



# NOTA DI LAVORO

125.2010

---

**Group Bargaining and  
Conflict**

---

By **Nicolas Quérou**, Queen's University  
Management School, Queen's  
University Belfast

# SUSTAINABLE DEVELOPMENT Series

Editor: Carlo Carraro

## Group Bargaining and Conflict

By Nicolas Quérou, Queen's University Management School, Queen's University Belfast

### Summary

We consider a situation where groups negotiate over the allocation of a surplus (which is used to fund group specific goods). Each group is composed of agents who have differing valuations for public goods. Members choose a representative to take decisions on their behalf. Specifically, representatives can decide to enter either a (cooperative) negotiation protocol or a conflict to appropriate the surplus. In the cooperative negotiations, disagreement corresponds to a pro rata allocation (as a function of the size of the groups). We analyse the conditions (on the internal composition of the groups) under which conflict will be preferred to negotiated agreements (and vice versa), and we derive welfare implications. Finally, we provide results of comparative statics that highlight the influence of changes in the internal composition of groups and in their relative size on the profitability of negotiated agreements.

**Keywords:** Bargaining, Conflict, Agency Problem

**JEL Classification:** C78, D74, J52

*This paper has been presented at the 15th Coalition Theory Network Workshop held in Marseille, France, on June 17-18, 2010 and organised by the Groupement de Recherche en Economie Quantitative d'Aix-Marseille, (GREQAM) [http://www.feem-web.it/ctn/events/10\\_Marseilles/ctn15i.htm](http://www.feem-web.it/ctn/events/10_Marseilles/ctn15i.htm).*

*I am grateful to Santiago Sanchez-Pages and to participants at the CTN workshop in Marseille for helpful comments.*

*Address for correspondence:*

Nicolas Quérou  
Queen's University Management School  
Queen's University Belfast  
25 University Square  
Belfast BT7 1NN  
UK  
E-mail: n.querou@qub.ac.uk

# Group bargaining and conflict

N. Qu erou\*

## Abstract

We consider a situation where groups negotiate over the allocation of a surplus (which is used to fund group specific goods). Each group is composed of agents who have differing valuations for public goods. Members choose a representative to take decisions on their behalf. Specifically, representatives can decide to enter either a (cooperative) negotiation protocol or a conflict to appropriate the surplus. In the cooperative negotiations, disagreement corresponds to a pro rata allocation (as a function of the size of the groups). We analyse the conditions (on the internal composition of the groups) under which conflict will be preferred to negotiated agreements (and vice versa), and we derive welfare implications. Finally, we provide results of comparative statics that highlight the influence of changes in the internal composition of groups and in their relative size on the profitability of negotiated agreements.

*Keywords:* Bargaining, conflict, agency problem.

*JEL codes:* C78, D74, J52.

## 1 Introduction

The issue of the prevalence of negotiated agreements over conflict has received a lot of attention in the recent decades. Even though the use of conflict is typically inefficient as it implies some waste of resources (a social cost), conflictual situations are widely observed in practice. More specifically, there are situations where two options exist: parties can decide to enter a negotiation

---

\*I am grateful to Santiago Sanchez-Pages and to participants at the CTN workshop in Marseille for helpful comments. Address: Queen's University Management School, Queen's University Belfast, 25 University Square, Belfast BT7 1NN (UK). E-mail: n.querou@qub.ac.uk.; Phone number: +44 (0)28 9097 3281.

protocol or a conflictual process. There are plenty of relevant examples that are consistent with such a situation.

In national sport leagues (US basketball, hockey as examples) collective bargaining agreements are basic contracts between the National League team owners and the Players Association. They are designed to be arrived at through the typical labour-management negotiations of collective bargaining. Regarding the National Hockey league, one of the most recent agreements was reached on July 2005 after a labor dispute which caused the cancellation of the 2004-2005 season. The contract was eventually ratified by the NHLPA membership and by the league's Board of Governors. In this example there are two groups, the team owners and the Players association. Even though negotiations resumed on July 2005, one could understand the final contract mainly as an outcome of a conflictual process between the two groups. Moreover this was obviously a conflict where both sides exerted costly efforts in order to influence the outcome.

Another relevant case is the problem of natural resource management. There are numerous examples of problems at the national or international level highlighting that parties sometimes decide to either follow a negotiation protocol or enter a conflict in order to lobby to influence the allocation process. For instance, in problems of fisheries management, quotas may result from international (this is currently a main issue in the European Union) or from local processes (involving cooperatives formed by fishermen, groups of environmentalists and local authorities). Parties have typically two types of choice at the beginning: entering a negotiation process or refusing to seat at the negotiation table and lobbying to influence the final outcome.

There are obviously other types of situation (collective bargaining/strikes, healthcare contracts,..) that would be consistent with the above description. In such situations, a negotiated agreement is socially preferable but groups can still decide to enter conflict. That is why it is important to understand the conditions under which groups will decide to enter one type of process (cooperative or conflictual) or the other.

The existing literature has mostly focused on situations where individuals are involved in the process, or where groups are uniform with respect to their members' individual preferences. In the present paper we consider a situation where two groups are involved in the process. A surplus has to be allocated either via a negotiated agreement, which is modeled by using the Nash bargaining solution (Nash (1950)), or by using conflict (which is

modeled by a costly contest as defined by Tullock (1980), and analysed in Hirshleifer (1989) or Skaperdas (1992)). Conflict will prevail if one group is willing to use it, while negotiation requires mutual consent. Members of a given group have differing valuations (either high or low) for the surplus. Each group chooses a representative who is given the authority to either negotiate cooperatively or to decide to engage the group in conflict. If conflict occurs then each group's member follows their leader's decision and individually decides how much effort to exert. We would like to stress that conflict should be understood in a quite wide perspective. Conflict should not be simply understood as military, but rather as a metaphore for unproductive and costly activities focused on the appropriation of the surplus (costly litigation, lobbying activities, strikes).

We provide conditions (linking individuals' characteristics with the internal structure and the relative size of each group) under which groups will decide to enter a negotiation protocol rather than a conflictual process (and vice versa). Specifically, the main conclusions are:

- There are cases where conflict is more likely to occur when groups have the same size;
- The emergence of negotiated agreements or conflict depends on the ratio of the valuations of members who value the most the surplus in both groups (that is, the high type members in both groups);
- When this ratio is sufficiently low (for one of the groups), a negotiated agreement is not sustainable;
- The situation is more complex when this ratio has moderate or large values. Whether cooperative bargaining is optimal or not depends qualitatively on structural conditions linking the internal composition of each group (whether members with high valuations of the surplus constitute the majority) with their relative size.

We conclude the analysis by providing results of comparative statics that highlight the influence of variations of the internal composition of each group on the range of situations for which negotiated agreements will prevail, and by deriving some implications regarding the structure of groups.

Our contribution can be related to two types of contribution. First, the present paper focuses on a problem of bargaining between groups. As in

most of this literature we make the assumption that, once the representative is chosen for each group, his preferences become those of the group.<sup>1</sup> However, the topic of this paper is quite different from most of the contributions on group bargaining that focus on non cooperative approaches (see Horn and Wolinsky (1988), Jun (1989), or Cai (2000)). Unlike these papers, we focus here on the conditions (regarding the groups' characteristics) under which negotiated agreements or conflict will emerge as equilibrium outcomes. Haller and Holden (1997) use the Nash bargaining solution and analyse the interplay between ratification requirement and a group's bargaining power. Again their perspective is quite different from the main points of the present analysis.

Secondly, this paper is related to the literature on negotiations and conflict. Various issues have been analysed so far. Anbarci et al. (2002) provide a comparison of several bargaining solutions (in terms of their relative efficiency) under the shadow of conflict. Baliga and Sjoström (2004) consider a situation where two agents simultaneously decide whether or not to go to war, and they highlight the potential benefit of cheap talk to maintain cooperation. Jackson and Morelli (2007) analyse a model where decision makers or two countries can either go to war or avoid it (by negotiating transfers), and they show how the incentives to rely on conflict depend on the decision makers' risk/reward ratio from a war. Ellingsen and Miettinen (2008) (pursuing the line of research initiated by Schelling (1956, 1963) and later on by Crawford (1982)) analyse a Nash demand game where negotiators might adopt different types of commitments. They show that, when commitment technologies are highly credible, and there is a small (vanishing) cost of commitment, there is a unique equilibrium where demands are incompatible. Sanchez-Page (2009) analyse a one-sided incomplete information bargaining model where the game ends with an agreement or an absolute conflict. However agents can opt for another option (limited conflict) in order to get information about the outcome of the absolute conflict. It is shown that war may have positive or negative effects on the whole process. Specifically, it can either create room for an agreement or lead to inefficiencies while bargaining is a feasible option.

---

<sup>1</sup>Notable exceptions are Ponsati and Sakovics (1996), who analyse how different preference aggregation protocols affect the bargaining outcomes, and Manzini and Mariotti (2005), who highlight the influence of differential information between members on the alliance behavior. By contrast the present paper focuses on the optimality of cooperative or conflictual behavior. It is assumed that each group uses majority voting, as this is the most widely used protocol.

We focus on understanding the reasons for the emergence of conflict or negotiated agreements as equilibrium outcomes. As such the present paper departs substantively from papers which focus on the analysis of how the shadow of conflict influences the nature of negotiated agreements (as in Anbarci et al. (2002)). In these papers agents anticipate the costs resulting from conflict. As a result they always agree on a negotiated agreement. By contrast we analyse (as in Jackson and Morelli (2007, 2009)) the incentives of decision makers to go to war or to rely on a negotiated agreement. We will show (as they do) that there are cases where entering a negotiation protocol or a costly conflict might become optimal. The main difference is that we allow explicitly for heterogeneous populations within each group (members with differing preferences), and we will show that the decision to enter negotiations or conflict depends on conditions that relate individuals' characteristics (members' valuations of the surplus) to group characteristics (internal composition, relative size). As such the present contribution complements those of the above papers by analysing the influence of collective characteristics on the emergence of one pattern of behavior at the equilibrium. Moreover, it extends the growing literature analysing the influence of collective structures on economic activities (see Brandts et al. (2009) for such a study in the context of rent seeking activities).

The paper is organized as follows. The model is introduced in Section 2. The payoffs resulting from cooperative bargaining and conflict are analysed in section 3. The full characterization of the equilibrium set and results of comparative statics are provided in section 4. The case where both groups have the same size and the general case are provided. Section 5 concludes. Some proofs are relegated in an appendix in section 6.

## 2 The model

### 2.1 Description of the situation

We consider a situation where a surplus  $\Phi$  has to be allocated between two groups  $G_1$  and  $G_2$  (of respective sizes  $n$  and  $m$ ). The allocation process can be specified as follows. First, each group chooses a representative who has full authority during the allocation process. Specifically, it is assumed that the members of a group are fully committed to the decision taken by their representative. Representatives are chosen by simple majority within each

group.<sup>2</sup> Members choose the representative such that the payoff resulting from this choice is maximal.

Second, the process enters the allocation stage. The representatives can either negotiate cooperatively (using the Nash bargaining solution) or they can decide that the groups will enter a conflict over the appropriation of the surplus. While cooperative negotiations require the consent of both parties, conflict will occur if only one representative is willing to use it. The surplus is allocated either by cooperative bargaining or the outcome of the costly contest (following recent contributions on the analysis of conflict, see Esteban and Ray (2008) among other examples). We will be more specific about the modeling of benefits and costs in the next section.

The share of the surplus secured is then used to fund group specific goods. More specifically, the problem analysed here focuses on situations where the outcome of the allocation process (shares of surplus for both parties) is characterized by rivalry in consumption and excludability at the inter-group level, but is non rival in consumption and non excludable at the intra-group level. This assumption is met in social settings where all members of a given group benefit from the share of the surplus secured. For instance, interest groups might negotiate or lobby to influence the allocation process; all members of one group benefit from the outcome. Unions and senior managers might bargain over wage increases or use conflict to force the decision. Wage increases benefit all workers: in case of conflict, they benefit both strikers and non strikers. From now on, thinking about groups as communities, we will assume that the surplus secured by each group is spent on (strictly) local public goods.

