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Bosses and Kings: Asymmetric Power in Paired Common Pool and Public Good Games

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Abstract:

Social dilemmas characterize decision environments in which individuals' exclusive pursuit of their own material self-interest can produce inefficient allocations. Two such environments are those characterized by public goods and common-pool resources in which the social dilemmas can be manifested in free riding and tragedy of the commons outcomes. Much field and laboratory research has focused on the effectiveness of alternative political-economic institutions in counteracting individuals' tendencies to underprovide public goods and over-extract common-pool resources. Previous laboratory research has not focused on the implications of power asymmetries in paired public good and common pool game settings. In our baseline treatments, we experiment with *simultaneous move* one-period games in which *paired comparisons* can be made across settings with public good and common pool games. In our central treatments, we experiment with *pairs* of *sequential move* one-period games in which second movers with asymmetric power — "bosses and kings" — *can* have large effects on efficiency and equity. The central questions are whether the bosses and kings *do* have significant effects on outcomes and whether those effects differ across the paired public good and common pool games in ways that can be rationalized by some theories but not others.

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I. Introduction

Social dilemmas characterize settings where a divergence exists between expected outcomes from individuals pursuing strategies based on narrow self-interest versus groups pursuing strategies based on the interests of the group as a whole. An ongoing discussion among social scientists undertaking research in the field and the laboratory has focused on the extent to which clear behavioral differences in social dilemma settings can be attributed to characteristics of the environment in which decision makers interact such as property rights, government regulation, and institutions that support voluntary cooperation (Camerer 2003; Casari and Plott, 2003; Cox, Ostrom, Walker, et al., 2009; Fehr and Gächter, 2000; Fehr and Schmidt, 1999; Ostrom and Walker, 2003).

When individuals make choices that do not fully account for social costs or benefits, their choices lead to outcomes that are suboptimal from the perspective of the group. The welfare implications of *not* solving social dilemma problems are substantial; they include manifold problems stemming from inadequate public services, overuse and possible destruction of natural resources, and global warming. A careful sorting out of how key underlying factors affect behavior and outcomes is essential to providing a better foundation for theory as well as sound policy advice.

Our research program focuses primarily on behavior within two social dilemma decision situations: public goods and common-pool resources. These two dilemma settings are frequently seen as fundamental to understanding core issues in collective action. Although pathbreaking research has been conducted on these settings in the field, field research does not involve the level of control that enables a careful and systematic approach to theoretical and behavioral integration.

Each of these dilemmas has been studied in the laboratory under varying contextual conditions including, but not limited to: size of group, type of incentives, communication, repetition of the game, and institutional changes that alter agents' feasible sets and payoffs. These two social dilemmas have not, however, been studied within one systematic research program that changes attributes of the decision situation for both public goods and common-pool resources to assess rigorously the impact of diverse institutional arrangements on behavior and outcomes. Nor have theories of behavior been assessed systematically in paired public good and common pool experiments where the core contextual attribute of agent power asymmetry is varied as an experiment treatment.

Our experimental design includes three pairs of games. Each pair consists of a public good game and a common pool game that have the same set of feasible allocations and payoffs. The only difference between the two games within a pair is whether the agents' initial endowments are private property or a common pool. In contrast, pairs of games differ in their power asymmetry. The baseline pair of games has symmetric power for all agents. The boss pair and king pair of games have different types of asymmetric power. The design of the experiment "crosses" the (private or common pool) property treatments with the (baseline or boss or king) power treatments in a 2 X 3 design. This design provides new insights into the ways in which (a) private property versus a common pool and (b) power symmetry versus power asymmetry affect behavior in environments characterized by social dilemmas.

The two games within each pair are isomorphic for unconditional preference theories. For example, self-regarding (or "economic man") preference theory and unconditional social preference theories (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002) predict that agents will choose the same allocations in the two baseline games. These theories do not necessarily predict that agents will choose the same allocations in a boss or king game as they do in the baseline game. But the unconditional preference theories do predict that agents will choose the same allocation in the two (private property or common pool) boss games. Similarly, economic man and unconditional social preference theories predict the same outcomes for the two king games. In contrast, the two games in either of the asymmetric power (boss or king) pairs are not isomorphic according to revealed altruism theory (Cox, Friedman, and Sadiraj, 2008). That theory's predicted differences between asymmetric power games are tested with data from the boss and king pairs of games.

II. Previous Research on Public Goods and Common Pool Game Settings

At a general level, the findings from laboratory experiments are that subjects faced with the public good game or the common pool game are frequently able to achieve outcomes with higher efficiencies than those predicted by game-theoretic equilibria based solely on an assumption of self-regarding (or "economic man") preferences. The extent to which these outcomes deviate from *in*efficient equilibria predicted by traditional theory, however, depends critically on the institutional context of the decision setting. Further, results have been reported that subjects are able to achieve and sustain more cooperative outcomes when the context of the game facilitates individuals gaining information that others are trustworthy. These results add importantly to the argument that successful and sustainable cooperation must be built on a foundation of trust and reciprocity. On the other hand, experiments that allow for more complex decision settings, such as asymmetry in payoffs or incompleteness in opportunities for group agreements, reveal the fragile nature of cooperative solutions (Walker and Ostrom, 2007; Ostrom, 2009).

