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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 or conformity. Using data from experiments conducted in three regions of Colombia that depend critically on a local fishery, 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.

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1. Introduction

In both public goods and common-pool resource experiments, subjects often 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 social dilemmas such as public goods and common-pool resource experiments.[1]

[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 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.

Consequently, 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 or conformity. Our interest in these alternative preferences comes from our desire to better understand the behavior of small-scale common pool resource users in the developing world. Evaluating the performance of small scale resource industries in the developing world, and possibly designing government interventions to promote more efficient use of local common pool resources, requires a clear understanding of the motivations and strategies of local resource users.

Given our interests, we conducted limited access, common pool resource experiments in three areas of Colombia that depend heavily on a local artisanal fishery to test our competing models. We share the concerns of Levitt and List (2007) and others that laboratory experiments with university students playing abstract games may not produce outcomes that are valid predictors of real world behavior. Therefore, using the taxonomy of Harrison and List (2004), we conducted framed field experiments—we were explicit that the experiments concerned extraction decisions from a shared fishery and our subject pool was drawn from populations in which small scale fishing from a local fishery is the main economic activity. In fact, most of our participants were fishermen. By presenting our subject pool with a common pool dilemma that closely resembles the dilemma they face in their everyday lives, we have more confidence that our results reveal more about the situations that motivate our study than had we conducted an abstract common pool resource experiment with university students.[2]

[2] Conducting framed experiments in the field reduces the possibility that the individuals in our experiments approached the game in ways that we did not intend. Commenting on the Henrich *et al.* (2005) experiments across 15 small-societies, Vernon Smith, Randolph Grace, Simon Kemp and others questioned the neutral frame of these experiments because the experiments could have been understood in different ways across the societies. Hence, they suggest that reported behavioral differences across societies could have been the result of different interpretations of the game instead of particular behavioral patterns in each society.

Moreover, several authors (including Cardenas and Ostrom, 2004; Henrich *et al.*, 2005; and Levitt and List, 2007) stress that subjects bring a context—economic, technological, and cultural factors—from their daily lives into experiments that the experimenter cannot control, but that can have important impacts on subjects' behavior. Of course, that context could vary considerably across different communities, producing much more heterogeneity in subject pools, and possibly behavior, than one might encounter in standard laboratory experiments. Obtaining valid inferences about real world behavior in small-scale common pool environments requires that we recognize and account for this possible heterogeneity. Therefore, we conducted our experiments in three regions of Colombia in communities that are similar in that all are highly dependent on a local fishery, but that they vary considerably across several other dimensions.

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). An individual that pursues a strategy of conditional cooperation pursues a strategy of reciprocal behavior. In 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 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 behavior. In common pool resource games, this suggests modifying an individual's 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 *et al.*, 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 an individual who balances self-interest with a preference for reciprocity will not have a Nash best-response function that is monotonically increasing. Instead, such an individual 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 *et al.* (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 or conditional cooperation 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.[3]

[3] Our concept of conformity is similar to the notion of 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

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 or conformity.[4] Each model produces a best-response function with unique characteristics. After describing our experimental design in section 3, we provide our empirical results in section 4. 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 estimated 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. This is consistent with our theoretical model that balances self-interest with a strong preference for conformity, but is inconsistent with pure self-interest, or self-interest combined with a preference for altruism, reciprocity, or inequity aversion. Moreover, our finding that average strategies are characterized by a monotonically increasing best-response function is robust across the three regions. In fact, we find little regional variation in the subject's behavior, suggesting that the participants in each of the regions approach the fundamental limited-access common pool problem in essentially the same way. In

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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). 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, our model also includes an internal penalty when an individual cooperates more than the others. This latter preference is an aversion to being "free ridden upon", as explained by Kurzban *et al*. (2001).

[4] 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 others' choices, but not their well-being, we do not call it an other-regarding preference.

section 5 we discuss the relationships of our approach and results to other common pool and public good experiments and we conclude in section 6.

