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What Motivates Common Pool Resource Users? Experimental Evidence from the Field

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Abstract: This paper develops and tests several models of pure Nash strategies of individuals who extract from a common pool resource when they are motivated by a combination of self-interest and preferences for altruism, reciprocity, inequity aversion and conformity. Using data from a series of common pool resource experiments conducted in three rural areas of Colombia, we test whether an econometric summary of the subjects' pure Nash strategies is consistent with one or more of these models. We find that a model that balances self-interest with a strong preference for conformity best describes average strategies. Our results are inconsistent with a model of pure self-interest, as well as models that combine self-interest with individual preferences for altruism, reciprocity and inequity aversion.

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1. Introduction

In both public goods and common-pool resource experiments, subjects typically cooperate to a greater degree than models of pure self-interest would predict. Similarly, in sequential two-person games, such as the ultimatum and trust games, the literature is dominated by examples in which outcomes clearly deviate from the subgame perfect equilibrium. Several models have emerged in an attempt to explain why individual choices differ from those predicted by purely self-interested Nash behavior (see Fehr and Gächter 2000, and Sobel 2005 for surveys). These models are rooted in the assumption that individuals are motivated by a combination of self-interest and other preferences (e.g., Levine 1998, Fehr and Schmidt 1999, Bolton and Ockenfels 2000, Bowles 2003). Although there is a significant theoretical and experimental literature explaining non-selfish behavior, there has been little research that develops and tests a unified theoretical framework to discriminate among competing models, particularly in the context of cooperative games such as public goods and common-pool resource experiments.[1] Consequently,

[1] Cox (2004) highlights the importance of discriminating among alternative motives for cooperative behavior to guide the formation of utility theory that increases the empirical validity of game theory. To begin addressing this

we develop and test several alternative models of pure Nash strategies for individuals who extract from a common pool resource when they are motivated by combinations of self-interest and altruism, reciprocity, inequity aversion, and conformity. Data generated from a series of common pool resource experiments conducted in three rural areas of Colombia are used to test whether an econometric summary of the subjects' pure Nash strategies reveals whether one of these motivations was dominant in our subject pool.

In the public goods and common-pool resource literatures, much attention has focused on "conditional cooperation" as an explanation for non-selfish behavior (see Fehr and Fischbacher 2002 for a review of this literature). An individual that pursues a strategy of conditional cooperation pursues a strategy of reciprocal behavior. That is, an individual cooperates with others when she expects them to do the same, and does not cooperate when she expects others to not cooperate. Specifically for a common pool resource game, a conditional cooperator will choose a low harvest level when she expects others to also conserve the resource, and will harvest more of the resource when she expects others to do likewise. Of course, this is simply a statement that a reciprocal strategy implies an upward-sloping individual Nash best-response function. What is often left unaddressed in the literature is the underlying preference that produces a strategy of conditional cooperation.

A *strategy* of reciprocation (i.e., conditional cooperation) is not the same as a *preference* for reciprocity, or what Sobel (2005) calls "intrinsic reciprocity" (also see Fehr and Fischbacher 2002). Paraphrasing Sobel, an individual with a preference for reciprocity is willing to sacrifice her own payoff to increase the payoffs of others in response to kind behavior, while she is also willing to sacrifice her own payoff to decrease the payoff of others in response to unkind

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issue, he uses a three-way experimental design to discriminate between conditional (trust and reciprocity) and unconditional cooperation (altruism or inequality aversion) in sequential games.

behavior. In the context of common pool resource games, this suggests modifying an individual utility function by including a term that places a positive weight on the payoffs of others when she expects them to harvest less than she will, and a negative weight on their payoffs when she expects them to harvest more than she will. This is similar to the notion of inequity aversion in which an individual conditions her harvest decision on how others' *payoffs* compare to her own instead of relative *choices* (Fehr and Schmidt 1999; Falk, Fehr, and Fischbacher 2002).

It is important to note that an individual with a preference for reciprocity will not necessarily engage in reciprocal behavior. In fact, we show that a preference for reciprocity does not generally produce a Nash best-response function that is monotonically increasing. Instead, an individual who balances self-interest with a preference for reciprocity will typically have a downward-sloping segment of her best-response function when she expects others to choose relatively low harvests, and then an upward-sloping segment along which she matches her harvests to the average of others' harvests. Falk, Fehr, and Fischbacher (2002) demonstrate the same strategy for an inequity averse individual in a common pool resource game. Empirically, the non-monotonicity of an individual best-response function can distinguish a strategy of reciprocation from a preference for reciprocity.

We show that a strategy of conditional cooperation, that is, a monotonically increasing best-response function, can be the strategy of an individual with a strong preference for conforming to what she expects others to do. Following Luzzati (1999), we model this preference as an internal penalty an individual feels when her choices deviate from the expected average choices of the others in her group.[2] Our concept of conformity is similar to the notion of

[2] Luzzati does not empirically test his model of conformity. Bowles' (2003) model of guilt is similar to our conformity model in that an individual incurs an internal penalty when she cooperates less than the other group members. However, in our model an individual also faces an internal penalty when she cooperates more than the

normative conformity used in cultural evolutionary models and the social learning literature (see Henrich and Boyd 2001, Henrich 2004, McElreath *et al*. 2005). Henrich and Boyd (2001) and Henrich (2004), explain normative conformity as a psychological propensity to match common behavior in order to avoid appearing deviant. This is a different notion than *conformist transmission*, which is understood as a tendency to copy the most frequently occurring behavior, particularly in uncertain or complex environments (Henrich 2004).

We begin our analysis in the next section by deriving the characteristics of pure Nash strategies when self-interest is combined with preferences for altruism, reciprocity, inequity aversion, and conformity.[3] Each model produces a best-response function with unique characteristics. To test these models, we conducted a series of common pool resource experiments in three rural areas of Colombia in communities that are highly dependent on a local fishery. Rather than use a neutral frame, we were explicit that the experiments concerned extraction decisions from a shared fishery.[4] Thus, our experimental design avoids the problem that individuals in different communities may approach a "neutral" or "decontextualized" experiment in different ways.[5] In the experiments, groups of five subjects played 10 rounds of an open access common pool resource game. In each round, subjects were asked to decide how much to extract from a shared fishery, and to also provide their expectation about the aggregate

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other group members. This latter preference is an aversion to being "free ridden upon", as explained by Kurzban, McCabe, Smith and Wilson (2001).

[3] Altruism, reciprocity, and inequity aversion are referred to as other-regarding preferences, social preferences, or interdependent preferences because the payoffs of others are included in one's utility function. Because conformity includes only the other group members' choices, but not their well-being, we refrain from also labeling this an other-regarding preference.

[4] Within their recent taxonomy of field experiments, Harrison and List (2004) would classify our experiments as *framed field experiments*, because they are conducted with a population of subjects for which the phenomenon of interest to us (behavior in a common pool fishery) is also an important element of the subjects' experiences.

[5] See the Henrich *et al*. 2005 experiments across 15 small-societies, and the comments made by Vernon Smith, Randolph Grace and Simon Kemp among others. The commentators questioned the neutral frame of these experiments, because it could have been understood in different ways across the societies. Hence, the reported behavioral differences across societies could have been the result of different interpretations of the game instead of particular behavioral patterns in each society.

level of extraction of the others in their group. We describe our experimental design in more detail in section 3.

Section 3 also contains our empirical results. With data on both individual choices and their expectations about the aggregate choices of others, we estimate individual levels of extraction that are conditioned on an individual's expectation of the extraction levels of the other four group members. We estimate spline functions to allow for the possibility that the individual best-response function is non-monotonic. We then compare the characteristics of the estimated best-response function to those of our theoretical models to determine which, if any, of our models of Nash strategies explains average strategies in our subject pool. We find that average strategies are best described by a monotonically increasing best-response function, which is consistent with our theoretical model that balances self-interest with a strong preference for conformity. However, such a best-response function is not consistent with pure self-interest, or self-interest combined with altruism, a preference for reciprocity, or inequity aversion.

In section 4 of the paper we discuss the relationships of our approach and results to other common pool and public good experiments, and in section 5 we conclude.

2. Models of Self-Interest, Altruism, Reciprocity, Inequity Aversion, and Conformity

In this section we present models of pure Nash strategies when individuals who exploit a common pool resource are motivated by pure self-interest, and self-interest combined with altruism, reciprocity, inequity aversion or conformity. Each of these alternatives generates best-response functions with distinct characteristics. Our experimental design and econometric estimations allow us to test which of these motivations is dominant in our subject pool.

2.1 Pure Self-Interested Nash Strategies

The benchmark model for our study is the standard problem of individual extraction strategies from a common pool resource that is exploited by *n* individuals. This static model is similar to those presented by Ostrom *et al*. (1994), Falk *et al*. (2002), and an earlier model developed by Cornes and Sandler (1983).

