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Michel Le Breton, Alban Thomas

And Vera Zaporozhets

Institut d'Economie Industrielle (IDEI) – Manufacture des Tabacs
Aile Jean-Jacques Laffont – 21, allée de Brienne – 31000 TOULOUSE – FRANCE
Tél. + 33(0)5 61 12 85 89 – Fax + 33(0)5 61 12 86 37 – **www.idei.fr** – contact@cict.fr

INSTITUT D'ECONOMIE INDUSTRIELLE

Bargaining in River Basin Committees: Rules Versus Discretion*

Michel Le Breton† Alban Thomas‡ Vera Zaporozhets§

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Abstract

In this paper, we introduce a game-theoretical non-cooperative model of bargaining to analyse project funding in the French river basin committees. After sorting out some of the main theoretical predictions, we proceed with an empirical application to the subsidy policy of French Water Agencies. The theoretical model of bargaining is simulated for various risk preferences, and a reduced-form estimation of the distribution of subsidies is performed. We find some evidence in support of the predictions regarding the role of bargaining in decision-making for water management.

1 Introduction

The main purpose of this paper is to analyse the decision-making process of two major actors in the French water policy: the Water Agencies (hereafter, WA) and the River Basin Committees (RBC). The general mission of WAs is to undertake actions to protect water against any action which can deteriorate its quality and quantity. To do so, WAs have two main financial instruments at their disposal. First, they collect taxes on water users, based on a set of various parameters and variables including the pollution levels resulting from the different activities. Second, they use these tax revenues to finance various operations and projects. In practice, the general mission of the WAs translates unto a set of practical

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†Toulouse School of Economics (GREMAQ and IDEI, Toulouse University)

‡Corresponding author. Toulouse School of Economics (LERNA, INRA) and IDEI, email thomas@toulouse.inra.fr

§Toulouse School of Economics (LERNA, INRA)

objectives: contribute to reaching an adequate ecological state of river basin resources, and to matching available water resources with water needs. This includes several orientations (Adour-Garonne Water Agency, 2012):

- Improve the quality of drinking water
- Reduce the impact of human activities on aquatic ecosystems
- Maintain the natural processes of aquatic ecosystems
- Put water at the heart of land management policies
- Promote the quantitative management of river streams, in particular during the summer
- Manage ground water resources in a sustainable manner.

Water users pay taxes but are also, more or less directly, the beneficiaries of these projects. In what follows, we will mostly group the users into three categories : the residential users, the industrial firms, and the farmers.

The French water policy relies upon the principle of decentralized management of the water resource by river basin. The way tax revenues collected by a Water Agency will be redistributed among the user categories is discussed within a River Basin Committee. Consisting of elected members of local and parliamentary chambers, of representatives of users and of the public administration, such a Committee (one for each of the six major French river basins) is in charge of elaborating the environmental objectives of the river basin, but also to agree among its members upon the distribution of subsidies and the determination of emission and use tax rates.

The fact that decisions on the Water Agency budget in terms of taxes and subsidies are discussed by River Basin Committee members implies that a significant degree of discretion is expected. Many representatives are participating to the Committees in order to obtain benefits for their sector (agriculture, industry, local communities), while representatives of the regions or the State may have preferences over a larger range of water users. We reproduce below some elements of the debates that took place during the Adour-Garonne RBC of July 4, 2011. These extracts indicate that indeed not all actors act in a complete consensual way.

· Mr. Frédéric Caméo-Ponz (representative of an environmental association): "*Concerning the issue of budget balancing, he approves of the limitation of tax increases, but asks for a modi cation of its distribution across user categories, to account for the polluter-pays principle".*"

· Mr. Robert Cabe (representative of a département): "*Moreover, while he agrees with Mr. Claude Miqueu, representative of a departement on the need to account for the opinion of local elected representatives, he points to the fact that it* *is necessary to make sure that such opinion corresponds e ectively to the general interest, and not to highly local ones, which would hamper reaching the objective of the creation of water reservoirs*".

· Mr. Marcel Menier (representative of the industry) "*reminds the Committee about the cumulated increase of 43.5 percent in taxes paid by the industry until 2014, which will be a major nancial burden to industrial rms. The industrial sector will therefore pay a particular attention to the changes in environmental tax rates along the 10th action programme*".

· Mr. Yves Casenove (representative of the industry) "*notes in reaction to a statement by Mr. Pierre Augey (representative of rural municipalities), that the increase in taxes did not result from a consensus during the 9th programme, the industrial sector being a strong opponent to this increase. He adds that a fair comparison with other river basins must be extended to aspects of water requirements. Indeed, it is only with a global evaluation of subsidies and taxes that an objective comparison across user categories can be achieved. Such procedure has no other goal but to make sure the distribution of the budget is organized within reasonable bounds, in order to make progress in the concertation*".

Our objective is to describe the negotiation process within River Basin Committees as a game where the actors will be the representatives of the different categories of users. An important aspect when considering a model of bargaining applied to water management decisions, is the fact that the latter may not reflect the observed distribution of water user representatives in the RBCs. Indeed, a representative of a given user category wishes to secure a minimum budget to be allocated to his own group, in the form of subsidies. In practice however, the representative may need to form a coalition with other representatives, to make sure his proposal will be accepted. A major determinant is therefore the weight each category has in the River Basin Committee, as well as the probability that a particular representative will have the initiative to make or discuss any proposal upon the budget to be distributed.

As for any game, we have to describe the strategies and the payoffs of the various players. In terms of outcomes, we also have to explain the two main dimensions which have just been described. What is the total amount of tax which is collected and how the tax burden is shared accross the different categories of users? How this money is used and distributed accross the different recipients? Who are the main beneficiaries of these operations? In Section 2, we describe the institutional setting concerning the French Water Agencies and the River Basin Committees, paying a particular attention to the distribution of representatives in these committees. The sequential model of bargaining is presented in Section 3, starting with related literature on bargaining in institutions. We then describe our game-theoretical approach, consisting in two stages: determination of the optimal share of budget to be bargained upon, and computation of the optimal pay-offs. We also provide some examples of the game, and show that in some cases, the bargaining stage over the budget may not exist. The empirical application is presented in Section 4. We describe the data collected from French Water Agencies on tax revenues and subsidies for various categories of water users, as well as on River Basin Committees. In this section, we first conduct a simulation experiment from the game-theoretical model calibrated on data from the Adour-Garonne water Agency. We then present a brief reduced-form estimation of the relationship between subsidy shares and the distribution of River Basin Committee representatives. Section 5 is the conclusion.

2 Institutional Setting

The French Water Agencies have been created in 1966, following the first Water Act of 1964, which institutionalized a decentralised water management system at the hydrogeographical level of the river basin. This system has been reinforced by the subsequent Water Acts of 1992 and 2006. The six Water Agencies (Adour-Garonne, Artois-Picardie, Loire-Bretagne, Rhin-Meuse, Rhône-Méditerranée-Corse and Seine-Normandie) are public establishments of administrative nature, under the supervision of two ministries: the Ministry of the Environment and the Ministry of Finance. Water Agencies participate at each river basin level to the national and European water policies, by developing a strategy originating from an overall view of water issues. On behalf of the State and the River Basin Committee, Water Agencies contribute to reaching a good state of water bodies by reducing the impact of human activities, by preserving water resources and by satisfying user needs through the search for an equilibrium between water resources and rational water use.

2.1 Water Agencies and Economic Instruments

Water Agencies reach these objectives through financial operations, by designing and developing framework plans for water management as planning tools (*SDAGE, Schema Directeur d'Amenagement et de Gestion des Eaux*) which are translated into Policy Instrument Plans (*Programmes de Mesures*). Water Agencies also have missions of information and dissemination to the public, and a mission of decentralised cooperation (Oudin-Santini Law of 27 January 2005).

In practice, this means that Water Agencies are in charge of financing common-interest or private projects dealing with water resources at the local level, and that their budget is funded by a series of water charges associated with resource conservation objectives (see Seroa da Motta et al., 2004; Thomas, 1995).

The total level of taxes collected by each Water Agency is determined in line with the expenses of all nature which must be supported by the Agency, in the framework of a multiyear intervention program approved by the Prime Minister after a recommendation by the Inter-ministerial mission on water. Table 1 presents the tax revenues by WA and intervention program, with the proportion of taxes paid by agriculture and industry. As can be seen from the table, the total budget has been reduced for the 8th multiyear intervention programme in all WAs. The share of tax revenues from the agricultural sector is always very low, ranging from 0.11 percent in Artois-Picardie during the 6th programme, to 7.95 percent for Adour-Garonne during the 9th programme. However, in a majority of cases, the share of agriculture has been increasing. The share of tax revenues from industry is much higher, and is generally decreasing in a significant way over time. This implies that budget increases have been possible with a higher contribution from the local communities over the multiyear programmes.

An important aspect of the current policy is the desire to promote a consensus among stakeholders in preserving the environment while maintaining a sustainable equilibrium between water availability and the user demands.

After the Water Act of 2006, new dispositions apply starting in 2007. The French Parliament now determines the priority orientations of the multiyear intervention programs of Water Agencies and determines the maximum level (ceiling) of their expenses (budget). These new dispositions also stipulate that the deliberations of the Executive Board of Water Agencies are taken after recommendation from the River Basin Committee, and in compliance with the total multiyear amount of expenses (budget), which is the object of a decree by the Ministry of the Environment and the Ministry of the Budget.

Table 2 presents the total subsidies distributed by each WA and intervention program, with the proportion of subsidies received by agriculture and industry. It is interesting to note that the proportion of total subsidies for the agricultural sector is highly heterogeneous across WAs, and across programmes for the same Water Agency. Some WAs have experienced a sharp decrease in the proportion of industrial subsidies, in particular Arois-Picardie and Seine-Normandie. This reflects the changes in the priority of WAs over time, and the fact that in many river basins, the number of conservation and resource management projects associated with industry has been declining. At the same time, for some WAs, objectives of reducing non point source pollution from agriculture have been up in the agenda, because many river basins were lagging behind in this respect. Moreover, some WAs in river basins where environmental pressures from agriculture are more significant, as in Loire-Bretagne, have implemented pollution-management programmes before other WAs, which may explain the relative decrease in the proportion of subsidies to agriculture.

Water Agencies are in charge of the secretary of River Basin Committees. They collect emission taxes according to the Polluter-Payer Principle and water use taxes. They give subsidies, low-interest or zero-interest rate loans for projects which contribute to the enhancement of water quality and the preservation of the environment.