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

The benchmark model for our study is the standard problem of individual extraction strategies from a common pool resource that is exploited by *n* self-interested 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 reflect the social dilemma 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 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 $x_i \leq x_i^{max}$. 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]:

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

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 a straightforward modification of [1], which we discuss in the next section, with parameters p = 116.875, c = 17.875, d = 2.75, e_i = 900, $x_i^{\min} = 0$, and $x_i^{\max} = 8$. In Figure 1 we have graphed $\hat{x}_i^s(x_{-i})$ 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 for which individual *i*'s extraction exactly matches her expectation of the average extraction of the others, subject 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>

2.1 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 preferences in the following way:

$$\beta_i = \beta_i(x_i - \bar{x}_{-i}) = \begin{cases} \alpha_i + \rho_i^+, \text{ if } x_i \geq \bar{x}_{-i} \\ \alpha_i - \rho_i^-, \text{ if } x_i < \bar{x}_{-i}, \end{cases} \qquad [6]$$

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 preference 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. She 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:

$$\begin{aligned} u_i &= e_i + px_i - c(x_i + x_{-i}) - dx_i(x_i + x_{-i}) \\ &\quad + \beta_i\left(\sum\nolimits_{j \neq i} e_j + px_{-i} + (n-1)c(x_i + x_{-i}) - dx_{-i}(x_i + x_{-i})\right). \end{aligned} \qquad [7]$$

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

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

Since u_i is strictly concave in x_i, [8] is necessary and sufficient to identify a best-response to x_{-i}. The solution to [8] with a non-binding capacity constraint is:

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

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:

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

2.1.1 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 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 $\partial\hat{x}_i^{\alpha}(x_{-i})/\partial x_{-i} = \partial\hat{x}_i^{s}(x_{-i})/\partial x_{-i} - \alpha_i d/2 < \partial\hat{x}_i^{s}(x_{-i})/\partial x_{-i}$.[5] These relationships reveal that when an individual balances altruism and 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.

To Figure 1 we have added a candidate $\hat{x}_i^{\alpha}(x_{-i})$ 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 preference is strong enough. Except at

[5] 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}.

$x_i^{max} = 8$, the individual will always choose lower 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 preference in our subject pool, an econometric analysis of individual extraction choices should generate a best-response function that is non-increasing, and has a strictly decreasing segment that lies strictly below the best-response function for a purely self-interested individual.

2.1.2 Reciprocity

Now consider an individual that is not motivated by altruism, but rather by a combination of reciprocity and self-interest. 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 2 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.[6] <INSERT FIGURE 2>

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 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 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).

There is an important special case that we need to recognize. 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,

[6] 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.

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 $x_i^{\rho}(x_{-i}) = \bar{x}_{-i}$. 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.

Except for the limiting case of pure reciprocity, if reciprocity is a dominant preference in our subject pool (but self-interest still plays a role), 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 $x_i = \bar{x}_{-i}$ for somewhat higher levels of others' extraction, and then follows $x_i = \bar{x}_{-i}$ for medium to high levels of the expectation of others' extraction. Importantly, 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 strategy of reciprocity to mean the strategy of an individual 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. However, an individual who balances preferences for self-interest and reciprocity will have a non-monotonic best-response function.

2.1.3 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 in this case is more involved, but nevertheless has a similar structure as the best-response function in Figure 2. In this case the best-response function lies below $x_i^{\rho}(x_{-i})$, due to the inclusion of the altruism parameter, except when it lies on the $x_i = \bar{x}_{-i}$ locus, and possibly at the capacity constraint $x_i^{max} = 8$. 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 $x_i = \bar{x}_{-i}$. How the function behaves for higher expected extraction of others depends on the relative importance of the reciprocity and altruism preferences.

2.1.4 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 individual who combines pure self-interest with inequity aversion has a utility function, $u_i = \pi_i - \beta_i(\pi_i - \bar{\pi}_{-i})$. In this utility function, $\bar{\pi}_{-i}$ is the average payoff of the other group members,

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

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 self-interest combined with inequity aversion generates a best-response function that has the same basic shape as that generated by self-interest combined with a preference for reciprocity (see their Figure 2). Therefore, we would not be able to distinguish the two within our framework.

2.2 Conformity

If individuals are motivated by a desire to conform or emulate the behavior of others in their group, then 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:

$$u_i = \pi_i - \gamma_i (x_i - \overline{x}_{-i})^2 / 2. \qquad [14]$$

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 linearly increasing in the size of that deviation. Maximizing [14] without the capacity constraint, $x_i \le x_i^{max}$, yields the individual's unconstrained best-response function:

$$\hat{x}_i^{\gamma}(x_{-i}) = \frac{p - c - dx_{-i}}{2d + \gamma_i} + \frac{\gamma_i x_{-i}/(n-1)}{2d + \gamma_i}. \qquad [15]$$

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 individual's best-response when she balances a preference for conformity and 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 [15] as

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

From [16] we have $\hat{x}_i^{\gamma}(0) = \hat{x}_i^s(0) \dfrac{2d}{2d + \gamma_i} < \hat{x}_i^s(0)$, 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 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

Our common pool resource experiments were conducted with subjects who face the same kind of dilemma 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. Subjects were recruited with the help of local leaders and in some cases university students in the region, who informed the community and more specifically the local fishermen about the experiments. Anyone was allowed to participate, but priority was given to those who indicated that fishing was their main livelihood.