Individual *i* extracts x_i units up to a capacity constraint $x_i^{\max}$. Units of extraction sell at a constant price *p*. The individual's extraction costs are $c\sum_{i=1}^{n} x_i + dx_i\sum_{i=1}^{n} x_i$, where *c* and *d* are positive constants. Define $x_{-i} = \sum_{j\neq i} x_j$, and write *i*'s extraction costs more compactly as $c(x_i + x_{-i}) + dx_i(x_i + x_{-i})$. These components of the cost function capture the social dilemma of the model in which $dx_i(x_i + x_{-i})$ captures the cost externality that is typical of common pool resource problems, while $c(x_i + x_{-i})$ captures negative externalities that reduce individual existence or non-use values. The individual has an endowment e_i.

Given the extraction of others, the individual's self-interested extraction choice is determined by maximizing:

$$\pi_i = e_i + px_i - c(x_i + x_{-i}) - dx_i(x_i + x_{-i}), \qquad [1]$$

subject to $x_i \le x_i^{max}$. Throughout we will let π_i denote individual *i*'s monetary payoff. Since π_i is strictly concave in x_i, the following Kuhn-Tucker condition is necessary and sufficient to identify a solution to [1]:

$$p - c - 2dx_i - dx_{-i} \ge 0, \text{ if } > 0, \ x_i = x_i^{max}. \qquad [2]$$

Letting [2] hold with equality and solving for x_i yields the unconstrained best-response function:

$$\hat{x}_i^s(x_{-i}) = (p - c - dx_{-i})/2d. \qquad [3]$$

The superscript *s* denotes the strategy of a purely self-interested individual. Incorporating the capacity constraint gives us the individual's best-response function:

$$x_i^s(x_{-i}) = \min\left[\hat{x}_i^s(x_{-i}),\ x_i^{max}\right]. \qquad [4]$$

Each subject in our experiments received the same payoff table generated from [1] with parameters p = 116.875, c = 17.875, d = 2.75, e_i = 900, $x_i^{\min} = 0$, and $x_i^{\max} = 8$. Figure 1 graphs $\hat{x}_i^s(x_{-i})$ and $x_i^s(x_{-i})$ using these parameters. Let $\overline{x}_{-i} = \sum_{j \neq i} x_j / (n-1)$ represent *i*'s expectation of the average extraction choices of the other group members, where n = 5. The function $x_i = \overline{x}_{-i}$ defines the set of choices in which individual *i*'s extraction choice exactly matches her expectation of the average extraction of the others up to the group and individual capacity constraint (32,8). The intersection of $x_i = \overline{x}_{-i}$ and $x_i^s(x_{-i})$ at (24,6) is the standard symmetric Nash equilibrium. It is easy to show, however, that the group's joint payoffs are maximized if all individuals extract a single unit.

<INSERT FIGURE 1>

2.2 Other Regarding Preferences: Altruism, Reciprocity and Inequity Aversion

Models of altruism, reciprocity and inequity aversion reflect a balance between self-regarding and other-regarding preferences. In these cases, an individual places a value on the payoffs of others. Suppose individual *i*'s utility is given by

$$u_i = \pi_i + \beta_i \sum_{j \neq i} \pi_j . \qquad [5]$$

Following Levine (1998) and Bowles (2003), β_i can be specified to capture both altruism and reciprocity motives in the following way:

$$\beta_i = \beta_i(x_i - \overline{x}_{-i}) = \begin{cases} \alpha_i + \rho_i^+, \text{ if } x_i \ge \overline{x}_{-i} \\ \alpha_i - \rho_i^-, \text{ if } x_i < \overline{x}_{-i}, \end{cases} \tag{6}$$

where α_i, ρ_i^+, and ρ_i^- are positive constants. We construct β_i in this way to guarantee that all best-response functions are piecewise linear. The value α_i is the altruism parameter; it is the marginal value that *i* places on the utility of the other players and is independent of their choices. In contrast, the reciprocity motive implies that the weight that the individual places on the payoffs of others is conditioned on how their average levels of extraction compare to her own. An individual places a positive value, ρ_i^+, on the payoffs of others when she expects that their average extraction will not exceed her own, but a negative weight on their payoffs, $-\rho_i^-$, when she expects that they will extract more than she will.

Upon substitution of [1] into [5] we have:

$$\begin{aligned} u_i &= e_i + px_i - c(x_i + x_{-i}) - dx_i(x_i + x_{-i}) \\ &\quad + \beta_i\left(\textstyle\sum_{j \ne i} e_j + px_{-i} + (n-1)c(x_i + x_{-i}) - dx_{-i}(x_i + x_{-i})\right). \end{aligned} \tag{7}$$

Maximizing u_i with respect to $x_i \le x_i^{max}$ requires:

$$\partial u_i / \partial x_i = p - c - 2dx_i - dx_{-i} - \beta_i[dx_{-i} + (n-1)c] \ge 0, \text{ if } > 0, \; x_i = x_i^{max}. \tag{8}$$

Note that $\partial^2 u_i / \partial x_i^2 = -2d < 0$, which indicates that u_i is strictly concave in x_i. Therefore, [8] is necessary and sufficient to identify a best-response to x_{-i}. The solution to [8] with a non-binding capacity constraint is:

$$\begin{aligned} \hat{x}_i^{\beta}(x_{-i}) &= \left(p - c - dx_{-i} - \beta_i[dx_{-i} + (n-1)c]\right)/2d \\ &= \hat{x}_i^s(x_{-i}) - \beta_i[dx_{-i} + (n-1)c]/2d. \end{aligned} \tag{9}$$

where $\hat{x}_i^s(x_{-i})$ is defined by [3]. Upon substitution of [6] we have:

$$\hat{x}_i^{\beta}(x_{-i}) = \begin{cases} \hat{x}_i^{\beta+}(x_{-i}) = \hat{x}_i^{s}(x_{-i}) - (\alpha_i + \rho_i^{+})[dx_{-i} + (n-1)c]/2d, \text{ for } x_i \geq \overline{x}_{-i} \\ \hat{x}_i^{\beta-}(x_{-i}) = \hat{x}_i^{s}(x_{-i}) - (\alpha_i - \rho_i^{-})[dx_{-i} + (n-1)c]/2d, \text{ for } x_i < \overline{x}_{-i}. \end{cases} \quad [10]$$

Incorporating the capacity constraint yields the individual's best-response when she is motivated by a combination of altruism, reciprocity, and pure self-interest:

$$x_i^{\beta}(x_{-i}) = \min\left[\hat{x}_i^{\beta}(x_{-i}),\ x_i^{max}\right]. \quad [11]$$

2.2.1 Altruism

We first consider an individual that balances altruism and self-interest when choosing her extraction, and does not have a preference for reciprocity. Ignoring the capacity constraint for a moment, set $\rho_i^{+} = \rho_i^{-} = 0$ in [10] to obtain $\hat{x}_i^{\beta}(x_{-i}) = \hat{x}_i^{\alpha}(x_{-i}) = \hat{x}_i^{s}(x_{-i}) - \alpha_i[dx_{-i} + (n-1)c]/2d$. Incorporating the capacity constraint ($x_i^{max} = 8$) gives us the best-response function for this individual, $x_i^{\alpha}(x_{-i}) = \min\left[\hat{x}_i^{\alpha}(x_{-i}),\ x_i^{max}\right]$. Note that $\hat{x}_i^{\alpha}(0) = \hat{x}_i^{s}(0) - \alpha_i(n-1)c/2d < \hat{x}_i^{s}(0)$ and $\partial\hat{x}_i^{\alpha}(x_{-i})/\partial x_{-i} = \partial\hat{x}_i^{s}(x_{-i})/\partial x_{-i} - \alpha_i d/2 < \partial\hat{x}_i^{s}(x_{-i})/\partial x_{-i}$.[6] These relationships reveal that when an individual balances altruism and pure self-interest, her unconstrained best-response function lies below and is more steeply downward-sloping than her unconstrained best-response function if she was purely self-regarding.

In Figure 2 we have used $\hat{x}_i^{\alpha}(x_{-i})$ and the capacity constraint to graph a representative best-response function, $x_i^{\alpha}(x_{-i})$, for an individual that balances altruism and pure self-interest. We assume that the capacity constraint is binding in this case for relatively low levels of extraction by the other individuals, but this need not be the case if the altruism motive is strong enough. Except at the capacity constraint ($x_i^{max} = 8$), the individual will always choose lower

[6] It is possible that the altruism motive is so strong that $\hat{x}_i^{\alpha}(0) = 0$, but we ignore this possibility because it implies that $\hat{x}_i^{\beta}(0) = 0$ for all x_{-i}.

levels of extraction than if she was purely self-interested. Moreover, if she does not extract up to the capacity constraint, then her extraction will be declining in her expectation of what others will extract. Therefore, if altruism is a dominant motive in our subject pool, an econometric analysis of individual extraction choices should generate a best-response function that is non-increasing and that has a strictly decreasing segment.

