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Structure and bargaining power in multilateral negotiations : Application to water management policies in France

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ABSTRACT

Environmental policies are characterized by a growing emphasis on participation, devolution and negotiated decision making. Increasingly, centralized top down decision making systems are being replaced by new forms of local governance. In their strongest versions, these involve delegation of formal authority to local stakeholders who are expected to decide collectively upon the management rules of local common-pool resources. Devolution is particularly important in relation to the allocation and management of scarce water resources. Indeed the French water law of 1992 institutionalised the notion of devolution by requiring that water management rules be negotiated at the river basin level between all stakeholders. Although stakeholder negotiation is becoming increasingly important, relatively little is understood about the influence of the structure of negotiations on their outcomes. There is therefore a rising demand for applied simulation models which can be used as 'negotiation-support tools' to address such questions as: what criteria should determine participation rules ? What kind of biases result from power asymmetries ? In this paper, we apply the Rausser-Simon (RS) framework to a specific negotiation process, involving water use and storage capacity. The RS framework is a computable non cooperative bargaining model designed to study complex real world multi-agent, multi-issue negotiation problems. The elements of the modelled negotiation structure include: the list of participants at the bargaining table; the set of issues being negotiated; the decision rule; political weights ("access"); and the nature of the outcome if agreement cannot be reached (the fall-back option).

The application we consider focuses on the upper part of the Adour Basin in south-western France. Increased irrigation use in recent years has led to recurrent water shortages, resulting in increased tensions among water users and potential damages to aquatic life. Public authorities have offered to finance new water supply facilities provided that stakeholders can agree on management issues such as quota allocations, water prices and dam configuration. A number of issues arise concerning the relationship between the structure of the negotiating process and the effectiveness with which participating stakeholders can pursue their individual interests.

The case study is modelled with seven aggregate players (three aggregate farmers representing three sub-basins - upstream, midstream and downstream - two environmental lobbies, the taxpayer and the water manager), and with up to nine negotiated variables (water quotas and water prices in each sub-basin, and the capacities of three dams). Farmers' utility functions are estimated using hydraulic data and calibrated linear programming farm models. The richness of the data and institutional information available to us provides a realistic environment in which to examine the effect of negotiation structure on participant power.

We focus in particular on the three farmer stakeholder group, whose interests are aligned but distinct, and so form a natural negotiating coalition. We construct experiments that enable us to evaluate the effects of negotiation structure on the effectiveness of this coalition. Our comparative statics experiments highlight a number of aspects of the relationship between negotiation structure and bargaining power. In addition to the standard indices of bargaining power - the distribution of access and "default strength" (i.e., stakeholders' relative tolerance for the outcome if negotiations break down) - our analysis identifies a number of other less obvious sources of power. A coalition member can advance his own interests by ceding his own political access to another coalition member who has a "better" strategic location. It is also shown that while the interests of the coalition as a whole will be advanced if its members cede access to a "spokesman" representing their common interests, some coalition members may be adversely affected. Finally, we consider the effect on the coalition of restricting the set of proposals that may be placed on the bargaining table in order to mitigate "beggar thy neighbour" behaviour by coalition members. This improves all farmers' utilities, except in some specific cases in which external constraints initially oblige players to act as if they were playing cooperatively. In conclusion, the value of this model is to be used by the negotiation stakeholders to explore the implications of alternative specifications of

the bargaining environment. In particular, the simulations reveal that the ways in which the negotiation structure interact with stakeholder bargaining power are complex and lead to non intuitive outcomes.

1 INTRODUCTION

Many areas of public policy, in particular for natural resources management, are characterized by an increasing emphasis on devolution, i.e., direct stake-holder participation in the policy formation process. The trend toward devolution has been particularly significant in the area of water policy, where conflicts are often very complex and sometimes outstrip the capabilities of even the best institutional arrangements. It is increasingly acknowledged that new solutions must be found outside the established process of centralized public decision-making. One of the responses has been to promote collective negotiated decision-making procedures. Examples abound in the domain of water management, with the goal to design policies that are not only environmentally and economically sustainable, but also politically viable. An analysis of one such collective negotiation among stakeholders, the so-called Three-Way Negotiations which took place in the early 'nineties in California, has been analyzed in Adams, Rausser and Simon (1996). Other, more recent examples include the San Francisco Estuary Project and the Sacramento Water Forum . In France, the principle of negotiated rules has been institutionalized in the Water Law promulgated in 1992. This law specifies that specific development plans be set up at the level of each hydrological basin, and that water regulations be negotiated at the much smaller scale of catchment areas. It is required that regulations be negotiated locally between all stakeholders under the supervision of local authorities .

Although stakeholder negotiation is becoming an increasingly important policymaking tool, relatively little is understood about the interactions between the structure of the negotiating process and outcomes of the negotiation (Thoyer et al, 2001). In this paper, we focus more specifically on the nature of stakeholder power within a collective negotiation, and how this power is influenced by the structure of the negotiation process and the interests of the participants. Understanding these relationships is important for negotiation participants, and for policymakers designing such processes.

For our purposes, we define bargaining power as the capacity of a stakeholder to influence the negotiated outcome in order to increase the utility he receives. In this paper, we are interested in the bargaining power wielded by a subset of stakeholders, whose interests are sufficiently aligned that they may be thought of as a loose coalition. In our case study, the coalition consists of farmers representing different sub-basins of a given river basin. While these farmers compete with each other for water, their interests are more closely aligned with each other's than with the other stakeholders at the table, including in particular those representing environmental and non-agricultural uses of water. We analyze three questions related to the bargaining power of our coalition. First, what are the sources of bargaining power, and how do they interact? Second, is it ever advantageous for some or all of the coalition members to delegate their bargaining position to a "spokesman" representing their joint interests? Third, how does the definition of the bargaining space-i.e., the vector of variables over which negotiations take place, and the restrictions imposed on these variables- affect the bargaining power and resulting utilities of participants? In particular, in some of the bargaining spaces we consider, individual farmers are permitted to pursue their own interests at the expense of the interests of the coalition as a whole, by allocating more water to their own sub-basins at lower prices than other farmers pay. Do coalition members benefit when restrictions are imposed on the degree to which they can distinguish their own interests from those of other farmers?

Understanding the factors determining the answers to such questions will facilitate the design of negotiation processes that represent the interests of all stakeholders in an implementable and sustainable fashion. At an intuitive level, stakeholders' power in the negotiation process is measured by their "access" to the decision-making process. Access is a catch-all term for many considerations, including the number of representatives included in the process, the capacity to set agendas, placement on key committees, etc. However, we show that other, more subtle, kinds of power can swamp the simple effects of access. In order for a negotiation process to fairly include all interests, the interactions among negotiation structure and stakeholder preferences that create bargaining power must be taken into consideration when policymakers design a negotiation process.

In order to address these questions, we model a specific negotiation process, regarding the use and storage of water in the three sub-basins of the upper Adour Basin in south-western France. For our purposes, this process has a number of advantages as a research topic. First, the negotiation process, designed by the national government, has a relatively transparent set of rules determining participants and a relatively well-defined outcome in the event that the parties are unable to negotiate a solution. Second, our modeling task is facilitated because the underlying hydrology of the river basin is well-documented and because a great deal of information is available regarding the agricultural use of water, in terms of both quantities used and the value of the resulting production. Third, two types of environmental goals are recognized explicitly by participants: the value of residual flows, which promote aquatic life, and the scenic costs of dams, which destroy attractive valley landscapes. These two goals both compete with each other and with farmers' use of water for production purposes. Finally, the natural division of farmers by sub-basin provides us with a subset of "natural allies," or coalition. The quality of the data and institutional information provides us with a rich and realistic environment for examining the effect of process structure on participant power. The paper is organized as follows. In section 2, we review the Rausser-Simon multilateral bargaining model, which provides the theoretical basis for this application. Section 3 introduces the Adour Basin, explains the nature of the negotiations that are underway and presents our formal specification of the bargaining problem. Section 4 contains our comparative statics analysis. Section 5 concludes.

2 THE UNDERLYING BARGAINING GAME

The analytical framework for this paper is a non-cooperative multilateral bargaining model developed in Rausser and Simon (1999) and applied in Adams et al. (1996). In this section, we review the main features of the model. In contrast to the vast theoretical literature on bilateral bargaining spawned by the seminal work of Rubinstein (1982), the Rausser-Simon framework is designed to analyze complex multi-issue, multiplayer bargaining problems. It has no closed form solution, and so must be solved using computational techniques.

The specification of a multilateral bargaining problem includes a finite set of players, denoted by $I = \{1, \cdots, I\}$ and indexed by i. The players meet together to select a *policy vector* from some set X of possible alternatives. X is assumed to be a compact subset of n-dimensional Euclidean space, where n is the cardinality of the vector of issues being negotiated. The policy vector $\vec{x}$ yields player i a utility of $u_i(\vec{x})$. We denote by $\vec{u}^0$ the vector of *disagreement* payoffs, i.e., the payoffs players receive if they fail to negotiate an agreement. Throughout this paper, we will assume that decisions are reached by *unanimity*, i.e., an element of X can be selected as the solution to the bargaining problem only if it is accepted by all parties at the bargaining table.