The subjects participated in a ten-round limited access common pool resource game in groups of five. Group assignments were fixed throughout the experiment.[7] Each subject received an identical payoff table that was generated from a simple modification of [1]. The concept of zero harvest is difficult to explain in the field because the participants depend so critically on their use of local natural resources. Therefore, individual harvest choices were shifted by one to range from one to nine instead of from zero to eight. Accordingly, we modified [1] by defining $\tilde{x}_i = x_i - 1$ and created the individual payoff table from

$\pi_i = e_i + p\tilde{x}_i - c(\tilde{x}_i + \tilde{x}_{-i}) - d\tilde{x}_i(\tilde{x}_i + \tilde{x}_{-i})$. We use the same parameters (p = 116.875, c = 17.875, d = 2.75, and e_i = 900) that we used to generate the graphs of individual best-response functions in Figures 1 and 2, with the exception that $x_i^{\min} = 1$, and $x_i^{\max} = 9$.[8] For the empirical analysis of the next section we shifted the data back so that individual harvests ranged from zero to eight to be consistent with the theoretical development in section 2.

In addition to deciding upon a level of extraction in each round, subjects were also asked to state their expectation of the total extraction by the other four group members, $x_{-i}^e = \sum_{j \neq i} x_j^e$.[9] The subjects were not allowed to communicate with each other during the experiment and all individual decisions were kept private. After all subjects had made their decisions for a round, the monitors collected this information and announced to the group the aggregate level of

[7] 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 but they were not explicitly informed about the second stage of the experiment. These additional data are not included in the present analysis. We analyze these additional data in Velez *et al*. (forthcoming).

[8] The experiment instructions, including the payoff table that was used in the experiments, are available upon request. The instructions were first written in English, and then translated to Spanish. We then translated the instructions back to English to minimize translation errors.

[9] In a public goods experiment, Croson (2007) 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' behavior include Bornstein and Ben-Yossef (1994), Komorita *et al.* (1992) and Yamagishi and Sato (1986).

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. The same monitors conducted all of the experiments.

Each session lasted about three hours. Average individual earnings were 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 a monitor and several practice rounds that did not count toward final earnings were played to familiarize the participants with the rules.

An important element of our design is that the same experiment was conducted in each of three regions. Our motivation for visiting different fishing areas was to examine whether the results were replicated across the regions. The three communities were chosen because they vary not only with respect to location, but also ethnic composition, the nature of the fishery, how formal fishing regulations and more informal community conservation efforts play a role in managing local harvests, and other dimensions. Table 1 presents some summary statistics about the subjects. Note that participants in the Magdalena and Pacific regions were roughly comparable across all five dimensions: the mean age was about 40 with about five years of formal education. Subjects in these two regions were overwhelmingly male fishermen who had lived in the same community for more than 10 years. In the Caribbean, subjects were younger and more educated. There was also a more even gender distribution (46 percent male). Relative to the other two communities, a smaller majority of subjects lived in the same community for over 10 years and earned their living primarily from fishing. <INSERT TABLE 1>

Participants in the Pacific region, more specifically the Ensenada de Tumaco, are members of Afro-Colombian communities, the majority of whom live in collectively owned territories. In the Ensenada de Tumaco, 91 percent of the participants report that fishing, particularly shrimp harvesting, is their main livelihood. Colombian fisheries are regulated by INCODER (Instituto Colombiano de Desarrollo Rural), a federal level agency under the Ministry of Agricultural Affairs. Compared to the other two regions, INCODER has a strong presence in this region, enforcing several regulations such as seasonal restrictions and the prohibition of certain methods of harvesting shrimp. In general, local fishermen in the Ensenada de Tumaco are aware of the regulations they operate under, and there is agreement among them about the need to regulate the shrimp fishery. Community-based organizations and international non-governmental organizations are also actively promoting the conservation of the natural resources of the region, particularly the mangrove forests. International conservation organizations are active here because they see this region as a threatened "hot spot" of biodiversity.