<INSERT FIGURE 2>

2.2.2 Reciprocity

Now consider an individual that is not motivated by altruism, but rather by a combination of reciprocity and self-interest. Again, ignoring the capacity constraint for the time being, substitute $\alpha_i = 0$ into [10] to obtain

$$\hat{x}_i^{\rho}(x_{-i}) = \begin{cases} \hat{x}_i^{\rho+}(x_{-i}) = \hat{x}_i^{s}(x_{-i}) - \rho_i^{+}[dx_{-i} + (n-1)c]/2d, \text{ for } x_i \geq \bar{x}_{-i} \\ \hat{x}_i^{\rho-}(x_{-i}) = \hat{x}_i^{s}(x_{-i}) + \rho_i^{-}[dx_{-i} + (n-1)c]/2d, \text{ for } x_i < \bar{x}_{-i}. \end{cases} \qquad [12]$$

With the capacity constraint the individual's best-response is $x_i^{\rho}(x_{-i}) = \min\left[\hat{x}_i^{\rho}(x_{-i}),\ x_i^{max}\right]$.

To derive the characteristics of $x_i^{\rho}(x_{-i})$ we need to examine how $\hat{x}_i^{\rho+}(x_{-i})$, $\hat{x}_i^{\rho-}(x_{-i})$, and $\hat{x}_i^{s}(x_{-i})$ are related. From [12] we have:

$$\hat{x}_i^{\rho+}(0) = \hat{x}_i^{s}(0) - \rho_i^{+}(n-1)c/2d < \hat{x}_i^{s}(0);$$

$$\hat{x}_i^{\rho-}(0) = \hat{x}_i^{s}(0) + \rho_i^{-}(n-1)c/2d > \hat{x}_i^{s}(0);$$

$$\partial\hat{x}_i^{\rho+}(x_{-i})\big/\partial x_{-i} < \partial\hat{x}_i^{s}(x_{-i})\big/\partial x_{-i} < \partial\hat{x}_i^{\rho-}(x_{-i})\big/\partial x_{-i}\,. \qquad [13]$$

These relationships indicate that $\hat{x}_i^{\rho+}(x_{-i})$ lies below and is more steeply downward sloping than $\hat{x}_i^{s}(x_{-i})$, while $\hat{x}_i^{\rho-}(x_{-i})$ lies above and has a shallower slope than $\hat{x}_i^{s}(x_{-i})$. In fact $\hat{x}_i^{\rho-}(x_{-i})$ may have a positive slope if ρ_i^{-} is high enough. Figure 3 graphs $\hat{x}_i^{s}(x_{-i})$, and possible $\hat{x}_i^{\rho+}(x_{-i})$ and

$\hat{x}_i^{\rho-}(x_{-i})$. The heavy dashed line is the individual's best-response function, $x_i^{\rho}(x_{-i})$, when she is motivated by a combination of pure self interest and reciprocity. This function combines $\hat{x}_i^{\rho+}(x_{-i})$ for $x_i \geq \overline{x}_{-i}$, $\hat{x}_i^{\rho-}(x_{-i})$ for $x_i < \overline{x}_{-i}$, and the capacity constraint.[7]

<INSERT FIGURE 3>

Like the model of altruism, the best-response function for one who balances pure self-interest with a preference for reciprocity may lie along the capacity constraint for relatively low levels of the expected extraction of others, but there will typically be a strictly decreasing segment. Along this decreasing segment, the individual's extraction exceeds her expectation of what others will extract. Thus, she rewards the others for their restraint by extracting less than if she was purely self-interested. After this declining segment, her best-response function is monotonically increasing along $x_i = \overline{x}_{-i}$, indicating that her extraction exactly equals the average of what she expects others to extract. For significantly higher levels of extraction by the others, the individual 'punishes' them by extracting more than if she was purely self-interested. Although our graph indicates a declining segment of the best-response function for very high levels of others' extraction, if the punishment motive is strong enough, then this will not occur and the best-response function will continue along $x_i = \overline{x}_{-i}$ up to the group and individual capacity constraint (32, 8).

[7] To show that $x_i^{\rho}(x_{-i}) = \overline{x}_{-i}$ in its third segment from the left, consider a pair (x_i^0, x_{-i}^0) in this segment, where $x_i^0 = x_{-i}^0/(n-1)$. To show that x_i^0 is a best-response to x_{-i}^0, suppose instead that some $x_i^1 < x_i^0$ is a best-response to x_{-i}^0. Note that $x_i^1 < x_{-i}^0/(n-1)$. However, using [12] $\min[\hat{x}_i^{\rho-}(x_{-i}), x_i^{max}]$ is the best-response for all $x_i < x_{-i}/(n-1)$. Since at a point like (x_i^0, x_{-i}^0), $\min[\hat{x}_i^{\rho-}(x_{-i}), x_i^{max}] > x_i^0 > x_i^1$, some $x_i^1 < x_i^0$ cannot be a best-response to x_{-i}^0. Now suppose that some $x_i^2 > x_i^0$ is a best-response to x_{-i}^0. Note that $x_i^2 > x_{-i}^0/(n-1)$, but for all $x_i \geq x_{-i}/(n-1)$, $\min[\hat{x}_i^{\rho+}(x_{-i}), x_i^{max}]$ is the best-response as long as $\hat{x}_i^{\rho+}(x_{-i}^0) \geq 0$. In Figure 3 note that at a point like (x_i^0, x_{-i}^0), $\min[\hat{x}_i^{\rho+}(x_{-i}), x_i^{max}] < x_i^0 < x_i^2$, which indicates that $x_i^2 > x_i^0$ cannot be a best-response to x_{-i}^0. Since higher or lower extraction levels than $x_i^0 = x_{-i}^0/(n-1)$ cannot be a best-response to x_{-i}^0, x_i^0 must be.

There is a special case that needs mentioning. It is possible that an individual's preference for both positive and negative reciprocity so completely dominates her pure self-interest that her best-response function is monotonically increasing. In this case, however, she will exactly match her extraction to the average extraction of the others in her group; that is, her best-response function collapses to simply $x_i^{\rho}(x_{-i}) = \overline{x}_{-i}$. We shall label the motivation that produces this best-response as *pure reciprocity* to reflect the fact that self-interest plays no role in determining this strategy.

This special case aside, if reciprocity is the most important motivator in our subject pool, then our estimation results should yield a non-monotonic regression that may lie along the capacity constraint for relatively low levels of expected extraction by others, but is strictly decreasing and lies above $x_i = \overline{x}_{-i}$ for somewhat higher levels of others' extraction, and then follows $x_i = \overline{x}_{-i}$ for mid to higher levels of the expectation of others' extraction.

It is important to note that a preference for reciprocity does not generally produce a strategy of reciprocity (i.e., conditional cooperation), as this strategy is commonly understood. If we take a reciprocal strategy to mean the strategy of one who tends to make more conservative choices when others do as well, and who tends to make less conservative choices when others are less conservative, then this individual will have a monotonically increasing best-response function. Except for the special case in which an individual's preference for reciprocity is so strong that her self-interests do not play a role in determining her strategy, an individual who balances preferences for self-interest and reciprocity will have a non-monotonic best-response function. In our analysis of our experimental data we will be looking for this non-monotonicity to determine if reciprocal preferences are dominant in our subject pool.

2.2.3 Altruism and Reciprocity

Our model of other-regarding preference, [5] and [6], allows for the possibility that an individual may combine preferences for self-interest, altruism, and reciprocity. Deriving an individual's best-response function when she is motivated by this combination of preferences is more involved, but nevertheless has a similar structure as the best-response function in Figure 3. In this case the best-response function lies below $x_i^{\rho}(x_{-i})$, due to the inclusion of the altruism parameter α_i, except when it lies on the $x_i = \overline{x}_{-i}$ locus, and possibly at the capacity constraint for low expected levels of others' extraction. Thus, except when the capacity constraint binds, the best-response function has a strictly declining segment at first and then a strictly increasing segment along $x_i = \overline{x}_{-i}$. How the function behaves for higher expected extraction of others depends on the relative importance of the reciprocity and altruism motives.

