THE EFFECT OF REWARDS AND SANCTIONS IN PROVISION OF PUBLIC GOODS

MARTIN SEFTON, ROBERT SHUPP and JAMES M. WALKER*

A growing number of field and experimental studies focus on the institutional arrangements by which individuals are able to solve collective action problems. Important in this research is the role of reciprocity and institutions that facilitate cooperation via opportunities for monitoring, sanctioning, and rewarding others. Sanctions represent a cost to both the participant imposing the sanction and the individual receiving the sanction. Rewards represent a zero-sum transfer from participants giving to those receiving rewards. We contrast reward and sanction institutions in regard to their impact on cooperation and efficiency in the context of a public goods experiment. (*JEL* C92)

I. INTRODUCTION

The experimental literature on voluntary public goods provision shows that groups attain better outcomes than implied by economic models based on individuals maximizing own-monetary earnings. At the same time, however, groups uniformly fail to achieve optimal outcomes, suggesting that incentives to free ride are important. Moreover, when the decision situation is repeated, the group outcome often deteriorates with repetition, suggesting that, in many settings, a group's ability to overcome free-rider incentives may be transitory as explained in Andreoni and Miller (1993), Croson (1998), Isaac, Walker, and Williams (1994).

In this paper we report an experiment examining the impact of introducing opportunities for individuals to reward or sanction other group members after observing their decisions. This institutional change is motivated by the observation that such opportunities are commonplace in field settings. In many group or team situations, individuals observe the actions of others, and individuals often have rich opportunities for reacting to others' behavior in ways that may impose costs or benefits on both parties. There is abundant anecdotal evidence that individuals sanction those who engage in selfish activities at the expense of other group members. For example, people who violate social norms are often ostracized. Similarly, there is strong anecdotal evidence that people are prepared to make sacrifices to help others on a quid pro quo basis.[1] Recent experiments with simple proposer-responder games also demonstrate that responders are willing to depart from own-earnings maximization by rewarding more generous proposers or sanctioning less generous proposers as seen in Andreoni, Harbaugh, and Vesterlund (2003) and Offerman (2002).

Given this evidence, it is quite plausible that individuals will sanction or reward other group members based upon their contributions to a public good in a laboratory setting. In turn, the possibility of receiving

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Sefton: Professor, School of Economics, University of Nottingham, Nottingham NG7 2RD, United Kingdom. Phone 44-115-846-6130, Fax 44-115-951-4159, E-mail martin.sefton@nottingham.ac.uk

Shupp: Assistant Professor, Department of Agricultural Economics, Michigan State University, East Lansing, MI 48824-1039. Phone 517-432-2754, Fax 517-432-1800, E-mail shupprob@msu.edu

Walker: Professor, Department of Economics, Indiana University, Bloomington, IN 47405. Phone 812-855-2760, Fax 812-855-3736, E-mail walkerj@indiana.edu

1. See Ostrom (1990) for an insightful discussion of governance of common pool resources and the role of sanctions. Also see Kerr (1999) for evidence related to social exclusion.

ABBREVIATION

VCM: Voluntary Contributions Mechanism

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such sanctions or rewards may affect contributions. Such contributions could be viewed as a response to the threat of negative reciprocation, in the case of sanctions, or the expectation of positive reciprocation, in the case of rewards. Our experiment directly compares the effectiveness of such negative and positive reciprocation in maintaining contributions to public goods.[2] In our experiment, groups of four subjects make contribution decisions in a sequence of ten public goods games without opportunities to reward or sanction. These subjects then play an additional ten games in which a second stage is added at the end of each game. Depending on treatment, in the second stage, subjects are given an opportunity to reward, sanction, or both reward and sanction other group members on the basis of their contribution decisions.

When neither rewards nor sanctions are available, our results mirror those of previous experiments: contributions and earnings steadily diminish with repetition. In the other treatments, the introductions of opportunities to reward and/or sanction initially increase contributions. However, in the reward treatment, contributions subsequently decrease to a level below that observed in the absence of opportunities to reward. Thus, the opportunity to reward by itself is insufficient to sustain contributions. In contrast, we find that sanctioning sustains public goods provision at a level above that observed in the absence of sanctioning opportunities, and so sanctioning appears to be a more effective mechanism for sustaining contributions. However, opportunities to sanction initially result in a loss of efficiency as the direct costs associated with sanctioning outweigh the effect of increased contributions. Only in later rounds, where it appears that the mere threat of being sanctioned sustains contributions, does the opportunity to sanction enhance group performance. Our treatment allowing both sanctions and rewards suggests a synergistic relationship between the two, insofar as this treatment generates the highest contributions and earnings.

Our data also allow us to make some observations about the way rewards and sanctions are used. Those subjects most willing to use rewards and sanctions are those who contribute more than the group average, and subjects who contribute more (less) than the group average are more likely to receive rewards (sanctions). We also observe, however, differences in the dynamic patterns of rewarding and sanctioning behavior. While initially subjects use rewards more frequently than sanctions, over time the use of rewards declines at a faster rate than the use of sanctions, so that in later rounds, rewards are used less frequently than sanctions.

The remainder of the paper is organized as follows. In the next section, we describe the nature of sanctions and rewards in the public goods laboratory setting. In The Decision Setting, we describe the specific experimental setting investigated here, and the Results presents the experimental results. The last section contains the concluding comments.

II. REWARDS AND SANCTIONS IN PUBLIC GOODS EXPERIMENTS

Our setting for studying public goods provision is the voluntary contributions mechanism (VCM) with linear payoffs.[3] In this setting, subjects are endowed with tokens that they can allocate between a private account and a group account. The returns from these accounts are structured so that group earnings are maximized when subjects allocate all their tokens to the group account. Private monetary incentives, however, point individuals toward placing all their tokens in their private accounts. The stylized results emerging from this type of decision setting are as follows: (1) there is considerable heterogeneity in individual allocations, (2) allocations to the group account exceed the prediction of zero tokens but are substantially below the optimal level of 100% of endowments, and (3) group allocations often decline significantly as the game is repeated.

These findings suggest the need for understanding the effectiveness of alternative institutional arrangements to facilitate group

2. Recent experimental studies provide strong support for the role of norms of reciprocity in social dilemma settings. For examples, see Orbell, van de Kragt, and Dawes (1988); Isaac, Walker, and Williams (1994); Sonnemans, Schram, and Offerman (1999); Keser (1997, 2000); Croson (1998); Gunnthorsdottir et al. (2000); Clark and Sefton (2001); Schmidt et al. (2001); Coats and Neilson (2005); and Seely, Van Huyck, and Battalio (2005).

3. See Ledyard (1995) for a review.

cooperation. Ostrom, Walker, and Gardner (1992) investigated the behavior in a common-pool resource game and found that covenants or promises about future actions can be useful in maintaining cooperation, even when the promises are nonbinding.[4] They also studied the effect of supporting covenants with sanctions. They found that covenants are even more effective when supported by internal sanctions, that is, sanctions imposed by group members. On the other hand, they found that sanctions used alone, without covenant opportunities, may actually lower group earnings when costs of sanctions are included.

Our study is most closely related to that of Fehr and Gächter (2000). They investigated a two-stage punishment game. The first stage corresponded to a single period of the VCM game. In the second stage, individual decisions are anonymously revealed to the group and subjects have an opportunity to punish each other. Punishment is costly, both to the person doing the punishment and the person being punished.[5] Public goods provision is significantly higher in the VCM game with opportunities to sanction than in the VCM game without opportunity for sanctions. Once the costs of sanctioning are taken into account, however, the welfare implications are somewhat ambiguous. In their partners treatment, which most closely parallels the experiments reported here, payoffs in the first decision round are lower than in the first period of the VCM game without sanctions. By the last period, however, the game with sanctions offers a payoff gain of approximately 20% relative to the VCM game without sanctions.

Our experiment builds on previous studies by contrasting sanction opportunities with reward opportunities. Analogous to the sanctioning game, the reward game is structured so that it is costly to reward other group members. Note this implies that withholding a reward is not equivalent to imposing a sanction, as withholding a reward increases own earnings, whereas sanctioning reduces own earnings. Thus, sanctions reduce the earnings of both the subject imposing the sanction and the subject being sanctioned, whereas rewards simply constitute a transfer of earnings from the subject giving the reward to the subject receiving the reward. In particular, while sanctions directly reduce group earnings, rewards allow individual group members to react to others' contributions without impinging directly on efficiency.

This asymmetry in how rewards and sanctions affect payoffs suggests at least two reasons why the behavioral effects of rewards and sanctions may differ. First, if the threat of sanctioning induces greater contributions to the public good, then sanctions need not be used, whereas if an expectation of rewards induces greater contributions, then rewards must be used to fulfill those expectations. Second, unlike rewards, sanctions can be used by contributors to reduce the earnings advantage of low contributors over other group members.

III. THE DECISION SETTING

The initial study includes 12 sessions. In each session, 12 subjects were recruited from introductory economics classes at Indiana University—Bloomington.[6] Via the computer, the 12 subjects were privately and anonymously assigned to four-person groups and remained in these groups throughout the session. No subject could identify which of the others in the room was assigned to their group. Since no information passed across groups, each session involved three independent groups. At the beginning of each session, subjects privately read a set of instructions.[7] A review of the instructions was then presented on an overhead screen so that the structure of the decision problem was public information. Subjects made all decisions privately. There were four treatment conditions: *sanction*, *reward*, *sanction&reward*, and *baseline*. Table 1 presents summary design information. Three

4. Also see Orbell, van de Kragt, and Dawes (1988) and Isaac and Walker (1988) for a discussion of the effectiveness of face-to-face nonbinding communication as an institution for facilitating cooperation in public goods environments.