The participants in the town of La Dorada, Caldas, and surrounding villages are part of a mostly white and mestizo population who harvest several species of fish from the Magdalena River and the adjacent lake, Charca de Guarinocito, in the interior of the country. Eighty-seven percent of the participants reported that small-scale fishing was their main economic activity. The presence in this area of INCODER is considered to be very weak—participants describe regulatory authorities as distant with no involvement at all with the community. Nevertheless, most of the participants were aware of seasonal restrictions on harvesting certain species. International conservation organizations are not present in this area. However, about 20 percent of the Magdalena participants belong to a local fishermen's association, which has been actively designing and enforcing their own rules for fishing in the Charca de Guarinocito.

Participants in the Caribbean region, more specifically near the city of Santa Marta, are part of a multiethnic population of whites, mestizos, African descendants, and indigenous peoples. The proportion of participants in this region who reported that fishing is their main economic activity is significantly lower than in the other two regions (64 percent). Some of the other participants are small-scale fish buyers who then re-sell their product in Santa Marta. The rest are farm workers. Generally, the participants did not know who had the authority to regulate the local fisheries. Although some methods of fishing are recognized as illegal, few other fishing rules, formal or informal, are observed in this region.

4. Results

Table 2 presents some summary statistics of the individuals' extraction choices and their expectations of the extraction choices of the others in their group, as well as the actual extraction choices of the others. To be consistent with the theoretical development in section 2, individual choices, x_i, in this section were adjusted to range between 0 and 8. The mean individual level of extraction was 4.6 units, which is less than the purely self-interested Nash equilibrium prediction of six units per person, but greater than the one unit per person harvest that maximizes a group's aggregate payoff.[10] We also calculated individual differences between their actual choice and their purely self-interested best-response given their reported expectations of what others would choose. 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. On average individuals expected that the other four members of their group would extract a total of

[10] Cardenas (2004) used a common pool design that is similar to ours to compare the behavior of villagers in the field and students in a university lab. The villagers in his experiments chose only slightly more conservative harvests than the students. Similar to our results, Cardenas found that both the villagers' and students' decisions tended to lie between their pure Nash strategies and the efficient harvest. Laboratory common pool resource experiments by Ostrom *et al*. (1994), Keser and Gardner (1999), and Casari and Plott (2003) revealed a tendency of subjects to choose harvests that are greater than their self-interested Nash harvests. Our results are not comparable to these studies because the design of our payoffs does not give subjects much opportunity to choose harvests above their Nash harvests.

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 (2007), in which 33 percent of her subject pool tended to be overly optimistic in their predictions about the contributions of their group members. Finally, note that the values presented in Table 2 are quite similar across the regions. This foreshadows one our important findings: there is very little regional variation in how the subjects behaved in the basic problem of a limited access common pool experiment.[11]

<INSERT TABLE 2>

To determine whether an econometric summary of these individual strategies reveals which motivation was dominant in our experiments, we estimated best-response functions with random effects Tobit models. The use of random effects models responds to the panel nature of our 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 (x_{-i}^{e}), but imposes continuity on the estimated regression. Although others have noted the theoretical possibility that best-response functions may not be monotonic (e.g., Falk *et al.*, 2002), to our knowledge no one has accounted for this possibility in their empirical analysis.[12]

The estimation results by region are reported in Table 3, which is a spline regression that divides the range of individuals' expectations of the extraction levels of the other group

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[11] However, in a follow-on study to this one we found significant regional variation in how villagers reacted to enhanced designs that allowed combinations of communication among the subjects and regulatory control of extraction (Velez *et al.* forthcoming).

[12] We note that we are testing models of static behavior using an experimental design that features a finitely repeated game. This could affect our conclusions because strategic incentives to build a reputation over a finite number of repetitions could influence decisions in a way that is not captured by our static models of alternative preferences (see Kreps et al. 1982 for a theory of cooperation in finitely repeated prisoner's dilemmas, and experimental tests by Andreoni and Miller 1993).

members, x_{-i}^{e}, into eight-unit intervals (variables Expect1 – Expect4). 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. However, all of the estimated coefficients for Expect1 through Expect4 are positive and, except for two coefficients, are statistically significant at the 5% level or lower. 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 any of the regions. Recall that our theoretical development yielded monotonic best-response functions in only two cases, conformity and pure reciprocity. Recall further that a preference for pure reciprocity produces the best-response function $x_i^{\rho}(x_{-i}) = \bar{x}_{-i} = x_{-i}/(n-1)$. We reject the hypothesis that pure reciprocity is dominant in our subject pool because the intercept estimate for each region in Table 3 is significantly greater than zero and, except for the Expect4 interval in the Caribbean, the slope coefficients are significantly less than $1/(n-1) = 0.25$. <INSERT TABLE 3>

