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SOCIAL NORMS AND BEHAVIOR IN THE LOCAL COMMONS THROUGH THE LENS OF FIELD EXPERIMENTS

Juan Camilo Cardenas[1]

For a forthcoming special issue of *Environmental and Resource Economics* (ERE) provisionally entitled "Environmental and Resource Social Sciences" co-edited by Olof Johansson-Stenman (University of Gothenburg) and Henk Folmer at the University of Groningen.

Abstract

Behavior in the local commons is usually embedded in a context of regulations and social norms that the group of users face. Such norms and rules affect how individuals value material and non-material incentives and therefore determine their decision to cooperate or over extract the resources from the common-pool. This paper discusses the importance of social norms in shaping behavior in the commons through the lens of experiments, and in particular experiments conducted in the field with people that usually face these social dilemmas in their daily life. Through a large sample of experimental sessions with around one thousand people between villagers and students, I test some hypothesis about behavior in the commons when regulations and social norms constrain the choices of people. The results suggest that people evaluate several components of the intrinsic and material motivations in their decision to cooperate. While responding in the expected direction to a imperfectly monitored fine on over extraction, the expected cost of the regulation is not a sufficient explanatory factor for the changes in behavior by the participants in the experiments. Even with zero cost of violations, people can respond positively to an external regulator that issues a normative statement about a rule that is aimed at solving the social dilemma.

Key words: social norms, regulations, cooperation, collective action, common-pool resources, experiemental economics, field experiments.

JEL Classification: D71, Q0, Q2, C9, H3, H4.

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NORMAS SOCIALES Y COMPORTAMIENTO EN LOS RECURSOS DE USO COMÚN A TRAVÉS DEL LENTE DE LOS EXPERIMENTOS EN CAMPO

Resumen

Las decisiones en los recursos de uso común están usualmente inmersas en un contexto de regulaciones y de normas sociales que deben enfrentar los usuarios. Dichas normas y reglas afectan la forma en que los individuos valoran los incentivos materiales y no materiales y por tanto determinan su decisión de cooperar o sobre explotar los recursos del espacio colectivo. Este artículo discute la importancia de las normas sociales en moldear el comportamiento en los recursos de uso común usando el lente de los experimentos económicos en campo, y en particular experimentos realizados con personas que usualmente enfrentan estos dilemas sociales en su vida cotidiana. A través de una muestra de sesiones experimentales con cerca de mil personas entre campesinos y estudiantes, pruebo algunas hipótesis sobre el comportamiento en los recursos comunes cuando hay regulaciones y normas sociales que restringen las acciones de las personas. Los resultados sugieren que las personas evalúan varios componentes de las motivaciones intrínsecas y materiales en sus decisiones de cooperar. Aunque si responden en la dirección esperada a multas bajo un monitoreo imperfecto de la sobre explotación, el costo esperado de la regulación no es un factor suficiente para explicar la variación en el comportamiento de los participantes en los experimentos. Incluso con regulaciones de costo cero de la violación, las personas responden positivamente a una regulación externa que envía un mensaje normativo acerca de la regla que se ha diseñado para resolver el dilema social.

Palabras clave: normas sociales, regulaciones, cooperación, acción colectiva, recursos de uso común, experimentos económicos.

Clasificación JEL: D71, Q0, Q2, C9, H3, H4.

1. Introduction.

The use of a local commons involves the basic dilemma arising from a conflict between the self-interest that drives individual extraction of its resources, and the group interest that drives its conservation. The documented evidence of so many failures, successes and situations in between invite us to continue pursuing this question. In fact, if Hardin's tragedy of the commons were a successful prediction, the World Database on Protected Areas (http://www.wdpa.org) would not include the thousands of terrestrial and maritime areas around the globe that deserve to be managed and conserved due to their ecological value despite the threats of human pressure to extract their resources. They would be gone by now, as the formal solutions Hardin suggested through private or state property emerged much later in human history, and with mixed results over their effectiveness. However, Hardin's prediction also warns us that the optimal conservation of the commons does not emerge naturally from the self-interest of humans. The conflict between self interest and group interest requires precisely the kind of institutions that international, national and local organizations promote through markets, states and communities, to prevent over exploitation of these local commons.

Today the vast majority of local commons worth conserving, due to the ecological goods and services they provide for human kind, are immersed in a mix of institutions that include imperfect markets, weak states and a diverse set of traditional and modern community arrangements that create monetary and non-monetary incentives, partially enforced regulations and social norms.

The role that social norms can play in shaping behavior and institutions has been recognized in many domains of social exchange. In general, norms shape preferences and constrain choices. Norms guide individual behavior within groups, and trigger intrinsic motivations and pro-social emotions.

The purpose of this paper is to reflect on the value added by experimental research on common-pool resources both in the lab and the field to the understanding of how institutions and behavior interact to produce tragedies or successes, and in particular discuss the role of social norms in these outcomes. In the first section I will provide a summary of the micro foundations in the problem of the commons from the different perspectives contributed by the behavioral sciences. Many of these behavioral foundations have been studied in the laboratory through experiments in social dilemmas, reciprocal exchange, public goods and common-pool resource experiments. These studies offer now some robust patterns about human intentions and actions, but also leave some questions unanswered that will be mentioned. The article will then proceed to present a series of experiments that the author has been conducted over the last years to focus on the patterns and open questions from this literature. These experiments offer some lights regarding the role of social norms in these environmental dilemmas and in particular with respect to the interaction of norms with the regulatory settings that the natural world implies for the users of local commons.

2. **Building the micro foundations of behavior in the commons (Step 1: material payoffs maximizers).**

Let me start by laying out a simple model that incorporates some of the key components in the study of common-pool resources. In this model there are N players that have a maximum level of effort e_i that they can allocate to extract resources from a local commons. The incentives are typical of a problem of extraction of natural resources when the players face joint access to the pool.

Individual payoffs increase at a decreasing rate with individual effort due to marginal decreasing returns to effort. However, individual payoffs are also affected by group extraction due to the externality from aggregate extraction. Typical examples are the degradation of the ecosystem capacity to provide the resources, the increase in extraction costs due to longer distances to extract remaining units, or the decrease in the natural renewal of the common-pool.

More formally, if Y_i represents income for player i, then ,

$Y_i = f(x_i, \sum_1^N x_j)$ where $\frac{dY}{dx_i} > 0, \frac{d^2Y}{dx_i^2} < 0$, and $\frac{dY}{d\sum x_j}$<0. [1]

This structure resembles the main features of many of the available models that are tested through experiments, starting with the seminal book by Ostrom, Gardner and Walker (1994), and the designs that such work inspired[2].

Suppose that each of these N players have to decide their level of extraction[3] $x_i \in (1,e_i)$, and that the direct benefits from extracting resources from the CPR are given by the expression $ax_i - \frac{1}{2}bx_i^2$, with a,b>0. On the other hand, the aggregate extraction increases i's payoffs because of the indirect benefits from the local commons. In other words, lower levels of extraction increase the public good benefits from conservation. With these two components, the expression for the payoffs of a player i are defined as follows:

$$Y_i = ax_i - \frac{1}{2}bx_i^2 + \varphi \sum_1^N (e_j - x_j) \qquad [2]$$

For n players, and assuming symmetric endowments for all, e_i = e, we can rewrite the expression as,

$$Y_i = ax_i - \frac{1}{2}bx_i^2 + \varphi ne - \varphi \sum_1^N (x_j) \qquad [3]$$

[2] The experimental design to be presented evolved from the original CPR experiments by Ostorm, Gardner and Walker (1994), an experimental model used by the author in the late 1990s (Cardenas et.al 2000; Cardenas, 2003) and further discussions with Ernst Fehr who contributed greatly to develop the model used in the present research.

