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"A Context-based Procedure for Assessing Participatory Schemes in Environmental Planning"

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A Context-based Procedure for Assessing Participatory Schemes in Environmental Planning

Abstract

The efficiency of participatory schemes in environmental planning is an emerging research area, and many issues are not solved yet regarding the assessment of such procedures. It is essential for decision makers to identify improvement opportunities of participatory schemes. We propose an original procedure to address such issue, through a bargaining model from the signaling game literature, which accounts for participation design as well as for agents' preferences, beliefs and bargaining power. The model is calibrated using qualitative data from surveys in French local communities involved in municipal solid waste management. Model simulations are used to test for assumptions on the stakeholder dialogue and explore sensitivity of game outcomes to structural parameters. We propose a set of performance indicators to identify the most effective participatory schemes in achieving convergence in stakeholder positions regarding environmental and land-use planning.

1. Introduction

Consultation-based management initiatives have emerged over the past decades as a response to social and political factors impeding stakeholders to reach an agreement on local projects. The assessment of their performance is of growing importance for public decision makers and managers (Ansell and Gash, 2007), in particular because of the need to identify suitable resources associated with positive outcomes of such negotiations (Wolf-Powers, 2010). Providing decision makers with a scientifically sound and context-specific information adapted to their needs is therefore a critical issue. However, heterogeneity in stakeholder-dialogue cases does not facilitate the construction of a common benchmark for guiding decision makers who may not be familiar with public participatory procedures.

The efficiency issue in stakeholder dialogues has been addressed with various approaches and applications (Davoudi and Evans, 2005), with few seminal works focusing on the relative role of various factors on the outcome of stakeholder dialogues (Margerum, 2002; Beierle and

Cayford, 2002). Participation procedures and stakeholders' satisfaction often stand out as the main drivers of success (Smith and McDonough, 2001). Nevertheless, the literature generally overlooked a large number of context variables from concertation schemes, while at the same time the scope of study of local negotiations became more complex (Menkel-Meadow, 2009), contributing to put forward the importance of context-based aspects of the debate (Braun and Schultz, 2010).

The role of such contingent, context-based components of stakeholder dialogue was addressed by some authors through approaches originating from governance studies (Koontz, 2005) or negotiation (Raymond, 2006). These studies contributed to shifting attention to political factors (Walker and Hurley, 2004) and the participation process design (Edelenbos and Klijn, 2006, Ansell and Gash, 2007), and most were taken from the literature on environmental management and planning. Recent empirical analyses include Ananda and Proctor (2013) on collaborative approaches to water management in Australia, van Rensburg et al. (2015) on wind farm planning decisions in Ireland, Skurray (2015) on institutional arrangements for common-pool resource management.

A standard approach in the economic literature consists in formal representations of complex relationships between players, even though relationships between the stakeholder dialogue and the outcome of the participatory scheme are often difficult to predict using simple mathematical representations, as acknowledged by Mathur and Skelcher (2007). In many settings, environmental planning with participatory schemes cannot be reduced to a two-player game with, e.g., environmentalists on one side and the industry on the other, but include the *principal* as a third agent (Wolf-Powers, 2010). Motivations for introducing a third agent (or player) include Chiu and Lai (2009), and Davoudi and Evans (2005) and Saarikoski (2006) for a three-player game with a principal facing two opposing coalitions. Moreover, the development of decentralized game models offered an extended perspective to economists willing to analyze collaborative bargaining. In this literature however, the relationship between agents does not always correspond to a participatory process.

In a majority of articles, the principal remains the first "active segment" facing agents with private information, contrasting with the timing of consultation-based procedures. In the

latter, messages received by the principal may be distorted (Goltsman and Pavlov, 2008), and moreover, the principal does not control the way stakeholders behave, or how they will contribute (centralized or decentralized system). This justifies in particular the need to characterize the principal's attitude: neutral or not, but always in reaction to stakeholders. Moreover, standard negotiation models often allow for the possibility that negotiation completely fails, an option the regulator or principal tries in practice to avoid at all costs in local planning procedures. Indeed, stakeholder dialogue always allows for making (little) progress on some technical or managerial features of the sector or process design, such as valuing some new categories of municipal solid waste in our application (see below).

In participatory processes, information transmission is not really costly, there is partial cooperation and always partial results from the negotiation. These limitations justify in our view the use of a *cheap talk* model à la Crawford and Sobel (1982), where information is transmitted between agents through ordinary, informal signals, before the final decision is made. Cheap talk can be seen as a way to reach, in some circumstances, more proximity between parties in a negotiation (Messer et al., 2013). In order to model the interactions between agents involved in stakeholder dialogue, we consider an original approach based on a signaling game, formally close to an extension of Alonso et al. (2008). It is necessary however to augment this model by introducing negotiation power and familiarity among players, considering a greater variety of dialogue modes. Based on this, the cheap talk approach can be reinterpreted in such a way that it shares similar features with actual stakeholder dialogue situations. Although the modeling strategy introduced in this paper is far from sufficient for representing the complexity of agent interactions, we believe it is an original methodological step in an effort to explore stakeholder dialogue effectiveness.

The complex nature of stakeholder dialogues requires a detailed characterization of agents' preferences, beliefs, and other drivers of their behavior. An additional contribution of the paper is therefore to present an original method to calibrate a cheap talk model, including the major determinants behind negotiation objectives and outcomes, with qualitative data obtained from field surveys. However, for calibration purposes, we consider not only information on stated preferences collected from stakeholders, but also revealed evidence

gathered during negotiation by means of a survey.[1] The cheap-talk model is calibrated by converting such qualitative survey data to numerical values, on each of three selected study areas. Predictions from the theoretical model are then obtained by a numerical root-finding algorithm. We consider as an empirical application the case of municipal solid waste management in France, as an illuminating example of environmental planning where stakeholder attachments are often clear cut, even incorporating a sophisticated amount of expertise during the stakeholder dialogue.

A final contribution of the paper is a method of performance assessment associated with stakeholder dialogue in environmental planning. Assessing the performance of participatory schemes is a challenging task, and this paper does not propose a comprehensive and generic method for evaluating such negotiation-based procedures. Rather, we consider only two indicators of performance that are relevant to facility siting process in environmental planning: the degree of convergence in the positions of opposing stakeholder groups, and the intensity of capital investment achieved through dialogue. We discuss in the paper the motivation for these indicators in relation with the literature on collaborative policy making.

The outline of the paper is as follows. Section 2 describes the way stakeholder dialogue is typically used in environmental and land-use planning, in particular in local solid waste management. We also present in this section the survey method and the study areas: three French sites concerned with municipal solid waste management. The cheap talk model is presented in Section 3 with its assumptions on preferences and dialogue modes, and the derivation of final outcomes. In Section 4, we present the calibration exercise, and we discuss the model simulation and validation checks. Section 5 concludes.

2. Stakeholder dialogue in controversial environmental planning, with an application to waste management

The upgrading of public services that rely on infrastructure subject to the NIMBY (Not In My Backyard) phenomenon often gives rise to difficult local negotiations (Feinerman et al.,

[1] The advantages of in-depth interviews with stakeholders are also discussed by Avci, Adaman and Özkaynak (2010).

2004). Because of comparable difficulties in policy making, the design of participatory procedures for achieving a collective agreement is not fundamentally different for a wide range of projects impacting the environment (industrial hub, landscape-modifying infrastructures, transportation, tourist facility, waste management, water dam, etc.)