The varying parametric and institutional contexts can be viewed, at least in part, as influencing the level of trust and reciprocity players may anticipate from their game counterparts. In some cases, based purely on own pecuniary payoffs, the change in context alters the non-cooperative Nash equilibrium and subsequently expected play from a traditional theoretical perspective. The contextual influences observed in the laboratory, however, go beyond those that can be explained by purely pecuniary motives. In one sense, it is the set of behavioral regularities that is essential to understanding the foundations of trust and cooperation and how the contextual structure of the experiment increases or decreases the likelihood of cooperation. Although there has been extensive field and laboratory investigation of each of these settings, few studies have examined whether important behavioral differences exist between public good and common pool settings when subjects face identical pecuniary incentives.

The experimental research on public good and common pool game settings is quite extensive. Our purpose here is not to review that literature but, rather, to provide a stylized characterization for comparison to the experiments reported herein. The existing literature is based extensively on versions of public good and common pool games described below in sections II.A and II.B. As summarized in section II.C, the experiment reported in this paper examines the behavioral outcomes associated with the interaction of dilemma situations incorporating private property or common property endowments and agent power asymmetry.

II.A. Public Good Games

The most commonly examined form of the public good game includes N players, who make decisions simultaneously (Isaac, Walker, and Williams, 1994). Each player in a linear voluntary contribution public good game begins with a private property endowment of E tokens worth Z dollars each. Each player is allowed to allocate a portion of her endowment to a group fund, yielding a benefit to that player and all other players in the group. That part of the endowment that is not allocated to the group fund is maintained in the agent's private fund. Each token allocated to the group fund yields less to the contributor than its value in his private fund but a greater amount to the group as a whole. For example, suppose that N=4, and that each token allocated to a player's private fund is worth $1, and each token allocated to the group fund yields $0.75 to *each* player (meaning that the value to the group of a token allocated to the group fund is $3). To maximize group earnings, all individuals would allocate their entire endowments to the group fund. If the game is played only once or is finitely repeated, however, an individual's noncooperative pecuniary self-interest is to allocate nothing to the group fund.

Although there are important differences in the strategic nature of the games, two studies are particularly relevant to the research presented here, Andreoni (1995) and Sonnemans, Schram, and Offerman (1998). Andreoni (1995) examines the impact of positive and negative frames on cooperation in a linear public goods game. In the positive frame, the subject's choice is framed as contributing to a public good, which will have a positive benefit to other subjects. In the negative frame, the subject's choice is framed as purchasing a private good which makes the other subjects worse off due to the opportunity cost of lowering the provision of the public good. The results of this study suggest that subjects are more cooperative in the positive framing version of the game. Sonnemans, Schram, and Offerman (1998) examine a repeated step-level social dilemma game framed as providing a public good or preventing a public bad. The two games are strategically equivalent *if* modeled with self-regarding preferences. In early decision rounds, behavior is not significantly different between the two games. Across later rounds, however, the setting in which the game is framed as preventing a public bad yields lower levels of cooperation (and efficiency).

II.B. Common Pool Games

Similar to the public good game, the most commonly examined form of the common pool game includes N players who make decisions simultaneously (Ostrom, Walker, and Gardner, 1992). In one form of this game, each player begins with an endowment of E tokens worth Z dollars each. Each player is allowed to invest a portion of his private property endowment in an investment opportunity (the common-pool resource) that initially yields higher returns at the margin than if these funds remain in the individual's private fund. However, the marginal gain from the investment opportunity in the common pool decreases with the overall size of the aggregate group investment. Each individual receives a return from the common pool as a proportion of her investment relative to the aggregate investment. To maximize joint payoffs, the group should invest some but not all of their endowments into the common pool. However, the dilemma is that each individual's noncooperative pecuniary interest is to invest more than the amount that would maximize group earnings.

II.C. Private versus Common Property

Numerous experimental studies involving private property endowments have demonstrated that individuals' decisions, in a variety of situations, reflect complex and diverse motivations beyond simple own-income maximization (see, for examples, Camerer, 2003; Camerer and Fehr, 2006; Ashraf, Bohnet, and Piankov, 2006; Cox, Friedman, and Gjerstad, 2007; Cox, Friedman, and Sadiraj, 2008). A largely unexplored question concerns the implications of such fairness behavior for allocation of common property endowments. Unfortunately, since the work of Garrett

Hardin (1968) on the "tragedy of the commons," some scholars have referred to *open access* resources as "common property" (Bromley, 1989). This has obfuscated the critical distinction between common property, *per se*, and the particular case of a common-pool resource in which there are no property rights and is thus open access. Consequently, the implications of fairness behavior for the allocation of common property endowments have not been overtly explored in experiments.