[3] We have eliminated in the action set the zero extraction option ($x_i^{so} = 0$) to avoid possible conflicts in conducting these experiments in the field. Previous experiments and pre-testing exercises suggest that there are strong aversions by villagers towards prohibitions using natural resources which could create strong reactions against the game framing. Interior solutions such as used in Ostrom, Gardner and Walker (1994) and Cardenas et.al (2000) are another alternative, but we have decided here to maintain corner solutions for simplicity. There are no analytical implications of using such constrained action set of 1 to e units.

If player i chooses x_i to maximize Y_i, the first order conditions that produce the optimal level of extraction x_i^{nash} are $\frac{\partial Y_i}{\partial x_i} = a - bx_i - \varphi = 0$, providing the following optimal individual extraction:

$$x_i^{nash} = \frac{a-\varphi}{b}, \text{ for } x_i \in [1,e] \quad [4]$$

The parameters of the model were chosen so that the experimental design could be easily explained to the participants, and constrained to the region of interest, that is, when the social dilemma happens because of the conflict between individual and group interests. To maintain the properties of a CPR problem we choose the following parameters: e=8, a=60, b=5, and $\varphi = 20$, yielding the following solution: $x_i^{nash} = (a - \varphi) / b = 8$. That is, every player i player should choose as her Nash best response to allocate her maximum endowment of labor into extracting the resource from the CPR.

To produce the socially efficient outcome, we maximize the aggregate payoffs and calculate the optimal level of extraction for the individuals, x_i^{so}. That is

$$Max\ W = \sum Y_i = \sum ax_i - \frac{1}{2}b\sum x_i^2 + \varphi n^2 e - \varphi n \sum x_i \quad [5]$$

The first order conditions for this problem require that

$\frac{\partial W}{\partial x_i} = a - bx_i - \varphi n = 0$, yielding the solution to the problem:

$$x_i^{Soc.Opt} = \frac{a-\varphi n}{b}, \text{ for } x_i \in [1,e] \quad [6]$$

For the parameters chosen above, and for a group of n=5 players, such solution would require each player to allocate (60-5*20)/5 < 0. Since x_i takes only nonnegative values -for purposes of framing in the experimental design, we have a corner solution at $x_i^{so} = 1$, i.e. all players should allocate a minimum of effort into extraction to produce the socially efficient outcome. Notice, as n decreases, the Nash and social optimum solutions converge to the same solution.

With these parameters and payoff structure we have now a typical CPR problem with the basic properties of a social dilemma. The two corner solutions ($x_i^{so} = 1$ and $x_i^{nash} = 8$) provide a simple setting for an experimental design to be tested in the campus lab and the field lab[4].

The following two panels in Figure 1 illustrate the properties of this model. The graphs are derived from a model where player i chooses her extraction level, x_i, with $1 \le x_i \le 8$, and payoffs that follow the conditions described above. For a group of five players, the aggregate extraction should follow $5 \le \sum x_j \le 32$. The experimental design used in these experiments involved a payoffs table that we provided the players with to make their decision, and included in the appendix A. The working of the table is very simple: each player decides her level of extraction by choosing a column from 1 to 8. The player will realize her payoffs when the experimenter announces the group extraction and therefore she

[4] By "field lab " I refer to an experimental setting that resembles the same laboratory conditions but where the framing, the context and the participants or subjects are not anymore those of a campus but of a field setting where participants are familiar with the problem. However, the set of instructions, incentives and control remain similar to those in the campus lab. Harrison & List (2004) refer to these also as 'artefactual field experiments'.

can subtract her own extraction from the group to obtain the row in the table. The cell with her level of extraction (column) and their extraction (row) will give the player the payoffs for that round. Notice in the table and in the figures below that when everyone chooses x=1 the group maximizes payoffs whereas at x=8 the group ends at the Nash equilibrium.

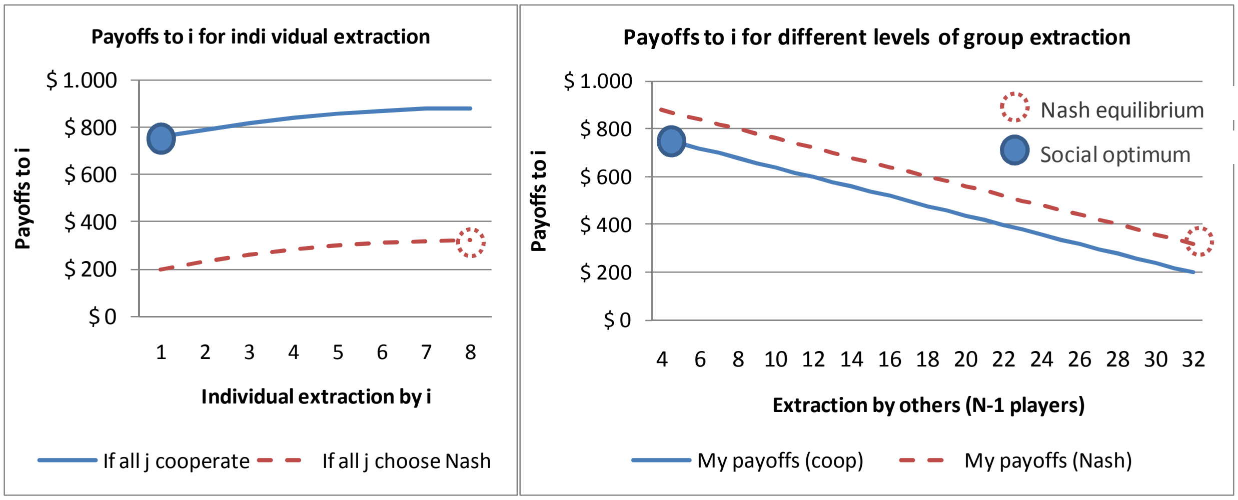

Figure 1. Two dimensions of the social dilemma in the commons.

Both panels in Fig.1 describe the basic monetary conditions for the social dilemma in a common-pool resource (CPR) problem. The two benchmarks of interest, a Nash equilibrium and a social optimum are shown as circles in the two panels as reference points.

In the left panel we see the payoffs for the player i as a function of her individual level of extraction under two scenarios. One, when all other players choose the cooperative strategy that maximizes the group outcome (solid line), and another when all other players choose their Nash strategy of maximizing their individual outcome (dotted line). The dotted line is obviously well below the cooperative solution as the Nash strategy leads every player towards the tragedy of the commons. The perspective of the individual action can be complemented in the right panel, using the (Schelling 1978) model of collective action, reversing the direction of the horizontal axis that shows in this case the aggregate extraction by the rest of the group extracting the commons. The vertical axis shows the payoffs to the ith player if using the cooperative or the Nash strategy. It is clear from both panels that a player maximizing her own individual payoffs in a one shot game with N-1 other players should follow her Nash strategy and increase her own extraction to the maximum (X_i=8).

In our parameterized model, at the Nash equilibrium each individual or the group makes about 42% of the income had the group reached the social optimum solution. This is the difference between the individual payoffs in the Nash and social optimum solution in the left panel. The gap between the two lines in the right panel explains why choosing the maximum individual extraction is a dominant strategy. Take for instance the payoffs at the Nash equilibrium. There, player i would have to forego 38% of her income ($320 - $198) if she were to follow the cooperative strategy and allocate 1 unit of effort instead of 8. Think at the other extreme, under a cooperative agreement among the five players at the social optimum. A player could increase earnings by 14% ($880-$758) by moving to the Nash strategy.

If this was a model with predictive power in an experimental setting, we would stop our research strategy right here and move on. However, this theoretical prediction explains only a small fraction of the data observed in the lab (with college students) or the field lab (with villagers that face these situations). In the next section I will describe the experimental design that tests this model and the results from around one thousand experimental participants and more than two hundred sessions among students and villagers who have participated in a repeated game setting and under different institutional treatments.