5. Over the past several years, the literature has produced several other studies designed to examine the use of rewards or sanctions in public goods settings or other dilemma settings, including Anderson and Putterman (2006); Andreoni, Harbaugh, and Vesterlund (2003); Bochet, Page, and Putterman (2006); Carpenter (forthcoming); Dickinson (2001); Dugar (2005); Falkinger et al. (2000); Kroll, Cherry, and Shogren (2003); Masclet et al. (2003); and Walker and Halloran (2004).

6. Students in introductory economics have majors in numerous disciplines including business, political science, journalism, and economics. Less than 5% are economics majors.

7. See Appendix A for a copy of the instructions.

TABLE 1
Design Information

Treatment	Sequence I (Rounds 1–10)	Sequence II (Rounds 11–20)	Number of Sessions	Number of Independent Groups
Baseline	VCM	VCM	3	9
Sanction	VCM	VCM/sanction	3	9
Reward	VCM	VCM/reward	3	9
Sanction&reward	VCM	VCM/sanction or reward	3	9

sessions were conducted using each of the four treatment conditions, yielding data on nine independent four-person groups in each condition.[8]

Each group participated in two sequences of ten decision rounds, Sequence I and Sequence II. The structures of Sequence I and Sequence II were explained prior to beginning Sequence I.[9] In all sessions and all treatment conditions, each round in Sequence I corresponded to a VCM game. At the beginning of each Sequence I decision round, each subject was endowed with six tokens to be allocated between their private account and the group account. For each token placed in his or her private account, a subject received 10 cents. For each token placed in the group account, each group member received 5 cents. After all subjects had made their decisions for a round, they were informed of the aggregate allocations to the group account, the allocation of each member of their group to the group account, and their own earnings for the round. Individual decisions were not linked to subject identifiers, and the order in which group member's decisions were presented on each subject's terminal was randomized each round. Thus, subject-specific reputations could not develop across rounds. This parallels the setting used by Fehr and Gächter (2000).

In the sanction, reward, and sanction&reward treatments, each round of Sequence II contained two stages. Stage 1 of each round involved a VCM game identical to that used in Sequence I decision rounds. In Stage 2, each subject received six additional tokens. How these tokens could be used varied across the three treatment conditions.

In Stage 2 of each round of the sanction treatment, subjects could allocate the additional tokens to a private account, from which the subject earned 10 cents per token, or use the tokens to sanction other group members.[10] The computer screen informing a subject of other group members' Stage 1 decisions was used for imposing sanctions. Alongside each group member's decision, subjects could indicate how many of their six tokens they wished to use to sanction each particular group member. Because the decisions of others were ordered randomly each round and did not contain subject identifiers, subjects could sanction only on the basis of current round decisions. For each token used to sanction another group member, that group member's earnings were reduced by 10 cents. The cost to the individual imposing the sanction was the foregone earnings from their own private account. Thus, each token used for sanctioning reduced group earnings by 20 cents. After sanctioning decisions were completed, each subject was informed of their earnings, including any sanctions they imposed or received. Subjects were informed of the total number of sanctions they received but could not identify which of the other subjects imposed the sanctions. Further, subjects were not informed

8. Each session was completed in approximately 1 hr. Subject earnings averaged $28.91 (which includes a $5 participation fee).

9. The procedure of informing subjects about both decision sequences prior to any decisions was for experimental control. Across experimental sessions, it is always possible that potential subjects may talk to subjects from prior experiments. This is true for all multisession experiments. Informing subjects of the full experimental protocol, prior to any decisions, eliminates the possibility that subjects have incorrect expectations regarding the nature of the experiment.

10. Unlike Fehr and Gächter (2000), our protocol includes a fixed number of tokens that can be used each round for sanctions/rewards. This protocol was used for control purposes. Across rounds and across treatments, subjects have identical opportunities for rewards/sanctions. Our design also used a constant "fee/fine" ratio for sanctions and a constant "fee/reward" ratio for rewards. See Casari (2005) for a discussion of the implications of alternative cost structures for sanctions.

of the number of sanctions other group members received.

Stage 2 of the reward treatment was identical to that of the sanction treatment, except instead of using tokens to sanction other group members, subjects could use tokens to reward other group members. Subjects using tokens to reward other group members also incurred a cost in the form of foregone earnings. However, for each token used to reward a group member, that group member received 10 cents. Thus, rewards constituted a pure redistribution of earnings.

In the sanction&reward treatment, both sanctions and rewards were allowed. Tokens could be allocated toward sanctions in which case the subject receiving the sanction had his earnings reduced by 10 cents, or allocated toward rewards in which case the subject receiving the reward had his earnings increased by 10 cents.

Opportunities for learning, or for employing history-dependant strategies, make it problematic to use comparisons of the Sequence I and Sequence II decisions to measure the effect of sanctions and rewards. For purposes of experimental control, a baseline treatment was conducted. All aspects of the baseline treatment were identical to those of the other treatments, except that there was no Stage 2 in the decision rounds of Sequence II, no opportunities for rewards or sanctions, and no language in the instructions related to opportunities to reward or sanction. In an effort to minimize potential behavioral differences across treatments due to reduced earnings potential in Sequence II of the baseline treatment, subjects were notified that at the end of each round of Sequence II, an additional 60 cents would be added to their earnings.

In all treatment conditions, subjects play a finitely repeated game with a commonly known final round. Under the assumption that it is common knowledge that subjects maximize own earnings, the theoretical prediction is straightforward. The subgame-perfect Nash equilibrium for each treatment condition calls for zero contributions in the VCM game and no sanctions or rewards.[11] As noted earlier, however, experimental studies of the VCM game typically find that the level of cooperation observed is not consistent with equilibrium predictions of zero provision of the group good.[12] Moreover, other studies have shown that subjects do use sanctions—even though they reduce own earnings—when they are available.

To the extent that motivations of fairness and reciprocity play a role in decision making, the sanction and reward decision environments investigated here allow for subjects to act on such motivations beyond changes that they make in their group allocations to the public good.[13] That is, in the setting here, subjects can respond via explicitly targeted sanctioning or rewarding behavior. Sanctions and rewards can be viewed as an extension of reciprocal behavior allowed through allocation decisions in the standard VCM game. Subjects make costly decisions that yield signals to others that are specifically targeted in relation to current round decisions.

IV. RESULTS

Group-level data are first analyzed to assess the effect of rewards and sanctions on levels of provision of the public good and overall earnings. We then examine overall levels of rewards and sanctions, and analyze rewarding and sanctioning behavior at the individual level.[14]

Allocations to the Group Account

Figure 1 shows average group allocations across all 20 rounds. Data are presented as

11. In the sanction treatments, there are other Nash equilibriums, including some that support efficient allocations. However, equilibrium strategies that support efficient allocations rely on noncredible threats to sanction free riders.

12. To explain this behavior, the theoretical literature focuses on factors within the game and those in the environment surrounding a particular play of the game that are posited to affect individual motivation and behavior. Recent modeling approaches have turned to representations of subjects' preferences beyond own pecuniary motivations. In addition to pecuniary payoffs, these models include subjects' orientations to altruism, fairness, or reciprocity. For examples, see Sugden (1984); Andreoni (1989); Bolton and Ockenfels (2000); Hoffman, McCabe, and Smith (1998); Fehr and Schmidt (1999); Falk and Fischbacher (2006); and Ahn, Ostrom, and Walker (2002).

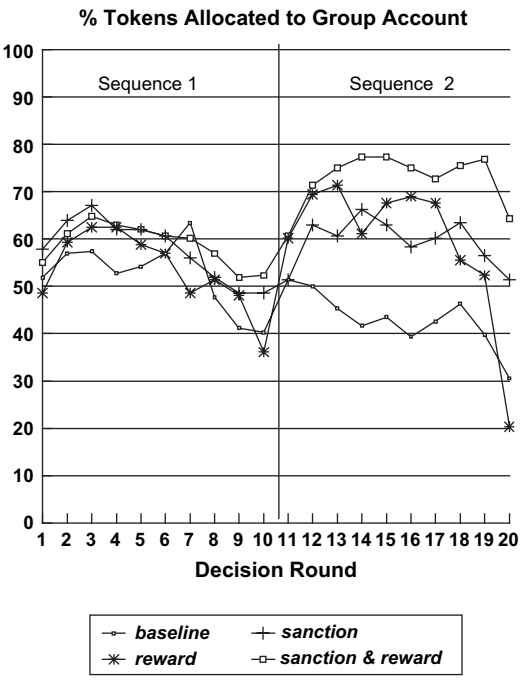
13. Although not targeted at specific individuals, reducing/increasing group allocations in the VCM game can be viewed as forms of sanctions/rewards imposed on others in the group. However, unlike the sanctions investigated here, individuals reducing group allocations in the stage game receive greater payoffs for themselves.

14. Appendix B contains summary of group-level data.

the percentage of tokens allocated to the group account. Recall, prior to making any decisions, subjects were informed of the decision environment for both Sequence I and Sequence II. In the reward, sanction, and sanction&reward treatments, the pattern of average group allocations across Sequence I (Rounds 1–10) is very similar to that in the baseline treatment. This evidence suggests that instructions that vary across treatment conditions for Sequence II have no differential impact on decisions in Sequence I.[15] Further, pooling across treatment conditions, the pattern of group allocations is consistent with that observed in previous studies. In the initial round, subjects allocate an average of 53% of endowments to the group account. Group allocations then decline across rounds to 44% in Round 10. Even in the final round of Sequence I, group allocations substantially exceed the zero allocation level based on the standard model of own-earnings maximization.[16]

As shown in Figure 1, the time trends of average group allocations diverge across treatments in Sequence II. Most notably, average group allocations in the reward, sanction, and sanction&reward treatments move away from the baseline treatment over early rounds of Sequence II. Similar to other VCM experiments with multiple decision sequences, in the baseline treatment there is a restart effect—group allocations are higher in Round 11 than in Round 10—and then allocations resume their downward trend. In the sanction and sanction&reward treatments, allocations increase and are sustained above 50% throughout Sequence II. Both treatments, however, show an end of experiment decay in group allocations, with the decay in the sanction&reward treatment beginning in Round 19. In the reward treatment the data reveal a similar, but more pronounced, dynamic. Group allocations are well above the baseline for most of Sequence II, but in Round 17 begin a sharp decay. By the last round, group allocations fall below that of the baseline.