It has been admitted that the Parliamentary control over the Agencies' taxes was insufficient with regards article 4 of the Constitution, as these taxes represent in fact "general taxes". Therefore the legislative supervision over the definition

Table 1: Tax revenues by Water Agency and multiyear intervention program (in million €)

	Multi-year Program				
	5 (1987-91)	6 (1992-96)	7 (1997-02)	8 (2003-06)	9 (2007-)
	Adour-Garonne				
	-	517.83	800.28	595.40	308.90
% agriculture	-	1.66	2.32	2.47	7.65
% industry	-	26.96	20.37	15.21	9.81
	Artois-Picardie				
	-	421.01	658.76	466.86	109.38
% agriculture	-	0.11	0.34	0.54	0.62
% industry	-	22.85	15.40	14.49	7.58
	Loire-Bretagne				
	306.88	739.02	1362.76	949.03	243.48
% agriculture	1.62	1.98	1.93	3.39	4.13
% industry	21.94	20.44	16.07	16.05	14.39
	Rhin-Meuse				
	207.60	508.04	791.88	598.15	150.37
% agriculture	0	0	0.33	0.52	0.19
% industry	44.33	28.53	20.17	17.59	20.52
	Rhône-Méditerranée-Corse				
	465.95	1245.99	1660.10	1454.33	368.42
% agriculture	2.39	1.11	0.66	0.79	0.67
% industry	27.00	17.76	11.53	9.75	9.70
	Seine-Normandie				
	-	2142.72	3758.32	2466.85	1378.83
% agriculture	-	0.41	0.82	0.78	0.37
% industry	-	13.37	9.88	9.14	6.03

Notes. For the 9th multiyear programme, data are available for the year 2007 for all Water Agencies, except for Seine-Normandie, for which data are available for 2007 and 2008.

Table 2: Subsidies by Water Agency and multiyear intervention program (in million €)

	Multi-year Program				
	5 (1987-91)	6 (1992-96)	7 (1997-02)	8 (2003-06)	9 (2007-)
	Adour-Garonne				
	185.57	461.61	605.44	507.97	963.40
% agriculture	2.87	0.84	7.73	5.19	6.46
% industry	24.50	28.92	5.87	17.38	17.15
	Artois-Picardie				
	-	340.49	400.48	263.19	490.80
% agriculture	-	1.65	11.15	8.49	8.42
% industry	-	36.43	4.64	6.46	14.32
	Loire-Bretagne				
	-	229.76	1017.97	999.98	1342.50
% agriculture	-	17.07	18.47	17.61	9.24
% industry	-	3.63	10.78	5.85	8.40
	Rhin-Meuse				
	176.15	494.08	633.32	439.57	780.24
% agriculture	0	2.35	8.94	6.82	5.61
% industry	42.40	28.15	33.59	20.41	21.10
	Rhône-Méditerranée-Corse				
	-	699.90	1836.48	1194.51	2237.20
% agriculture	-	0.69	3.84	2.15	3.04
% industry	-	20.31	23.67	10.99	27.18
	Seine-Normandie				
	816.33	1951.77	2976.63	1723.91	2878.20
% agriculture	0.13	0.83	2.95	3.66	5.27
% industry	14.45	8.62	6.34	3.38	6.14

Notes. For the 9th multiyear programme, data are available for the year 2007 for all Water Agencies, except for Seine-Normandie, for which data are available for 2007 and 2008.

of tax bases and unit tax rates was considered insufficient and a reform had to take place. Moreover, the Parliament did not intervene in the supervision of the multiyear intervention programs of the Water Agencies, although the total Agencies' budget was around 1 percent of all civil expenditures of the State.

The reform of 2006 was devoted to making the system compliant with the Constitution, by reinforcing the role of the Parliament. To compensate for such a "nationalisation" process, the role of Basin Committees is reinforced, while maintaining the control from the State. The goal of the reform was also to optimise operational efficiency and provide enough flexibility in the determination of taxes.

In compliance with article 34 of the Constitution, the law now sets the rules on tax bases and ceilings for the unit tax rates. The law also provides the main orientations for the multiyear intervention programs, sets the expected level of agencies' budget and leaves to the government the task of supervising the objectives in terms of expenses by major domain of intervention.

2.2 The River Basin Committees and the Executive Boards of the Water Agencies

The Water Act of December 16, 1964 has decided the creation of six river basins, with a RBC and a WA in each. Concertation and user participation are the rule since this date, as users and local elected persons are represented and have a majority in both the Committee and the Executive Board of the WA. The RBC has three colleges: local elected persons, users and representatives of the State (administration). Each college elects among its members the administrators of the Water Agency.

The Water Act of January 2, 1992 instituted the principle and the tools of integrated water management by river basin. This law also translates European directives into French national law. These new tools are the SDAGE (*Schemas Directeurs d'Amenagement et de Gestion des Eaux*) and the SAGE (*Schemas d'Amenagement et de Gestion des Eaux*). The SDAGE are designed by the RBCs, while the SAGE are designed at the sub-river basin level, in the framework of the Local Water Commission, which includes 50 percent elected persons, 25 percent users and 25 percent representatives of the State.

RBCs are the expression of the decentralised management of the resource by river basin. Consisting of elected members of local and parliamentary chambers, of representatives of users and of the public administration, these Committees are in charge of elaborating the environmental objectives of the river basin within the framework of the SDAGE. The Executive Board of the Agency is a subset of the Basin Committee, with the exception of its president, who is nominated by a governmental decree (and a representative of the Agency staff).

River Basin Committees are often considered the parliament of the river basin, with the Water Agency being the executive body in charge of implementing the policy.

The government determines the number of Basin Committee members, including the representation of each category of users (agriculture, tourism, industry, etc.) For example in 1999, members of River Basin Committees and Executive Boards of all Agencies have been renewed with a better representation of communities (urban and rural), consumer associations, environmental associations, agriculture and a new representative for small and medium industries. There are now about 40 percent of members for local communities (elected persons), 40 percent for user representatives, and 20 percent for representatives of the State.

Often presented as "Water Parliaments", River Basin Committees participate in the design and adoption of the multiyear intervention programs, they determine the major priorities of the intervention policy of the Agencies, they vote on the tax basis and emission tax rates. In practice, they discuss on the proposal by the Executive Board on use and emission tax rates, and on tax bases. They also discuss on the allocation of the budget to the funding of local projects regarding water resources, through subsidies. The important aspect is that the Executive Board presents a proposal which has to be agreed upon, and verified that it is consistent with the maximum budget allowed by the Parliament (because expenses must be fully covered by tax receipts).

The composition of River Basin Committees depends on the geographical range of the basin (between 70 and 120 members). Representatives of the State have the minority while the number of local elected persons is greater than 1/3 on average, and representatives of users and socio-professional groups have the majority.

The distribution of industry representatives by sector is decided by governmental decree, and is expected to be representative of existing economic interests.

The Executive Board of the Water Agency has the same number of members for all Agencies. Initially of 16 in 1966, it is now 25 (plus the President) since the 15 September 1986 decree. It now gives the same representation to the local communities and users as the State. Administrators of the Agency are elected by the members of the River Basin Committee (except the representatives of the State), within each college (see above).

Table 3 presents for example the distribution of representatives in WAs, during the 8th action programme (2003-2006). It can be seen that the proportion of representatives for local communities, regions and districts is significant, compared to the representatives of water users (agriculture, industry, residential water users). Representatives of the State are also included, from various Ministries as well as from State prefectures. Representatives from the agricultural sector are typically more numerous in River Basin Committees characterized by a higher agricultural activity, as Adour-Garonne and Loire-Bretagne.

Commissions within the RBC are delegated by the Executive Board to work on important projects. It is important to note also a Subsidy Commission and

Table 3: Distribution of representatives in River Basin Committees, 8th Action Programme (2003-2006)

	Agency					
	AG	AP	LB	RM	RMC	SN
Region	6	3	8	3	5	7
District	18	17	28	15	26	25
Inter-district	3	1	2	4	1	4
Rural communities	1	1	1	1	1	4
Urban communities	2	2	4	3	4	12
Coastal communities	0	0	0	0	0	2
Other communities	8	5	7	3	11	21
Agriculture	7	4	7	2	6	7
Fishery & fish industry	4	3	6	2	6	8
Tourism	2	1	3	1	3	3
Industry	11	12	17	11	17	25
Energy	2	0	1	1	2	2
Water supply industry	2	1	1	1	3	3
Residential water users	4	2	4	2	4	6
Ecologists	4	3	5	3	5	9
Professional bodies	8	5	12	5	8	11
Ministry of Environment	1	1	1	1	1	7
Ministry of land devt. & rural affairs	1	1	1	1	1	1
Ministry of health	1	1	1	1	1	2
Ministry of the Interior	1	1	1	1	1	2
Ministry of Industry	1	1	1	1	1	2
Ministry of Agriculture	1	1	1	1	1	2
Other ministries	3	7	5	4	6	15
State prefectures	6	2	9	3	7	8
Total	97	75	126	71	121	187

Notes. AG: Adour-Garonne, AP: Artois-Picardie, LB: Loire-Bretagne, RM: Rhin-Meuse, RMC: Rhône-Méditerranée-Corse, SN: Seine-Normandie.

a Program Commission. The Subsidy Commission makes recommendations on major subsidies to be granted to water-related projects. The Executive Board of the Water Agency deliberates on the multiyear intervention programs (Program Commission), use and emission tax rates and tax basis, deliberates on the general conditions for attribution of subsidies, and on the actual granting of subsidies (Subsidy Commission). A proposal is constructed by the Executive Board and submitted for approval to the River Basin Committee. If it is not accepted by the latter, a new proposal is constructed by taking (some of) the recommendations of the River Basin Committee. If not accepted, the previous plan on taxes is maintained, until an agreement is reached.

3 The Sequential Model of Bargaining

In this paper, we will ignore the tax dimension of the problem and assume that the total amount of tax collected and its distribution among the different categories of users is exogenous. We will focus exclusively on the distribution of the budget (resulting from the taxes) among the different users in terms of projects financing. We proceed as if the unique task of the water agency committee was to decide how to allocate a given budget, denoted by B, among a number of possible alternative recipients/uses. If the number of users is k, then an outcome of the decision process is a vector with k nonnegative coordinates summing to B. We should note that the social situation considered here is zero-sum and conflictual, leaving no room for efficiency considerations: every vector is a Pareto optimum as the groups are in competition to obtain the financing of their demands/projects. The game we consider is a bargaining game where each player can in a way or another influence at some stage the outcome of the process.