3. Testing the model in the campus lab and the field lab.

During the years of 2001 and 2002 we were able to visit ten villages in the coastal and Andean regions of Colombia and conduct several sessions of CPR experiments using this basic model. Groups of five voluntary participants were invited to participate in a session that lasted about two to three hours between explanations of the instructions, conducting the experiment and concluding with a short survey and payments to participants. Each participant earned in average between one and two day's wages depending on the decisions made. Payments were made in private and individual information was kept confidential.

In each of these sessions the players had to make decisions over 20 rounds in two stages. During the first 10 rounds (stage 1) they could not communicate with each other and were not subject to any other coordination device imposed by the experimenter or anyone else. During this stage each player had to write down her decision in a piece of paper collected by the experimenter who added the extraction of the group and announced publicly the group outcome. With the group outcome and the individual choice each player could calculate her payoffs in that round. Both choices and payoffs in each round were kept confidential. However, players would observe the group behavior and could easily notice if their individual extraction deviated below or above the average extraction of the rest in the group.

During the second stage, which we will explore later, each group was subject to a particular new institution that included self-governing mechanisms such as face-to-face communication, or externally imposed regulations with high and low fines and subsidies, or regulations that the players could vote on to be implemented.

The first 10 rounds in stage 1 provide baseline data about behavior that we can compare to when introducing new rules in round 11 and for the remaining of the session. With data from 219 experimental sessions and 1,095 participants (230 college students and 865 villagers from Colombia) we find that a small fraction of players choose the Nash strategy of the game (X_i=8) in the baseline game where the same five players decide over a 10 rounds session under no communication or any other coordination device.

The following histograms (Figure 2) show the frequencies of decisions for the first round (t=1), the aggregate for all ten rounds (t=1-10), and the last round (t=10). The overall data set for ten rounds of this experiment add up to 10,950 observations, probably the largest available for a singular experimental design of a CPR game.

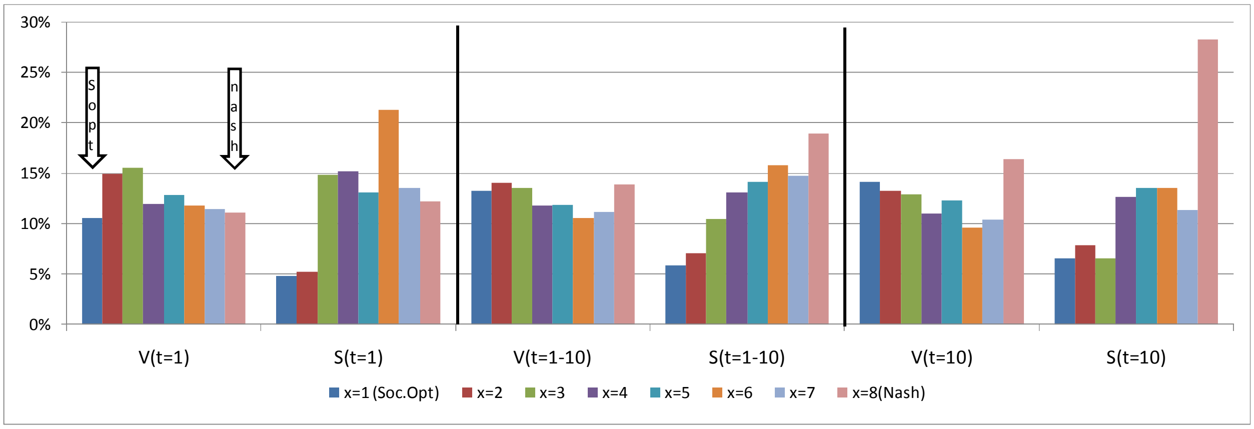

Figure 2. Histograms of decisions for baseline treatment, rounds 1 to 10 (stage 1). V=villagers, S=students. Sample: 219 sessions, 1,095 participants (865 villagers and 230 college students), 10,950 observations.

The patterns of the data shown in Figure 1 offer some first insights for the analysis of behavior in the lab. First of all, only a small fraction of people do behave as in the Nash prediction. The closest approximation is the case of a quarter of students that in round 10 follow such strategy. Yes, students seem to follow an increasing trend of moving towards such prediction but it does not seem to come to a full convergence. In fact a subset of 15 sessions of these experiments went all the way to 20 rounds under the baseline incentives, and for these the fraction of Nash choices accounted to 46% for students and 11.7% for villagers[5]. If we relax slightly the criterion to evaluate the choices of players considered as maximizing their own material payoffs, e.g. by evaluating those with extraction levels of x≥6, we still observe that 36.4% of cases for villagers and 53% for students follow these strategies in the game. In fact these proportions do not change much if one evaluates them for the very first round or for the entire sample.

The remaining behavior that does not fit the prediction of using the dominant strategy in every round (i.e. X=8) deserves an inquiry into the possible motivations that may shape behavior of these individuals. Take again the last round of this first stage of the game so that we allow for learning during the game. The social optimum choice (x=1) is chosen by 14.1% of villagers and by 6.5% of students. If we add the closer choices that are clearly pro-social (e.g. x≤3) we have about 40.3% of villagers and 20.9% of students deciding such level of extraction. After 9 rounds it should be clear to these people that by doing so they are foregoing some extra payoffs by deviating from the Nash strategy and towards the group outcome.

Is there room for social norms to play a role here? We think so. The experimental setting included a mild frame about a common-pool resource; the participants were sitting looking at each other; they probably had some expectations and knowledge about the previous history of the others in their group derived from previous exchanges before the experiment; they probably had implicit common understandings of the behavior that is 'socially desirable' and 'individually allowed' in these cases and for such context; and finally they may have some sympathy sentiments towards the others playing with them.

[5] Moreover, out of the 10,95 participants only 3 villagers and 2 students chose x=8 as their only strategy throughout the 10 rounds of the first stage of the game.

In the next section I will build these behavioral elements into the analysis and attempt to shed some lights to explain why it is so common to observe this behavior in the laboratory, with subject pools of students and non-students around the world and within several types of experiments on social dilemmas such as PD games, CPRs, voluntary contributions or public goods.

4. Richer behavioral micro foundations (Step 2: the role of motivations and social norms)

The new developments in several areas of the analysis of behavior can enrich our challenge of solving the puzzles above. In Cardenas (2009) I have outlined some of the relevant areas of research the environment and development from the experimental standpoint, and have also reviewed some of the more recent and relevant surveys worth mentioning here. Worth mentioning are the recent surveys by Sturm & Weimann (2006), Ehmke & Shogren (2009), & Ehmke (forthcoming), and Cardenas & Carpenter (2008) covering experimental work regarding the environment and development issues. With respect to the environment it is worth also mentioning the review made by Harrison (2006) who looked at the literature on laboratory experiments aimed at addressing criticisms related to hypothetical bias in the stated and revealed preferences of approaches that emphasize environmental valuation. Murphy & Stevens (2004) likewise evaluated the use of experiments to correct problems of hypothetical bias in contingent valuation studies. List & Gallet (2001) address the issue of hypothetical versus experimental valuations of environmental goods, showing an increase in the use of experimental methods for studying environmental and resource economics questions. A handbook chapter by Shogren (2005), shows the challenges for environmental valuation including tests of rationality in environmental choices, the problem of estimating the value of environmental goods, and the challenge of designing incentives dependent on the elicitation method. As noted by Shogren (2005), since the 1980s, several authors had already begun began calling attention to experimentation as something complementary to nonmarket valuation exercises, such as which were fashionable at the time. As for natural resource management, Ostrom (2006) surveyed the value of conducting laboratory and field experiments for the study of common-pool resource problems.