The usual features of stakeholder dialogue in environmental planning

It is interesting for local planners, when they have the opportunity of designing their own procedure, to know which participatory scheme is preferable, regarding in particular the probability of success. Participatory approaches at the local level correspond broadly to a stakeholder dialogue, and in most developed countries a typical procedure for environmental planning can be described as follows. Stakeholders are involved in a series of participatory sessions (public hearing, working group, public event, open forum, etc.) during a process which can take several years. In practice, the process starts with a proposal from a company (public or under delegation) in charge of the facility design and/or upgrading investment. Such proposal is a combination of technical, financial and management options together with a size of operation, which can in principle all be opposed by (some) stakeholders. Stakeholders respond with counter-proposals consisting in required modifications on some components of the project design. If proposals and counter-proposals made by stakeholders for facility siting or upgrading investments do not converge to a satisfactory outcome for the majority of stakeholders, then this long and iterative process produces poor results. In the case of a more successful outcome, then the participatory process succeeds in achieving a final outcome in the form of a larger set of new management provisions, which have been subject to negotiation and approval by both sides. In case of real success, the fraction of strong disagreement remaining among groups is expected to be small.

Municipal solid waste is often considered an “environmental bad” (Davoudi, 2000; Feinerman et al., 2004) implying political, economic and cultural aspects (Bulkeley et al., 2005; Wagner, 2011). It is less the choice of the management mode in itself that matters in practice, than aspects of quality of life and environmental conservation, technical process safety and efficiency. Management decisions for municipal solid waste are often conditional on public participation procedures (Petts, 2004). As these procedures can be in practice difficult and

subject to major sources of conflicts (Wiedemann and Femers, 1993), it is a particularly interesting sector for exploring the performance of participatory schemes implemented for environmental planning.

In a way similar to the general procedure presented above, in the case of municipal solid waste management, an operator in charge of the public service of waste collection and disposal has at some point in time to upgrade the waste management system on a large area. In France for example, this operator will be acting on behalf of an association of local communities in a given district. In cases where the operator faces opposition from local residents, and/or lacks expertise or space to deal satisfactorily with solid waste, the operator can initiate a consultation procedure, opening a dialogue period among numerous stakeholders.

During the stakeholder dialogue, stakeholders exchange over various aspects of the design of a project. Such design has a particularly sophisticated nature, as environment-related projects have typically to deal jointly with several resource flows and are characterized by various intermediate stages (transformation, transportation, collection, possible marketing of co-products, etc.). Moreover, besides investment in new or upgraded capital stock, management options may also be modified, e.g., modified procedures for labor management and supervision, expertise and capacity building. Hence, aspects related to human capital are part of the project features that are relevant to the dialogue among stakeholders.

Consider for instance the main issue of dealing with the interdependencies between the different flows, reclamation and treatment facilities of the waste management system, i.e., complementarities in the logistic chain. On this aspect, some stakeholders on one extreme will prefer a single final treatment of waste that reduces coordination problems, while at the other extreme other stakeholders will be in favor of diversification of industrial solutions, implying more difficult coordination issues. On the basis of such oppositions among stakeholders, groups are formed among stakeholders that will defend a project design according to (presumably fairly homogeneous) internal preferences. Groups are then pushing for outcomes that remain distinct, but not necessarily far apart from each other at the end of the process, if successful.

Our framework seems to be more consistent with European waste management systems than North America regarding waste treatment aspects. Indeed, the variety of possible disposal options is much wider in European countries. According to Hoornweg and Bhada-Tata (2012), sanitary landfill accounts for about 27 percent of solid waste disposal in Europe but 91 percent in North America, while open dump and incineration represent a significant part of waste treatment in Europe but are almost nonexistent in North America. This implies that the planning issue in North America is limited, in the case of solid waste treatment, to the choice of a landfill site than in the European case.

Main variables influencing stakeholder dialogue

Whatever counter-proposals stakeholders are put forward during the process, they are always related to their preferences or objectives, typically assumed stable private information in the literature. We consider in this paper that both terms (preferences and objectives) are equivalent, as we do not explore multiple objectives from the same economic agent. Stakeholders' moderation, or on the contrary extremism, in their preferences may determine whether consultation is worth trying (Krishna and Morgan, 2001; Mitusch and Strausz, 2005). In the economic literature, the discrepancy between agents' objectives is the preferred determinant of the poor quality of information exchange between participants to the negotiation, even under incomplete information (Goltsman and Pavlov, 2008). As in any negotiation with participants sharing different objectives, their messages are likely to be strategically designed for the state of negotiation. Hence, during stakeholders' dialogue, private information can be revealed but not necessarily verified.

Other determinants than stakeholders' own preferences or objectives are likely to play a role in the building of their proposals and communication to other stakeholders. As noted by Ansell and Gash (2007), the stakeholders' level of commitment to collaboration is related to the motivation to participate in collaborative governance, the legitimacy of the project, or the fulfilment of a legal obligation. Therefore, the shared need for negotiation to succeed may explain the will of participants to reduce the difference between one's own outcome and the opponent's one. The initial state of management or the lack of proper infrastructure may thus imply some pressure on stakeholders to engage in a dialogue. Another factor may also be the

distribution of bargaining power or influence across agents engaged in negotiation, which sometimes plays a more important role in the process than the difference between agents' interests (Van Bommel et al., 2009).

The literature on collaborative bargaining has identified several other dimensions of importance for analyzing participatory schemes beyond preferences, pressure to collaborate, and bargaining power. These additional dimensions concern a) the role played by the principal, e.g., environmental planner in our framework, and b) the type of relationships between players in the bargaining game.

First, the principal's attitude is emphasized as a major determinant for agents to agree to collaborate (Margerum, 2002; Petts, 2004; Ansell and Gash, 2007). Moreover, the position granted to the principal and, more generally, whether the consultation takes place in a centralized or decentralized setting, also matters (see, e.g., Bourdeaux, 2007). In this respect, Suh and Wen (2009) link bargaining power with the way the game is structured. Second, familiarity among stakeholders is likely to modify the outcome of a planned consultation, mainly because of a more transparent bargaining environment instead of a conflict-driven one (Wiedemann and Femers, 1993; Bouwen and Taillieu, 2004; Braun and Schultz, 2010). However, the implementation of a more familiar interaction between agents does not prevent interplay among basic factors, such as non-compatible interests or bargaining power (Lejano and Ingram, 2009; Maguire and Lind, 2003), or the difficult context of a bargaining procedure (Nicklin et al., 2011). Besides such other variables, familiarity between stakeholders will eventually concern the volume and quality of the information shared by stakeholders (Reimer and Hoffrage, 2006).

A benchmark for relative performance of participatory schemes

Building upon the discussion above, we consider the issue of assessing the performance of participatory schemes in environmental planning, taking as observed outcome a series of management decisions that has become acceptable to parties. Such outcome is based on the new components of management project, upon which each group consents to at the end of the dialogue, rather than obtaining at all costs decisions that are in line with their initial objective.

