

**Institutional Effects on Individual Behavior in the Commons:
Experimental Evidence from the Field
Dissertation Prospectus
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I. Introduction

An important part of the livelihood of the rural poor in the developing world depends on their ability to extract common pool resources and the environmental consequences of their management (Bardhan et al., 2000).¹ Hence, is not surprising that one of the recurrent topics in the literature of collective action is cooperative behavior at the local level to manage natural resources. In this literature the management of common pool resources is presented as a collective action dilemma: “a situation in which mutual cooperation is collectively rational for a group as a whole, but individual cooperation may not be rational for each member.” (Bardhan et al., 2000:54). This dilemma represents both a threat to the sustainability of natural resources and an opportunity for cooperative behavior by members of a particular community.

Initial research in this area concluded that the only way to overcome this dilemma was through external intervention or by the definition of property rights (Hardin, 1968). However, there is already a fair amount of evidence that contradicts Hardin’s prediction about the tragedy of the commons and the definition of property rights or centralized regulations as the only solutions to solving overexploitation dilemmas. Successful self-governing management and community-based initiatives to manage natural resources are found around the world and have been documented by many scholars of different disciplines. (For example Ostrom, 1990; Baland and Platteau, 1996; Wade, 1998).

¹ The definition of common pool resources understood here is the one stated by Ostrom et al. (1992: 404): “Common-pool resources are natural or man-made resources whose yield is subtractable and the exclusion from is non-trivial (but not impossible).” Here, the subtractable characteristic means that one person’s use, subtracts from the quantity of resource units available to others.

Cooperative behavior found in the field has been reproduced in more controlled environments through the use of economic experiments that test results predicted by noncooperative game theory (For example see Ostrom et al., 1994). Contrary to game theory predictions, the experimental results show that individuals facing laboratory social dilemmas achieve better outcomes than predicted by noncooperative game theory. These results have been found consistently when individuals are permitted to communicate or when internal sanctioning mechanisms are available (Ostrom et al., 1992).

Some authors have attributed this cooperative or non Nash behavior in the experiments to the existence of some notion of kindness that people bring from outside the laboratory and that reveal a taste for cooperation (Andreoni, 1995). A similar explanation is based on the notion that some individuals have social preferences or other regarding preferences. According to Fehr et al. (2002b:C2) this means that the person is not solely motivated by material self-interest, but also cares positively or negatively about the material payoffs of others. In other words, instead of considering a conventional model with self regarding preferences, they consider an individual that takes into account not only the consequences of her actions for herself, but for others as well. Thus, a balance between self-regarding and other regarding preferences may explain individual behavior.

This notion of other regarding preferences generates interesting puzzles for economic theory, especially if considering a context of endogenous preferences.² In this framework, an external regulation that intends to solve the collective action problem may have unintended consequences. In a rational choice framework, the effects of an external regulation are limited to changes in the costs or benefits of certain behavior. Law expands or contracts horizons of opportunities by providing information about the external environment (Scott, 2000). Hence, no change is expected in individual's preferences. However, in a behavioral context, institutions and regulations may shape preferences, and norms maybe internalized. If this is true, then a well-intentioned regulation may crowd out cooperative behavior in favor of greater self-interest. Cardenas, Stranlund and Willis (2000) call this effect "institutional crowding out."

² For more on endogenous preferences see Sunstein, 1993; Bowles, 1998; Frey, 2000.

There is growing literature based on empirical and experimental evidence that identifies the existence of a crowding out effect of other regarding preferences due to external interventions in social dilemmas. This literature, extensively surveyed by Frey and Jegen (2001), analyzes the effects of external monetary incentives or regulations on individuals' intrinsic motivation or other regarding preferences.³ In the case of common pool dilemmas, experimental studies suggest that external regulation may undermine collective action already in place or reduce local cooperation. (See for example, Ostman, 1998; Ostman and Beckenkamp, 1999; Cardenas, Stranlund and Willis, 2000; Ostrom, 2000). Bowles (2003:462) explains this situation as the government's destruction of the community's capacity to regulate access to a common pool resource. According to him, "this occurs when the presence of one institution undermines the functioning of another", an opposite situation to institutional complementarity, which is "a situation where the beneficial effects of one institution are enhanced by the presence of the other, and conversely" (Bowles, 2003:273).

The existing literature on crowding out questions the role of external interventions in solving collective action dilemmas and opens the discussion of how external regulation may negatively affect individual preferences. However, it is necessary to further analyze these results to understand if different external regulations may have different effects, or if it is possible to find complementarities between different institutions. This is particularly relevant given that there are also limitations to self-governing initiatives: sometimes appropriators will not organize or will fail in their efforts (Ostrom, 1998; Agrawal and Gibson, 1999; Leach et al., 1999; Baland and Platteau, 1996).

There still exists an overexploitation problem in many settings and it is not clear what should be the role of the state in those communities who fail to overcome the common pool dilemma. The role that a central authority should have in the management of self-governed resources in order to sustain those initiatives and help to achieve better

³ The intrinsic motives are understood as motives coming from the person as opposed to extrinsic motivation, where incentives are coming from outside the person (Frey and Jegen, 2001). According to Deci et al. (1999: 627), "some activities provide their own inherent reward, so motivation for these activities is not dependent on external rewards". Deci et al. (1999) referred to these activities as intrinsically motivated.

outcomes is also a matter of discussion. Possible actions of a central authority include command and control type of regulations, the introduction of market based incentives, the development of an external set of conflict-resolution mechanisms, the enforcement of rules previously defined by the local users, mechanisms to discuss the use of external rules with local users or projects to enhance the capabilities of particular social actors, among others (Ostrom, 1998; Leach et al., 1999; Baland and Platteau, 1996).

Therefore, the role of the state and how to design better institutions to manage the commons is still an open question. How communities react to the incentives and instruments designed by central and local governments are a challenge for those interested in policy making. But even further, how those outcomes may change depending on the level of participation of those communities in the regulatory process, or depending on the level of interaction between informal and formal regulations, are important questions that should be addressed to achieve better outcomes.

The literature on crowding out contributes to the understanding of how institutions and preferences may interact. However, it is silent on how to model the effects of different institutions on individual choices when taking into account the existence of other regarding preferences. It is not enough to identify the interaction between institutions and preferences: it is necessary to isolate the effect of different institutions on individual choices and preferences. Furthermore, it is important to characterize the type of preferences that cause deviations of individual choices from purely self-interested behavior.

Hence, the aim of this research is twofold. First, it is to develop an empirical characterization of how individual behavior deviates from purely self-interested Nash behavior. The models developed here consider the difference between actual choices and individual Nash best response functions to be an indicator of the existence of other regarding preferences; in other words, an indicator of how individuals balance self-interests and those of the entire group as proposed by Cardenas et al. (2000). However, this research goes further in this idea by addressing whether the existence of other

regarding preferences reveals the presence of altruistic or reciprocal behavior. If it is altruism, each individual will place a positive value on others' utility in his or her utility function. If it is reciprocity, each individual will face an internal penalty if their choices deviate from the choices of others. In both cases, individual acts are conditioned on the choices of others.

Second, the research asks how different institutions affect individuals' other regarding preference and choices. This issue is important to identify under what conditions individuals choices deviate from Nash best responses and how the deviations may change under different institutions. In particular, it explores possible complementarities between external and internal regulations to overcome common pool dilemmas, following the claim that well-designed institutions can make communities and state initiatives complements instead of substitutes (Bowles and Gintis, 2001; Baland and Platteau, 1996).⁴

The methodology chosen to develop this project relies on experimental techniques to gather the necessary data. The plan is to develop and conduct common pool experiments in rural villages of Colombia. The idea is to test the effects of different institutions (captured by the design of different treatments) in controlled environments, but with participants who face social dilemmas about the exploitation of natural resources in their everyday lives. This characteristic is important, considering that there is information that participants bring to the game about their actual context and backgrounds, which is not controlled by the experiment but may have influence on their preferences and choices (Cardenas and Ostrom, 2001).

The rest of this prospectus is organized as follows: The second section reviews the relevant literature and identifies the gaps that will be addressed in this research. The third section states in more detail the research questions and develops the research hypotheses. The fourth section develops the theoretical model used to approach these questions and

⁴Baland and Platteau (1996: 379) argue that these complementarities between government and user groups or communities can be exploited in co-management arrangements that can be more efficient than the "spurious and simplistic 'state versus community' dichotomy".

that motivate the econometric estimation that will be used to analyze the experimental data. The fifth section focuses on the experimental design, and the last section gives some final considerations about the project.

II. Literature Review

This section describes the relevant literature for the research questions proposed in this prospectus. First, it reviews the findings of the work done in laboratory experiments and experiments in the field on common pool resource games; second, it goes through the theoretical models that include social preferences and other regarding preferences as an explanation to cooperative behavior, and third, describes the results suggested by the crowding out literature that consider the existence of other regarding preferences. Under the crowding out literature, special attention is paid to the experimental works related to the effect of external regulations on common pool resources since they have a direct relationship with the aim of this research.