Many of the studies surveyed in these works identify a series of anomalies or deviations from the conventional game theoretical prediction of a self-oriented material payoffs maximizer with perfect information and calculations capacity. Among the most relevant patterns of behavior or domains of relevant phenomena for environmental and resource issues are the following:

- Contributions to Public Goods: See Alpizar et.al (2008a, 2008b); Barr (2003); Carpenter & Seki (2006); Carpenter et.al (2004); Falk et.al (2002) Gaechter et.al (2004); Gaechter and Hermman (2006); Herrmann et.al (2008); Ibañez & Carlsson (2009); Osés-Erasoa & Viladrich-Grau (2007); Rondeau et.al (2005).
- Cooperative behavior in Common-pool resources: Cardenas et.al (2000, 2002, 2005); Cardenas (2003, 2004); Cardenas & Ostrom (2004); Lopez et.al (2009); Velez et.al (2006); Ostrom et.al 1994; Rodriguez et.al (2006)
- Disparities between WTP/WTA in valuing environmental benefits: See List & Gallet (2001); Knetsch & Sinden (1984); Knetsch (1989): Harrison (2006); Shogren (2005); Sturm & Weimann (2006).
- Ecological or environmental intrinsic values: See Boyce et.al (1992); Caseya et.al (2008); Jack et.al (2008); Marette et.al (2008); Sandua et.al (2008).

Although this literature enriches the narrow homo-economicus model by bringing up evidence rejecting its main predictions, and by offering new theoretical pieces that could serve as basis for a better model of behavior, the integration of all these phenomena into one singular model is still missing.

Folmer (2009) evaluates the contributions of psychology, micro-economics and micro-sociology, and within economics he evaluates the contributions that the neoclassical, neo-institutional and behavioral economics approaches have brought to this challenge. He, however, is rather skeptical that the solution to explaining these anomalies or regularities in economic behavior is going to come from the discipline or any of these three paradigms. Instead, he calls for the use of a social rationality model, inspired by sociology, psychology and anthropology where bounded actions and social influences play a central role in choice and in a more integral manner. Folmer argues that the fragmentation of factors in the analysis of rationality may create risks of not getting the whole picture right. For instance, the interactions between material payoffs and intrinsic motivations might be missed if only the latter are taken into account when explaining why people decide to trust others.

In an attempt to combine the different levels of motivations, incentives and constraints from formal and non-formal institutions, Cardenas and Ostrom (2004) present a model of simultaneous layers that influence choice and transform the payoffs structure of a material incentives game into a subjective payoffs game that guides the final choice to cooperate or not in a social dilemma. The model developed there was influenced by the work that Ostrom (1998) had been proposing for a behavioral model of rational action in the problem of collective action. The layers include the material payoffs of the game and its basic conditions such as being a one-shot or a repeated game; the regulations that bind actions based on a level of enforcement; and also other layers of the game where the identity of the individual (e.g. her own moral norms) and group norms in which the game is being played interact with the material payoffs game, altering the weight that the incentives to free-ride have against the incentives to cooperate. In this framework, players go back and forth across these layers finding the relevant information from regulations, norms, biases, and material incentives until they find their best response in terms of subjective payoffs. The model is reprinted in Figure 3 below. This model was tested econometrically with a set of CPR experiments in the field, showing that a fraction of the variation in behavior can be explained by these individual and group based factors that the participants brought from outside of the laboratory.

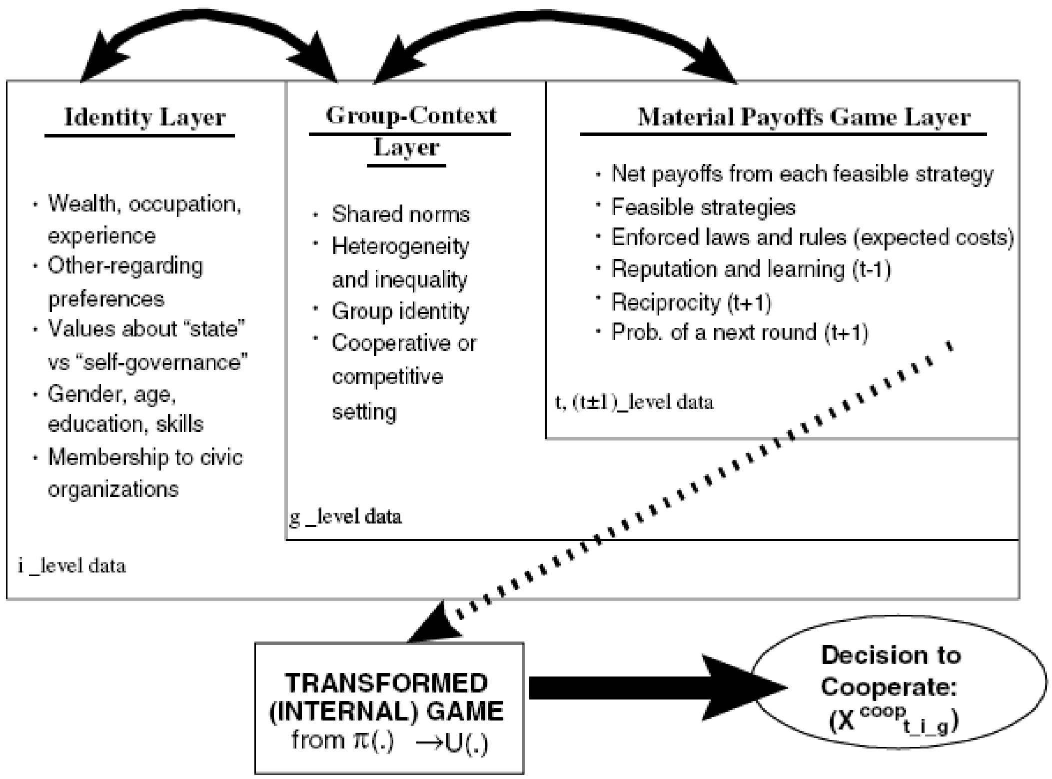

Figure 3. Layers of information that transform the material payoffs of a social dilemma. From Cardenas & Ostrom (2004).

With a similar flavor, Folmer (2009) brings the attention to the RREEMM model by Lindenberg, heavily influence by psychology. In such model both substantive and operational goals work as motivators for action, but the processing of information is subject to constraints in the capacity of processing data, and subject to trial and error algorithms with stopping rules that guide choices. Within this kind of framework individuals may not choose the optimal solution that the perfect data processing homo-economicus might be able to choose. Here the heuristics, the social norms and the limited capacity of data processing may bring players to other equilibria that may suffice for the substantive and operational goals of the individual but that might be sub-optimal if compared to the solution offered by the perfectly rational homo-economicus.

In all these new developments that responded to the narrow scope of the homo-economicus model, norms play a very prominent role. Elster (1989) creates a distinction between social norms and moral norms worth mentioning. In the case of former, he argues that a norm, to be social, needs to be shared by others and needs to be at least partially maintained through the approval or disapproval of those same people. Also, Elster argues that social norms are usually sustained through social emotions such as shame, guilt, or embarrassment. This author defines norm as *"the propensity to feel shame and to anticipate sanctions by others at the thought of behaving in a certain, forbidden way"* (page 105). When this propensity is shared with other people, it becomes a social norm. (Young 2008) defines social norms as *"customary rules of behaviour that coordinate our interactions with others"*. In his definition the idea that each player expects others to follow that particular way of acting is crucial to the emergence of norms as useful mechanisms for inducing cooperative behavior within a group that, as in our case, face a social dilemma.

Norms in general create two kinds of effects on individual behavior, they can limit choices and they can shape preferences (Baland & Platteau, 1996). In the first case, there are ways in which norms can limit the choices of players. For instance, recalling the principle of reciprocity by Sugden (1984), Baland & Platteau (1996) show how a social dilemma can be turned into a multiple coordinating equilibria game if players follow the reciprocal norm of "not free-riding when others are cooperating". If all players follow such norm, the game can produce many equilibria away from the zero cooperation solution, including the social optimum one. When norms shape preferences or expectations, several possibilities can emerge for the solution to the cooperation problem. The first one to be considered is that individuals derive utility from the improvements of well-being of others due to altruistic or cooperating actions. If the gift given to others yields enough utility that compensates the cost of the gift, such action might be a rational one. Next in line is a more complex possibility of transforming the utility function using the inequality aversion model of Fehr and Schmidt (1999) where individuals have a combination of utility from own payoffs, and disutilities from an advantageous inequality (guilt) and a disadvantageous inequality (envy) from the allocation of outcomes in the game. For the particular case of common pool resources Falk et.al (2002) test this model against experimental data from CPR games shedding some lights on how relative payoffs play an important role in pro-social behavior. For a more general treatment of these models see chapter 3 in Bowles (2004).