FIGURE 1
Allocations to Group Account



Statistical tests bear out the trends shown in Figure 1. Group allocations in Round 11 are not significantly different across treatments at conventional levels; allocations in Round 20, as well as across all rounds of Sequence II, are significantly different.[17] Considering each treatment separately, group allocations in Round 20 are significantly lower than in Round 11 for the baseline and reward treatments but not for the sanction or sanction&reward treatments.[18] Comparing the baseline and reward treatments, group allocations are not

15. Treating each group as an independent observation and averaging across decision rounds of Sequence I, an F-test of differences across treatments is not significant ($F = 0.18$, $n = 36$, $p = 0.907$). A nonparametric Kruskal-Wallis test supports this conclusion.

16. As Isaac, Walker, and Williams (1994) demonstrated, the level and rate of group allocations in VCM games is strongly correlated with the marginal per capita return from the group account, as well as group size and number of rounds. Fehr and Gächter, in their partners treatment, with four-person groups and a marginal per capita return of 0.4, found an overall average group allocation of 37% over ten rounds and 18% in the final round. In a related study, with virtually identical parameters to our own, Swope (2002) found an overall group allocation of 45% and a final round allocation of 23%.

17. Round 11 ($F = 0.39$, $n = 36$, $p = 0.759$), Round 20 ($F = 4.87$, $n = 36$, $p = 0.007$), all rounds ($F = 2.64$, $n = 36$, $p = 0.066$). Nonparametric tests support these conclusions.

18. Two-tailed paired t-test, $n = 9$, differences between Rounds 11 and 20, baseline ($t = 4.16$, $p = 0.003$), reward ($t = 3.72$, $p = 0.005$), sanction ($t = 0.00$, $p = 0.500$), and sanction&reward ($t = -0.474$, $p = 0.648$). Nonparametric tests support these conclusions.

significantly different in Round 11 or 20, but are significant when comparing average allocations over Sequence II, reflecting the temporary increase in allocations resulting from the introduction of rewarding opportunities.[19] In contrast, a comparison of the baseline and sanction&reward treatments shows that a significant difference in group allocation levels emerges after Round 11 and is sustained throughout the rest of Sequence II.[20] The difference between the baseline and sanction treatments is less pronounced and indeed not significant at conventional levels (even though, as already noted, group allocations exhibit different dynamics in the two treatments).[21]

Of course, the pooled averages plotted in Figure 1 disguise the degree of variation across groups in each treatment condition. Figure 2 shows the percentage of tokens allocated to the group account across each of the 20 decision rounds for each group. Clearly, considerable variation exists across groups and across treatment conditions. Two observations are of particular note. First, in each treatment condition, there are some groups that are able to achieve sustained high levels of cooperation. Second, in the reward treatment, there is a high level of consistency across groups in the decline in group allocations in the later rounds of Sequence II.

Group Efficiency

Efficiency in allocations is measured as actual group earnings as a percentage of maximum possible earnings. For each round of Sequence I, maximal group earnings of 480 cents are attained when all tokens are allocated to the group account. Sequence II maximal group earnings of 720 cents are attained when all tokens are allocated to the group account in Stage 1, and in the sanction and sanction&reward treatments no sanctions are used in Stage 2. Given that allocations are very similar across treatments in Sequence I, earnings and efficiencies are also, averaging 78%.[22] In Sequence II, the divergent patterns in allocations and the use of rewards and sanctions generate differences in earnings, resulting in efficiencies. Following Round 11, the initial impact of allowing rewards and/or sanctions is a shift upward in efficiencies in the reward and sanction&reward treatments relative to the baseline, and a downward shift in the sanction treatment.

As shown in Figure 3, however, efficiencies follow a different dynamic across the treatment conditions. Efficiencies in the sanction treatment show a statistically significant increase, from Rounds 11 to 20, although they remain below the levels of the other treatments. Efficiencies in the sanction&reward treatment remain relatively stable, with a sharp decline in Round 20. Efficiencies in the reward treatment are relatively stable until Round 17, where they begin a steady decline.[23]

Levels of Sanctions and Rewards

As well as allowing a comparison of the effects of rewards and sanctions on group account allocations and earnings, our data supply evidence about how rewards and sanctions are actually used. Figure 4 shows the average percentage of tokens used for sanctions/rewards across rounds. As seen in the left-hand panel, in the sanction treatment, subjects begin by allocating on average 31% of their Stage 2 tokens to sanctions, but this percentage falls to 16% by the final round.

19. Baseline versus reward, two-tailed t-test, n = 18, Round 11 ($t = -0.78$, $p = 0.447$), Round 20 ($t = 0.927$, $p = 0.368$), all rounds ($t = -1.84$, $p = 0.089$). Nonparametric tests support these conclusions.

20. Baseline versus sanction&reward, two-tailed t-test, $n = 18$, Round 11 ($t = -0.84$, $p = 0.415$), Round 20 ($t = -3.096$, $p = 0.007$), all rounds ($t = -2.715$, $p = 0.016$). Nonparametric tests support these conclusions.

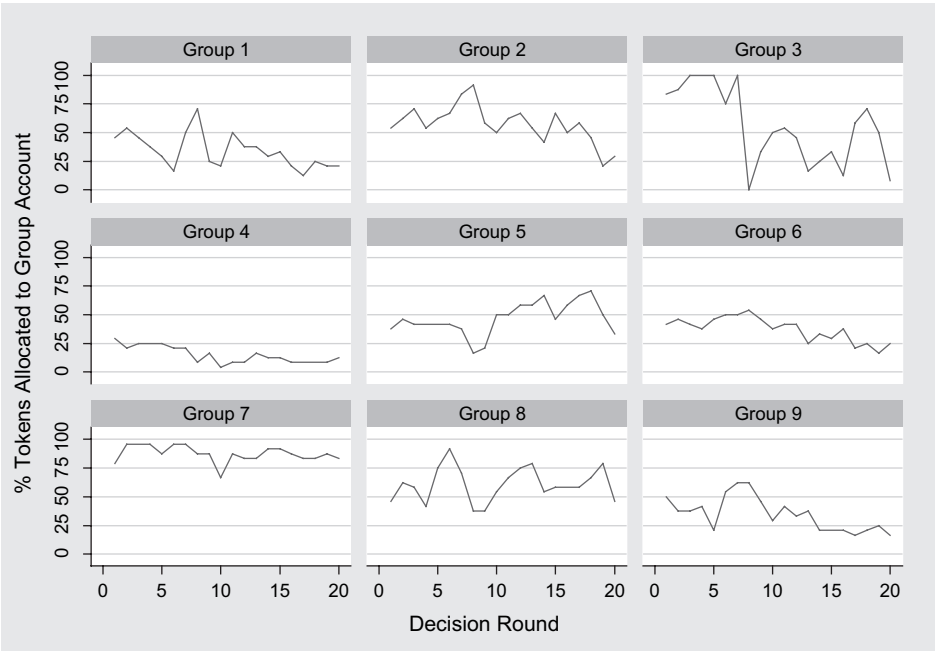
21. Baseline versus sanction, two-tailed test, $n = 18$, Round 11 ($t = 0.00$, $p = 0.500$), Round 20 ($t = -1.47$, $p = 0.163$), all rounds ($t = -1.36$, $p = 0.191$). Nonparametric tests support these conclusions.

22. An alternative specification would calculate efficiency as the increase in earnings over minimum possible earnings. In Sequence I, with no possibilities for sanctions or rewards, minimum possible group earnings occur when no tokens are allocated to the group account. Using this measure, the average efficiency was 56% in Sequence I, pooling across all four treatments. Finally, it is certainly the case that the gains from cooperation (increases in social welfare) may go beyond pure increases in pecuniary earnings.

23. Using a paired t-test, comparing Round 11 to Round 20, the reward treatment yields an average decrease of 13.3% ($t = 3.723$, $n = 9$, $p = 0.006$), while the sanction treatment yields an average increase of 10.2% ($t = 2.393$, $n = 9$, $p = 0.044$). Nonparametric statistics support these conclusions.