Members of each group have two possible types. They have either low or high valuation for local public goods. Specifically, let  $\theta_H^i$  (respectively,  $\theta_L^i$ ) denote the valuation of members of group  $i$  that are high type. The valuation of low type members in group  $i$  is denoted by  $\theta_L^i$ . It is assumed that  $\theta_H^i > \theta_L^i$  for each group  $i$ . Their internal composition is defined by a parameter  $n_i$  ( $i = 1, 2$ ), which denotes the number of high type members of group  $i$ .

At this stage of the description we would like to stress one important remark regarding the above process. During the second stage representatives can either choose to use a negotiation process or a conflict. In other words

---

<sup>2</sup>It is implicitly assumed that there is one candidate from each sub-population of agents in each group.



it is assumed that representatives have two possible choices: to go to or to avoid war. If both representatives decide to avoid war then this corresponds to a situation where they can sign some enforceable treaty so that they do not go to war provided that a mutually suitable allocation is chosen via negotiations. Even though we model negotiations as a cooperative bargaining process by using the Nash bargaining solution, we have to define what are usually called the threat points or disagreement payoffs. These would correspond to perpetual disagreement during negotiations. In the present case we assume a proportional situation, that is, we assume that the disagreement payoff of respectively groups 1 and 2 corresponding to the negotiation process are equal to

$$\frac{n}{n+m}\Phi_{dis}$$

and

$$\frac{m}{n+m}\Phi_{dis},$$

where  $\Phi_{dis}$  is the disagreement surplus, which is smaller than the surplus  $\Phi$  both groups can secure by negotiating successfully. In other words, it is assumed that, if both groups decide to avoid war but are yet not able to agree on a division of the surplus then they receive a share of the surplus according to a pro rata rule (or any division that is increasing in the relative size of a group). This implicitly assumes some sort of proportional representation, which makes sense when the surplus to be allocated is used for public spendings on (local) public goods. In such situations the pro rata allocation rule can be thought about as some sort of status quo allocation rule in case both parties agree to negotiate. In local funding related issues (healthcare for instance), it makes sense to use the relative population size to determine the status quo allocation rule.

## 2.2 Discussion of the assumptions

There are several features of the above model that deserve further comment. First, the above specification might correspond to a situation where there is a third party, which is acknowledged informally by both groups as having some ability to intervene in case a negotiation process is chosen but fails to provide an agreement. At the same time, this third party does not have any formal authority, which means that both groups can decide to go to war if they are willing to do so. With such an interpretation in mind, the question would become: If groups can either delegate their authority to a regulator (whose principles of distributive justice correspond to the Nash bargaining solution) or remain uncommitted and appropriate the surplus by conflict,

what is the influence of collective characteristics on the emergence of a social contract or conflict as an equilibrium outcome? It is important to notice that this third party would never intervene actually, since a mutually suitable (efficient) agreement would always result when both countries are willing to rely on a negotiation process.

Secondly, there is an important assumption about the payoffs of the groups corresponding to the situation where they agree to commit to the negotiation protocol but would fail to reach an agreement. Specifically, the disagreement payoffs corresponding to the negotiation process do not (necessarily) correspond to the payoffs resulting from conflict. Why is it so? The main starting point is that disagreement is not equivalent to conflict in the present setting. From a general point of view, there are many situations where agents could disagree on an issue but would not enter an open conflict since the latter could be very destructive. The present model would thus refer to situations where group representatives understand that there are circumstances where it is preferable to avoid war, even though negotiations do not necessarily lead to an (efficient) agreement. Another potential interpretation exists if one relies on the idea that the Nash bargaining solution would correspond to the principles of distributive justice of a regulator. In such a case the specifics of negotiations would rely on this regulator's principles, and the definition of the disagreement points would depend on his specification of the protocol. It could well be the case that the regulator would define what happens in case of disagreement during negotiations by relying on his knowledge about the characteristics of the groups. The relative size of the groups would then be a reasonably natural criterion. With this perspective in mind, the group representatives could decide to use conflict if they reject the course of action specified by the social contract offered by the regulator.

There is a final comment to be made. As explained above the specification of the disagreement payoffs adopted in the present setting seems to be reasonable and to make sense in certain situations, but one might argue that it could be the outcome of some endogenous process too. A first possibility would be to assume that it would follow from the agents' anticipation of (future) costs of conflict. In this case the situation would correspond to a problem under the shadow of conflict. This is not the kind of situation we want to analyse, as it takes the fact that both parties would seat at the negotiation table as granted. Moreover the usual conclusion is that conflict never occurs in such problems. We would like to stress that the main purpose of the present analysis is rather to understand the structural conditions (on collective characteristics) that would explain the emergence of either ne-

gotiated agreements or conflict. We want to understand why it is the case that agents might decide to seat at the negotiation table or refuse to do so. As such we do consider a setting where the options to negotiate and to use conflict are simultaneous rather than sequential.

A second possibility would be to consider a dynamic problem where both parties would have the opportunity to use either pattern of behavior at each period. This would allow for an endogenous definition of the disagreement payoffs corresponding to the option to negotiate. In such a situation the analysis of conditions under which one pattern of behavior or the other will dominate would be clearly interesting. However a first problem would be to analyse if there are conditions that could explain the existence of conflict. We want to focus on the influence of collective characteristics in the present setting. That is why we consider the present framework as appropriate since it enables us to focus specifically on this problem. Nonetheless, extending the present work to a dynamic setting is obviously an important point for future research.

### **2.3 Timing of the game and final remarks**

To summarize, the timing of the game is as follows. First, a representative is chosen by the members of a group.<sup>3</sup> Members choose a representative according to the (expected) payoff that will result from this choice. Secondly, the representatives of both groups decide whether they will negotiate cooperatively or they will fight over the appropriation of the surplus. Thirdly, the allocation is the Nash bargaining solution (where the disagreement point is defined by using a pro rata allocation rule), or the outcome of a costly contest. Finally, the resulting allocation is used to provide local public goods which are group specific.

Before concluding this section, let us be slightly more specific about the choice of the representatives. In the analysis there will be several instances where the equilibria of the overall game will not depend on the choice of the representative. In some other cases they will only depend on which type of agents constitutes the majority in the group considered. This depends on the following fact. The problem is similar to a voting process where there are only two alternatives, namely negotiating or using conflict. This implies that there is no difference (concerning the equilibrium outcomes) between

---

<sup>3</sup>The specific voting process that is used does not really matter, as it will become obvious in the analysis. As said previously, we will consider that the representative is chosen by simple majority.

the cases where agents use sincere or strategic voting to choose their representative in the present setting. Indeed there will be two options: either one pattern of behavior is clearly optimal for both types of members (in a given group), and the choice of the representative does not matter; or the preferred option differs within the group, which means that the agents' type which constitutes the majority will rule the election process. In the analysis we will not make a distinction between sincere and strategic voting, and we will mainly characterize the equilibrium outcomes (emergence of negotiated agreements or conflict).

In the next section we will solve the above game. Specifically, we will solve for the subgame perfect equilibrium (SPE) of the four stage game, and we will analyse the conditions under which negotiated agreements (or conflict) will prevail at the equilibrium.

### 3 Preliminaries: The contest and the cooperative bargaining games

As usual when dealing with subgame perfect equilibria, we will use backward induction arguments to analyse the model. In the present section we analyse the last stage of the process. We first derive the payoffs of each type of members in a given group when groups are involved in conflict or in cooperative bargaining.

#### 3.1 The contest game

If at least one representative has decided to use conflict as a way to appropriate the surplus, then a contest game occurs. As explained in the previous section, a representative has full authority over the decision to rely on bargaining or conflict. This means that all members of the group are committed to follow his decision. This has the following implication in the contest game. All members of a group are assumed to exert (costly) efforts to influence the overall probability of appropriating the surplus. We use a form of group contest success function that has been recently axiomatized (Munster (2009)). Specifically, if  $e_i^j$  denotes the effort exerted by member  $i$  of group  $j$ , then the probability that group  $j$  appropriates the surplus through conflict is  $\frac{\sum_{l \in G_j} e_l^j}{\sum_{l \in G_1} e_l^1 + \sum_{k \in G_2} e_k^2}$ , where  $j = 1, 2$  respectively. If no member exerts effort, then each group has probability  $\frac{1}{2}$  of appropriating the surplus. If group  $j$  does not win, it gets a zero payoff.

Concerning the equilibrium definition used in the contest game, we follow Esteban and Ray (2007). Specifically, an equilibrium in the contest game is defined as a vector of (non negative) levels of effort  $(e_1^{j*}, \dots, e_{|G_j|}^{j*})$  for any group  $j = 1, 2$  (where  $|G_1| = n$  and  $|G_2| = m$ ) such that, for any  $j = 1, 2$  and any  $i \in \{1, \dots, |G_j|\}$ , we have:

$$e_i^{j*} = \max_{e_i^j \geq 0} \frac{e_i^j + \sum_{l \neq i, l \in \{1, \dots, |G_j|\}} e_l^{j*}}{e_i^j + \sum_{l \neq i, l \in \{1, \dots, |G_j|\}} e_l^{j*} + \sum_{l \in \{1, \dots, |G_{-j}|\}} e_l^{-j*}} \theta_k^j \Phi - e_i^j, \quad (1)$$

where  $-j \neq j$ , and  $k = L, H$  denotes the type of member  $i$  of group  $j$ . In other words, member  $i$  of group  $j$  exerts the level of effort that maximizes his expected payoff in the contest, assuming that all other agents (other members of the same group, and members of the opposing group) exert their equilibrium level of effort.

We need several steps to derive the solution of this stage of the game. First, each group has incentives to exert a positive level of (aggregated) effort at the equilibrium. Indeed, if it is not the case then each group has the same chance to appropriate the surplus. It is straightforward to check that any member has incentives to increase his effort (assuming that all other agents exert no effort) by a small amount, as this increases the probability that his group wins the contest from  $\frac{1}{2}$  to 1.

A second point is that we will focus on symmetric equilibrium. Specifically, we will focus on equilibria where, for a given group, members of the same type exert the same level of effort. This implies that such an equilibrium is described by vectors  $(e_H^1, \dots, e_H^1, e_L^1, \dots, e_L^1)$  (for group 1) and  $(e_H^2, \dots, e_H^2, e_L^2, \dots, e_L^2)$  (for group 2) where the  $n_1$  (respectively,  $n_2$ ) first terms of the first (respectively, second) vector refer to the level of contribution of high type members of group 1 (respectively, of group 2), and the remaining terms to the level of contribution of low type members of group 1 (respectively, of group 2).

The next step is to consider the possible types of symmetric equilibrium. They can be described as follows (focusing on group 1):

1.  $e_H^1 > 0$  and  $e_L^1 > 0$
2.  $e_H^1 > 0$  and  $e_L^1 = 0$
3.  $e_H^1 = 0$  and  $e_L^1 > 0$

$$4. e_H^1 = 0 = e_L^1.$$

Case 4 has already been ruled out by the argument presented in the first point discussed above.

Let us focus on the first case. If such a case is valid, then the equilibrium levels of effort satisfy the following first order conditions (that are necessary and sufficient from (strict) concavity of expected payoffs (1)):

$$\frac{n_2 e_H^2 + (m - n_2) e_L^2}{[(n_1 - 1) e_H^1 + (n - n_1) e_L^1 + n_2 e_H^2 + (m - n_2) e_L^2 + e]^2} \theta_H^1 \Phi = 1,$$

for a high type member of group 1, and

$$\frac{n_2 e_H^2 + (m - n_2) e_L^2}{[n_1 e_H^1 + (n - n_1 - 1) e_L^1 + n_2 e_H^2 + (m - n_2) e_L^2 + e]^2} \theta_L^1 \Phi = 1,$$

for a low type member of group 1. Because  $\theta_H^1 \neq \theta_L^1$  a simple inspection of the above two first order conditions leads to the conclusion that they cannot be satisfied simultaneously. This rules out case 1.

