WO1-4 4/16/01

WHAT DO PEOPLE BRING INTO THE GAME?
HOW NORMS HELP OVERCOME THE TRAGEDY OF THE COMMONS

By **Juan-Camilo Cárdenas** and **Elinor Ostrom***

* Cardenas: Facultad de Estudios Ambientales y Rurales, Universidad Javeriana, Bogota, COLOMBIA (e-mail: jccarden@javeriana.edu.co); Ostrom: Workshop in Political Theory and Policy Analysis, and Center for the Study of Institutions, Population, and Environmental Change, Indiana University, Bloomington, IN 47408-3895 (e-mail: ostrom@indiana.edu). Prepared for presentation at the Norms and the Law seminar organized by the Center for Interdisciplinary Studies, Washington University School of Law, St. Louis, Missouri, March 30-31, 2001. Support received from the National Science Foundation (Grant #s SBR-9319835 and SBR-9521918) and the Bradley Foundation is gratefully acknowledged. Cardenas thanks the Workshop for providing a one-year appointment as Visiting Scholar during 1999-2000 and the RFF Joseph L. Fisher Dissertation Award grant. Comments by Mike McGinnis and James Walker on past versions helped improve this version as well as the excellent editing by Patty Zielinski.

* * * * *

WORKSHOP IN POLITICAL THEORY AND POLICY ANALYSIS

INDIANA UNIVERSITY, 513 NORTH PARK, BLOOMINGTON, IN 47408-3895

Phone: 812-855-0441 / Fax: 812-855-3150

workshop@indiana.edu

http://www.indiana.edu/~workshop

What Do People Bring Into the Game?
How Norms Help Overcome the Tragedy of the Commons

By **Juan-Camilo Cárdenas** and **Elinor Ostrom***

Contemporary economic theory is one of the more successful, empirically verified, social science theories to explain human behavior. It does best, however, in the settings for which it was developed the exchange of goods and services in an open, competitive market. The theory is based on a theory of goods, an institutional mechanism, and a model of human behavior. When the goods involved are not easily excludable and rivalrous, individuals tend to use nonmarket institutions. In these settings, the model of the individual *(homo economicus)* no longer generates empirically verifiable predictions (Elinor Ostrom et al. 1994; Colin F. Camerer, 1997, 1998; Herbert Gintis, 2000). Governing and managing renewable, common-pool resources (CPRs) in an economically and ecologically sustainable manner is a problem where economic theory does not generate clear predictions supported by empirical evidence in experimental or field settings (Michael D. McGinnis, 2000).

In public good experiments, for example, instead of contributing nothing to the provision of a public good, as is predicted by neoclassical theory, individuals tend to contribute between 40 to 60 percent of their assets in a one-shot game (Douglas D. Davis and Charles A. Holt, 1993). In repeated games, the level of contribution starts at around 50 percent but slowly decays toward the predicted zero level (John O. Ledyard, 1995). With nonbinding communication cheap talk or with the possibility of punishing those who do not contribute, however, subjects are able to sustain cooperation for long periods of time (David Sally, 1995). Similarly, subjects tend to approach optimal withdrawal levels in common-pool resource experiments when they are able to communicate, come to their own agreements, and use agreed-upon punishments if someone deviates from the agreement (Ostrom et al., 1994).[1]

Field studies also find that the theoretical predictions of users trapped in inexorable tragedies (Garrett Hardin, 1968) are frequently not confirmed (Daniel W. Bromley et al., 1992; Elinor Ostrom, 1990). Achieving effective, self-organized solutions is, on the other hand, not a guaranteed outcome, but attributes of resources and of participants have consistently been found to affect levels of organization (Clark Gibson et al., 2000). Political economists face a major theoretical challenge to construct a behavioral theory of human behavior consistent with contemporary economic theory when applied to the exchange of private goods in full-information, market settings (Albert Hirschmann, 1985). The theory needs to encompass a full array of goods, a broader model of the individual (including the types of norms adopted by individuals), the importance of group characteristics, the possibilities for using reputation and reciprocity, and the specific rules used in particular settings. Given the number of variables potentially involved, identifying how they are interlinked is one of the most important next steps toward a new theoretical synthesis. In this paper, we take a small step in this direction.

An encouraging theoretical breakthrough of recent times is the indirect evolutionary approach pioneered by Werner Guth and colleagues (Werner Guth, 1995; Werner Guth and Hartmut Kliemt, 1998). Guth provides a theoretical demonstration that norms of reciprocity can adapt within a game over a relatively small number of iterations. Gu̇th's theoretical model is of a two-person game of trust, and initial experiments to test his theory generates results consistent with it (Steffan Huck and J. Oechssler, 1999). In this paper, we first introduce the reader to the indirect evolutionary approach to a game of trust and the initial testing of this model. Second, we construct a common-pool resource game in which individual norms have the possibility of evolving over time. Third, we examine the empirical veracity of this theory using empirical findings in several laboratory and field experiments. We find that several anomalies are explained by adding the possibility that individuals bring norms to a game that are then affected by the game structure itself as well as the structure of the group in which they find themselves. Fourth, we present a general framework that is useful in helping to identify the multiple contextual layers that affect how individuals behave in common-pool resource dilemmas and other social dilemmas of broad interest to political economists as well as policymakers.

I. An Indirect Evolutionary Approach to a Game of Trust

Recent work on an indirect evolutionary approach to understanding human behavior offers a rigorous theoretical approach to understanding how preferencesCincluding those associated with social norms may evolve (or adapt) as a result of a learning process (Werner Guth and Menahem Yaari, 1992; Guth, 1995). Social dilemmas associated with games of trust are a particularly useful theoretical environment in which to discuss the indirect evolutionary approach, especially since recent empirical studies provide evidence consistent with this theory.

In a 2-person game of trust, Player 1 must decide whether to trust a Player 2 to perform an act that will return that player a smaller material payoff than breaching the trust of Player 1. The starred payoffs in Figure 1 represent a standardized version of the material outcomes of this game. As shown in Figure 1, the first mover can either trust, T, or not trust, NT, Player 2. If Player 1 does not trust Player 2, both receive a material reward less than one that is feasible. If Player 1 trusts, Player 2 faces the temptation not to perform, NP, and will receive a higher material reward than if Player 2 performs, P, the desired action. Most forms of contractual relations have this basic structure. Such contracts may relate to strictly private goods or involve the provision of a public good or the maintenance of a common-pool resource or a household.

[Figure 1 about here]

For a rational egoist playing this game, the material outcomes are linearly related to utility. One can simply drop the stars in Figure 1 to reflect such a player's preference. For such players, the equilibrium strategy is for Player 1 to choose NT because Player 1 can predict that Player 2 will choose NP. Thus, both players end up with s^* in objective terms when they could have realized $r^* > s^*$. The regular policy "solution" to this problem is to propose the creation of a third party enforcer who will rigorously enforce all contracts. The third party enforcer removes the dilemma of contractual relationships. While this is an external solution, the cost of the enforcer is rarely taken into account. And, why the enforcer might perform his own costly actions rather than shirk or seek illegal rents is ignored.

To represent the utility function of individuals who have learned a social norm, such as to return trust with performance, it is necessary to add a term to the material payoffs to reflect the internal benefits and costs of taking actions consistent or inconsistent with the norm (see Sue Crawford and Elinor Ostrom, 1995). Thus in Figure 2, representing the trust game with payoffs in utility space, a change parameter, m, has been added to reflect the subjective payoffs of breaching trust to be added to the material payoff. The parameter, m, can now be used to represent a trustworthy, $\underline{m}$ type for whom $\underline{m} + 1 < r$ ($\underline{m} < r-1 < 0$) and an opportunist $\overline{m}$ type for whom $\overline{m} + 1 > r$ ($\overline{m} > r-1$). For the trustworthy type, the choice of P is rational; while for the opportunist, the choice of NP is rational. Obviously the value of m could vary substantially from one person to another, but all m's will fall somewhere within the two inequalities. Thus, one can characterize the variance of utilities as falling into two broad categories.

[Figure 2 about here]

While the value of m affects the choice that an individual makes, it does not affect the objective payoff received after decisions are made regarding the moves taken. Thus, social norms may lead individuals to behave differently in the same objective situation depending on how strongly an individual values conformance with (or deviance from) the norm. By their behavior, however, different types of players are more or less likely to gain higher objective returns. In an evolutionary process, one can posit a game where nature chooses which of the two m-types will hold the position of Player 1 or Player 2. If this game is one of complete information so that Player 1 knows the type of Player 2, then all Player 1's (no matter which type they are) will play NT when faced with an opportunist and will play T when facing a trustworthy type. Trustworthy types will receive more opportunities to perform and receive r, and opportunists will only receive s.

In an evolutionary process, only one type would survive in a complete information setting the trustworthy type (Güth and Kliemt, 1998: 386). Viewed as a cultural evolutionary process, new entrants to the population would be more likely to adopt the preference ordering of those who obtained the higher material payoffs in the immediate past (Robert Boyd and Peter J. Richerson, 1985). Viewed as a learning process, those who were less successful would tend to learn the values of those who had achieved higher material rewards (Tilman Börgers and Roger Sarin, 1997). In a setting where a player's type is common knowledge, opportunists would not survive.

If only information about the proportion, q, of a population that is trustworthy is known, however, and no information is known about the type of a specific player, then Guth and Kliemt (1998) have shown that first players will trust Player 2's so long as $qr > s$. In such a setting, the share of the population held by the trustworthy types is bound to decline. On the other hand, if there is a noisy signal (Robert Frank, 1987) about a player's type that is at least more accurate than random, the trustworthy type will survive as a substantial proportion of the population.