Precisely, we will assume that the game is sequential with two stages. In the fist stage, the players will interact to decide which fraction of the budget is distributed proportionally to the taxes paid by the different groups. If this fraction is say 20%, it means that 20% of the budget is allocated on the base of taxes. Denoting by $B' = \frac{B}{5}$ this budget, then, if the tax contribution of the residential users is, say, 35%, this means that the projects emanating from that group will receive a support corresponding to 35% of B'. This way of proceeding is the implementation of Margaret Thatcher's device "We are simply asking to have our own money back".

In the second stage, the players will interact to decide how to allocate the residual buget, say $B'' = \frac{4B}{5}$ among the recipients. In the second stage no constraints (besides feasibility) are imposed on the division of B''. The game which is described in the next section consists in each round of a sequence of proposal and votes. We will calculate the sequential equilibrium of that game.

We will write down the equilibrium predictions for different specification of the parameters on top of which the probabilities describing the chances to become a proposer. The main feature of the equilibrium solution will be described at well as its comparative statics. Since it is possible in general to obtain a closed-form solution of the equilibrium equations, we will use a numerical algorithm to solve for optimal solutions (see Section 4).

3.1 Related Literature

Our model has its roots in the literature on bargaining. The closest theoretical papers to our model are Baron and Ferejohn (1989) and Banks and Duggan (2001) hereafter denoted as BF[1] and BD. Like BF, we assume that the policy consists in the distribution of a budget among a group of users. Their bargaining game consists in a sequence (possibly infinite) of stages where at each stage a proposer is selected to make a proposal which is submitted to a vote. If a winning coalition of players vote in favor of the proposal, then the game ends and the proposal is implemented. Unlike BF, we have a first stage with a sequence (possibly infinite) of rounds: at each round a proposer is selected to make a proposal (a proposal is a %) which is submitted to vote. If a winning coalition of players vote in favor of the proposal then the game ends and the first stage is completed. The difference with BF is that a proposal is here a scalar instead of a vector. The relevant bargaining model is the general BD model which considers arbitrary unidimensional or multidimensional policy spaces. In our second stage, we are back in the policy situation considered by BF but, for the sake of tractability, instead of modelling the second stage as BF did, we model it as an ultimatum game (one round instead of a sequence of rounds).

When we solve backward for the two-stage game, the reduced game that we obtain is thus a BD game where the players have anticipated rationaly their payoffs in the continuation game. More precisely, given the fraction proposed in stage 1 and the residual budget which will be distributed in stage 2, they can calculate their shares in stage 2. This amounts to calculating the chance of being a proposer and the chance of being listed in a proposal initiated by another proposer. By accepting to go for stage 2, players endorse a risk as the outcome of stage 2 is not known with certainty. In stage 1, their attitude towards risk combined with their characteristics as taxpayers determine their indirect utility for rule versus discretion. We therefore obtain a one dimensional BD bargaining problem, which has been investigated by many authors whose contributions are discussed below.

[1]Eraslan (2002) extends the analysis of BF to set-ups with heterogeneous discounts and recognition probabilities (or protocols), and consider the full range of super-majority rules. She establishes the uniqueness of stationary subgame perfect equilibrium payoffs under linear utilities, and shows that expected payoffs are egalitarian under a wide range of asymmetric protocols. Her uniqueness result has been further generalized by Eraslan and Mc Lennan (2006).

The closest empirical paper to ours is Kauppi and Widgren (2004). Like us[2], they want to constrast two alternative explanations of the allocation of the European union (EU) budget. In their setting, the players are the countries which are state members of the EU. One possible explanation called the *needs view*" postulates that members allocations are determined by principles of solidarity which can be evaluated in several ways. Given that the bulk of the budget spending is devoted to agriculture and poor regions, Kauppi and Widgren measure the needs of the EU countries by the extent of their agricultural production and their relative income levels. A second explanation called the *power politics view*" considers the problem, as we do, as a *divide-the-dollar* bargaining game where the power of of the player is exclusively described by his voting weight. Power is evaluated through power indices with a special attention to the Shapley-Shubik index. Kauppi and Widgren conduct an empirical analysis based on 1976-2001 data on the patterns of the EU budget shares and on measures of each member state's needs and political power. Their results indicate that at least 60% of the budget expenditures can be attributed to selfish power politics and the remaining 40% to the declared benevolent budget policies. Hower, when they apply specific voting power measures that allow for correlated preferences and cooperative voting patterns between the member states, their estimates indicate that the power politics view explains as much as 90% of the budget shares.

Kauppi and Widgren's bargaining solution is borrowed from *cooperative game theory*, in contrast to ours which is based on a non-cooperative bargaining game. Kauppi and Widgren's measure of power is entirely based upon the voting weight, while ours also depends of the *proposal power*. Several empirical analysis and testing of the Baron-Ferejohn's predictions have been conducted. Knight[3] (2005) has estimated the value of power proposal on the basis of the decisions of the US House Committee on Transportation and Infrastructure. Each transportation project is matched with a congressional district (city or county name). Summary statistics show that almost all committee members received at least some project spending, 72% of non-committee members in 1991 were excluded from the coalition. Committee members averaged $55 million and non-committee members only $ 6 million in 1991[4]. Knight runs simple a regression with the project spending as the dependent variable, and representation in the commitee as explanatory variables, and tests for the theoretical prediction both in quantitative and qualitative terms. He concludes that the evidence supports the key qualitative predictions of the BF bargaining model.

Empirical models of bargaining in the BF vein has also been considered in

[2]We contrast the "rule view" with the "power view" or "discretion view".

[3]See also Knight (2004).

[4]For more anecdoctical or statistical evidence of positive correlation between federal spending in jurisdictions and representation by politically powerful congressional delegations (representatives in relevant committees especially those with tenure or in the majority party), see Ferejohn (1974) and Levitt and Poterba (1999).

corporate finance (Eraslan, 2002) and in the analysis of the formation of coalition governments in Europe (Diermeier and Merlo, 2004).

3.2 The Basic Setting

The policy space is the simplex $X \equiv \left\{ x \in \mathbb{R}_+^k : \sum_{i=1}^k x_i = 1 \right\}$ where k denotes the number of different categories of users. Without loss of generality, we assume that the total budget to be distributed is equal to 1. The decision making process whose ultimate objective is to implement a policy $x \in X$ is described as a game whose players are the members of the RBC. In our setting, the budget is defined as the total amount of taxes which are collected by the WA. We denote by γ_i the fraction of aggregate taxes paid by the i^{th} category of users, i.e.,

$$\gamma_i = \frac{t_i}{\sum_{j=1}^{k} t_j} .$$

where t_i is the amount of taxes paid by the i^{th} group of users. The vector $\gamma = (\gamma_1, \gamma_2, ..., \gamma_k))$ will play an important role in our model. Hereafter , we assume, without loss of generality, that the coordinates of the vector γ are increasing i.e. $\gamma_i \leq \gamma_{i+1}$ for all $i = 1, ..., k-1$.

Let n denote the total number of players (committee members). Some of these members are representatives of the different categories of users while others are representatives of central administrations or of local governments. We sassume that each of these groups has at least one direct representative in the committee. This implies that $n \geq k$. The representatives of water users in the committee are assumed to be selfish i.e. driven exclusively by their own shares in the proposal. In contrast, the preferences of the other committee members can possibly aggregate the welfare of the k categories of users. We index them by $j = k+1, \ldots, n$. We assume that each member $j = k+1, \ldots, n$ assigns weight or relative importance β_i^j to any group $i = 1...k$. Then, given the vector of shares $x = (x_1, ..., x_k)$ the utility of any member $j = k+1, \ldots, n$ is given as:

$$u_j(x) = \sum_{i=1}^{k} \beta_i^j u_i(x_i),$$

where $u_i : \mathbb{R}_+ \to \mathbb{R}_+$ is a twice continuously differentiable function such that $u_i' > 0$ and $u_i'' < 0$ and for any $j = k+1, \ldots, n$ and $i = 1, \ldots, k$, the weights $\beta_i^j \in [0,1]$ and $\sum_{i=1}^k \beta_i^j = 1$. Note that we do not impose the weights to be strictly exclusive. For instance, we could have a representative acting exclusively as a representative of one category of users. In what follows, we refer to the situation where all the vectors β^j have all their coordinates equal to 0 except one as the ***corner regime***. It corresponds to the situation where each representative $j = k+1, \ldots, n$ acts on behalf of a single group of users.

Players will act as voters and as proposers. The voting side will be described by a ***weighted majority game***. We denote by q_i the voting weight (number of representives) of sector i for all $i = 1, ..., k$. We assume that all other voters have a weight equal to 1. The quota Q of the game could be in principle any number between $\left\lfloor \frac{\left(\sum_{i=1}^{k} q_i\right)+(n-k)}{2} \right\rfloor$[5] and $\left(\sum_{i=1}^{k} q_i\right) + (n-k)$. Therefore, in principle, our framework allows for a wide range of voting mechanisms. When $Q = \left\lfloor \frac{\left(\sum_{i=1}^{k} q_i\right)+(n-k)}{2} \right\rfloor$, to be passed, a proposal needs the approval of a majority of members while when $Q = \left(\sum_{i=1}^{k} q_i\right) + (n-k)$, unanimity is required. Unless otherwise specified, we will assume hereafter that Q is the majority quota. The set of (minimal) winning coalitions is denoted by $(\mathcal{W}_m)$ $\mathcal{W}$.

The distribution of proposal powers is described by a vector $p = (p^1, p^2, ..., p^n)$ such that $p^i \geq 0$ for all $i = 1, ..., n$, and $\sum_{i=1}^{n} p^i = 1$. Here, p^i denotes the probability that member i is recognized to be in charge of making a proposal. As demonstrated by Kalandrakis (2006) in the case of the Baron and Ferejohn 's bargaining game, the vector p has a strong impact on the equilibrium outcome. More precisely, under some minimal qualifications, any policy in X can be obtained as an equilibrium outcome for an appropriate choice of p. While playing an important role in our framework too, it will not have such a strong impact.

The game form we consider works as follows. We model the process as a decision which is decomposed into two steps. One the one hand, players may decide that a fraction α of the total budget is allocated according to the vector γ: for this part of the budget, each group of users receives a share corresponding to its tax contribution. On the other, the residual part of the budget, $1-\alpha$, is not subject to any constraint.

