = (9.5, 5.5, 5.5, 5.5)$. If $k = 1$, then he/she prefers to be in the larger coalition $\{k, l\}$ by the same argument as above. If $k \neq 1$, then $\{k, l\}$ definitely yields larger payoffs. As for the optimality of w^* , note that player 1 needs to receive 9.5 (in terms of the limiting payoff) in the grand coalition, since player 1 always has an option to go as a solo and earns 9.5.

(3) For Case(3), note that σ^* brings about $\rho = [\{i\}, \{j, k, l\}]$, $\gamma = [N]$ and final payoffs $(w_1^*, w_2^*, w_3^*, w_4^*) = (9.5, 7.5, 7.5, 7.5)$ if $i = 1$, and $\rho = [\{i\}, \{j\}, \{k, l\}]$, $\gamma = [\{1\}, \{2, 3, 4\}]$ and final payoffs $(w_1^*, w_2^*, w_3^*, w_4^*) = (9.5, 5.5, 5.5, 5.5)$ if $i \neq 1$.

(i) Suppose that $i = 1$. Even if j offers any other smaller coalitions, $\gamma = [\{1\}, \{2, 3, 4\}]$ shall realize in the negotiation stage, and it gives the same payoffs, which is not profitable for j .

(ii) Suppose that $i \neq 1$. Assume also that $j = 1$. The offer $\{j, k, l\}$ is worst for $j = 1$ since his/her payoff is only 5.5. In addition, player 1 is worse off by forming a solo $\{1\}$, by Observation 2. Now, assume that $j \neq 1$. If j offers $\{j, k, l\}$, player k or l who is player 1 rejects the offer and forms $\{1\}$. The offer, which has a possibility to be accepted, is to form a duo with player 1 or the other. Then, player j shall always choose player 1, since the coalitional payoff is larger with player 1 (16) than with the other (11). (Player j will earn $5.5 + 9.5(1 - \delta)$ with 1, however $5.5 + 5.5(1 - \delta)$ with the other.)

(4) For Case(4), σ^* yields $\rho = [N]$, $\gamma = [N]$ and final payoffs $(w_1^*, w_2^*, w_3^*, w_4^*) = (9.5, 7.5, 7.5, 7.5)$.

For proposer $i = 1$, the best deviation is to form $\{i\}$ or $\{i, j\}$. However, Observation 2 asserts that i prefers to be in a larger coalition, so i offers the grand coalition. As for the acceptance decision, suppose that $j \neq 1$ rejects the grand coalition with payoffs 7.5. From (3) above, if j forms $\{j\}$, then j earns only 5.5. The best deviation for j is to reject the offer and form $\{j, 1\}$. However, for a sufficiently large δ , it is never better for j than accepting the first offer.

Suppose now that $i \neq 1$. For player $i \neq 1$, from the arguments above, there is no way to

earn more than 7.5; therefore, it is optimal.

6. Conclusion

The equilibrium described above achieves the formation of the grand coalition as desired. Obviously, the pre-negotiation stage yields a chance for players to offer the first proposer a sufficient payoff to keep him/her from separating out. Although we conjecture that this result holds for general cases, one should not count too much on prenegotiation in all respects, because this result heavily depends on the specific rule of the choice of proposer and knowledge of it. Rather, a more interesting fact is the appearance of multiple coalitions in two stages. Even though these are off-path phenomenon, in the equilibrium obtained above, we see that when one player rejects the offer in the pre-negotiation stage, then at the negotiation stage, the rest of players (forming one coalition for negotiation) split into two groups to block the deviator's move. This would include a kind of overlapping structure among several coalitions formed for different stages. Similarly, in cases where players are divided into two coalitions for negotiation, at the later stage, these players coalesce together to form a grand coalition. These observations illustrate the potential of the framework employed here in explaining a variety of realistic phenomena.

As to the implication for environmental issues, a "coalition" is one of the key concepts in understanding and analyzing the international framework to cope with global environmental problems. However, the notion of a coalition is very malleable and what is meant by a coalition differs substantially from each other. Although this could be a merit of coalitional analyses, this may well be a demerit, too. In this paper, we try to restrict the function of a coalition and then to enrich the structure by allowing coalition to overlap through an inter-temporal setting. Obviously what we obtained is quite limited, but thinking of the importance and changing natures of international cooperation structures against the climate change, we believe that a further development of the idea posited here is worthwhile.

References

- Binmore, K. (1985), 'Bargaining and Coalitions', *Game-Theoretic Models of Bargaining*, 269-304, Cambridge; New York and Sydney: Cambridge University Press.
- Bloch, F. (1996), 'Sequential Formation of Coalitions in Games with Externalities and Fixed Payoff Division', *Games and Economic Behavior* **14**, 90-123.
- Carraro, C. and D. Siniscalco (1993), 'Strategies for the International Protection of the Environment', *Journal of Public Economics* **52**, 309-328.
- Carraro, C. and D. Siniscalco (1998), 'International Environmental Agreements: Incentive and Political Economy', *European Economic Review* **42**, 561-572.
- Chander, P. and H. Tulkens (1997), 'The Core of an Economy with Multilateral Environmental Externalities', *International Journal of Game Theory* **26**, 379-401.
- Chatterjee, K., B. Dutta, D. Ray and K. Sengupta (1993), 'A Non-Cooperative Theory of Coalitional Bargaining', *Review of Economic Studies* **60**, 463-477.
- Cho, I-K., K. Jewell and R. Vohra (2002), 'A Simple Model of Coalitional Bidding', *Economic Theory* **19**, 435-457.
- Conconi, P. and C. Perroni (2002), 'Issue Linkage and Issue Tie-In in Multilateral Negotiations', *Journal of International Economics* **57**, 423-447.
- Jackson, M. and A. Wolinsky (1996), 'A strategic Model of Social and Economic Networks', *Journal of Economic Theory* **71**, 44-74.
- Konishi, H. and D. Ray (2002), 'Coalition Formation as a Dynamic Process', forthcoming, *Journal of Economic Theory*.
- Okada, A. (2000), "The Efficiency Principle in Non-Cooperative Coalitional Bargaining," *Japanese Economic Review* **51**, pp34-50.
- Ray, D. and R. Vohra (1997), 'Equilibrium Binding Agreement', *Journal of Economic Theory* **73**, 30-78.
- Ray, D. and R. Vohra (1999), 'A Theory of Endogenous Coalition Structures', *Games and Economic Behavior* **26**, 286-336.
- Ray, D. and R. Vohra (2001), 'Coalitional Power and Public Goods', *Journal of Political Economy* **109**, 1355-1384.
- Rubinstein, A. (1982), 'Perfect Equilibrium in a Bargaining Model', *Econometrica* **50**, 97-109.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Papers Series