We suggest selecting as a first performance indicator the deviation from initial objectives to final outcomes reached, which may be considered a form of convergence. The gap between the initial objective and the outcome for each stakeholder group is an indicator of the concessions made. Another indicator is the intensity of capital stock investment associated with the final agreed-upon components of the management project. Performance in this case is expressed as the ability for the participatory process to move away from a dead-end situation (blocking in practice some components of new capital stock), precisely by reducing the gap between the management provisions (or outcomes) accepted by each group. Biddle and Koontz (2014) correlate the outputs from collaborative governance processes with stakeholders' participation in the case of watershed-level water quality management. They show that collaborative processes with stakeholder participation can provide intermediate outputs of pollution reduction goals that serve as proxies of environmental outcomes.

Figure 1 presents the initial objectives, final outcomes and displacements for both players (B_1 and B_2). The gap between the final outcomes (A) defines the magnitude of unachieved concessions between parties, and in a complementary way the investment in capital stock that is ultimately achievable can be denoted the outcome of the process.

[FIGURE 1 ABOUT HERE]

Ultimately, these two performance indicators are originating from the need to upgrade facilities in an initial situation of poor management performance. The final objective of the environmental planner may be seen as the *performativity* (Callon, 2010) of a new management system and its environmental rearrangement. We follow here Beierle (1999) and Leach et al. (2002) who recommend as a benchmark for performance assessment the common social objective arising from a critical situation (a bad initial management state). As noted above, the participatory initiative may be considered a means to upgrade local management capacities for solid waste. The initial issue shared by all concerns the improvement of the proportion of waste taken care of (collection, diversion, treatment) by the community (within a common waste management network), reducing its undesirable impacts.

We assume that the common social goal lies somewhere between extreme stakeholder preferences, as some linear combination of stakeholder welfare objectives. Such social goal is

not identified however, because stakeholder preferences and the associated weights in the social welfare function are not observed, and would require dedicated revealed or stated preference elicitation procedures. Therefore, we can only consider that it is "socially desirable" that stakeholder positions converge towards each other, even though the final outcome may not reach a socially optimal position.

Consequently, a concerted management initiative can be considered successful not only because it allows for a higher level of acceptable solutions to be possible (investment in management renewal, A in Figure 1), but also because negotiation allows stakeholders to partly converge towards the final outcome (stakeholder displacements B_1 and B_2 in Figure 1, see Leach et al., 2002).

The investigation method and study areas

In order to explore the performance of consultation-based management procedures applied to municipal solid waste management, it is necessary to conduct a thorough analysis of the dimensions described above. Instead of considering a large sample of municipalities with cost of data collection issues, we select a limited number of study areas (three sites), paying attention to their differences in terms of management modes and intrinsic characteristics. Some aspects of collaborative participation have to be distinct in order to identify sources of management performance. However, at the same time, the study areas need to have some features in common so that some homogeneity in model parameters (and/or assumptions) can be expected. We first identified the list of all (26) on-going participation-based procedures for municipal solid waste management in France in 2005 and 2006 (with the support of experts from ADEME, the French Agency for Energy and Waste Management). Three areas were selected out of this list, based on criteria such as the existence of a consultation-based procedure involving several stakeholders who engage in this form of dialogue.

Study area 1 is located in the central-east region and covers several geographical areas, of which only one can be considered industrial in nature. The population covered is between 250,000 and 300,000 inhabitants. Study area 2 is located to the south-west and is also heterogeneous in terms of geographical features, from a coastal urbanized zone to the west, a

rural landscape to the east, and a population between 200,000 and 250,000 individuals. Study area 3 is a site located to the north-west of the country and includes only coastal local communities, with a population a little over 50,000 individuals at the beginning, but the planning reflection subsequently extends beyond 150,000 individuals.

To explore the heterogeneity of the population in the three study areas, we collected data from INSEE (French Institute for Statistics and Economic Analysis) at the district level, to match the corresponding geographical areas. The population characteristics in the three study areas are remarkably homogeneous in terms of annual household median income (19,903 euros, 18,542 euros and 18,608 euros for study area 1, 2 and 3 respectively) and income interquartile range (3.95, 3.96 and 3.87 in study area 1, 2 and 3 respectively). Concerning education, the proportion of adult population with a higher education degree ranges from 21.62 in area 2 to 22.63 in area 3, and the proportion of adults without any degree is respectively 15.63 in area 1, 15.50 in area 2 and 10.86 in area 3. Only population density is fairly-different across those study areas, with respectively 154.65, 141.00 and 182.47 inhabitants per square km for area 1, 2 and 3. Therefore, the requirement that study areas should be fairly homogeneous (for parameters to be assumed common) seems to be satisfied.

Our field survey consisted of two waves: first, a 6-month exploratory survey at the end of 2006, with direct interviews on the three study areas with local managers, scientific and technical experts; second, at the end of 2008, the main field survey was conducted. It included about 50 semi-direct interviews, the visit of the major treatment facilities in operation, and a collection of published material related to the municipal solid waste management project in the local media, over the period of the dialogue (2000-2008). This information was supplemented by numerous technical reports (public or for internal use), providing us with data capturing the diversity of stakeholders and of their positions involved in each study area.

In all three sites, the stakeholder dialogue runs over 6 to 7 years and shares similar stages, from the creation of a waste management agency between 2000 and 2002, to the provision of substantial funding of new waste facilities between 2008 and 2012. In all cases, the dialogue has been initiated by an elected administrator, playing most of the time the role of the principal of the game. Thanks to this quasi-ethnographical survey, we were able to distinguish

between two stakeholder coalitions in each study area, each defending technical and political objectives (Weible, 2006). Our results on these preference points are consistent with previous results in Davoudi and Evans (2005), Davoudi (2000) and Saarikoski (2006). Although the stages look similar across the study area, the actual negotiation processes were fairly different because of heterogeneous contexts, participatory schemes, and positions taken by stakeholders.

Field surveys revealed that stakeholders have different objectives regarding

a) spatial localization of management efforts and infrastructures,

b) comparative technical performance of the solid waste management solutions,

c) management system: internal complementarities in the logistic chain and interdependencies, -even outside the management area,

d) manageability of health and environmental impacts,

e) quality aspects, and more broadly the motivation to go beyond standard management practices,

f) information and relations between the solid waste management agency and the public,

g) financial aspects.

3. The model

There are two groups of agents, *j=1, 2*, each with *message* m_j and associated *outcome* y_j, which we normalize according to the standard cheap talk literature: $m_j, y_j \in [-1,1]$. The model represents a *dialogue* as a set of agents' interactions according to a three-stage game, and we make the simplifying assumption that each group is homogeneous, so that each group of agents is considered a *player*. In stage 1, each player identifies its initial objective denoted θ_j. In stage 2, messages $\{m_1, m_2\}$ are sent by players, either directly to the principal in the centralised case, or to each other in the decentralised case. In stage 3, outcomes y_1 and y_2 are observed and the game ends. The main difference between both versions of the game is that, in the centralized case, the principal determines the preferable outcome $\{y_1, y_2\}$ from

messages $\{m_1, m_2\}$ according to her own attitude, whereas in the decentralized case, the principal leaves the coordination task to the players. In the latter case, the principal expects players to look for outcomes that are more coordinated than their initial objective $\{\theta_1, \theta_2\}$ because players are concerned about welfare improvement from negotiation. In each case, one can make behavorial assumptions on the principal and/or on the players.