A. Common Pool Experiments

Common pool experiments typically intend to recreate situations that imply the existence of negative appropriation externalities (Walker et al., 2000). In particular, those externalities arise whenever the appropriation or extraction by one individual affects the net returns to the extraction of others. These externalities are generally captured in the form of cost externalities although they could also be captured as benefit or revenue externalities.

In any case, due to the existence of negative externalities and in the absence of any regulatory system (open access), traditional noncooperative game theory predicts an overuse of resources. Each individual maximizes his payoffs subject to the strategies chosen by other players, but without taking into account the externality it generates. At the aggregate level, the findings of the experiments that recreate an open access resource have found support for this hypothesis and generally sub optimal results have been

reported (Ostrom et al., 1994). However, subjects' decisions tend to be neither Nash strategies nor efficient choices, but some choice in the middle (Cardenas et al., 2000). Other authors report high levels of cooperation in the first rounds of the experiment but declining cooperation rates over time (Fehr et al., 2002b).

Research in laboratory and field experiments also have tried different institutional arrangements to test if these predictions still hold, or if it is possible to have more cooperative choices. A common institutional arrangement that tries to resemble non-binding local agreements is face-to-face communication. Theoretically, the option of communication should not have any affect on individual choices. In practice, the evidence systematically shows that individuals that are allowed to communicate with each other cooperate more and substantially increase their earnings compared to the open access situation (Ostrom et al., 1994). Experiments in the field, in rural villages of Colombia, have also found these results as reported by Cardenas et al. (2000).

Other types of institutional arrangements are schemes that recreate internal monitoring and sanctioning systems which are very common in the field. Since punishment is costly for the punisher the purely self interested or self regarding assumption predicts zero punishment. However, experimental results suggest that individuals are willing to sanction non cooperators even if is costly for them (Ostrom et al., 1992; 1994, Kroll et al., 2003; Fehr and Gatchter, 2000). In the results reported by Ostrom et al. (1992, 1994), the opportunity to sanction others dramatically increases average net yields for participants if they are also able to communicate and have the right to choose their own sanctioning mechanism. Without communication, participants overuse the sanction systems and average net yields are lower compared to the baseline treatment. But with communication and voting on the establishment of internal sanctions, outcomes are closer to the social optimal and there is actually little need to use sanctions.

These results are relevant for the research questions proposed here because they identify the importance of institutions in determining individual choices and because they question the traditional economic framework that fails to predict individual choices.

These results refute the assumption of purely self-interested individuals and call for a more complete framework for modeling individual actions. The next section develops this idea and reviews the studies that propose different explanations for cooperative behavior.

A third type of institutional arrangements considers the existence of an external authority. Different types of designs with an external authority are found in these types of experiments. The external authority may impose the rule to regulate the extraction of the resource (Cardenas et al., 2000; Ostman, 1998; Ostman and Beckenkamp, 1999); could also enforce a rule chosen by the participants (Walker et al., 2000; Kroll et al., 2003), or may or may not regulate the resource depending on a referendum voted on by the participants (Tyran and Feld, 2001; Cardenas, 2003; Guillen et al., 2003).

The external authority can be considered in contexts with perfect or imperfect enforcement. In the case of perfect enforcement, the authority is assumed to have the power to automatically implement the desired rule. This is the case in the experiments developed by Walker et al. (2000) and Kroll et al. (2003). In those experiments, the participants play a two-stage game. In the first stage, each participant proposes and then votes for an allocation rule for each participant member. In the second stage, the external authority automatically enforces the allocation rule chosen in the first stage either by majority or unanimity rule. If no agreement is reached, the participants anonymously make their choices.

The results obtained in these experiments conclude that the voting mechanism substantially increased efficiency when proposals were adopted compared to the baseline. Actually, efficiency also increased when the proposals did not pass. Hence, the authors concluded that the voting mechanism is an institution that facilitates the self-governing process.

Although not mentioned by the authors, it is possible to interpret these experiments as the result of the presence of complementarities between the self-governing institution

(allocation rules) and the external regulation (enforcement). However, the role of the external authority that is assumed is implausible. Perfect enforcement is unlikely to be found in the field, especially in the regulation of common pool resources. For that reason, the experiment design proposed in this prospectus addresses similar types of complementarities, but considers an imperfect monitoring and enforcement mechanism. It is important to examine whether a voting mechanism still increases efficiency when the resulting regulation is imperfectly enforced.

The other types of experiments mentioned above that consider an external authority or regulation to solve a collective action problem are directly related to the issue of crowding out of other regarding preferences. For that reason it is important to first introduce the literature that consider the existence of individuals' social preferences and then continue with the experimental evidence that considers external intervention.

B. Individuals' Social Preferences

The experimental evidence that identifies the existence of social preferences or other regarding preferences are not limited to common pool games. Prisoner dilemmas, public good games, dictator, ultimatum and gift exchange games have also found evidence of social preferences. (For a survey see Fehr et al., 2002b). Overall, the results of these games show that the self-regarding model is not enough to explain cooperative behavior.⁵

On the contrary, individuals' choices reveal a balance between self-regarding and other regarding preferences or social preferences.⁶ These other regarding preferences include spite, altruism, reciprocity and inequity aversion, among others. The key aspect of other

⁵ The assumption of self-regarding or self-interested preferences as the only motive to explain individual behavior has also been criticized outside the experimental literature. For example Amartya Sen in many of his works has pointed out the need to depart from such a narrow characterization of behavior to include other motives as "sympathy" and "commitment" (See Sen, 1995, 1997 and 1999). In the particular case of the provision of an environmental public good he gives the following explanation: "For efficient provision of public goods, not only do we have to consider the possibility of state action and social provisioning, we also have to examine the part that can be played by the development of social values and of a sense of responsibility that may reduce the need for forceful state action" (Sen, 1999:269).

⁶ Jon Elster (1989b) suggests that individual action is shaped jointly by self-interest, non-selfish motives and social norms.

regarding preferences is that the individual places a value on how his action affects others. If this value is positive (negative) and independent of other choices it is known as altruism (spite), and if it is positive but depends of the choices of others, it is known as reciprocity.⁷ In the case of inequity aversion, individuals behave similar to reciprocators because they want to achieve an equitable distribution of material resources (Bowles, 2003; Fehr et al., 2002b).⁸

In the case of common pool or public good games, traditional game theorists have tried to explain deviations from Nash responses as a consequence of the repeated nature of the game. In repeated interactions, cooperation can be in an individual's long run self-regarding interest. Hence, in this case, cooperation is understood as a strategy to build reputation. In this sense, cooperation is a strategic action to achieve self-regarding motives. A second hypothesis has claimed confusion and misunderstanding of the game as the reasons for cooperative choices.

Rigorously controlled experiments as those performed by Andreoni (1988b, 1995), Isaac and Walker (1998), and Sefton and Steinberg (1996), contradict these hypotheses. Individuals still show higher levels of cooperation even when they face different participants in each round of the experiments. Hence, the explanation of cooperation as strategic behavior fails in these settings. Similar evidence has been found in one-shot games when there is a possibility to punish free riders. Higher rates of punishment refute the explanation based on strategic punishment (Falk and Fischbacher, 2000).

The confusion hypothesis has also been questioned in the experimental literature. In this case the discussion relies on the experimental design and the conclusions depending on the type of equilibrium used; whether it is a corner solution or an interior solution. Initially, the cooperation rates found in public good type experiments were thought to be

⁷ "It is important to emphasize that reciprocity is not driven by the expectation of future material benefit. It is therefore, fundamentally different from "cooperative" or "retaliatory" behavior in repeated interactions. These behaviors arise because actors expected future material benefits from their actions; in the case of reciprocity, the actor is responding to friendly or hostile actions even if no material gains can be expected" (Fehr et al., 2002:C3).

⁸ Falk and Fischbacher (2000) criticize this approach because reciprocators take into account not only the consequence of an action (as those who face inequity aversion) but also the intention underlying this action.

a result of the use of corner solutions.⁹ When the equilibrium lies on the boundary, subjects can commit errors by exceeding the equilibrium level but not by giving less. Hence, the mean would be positive regardless of the existence of other regarding preferences if subjects made random errors (For a survey see Sefton and Steinberg, 1996; Keser, 1996; Andreoni, 1995).

With this in mind, experiments have been designed with non-dominant interior solutions instead of corner solutions.¹⁰ In this case, subjects may commit errors in both directions and therefore, on average, errors should cancel out. Experiments done in this way were expected to show no cooperation levels. However, subjects still contribute between 23%-25% over the predicted equilibrium (Sefton and Steinberg, 1996; Keser, 1996; Laury and Holt, 1998). On this matter, Sefton and Steinberg (1996: 282) conclude that “neither coordination problems nor subject confusion can explain much of the apparent altruism...Some subjects remain altruistic despite the best efforts of experiments to induce egoistic preferences.” Andreoni (1995) reaches similar conclusions with experiments designed to test the confusion hypothesis with non-dominant interior solutions. He attributed this cooperative behavior in the experiments to the existence of some notion of kindness that people bring from outside and that reveal a taste for cooperation.