A bargaining game is derived from a bargaining problem by superimposing upon it a *negotiation process*. A bargaining game is formulated with a finite number, T, of bargaining rounds. Once we have explained how to solve the finite-round game, we will define the solution to the limit bargaining game to be the limit of the (unique) subgame-perfect equilibria of the finite-round games. At the beginning of the t'th round ($t < T$) of the finite game, provided that the game has not already concluded by this round, nature chooses at random some player to be the proposer for this round; nature's choice is governed by an exogenously probability distribution, $\vec{w} = (w_i)_{i \in I}$, where $w_i \in [0, 1]$, player i is chosen with probability w_i; and $\sum_i w_i = 1$. The vector $\vec{w}$ is interpreted as a distribution of *access* to the political system, and w_i is referred to as player i's *access probability*;

The player selected by nature then makes a proposal, which is a policy vector in X . All the other players vote on whether or not to accept the proposal on the table. The game concludes in this round if and only if all players vote to accept the proposal; if some player votes against the proposal, play proceeds to the next round. If the T'th round of the game is reached, and if the proposal in this round is rejected, then players receive the vector of disagreement payoffs $\vec{u}^0$. We assume throughout that the set X contains a proposal that strictly Pareto dominates $\vec{u}^0$.

There is a simple characterization of the subgame perfect equilibrium strategies for a game with T rounds of bargaining: a proposal made by player i in period T is accepted if and only if it yields each player j a utility level at least as great as the player's disagreement utility . In each round $t < T$, a proposal by i is accepted if and only if it yields each j a utility level at least as great as j's expected utility from playing the subgame starting from round $t + 1$. Clearly the game can be solved recursively, starting from the last round: in each round t, player i computes the policy vector that maximizes i's utility, subject to the constraint that for each j, the vector yields player j no less than its default utility if $t = T$, or its expected utility conditional on reaching the next round if $t < T$ (also called j's reservation utility). If the solution to i's constrained maximization problem yields i at least i's expected utility from proceeding to the next round, then i proposes the vector; otherwise i proposes a vector that will be rejected, and thus passes on to the next round [1] . An elementary example is provided in Adams et al (1996).

3 ADOUR RIVER NEGOTIATIONS

We calibrate the Rausser-Simon bargaining model to a specific case study, the negotiation over the *Adour river* catchment: our analysis is based on extensive work regarding the hydrology, agriculture and political economy of the upstream part of the Adour river basin in southwestern France, from its origin in the Pyrenees to its junction with the Midouze river (Faysse, 1997; Faysse and Morardet, 1999; Cemagref, 1994; Gleyses and Morardet, 1997).

3.1 Background

Over the past twenty years, the use of river water for irrigation has increased substantially in the Adour basin, and now is its most important use by volume. Most of the agricultural use occurs in the dry summer months of July and August, when the river flow is also low. Increased irrigation has led to a water deficit in the basin equal to roughly a fifth of annual agricultural use. Environmental groups and downstream users have expressed growing concern due to the reduction in river flows. One solution to the water deficit would be the construction of up to three dams located at specific points on the river: these dams would capture water during the winter months in order to release the water in summer. This proposal has attracted opposition from other environmental groups, who are concerned about the effects of dams on the natural landscape (see Figure 1).

Under the national French water law passed in 1992, water is proclaimed a national common heritage, and stakeholders are assigned responsibility for designing the regulations governing its use. Management of water resources is expected to reconcile water user needs and environmental uses of water. Specific water development plans were developed for each hydrological basin , and regulations to implement these plans must be developed and enforced at the catchment level, through *negotiated decision-making among all stakeholders under conditions defined by the relevant government authorities.* The Adour basin is an example of such a catchment area .

[1] Rauuser and Simon (1991) demonstrate that if X is compact and each player's utility is strictly quasi-concave on X, then every finite game has a unique *solution vector*, consisting of a point in X for each player, which will be proposed by that player if he is chosen in the first round to be the proposer. Moreover, with probability one, players in round one accept whichever proposal is made. Now consider a sequence of finite-round bargaining games, which are all identical except that the number of bargaining periods increases without bound. It can be shown that any sequence of solution vectors for these games has a limit in X, and that limit is *deterministic*, i.e., all players' solution proposals converge to the same point in X.

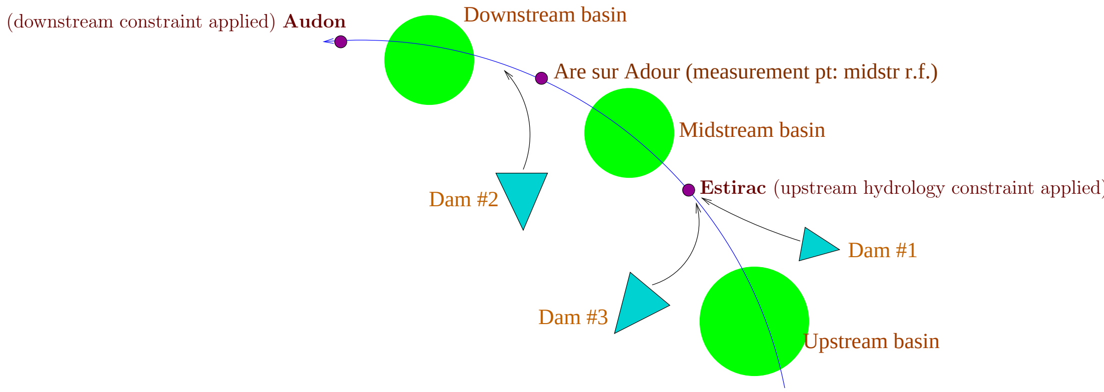

Figure 1: A schematic of the Adour Basin

In the Adour case, stakeholders were charged with determining the size of dams, the amount of water that should be allocated to irrigation, how this water should be allocated among agricultural users, and the price that users should pay for this water. The negotiating group included elected representatives of agricultural producers; a group representing the interests of urban and industrial consumers downstream from our study area, environmental interests and the manager of the semi-public Adour Basin water authority that maintains infrastructure, delivers water, and monitors river flow.

3.2 Structure of the negotiation

The Adour Basin consists of three sub-basins. We will label these by U, M and D, for *upstream*, *midstream* and *downstream*. Farmers in each sub-basin are negotiating over the quota allocation they will receive. The negotiated quota allocation determines the maximum cubic meters a farmer is entitled to use per eligible hectare farmed.

Farmers are required to pay a fixed unit price for each quota unit at the time it is allocated. Revenue from quota sales accrues to the water manager, to offset his operating costs . A budget constraint (the water manager's operating costs must be covered) relates the level of quota sales to the minimum level of prices that can be charged for quotas. Operating costs have been estimated to be an affine function of aggregate dam capacity. Operating revenues are the inner product of after-tax quota prices and the water allocation.

Quota sales are limited by hydrology constraints, described below, which depend in part on the natural flows of water through the three sub-basins. There are proposals on the table to supplement these natural flows by building as many as three dams. Although there is a maximum capacity level for each dam, determined by technological considerations, the actual size of the dams, however, is to be negotiated. The dams, if constructed, will have different implications for water flows in the sub-basins: dam 2 will increase flows to sub-basin D only, while dams 1 and 3 increase flows to all three sub-basins. Dam construction is to be financed by general taxation. That is, farmers will be required to finance the operating cost, but not the capital cost, of the dams. Dam construction is controversial: on the plus side, new dams would increase the residual flow of water through the sub-basins, benefiting users who are downstream of the sub-basins, promoting aquatic life, and relaxing the hydrological constraints on farmers; on the minus side, dams are costly and degrade the quality of the rural landscape.

For each sub-basin, the residual flow of water cannot fall short of a minimum level (called objective flow), which was set in the Adour-Garonne Water Development Plan in order to protect aquatic life in the river. The residual flow in each sub-basin is calculated as the difference between the total volume of water that flows into the sub-basin, including releases from existing and proposed new dams, and the total volume of water used by farmers within that sub-basin. Two of the three classes of variables being negotiated will affect directly the hydrology constraints: dam capacities, which affect water inflows, and quotas, which determine water outflows. In most years (eight out of ten), rainfall is sufficient that none of the hydrology constraints would bind even if no dams were constructed. We will henceforth refer to this state of affairs as normal conditions. In the remaining years, referred to as drought conditions, water is sufficiently scarce that the up- and mid-stream hydrology constraints will be binding unless dam capacities are sufficiently increased.

3.3 The bargaining space

There are three classes of continuous negotiated variables: prices, quotas and dam capacities. There are three prices and three quotas, one pair for each sub-basin, and three proposed dams for which capacity has to be decided upon. In the bargaining games we simulate, we distinguish between three regimes, identified as *CPCQ, CPIQ* and *IPCQ.* Each regime is examined under both normal and drought conditions. In regime CPCQ (common prices, common quotas) the bargaining space is restricted so that a common price and a common quota applies to all sub-basins. In regime CPIQ (common prices, individual quotas), the price remains common but bargainers are allowed to specify distinct quota levels for each sub-basin. In regime IPCQ (for individual prices, common quotas), prices are common and quotas are distinct .