Finally, it could be useful to also mention the typology that Ostrom (2005) offers for her grammar of institutions (Crawford and Ostrom, 1995). Any institution, she argues, includes a syntax of five components (Attributes, Deontic, Aim, Conditions and OrElse). The Attributes describe who the institution applies to; the Deontic describes the "may, must and must not" conditions of the institution; the Aim describes the conditions of actions or outcomes to which the Deontic applies; the Conditions describe when an action is permitted, obligatory or forbidden; and the Or Else component assigns consequences to those not following the ruling. Using this syntax, Ostrom identifies *"Rules"* as those including the complete set of ADICO conditions above. If the institution lacks the Or Else condition we would have *"Norms"* (with the ADIC syntax). Finally, if the institution only includes the AIC components, Ostrom includes them in the category of *"shared strategies"*.

The reason for bringing this typology her is that it can enhance the analysis of norms by including the possibility of regulations that states or communities may have formalized into formal institutions. The vast majority of the local commons in the world today most likely include a combination of formal and informal institutions and therefore the interaction between norms, rules and shared strategies becomes essential.

Thanks to these institutional and behavioral factors that shape preferences, norms and limit actions, humans have been able to evolve the capacity to cooperate in social dilemmas. The ethnographic evidence compiled by Ostrom (1990) for the case of common-pool resources, and also documented by Baland & Platteau (1996) or Wade (1994) suggests that humans have been able to sustain a set of institutions that have harmonized individual and group interests in the use of natural resources. A theoretical work by Sethi & Somanathan (1996) from evolutionary game theory shows that norms can emerge in groups that share a common-pool resource via restraint and punishment by group members. Their model includes three types of players: defectors, enforcers who sanction defectors, and cooperators who do not sanction. Other theoretical works (Axelrod, 1981; Taylor, 1987) have shown that cooperation can emerge among selfish individuals if the right conditions for repetition in the game, low discounting of time and strategies such as the "nice tit-for-tat" emerge. Nowak (2006) provides probably the best summary of the five rules of cooperation that have been identified in nature and in humans, starting with the reciprocal altruism by Trivers (1971), and the strategies of direct, indirect and network reciprocities, to finally, group selection. The role that social preferences play in these models is important, as they allow players to care about the others and be able to sacrifice individual well-being on behalf of the group or some group members. Further, the inclusion of other-regarding preferences has been argued as critical for the study of ecological behavior (Gintis, 2000).

Van Lange et.al (2007) offer a more comprehensive account of the inter-personal orientations from social psychology that ultimately welcome both the self-oriented as well as the other-regarding preferences into one. In their approach players' have social orientations that are based on the individual and relative payoffs. He proposes five dimensions of interpersonal orientations: 1. Altruism: where an individual enhances the outcomes of others; 2. Prosocial orientation: where individuals enhance joint outcomes (cooperation) or the equality of outcomes (egalitarianism); 3. Individualism: enhancing the outcomes to self; 4. Competition: enhancing the relative outcomes in favor of self; and 5. Aggression: aiming at reducing the outcomes for other. The canonical model of homo-economicus would only focus on 3. But the evidence of consistent rational behavior in controlled experiments towards the other types is reported in Van Lange's work and others (See Barr et.al 2009 for a recent cross-cultural study using three bargaining games to test the consistency of a model of inequality aversion).

In summary, much of the literature that has contributed to move beyond the model of homo-economicus with new elements of bounded rationality, other-regarding preferences and the capacity to follow norms can now be grouped to offer insights for a model of social rationality as suggested by Folmer (2009). There are four key elements that are complementary and of use in our analysis of behavior in the commons:

- **Self-regarding preferences:** Individuals care about their material well-being and choose alternatives of action that increase their material payoffs. In the commons, extracting resources form the commons increases income and other sources of well-being.
- **Other-regarding preferences:** Individuals care about the payoffs of themselves relative to the payoffs of others in the group of reference. In the commons players may refrain themselves from extracting one more unit so that is left available for others. These other-regarding preferences include at least the following two options:
    - **Altruism:** Individuals are capable of foregoing personal material well-being to increase that of others through gifts.
    - **Inequity aversion:** Individuals dislike unfair outcomes in both directions, that is, in their favor (guilt) or in favor of others (envy), probably with larger disutility for the latter.
- **Ecological preferences:** Individuals place an intrinsic value on the existence of the environment or an ecosystem, including its components and flows.
- **Norms:** Individuals are capable to follow commonly shared norms that may reduce their material individual well-being.

There are other relevant elements of behavior that could play a role here (CARDENAS and CARPENTER 2008) but are left aside for the analysis that follows. I have already mentioned the applications of prospect theory (Kahneman & Tversky) and the endowment or loss aversion effects to environmental outcomes (Knetsch 1989). Other of the important effects include preferences over risk and over time that can shape inter-temporal decisions or decisions under uncertainty. The experimental design reported here, however, does not have the inter-temporal dimension and therefore is not included as an explanatory factor in the analysis of the observed data.

5. Explaining an interior equilibrium in the CPR experiment.

It has been shown in figure 2 that the group and individual behaviors of these experiments seem to move towards an interior point where some players choose the Nash strategy, others the cooperative strategy and others choose in between. As groups, the level of extraction does not move towards the full exhaustion of the resource, neither towards the socially optimum. Figure C.1 in the appendix shows a box plot graph for both subject pools suggesting that there is no clear trend towards any particular benchmark. The patterns are also statistically different[6] between students and villagers and therefore deserve a discussion of the plausible reasons.

Let us come back to the basic model pictured in Fig.1 and use a snapshot of the average choice observed in the lab, and what the individual and group incentives are like at one particular point. Suppose a particular player and her group are located at the average behavior observed in these experiments of 4 units of individual extraction and thus 20 units for the group. At this point a particular player can make \$518 if she chooses x=1 or \$640 if she chooses her Nash strategy (x=8), as one can see in Figure 1 or the payoffs table in the appendix. For any particular level of group extraction the Nash choice will give this player around \$122 monetary units above the cooperative strategy. This is the gap between the maximum and minimum levels shown in the left panel of Fig.1. These incentives however have to be contrasted with those shown in the right panel where the externalities to others are better depicted. Notice that every effort by one individual to move to the left (cooperate) increases the payoffs of both the Nash and Cooperative players. This is represented by the φ factor in equations [2] and [3], by the slope of the two curves in the right panel of Fig.1, and in the payoffs table in Appendix A. A reduction of one unit of extraction by one player increases the payoffs of each other player by φ=\$20 in our model. If player i moves to the left one step she is foregoing her personal income by some amount but is improving the outcome of the other four players by moving them on row up in the table, i.e. increasing everyone's earnings by \$20. Every column to the left decreases one's payoffs by some amount that is marginally increasing when moving from the dominant strategy to the social optimum. For instance, moving from x=8 to x=7 means foregoing only \$2, whereas moving from x=2 to x=1 implies foregoing \$32. At around the average level of extraction, moving from x=4 to x=3 each individual foregoes \$22 but increases everyone's payoffs by \$20. Rings a bell?.

Foregoing the income not earned by playing the Nash strategy may bring other impacts over the individual and group outcome that may justify its cost. The first one is that reducing one's extraction increases the public good component of the commons which affects also the others in the group. This is clear from the framing and from the payoff table structure. In that sense, moving from the high extraction to the low extraction level the player is providing a gift to the others in the group. To be more concrete, every unit that is not extracted provides a gift of \$80 to the group.