Further research in this area has explained the outcomes of experimental social dilemmas as the interaction between selfish and reciprocal types (Fehr et al., 2002a, Falk et al., 2002, Fehr et al., 2002b). This type of literature claims that beyond altruist motives, the presence of subjects with reciprocal preferences is the key feature to understanding

⁹ The conclusions related to the design of public good games may be applied as well to common pool games since both dilemmas share many characteristics. The restraint in resource use in the case of common pool dilemmas is analytically equivalent to contributing to a public good. The first case implies a negative externality, while the second case implies a positive externality (Bardhan, Bowles and Gintis, 1998; Ledyard, 1995).

¹⁰ Sefton and Steinberg (1996) proposed the use of dominant interior solutions instead of non dominant interior solution in order to avoid further confusion. With non-dominant interior solutions subjects may be unable to calculate the Nash equilibrium. However, in their experiments designed to test these hypothesis, no striking difference between dominant interior solutions and non dominant interior solution results were found. Non-dominant interior solution outcomes are more dispersed than dominant interior solutions, but contribution means in dominant interior solutions, although lower, are not significantly different from contribution means with a non-dominant interior solution. Laury and Holt (1998) found similar results.

cooperative behavior. Reciprocators are subjects that cooperate conditioned on the behavior of others. If others cooperate they do so despite the free riding incentives, but if others free ride they also free ride, or punish if possible. Hence, in a game with reciprocators a cooperative equilibrium is possible.

The existence of reciprocal preferences also helps to explain the results of different institutional environments. If everyone is selfish it is difficult to explain the communication treatment. However, in the presence of reciprocators, the communication treatment serves as a way to coordinate action by identifying subjects' types and devising verbal agreements (Fehr et al., 2002b; Ostrom et al., 1994). Also, in the presence of reciprocators, it is possible to explain the existence of no strategic punishment. In this case, the reciprocators help to enhance cooperative behavior by disciplining the selfish and those who intend to free ride (Fehr et al., 2002b, Falk and Fischbacher, 2000).

Other types of preferences or social emotions that help to explain cooperative behavior are “visceral reactions” such as shame or guilt. People may have social norms that prescribe cooperation among peers or norms about how much they should contribute or appropriate. If they violate the norm, they experience guilt, but if they are publically sanctioned for this behavior they experience shame (Bowles and Gintis, 2002; Bowles, 2003; Elster, 1989a). In the presence of these emotions, the verbal criticism common in many communication treatments can be explained (Ostrom, 1994). People (even if they are selfish) care what others think and hence may feel shame if others find out that they are free riding.

Rege and Telle (2003) examine this hypothesis by conducting public goods experiments in which the identity of each person and his contribution to the public good is revealed. The results show that social approval, due to the social emotions that it may evoke, is an effective channel to increase cooperation. In a similar way, with the presence of these types of emotions, the effect of punishment is not just a change in individuals' incentives structure, it is also an instrument that produces shame.

The findings of this literature are very important for the research questions proposed here because they identify the existence of other regarding and social preferences and their influence on individual choices. Furthermore, it raises the question of how to model those preferences from a theoretical perspective (Rabin, 1993; Levine, 1998; Charness and Rabin, 2000; Bowles, 2003). However, the models that capture other regarding preferences are in general too complicated to be tested with experiments. Simpler models have tried to model reciprocity by using models of inequity aversion (Fehr and Schmidt 1999; Bolton and Ockenfels, 2000). These models are based on the assumption that “fair” types dislike inequitable distributions and as reciprocators face disutility if others deviate from the norm (Fehr et al., 2002b). Falk et al. (2002), argue that the model of inequity aversion derived by Fehr and Schmidt (1999) actually explains major experimental regularities in common pool resource games. In the model developed by Fehr and Schmidt (1999), subjects are averse to differences in payoffs among individuals, with disadvantageous differences being more heavily weighted than advantageous differences. This cost due to differences in payoffs among individuals determines the conditional behavior of a substantial percentage of subjects that act depending on what others do.

One of the models developed in this prospectus is based on this notion of reciprocity consistent with inequity aversion. Hence, an individual will face an additional cost if his choices deviate from the others’ average choices. There is also another model that captures other regarding preferences in the form of altruism as developed by Levine (1998) and Bowles (2003). The level of altruism of an individual is captured by a weight on the income of others in his or her payoff function. These models are explained in detail in section IV.

C. Crowding Out Theory

The literature about crowding out of intrinsic motivation due to external interventions first starts in the psychology literature regarding the introduction of incentives in the context of education (For a survey see Deci, Ryan and Koestner, 1999; Cameron, Banko and Pierce, 2001). This literature carefully tries to capture the effects of different types of

incentives, including verbal, monetary and non-monetary rewards on the performance of different types of tasks defined by the level of interest.

The psychological literature reports experiments in which different types of monetary and no monetary rewards are given to individuals in order to increase the time spent on particular tasks. In those experiments, the rewards have the expected effect during the period in which they are applied and people actually spend more time on the desirable tasks. However, when the rewards were removed, individuals spent less time in those tasks compared to when rewards were offered. Deci, Ryan and Koestner (1999) reported 128 experiments and concluded that tangible rewards have a negative effect on intrinsic motivation. Even further, the authors conclude that monetary rewards undermine people from taking responsibility for motivating or regulating themselves. However, they also identify some types of rewards that do not have a detrimental effect on intrinsic motivation: these include unexpected rewards, task- contingent rewards, and some forms of verbal rewards.

The economic literature also identifies the existence of a crowding out effect due to the introduction of monetary incentives or punishments (For a survey on this literature see Frey and Jegen, 2001). In this context, crowding out occurs when an individual's motivation is negatively affected because a previously non-monetary relationship is transformed into an explicitly monetary one. Hence, people are willing to cooperate less or with a higher price under the presence of monetary incentives, unless they have weak or non-existent intrinsic motives. Then, incentive instruments may have the desired effect.

Under this framework is found the early work of Titmus (1971) with blood donors, and the research on nuclear waste disposal in Switzerland by Frey, Oberholzer and Gee (1997) and in the U.S.A by Kunreuther and Easterling (1990). In these cases, the authors analyzed if the willingness to donate blood or to accept nuclear waste disposal are reduced when monetary incentives are offered. The results show evidence of a crowding

out effect in all the cases. Individuals are not willing to donate blood or accept nuclear waste disposal, or are willing to do so at a higher price, with monetary incentives.

Gneezy and Rustichini (2000) report another example of crowding out of intrinsic motivation. In their experiments a fine was used to penalize the parents who picked-up their children late from kindergarten. The results from the experiment show that the fine, instead of reducing late arrivals, increased tardiness because parents interpreted this fine as a price for being late. Even more striking, this behavior continued after the fine was removed. Hence, the authors conclude that the feeling of guilt for the violation of a moral obligation was crowded out by the external regulation.

In principal agent relationships there are also experimental evidence and theoretically approximations that identify the existence of a crowding out effect due to external interventions (Fehr and Gächter, 2000; Frey, 1994). These models explain how rewards or commands used to raise the performance of agents may undermine their intrinsic motivation, due to the crowding out effect being larger than the disciplining effect (Frey, 1994).

In a different approach, regarding the introduction of incentive compatible devices rather than monetary incentives, Frohlich and Oppenheimer (1998) suggest that those devices that impose impartial reasoning undermine the importance and need for ethical behavior.¹¹ As a consequence, those who never had the dilemma between self-interest and group interest are less willing to take in account ethical considerations in other situations. This result suggests important considerations for policy devices in which the failure to sustain a mechanism of this type could result in an even worse situation if ethical behavior has been crowded out.

The results reported by the literature reviewed above give important insights for the research questions proposed here, because they identify possible crowding out effects of

¹¹According to the authors the incentive compatible device is understood as an institutional structure “that would align individual interests and group interests” (Frohlich and Oppenheimer, 1998: 1). Hence, in those cases, the best for the group is also the best for the individual.

intrinsic motivation due to external intervention in different situations. However, we are particularly interested in the effect of external regulation in common pool types of dilemmas. Hence, the following section reviews the literature on crowding out that is specifically related with these types of problems from an experimental perspective.¹²

Common Pool Dilemmas

In the case of public goods or common pool dilemmas, the existence of crowding out is a crucial question, since external regulations may undermine self-governed solutions or crowd out intrinsically motivated other-regarding preferences and public motivations to solve cooperative problems.¹³

However, the works found in this literature do not use the same criteria to define and measure the crowding out effect. Hence, it is difficult to compare the results across studies. Nevertheless, it is possible to identify the variables that may have an effect on the existence or level of crowding out, or as it is interpreted here, an effect on individuals' deviations from Nash responses. According to the literature, those variables are the level of enforcement and the type of institution or frame used by the external mechanism.¹⁴ The regulatory frame is a crucial feature since it may determine the perception of the norm among the individuals. In this context, the voting process is identified as a

¹²It is worth to mention that the findings of the crowding out literature do not represent homogenous results. Some other research has found different effects due to the introduction or removal of external interventions. For example, Bohnet and Cooter (2001), found that regulation's largest effect come from coordination of individuals' expectations rather than changes in individuals' preferences. On the other hand, Guillen et al. (2003), found that the introduction and then removal of a perfectly enforced regulation, has stronger educational effects rather than crowding out effects.