FIGURE 2
Allocations to Group Account: By Group

baseline



sanction

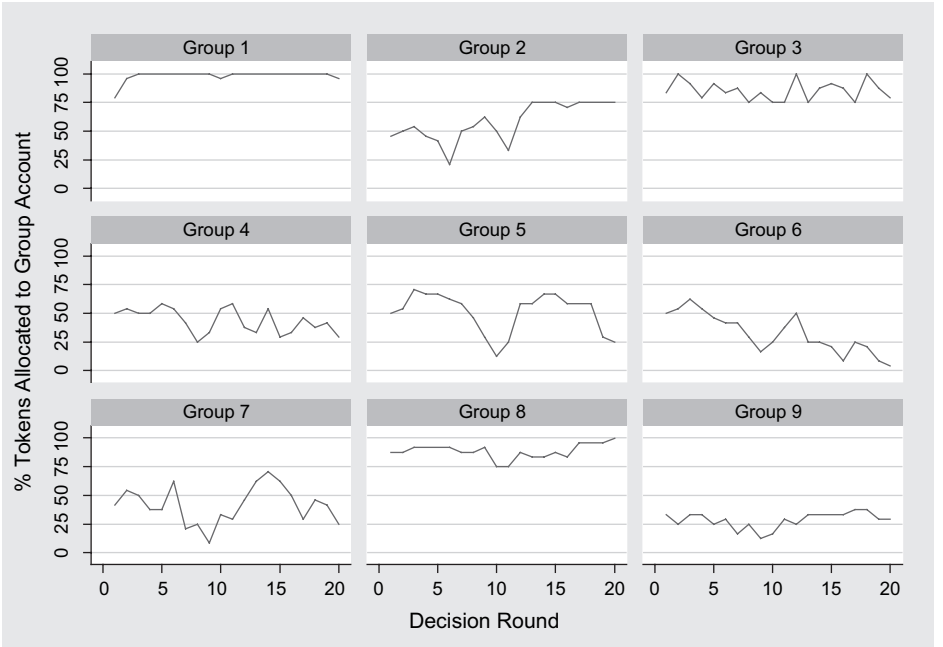
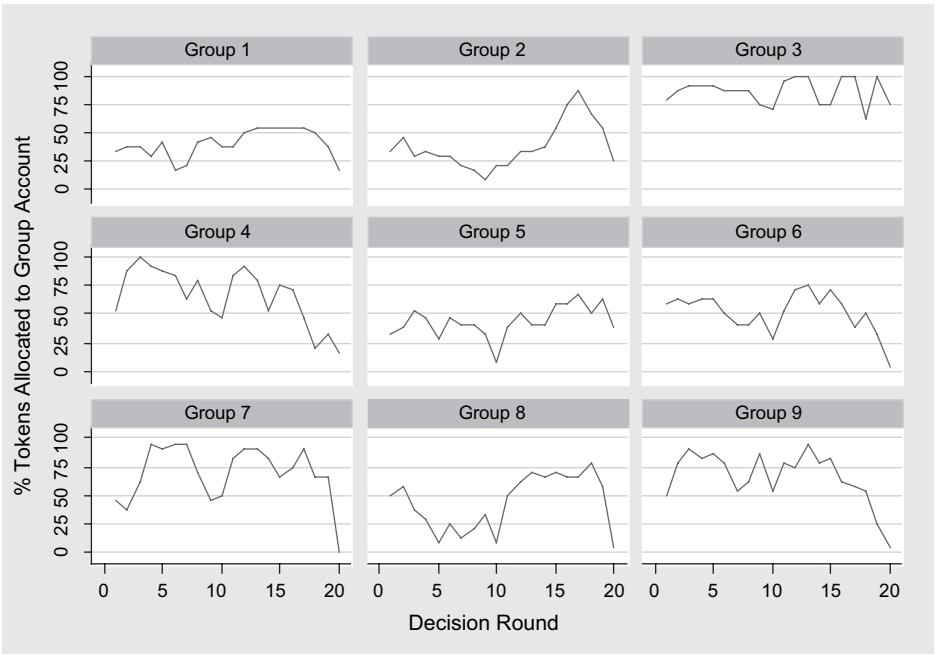


FIGURE 2
Continued

reward



sanction & reward

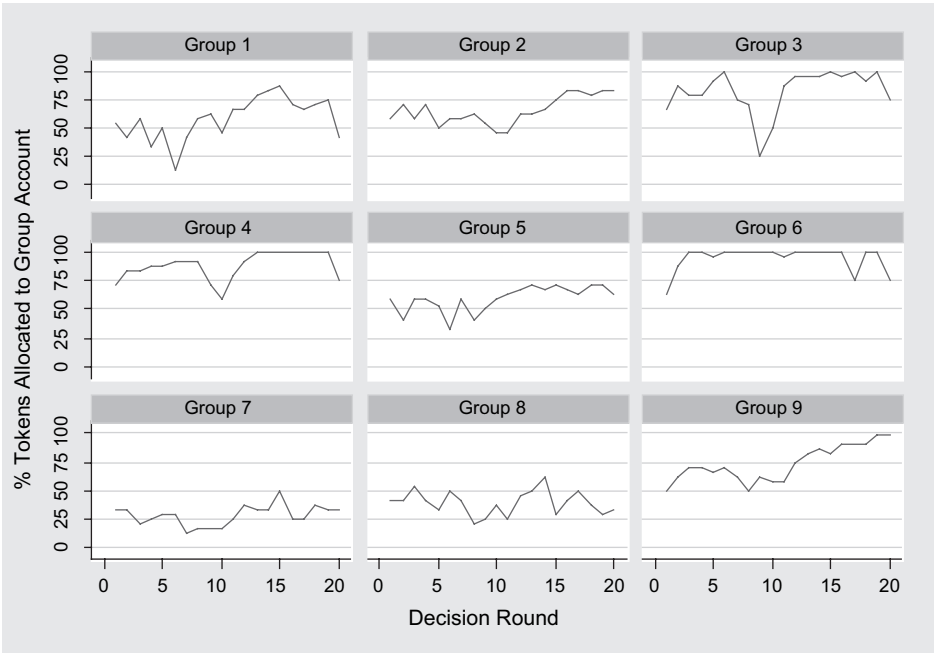
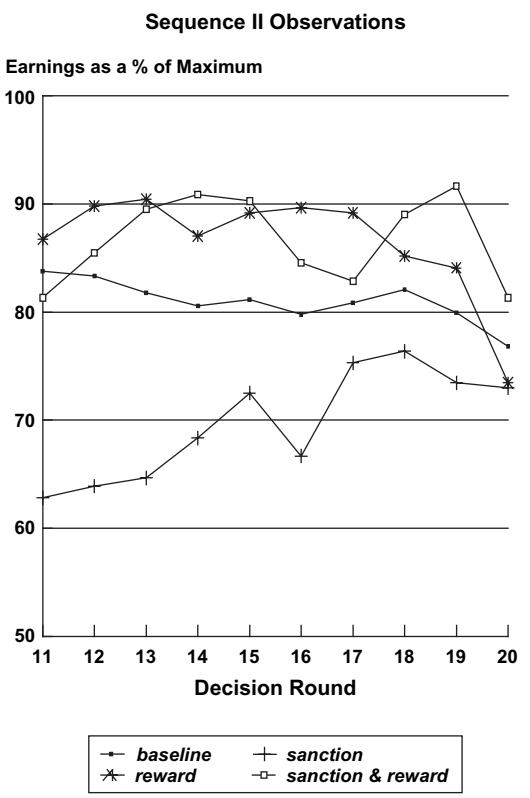


FIGURE 3
Efficiency: Earnings as a % of Maximum



The decline in the use of rewards is more pronounced. In the reward treatment, the percentage of Stage 2 tokens used for rewarding falls sharply, from 41% in Round 11 to 3% in the final round. The right-hand panel of Figure 4 shows the use of rewards and sanctions in the sanction&reward treatment. Again, subjects initially prefer using rewards to sanctions. In Round 11, 42% of Stage 2 tokens are allocated to rewards and only 8% to sanctions. However, this pattern is not maintained. In the final round, only 8% of Stage 2 tokens are used for rewarding other subjects and 10% for sanctioning.[24]

For further analysis of rewarding and sanctioning behavior we focus on four issues: (1) who sanctions or rewards, (2) recipients of sanctions or rewards, (3) the impact of sanctions or rewards on the distribution of individual and group earnings, and (4) the impact of sanctions or rewards on subsequent individual group account allocation decisions.

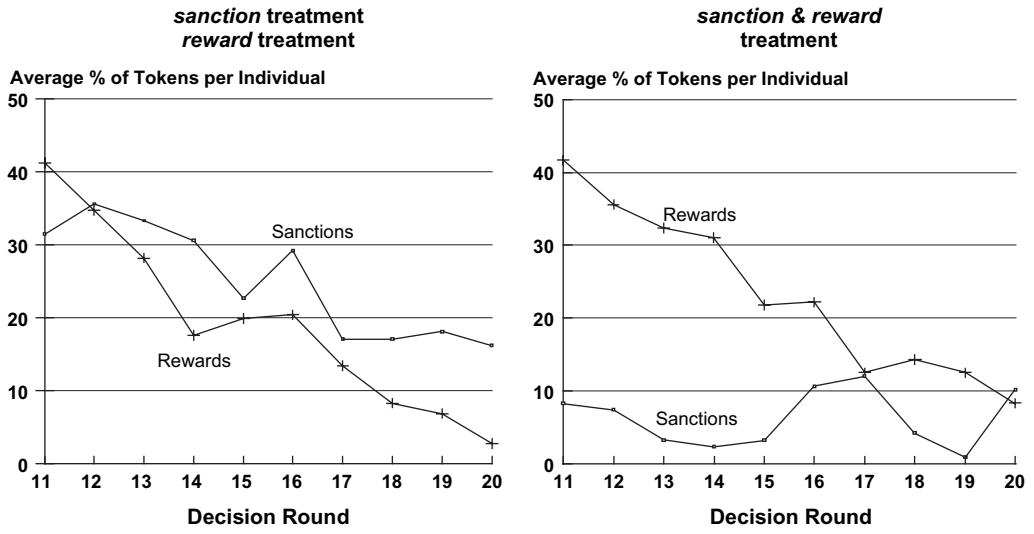
Who Sanctions/Rewards. To examine the characteristics of individuals who use sanctions/rewards, we use a multivariate Tobit regression analysis. The dependent variable is an individual's expenditures on sanctions/rewards in a given round, while the explanatory variables are the individual's allocation to the group account in that round, the average allocation by that individual's group in that round, and round and group dummies to capture time- and group-fixed effects. The results are shown in Table 2. The primary conclusions of this analysis are rather intuitive. In the sanction (reward) treatment, controlling for the group's per capita allocation to the group account, those individuals who allocate most to the group account tend to sanction (reward) most. The sanction&reward treatment yields a somewhat different result. Those that tend to allocate more to the group account tend to sanction more. However, in this treatment, there is not a statistically significant relationship between one's own allocation and the level of rewards given. In fact, in this treatment condition, there is no statistically significant correlation between total sanctions given and total rewards given by individuals.[25] Finally, controlling for the variation in individual allocations to the group account, groups that allocated less to the group account on a per capita basis do more sanctioning and less rewarding, although this relationship is not statistically significant in the reward treatment.