Our working papers are available on the Internet at the following addresses:

Server WWW: WWW.FEEM.IT

Anonymous FTP: FTP.FEEM.IT

http://papers.ssrn.com/abstract_id=XXXXXX

SUST	1.2001	<i>Inge MAYERES and Stef PROOST: <u>Should Diesel Cars in Europe be Discouraged?</u></i>
SUST	2.2001	<i>Paola DORIA and Davide PETTENELLA: <u>The Decision Making Process in Defining and Protecting Critical Natural Capital</u></i>
CLIM	3.2001	<i>Alberto PENCH: <u>Green Tax Reforms in a Computable General Equilibrium Model for Italy</u></i>
CLIM	4.2001	<i>Maurizio BUSSOLO and Dino PINELLI: <u>Green Taxes: Environment, Employment and Growth</u></i>
CLIM	5.2001	<i>Marco STAMPINI: <u>Tax Reforms and Environmental Policies for Italy</u></i>
ETA	6.2001	<i>Walid OUESLATI: <u>Environmental Fiscal Policy in an Endogenous Growth Model with Human Capital</u></i>
CLIM	7.2001	<i>Umberto CIORBA, Alessandro LANZA and Francesco PAULI: <u>Kyoto Commitment and Emission Trading: a European Union Perspective</u></i>
MGMT	8.2001	<i>Brian SLACK (xlv): <u>Globalisation in Maritime Transportation: Competition, uncertainty and implications for port development strategy</u></i>
VOL	9.2001	<i>Giulia PESARO: <u>Environmental Voluntary Agreements: A New Model of Co-operation Between Public and Economic Actors</u></i>
VOL	10.2001	<i>Cathrine HAGEM: <u>Climate Policy, Asymmetric Information and Firm Survival</u></i>
ETA	11.2001	<i>Sergio CURRARINI and Marco MARINI: <u>A Sequential Approach to the Characteristic Function and the Core in Games with Externalities</u></i>
ETA	12.2001	<i>Gaetano BLOISE, Sergio CURRARINI and Nicholas KIKIDIS: <u>Inflation and Welfare in an OLG Economy with a Privately Provided Public Good</u></i>
KNOW	13.2001	<i>Paolo SURICO: <u>Globalisation and Trade: A “New Economic Geography” Perspective</u></i>
ETA	14.2001	<i>Valentina BOSETTI and Vincenzina MESSINA: <u>Quasi Option Value and Irreversible Choices</u></i>
CLIM	15.2001	<i>Guy ENGELEN (xlii): <u>Desertification and Land Degradation in Mediterranean Areas: from Science to Integrated Policy Making</u></i>
SUST	16.2001	<i>Julie Catherine SORS: <u>Measuring Progress Towards Sustainable Development in Venice: A Comparative Assessment of Methods and Approaches</u></i>
SUST	17.2001	<i>Julie Catherine SORS: <u>Public Participation in Local Agenda 21: A Review of Traditional and Innovative Tools</u></i>
CLIM	18.2001	<i>Johan ALBRECHT and Niko GOBBIN: <u>Schumpeter and the Rise of Modern Environmentalism</u></i>
VOL	19.2001	<i>Rinaldo BRAU, Carlo CARRARO and Giulio GOLFETTO (xliii): <u>Participation Incentives and the Design of Voluntary Agreements</u></i>
ETA	20.2001	<i>Paola ROTA: <u>Dynamic Labour Demand with Lumpy and Kinked Adjustment Costs</u></i>
ETA	21.2001	<i>Paola ROTA: <u>Empirical Representation of Firms’ Employment Decisions by an (S,s) Rule</u></i>
ETA	22.2001	<i>Paola ROTA: <u>What Do We Gain by Being Discrete? An Introduction to the Econometrics of Discrete Decision Processes</u></i>
PRIV	23.2001	<i>Stefano BOSI, Guillaume GIRMANS and Michel GUILLARD: <u>Optimal Privatisation Design and Financial Markets</u></i>
KNOW	24.2001	<i>Giorgio BRUNELLO, Claudio LUPI, Patrizia ORDINE, and Maria Luisa PARISI: <u>Beyond National Institutions: Labour Taxes and Regional Unemployment in Italy</u></i>
ETA	25.2001	<i>Klaus CONRAD: <u>Locational Competition under Environmental Regulation when Input Prices and Productivity Differ</u></i>
PRIV	26.2001	<i>Bernardo BORTOLOTTI, Juliet D’SOUZA, Marcella FANTINI and William L. MEGGINSON: <u>Sources of Performance Improvement in Privatised Firms: A Clinical Study of the Global Telecommunications Industry</u></i>
CLIM	27.2001	<i>Frédéric BROCHIER and Emiliano RAMIERI: <u>Climate Change Impacts on the Mediterranean Coastal Zones</u></i>
ETA	28.2001	<i>Nunzio CAPPUCCIO and Michele MORETTO: <u>Comments on the Investment-Uncertainty Relationship in a Real Option Model</u></i>
KNOW	29.2001	<i>Giorgio BRUNELLO: <u>Absolute Risk Aversion and the Returns to Education</u></i>
CLIM	30.2001	<i>ZhongXiang ZHANG: <u>Meeting the Kyoto Targets: The Importance of Developing Country Participation</u></i>
ETA	31.2001	<i>Jonathan D. KAPLAN, Richard E. HOWITT and Y. Hossein FARZIN: <u>An Information-Theoretical Analysis of Budget-Constrained Nonpoint Source Pollution Control</u></i>
MGMT Coalition	32.2001	<i>Roberta SALOMONE and Giulia GALLUCCIO: <u>Environmental Issues and Financial Reporting Trends</u></i>
Theory Network	33.2001	<i>Shlomo WEBER and Hans WIESMETH: <u>From Autarky to Free Trade: The Impact on Environment</u></i>
ETA	34.2001	<i>Margarita GENIUS and Elisabetta STRAZZERA: <u>Model Selection and Tests for Non Nested Contingent Valuation Models: An Assessment of Methods</u></i>