The realization of many of the possible gains from exchange with private property requires trust and reciprocity since contracts are typically incomplete (Fehr, Gächter, and Kirchsteiger, 1997), just as efficient outcomes with common property also require trust and reciprocity (Ostrom, 1998). Field studies have challenged the commonly accepted conclusions related to the "tragedy of the commons" and illustrated the substantial difference in incentives and behavior between open access resources (Berkes et al., 2006) and common property resources (National Research Council, 1986, 2002; Dietz, Ostrom, and Stern, 2003; Dolšak and Ostrom, 2003). In addition to the institutional context in which users of the commons make decisions, in both experimental and field research trust appears to be a core variable explaining why participants in some settings tend to cooperate while tending not to cooperate in other settings (Ostrom, Gardner, and Walker, 1994; Ostrom, 2009; Walker and Ostrom, 2007).

In previous research (Cox, Ostrom, Walker, et al., 2009), we examined two versions of the investment (or trust) game that are isomorphic for both self-regarding ("economic man") preferences and various models of social preferences (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2001; Charness and Rabin, 2002; Cox and Sadiraj, 2007). We found that first movers more frequently left the full joint fund untouched in the Common Property Trust Game than they contributed the maximum in the Private Property Trust Game. Second movers responded by returning insignificantly more to the first movers in the Common Property Trust Game than in the Private Property Trust Game. In terms of overall earnings, the Common Property Trust Game yielded only a 5 percent increase over the Private Property Trust Game. In a later paper, Cox and Hall (2010) reported an experiment that differed from the Cox, Ostrom, Walker, et al. (2009) experiment in two ways: subjects earned their (private or common property) endowments in a real effort task and second movers entered strategy method responses. Cox and Hall report that second movers are significantly less cooperative with common property earned endowments than with private property earned endowments, which is an idiosyncratic prediction of the model of reciprocity developed in Cox, Friedman, and Sadiraj (2008). Sell and Son (1997) examined two decision environments that are similar to our public good and common pool baseline decision environments described below. They reported higher levels of efficiency in their common pool decision setting.

Building on these previous studies, we report here an experiment designed to contrast paired public good and common pool game settings characterized by money-payoff-equivalent feasible sets. Of particular importance are the aspects of the decision settings that allow for contrasting behavior between symmetric and asymmetric power relations among agents.

III. Paired Public Good and Common Pool Games with Symmetric and Asymmetric Power

In addition to overtly recognizing the role of private versus common property endowments, we begin with the observation that institutions for private provision of public goods and private maintenance of common-pool resources exist within larger economic and political contexts that often involve asymmetries in power. The experiment reported herein focuses on the implications of asymmetric power of players who move last in a sequential game of more than two players. We call the two types of strategic agents with asymmetric power “bosses” and “kings.” A “boss” makes her decision after observing the decisions of other agents. A “king” observes others’ decisions before making his decision and, in addition, can exercise a sovereign right to appropriate surplus created by others. More specifically, we examine the efficiency of allocations made by voluntary contributions to public goods when the ordinary participants know that the final distribution of the surplus generated by their contributions will be made by a strategic agent with asymmetric power. Similarly, we examine the efficiency of decisions made by voluntary participation in common-pool resource extraction activities when the ordinary participants know that the final distribution of a surplus will be made by a strategic agent with asymmetric power.

In a standard voluntary contributions mechanism (VCM) game, N symmetric agents (“citizens”) simultaneously decide on the amounts they will contribute to a public good. They share equally in the surplus created by their contributions. In the extended game with a “boss” (the BVCM game), N-1 “workers” first decide how much they will contribute to a public good; the boss subsequently observes their contributions and decides whether to also contribute to the public good or just share equally in the surplus created by the workers’ contributions. In the extended game with a “king” (the KVCM game), N-1 “peasants” first decide how much they will contribute to a public good; the king subsequently observes their contributions and decides whether to also contribute to the public good or appropriate some or all of the peasants’ contributions for his private consumption. The public good produced with contributions remaining after the king’s move is shared equally.

In our baseline common pool (CPR) game, N symmetric agents (“citizens”) simultaneously decide how much to extract from the common pool. They share equally in the remaining common pool. In the extended game with a "boss" (the BCPR game), N-1 "workers" first decide how much to extract from the common pool. The boss subsequently observes the amount of remaining resource and decides how much to extract herself. The workers and boss face the same constraint on the maximum amount each can extract. The resource remaining in the common pool after extractions by theworkers and the boss is shared equally. In the extended game with a "king" (the KCPR game), N-1 "peasants" first decide how much to extract from the common pool; the king subsequently observes the amount of remaining resources and decides how much to extract himself. The peasants each face the same constraint on the maximum amount each can extract. The king faces no constraint on his extraction other than the size of the common pool; that is, he can exercise his sovereign right to extract *all* of the resource remaining after the peasants' extractions. The resource remaining in the common pool after extractions by the peasants and the king is shared equally.

The symmetric and asymmetric games can be played by any number of agents larger than three. We report experiments with four agents.