2.2.4 Inequity Aversion

Our model of reciprocity and pure self-interest generates a best-response function with similar characteristics to that presented by Falk *et al*. (2002), who adapted Fehr and Schmidt's (1999) notion of inequity aversion to the common pool resource problem. An inequity averse individual's utility function is assumed to be

$$u_i = \pi_i - \beta_i(\pi_i - \overline{\pi}_{-i}). \qquad [14]$$

In this utility function, $\overline{\pi}_{-i}$ is the average payoff of the other group member, that is,

$\overline{\pi}_{-i} = \sum_{j \neq i} \pi_j \big/ (n-1)$;

$$\beta_i = \begin{cases} \rho_i^{+}, \text{ if } \pi_i \geq \overline{\pi}_{-i} \\ -\rho_i^{-}, \text{ if } \pi_i < \overline{\pi}_{-i}, \end{cases}$$

and ρ_i^+ and ρ_i^- are positive constants. In this model, subjects are averse to differences in payoffs among individuals, with disadvantageous differences being more heavily weighted than advantageous differences (i.e., $\rho_i^- > \rho_i^+$). Falk *et al*. (2002) demonstrate that inequity aversion generates a best-response function that has the same basic shape as that generated by reciprocity (see their Figure 2). Therefore, we would not be able to distinguish the two within our framework.

2.3 Conformity

If individuals are motivated by a desire to conform or emulate the behavior of others in their group, following Luzzati (1999) they bear an internal penalty when their choices deviate from the choices of others. Suppose individual *i*'s utility is given by:

$$u_i = \pi_i - \gamma_i (x_i - \overline{x}_{-i})^2 / 2. \qquad [15]$$

The quadratic penalty function implies that the marginal internal penalty that the individual experiences when her choice deviates from the average choices of the others is increasing in the size of that deviation. Maximizing [15] without the capacity constraint, $x_i \le x_i^{max}$, yields the individual's unconstrained best-response function:

$$\hat{x}_i^\gamma (x_{-i}) = \frac{p - c - dx_{-i}}{2d + \gamma_i} + \frac{\gamma_i x_{-i} / (n-1)}{2d + \gamma_i}. \qquad [16]$$

Incorporating the capacity constraint yields the individual's best-response when she has a preference for conformity, $x_i^\gamma (x_{-i}) = \min[\hat{x}_i^\gamma (x_{-i}), x_i^{max}]$.

To compare an individuals' best-response when she balances a preference for conformity and simple self-interest to her best-response when she is motivated solely by self-interest, note from [3] that $2d\hat{x}_i^s(x_{-i}) = p - c - dx_{-i}$. Therefore, we can rewrite [16] as

$$\hat{x}_i^{\gamma}(x_{-i}) = \hat{x}_i^{s}(x_{-i})\frac{2d}{2d+\gamma_i} + \frac{\gamma_i x_{-i}/(n-1)}{2d+\gamma_i}. \quad [17]$$

From [17] we have $\hat{x}_i^{\gamma}(0) = \hat{x}_i^{s}(0)\frac{2d}{2d+\gamma_i} < \hat{x}_i^{s}(0)$, and

$$\partial\hat{x}_i^{\gamma}(x_{-i})/\partial x_{-i} = \left(\partial\hat{x}_i^{s}(x_{-i})/\partial x_{-i}\right)\frac{2d}{2d+\gamma_i} + \frac{\gamma_i/(n-1)}{2d+\gamma_i} > \partial\hat{x}_i^{s}(x_{-i})/\partial x_{-i}.$$

Thus, $\hat{x}_i^{\gamma}(x_{-i})$ has a lower intercept than $\hat{x}_i^{s}(x_{-i})$, but a greater slope. In fact, if the preference for conformity is strong enough, $\hat{x}_i^{\gamma}(x_{-i})$ can be upward sloping (this occurs if $\gamma_i/(n-1) > d$). In general, conformity can produce several best-response functions with different characteristics. However, all such best-response functions are monotonic except when the capacity constraint is binding. If the conformity preference is relatively weak so that an individual's best-response function is downward sloping, then we would not be able to distinguish conformity from altruism. However, if the preference for conformity is relatively strong, then the best-response function will be monotonically increasing which, of course, is consistent with a strategy of conditional cooperation. Of all the models that we have considered, recall that the only other preference that can produce an upward sloping best-response function is pure reciprocity, which produces the best-response function $x_i^{\rho}(x_{-i}) = \overline{x}_{-i}$. Any other monotonically increasing best-response function is consistent only with a strong preference for conformity.

3. Experimental Design and Results

Our common pool resource experiments were conducted with subjects who face the same kind of dilemma about the exploitation of local natural resources in their everyday lives. A total of 420 individuals participated in our experiments, which were conducted in three regions of

Colombia—on the Pacific Coast, the Caribbean Coast and the Magdalena River—in communities in which the primary activity is artisanal fishing. Table 1 presents some summary statistics about the subject pool. Over three-quarters of the subjects were male fishermen; the average age was about 38.6 with an average of 5.5 years of formal schooling. Many of the subjects knew each other from daily interactions.

<INSERT TABLE 1>

The subjects were placed into groups of five and participated in a ten-round common pool resource game.[8] Each subject received an identical payoff table that was generated from [1] with parameters p = 116.875, c = 17.875, d = 2.75, e_i = 900, $x_i^{min} = 0$ and $x_i^{max} = 8$.[9] In each round, besides deciding upon a level of extraction, subjects were also asked to state their expectation of the total extraction by the other four group members.[10] The subjects were not allowed to communicate with each other during the experiment. After all subjects had made their decisions for a round in private, the monitor collected this information and announced to the group the aggregate level of extraction for that round. Individuals then calculated both the actual level of total extraction by the others and their own payoffs given the others' decisions.

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[8]Assignment to groups was not completely random. We tried to ensure that relatives were in separate groups. Each group played 10 additional rounds with different treatments involving combinations of communication and regulatory control. These additional data are not included in the present analysis.

[9] The experiment instructions, including the payoff table, are available upon request. **<attached now as a reviewer's appendix>.** The instructions were first written in English, and then translated to Spanish. We then translated the instructions back to English to avoid translation errors. In the experiments, participants were asked to choose a harvest level between 1 and 9 units, instead of between 0 and 8 units. The reason for this is that the concept of zero harvest is very difficult to explain in the field since the participants depend so critically on their use of local natural resources. The payoff table they were given was modified to account for this. However, our analysis assumes that individual harvest choices vary from 0 and 8.

[10] In a public goods experiment, Croson (1998) also asked subjects about their expectations about the choices of the other group members. However, she compensated them for more accurate predictions. In our experiments, subjects' earnings were based solely on their choices and were not affected by their predictions of others' choices. Other studies that use the expectations about other group members are Bornstein and Ben-Yossef (1994), Komorita, Parks, and Hulbert (1992) and Yamagishi and Sato (1986).

Average individual earnings were about 15,340 pesos per person (about US$6). Daily wages in these regions averaged 10,000-15,000 pesos during the summer of 2004. Earnings were paid in cash at the end of each experiment. Before each experiment began, instructions were read aloud by the monitor and several practice rounds that did not count toward final earnings were played to familiarize the participants with the rules.

Table 2 presents some summary statistics of the individuals' extraction choices and their expectations of the aggregate extraction choices of the others in their group, as well as the actual extraction choices of the others. The mean individual level of extraction was 4.6 units, but the purely self-interested Nash equilibrium prediction is that each individual would extract six units. We also calculated individual differences between their actual choice and their purely self-interested best-response given their reported expectations of what others would do. Not surprisingly, subjects did not pursue self-interested Nash strategies as suggested by an average deviation of 2.5 units from their purely self-interested Nash strategies. Moreover, subjects tended to be too optimistic about the extraction choices of the others in their group. As shown in Table 2, on average, individuals expected that the other four members of their group would extract a total of 15.4 units, 2.9 units less than their actual extraction (or 0.7 units per person). This over-optimism is consistent with the public goods experiments of Croson (1998), in which 33% of her subject pool tended to be overly optimistic in their predictions about the public good contributions of their group members.

<INSERT TABLE 2>

To determine whether an econometric summary of these individual strategies reveals which motivation was dominant in our experiments, we estimated their best-responses using random effects Tobit models. The use of random effects models responds to the nature of our experimental data in which repeated observations are obtained from each individual; the Tobit model accounts for the censored nature of our data since individual decisions were constrained to be between 0 and 8 units. Moreover, since our theoretical development yielded piece-wise linear best-response functions which in some cases are non-monotonic, we estimated spline functions which allow the slope of the regression to vary in different intervals of the expected extraction of others, but imposes continuity on the estimated regression. Although others have noted the theoretical possibility that the best-response functions may not be monotonic (*e.g.*, Falk *et al*. 2002), to our knowledge no one has accounted for this possibility in empirical work.