NRM	35.2001	<i>Carlo GIUPPONI</i> : <u>The Substitution of Hazardous Molecules in Production Processes: The Atrazine Case Study in Italian Agriculture</u>
KNOW	36.2001	<i>Raffaele PACI and Francesco PIGLIARU</i> : <u>Technological Diffusion, Spatial Spillovers and Regional Convergence in Europe</u>
PRIV	37.2001	<i>Bernardo BORTOLOTTI</i> : <u>Privatisation, Large Shareholders, and Sequential Auctions of Shares</u>
CLIM	38.2001	<i>Barbara BUCHNER</i> : <u>What Really Happened in The Hague? Report on the COP6, Part I, 13-25 November 2000, The Hague, The Netherlands</u>
PRIV	39.2001	<i>Giacomo CALZOLARI and Carlo SCARPA</i> : <u>Regulation at Home, Competition Abroad: A Theoretical Framework</u>
KNOW	40.2001	<i>Giorgio BRUNELLO</i> : <u>On the Complementarity between Education and Training in Europe</u>
Coalition Theory Network	41.2001	<i>Alain DESDOIGTS and Fabien MOIZEAU</i> (xlvi): <u>Multiple Politico-Economic Regimes, Inequality and Growth</u>
Coalition Theory Network	42.2001	<i>Parkash CHANDER and Henry TULKENS</i> (xlvi): <u>Limits to Climate Change</u>
Coalition Theory Network	43.2001	<i>Michael FINUS and Bianca RUNDSHAGEN</i> (xlvi): <u>Endogenous Coalition Formation in Global Pollution Control</u>
Coalition Theory Network	44.2001	<i>Wietze LISE, Richard S.J. TOL and Bob van der ZWAAN</i> (xlvi): <u>Negotiating Climate Change as a Social Situation</u>
NRM	45.2001	<i>Mohamad R. KHAWLIE</i> (xlvii): <u>The Impacts of Climate Change on Water Resources of Lebanon- Eastern Mediterranean</u>
NRM	46.2001	<i>Mutasem EL-FADEL and E. BOU-ZEID</i> (xlvii): <u>Climate Change and Water Resources in the Middle East: Vulnerability, Socio-Economic Impacts and Adaptation</u>
NRM	47.2001	<i>Eva IGLESIAS, Alberto GARRIDO and Almudena GOMEZ</i> (xlvii): <u>An Economic Drought Management Index to Evaluate Water Institutions' Performance Under Uncertainty and Climate Change</u>
CLIM	48.2001	<i>Wietze LISE and Richard S.J. TOL</i> (xlvii): <u>Impact of Climate on Tourist Demand</u>
CLIM	49.2001	<i>Francesco BOSELLO, Barbara BUCHNER, Carlo CARRARO and Davide RAGGI</i> : <u>Can Equity Enhance Efficiency? Lessons from the Kyoto Protocol</u>
SUST	50.2001	<i>Roberto ROSON</i> (xlviii): <u>Carbon Leakage in a Small Open Economy with Capital Mobility</u>
SUST	51.2001	<i>Edwin WOERDMAN</i> (xlviii): <u>Developing a European Carbon Trading Market: Will Permit Allocation Distort Competition and Lead to State Aid?</u>
SUST	52.2001	<i>Richard N. COOPER</i> (xlviii): <u>The Kyoto Protocol: A Flawed Concept</u>
SUST	53.2001	<i>Kari KANGAS</i> (xlviii): <u>Trade Liberalisation, Changing Forest Management and Roundwood Trade in Europe</u>
SUST	54.2001	<i>Xueqin ZHU and Ekko VAN IERLAND</i> (xlviii): <u>Effects of the Enlargement of EU on Trade and the Environment</u>
SUST	55.2001	<i>M. Ozgur KAYALICA and Sajal LAHIRI</i> (xlviii): <u>Strategic Environmental Policies in the Presence of Foreign Direct Investment</u>
SUST	56.2001	<i>Savas ALPAY</i> (xlviii): <u>Can Environmental Regulations be Compatible with Higher International Competitiveness? Some New Theoretical Insights</u>
SUST	57.2001	<i>Roldan MURADIAN, Martin O'CONNOR, Joan MARTINEZ-ALER</i> (xlviii): <u>Embodied Pollution in Trade: Estimating the "Environmental Load Displacement" of Industrialised Countries</u>
SUST	58.2001	<i>Matthew R. AUER and Rafael REUVENY</i> (xlviii): <u>Foreign Aid and Direct Investment: Key Players in the Environmental Restoration of Central and Eastern Europe</u>
SUST	59.2001	<i>Onno J. KUIK and Frans H. OOSTERHUIS</i> (xlviii): <u>Lessons from the Southern Enlargement of the EU for the Environmental Dimensions of Eastern Enlargement, in particular for Poland</u>
ETA	60.2001	<i>Carlo CARRARO, Alessandra POME and Domenico SINISCALCO</i> (xlix): <u>Science vs. Profit in Research: Lessons from the Human Genome Project</u>
CLIM	61.2001	<i>Efrem CASTELNUOVO, Michele MORETTO and Sergio VERGALLI</i> : <u>Global Warming, Uncertainty and Endogenous Technical Change: Implications for Kyoto</u>
PRIV	62.2001	<i>Gian Luigi ALBANO, Fabrizio GERMANO and Stefano LOVO</i> : <u>On Some Collusive and Signaling Equilibria in Ascending Auctions for Multiple Objects</u>
CLIM	63.2001	<i>Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH</i> : <u>A Note on Testing for Environmental Kuznets Curves with Panel Data</u>
CLIM	64.2001	<i>Paolo BUONANNO, Carlo CARRARO and Marzio GALEOTTI</i> : <u>Endogenous Induced Technical Change and the Costs of Kyoto</u>
CLIM	65.2001	<i>Guido CAZZAVILLAN and Ignazio MUSU</i> (l): <u>Transitional Dynamics and Uniqueness of the Balanced-Growth Path in a Simple Model of Endogenous Growth with an Environmental Asset</u>
CLIM	66.2001	<i>Giovanni BAIOCCHI and Salvatore DI FALCO</i> (l): <u>Investigating the Shape of the EKC: A Nonparametric Approach</u>
CLIM	67.2001	<i>Marzio GALEOTTI, Alessandro LANZA and Francesco PAULI</i> (l): <u>Desperately Seeking (Environmental) Kuznets: A New Look at the Evidence</u>
CLIM	68.2001	<i>Alexey VIKHLYAEV</i> (xlviii): <u>The Use of Trade Measures for Environmental Purposes – Globally and in the EU Context</u>
NRM	69.2001	<i>Gary D. LIBECAP and Zeynep K. HANSEN</i> (li): <u>U.S. Land Policy, Property Rights, and the Dust Bowl of the 1930s</u>