III.A. Public Good Games

A public good game is a surplus creation game. Each agent is endowed with \$10. Each \$1 contributed to the public good yields \$3. Let x_j denote the contribution to the public good by agent j. The dollar payoff to agent i equals the amount of her endowment that is *not* contributed to the public good plus an equal share (in this case one-fourth) of the tripled amount contributed to the public good by all agents:

$$\pi_i = 10 - x_i + 3\sum_{j=1}^{4} x_j / 4$$

III.A.1. VCM Game

In this game, the agents all move simultaneously. Each of the four agents chooses the dollar amount to contribute x_j, $j = 1,2,3,4$, from the feasible set $X = \{0,1,2,\cdots,10\}$.

III.A.2. BVCM Game

In this game, three agents simultaneously move first. Subsequently, the boss observes their choices and then decides how much to contribute. Each of the four agents chooses the amount to contribute x_j, $j = 1,2,3,4$, from the same feasible set X as in the (baseline) VCM game.

III.A.3. KVCM Game

In this game, three agents simultaneously move first. Subsequently, the king observes their choices and then decides how much to contribute or how much to appropriate from the other three subjects' contributions. Each of the three first movers chooses the amount to contribute x_j, $j = 1,2,3$, from the same feasible set X as in the VCM and BVCM games. The king can choose to contribute any non-negative integer amount up to 10 to the public good. Alternatively, the king can choose to take (in integer amounts) any part of the tripled amount contributed by the three peasants if it is strictly positive. Define $\theta = -3\sum_{j=1}^{3} x_j$. The king can choose an amount x_4 (to take or contribute) from the feasible set $K_{VCM} = \{\theta, \theta+1, \theta+2, \cdots, 10\}$.

III.B. Common Pool Games

A common pool game is a surplus destruction game. The common pool is endowed with \$120. Each \$3 extracted from the common pool increases the private payoff of the extracting agent by \$1. Let z_j denote the amount extracted from the common pool by agent j. The dollar payoff to agent *i* equals one-third of his extraction from the common pool plus an equal share (in this case one-fourth) of the remaining value of the common pool after the extractions by all agents:

$$\pi_i = \frac{1}{3} z_i + (120 - \sum_{j=1}^{4} z_j) / 4$$

III.B.1. CPR Game

In this game, the agents all move simultaneously. Each of the four agents chooses the dollar amount to extract z_j, $j = 1, 2, 3, 4$, from the feasible set $\mathrm{Z} = \{0, 3, 6, \cdots, 30\}$.

III.B.2. BCPR Game

In this game, three agents simultaneously move first. Subsequently, the boss observes their choices and then decides how much to extract. Each of the four agents chooses the amount to extract z_j, $j = 1, 2, 3, 4$, from the same feasible set Z as in the (baseline) CPR game.

III.B.3. KCPR Game

In this game, three agents simultaneously move first. Subsequently, the king observes their choices and then decides how much of the remaining resource to extract. Each of the three first movers chooses an amount to extract z_j, $j = 1, 2, 3$, from the same feasible set as in the CPR and BCPR games. The king chooses an amount z_4 to extract from the feasible set of integers $\mathrm{K}_{CPR} = \{0, 3, 6, \cdots, 120 - \sum_{j=1}^{3} z_j\}$.

III.C. Implications of Unconditional Preference Models

The feasible allocations and associated payoffs for all agents are the same within each of the three pairs of games: (1) VCM and CPR, (2) BVCM and BCPR, and (3) KVCM and KCPR. If the amount $3x_j$ *added to* the public good equals the amount $30 - z_j$ *left in* the common pool by each of the four agents (that is, $3x_j = 30 - z_j$, $j = 1,2,3,4$) then all agents receive the same payoffs in each of the two games in any one of the three pairs of public good and common pool games.[1] Therefore, if agent behavior is modeled with either self-regarding (i.e., "economic man") preferences or unconditional social preferences (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Cox and Sadiraj, 2007), then play is predicted to be the same within each pair of public good and common pool games. In other words, for unconditional distributional preferences models, the two games in each (baseline or boss or king) pair of public good and common pool games are strategically equivalent (or isomorphic).

IV. Experiment Results

Experiment sessions were conducted at both Georgia State University and Indiana University. In each session, N subjects were recruited from subject data bases that included undergraduates from a wide range of disciplines. Via the computer, the 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 numerous independent groups. At the beginning of each session, subjects privately read a set of instructions that explained the decision setting. In addition, an experimenter reviewed he instructions publicly. The games described above were operationalized in a one-shot decision setting with a double-blind payoff protocol. The game settings and incentives were induced in the following manner.

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[1]Note that this statement does not preclude heterogeneous play across agents for which $x_i \neq x_j$ or $z_i \neq z_j$ for $i \neq j$.

In the VCM treatment, each individual is endowed with 10 tokens worth $1 each in his/her Individual Fund. Thedecision task is whether to move tokens to a Group Fund. Any tokens moved to the Group Fund are tripled in value. Individual earnings equal the end value of the Individual Fund plus one-fourth of the end value of the Group Fund. Second movers in the BVCM and KVCM treatments are allowed choices as described in section III.

In the CPR treatment, each group is endowed with 40 tokens worth $3 each in their Group Fund. The choice of each individual is whether to move tokens to his/her own Individual Fund. Any tokens moved from the Group Fund reduce the value of the Group Fund by $3, and increase the value of the Individual Fund of the decision maker by $1. Individual earnings equal the end value of the Individual Fund plus one-fourth of the end value of the Group Fund. The second movers in the BCPR and KCPR treatments are allowed choices as described in section III.