Joel Guttman (1999) has undertaken an indirect evolutionary analysis of a finitely repeated PD game in which players can decide to stay with the same partner with whom they are randomly matched or exit after a transaction and be matched with a new partner. He finds that even starting with a very small proportion of reciprocator-type players, encourages opportunist-types to reciprocate during most of their transactions and only defect in the last period. Thus, the important result of David M. Kreps et al. (1982) that cooperation can be an equilibrium in a finitely repeated PD game has now been embedded in an endogenous process whereby reciprocator-types survive in a competitive, evolutionary environment and their presence induces rational egoists to mimic their behavior (and gain a reputation for reciprocation) until the last periods of the game.

From the initial work applying the indirect evolutionary approach, one can make several conclusions. First, individuals who adopt social norms consistent with conditional cooperation are able to survive in repeated dilemma situations so long as at least a small proportion of the players starts off as norm-following types and some information about individual player types is generally known. Second, the long-term growth of norm-following types in a population is more dependent on the development of mechanisms for revealing players' types than on the initial distribution of types in the beginning of a process. Developing low-cost methods to reveal the reliability of participants is thus a crucial step in enabling trustworthy participants to perform and thus return a higher outcome to themselves and the discriminating trustors. This is, of course, consistent with the historical findings of institutional economists (Paul R. Milgrom et al., 1990).

II. Revisiting the Common-Pool Resource Game

Evidence that appears to be consistent with the indirect evolutionary approach has been generated in a series of laboratory experiments conducted at Indiana University and field experiments conducted in three rural villages in Colombia. While the specific parameters differed, the underlying game structure was a common-pool resource game (see Ostrom et al., 1994; Juan-Camilo Cárdenas, 2000a). In both sets of experiments, a series of eight players were faced with a decision to invest or retain assets in a common-pool resource. In the laboratory experiment (OGW-CPR), subjects were assigned tokens that could be invested in an arena where returns were based on the investments of others or in an arena with a constant return (similar to a wage rate). In the field experiments (JCC-CPR), subjects who were familiar with the problems of managing local forests were given instructions that they could allocate up to eight months time harvesting from a forest. Both games have equivalent incentives and dilemmas where the Nash strategy yields an inferior solution, and where there are strong individual incentives to deviate from a social optimal strategy.

When subjects made independent decisions without prior communication, the outcomes achieved in both settings approached the Nash equilibrium after several initial rounds of play. When subjects in both environments were allowed to engage in nonbinding communication, however, they substantially increased the value of the joint returns achieved. The variance in outcomes achieved was greater in the field experiments where subjects knew who the other players were than in the field experiments where university students were unlikely to know one another outside the experimental setting.

The common-pool resource game with communication can be reinterpreted in a manner consistent with the indirect evolutionary approach so as to examine hypotheses derived from that theory using the data from these experiments. If we consider the case of face-to-face communication where the group agrees on choosing an allocation that yields the social optimal outcome (in OGW-CPR, this corresponds to all 8 players allocating 4 or 5 tokens to the private account; in JCC-CPR, this corresponds to all 8 players allocating 1 month in the forest), we can analyze the problem from the standpoint of each player that faces the choice to cooperate following an agreement or to deviate and follow a best response based on the payoffs. In this interpretation, the group can be viewed as the first mover who may trust or not trust the i^{th} player who now holds an analogous position to the second player in the trust game. If the i^{th} player chooses to cooperate, i.e. allocate Xi^{S0}, then the social optimum is achieved. If the player decides to follow the best response according to a pure material payoffs maximization, however, the payoffs for the rest of the group are reduced by a certain amount while the gains of the eighth player increase considerably. We represent this interpretation in Figure 3 as a sequential trust game with the payoffs involved in the two CPR designs described. We can observe the similarities with the Trust game by Güth and Kliemt (see Figure 3). In the two panels, we represent the game where the payoffs in the bottom are the average gains for the rest of the group members, and the gains for the second mover, player i.

[Figure 3 about here]

Notice the similarities with the basic structure of the trust game. If the group does not create a sufficient collective level of trust, they will all follow the Nash strategy. In this case, the best response for player i would be to follow the Nash strategy also. This takes all players to the left branch of the game yielding $155 or $0.66 in earnings for the two designs. By cooperating just as the rest of the group, all players achieve the social optimum yielding $645 or $0.90, respectively. By choosing the Nash strategy after being trusted by the group, player i can increase considerably his/her payoffs earning to $891 or $1.35 while reducing the others' average payoffs to $583 or $0.84.

There is a difference, though, with the payoffs structure proposed by Güth and Kliemt. In their design the inequality $l>r>s>0$ does not follow in the CPR structures used here. In these cases, the payoffs to the rest in the group when player i exploits or does not perform is still better than the payoffs when there is no cooperation at all. The reason for this difference is that when seven out of eight players cooperate, there is still sufficient provision of the public good for the seven cooperators to benefit even if player i free-rides on the partial cooperation. Obviously, as group size decreases such inequality would reverse, with the extreme case of a two-player CPR dilemma. This difference with the trust game structure, however, does not seem to invalidate the main points of the present analysis where we are interested in the behavior of player i and his/her incentives to cooperate or not.

In a game with these payoffs, the strategy that a material payoffs maximizer should follow as player i after the group agrees to cooperate and chooses the group maximizing strategy, would be to deviate (exploit) and play his/her best response. However, when face-to-face communication is introduced into this game, a considerable number of players seem to follow the cooperation strategy.

A. **Introducing Subjective Payoffs**

The indirect evolutionary approach suggests that people transform the material incentives in a game into subjective payoffs. This may explain why some people may rationally choose to perform after being trusted by others. The utility incentives in the trust game assume that if $m+1 < r$ then we have a trustworthy ($\underline{m}$ type), while if $m+l>r$ we have a rational egoist ($\overline{m}$ type).

Using the parameters of the field experiments we can also make the transformation (see Figure 4) and assume that the second mover, player i, can also be of certain m type, where the subjective payoffs are transformed as in the Güth and Kliemt model. Therefore, if \$891+m < \$645, player i would be considered a trustworthy person and should then choose $Xi=l=Xi^{S0}$. In such case, for the trustworthy, the \$246 (891-645) extra earnings are not worth the \$62 (645-583) losses induced to each of the rest in the group. In the case of the rational egoist, where \$891+m>645, $\overline{m}$ would have values greater than -246 inducing player i to follow the Nash best response.

[Figure 4 about here]

In the same way that we find field evidence of groups both failing and succeeding in managing a similar pool of resources that are commonly owned, we find both cooperators and egoists in the experimental lab under the exact same payoffs' incentives. Therefore, we have a theory that is both rejected and confirmed by empirical evidence. Such is the case of predicting if individuals in the lab may cooperate in a collective action dilemma when there are clear material incentives not to do so. Fortunately, we have begun to understand several factors that induce cooperative behavior in humans despite clear incentives that should make them act opportunistically if they were to behave as *homo economicus.* We observe in many social exchange relations involving coordination and conflict problems that people do contribute to public goods and do participate in collective action, although not always. On the other hand, the extensive evidence from experimental research still shows a great variation of levels of cooperation within the exact same treatment. This variation cannot be explained by the laboratory setting or the rules induced by the experimenter. It may, rather, emerge from elements that the subjects bring into the lab from their own experience, values, or background.

However, some elements of the experimental design of the game seem to show consistency. First, there seems to be a set of innate elements of human behavior, such as loss aversion, fairness, and reciprocity that would make the *homo economicus* model unlikely to fit the behavior of individuals. Strong support now exists that (1) when the situation involves elements such as being a repeated game, (2) when there is a certain probability of meeting the same counterparts in the next round, and (3) when institutions transform the preferences of the players by creating, nonpecuniary rewards from cooperation and penalties from defection, people might choose to cooperate rather than defect. When they do cooperate, they yield outcomes with levels of social efficiency that are greater than the prediction of the likely behavior of selfish and narrow free-rider agents. The next sections go into detail on these factors and empirical evidence about some of them.

III. Layers of Information that People Bring into the Game

Institutions as "rules of the game" transform many elements involved in the decision of the individual. Most of these elements enter the decision as information or lack of it about several components of the game. Some of the most important information pieces with which institutions provide people are the expected benefits and costs to the player and to others from feasible actions, the expected behavior by the others, the feasible strategies, and the nonmaterial rewards and penalties from certain behaviors by other players in the game.

Elinor Ostrom (1998, 2000) argues that studying the context in which a game happens is crucial because institutions do at least three key jobs in affecting individuals' decisions to cooperate. First, institutions teach and reinforce certain social norms. Second, they allow participants to gather information about behavior of others. And third, they entitle other people to reward and punish certain behaviors with material and nonmaterial incentives. Again, notice that these three are flows of information that individuals use when deciding to cooperate or not cooperate in a collective action dilemma. Following then our proposal for an indirect evolutionary model, what these sets of information provided by institutions are doing is to affect the transformation that the individual makes from the objective material payoffs into their internal subjective ones. The subjective payoffs are the one the player will ultimately use to choose a rational strategy to follow.

Notice, however, that an individual will *simultaneously* use several sets of information to make the decision once the game has been internally transformed. The experimental evidence shows, for instance, that both group identity and the Marginal Per-Capita Return (MPCR) increase contributions in public goods games (Ledyard, 1995). However, when an individual faces a game where there seems to be a clear group identity but the MPCR is low (because the temptation from not contributing is rather high), the second effect may overpower the first one. In this case, the individual may defect by not contributing. For other types of individuals, they will still contribute. Internally, each of them made their own trade-offs of the relative values of group identity and the costs of defecting against the rewards from contributing or free-riding according to their own sets of principles and expectations about the behavior and reactions by others. Thus, although we may know the marginal effect of institutional factors acting alone on cooperation, most individuals simultaneously face many sets of information that institutions provide about a transaction, and then place internal values and tradeoffs on them.