This conclusion deserves further comment. It implies that intra group equilibrium levels of effort are characterized as follows. One type of members exert positive levels of effort while members from the other type do not contribute (they free ride on the efforts of others). This implication relies on the specific form of the rent seeking functions used in (1). With functions where the rent seeking technology is more general (for instance, with convex costs of effort) all members will exert positive levels of effort, but the members who previously did not contribute will still free ride on the efforts of others, that is, they will still exert a lower level of effort. This is intuitively perfectly consistent with the kind of situations we consider. Let us consider the example of union - management relationships as an illustrative example. If wage increases are the outcome of a conflict, they benefit both striking and non striking workers. As such workers have incentives to free ride and to not participate in strike. This is the exact meaning of the above conclusion. We will keep the above form of rent seeking technology as this will enable us to present results in the simplest possible form.

Let us come back to the analysis. We now analyse the conditions under which the equilibrium levels of effort could correspond to either case 2 or case 3. Let us first consider that case 2 is satisfied, that is, we have:

$$e_H^1 > 0, e_L^1 = 0.$$

Then this is equivalent to assuming that the expected payoff of low type member of group 1 is a decreasing function of his own level of effort. Thus, differentiating expression (1) with respect to  $e_L^1$ , we have:

$$\frac{n_2 e_H^2 + (m - n_2) e_L^2}{[n_1 e_H^1 + (n - n_1) e_L^1 + n_2 e_H^2 + (m - n_2) e_L^2]^2} \theta_L^1 \Phi \leq 1.$$

Moreover, assuming positive levels of effort for high type members of group 1,  $e_H^1$  is then characterized by the following condition:

$$\frac{n_2 e_H^2 + (m - n_2) e_L^2}{[n_1 e_H^1 + (n - n_1) e_L^1 + n_2 e_H^2 + (m - n_2) e_L^2]^2} \theta_H^1 \Phi = 1.$$

Combining the above two conditions, we obtain that

$$[n_2 e_H^2 + (m - n_2) e_L^2] \theta_L^1 \Phi \leq [n_2 e_H^2 + (m - n_2) e_L^2] \theta_H^1 \Phi.$$

Simplifying, we deduce the equivalent expression:

$$\theta_L^1 \leq \theta_H^1,$$

which is always satisfied. Thus case 3 is never valid at the equilibrium.

Now we are in a position that enables us to characterize the optimal levels of effort. We know that necessarily  $e_L^1 = e_L^2 = 0$  at the equilibrium. Moreover,  $(e_H^1, e_H^2)$  is the solution to the system defined by the following conditions (for  $j = 1, 2$ ):

$$\frac{n_{-j} e_H^{-j}}{[n_1 e_H^1 + n_2 e_H^2]^2} \theta_H^j \Phi = 1.$$

We derive the following equality:

$$n_2 e_H^2 \theta_H^1 = n_1 e_H^1 \theta_H^2$$

which leads to the following relation between  $e_H^1$  and  $e_H^2$ :

$$e_H^2 = \frac{n_1 \theta_H^2}{n_2 \theta_H^1} e_H^1.$$

Plugging it into the first order condition and solving for  $e_H^1$ , we obtain:

$$e_H^1 = \frac{\frac{\theta_H^2}{n_1}}{[1 + \frac{\theta_H^2}{\theta_H^1}]^2} \Phi.$$

We finally obtain the following expression of the expected payoff of a high type member of group 1:

$$EU_H^1 = \frac{\theta_H^1 + \frac{n_1-1}{n_1}\theta_H^2}{[1 + \frac{\theta_H^2}{\theta_H^1}]^2}\Phi,$$

and the expected payoff of a low type member of group 1 is as follows:

$$EU_L^1 = \frac{\theta_L^1}{1 + \frac{\theta_H^2}{\theta_H^1}}\Phi.$$

To understand the difference between these two expressions, one needs to keep in mind that low type members do not exert effort at the equilibrium. Thus, they do not bear the burden of conflict.

We conclude the section by summing up their main findings.

**Proposition 3.1.** *If conflict occurs at the final stage of the game, then a high type member of group  $j$  obtains the following expected payoff (for  $j = 1, 2$ ):*

$$EU_H^j = \frac{\theta_H^j + \frac{n_j-1}{n_j}\theta_H^{-j}}{[1 + \frac{\theta_H^{-j}}{\theta_H^j}]^2}\Phi.$$

*The (expected) payoff secured by low type members is:*

$$EU_L^j = \frac{\theta_L^j}{1 + \frac{\theta_H^{-j}}{\theta_H^j}}\Phi.$$

In the next section we will analyse the outcome of the game at the final stage if representatives decide to allocate the surplus by using a negotiated arrangement.

### 3.2 The cooperative bargaining game

If both representatives decide to choose a negotiated arrangement, then the allocation corresponds to the Nash bargaining solution. To define the solution we need to specify the disagreement point, that is, the allocation that results from (perpetual) disagreement.

First, it is assumed that the disagreement surplus is  $\Phi_{dis} < \Phi$ , that is, the



surplus shrinks down in case of disagreement. This might correspond to a situation where groups are allocated funding by local authorities. To provide incentives to reach an agreement the surplus available is larger if the two communities agree on an allocation than if they disagree perpetually.

Second, each representative obtains a share of the disagreement surplus that is a function of the relative size of his own group. Again, this is an intuitive assumption as there are several real life examples where communities are allocated funding on the basis of their (relative) size.

Now we are in a position to derive the optimal allocation of the surplus if representatives rely on a negotiated arrangement. Let us denote this allocation by  $(\alpha^*, 1 - \alpha^*)$  where  $\alpha^* \in [0, 1]$  denotes the share of the surplus allocated to the representative of the first group. Then  $\alpha^*$  is the solution to the following problem:

$$\max_{\alpha \in [0, 1]} \left\{ \theta_i^1 \alpha \Phi - \theta_i^1 \frac{n}{n+m} \Phi_{dis} \right\} \left\{ \theta_j^2 (1 - \alpha) \Phi - \theta_j^2 \frac{m}{n+m} \Phi_{dis} \right\},$$

where  $i, j = L, H$  denotes the type of the representative of group 1 (respectively, group 2). It can be immediately checked that  $0 < \alpha^* < 1$  because of the specification of the disagreement point. Thus the optimal share is characterized by the following first order condition:

$$\theta_i^1 \Phi \left\{ \theta_j^2 (1 - \alpha^*) \Phi - \theta_j^2 \frac{m}{n+m} \Phi_{dis} \right\} - \theta_j^2 \Phi \left\{ \theta_i^1 \alpha^* \Phi - \theta_i^1 \frac{n}{n+m} \Phi_{dis} \right\} = 0.$$

Simplifying, we obtain:

$$\left\{ (1 - \alpha^*) \Phi - \frac{m}{n+m} \Phi_{dis} \right\} = \left\{ \alpha^* \Phi - \frac{n}{n+m} \Phi_{dis} \right\}.$$

Now solving for  $\alpha^*$  we obtain:

$$\alpha^* = \frac{1}{2} + \frac{1}{2} \left[ \frac{n}{n+m} - \frac{m}{n+m} \right] \frac{\Phi_{dis}}{\Phi}.$$

We can now recap the main findings of the present section as follows:

**Proposition 3.2.** *Assume that representatives decide to rely on a negotiated arrangement. Then the resulting payoff for  $i$  type members of group 1 (where  $i = L, H$ ) is given by the following expression*

$$\Pi_i^1 = \theta_i^1 \left\{ \frac{1}{2} + \frac{1}{2} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right\} \Phi.$$

Respectively, the payoff for  $i$  type members of group 2 (where  $i = L, H$ ) is given by the following expression:

$$\Pi_i^2 = \theta_i^2 \left\{ \frac{1}{2} + \frac{1}{2} \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi} \right\} \Phi.$$

Before concluding the present section let us make an additional comment. The negotiated arrangement described in proposition 2.2 is efficient by definition of the Nash bargaining solution. The allocation resulting from conflict is obviously inefficient due to the social cost that is beared by both groups.

## 4 Characterization

Going backward, we now proceed with the analysis of the first two stages of the process. Specifically, we will focus in the next section on the incentives of each group to rely on conflict or negotiations by analysing the delegation problem, and we will characterize the equilibria of the full game. In this section we will first provide the analysis for the symmetric case, that is, the situation where both groups have the same size ( $n = m$ ), in order to provide preliminary insights. We will then develop the full analysis of the general case, which will enable us to highlight some qualitative differences between the symmetric and general cases. Finally, we will provide results of comparative statics and some general implications resulting from these results.

### 4.1 The symmetric case

#### 4.1.1 Conflict or negotiated agreement?

We now go one step backward and we analyse the incentives of each type of member to opt for conflict or negotiation. Again an important feature of the model must be kept in mind. One can highlight it by focusing on the case of the contest game.

If at least one representative decided to use conflict, then we know (by proposition 2.1) that low type members of each group will (to some extent) free ride on the efforts of high type members. This does not depend on the identity of the representative of the group. There is however a main difference when a high type member represents the group and when this is not the case. If such a member is the representative then he can decide to either negotiate or fight, depending on what is optimal for him. If he is not, then he cannot decide and must follow the leader's decision. In other words, one

could expect strategic incentives from low type members to rely on conflict as they do not bear most of the burden resulting from conflict. The analysis that follows will highlight this point (among others), and will focus mainly on the conditions (on the intra and inter group compositions, and on individual characteristics as well) that guarantee that negotiated arrangements will prevail over conflict (and vice versa).

Let us now proceed with the analysis. The first step is to understand the conditions under which one allocation method prevails over the other. We will focus on the case of group 1 for the exposition of the conditions (the case of group 2 is symmetric). From proposition 2.2, we know that, provided the representatives decided to negotiate, the payoff of a type  $i$  member is then given by:

$$\Pi_i^1 = \theta_i^1 \left\{ \frac{1}{2} + \frac{1}{2} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right\} \Phi. \quad (2)$$

Now, if at least one representative is willing to use conflict, using proposition 2.1 the payoff of a high type member becomes

$$EU_H^1 = \frac{\theta_H^1 + \frac{n_1-1}{n_1} \theta_H^2}{\left[1 + \frac{\theta_H^2}{\theta_H^1}\right]^2} \Phi, \quad (3)$$

and the expected payoff of a low type member is

$$EU_L^1 = \frac{\theta_L^1}{1 + \frac{\theta_H^2}{\theta_H^1}} \Phi. \quad (4)$$

Let us first consider the case of a high type member. Using expressions (2) and (3) and simplifying, we find that whether conflict is preferable than negotiation is equivalent to the following condition:

$$EU_H^1 \geq \Pi_H^1 \iff 1 + \frac{n_1-1}{n_1} \frac{\theta_H^2}{\theta_H^1} \geq \left[1 + \frac{\theta_H^2}{\theta_H^1}\right]^2 \left\{ \frac{1}{2} + \frac{1}{2} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right\}.$$

To highlight the main features of the analysis in a simple benchmark, we focus first on the case where the two groups have the same size, that is, where  $n = m$ . This has the advantage of simplifying the above condition as follows:

$$EU_H^1 \geq \Pi_H^1 \iff 1 + \frac{n_1-1}{n_1} \frac{\theta_H^2}{\theta_H^1} \geq \left[1 + \frac{\theta_H^2}{\theta_H^1}\right]^2 \frac{1}{2}.$$

The right hand side term is a polynomial function of the ratio  $\frac{\theta_H^2}{\theta_H^1}$ ; developing it leads to the following expression:

$$-\left(\frac{\theta_H^2}{\theta_H^1}\right)^2 - \frac{2}{n_1} \frac{\theta_H^2}{\theta_H^1} + 1 \geq 0.$$

Solving for  $\frac{\theta_H^2}{\theta_H^1}$ , we obtain the following properties:

1. When  $\frac{\theta_H^2}{\theta_H^1} \in ]0, \frac{1}{n_1}[\sqrt{1 + (n_1)^2} - 1][$  then high type members prefer conflict over negotiated arrangements;
2. When  $\frac{\theta_H^2}{\theta_H^1} \geq \frac{1}{n_1}[\sqrt{1 + (n_1)^2} - 1]$  then high type members are willing to rely on negotiations.