The Nash Equilibrium for the special case of self-regarding (or "economic man") preferences would call for each subject to make a zero contribution to the Group Fund in all of the public good treatments. In the common pool treatments, the equilibrium entails each subject extracting 10 tokens from the Group Fund. In contrast, the group optimum occurs when all tokens are contributed to the Group Fund in a public goods game and when no tokens are extracted from the Group Fund in a common pool game.

Data are reported for the number of individual subjects (and four person groups) listed in Table 1.We doubled the initial sample size for the KVCM and KCPR treatments after observing a striking difference (reported below) between these treatments, in order to ensure that this result was not due to a small sample bias. That is why the sample size for these two treatments is larger than the others.

Table 1. Number of Individual Subject (and group) Observations by Treatment

VCM	Boss VCM (BVCM)	King VCM (KVCM)	CPR	Boss CPR (BCPR)	KingCPR (KCPR)
32 (8 groups)	28 (7 groups)	76 (19 groups)	36 (9 groups)	32 (8 groups)	76 (19 groups)

The summary presentation of results focuses on three primary behavioral characteristics of the experiments: (1) efficiency or variation in payoffs across the six treatment conditions; (2) choices by first movers in all treatments; and (3) choices by second movers in the four sequential treatment conditions.

IV.1. Realized Surplus with Public Goods and Common Pools

The most fundamental issue related to the alternative treatment conditions is the impact of the institutional configuration on the ability of group members to generate surplus (by contributing from their private property endowments to the public good) in the three public good conditions and not to destroy surplus (by not extracting from their common property endowments) in the three common pool conditions. Using each four-member group as the unit of observation, note that both the minimum possible group payoff ($40) and the maximum possible group payoff ($120) are constant across all six treatments. Figure 1 displays actual average group payoffs in our six treatment conditions.

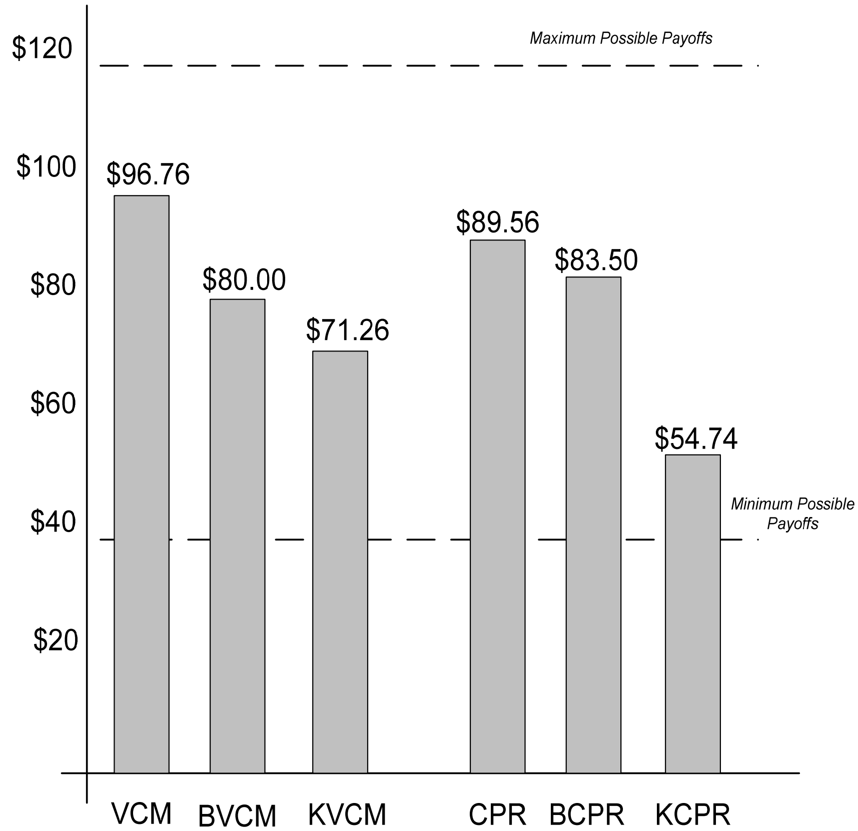

Figure 1. Average Group Payoff by Treatments

Result 1: Average group payoffs across the two baseline conditions (VCM and CPR) are very similar. Payoffs are well above the minimum predicted by Nash equilibrium for the special case of self-regarding preferences (which is $40).

The data for the baseline public good treatment are consistent with findings from a large number of VCM experiments: the "complete free riding" prediction from the self-regarding preference model fails empirically. The data for the baseline common pool (CPR) treatment are inconsistent with a strong form "tragedy of the commons" prediction that most or all available surplus will be destroyed.

Result 2: Average payoffs are lower in the BVCM and BCPR treatments than in the baseline VCM and CPR treatments, and are even lower in the KVCM and KCPR treatments.