¹³It is important to clarify that the notion of crowding out in public goods or common pool dilemmas understood here it is not the same as the earlier literature reviewed in Andreoni (1993). This type of literature tests if government contributions will crowd out individuals' contribution to public goods as predicted by theory.

¹⁴The concept of framing understood here is in the same line as the work done by Kahneman and Tversky (2000). They identify the effects of framing on individual choices as one of the components of the Prospect theory where individuals' choices depend on the description (framing effect) and interpretation of the problems (mental accounting). Hence, the authors present the framing effect in two levels, experimental manipulation and mental account. The first case, related with the formulation to which decision makers are exposed and the second case, with the interpretation that they construct for themselves.

mechanism that may change the perception of the norm and hence, shape different choices.

The importance of the perception of the norm is consistent with Frey and Jegen's (2001) considerations about the channels that account for the existence of crowding out effect: First, a change in preferences, and second, a fixed set of preferences but a change in the perceived nature of the performed task. It is also consistent with the two psychological conditions identified by Frey and Jegen (2001) under which crowding out effects may appear. If individuals perceive the external regulation as a controlling mechanism, crowding out occurs, but if individuals perceive an external regulation as supportive, then a crowding –in of intrinsic motivation occurs.

The hypothesis related with the level of monitoring and enforcement imposed by the external regulation is stated by Ostrom (2000). She argues that a system with a mild degree of external monitoring discourages the formation of social norms to solve the dilemma, and at the same time encourages the players to cheat the system. However, this is not the case in a world with no or poorly enforced external regulation, in which social norms evolve to support cooperation, or in a world with perfectly enforced external regulation in which there is not a need for an internal norm to develop.

Bohnet et al. (2000) give similar insights regarding the effects of enforcement levels. Using two-person contract games, the authors found that weak levels of contract enforceability actually crowd in trustworthiness, but with intermediate levels, honesty is crowded out. High levels of contract enforceability, on the other hand, do not produce social norms and preferences are irrelevant for these outcomes. This work, developed under an evolutionary approach, identifies trustworthiness as successful trait. In the absence of an enforceable legal system, individuals only participate in a contract if they can trust their partners.

To measure how external interventions may crowd out trust in contracts, Bohnet et al. (2000) defined a categorical variable (λ) depending on the level of enforcement and

examined if this variable affects the performance of the individual. Lambda is equal to -1 if there is medium enforcement, is equal to 1 if low enforcement is in place and is equal to 0 if there is high enforcement. Hence, if the theory of crowding out is accurate the lambda would help to explain the propensity of second movers to perform, as the authors in fact reported.

Ostman and Beckenkamp (1999), as well, study the effect of different levels of enforcement on common pool games. The authors develop a series of experiments in which an external regulator changes its level of enforcement through changing the levels of sanctions. The results of their experiments show a U shape type of relationship between the level of sanction and individual choices. Nonexistent sanctions imply the usual overuse of the resources. A mild level of sanction implies a reduction in the overuse, and higher levels of sanctions cause an overuse of resources. The authors attribute the latter result to a possible negative effect of a perception that the rule is unfair.

In an earlier work, Ostman (1998) also found evidence of crowding out due to an external intervention (external agent is paid for inspection) but without varying the level of the sanction. The author concludes that the presence of an external regulation implies a shift in “responsibilities” from the individuals facing the problem to the regulatory agency. This conclusion is reached by observing that the level of efficiency, calculated as the percentage of the total level of extraction to the optimum level of extraction, is reduced with the introduction of an external regulation.

In common pool experiments conducted in rural villages of Colombia by Cardenas, Stranlund and Willis (2000), the authors found evidence of “institutional crowding out” of other regarding preferences under weak enforcement. In their experiments, they found that the external regulation does not have the expected result and people actually behave more selfishly than without the regulation. Individual choices were closer to the self-interested choices when they faced modestly enforced external regulation than in the case with no regulation. Furthermore, payoffs were lower than in the baseline treatment

without regulation or communication and lower than in the case where communication was allowed.¹⁵

An important contribution of Cardenas et al. (2000) is the methodology used to measure the crowding out effect. Instead of measuring average levels of appropriation or contribution with and without regulation, the authors considered deviations from Nash best-responses as an indicator of crowding out effect. Hence, a movement toward the Nash best-response due to the introduction of an external regulation implies a crowding out of other regarding preferences.

The results regarding the level of enforcement are especially relevant for the developing world, where low or mild enforcement, and costly monitoring characterize the application of environmental law in rural areas. It opens the question of how to design regulation to avoid crowding out and how to promote compliance behavior in scenarios with weak enforcement and the presence of other regarding or social preferences.

Tyran and Feld (2001) shed some light on this question when they investigated the effects of mild and severe legal sanctions in a public good type of experiments. Their results provide insights on how different institutions may change the perception of the norm. The authors founded that severe sanctions (exogenously imposed law) almost perfectly avoid free riding, which was not the case with exogenous mild sanctions where net and gross efficiency was reduced.¹⁶ However, this behavior was reversed when mild sanctions were accepted by a referendum (endogenously chosen law). Individuals tended to cooperate or follow the law if they expected others to do the same. Hence, the voting mechanism provides a sign of others' intentions to cooperate, or others' perception of unacceptable behaviors.¹⁷

¹⁵ "Institutional crowding out suggests that well-intentioned but modestly enforced government controls of local environmental quality and natural resources use may perform rather poorly, especially as compared to informal local management" (Cardenas et al., 2002: 1721).

¹⁶Tyran and Feld (2001:13) measure net efficiency as the average realized income gain from cooperation as percentage of the potential income gain from cooperation. And Gross efficiency is measured, as the level of contribution to the public good.

¹⁷"If a mild legal sanction is perceived as an indication that an act is unacceptable it may increase cooperation. In contrast, if a mild legal sanction is perceived as the price to pay for acceptable behavior, it

In this case, voting is used as an instrument that coordinates individual behavior by signaling others' intentions, or because it encourages a social norm. These effects shows how institutions could frame choices and how individuals might react depending on the perception of the norm.

Further research on voting mechanisms found similar results. Alm et al. (1998), also find that voting is likely to change social norms in the context of individual tax compliance. In their experiments, participants are able to vote for different levels of enforcement or tax rates to change the current regulatory system. However, in contrast to the results reported above, in this case voting may destroy any pre-vote social norm about tax compliance. When greater levels of enforcement are voted down in their experiments, compliance is lower than pre-vote compliance under identical regimes. In this case, according to the authors, participants interpret the voting results as a signal that non-compliance is now socially acceptable. Actually, the authors report that greater enforcement levels are always voted down in the absence of communication. But, if participants are allowed to communicate they select greater levels of enforcement, and compliance behaviors are close to optimal levels. Hence, the authors conclude that communication induces tax compliance as a social norm.

These results show how voting mechanisms can actually have opposite outcomes and could crowd in or crowd out social norms or other cooperative oriented behavior. The results are not homogenous and call for further research to explore in detail the opportunities and threats that voting mechanisms may offer to reduce crowding out effects. The outcomes may depend on the signaling processes captured in the voting mechanism, or they may depend on the level of enforcement, or both.

Other experiments suggest that the different results obtained in the voting procedures may depend on the actual context and background of the participants. Cardenas (2003) reports common pool experiments in which participants vote for the introduction of an

may instead reduce cooperation. This may be the case if people behave morally out of intrinsic motivation (an internalized moral obligation), and if this moral obligation is crowded out by monetary incentives" (Tyran and Feld, 2001:20).

external regulation. The results show that in the majority of the cases participants in rural areas opposed external regulation. However, those groups showed a willingness to cooperate in the first rounds after the voting took place. In the following rounds this cooperation diminished but was still superior than the case without regulation. In those cases, although the voting process refuted the regulation, it enhanced cooperative behavior compared with the case without regulation.

However, different results were found when the participants were students in urban areas. They normally voted in favor of the regulation and their results were not different from their behavior under imposed regulation. In this case, the voting system did not improve levels of cooperation.

These results suggest that differences of individual behavior may depend not just on the type of regulation and frame used in the external intervention, but also on the information that participants bring to the game. This information is not controlled by the experiment, but may have an influence on individuals' preferences and choices (Cardenas and Ostrom, 2001). Hence, it is important to consider the information about participants' actual context when interpreting the results obtained in the experiments.

To improve upon these lines, this research will include a survey that captures key information about participants. The information collected will be an additional input to explain individual choices and will be considered in the econometric models.

The experiments proposed in this prospectus also explore the effects of voting systems on individual choices. The idea is to examine if voting procedures could be an instrument to enhance participation by changing the perception of the norms as supporting rather than controlling mechanisms.

In previous experiments found in the literature, participants are able to choose whether or not they want a regulatory system. However, it is unlikely that in real settings environmental authorities will stop regulating a resource because the community does not

want a regulation. This is particularly the case if those resources have a value that goes beyond the community interests. Hence, the experiment design developed in this prospectus uses voting procedures to capture a more participatory system in which the participants are able to decide certain characteristics of the regulatory system. This is introduced with the idea to explore institutional complementarities between internal and external mechanisms. Other institutional designs that combine communication with external regulation are also considered. An explanation of the experimental design is developed in the following sections.