We assume players' preferences depend on several aspects: their "selfish" interest in seeing the outcome as close as possible to their own objective, the need for the negotiation to succeed, and the consideration for the other player. The second aspect accounts for the loss each player would incur if an agreement is not reached and the negotiation fails. Presumably, the more serious the local environmental situation, the higher the probability that players will find it ultimately necessary to make a compromise. Therefore, each player is also seeking to reduce the difference between her own outcome and the opponent's one, which is driven only by the (selfish) need for negotiation to succeed.

From these assumptions, the payoff function of payer *i, i=1, 2,* is:

$$\pi_i = -\left(y_i - \theta_i\right)^2 - \delta\left(y_i - y_{-i}\right)^2, \qquad (1)$$

where $\delta \geq 0$. The third aspect related to the consideration for the other player translates into a weighted function of payoffs from both players being maximized. While the second component of preferences could be considered intrinsic because it refers to the gain or loss for the player in case final claims are too far apart, the third component is directly associated with some form of openness typical of concerted (or participatory) setup. More precisely, the player can be interested in seeing the other player being acknowledged for what he claims as legitimate, and then receiving a minimum payoff from dialogue, even though this will not guarantee that her own payoff will not be lower (or higher). Let λ_i denote the weight put by player *i* on her own payoff, with $1-\lambda_i$ the weight on the other player's payoff, which then represents their consideration for others. Each player would finally maximize $\lambda_i \pi_i + \left(1-\lambda_i\right)\pi_{-i}$ with respect to message m_i.

Consider now the preferences of the principal, who can be considered either neutral (in the same sense as the game-theory) or "soft", in a sense we define below. The neutral principal

puts equal weight on both players; he maximizes $E\left[\pi_1+\pi_2 \mid m\right]$, with π_j the profit function of player *j* and $m=\{m_1,m_2\}$. On the contrary, a "soft" principal leaves to each player the task of expressing the weight or consideration the other player deserves, instead of forming an objective function based on the principal's equal consideration for both players. The soft principal would then maximize $E\left[\left(1-\lambda_2\right)\pi_1+\left(1-\lambda_1\right)\pi_2 \mid m\right]$, where $1-\lambda_i$ is the weight or consideration associated by player *i* with the other player case. We assume that $\lambda_{-i}>0, i=1,2,$ (i.e., each player has minimum consideration for the other one). It is important in addition to note that it is not only the nature of the principal (neutral or not) that matters, but the perception the players have on the nature of the principal regarding neutrality or not. Then, there are four subcases of the centralized case to consider: i) the principal is neutral and considered as such; ii) the principal is "soft" and considered as such; iii) the principal is neutral but considered "soft" by both players; iv) the principal is "soft" but considered neutral by both players[2]. In each subcase, players 1 and 2 determine their best signal to send to the principal, given the perceived behavior of the principal.

Our definition of a "soft" principal contrasts with the framework of Calcott and Hutton (2006), who examine the possibility that principals may be biased against projects (even efficient ones), and analyze the relationship between environmental liability regime and the possibility of harsher regulation in regulatory gatekeeping. They show that adopting a soft liability regime does not compensate in general the regulator's bias against projects. In contrast, the principal in our framework may be neutral or soft, but only with respect to the weights associated with players, as described above, and not with respect to regulation enforcement as in Calcott and Hutton (2006). However, the possibility they consider of a biased principal (towards some projects or stakeholders) could be an interesting extension of our framework.

[2] In our model, we assume that the principal treats both players identically, even when he is "soft", and that players perceive the principal as acting symmetrically over both players. It is also possible to consider the case of players perceiving differently the attitude of the principal (neutral or soft). Because dealing with all possible cases would complicate the analysis, we do not consider such additional case, although adapting the present model would be feasible. Instead, we deal only with the presumably more common cases, namely, that the principal is perceived identically by both players. Furthermore, as we will show below, differences in those dialogue sub-modes have a lower impact on performance as other parameters, so that it is likely that including this case would not significantly modify our results and conclusions.

Second, consider the decentralized case, where the nature of the principal does not matter. On the contrary, it is the degree of familiarity of players regarding their opponent that matters. Player *j* may believe that the other player has the same "perception" of the situation as himself or not, depending on whether players are familiar with each other (through, e.g., previous interactions and experience). If players 1 and 2 do not have reasonable knowledge of each other, we assume that player 1 believes that player 2 shares with him the system of weights λ_1 for player 1 and $(1-\lambda_1)$ for himself. And similarly for player 2, who would believe player 1 to share his system of weights λ_2 and $(1-\lambda_2)$. If however, there is some degree of knowledge between both players, then each player would use this information. For example, player 1 would still apply weights λ_1 and $(1-\lambda_1)$, but would acknowledge the fact that player 2 uses the system of weights λ_2 and $(1-\lambda_2)$, and symmetrically for player 2.

Combining centralized and decentralized cases, we now deal with eight possible dialogue modes: the principal is neutral/soft and perceived as neutral/soft by the players, there is reciprocal familiarity/no familiarity across both players, and player 1(2) is familiar with player 2(1) but player 2(1) is not with player 1(2). In all cases, player *j* will design his message in such a way that the receiver will select the best possible outcome for player *j*. In what follows, we will make the important (and in our opinion, realistic) assumption that each player develops, in a symmetric way, an inference upon the inference the other player is making. We proceed in three steps. First, we characterize the outcomes observed at the end of the dialogue process, taking as given the inference adopted by players. Second, we characterize the inference upon which players base their messaging strategy, i.e., the way they use available information given their preferences and perceptions. Third, we solve the model for optimal messages and outcomes by replacing inferences by their expression.

Details of the model solutions are presented in the Appendix.

4. **Model calibration and simulation**

We first discuss in this section the method used to calibrate our messaging model. Since the model is based mostly on unobserved preferences, beliefs, bargaining power, willingness for agreement, the way to proceed departs from usual structural econometric approaches. We use in-depth qualitative surveys in the three study areas presented in Section 2, to construct proxy variables for the components of the model, that is, the initial objective of player *j*, θ_j, the weight placed by player *j* on himself, λ_j – thus the weight he assigns the other player (1- λ_j) – and the willingness or pressure for agreement, δ.

There are eight possible dialogue modes, depending on players' vision of the attitude of the principal (centralized case) and on players' familiarity with each other (decentralized case). This yields eight additional parameters if we consider the probability associated with each case. In terms of outcomes, concessions $\{y_1, y_2\}$ reached at the end of the stakeholder dialogue process can be considered dependent "observed variables".

The calibration of the above parameters is a major effort in the present work, which is justified in our view by the complex nature of stakeholder dialogue, and by the lack of empirical data from actual concerted experiences (cf. Kontoleon et al., 2002; Money and Allred, 2009; French and Bayley, 2011). As pointed out by Thomson et al. (2007), the performance of planning procedures can be assessed from a quantitative analysis of components of the dialogue and its observed effects. The usual way of collecting information on planning procedures is to conduct a direct qualitative survey of stakeholders and decision makers (including possibly the public). On solid waste management issues, standard techniques such as the Analytical Hierarchy Process (Strager and Rosenberger, 2006; Ananda and Herath, 2008), Likert-scale questions (Thomson et al., 2007), or nonparametric test procedures (Garmendia and Stagl, 2010), have been employed. Collecting information directly from stakeholders can lead to strategic and cognitive biases (Watkin et al., 2012; Paolisso, 2002) that can partly be controlled for by using post-survey validity-check procedures (consistency ratio).