Our regression results are reported in Table 3. Model 1 is a spline regression that divides the range of individuals' expectations of the extraction levels of the other group members, denoted x_{-i}^{e}, into four-unit intervals. Recall that for our models of pure self-interest alone and for self-interest combined with altruism, reciprocity or inequity aversion, individual best-response functions could exhibit a flat segment at the capacity constraint of eight units for relatively low levels of expected extraction of others, but that each must have a monotonically decreasing segment. In contrast, the estimated best-response function is flat and lies below the capacity constraint for $x_{-i}^{e} < 8$ (the estimate of the constant is 2.46 and statistically significant, but the slope coefficients for the intervals $0 \le x_{-i}^{e} < 4$ and $4 \le x_{-i}^{e} < 8$ are not significant), after which it monotonically increases as the expected extraction of others increases (the remaining slope coefficients are positive and significant). Because there are no declining segments, we can clearly reject the hypotheses that pure self-interest, or self-interest combined with altruism, reciprocity or inequity aversion can explain average behavior in our experiments. Furthermore, recall that a preference for pure reciprocity produces the best-response function $x_i^{\rho}(x_{-i}) = \overline{x}_{-i} = x_{-i}/(n-1)$. We can also reject the hypothesis that pure reciprocity is dominant in our subject pool, because the intercept estimate is greater than zero and the slope coefficients never approach $1/(n-1) = 0.25$.

<INSERT TABLE 3>

Instead, it appears that the model of conformity best describes average strategies in our experiments. Recall that our model of conformity generates a Nash best-response function that is monotonic except possibly at the capacity constraint. In addition, we showed that if the desire of an individual for conformity dominates her pure self-interest, then her best-response function will be increasing. Except for the flat segment for low levels of expected extraction by others, which we will revisit shortly, this is exactly what our regression results indicate. Therefore, average strategies in our experiments are consistent with a strong preference for conformity, and not with altruism, reciprocity, or inequity aversion. Of course, we do not claim that our results suggest that all subjects were conformists, only that a desire to conform appears to be the dominant motivation.

As discussed by Carpenter (2004), the conformity motive could generate less cooperative outcomes than predicted by the model of pure self-interests; that is, subjects could conform to similarly high levels of extraction. In our case, mean levels of individual extraction were well below the conventional Nash prediction (see Table 2). Thus, it appears that the conformity motive led to a more cooperative (though not efficient) utilization of the commons.

The spline function estimated in Model 1 was useful to test for any changes in the slope of the regression. However, the coefficients obtained for each interval suggest that the expected extraction of others could be partitioned into fewer intervals. The first two intervals of Model 1 show positive coefficients that are not significantly different from zero. Furthermore, the rest of the intervals have coefficients that are statistically greater than zero, but they are not significantly different from each other. The null hypothesis that the estimated coefficients for the higher intervals are equal to each other cannot be rejected (Wald test, $p = 0.59$). This leads us to Model 2 which includes just two intervals, $0 \leq x_{-i}^{e} < 8$ and $8 \leq x_{-i}^{e} \leq 32$. The results reveal a statistically positive slope coefficient in both intervals; however, the coefficients are statistically different ($p = 0.03$).

In each model we also included the period as an explanatory variable to capture the effect of time on individual choices. In all cases, individual extraction is increasing slightly as the experiment proceeds. This is consistent with results that others have found in games of social dilemmas; namely, high levels of cooperation in the early rounds of these experiments, but declining cooperation rates over time (Fehr *et al*., 2002).

Finally, we also examined the effects of regions and individual characteristics such as age, gender and years of education. We included dummy variables to capture regional effects, none of which are statistically significant. Likewise, age and gender are not significant. However, the coefficient for education is positive and highly significant in each of our models. It is possible that the more educated individuals may be better able to identify the purely self-interested Nash strategy and use this to their advantage. This result could also suggest that those with lower levels of education, who may be more unsure about what to choose, might be more likely to use the decisions of others to guide their decisions; that is, having trouble determining a payoff-maximizing strategy, they revert to trying to ensure that their choices roughly conform to what the rest of the group is doing (Smith and Bell 1994).

4. Relationship to Other Experiments

Our approach and results differ from similar studies in significant ways. There are only a few studies involving common pool resource experiments that attempt to disentangle alternative motives for cooperative behavior. Cardenas, Stranlund, and Willis (2000) found that external regulation of a common pool resource tended to crowd out other-regarding behavior in favor of more self-interested choices. However, they do not attempt to distinguish among the range of motives that we consider, preferring to classify choices that were more cooperative than pure Nash choices as evidence of other-regarding motives. Falk, Fehr, and Fischbacher (2002) develop a theoretical explanation of behavior in common pool resource games by using Fehr and Schmidt's (1999) model of inequity aversion and argue that their model explains the empirical regularities reported in Walker, Gardner and Ostrom (1990) and Ostrom, Walker and Gardner (1992). They focus on last-period choices and, hence, do not attempt to estimate best-response functions as we do. Importantly, our results are not consistent with their model of inequity aversion.

Casari and Plott (2003) found that about one-third of their subjects in a common pool experiment were either altruistic or spiteful, but that most were spiteful. We, of course, reject altruism as a dominant motivation in our experiments. On the possibility of spitefulness, our results are not comparable to Casari and Plott's simply because our experimental design did not give the subjects as much of an opportunity to be spiteful as theirs did.

The analysis of alternative motivations is more prominent in other contexts. Fehr and Fischbacher (2002) survey the experimental evidence of ultimatum, dictator, public goods, and gift exchange games (among others) and argue that many experimental results can be explained by individual preferences for fairness and reciprocity. However, public goods and common pool resource games have an important characteristic that distinguishes them from the sequential games they review and which could affect the nature of other-regarding behavior. In these multi-person cooperation games, each individual has a similar, if not identical, role. In common-pool resource experiments, for example, each person must make the same type of decision—how much to extract from the shared resource—even if it is possible that payoffs from extraction are heterogeneous. On the other hand, individuals in sequential games usually have clearly distinct roles (e.g., proposer and responder in an ultimatum game) with asymmetric bargaining power. Unlike sequential games, the symmetry of subject roles in cooperation games allows for the possibility that conformity—the desire not to deviate "too far" from other group members' choices—may explain the behavior of some individuals in these games.

In public goods experiments, much attention focuses on classifying individuals as "types" rather than on estimating best-response functions. For example, Fischbacher, Gachter and Fehr (2001) found that about half of their subjects could be classified as conditional cooperators. Similarly, Kurzban and Houser (2005) identify 20% of their subjects as free-riders, 13% as cooperators and 63% as conditional cooperators. The importance of the conditional cooperation strategy in these studies is consistent with our estimation of a monotonically increasing average best-response function; that is, conditional cooperation is dominant in our experiments as well. However, we have been careful to derive strategies from alternative preferences, paying particular attention to the distinction between a preference for reciprocity and a strategy of reciprocation. Our results suggest that conditional cooperation is more likely to be the result of a preference for conformity rather than an other-regarding preference for reciprocity.

Croson's (1998) examination of voluntary contributions to a public good is similar to our work in that she estimates the effect of beliefs about the contributions of others on individual contributions and finds a positively sloped best-response function as well. However, she labels this as reciprocal behavior following Sugden's (1984) model of reciprocity. In contrast to a preference for reciprocity, Sugden's model of reciprocity does not use an interdependent preferences framework. He uses a conventional self-regarding model constrained by a moral obligation to contribute to the public good as long as others do. Moreover, Croson estimates simple linear regressions, and therefore, does not allow for the possibility that her estimated best-response function could be non-monotonic. If Croson's estimated best-response function is truly monotonic, then we would argue that her result suggests that her subjects showed a preference for conformity, rather than a preference for reciprocity.

In fact, economists have not shown much interest in conformity as a motive driving individual behavior in games, although some have considered conformism in the context of public goods games. For example, Carpenter (2004) shows empirically that conformity can play a role in determining outcomes of public good games and can erode cooperative behavior. Our results suggest that conformity actually supports more efficient outcomes. Interestingly, Bardsley (2000) and Frey and Meier (2004) have called for the need to distinguish conformity from reciprocity. Bardsley and Sausgraber (2005) is an attempt to do so, but they state that reciprocity can generate a positive relationship between an individual's contribution and the contributions of the others in her group. In contrast, we have shown that a preference for reciprocity produces a non-monotonic relationship between an individual's harvest from a common property resource and her expectation of the harvests of other group members. Nevertheless, Bardsley and Sausgraber argue that conformity is an important consideration in public goods games. We have reached the same conclusion.

5. Conclusions

This paper is unique in a number of ways. First, we use a unified theoretical framework to simultaneously test multiple models of behavior that combine self-interest with other motives: altruism, reciprocity, inequity aversion or conformity. This allows us to discriminate among competing explanations for experimental results that clearly deviate from purely self-interested behavior. In particular, we have been careful to discriminate between a preference for reciprocity and reciprocal behavior, and have shown that the former does not generally imply the latter.