Recipients of Sanctions/Rewards. We next examine the characteristics of subjects who receive sanctions/rewards. To account for the fact that subjects could receive both sanctions and rewards in the sanction&reward treatment, we calculate "net reward" as the difference between reward received and sanction received. Thus, sanctions are measured as

24. Given that subjects had six tokens to use for sanctions/rewards, it is possible that some subjects, especially in early rounds, faced a binding constraint in their decisions to sanction or reward. Across all three treatments, however, in only 81 of 1080 decisions did a subject allocate all six tokens to either sanctions or rewards.

25. Correlation coefficient = $-.056$, $p = 0.744$, $n = 36$.

FIGURE 4
Tokens Used for Sanctions and/or Rewards



negative rewards. Following an approach similar to that used by Fehr and Gächter (2000), Figure 5 shows net rewards received as a function of an individual's deviation from the average group allocation of other group members. Deviations are grouped into intervals, and the average net reward received over observations falling in each interval is plotted.

Our data support Fehr and Gächter's interpretation of the determinants of being sanctioned. In the sanction treatment, subjects are more heavily sanctioned the further their own allocation to the group account falls below the average allocation of the rest of their group. As observed by Fehr and Gächter (2000) and Ostrom, Walker, and Gardner (1992), however, there is some sanctioning of those making group allocations well above the group average.[26] In the sanction&reward treatment, those making group allocations well below the average of other group members are sanctioned but not at the level observed in the sanction treatment. As expected, those in the reward treatment that make allocations above the average of other group members receive the majority of the rewards. Interestingly, however, the average rewards for those making group allocations well above the average of other group members are no greater than for those just above the average of others. Further, large deviations below the average of other group members were sanctioned at a magnitude much higher than rewards for allocations well above the average of other group members. This asymmetry may, in part, explain why rewards alone tended to be less successful in sustaining increased group account allocations.

To characterize the determinants of rewards and sanctions more formally, we estimate a multivariate regression model similar to that used by Fehr and Gächter. Again, we use a Tobit specification with net reward received as the dependent variable, and others' average group allocation, and negative and positive deviations from this, as explanatory variables. Denoting own group allocations by A_i, and the average allocation of the other group members by $\bar{A}_{-i}$, the variable *absolute negative deviation* is defined as $\max\{\bar{A}_{-i} - A_i, 0\}$, and *absolute positive deviation* as $\max\{A_i - \bar{A}_{-i}, 0\}$.[27] The results are

26. Both of these studies suggest "blind revenge" as one possible motivation for this type of behavior.

27. Fehr and Gächter (2000) used sanction received as the dependent variable, so consistency with their reported results requires that our coefficients have the opposite signs.

TABLE 2
Individual Expenditures on Sanctions and Rewards

	Dependent Variable: Expenditures on Sanctions		Dependent Variable: Expenditures on Rewards	
Independent Variables	**Sanction**	**Sanction&reward**	**Reward**	**Sanction&reward**
Group per capita allocation to group account	−0.726 ($p = 0.030$)	−2.533 ($p = 0.000$)	0.200 ($p = 0.266$)	1.845 ($p = 0.000$)
Individual allocation to group account	0.759 ($p = 0.000$)	0.790 ($p = 0.001$)	0.272 ($p = 0.001$)	−0.293 ($p = 0.151$)

Notes: Tobit maximum likelihood estimates. Group and round dummies were also included as independent variables.

presented in Table 3. In the sanction treatment, higher negative deviations are more heavily punished (fewer net rewards), which is consistent with the findings of Fehr and Gächter. However, neither ''others' average allocation'' nor ''absolute positive deviation'' is statistically significant. This differs from the results of Fehr and Gächter, where others' average allocation is significant. In the regression for the sanction&reward treatment, net rewards are positively correlated with others' average allocation, higher negative deviations lead to higher sanctions, and higher positive deviations lead to higher rewards. Note, that, consistent with the results reported above, holding constant the size of the deviation, negative deviations lead to higher sanctions than rewards for positive deviations. Similarly, in the reward treatment, rewards are higher in those groups in which other group members allocate more and are positively correlated with one's own group allocation as a deviation from that of others in one's group.

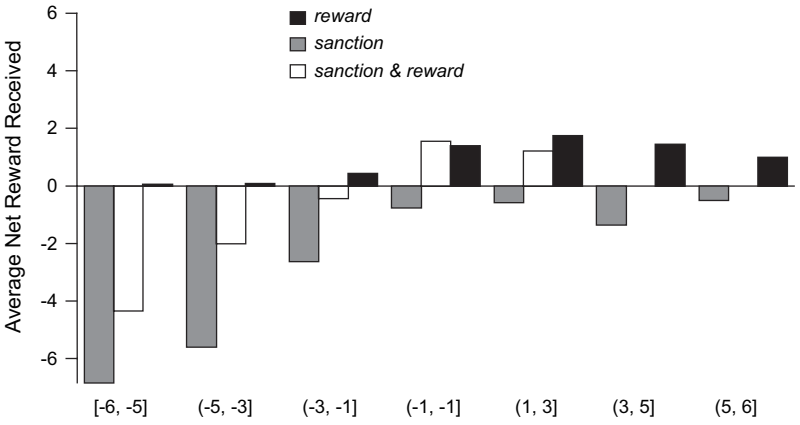
Distribution of Individual and Group Earnings. Sanctions and rewards have the potential to impact the distribution of earnings across individuals and across groups beyond their impact on group account allocation decisions. The analyses above examined the characteristics of subjects who received sanctions/rewards and those who chose to sanction/reward. To examine how these factors combine to impact earnings distributions, we examine each subject's and each group's earnings, pooled across Rounds 11–20. In summary, based on both the range in earnings and variance, the strongest evidence regarding income dispersion comes from the sanction treatment. This treatment includes the widest range of incomes for individuals and groups, as well as the highest variance.[28] This finding is largely attributable to behavior in two of the nine groups in this treatment. These two groups used substantively higher levels of sanctions than the other groups in this treatment. The two groups not only had the lowest levels of group earnings, the eight subjects in these two groups were among the nine lowest earners in this treatment condition.

Dynamics in Individual Decision Making. In this section, we turn to modeling individual group account allocations across decision rounds, in each treatment condition. Our approach follows closely that used in Ashley, Ball, and Eckel (2005). We use a multivariate Tobit regression analysis with individual fixed effects, with the dependent variable an individual's group account allocation in a given round. The explanatory variables are the individual's group account allocation lagged one round and lagged two rounds, an individual's positive (negative) deviation from the average group account allocation of other group members in the last round, and rewards and/or sanctions received in the last round. Table 4 shows estimates for each treatment condition.

For our purposes, of primary interest is the response of individuals to positive or negative deviations from others' allocations in the previous round, and the response to sanctions

28. The unit of observation is the average per round value measured in cents for (1) individual subject's earnings within a treatment ($n = 36$) and (2) individual group's earnings within a treatment on a per capita basis ($n = 9$). Individuals by treatment: sanction (range = 123, var = 1258.31), sanction&reward (range = 86.5, var = 391.54), reward (range = 66, var = 237.56), baseline (range = 50, var = 220.77. Groups by treatment: sanction (range = 106.5, var = 1248.01), sanction&reward (range = 42.25, var = 225.57), reward (range = 25.25, var = 64.42), baseline (range = 45.5 var = 193.98).

FIGURE 5
Net Reward Received in Relation to Deviation from Others' Average Group Allocation



and/or rewards. Consistent with previous findings and models of reciprocity, both positive and negative deviations from the average group account allocations of others is of the expected sign across all treatments. Subjects who give more than others tend to lower their contributions, while subjects who give less than others tend to raise their contributions. The effect of positive deviation is apparently stronger, indicating that the reduction in contributions among those subjects who give more than others tends to be greater than the increase in contributions among those that give less than others. Indeed, the coefficient on negative deviation is not significant at the 10% level in the sanction and sanction&reward treatments. Similarly, the coefficients on sanctions and rewards have the expected sign, indicating that these instruments encourage recipients to increase contributions. However, the magnitude of the effect of sanctions is rather weak—a sanction of one token induces the recipient to increase contributions by about a tenth of a token—and insignificant in the case of the sanction&reward treatment. The coefficients on rewards—1.00 in the reward treatment and 0.39 in the sanction& reward treatment—suggest a greater response. These estimates are suggestive as to one of the reasons for the decline in sanctions given across rounds. On the other hand, they point to an even greater problem in the reward treatment. Rewards appear to induce a response that is efficiency enhancing. Even with this relatively large response, however, groups do not maintain rewards at initial levels. In fact, the level of rewards across rounds declines at a faster rate than that for sanctions.

V. CONCLUDING COMMENTS

Experiments on the provision of public goods offer a rich testing ground for examining norms of behavior and how such behavior is impacted by alternative institutional arrangements. In particular, this paper focuses on reciprocity as a behavioral norm, examining changes in individual group allocations as a general form of reciprocity, and sanctions and rewards as targeted forms of reciprocity.