Formally, the game has two stages. The first stage is a bargaining game a la Banks and Duggan on the one-dimensional variable α. The game is a sequential game with a possibly (infinite) number of rounds. At each round t, a proposer is $i(t)$ is selected. He makes a proposal $\alpha(i, , t)$. Each member of the committee approves (a) or rejects (r) the proposal. If the subset of members who approve the proposal is a winning coalition, then the proposal is adopted. Otherwise, we move to round $t+1$ and the procedure is repeated. If the procedure never ends, the vector γ is adopted.

The second stage (if any, as if $\alpha = 1$ there is no budget left for stage 2) is an ultimatum game. A proposer i is selected, and makes a proposal $x(i) \in X$. Each member of the committee approves (a) or rejects (r) the proposal $x(i)$. If the subset of members who approve the proposal is a winning coalition, then the proposal is adopted. Otherwise, the vector γ is adopted for the residual budget.

[5]For any real number x, $\lfloor x \rfloor$ denotes the smallest integer greater than x.

The payoffs of the members $j = 1, ..., n$ are described by their utility functions u_j and their discount factor $\delta_j \in [0, 1]$.[6]

3.3 The Second Stage (Continuation Game)

We describe in this subsection the ultimatum game. The final outcome of this subgame is the allocation of $(1 - \alpha)$ among the groups of users. Nature draws proposer j with probability $p^j \geq 0$. Of course, $\sum_{j=1}^k p^j = 1$. Proposer j selects a vector $x^j \in \mathbb{R}_+^k$ such that $\sum_{i=1}^k x_i^j = (1 - \alpha)$. We denote by S_α such simplex. If a majority of voters vote in favor of the proposal, the proposal is adopted. Otherwise, the proposal is defeated and the default option γ is used to allocate the residual fraction of the budget. The voting response is quite easy to characterize. Voter l will vote for the proposal x^j if

$$v_l\left(x^j\right) \equiv u_l\left(\alpha\gamma + x^j\right) \geq u_l\left(\gamma\right) = v_l\left(\gamma\right).$$

We assume here that ties are broken in favor of the proposer. If the proposer (who acts here as a principal) wants the proposal to be passed, he will consider the cost of buying a minimal winning coalition. Let S be any such coalition. In such case the constraints are

$$u_l\left(\alpha\gamma + x^j\right) \geq u_l\left(\gamma\right) \text{ for all } l \in S,$$

and the problem of the principal (proposer j) reads:

$$\underset{x^j \in S_\alpha}{Max} u_j\left(\alpha\gamma + x^j\right),$$

subject to the constraints

$$u_l\left(\alpha\gamma + x^j\right) \geq u_l\left(\gamma\right) \text{ for all } l \in S \backslash \{j\}.$$

Let us denote by $C(\alpha, S, j)$ the value of this problem and by $C(\alpha, j)$ the value $\underset{S \in \mathcal{W}_m}{Max} C(\alpha, S, j)$. We also denote by $x_*^j(\alpha)$ the optimal solution of this problem. For the time being, we proceed as if this solution was unique.

Let us look at the solution for the corner regime under complete information.[7] In such case, each player $j = k + 1, ..., n$ acts on behalf of one of the single group. Let us denote by $M_i\left(m_i\right)$ the group(number) of representatives in the set $\{k + 1, ..., n\}$ acting for user i. We have obviously

$$\sum_{i=1}^k m_i = n - k.$$

[6] In the remaining of the paper, we take $\delta_j = 1, \forall j = 1, \ldots, n$. The general case is discussed in Section 5.

[7] See Appendices 1 and 2 for a discussion on the difficulties associated with interior regimes and incomplete information.

In such case, the group of voters voting on behalf of the interest of the group i has a weight equal to

$$w_i = q_i + m_i.$$

Further, the group of supporters of group i will vote in favor of the proposal if and only if

$$x_i \geq \gamma_i \left(1 - \alpha\right).$$

In such case, things are as if proposer j representing group $i(j)$ makes a proposal to win the votes of a winning coalition in a weighted majority game with $\{1, 2, ..., k\}$ as the set of players and w_i being the weight of player i. The probability of player i to be selected as a proposer is now equal to $\widehat{p}^i = p^i + \sum_{j \in M_i} p^j$. The set of (minimal) winning coalitions of this simple game is denoted by $(\widehat{\mathcal{W}}_m)$ $\widehat{\mathcal{W}}$. It is straightforward to see that in such a case,

$$C(\alpha, S, j) = (1 - \alpha) - \sum_{i \in S \backslash \{j\}} \gamma_i \left(1 - \alpha\right) = (1 - \alpha) \left(1 - \sum_{i \in S \backslash \{j\}} \gamma_i\right),$$

and therefore

$$C(\alpha, j) = (1 - \alpha) \left(1 - \underset{S \cup \{j\} \in \widehat{\mathcal{W}}_m}{Min} \sum_{i \in S \backslash \{j\}} \gamma_i\right).$$

As we can see , the problem in such a case amounts to calculating $\underset{S \cup \{j\} \in \widehat{\mathcal{W}}_m}{Min} \sum_{i \in S \backslash \{j\}} \gamma_i$. This problem can be formulated as a combinatorial optimization problem as follows:

$$\underset{x^j \in \mathbb{R}_+^{k-1}}{Min} \sum_{i=1, i \neq j}^{k} \gamma_i z_i,$$

subject to the constraints

$$\sum_{i=1, i \neq j}^{k} w_i z_i \geq \left\lfloor \frac{\sum_{i=1}^{k} w_i}{2} \right\rfloor - w_j$$

and $z_i \in \{0, 1\}$ for all $i = 1, ..., k$.

The integer constraints transform this rather simple linear problem into a difficult problem identified in the operations research literature as the ***Knapsack Problem*** (Kellerer, Pferschy and Pisinger (2004), Martello and Toth (1990)[8]).

[8] See also Chakravarty, Goel and Sastry (2000) and Prasad and Kelly (1990).

No simple algorithm exists to find the solution (and the value) in polynomial time. If we consider the linear relaxation

$$z_i \in [0,1] \text{ for all } i = 1, ..., k,$$

things become very simple. Indeed, let us consider the impact of a small change (dz_i, dz_l) leaving the constraint unchanged i.e; such that $w_i dz_i + w_l dz_l = 0$. The change in the objective is equal to $\gamma_i dz_i + \gamma_l dz_l = dz_i(\gamma_i - \gamma_l \frac{w_i}{w_l})$. Therefore, if $\frac{\gamma_i}{w_i} > \frac{\gamma_i}{w_l}$ then the change is positive if dz_i is positive and negative otherwise. This suggests the following optimal solution. Order the numbers $\left(\frac{\gamma_i}{w_i}\right)_{1 \leq i \leq k}$ in increasing order. Let σ be that order. Then, define

$$z_{\sigma(i)} = 1 \text{ for all } i = 1, .., i^* - 1$$

and

$$z_{\sigma(i^*)} = \left\lfloor \frac{\sum\limits_{i=1}^{k} w_i}{2} \right\rfloor - w_j - \sum_{i=1}^{i^*-1} w_{\sigma(i)} z_{\sigma(i)},$$

where

$$i^* = \underset{1 \leq i \leq n}{Inf} \left\{ i : \sum_{i=1}^{i^*-1} w_{\sigma(i)} z_{\sigma(i)} \geq \left\lfloor \frac{\sum\limits_{i=1}^{k} w_i}{2} \right\rfloor - w_j \right\}.$$

This algorithm is simple but its performance under the integer constraints is not clear. Of course, for a small value of k , in particular $k = 3$, we can find the solution by elementary checking. Let $k = 3$ and let us assume that the three coalitions $\{1,2\}, \{1,3\}$ and $\{2,3\}$ are minimal winning coalitions. In such a case, $\underset{S \cup \{j\} \in \widehat{\mathcal{W}}_m}{Min} \sum_{i \in S \backslash \{j\}} \gamma_i = \underset{l \in \{1,2,3\} \backslash \{j\}}{Min} \gamma_l$. This means that

$$\text{If } j = 1, \text{then } x_*^1(\alpha) = (1-\alpha))\,(1-\gamma_2, \gamma_2, 0)\,.$$

$$\text{If } j = 2, \text{then } x_*^2(\alpha) = (1-\alpha))\,(\gamma_1, 1-\gamma_1, 0)\,.$$

$$\text{If } j = 3, \text{then } x_*^3(\alpha) = (1-\alpha))\,(\gamma_1, 0, 1-\gamma_1)\,.$$

Note also that the problem has a straightforward solution in the ***symmetric case***, i.e., when $w_i = 1$ for all $i = 1, ..., k$. In such case, if $j \notin \left\{1, 2, ..., \frac{k-1}{2}\right\}$:

$$z_i = \left(\begin{array}{c} 1 \text{ if } i = 1, 2, ..., \frac{k-1}{2}, \\ 0 \text{ otherwise,} \end{array} \right.$$

and if $j \in \left\{1, 2, ..., \frac{k-1}{2}\right\}$:

$$z_i = z_i = \left(\begin{array}{c} 1 \text{ if } i = 1, 2, ..., \frac{k+1}{2} \text{ and } i \neq j, \\ 0 \text{ otherwise.} \end{array} \right.$$

As we have seen, the closed-form determination of x_{i*}^j may be rather difficult in the general case (even under our assumption of corner regime) as there exists a trade-off between the voting weight w_i of a player and its cost as reflected by his reservation value γ_i.

3.4 The First Stage

The first stage is a one-dimensional bargaining game a la Banks and Duggan once we account for the backward solution of the continuation game. When the continuation game has been solved, we have the optimal solution $x_*^j(\alpha)$ for all $j = 1, ..., k$. We ignore for the moment the issue of multiplicity and the attached issue of randomization. Therefore, in the first stage of the game, each player i looks at the choice of α as truly the choice of a lotery where he receives a prize equals to $x_{i*}^j(\alpha)$ with probability p^j. The (instantaneous) expected utility $V_i(\alpha)$ of player i is equal to

$$\sum_{j=1}^{k} p^j u_i \left(\alpha\gamma_i + x_{i*}^j(\alpha)\right).$$

Here, when $j \neq i$, x_{i*}^j is either equal to 0 or to $(1-\alpha)\gamma_i$. The true determinant of his expected utility consist therefore of two numbers: the probability denoted P^i that i is considered in the continuation game when i is not the proposer himself, and the coalition S^i of groups who receive a positive share in his proposal. The total share x_i of player i is equal to

$\alpha\gamma_i + (1-\alpha)\left(1 - \sum_{j\in S^i}\gamma_j\right) = \gamma_i + (1-\alpha)\sum_{j\in N\setminus S^i\cup\{i\}}\gamma_j$ with probability $\widehat{p}^i$,
γ_i with probability $\widehat{P}^i$,
$\alpha\gamma_i$ with probability $1 - \widehat{p}^i - P^i$.