Since the best response functions in each region are monotonically increasing in the expected extraction of others, 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 an individual's desire for conformity dominates her pure self-interest, then her best-response function will be non-decreasing, which is exactly what our regression results indicate. Therefore, average strategies in each region 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 preference. As discussed by Carpenter (2004), the conformity preference could generate less cooperative outcomes than predicted by the model of pure self-interest; 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 preference led to a more cooperative (though not efficient) utilization of the commons; this result is robust across the three regions.

The spline functions estimated in Table 3 were useful to test for any changes in the slope of the regression over the four intervals. It turns out that not only are each of the interval coefficients non-negative, but also that individual choices are increasing at about the same rate in each interval: in each region we cannot reject the hypothesis that the four slope coefficients are equal.[13] This leads us to the random effects Tobit model in Table 4, which includes all three regions and no longer has separate intervals for the expectations of others, x_{-i}^{e}. To allow for possible regional differences, we interact all variables of interest with regional dummy variables. The constant is interpreted as individual harvest in the Caribbean when all other variables are evaluated at zero; the coefficients labeled Magdalena and Pacific are shifts in the constant for these regions. A Wald test of the joint hypothesis that the constants for each of three regions are the same (*i.e.*, Magdalena = Pacific = 0) cannot be rejected ($\chi^2(2)=3.63$, $p=0.16$). A similar joint test of the hypothesis that the three regional interactions with expected harvests (x_{-i}^{e}) are equal also cannot be rejected ($\chi^2(2)=2.25$, $p=0.32$). That the estimated intercept and slope are the same in each region indicates that best-response functions are largely indistinguishable and provides strong evidence of the robustness of the results across regions. Thus, despite the regional

[13] For each region, a Wald test of the null hypotheses Expect1=Expect2=Expect3=Expect4 yields the following results: Caribbean: $\chi^2(3)=6.14$ (p=0.11); Magdalena: $\chi^2(3)=0.64$ (p=0.89); Pacific: $\chi^2(3)=1.66$ (p=0.65).

heterogeneity in our subject pool, it appears that the subjects in each of the regions approached the fundamental limited access common pool problem in essentially the same way. <INSERT TABLE 4>

We also included the period as an explanatory variable to reflect changes in individual choices over the course of the experiment. In Table 4, although the three Region × Period coefficients are positive, it is only significant (but still small) in the Magdalena. There is no statistically significant difference in the effect of time among the three regions (*p*=0.39). Therefore, there is at most rather weak evidence of a relatively small increase in individual extraction choices over time.

Finally, we also examined the effects of individual characteristics such as age and years of education in each region.[14] Age is not significant in any region, but education is positive and significant in the Caribbean and Magdalena (we cannot reject the hypothesis that the education effect is the same in these two regions, *p*=0.97). It is possible that in these regions the more educated individuals may be better able to take advantage of the restraint that others show in their choices of extraction. 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).

[14] We did not include gender, primary occupation or time living in region in the regression due to insufficient variability. Including these variables has no qualitative effect on any of our results.

5. Relationship to Other Experiments Concerning Alternative Preferences

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 preferences for cooperative behavior. Cardenas *et al.* (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 did not attempt to distinguish among the range of preferences that we consider, preferring to classify choices that were more cooperative than pure Nash choices as evidence of other-regarding preferences. Falk *et al.* (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 *et al.* (1990) and Ostrom *et al.* (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.[15] 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 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 and argue that many experimental results can be explained by individual preferences for fairness and reciprocity. However, public goods and common pool resource

[15] According to Casari and Plot (2003, pp 226): "A spiteful agent finds enjoyment in decreasing the earnings of others and is, therefore, willing to pay in order for that to happen." Consequently a spiteful player would choose a harvest level that exceeds what a purely-self-interested individual would choose.

games have an important characteristic that distinguishes them from the sequential games they review and which could affect the nature of alternative preferences. 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 *et al.* (2001) found that about half of their subjects could be classified as conditional cooperators. Similarly, Kurzban and Houser (2005) identify 20 percent of their subjects as free-riders, 13 percent as cooperators and 63 percent 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. 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 than a preference for reciprocity.