Second, although we are not the first to discuss conformity, few studies consider this motive as an alternative explanation for conditional cooperation. In fact, we conclude that the conditional cooperation that we observe is more likely to be generated by preferences for conformity than a preference for reciprocity. Moreover, this observation suggests the possibility that some observed reciprocal behavior in other studies may in fact be due to conformity. This distinction has potentially important implications for common pool resource management because they reflect substantively different underlying behavioral motivations. In particular, whereas reciprocity implies that utility is at least partially based on the welfare of others (in other words, an other-regarding preference), the utility of conformists is independent of others' well-being. Consequently, individuals motivated by reciprocity may respond differently to policies that seek to encourage more efficient resource use than conformists. Thus, the efficient design of policies to regulate common pool resource use depends critically on understanding the underlying motivations of those that are to be regulated.

Finally, although other studies have recognized the theoretical possibility that best-response functions may be non-monotonic, no other study empirically accounts for this by estimating a spline function, or some other non-linear form. Our theoretical development suggested that doing so is critical for understanding underlying individual preferences. We apply the spline function technique to describe aggregate outcomes. With a sufficient number of observations for individuals, it could also be used to describe strategies on an individual level.

It is clear that alternative individual motivations will have profound impacts on the design of policies to manage common pool resources. Because of this, future research should also consider the effects of different institutions on outcomes in the presence of alternative motives. Indeed, institutions may affect preferences as suggested by several authors including Cardenas, Stranlund and Willis (2000) and Frey and Jegen (2001). Thus, examining the interactions between preferences and institutions appears to be a fruitful area for new research.

A more important extension of our work, however, may be to analyze why the conformity motive is so dominant. Several explanations suggest themselves. We have already suggested that conformity may, in fact, be a second-best strategy for individuals who are unable to formulate a payoff-maximizing strategy. For some, the complexity of the game may be difficult to manage, and emulating what others do is an easier alternative than trying to figure out a payoff-maximizing strategy. This would be consistent with Henrich's (2004) *conformist transmission*, which is a tendency to copy what the majority of others are doing, particularly in uncertain or complex environments. (Also see Henrich and Boyd, 2001). An aversion to risk may be at work here as well. Doing what others do may seem to be a less risky strategy than alternative strategies in a complex environment. One could examine the relationship between the tendency to conform and the complexity of a game in a well-designed set of experiments. We think that this would be a fruitful exercise for the future.[11]

The importance of conformity in our experiments may also be due to the field setting. As Cardenas and Ostrom (2004) and Henrich *et al*. (2005) point out, it seems likely that the

[11] See Baron, Vandello and Brunsman (1996) for experiments along these lines.

subjects' prior experiences with common pool resources and similar social dilemmas, as well as their interactions with each other, could influence their preferences and choices in ways that cannot be controlled by the experiment. The subjects in our experiments face common pool resource problems in their daily lives, and in many cases knew each other quite well. What looks like conformity to us may, in fact, be a manifestation of existing strategies or behavioral norms these communities have adopted to deal with the social dilemmas they routinely encounter. Although we found that our main conclusion about the importance of the conformity motive did not vary across the three regions we visited, one should stop short of concluding that this result is likely to be robust in other contexts. Additional research in this area is needed to generate comparable results across subjects in different environments. Ultimately, a sufficient number of similar studies would allow us to draw broader conclusions about what motivates common pool resource users across the developing world.

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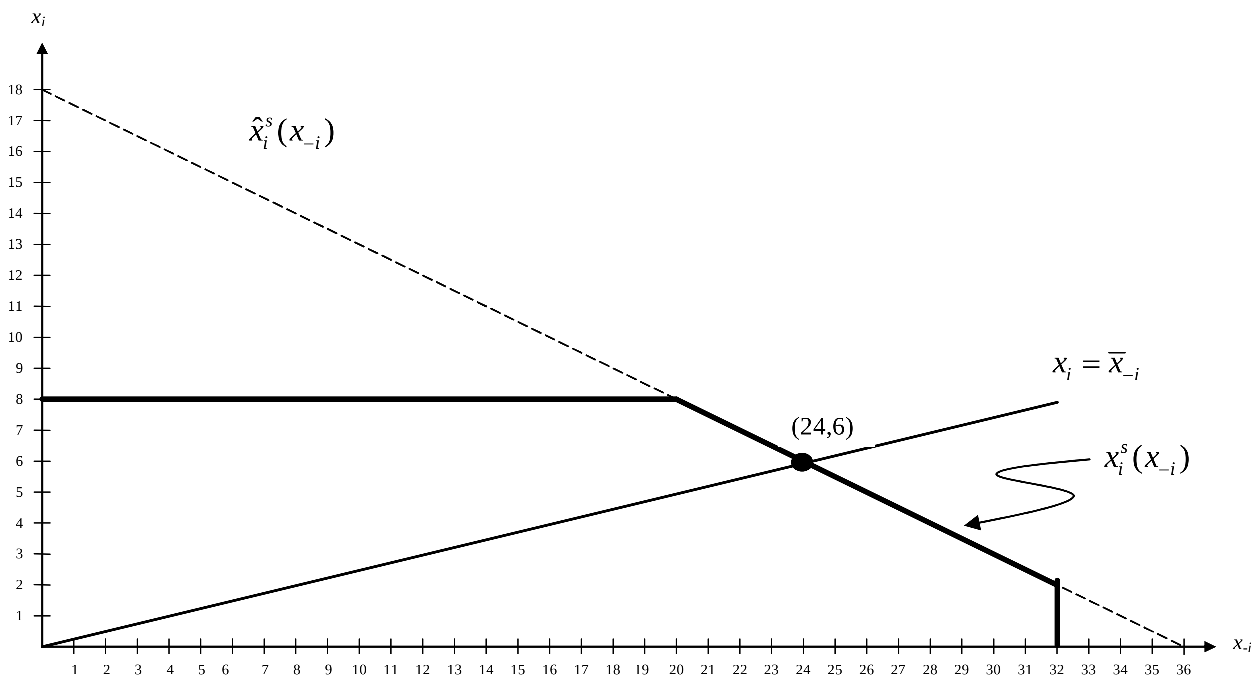

Figure 1: An Individual's Self-Interested Nash Strategy

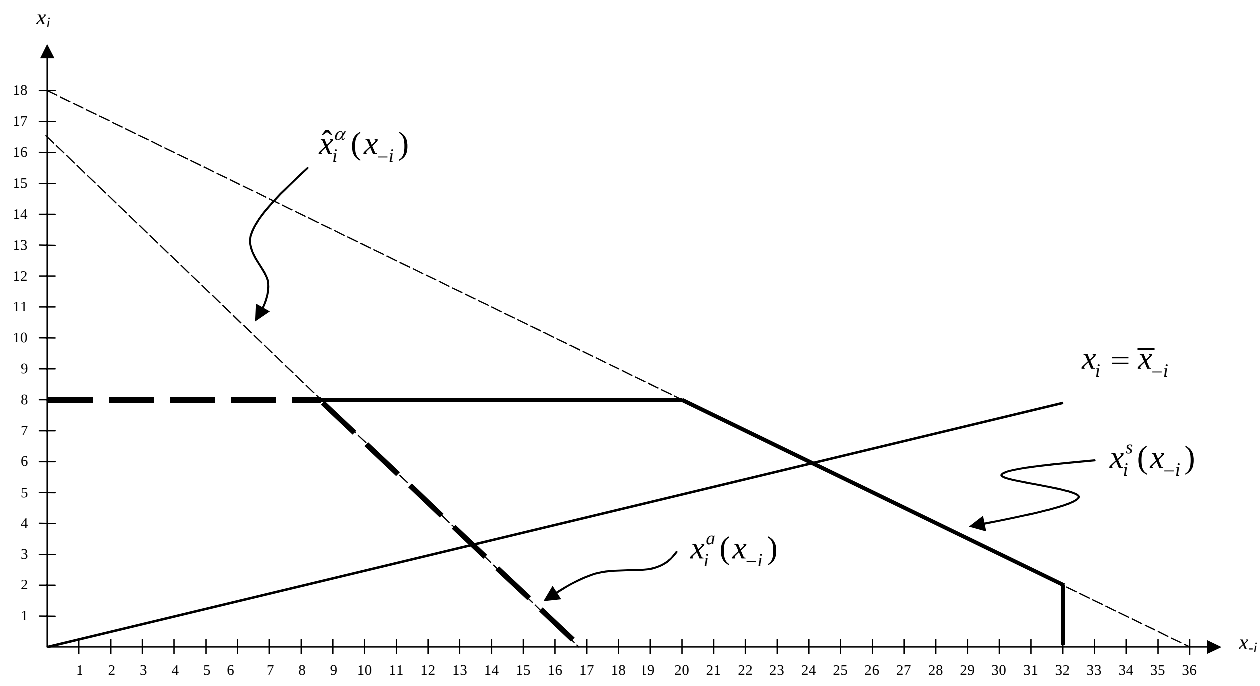

Figure 2: Balancing Altruism and Pure Self Interest.