In our case however, we use interviews of individual stakeholders, but also an overview of their real options and concessions in the course and at the end of negotiation (see Table 1 in

the Appendix for examples of data collected). As described in section 2, the calibration draws on separate but related data sets (as in Masuda et al., 2008). The first data set consisted of printed documents including exploitation and local planning reports, articles from local newspapers, promotional material, etc., over the years 2000 to 2008**.** The second data set was a group of interviews with all of the relevant participants, and the visit of the major solid-waste treatment facilities. These data sets are then integrated into the same calibration protocol, which ultimately yields the quantitative results presented in Table 2. We are therefore in a position to revisit the consistency of stakeholders' engagement throughout the negotiation phase. Therefore, for each variable or parameter to be quantified, we first proceed to select (and order) relevant data to calibrate. We then construct a cardinal notation scale which is specific to each variable or parameter, and we can assign at the end a score to each.

According to the existing literature, the discrepancy between groups' interests is a major factor for explaining the success or failure of a negotiation. It is a particularly challenging to quantify the collective objective of each group, and we have seen in Section 2 that this variable is grounded on seven management aspects considered particularly important because the most often cited in debates.

In Table 1 (Appendix), we illustrate the calibration method on the example of aspect c) (Management system complementarities between processes, described in section 2). Table 1 is a significant reduction in size from the original collected data, as it only deals with a single aspect (out of seven), a single study area (case 1) and only three stakeholders (out of 30) are represented. A range indicator specific to aspect c) is constructed, by selecting the extreme positions recorded during the negotiation phase (as in Biddle and Koontz, 2014), from one extreme (a single process) to the other (multiple and simultaneous processes). These two extreme indicators are then rescaled to lie between -1 and 1. It is used to locate each player on the [-1, 1] scale according to his stated options during the negotiation compared to the lower or upper bound of the range (column *Objective* in Table 1).

Since player objectives are expressed or observed several times and on multiple aspects (see Awakul and Ogunlana, 2002), an aggregation procedure is required, based on the relative importance of each of their positions. This is the purpose of column *Weight* in Table 1. Weighting scales can be constructed for each stakeholder by using ordinal information from

528 the survey in order to state whether a particular aspect is equally, more or less important than
529 another for a given stakeholder (as in Li et al., 2012). For example, decisive and irreversible
530 votes have more weight than oral statements, even the more so when the latter are not
531 repeated or confirmed by subsequent actions.
532 Once preference indicators are computed for each stakeholder, we assign stakeholders to two
533 groups using a similarity procedure. We perform a parametric significance test on the
534 difference between the stated preference of a particular stakeholder and the average
535 preference indicator of his alleged group, to check for inconsistent assignment. In our three
536 study areas, solid waste industrialists and technical consultants always belong to the same
537 group (Group 1), and their location within this group is always strong. The public and elected
538 local authorities are distributed across both groups, and their location is almost never
539 "extreme". On the other hand, environmental associations and public planning authorities turn
540 out to have a fairly "extreme" location when belonging to Group 2. Once groups are formed,
541 they are considered players in our game, as explained in Section 3.
542
543 The same way as for preferences, we also need to calibrate parameters λ_j representing the
544 considerations each player has for the other. They are quantified in a similar manner to the
545 procedure above, by constructing a range of values from salient features reported in our
546 dataset following the management process. We account for the negotiation power each player
547 is likely to have (and believes the other player has).
548
549 Another parameter to calibrate is δ, measuring the willingness of players to reach an
550 agreement. The value of this variable therefore depends on the management and policy habits
551 and arrangements prevailing on the particular site at the beginning of the dialogue. We are
552 actually calibrating exclusively the *external* pressure on players that makes them more
553 inclined to endorse the final outcome. This is the difference with the "social pressure to
554 collaborate" of Suzuki and Iwasa (2009), who include also *internal* factors (such as
555 interpersonal relationship between stakeholders). In economic terms, such pressure would be
556 interpreted as a way to offset the "coordination loss" between agents. Parameter values are
557 then discussed with and validated by communication experts who were involved in these
558 study areas (a consulting firm on cases 1 and 2 and an independent consultant on cases 1 and
559 3).

Concerning the dialogue modes, we have seen above that we can consider eight possibilities. The qualitative surveys allow us to evaluate the relative frequency of every mode in the three areas, each exhibiting a particular combination of these modes. The relative frequency associated with each mode is distributed in a fairly homogeneous way across cases, between 0.07 and 0.2. From there, we can compute an expected outcome level, using as weights the empirical relative frequency (rate of occurrence) of each mode. All modes may be simultaneously present to form a final outcome matrix. In order to obtain a synthetic formula for the final outcome, we assign to each dialogue mode *g, g=1, 2,…,8,* its positive weight β_g such that $\sum_{g=1}^{g=8} \beta_g = 1$. We then compute an average outcome – which corresponds to a particular participatory scheme – as

$$\sum_{g=1}^{g=8} \beta_g Y_g \left(\theta_1, \theta_2, \lambda_1, \lambda_2, \delta\right), \qquad (2)$$

where $Y_g \left(\theta_1, \theta_2, \lambda_1, \lambda_2, \delta\right)$ denotes the theoretical solution depending on contextual parameters and players' parameters in dialogue mode *g*.

We mentioned in Section 2 that our performance indicators for participatory schemes are the reduction of the gap ("displacement") between initial player objectives, and the level of investment observed in the final outcome. As for other variables, interviews and field survey data are used to quantify these two performance indicators. For the "displacement" variable, we account for three components: the range of the displacement, the stakeholders' awareness or lack of information about what they are giving up, and the reversibility of the displacement. As far as the level of investment in solid waste management is concerned, we consider four components: technical, logistic and economic capacity building; organizational, administrative and legal benefits; new infrastructures or management systems allowing better outlets for solid waste to be found; new projects of infrastructure or management systems allowing to reach the same objective. To measure more precisely the importance of these four components, we use three variables for the calibration scale: the proportion of solid waste tonnage or of local managers covered, the perennial nature of this capital (following Beierle, 1999), and the degree of consensual dissatisfaction with the way the issue of solid waste was tackled (penalty for waste export and transportation).

590
591 Table 2 presents the calibrated values of the parameters of interest, including the outcome
592 variables and the relative frequency of each of the eight situations.
593
594 [TABLE 2 ABOUT HERE]
595
596 The model provides us with two types of indicators relative to the performance of the
597 consultation game: the difference between both players' outcome level, $y_1 - y_2$, and the
598 displacement from the initial objective to the final outcome, $y_i - \theta_i, i = 1,2$. These two
599 indicators can be compared with the calibrated outcome variables, namely, the level of
600 investment in waste treatment and management, and the level of stated stakeholders'
601 displacement (in the survey). Such comparison is used as a means to assess the ex post
602 validity of the model, i.e., by computing a measure of distance between the calibrated variable
603 from the survey, and the corresponding simulated value from the model.
604
605 *Model Simulation and Validation*
606
607 In Table 3, we report the calibrated performance indicators, to be compared with our model
608 simulations. We normalize the outcomes and model simulations by taking area 3 as a
609 benchmark for results from areas 1 and 2. More precisely, we solve the model for areas 1 and
610 2, imposing calibrated displacement and investment to equal their normalized value for area
611 3. Therefore, model validation is only feasible for the first two study areas. The difference
612 between the stated performance level and the simulated performance level from the model is
613 expressed as a proportion of the stated performance. As can be seen from Table 3, the
614 average "error" of prediction is fairly limited (less than 5 percent in all cases).
615
616 [TABLE 3 ABOUT HERE]
617
618 Finally, to have a better evaluation of the relative contribution of each parameter or variable
619 of interest in the final performance of the stakeholder dialogue, we compute the elasticity of
620 the dialogue performance with respect to each parameter or variable. To do so, we compute an