III. Collective action in the field: Research Questions

The behavioral literature has empirical and experimental evidence related to the existence of self-regarding and other regarding preferences as determinants of individual behavior. Furthermore, there is relevant evidence that shows the possible negative effects of external interventions on individuals' other regarding preferences. Hence, it is important to characterize individuals' other regarding preferences and determine how these may change under different institutions and regulations.

To answer this question it is necessary to gain an understanding of how external regulation and different institutions interact with preferences and social norms in the context of common pool dilemmas. External regulation may be able to change the social meaning of a particular situation (expressive effect) and generate a process of internalization (Scott, 2000). These processes are yet not fully understood and many questions need to be answered regarding the effects of different institutions on individuals' non-Nash behavior.

The literature reviewed seems to agree that individuals' deviations from cooperative behavior are more likely to occur when mild enforcement is applied. Institutional framing and individuals' perceptions of norms have also been identified as important features that may influence individual choices. In particular, voting is highlighted as an institution that

may change the perception of the norm as a supporting rather than a controlling mechanism.

The models developed in this proposal explain the difference between individuals' actual choices and their Nash best response functions as an indicator of the existence of other regarding preferences or social preferences. Hence, the existence of other regarding preferences are interpreted as deviations from Nash best responses. These other regarding preferences may be present in the form of altruism or reciprocity. In fact, the econometric estimation of the models developed here intends to identify whether altruistic or reciprocal behavior explains individual choices and how these preferences may change due to the introduction of different institutions. In our analysis we also consider how different levels of enforcement may interact with different institutions and have an affect on individuals' preferences and choices. A detailed explanation of the models considering altruism and reciprocity is developed in the next section.

In order to test how different institutions affect individuals' other regarding preferences or deviations from Nash best responses, a series of experiments were designed, in the context of common pool dilemmas with six different types of treatments:

1. Open Access
2. Face-to-Face Communication
3. External Regulation
4. External Regulation and Face-to-Face Communication
5. Participatory Regulation
6. Participatory Regulation and Face-to-Face Communication

These treatments are summarized here and explained in detail in section V. The first treatment, *open access* or the baseline treatment, captures individual choices in a setting without any kind of institutional arrangement. The second treatment, *face-to-face communication*, intends to capture the effects of non-binding local agreements or informal regulations on individual choices. In other words, a scenario where individuals

generate nonenforceable (verbal) agreements as those developed in the field. In the third treatment, *external regulation*, an individual penalty for over extraction is externally introduced. In this case, the external regulator chooses the level of the environmental target and a constant audit probability. Two scenarios are designed under this treatment. A case with low penalty, in which the predicted Nash equilibrium is the same as in the case without regulation, and a second case with a mid level of penalty, in which the predicted Nash equilibrium is less than the case without regulation. The fourth treatment, *External Regulation and Face-to-Face Communication*, is similar to the previous treatment but in addition to the external regulation participants are able to communicate as in the second treatment. The fifth treatment, *Participatory Regulation*, intends to capture a participatory process in which individuals participate in the regulatory design. Hence, participants are able to choose the level of the penalty but the external regulator performs the monitoring and enforcement process. The choice of the penalty is made through a voting procedure given a set of choices proposed by the external regulator. Finally the last treatment, *Participatory Regulation and Face-to-Face Communication*, is the same as the previous one but in addition to the participation process, face-to-face communication is allowed.

Some Hypotheses

In a scenario without institutional arrangements as in the case of the open access treatment, sub optimal results are expected, as reported in the related literature. However, that does not necessarily imply that subjects' decisions will tend to be strictly Nash best responses choices, due to the existence of other regarding preferences.

Individual choices in the context of an external regulation are expected to be consistent with the literature on crowding out and hence reduce deviations from Nash best responses toward more self-interested choices.

On the contrary, the introduction of communication will support cooperation by promoting group cohesion and enhancing social norms. Communication serves as a way

to coordinate action, by identifying subjects' preferences and devising verbal agreements. Even in the case of external regulation, the possibility of communication may work as a mechanism to socialize information about the consequences of non-compliance. Hence, it may work as an instrument to build consensus around the social norm. The opportunity to discuss the objectives of an external regulation may help to improve outcomes and increase deviations from Nash responses, even when the target is chosen exogenously. This situation may reveal positive interactions between informal regulations, captured through communication, and formal regulations.

Other complementarities may be found in the case of communication and external regulation. If we accept that communication could encourage peer pressure and promote "prosocial emotions"¹⁸ as shame and guilt then it could also be thought as an instrument to encourage deviations from Nash best responses toward more group oriented outcomes. In the case of *face-to-face communication* and *participatory regulation*, the opportunity to communicate may coordinate the voting procedure by reaching a consensus that otherwise would be limited by the outcomes of majority rule. In summary, when communication is allowed, cooperative behavior is expected to increase.¹⁹

The idea behind the introduction of participatory regulations such as voting is to test whether this mechanism is able to change the perception of the norm as a supporting rather than controlling mechanism. In other words, by using voting systems we want to test if there are possible complementarities between a self-governing process (choosing the penalty) and external interventions (monitoring and enforcement).

The participation of the community in the regulatory process through voting procedures will give signals about the preferences of other participants. Hence, each individual will update her strategies according to these signals. This argument is based on the experimental evidence that shows how people will follow a rule if they think others will

¹⁸ Bowles and Gintis (2002) introduced this concept.

¹⁹ Outside of the experimental literature, Sen (1999: 273) also identifies *public discussion* as one of the mechanisms that may influence behavior and preferences through value formation. Other mechanisms pointed out by Sen are *reflection and analysis* and our willingness to follow *conventions*.

follow the rule as well (Tyran and Feld, 2001). It also supports the thesis of reciprocity as a common determinant of social preference (Fehr et al, 2002b). Overall, participatory regulation is expected to move individual choices toward group-oriented outcomes.

Another hypothesis, which interacts with the different types of institutions, is related to the level of enforcement. It is important to examine whether different levels of enforcement will have an impact on non-Nash behavior as stated by Ostrom (2000).²⁰ The effect of different regulations on individuals' choices may interact with the effect produced by the level of enforcement. Thus, by using different levels of enforcement through different penalty levels, we will test if mild degrees of external monitoring discourage the formation of social norms to solve the cooperation dilemma by providing incentives for the players to cheat the system. We will also analyze if low levels of external regulation encourage the formation of social norms that support cooperation.

Finally, "what people bring to the lab" will also be considered in the analysis. These variables are not controlled by the experiment, but may still have influence on individuals' choices.²¹ The existence of non-Nash behavior and the effect of different institutions are expected to be consistent with the participants' social context. For example, a history of cooperation within the community or high levels of social capital may increase deviations from Nash best responses, whereas a negative perception of the state may reduce this effect when external regulations are introduced.²²

²⁰ The level of enforcement may also have an effect on the perception of the norm. For example, with higher levels of enforcement the norm may be perceived as unfair.

²¹ Cardenas and Ostrom (2001) stated a similar idea when they analyzed how participants use information not included in the game about their actual context and backgrounds when evaluating their actions. In the experiments developed in this research, the relevant information will be captured through a survey given to the participants after the game. This survey includes questions regarding individuals' socio economic data, individuals' perception of the state, history of cooperation within the community, as well as other variables that are included to capture levels of social capital. Some of the information gathered in this survey will be used as explanatory variables in the econometric models and also as inputs to interpret the results. A complete survey is included at the end of this document in the Appendix. Another tool used in the field to gather relevant information about the participants and their relationships in the community is the Participatory Rural Appraisal (PRA). This tool used by Chambers and Guijt (1995) and by Lopez et al. (2004) at Javeriana University gathers key information about the community and their perception of natural resource management through a final workshop that is performed after the experimental sessions. This information will also help the interpretation of the results of the experiments.

²² An external regulation imposed on a community with high levels of social capital may have contradictory effects. On one hand, high levels of social capital may reveal a strong presence of other regarding

IV. Theoretical Models

The benchmark model considers a common pool problem without the presence of other regarding preferences based on the work done by Ostrom (1994), Falk et al. (2002), and an earlier model developed by Cornes and Sandler (1983). In this model the social dilemma is captured by the existence of a negative cost externality, $d \left(x_i \sum_{i=1}^n x_i \right)$, and by an additional term, $c \left(\sum_{i=1}^n x_i \right)$, that capture negative externalities that reduce individual existence or non-use values.²³

According to a conventional model in which individual behavior is entirely explained by self interest, or what is called self-regarding preferences, each individual faces the following problem:

$$\max_{x_i} U_i = e + p x_i - c \left(\sum_{i=1}^n x_i \right) - d \left(x_i \sum_{i=1}^n x_i \right),$$

where x_i is i 's level of harvest, p is the constant price for harvest and e is an endowment of money. There are n identical harvesters. The corresponding first order condition gives the solution for i 's best response function. In this case, is assumed that there is not a dominant strategy and i 's best choice depends on the choices of others.

$$(1) \quad p - c - 2dx_i - d \sum_{i \neq j} x_j = 0$$

From (1) we can obtain i 's Nash best-response function

$$(2) \quad x_i^n = \frac{p - c - dx_{-i}}{2d}, \quad x_{-i} = \sum_{j \neq i}^n x_j$$

preferences and then a possible crowding out effect due to the introduction of an external regulation. However, this social capital may also reveal a relationship based on trust between the community and the state, and hence a respect and consensus for the legitimate rules imposed to enhance the welfare of the members of the community.