Our motivation for considering these different regimes is two-fold: First, our objective is to consider the effect of different institutional specifications of the bargaining space on bargaining performance, and these are three natural polar possibilities. Second, we would expect that if farmers are "forced" by institutional necessity to adopt common positions during the negotiating process, rather than pursuing their own private goals at the expense of farmers as a group, then their performance as a group would be higher. The comparison of the three specified regimes allows us to test this conjecture.

3.4 Bargaining Participants

There are seven players. The utility of the three farmers were assessed through calibrated farm models. For the other agents, the functional forms of their utility functions and their parameters were chosen on an ad hoc basis to reflect in a qualitative way the relative importance that the agents assign to different concerns.

(1) **three farmers**, each one an aggregation of all the farmers in a given sub-basin. Farmers are identified by their sub-basins, i.e., Fu, Fm and Fd. Each farmer's objective is to maximize his utility from production. To evaluate their profit function, we modeled farmers' behavior with mathematical programming techniques. The objective was to generate a set of data on profits, quotas and prices in order to finally estimate the parameters of the profit function through econometric techniques. Each farmer's utility is translog in his price and quota. For $i \in [Fu, Fm, Fd]$, we have

$$u_i(p_i, q_i) = exp\left(a_i^0 + \sum_{k=1}^{5} a_i^k x_i(k)\right) \quad (1)$$

where

$$x_i(k) = [(ln(1+p_i) \quad ; ln(1+p_i^2) \quad ; ln(1+q_i) \quad ; ln(1+q_i^2) \quad ; ln((1+p_i)(1+q_i))]$$

with p_i, the quota price facing the i'th farmer and q_i, the i'th component of the water allocation vector.

Higher quotas increase utility, given the quota price, and lower quota prices increase utility, given the quota level. While dam capacities are not explicit arguments of farmers' utility functions, they do, however, affect farmers' utilities through the model constraints. Farmers are distinguished from each other by their willingness to pay for quotas. For a given water quota, farmer Fm has the highest willingness to pay. Farmer Fu has the second highest willingness to pay, and farmer Fd has the lowest willingness to pay. The farmers also vary in the number of hectares cultivated. Fu is substantially larger than the other two.

(2) **an environmentalist (Ev)**, representing a weighted combination of diverse environmental interests and recreational users. This party is primarily concerned about damage to the rural landscape from dam construction, and secondarily about maintaining adequate river flow rates. It has a CES utility function that is decreasing in DC_k the capacity of the k'th dam, expressed as a fraction of its maximum capacity and RF_b the residual flow of water in the b'th sub-basin also expressed as a fraction of the maximum feasible residual flow.

$$U_e(x) = exp\left(b_0 \sum_{k=1}^{4} b_k x(k)^{\rho}\right)^{1/\rho} \tag{2}$$

where $x(k) = [(RF_u + RF_m) \quad ; RF_d \quad ; (2 - DC_1 - DC_2) \quad ; (1 - DC_3) \quad]$

(3) **a downstream user (Ds)** representing all stakeholders in the Adour basin that are downstream of all three of the sub-basins that we study. These users are primarily concerned with minimizing upstream demands on water flows and secondarily concerned with preserving the rural landscape. The form of these players' utilities is the same as the environmentalists' but the weights differ sharply: the environmentalist assigns a much greater weight to the terms involving dam capacity (the DC's); the downstream user weights the terms involving residual flows (the RF's) much more heavily.
Note that both flows in sub-basins U and M, and the capacities of dams 1 and 2, are perfect substitutes for one another, and imperfect substitutes for the remaining variable. The reason is that dam 3 is considered to have a particularly significant impact on the landscape, because it is in the mountains in a particularly scenic valley, while residual flow in basin D is considered particularly important for maintaining aquatic life and recreational activities.

(4) **the manager (Mg)**, who administers the distribution of water in the district. For statutory reasons, the manager is equally concerned to avoid budget imbalance (positive or negative). Further, he derives utility from increasing the scope of the water system he administers. That is, he prefers a larger operation, and therefore higher dam capacities. the manager's utility is also CES, of the form

$$U_{Mg}(x) = exp\left(c_0 \sum_{k=1}^{2} c_k x(k)^{\sigma}\right)^{1/\sigma} \tag{3}$$

where $x(1) = (3 - DF_1 - DF_2 - DF_3)$ and $x(2)$ is a measure of the positive or negative budget imbalance.

(5)**the taxpayer (Tp)**: taxpayers in our model are represented by a local politician, whose primary objective is to save his constituents' money, hence he disapproves of dams. The taxpayer shares the downstream user's concern for the residual flows. His utility is CES in three arguments, the first two are the same as the first two variables for the downstream user and the environmentalist; the third term represents the relative construction cost of the dams.

$$U_{Tp}(x) = exp\left(d_0 \sum_{k=1}^{3} d_k x(k)^{\omega}\right)^{1/\omega} \tag{4}$$

where $x(1) = RF_u + RF_m$, $x(2) = RF_d$ and $x(3) = 3 - \sum_i C_i$ with C_i is the construction cost of the i'th dam, expressed as a fraction of the cost of constructing the most expensive version of this dam.

The preference profile described above gives rise to a clear-cut conflict between farmers on the one hand, and the taxpayer and the environmentalist on the other. Farmers prefer higher quotas, and, when the hydrology constraints are binding, prefer greater dam capacity to less. The taxpayer and environmentalist prefer lower quotas, because quotas and residual flows are inversely related, and less dam capacity, either to lower the tax burden or preserve the rural landscape. The relationship between the manager and the downstream user to these opposing camps is less clear-cut. Like the farmers, the manager prefers higher quotas and more dam capacity, but, in contrast to the farmers, he also prefers higher prices. Like the taxpayer and the environmentalist, the downstream user prefers lower quotas because he values higher residual flows; in contrast to those parties, however, the downstream user prefers more dam capacity, because his primary concern about residual flows dominates his secondary concern about the landscape.

4 COMPARATIVE STATISTICS ANALYSIS

In this section, we apply our model of the Adour River negotiations to a number of questions regarding bar- gaining power. In subsection 4.1 we introduce our method of analysis with a stripped down model in which only three players participate. In subsection 4.2 we investigate whether farmers benefit more when they participate independently in the bargaining process, or when they are represented by a common spokesman, charges with maximizing the joint interests of all farmers. Finally, in subsection 4.3, we consider how the definition of the bargaining space affects player utilities. In particular, we examine whether farmers' bargaining power is increased if the maximum permissible degree of heterogeneity across water prices or quotas is restricted.

In our model, it is important to emphasise that there is no such thing as a farmer coalition. Each farmer faces two forms of opposition. One is the opposition from non farmers who, on the whole, have opposite interests to him. Non farmers want high residual flows, therefore low aggregate quotas - no matter how the restriction on quotas is distributed among farmers - and they prefer high prices to offset investment costs - no matter which farmer pays. In that sense, farmers form an informal coalition because they face the same opponents. The other opposition comes from internal competition to share the burden imposed by others, each farmer wanting his fellow farmers to support a larger share. In this internal competitive game, they are not equal:

- *in terms of relative preferences* for quotas and prices (because Fm has the greatest willingness to pay for quotas).
- *in terms of potential contribution to budget constraint*: since Fu has the largest irrigated area, a unit increase in Fu's price or quota raises more revenue than a unit increase in either one of the two other farmers' prices or quotas.
- *in terms of location in the river basin*: a decrease in Fu's quota will benefit the two downstream basins, therefore contributing to satisfy the three hydrological constraints, whereas any decrease

of the quotas allocated to the downstream farmers will only contribute to the downstream hydrological constraint.

4.1 Shifting Access: a simple example

To introduce our method of analysis, we begin with a stripped down model in which all but three of the players specified above are excluded from the bargaining process. The players that remain are Fu, Fm and Ds. The comparative statics experiment we consider is a shift in access from farmer Fu to farmer Fm. For this example, we restrict our analysis to the CPCQ regime, and assume that in the final round of bargaining, Ds's participation constraint is binding on both of the other players. It is said that Ds is default strong.

The example illustrates, in a much simplified context, how we analyze the comparative statics properties of our model. In particular, the example illustrates the nature of the inductive arguments we use, and demonstrates how effects in the last rounds of the game *build on each other* and become magnified as we move backwards through the inductive chain.

Specifically, one would expect that a reallocation of access from Fu to Fm would increase Fm's utility while decreasing Fu's. In fact, the outcome is that both Fm and Fu benefit from the shift. That is, Fu actually benefits by ceding power to a fellow farmer. Ds is worse off. The key to the argument is the strategic role that farmer Fm's plays in the bargaining. By augmenting Fm's power, even at the expense of his own, Fu can increase the effectiveness with which Fm plays this role. Because Fu's preferences are partially aligned with Fm's, Fu gains an indirect benefit as a result, which more than offsets the direct loss resulting from the reduction in his own power.