The above properties highlight the way both the structure of group 1 (via parameter  $n_1$ ) and the characteristics of high members of each group (via the ratio  $\frac{\theta_H^2}{\theta_H^1}$ ) influence the profitability of conflict and negotiations for high type members of group 1. This depends on how the valuation of high type members of the other group compares with respect to their own valuation. When  $\theta_H^2$  is sufficiently large, then high type members of group 2 are more willing to provide efforts during conflict than similar members in group 1. They realize that they will lose more by relying on conflict than on negotiations. When the comparison of the valuations is reversed then high type members of group 1 have incentives to rely on an aggressive strategy.

Let us now consider the case of low type members. Using expressions (2) and (4) it is straightforward to conclude that conflict is preferred to negotiations if and only if the following inequality holds:

$$\frac{1}{2} - \frac{1}{2} \frac{\theta_H^2}{\theta_H^1} \geq 0,$$

or

$$\theta_H^1 \geq \theta_H^2.$$

Now we are in a position to state the main result when groups have the same size.

**Proposition 4.1.** *Let us consider the case where groups have the same size, that is,  $n = m$ . It can be described as follows (where  $i, j = 1, 2$  and  $i \neq j$ ):*

- When  $\frac{\theta_H^j}{\theta_H^i} \in ]0, \frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1][$ , then all members of group  $i$  prefer conflict over negotiations;
- When  $\frac{\theta_H^j}{\theta_H^i} \in [\frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1], 1[$ , then high type members of group  $i$  are willing to rely on negotiations, while low type members prefer conflict;

- Finally, when  $\frac{\theta_H^j}{\theta_H^i} \geq 1$ , then all members of group  $i$  prefer a negotiated arrangement.

*Proof.* In the Appendix. □

The above proposition describes the situation when groups have the same size. In this case the profitability of conflict over negotiation does not depend on the relative size of the groups, but on a relationship between their internal composition (via parameter  $n_i$ ) and the members' characteristics (via the ratio  $\frac{\theta_H^j}{\theta_H^i}$ ).

There are several interesting implications. First, for low and high values of ratio  $\frac{\theta_H^j}{\theta_H^i}$  the situation is simple as it corresponds to a case of common opinion within each group. For low values of  $\frac{\theta_H^j}{\theta_H^i}$  then all members of group  $i$  prefer an aggressive strategy, while they unanimously prefer a negotiated arrangement when this ratio becomes sufficiently large.

Second, there is internal disagreement over which strategy should be preferred for intermediate values of the ratio. In such cases members with a high valuation would prefer negotiations, while members with a low valuation would prefer an aggressive strategy. This means that the choice of the representative will depend on an additional parameter (compared to the cases depicted previously), namely the type of agents who constitute the majority within each group.

Let us proceed with the final step of the analysis of the equilibrium. We will provide conditions under which either conflict or negotiation will prevail by analysing the choice of the representatives for each group, taking the choice of the other representative as given.

#### 4.1.2 Characterization of the equilibrium set

Going one more step backward, we reach the first stage of the game, namely the choice of the representative. This choice will then determine whether conflict or negotiation will prevail at the equilibrium. This will enable us to provide implications regarding the optimal structure of the groups, that is, to assess the conditions (on the internal structure of each group and on their relative size as well) that would ensure that negotiated arrangements prevail at the equilibrium. Since conflict yields a loss of the surplus, it is obvious that negotiated arrangements are (socially) preferable.

The final part of the characterization of the equilibrium is relatively straightforward. Specifically, we characterized in section 2.3 the optimal strategy for each type of members within a single group. Now we need to derive the implications of this characterization when the strategy of the two groups are considered simultaneously.

Let us focus first on the case of groups with the same size. Coming back to the results provided in proposition 2.3 there are three cases to consider. If  $\frac{\theta_H^j}{\theta_H^i} \in ]0, \frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1][$ , then we know that all members of group  $i$  prefer conflict over negotiations. At the same time we have  $\frac{\theta_H^i}{\theta_H^j} \in ]\frac{n_i}{\sqrt{1 + (n_i)^2} - 1}, +\infty[$ , which implies that all members of group  $j$  would prefer a negotiated arrangement. Indeed, one can check immediately that

$$\frac{n_i}{\sqrt{1 + (n_i)^2} - 1} > 1,$$

which leads to the above conclusion by using the third case in proposition 2.3 for group  $j$ . In such a situation it follows then that conflict will be the outcome of the game, and this is independent from the specific choice of representative for each group.

When  $\frac{\theta_H^j}{\theta_H^i} \in [\frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1], 1[$ , then we know that high type members of group  $i$  are willing to rely on negotiations, while low type members prefer conflict. Again, since this implies that  $\frac{\theta_H^i}{\theta_H^j} \in ]1, \frac{n_i}{\sqrt{1 + (n_i)^2} - 1}]$  then it follows from the third case in proposition 2.3 that all members of group  $j$  would prefer a negotiated arrangement. This has an important implication, namely that the outcome of the game depends on the internal composition of group  $i$ . Specifically, if high type members constitute the majority, then we know that a high type representative will be chosen in group  $i$ , who would be willing to use a cooperative agreement. In such a case negotiation is favored by both groups, and a negotiated arrangement will prevail. Now if high type members are a minority in group  $i$ , then conflict will be chosen by group  $i$  and this will be the outcome of the game.

Finally, when  $\frac{\theta_H^j}{\theta_H^i} \geq 1$ , then all members of group  $i$  prefer a negotiated arrangement. This implies that  $\frac{\theta_H^i}{\theta_H^j} \in ]0, 1]$  and this has two possible implications for the optimal strategy within group  $j$ . Specifically, we have:

1. Either  $\frac{\theta_H^i}{\theta_H^j} \in ]0, \frac{1}{n_j}[\sqrt{1 + (n_j)^2} - 1][$  and we conclude that all members

of group  $j$  prefer conflict over negotiations;

2. Or  $\frac{\theta_H^i}{\theta_H^j} \in ]\frac{1}{n_j}[\sqrt{1 + (n_j)^2} - 1], 1]$  and then high type members of group  $j$  are willing to rely on negotiations, while low type members prefer conflict.

In the first sub case we can conclude that conflict will be the outcome of the game, as this would be the optimal strategy for group  $j$ . In the second sub case a negotiated arrangement will prevail if high type members constitute the majority in group  $j$ , while conflict will emerge if they are a minority.

To summarize, we obtain:

**Theorem 1.** *Let us consider the case where groups have the same size. The situation can be characterized as follows:*

1. If  $\frac{\theta_H^2}{\theta_H^1} \in ]0, \frac{1}{n_1}[\sqrt{1 + (n_1)^2} - 1][$  then conflict is the outcome of the game. The conclusion does not depend on the choice of the representatives.
2. If  $\frac{\theta_H^2}{\theta_H^1} \in [\frac{1}{n_1}[\sqrt{1 + (n_1)^2} - 1], 1[$  then two sub cases can occur:
  - (a) if high type members constitute the majority in group 1, then a cooperative agreement will prevail.
  - (b) Otherwise conflict is the outcome of the game.
3. If  $\frac{\theta_H^2}{\theta_H^1} \geq 1$  then two sub cases can occur:
  - (a) Either  $\frac{\theta_H^1}{\theta_H^2} \in ]0, \frac{1}{n_2}[\sqrt{1 + (n_2)^2} - 1][$  and then conflict is the outcome of the game;
  - (b) Or  $\frac{\theta_H^1}{\theta_H^2} \in [\frac{1}{n_2}[\sqrt{1 + (n_2)^2} - 1], 1]$  and then a negotiated arrangement will prevail if high type members constitute the majority in group 2, while conflict will be the outcome of the game otherwise.

There are several interesting implications to the above result.

First, one might expect conflict to be a frequent outcome of the game. More precisely, when the ratio of high type members' valuations  $\frac{\theta_H^j}{\theta_H^i}$  is either sufficiently low or high then a negotiated agreement is not sustainable. This implication was quite expected as conflict will prevail as soon as at least one party will find it profitable, while a negotiated agreement requires mutual consent.

The intuition is as follows. Let us focus on the case where  $\frac{\theta_H^j}{\theta_H^i}$  is low, the second case is symmetric once the role of each group is reversed. In such a situation high type members of group  $i$  value the funding for local public goods much more than high type members in group  $j$ , which increases the incentives of high type members in group  $i$  to exert efforts to appropriate the surplus. This increases the chance that group  $i$  will indeed appropriate the surplus, which in turn increases the incentives for Low type members of group  $i$  to choose conflict as well. Thus all members of group  $i$  favor conflict over negotiation, and conflict will prevail.

Second, the optimality of negotiated arrangements crucially depend on the internal composition of the groups. Specifically, if members with a high valuation for (local) public goods constitute the majority in both groups, then a negotiated agreement will be optimal provided that  $\frac{\theta_H^j}{\theta_H^i}$  satisfies the following condition:

$$\frac{\theta_H^j}{\theta_H^i} \in [s_i, s_j] := \left[ \frac{1}{n_i} [\sqrt{1 + (n_i)^2} - 1], \frac{n_j}{\sqrt{1 + (n_j)^2} - 1} \right]. \quad (5)$$

The above condition depends obviously on the specific values of parameters  $n_i$  and  $n_j$ , namely, the number of high type members in each group. In other words, whether cooperative bargaining is optimal or not depends qualitatively on whether high type members constitute the majority in at least one group or not. Then, provided it is the case, negotiation will emerge at the equilibrium for intermediate values of the ratio  $\frac{\theta_H^j}{\theta_H^i}$ .

The intuition is as follows. For intermediate values of this ratio the situation is balanced in that the valuations of the high type members in each group are approximately the same. As such conflict becomes less attractive compared to negotiation. More precisely, for values of the ratio  $\frac{\theta_H^j}{\theta_H^i}$  close to, but below 1, the loss of surplus resulting from conflict outweighs the potential gains for all members of group  $j$ , and for high type members of group  $i$ . This decreases the incentives of high type members to exert effort in group  $i$ . However, conflict would still be preferable for low type members of group  $i$  (the potential gain has decreased compared to the first case, but they mostly free ride during conflict). As such for cooperative bargaining to occur it is necessary that high type constitute the majority in group  $i$ .



## 4.2 The general case

Now we come back to the general case where the two groups may have different sizes. The next result will highlight the main difference in such a situation. Specifically it becomes more complex as there is an added dimension, that is, whether the first or second group is the largest one. This will make the analysis more complex, as the description of the ranges over which conflict/negotiation is preferred will be less straightforward.

### 4.2.1 Conflict or negotiated agreement?

From expressions (2) and (3) conflict is profitable for high type members of group 1 if and only if the following inequality holds:

$$\frac{1 + \frac{n_1-1}{n_1} \frac{\theta_H^2}{\theta_H^1}}{[1 + \frac{\theta_H^2}{\theta_H^1}]^2} \geq \left\{ \frac{1}{2} + \frac{1}{2} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right\},$$

or

$$1 + \frac{n_1-1}{n_1} \frac{\theta_H^2}{\theta_H^1} \geq [1 + \frac{\theta_H^2}{\theta_H^1}]^2 \left\{ \frac{1}{2} + \frac{1}{2} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right\}.$$

Developping the above expression and simplifying, high type members of group 1 prefer an aggressive strategy if and only if the ratio  $\frac{\theta_H^2}{\theta_H^1}$  satisfies the following inequality:

$$-\frac{1}{2} \left[ 1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right] \left( \frac{\theta_H^2}{\theta_H^1} \right)^2 - \left[ \frac{1}{n_1} + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right] \frac{\theta_H^2}{\theta_H^1} + \frac{1}{2} \left[ 1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right] \geq 0. \quad (6)$$

This is a polynomial expression of the form  $a \left( \frac{\theta_H^2}{\theta_H^1} \right)^2 + b \frac{\theta_H^2}{\theta_H^1} + c$ ; thus, we know that the above inequality will never hold if

$$\Delta = b^2 - 4ac = \frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1 < 0.$$

Second, provided that  $\Delta \geq 0$  then it can be checked that the following conclusion holds:

- Condition (6) is satisfied on  $\left[ 0, \frac{\sqrt{\frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_1} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} \right]$ ;
- Condition (6) does not hold on  $\left] \frac{\sqrt{\frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_1} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}, +\infty \right[$  (negotiation is preferred over conflict).