²³ This additional term was introduced to obtain the intended design in the experiment. In the absence of this term the Nash Equilibrium in the experiment payoff table was too close to the Social Optimum. This would be a problem for the analysis since the idea is to explain deviations from Nash best responses.

To find the Nash equilibrium, return to (1) and impose symmetry; that is, $x_i = x \forall i$, to obtain $p - c - 2dx - d(n-1)x = 0$. Solve this equation to obtain

$$(3) \quad x^n = \frac{p - c}{d(n + 1)}.$$

As is shown below, the level of harvest x^n is different from the optimal level of harvest x^* determined by the social optimum. A central planner, interested in the welfare of society, and given the same weight to all of its members, will obtain the social optimum by maximizing joint profits. Imposing symmetry, the maximization problem can be expressed as the following,

$$\max_x e + px - cnx - dnx^2$$

The first order condition for x is:

$$(4) \quad p - cnx - dn(2x) = 0.$$

Solving (4) for x yields the socially optimal level of individual harvests,

$$(5) \quad x^* = \frac{p - cn}{2dn}.$$

Calculating the difference between the symmetric Nash equilibrium harvest the socially optimal level yields,

$$x^* - x^n = \frac{p - cn}{2dn} - \frac{p - c}{d(n + 1)} < 0.$$

Given that the socially optimal level of extraction is less than the Nash equilibrium, $x^* < x^n$, the level of extraction determined by purely self-regarding preferences generates an overuse of resources. Hence, in order to obtain an outcome equal or at least closer to the social optimum, the regulator will enforce an individual quota so \bar{x} such that $\bar{x} \geq x^*$ and $\bar{x} < x^n$.

This quota will be enforced by introducing a penalty for levels of extraction greater than the allowed level of extraction. Hence, the regulator will define a level of penalty

together with an audit probability to encourage the desired level of extraction. Let ϕ be the constant marginal expected penalty. Then, assuming risk-neutrality, the problem for individual i facing an individual penalty, can be expressed as the following:

$$\max_{x_i} p x_i - c \left(\sum_{i=1}^n x_i \right) - d \left(\sum_{i=1}^n x_i \right) x_i - \phi (x_i - \bar{x}),$$

The new first order condition for this maximization problem is

$$(6) \quad p - c - d \left(2x_i + \sum_{i \neq j} x_j \right) - \phi = 0 \quad \text{if } x_i < \bar{x}. \text{ And the new best-response}$$

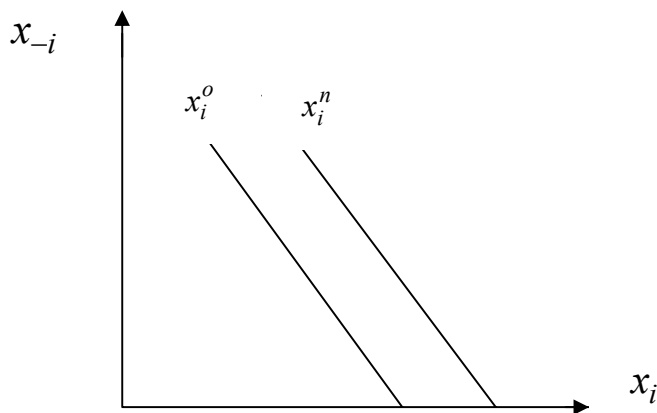
function including a constant marginal expected penalty is

$$(7) \quad x_i^o = \frac{p - c - d x_{-i} - \phi}{2d}, \quad x_{-i} = \sum_{j \neq i} x_j.$$

Comparing (7) and (2) it can be observed that the inclusion of ϕ produces a parallel shift down of the best response function as presented in Figure 1 below. In order, to find the new equilibrium level, impose symmetry $x_i = x \forall i$ on (6) and the first order condition will give the new Nash equilibrium,

$$(8) \quad x^o = \frac{p - c - \phi}{d(n+1)} < x^n.$$

Figure 1



In the context of exogenous self-regarding preferences the effect of the external regulation is straightforward. The introduction of the penalty will change the incentive structure of each individual and the inclusion of the expected penalty will reduce extraction levels. However, as discussed before, in a context of endogenous preferences and considering the existence of other regarding preferences the effects are not clear and need to be estimated. Two models are considered below that take into account the existence of other regarding preferences. The first is a model with altruism, while the second includes a reciprocity motive.

Altruism

If we consider an individual that takes into account not only the consequences of her actions for herself but for others as well, individual behavior is explained by self-regarding and other regarding preferences. We can incorporate altruism in a way that is similar to Bowles (2003) and Levine (1998), who incorporate altruism as a weight of others' utility in i 's utility function. Hence, i 's utility depends on her own income and the income of other individuals. Following this idea, the maximization problem faced by individual i in a context of open access is now the following:

$$\begin{aligned} \max_{x_i} U_i = & e + p x_i - c \left(\sum_{i=1}^n x_i \right) - d \left(\sum_{i=1}^n x_i \right) x_i + \\ & \beta_i \left\{ (n-1)e + \sum_{j \neq i} p x_j - (n-1)c \left(\sum_{i=1}^n x_i \right) - \sum_{j \neq i} d \left(\sum_{i=1}^n x_i \right) x_j \right\} \end{aligned}$$

With $x_{-i} = \sum_{j \neq i} x_j$ we can express i 's utility function as:

$$\begin{aligned} \max_{x_i} U_i = & e + p x_i - c \left(\sum_{i=1}^n x_i \right) - d (x_i^2 + x_i x_{-i}) \\ & \beta_i \left\{ (n-1)e + p x_{-i} - (n-1)c (x_i + x_{-i}) - d (x_i^2 + x_i x_{-i}) \right\} \end{aligned}$$

where β_i is the weight of others' income in i 's utility function.

The first order condition given other regarding preferences is

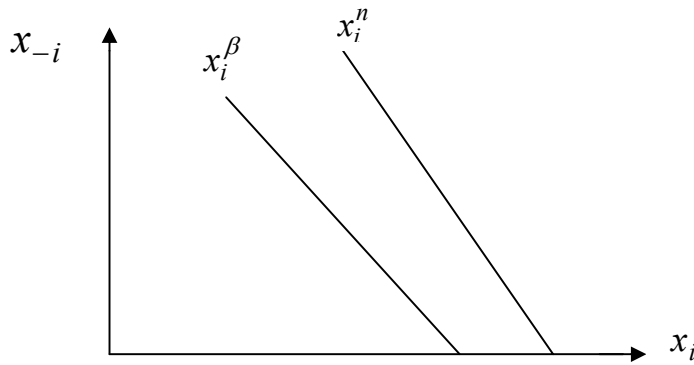
$$(9) \quad p - c - 2dx_i - dx_{-i} - \beta_i x_{-i} d - \beta_i (n-1)c = 0$$

The Nash best-response with altruism is

$$(10) \quad x_i^\beta(x_{-i}) = \frac{p - c - dx_{-i} - \beta_i dx_{-i} - \beta_i (n-1)c}{2d}.$$

Compared to the model of self regarding preferences, the best response function of an individual with other regarding preferences shows a change in the slope of the function by the parameter β_i and a shift in the intercept. These new features imply a lower to over-extraction of resources because the individual is taking into account the payoffs of others. Hence, given x_{-i} , $x_i^\beta < x_i^n$.