Croson's (2007) 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 her result may suggest 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 preference driving individual behavior in games, although some have considered it 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) 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.

6. 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 preferences: 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. This distinction forced us to use spline functions in the analysis of our data because a preference for reciprocity will typically produce a non-monotonic best response. Although other studies have recognized the theoretical possibility that best-response functions may be non-monotonic, no other study accounts for this by estimating a spline function or some other non-linear form.

Second, although we are not the first to discuss conformity, few studies consider this preference 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 also has potentially important implications for common pool resource management, because individuals who are motivated by reciprocity may respond differently than conformists to policies that seek to encourage more efficient resource use. The design of efficient policies when individuals are motivated by alternative preferences seems to us to be an important area for future research.

Third, our choice to conduct framed experiments in the field is certainly important. We have stated several times that our study is motivated by our interest in the behavior of small-scale common pool resource users in the developing world. Thus, rather than trying to address this issue with students in a university lab, it is appropriate that we traveled to a developing country and conducted experiments that presented a common pool dilemma to individuals whose livelihoods are tied to a common pool resource. Moreover, since it is widely recognized that the context of subjects' lives can influence play in experiments, it is important that we conducted our experiments in three geographically distinct fishing areas. The fact that we did not find much regional variation in how small scale resource users in very different fishing areas of Colombia deal with the standard limited access common pool dilemma makes our results substantially more powerful than had we visited only one region.

There are, of course, many ways to extend the results of our research, but to us the most important need is to analyze whether the conformity preference that we found to be so dominant is robust across different common pool problems in different field settings. And, if so, why is this preference is so important? Several explanations are possible. 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. But it is just as likely that the importance of conformity in our experiments may be due to the field setting. As Cardenas and Ostrom (2004), Henrich *et al.* (2005), and Levitt and List (2007) suggest, 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 know 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.

This last issue calls for a concerted effort to link details about individuals' lives, particularly the community norms they actually operate under, to their behavior in experiments. Although we have been able to exploit field experiments in important ways—by exploring the motivations of the very individuals that concern us, and by conducting our experiments in different settings to examine the role of regional heterogeneity—we do not have the sort of detailed field data necessary to address the fundamental issue of the joint endogeneity and stability of individual preferences and community norms of behavior. Obtaining these data is likely to yield a more complete understanding of what motivates individuals in common pool resource problems and other social dilemmas.

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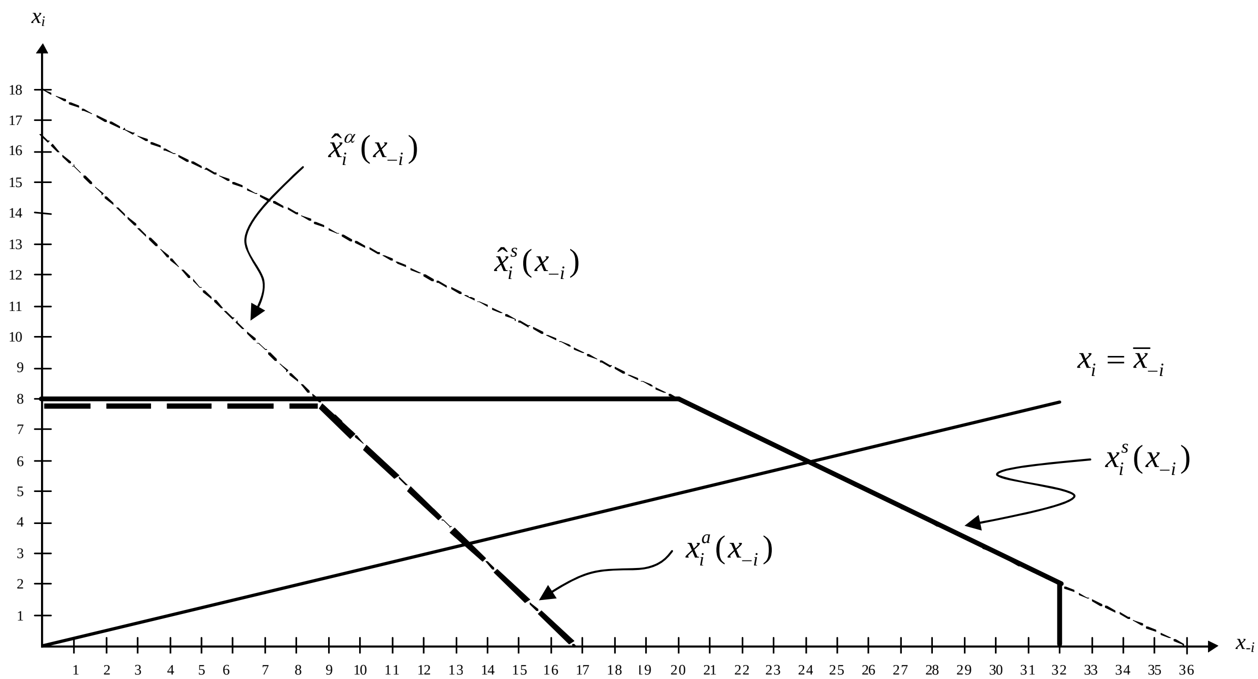