Our results show that rewards and sanctions are not symmetric in their behavioral effects: opportunities to reward or sanction are used differently by subjects and have different consequences for facilitating cooperation.[29] Initially, subjects chose to use rewards more than sanctions. However, the rate of decay in the level of rewards was faster than that for sanctions. Subjects appeared to

29. Based on differences in implementation costs, Oliver (1980) developed an argument that sanctions will be more efficient in settings where near-unanimous cooperation is required, while rewards will be more efficient if cooperation by only a small proportion of a group is required.

TABLE 3
Recipients of Sanctions or Rewards—Dependent Variable: Net Rewards Received

Independent Variables	Sanction	Reward	Sanction&reward
Others' average group account allocation	0.460 ($p = 0.101$)	0.532 ($p = 0.000$)	0.750 ($p = 0.000$)
Absolute negative deviation	−1.855 ($p = 0.000$)	−0.862 ($p = 0.000$)	−1.249 ($p = 0.000$)
Absolute positive deviation	0.223 ($p = 0.301$)	0.626 ($p = 0.000$)	0.312 ($p = 0.017$)

Notes: Tobit maximum likelihood estimates. Group and round dummies were also included as independent variables.

"give up" more quickly on the use of rewards. Further, sanctions appeared to be imposed in a more intuitive way than rewards. There was a clear positive correlation between the number of sanctions received and the degree to which an individual's group allocation was below that of other group members. Rewards were generally given to those with group allocations above the average of others, but the magnitudes varied little with how far an individual's group allocation was above the average of others, suggesting that there was not a clear consensus on how rewards should be used. The opportunity to reward other group members led to a modest increase in group allocations and earnings, although this was due to behavior in initial rounds that did not survive repetition. On the other hand, in treatments that allowed sanctions, groups were better able to sustain group allocations, although the beneficial impact on earnings was hindered by the cost of sanctions.[30]

These results lend some support to arguments that the use of sanctions may be necessary to promote cooperation initially, but the threat of sanctions may be sufficient to sustain cooperation. These results also point to the complexities involved in using a reward system for sustaining cooperation. One might argue that a successful reward system requires continued use of rewards and those rewards must be in the form of transfers from those allocating less to the public good to those allocating more. In our experiments, however, it was those subjects who allocated relatively more to the group account who tended to give more rewards. Further, as noted above, it appears that subjects lacked a clear focal point or consensus in regard to where rewards should be targeted. The significant decay in rewards across decision rounds suggests that groups may have difficulty in maintaining a rewards system.

The results from the sanction treatment of this study are qualitatively consistent with those of Fehr and Gächter (2000) and other recent studies that examine sanctioning. Subjects use sanctions and overall group allocations increase. The primary behavioral difference among these studies is the degree to which sanctions increase group allocations and the extent to which increased group allocations succeed in increasing overall earnings. There are structural differences among these studies that might account for this difference. In particular, some studies follow Fehr and Gächter, and employ parameterizations where subjects faced convex costs of imposing sanctions (Carpenter 2007; Masclet et al. 2003). In these studies, it was relatively inexpensive to assign a small number of sanctions to another group member. Further, each unit of sanction reduced earnings by a fixed percentage. Thus, in absolute terms, sanctions reduced earnings more for high earners. Others, like the study here, use a simpler linear framework (Bochet, Page, and Putterman 2006; Yamagishi 1986). In this case, there is a one-to-one mapping from costs of imposing a sanction to the

30. To examine the robustness of our results, we conducted an additional session, with three groups of four subjects, of both the reward and the sanction treatments, but with 20 rounds in Sequence II instead of 10. The results from these sessions are strikingly similar to those from our original design. In addition, our initial instructions specifically included wording that referred to opportunities to "sanction" or "reward" others. To investigate whether this framing may have had an impact on behavior, we ran two additional sessions, six 4-person groups, of our sanction&reward treatment. These sessions replaced references to sanctions and rewards with wording that simply referred to opportunities to decrease or increase others' earnings. The general pattern of change in group allocations is similar to that observed in the sanction&reward treatment in the initial study. Further, the use of rewards and sanctions in these sessions is very similar to that observed in the original sanction&reward sessions. Appendix B includes summary information on these additional experiments.

TABLE 4
Decision Making Across Rounds—Dependent Variable: Individual Group Allocations

Independent Variables	Sanction	Reward	Sanction&reward
Individual group allocation in previous round	0.537 ($p = 0.011$)	1.268 ($p = 0.000$)	0.240 ($p = 0.326$)
Individual group allocation lagged 2 rounds	−0.166 ($p = 0.084$)	−0.102 ($p = 0.468$)	0.020 ($p = 0.850$)
Positive deviation from others in previous round	−0.427 ($p = 0.052$)	−1.668 ($p = 0.000$)	−0.770 ($p = 0.003$)
Negative deviation from others in previous round	0.409 ($p = 0.104$)	1.175 ($p = 0.000$)	0.453 ($p = 0.125$)
Sanctions received in previous round	0.121 ($p = 0.097$)		0.082 ($p = 0.624$)
Rewards received in previous round		1.007 ($p = 0.000$)	0.390 ($p = 0.003$)

Notes: Tobit maximum likelihood estimates. Individual fixed effects were also included as independent variables.

magnitude of the sanction. The weaker effect of sanctions in our study may reflect the intuitive notion that sanctions will be more readily used when they are less costly to impose, and will be more effective when they impose greater costs upon those sanctioned.[31]

The one-to-one nature of our sanctioning technology limits the ability of subjects to use sanctions to reduce disadvantageous payoff inequality (in the sense of Fehr and Schmidt 1999).[32] Even so, subjects do use sanctions in our experiment. In this respect, our results support Falk, Fehr, and Fischbacher's (2005) findings from a "low-sanction" prisoner's dilemma experiment, which also employs a one-for-one sanctioning technology. They observe a substantial number of subjects cooperating and sanctioning defectors, and interpret the driving force behind these sanctions to be a desire to retaliate against unfair behavior, rather than to reduce unfair payoff differences. In this sense, our experimental results complement a growing number of experimental studies of public goods provision that find support for behavior based on reciprocity or conditional cooperation. Future theoretical work, and experimental tests of these theories, faces the challenge of more clearly articulating the scope of these norms of reciprocity, as well as how these norms vary and interact across individuals and across institutional arrangements.

31. Ostrom, Walker, and Gardner (1992) showed that the frequencies of use of sanctions in a common-pool resource environment are inversely related to the cost of sanction and positively correlated with the magnitude of the sanction. The Ostrom, Walker, and Gardner study found little evidence that sanctions improve earnings net of sanctions. In addition, Fehr and Gächter recently conducted experiments examining the cost technology associated with rewards and sanctions. They found that when the ratio of the cost of being sanctioned to the cost of sanctioning is 1:1, group allocations display a slight downward trend, whereas when the ratio is 3:1, group allocations increase to near 100% (S. Gächter, personal communication).

32. With this one-to-one sanctioning technology, a subject cannot use sanctions to reduce his/her earnings disadvantage relative to a free rider. However, coordinated sanctioning by the rest of the group could reduce a free rider's earnings advantage.

APPENDIX A: INSTRUCTIONS

Screen prints from instructions for sanction&reward treatment. Instructions for the other treatments were very similar, variations only in regard to whether rewards only, sanctions only, or no rewards and sanctions were permitted.

This is an experiment about decision making. Several research foundations have provided the funds for this experiment. The instructions are simple and if you follow them carefully and make good decisions you might earn a considerable amount of money which will be paid to you privately and in cash at the end of today's session. The amount of money you earn depends on the decisions that you and the other participants make. You will never be asked to reveal your identity to anyone during the course of the experiment. Your name will never be associated with any of your decisions. In order to keep your decisions private do not reveal your choices to any other participant.

This experiment

This experiment consists of two sequences of decision rounds. Each sequence contains ten decision rounds. You will be in a group of size four (you plus three other people). We have already randomly assigned you to a group. You will remain in this group for the rest of this experiment. However, you will not be told each other's identities. Your earnings will depend upon the decisions that you make and the decisions that the other people in your group make.

Sequence 1 (Decision Rounds 1–10)

Each round you will be endowed with six tokens. You must choose how many of these tokens to keep in your private account and how many tokens to allocate to a group account. The amount of money that you earn in each decision round depends on how many tokens

you place in your private account, how many tokens you allocate to the group account, and how many tokens the others in your group allocate to the group account.

You can choose any number of tokens to allocate to your private account, from zero through six tokens, and any number to allocate to the group account (also any number from zero through six tokens). However, the number of tokens you allocate to your private account and to the group account must sum to six.

You will earn 10 web-cents for each token you allocate to your private account.

For each token you allocate to the group account, you will earn 5 web-cents, and each of the other three people in your group will also earn 5 web-cents (a total of 20 web-cents for all four of you together).

For each token another person in your group allocates to his/her own private account, this person also earns 10 web-cents.

For each token another person in your group allocates to the group account, this person will earn 5 web-cents, and each of the other people in your group will also earn 5 web-cents (a total of 20 web-cents for the group).

To summarize, in each of Rounds 1–10 you will earn:

10 web-cents times the number of tokens you allocate to your private account plus
5 web-cents times the total number of tokens allocated to the group account by everyone in their group.

At the beginning of each round, you will see a screen like the one shown below.

You will enter an amount to allocate to the group account by clicking the "+1" and "−1" buttons. The amount allocated to your private account is the part of your endowment that is left after you have entered your group allocation amount. Once you have entered an amount, click the "submit allocation decision" button and you will be asked to confirm your decision. If your decision is ok, click "ok." If it is not, or you wish to change your decision, click "cancel." Please try this now.