Fm's strategic role derives from the fact that Fm's is the unique participation constraint that is binding on Ds in the penultimate round of bargaining . Each cluster of bars in Figure 2 decomposes the change in the indicated player's expected utility in the indicated round, as access is shifted from Fu to Fm. Consider, for example, of the left-most cluster in the top-right panel. The first three bars represent changes in Fu's utility from, respectively, Fu's, Fm's, and Ds's proposals. The fourth bar represents the effect of the change of access, equal to the increase in Fm's access times the difference between Fu's utility from Fm's vs Fu's own proposal. The fifth bar represents the change in total effect, i.e., the effect of the access shift on Fu's expected utility conditional on reaching round $T-2$.

Since Fm strictly prefers his own proposal to the one made by Fu, the effect of the access shift in the final round of bargaining is to increase Fm's conditional on reaching this round, while decreasing Fu's. The impact of the shift on Ds in this round is negligible. We now trace the impact of this initial change as we move backwards up the inductive chain, with the help of the four panels of Figure 2. Consider first the penultimate round, represented graphically in the top left panel. As we have just discussed, Fm's participation constraint is binding on Ds in the penultimate round. As Fm's access increases, his constraint tightens and Ds's utility from his own proposal declines, while Fm's and Fu's both increase. (These changes correspond to the positive bars in the middle of Fu's and Fm's clusters, and the negative bar in the corresponding place for Ds.) As in the final round, the access shift benefits Fm while hurting Fu, leaving Ds essentially unaffected. The net effect on Fu of the two changes is positive, as indicated by the positive right-most bar in Fu's cluster. For Fm, both effects of the access shift reinforce each other, while for Ds, the only significant consideration is the loss from his own proposal.

We now move to the top-right panel of Figure 2, which describes what happens in round $T-2$. All the factors that applied in round $T-1$ apply in this round also, but they are reinforced by the fact that Ds's participation constraint in this round becomes slacker as Fm's access increases. The main difference between this and the penultimate round is that both farmers in this round gain when either makes a proposal, as a result of the loss Ds experiences in round $T-1$. Thus, in this round, the negative impact

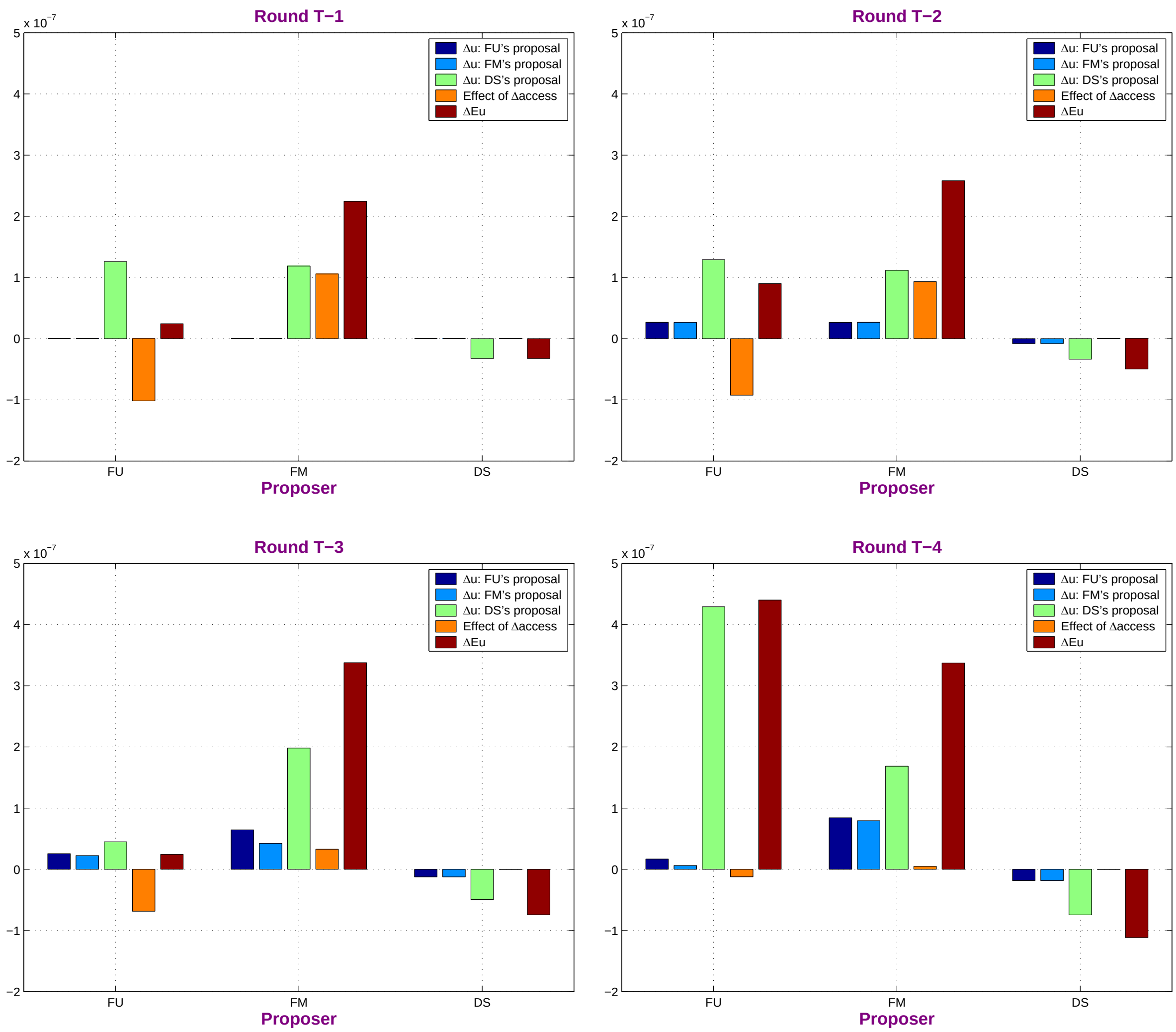

Figure 2: Fu gains by ceding access to Fm

on Ds accumulates. Matters get worse and worse for Ds in rounds $T-3$ and $T-4$, and conversely, better and better for the two farmers. By the time round $T-4$ has been reached, all three players are announcing essentially the same proposal, so that the changes depicted in the bottom-right panel represent the comparative statics of the solution to the game.

To summarize the argument, when access is transferred from Fu to Fm, Fm's participation constraint tightens and, since this constraint is binding on Ds, Ds is weakened. Since Ds's constraint is binding on farmers, they each benefit as a result, both because Ds's proposals are less onerous and because their own proposals are less constrained. For farmer Fu these indirect gains dominate Fu s direct loss due to the reduction in his access probability.

This simple example illustrates three characteristics of the model:

1. *the snowball effect* of the bargaining effects in the last rounds. In the following text, it will allow us to examine only the last few rounds to explain the outcome of our simulations. ;

2. *the strategic importance of the default-strength* of each player: when the participation constraint of a player in the last round is binding on other players, this player benefits from a bargaining comparative advantage which will tend to be reinforced round after round. It is important to underline that this *default strength*is directly related to the utility that the player derives from the fall-back option, that is from the policy which will be implemented if no agreement is reached. It can be assumed that the fall-back option is the status quo solution but the state can also *threat* participants to impose a centralized solution which will yield differentiated advantages to players. Default strength is therefore embedded in the structure of the negotiation and can be oriented by exogenous actors.

3. *the non intuitive effect of sources of power interactions*: this example highlights a striking characteristic of the model, which distinguishes it from reduced-form models of bargaining such as the Nash Bargaining model, and closely related models of policy formation such as the "political preference function" approach. In all these models, there is a monotone relationship between a player's exogenously specified indices of bargaining power-e.g., default strength and bargaining weights-and the utility the player derives from the bargaining outcome. In our model, there are other, less straightforward, sources of bargaining strength: we demonstrate here that a member of a bargaining coalition can actually benefit by ceding his bargaining power, as defined in the conventional way, to another, strategically located coalition member, who can use that power more effectively, to the benefit of all coalition members.

4.2 Combining forces: impact of a common spokesman for farmers

In our second experiment, we consider the effect on farmers' performance of introducing a farmer spokesman. Our spokesman is modelled as a slightly different kind of player from the others: he is selected at each round to make a proposal with a given access probability ; but he does not have a participation constraint (his approval is not required in order for a proposal to be accepted) and the notion of default strength does not apply to him. The spokesman is similar to an attorney hired to represent the interests of his clients: ultimately, the client themselves, not the attorney, must decide whether or not to accept any proposed deal.
The spokesman's utility function is defined as the simple average of the three farmers' utility functions. In this experiment, we consider the effect of increasing the spokesman's access. The access vector for non-farmer parties is held constant throughout, and farmers' access probabilities are reduced by equal amounts to accommodate the spokesman's increased access.