NRM	70.2001	<i>Lee J. ALSTON, Gary D. LIBECAP and Bernardo MUELLER</i> (li): <u>Land Reform Policies. The Sources of Violent Conflict and Implications for Deforestation in the Brazilian Amazon</u>
CLIM	71.2001	<i>Claudia KEMFERT</i> : <u>Economy-Energy-Climate Interaction – The Model WIAGEM -</u>
SUST	72.2001	<i>Paulo A.L.D. NUNES and Yohanes E. RIYANTO</i> : <u>Policy Instruments for Creating Markets for Biodiversity: Certification and Ecolabeling</u>
SUST	73.2001	<i>Paulo A.L.D. NUNES and Erik SCHOKKAERT</i> (lii): <u>Warm Glow and Embedding in Contingent Valuation</u>
SUST	74.2001	<i>Paulo A.L.D. NUNES, Jeroen C.J.M. van den BERGH and Peter NIJKAMP</i> (lii): <u>Ecological-Economic Analysis and Valuation of Biodiversity</u>
VOL	75.2001	<i>Johan EYCKMANS and Henry TULKENS</i> (li): <u>Simulating Coalitionally Stable Burden Sharing Agreements for the Climate Change Problem</u>
PRIV	76.2001	<i>Axel GAUTIER and Florian HEIDER</i> : <u>What Do Internal Capital Markets Do? Redistribution vs. Incentives</u>
PRIV	77.2001	<i>Bernardo BORTOLOTTI, Marcella FANTINI and Domenico SINISCALCO</i> : <u>Privatisation around the World: New Evidence from Panel Data</u>
ETA	78.2001	<i>Toke S. AIDT and Jayasri DUTTA</i> (li): <u>Transitional Politics. Emerging Incentive-based Instruments in Environmental Regulation</u>
ETA	79.2001	<i>Alberto PETRUCCI</i> : <u>Consumption Taxation and Endogenous Growth in a Model with New Generations</u>
ETA	80.2001	<i>Pierre LASSERRE and Antoine SOUBEYRAN</i> (li): <u>A Ricardian Model of the Tragedy of the Commons</u>
ETA	81.2001	<i>Pierre COURTOIS, Jean Christophe PÉREAU and Tarik TAZDAÏT</i> : <u>An Evolutionary Approach to the Climate Change Negotiation Game</u>
NRM	82.2001	<i>Christophe BONTEMPS, Stéphane COUTURE and Pascal FAVARD</i> : <u>Is the Irrigation Water Demand Really Convex?</u>
NRM	83.2001	<i>Unai PASCUAL and Edward BARBIER</i> : <u>A Model of Optimal Labour and Soil Use with Shifting Cultivation</u>
CLIM	84.2001	<i>Jesper JENSEN and Martin Hvidt THELLE</i> : <u>What are the Gains from a Multi-Gas Strategy?</u>
CLIM	85.2001	<i>Maurizio MICHELINI</i> (liii): IPCC “Summary for Policymakers” in TAR. <u>Do its results give a scientific support always adequate to the urgencies of Kyoto negotiations?</u>
CLIM	86.2001	<i>Claudia KEMFERT</i> (liii): <u>Economic Impact Assessment of Alternative Climate Policy Strategies</u>
CLIM	87.2001	<i>Cesare DOSI and Michele MORETTO</i> : <u>Global Warming and Financial Umbrellas</u>
ETA	88.2001	<i>Elena BONTEMPI, Alessandra DEL BOCA, Alessandra FRANZOSI, Marzio GALEOTTI and Paola ROTA</i> : <u>Capital Heterogeneity: Does it Matter? Fundamental Q and Investment on a Panel of Italian Firms</u>
ETA	89.2001	<i>Efrem CASTELNUOVO and Paolo SURICO</i> : <u>Model Uncertainty, Optimal Monetary Policy and the Preferences of the Fed</u>
CLIM	90.2001	<i>Umberto CIORBA, Alessandro LANZA and Francesco PAULI</i> : <u>Kyoto Protocol and Emission Trading: Does the US Make a Difference?</u>
CLIM	91.2001	<i>ZhongXiang ZHANG and Lucas ASSUNCAO</i> : <u>Domestic Climate Policies and the WTO</u>
SUST	92.2001	<i>Anna ALBERINI, Alan KRUPNICK, Maureen CROPPER, Nathalie SIMON and Joseph COOK</i> (lii): <u>The Willingness to Pay for Mortality Risk Reductions: A Comparison of the United States and Canada</u>
SUST	93.2001	<i>Riccardo SCARPA, Guy D. GARROD and Kenneth G. WILLIS</i> (lii): <u>Valuing Local Public Goods with Advanced Stated Preference Models: Traffic Calming Schemes in Northern England</u>
CLIM	94.2001	<i>Ming CHEN and Larry KARP</i> : <u>Environmental Indices for the Chinese Grain Sector</u>
CLIM	95.2001	<i>Larry KARP and Jiangfeng ZHANG</i> : <u>Controlling a Stock Pollutant with Endogenous Investment and Asymmetric Information</u>
ETA	96.2001	<i>Michele MORETTO and Gianpaolo ROSSINI</i> : <u>On the Opportunity Cost of Nontradable Stock Options</u>
SUST	97.2001	<i>Elisabetta STRAZZERA, Margarita GENIUS, Riccardo SCARPA and George HUTCHINSON</i> : <u>The Effect of Protest Votes on the Estimates of Willingness to Pay for Use Values of Recreational Sites</u>
NRM	98.2001	<i>Frédéric BROCHIER, Carlo GIUPPONI and Alberto LONGO</i> : <u>Integrated Coastal Zone Management in the Venice Area – Perspectives of Development for the Rural Island of Sant’Erasmus</u>
NRM	99.2001	<i>Frédéric BROCHIER, Carlo GIUPPONI and Julie SORS</i> : <u>Integrated Coastal Management in the Venice Area – Potentials of the Integrated Participatory Management Approach</u>
NRM	100.2001	<i>Frédéric BROCHIER and Carlo GIUPPONI</i> : <u>Integrated Coastal Zone Management in the Venice Area – A Methodological Framework</u>
PRIV	101.2001	<i>Enrico C. PEROTTI and Luc LAEVEN</i> : <u>Confidence Building in Emerging Stock Markets</u>
CLIM	102.2001	<i>Barbara BUCHNER, Carlo CARRARO and Igor CERSOSIMO</i> : <u>On the Consequences of the U.S. Withdrawal from the Kyoto/Bonn Protocol</u>
SUST	103.2001	<i>Riccardo SCARPA, Adam DRUCKER, Simon ANDERSON, Nancy FERRAES-EHUAN, Veronica GOMEZ, Carlos R. RISOPATRON and Olga RUBIO-LEONEL</i> : <u>Valuing Animal Genetic Resources in Peasant Economies: The Case of the Box Keken Creole Pig in Yucatan</u>
SUST	104.2001	<i>R. SCARPA, P. KRISTJANSON, A. DRUCKER, M. RADENY, E.S.K. RUTO, and J.E.O. REGE</i> : <u>Valuing Indigenous Cattle Breeds in Kenya: An Empirical Comparison of Stated and Revealed Preference Value Estimates</u>
SUST	105.2001	<i>Clemens B.A. WOLLNY</i> : <u>The Need to Conserve Farm Animal Genetic Resources Through Community-Based Management in Africa: Should Policy Makers be Concerned?</u>
SUST	106.2001	<i>J.T. KARUGIA, O.A. MWAI, R. KAITHO, Adam G. DRUCKER, C.B.A. WOLLNY and J.E.O. REGE</i> : <u>Economic Analysis of Crossbreeding Programmes in Sub-Saharan Africa: A Conceptual Framework and Kenyan Case Study</u>
SUST	107.2001	<i>W. AYALEW, J.M. KING, E. BRUNS and B. RISCHKOWSKY</i> : <u>Economic Evaluation of Smallholder Subsistence Livestock Production: Lessons from an Ethiopian Goat Development Program</u>