The framework we present here is an attempt to organize the kinds of information that the individual may use. We then provide some experimental evidence in this respect for the particular case of common-pool resource dilemmas. The framework, first proposed in Cardenas (2000a), is inspired by the indirect evolutionary approach proposal, and also combines inputs from Ostrom (1998), Samuel Bowles's (1998) argument for an endogenous preferences model, and by Kevin A. McCabe and Vernon L. Smith's (forthcoming) cognitive model of trusting behavior.

As a starting point, let us assume that an individual is facing a game with the characteristics of a collective action dilemma. The game has a material payoff structure where the Nash strategy is to defect but a Pareto-optimal solution is achieved at universal cooperation. And let us also assume that it is very costly to write and enforce contracts among the players to guarantee their universal cooperation. Knowing these basic elements and the dilemma involved, what would the player choose?

Although a fraction of people might behave as predicted by the Nash strategy[2], we do observe an important fraction of players choosing to cooperate. And the arguments explaining this range go from lack of learning and understanding of the game to altruistic preferences of humans. Reciprocity explanations are also offered when people foresee a repeated game with possibilities of meeting the same players again. They may want to build a reputation by showing an interest in cooperation now for future gains. Further, if each player had some additional information about past actions by the others, and the group had a certain feature that promotes group identity, it would be more likely that cooperation is the choice by most in the group. Notice that this is a process where each player gathers information not only about the static game structure (feasible strategies and payoffs), but also about the possibility of a supergame. Information about the possible behavior of the others is also important since no one can enforce any contract, and it is in everyone's best interest to maintain private information about behavior and preferences.

Because enforcing a contract is very costly and unlikely in many of these collective action dilemmas, and because there is incomplete information from the standpoint of each player, each player will try to look at the other levels of information. These levels enable the player to decide whether to trust the others in the group and cooperate, once they are aware that universal cooperation brings the Pareto-superior outcome. If the information they are able to gather does not provide grounds for a significant fraction of trustworthy partners, then the player may fail to cooperate.

Figure 5 shows how these additional data can be ordered in layers of information for the player to examine. We can classify these data into four main layers of information, namely: the static game, the dynamic game, the group context, and the identity layer.

[Figure 5 about here]

Our framework implies that individuals try to gather and evaluate as much information as they can about these four layers. This enables them to construct their internal (transformed) game with a set of feasible strategies and subjective payoffs compatible with the indirect evolutionary approach. The transformed game will then have a different set of payoffs, a different set of feasible strategies, and eventually a different set of Nash strategies. In the process, someone's social norms or their principles eliminate some of the possible moves, or because nonpecuniary costs or rewards change the relative payoffs. This might then transform PD games into other types of games, such as chicken or assurance games. These games yield different outcomes in terms of Nash equilibria and stability properties, including the case of cooperating as a Nash strategy despite the original structure of an n-person PD game. The transformation of the game does not have to be a monotonic transformation of the payoffs structure.

If these arguments are valid, they may help explain recent experimental findings. For example, cultural differences have an effect on cooperative behavior under the same material payoff incentives. Joseph Henrich (2000) and Joseph Henrich et al. (2001) report on a series of ultimatum, public goods, and dictator games from field experiments with fifteen small-scale societies in twelve countries. The behavior in the same objective game varies with the culture of the group and differs from the same replication of experiments with university students.

In summary, the layers of information are used by players facing a collective action dilemma as sources for responding to questions like the following:

What do I get from each of the possible actions in this round of the game?	**Static Game Layer**
What can I learn from previous rounds of this same game? What can happen in future rounds of this game because of what I do in this and previous rounds?	**Dynamic Game Layer**
Who are the others in the game? Can they be trusted? Do they usually cooperate in this and other games? Do they have social norms to follow?	**Group-Context Layer**

Do I care if I defect on others? Do I enjoy cooperating? Or competing? Does my experience in similar games provide hints to play?	**Identity Layer**

Given these questions, let us now look in detail at the layers of information proposed in the framework.

a. The Static Game Layer

In the first layer, the player observes the structure of material payoffs and feasible strategies for a one-shot game. The set of actions and payoffs will produce possible Nash equilibria, some of which may be more socially desirable than others. At this point, such information may already give players an idea of strategies that they should follow, or better, it will help them eliminate irrational strategies where neither they or others might benefit. The player is now left with those strategies that cause positive outcomes but probably involve a level of conflict. The game at this layer includes the set of formal rules that are effectively enforced, and therefore the observed game is in fact the one resulting after applying those formal rules and the material rewards, penalties or restrictions that are fully enforced.[3] In brief, this layer includes all the basic analysis that conventional game theory makes about a game.

b. The Dynamic Game Layer

At another level of information, we have the *dynamic game layer.* Most social exchange relations of the collective action type involve more than one round and a nonzero probability of facing the same counterparts in future rounds of the game. Robert Axelrod's (1984) argument of cooperation emerging from self-oriented maximizers was based on such grounds. The likelihood that the same players meet in future rounds creates several effects in the dynamic game. Since players can learn and have memory, they can both build a reputation and build a history of the reputation built by others. Notice how the modules suggested by McCabe and Smith (forthcoming) function here, particularly the one on goodwill accounting. Since the strategy of tit-for-tat produces strong results in the long run against most other strategies, the information that can be gathered about past rounds and the probability of future ones with the same players will create the conditions for feeding cooperation through reciprocity including the retaliation towards noncooperators as a group selection mechanism. There is evidence, for instance, that longer timeframes in voluntary contributions in public goods games produced and sustained higher rates of contributions (R. Mark Isaac et al., 1994). However, time has also shown to decrease the rate of contributions, other things held constant, and especially in the absence of coordination or correcting mechanisms such as face-to-face communication, endogenous monitoring and sanctioning, or external regulation.

c. The Group-Context Layer

Another information layer is supported on the notion that a player's decisions are also influenced by recognizing who the other players are in the transaction. Who the others are is important in the game because (1) there might be a possibility that the same players meet with me in a future round of the game and therefore reciprocity and retaliation processes affect future outcomes, or (2) my own set of preferences include my caring for the well-being of certain individuals (relatives, friends, neighbors), or ultimately (3) some natural altruistic preferences toward humans in general. In any case, even if I am an egoist, my preferences and, therefore, my choice will be determined by the group of other players.

The best theoretical support for the impact of this layer comes from evolutionary models where the gains from cooperating or defecting may be affected by the frequency of cooperators and defectors in the group (Bowles, 1998). The information a player has about the composition of the group will determine if there is enough environment of trust for choosing to cooperate for mutual gains.

There is also empirical evidence supporting the existence of this information layer. Group identity, group cohesion, and social distance have been shown to affect the likelihood that the individual cooperates. Edward Lawler and Jeongkoo Yoon (1996), for instance, show in a series of experiments how the level and equality of power in relations where a mutual agreement is needed increased the frequency of agreements. They also provide evidence that the exchange relation becomes "objectified" and therefore positive emotional processes during exchange increased commitment.[4] Peter Kollock (1998) provides data from a set of experiments studying how group identity has a direct effect in cooperative behavior. No knowledge of who the others are still induced cooperation to be ranked above defecting on the others. However, when these college students received information about the others (being from the same fraternity, from any other fraternity, from the same campus, from another campus, from the police department), certain significant changes in behavior were found. In general, the in-group/ out-group effects emerged as expected from recent discussions and more experimental evidence (see also John Orbell et al., 1988).

In the case of reported behavior from nonexperimental settings, Alberto Alesina and Eliana La Ferrara (1999) show evidence from U.S. survey data that the participation of individuals in social organizations and activities is higher for more equal and less fragmented localities in terms of race or ethnicity. Group heterogeneity and inequality are still presented to be part of the core explanations for collective action since Mancur Olson (1965) and more recently with Theodore Bergstrom et al. (1986). Much of the arguments for heterogeneity inducing higher cooperation are based on the asymmetric payoffs structure where the players with higher stakes may be more willing to provide the public good. We would assign such effects to the static game layer in the framework. However, other elements arising from group composition may also enter into play even under a symmetric payoff. One of these cases is the effect that social differences may have in a group, for instance due to wealth. For a more detailed discussion on how wealth differences may have an effect in solving these dilemmas see J. C. Cardenas (2000b).

d. The Identity Layer

In this layer, the players store and process information about themselves that may affect the feasible strategies or the subjective payoffs from each strategy. Certain values inherent to the player will increase or decrease the subjective payoffs from cooperating or free-riding because of the existence of other-regarding or process-related preferences. The player's own stock of human capital will affect preferences as well. This information is not necessarily given to the player by the institutions of the particular game, but is already stored in his/her mind and is used depending on the externalities involved in the game.[5] An example of the weights that one's pleasure or joy from cooperating or defecting play in decisions is obvious in the transformation of the game. A starting point for supporting the role of this layer in decision-making might be Amartya Sen's (1977) rejection of egoism and opportunism as the only rationalities possible for humans. His discussion of behaviors based on sympathy which is still based on egoist rationality but especially on commitment, which involves other-regarding preferences, better explains voluntary contributing behavior in public goods. This discussion then gives rise to the concept of meta-preferences, which in a way is a meta or superior ranking of preference ranking. Also, inherently human traits such as reciprocal fairness (Ernst Fehr and Jean-Robert Tyran, 1997; Daniel Kahneman et al., 1986) create reciprocal behavior that goes against the opportunist prediction.

This layer is also quite important when there is imperfect information about the material game (payoffs, strategies, and other players). Past experience in similar games, skills, and education can help enlighten the player about the game. Further, the framing of the game plays a role in switching on this layer. Games with the exact same structures produce different behavior depending on the framing (Elizabeth Hoffman et al., 1996, 1999). Institutions in field settings can induce different preferences in the way they frame a social exchange situation (Bowles, 1998).