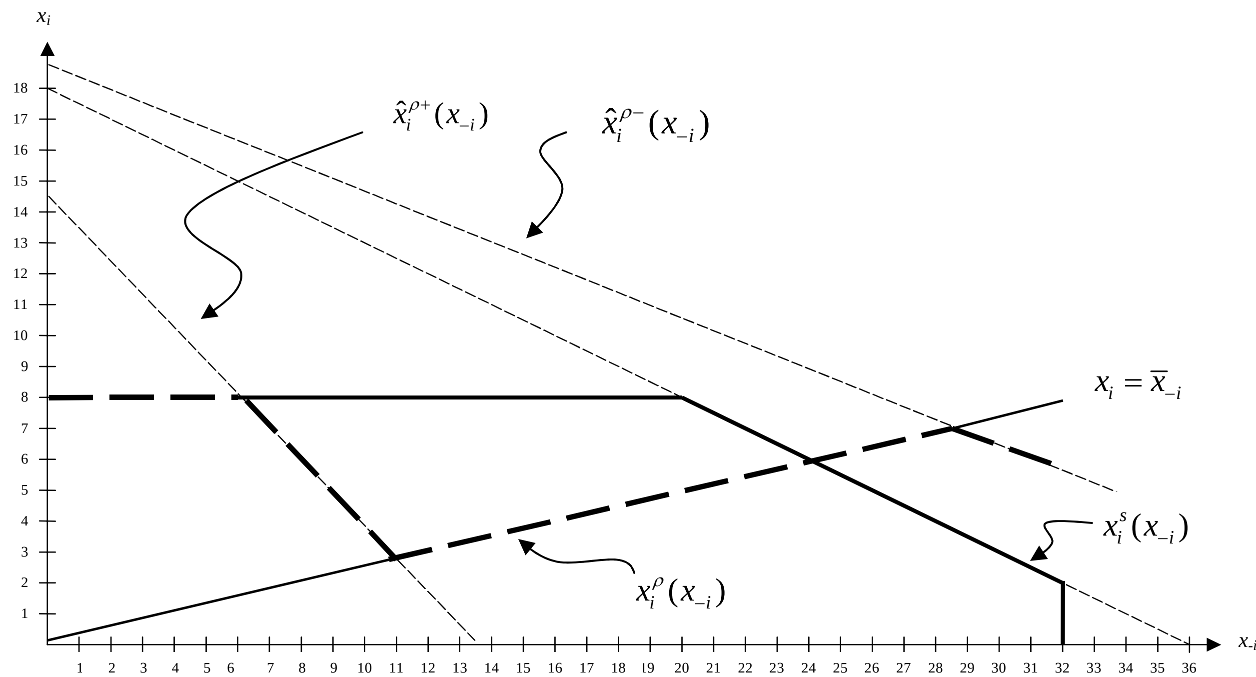

Figure 3: Balancing Reciprocity and Self-Interest.

Table 1: Summary Statistics of Subject Characteristics

Region	Mean age	Mean number of years of formal education	Number of males	Number of females
Magdalena	41.3	4.8	119	21
Pacific	39.9	5.4	123	17
Caribbean	34.6	6.4	65	75
All Regions	38.6	5.5	307	113

Table 2: Summary Statistics of Individual Extraction and the Extraction of Others

Variable	All rounds	Last round
Mean level of extraction	4.6	4.8
Mean deviation from self-interested best-response	2.5	2.3
Mean expected level of extraction of others	15.37	15.38
Mean actual level of extraction of others	18.32	19.14

Table 3: Random Effects Tobit Models of Individual Best-Responses

	MODEL 1	**MODEL 2**
Constant	2.46 (0.45)***	2.48 (0.43)***
$0 \le x_{-i}^{e} < 4$	0.07 (0.62)	
$4 \le x_{-i}^{e} < 8$	0.04 (0.05)	
$8 \le x_{-i}^{e} < 12$	0.17 (0.04)***	
$12 \le x_{-i}^{e} < 16$	0.09 (0.04)**	
$16 \le x_{-i}^{e} < 20$	0.12 (0.04)***	
$20 \le x_{-i}^{e} < 24$	0.10 (0.50)**	
$24 \le x_{-i}^{e} < 28$	0.17 (0.06)***	
$28 \le x_{-i}^{e} < 32$	0.16 (0.07)**	
$0 \le x_{-i}^{e} < 8$		0.06 (0.02)***
$8 < x_{-i}^{e} \le 32$		0.13 (0.007)***
x_{-i}^{e}		
Period	0.03 (0.01)***	0.03 (0.01)***
Regional effects		
Pacific	-0.06 (0.21)	-0.05 (0.21)
Magdalena	0.08 (0.21)	0.08 (0.21)
Individual characteristics		
Age	0.00 (0.006)	-0.00 (0.006)
Gender =1 if female	0.04 (0.20)	0.04 (0.20)
Education (years)	0.10 (0.03)***	0.10 (0.03)***
Wald χ^2	**447.96*** **	**444.74*** **

The dependent variable is the individual's level of extraction, x_i. Standard errors are shown in parenthesis. * reflect p-values: * $p \le 0.10$; ** $p \le 0.05$; *** $p \le 0.01$. Number of observations = 4050. Number of subjects = 405. Although 420 individual participated in the experiments, we did not have complete information on the age, gender, or education of 15 of them. Thus, these individuals' choices were not included in the regressions.

Reviewer's Appendix: Experiment Instructions[12]

Before we begin, we want to thank you all for accepting this invitation and participating in this exercise. The objective of this exercise is to understand how people make decisions related to the use of a shared natural resource. All the decisions you make, as well as all the other information you will provide us, will remain confidential. We will not divulge your individual decisions to any other member of the community, nor to any other person.

Introduction

The exercise in which you are going to participate can be different from other exercises in which members of your community might have participated in the past, therefore, any comment that you might have heard about the exercise does not necessarily apply to the version in which you will participate.

This exercise is similar to a situation in which a group of people have to make decisions on how to use a shared natural resource. For example, a forest, a drinking water source, or a fishing area. In this experiment, the resource will be referred as a fishery.

You have been selected to participate in a group of 5 people. Today, there are 3 groups participating at the same time. However, each group is independent and the decisions of the other groups do not affect the decisions of your group. Each group will be differentiated by the color of the sheets used during the exercise.

In this exercise you will earn money depending on your decisions and the decisions of the other members of your group. The reason why we use money in this exercise is to represent real life situations in which your economic decisions will bring yourself monetary consequences. You will play several rounds equivalent, for example, to periods such as years, months, or fishing seasons.

In each round, you will earn a number of points that will be equivalent to a number of pesos. At the end of the exercise, we will sum the total number of pesos earned in all the rounds, we will round the total earned, and we will personally hand that to you in cash.

We will now explain how to participate in the exercise. Please pay a lot of attention to the instructions. If you understand the instructions, you will be able to make better decisions in the exercise. Please, remain seated and do not speak with other participants. If you have a question, raise you hand. The assistant will answer your question in private.

Earnings Table

We will now hand out the EARNINGS TABLE which contains all the information you will need to make your decisions in this exercise.

[12] Thanks to Juan Camilo Osorio for translating the instructions from Spanish to English.

All participants have the same EARNINGS TABLE that you do. The numbers in the table are points equivalent to the pesos you can earn in each round, depending on both what you decide to extract and the decisions made by others in your group.

In each round you have to decide how many units of the resource you will extract. We will call your decision "MY LEVEL OF EXTRACTION." These units correspond to the columns 1 to 9 in the EARNING TABLE. In this exercise, each participant can extract a maximum of 9 units, and a minimum of 1.

In the EARNINGS TABLE, the decisions of the other members of your group correspond to the column "LEVEL OF EXTRACTION OF OTHERS", which will be a number between 4 and 36. This number is the sum of the units extracted by the other members of the group. In other words, "LEVEL OF EXTRACTION OF OTHERS" is equal to: the total extraction of the whole group, minus the amount you extracted. When you make your decision, you will not know the decisions made by the other members of your group.

Once all participants hand in their decisions, we will sum all the levels of extraction and will announce the group's TOTAL LEVEL OF EXTRACTION. With this information you will be able to calculate the "LEVEL OF EXTRACTION OF OTHERS," which is equal to the "TOTAL LEVEL OF EXTRACTION" minus "MY LEVEL OF EXTRACTION".

Let's see some examples so that you can understand how to use the EARNINGS TABLE.