Now it remains to assess the sign of  $\Delta$ . The first thing to note is that  $\Delta$  is positive if the first group is larger than the second one. Indeed, if  $n \geq m$  then  $\Delta = \frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1 > 0$  since it is the sum of three positive terms.

Let us then consider that  $m > n$ ; this is not sufficient to ensure that  $\Delta$  be negative. More precisely, we must have

$$\frac{1}{n_1} + n_1 < 2 \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}. \quad (7)$$

Since  $2 \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} < 2$ , then the only case where the above inequality could hold is  $n_1 = 1$ . As this would depend on the specific value of the ratio  $\frac{\Phi_{dis}}{\Phi}$ , we will assume instead that either the internal composition of group 1 or the value of  $\frac{\Phi_{dis}}{\Phi}$  is such that condition (7) does not hold. Thus, we consider from now on that  $\Delta$  is positive.

Let us now analyse the strategy of low type members in the first group. From expressions (2) and (4) conflict is profitable if and only if the following inequality holds:

$$\frac{1}{1 + \frac{\theta_H^2}{\theta_H^1}} \geq \left\{ \frac{1}{2} + \frac{1}{2} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right\},$$

or

$$1 \geq \left[ 1 + \frac{\theta_H^2}{\theta_H^1} \right] \left\{ \frac{1}{2} + \frac{1}{2} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right\}.$$

Developping the above expression and simplifying, low type members of group 1 prefer an aggressive strategy if and only if the ratio  $\frac{\theta_H^2}{\theta_H^1}$  satisfies the following inequality:

$$\frac{\theta_H^2}{\theta_H^1} \leq \frac{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}. \quad (8)$$

Combining the conclusions obtained for the two types of agents, we obtain the following result:

**Proposition 4.2.** *In the general case ( $n \neq m$ ) the situation can be described as follows (where  $i, j = 1, 2$  and  $i \neq j$ ):*

- When  $\frac{\theta_H^j}{\theta_H^i} \in ]0, \frac{\sqrt{\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} + 1 - \frac{1}{n_i} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} [$ , then all members of group  $i$  prefer conflict over negotiations;

- When  $\frac{\theta_H^j}{\theta_H^i} \in \left[ \frac{\sqrt{\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} + 1 - \frac{1}{n_i} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}, \frac{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} \right]$ , then high type members of group  $i$  are willing to rely on negotiations, while low type members prefer conflict;
- Finally, when  $\frac{\theta_H^j}{\theta_H^i} \geq \frac{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}$ , then all members of group  $i$  prefer a negotiated arrangement.

*Proof.* In the Appendix. □

The qualitative implications of the above proposition are similar than in the case of groups of identical size. However, there is an additional property when groups have different sizes. It follows from inspection that the set of values of the ratio  $\frac{\theta_H^j}{\theta_H^i}$  for which a negotiated agreement is unanimously preferred within group  $i$  becomes larger compared to the case where groups have the same size. More precisely, the lower bound of this set becomes smaller as soon as  $n \neq m$  (this is obvious looking at the third case in proposition 2.4).

#### 4.2.2 Characterization of the equilibrium set

Now we would like to check if the conclusions obtained in section hold in the general case. For instance, it would be interesting to understand what would happen if one group dominates the other in terms of its size. Would conflict be more likely to occur than in the benchmark case? From a general point of view it is important to understand the specific influence of the relative size of the groups. This is the aim of the present section.

Let us first describe the outcome of the game. We can rely on the same arguments than in the proof of Theorem 1 to obtain the following result:

**Theorem 2.** *Let us consider the general case ( $n \neq m$ ). The situation can be characterized as follows:*

1. If  $\frac{\theta_H^2}{\theta_H^1} \in ]0, \frac{\sqrt{\frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} + 1 - \frac{1}{n_1} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} [$  then conflict is the outcome of the game. The conclusion does not depend on the choice of the representatives.
2. If  $\frac{\theta_H^2}{\theta_H^1} \in \left[ \frac{\sqrt{\frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} + 1 - \frac{1}{n_1} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}, \frac{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} \right]$  then two sub cases can occur:

- (a) if high type members constitute the majority in group 1, then a cooperative agreement will prevail.
- (b) Otherwise conflict is the outcome of the game.
3. If  $\frac{\theta_H^2}{\theta_H^1} \geq \frac{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}$  then three sub cases can occur:
- (a) If  $\frac{\theta_H^1}{\theta_H^2} \in ]0, \frac{\sqrt{\frac{1}{(n_2)^2} + \frac{2}{n_2} \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}} + 1 - \frac{1}{n_2} - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}} [$  then conflict is the outcome of the game;
- (b) In case  $\frac{\theta_H^1}{\theta_H^2} \in ] \frac{\sqrt{\frac{1}{(n_2)^2} + \frac{2}{n_2} \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}} + 1 - \frac{1}{n_2} - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}, \frac{1 - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}} [$  then a negotiated arrangement will prevail if high type members constitute the majority in group 2, while conflict will be the outcome of the game otherwise;
- (c) Finally, provided that  $\frac{\theta_H^1}{\theta_H^2} \in \left[ \frac{1 - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}, \frac{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} \right]$  a negotiated agreement will prevail.

*Proof.* In the Appendix. □

The qualitative implications of the general case are similar to those of the case where groups have the same size for most cases. There is a notable difference, namely sub case 3, point c. When groups have different sizes there now exists a set of situations where the optimality of negotiated agreements does not depend on their internal composition. This set does not exist when groups have the same size. This implies that in this sub case conflict is less likely to occur when groups do not have the same size or, in other words, when groups are differentiated by the negotiation protocol (as a function of their relative sizes).

### 4.3 Comparative statics

We conclude the analysis by providing results of comparative statics regarding the influence of the fundamentals of the problem on the range of situations for which a negotiated agreement will prevail. We will provide separate results for the symmetric and general cases (because of the differences in the characterization of equilibria), and we will discuss potential implications.

### 4.3.1 The symmetric case

In the present sub section we will try to understand how the number of high type members in each group influences the range of parameters over which negotiated arrangements will prevail. To answer this question we now provide a few results of comparative statics.

The main result can be stated as follows.

**Proposition 4.3.** *Let us consider  $s_i$  and  $s_j$  as defined in (5). Then we have the following properties:*

- $s_i$  increases with an increase in the proportion of high type members in group  $i$  (as measured by  $n_i$ );
- $s_j$  decreases with an increase in the proportion of high type members in group  $j$  (as measured by  $n_j$ ).

*Proof.* In the Appendix. □

The above proposition has several interesting implications. Let us first consider that high type members constitute the majority in both groups. In such a case negotiated arrangements prevail for values of the ratio  $\frac{\theta_H^j}{\theta_H^i}$  lying in the interval  $[s_i, s_j]$ . From proposition 2.5 we deduce that this interval shrinks down as the number of high type members increases in either groups.

Let us focus on the case of group  $i$ . An increase in the number of high type members in the other group has two opposite effects. On one side it has a positive effect as it increases the probability that high type members constitute the majority in group  $j$ , which increases the chance of a negotiated agreement (which is preferred by group  $i$ ). On the other side such an increase has a negative effect on the size of interval  $[s_i, s_j]$ .

Now we move on to the general case, and we will check whether the above qualitative properties continue to hold. Then we will provide some general implications of the results.

### 4.3.2 The general case

We can use theorem 2 to characterize the set of situations where negotiated agreements will prevail. We focus on the ideal case where high type members constitute the majority in both groups. Then from points 2a), 3b) and 3c)

we can conclude that negotiation is optimal when the ratio  $\frac{\theta_H^2}{\theta_H^1}$  satisfies the following condition:

$$\frac{\theta_H^2}{\theta_H^1} \in \left[ \frac{\sqrt{\frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_1} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}, \frac{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{\sqrt{\frac{1}{(n_2)^2} + \frac{2}{n_2} \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_2} - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}} \right]. \quad (9)$$

We can now provide results of comparative statics. Let us introduce the following notations:

$$th_1 = \frac{\sqrt{\frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_1} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}},$$

and

$$th_2 = \frac{\sqrt{\frac{1}{(n_2)^2} + \frac{2}{n_2} \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_2} - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}.$$

We can provide interesting insights about the influence of the parameters of the problem on the value of  $th_i$  which in turn will enable us to assess the influence of the internal composition and the relative size of each group, and of the specification of the disagreement surplus  $\Phi_{dis}$ , on the relative optimality of negotiated agreements over conflict.

We obtain the following result:

**Proposition 4.4.** *The influence of the structural parameters of the game is described below (where  $i \neq j$ ):*

- *Threshold  $th_i$  ( $i = 1, 2$ ) decreases with an increase in the value of the disagreement surplus  $\Phi_{dis}$ .*
- *It decreases as the size of group  $i$  increases.*
- *It increases as the size of group  $j$  increases.*
- *It increases as the number of high type members in group  $i$  increases.*

*Proof.* In the Appendix. □

Using proposition 3.4 we can now assess the influence of the structural parameters on the optimality of negotiated agreements.

**Lemma 4.1.** *We have the following results:*

- *The interval (9) expands as the value of the disagreement surplus  $\Phi_{dis}$  increases.*
- *It shrinks down as the number of high type members in group  $i$  ( $i = 1, 2$ ) increases.*
- *The effect of an increase in the size of one group is ambiguous.*

*Proof.* • From the first point in proposition 4.4 we know that an increase in the value of the disagreement surplus  $\Phi_{dis}$  will result in a decrease of the value of the first bound defining the interval (9). Moreover, the upper bound is equal to  $\frac{1}{th_2}$ ; as such one can immediately check<sup>4</sup> that an increase in the value of  $\Phi_{dis}$  will result in an increase in the value of the upper bound. This concludes the proof.

- From the last point in proposition 4.4 we know that an increase in the number of high type members in group 1 will result in an increase in the value of the lower bound defining the interval (9). An increase in the number of high type members in group 2 will result in a decrease in the value of the upper bound defining it. This concludes the proof.
- Finally, let us focus on the influence of an increase in  $n$ . The first bound defining (9) will then increase, and the second bound will decrease. This concludes the proof of the lemma. □

There are several implications following from the above result. First, the effects of the disagreement surplus and of the proportion of high type members (in each group) are clear. Increasing  $\Phi_{dis}$  will contribute to making negotiated arrangements more profitable compared to conflict, while the effect will be exactly the opposite for an increase in the proportion of high type members.

Second, it is not possible to sign the effect of an increase in the size of a particular group. This is quite logical as such an increase has an opposite effect on the payoff secured by agents who have the same type but are members of different groups. Thus, this affects the profitability of negotiation over conflict in two opposite ways.

---

<sup>4</sup>Since  $(\frac{1}{th_2})' = -\frac{(th_2)'}{(th_2)^2}$ .

### 4.3.3 Implications

From a general point of view we can conclude that the qualitative implications of the benchmark case are reinforced in the general situation. Focusing on the case of group  $i$ , theorem 2 and the above lemma suggest that:

- When  $n_j \leq \frac{m}{2}$  negotiated arrangements will be more likely (considering the case of group  $i$ ) as the number of high type members  $n_j$  increases;
- When  $n_j \geq \frac{m}{2} + 1$  then negotiated arrangements will be more likely as the number of high type members is as small as possible.