621 average performance indicator from the displacement and the investment stated outcomes,
622 and run the model with a small change (typically, 1E-8) in the parameter or variable of
623 interest, to estimate the marginal effect. Table 4 reports computed elasticities at the calibrated
624 values for the three study areas.
625
626 [TABLE 4 ABOUT HERE]
627
628 Interestingly, elasticities with respect to parameters δ, θ and β are fairly different across
629 study areas, even though their calibrated values are roughly similar, as other parameters are
630 naturally different across study areas. The parameter δ for pressure to cooperate is associated
631 with the highest elasticity on average, although it is less than the objectives parameter for area
632 1. The probability associated with the eight dialogue modes does not seem to influence
633 performance much in relative terms.
634

635 ## 5. **Discussion and conclusion**
636

637 We have proposed an original model based on messaging ("cheap talk"), to investigate the
638 performance of participatory procedures on environmental and land-use planning. The
639 application deals with three French study areas involved in municipal solid waste
640 management, where stakeholders' attitudes and objectives have been quantified from
641 qualitative surveys. The novelty of the approach is to exploit these qualitative data for
642 constructing quantitative indicators (as proxies for negotiation background and outcomes) to
643 calibrate the theoretical model of negotiation. The performance of the dialogue is evaluated
644 by considering two dimensions: the resulting level of investment for waste collection,
645 diversion, treatment, and the displacement of stakeholders from their initial objectives to the
646 acceptance of the final outcome.

647 Comparing the observed outcomes from qualitative surveys with simulated outcomes from
648 our model, the latter performs well in terms of reproducing the negotiation outcomes. The
649 model could therefore be of interest for testing the performance of participatory schemes for
650 land use projects impacting the environment in other contexts. However, it should not be

considered a tool for predicting outcomes of future negotiation procedures, because of the required ex post calibration of variables and parameters of interest.

In terms of the economics of public participation, this analysis is providing us with interesting evidence. Concerning the performance of stakeholder dialogue in environmental planning, it is not sufficient to rely on technical expertise or communication experts (policy options regularly put forward in practice, see Braun et Schultz, 2010). Agents' perceptions and their bargaining power are also factors to consider. The discrepancy between agents' initial objectives remains a major critical factor, consistent with insight from the economic literature. In contrast, with little emphasis in the economic literature, the willingness to reach an agreement, related to local previous critical conditions, proves to be another major driver of a successful negotiation.

A contribution of the present paper is to illustrate how economic modelling can contribute to assess productivity of stakeholder dialogue and negotiation with numerous factors. We believe it is an interesting complement to several papers dealing with noxious facility siting. Feinerman et al. (2004) propose a framework for analyzing differences between political siting and socially optimal locations for landfill. They test in particular whether NIMBY conflicts can be resolved by democratic political processes where the principal's utility depends on social welfare and political rewards. As our paper focuses on the performance of stakeholder dialogue in participatory schemes with a calibration exercise that extends beyond residential households as stakeholders, it could provide an interesting extension of Feinerman et al. (2004). This is also true of Swallow et al. (1992), who propose a general and practical approach (without empirical application) to the public-choice problem of noxious facility siting, by decomposing the site selection process in three stages (minimum technical standards, social selection criteria, and community acceptance). However, these authors are interested in the role of observed criteria characterizing the three stages above and not in the assessment of participatory schemes.

Lejano and Davos (2002) propose a theoretical framework to incorporate equity principles into the optimal siting decision process, with an application of bargaining games to an incinerator siting. In their model, utility transfers are not feasible and the optima location is entirely determined from estimates of (cancer) risk for various possible sites. Environmental

683 and health risk preferences and perceptions by stakeholders is in fact one (out of seven) aspect
684 that we consider in the present paper. The way Lejano and Davos (2002) address the risk and
685 utility issue is however more detailed than ours. Lami and Abastante (2014) focus also
686 exclusively on the choice of waste treatment technology (neither sorting nor prevention of
687 waste emission), and they explore more deeply the issue of benefits and costs for the
688 stakeholders. Finally, Santore (2014) examine in a theoretical paper the *ex ante* efficiency of
689 noxious facility siting when communities have heterogeneous preferences over income. They
690 show that simple lotteries (without host compensation) may be preferred to determine the
691 community where the noxious facility will be sited. Such analysis is at the community level
692 and does not include stakeholder dialogue and a participatory scheme, as it is more interested
693 in efficiency arguments for the decision maker, in a top-down decision perspective.
694
695 The set of papers above mostly consider top-down policies and centralized compensation
696 schemes, and as the present paper shows, there is room for stakeholder dialogue as a
697 complementary policy. This paper contributes to the literature on the economics of
698 stakeholder dialogue by confirming the usefulness of cheap talk models, which have been
699 recognized to be potentially useful for analyzing private negotiations and public policy
700 decision at a general level (Farrell and Rabin, 1996). They stand out as potentially promising
701 in an intermediary space: for analyzing the political economy of highlights in local
702 environmental planning.
703

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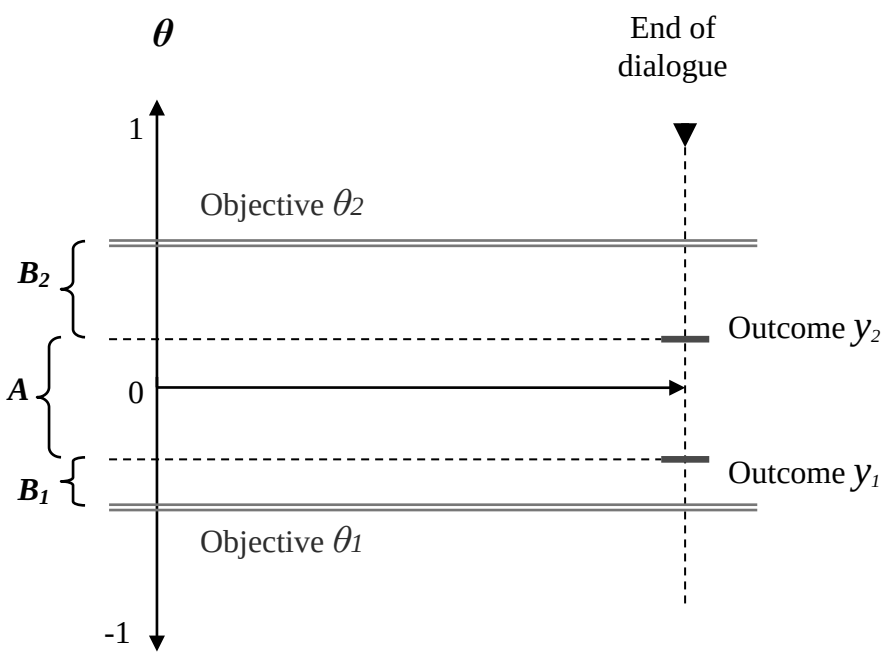
Figure 1. Initial objectives, outcomes and displacements