The case for endogenous preferences is also supported by Gary Becker (1996) who proposes a utility function dependent on not only the consumption of the goods, but what he calls *Personal capital,* which accounts for *"the relevant past consumption and other personal experiences that affect current and future utilities,"* and *Social capital,* which *"incorporates the influence of past actions by peers and others in an individual's social network and control system."* Notice how the dynamic game layer enters into play, but also the context-group layer that I discuss below.

A growing, but still not systematic, area of work studying whether certain aspects inherent to the subjects participating in an experiment may explain part of their behavior. For instance, gender effects in public goods contributions have been studied for the last decade but the results, as Ledyard (1995) reports,[6] are still inconclusive. Accounting for the particular major of the student participating has also been a focus of attention. Early experiments in the 1980s asked whether economics majors showed higher levels of free-riding with modest strong results (Gerald Marwell and Ruth E. Ames, 1981; R. Mark Isaac et al., 1985, reported in Ledyard, 1995). More recently, Charles Cadsby and Elizabeth Maynes (1998) reported that nurses showed higher levels of cooperation than economics and business students in a threshold public goods game where there was equilibria at both cooperative and noncooperative behaviors. These results would also be consistent with the work by Robert H. Frank et al. (1993) on the behavior of economics majors being closer to game theoretical predictions. In another also interesting study, Axel Ockenfels and Joachim Weinmann (1999) found that East-Germany participants behaved less cooperatively than West Germany ones in both public goods (ten rounds, 5 person) and solidarity (one-shot, 3 person) games.

More recently, Sally (2001) has proposed a formal model to introduce the concept of sympathy as a key to determining the willingness to cooperate by a player. He defines sympathy as the "fellow-feeling person i has for person j" and models it as a function of both the physical and psychological distances between *i* and j. His approach, as compared to ours, is the combination of the last two layers in the sense that it involves both the information about self and the information about the others when playing the game. In fact, Sally differentiates sympathy from altruism. He uses a reciprocity argument in the former case since persons will reduce their fellow-feeling for another when they feel they are being manipulated and taken advantage of.

e. Cross-effects between Layers

Notice also in the diagram the two-way arrows above the layers. Either layer can reinforce or decrease the effect of other layers. Trade-offs also exist across layers; that is, the relative weight of one layer may increase or decrease because of another layer. For instance, if there is such a trade-off between the additional gains from defection in the one-shot game and the nonmaterial satisfaction of cooperating and allowing the others in the group to benefit, a threshold or a marginal rate of substitution should exist for these. The level of the threshold would depend on the information the player has from the static game layer and the preferences and group layers. The opposite of a trade-off might be in place also when competitive and egoistic preferences, for instance, reinforce the defection rate with an increase in the temptation (difference between the cooperation payoff and the defection one).

The importance of cross-effects in the institutional factors that determine cooperation has been understudied, particularly in experiments. Ledyard (1995: 144), in fact, mentions the need for and lack of research on this area, on how the marginal effect of one variable depends on the level of another institutional variable. He cites the work by R. Mark Isaac and James Walker (1988) and Isaac et al. (1994) on how the effect of the marginal per capita returns (MPCR) on contributions to public goods is affected by group size.

f. (Some Hypotheses About) Decision-Making under This Framework

So far, it still looks quite complicated to figure out how all these factors enter into play in the decision by the individual. So let us try to make some sense of the elements so far reviewed and proposed. First of all, we would argue that not all the information in all the layers is used in all exchange situations. And, therefore, the question is what information to use and when.

The first proposition about the framework is that the individual switches these layers on and off depending on the overall structure of the game, including the payoffs, the feasible strategies, the other players, and the norms and rules that are shared by such groups. But especially, these are switched on or off depending on the availability of information the player has about these institutional factors of the game. If players do not know who the others are in the group involved in the transaction, the role of the context-group layer is useless for them. If the player does not have any assurance that there might be a next round in the same game and with the same players, there is no need to think of the dynamic game layer for the reciprocity effects to take place.[7]

The most extreme case is when the player faces a transaction in a market that one could consider as competitive and close to the Walrasian world; that is, where enough suppliers and buyers and enough information and zero transaction costs that assure the nonexistence of any kind of externalities. In this case, players do not need to use any other layer of information except from the static game where they would compare prices and choose the one that better satisfies their demand for any good or service. At this trivial game, the transformed (internal) game will probably have the same properties of the material one in terms of Nash equilibria and social efficiency. But not many transactions resemble these for most social exchange relations in which humans are involved. So we are still left with the question of what switches on the other layers.

This takes us to a first condition for the other layers to enter into play, namely, the existence of externalities or interdependencies not accounted for in the static game. The Prisoners' Dilemma game is the typical case, although not the only one. However, this condition is not sufficient for the player to use the information from the other layers. For example, if there are sufficiently strong and enforceable rules and norms to induce a behavior that avoids the externality, players would not need to think about their personal preferences regarding causing negative or positive effects onto others when defecting or cooperating respectively.

The next proposition to make is that the existence of asymmetric information across the players involved in the transaction switches one or more of the other layers of information—particularly private (asymmetric) information about the variables that cause the externality. If there were sufficiently low transaction costs in writing and enforcing a contract among the players, these would be the variables included in such a contract. In common-pool resources we are talking about the individual levels of appropriation that decrease the availability of the resource for others but which would be very costly to be known for the other members of the group or by an authority.

Of course, in the case of no transaction costs for writing such contracts or for the players to bargain to an efficient solution, we would be back to the Coasian solution—in which case we are basically at the static game layer because either the players or an external regulator would already have eliminated the socially inefficient possible actions with a rule (e.g., a Pigouvian tax), or the players would already contract such elimination and payoff transfers through bargaining.

Unfortunately, many social exchange transactions involve some kind of private information that gives the player the possibility of deriving rents from the transaction. Workers would perform at effort levels below what the employer would like them to, given the difficulty of writing a contract based on effort rather than time at the workplace. Sharecroppers and landlords also find their utility function in conflict because they have different stakes and risks in the game. Common-pool resource users may not be authorized to enforce a rule about extracting a resource and excluding users might be difficult driving extraction to limits above the natural capacity of the ecosystem to sustain production. Polluters would engage in production levels above those that the environmental regulator would like them to, if the monitoring of emissions is imperfect or costly.

In summary, we suggest the following three propositions about the use of the information in the four layers of the framework above. First, there must be an externality involved in the basic structure of the static game for the other three layers besides the static game to be switched on. This condition is already implied because of the definition of an external economy: that there are sufficiently high transaction costs in writing and enforcing a contract that could correct for those externalities. These conditions are necessary but not sufficient for the individual to switch on the other layers. However, when there are no external costs from the transactions, including the costs of enforcing a contract to coordinate actions and outcomes, the other layers turn out to be useless as they do not help the decision, and the game is basically a static and certain one.

Second, the existence of private (asymmetric) information among the players of the game with regard to the variables that cause the externality will induce the players to switch on the other layers when deciding on a strategy. The reason the other layers are turned on is because they are needed by the decision maker in order to create the transformed or internal game from the one originally pictured at the static game layer. Because there are social losses from the incomplete information, the player needs to build a better story beyond the simple material payoffs and feasible strategies.

Third, as the externalities in the transaction increase (e.g., larger conflict and temptation dimensions in the static game structure), and the higher the transaction costs are for the players to enforce a contract to internalize them, the relative weight of the other layers will increase in the decision to cooperate. It is quite striking how well certain predictions from game theory work in experimental settings while predicting poorly human behavior in other types of game structures. In the former, we can mention the case of auction-based markets where convergence towards equilibrium works in a very predictable way. In the latter, we can mention public goods, dictator and ultimatum experiments. Bowles suggests from the existing experimental work that "the more the experimental situation approximates a competitive (and complete contracts) market with anonymous buyers and sellers, the less other-regarding behavior will be observed" (1998: 89). Notice that the competitive market experiments do involve private information by the players. For instance, buyers do not know the marginal cost of sellers. Yet after a few rounds, the system converges towards market-efficient prices. However, these transactions do not involve an externality in the decisions made by sellers and buyers since the prices paid at equilibrium are accounting for the full costs of the market transaction.

In the case of dictator, ultimatum and public goods games we find the conditions mentioned in both proposition one and two. Players do affect the payoffs of others in their decision, and the basic nature of the game impedes enforcing contracts that account for the externalities. In the case where the experimental design allows the players to devise institutional forms of coordinating their actions, transaction costs and private information still make it difficult to achieve Pareto-optimal outcomes.

IV. Empirical Evidence from the Campus and the Field Labs

When reviewing the experimental literature, one notices that especially the last two layers (group-context and Identity) are related to the type of "systemic" variables that are difficult to control for in the lab, and mentioned by Ledyard (1995). Gender, culture, beliefs, group identity, and social context are among these. The experimental evidence mentioned previously, and the importance of these factors in forming the context of the game, give support for the methodological step forward we present; i.e., to bring the experimental lab to the field and enrich the analysis that Ledyard has identified as important but difficult.

We adapted the basic CPR experimental design (Ostrom et al, 1994) to study different questions about cooperation in local commons dilemmas in rural villages of Colombia. The experiments were conducted in the summer of 1998 in three different villages where roughly 180 subjects participated in a series of experiments in groups of eight people, under different treatments. We also asked the participants to fill out an anonymous survey at the exit of the sessions—information that we were able to link to their decisions in the field lab. This link allowed us to test some of the hypotheses discussed in this paper.