After all individuals have made their decisions for the round, the computer will tabulate the results. You will be informed of the total allocation to the group account and your total earnings for the round. You will also be informed of the allocation decisions of each member of the group. On your own screen your allocation decision will be listed first, and the other three decisions will be listed in random order. Thus, information about individual decisions will be completely anonymous.

This same process will be repeated for a total of ten rounds. Notice that you will have six tokens to allocate in each of the ten rounds. Note that at the end of a round, the decisions of the other people in your group are listed in random order. This means, for example, that the person listed second in one round may be different from the person listed second in another.

Sequence 2 (Decision Rounds 11–20)

In the second sequence of decision rounds (Rounds 11–20), each decision round will have two parts.

Part 1 of Sequence 2

In the first part of the decision round, the type of decision you make will be just like the type of decision you made in Rounds 1–10.

In Part 1 of each round, you will be endowed with six tokens.

You must choose how many of these tokens to keep in your private account and how many tokens to allocate to a group account. The amount of money that you earn in Part 1 of each decision round depends on how many tokens you place in your private account, how many tokens you allocate to the group account, and how many tokens the others in your group allocate to the group account. You can choose any number of tokens to allocate to your private account, from zero through six tokens, and any number to allocate to the group account (also any number from zero through six tokens). However, the number of tokens you allocate to your private account and to the group account must sum to six.

You will earn 10 web-cents for each token you allocate to your private account.

For each token you allocate to the group account, you will earn 5 web-cents, and each of the other three people in your group will also earn 5 web-cents (a total of 20 web-cents for all four of you together).

For each token another person in your group allocates to his/her own private account, this person will earn 10 web-cents.

For each token another person allocates to the group account, this person will earn 5 web-cents, and each of the other people in your group will also earn 5 web-cents (a total of 20 web-cents for the group).

To summarize, in the first part of each of Rounds 11–20 you will earn:

10 web-cents times the number of tokens you allocate to your private account plus
5 web-cents times the total number of tokens allocated to the group account by everyone in their group.

In each round in the second sequence, at the end of Part 1 you will be informed of the total allocation to the group account and your total earnings for Part 1 of that round. You will also be informed of the allocation decisions of each member of the group. On your own screen your allocation decision will be listed first, and the other three decisions will be listed in random order. Thus, information about individual decisions will be completely anonymous.

Part 2 of Sequence 2

In the second part of each round in the second sequence you will be endowed with six tokens.

You must choose how many of these tokens to keep in your private account and how many tokens to use to reward or sanction each of the other group members.

The amount of money that you earn in the second part of a round depends on how many tokens you place in your private account, and how many tokens the others in your group reward or sanction you.

In Part 2, you can choose any number of tokens to allocate to your private account, from zero through six tokens, and any number to reward or sanction other group members (also any number from zero through six tokens for each other group member). However, the number of tokens you allocate to your private account and to rewarding or sanctioning other group members must sum to six.

You will earn 10 web-cents for each token you allocate to your private account. For each token you use to reward another group member, that group member will receive 10

web-cents. For each token you use to sanction another group member, that group member will lose 10 web-cents.

For each token another person in your group allocates to his/her private account, this person will earn 10 web-cents.

For each token this person uses to reward another group member, that group member will receive 10 web-cents. In particular, if another person in your group rewards you, you will receive 10 web-cents. For each token this person uses to sanction another group member, that group member will lose 10 web-cents. In particular, if another person in your group sanctions you, you will lose 10 web-cents.

To summarize, in Part 2 of each round in the second sequence you will earn:

10 web-cents times the number of tokens you allocate to your private account plus
10 web-cents times the number of tokens the other group members reward you minus
10 web-cents times the number of tokens the other group members sanction you.

Your total earnings for the round will be the sum of your earnings from Part 1 and Part 2 of that round. It is possible for your earnings to be negative in a given decision round.

In Part 1 of each round, you will decide how to allocate your tokens between your private account and the group account. You will then see the results from Part 1 and move to Part 2.

At the beginning of Part 2, you will see a screen like the one shown below.

The first column of each row lists how many tokens another group member allocated to the group account in Part 1. The amount you enter in the two columns beside it is the number of tokens you wish to use to reward (first column) or sanction.

Remember, in Part 2 of each Sequence 2 round, you will have six tokens that can be allocated to your private account or used to reward and/or sanction the other players in your group.

As in Part 1, you enter amounts by clicking the "+1" and "−1" buttons. Also as in Part 1, the amount of tokens allocated to your private account is the amount of your endowment that is left after you have entered your reward and/or sanction amounts. Once you have entered these amounts, click the "submit reward/sanction decisions" button. You will be asked to confirm your decision. If your decision is ok, click "ok." If it is not, or you wish to change your decision, click "cancel."

Remember, in Part 2, the number of tokens you allocate to your private account and the number you use to reward or sanction other group members must sum to six. That is, you can enter any number between zero and six inclusive in any of the spaces in the table, but all the numbers you enter must add up to six or less.

After all individuals have made their decisions for the Part 2 of each round, the computer will tabulate the results and you will be informed of your earnings from Part 1, Part 2, and the total for the round.

This same process will be repeated for all ten rounds of the second sequence, that is, Rounds 11–20. Notice that you will have six tokens to allocate in each part of each of the ten rounds. Note that at the end of a round, the decisions of the other people in your group are listed in random order. This means, for example, that the person listed second in one round may be different from the person listed second in another.

Earning money in this experiment

We will record your web-cent earnings in every round of this experiment. At the end of the experiment, we will add up these web-cent earnings and convert them to U.S. dollars by multiplying by 0.01. We will pay you this amount privately and in cash. Your earnings are your own business and you do not have to discuss them with anyone.

During the experiment, you are not permitted to speak or communicate with the other participants. If you have a question while the experiment is going on, please raise your hand and one of us will come to your seat to answer it. At this time, do you have any questions about the instructions or procedures? If you have a question now or at any time during the experiment, please raise your hand and one of us will come to your seat to answer it.

Finally, a history screen with a summary of past decisions and earnings will be available. To see the history screen, click the "history" button at the bottom of your screen. To continue, you must click the "close history" button at the bottom of the history screen.

Please click "continue" to begin the experiment.

APPENDIX B: GROUP DATA

Appendix Table B1 gives average data in terms of tokens per group member per round. B refers to baseline, etc. X refers to additional experiments with extended time horizon. N refers to additional experiments using neutral language.

APPENDIX TABLE B1

Group-Level Data

	Allocation to Group Account in Round						Sanctions in Round			Rewards in Round		
Group	**1**	**10**	**Sequence I**	**11**	**Last**	**Sequence II**	**11**	**Last**	**Sequence II**	**11**	**Last**	**Sequence II**
B1	2.75	1.25	2.375	3.00	1.25	1.725	—	—	—	—	—	—
B2	3.25	3.00	3.925	3.75	1.75	2.975	—	—	—	—	—	—
B3	5.00	3.00	4.375	3.25	0.50	2.250	—	—	—	—	—	—
B4	1.75	0.25	1.175	0.50	0.75	0.625	—	—	—	—	—	—
B5	2.25	3.00	2.250	3.00	2.00	3.350	—	—	—	—	—	—
B6	2.50	2.25	2.700	2.50	1.50	1.775	—	—	—	—	—	—
B7	4.75	4.00	5.325	5.25	5.00	5.175	—	—	—	—	—	—
B8	2.75	3.25	3.450	4.00	2.75	3.850	—	—	—	—	—	—
B9	3.00	1.75	2.650	2.50	1.00	1.525	—	—	—	—	—	—
S1	4.75	5.75	5.825	6.00	5.75	5.975	0.25	0.00	0.100	—	—	—
S2	2.75	3.00	2.850	2.00	4.50	4.150	3.00	0.75	1.600	—	—	—
S3	5.00	4.50	5.100	4.50	4.75	5.150	0.50	0.75	0.750	—	—	—
S4	3.00	3.25	2.825	3.50	1.75	2.400	3.00	1.50	1.800	—	—	—
S5	3.00	0.75	3.100	1.50	1.50	3.025	3.75	3.00	3.375	—	—	—
S6	3.00	1.50	2.525	2.25	0.25	1.350	0.75	0.00	0.250	—	—	—
S7	2.50	2.00	2.225	1.75	1.50	2.775	3.50	2.50	3.825	—	—	—
S8	5.25	4.50	5.300	4.50	6.00	5.325	1.00	0.00	0.725	—	—	—
S9	2.00	1.00	1.500	1.75	1.75	1.925	1.25	0.25	1.150	—	—	—
R1	2.00	2.25	2.050	2.25	1.00	2.775	—	—	—	2.50	0.00	1.250
R2	2.00	1.25	1.600	1.25	1.50	2.925	—	—	—	2.50	0.50	1.575
R3	4.75	4.25	5.100	5.75	4.5	5.300	—	—	—	2.25	1.00	0.850
R4	3.25	2.75	4.475	5.00	1.00	3.425	—	—	—	2.50	0.00	1.300
R5	2.00	0.50	2.225	2.25	2.25	3.025	—	—	—	3.00	0.00	1.350
R6	3.50	1.75	3.100	3.25	0.25	3.075	—	—	—	2.75	0.00	1.200
R7	2.75	3.00	4.150	5.00	0.00	4.300	—	—	—	3.50	0.00	0.975
R8	3.00	0.50	1.700	3.00	0.25	3.575	—	—	—	2.00	0.00	1.425
R9	3.00	3.25	4.375	4.75	0.25	3.700	—	—	—	1.25	0.00	0.525
RS1	3.25	2.75	2.750	4.00	2.50	4.250	0.75	0.75	0.750	2.75	1.50	1.925
RS2	3.50	2.75	3.525	2.75	5.00	4.350	2.00	0.00	0.525	0.75	0.25	0.550
RS3	4.00	3.00	4.350	5.25	4.50	5.625	0.00	1.75	0.175	2.25	0.00	0.900
RS4	4.25	3.50	4.900	4.75	4.50	5.675	0.50	0.25	0.125	2.50	0.50	1.850
RS5	3.50	3.50	3.075	3.75	3.75	4.025	0.00	0.00	0.250	2.75	0.00	0.875
RS6	3.75	6.00	5.675	5.75	4.50	5.675	0.25	2.25	0.525	5.00	0.00	3.150
RS7	2.00	1.00	1.400	1.50	2.00	2.000	0.25	0.00	0.400	1.75	0.00	0.500
RS8	2.50	2.25	2.325	1.50	2.00	2.425	0.50	0.50	0.325	2.50	0.00	0.575
RS9	3.00	3.50	3.750	3.50	6.00	5.175	0.25	0.00	0.300	2.25	2.25	2.225
SX1	4.50	2.00	3.400	3.75	2.50	3.388	2.00	1.50	1.000	—	—	—
SX2	3.75	5.50	5.200	5.75	6.00	5.613	1.75	0.00	0.400	—	—	—
SX3	1.00	2.00	2.600	2.75	3.25	3.200	2.00	0.75	1.163	—	—	—
RX1	4.25	1.00	4.275	5.50	0.50	1.888	—	—	—	4.00	0.00	0.700
RX2	2.75	1.25	1.475	1.25	1.00	2.238	—	—	—	1.25	0.00	1.050
RX3	3.25	1.00	2.825	2.75	0.50	4.025	—	—	—	2.00	0.00	0.600
RSN1	2.00	2.00	2.100	1.75	3.75	3.175	0.75	1.25	1.475	0.50	0.50	0.850
RSN2	2.25	2.25	1.925	2.25	1.75	1.400	1.25	0.50	0.500	2.50	0.25	2.025
RSN3	4.25	0.00	2.275	3.00	5.25	4.750	1.75	0.00	0.925	3.00	1.50	1.875
RSN4	2.00	1.75	2.075	2.00	2.25	2.175	0.75	1.00	0.800	2.25	0.25	0.725
RSN5	2.50	0.25	1.725	1.50	0.75	1.625	1.00	0.25	0.400	1.50	0.00	0.700
RSN6	0.75	1.25	0.875	1.00	1.25	1.300	0.75	0.00	0.325	2.25	0.50	1.050