We deduce that

$$\begin{aligned} V_i(\alpha) &= \widehat{p}^i u_i \left(\gamma_i + (1-\alpha)\sum_{j\in N\setminus S^i\cup\{i\}}\gamma_j\right) + \widehat{P}^i u_i(\gamma_i) \\ &\quad + (1 - \widehat{p}^i - \widehat{P}^i) u_i(\alpha\gamma_i). \end{aligned}$$

Straightforward calculations lead to

$$V_i'(\alpha) = -\widehat{p}^i \left(\sum_{j \in N \setminus S^i \cup \{i\}} \gamma_j \right) u_i' \left(\gamma_i + (1-\alpha) \sum_{j \in N \setminus S^i \cup \{i\}} \gamma_j \right) + \gamma_i (1 - \widehat{p}^i - \widehat{P}^i) u_i'(\alpha \gamma_i),$$

and

$$V_i''(\alpha) = \widehat{p}^i \left(\sum_{j \in N \setminus S^i \cup \{i\}} \gamma_j \right)^2 u_i'' \left(\gamma_i + (1-\alpha) \sum_{j \in N \setminus S^i \cup \{i\}} \gamma_j \right) + (\gamma_i)^2 (1 - \widehat{p}^i - \widehat{P}^i) u_i''(\alpha \gamma_i).$$

We deduce from our assumption on u_i that $V_i''(\alpha) < 0$ for all $\alpha \in [0,1]$, i.e., the function is strictly concave on the unit interval. We will denote by α_i^* the (unique) peak of player i. Since all the assumptions of Banks and Duggan are met, we deduce from their results that if all the players are perfectly patient, then the equilibrium outcomes of the game coincide with the core. This implies that if k is odd, then the equilibrium is unique and equal to the median value α^* of the vector $(\alpha_1^*, ..., \alpha_k^*)$. We will discuss below what happens when the players are not perfectly patient or when the voting game is not the majority game. Let $s_i \equiv \sum_{j \in S^i} \gamma_j$. The following proposition summarizes the information that we have.

Proposition

Assume that the utility function $u_i(x_i)$ is such that $u_i(0) = 0$, $u_i' > 0$, $u_i'' \le 0$, then $V_i''(\alpha) \le 0$ on $[0,1]$ for any $i = 1, ..., k$. Moreover, there exist threshold values $\underline{\gamma}_i$ and $\overline{\gamma}^i$ such that $0 \le \underline{\gamma}_i < \overline{\gamma}_i \le 1$ and:

(i) if $0 \le \gamma_i \le \underline{\gamma}_i$ function $V_i(\alpha)$ is decreasing on the whole interval $[0,1]$;

(ii) if $\underline{\gamma}_i < \gamma_i < \overline{\gamma}_i$ function $V_i(\alpha)$ has a unique maximum on the interval $(0,1)$;

(iii) if $\gamma_i > \overline{\gamma}_i$ function $V_i(\alpha)$ is increasing on the whole interval $[0,1]$.

The thresholds $\overline{\gamma}_i$ and $\underline{\gamma}_i$ are calculated as:

$$\overline{\gamma}_i = \frac{\widehat{p}_i (1 - s_i)}{1 - \widehat{P}_i} \tag{1}$$

and

$$\underline{\gamma}_i = \frac{\widehat{p}_i (1 - s_i) u_i'(1 - s_i)}{\widehat{p}_i u_i'(1 - s_i) + \left(1 - \widehat{p}_i - \widehat{P}_i\right) u_i'(0)}. \tag{2}$$

Proof.
The first derivative of the expected utility is:

$$V_i'(\alpha) = \widehat{p}_i u_i'(\alpha\gamma_i + (1-\alpha)(1-s_i))(\gamma_i + s_i - 1) + \\ +(1-\widehat{p}_i - \widehat{P}_i)u_i'(\alpha\gamma_i)\gamma_i. \tag{3}$$

The second derivative is

$$V_i''(\alpha) = \widehat{p}_i u_i''(\alpha\gamma_i + (1-\alpha)(1-s_i))(\gamma_i + s_i - 1)^2 + \\ +(1-\widehat{p}_i - \widehat{P}_i)u_i''(\alpha\gamma_i)(\gamma_i)^2. \tag{4}$$

Since $u_i''(\cdot) < 0$ it follows from (4) that $V_i''(\alpha) \leq 0$.

It is easy to see that

$$V_i'(1) = u_i'(\gamma_i)\left[(1-\widehat{P}_i)\gamma_i - \widehat{p}_i(1-s_i)\right],$$

therefore for $\gamma_i \geq \overline{\gamma}_i = \frac{\widehat{p}_i(1-s_i)}{1-\widehat{P}_i}$ the function $V_i'(1) \geq 0$ and for $\gamma_i \leq \overline{\gamma}_i$ the opposite inequality holds true.

The derivative at $\alpha = 0$ is:

$$V_i'(0) = \widehat{p}_i u_i'(1-s_i)(\gamma_i + s_i - 1) + (1-\widehat{p}_i - \widehat{P}_i)u_i'(0)\gamma_i.$$

One can check that: $V_i'(0) \leq 0$ if and only if $\gamma_i \leq \underline{\gamma}_i$, where $\underline{\gamma}_i$ satisfies (2).

Since $u_i'' \leq 0$ we can deduce that $u_i'(0) \geq u_i'(1-s_i)$. Substituting this into (2) we prove that $\underline{\gamma}_i \leq \overline{\gamma}_i$.

Since $\widehat{P}_i \leq 1 - \widehat{p}_i$ from (1) we deduce that $\overline{\gamma}_i \leq 1$.

Summing up, for $0 \leq \gamma_i < \underline{\gamma}_i$ the function $V_i(\alpha)$ is decreasing on the whole interval $[0,1]$, for $\gamma_i > \overline{\gamma}_i$ it is increasing on the whole interval, and for $\underline{\gamma} \leq \gamma_i \leq \overline{\gamma}_i$ it has unique maximum on the interval $[0,1]$. ■

3.5 Examples

From the above arguments, it is clear that any more accurate description of the peaks α_i^* and the median α^* will rely on more detailed information on the parameters of the game. We illustrate the proposition through a series of examples.

Example 1 *Suppose the players have the same weights and the same probabilities of being chosen as the proposer, i.e.,* $\omega_i = 1$ *and* $\widehat{p}_i = 1/k$ *for each* $i = 1, \dots, k$

Then:

$$V_1(\alpha) = \frac{1}{k}u_1(\alpha\gamma_1 + (1-\alpha)(1-s_1)) + (1-\frac{1}{k})u_1(\gamma_1),$$

where s_1 is de ned in a similar way as before. Then:

$$V_1'(\alpha) = \frac{1}{n} u_1'(\alpha\gamma_1 + (1-\alpha)(1-s_1))[\gamma_1 - 1 + s_1].$$

The term in the square brackets is non-positive, therefore $\alpha_i^* = 0$, i.e., he prefers pure bargaining outcome. The reason is that everybody chooses him as a coalitional partner.

On the contrary, nobody would choose player k as a coalitional partner. One can check that in this case:

$$V_n(\alpha) = \frac{1}{k} u_n(\alpha\gamma_n + (1-\alpha)(1-s_n)) + \left(1 - \frac{1}{k}\right) u_n(\alpha\gamma_n)$$

and

$$V_n'(1) = \frac{1}{k} u_n'(\gamma_n)(1-s_n))[n\gamma_n - 1 + s_n].$$

The term in the square brackets is positive since $n\gamma_n > \sum_{j=1}^{k} \gamma_j = 1$. Therefore, player k never prefers pure bargaining outcome, i.e. $\alpha_k^* \in (0, 1]$.

The second example calls our example on the role of the risk aversion parameters.

Example 2 *Suppose that $\omega_i = 1$ and $\gamma_i = \widehat{p}_i = 1/k$ for each $i = 1, \ldots, k$. The players di er only in risk aversion, and for simplicity we consider CARA (Constant Absolute Risk Aversion) utility functions $u_i(x) = 1 - e^{-\rho_i x}$, where $\rho_i > 0$. We also consider an arbitrary quota Q.*

One may check that $s_i = \frac{Q-1}{k}$ and $\widehat{P}_i = (1 - \frac{1}{k})\frac{Q}{k}$. Then:

$$\overline{\gamma}_i = \frac{k+1-Q}{k(k-Q)+Q} > \frac{1}{k}.$$

Therefore, in this case nobody would choose $\alpha = 1$.

It is easy to check that:

$$\underline{\gamma}_i = \frac{k+1-Q}{k + (k-1)(k-Q)e^{\rho_i \frac{k+1-Q}{k}}}.$$

It implies that for $\rho_i \leq \frac{k}{k+1-Q} \ln \frac{k}{k-1} \equiv \overline{\rho}$ the lower bound $\underline{\gamma}_i$ is larger thanor equal to $\frac{1}{k}$. Thus, if the coe cient $\rho_i \leq \overline{\rho}$ then $\alpha_i^* = 0$. On the other hand, for $\rho_i > \overline{\rho}_i$, $\underline{\gamma}_i < \frac{1}{n}$, and $\alpha_i^* \in (0, 1)$ that is calculated as $\alpha_i^* = 1 - \frac{\overline{\rho}}{\rho_i}$. Summing up, for this particular case:

$$\alpha_i^* = \begin{cases} 0, \text{ if } \rho_i \leq \overline{\rho}, \\ 1 - \frac{\overline{\rho}}{\rho_i}, \text{ if } \rho_i > \overline{\rho} \end{cases}.$$

In the case where k is odd and $Q = \frac{k+1}{2}$, we obtain:

$$\alpha_i^* = \begin{cases} 0, \text{ if } \rho_i \leq \frac{2k}{k+1} \ln \frac{k}{k-1} \\ 1 - \frac{\frac{2k}{k+1} \ln \frac{k}{k-1}}{\rho_i}, \text{ if } \rho_i > \frac{2k}{k+1} \ln \frac{k}{k-1} \end{cases}$$

In such case, if $\rho_i \leq \overline{\rho}$ for at least Q players then the median voter's ideal point $\alpha^* = 0$, and then the whole budget will be allocated according to the bargaining procedure. On the contrary, if there are at least Q players for whom $\rho_i > \overline{\rho}$ then for these players $\alpha_i^* \in (0,1)$ and $\alpha^* \in (0,1)$. One may check that for $k = 3$ and $Q = 2$, $\overline{\rho} \approx 0.6$. Let's take for simplicity $\rho_1 \leq \overline{\rho}$ and $\overline{\rho} < \rho_2 < \rho_3$. Then, $\alpha_1^* = 0$ and $\alpha_3^* > \alpha_2^* > 0$, and $\alpha^* = \alpha_3^* \in (0,1)$

In the last example, we considered the case where the probability of being a proposer is equal to the (relative) tax contribution: the more you pay, the more likely your are going leading the bargaining at the distributive stage. This is similar to the situation considered by Peleg (1992)[9] under the heading "Voting by Count and Account", where the political power of a player depends upon his tax bill. In such case, it is easy to establish that all the budget is allocated in the first stage ,i.e., rules dominates discretion.