[6] A Two-sample Wilcoxon rank-sum (Mann-Whitney) test of differences in the group extraction across the two samples yields a z-value of -27.756 and a p-value=0.0000. Also, a non-parametric test for the equality of medians yields a p-value=0.000 for both individual and group extraction.

Our candidates from the models based on other-regarding preferences are altruism, inequity aversion and cooperation. By refraining from extracting one unit above the group average the individual is providing a public good to the group. Also, such choice helps equalizing the relative payoffs towards more equal distribution of effort and outcomes. In other words, free-riding or overextracting has the effect of creating more distance between the free-rider and the group, except of course when everybody free-rides.

On the other hand, by reducing extraction each player is also signaling that she is willing to forego income in order to contribute to the group outcome, which in turn can be interpreted by the group as a player that is willing to work towards a group oriented strategy which should bring everybody up to the social optimum. This signal can work in the direction that Sugden's norm of reciprocity that 'nobody should free-ride if the rest are cooperating'.

However, these processes would work just up to the point, otherwise a group under these motivations and mechanisms should move all the way towards the social optimum and we would be observing an assurance game or a coordination game rather than a social dilemma or a public goods, CPR or any n-prisoners' dilemma game.

So, the we can infer that some of these preferences and norms may be playing a role in the shift from the Nash equilibrium of zero-cooperation towards the intermediate point we observe in the vast sample of the commons experiment for both students and villagers.

Can groups shift further up in terms of social efficiency? The answer is yes. The next step in our analysis is to test the role of external and endogenous mechanisms that can be brought to the experiment and see their effectiveness in inducing individual behavior that is more group oriented.

6. Norms and Rules in the lab.

As mentioned before, the experiments conducted in this large sample included all a second stage of rounds (t=11-20) where participants faced a new institution that was aimed at solving the collective action problem. A sub-sample of the experiments we call "**Baseline**" were conducted under the same conditions of the first ten rounds, that is, players were told that they would play for another ten rounds under the exact same conditions where players made their decisions individually and privately, without communication or any other coordination device and with only the group outcome announced in every round.

The next set of sessions that I will label "**Self-Governance**" included the possibility of face-to-face communication among the five players in that session. Here we have two variations: one-shot communication and repeated communication. In the former, only for one time the group was allowed to talk for five minutes after which they had to sit and make their decisions for the remaining ten rounds. In the latter, the communication was allowed for five minutes in every round before the decision was made.

A third subset of sessions is grouped as "**External Regulations**". In these sessions we introduced a new rule aimed at achieving the goal of the social optimum that maximized the payoffs of the group. In each of these we explicitly told the participants the following:

"You may have noticed that if each player in the group chooses a level of extraction of 1 unit the group makes the maximum possible of points. With this rule we will try that the group earns the maximum possible. We will try with this rule that each player in your group chooses a LEVEL OF EXTRACTION of 1 unit."

After this paragraph we continued explaining the particular condition of the regulation. For some the violation of the rule implied a sanction with a certain probability of monitoring and enforcement. For others it did not imply a material sanction but a public announcement of the individual action made by the player. And for others it implied a subsidy for the inspected player if in compliance. However, we will focus on three cases that offer some insights into the role of rules and norms on behavior. The three cases will be when there was no fine to violators, a low fine, and a high fine. We will contrast this case with the cases where players were allowed to have a face-to-face conversation during the game.

Theoretical prediction of a homo-economicus model of behavior under regulation.

Let us first provide a benchmark game theoretical solution to the problem in the case of a player that maximizes material payoffs. See Cardenas (2004) for details on this experimental design and modeling, and Cardenas et.al 2000 for the first field experiment with an external regulation being tested. First of all we will assume that as in reality the regulator has limited resources for enforcement and therefore has a partial capacity to monitor and sanction violators of a norm.

The challenge for an external regulator is to design an instrument that induces an individual behavior across players that produces the social optimum. However, a more realistic regulatory setting will involve a level of incomplete monitoring and therefore private information by the local users given that regulators face a costly enforcement of the instrument. Using the model developed in equations [1] through [6] we can integrate the regulatory component for the case of a monetary consequence of violating the rule of the socially optimum solution, that is, when x=1. For this we introduce a regulation in the form of a fine *f*, with certain probability *p* of inspection, to individual levels of extraction that are above the social optimal solution, that is when x>1. Such regulation imposes an expected cost to the user, which he may balance against the certain benefit of over-extraction. These regulations can take many forms in the field[7], mostly through state governance systems of different types and levels, but in most cases involving a cost imposed to the resource user and a probability of monitoring and enforcement. In particular, equation [2] includes now the new expected payoffs function for a player i as follows:

$$Y_i = ax_i - \frac{1}{2}bx_i^2 + \varphi \sum_1^N (e_j - x_j) - pf(x_i - x_i^{SO}) \qquad [7]$$

This generates a new first-order conditions for the Nash solution that require the following equality to hold: $\frac{\partial Y_i}{\partial x_i} = a - bx_i - \varphi - pf = 0$, generating for the symmetric case a new Nash strategy for each player when facing the regulation:

$$x_i^{nash-REG} = \frac{a-\varphi-pf}{b}, \text{ for } x_i \in [1,e] \qquad [8]$$

---

[7] These costs of non-compliance include fine for over extraction, confiscation of equipment (e.g. chain saw, traps, boat engines, fishing nets), or prohibition of extraction for a certain period of time.

As the fine or the probability of enforcement increase, the player should reduce her extraction. A regulator may then combine the product (*p*f*) to optimize his resource constraints or to comply with legal constraints about the maximum fine allowed.

The trivial case of a zero fine or a zero probability of inspection yields the exact same Nash solution to the game shown in equation [4]. Once these two parameters are nonzero, the expected costs will affect the Nash strategy of the player

In our field experiments we tested three different values for the fine $0, $50 and $175. It easy for the reader to verify that if we set p=0.2, a fine f=50 will a player to shift her Nash strategy from x=8 to x=6 units, whereas a fine of $175 (also under p=0.2) would induce a Nash strategy that is equivalent to the social optimum solution. On the other hand, the benchmark to compare the face-to-face communication against is the "cheap talk" hypothesis that predicts no effect of any non-binding promise to cooperate since the decisions remain private and confidential. However, we know from a vast literature from social psychology and political science that communication does have a very strong effect on cooperative behavior (See chapter 7 in Ostrom et.al 1994 for a survey of such literature)

In the next figure 5 we graph the frequencies of decisions in the range from 1 to 8 units of extraction for all rounds in the second stage, and for the five institutions we want to compare to:

- **CX: One-shot communication**. The group can have, only once, a five minutes face-to-face communication before they start making their ten decisions.
- **CX-t: Repeated communication.** The group can have a five minutes conversation before each round.
- **XRH: High fine.** In each round one player is chosen randomly and if violating the rule (x=1) she pays $175 per unit of extraction above 1.
- **XRL: Low fine.** In each round one player is chosen randomly and if violating the rule (x=1) she pays $50 per unit of extraction above 1.
- **XnoR: No Fine and Public announcement**. In each round one player is chosen randomly and if violating the rule (x=1) she pays no fine and must show the monitor her extraction level which will be announced publicly to the group.

For purposes of simplification we have merged the students and villagers' data for the second stage without major effects on the analysis and results that follow[8].

Several results are of major importance here. First of all, all treatments have a positive effect on cooperation. The fraction of players following the social optimum strategy increases substantially if compared to the baseline data described in Figure 2. The two most effective institutions, with almost identical distributions are the repeated communication (CX-t) and the high fine (XRH). The cases of one-shot communication (CX) and the low fine (XRL) rate in a second place with similar results, and

[8] The patterns across the two subject pools in the second stage are quite similar for the sessions under these treatments. A Two-sample Wilcoxon rank-sum (Mann-Whitney) test yields a p-value=0.4216 for the individual extraction levels (n=4,200 observations). The test for differences in the median also shows no statistical difference.

finally the zero fine + public announcement case (XnoR) which shows also some degree of effectiveness by also shifting players towards lower levels of extraction.