The baseline design of the experiment is as follows. Participants were told that they would participate in a group of eight people in the same room, in a game where they had to choose privately the number of times (e.g., months per year) they would go to a forest to extract a resource (e.g., firewood). Their earnings from such decision would depend not only on the months they went to the forest but also on the choices the rest of their group made. They would know the earnings in a round by looking at the column of the choice they made, and the row "their months in the forest," which could be calculated from the total number of months in the forest announced by the monitor after adding the eight decisions. They would play under this treatment for a number of rounds (at least eight) without any interaction among the players. Clearly, there is an incentive to increase the number of "months in the forest," but also there is a group externality in doing so that drives earnings to lower levels if the group on average goes too many "months to the forest."

The key benchmarks to study the behavior of individuals were at a social optimal equilibrium where every player had to go to the forest only one month yielding $645 in each round; and a Nash equilibrium where everyone would go six months yielding a suboptimal result of $155 per round.

Fifteen groups of eight people participated through this treatment for about nine rounds at which point they were told that a new set of rules was to be introduced in the game. For five of the groups they were told that an *external regulation* will attempt to improve things, while for the other ten groups they were told that they will have a *face-to-face group discussion* before each round to comment openly about the game developments.

In the case of the external regulation, the participants were informed that playing one month in the forest brings payoffs to the social optimum and that to achieve such outcome, an inspector (the monitor) would audit randomly one of the players with a probability of 1/16 in each round. If the player had chosen two or more months in the forest, he/she would be imposed a penalty of $100 for each month in excess, and such points be subtracted from their earnings.

These two different institutions induced significant changes in the behavior of the participants, sometimes against the prediction from game theoretical analysis. In the case of the external regulation, the expected costs of violation of the rule were supposed to induce a partial improvement of social efficiency, which in fact happened in the early rounds after the new rule was introduced. But rapidly by the third round with such regulation, the gains were eroded and selfish behavior along with an imperfect monitoring created more inefficiencies than good in the results, even if compared to the rounds prior to the introduction of the rule. These results are discussed in more detail in Cardenas et al. (2000b).

In the case of the groups under face-to-face communication, we found similar results to the experimental literature where despite being a nonbinding institution it did create and sustained, in average, a more cooperative behavior among players bringing social efficiency levels higher. However, there was still a wide variation when looking at the individual level within groups. Given that all of the groups were facing the exact same payoffs structure and experimental environment, several questions emerged on whether the actual characteristics of the participants played a role in their lab behavior. Thanks to the survey that we conducted at the exit of the sessions, we could gather information about a variety of topics. These included from demographic basic variables such as gender, age, education, to personal opinions about the role of government and community governance structures, their economic activities, assets, and occupation, among others.

In order to test for the combined effects of some of the factors discussed in the layers of the model, we used a regression analysis model in which we attempted to estimate the level of cooperation in each round as a function of vectors of variables from all the layers, thanks to the round level data from the experiment, the individual level data we gathered about the participants, and the construction of group level data for each of the eight player groups. Thus, each observation in the regression corresponds to the decision by one player in a specific round of the game.

The dependent variable and our index of cooperation, XDEVIA, is the distance in "months" units from the Nash best response in a specific round. In other words, it measures how much the player was willing to deviate from a selfish strategy and towards a group-oriented strategy by reducing their "months in the forest." The independent variables included were:

DELTAVG7: Change (average reduction) in "months in the forest" by the other seven players in the group. Calculated as (3months by other 7 players in t-i - 3 months in t), and based on experimental behavior.

ROUND: Round number. Accounts for the learning or adaptation processes in each treatment. Based on experimental behavior.

AVCOOPLB: Average number of days in nonpaid labor contributed during last year by the group members. A proxy of "cooperative" behavior in community projects. Based on the anonymous survey filled at the exit of the session.

HHWEALT2: Household wealth based on land, livestock, and machinery, valued at local prices and adjusted across villages. Based on the survey.

WLTHDS2A: Wealth distance = Absolute value of the difference between the player's wealth and the average of other seven player's wealth. Based on the survey.

WLT_DIS2: Cross-effect variable = HHWEALT2 * WLTHDS2A. Accounts for differences in the marginal effect of wealth distance for different social (wealth) classes.

BESTATE: A dummy where 1 if individual believes that a "State" organization should manage the local commons from where they extract resources. 0 otherwise. Based on survey.

PARTORGS: Number of community organizations the player belongs to or participates in. Includes parents association, cooperatives, water committees, etc. Based on survey.

Given that all the experimental decisions were made under the exact same payoff structure and experimental environment regarding formal rules about the choice variable ("months in the forest"), the only variables we could consider in the first layer would be the estimation intercept[8] and a dummy variable (CEW41) for one group that showed an entirely different behavior during the communication rounds because it did not engage in a discussion about the game or strategies to improve the results. Dropping this group from the sample would not affect the significance and signs of the estimators, however. The sample size is in each case the number of decisions made during a set of rounds in a stage by all eight players and for all the groups under each treatment.

Tables 1 and 2 summarize the results of applying the same model and the same data sets using two estimators. Table 1 uses the simple OLS procedure. Table 2 uses a "fixed effects" estimator. The results are basically the same and there are some trade-offs in precision and efficiency of the estimator.

The tables are organized in columns for each of the two stages (Noncommunication and Communication for COM data, and Non-Regulation and Regulation for the REG data). In the case of stage 1, we also merged the No-COM and No-REG data as the groups did not know in advance which new rule they would face, therefore no structural differences should be expected and the data could be pooled.

The estimation results yield some light on how information about the four layers may explain the variation across groups and across players that otherwise could not be explained by the material incentives of the game since within treatments these were identical. However, each group of eight people consisted of members of the same village. Therefore, a prior history existed of experience, reputation, beliefs, and other factors that determine their willingness to cooperate with the other seven people in their group. The significance and signs of many of these variables show how these play an effect on behavior in the experiment. Further, the results suggest how powerful field experiments can be as there seems to be information that the players bring into the game and use it in their decision making.

Let us turn to some of the most relevant statistical results from these estimations. In terms of the regressions, the "Fixed Effects Estimator" does not seem to invalidate most of the simple OLS results, thus confirming the importance of having simultaneously effects at the round, individual, and group levels. There are obviously some sacrifices in estimator efficiency, which we can attribute to the fact that introducing the dummy variables may cause co linearity, which does not produce bias but increases the standard error of the coefficients.

The explanatory power of the model is much higher for the second stage, where each "experimental institution" (communication or regulation) provides a stronger framing for the players and induces them to use the information from the four layers in their decisions, in sometimes different ways. This is not only seen in the higher AdjR2, but in the significance of several variables in stage 1 versus stage 2.

The opposite but significant signs for some variables are quite interesting. Notice that BESTATE has opposite signs for the COM and REG data-sets, suggesting that under the external regulation, "state believers" will proportionally comply *more* with the rule, but cooperate *less* under the self-governance environment of nonbinding communication. In the meantime, notice the case for PARTORGS: The signs are negative in both cases, however they are much larger and significant for the REG environment. "Natural cooperators" in the field under an experimental "external regulation" environment were less prone to comply with the norm. Interesting however, that this variable did not show a positive significant effect under the COM environment.

The effect of wealth and wealth distance is extensively discussed in another paper (Cardenas, 2000b). Basically, those players with higher levels of wealth and larger wealth distance to the other players in the group seemed less willing to cooperate. This is consistent with the findings of Sally (2001), who suggests that sympathy is a key factor in determining willingness to cooperate is a direct inverse function of physical and psychological distance between a person and others. The explanations emerge from a combination of "experience" in similar situations and the context of the group in which each player participates, particularly in terms of social distance. Poorer people face similar dilemmas more frequently. And, they do so with people of similar levels of wealth or social status. As we see in the estimation results, wealth and wealth distance to the other seven players decreases cooperation.

Reciprocity, expressed in the positive and significant sign of DELTAVG7, is confirmed. Reduction in extraction by other players is followed by a reduction in one's extraction. This rejects again the free-riding hypothesis that predicts that as the other players reduce their "months in the forest," the i^{th} player should increase "his/her months" and increase earnings. Notice that the sign and size of the coefficient remains relatively constant across stages. However, the effect is much stronger for the REG treatment. In this case, we had a strong negative reciprocity in action, which is discussed in more detail elsewhere (Cardenas et al., 2000). Negative reciprocity, caused by the external regulation, is what seems to crowd-out the other-regarding preferences that seemed to exist prior to the introduction of the rule.

The ROUND variable coefficient, basically zero and insignificant for stage 1 and stage 2 in COM contrasts with the negative effect in REG stage 2, which is part of the erosion of cooperative behavior that the rule induces at the first rounds of stage 2. In the case of COM, the coefficient shows a negative but insignificant t-value suggesting that the self-governance experimental institution sustained cooperation over time, other things held constant. However, it is interesting to note that during stage 1 there is no negative or decreasing trend as is usually observed in other CPR and VCM experiments where the partial levels of cooperation at early rounds decrease under a noncooperative repeated game. One plausible explanation is that under this experimental design, players were not told of the last round of stage 1.

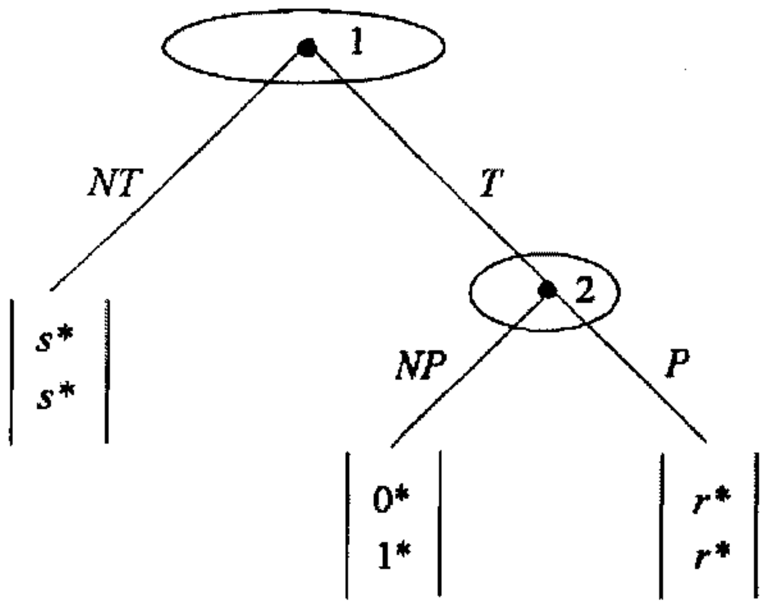
These are some of the most interesting results that we learned from bringing the lab to the field and using the information about the actual context and background of the experiment participants. In other experimental settings, such information would not vary as much across students and therefore, would be of no use. The field experiments we report here allowed us to use such information and test some of the arguments developed in the framework of a layer of information people use when facing a game for which there is room for strategic behavior, transaction costs, and collective action dilemmas.