This provides welfare implications on the internal composition of the groups as negotiated arrangements are (socially) efficient. We can add the following insights. When the ratio  $\frac{\theta_H^j}{\theta_H^i}$  is sufficiently small, that is, when it is less than

$$\frac{\sqrt{\frac{1}{(n_1)^2} + \frac{2}{n_1} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} + 1 - \frac{1}{n_1} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}$$

then it would be preferable that the number of high type members in group  $i$  be as low as possible (this follows from inspection of the expressions of payoffs used in the proof of proposition 3.4). Respectively, when the ratio is sufficiently large (greater than  $\frac{n_j}{\sqrt{1+(n_j)^2-1}}$ ) then it would be preferable that the number of high type members in group  $j$  be as low as possible. Indeed this would ensure that the interval over which negotiated arrangements would prevail becomes as large as possible.

## 5 Conclusion

We consider a situation where a resource has to be allocated between different groups whose members have either high or low valuation for the resource. The (two) groups can either negotiate cooperatively or use conflict to solve the allocation problem. We show that the incentives to negotiate or to go to war depend on the ratios of high type members' valuations. Specifically, the situation is described as follows:

- When the valuation of high type members in one group is sufficiently small compared to that of the other group, conflict will be optimal;
- For intermediate values of the ratio  $\frac{\theta_H^2}{\theta_H^1}$  the emergence of conflict/negotiation depends on the internal composition of group 1. If high type members



constitute the majority then negotiation emerges, otherwise conflict is optimal;

- When  $\frac{\theta_H^2}{\theta_H^1}$  is sufficiently large, conflict emerges if  $\frac{\theta_H^1}{\theta_H^2}$  is sufficiently low or moderate (if and only if high type members do not constitute the majority in group 2), otherwise negotiation becomes optimal.

Another implication of the analysis is that conflict is more likely to emerge when groups have the same size. We finally provide results of comparative statics. Provided that high type members constitute the majority in both groups, negotiation is less likely to emerge as the proportion of high type members increases. This suggests that it would be important (for economic efficiency) to ensure that groups are balanced regarding their internal composition. Moreover, it seems that situations with groups of the same size are more likely to promote conflictual situations.

Even though the above analysis provides some interesting insights on the influence of internal and external structures of groups on the emergence of conflict or negotiation, several extensions could (and should) be considered. For instance, we assume that agents have complete information. Even though the assumption that members of a given group have a reasonably good knowledge of the characteristics of their own group makes sense in some situations, it would be useful to analyse a situation where information about the group characteristics is asymmetric. Moreover, we assume that the share of the surplus secured by each group is used entirely to fund (strictly) local public goods. In many real life situations, funds are likely to be divided between private and public goods. It would be very interesting to extend the analysis to such settings. We leave this for future work.

## 6 Appendix

### 6.1 Proof of Proposition 4.1

*Proof.* • The fact that  $\frac{\theta_H^j}{\theta_H^i} \in ]0, 1[$  implies that  $\theta_H^i \geq \theta_H^j$ , which leads to the conclusion that low type members of group  $i$  prefer conflict over negotiations. Moreover, we know that, provided  $\frac{\theta_H^j}{\theta_H^i} \in ]0, \frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1][$  then high members of group  $i$  prefer conflict as well. This concludes the proof of the first part of the proposition.

- It can be immediately checked that  $\frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1] < 1$  for any

$n_i \geq 1$ ; we deduce that in case  $\frac{\theta_H^j}{\theta_H^i} \in [\frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1], 1[$  high type members of group  $i$  are willing to rely on negotiated arrangements. Since  $\theta_H^i \geq \theta_H^j$  low type members still prefer conflict. This concludes the proof of the second part of the proposition.

- Finally, when  $\frac{\theta_H^j}{\theta_H^i} \geq 1 > \frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1]$  then high type members of group  $i$  prefer a negotiated arrangement. Moreover this implies that  $\theta_H^j \geq \theta_H^i$ , which means that low type members prefer a negotiated arrangement. This concludes the proof of the proposition.  $\square$

## 6.2 Proof of Proposition 4.2

*Proof.* It can be immediately checked that

$$\frac{\sqrt{\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_i} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} < \frac{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}};$$

indeed we have

$$\begin{aligned} & \frac{\sqrt{\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_i} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} - \frac{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} \\ &= \frac{\sqrt{\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} - \frac{1}{n_i} - 1}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} \end{aligned}$$

which is negative as  $\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1 < (\frac{1}{n_i} + 1)^2$  since  $\frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} < 1$  by assumption. Now the proof follows from the same arguments than that of proposition 2.3.  $\square$

## 6.3 Proof of Theorem 2

*Proof.* The proof of cases 1, 2, and 3 (sub cases a and b) follows from the same arguments than that of theorem 1 and is thus omitted.

Finally, to prove sub case 3c it is sufficient to note that

$$\frac{\theta_H^2}{\theta_H^1} \geq \frac{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}} \iff \frac{\theta_H^1}{\theta_H^2} \leq \frac{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}$$

and that

$$\frac{1 - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}} < \frac{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}},$$

finally when  $\frac{\theta_H^1}{\theta_H^2} \geq \frac{1 - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}$  we know that all members of group 2 prefer a negotiated agreement, which implies that both groups favor such an arrangement when the ratio  $\frac{\theta_H^1}{\theta_H^2}$  belongs to the interval  $[\frac{1 - \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 + \frac{m-n}{n+m} \frac{\Phi_{dis}}{\Phi}}, \frac{1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}{1 - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}]$ . This concludes the proof.  $\square$

## 6.4 Proof of Proposition 4.3

*Proof.* • Using that  $s_i = \frac{1}{n_i}[\sqrt{1 + (n_i)^2} - 1]$  and differentiating with respect to  $n_i$ , we obtain:

$$\begin{aligned} \frac{\partial s_i}{\partial n_i} &= -\frac{1}{(n_i)^2}[\sqrt{1 + (n_i)^2} - 1] + \frac{1}{\sqrt{1 + (n_i)^2}} \\ &= \frac{1}{(n_i)^2 \sqrt{1 + (n_i)^2}} \{-1 + \sqrt{1 + (n_i)^2}\} \end{aligned}$$

which is positive for any non negative value of  $n_i$ . This concludes the proof of the first part of the proposition.

- Using that  $s_j = \frac{n_j}{\sqrt{1+(n_j)^2}-1}$  and differentiating with respect to  $n_j$ , we obtain:

$$\begin{aligned} \frac{\partial s_j}{\partial n_j} &= \frac{\sqrt{1 + (n_j)^2} - 1 - \frac{(n_j)^2}{\sqrt{1+(n_j)^2}}}{[\sqrt{1 + (n_j)^2} - 1]^2} \\ &= \frac{1 - \sqrt{1 + (n_j)^2}}{\sqrt{1 + (n_j)^2}[\sqrt{1 + (n_j)^2} - 1]^2} \end{aligned}$$

which is negative for any non negative value of  $n_i$ . This concludes the proof of the proposition.  $\square$

## 6.5 Proof of Proposition 4.4

*Proof.* In each case we come back to the expression of  $th_i$  and we differentiate it with respect to the appropriate parameter.

- We obtain after simplification the following expression:

$$\frac{\partial th_i}{\partial \Phi_{dis}} = \frac{n-m}{(n+m)} \frac{1}{\Phi} \frac{\left[ \frac{1}{n_i} - \frac{1}{(n_i)^2} - 1 - \frac{1}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right] \frac{1}{\sqrt{\frac{1}{(n_i)^2} + 1 + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}} - 1 + \frac{1}{n_i}}{\left[ 1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right]^2}.$$

Since  $\frac{1}{n_i} - 1 < 0$  for any  $n_i$  at least equal to one, it is easily checked that the numerator of the above expression is negative.

- After simplification, we obtain:

$$\frac{\partial th_i}{\partial n} = \frac{2m}{(n+m)^2} \frac{\Phi_{dis}}{\Phi} \frac{\left[ \frac{1}{n_i} - \frac{1}{(n_i)^2} - 1 \right] \frac{1}{\sqrt{\frac{1}{(n_i)^2} + 1 + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}} - 1 + \frac{1}{n_i}}{\left[ 1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right]^2}.$$

Again, as  $\frac{1}{n_i} - 1 < 0$  it is easily checked that the above expression is negative.

- Differentiating with respect to  $m$  and simplifying, we obtain:

$$\frac{\partial th_i}{\partial m} = -\frac{2n}{(n+m)^2} \frac{\Phi_{dis}}{\Phi} \frac{\left[ \frac{1}{n_i} - \frac{1}{(n_i)^2} - 1 \right] \frac{1}{\sqrt{\frac{1}{(n_i)^2} + 1 + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi}}} - 1 + \frac{1}{n_i}}{\left[ 1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right]^2},$$

which is positive since  $\frac{1}{n_i} - 1$  is negative.

- We obtain:

$$\frac{\partial th_i}{\partial n_i} = \frac{-\frac{1}{n_i} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + \sqrt{\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1}}{\left[ 1 + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right] \sqrt{\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1}} \frac{1}{(n_i)^2}.$$

Since we have

$$\left( \frac{1}{n_i} + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right)^2 = \frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + \left( \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right)^2 < \frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1$$

it follows that

$$\begin{aligned} & -\frac{1}{n_i} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + \sqrt{\frac{1}{(n_i)^2} + \frac{2}{n_i} \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + 1} \\ & > -\frac{1}{n_i} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + \sqrt{\left( \frac{1}{n_i} + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} \right)^2} = -\frac{1}{n_i} - \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} + \frac{1}{n_i} + \frac{n-m}{n+m} \frac{\Phi_{dis}}{\Phi} = 0. \end{aligned}$$

Thus we have  $\frac{\partial th_i}{\partial n_i} > 0$ , which concludes the proof.

□

## References

- [1] Anbarci, N., Skaperdas, S., and C. Syropoulos (2002), "Comparing Bargaining Solutions in the Shadow of Conflict: How Norms Against Threats Can Have Real Effects", *Journal of Economic Theory* 106, 1-16.
- [2] Baliga, S., and T. Sjoström (2004), "Arms Races and Negotiations", *Review of Economic Studies* 71, 351-369.
- [3] Brandts, J., Abbink, K., Herrmann, B., and H. Orzen (2009), "Inter-Group Conflict and Intra-Group Punishment in an Experimental Contest Game", *American Economic Review*, forthcoming.
- [4] Cai, H. (2000), "Bargaining on Behalf of a Constituency", *Journal of Economic Theory* 92, 234-273.
- [5] Crawford, V. (1982), "A Theory of Disagreement in Bargaining", *Econometrica* 50, 607-637.
- [6] Ellingsen, T., and T. Miettinen (2008), "Commitment and Conflict in Bilateral Bargaining", *American Economic Review* 98, 1629-1635.
- [7] Esteban, J., and D. Ray (2008), "On the Salience of Ethnic Conflict", *American Economic Review* 98, 2185-2202.
- [8] Haller, H., and S. Holden (1997), "Ratification Requirement and Bargaining Power", *International Economic Review* 38, 825-851.
- [9] Hirshleifer, J. (1989), "Conflict and Rent Seeking Success Functions: Ratio vs Difference Models of Relative Success", *Public Choice* 63, 101-112.
- [10] Horn, H., and A. Wolinsky (1988), "Worker Substitutability and Patterns of Unionisation", *Economic Journal* 98, 484-497.
- [11] Jackson, M., and M. Morelli (2007), "War, Transfers, and Political Bias", *American Economic Review* 97, 1353-1373.
- [12] Jackson, M., and M. Morelli (2009), "Strategic Militarization, Deterrence and Wars", *Quarterly Journal of Political Science*, forthcoming.
- [13] Jun, B. (1989), "Non Cooperative Bargaining and Union Formation", *Review of Economic Studies* 56, 59-76.
- [14] Manzini, P., and M. Mariotti (2005), "Alliances and Negotiations", *Journal of Economic Theory* 121, 128-141.