SUST	108.2001	<i>Gianni CICIA, Elisabetta D'ERCOLE and Davide MARINO: <u>Valuing Farm Animal Genetic Resources by Means of Contingent Valuation and a Bio-Economic Model: The Case of the Pentro Horse</u></i>
SUST	109.2001	<i>Clem TISDELL: <u>Socioeconomic Causes of Loss of Animal Genetic Diversity: Analysis and Assessment</u></i>
SUST	110.2001	<i>M.A. JABBAR and M.L. DIEDHOU: <u>Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa</u></i>
SUST	1.2002	<i>K. TANO, M.D. FAMINOW, M. KAMUANGA and B. SWALLOW: <u>Using Conjoint Analysis to Estimate Farmers' Preferences for Cattle Traits in West Africa</u></i>
ETA	2.2002	<i>Efrem CASTELNUOVO and Paolo SURICO: <u>What Does Monetary Policy Reveal about Central Bank's Preferences?</u></i>
WAT	3.2002	<i>Duncan KNOWLER and Edward BARBIER: <u>The Economics of a "Mixed Blessing" Effect: A Case Study of the Black Sea</u></i>
CLIM	4.2002	<i>Andreas LÖSCHEL: <u>Technological Change in Economic Models of Environmental Policy: A Survey</u></i>
VOL	5.2002	<i>Carlo CARRARO and Carmen MARCHIORI: <u>Stable Coalitions</u></i>
CLIM	6.2002	<i>Marzio GALEOTTI, Alessandro LANZA and Matteo MANERA: <u>Rockets and Feathers Revisited: An International Comparison on European Gasoline Markets</u></i>
ETA	7.2002	<i>Effrosyni DIAMANTOUDI and Eftichios S. SARTZETAKIS: <u>Stable International Environmental Agreements: An Analytical Approach</u></i>
KNOW	8.2002	<i>Alain DESDOIGTS: <u>Neoclassical Convergence Versus Technological Catch-up: A Contribution for Reaching a Consensus</u></i>
NRM	9.2002	<i>Giuseppe DI VITA: <u>Renewable Resources and Waste Recycling</u></i>
KNOW	10.2002	<i>Giorgio BRUNELLO: <u>Is Training More Frequent when Wage Compression is Higher? Evidence from 11 European Countries</u></i>
ETA	11.2002	<i>Mordecai KURZ, Hehui JIN and Maurizio MOTOLESE: <u>Endogenous Fluctuations and the Role of Monetary Policy</u></i>
KNOW	12.2002	<i>Reyer GERLAGH and Marjan W. HOFKES: <u>Escaping Lock-in: The Scope for a Transition towards Sustainable Growth?</u></i>
NRM	13.2002	<i>Michele MORETTO and Paolo ROSATO: <u>The Use of Common Property Resources: A Dynamic Model</u></i>
CLIM	14.2002	<i>Philippe QUIRION: <u>Macroeconomic Effects of an Energy Saving Policy in the Public Sector</u></i>
CLIM	15.2002	<i>Roberto ROSON: <u>Dynamic and Distributional Effects of Environmental Revenue Recycling Schemes: Simulations with a General Equilibrium Model of the Italian Economy</u></i>
CLIM	16.2002	<i>Francesco RICCI (I): <u>Environmental Policy Growth when Inputs are Differentiated in Pollution Intensity</u></i>
ETA	17.2002	<i>Alberto PETRUCCI: <u>Devaluation (Levels versus Rates) and Balance of Payments in a Cash-in-Advance Economy</u></i>
Coalition Theory Network	18.2002	<i>László Á. KÓCZY (liv): <u>The Core in the Presence of Externalities</u></i>
Coalition Theory Network	19.2002	<i>Steven J. BRAMS, Michael A. JONES and D. Marc KILGOUR (liv): <u>Single-Peakedness and Disconnected Coalitions</u></i>
Coalition Theory Network	20.2002	<i>Guillaume HAERINGER (liv): <u>On the Stability of Cooperation Structures</u></i>
NRM	21.2002	<i>Fausto CAVALLARO and Luigi CIRAULO: <u>Economic and Environmental Sustainability: A Dynamic Approach in Insular Systems</u></i>
CLIM	22.2002	<i>Barbara BUCHNER, Carlo CARRARO, Igor CERSOSIMO and Carmen MARCHIORI: <u>Back to Kyoto? US Participation and the Linkage between R&D and Climate Cooperation</u></i>
CLIM	23.2002	<i>Andreas LÖSCHEL and ZhongXIANG ZHANG: <u>The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol and the Subsequent Deals in Bonn and Marrakech</u></i>
ETA	24.2002	<i>Marzio GALEOTTI, Louis J. MACCINI and Fabio SCHIANTARELLI: <u>Inventories, Employment and Hours</u></i>
CLIM	25.2002	<i>Hannes EGLI: <u>Are Cross-Country Studies of the Environmental Kuznets Curve Misleading? New Evidence from Time Series Data for Germany</u></i>
ETA	26.2002	<i>Adam B. JAFFE, Richard G. NEWELL and Robert N. STAVINS: <u>Environmental Policy and Technological Change</u></i>
SUST	27.2002	<i>Joseph C. COOPER and Giovanni SIGNORELLO: <u>Farmer Premiums for the Voluntary Adoption of Conservation Plans</u></i>
SUST	28.2002	<i><u>The ANSEA Network: Towards An Analytical Strategic Environmental Assessment</u></i>
KNOW	29.2002	<i>Paolo SURICO: <u>Geographic Concentration and Increasing Returns: a Survey of Evidence</u></i>
ETA	30.2002	<i>Robert N. STAVINS: <u>Lessons from the American Experiment with Market-Based Environmental Policies</u></i>
NRM	31.2002	<i>Carlo GIUPPONI and Paolo ROSATO: <u>Multi-Criteria Analysis and Decision-Support for Water Management at the Catchment Scale: An Application to Diffuse Pollution Control in the Venice Lagoon</u></i>
NRM	32.2002	<i>Robert N. STAVINS: <u>National Environmental Policy During the Clinton Years</u></i>
KNOW	33.2002	<i>A. SOUBEYRAN and H. STAHN : <u>Do Investments in Specialized Knowledge Lead to Composite Good Industries?</u></i>
KNOW	34.2002	<i>G. BRUNELLO, M.L. PARISI and Daniela SONEDDA: <u>Labor Taxes, Wage Setting and the Relative Wage Effect</u></i>
CLIM	35.2002	<i>C. BOEMARE and P. QUIRION (lv): <u>Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences</u></i>