The goal of this experiment is to explore the natural conjecture that farmers will be able to negotiate more effectively as a group, the more they can present a "united front" at the bargaining table. When each farmer's proposal is weighted according to his access probabilities, farmers will tend to suffer, on average, from the fact that other farmers fail to take account of their interests. The spokesman, on the other hand, will internalise any externalities that exist between farmers, but are unexploited by them when they negotiate individually. We would expect, therefore, that in the solution to the bargaining game the mean of farmers' payoffs will, typically, increase with the spokesman's access. A number of questions arise in the context of our particular model: Does the spokesman always improve farmers performance ? Under what conditions will the spokesman's contributions have the greatest impact ? Which farmers benefit from the spokesman's participation and which, if any, lose? What is the precise nature of the externalities that are ignored by individual farmers and internalised by the spokesman ?

To address these questions, we considered the role of the spokesman for a range of circumstances, varying both the issue space (regime) and level of environmental requirements . The effects of increasing the spokesman's access on farmers' solution payoffs are summarized in Figure 3 for all combinations of regimes and hydrological conditions. The horizontal axis plots the spokesman's access probability; the vertical axis plots players' utilities, relative to their mean utilities across all iterations of the experiment. The highlights of these four graphs are: (i) the mid-stream and downstream farmers always benefit from

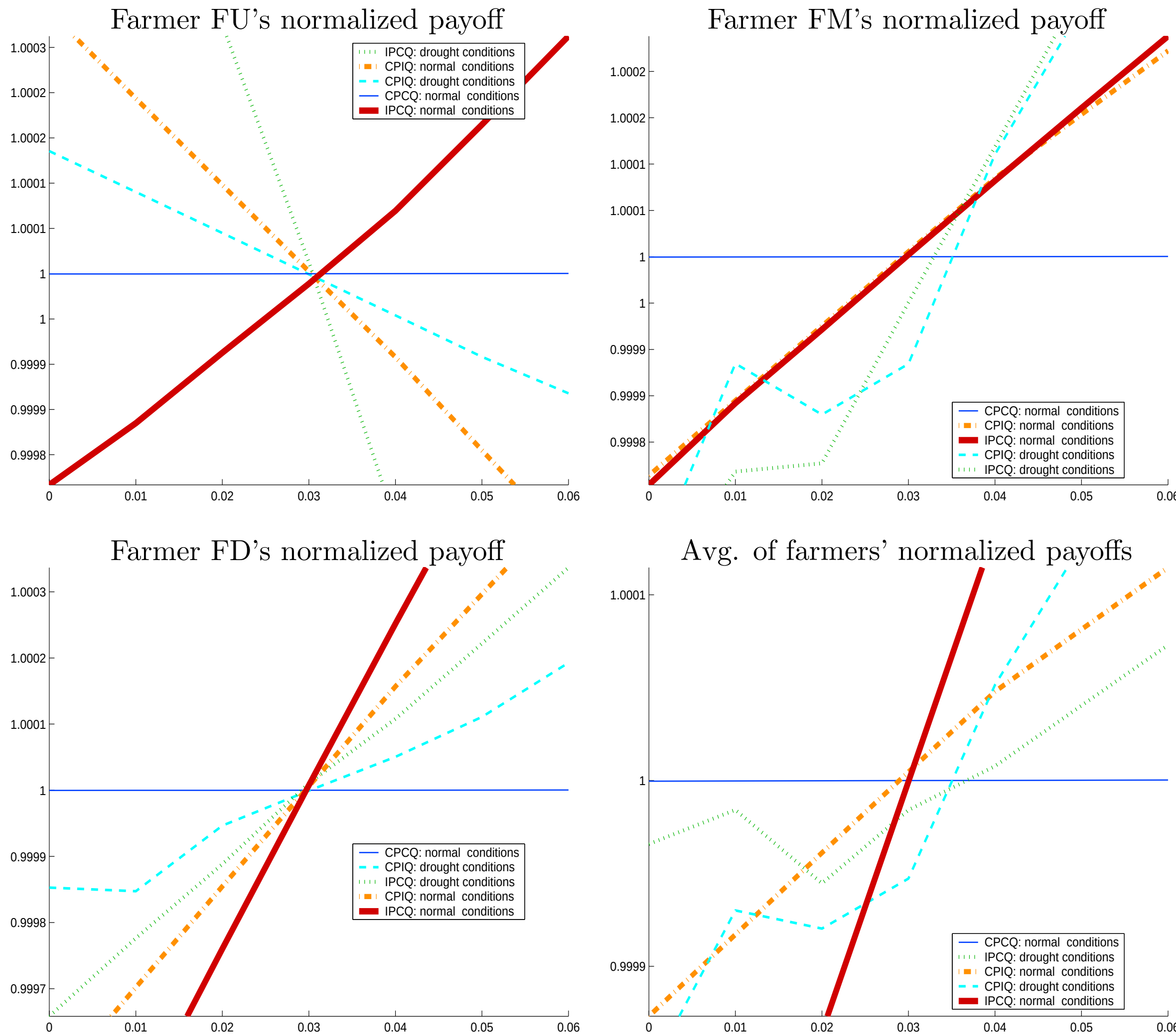

Figure 3: Comparison of normalized payoffs as spokesman's access increases by regime and hydrological conditions

the spokesman's involvement; (ii) in all cases except the normal conditions IPCQ regime, farmer Fu becomes worse off as the spokesman gains access; (iii) relative to his effect in other regimes, the spokesman has an imperceptible effect on farmers' utilities in regime CPCQ.

It has to be emphasised that, due to the snowball effect presented in section 4.1, the explanations for the effects observed can be tracked back by studying the differences between the spokesman's proposal and the average of farmers' individual proposals in the final round of bargaining.

- **Why does the spokesman always arbitrate against Fu, except in the normal conditions IPCQ regime?**

In IPCQ and CPIQ regimes, farmers have ample opportunity to pursue their own interests at the expense of other farmers. Specifically, in IPCQ (resp. CPIQ) each farmer assigns high prices (resp. low quotas) to other farmers, and a low price (resp. high quota) to himself. This behavior is demonstrated, for the

IPCQ drought conditions, in the top panel of Figure 4. The Figure 4 depicts information about the proposals made by each of the three farmers, about the spokesman's proposal and about the average of the three farmers' proposals. From left to right, the cluster of seven bars for each player represents: the common quota; three individual price levels; the average of individual price proposals; the average of Dam Capacities for dams 1 and 2; the capacity of dam 3; the average of up- and mid-stream residual flows; downstream residual flows . In the lower panels of the figure, we display the difference between the spokesman's proposal and the average of the three farmer's proposals.

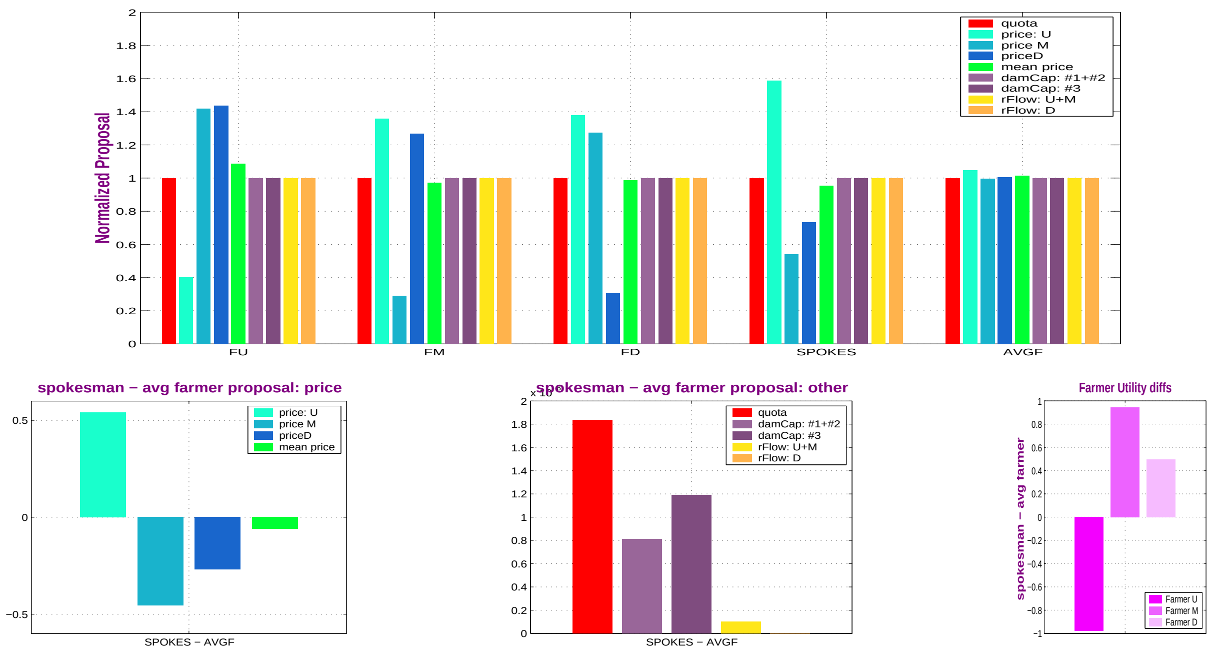

Figure 4: Farmer proposals: regime IPCQ, drought conditions, final round

When the budgetary constraint is limiting (or when the participation constraint of a player who cares about budget balance, ie the taxpayer or the manager, is limiting on farmers), then the spokesman will have to arbitrate between the three farmers to meet the constraint. It is the case in the IPCQ regime for strict environmental standards. The least costly option in terms of the spokesman utility is therefore to increase the price charged to farmer U. The spokesman exploits Fu's comparative advantage in generating revenue by proposing an asymmetric distribution of prices, and is able to cover the manager's budget constraint at significantly lower prices. Rather than taking the entire efficiency benefit in the form of price reductions, the spokesman chooses to "purchase" a slight increase in quota levels. Farmers Fm and Fd clearly prefer the spokesman's proposal to the average of their own proposals. In situation of strict environmental standards, the increase in quota is insufficient to compensate farmer U for the price increase, and farmer U is worse off.

