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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

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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 $a_i \in \boldsymbol{R}_+ (= A_i)$ 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 $\gamma = [M_1, M_2, \ldots, M_k]$ with $|M_j| = m_j$, let $a_M(\rho) \in \boldsymbol{R}_+^m (= A_M)$ 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 $\gamma = [M_1, M_2, \ldots, M_k]$ 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 $\gamma = [M_1, M_2, \ldots, M_k]$ as $a_i^*(\gamma)$, $i \in M_j$. When $\gamma = [M_1, M_2, \ldots, M_k]$ 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 $[m_1, m_2, \ldots, m_k]$ (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 sidepaymens. 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 , $\mathrm{G}[G_\pi]$ 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 $\mathrm{G}_\pi[G_\pi]$ is another non-cooperative game and hence $\mathrm{G}[\mathrm{G}_\pi[G_\pi]]$ 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 $\mathrm{G}[\mathrm{G}_\pi[G_\pi]]$. Since $\mathrm{G}[G_\pi]$ 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 $u_i : A \to \boldsymbol{R}$, 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., $\pi^n = [\{1\}, \{2\}, \ldots, \{n\}]$.

A coalitional bargaining game under a coalition structure $\mathrm{G}_\pi(\rho)$ 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_π (Γ_π) 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 $\mathrm{G}_\pi(\pi^n)$ 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 $(1, 2, \ldots, n)$ 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 $C = [M_1, M_2, \ldots, M_k]$, $0 \le k \le n$ 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 $v_M : \Pi_{C \cup [M]} \rightarrow \boldsymbol{R}^m$ satisfying

$$\sum_{\iota \in M} v_\iota(\gamma) = \sum_{\iota \in M} u_\iota(a^*(\gamma)) . \qquad (1)$$

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 ($= H^r(C)$, 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 $w_M : \Pi_{C \cup [M]} \rightarrow \boldsymbol{R}^m$.

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 if 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 $\mathrm{G}[G_\pi]$ by our definition. On the other hand, our negotiation stage is $\mathrm{G}_\pi[G_\pi]$ and pre-negotiation stage is G, since the pre-negotiation stage is played independently by n players. Therefore, our entire game is expressed as $\mathrm{G}[\mathrm{G}_\pi[G_\pi]]$.

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 $\delta \to 1$, 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 $\delta \to 1$) 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 $\delta \to 1$.

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 $\pi(N\text{-}P\text{-}M)$ in general. However, as shown in the following claims, for every subgame with state such that $P \neq \varnothing$ the optimal strategy does not depend on $\pi(N\text{-}P\text{-}M)$, 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(ρ)=(19/64) Σ v(s*(ρ))

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

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

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

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

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

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

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

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

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

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

$$v_r^*(\gamma) = \frac{15}{64}\sum_{\iota \in N} u_\iota(a^*(\gamma)) \text{ , } r = j,k,l$$

2) for the other γ,

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

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 $a_\iota^* = 3$ for every $\iota \in M$, 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 $P = \phi$, 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 $P = \phi$. Suppose also that, according to the pre-negotiation agreement, s_M^* induces a hitory $h^f(s_M^*)$ such that a proposer p makes an offer $x^* = [M, a_M^*, v_M^*]$ with $M = N$ and $a_\iota^* = 4$ for every $\iota \in M$, 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 $P = \phi$. 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 $a_\iota^* = 4$ for every $\iota \in M$, 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 ι makes an offer $x^* = [M, a_M^*, v_M^*]$ with $M = \{1, 2, 3, 4\}$ and $a_\iota^* = 4$ for every $\iota \in M$, 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 $P = \phi$. 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 $\mathrm{G}_\pi(\rho)$ 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) $P = \phi$

(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 $\delta \to 1$) 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 $\delta \to 1$) 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.

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