Power asymmetries decrease efficiency (or realized surplus) in both public good and common pool settings. Low efficiency is especially a feature of the king treatment for the common pool setting; treatment KCPR comes closest to manifesting a strong form tragedy of the commons.

Result 3: Pooling across decision groups (n=70), least squares analysis of total group token allocations to the Group Fund leads to the following results related to selective tests of equality: VCM = BVCM, p = .05; VCM = KVCM, p = .00 ; BVCM = KVCM, p= .11; CPR = BCPR, p = .71; CPR = KCPR, p = .00; BCPR = KCPR, p= .00; VCM = CPR, p = .07; BVCM = BCPR, p = .66; KVCM = KCPR, p = .04; Lab Location (GSU versus IU), p=.14.[2]

Payoff differences between treatments in public good settings are significant for VCM vs. BVCM and for VCM vs. KVCM. Payoff differences between treatments in common pool settings are significant for CPR vs. KCPR and for BCPR vs. KCPR. Payoffs are significantly lower for KCPR than for KVCM.

IV.2. Type X Decisions and Payoffs

For comparison purposes, the decisions of Type X subjects (all subjects in the simultaneous VCM and CPR games, and those randomly assigned to be first movers in the sequential games) are presented as the dollar amounts allocated to the Group Fund in the public good games or dollar amounts left in the Group Fund in common pool games. In the notation of

[2]All linear model analyses are conducted with robust standard errors.

section III, the bar graph shows the average value across Type X subjects of $3x_j$ in public good games and $30 - z_j$ in common pool games.

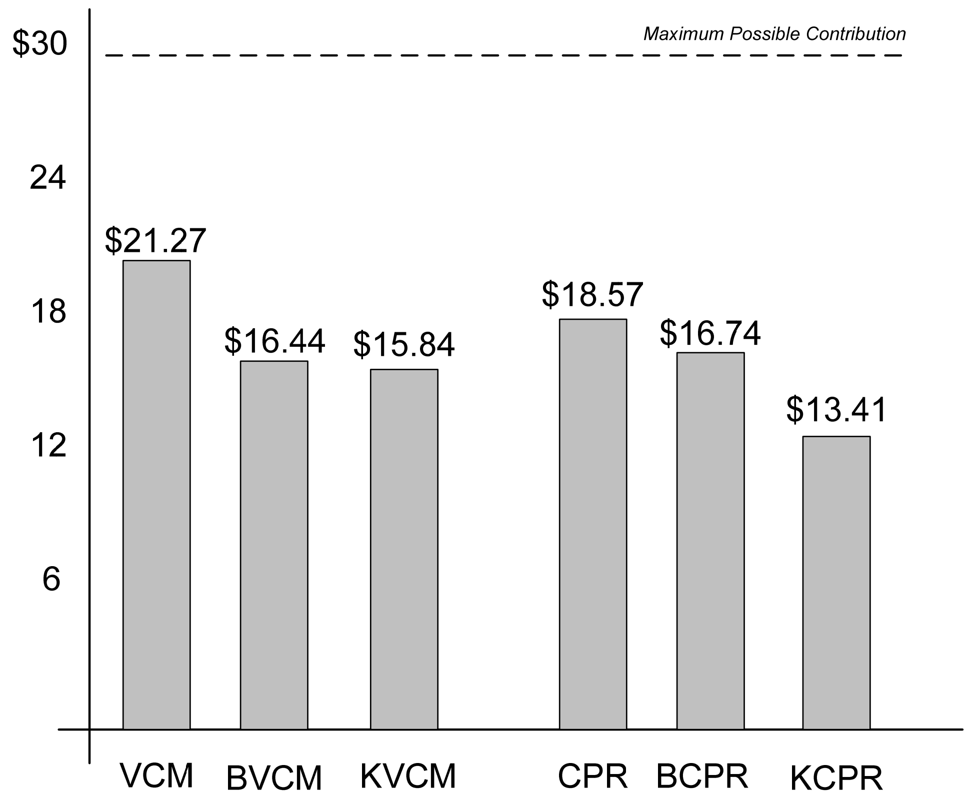

Figure 2. Average Individual Type X Decisions Represented as $ in Group Fund

Result 4: Pooling across Type X decision makers (n=227), least squares analysis of Type X token allocations to the Group Fund (tokens left in the Group Fund) leads to the following results related to selective tests of equality: VCM = BVCM, p = .16; VCM = KVCM, p = .01; BVCM = KVCM, p= .52 ; CPR = BCPR, p = .78; CPR = KCPR, p = .02; BCPR = KCPR, p= .13; VCM = CPR, p = .20; BVCM = BCPR, p = .92; KVCM = KCPR, p = .28; Lab Location (GSU versus IU), p=.19.

Payoff differences between treatments in public good settings are significant for VCM vs. KVCM. Payoff differences between treatments in common pool settings are significant for CPR vs. KCPR. Finally, allowing for Type Y allocation decisions (discussed below), in the public good setting, first mover (Type X) payoffs are significantly lower for KVCM than for the baseline treatment VCM. In the common pool setting, first-mover payoffs are significantly lower in KCPR than in CPR.