When the hydraulic constraints are binding (or when the participation constraint of a player who cares about residual flows - the downstream user, the tax payer, the environmentalist - is limiting), the spokesman will choose to reduce the quota attributed to farmer Fu. A quota is more costly in an environmental sense when assigned to Fu than it is when assigned to Fm or Fd, because the former reduces the water availability in all three sub-basins while the latter affects only the mid-stream and downstream basins. This is the case in the CPIQ regimes (normal and drought conditions). These points are illustrated in figure 5, for the CPIQ normal regime.

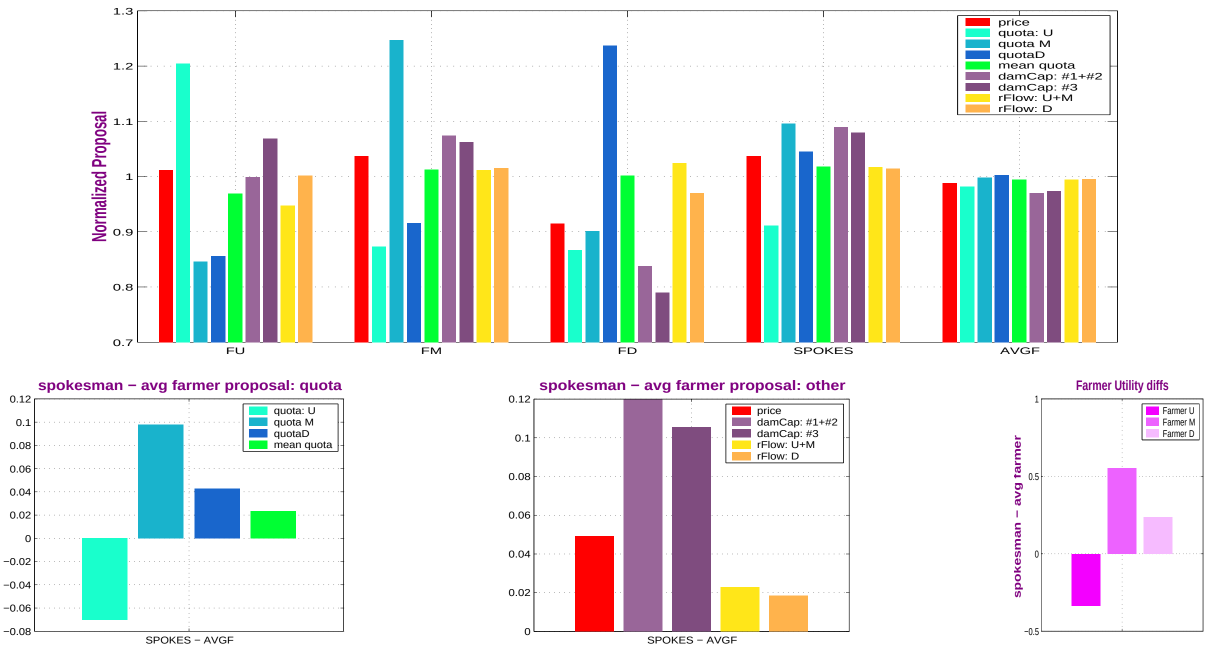

Figure 5: Farmer proposals: regime CPIQ, normal conditions, final round

- **Why does Fu gain when spokesman's access increases in IPCQ normal regime ?**

In the normal condition IPCQ regime, the budgetary constraint is not binding in the last round on either individual farmers or the spokesman. Therefore the spokesman will assign prices to farmers according to their relative preference for quotas and prices. Since the midstream farmer has the highest willingness to pay for quota, he is attributed the highest price (see Figure 6).

However, it has to be emphasised that the farmers propose a significantly higher vector of per-unit price than the spokesman's proposal, in exchange for a very small increase in the common quota. This asymmetry in price proposals is due to the downstream player Ds whose constraint is binding. Ds has a second order preference for higher prices and is willing to "trade" additional quotas for higher prices, though on extremely unfavourable terms for farmers. Farmers on the other hand are willing to assign very high prices to their fellow farmers in exchange for gains that they would not consider worth the cost if they had to pay it themselves. It is an extreme example of the "*beggar thy neighbour*" behaviour. When the spokesman selects a proposal, by contrast, he fully takes into account the disutility that all farmers incur from higher prices , and so refrains from pushing quotas beyond the level that farmers would be individually willing to pay for.

In such context, the spokesman proposes a vector of prices which is much lower than the average proposal of the three farmers. He reduces very slightly dam capacities with an insignificant reduction of the common quota, which leaves the three farmers better off. The spokesman's effect is therefore to mitigate negative cross-externalities among farmers.

- **Why is the effect of the spokesman in CPCQ regime insignificant ?**

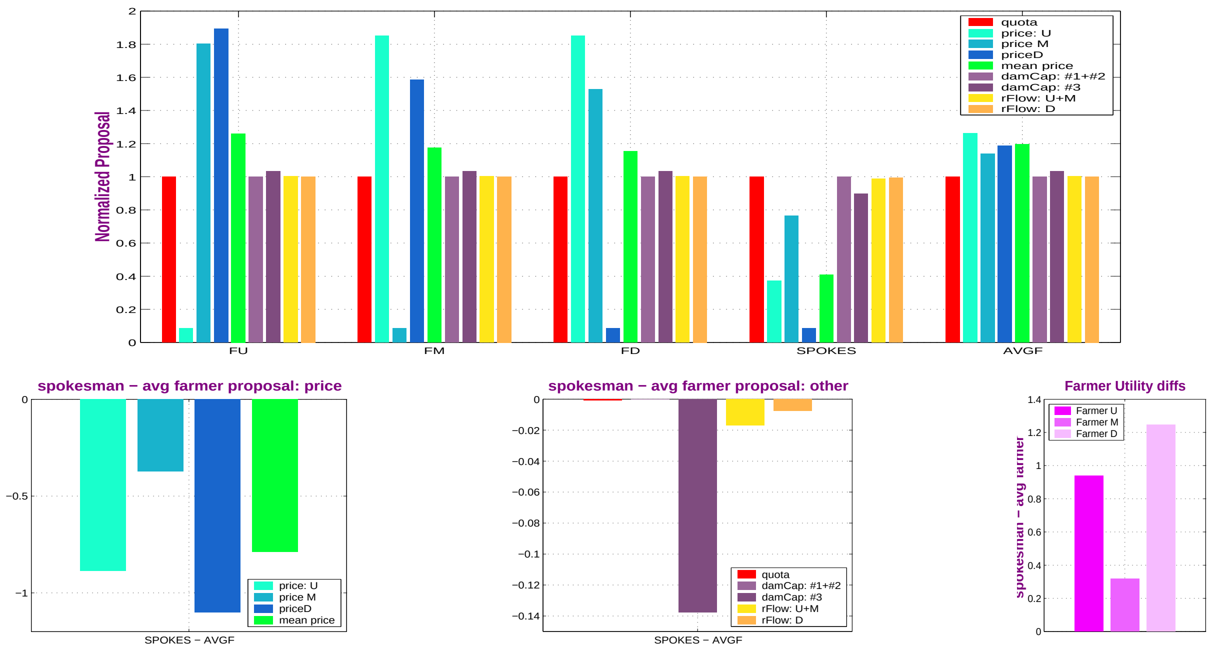

Figure 6: Farmer proposals: regime IPCQ, normal conditions, final round

In regime CPCQ, the opportunities for self-promotion at the expense of the group are not available to farmers. Under drought conditions, all farmers, including the spokesman, are forced by hydrology constraints to make identical proposals. Clearly in this context, the spokesman cannot play any role at all. In normal conditions, however, there is still room for farmers to differ between themselves, since each farmer has a different willingness to pay for the marginal quota: Fm proposes the highest quotas, prices and dam capacity levels, and Fd the lowest. When the spokesman's access increases, each farmer does slightly better because the probability that a "detrimental" proposal of another farmer be selected is reduced. Since each farmer's utility from the spokesman proposal exceeds his expected utility from all farmers' proposals, his risk exposure is reduced.