CLIM	36.2002	<i>T. TIETENBERG</i> (lv): <u>The Tradable Permits Approach to Protecting the Commons: What Have We Learned?</u>
CLIM	37.2002	<i>K. REHDANZ and R.J.S. TOL</i> (lv): <u>On National and International Trade in Greenhouse Gas Emission Permits</u>
CLIM	38.2002	<i>C. FISCHER</i> (lv): <u>Multinational Taxation and International Emissions Trading</u>
SUST	39.2002	<i>G. SIGNORELLO and G. PAPPALARDO</i> : <u>Farm Animal Biodiversity Conservation Activities in Europe under the Framework of Agenda 2000</u>
NRM	40.2002	<i>S.M. CAVANAGH, W. M. HANEMANN and R. N. STAVINS</i> : <u>Muffled Price Signals: Household Water Demand under Increasing-Block Prices</u>
NRM	41.2002	<i>A. J. PLANTINGA, R. N. LUBOWSKI and R. N. STAVINS</i> : <u>The Effects of Potential Land Development on Agricultural Land Prices</u>
CLIM	42.2002	<i>C. OHL</i> (lvi): <u>Inducing Environmental Co-operation by the Design of Emission Permits</u>
CLIM	43.2002	<i>J. EYCKMANS, D. VAN REGEMORTER and V. VAN STEENBERGHE</i> (lvi): <u>Is Kyoto Fatally Flawed? An Analysis with MacGEM</u>
CLIM	44.2002	<i>A. ANTOCI and S. BORGHESI</i> (lvi): <u>Working Too Much in a Polluted World: A North-South Evolutionary Model</u>
ETA	45.2002	<i>P. G. FREDRIKSSON, Johan A. LIST and Daniel MILLIMET</i> (lvi): <u>Chasing the Smokestack: Strategic Policymaking with Multiple Instruments</u>
ETA	46.2002	<i>Z. YU</i> (lvi): <u>A Theory of Strategic Vertical DFI and the Missing Pollution-Haven Effect</u>
SUST	47.2002	<i>Y. H. FARZIN</i> : <u>Can an Exhaustible Resource Economy Be Sustainable?</u>
SUST	48.2002	<i>Y. H. FARZIN</i> : <u>Sustainability and Hamiltonian Value</u>
KNOW	49.2002	<i>C. PIGA and M. VIVARELLI</i> : <u>Cooperation in R&D and Sample Selection</u>
Coalition Theory Network Coalition Theory Network	50.2002	<i>M. SERTEL and A. SLINKO</i> (liv): <u>Ranking Committees, Words or Multisets</u>
ETA	51.2002	<i>Sergio CURRARINI</i> (liv): <u>Stable Organizations with Externalities</u>
ETA	52.2002	<i>Robert N. STAVINS</i> : <u>Experience with Market-Based Policy Instruments</u>
ETA	53.2002	<i>C.C. JAEGER, M. LEIMBACH, C. CARRARO, K. HASSELMANN, J.C. HOURCADE, A. KEELER and R. KLEIN</i> (liii): <u>Integrated Assessment Modeling: Modules for Cooperation</u>
CLIM	54.2002	<i>Scott BARRETT</i> (liii): <u>Towards a Better Climate Treaty</u>
ETA	55.2002	<i>Richard G. NEWELL and Robert N. STAVINS</i> : <u>Cost Heterogeneity and the Potential Savings from Market-Based Policies</u>
SUST	56.2002	<i>Paolo ROSATO and Edi DEFRANCESCO</i> : <u>Individual Travel Cost Method and Flow Fixed Costs</u>
SUST	57.2002	<i>Vladimir KOTOV and Elena NIKITINA</i> (lvii): <u>Reorganisation of Environmental Policy in Russia: The Decade of Success and Failures in Implementation of Perspective Quests</u>
SUST	58.2002	<i>Vladimir KOTOV</i> (lvii): <u>Policy in Transition: New Framework for Russia's Climate Policy</u>
SUST	59.2002	<i>Fanny MISSFELDT and Arturo VILLAVICENCO</i> (lvii): <u>How Can Economies in Transition Pursue Emissions Trading or Joint Implementation?</u>
VOL	60.2002	<i>Giovanni DI BARTOLOMEO, Jacob ENGWERDA, Joseph PLASMANS and Bas VAN AARLE</i> : <u>Staying Together or Breaking Apart: Policy-Makers' Endogenous Coalitions Formation in the European Economic and Monetary Union</u>
ETA	61.2002	<i>Robert N. STAVINS, Alexander F. WAGNER and Gernot WAGNER</i> : <u>Interpreting Sustainability in Economic Terms: Dynamic Efficiency Plus Intergenerational Equity</u>
PRIV	62.2002	<i>Carlo CAPUANO</i> : <u>Demand Growth, Entry and Collusion Sustainability</u>
PRIV	63.2002	<i>Federico MUNARI and Raffaele ORIANI</i> : <u>Privatization and R&D Performance: An Empirical Analysis Based on Tobin's Q</u>
PRIV	64.2002	<i>Federico MUNARI and Maurizio SOBRERO</i> : <u>The Effects of Privatization on R&D Investments and Patent Productivity</u>
SUST	65.2002	<i>Orley ASHENFELTER and Michael GREENSTONE</i> : <u>Using Mandated Speed Limits to Measure the Value of a Statistical Life</u>
ETA	66.2002	<i>Paolo SURICO</i> : <u>US Monetary Policy Rules: the Case for Asymmetric Preferences</u>
PRIV	67.2002	<i>Rinaldo BRAU and Massimo FLORIO</i> : <u>Privatisations as Price Reforms: Evaluating Consumers' Welfare Changes in the U.K.</u>
CLIM	68.2002	<i>Barbara K. BUCHNER and Roberto ROSON</i> : <u>Conflicting Perspectives in Trade and Environmental Negotiations</u>
CLIM	69.2002	<i>Philippe QUIRION</i> : <u>Complying with the Kyoto Protocol under Uncertainty: Taxes or Tradable Permits?</u>
SUST	70.2002	<i>Anna ALBERINI, Patrizia RIGANTI and Alberto LONGO</i> : <u>Can People Value the Aesthetic and Use Services of Urban Sites? Evidence from a Survey of Belfast Residents</u>
SUST	71.2002	<i>Marco PERCOCO</i> : <u>Discounting Environmental Effects in Project Appraisal</u>
NRM	72.2002	<i>Philippe BONTEMS and Pascal FAVARD</i> : <u>Input Use and Capacity Constraint under Uncertainty: The Case of Irrigation</u>
PRIV	73.2002	<i>Mohammed OMRAN</i> : <u>The Performance of State-Owned Enterprises and Newly Privatized Firms: Empirical Evidence from Egypt</u>
PRIV	74.2002	<i>Mike BURKART, Fausto PANUNZI and Andrei SHLEIFER</i> : <u>Family Firms</u>
PRIV	75.2002	<i>Emmanuelle AURIOL, Pierre M. PICARD</i> : <u>Privatizations in Developing Countries and the Government Budget Constraint</u>
PRIV	76.2002	<i>Nichole M. CASTATER</i> : <u>Privatization as a Means to Societal Transformation: An Empirical Study of Privatization in Central and Eastern Europe and the Former Soviet Union</u>