Figure 1: Pure self-interest and self-interest balanced with altruism

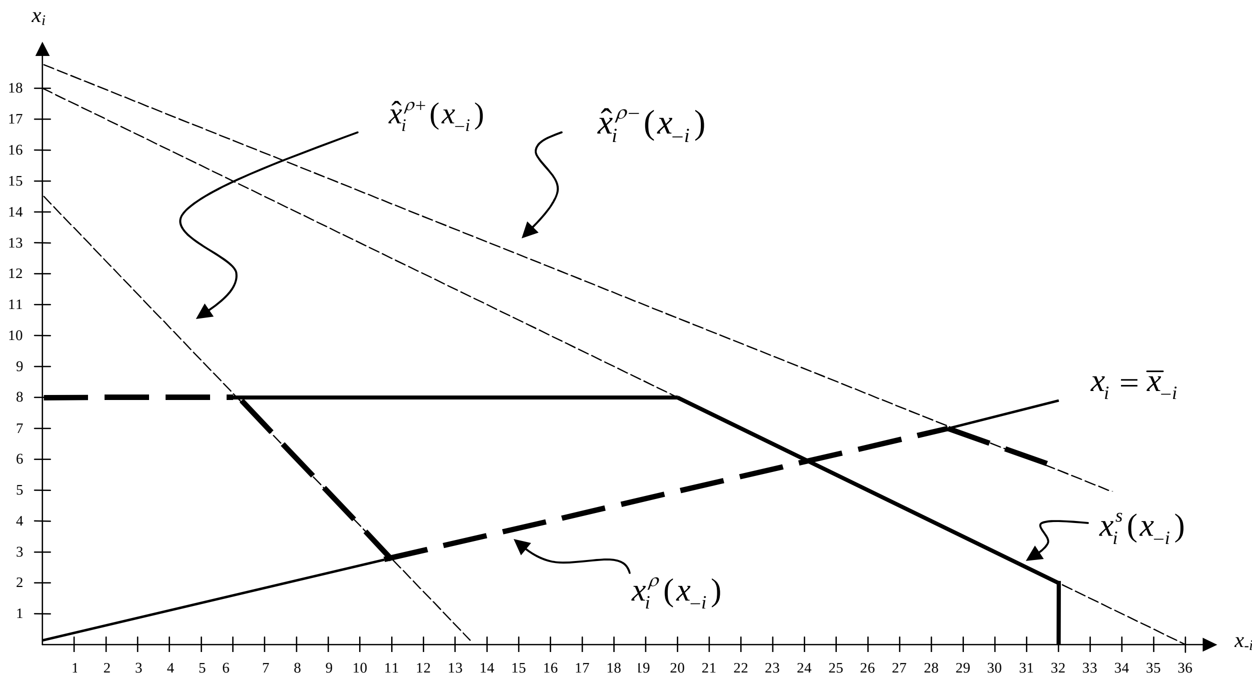

Figure 2: Balancing reciprocity and self-interest

Table 1: Summary statistics of subject characteristics

Subject Characteristics	*N*	Caribbean	*N*	Magdalena	*N*	Pacific	*N*	All
Mean Age (years)	139	34.6 (13.5)	140	41.3 (16.2)	137	39.9 (13.6)	416	38.6 (14.8)
Mean years of formal education	137	6.4 (3.7)	140	4.8 (3.2)	131	5.4 (3.3)	408	5.6 (3.5)
Percent Male	140	46%	140	85%	140	88%	420	73%
Percent who have lived in the same community for 10	139	78%	139	93%	137	93%	415	88%
Percent for whom fishing is their main activity	127	64%	138	88%	138	91%	403	82%

There were 140 participants in each of the three regions, *N* = number of responses. Standard deviations are in parentheses.