In conclusion
This experiment reveals that in negotiations where there is scope for *beggar thy neighbor* behavior (i.e. regimes IPCQ and CPIQ), the intervention of a spokesman will benefit the farmers as a group. However, this global benefit is obtainable only because the spokesman can discriminate against one of the farmers, the farmer who can contribute to relax the limiting constraint at least costs in terms of efficiency loss. As we have observed, farmer Fu is the target of discrimination in both regimes: in IPCQ, a unit increase in Fu's price raises more revenue than a unit increase in either one of the other farmers' prices; in CPIQ, a unit increase in Fu's quota requires a larger increase in dam capacity than a unit increase in either one of the other farmers' quotas. Hence the spokesman, whose task is to maximize the sum of farmers' utilities, assigns a higher price and lower quota to Fu. We would expect, therefore, that in such situations, Fu would not agree to the appointment of a spokesman of the kind we model. On the other hand, since the farmer group does better on average with the spokesman, Fu could in principle be sufficiently compensated with side-payments that all coalition members would benefit from the spokesman's participation. However, it should be warned that the spokesman, by pursuing the interests of the group as a whole, may act in a way that is detrimental to the interests of one member of the group, and therefore reduces the welfare of all group members. If this member plays an important strategic role in the bargaining (i.e.,

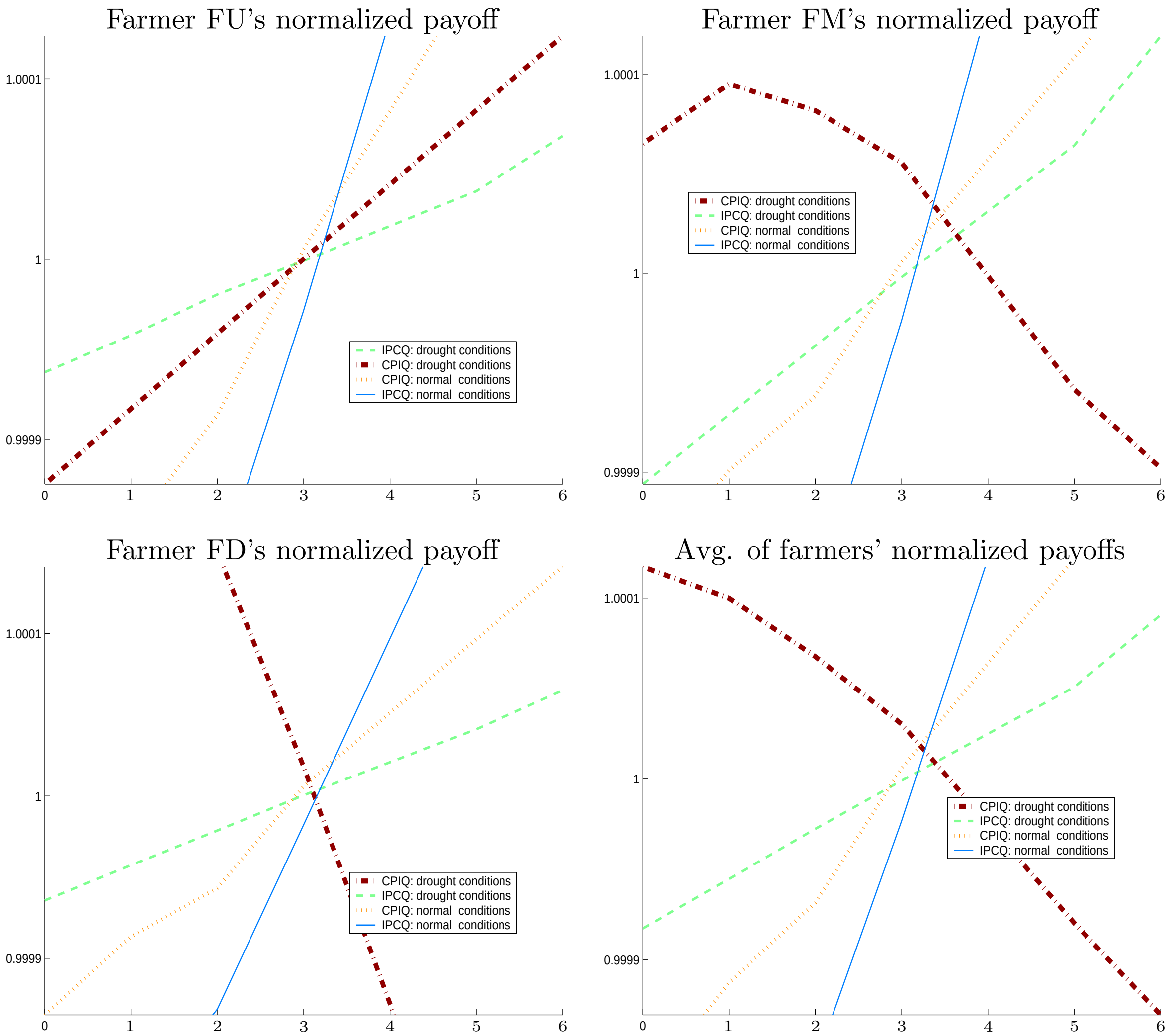

Figure 7: Comparison of normalized payoffs: heterogeneity experiment

his participation constraint is binding when members of the opposition make proposals), the spokesman, by weakening the key member's position, may ultimately weaken the group as a whole.

4.3 Reducing the Degree of Proposal Heterogeneity

In this experiment, we try to accomplish a similar role to the one that the spokesman accomplished, by reducing the degree of permissible heterogeneity among player proposals, in IPCQ and CPIQ regimes. We conduct comparative statics by progressively moving from an individualized regime (IPCQ or CPIQ) to the common regime (CPCQ). Technically, in regime CPIQ (respectively IPCQ), the specification of the bargaining space includes an upper bound on the standard deviation of the three quotas (resp. three prices) proposed by any player. In the current comparative statics experiment, we consider the effect of six successive reductions of this bound, each time by one percentage point of the original bound. The progressive move from individualized to common regime limits the incentive for farmers to compete with each other and forces them to adopt a common position.

Intuitively we would expect that any situation in which farmers are required to set their proposals into line should lead to higher individual farmer outcomes since the "beggar-thy-neighbor" behavior will be increasingly proscribed . The effects of limiting proposal heterogeneity on farmers' solution payoffs is illustrated in Figure 7 for the case in which Ds is default strong . The graphs reveal some interesting differences from the preceding experiment. The two most striking of these are: (i) in all cases, Fu does better as heterogeneity is restricted (whereas he usually did worse as the spokesman's access increased); (ii) in regime CPIQ under drought conditions, all farmers except Fu do worse as heterogeneity is restricted;

- **Why do farmers better in all situation (except for Fm and Fd in CPIQ drought)?**

As in the preceding subsection, we will focus our attention on the final round of bargaining. In the IPCQ regime, the effect of the heterogeneity restriction is that the average price assigned to farmers Fu declines sharply. The picture is less clear for farmers Fm and Fd: in the normal conditions, they are also assigned a slightly lower average price (with a slightly higher quota); and in drought conditions, they get a higher average price, compensated by a large quota.

When he has to satisfy the decrease in heterogeneity, each farmer must either lower other farmers' prices, increase his own, or do both. Due to a tight budget constraint, each farmer is obliged to raise his own price while lowering the prices charged to others. To compensate, he will bid for a higher common quota and therefore for slightly higher dam capacities (up to the point where the marginal cost of increasing dam capacity exceeds the marginal benefit of higher quotas). The result is that each farmer's average utility from the three farmer proposals increases as heterogeneity is limited since each farmer does worse under his own proposal, but gains from other farmers proposals (which therefore increases his reservation utility in the following round). He has therefore to pay for a higher share of the costs but this *constrained altruism* leads to more collective efficiency. On average, all farmers benefit as the constraint tightens, even though Fd's and Fu's prices rise in the drought situation.

In the CPIQ normal conditions regime (pictured in Figure 8), each farmer's quota proposal increases on average as the constraint tightens. What happens here is very similar to what happens in the IPCQ regime: as the constraint tightens, farmers must reduce the gap between the quotas they assign to themselves and those that they assign to other farmers. So they lower their own assignments and raise the others. Once again, farmers do worse under their own proposals, but better when other farmers propose: farmers are thus obliged by the tightening constraint to provide externalities to the others.

- **Why all farmers except Fu do worse as heterogeneity is restricted in regime CPIQ under drought conditions?**

In regime CPIQ under drought conditions, farmers' utilities on average actually decline as the heterogeneity constraint tightens. (Fu's increases, but Fm's and Fd's decline). This property distinguishes the present scenario from all the others we have considered: in the others, the "unifying factor"- the heterogeneity constraint-benefited farmers on average. As we shall see, the reason for this surprising outcome is that in this context, there is an unusual alignment of interests between farmer Fd and the other two farmers. It actually helps farmers further upstream to be able to assign high quotas to Fd. As the heterogeneity constraint tightens, their flexibility to do this is curtailed, and their bargaining strength is weakened.