Example 3 *Suppose that $\omega_i = 1$ and $\gamma_i = \widehat{p}_i = \gamma_i$ for each $i = 1, \ldots, k$.*

First, let us consider the behavior of players $i = 1; \ldots, Q-1$. They are always included in a winning coalition because they are the \cheapest". Therefore, their expected utilities can be expressed as

$$V_i(\alpha) = \widehat{p}_i u_i \left(\alpha\gamma_i + (1-\alpha) \left(1 - \sum_{\substack{j=1 \\ j \neq i}}^{Q} \gamma_j \right) \right) + (1 - \widehat{p}_i) u_i(\gamma_i).$$

It is easy to see that the derivative of $V_i(\alpha)$ is:

$$V_i'(\alpha) = -\widehat{p}_i u_i' \left(\alpha\gamma_i + (1-\alpha) \left(1 - \sum_{\substack{j=1 \\ j \neq i}}^{Q} \gamma_j \right) \right) \sum_{j=Q+1}^{k} \gamma_j.$$

Since $u_i' > 0$ then $V_i'(\alpha) < 0$ for all $i = 1, \ldots, Q-1$. It means that each $i = 1, \ldots, Q-1$, $\alpha_i^* = 0$ at the rst stage of the game. Note that this results holds for any $\widehat{p}_i$.

Player $i = Q$ is included in a winning coalition when a proposer is any of $j = 1, \ldots, Q-1$. Therefore, the expected utility for this player is

[9] See also O'Neill and Peleg (2000). It also appears in the case in the German pollution management (The *Genossenschaften*) as studied by Klevorick and Kramer (1973).

$$V_Q(\alpha) = \widehat{p}_Q u_Q \left(\alpha\gamma_Q + (1-\alpha)\left(1 - \sum_{j=1}^{Q-1}\gamma_j\right)\right) + \sum_{j=1}^{Q-1}\widehat{p}_i u_Q(\gamma_Q) + \left(1 - \sum_{j=1}^{Q}\widehat{p}^j\right) u_Q(\alpha\gamma_Q),$$

and therefore:

$$V_Q'(\alpha) = -\widehat{p}_Q u_Q'\left(\alpha\gamma_Q + (1-\alpha)\sum_{j=Q}^{k}\gamma_j\right)\sum_{j=Q+1}^{k}\gamma_j + \sum_{j=Q+1}^{k}\widehat{p}^j u_Q'(\alpha\gamma_Q)\gamma_Q.$$

Substituting for $\widehat{p}^i = \gamma_i$ *for all* $i = 1...k$ *we get*

$$V_Q'(\alpha) = \gamma_Q \sum_{j=Q+1}^{k}\gamma_j\left[u_Q'(\alpha\gamma_Q) - u_Q'\left(\alpha\gamma_Q + (1-\alpha)\sum_{j=Q}^{k}\gamma_j\right)\right]$$

and since u_i' *is decreasing then* $V_q'(\alpha) > 0$. *Therefore,* $\alpha_q^* = 1$.

Now we turn to the behavior of the players $i = Q+1, ..., k$. *Any such player* i *is never included to a winning coalition except the case when* i *himself is a proposer. Therefore,*

$$V_i(\alpha) = \widehat{p}_i u_i\left(\alpha\gamma_i + (1-\alpha)\left(1 - \sum_{j=1}^{Q-1}\gamma_j\right)\right) + (1-\widehat{p}_i)u_i(\alpha\gamma_i).$$

The derivative in this case is:

$$\begin{aligned} V_i'(\alpha) &= -\widehat{p}_i u_i'\left(\alpha\gamma_i + (1-\alpha)\sum_{j=Q}^{k}\gamma_j\right)\left(1 - \gamma_i - \sum_{j=1}^{Q-1}\gamma_j\right) + \\ &\quad +(1-\widehat{p}_i)u_i'(\alpha\gamma_i)\gamma_i. \end{aligned}$$

Substituting for $\widehat{p}_i = \gamma_i$ *for all* $i = 1, ..., k$ *we get*

$$\begin{aligned} V_i'(\alpha) &= \gamma_i(1-\gamma_i)\left[u_i'(\alpha\gamma_i) - u_i'\left(\alpha\gamma_i + (1-\alpha)\sum_{j=Q}^{k}\gamma_j\right)\right] + \\ &\quad +\gamma_i\sum_{j=1}^{q-1}\gamma_j u_i'\left(\alpha\gamma_i + (1-\alpha)\sum_{j=Q}^{k}\gamma_j\right). \end{aligned} \tag{5}$$

The rst term is positive since u_i' *is decreasing and the second one is positive since* $u_i' > 0$ *for all* $i = 1, ..., k$. *Thus,* $V_i'(\alpha) > 0$ *for* $i = Q+1, ..., k$*, and then* $\alpha_i^* = 1$ *for* $i = Q+1, ..., k$.

Summing up, we obtain that for q *players* $i = q, ..., k$ *the preferred* $\alpha_i^* = 1$ *and therefore* $\alpha^* = 1$ *is chosen. It means that in this speci c case there will be no bargaining stage, the whole budget will be distributed according to the criterion.*

In all these examples, we have assumed that the weights are all equal. This is a very peculiar assumption, as we have to remember that the game we consider is a reduced game where in fact there are k players, as the $n-k$ last players have been asssumed to act as representatives of one on the k groups. So, even if the k groups are equally represented, our assumption will be valid iff the $n-k$ other players distribute themselves equally among the k groups. It is not easy to derive precise results in the general case, as the determination of the coalition S^i for all i is not straightforward.

4 Empirical Application

In this section, we present a statistical analysis of the WA policy instruments in terms of tax and subsidy distribution across user categories. We also discuss the composition of the River Basin Committees (relative number of representatives) in more detail. Data collected on Water Agencies allow us to perform a straightforward simulation experiment, to illustrate in particular the role of risk aversion in the theoretical model presented above. We finally perform a reduced-form econometric analysis of the relationship between the River Basin Committee distribution and the tax or subsidy level.

4.1 Data

Data have been collected from the Water Agencies on two aspects:

- tax receipts and subsidies by category of user and year
- composition of River Basin Committees.

The period covers the years 1987-2007, although there are missing data for some Agencies and years. Subsidies granted by Water Agencies are mostly devoted to infrastructure building and operating costs of abatement by private agents or local communities. A number of subsidy programs are however devoted by technical assistance and preliminary technical studies and reporting. Subsidies include the following categories:

- Local communities, cities: municipal wastewater treatment plants, wastewater networks, operational and technical assistance, refuse recycling;
- Industry: industrial pollution abatement plants, operational and technical assistance;
- Agriculture: point- and nonpoint-source pollution abatement;
- Environment: water resource management, restoration of aquatic areas, restoration of drinking water sources.

Taxes include the following categories: urban and industrial wastewater effluent emissions, agricultural point source emissions (livestock), nonpoint source emissions (pesticides, from 2006), residential and industrial water withdrawals and net consumption, irrigation water withdrawals.

Table 4: Average ratio of tax over subsidies for agriculture and industry, by Water Agency and multiyear intervention program

	Multi-year Program			
	6 (1992-96)	7 (1997-02)	8 (2003-06)	9 (2007-)
	Adour-Garonne			
% agriculture	2.5814	0.5334	1.3302	1.5200
% industry	1.111	4.8050	1.0411	0.7540
	Artois-Picardie			
% agriculture	0.1634	0.060	1.5206	0.0826
% industry	0.8433	5.7200	7.6250	0.6587
	Loire-Bretagne			
% agriculture	0.1806	0.2806	0.2229	0.2314
% industry	7.1860	2.1526	3.1320	1.6932
	Rhin-Meuse			
% agriculture	0.0000	0.0695	0.1189	0.0374
% industry	1.0462	0.8512	1.1843	2.3152
	Rhône-Méditerranée-Corse			
% agriculture	0.6601	0.2283	0.5158	0.1710
% industry	1.2963	0.5479	1.1144	1.0450
	Seine-Normandie			
% agriculture	0.8462	0.6280	0.4124	0.6484
% industry	1.4506	2.2652	3.9412	1.6721

Notes. % agriculture (resp. industry): ratio of tax over subsidies to agriculture (resp. industry).

The proportion of subsidies received by each user category (agriculture, industry) is computed for each WA and each multiyear intervention programme.

To have an idea of the relative advantage associated with each user category, we compute the ratio of tax over subsidies for agriculture and industry. Table 4 presents the average ratio, by Water Agency and multiyear intervention programme. This ratio measures the "net contribution" of agriculture and industry, a value of 1 indicating a neutral position regarding the Water Agency budget. As can be seen from the table, almost all WAs grant more subsidies than they collect taxes from agriculture, with the exception of Adour-Garonne. On the other hand, industry is in a majority of cases contributing more in terms of tax revenues. The ratio is highly heterogeneous across multiyear intervention programmes, reflecting the fact that changes in policy priorities have occured over the period.

Regarding the River Basin Committees, the number of representatives is heterogeneous across river basins, and include water users, the administration and economic sectors. We compute the proportion of each category of users (with a particular focus on agriculture and industry) with respect to the size of the entire committee, and with respect to the number of user representatives (agriculture, industry, tourism, fisheries, angling, energy producers, etc.) Table 5 presents the distribution of Committee representatives for the three categories: agriculture, industry, and environmental associations (ecologists). We distinguish in this table between the proportion of representatives over the total number of committee members, and the proportion over the total number of user representatives.

4.2 Simulation Experiment

The simulation experiment aims at exploring the optimal solutions provided by the theoretical bargaining model, once model parameters have been calibrated from the data. More precisely, we consider as a baseline the case of the Adour-Garonne WA during the 8th Action Programme (2003-2006).