REFERENCES

Ahn, T. K., E. Ostrom, and J. Walker. "Incorporating Motivational Heterogeneity into Game Theoretic Models of Collective Action." Working Paper, Indiana University, 2002.

Anderson, C., and L. Putterman. "Do Non-Strategic Sanctions Obey the Law of Demand? The Demand for Punishment in the Voluntary Contribution Mechanism." *Games and Economic Behavior*, 54, 2006, 1–24.

Andreoni, J. "Giving with Impure Altruism: Applications to Charity and Ricardian Equivalence." *Journal of Political Economy*, 97, 1989, 1447–58.

Andreoni, J., W. Harbaugh, and L. Vesterlund. "The Carrot or the Stick: Rewards, Punishments and Cooperation." *American Economic Review*, 93, 2003, 893–902.

Andreoni, J., and J. Miller. "Rational Cooperation in the Finitely Repeated Prisoner's Dilemma: Experimental Evidence." *Economic Journal*, 103, 1993, 570–85.

Ashley, R., S. Ball, and C. Eckel. "Motives for Giving: A Reanalysis of Two Classic Public Goods Experiment." Working Paper, Virginia Technological Institute, 2005.

Bochet, O., T. Page, and L. Putterman. "Communication and Punishment in Voluntary Contribution Experiments." *Journal of Economic Behavior and Organization*, 60, 2006, 11–26.

Bolton, G. E., and A. Ockenfels. "ERC: A Theory of Equity, Reciprocity, and Competition." *American Economics Review*, 90, 2000, 166–93.

Carpenter, J. (forthcoming). "Punishing Free-Riders: How Group Size Affects Mutual Monitoring and the Provision of Public Goods." *Games and Economic Behavior* (2007), doi: 10.1016/j.geb.2006.08.011.

Casari, M. "On the Design of Peer Punishment Experiments." *Experimental Economics*, 8, 2005, 107–15.

Clark, K., and M. Sefton. "The Sequential Prisoners Dilemma: Evidence on Reciprocation." *Economic Journal*, 111, 2001, 51–68.

Coats, J., and W. Neilson. "Beliefs about Other-Regarding Preferences in a Sequential Public Goods Game." *Economic Inquiry*, 43, 2005, 614–22.

Croson, R. "Theories of Commitment, Altruism and Reciprocity: Evidence from Linear Public Goods Games." Working Paper, University of Pennsylvania, 1998.

Dickinson, D. "The Carrot vs. the Stick in Work Team Motivation." *Experimental Economics*, 4, 2001, 107–24.

Dugar, S. "Approval and Disapproval in Minimum Action Games." Working Paper, University of Arizona, 2005.

Falk, A., E. Fehr, and U. Fischbacher. "Driving Forces Behind Informal Sanctions." *Econometrica*, 73, 2005, 2017–30.

Falk, A., and U. Fischbacher. "A Theory of Reciprocity." *Games and Economic Behavior*, 54, 2006, 293–315.

Falkinger, J., E. Fehr, S. Gächter, and R. Winter-Ebmer. "A Simple Mechanism for the Efficient Provision of Public Goods: Experimental Evidence." *American Economic Review*, 90, 2000, 247–64.

Fehr, E., and S. Gächter. "Cooperation and Punishment in Public Goods Experiments." *American Economic Review*, 90, 2000, 980–94.

Fehr, E., and K. Schmidt. "A Theory of Fairness, Competition, and Cooperation." *Quarterly Journal of Economics*, 114, 1999, 817–68.

Gunnthorsdottir, A., D. Houser, K. McCabe, and H. Ameden. "Excluding Free-Riders Improves Reciprocity and Promotes the Private Provision of Public Goods." Working Paper, University of Arizona, 2000.

Hoffman, E., K. McCabe, and V. Smith. "Behavioral Foundations of Reciprocity: Experimental Economics and Evolutionary Psychology." *Economic Inquiry*, 36, 1998, 335–52.

Isaac, M., and J. Walker. "Communication and Free Riding Behavior: The Voluntary Contribution Mechanism." *Economic Inquiry*, 26, 1988, 585–608.

Isaac, M., J. Walker, and A. Williams. "Group Size and the Voluntary Provision of Public Goods." *Journal of Public Economics*, 54, 1994, 1–36.

Kerr, N. "Anonymity and Social Control in Social Dilemmas," in *Resolving Social Dilemmas*, edited by M. Foddy, M. Smithson, S. Schneider, M. Hogg. Philadelphia, PA: Psychology Press, 1999, 103–20.

Keser, C. "SUPER: Strategies Used in Public Goods Experimental Rounds." Working Paper, University of Mannheim, 1997.

———. "Cooperation in Public Goods Experiments." Working Paper, CIRANO, 2000.

Kroll, L., T. Cherry, and J. Shogren. "Voting, Punishment and Public Goods: An Experimental Investigation." Working Paper, St. Lawrence University, 2003.

Ledyard, J. "Public Goods: A Survey of Experimental Research, " in *Handbook of Experimental Economics*, edited by J. Kagel and A. Roth. Princeton, NJ: Princeton University Press, 1995, 111–94.

Masclet, D., C. Noussair, S. Tucker, and M. Villeval. "Monetary and Non-Monetary Punishment in the Voluntary Contributions Mechanism." *American Economic Review*, 93, 2003, 366–80.

Offerman, T. "Hurting Hurts more than Helping Helps". *European Economic Review*, 46, 2002, 1423–37.

Oliver, P. "Rewards and Punishments as Selective Incentives for Collective Action: Theoretical Investigations." *American Journal of Sociology*, 85, 1980, 1356–75.

Orbell, J., A. van de Kragt, and R. Dawes. "Explaining Discussion Induced Cooperation." *Journal of Personality and Social Psychology*, 54, 1988, 811–9.

Ostrom, E. *Governing the Commons*. New York: Cambridge University Press, 1990.

Ostrom, E., J. Walker, and R. Gardner. "Covenants With and Without a Sword: Self-Governance is Possible." *American Political Science Review*, 86, 1992, 404–17.

Schmidt, D., R. Shupp, J. Walker, T. Ahn, and E. Ostrom. "Dilemma Games: Game Parameters and Matching Protocols." *Journal of Economic Behavior and Organization*, 46, 2001, 357–77.

Seely, B., J. Van Huyck, and R. Battalio. "Credible Assignments Can Improve Efficiency in Laboratory

Public Goods Games." *Journal of Public Economics*, 89, 2005, 1437–55.

Sonnemans, J., A. Schram, and T. Offerman. "Strategic Behavior in Public Good Games: When Partners Drift Apart." *Economics Letters*, 62, 1999, 35–41.

Sugden, R. "Reciprocity: The Supply of Public Goods Through Voluntary Contributions." *Economic Journal*, 94, 1984, 772–87.

Swope, K. "An Experimental Investigation of Excludable Public Goods." *Experimental Economics*, 5, 2002, 209–22.

Walker, J., and M. Halloran. "Rewards and Sanctions and the Provision of Public Goods in One-Shot Settings." *Experimental Economics*, 7, 2004, 235–47.

Yamagishi, T. "The Provision of a Sanctioning System as a Public Good." *Journal of Personality and Social Psychology*, 51, 1986, 110–6.

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