Imagine you decide that "MY LEVEL OF EXTRACTION" is 4 units, and that the other members of the group extract 4 units each. We will announce that the TOTAL level of extraction is 20 units. Since you decided to extract 4, you can calculate the "LEVEL OF EXTRACTION OF OTHERS," which is equal to the "TOTAL LEVEL OF EXTRACTION" minus "MY LEVEL OF EXTRACTION". In this case, the "LEVEL OF EXTRACTION OF OTHERS" is 20 – 4 = 16 units. Thus, as seen in the table, your earnings will be 859.

In the previous example all the members of the group picked the same level of extraction. However, each person can pick a different number. For example, if you choose 4 and the other members of the group extract 2, 3, 7 and 8, we will announce that the TOTAL level of extraction is 24. Given the fact that you decided to extract 4, the "LEVEL OF EXTRACTION OF OTHERS" will be 20. In other words, the "TOTAL LEVEL OF EXTRACTION (24) minus "MY LEVEL OF EXTRACTION" (4). In this case, as seen on the table, your earnings will be 754.

The EARNINGS TABLE has an additional table called "Average of others". This column indicates you the average decision of your group for a determined level. For example, if the others extract 8, this means that the average amount extracted per person is 2. Instead, if the others extract 20, the average amount extracted per person is 5.

Take a few seconds to look at the EARNINGS TABLE and understand how it works. If you have any questions, please raise your hand and someone will come to you.

Decision Card
I will now explain how you will inform us in each round your level of extraction. In each round you will receive a "decision card". The decision cards are these small pieces of paper.

DECISION CARD	
Participant Number:	
Round Number:	
My level of extrac1tion: (a number between 1 – 9):	
How much do you think others will extract? (a number between 4 – 36):	

In each round you will have to write:
- The number of the round, which will be announced by us.
-"MY LEVEL OF EXTRACTION", in other words, how many units will you extract, which in this case will be a number between 1 and 9.
-You also have to write what you <u>think</u> the other members of your group will extract.

This is the sum of the levels of extraction that you think the other 4 members of your group will extract. This sum is a number between 4 and 36. Remember that when you make your decision you do not know what the others are choosing. However, we want to know how much you think the others will extract. For example, if you think that two people will choose 3 and the other two 5, then, what you think the others will extract is 16 (3 +3+ 5 + 5).

What you write on the level of extraction of others will not affect your earnings, either if it is equal or different to what actually happened. However, we are interested to know what you are thinking about the level of extraction of the others when you make your choice.

After all the members of your group have made their decisions, we will pick up the 5 participants' cards and calculate the groups' TOTAL level of extraction. Once we announce the total extraction of the group you will be able to calculate the true "LEVEL OF EXTRACTION OF OTHERS." With this information and your level of extraction, you will be able to calculate how much you earned by looking at the EARNINGS TABLE.

It is very important that you remember that your decisions are private and that you can not show them to the other members of the group. We will only announce the TOTAL level of extraction.

Calculation sheet

Each one of you will receive a calculation sheet with which you record your decisions and earnings. Please write your participant number in the calculation sheet. This is the same number that is written in the decision cards.

Let's see how to use the calculation sheet by looking at an example. Suppose you decided to extract 4 units. In consequence, you have to write 4 under column A of the calculation sheet, as shown in the example. You should also write this number in "MY LEVEL OF EXTRACTION" in the Decision Card .You are writing your decision in two places, in the Decision Card, which you will hand in back to us, and in the calculations sheet. Please, check that you have written the same number in the two sheets before you hand in the decision card.

After all the members of the group have finished taking their decisions, we will pick up the cards of the 5 participants and calculate the groups' TOTAL level of extraction.

Suppose the "TOTAL LEVEL OF EXTRACTION" is 20 units. You should write 20 in the column B in the calculations sheet. In order to calculate accurately the "LEVEL OF EXTRACTION OF OTHERS," you should subtract Column A ("MY LEVEL OF EXTRACTION") from Column B ("TOTAL LEVEL OF EXTRACTION") You should write the result in Column C ("LEVEL OF EXTRACTION OF OTHERS") In our example, the "LEVEL OF EXTRACTION OF OTHERS" is 16 (20 – 4.)

In order to calculate your earnings, you should use the EARNINGS TABLE. In this case, given that "MY LEVEL OF EXTRACTION" is 4 and the "LEVEL OF EXTRACTION OF OTHERS" is 16, then your earnings will be 859. This is the information you should write in column D.

Practice rounds

Before we begin the exercise we will do some practice rounds. The decisions that you take in these practice rounds would not affect your earnings today.

The first practice round will be done altogether. First, write the number of the round in the decision card, in this case (P) of practice. After that, looking at the EARNINGS TABLE suppose that each one of you picked 5. Write this in the decision card and in Column A of the earnings sheet. You should also write in the decision card what you think the other members of your group will extract. In this case, it is 20, because we know that all of them picked 5. Remember, when we begin the real exercise, you will not know the exact number of extraction of the other members while you will be picking your level of extraction. In the next rounds you will write what you think the others will extract.

Given that all the members of the group picked 5 in this example, the total level of extraction for the group is 25. Each one should write now 25 under Column B ("TOTAL LEVEL OF EXTRACTION") in the calculations sheet.

Now subtract "MY LEVEL OF EXTRACTION" (5) from the "TOTAL LEVEL OF EXTRACTION" (25). In other words, column B minus Column A. This operation is equal to 20. This number is the true "LEVEL OF EXTRACTION OF OTHERS", which you should write in

Column C. Using the number in Column A, “MY LEVEL OF EXTRACTION,” and the number under column C, the “LEVEL OF EXTRACTION OF OTHERS”, you should use the earnings table to determine your earnings for this round. In this case, your earnings will be 790. Write your earnings in column D.

We did this example and the previous one supposing that everyone picked the same level of extraction. However, when you make your decision, you may choose the level of extraction that you want by looking at the EARNINGS TABLE. *Are there any questions?*

Let’s continue with the next practice round. First, write down the round’s name in the decision card, in this case (P) of practice. Now, each one of you has to decide your level of extraction using the EARNINGS TABLE. Write it down in the decision card and in Column A in the calculations sheet. Before you hand in the decision card, check that the number in column A is equal to the one you wrote in “MY LEVEL OF EXTRACTION” in the decision card. You should also write in the decision card the level of extraction that you believe the other members of the group will extract.

EARNINGS TABLE

	My level of extraction									
Level of extraction of others	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Average of the others**
4	900	996	1087	1172	1252	1326	1395	1458	1516	**1.0**
5	882	976	1064	1146	1223	1295	1361	1421	1476	**1.3**
6	864	955	1040	1120	1194	1263	1326	1384	1436	**1.5**
7	846	934	1017	1094	1165	1231	1292	1347	1396	**1.8**
8	829	914	994	1068	1137	1200	1258	1310	1357	**2.0**
9	811	893	970	1042	1108	1168	1223	1273	1317	**2.3**
10	793	873	947	1016	1079	1137	1189	1236	1277	**2.5**
11	775	852	923	989	1050	1105	1154	1198	1237	**2.8**
12	757	831	900	963	1021	1073	1120	1161	1197	**3.0**
13	739	811	877	937	992	1042	1086	1124	1157	**3.3**
14	721	790	853	911	963	1010	1051	1087	1117	**3.5**
15	703	769	830	885	934	978	1017	1050	1077	**3.8**
16	686	749	807	859	906	947	983	1013	1038	**4.0**
17	668	728	783	833	877	915	948	976	998	**4.3**
18	650	708	760	807	848	884	914	939	958	**4.5**
19	632	687	736	780	819	852	879	901	918	**4.8**
20	614	666	713	754	790	820	845	864	878	**5.0**
21	596	646	690	728	761	789	811	827	838	**5.3**
22	578	625	666	702	732	757	776	790	798	**5.5**
23	560	604	643	676	703	725	742	753	758	**5.8**
24	543	584	620	650	675	694	708	716	719	**6.0**
25	525	563	596	624	646	662	673	679	679	**6.3**
26	507	543	573	598	617	631	639	642	639	**6.5**
27	489	522	549	571	588	599	604	604	599	**6.8**
28	471	501	526	545	559	567	570	567	559	**7.0**
29	453	481	503	519	530	536	536	530	519	**7.3**
30	435	460	479	493	501	504	501	493	479	**7.5**
31	417	439	456	467	472	472	467	456	439	**7.8**
32	400	419	433	441	444	441	433	419	400	**8.0**
33	382	398	409	415	415	409	398	382	360	**8.3**
34	364	378	386	389	386	378	364	345	320	**8.5**
35	346	357	362	362	357	346	329	307	280	**8.8**
36	328	336	339	336	328	314	295	270	240	**9.0**