Nine categories of players are considered: 1 - Farmers ; 2 - Industry (incl. energy) ; 3 - Urban communities ; 4 - Rural communities (incl. representatives of the Ministries of Agriculture, Land Development and Rural Affairs ; 5 - Ministry of Industry ; 6 - Environmental associations (incl. fishery, water suppliers, Ministries of Tourism, Health, Environment, the Interior, associations of residential water users ; 7 - Other communities ; 8 - Districts and regions ; 9 - Professional bodies. The first three categories correspond to water users (paying emission and water use taxes, and receiving subsidies from the WA), while categories 4 to 6 are special-interest groups and Ministries. The last three categories, from 7 to 9, consist of players having a less important role in RIver Basin Committees.

Based on the observed distribution of representatives in the Adour-Garonne River Basin, we can compute the vector of weights (w) to be used in determining winning coalitions. On the other hand, the vector of probabilities to be selected as a proposer (p) is not observed; we therefore assume that $p_i = 2w_i$ for $i = 1, 2, 3$, $p_i = w_i$ for $i = 4, 5, 6$, and $p_i = w_i/2$ for $i = 7, 8, 9$, and the probability vector is normalized so that $\sum_{i=1}^{n} p_i = 1$.

This provides us with the following vectors of weights and probabilities:

$$w = \{0.0805, 0.1494, 0.0230, 0.0345, 0.0115, 0.2069, 0.0920, 0.3103, 0.0920\}$$

$$p = \{0.1600, 0.2971, 0.0457, 0.0343, 0.0114, 0.2057, 0.0457, 0.1543, 0.0457\}.$$

The utility function of agents is not observed either. We assume a CRRA (Constant Relative Risk Aversion) utility function of the form $u(x) = x^{1-\rho}/(1-\rho)$, where ρ is the Arrow-Pratt risk aversion coefficient. The model solutions are computed for various values of this coefficient: $\{0.05, 0.1, 0.25, 0.5, 0.75\}$, and we assume for simplicity that all users have the same utility function.

The distribution of tax payments for user categories (γ) is computed from the average multi-year budget over the entire action programme, and is equal to $\gamma = \{0.0519, 0.1738, 0.7743\}$, corresponding to farmers, industries and local

Table 5: Relative Composition of River Basin Committees (agriculture, industry, ecologists)

	Multi-year Program				
	5 (1987-91)	6 (1992-96)	7 (1997-02)	8 (2003-06)	9 (2007-)
	Adour-Garonne				
% agriculture	5.95	6.13	6.82	7.18	7.21
% agriculture / users	16.66	16.66	18.16	18.67	18.42
% industry	11.90	12.25	11.59	11.28	11.34
% industry / users	33.33	33.33	30.93	29.33	28.94
% ecologists	2.38	2.45	3.54	4.10	4.12
	Artois-Picardie				
% agriculture	4.41	4.51	5.16	5.40	5.33
% agriculture / users	11.53	11.19	13.22	14.28	14.28
% industry	16.17	16.56	16.51	16.22	16.00
% industry / users	42.30	41.05	42.15	42.85	42.85
% ecologists	2.94	3.01	3.75	4.05	4.00
	Loire-Bretagne				
% agriculture	6.14	6.31	6.25	5.87	5.55
% agriculture / users	16.66	17.00	16.57	15.61	14.89
% industry	14.03	14.44	13.63	13.33	13.49
% industry / users	38.09	38.83	36.13	35.43	36.17
% ecologists	2.63	2.70	3.49	3.92	3.96
	Rhin-Meuse				
% agriculture	1.64	1.70	2.50	2.85	2.81
% agriculture / users	4.54	4.54	6.64	7.69	7.69
% industry	16.39	17.07	16.37	15.71	15.49
% industry / users	45.45	45.45	43.35	42.30	42.30
% ecologists	3.27	3.41	4.04	4.28	4.22
	Rhône-Méditerranée-Corse				
% agriculture	4.80	4.80	4.82	4.89	4.95
% agriculture / users	13.15	12.63	12.50	12.37	12.24
% industry	15.38	15.38	14.26	13.88	14.05
% industry / users	42.10	40.42	36.94	35.05	34.69
% ecologists	2.88	2.88	3.65	4.08	4.13
	Seine-Normandie				
% agriculture	3.88	3.94	4.14	3.99	3.74
% agriculture / users	10.52	10.52	10.91	10.78	10.44
% industry	15.53	15.78	14.88	13.88	13.36
% industry / users	42.10	42.10	39.22	37.54	37.31
% ecologists	2.91	2.95	4.38	4.94	4.81

Notes. % agriculture (resp. industry) / users: proportion (in percent) of agricultural (resp. industrial) representatives with respect to number of user representatives.

communities in that order. Concerning the weights given to each user category by the players, we consider first that users put a weight of 1 on their own category and 0 on the $k-1$ others. As for weights given by other players ($i > 3$), we assume that the weights for categories 4 to 6 correspond to the ones for user categories, given that the representatives therein have strong special interests for farmers, industries and local communities respectively. For players 7 to 9, we assume that other communities and professional bodies have more interest in local communities as opposed to farmers and industries, while districts and regions put equal weights on all users. The matrix of weights is the following one, with categories in row and water users in column:

$$\beta = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.3 & 0.2 & 0.5 \\ 1/3 & 1/3 & 1/3 \\ 0.2 & 0.3 & 0.5 \end{pmatrix}.$$

The model is solved according to the following algorithm. First, we construct the set of all possible coalitions (2^9) and retain the winning coalitions, with the simple majority rule based on vector w. Second, we loop over a grid of values for $\alpha \in [0, 1[$ and for each α, we scan over all winning coalitions and consider each player in turn in that coalition. For each, we find the optimal coalition when he is a proposer, in terms of transfer minimization (when the proposer is a water user) or of utility maximization otherwise. In the latter case, we solve numerically for the optimal solution x^* using a constrained non linear mathematical programming algorithm. Third, we find for each player the set of optimal payments providing the maximum expected utility, and we retain the corresponding α. Finally, we find the first-stage solution for α by retaining the median value of the sorted vector of αs over all players. This procedure is repeated for different values of the risk aversion coefficient.

As an example, when the risk aversion parameter $\rho = 0.5$ and $\alpha = 0.15$, Table 6 reports the equilibrium shares from the second stage computed with our procedure, for each player as a proposer in turn, as well as the corresponding optimal winning coalition. It is interesting to see that, when water users are proposers, the selected winning coalition always contains the set of all three water users.

For the smallest value of the Arrow-Pratt coefficient ($\rho = 0.05$), the optimal first-stage α is equal to 0.1, while for the other values of this parameter, the optimal alpha is 0.15. This indicates that the solution is not very sensitive to risk aversion, at least under the assumption that all agents have the same utility

Table 6: Equilibrium budget shares form second stage and associated winning coalitions , by proposer - $\alpha = 0.15$, $\rho = 0.5$

Proposer player	p	w	Water users			Players in coalition 1	2	3	4	5	6	7	8	9
1	0.1600	0.0805	0.7369	0.0483	0.2148	X	X	X		X	X			X
2	0.2971	0.1494	0.0144	0.7707	0.2148	X	X	X		X		X	X	
3	0.0457	0.0230	0.0144	0.0483	0.9373	X	X	X		X		X	X	X
4	0.0345	0.0345	0.3118	0.2541	0.4341				X	X		X	X	X
5	0.0114	0.0114	0.2516	0.2757	0.4727	X		X		X	X		X	X
6	0.2057	0.2057	0.2365	0.2854	0.4781	X	X				X		X	
7	0.1543	0.3103	0.2780	0.2907	0.4313						X	X	X	X
8	0.1543	0.3103	0.2274	0.3443	0.4283					X	X	X	X	
9	0.0457	0.0920	0.8532	0.0261	0.1207	X						X	X	X

function. 85 percent of the subsidy allocation is subject to bargaining, given the weights associated to the players.

4.3 A Reduced-Form Econometric Analysis

The purpose of this subsection is to test for the assumption that the representation of the agricultural and industrial sectors in River Basin Committees has a positive impact on subsidies received. Users are paying taxes according to their contribution to water depletion and effluent emissions. Since the unit emission tax rates are depending on a set of pollutants and that the various categories of users have heterogeneous pollution patterns, the best way to represent the sector contribution to Water Agency receipts is to consider the overall tax receipts by category of tax (emissions or water use). In the following, we consider only the agricultural and the industrial sectors as user groups, because the subsidy and tax shares of the third group (the local communities) are directely obtained from the complement to 1 of the sum for these sectors.

The system of equations is the following:

$$x_{ijt} = \beta_0 + \beta_1 p_{ijt} + \beta_2 p_{ikt} + \beta_3 \gamma_{ijt} + \beta_4 x_{ikt} + \alpha_i + \varepsilon_{it}, \tag{6}$$
$$i = 1, 2, \ldots, 6;\ t = 1, 2, \ldots, T;\ j, k = \text{agriculture, industry},$$

where x_{ijt} is the share of total subsidies received by the user category j (agriculture, industry) by Water Agency i at time t, p_{ijt} and p_{ikt} are the proportions of representatives in the River Basin Committee for user category j and k respectively, and γ_{ijt} is the share of tax payments to the Water Agency paid by user category j. Unobserved heterogeneity specific to Water Agency i is captured by the individual effect α_i, and ε_{it} is an i.i.d. random disturbance. Because the proportion of representatives and/or the share of tax or subsidy is likely to be correlated with water agency-specific unobserved heterogeneity, a fixed effect procedure is considered to avoid a possible endogeneity bias.

Since a significant proportion of RBC members are not likely to have a significant role in the discussions over the distribution of subsidies, we consider two measures of user-category representation in the RBCs. The first one is the proportion of each category of users (agriculture, industry) with respect to the size of the entire committee, and the second one is the proportion with respect to the number of user representatives (agriculture, industry, tourism, fisheries, angling, energy producers, etc.) in the RBC.

As agriculture was not subsidized by all Water Agencies at all time periods, the dependent variable has some zero values for the agricultural sector. For this reason, the model has to be estimated by a Tobit procedure to correct for this, and produce consistent estimates in the case of agriculture. As far as industry is concerned, the dependent variable is not censored, so that a linear regression model is employed. Because the number of Water Agencies (6) is far lower than the number of time periods, the issue of the incidental parameter is not serious here, and fixed effects for Agencies can simply be added to the model to control for river basin-specific unobserved heterogeneity. Parameter estimates would be similar to the ones obtained from a Within procedure in the linear case.