V. Conclusions

The framework that we have presented provides some initial guidance in organizing the multiple types of variables that appear to affect individual decision making outside a highly competitive market setting. Depending on the context that individuals face, they may dig ever deeper into a set of layers of information that are relevant to their decisions depending on whether the game is on-going, whether communication is possible, and whether the others and their attributes are known to the players.

We have presented above some of the most interesting results that we learned from bringing the lab to the field and using the information about the context and background of the experiment participants. In other experimental settings, such information would be considered as noise if compared to university laboratories. Or, at best, such information would not vary as much across students and therefore would be of no use. The field experiments we report here allowed the subjects to use information from their own context and for the researchers to examine the impact of this information on decisions. We found positive support for many of the arguments derived from our framework. It does appear that individuals use diverse layers of information depending on the structure of a game and the context within which they are playing that game.

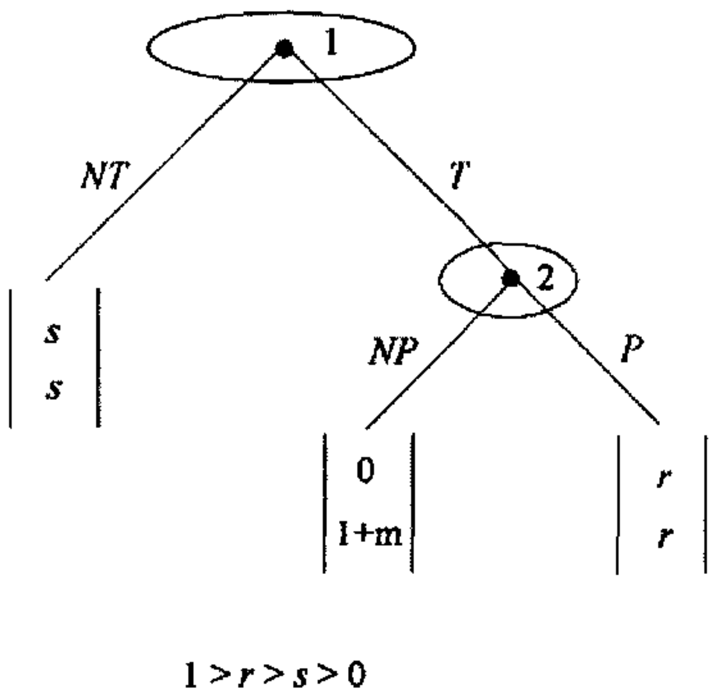
Figure 1. The trust game: Material outcomes



$$1^* > r^* > s^* > 0$$

Source: Modified from Güth and Kliemt (1998: 381).

Figure 2. The trust game: Utilities



Source: Modified from Guth and Kliemt (1998: 386).

Figure 3. CPR material incentives as a trust game for the i^th^ player (2 experimental designs)

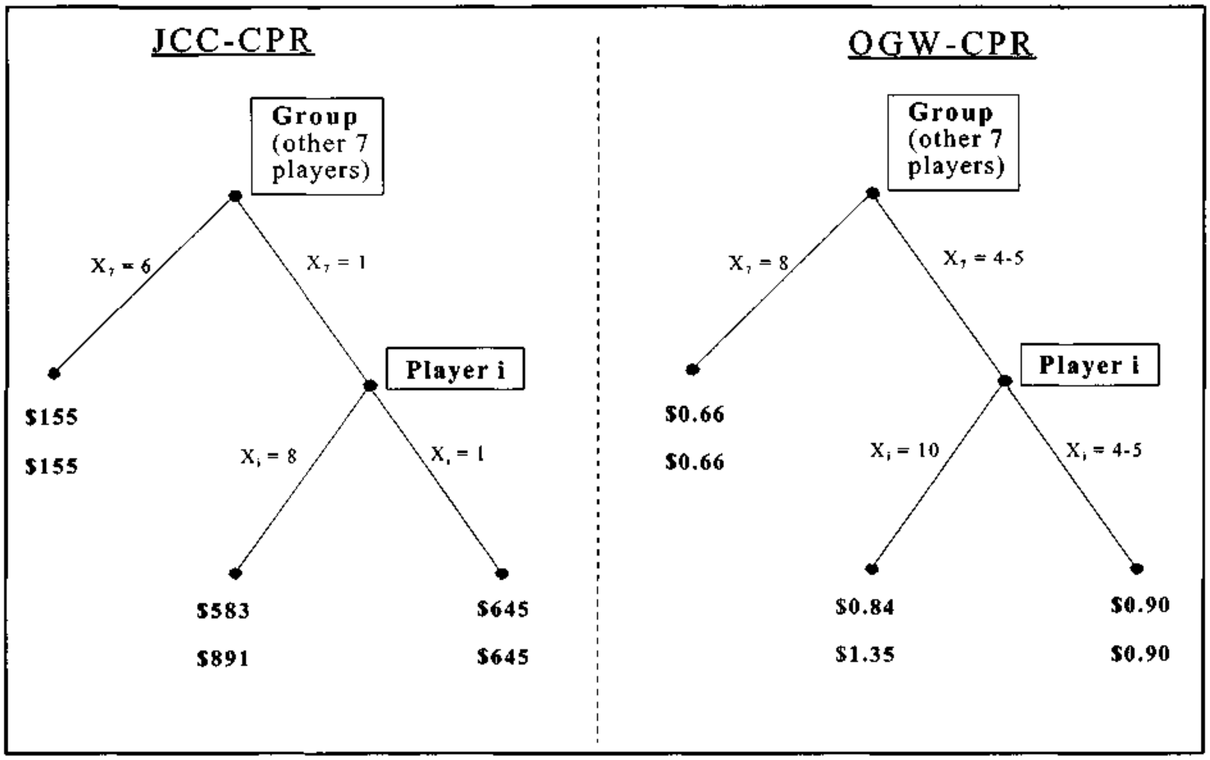


Figure 4. CPR transformed incentives as a trust game for the i[th] player

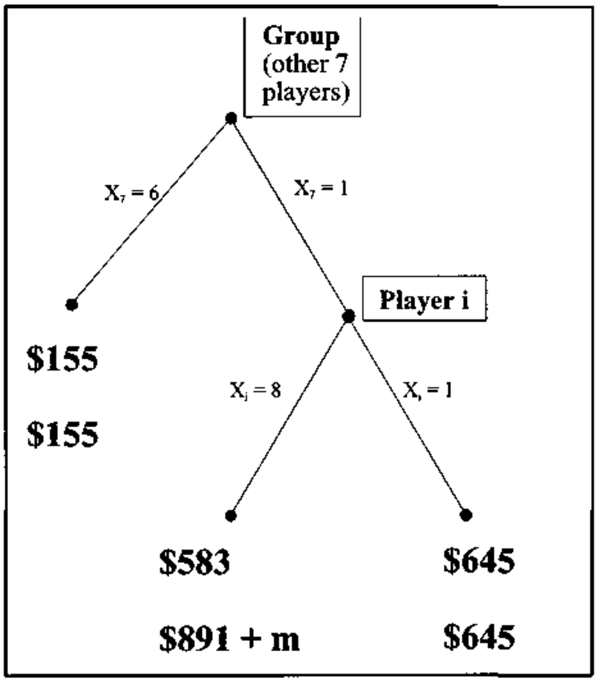


Figure 5. A framework of the multiple layers of information players use in the game