IV.3. Type Y Decisions and Payoffs

Figure 3 displays the decisions of the second movers (Type Y) for the four treatments with sequential decision making. For the boss treatments, decisions are represented as average dollar amounts contributed to the Group Fund (BVCM setting) or left in the Group Fund (BCPR setting). For the kings treatment, in the notation of section III, the bar graph for KVCM shows the average value across Type Y subjects of $3x_4$, where x_4 is a negative (positive) amount withdrawn from (contributed to) the Group Fund that is chosen from the feasible set $K_{VCM} = \{\theta, \theta+1, \theta+2, \cdots, 10\}$, for $\theta = -3\sum_{j=1}^{3} x_j$. For the KCPR treatment, the bar graph shows the average value across Type Y subjects of $30 - z_4$, where z_4 is the amount withdrawn from the Group Fund, chosen from the feasible set $\mathrm{K}_{CPR} = \{0, 3, 6, \cdots, 120 - \sum_{j=1}^{3} z_j\}$.[3]

[3]The maximum amount that can be withdrawn by a Type Y subject in either the KVCM or KCPR treatment depends on the decisions by Type X subjects in his/her decision making group in the relevant treatment session. The Type X data reported in Figure 2 show the average constraint faced by the Type Y subjects in Figure 3, pooling across decision making groups in the relevant treatment condition.

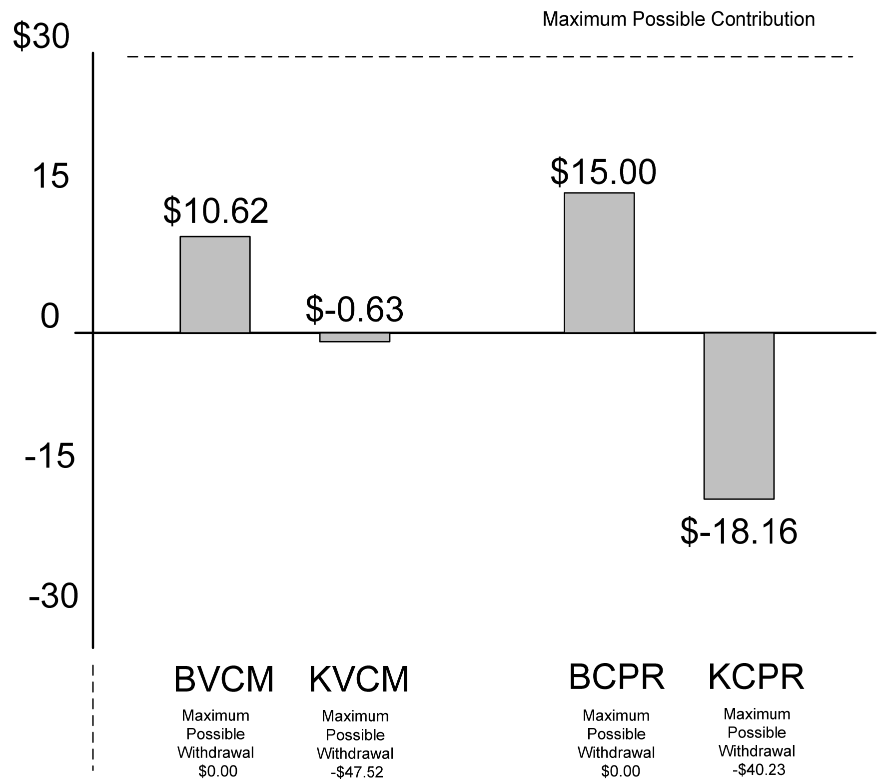

Figure 3. Average Individual Type Y Decisions Represented as $ in Group Fund

We next report an analysis of Type Y token allocations using treatment dummy variables, with BVCM as the omitted category.

Result 5: Pooling across Type X decision makers (n=53), a tobit regression of Type Y decisions controlling for the total Type X token allocation (XSUM) to the Group Fund (or total tokens left in the Group Fund) and treatment and location dummy variables produces the following coefficient estimates: DUMBCPR: 2.71 (p=.71); DUMKCPR: -15.47 (p=.03); DUMKVCM: -7.25 (p=.29); DUMIU: 5.99 (p=.21); XSUM: -0.29 (p=.34); CONSTANT: 10.99 (p=.13).

Only one coefficient estimate is statistically significant, the negative coefficient for the dummy variable for the King CPR treatment (DUMKCPR). The coefficient for the King VCM treatment (DUMKVCM) is negative but insignificant. After controlling for treatment effects, the amount first movers contribute to a pubic good or leave in the common pool (XSUM) is not a significant determinant of second mover choice.

In summary, the analysis of data from the experiment suggests that the opportunity for second movers to exploit cooperative decisions by first movers: (a) significantly reduces first movers' level of cooperation (and resulting efficiency); and (b) increases second movers' exploitation of the cooperativeness of first movers. Further, the data support the conclusion that the level of exploitation is greatest in the KCPR setting.