PRIV	77.2002	<i>Christoph LÜLSFESMANN</i> : <u>Benevolent Government, Managerial Incentives, and the Virtues of Privatization</u>
PRIV	78.2002	<i>Kate BISHOP, Igor FILATOTCHEV and Tomasz MICKIEWICZ</i> : <u>Endogenous Ownership Structure: Factors Affecting the Post-Privatisation Equity in Largest Hungarian Firms</u>
PRIV	79.2002	<i>Theodora WELCH and Rick MOLZ</i> : <u>How Does Trade Sale Privatization Work? Evidence from the Fixed-Line Telecommunications Sector in Developing Economies</u>
PRIV	80.2002	<i>Alberto R. PETRUCCI</i> : <u>Government Debt, Agent Heterogeneity and Wealth Displacement in a Small Open Economy</u>
CLIM	81.2002	<i>Timothy SWANSON and Robin MASON</i> (Ivi): <u>The Impact of International Environmental Agreements: The Case of the Montreal Protocol</u>
PRIV	82.2002	<i>George R.G. CLARKE and Lixin Colin XU</i> : <u>Privatization, Competition and Corruption: How Characteristics of Bribe Takers and Payers Affect Bribe Payments to Utilities</u>
PRIV	83.2002	<i>Massimo FLORIO and Katuscia MANZONI</i> : <u>The Abnormal Returns of UK Privatisations: From Underpricing to Outperformance</u>
NRM	84.2002	<i>Nelson LOURENÇO, Carlos RUSSO MACHADO, Maria do ROSÁRIO JORGE and Luís RODRIGUES</i> : <u>An Integrated Approach to Understand Territory Dynamics. The Coastal Alentejo (Portugal)</u>
CLIM	85.2002	<i>Peter ZAPFEL and Matti VAINIO</i> (Iv): <u>Pathways to European Greenhouse Gas Emissions Trading History and Misconceptions</u>
CLIM	86.2002	<i>Pierre COURTOIS</i> : <u>Influence Processes in Climate Change Negotiations: Modelling the Rounds</u>
ETA	87.2002	<i>Vito FRAGNELLI and Maria Erminia MARINA</i> (Iviii): <u>Environmental Pollution Risk and Insurance</u>
ETA	88.2002	<i>Laurent FRANCKX</i> (Iviii): <u>Environmental Enforcement with Endogenous Ambient Monitoring</u>
ETA	89.2002	<i>Timo GOESCHL and Timothy M. SWANSON</i> (Iviii): <u>Lost Horizons. The noncooperative management of an evolutionary biological system.</u>
ETA	90.2002	<i>Hans KEIDING</i> (Iviii): <u>Environmental Effects of Consumption: An Approach Using DEA and Cost Sharing</u>
ETA	91.2002	<i>Wietze LISE</i> (Iviii): <u>A Game Model of People's Participation in Forest Management in Northern India</u>
CLIM	92.2002	<i>Jens HORBACH</i> : <u>Structural Change and Environmental Kuznets Curves</u>
ETA	93.2002	<i>Martin P. GROSSKOPF</i> : <u>Towards a More Appropriate Method for Determining the Optimal Scale of Production Units</u>
VOL	94.2002	<i>Scott BARRETT and Robert STAVINS</i> : <u>Increasing Participation and Compliance in International Climate Change Agreements</u>
CLIM	95.2002	<i>Banu BAYRAMOGLU LISE and Wietze LISE</i> : <u>Climate Change, Environmental NGOs and Public Awareness in the Netherlands: Perceptions and Reality</u>
CLIM	96.2002	<i>Matthieu GLACHANT</i> : <u>The Political Economy of Emission Tax Design in Environmental Policy</u>
KNOW	97.2002	<i>Kenn ARIGA and Giorgio BRUNELLO</i> : <u>Are the More Educated Receiving More Training? Evidence from Thailand</u>
ETA	98.2002	<i>Gianfranco FORTE and Matteo MANERA</i> : <u>Forecasting Volatility in European Stock Markets with Non-linear GARCH Models</u>
ETA	99.2002	<i>Geoffrey HEAL</i> : <u>Bundling Biodiversity</u>
ETA	100.2002	<i>Geoffrey HEAL, Brian WALKER, Simon LEVIN, Kenneth ARROW, Partha DASGUPTA, Gretchen DAILY, Paul EHRlich, Karl-Goran MALER, Nils KAUTSKY, Jane LUBCHENCO, Steve SCHNEIDER and David STARRETT</i> : <u>Genetic Diversity and Interdependent Crop Choices in Agriculture</u>
ETA	101.2002	<i>Geoffrey HEAL</i> : <u>Biodiversity and Globalization</u>
VOL	102.2002	<i>Andreas LANGE</i> : <u>Heterogeneous International Agreements – If per capita emission levels matter</u>
ETA	103.2002	<i>Pierre-André JOUVET and Walid OUESLATI</i> : <u>Tax Reform and Public Spending Trade-offs in an Endogenous Growth Model with Environmental Externality</u>
ETA	104.2002	<i>Anna BOTTASSO and Alessandro SEMBENELLI</i> : <u>Does Ownership Affect Firms' Efficiency? Panel Data Evidence on Italy</u>
PRIV	105.2002	<i>Bernardo BORTOLOTTI, Frank DE JONG, Giovanna NICODANO and Ibolya SCHINDELE</i> : <u>Privatization and Stock Market Liquidity</u>
ETA	106.2002	<i>Haruo IMAI and Mayumi HORIE</i> (Iviii): <u>Pre-Negotiation for an International Emission Reduction Game</u>