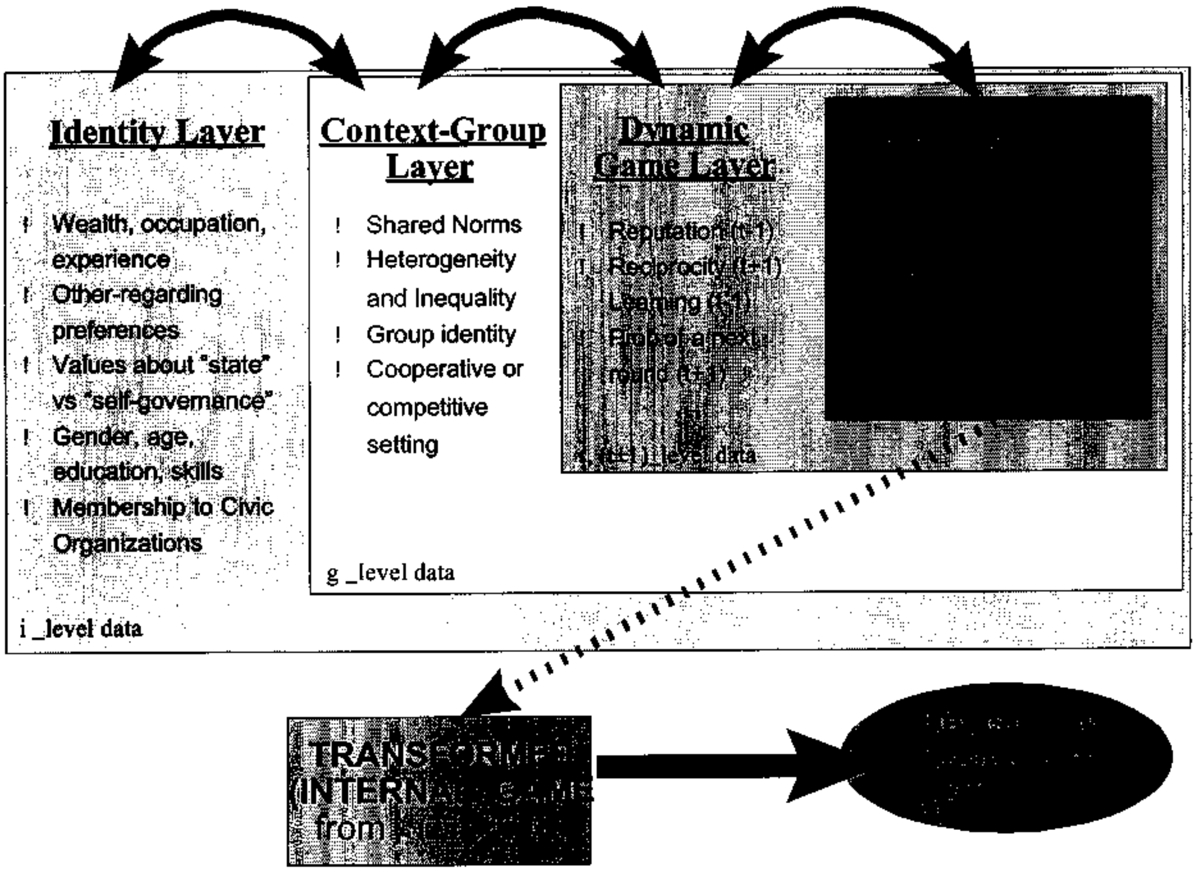


Table 1. Explaining CPR appropriation as a function of the framework's multiple layers. OLS Regression results

Models I.(no-COM/REG), II.(COM), III.(REG) (Simple OLS estimations)

Independent Variable: "Months in the Forest" = level of individual appropriation of the CPR

		Stage 1: Rounds (1 to 9)			Stage 2: (11 to 19)	
Label	Variable	No-COM	No-REG	No-COMREG	COM	REG
Static Layer:						
	INTERCEP	3.6134	3.2035	3.7052	6.9163	11.7069
		8.482	*5.739*	*10.772*	*10.711*	*13.343*
Dynamic Layer:						
Avg reduction by other 7 players	DELTAVG7	0.3713	0.4239	0.3887	0.2786	0.4381
		3.922	*3.664*	*5.184*	*3.389*	*2.747*
Learning	ROUND	-0.0266	0.0457	-0.0034	-0.0322	-0.4240
		-0.606	*0.701*	*-0.090*	*-0.963*	*-9.020*
Context-Group Layer:						
Avg. labor contributions by group	AVCOOPLB	-0.1095	0.0409	-0.1128	0.0392	0.2121
		-2.917	*0.605*	*-3.525*	*1.116*	*3.527*
Wealth distance	WLTHDS2A	0.3524	-0.7793	0.1554	-1.7917	-4.0839
		1.415	*-1.460*	*0.694*	*-7.932*	*-8.636*
	WLT_DIS2	0.0391	-0.1245	-0.0774	0.5905	1.3955
		0.409	*-0.636*	*-0.894*	*6.936*	*8.171*
Identity Layer:						
Individual's Wealth	HHWEALT2	-0.3818	0.6483	0.0198	-1.0475	-1.8788
		-1.848	*1.792*	*0.109*	*-5.549*	*-5.886*
1 if thinks State should solve the problem	BESTATE	0.1540	1.1768	0.3020	-1.0425	1.3334
		0.680	*3.755*	*1.646*	*-5.116*	*4.774*

Table 2. Explaining CPR appropriation as a function of the framework's multiple layers. Fixed Effects Estimator (Regression results)

Models IV.(no-COM/REG), V.(COM), VI.(REG) (Fixed Effects Estimator)

Independent Variable: "Months in the Forest" = level of individual appropriation of the CPR

Label	Var	Stage 1: Rounds (1 to 9) No-COM	No-REG	No-COMREG	Stage 2: Rounds (11 to 19) COM	REG
Static Layer:						
	_INTERCEP	4.8267	3.5915	-8.5461	7.1965	13.4515
		9.106	*5.714*	*-3.885*	*10.425*	*15.736*
Dynamic Layer:						
Avg reduction by other 7 players	_DELTAVG7	0.3491	0.4434	0.3894	0.2473	0.3700
		3.765	*3.898*	*5.292*	*3.061*	*2.481*
Learning	_ROUND	-0.0209	0.0455	0.0015	-0.0549	-0.4231
		-0.486	*0.718*	*0.042*	*-1.636*	*-9.601*
Context-Group Layer:						
Avg. labor contributions by group	_AVCOOPLB	-0.0701	-0.2567	1.3915	0.0838	-1.2233
		-1.039	*-2.043*	*5.311*	*1.282*	*-5.858*
Wealth distance	_WLTHDS2A	0.1649	-0.1717	0.0902	-1.6522	-1.8301
		0.456	*-0.267*	*0.287*	*-4.959*	*-3.341*
Wealth*Wealth Distance	_WLT_DIS2	0.1757	-0.2962	0.0006	0.5371	0.5623
		1.452	*-1.256*	*0.006*	*4.876*	*2.838*
Identity Layer:						
Individual's Wealth	_HHWEALT2	-0.6323	1.0281	-0.0829	-1.0181	-0.5593
		-2.643	*2.462*	*-0.392*	*-4.619*	*-1.575*
1 if believes State should solve the problem	_BESTATE	-0.1162	0.8516	0.0620	-1.1979	0.5285
		-0.467	*2.363*	*0.305*	*-5.347*	*1.718*
No. Organizations participates in	_PARTORGS	0.0822	-0.8098	-0.1494	-0.1646	-0.7149
		0.758	*-4.625*	*-1.608*	*-1.602*	*-4.765*
Fixed Effects (No. dummies)		10 groups	5 groups	15 groups	10 groups	5 groups
Sample size	N	583	276	850	676	344
R2 adjusted	ADJR2	10.86%	22.69%	10.67%	18.67%	49.45%

In italics are t-values for Ho: Coeff.=0.

References

Alesina, Alberto and La Ferrara, Eliana. "Participation in Heterogenous Communities." NBER Working paper no. 7155, National Bureau of Economic Research, 1999.

Axelrod, Robert. *The evolution of cooperation.* New York: Basic Books, 1984.

Becker, Gary. *Accounting for tastes.* Cambridge, MA: Harvard University Press, 1996.

Bergstrom, Theodore; Blume, Lawrence and Varian, Hal. "On the Private Provision of Public Goods." *Journal of Public Economics,* 1986, *29,* pp. 25-49.

Börgers, Tilman and Sarin, Rajiv. "Learning Through Reinforcement and Replicator Dynamics," *Journal of Economic Theory,* 1997, *77,* 1-14.

Bowles, Samuel. "Endogenous Preferences: The Cultural Consequences of Markets and Other Economic Institutions." *Journal of Economic Literature,* March 1998, *36,* pp. 75-111.

Boyd, Robert and Richerson, Peter J. *Culture and the evolutionary process.* Chicago: University of Chicago Press, 1985.

Bromley, Daniel W.; Feeny, David, McKean, Margaret, Peters, Pauline, Gilles, Jere, Oakerson, Ronald, Runge, C. Ford and Thomson, James, eds. *Making the commons work: Theory, practice, and policy.* San Francisco: ICS Press, 1992.

Cadsby, Charles Bram and Maynes, Elizabeth. "Choosing between a Socially Efficient and a Free-riding Equilibrium: Nurses versus Economics and Business Students." *Journal of Economic Behavior and Organization,* November 1998, *37*(2), pp. 183-92.

Camerer, Colin F. "Progress in Behavioral Game Theory." *Journal of Economic Perspectives,* 1997, *11*(4), pp. 167-88.

_____. "Bounded Rationality in Individual Decision-Making." *Experimental Economics,* 1998, *1*(2), pp. 163-83.

Cárdenas, Juan-Camilo. "Rural Institutions, Poverty and Cooperation: Learning from Experiments and Conjoint Analysis in the Field." Ph.D. dissertation, University of Massachusetts, Amherst, Department of Resource Economics, 2000a.

_____. "Real Wealth and Experimental Cooperation: Evidence from Field Experiments." Research Medals Competition, *Second Global Development Network Conference GDN2000,* Tokyo, Japón, December 11-13, 2000. <http://www.gdnet.org/awards-shrtlist.htm>, 2000b.

Cárdenas, Juan-Camilo; Stranlund, John K. and Willis, Cleve E. "Local Environmental Control and Institutional Crowding-out." *World Development,* October 2000, *28*(10), pp. 1719-33.

Crawford, Sue E. S. and Ostrom, Elinor. "A Grammar of Institutions." *American Political Science Review,* September 1995, *89*(3), pp. 582-600.

Davis, Douglas D. and Holt, Charles A. *Experimental economics.* Princeton, NJ: Princeton University Press, 1993.

Fehr, Ernst and Tyran, Jean-Robert. "Institutions and Reciprocal Fairness." *Nordic Journal of Political Economy,* January 1997, *23*(2), pp. 133-44.

Frank 1987

Frank, Robert H.; Gilovich, Thomas and Regan, Dennis T. "Does Studying Economics Inhibit Cooperation?" *Journal of Economic Perspectives,* 1993, *7*(2), pp. 159-71.

Gibson, Clark; Ostrom, Elinor and McKean, Margaret, eds. *People and forests: Communities, institutions, and governance.* Cambridge, MA: MIT Press, 2000.