Table 7 presents estimation results of the fixed-effect Tobit model for agricultural subsidies (relative to the total budget). The share of agricultural representatives has the expected positive sign, and is significant, reflecting the ability of this sector to collect more subsidies from the global WA budget when it is more represented in th RBC. This effect holds, either in proportion of River Basin Committee members, or in proportion of water user representatives in the RBC. The share of industrial subsidies is negative and significant, as expected, illustrating the competition for subsidies between both sectors. On the other hand, a surprising result is that the share of total tax revenues paid by agriculture is negative and significant. This result means that, when controlling for the number of agricultural representatives in the Committees, agriculture does not succeed in compensating a higher tax burden by more subsidies.

Results for the share of subsidies granted to industry are presented in Table 8. In this case, the proportion of representatives from industries is not significant, indicating that the simple use of this proportion is not sufficient to explain increases in relative subsidies associated with this sector. On the other hand, the share of tax revenues collected from industry is significant and has the expected positive sign. The share of agricultural industrial subsidies is negative and significant, as expected, illustrating the competition for subsidies between both sectors, as was the case in Table 7 for agriculture. The conclusion to this reduced-form estimation is that the agricultural and industrial sectors experience heterogeneous performance in obtaining a larger share of subsidies from the WA total budget. While agriculture benefits from a larger number of representatives in River Basin Committees, industry experiences a positive relationship between tax collected

Table 7: Fixed-effect Tobit parameter estimates. Dependent variable: proportion of subsidies received by agriculture

Variable	Estimate	t-statistic	Estimate	t-statistic
Share of agriculture in committee	2.4582**	2.00	-	-
Share of agricultural users	-	-	0.8861**	2.02
Share of industry in committee	-0.0768	-0.10	-	-
Share of industry users	-	-	-0.1939	-0.77
Share of industrial subsidies	-0.2206***	-4.38	-0.2197***	-4.38
Share of agricultural tax	-1.6552**	-2.03	-1.7905**	-2.19
Intercept	-0.035	-0.24	0.02552	0.20
Sigma	0.0410***	13.08	0.0408***	13.08
Log-L	148.47		148.8634	

Notes. 95 observations, 8 censored at 0 and 87 uncensored. *, ** and *** respectively indicates a parameter significant at the 10, 5 and 1 percent level.

Table 8: Fixed-effect parameter estimates. Dependent variable: proportion of subsidies received by the industrial sector

Variable	Estimate	t-statistic	Estimate	t-statistic
Share of agriculture in committee	-2.4498	-1.09	-	-
Share of agricultural users	-	-	-1.1541	-1.23
Share of industry in committee	-0.1931	-0.14	-	-
Share of industry users	-	-	-0.3254	-0.66
Share of agricultural subsidies	-0.5245**	-2.56	-0.4923**	-2.39
Share of industry tax	0.5906***	3.00	0.6446***	3.23
Intercept	0.2874	1.00	0.3613	1.53

Notes. 95 observations. *, ** and *** respectively indicates a parameter significant at the 10, 5 and 1 percent level.

for water use and emissions, and subsidies from the WA total budget.

5 Discussion and Extensions

The objective of this section is to discuss several features and assumptions of our model and to explore directions for extending or revising the model.

The model developed in this paper is based on a set of assumptions concerning the functioning of water basin committees and the preferences of their members. For the sake of illustration, consider the Adour-Garonne River Basin Committee. It has now (as of 2012) $n = 135$ members divided into three colleges: a first college of 54 members representing the local governments (local communities), a second college of 54 members representing users and experts (professional bodies) and a third college of 27 members representing the central government (representatives of the State and public boards). The first college is composed of representatives from the regions, the *departements* (French districts), the large munipalities and and the small municipalities (with a qualification for the municipalities located in either mountain areas or seaside areas). The second college has 9 representives from agriculture, 27 representives from the industry and 18 representives from different associations (consumers, protection of the environment), regional *Social and Economic Councils* and groups of experts. A key assumption of our paper is that the interests among group users are conflictual and that the representatives often act on behalf of a particular group. Of course it is not straightforward to collect direct evidence supporting that assumption. A careful examination of the proceedings reproducing the synthesis of the debates within the committee is a first step in that direction.

The second critical assumption of this paper is the choice of the conflict dimension. In the empirical section, we have priviledged the case where the conflict is between the three main groups of users. While there is clear evidence to support such assumption, we could have instead privileged the geographic dimension of conflict. Indeed, each Water Agency is in charge of the various sub-river basins within the broad hydrographical river basin, with local delegations for each. For example, the Adour-Garonne WA has five such delegations, with permanent staff dedicated to local water management issues. Instead of having $k = 3$ and a dispute among users, we could instead consider $k = 5$ (or even a finer grid) and consider a dispute among territories. In fact, the balanced composition of the committee in terms of geographic areas may suggest that this characteristic is important. In such case, our model would become closer to the seminal study of Kauppi and Widgren (2004). Nevertheless, we woul have also to make some assumptions on the preferences of those who are not affiliated to a specific area as the members of the third college. We do not know if there are (as we observe for users) cross subsidies across territories.

Some more theoretical assumptions may also be challenged. The model has been developed under the assumption that players were perfectly patient and that the rule used was the majority rule. It is important to investigate to which extent our analysis could cover more general situations. Since the policy space is one dimensional, even if the players are not perfectly patient, we deduce from Banks and Duggan (2000) that for any voting rule, there exist non-delay stationnary equilibria in pure strategies. Furthermore, by their continuity theorem, pure strategy equilibrium outcomes converge to core outcomes when discount factors converge to one. If the players are not perfectly patient, then the analysis of equilibria is more intricate. Cho and Duggan[10] (2003) have proved that in any non-delay stationary equilibrium, the acceptance set is an interval. Cardona and

[10]They also prove uniqueness in the case where the utilities are quadratic and the voting game is strong.

Ponsati (2011) have proved that under a strong condition on the utilities and if the voting rule is anonymous and proper, then the equilibrium is unique.They also analyse the impact of the quota on the social welfare. None of these conditions on utilities are satisfied in our setting. However, Predtetchinski (2011) has proved that when the discount rates tend to 1 then the approval set converges to a unique asymptotic equilibrium outcome which is solution of a well defined equation. It would be interesting to calculate this limit in our framework and to proceed to a subsequent analysis of the social welfare attached to any of the possible quotas.

As a final point, let us remember that in this paper, our bargaining setting has been described as a non-cooperative game. We could have instead, like Kauppi and Widgren, adopted a cooperative framework. This would be quite relevant in the case where geographic characteristics would be considered as the most important dimension in the bargaining. In such case, it would be relevant to define the game as a weigted majority game and to calculate the shapley value of the game as Kauppi and Widgren did or other solutions like for instance the nucleolus (Le Breton, Montero and Zaporozhets, 2012; Montero, 2006). Along these lines, we could also consider any mix betwwen the "tax solution" γ and a copperative bargaining solution.

Finally, concerning the empirical application, it is clear that results from a reduced-form econometric procedure cannot confirm all the predictions of our bargaining model. This is particularly true as the proportion of the "secured" budget without bargaining (α) is a complex function of probabilities p, weights w and initial tax shares γ, with does not in general has a closed-form solution. Given the complexity of the optimal solutions from the model of bargaining, structural econometrics would be needed to identify risk preferences and deal adequately with unobserved weights w. This is left for future research.

6 Appendix

6.1 Interior Regimes

In the case where we are not in a corner regime i.e. when a representative puts positive weights on several groups of users, things become a bit more complicated from an analytical perspective. Note hovewer that the problem is well defined as under the assumption that u_i is concave for all $i = 1, ..., k$ the sets $S_\alpha^l \equiv \{x \in S_\alpha : u_l(\alpha\gamma + x^j) \geq u_l(\gamma)\}$ are convex for all $l = 1, ..., n$. The problem of the proposer is:

$$\underset{x^j \in \mathbb{R}_+^k}{Max} v_j\left(x^j\right) \equiv u_j\left(\alpha\gamma + x^j\right)$$

subject to the constraints

$$x^j \in \underset{S \in \mathcal{W}_m}{\cup} \underset{l \in S}{\cap} S_\alpha^l$$

Since u_j is concave and $\underset{l \in S}{\cap} S_\alpha^l$ is convex and non-empty, the set of solutions of the above problem for a fixed $S \in \mathcal{W}_m$ is convex. It is not necessarily a singleton. There are however specific situations where there is a unique solution. This is for instance the case when u_j is strictly concave. When the functions u_j are differentiable, the Kuhn-Tucker conditions describing a solution write:

$$\beta_i^j u_i'(x_i) = \lambda - \sum_{l \in S} \mu^l \beta_i^l u_i'(x_i) - \theta_i \text{ for all } i = 1, ..., k$$

where the Lagrange multipliers λ, θ_i for all $i = 1, ..., k$ and μ^l for all $l \in S$ are non negative. It simplifies to:

$$u_i'(x_i) = \frac{\lambda - \theta_i}{\beta_i^j + \sum_{l \in S} \mu^l \beta_i^l} \text{ for all } i = 1, ..., k$$

If $x_i > 0$ for all $i = 1, ..., k$, then we obtain:

$$u_i'(x_i) = \frac{\lambda}{\beta_i^j + \sum_{l \in S} \mu^l \beta_i^l} \text{ for all } i = 1, ..., k$$

To solve explicitely the equations, we need to identify which participation constraints $l \in S$ are active and which ones are not.

6.2 Incomplete Information

In our analysis of the corner regime, we have assumed that the type β^l of each voter l is common knowledge. While reasonable when l represents explicitely a well defined group of users, it is less so when it is not the case. If β^l is private information for each voter $l = k+1, ..., n$, then we introduce adverse selection into our framework. To each offer x^j made by proposer j is now attached a vector of probabilities $\pi\left(x^j\right) = \left(\pi^l\left(x^j\right)\right)_{1\leq l\leq n}$ where $\pi^l\left(x^j\right)$ denotes the probability that voter l accepts the offer. The probability that the offer x^j is accepted is equal to:

$$P\left(x^j\right) = \sum_{S\in\mathcal{W}}\left(\prod_{l\in S}\pi^l\left(x^j\right)\right)\left(\prod_{l\notin S}(1-\pi^l\left(x^j\right))\right)$$

The expected utility of the proposer is then :

$$P\left(x^j\right)v_j\left(x^j\right) + (1-P\left(x^j\right))v_j\left(\gamma\right)$$

His objective is to maximize that function under the constraint that $x^j \in S_\alpha$.

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