The phenomenon just described does not arise in the final round of bargaining. As Figure 9 illustrates, the drought effect tightens both the budget and the hydraulic constraints. To cover the budget con-

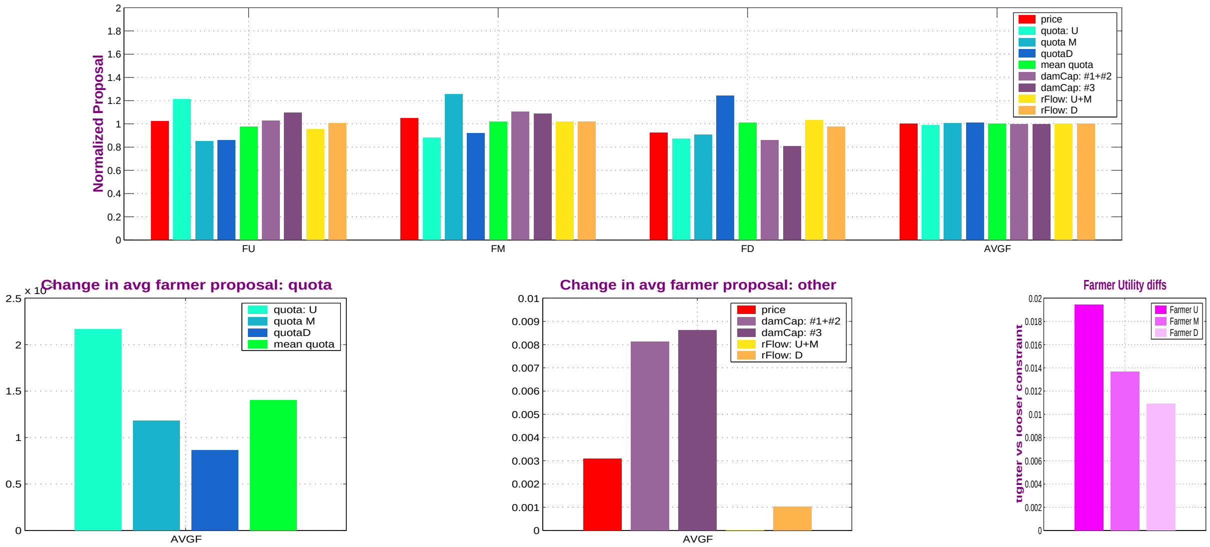

Figure 8: Farmer proposals: CPIQ, normal conditions, final round: Ds is default strong

straint, farmers Fu and Fm have to choose, on the margin, between either raising the common price or increasing the total amount of distributed quotas (without hitting one of the three hydraulic constraints). In the latter option, the easiest is to allocate more quotas to Fd whose use of quotas has a smaller impact on residual flows. Under these conditions, both farmers prefer to give up their own quotas and hand them to Fd than raise prices. That is, the position of Fd downstream of the river and faced with a less tight hydraulic constraint, provides the group with a positive externality: he can be given more quotas without requiring more dam capacity and he can therefore contribute to the budget without increasing the common price. However, as the heterogeneity constraint is tightened, the value of this externality is reduced and the utility of the farmer coalition, on average, declines.

In conclusion,
In contrast to the role of the spokesman, tightening the heterogeneity constraint to force farmers to align their proposals actually benefits Fu. The spokesman's objective is to obtain the most efficient allocation of quotas for the farmer coalition as a whole: he therefore sacrifices the farmer who is the most useful for fulfilling the constraints. In the heterogeneity experiment, in contrast, farmers remain primarily concerned with individual gain. However, by being forced to align their proposals, they have to make better offers to their fellow farmers. They therefore indirectly strengthen the farmer coalition as a whole except in the case when the exploitation of their difference yielded more benefits than the elimination of the beggar-thy-neighbor behavior.

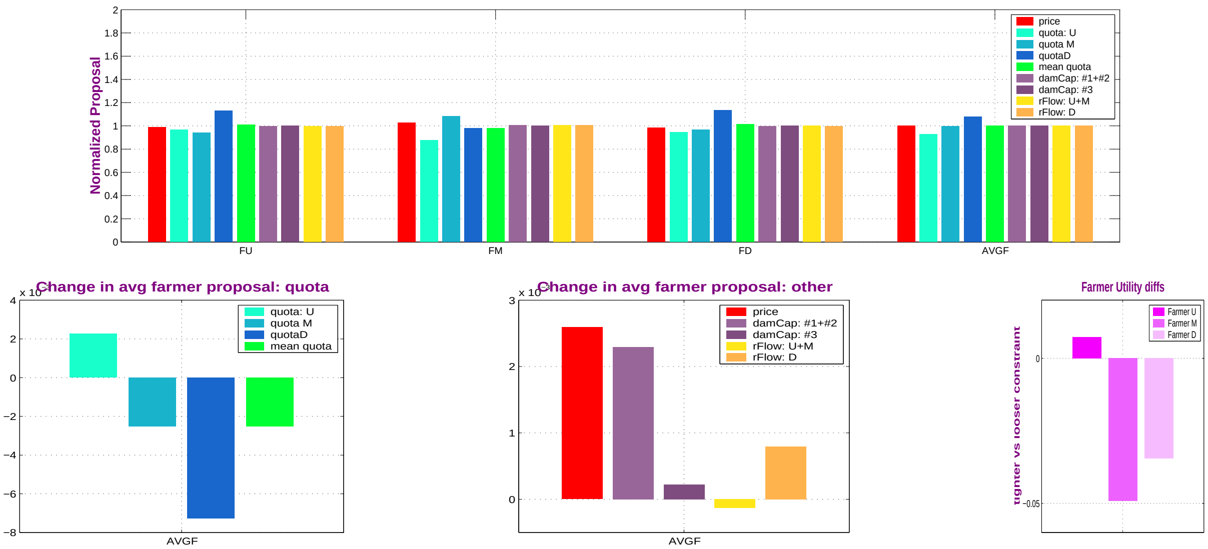

Figure 9: Farmer proposals: CPIQ, drought, penultimate round: Ds is default strong

5 CONCLUSION

We have explored the interactions between the structure of the bargaining process, and the effective power of bargaining participants. Overall, our results indicate that the structure of the negotiation process is an important determinant of negotiation outcomes. For participants, there are a number of sources of bargaining power. The two direct sources are access, modeled as the probability of being chosen to make a proposal, and default strength, or how well the participant will fare if the negotiation does not result in an agreement. Our analysis has identified a number of other sources of power. First, our examination of how farmers fared depending on the allocation of access showed that giving up access in favor of a stronger ally could increase one's ability to influence the negotiation outcome to one's own advantage. Our experiment regarding the appointment of a common spokesman for farmers showed that the welfare of farmers as a whole increases with the use of a spokesman; however, it also suggests that side payments may be required for the participants to implement such a solution. Alternatively, such considerations may be included ex ante when defining who may participate in a negotiation process. Essentially, the spokesman improves average farmer welfare because he does not engage in "beggar-thy-neighbor" behavior when making a proposal. Our experiment regarding the maximum degree of heterogeneity allowed in the policy variables for the three farmers showed that restrictions on the bargaining space usually affects positively the welfare of farmers. However, allies can sometimes gain collectively by exploiting their differences rather than by aligning their positions. The homogeneity strategy can therefore be detrimental. The general conclusion is that sources of bargaining power are very diverse and are sometimes not easily anticipated. It therefore hints that pre-negotiation bargains may be necessary to define collectively the structure of the negotiation.

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NOTE

In our multi-issue bargaining model, it is necessary to distinguish between first-order and second-order preferences. At a first-order level, each negotiator has different concerns, and each is indifferent to some issue that matters a great deal to another negotiator. For example, each farmer group is concerned about the price and quota level that applies to its own sub-basin, and is, to a first-order approximation, indifferent between alternative allocations of quotas and prices to the other two sub-basins. Similarly, the environmentalist is unconcerned about the cost to farmers of acquiring quotas. In the context of our model, in which each party makes a proposal that affects all parties, this state of affairs is entirely unsatisfactory: allocations that have a significant impact on some parties may be determined by arbitrary resolutions of indifference by others. To address this problem we are obliged to specify "second-order preferences" for each agent. For example, we assume that at a second-order level, farmers in one sub-basin prefer equal to unequal distributions of benefits and costs among the farmers in other sub-basins. To implement the idea of second-order preferences, we add to each agent's first-order utility function a second utility function that is weighted by an extremely small coefficient. When a second-order preference involves maximizing a gain, we specify it as a Cobb-Douglas. When it involves minimizing a loss, we specify it as a quadratic. Other things equal, these specifications ensure that agents choose a balanced bundle.

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