Figure 2



In this framework, if a constant marginal expected penalty ϕ is introduced, the problem faced by individual i with other regarding preferences is the following:

$$\begin{aligned} \max_{x_i} U_i = & e + px_i - c \left(\sum_{i=1}^n x_i \right) - d(x_i^2 + x_i x_{-i}) - \phi(x_i - \bar{x}) + \\ & \beta_i \left\{ (n-1)e + \sum_{j \neq i} px_j - (n-1)c \left(\sum_{i=1}^n x_i \right) - d(x_i^2 + x_i x_{-i}) - \sum_{j \neq i} \phi(x_j - \bar{x}) \right\} \end{aligned}$$

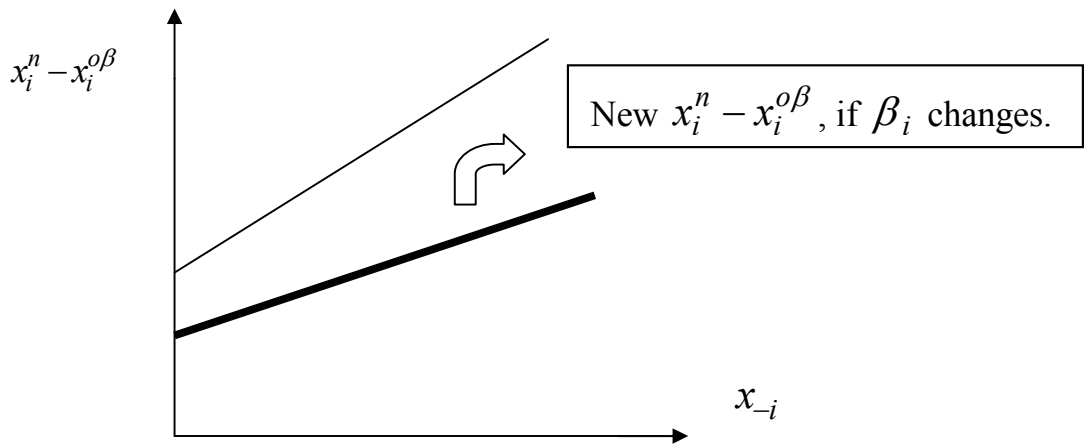
The first order condition of this maximization problem will give a best response function of the form,²⁴

$$(11) \quad x_i^{o\beta} = \frac{p - c - dx_{-i} - \beta_i dx_{-i} - \beta_i(n-1)c - \phi}{2d}.$$

If we accept that the choice determined by the other regarding best response, x_i^β or $x_i^{o\beta}$ (if an external regulation is introduced), is in fact the actual choice made by the participants in the game, \hat{x}_i or \hat{x}_i^o , we can consider the difference between the Nash best response function and the actual choice to be an indicator of how that individual balances self-regarding and other-regarding interests. Hence the difference can be expressed as:

$x_i^n(x_{-i}) - x_i^\beta(x_{-i}) = \frac{(n-1)c\beta_i}{2d} + \frac{\beta_i x_{-i}}{2}$. Which should be equal to the difference, $x_i^o(x_{-i}) - x_i^{o\beta}(x_{-i}) = \frac{(n-1)c\beta_i}{2d} + \frac{\beta_i x_{-i}}{2}$, when an external regulation is introduced. This difference is determined by a positive constant (the first term) and increases depending on the choices of others according to the positive slope $(\frac{\beta_i}{2})$.

Figure 3



²⁴ In this case individual i is considering the expected penalties faced by others. The same result is obtained if individual i does not consider expected penalties faced by others.

However, if it is true that regulations or institutions shape preferences, the weight that individuals place on the payoff of others (β_i) may change depending on their perceptions of the norm or attitudes toward the regulatory agency. In this context, crowding out or crowding in of other regarding preference (in this case altruism) may occur, if the parameter β_i changes when the external intervention is introduced.²⁵ Hence, deviations from the Nash best response will increase or decrease depending on the perception of the norm.

Reciprocity

The key aspect of other regarding preferences is that the individual places a value on how his action affects others. Fehr et al. (2002b) and Falk et al. (2002) argue that many experimental outcomes are explained by the presence of reciprocity and equity motives. In order to capture this idea, the model developed here is based on the notion of reciprocity motives consistent with inequity aversion as proposed by Fehr et al. (2002b).²⁶ In this context, an individual will face an additional cost if his choices deviate from others' average choices, a similar idea as the model developed by Fehr and Schmidt (1999).

Hence, the maximization problem faced by individual i is the following:

$$\max_{x_i} U_i = e + p x_i - c \left(\sum_{i=1}^n x_i \right) - d \left(\sum_{i=1}^n x_i \right) x_i - \beta_i^r \frac{(x_i - \tilde{x}_{-i})^2}{2}$$

Where $\tilde{x}_{-i} = \frac{\sum_{j \neq i} x_j}{n-1}$, and β_i^r is the cost individual i faces if his choice deviate from

²⁵ A change in the distance between $x_i^\beta(x_{-i})$ and $x_i^n(x_{-i})$ is not necessarily an evidence of a crowding out effect as proposed by Cardenas et al. (2001). This change may be caused by an updating of choices given a change in the choices of others. Crowding out will occur if the parameter β_i changes by the introduction of an external regulation.

²⁶ An example given by Fehr et al. (2002: C3), explains this idea: "both reciprocity and inequity aversion imply the desire to reduce the payoff of another person if that person made a decision such that the payoff of the reciprocal or inequity averse person is much lower than the payoff of the other person."

others' average choices. The first order condition and the Nash strategy given this type of other regarding preferences are calculated below:

$$(12) \quad \begin{aligned} p - c - 2dx_i - dx_{-i} - \beta_i^r(x_i - \tilde{x}_{-i}) &= 0; \\ p - c - 2dx_i - dx_{-i} - \beta_i^r x_i + \beta_i^r \left(\frac{x_{-i}}{n-1}\right) &= 0 \end{aligned}$$

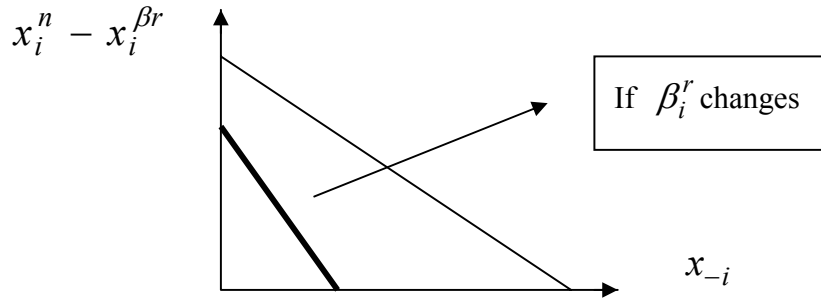
An individual's best-response in this situation is

$$(13) \quad x_i^{\beta_i^r}(x_{-i}) = \frac{p - c - x_{-i}(d - \beta_i^r/n - 1)}{2d + \beta_i^r}.$$

Again, compared with the model of self-regarding preferences, the best response function of an individual with other regarding preferences shows a change in the slope of the function by the parameter β_i^r and a shift in the intercept. As in the case of altruism, these changes in the best response function initially imply a lower incentive to over-extract because the individual has taken into account the choices of others. But as the harvests by others increase, the incentive for over extraction also increases due to the presence of the reciprocity motive. Hence, the difference between a Nash best response function with self regarding preferences and a Nash best response function including the reciprocity motive can be expressed as a function of x_{-i} , with the first term being a positive constant and the second term being x_{-i} times a negative slope:

$$x_i^n(x_{-i}) - x_i^{\beta_i^r}(x_{-i}) = \frac{\beta_i^r(p - c)}{2d(2d + \beta_i^r)} - \frac{\beta_i^r \left(\frac{n+1}{n-1}\right) x_{-i}}{2(2d + \beta_i^r)}$$

Figure 4



In this context, if an external regulation is introduced considering reciprocity motives, the problem faced by the individual i is the following:

$$\max_{x_i} U_i = e + px_i - c \left(\sum_{i=1}^n x_i \right) - d \left(\sum_{i=1}^n x_i \right) x_i - \beta_i^r \frac{(x_i - \tilde{x}_{-i})^2}{2} - \phi(x_i - \bar{x})$$

Where ϕ is the usual constant marginal expected penalty. Solving the corresponding first order condition, the maximization problem will lead us to a best response function of the form:

$$(14) \quad x_i^{\circ\beta r}(x_{-i}) = \frac{p - c - x_{-i}(d - \beta_i^r / (n-1)) - \phi}{2d + \beta_i^r}$$

In this scenario, the difference between $x_i^{\circ}(x_{-i}) - x_i^{\circ\beta r}(x_{-i})$ will be equal to

$$\frac{\beta_i^r (p - c - \phi)}{2d(2d + \beta_i^r)} - \frac{\beta_i^r \left(\frac{n+1}{n-1} \right) x_{-i}}{2(2d + \beta_i^r)}$$

This difference also depends on x_{-i} and has a negative slope and a positive constant. However, if different regulations or institutions shape individuals' preferences, the cost that individuals place on the difference between their choices and the choices of others may change depending on their perceptions of the norm or attitudes toward the regulatory agency. Hence, deviations from Nash best responses may change if the parameter β_i^r changes when external intervention is introduced.

How to characterize deviations from Nash best responses?

Based on the models developed above, an econometric estimation is proposed to characterize non-Nash behavior and how different institutions affect individuals' deviations from Nash best responses. Hence, the econometric model has the following form:

$$x_i^n(x_{-i}) - \hat{x}_i(x_{-i}) = \mu_0 + \mu_1 x_{-i} + \mu_2 T_i + \mu_3 (T_i x_{-i}) + \mu_4 C_i + \mu_5 (C_i x_{-i})$$

Where x_i^n is the benchmark determined by the Nash best response function considering self-regarding preferences, and \hat{x}_i is the actual choice of individuals that assumes the existence of other regarding preferences. x_{-i} is the individual's expectation about choices of others and T_i refers to the type of treatment or regulation under which the decisions take place.²⁷ Finally, C_i captures the region or the characteristics of the region where the experiment is conducted.