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952

953 Table 2. Calibrated parameters – Cheap talk model

Parameter / Variable	Area 1	Area 2	Area 3
Pressure to co-operate (δ)	0.31	0.10	0.19
Objective of Player 1 (θ_1)	- 0.25	- 0.24	- 0.26
Objective of Player 2 (θ_2)	0.26	0.22	0.32
Weight associated with Player 1 by himself (λ_1)	0.64	0.72	0.59
Weight associated with Player 2 by himself (λ_2)	0.53	0.42	0.52
Outcome 2: Displacement with respect to initial objective	1.125	0.5875	1
Outcome 1: Level of new capital stock investments in solid waste management	1.375	0.833	1
Relative frequencies			
a. Principal neutral and perceived as such	0.13	0.217	0.166
b. Principal neutral but perceived as soft	0.115	0.102	0.104
c. Principal soft but perceived as neutral	0.085	0.104	0.095
d. Principal soft and perceived as such	0.18	0.137	0.125
Centralized case (a. to d.)	0.51	0.56	0.49
e. Familiar players	0.121	0.097	0.133
f. Non familiar players	0.142	0.158	0.13
g. Player 1 familiar with Player 2, but not the reverse	0.1	0.066	0.13
h. Player 2 familiar with Player 1, but not the reverse	0.127	0.119	0.117
Decentralized case (e. to h.)	0.49	0.44	0.51

954
955

Table 3. Observed and Simulated Performance Indicators

	Study area1	Study area 2	Study area 3
Calibrated displacement	1.125	0.5875	1
Calibrated investment	1.375	0.833	1
Calibrated displacement (area 3 as benchmark)	0.278	0.1265	0.253
Calibrated investment (area 3 as benchmark)	0.232	0.3335	0.327
Simulated displacement from model	0.274	0.1325	0.253
(prediction error in %)	(1.44 %)	(4.74 %)	(---)
Simulated investment from model	0.236	0.3275	0.327
(prediction error in %)	(1.7 %)	(1.8 %)	(---)

962

963 Table 4. Elasticity of Dialogue Performance

964

Parameter / Variable	Area 1	Area 2	Area 3
Pressure to co-operate (δ)	0.383	0.905	0.697
Objective of Player 1 (θ_1)	0.487	0.718	0.577
Objective of Player 2 (θ_2)	0.443	0.704	0.552
Weight associated with Player 1 (λ_1)	0.116	0.018	0.078
Weight associated with Player 2 (λ_2)	0.081	0.113	0.066
β_1 Principal neutral and perceived as such	0.019	0.013	0.018
β_2 Principal neutral but perceived as soft	0.016	0.017	0.018
β_3. Principal soft but perceived as neutral	0.016	0.002	0.016
β_4 Principal soft and perceived as such	0.036	0.004	0.046
β_5 Familiar players	0.050	0.036	0.031
β_6 Non familiar players	0.039	0.018	0.026
β_7 Only Player 1 familiar with Player 2	0.009	0.020	0.003
β_8 Only Player 2 familiar with Player 1	0.007	0.005	0.002

965

966

Appendix

Details of the cheap-talk model solutions

Final stage: outcomes

In the centralized case, the principal receives the set of messages from players $m \equiv (m_1, m_2)$ and makes decisions that depend on the principal's inference upon players' objectives θ_1 and θ_2, given *m*. If the principal is neutral (denoted *n*), outcome is, for player *j*, *j= 1, 2*:

$$y_j^{Cn} = \frac{1+2\delta}{1+4\delta} E\left[\theta_j \middle| m\right] + \frac{2\delta}{1+4\delta} E\left[\theta_{-j} \middle| m\right], \qquad \text{(A1)}$$

where *–j = 3-j*.

If the principal is soft (denoted *b*), we have:

$$y_j^{Cb} = \frac{A+\delta B_1}{A+4\delta C} E\left[\theta_j \middle| m\right] + \frac{\delta B_2}{A+4\delta C} E\left[\theta_{-j} \middle| m\right], \quad j=1,2\,; -j=3-j\,, \qquad \text{(A2)}$$

where

$A = (1-\lambda_1-\lambda_2+\lambda_1\lambda_2)$, $B_1 = \left(2-\lambda_1-3\lambda_2+\lambda_1\lambda_2+\lambda_2^2\right), B_2 = \left(2-\lambda_2-3\lambda_1+\lambda_1\lambda_2+\lambda_1^2\right)$

and $C = \left(1-\lambda_1-\lambda_2+\frac{\lambda_1\lambda_2}{2}+\frac{\lambda_1^2}{4}+\frac{\lambda_2^2}{4}\right)$.

In the decentralized case, each player designs his own message in such a way that negotiation can be ultimately to his advantage. Let y_j^D denote a just about acceptable outcome for player *j* from his point of view, adjusted with respect to all messages exchanged during the dialogue. However, y_j^D is not a beneficial public claim for player *j* during the cheap talk game. Each player *j* then opts to select another arguable claim or outcome, denoted y_j^{Prime}. We have

$$y_j^{Prime} = \frac{\lambda_j}{\lambda_j+\delta}\theta_j + \frac{\delta}{\lambda_j+\delta} E\left[y_{-j} \middle|\, \theta_j, m\right], j=1,2\,; -j=3-j\,. \qquad \text{(A3)}$$

We can see that players account in their proposition $y_j^{Prime}, j=1,2$, for the possible proposition they think the other player can submit to the principal: $E\left[y_j \middle|\, \theta_{-j}, m\right]$.

991 According to the assumption on symmetric inference discussed above, player 1 for example
992 has to infer two components when considering $E\left[y_2 \middle| \theta_1, m \right]$: $E\left[\theta_2 \middle| \theta_1, m\right]$ and what player
993 2 would infer for $E\left[y_1 \middle| \theta_2, m \right]$. Using expressions above, player 1 selects
994

995
$$y_j^D = \frac{\lambda_j}{\lambda_j + \delta}\theta_j + \frac{\delta}{\left(\lambda_j + \delta\right)\left(\lambda_1\delta + \lambda_2\delta + \lambda_1\lambda_2\right)}\left[\delta\lambda_j E\left[\theta_j \middle| \theta_{-j}, m\right] + \left(\lambda_j + \delta\right)\lambda_{-j} E\left[\theta_{-j} \middle| \theta_j, m\right]\right], \quad j = 1,2\,;\, -j = 3 - j. \tag{A4}$$

996
997 Such formulae are valid when players have a reasonable degree of familiarity with each other
998 (case Φ). On the other hand, when a player does not account for the consideration perceived
999 by the other player (case of no familiarity Γ), we have for player *j*, $\lambda_i \equiv \left(1 - \lambda_j\right)$. Player *j* then
1000 uses this expression both in y_j^D and y_i^D, to obtain an outcome for himself noted $y_j^{D\Gamma}$, and
1001 another for the other player noted $\overset{\vee}{y}_i^{D\Gamma}$.
1002
1003 *Intermediate stage: messages and inferences*
1004 Let us now characterize the way players determine the message they will use in the dialogue.
1005 During the messaging with the principal or between players, expectations are formed on the
1006 player's objective, conditioned on the messages (and in the decentralized case, on the value of
1007 their own preference in addition).
1008
1009 In the centralized case, player 1 moves in such a way that the principal's inference regarding
1010 θ_1 ($E\left[\theta_1 \middle| m\right] = \zeta_1$) is best for player 1:

1011
$$\zeta_1^* = \arg\max_{\zeta_1} E\left[-\lambda_1\left(y_1 - \theta_1\right)^2 - \left(1 - \lambda_1\right)\left(y_2 - \theta_2\right)^2 - \delta\left(y_1 - y_2\right)^2 \middle| \theta_1\right], \tag{A5}$$

1012 where $y_1 = y_1^C$ and $y_2 = y_2^C$. Player 2 acts in a symmetric way.
1013 If players believe the principal is neutral, player 1 will orient the principal towards an
1014 inference ζ_1^n on $E\left[\theta_1 \middle| m\right]$ such that:

$$\zeta_1^{n*} = \frac{W_1^n}{1 - Z_1^n Z_2^n}\theta_1 + \frac{Z_1^n W_2^n}{1 - Z_1^n Z_2^n}\theta_2, \qquad \text{(A6)}$$

and similarly for player 2, where

$$W_j^n = \frac{\lambda_j(1+2\delta)}{(\lambda_j + \delta)} \text{ and } Z_j^n = \frac{\delta(1-2\lambda_j)}{(\lambda_j + \delta)} = 1 - W_j^n.$$

When players believe the principal is soft, player *j* will drive the principal towards inference ζ_j^b on $E[\theta_j \mid m]$:

$$\zeta_j^{b*} = \frac{W_j^b}{1 - Z_i^b Z_j^b}\theta_j + \frac{Z_j^b W_i^b}{1 - Z_i^b Z_j^b}\theta_i, \qquad \text{(A7)}$$

with

$$W_j^b = \frac{\lambda_j(A+\delta B)(A+4\delta C)}{\delta[(A+\delta B)-(\delta D)]^2 + \lambda_j(A+\delta B)^2 + (1-\lambda_j)(\delta D)^2} \qquad \text{(A8)}$$

and

$$Z_j^b = \frac{\delta[(A+\delta B)-(\delta D)]^2 + [(1-\lambda_j)(A+4\delta C)-(A+\delta B)](\delta D)}{\delta[(A+\delta B)-(\delta D)]^2 + \lambda_j(A+\delta B)^2 + (1-\lambda_j)(\delta D)^2} = 1 - W_j^b. \qquad \text{(A9)}$$

In the decentralized case, when player *j* is familiar with the other player *i*, he will send the following inference:

$$\zeta_j^{\Phi*} = \frac{W_j^\Phi}{1 - Z_i^\Phi Z_j^\Phi}\theta_j + \frac{Z_j^\Phi W_i^\Phi}{1 - Z_i^\Phi Z_j^\Phi}\theta_i, \qquad \text{(A10)}$$

where $W_j^\Phi = \frac{(\lambda_j\delta + \lambda_i\delta + \lambda_i\lambda_j)}{(\lambda_j - \lambda_j^2 + \delta)}$ and $Z_j^\Phi = 1 - \frac{(\lambda_j\delta + \lambda_i\delta + \lambda_i\lambda_j)}{(\lambda_j - \lambda_j^2 + \delta)} = 1 - W_j^\Phi$.

On the other hand, when player *j* is not familiar with player *i*, we simply have $W_j^\Gamma = 1$ and $Z_j^\Gamma = 1 - W_j^\Gamma$. Finally, combining the formulae for outcomes y_j^* with those for inferences ζ_j^*, we can compute the final outcomes corresponding to the eight possible dialogue modes.

Appendix.

Table 1. Example of objectives' calibration: study area 1, debate on aspect c), stakeholders 1, 20 & 27.

Aspect under discussion	**c) Management system: internal complementarities in the logistic chain and interdependencies**	**Values**	
	Extreme case. Reduce coordination and complementarity issues in the management system, thanks to a single direct process leading to a single final solid waste treatment	Limit: -1	
Scale for positioning objectives		*Interval:*	
	Single process	[-1, -0.75]	
	Several processes: one is leading and the others are secondary	[-0.75, -0.45]	
	Two processes or more, but several processes possibly to discard	[-0.45, -0.15]	
	Two processes or more, but one process possibly to discard	[-0.15, 0.15]	
	Combined but prioritized processes	[0.15, 0.45]	
	Combined but not prioritized processes	[0.45, 0.75]	
	Maximum diversification of processes	[0.75, 1]	
	Extreme case. Invest in a deep diversification of waste treatment and reclamation processes, requiring a major effort on coordination and complementarity between the various waste volumes and facilities	Limit: 1	
Stakeholders	***Major information in the data set***	***Objective***	***Weight***
#1	*November 2006*. For Mr. X., the plan at the end of year 2006, labeled "all incineration" remains satisfactory", he votes in favor (Regional media, November 14, 2006).	-0.85	0.65
	November 2006. Mr. Y in local community Y (less involved than Mr. X in the intercommunal association) claims: "We need to find a site for waste incineration and I do not believe in agricultural spreading", but he will vote in favor (Intercommunal association committee, November 2006).	-0.7	0.55
	Over the whole negotiation period. Mr X challenges the claim that every possible evaluation study has been conducted for the siting of an incinerator. He also repeatedly questions the quality of the compost obtained from mechanical biological treatment**.** *During the interview*: "This plan is definitely not better than the one before. I don't think methanization will work".	-0.9	0.5
		Weighted average -0.82	**Total weight 1.70**
#20	"The commitee of inquiry issues a positive opinion, provided the future of site		

	Z is mentioned in the plan, following the achievement of the objectives below: A single waste treatment and storage area for the intercommunal association of case 1", or: "As many mechanical-biological waste treatment facilities as there are storage sites» (*Public Inquiry p. 220 and p. of Conclusions, September 14, 2007*). *Public investigators mention an additional process: the "reversible storage of solid waste waiting to be treated"* (*Public Inquiry p. 7 of Conclusions, September 14, 2007*).	0 0.2 **Weighted average 0.02**	0.75 0.1 **Total weight 0.85**
#27	*Beginning of period.* The mere creation of the intercommunal waste agency in study area 1 would demonstrate, according to ecologist elected representatives [Mr A and Mrs. B], "the willingness to set up an incinerator (…), but since it would need to be fueled with solid waste, it will not be possible to sort them in order to reduce their volume". Ecologist representatives ask for an "objective" study of the intercommunal waste agency in study area 1 that would explore thoroughly all solutions for solid waste treatment *(Regional press media, December 2, 2002).* *Beginning of period.* « They propose as an alternative to waste incineration the development of waste sorting, methanization and landfills » *(Regional media, December 2, 2002*). *July 2003.* Mrs. C is convinced by the methanization process: "Stabilisation is interesting because it reduces the volume of solid waste, but it does not allow for recycling, while there is a huge deficit of organic matters in the soil" (*Regional media, July 2003).* *January 2007. Web page of the Green Party (ecologists) of the county*: the intended plan seems to diverge from the orientations of the intercommunal waste agency in study area 1. Mrs. B for the Green Party focuses her criticisms on the poor ambitions in terms of prevention and reduction of solid waste upstream, and on the fact that a recycling-based energy project is likely to be abandoned.	0.35 0.15 0.2 **Weighted average 0.26**	0.45 0.2 0.35 **Total weight 1**

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