- [15] Munster, J. (2009), "Group Contest Success Functions", *Economic Theory* 41, 345-357.
- [16] Nash, J. (1950), "The Nash Bargaining Problem", *Econometrica* 18, 155-162.
- [17] Ponsati, C., and J. Sakovics (1996), "Multiperson Bargaining Over Two Alternatives", *Games and Economic Behavior* 12, 226-244.
- [18] Sanchez-Pages, S. (2009), "Conflict as a Part of the Bargaining Process", *Economic Journal* 119, 1189-1207.
- [19] Schelling, T. (1956), "An Essay on Bargaining", *American Economic Review* 46, 281-306.
- [20] Schelling, T. (1963), *The Strategy of Conflict*, London and New York, Oxford University Press.
- [21] Skaperdas, S. (1992), "Cooperation, Conflict, and Power in the Absence of Property Rights", *American Economic Review* 82, 720-739.
- [22] Tullock, G. (1980), "Efficient Rent Seeking", in **Toward a Theory of the Rent Seeking Society**, J.M. Buchanan, Tollison, R., and G. Tullock (eds), College Station, TX, Texas A and M university Press.

## NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

### Fondazione Eni Enrico Mattei Working Paper Series

Our Note di Lavoro are available on the Internet at the following addresses:

<http://www.feem.it/getpage.aspx?id=73&sez=Publications&padre=20&tab=1>  
[http://papers.ssrn.com/sol3/JELJOUR\\_Results.cfm?form\\_name=journalbrowse&journal\\_id=266659](http://papers.ssrn.com/sol3/JELJOUR_Results.cfm?form_name=journalbrowse&journal_id=266659)  
<http://ideas.repec.org/s/fem/femwpa.html>  
<http://www.econis.eu/LNG=EN/FAM?PPN=505954494>  
<http://ageconsearch.umn.edu/handle/35978>  
<http://www.bepress.com/feem/>

### NOTE DI LAVORO PUBLISHED IN 2010

- GC 1.2010 Cristina Cattaneo: [Migrants' International Transfers and Educational Expenditure: Empirical Evidence from Albania](#)
- SD 2.2010 Fabio Antoniou, Panos Hatzipanayotou and Phoebe Koundouri: [Tradable Permits vs Ecological Dumping](#)
- SD 3.2010 Fabio Antoniou, Panos Hatzipanayotou and Phoebe Koundouri: [Second Best Environmental Policies under Uncertainty](#)
- SD 4.2010 Carlo Carraro, Enrica De Cian and Lea Nicita: [Modeling Biased Technical Change. Implications for Climate Policy](#)
- IM 5.2010 Luca Di Corato: [Profit Sharing under the threat of Nationalization](#)
- SD 6.2010 Masako Ikefuji, Jun-ichi Itaya and Makoto Okamura: [Optimal Emission Tax with Endogenous Location Choice of Duopolistic Firms](#)
- SD 7.2010 Michela Catenacci and Carlo Giupponi: [Potentials and Limits of Bayesian Networks to Deal with Uncertainty in the Assessment of Climate Change Adaptation Policies](#)
- GC 8.2010 Paul Sarfo-Mensah and William Oduro: [Changes in Beliefs and Perceptions about the Natural Environment in the Forest-Savanna Transitional Zone of Ghana: The Influence of Religion](#)
- IM 9.2010 Andrea Boitani, Marcella Nicolini and Carlo Scarpa: [Do Competition and Ownership Matter? Evidence from Local Public Transport in Europe](#)
- SD 10.2010 Helen Ding and Paulo A.L.D. Nunes and Sonja Teelucksingh: [European Forests and Carbon Sequestration Services : An Economic Assessment of Climate Change Impacts](#)
- GC 11.2010 Enrico Bertacchini, Walter Santagata and Giovanni Signorello: [Loving Cultural Heritage Private Individual Giving and Prosocial Behavior](#)
- SD 12.2010 Antoine Dechezleprêtre, Matthieu Glachant and Yann Ménière: [What Drives the International Transfer of Climate Change Mitigation Technologies? Empirical Evidence from Patent Data](#)
- SD 13.2010 Andrea Bastianin, Alice Favero and Emanuele Massetti: [Investments and Financial Flows Induced by Climate Mitigation Policies](#)
- SD 14.2010 Reyer Gerlagh: [Too Much Oil](#)
- IM 15.2010 Chiara Fumagalli and Massimo Motta: [A Simple Theory of Predation](#)
- GC 16.2010 Rinaldo Brau, Adriana Di Liberto and Francesco Pigliaru: [Tourism and Development: A Recent Phenomenon Built on Old \(Institutional\) Roots?](#)
- SD 17.2010 Lucia Vergano, Georg Umgieser and Paulo A.L.D. Nunes: [An Economic Assessment of the Impacts of the MOSE Barriers on Venice Port Activities](#)
- SD 18.2010 ZhongXiang Zhang: [Climate Change Meets Trade in Promoting Green Growth: Potential Conflicts and Synergies](#)
- SD 19.2010 Elisa Lanzi and Ian Sue Wing: [Capital Malleability and the Macroeconomic Costs of Climate Policy](#)
- IM 20.2010 Alberto Petrucci: [Second-Best Optimal Taxation of Oil and Capital in a Small Open Economy](#)
- SD 21.2010 Enrica De Cian and Alice Favero: [Fairness, Credibility and Effectiveness in the Copenhagen Accord: An Economic Assessment](#)
- SD 22.2010 Francesco Bosello: [Adaptation, Mitigation and "Green" R&D to Combat Global Climate Change. Insights From an Empirical Integrated Assessment Exercise](#)
- IM 23.2010 Jean Tirole and Roland Bénabou: [Individual and Corporate Social Responsibility](#)
- IM 24.2010 Cesare Dosi and Michele Moretto: [Licences, "Use or Lose" Provisions and the Time of Investment](#)
- GC 25.2010 Andrés Rodríguez-Pose and Vassilis Tselios (lxxvi): [Returns to Migration, Education, and Externalities in the European Union](#)
- GC 26.2010 Klaus Desmet and Esteban Rossi-Hansberg (lxxvi): [Spatial Development](#)
- SD 27.2010 Massimiliano Mazzanti, Anna Montini and Francesco Nicolli: [Waste Generation and Landfill Diversion Dynamics: Decentralised Management and Spatial Effects](#)
- SD 28.2010 Lucia Ceccato, Valentina Giannini and Carlo Gipponi: [A Participatory Approach to Assess the Effectiveness of Responses to Cope with Flood Risk](#)
- SD 29.2010 Valentina Bosetti and David G. Victor: [Politics and Economics of Second-Best Regulation of Greenhouse Gases: The Importance of Regulatory Credibility](#)
- IM 30.2010 Francesca Cornelli, Zbigniew Kominek and Alexander Ljungqvist: [Monitoring Managers: Does it Matter?](#)
- GC 31.2010 Francesco D'Amuri and Juri Marcucci: ["Google it!" Forecasting the US Unemployment Rate with a Google Job Search index](#)
- SD 32.2010 Francesco Bosello, Carlo Carraro and Enrica De Cian: [Climate Policy and the Optimal Balance between Mitigation, Adaptation and Unavoided Damage](#)

SD	33.2010	Enrica De Cian and Massimo Tavoni: <a href="#">The Role of International Carbon Offsets in a Second-best Climate Policy: A Numerical Evaluation</a>
SD	34.2010	ZhongXiang Zhang: <a href="#">The U.S. Proposed Carbon Tariffs, WTO Scrutiny and China's Responses</a>
IM	35.2010	Vincenzo Denicolò and Piercarlo Zanchettin: <a href="#">Leadership Cycles</a>
SD	36.2010	Stéphanie Monjon and Philippe Quirion: <a href="#">How to Design a Border Adjustment for the European Union Emissions Trading System?</a>
SD	37.2010	Meriem Hamdi-Cherif, Céline Guivarch and Philippe Quirion: <a href="#">Sectoral Targets for Developing Countries: Combining "Common but Differentiated Responsibilities" with "Meaningful participation"</a>
IM	38.2010	G. Andrew Karolyi and Rose C. Liao: <a href="#">What is Different about Government-Controlled Acquirers in Cross-Border Acquisitions?</a>
GC	39.2010	Kjetil Bjorvatn and Alireza Naghavi: <a href="#">Rent Seekers in Rentier States: When Greed Brings Peace</a>
GC	40.2010	Andrea Mantovani and Alireza Naghavi: <a href="#">Parallel Imports and Innovation in an Emerging Economy</a>
SD	41.2010	Luke Brander, Andrea Ghermandi, Onno Kuik, Anil Markandya, Paulo A.L.D. Nunes, Marije Schaafsma and Alfred Wagtenonk: <a href="#">Scaling up Ecosystem Services Values: Methodology, Applicability and a Case Study</a>
SD	42.2010	Valentina Bosetti, Carlo Carraro, Romain Duval and Massimo Tavoni: <a href="#">What Should We Expect from Innovation? A Model-Based Assessment of the Environmental and Mitigation Cost Implications of Climate-Related R&amp;D</a>
SD	43.2010	Frank Vöhringer, Alain Haurie, Dabo Guan, Maryse Labriet, Richard Loulou, Valentina Bosetti, Pryadarshi R. Shukla and Philippe Thalmann: <a href="#">Reinforcing the EU Dialogue with Developing Countries on Climate Change Mitigation</a>
GC	44.2010	Angelo Antoci, Pier Luigi Sacco and Mauro Sodini: <a href="#">Public Security vs. Private Self-Protection: Optimal Taxation and the Social Dynamics of Fear</a>
IM	45.2010	Luca Enriques: <a href="#">European Takeover Law: The Case for a Neutral Approach</a>
SD	46.2010	Maureen L. Cropper, Yi Jiang, Anna Alberini and Patrick Baur: <a href="#">Getting Cars Off the Road: The Cost-Effectiveness of an Episodic Pollution Control Program</a>
IM	47.2010	Thomas Hellman and Enrico Perotti: <a href="#">The Circulation of Ideas in Firms and Markets</a>
IM	48.2010	James Dow and Enrico Perotti: <a href="#">Resistance to Change</a>
SD	49.2010	Jaromir Kovarik, Friederike Mengel and José Gabriel Romero: <a href="#">(Anti-) Coordination in Networks</a>
SD	50.2010	Helen Ding, Silvia Silvestri, Aline Chiabai and Paulo A.L.D. Nunes: <a href="#">A Hybrid Approach to the Valuation of Climate Change Effects on Ecosystem Services: Evidence from the European Forests</a>
GC	51.2010	Pauline Grosjean (lxxxvii): <a href="#">A History of Violence: Testing the 'Culture of Honor' in the US South</a>
GC	52.2010	Paolo Buonanno and Matteo M. Galizzi (lxxxvii): <a href="#">Advocatus, et non Iatro? Testing the Supplier-Induced-Demand Hypothesis for Italian Courts of Justice</a>
GC	53.2010	Gilat Levy and Ronny Razin (lxxxvii): <a href="#">Religious Organizations</a>
GC	54.2010	Matteo Cervellati and Paolo Vanin (lxxxvii): <a href="#">"Thou shalt not covet ...": Prohibitions, Temptation and Moral Values</a>
GC	55.2010	Sebastian Galiani, Martín A. Rossi and Ernesto Schargrodsky (lxxxvii): <a href="#">Conscription and Crime: Evidence from the Argentine Draft Lottery</a>
GC	56.2010	Alberto Alesina, Yann Algan, Pierre Cahuc and Paola Giuliano (lxxxvii): <a href="#">Family Values and the Regulation of Labor</a>
GC	57.2010	Raquel Fernández (lxxxvii): <a href="#">Women's Rights and Development</a>
GC	58.2010	Tommaso Nannicini, Andrea Stella, Guido Tabellini, Ugo Troiano (lxxxvii): <a href="#">Social Capital and Political Accountability</a>
GC	59.2010	Eleonora Patacchini and Yves Zenou (lxxxvii): <a href="#">Juvenile Delinquency and Conformism</a>
GC	60.2010	Gani Aldashev, Imane Chaara, Jean-Philippe Platteau and Zaki Wahhaj (lxxxvii): <a href="#">Using the Law to Change the Custom</a>
GC	61.2010	Jeffrey Butler, Paola Giuliano and Luigi Guiso (lxxxvii): <a href="#">The Right Amount of Trust</a>
SD	62.2010	Valentina Bosetti, Carlo Carraio and Massimo Tavoni: <a href="#">Alternative Paths toward a Low Carbon World</a>
SD	63.2010	Kelly C. de Bruin, Rob B. Dellink and Richard S.J. Tol: <a href="#">International Cooperation on Climate Change Adaptation from an Economic Perspective</a>
IM	64.2010	Andrea Bigano, Ramon Arigoni Ortiz, Anil Markandya, Emanuela Menichetti and Roberta Pierfederici: <a href="#">The Linkages between Energy Efficiency and Security of Energy Supply in Europe</a>
SD	65.2010	Anil Markandya and Wan-Jung Chou: <a href="#">Eastern Europe and the former Soviet Union since the fall of the Berlin Wall: Review of the Changes in the Environment and Natural Resources</a>
SD	66.2010	Anna Alberini and Milan Ščasný: <a href="#">Context and the VSL: Evidence from a Stated Preference Study in Italy and the Czech Republic</a>
SD	67.2010	Francesco Bosello, Ramiro Parrado and Renato Rosa: <a href="#">The Economic and Environmental Effects of an EU Ban on Illegal Logging Imports. Insights from a CGE Assessment</a>
IM	68.2010	Alessandro Fedele, Paolo M. Panteghini and Sergio Vergalli: <a href="#">Optimal Investment and Financial Strategies under Tax Rate Uncertainty</a>
IM	69.2010	Carlo Cambini, Laura Rondi: <a href="#">Regulatory Independence and Political Interference: Evidence from EU Mixed-Ownership Utilities' Investment and Debt</a>
SD	70.2010	Xavier Pautrel: <a href="#">Environmental Policy, Education and Growth with Finite Lifetime: the Role of Abatement Technology</a>
SD	71.2010	Antoine Leblois and Philippe Quirion: <a href="#">Agricultural Insurances Based on Meteorological Indices: Realizations, Methods and Research Agenda</a>
IM	72.2010	Bin Dong and Benno Torgler: <a href="#">The Causes of Corruption: Evidence from China</a>
IM	73.2010	Bin Dong and Benno Torgler: <a href="#">The Consequences of Corruption: Evidence from China</a>