With this specification it is not possible to directly estimate the coefficients β_i or β_i^r but, depending on the sign of μ_1 , it is possible to explain the difference between the Nash best response function and actual choices by identifying in aggregate terms the type of preferences underlying individuals choices. If μ_1 is positive, then individuals behave as if they have altruistic preferences. On the other hand, if μ_1 is negative, individuals behave as if they have a reciprocity motive determining their choices. The coefficients μ_2 and μ_3 will capture the effect of different regulation on μ_0 and μ_1 . These coefficients, μ_0 and μ_1 , will capture individuals' deviations from Nash best responses and thus can be interpreted as proxies of individuals' preferences. Also, μ_4 and μ_5 will identify if there is a difference between individual preferences and choices depending on the region where the experiments are run.

²⁷ In each period x_{-i} is obtained by asking each participant the expected level of extraction of others.

In addition we want to explain individual choices \hat{x}_i as a function of individual socio economic characteristics, type of regulation, number of periods and the expected choices of others. This regression aims to identify which individual characteristics that are not controlled by the experiment (socio economic characteristics) may affect individual choices, as well as the direct effects of experimental variables like type of regulation and period number.

The models presented here will be estimated by using Panel Data Tobit Models since this type of estimation technique considers count data for the dependent variable and the presence of repeated measures (For an example of the application of this technique, see Bardsley and Moffatt, 2000; Anderson and Stafford, 2003).

V. Experiment Design

The project will run experiments in 3 regions of Colombia (Amazon Region, Pacific Coast and Atlantic Coast) with direct users of natural resources, the majority of whom will be fishermen. Approximately 420 individuals will participate in these experiments with average earnings of 8 dollars per person (a total of U.S \$3360). The experiment design includes 6 types of treatments that capture different types of regulations as explained below. The plan is to run 12 experiments per treatment in groups of 5 participants. That will imply 4 groups per treatment in each region.

In each experiment the participants will have to decide anonymously their level of extraction according to a payoff table that captures the benchmark common pool dilemma modeled in the previous section.²⁸ Each group will face 10 rounds of *Open Access or baseline treatment* (no communication and no regulation) and then 10 additional rounds with a different type of rule.²⁹ Hence, the participants face in the second part of the experiment any of the following treatments:

²⁸ The values used to create the payoff table are the following: $p = 116.875$, $c = 17.875$, $d = 2.75$ and $e=900$. The payoff table and the instructions given to the participants can be found in the Appendix.

²⁹ The experiment design and instructions used in our experiment are modifications of the work done by Cardenas et al. (2002).

1. Face-to-Face Communication
2. External Regulation with low level penalty
3. External Regulation with mid level penalty
4. External Regulation with low level penalty and Face-to-Face Communication
5. External Regulation with mid level penalty and Face-to-Face Communication
6. Participatory Regulation
7. Participatory Regulation and Face-to-Face Communication

In the treatment of Face-to-Face Communication the participants will be able to discuss for 5 minutes anything related to the experiments with the other members of the group. After the discussion time is over, each participant will have to decide their level of extraction anonymously as they did in the first 10 rounds. This procedure will be applied to all treatments with face-to-face communication.

In all the treatments involving an external regulation the environmental target is set to 1 unit of extraction and the audit probability is fixed at 10%. The low penalty is 27 pesos for each additional unit extracted over the target and the mid penalty is 165 pesos for each additional unit of extraction. The expected Nash equilibrium in the case of the low penalty is the same as in the case of no regulation (6 units). Hence, the effect of this penalty will capture the framing effects due to the introduction of an external regulation. In the case of the mid level of penalty, the expected Nash equilibrium is 5. After each participant has chosen his or her level of extraction, the instructor will choose someone randomly to be inspected. If his or her level of extraction is greater than 1 then that person will face a financial penalty. However, only the person inspected will know the result of the inspection. This procedure will be repeated each round.

In the case of *Participatory Regulation*, the participants will choose through a voting procedure their preferred penalty level. Their options will be 27 pesos for each additional unit or 165 pesos for each additional unit. Again, the allowed level of extraction is 1 and the audit probability is 10%.

A summary of the experiments design is presented in the matrix below:

Fix Target = 1 and Fix audit probability = 0.1			
	NO EXTERNAL REGULATION	EXTERNAL REGULATION	PARTICIPATION-REGULATION (VOTING)
NO COMUNICACION		LOW ENFORCEMENT (Penalty = 27 pesos)	GOVERNMENT PROPOSES MENU OF OPTIONS Possible level of penalties for each additional unit extracted: 27 pesos 165 pesos
		HIGH ENFORCEMENT (Penalty = 165 pesos)	
COMUNICACION	FACE-TO-FACE COMUNICACION	LOW ENFORCEMENT (Penalty = 27 pesos)	GOVERNMENT PROPOSES MENU OF OPTIONS Possible level of penalties for each additional unit extracted: 28 pesos 165 pesos
		HIGH ENFORCEMENT (Penalty = 165 pesos)	

VI . Final Considerations

Different solutions to overexploitation problems have been developed around the world. Ranging from community-based initiatives to market-based institutions with tradable property rights, most of the instruments used in developing countries still focus on “command and control” type of regulations. One type of instrument used by local authorities is the enforcement of individual quotas to restrict the level of effort or the harvest of particular resources. Some of these quotas are decided as part of local agreements between users of the resources and local governments. The level of compliance and cooperation with different types of rules vary from case to case.

In order to gain a better understanding of this issue, common pool experiments were designed to isolate the affects of different institutions on individual choices. These experiments will test the effects of different institutions and regulatory schemes on individual preferences and choices. Participants of those experiments will be direct users of natural resources in rural villages of Colombia.

The experiments will be developed along the same lines as those used by Cardenas et al. (2000) in which the effect of an external regulation is tested and compared with different types of institutions. Cardenas et al. (2000) found that the introduction of an external regulation may not have the result predicted by the self-regarding model and actually institutional crowding out may occur.

This prospectus extends previous analyses by modeling the effects of different institutions when considering the existence of other regarding preferences. Furthermore, it also develops theoretical models to characterize individual preferences and non-Nash behavior. These models will be empirically tested to estimate whether individual behavior is consistent with altruistic or reciprocity motives, and the extent by which these preferences are affected by the introduction of different institutions.

The expected results of this research will be relevant to scholars and policymakers interested in the problems of collective action and the management of natural resources. On one hand, this research will contribute to the achievement of a more complete theoretical model that will be able to explain individual behavior in the context of other regarding preferences. On the other hand, it also will help us to understand how to design institutions that considers the existence of other regarding preferences to enhance rather than undermine cooperative behavior.

At the local level, this research provides interesting information that may help to design regulatory systems that promote collective action in the management of natural resources. The information provided by the experiments and the information collected in the survey will yield important insights regarding the actual management of natural resources and the perception of regulatory systems.

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Appendix

PAYOFF TABLE*

Level of extraction of others	My level of extraction								
	0	1	2	3	4	5	6	7	8
0	900	996	1087	1172	1252	1326	1395	1458	1516
1	882	976	1064	1146	1223	1295	1361	1421	1476
2	864	955	1040	1120	1194	1263	1326	1384	1436
3	846	934	1017	1094	1165	1231	1292	1347	1396
4	829	914	994	1068	1137	1200	1258	1310	1357
5	811	893	970	1042	1108	1168	1223	1273	1317
6	793	873	947	1016	1079	1137	1189	1236	1277
7	775	852	923	989	1050	1105	1154	1198	1237
8	757	831	900	963	1021	1073	1120	1161	1197
9	739	811	877	937	992	1042	1086	1124	1157
10	721	790	853	911	963	1010	1051	1087	1117
11	703	769	830	885	934	978	1017	1050	1077
12	686	749	807	859	906	947	983	1013	1038
13	668	728	783	833	877	915	948	976	998
14	650	708	760	807	848	884	914	939	958
15	632	687	736	780	819	852	879	901	918
16	614	666	713	754	790	820	845	864	878
17	596	646	690	728	761	789	811	827	838
18	578	625	666	702	732	757	776	790	798
19	560	604	643	676	703	725	742	753	758
20	543	584	620	650	675	694	708	716	719
21	525	563	596	624	646	662	673	679	679
22	507	543	573	598	617	631	639	642	639
23	489	522	549	571	588	599	604	604	599
24	471	501	526	545	559	567	570	567	559
25	453	481	503	519	530	536	536	530	519
26	435	460	479	493	501	504	501	493	479
27	417	439	456	467	472	472	467	456	439
28	400	419	433	441	444	441	433	419	400
29	382	398	409	415	415	409	398	382	360
30	364	378	386	389	386	378	364	345	320
31	346	357	362	362	357	346	329	307	280
32	328	336	339	336	328	314	295	270	240

* “0” units of extraction is a concept very difficult to explain in the field, since the participants are persons who depend from the extraction of natural resources. Hence, for the experiments in the field, the columns were relabeled so “My level of extraction” will be a number between 1 and 9 and the “Level of extraction of others” a number between 4 and 36. The highlighted cells are the best response function. The Nash equilibrium is reached if all the participants choose 6 and the social optimum is obtained when all the participants choose 1.