Table 2: Summary statistics of individual extraction and the extraction of others

Subject Characteristics	*N*	Caribbean	*N*	Magdalena	*N*	Pacific	*N*	All
Mean individual level of extraction (x_i)	1400	4.6 (2.4)	1400	4.5 (2.5)	1400	4.6 (2.3)	4200	4.6 (2.4)
Mean deviation from self-interested best-response ($x_i^s(x_{-i})$)	1400	2.7 (3.1)	1400	2.6 (3.3)	1400	2.3 (3.3)	4200	2.5 (3.3)
Mean expected level of extraction of others (x_{-i}^e)	1400	14.6 (8.5)	1400	14.8 (8.7)	1400	16.7 (8.5)	4200	15.4 (8.6)
Mean actual level of extraction of others (x_{-i})	1400	18.4 (4.6)	1400	18.0 (5.2)	1400	18.6 (4.8)	4200	18.3 (4.9)

To be consistent with the theoretical development in equation [1], this table presents individual extraction choices ranging between $x_i^{min} = 0$ and $x_i^{max} = 8$. The Nash equilibrium with purely self-interested agents is $x_i = 6$, and the social optimum is $x_i = 1$.

Table 3: Random effects tobit estimation of individual best-response functions by region

	Caribbean			Magdalena			Pacific		
	Coef.	**Std. Error**		**Coef.**	**Std. Error**		**Coef.**	**Std. Error**	
Constant	2.07	(0.70)	***	1.95	(0.75)	***	3.30	(0.57)	***
Expect1 $\left(0 \le x_{-i}^{e} < 8\right)$	0.02	(0.04)		0.09	(0.05)	*	0.11	(0.05)	**
Expect2 $\left(8 \le x_{-i}^{e} < 16\right)$	0.13	(0.03)	***	0.14	(0.03)	***	0.11	(0.03)	***
Expect3 $\left(16 \le x_{-i}^{e} < 24\right)$	0.08	(0.03)	***	0.12	(0.04)	***	0.10	(0.03)	***
Expect4 $\left(24 \le x_{-i}^{e} < 32\right)$	0.18	(0.05)	***	0.11	(0.05)	**	0.17	(0.04)	***
Period	0.03	(0.02)		0.05	(0.02)	**	0.01	(0.02)	
Age	0.01	(0.01)		0.00	(0.01)		0.00	(0.01)	
Education	0.17	(0.05)	***	0.17	(0.06)	***	–0.06	(0.03)	*
N	1400			1400			1400		
Wald $\chi^2(7)$	135.46		***	154.86		***	180.77		***

The dependent variable is the individual's level of extraction, x_i, which could range between 0 and 8, inclusive. Asterisks reflect p-values: * $p \le 0.10$; ** $p \le 0.05$; *** $p \le 0.01$. Although 140 individuals participated in the experiments, we did not have complete information on the age or education for some of them (see Table 2). We assumed the missing values were equal to the mean for the region; this assumption has no qualitative effect on our conclusions.

Table 4: Random effects tobit estimation of individual best-response functions for all regions

	All Regions		
	Coef.	**Std. Error**	
Constant	1.61	0.60	***
Caribbean × Expect (x^e_{-i})	0.10	0.01	***
Caribbean × Period	0.03	0.02	
Caribbean × Age	0.01	0.01	
Caribbean × Education	0.17	0.04	***
Magdalena	0.24	0.90	
Magdalena × Expect (x^e_{-i})	0.12	0.01	***
Magdalena × Period	0.06	0.02	***
Magdalena × Age	0.00	0.01	
Magdalena × Education	0.17	0.05	***
Pacific	1.58	0.88	*
Pacific × Expect (x^e_{-i})	0.12	0.01	***
Pacific × Period	0.01	0.02	
Pacific × Age	0.00	0.01	
Pacific × Education	–0.07	0.05	
N		4200	
Wald χ^2		463.93	***

The dependent variable is the individual's level of extraction, x_i, which can range between 0 and 8, inclusive. Asterisks reflect p-values: * $p \leq 0.10$; ** $p \leq 0.05$; *** $p \leq 0.01$. Although 420 individuals participated in the experiments, we did not have complete information on the age or education for some of them (see Table 2). We assumed the missing values were equal to the mean for the region; this assumption has no qualitative effect on our conclusions.