- IM 74.2010 Fereydoun Verdinejad and Yasaman Gorji: [The Oil-Based Economies International Research Project. The Case of Iran.](#)
- GC 75.2010 Stelios Michalopoulos, Alireza Naghavi and Giovanni Prarolo (lxxxvii): [Trade and Geography in the Economic Origins of Islam: Theory and Evidence](#)
- SD 76.2010 ZhongXiang Zhang: [China in the Transition to a Low-Carbon Economy](#)
- SD 77.2010 Valentina Iafolla, Massimiliano Mazzanti and Francesco Nicolli: [Are You SURE You Want to Waste Policy Chances? Waste Generation, Landfill Diversion and Environmental Policy Effectiveness in the EU15](#)
- IM 78.2010 Jean Tirole: [Illiquidity and all its Friends](#)
- SD 79.2010 Michael Finus and Pedro Pintassilgo: [International Environmental Agreements under Uncertainty: Does the Veil of Uncertainty Help?](#)
- SD 80.2010 Robert W. Hahn and Robert N. Stavins: [The Effect of Allowance Allocations on Cap-and-Trade System Performance](#)
- SD 81.2010 Francisco Alpizar, Fredrik Carlsson and Maria Naranjo (lxxxviii): [The Effect of Risk, Ambiguity and Coordination on Farmers' Adaptation to Climate Change: A Framed Field Experiment](#)
- SD 82.2010 Shardul Agrawala and Maëlis Carraro (lxxxviii): [Assessing the Role of Microfinance in Fostering Adaptation to Climate Change](#)
- SD 83.2010 Wolfgang Lutz (lxxxviii): [Improving Education as Key to Enhancing Adaptive Capacity in Developing Countries](#)
- SD 84.2010 Rasmus Heltberg, Habiba Gitay and Radhika Prabhu (lxxxviii): [Community-based Adaptation: Lessons from the Development Marketplace 2009 on Adaptation to Climate Change](#)
- SD 85.2010 Anna Alberini, Christoph M. Rheinberger, Andrea Leiter, Charles A. McCormick and Andrew Mizrahi: [What is the Value of Hazardous Weather Forecasts? Evidence from a Survey of Backcountry Skiers](#)
- SD 86.2010 Anna Alberini, Milan Ščasný, Dennis Guignet and Stefania Tonin: [The Benefits of Contaminated Site Cleanup Revisited: The Case of Naples and Caserta, Italy](#)
- GC 87.2010 Paul Sarfo-Mensah, William Oduro, Fredrick Antoh Fredua and Stephen Amisah: [Traditional Representations of the Natural Environment and Biodiversity Conservation: Sacred Groves in Ghana](#)
- IM 88.2010 Gian Luca Clementi, Thomas Cooley and Sonia Di Giannatale: [A Theory of Firm Decline](#)
- IM 89.2010 Gian Luca Clementi and Thomas Cooley: [Executive Compensation: Facts](#)
- GC 90.2010 Fabio Sabatini: [Job Instability and Family Planning: Insights from the Italian Puzzle](#)
- SD 91.2010 ZhongXiang Zhang: [Copenhagen and Beyond: Reflections on China's Stance and Responses](#)
- SD 92.2010 ZhongXiang Zhang: [Assessing China's Energy Conservation and Carbon Intensity: How Will the Future Differ from the Past?](#)
- SD 93.2010 Daron Acemoglu, Philippe Aghion, Leonardo Burszty and David Hemous: [The Environment and Directed Technical Change](#)
- SD 94.2010 Valeria Costantini and Massimiliano Mazzanti: [On the Green Side of Trade Competitiveness? Environmental Policies and Innovation in the EU](#)
- IM 95.2010 Vitoria Cerasi, Barbara Chizzolini and Marc Ivaldi: [The Impact of Mergers on the Degree of Competition in the Banking Industry](#)
- SD 96.2010 Emanuele Massetti and Lea Nicita: [The Optimal Climate Policy Portfolio when Knowledge Spills Across Sectors](#)
- SD 97.2010 Sheila M. Olmstead and Robert N. Stavins: [Three Key Elements of Post-2012 International Climate Policy Architecture](#)
- SD 98.2010 Lawrence H. Goulder and Robert N. Stavins: [Interactions between State and Federal Climate Change Policies](#)
- IM 99.2010 Philippe Aghion, John Van Reenen and Luigi Zingales: [Innovation and Institutional Ownership](#)
- GC 100.2010 Angelo Antoci, Fabio Sabatini and Mauro Sodini: [The Solaria Syndrome: Social Capital in a Growing Hyper-technological Economy](#)
- SD 101.2010 Georgios Kossioris, Michael Plexousakis, Anastasios Xepapadeas and Aart de Zeeuw: [On the Optimal Taxation of Common-Pool Resources](#)
- SD 102.2010 ZhongXiang Zhang: [Liberalizing Climate-Friendly Goods and Technologies in the WTO: Product Coverage, Modalities, Challenges and the Way Forward](#)
- SD 103.2010 Gérard Mondello: [Risky Activities and Strict Liability Rules: Delegating Safety](#)
- GC 104.2010 João Ramos and Benno Torgler: [Are Academics Messy? Testing the Broken Windows Theory with a Field Experiment in the Work Environment](#)
- IM 105.2010 Maurizio Ciaschini, Francesca Severini, Claudio Soggi and Rosita Pretaroli: [The Economic Impact of the Green Certificate Market through the Macro Multiplier Approach](#)
- SD 106.2010 Joëlle Noailly: [Improving the Energy-Efficiency of Buildings: The Impact of Environmental Policy on Technological Innovation](#)
- SD 107.2010 Francesca Sanna-Randaccio and Roberta Sestini: [The Impact of Unilateral Climate Policy with Endogenous Plant Location and Market Size Asymmetry](#)
- SD 108.2010 Valeria Costantini, Massimiliano Mozzanti and Anna Montini: [Environmental Performance and Regional Innovation Spillovers](#)
- IM 109.2010 Elena Costantino, Maria Paola Marchello and Cecilia Mezzano: [Social Responsibility as a Driver for Local Sustainable Development](#)
- GC 110.2010 Marco Percoco: [Path Dependence, Institutions and the Density of Economic Activities: Evidence from Italian Cities](#)
- SD 111.2010 Sonja S. Teelucksingh and Paulo A.L.D. Nunes: [Biodiversity Valuation in Developing Countries: A Focus on Small Island Developing States \(SIDS\)](#)
- SD 112.2010 ZhongXiang Zhang: [In What Format and under What Timeframe Would China Take on Climate Commitments? A Roadmap to 2050](#)

- SD 113.2010 Emanuele Massetti and Fabio Sferra: [A Numerical Analysis of Optimal Extraction and Trade of Oil under Climate Policy](#)
- IM 114.2010 Nicola Gennaioli, Andrei Shleifer and Robert Vishny: [A Numerical Analysis of Optimal Extraction and Trade of Oil under Climate Policy](#)
- GC 115.2010 Romano Piras: [Internal Migration Across Italian regions: Macroeconomic Determinants and Accommodating Potential for a Dualistic Economy](#)
- SD 116.2010 Messan Agbaglah and Lars Ehlers (lxxxiv): [Overlapping Coalitions, Bargaining and Networks](#)
- SD 117.2010 Pascal Billand, Christophe Bravard, Subhadip Chakrabarti and Sudipta Sarangi (lxxxiv): [Spying in Multi-market Oligopolies](#)
- SD 118.2010 Roman Chuhay (lxxxiv): [Marketing via Friends: Strategic Diffusion of Information in Social Networks with Homophily](#)
- SD 119.2010 Françoise Forges and Ram Orzach (lxxxiv): [Core-stable Rings in Second Price Auctions with Common Values](#)
- SD 120.2010 Markus Kinader (lxxxiv): [The Repeated Prisoner's Dilemma in a Network](#)
- SD 121.2010 Alexey Kushnir (lxxxiv): [Harmful Signaling in Matching Markets](#)
- SD 122.2010 Emiliya Lazarova and Dinko Dimitrov (lxxxiv): [Status-Seeking in Hedonic Games with Heterogeneous Players](#)
- SD 123.2010 Maria Montero (lxxxiv): [The Paradox of New Members in the EU Council of Ministers: A Non-cooperative Bargaining Analysis](#)
- SD 124.2010 Leonardo Boncinelli and Paolo Pin (lxxxiv): [Stochastic Stability in the Best Shot Game](#)
- SD 125.2010 Nicolas Qu  rou (lxxxiv): [Group Bargaining and Conflict](#)

(lxxxvi) *This paper was presented at the Conference on "Urban and Regional Economics" organised by the Centre for Economic Policy Research (CEPR) and FEEM, held in Milan on 12-13 October 2009.*

(lxxxvii) *This paper was presented at the Conference on "Economics of Culture, Institutions and Crime" organised by SUS.DIV, FEEM, University of Padua and CEPR, held in Milan on 20-22 January 2010.*

(lxxxviii) *This paper was presented at the International Workshop on "The Social Dimension of Adaptation to Climate Change", jointly organized by the International Center for Climate Governance, Centro Euro-Mediterraneo per i Cambiamenti Climatici and Fondazione Eni Enrico Mattei, held in Venice, 18-19 February 2010.*

(lxxxiv) *This paper was presented at the 15th Coalition Theory Network Workshop organised by the Groupement de Recherche en Economie Quantitative d'Aix-Marseille, (GREQAM), held in Marseille, France, on June 17-18, 2010.*