(xlii) This paper was presented at the International Workshop on "Climate Change and Mediterranean Coastal Systems: Regional Scenarios and Vulnerability Assessment" organised by the Fondazione Eni Enrico Mattei in co-operation with the Istituto Veneto di Scienze, Lettere ed Arti, Venice, December 9-10, 1999.

(xliii) This paper was presented at the International Workshop on "Voluntary Approaches, Competition and Competitiveness" organised by the Fondazione Eni Enrico Mattei within the research activities of the CAVA Network, Milan, May 25-26, 2000.

(xliv) This paper was presented at the International Workshop on "Green National Accounting in Europe: Comparison of Methods and Experiences" organised by the Fondazione Eni Enrico Mattei within the Concerted Action of Environmental Valuation in Europe (EVE), Milan, March 4-7, 2000

(xlv) This paper was presented at the International Workshop on "New Ports and Urban and Regional Development. The Dynamics of Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, May 5-6, 2000.

- (xlv) This paper was presented at the Sixth Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Louvain-la-Neuve, Belgium, January 26-27, 2001
- (xlvii) This paper was presented at the RICAMARE Workshop “Socioeconomic Assessments of Climate Change in the Mediterranean: Impact, Adaptation and Mitigation Co-benefits”, organised by the Fondazione Eni Enrico Mattei, Milan, February 9-10, 2001
- (xlviii) This paper was presented at the International Workshop “Trade and the Environment in the Perspective of the EU Enlargement”, organised by the Fondazione Eni Enrico Mattei, Milan, May 17-18, 2001
- (xlix) This paper was presented at the International Conference “Knowledge as an Economic Good”, organised by Fondazione Eni Enrico Mattei and The Beijer International Institute of Environmental Economics, Palermo, April 20-21, 2001
- (l) This paper was presented at the Workshop “Growth, Environmental Policies and Sustainability” organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001
- (li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on “Property Rights, Institutions and Management of Environmental and Natural Resources”, organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001
- (lii) This paper was presented at the International Conference on “Economic Valuation of Environmental Goods”, organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001
- (liii) This paper was circulated at the International Conference on “Climate Policy – Do We Need a New Approach?”, jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001
- (liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002
- (lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001
- (lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy “The International Dimension of Environmental Policy”, organised with the collaboration of the Fondazione Eni Enrico Mattei, Acquafredda di Maratea, October 6-11, 2001
- (lvii) This paper was presented at the First Workshop of “CFEWE – Carbon Flows between Eastern and Western Europe”, organised by the Fondazione Eni Enrico Mattei and Zentrum für Europäische Integrationsforschung (ZEI), Milan, July 5-6, 2001
- (lviii) This paper was presented at the Workshop on “Game Practice and the Environment”, jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002

2002 SERIES

CLIM	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
VOL	<i>Voluntary and International Agreements</i> (Editor: Carlo Carraro)
SUST	<i>Sustainability Indicators and Environmental Evaluation</i> (Editor: Carlo Carraro)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
KNOW	<i>Knowledge, Technology, Human Capital</i> (Editor: Dino Pinelli)
MGMT	<i>Corporate Sustainable Management</i> (Editor: Andrea Marsanich)
PRIV	<i>Privatisation, Regulation, Antitrust</i> (Editor: Bernardo Bortolotti)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)