Gintis, Herbert. "Beyond *Homo Economicus*: Evidence from Experimental Economics." *Ecological Economics,* 2000, *35*(3), pp. 311-22.

Güth, Werner. "An Evolutionary Approach to Explain Cooperative Behavior by Reciprocal Incentives." *International Journal of Game Theory,* 1995, *24,* pp. 323-44.

Güth, Werner and Kliemt, Hartmut. "The Indirect Evolutionary Approach: Bridging the Gap between Rationality and Adaptation." *Rationality and Society,* August 1998, *10*(3), pp. 377-99.

Güth, Werner and Tietz, Reinhard. "Ultimatum Bargaining Behavior: A Survey and Comparison of Experimental Results." *Journal of Economic Psychology,* 1990, *11,* pp. 417-49.

Güth, Werner and Yaari, Menahem. 1992. "An Evolutionary Approach to Explaining Reciprocal Behavior in a Simple Strategic Game," in Ulrich Witt, ed., *Explaining process and change: Approaches to evolutionary economics*. Ann Arbor: University of Michigan Press, 1992.

Guttman 1999

Hardin, Garrett. "The Tragedy of the Commons." *Science,* December 1968, *162*, pp. 1243-48.

Henrich, Joseph. "Does Culture Matter in Economic Behavior? Ultimatum Game Bargaining among the Machiguenga of the Peruvian Amazon." *American Economic Review*, September 2000, *90*(4), pp. 973-79.

Henrich, Joseph; Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. and McElreath, R. "Cooperation, Reciprocity and Punishment in Fifteen Small-scale Societies." *American Economics Review*, May 2001, forthcoming.

Hirschmann, Albert. "Against Parsimony: Three Easy Ways of Complicating Some Categories of Economic Discourse." *Economics and Philosophy*, 1985, *1*, pp. 7-21.

Hoffman, Elizabeth; McCabe, Kevin and Smith, Vernon L. "Social Distance and Other-Regarding Behavior in Dictator Games: Reply." *American Economic Review*, June 1996, *86*(3), pp. 653-60.

Hoffman, Elizabeth; McCabe, Kevin and Smith, Vernon L. "Social Distance and Other-Regarding Behavior in Dictator Games: Reply." *American Economic Review*, March 1999, 89(1), pp. 340-41.

Huck, Steffan and Oechssler, Jörg. "The Indirect Evolutionary Approach to Explaining Fair Allocations." *Games and Economic Behavior*, 1999, *28*, pp. 13-24.

Isaac, R. Mark and Walker, James. "Group Size Effects in Public Goods Provision: The Voluntary Contribution Mechanism." *Quarterly Journal of Economics*, February 1988, *103*, pp. 179-99.

Isaac, R. Mark; McCue, Kenneth F. and Plott, Charles R. "Public Goods Provision in an Experimental Environment." *Journal of Public Economics*, 1985, *26*, pp. 51-74.

Isaac, R. Mark; Walker, James and Williams, Arlington. "Group Size and the Voluntary Provision of Public Goods: Experimental Evidence Utilizing Large Groups." *Journal of Public Economics*, May 1994, *54*(1), pp. 1-36.

Kahneman, Daniel, Knetsch, Jack L. and Thaler, Richard H. "Fairness and the Assumptions of Economics." *Journal of Business*, 1986, *59*(4), pp. S285-300.

Kollock, Peter. "Transforming Social Dilemmas: Group Identity and Co-operation," in Peter A. Danielson, ed., *Modelling rationality, morality and evolution*. New York: Oxford University Press, 1998.

Kreps, David M.; Milgrom, Paul, Roberts, John and Wilson, Robert. "Rational Cooperation in the Finitely Repeated Prisoner's Dilemma." *Journal of Economic Theory*, 1982, *27*, pp. 245-52.

Kruse, Jamie Brown and Hummels, David. "Gender Effects in Laboratory Public Goods Contribution: Do Individuals Put Their Money Where Their Mouth Is?" *Journal of Economic Behavior and Organization*, 1993, *22*(3), pp. 255-67.

Lawler, Edward and Yoon, Jeongkoo. "Commitment in Exchange Relations: Test of a Theory of Relational Cohesion." *American Sociological Review*, February 1996, *61*, pp. 89-108.

Ledyard, John O. "Public Goods: A Survey of Experimental Research," in John Kagel and Alvin Roth, eds., *Handbook of Experimental Economics*. Princeton, NJ: Princeton University Press, 1995.

Marwell, Gerald and Ames, Ruth E. "Economists Free Ride, Does Anyone Else?: Experiments on the Provision of Public Goods, IV." *Journal of Public Economics*, June 1981, *15*(3), pp. 295-310.

McCabe, Kevin A. and Smith, Vernon L. "Strategic Analysis by Players in Games: What Information Do They Use?," in Elinor Ostrom and James Walker, eds., *Trust, Reciprocity, and Gains from Association: Interdisciplinary Lessons from Experimental Research*. New York: Russell Sage Foundation, forthcoming.

McGinnis, Michael D. "Issue Linkages and the Evolution of International Cooperation." *Journal of Conflict Resolution*, March 1986, *30*(1), pp. 141-70.

McGinnis, Michael, ed. *Polycentric games and institutions: Readings from the Workshop in Political Theory and Policy Analysis*. Ann Arbor: University of Michigan Press, 2000.

Milgrom, Paul R.; North, Douglass C. and Weingast, Barry R. "The Role of Institutions in the

Revival of Trade: The Law Merchant, Private Judges, and the Champagne Fairs." *Economics and Politics,* March 1990, *2*(1), pp. 1-23.

Ockenfels, Axel and Weinmann, Joachim. "Types and Patterns: An Experimental East-West-German Comparison of Cooperation and Solidarity." *Journal of Public Economics,* 1999, *71*(2), pp. 275-87.

Olson, Mancur. *The logic of collective action: Public goods and the theory of groups*. Cambridge, MA: Harvard University Press, 1965.

Orbell, John M.; van de Kragt, Alphons J.C. and Dawes, Robyn M. "Explaining Discussion-Induced Cooperation." *Journal of Personality and Social Psychology,* 1988, *54*(5), pp. 811-19.

Ortmann, Andreas and Tichy, Lisa K. "Gender Differences in the Laboratory: Evidence from Prisoner's Dilemma Games." *Journal of Economic Behavior and Organization*, 1999, *39*, pp. 327-39.

Ostrom, Elinor. *Governing the commons: The evolution of institutions for collective action*. New York: Cambridge University Press, 1990.

_____. "A Behavioral Approach to the Rational Choice Theory of Collective Action." *American Political Science Review,* March 1998, *92*(1), pp. 1-22.

_____. "Collective Action and the Evolution of Social Norms." *Journal of Economic Perspectives,* Summer 2000, *14*(3), pp. 137-58.

Ostrom, Elinor; Gardner, Roy and Walker, James. *Rules, games and common-pool resources*. Ann Arbor: University of Michigan Press, 1994.

Putnam, Robert D. "Diplomacy and Domestic Politics: The Logic of Two-level Games." *International Organization*, Summer 1988, *42*(3), pp. 427-60.

Roth, Alvin E. "Bargaining Experiments," in John H. Kagel and Alvin E. Roth, eds., *The handbook of experimental economics*. Princeton, NJ: Princeton University Press, 1995, pp. 253-348.

Sally, David. "Conservation and Cooperation in Social Dilemmas. A Meta-Analysis of Experiments from 1958-1992." *Rationality and Society,* January 1995, *7*, pp. 58-92.

_____. "On Sympathy and Games." *Journal of Economic Behavior and Organization*, 2001, *44*, pp. 1-30.

Sen, Amartya. "Rational Fools: A Critique of Behavioral Foundations of Economic Theory." *Philosophy and Public Affairs,* Summer 1977, *6*(4), pp. 317-44.

Notes

1. Probably the clearest rejections of theoretical predictions have occurred in ultimatum and dictator experiments where first movers tend to offer second movers a far larger share of the bounty than predicted and where second movers (when given a chance) turn down offers that are not perceived, given the experimental conditions, as being fair (see Werner Güth and Reinhard Tietz, 1990; Alvin Roth, 1995).

2. There seems to be a certain fraction of *homo economicus* in society as shown in many types of bargaining, dictator, and ultimatum game experiments.

3. Once enforcement of rules suffers from any kind of transaction costs, the other layers of information enter into play to determine the actual response to a certain formal but partially enforced rule.

4. Here we see some of the elements of process-regarding and other-regarding preferences discussed in the "preferences layer."

5. In the case of transactions under perfectly competitive markets where there are no externalities involved, it is very unlikely that the player will use this layer of information because the perfectly competitive transaction has accounted by definition for all effects on others, and the decision ultimately is based on the price and my demand for it.

6. See also Jamie Brown Kruse and David Hummels (1993), where they suggest that contrary to recent propositions that females tend to cooperate more, males contributed at higher rates. Meanwhile, Andreas Ortmann and Lisa Tichy (1999) found that females cooperated more in the first round but that the difference faded by the end of the game because, they argue, of the effect of experience in previous rounds. They also report that the gender composition had an impact in behavior, namely, that single sex groups of females showed a higher rate than single males groups. This last result would support the arguments about the *Group-Context Layer* in the framework presented here.

7. One caveat would be when there is no likelihood of a next round in this game, but the player knows with some certainty that he/she will meet with the *same* players in an entirely different game in which case the one-shot decision to cooperate might be influenced by that. This is developed in much detail on the multi-level and linked games literature (Robert Putnam, 1988; Michael McGinnis, 1986).

8. The positive value for the intercept coefficient says in this case that if all other variables had a value of zero, there is still a willingness to cooperate XDEVIA greater than zero.