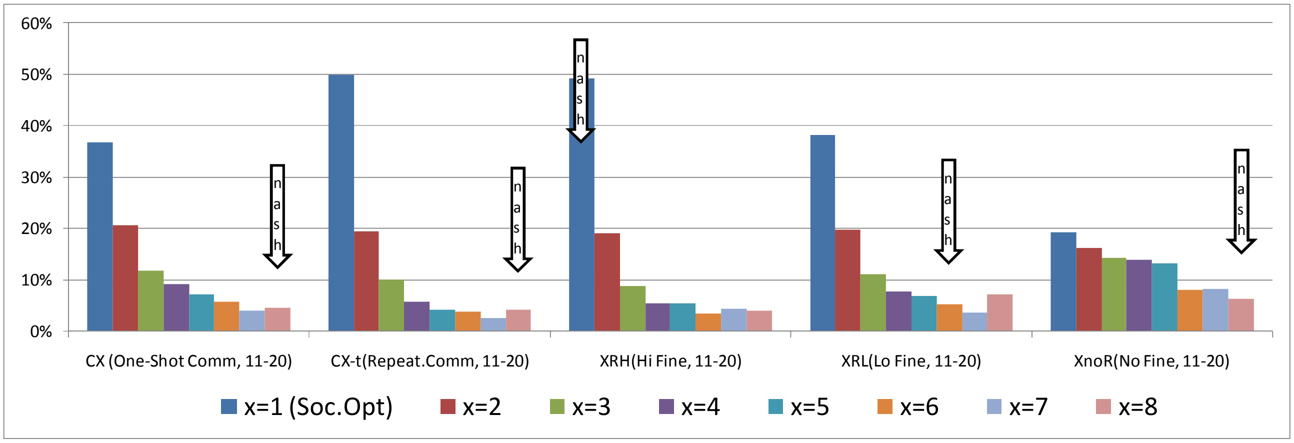

Figure 4. Histograms of decisions for different institutions, rounds 11 to 20 (stage 2).

In previous papers we have analyzed in further detail some of the comparisons within some of these treatments. Cardenas, Ahn & Ostrom (2004) discuss the differences between one-shot and repeated communication and how these self-governing mechanisms create norms that induce cooperation in the laboratory. The analysis –not shown here for space considerations- show that over time (rounds) the two communication institutions start with a strong cooperative behavior but the fraction of players choosing the optimal solution decreases over time in the one-shot communication case. We argue that the repeated communication serves the purpose of not only clarifying the solution among the players[9], that is, it helps to build a convention or coordination agreement regarding behavior, according to the definition by Young (2008) provided before; but the repeated communication setting also provides the other element that seems to operate for social norms, namely, the emotional component (Elster, 1989; Sethi & Somanathan, 1996) of inducing the non-material incentives (e.g. guilt and shame) among the players through the evaluative routine of discussing over the results of the previous rounds.

Let us turn now to the next three institutions in the right of Figure 4. As the model predicted, the level of cooperation increases with the expected cost $pf(x_i - x_i^{SO})$, but the data does not match exactly with the prediction of the Nash equilibrium. Notice, about half of people are extracting "too much" under the high fine (XRH) and "too many" people are extracting much less than they should in the low fine (XRL). Further, too many people are refraining to extract in the No-fine and public announcement rule (XnoR). Notice that the regulated cases (XRH and XRL), individual and group extraction did decrease and earnings went up significantly. However, the difference between the high and low fines is rather small in terms of observed behavior. In both cases a large fraction of players shifted their actions towards the behavior mandated by the norm, namely, x=1. Between 40 and 50% of decisions matched the prescription of x=1 unit of extraction. A median test across the two types of regulations suggests

[9] Notice, in the face-to-face communication treatments the experimenter does not provide the optimal solution to the players as in the regulation cases.

that there was no major difference between the two mechanisms for round t=11 right after the regulation was imposed. Further, the difference in behavior did not change or diverge across the two levels of fines over time.

Given that all three institutions do have a previous stage of our baseline treatment (Figure 2), we can attribute these differences in behavior to the regulatory institution. However, the data may suggest that the effect of a change in the material incentives is interacting with the non-material incentives created also by the introduction of these institutions. The normative role that the experimenter plays as yet another external authority in the experiment is part of the explanation. Secondly, the introduction of the regulation does include a normative component of explicitly mentioning that it is aimed at maximizing the group outcome. From the stand point of the expected cost of the regulation, in a Beckerian world, this introduction of the external regulation brings a change in relative prices and therefore a change in behavior. The regulation may change also the relative opportunity cost of cooperating by enhancing certain elements of the social preferences of the players. It is just an extension of (North 1990), institutions change relative prices, including the "prices" associated with emotions or other-regarding preferences.

In two papers that use part of these data Cardenas (2004) and Rodriguez et.al (2008) we discuss the cases of low vs high fines (XRH and XRL) against two other possibilities where players could vote for the implementation of these regulations. In those studies we compare the behavior of the cases when the regulation was passed and those where it did not. Among the more striking results of those experiments is that the behavior of individuals who rejected the regulation and preferred to continue playing under the baseline setting –without any monitoring and fining was however as cooperative in the first rounds after t=11. Then other mechanisms entered into action (e.g. reciprocity) and cooperation decreased over rounds but still those who rejected the monetary component of the regulation seemed to have internalized its normative element that shaped the emergence of a social norm to guide their behavior.

The model proposed in Rodriguez et.al (2008) which also uses a simulation exercise to replicate these experiments, includes three types of players with different preferences (Selfish, Conditional Cooperator and Unconditional Cooperator). The argument there is that the introduction of even weak regulations, with the right balance of social preferences and mix of types of players can change preferences and induce behavior that is more cooperative that a model where all players act as selfish or homo-economicus.

The natural world does have a setting for common-pool resource users where both external regulations that alter relative prices and social norms that affect the non-material incentives coexist. This is the approach in the model of layers of information described in Figure 3. A commons user will switch back and forth between the layer of the material payoffs, estimate a rational best response based on the incentives and expected costs of the regulation, but she will also go to the layer of information that alters the non-material payoffs because of intrinsic motivations or the social emotions exercised by others in the group that share the same social norms. At the end the player will transform the payoffs obtained in the material payoffs layer into subjective values and eventually will see the problem not anymore as a social dilemma but as an assurance game (Baland & Platteau, 1996). Other players may give less weights to those subjective payoffs and continue to see the game as a cooperation problem.

7. Final remarks: the value added of doing experiments in the campus lab and the field lab.

We have reported here a set of experiments that combine two elements that are common in the natural world of commons users: social norms that shape behavior and external regulations that shape relative prices. Separating these two components that usually interact in the world of the commons, thanks to laboratory experiments can help us test alternative theories of behavior that seem to respond to different incentives, some of which may be material and others non-material, due to intrinsic motivations. Nevertheless, the results reported here also suggest that even if we try in the lab to isolate one single mechanism (e.g. a regulation that imposes a fine on over-extraction, with a partial level of monitoring) individuals will anyway bring to the lab their own subjective valuation of such mechanism and combine it to enrich their decision making in ways that cannot be explained only through a simple model of a rational maximize of the short-run material payoffs to self.

These experiments confirm that individuals do pay attention to the changes in the relative prices of cooperation and over extraction in the commons, but that they are willing to forego material payoffs from a Nash strategy to satisfy the need to comply with social norms. These social norms sometimes come from external regulators, other from the own group.

By doing these controlled experiments in the field we also enrich the possibility that the actual context of the participants be part of the game and therefore we learn more about the interactions between the social norms that are built before the experiment and what happens during the experiment. One example can be seen in Cardenas (2003) where the actual social distance among the experimental subjects measured by the differences in the real wealth they had in the village explained the willingness to cooperate in the experiment during similar common-pool resource games.

The external validity controversy will now extend to the argument above. In the same manner that we need to continue exploring the degree to which people in a controlled experiment will respond similarly to the incentives and institutional changes in the natural world, we will have to test also that the interactions between norms and rules that we observe in the lab will also replicate outside. This will require more creativity in maintaining control and at the same time enrich the experimental designs we test (Cardenas, 2009). Doing so in the field lab will be complementary to testing some of these hypotheses in the campus lab with students.

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Appendix A. Payoffs table.

THEIR EXTRACTION

	My level of extraction							
Their total	1	2	3	4	5	6	7	8	Su promedio
4	758	790	818	840	858	870	878	880	1
5	738	770	798	820	838	850	858	860	1
6	718	750	778	800	818	830	838	840	2
7	698	730	758	780	798	810	818	820	2
8	678	710	738	760	778	790	798	800	2
9	658	690	718	740	758	770	778	780	2
10	638	670	698	720	738	750	758	760	3
11	618	650	678	700	718	730	738	740	3
12	598	630	658	680	698	710	718	720	3
13	578	610	638	660	678	690	698	700	3
14	558	590	618	640	658	670	678	680	4
15	538	570	598	620	638	650	658	660	4
16	518	550	578	600	618	630	638	640	4
17	498	530	558	580	598	610	618	620	4
18	478	510	538	560	578	590	598	600	5
19	458	490	518	540	558	570	578	580	5
20	438	470	498	520	538	550	558	560	5
21	418	450	478	500	518	530	538	540	5
22	398	430	458	480	498	510	518	520	6
23	378	410	438	460	478	490	498	500	6
24	358	390	418	440	458	470	478	480	6
25	338	370	398	420	438	450	458	460	6
26	318	350	378	400	418	430	438	440	7
27	298	330	358	380	398	410	418	420	7
28	278	310	338	360	378	390	398	400	7
29	258	290	318	340	358	370	378	380	7
30	238	270	298	320	338	350	358	360	8
31	218	250	278	300	318	330	338	340	8
32	198	230	258	280	298	310	318	320	8

Appendix B. Experimental protocol summary.

The following stages were conducted for each of the sessions or groups.

Pre-game stage (instructions and practice rounds):

Each of the experiments begins with the reading of the instructions to the group of five players, and the handing out of the following forms (available from author): the GAME CARDS where they write their choice, i.e her extraction level, in each round; the DECISIONS RECORDS SHEET where they keep record of their choices and earnings; and the PAYOFF TABLE (see appendix). Once all questions from participants are clarified, the experimenter continues by conducting one round as an example, and at least one more practice round. After solving questions, stage 1 begins.

Stage 1 (Rounds 1-10):

In stage 1 of the experiment each of the players must decide privately the individual level of extraction from the commons, and write it down in one yellow round card; the same information is also recorded in the blue records sheet. The monitor collects the 5 cards, adds the total extraction for the group which he writes in the monitor's record sheet, and announces publicly such total. Each player must write the group's total, and by subtracting her individual extraction, she is able to calculate the payoffs for that round. She writes her total gains for the round and the experiment proceeds to the next round by filling a new round card. It was common information that round 10 was the final under such rules. Once they had finished calculating their earnings for round 10, they were told that the rules of the exercise were going to change for stage 2 of the game. Also, they were never told in advance what the rules for the second stage were.

Stage 2 (New rule, Rounds 11-20):

The second stage started by announcing that they will be playing for another 10 rounds under a new set of rules.

For the case of the face-to-face communication we started stage 2 by saying to the participants that in every round, and before they made their decisions, they would be allowed to have a 3-5 minutes discussion on anything they wanted about the development of the game and that no arrangements were allowed to redistribute earnings once the experiment had ended. However, they were told, decisions remained individual and confidential.

For the groups under the regulation treatments, the second stage started by the monitor explaining how they probably had noticed that the group could earn the maximum of points if every player chose a level of extraction equals to one unit (this information was not given to the communication groups though)[10]. They were also told that for achieving such goal the monitor would choose randomly in every round one player and would verify her compliance with the stated rule. Had the player chosen a higher level of extraction, she would see her earnings reduced in $50 ($175 for the high penalty treatment) times the units of extraction above 1. For the case of no fine, the monitor would announce publicly the extraction level of the randomly chosen player, and continue to the next round.

We also had control groups under a baseline treatment with no change in the rules for the second stage.

[10] The reason for announcing this is to make sure that the players have a benchmark to compare to when facing a penalty if chosen for the inspection, and that the external policy is common knowledge. It was very clear in many sessions that by round 10 of the first stage such was the social optimum solution for many of the players. In no single occasion such solution was questioned, although we did allowed participants to make questions before stage 2 begun.

Exit stage (Calculate earnings, fill out survey):

After all rounds from stage 2 end, the monitors calculated total earnings for each player by adding the column of round earnings and subtracting the cases where a fine was imposed. While the monitor made the calculations, the players responded the exit survey anonymously and in private. Then payments were made in cash to each player and in private, upon returning the filled survey.

Appendix C.

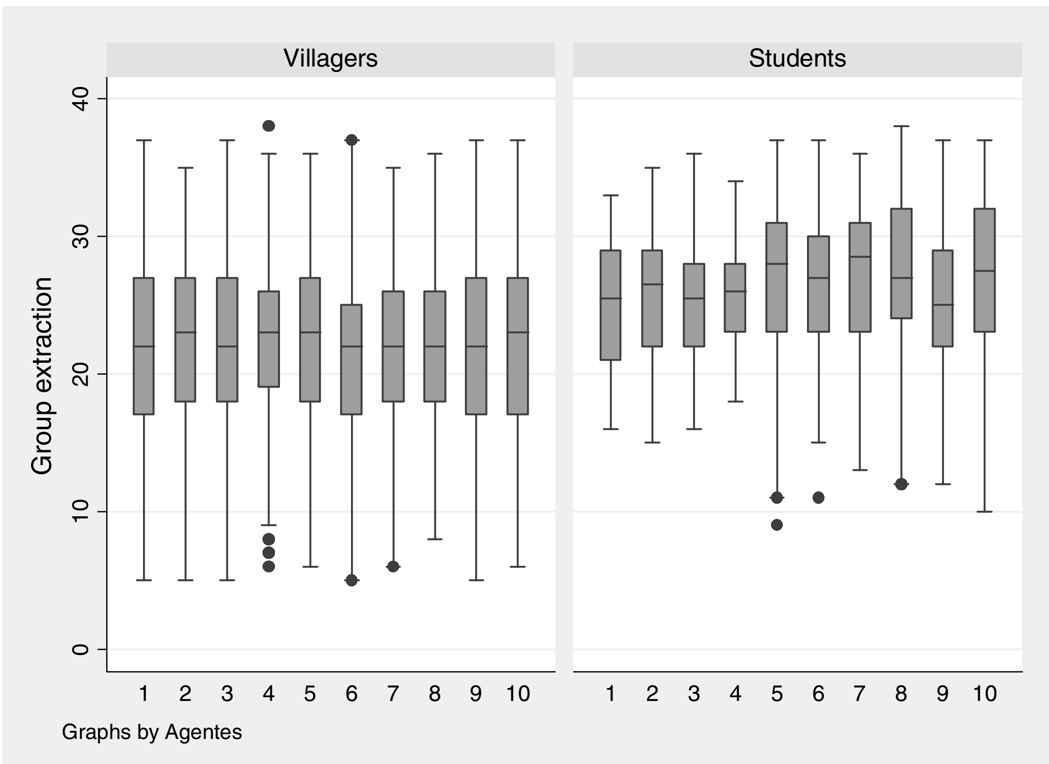

Figure Appendix C.1. Box plot of group extraction over rounds, for the baseline game, and by subject pool.