V. Implications of Reciprocal Preferences

Some of the observed differences between games can be modeled with straightforward reinterpretation of recent theory of reciprocal preferences (Cox, Friedman, and Gjerstad, 2007; Cox, Friedman, and Sadiraj, 2008). Reciprocal preference theory is distinguished from self-regarding ("economic man") theory and from unconditional social preference theory (e.g., Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Cox and Sadiraj 2007) by two axioms, Axiom R (for reciprocity) and Axiom S (for status quo). These axioms specify how first movers' actions affect the other-regarding preferences of subsequent movers in a game when the feasible sets that can be determined by first movers' actions are MGT ("more generous than") ordered (Cox, Friedman, and Sadiraj, 2008, p. 36). The parametric model (Cox, Friedman, and Gjerstad, 2007) and nonparametric model (Cox, Friedman, and Sadiraj, 2008) of reciprocal preference theory were applied to data from many two-player games, and the formal development of the theory emphasized the two-player interpretation.

Straightforward reinterpretation of the two-player reciprocal preference models allows us to apply the theory to the second mover's preferences for her own payoffs and payoff of the three first movers in our bosses and kings treatments by defining the relevant "other player's" payoff as the average payoff of first movers. Define "my income" m as the second mover's money payoff in a game and define "your income" y as the average payoff of first movers in the game. Suppose that the second mover's preferences for m and y can be modeled with the type of reciprocal preferences in Cox, Friedman, and Sadiraj (2008), specifically that the preferences satisfy Axiom R and Axiom S. This theory predicts some properties of the data reported above.

Consider, for example, the play by kings in the KVCM and KCPR games. The decisions by the first movers ("peasants") determine the opportunity set of the second mover ("king"). As above, let the peasants be players 1, 2, and 3, and let the king be player number 4. Let the peasants' total contribution to the public good be denoted by $X_{-4} = \sum_{j=1}^{3} x_j$ and the peasants' total withdrawal from the common pool be denoted by $Z_{-4} = \sum_{j=1}^{3} z_j$. As above, let the king's choices in the public good and common pool games be denoted, respectively, by x_4 and z_4. If the peasants in KVCM contribute more in situation B than in situation A ($X_{-4}^{B} > X_{-4}^{A}$), then the king's opportunity set in situation B is "more generous than" it is in situation A (Cox, Friedman, and Sadiraj, 2008, p. 36). If the peasants in KCPR extract less from the common pool in situation B than in situation A ($Z_{-4}^{B} < Z_{-4}^{A}$), then the king's opportunity set in situation B is "more generous than" it is in situation A. Axiom R (Cox, Friedman, and Sadiraj, 2008, p. 40) implies that x_4 will be increasing in X_{-4} and that z_4 will be decreasing in Z_{-4} (or, alternatively, increasing in $120 - Z_{-4}$). The data are (weakly) consistent with this implication of the theory.

A more idiosyncratic prediction of reciprocal preference theory can explain what may, at first, appear to be a puzzling property of the data; kings appropriate more for themselves in the KCPR game than in the KVCM game even though peasant behavior is virtually the same in these two games. On average, as shown in Figure 2 and Result 4, peasants contribute \$15.84 to the public good in KVCM and leave an insignificantly smaller amount \$13.41 in the common pool in KCPR while, as shown in Figure 3, kings take on average \$0.63 in KVCM but take \$18.16 in KCPR. This different behavior by kings in these two games is predicted by Axiom S (Cox, Friedman, and Sadiraj, 2008, p. 41), together with Axiom R, in the theory. In the KVCM game, the endowments are private property, with a zero endowment of the public good, which (if not changed by the peasants) constitutes the *least* generous possible opportunity set for the king. Any contribution to the public good by the peasants creates an opportunity set that is more generous to the king than is the endowed set; and larger contributions yield sets that are more generous to the king than do smaller contributions. In contrast, in the KCPR game the endowment consists entirely of a common pool, with zero endowment of private property, which (if not changed by the peasants) constitutes the *most* generous possible opportunity set for the king. Any extraction from the common pool by the peasants creates an opportunity set that is less generous to the king than is the endowed set; larger extractions yield sets that are less generous to the king than do smaller extractions. Therefore, in the event that peasants contribute an amount to the public good (in KVCM) that is the same as the amount they leave in the common pool (in KCPR), the theory predicts that the king will be less altruistic in KCPR than in KVCM. This is what was observed in our experiment.

Conventional (i.e. non-reciprocal) preferences can explain another property of the data; kings appropriate more for themselves than do bosses in both public good and common pool games. On average, as shown in Figure 2, peasants contribute \$16.44 to the public good in BVCM and \$15.84 in KVCM, two figures that are not significantly different. However, as shown in Figure 3, bosses contribute on average \$10.62 in BVCM whereas kings take on average \$0.63 in KVCM. Conventional convex preferences (Cox, Friedman, and Sadiraj, 2008, pp. 41-45) are consistent with this different behavior by kings and bosses. Bosses can choose a zero or positive amount to contribute in the BVCM game ($0 \le x_4 \le 10$) whereas kings can contribute positive amounts, contribute nothing, or expropriate peasants' contributions ($-\sum_{j=1}^{3} x_j \le 0 \le x_4 \le 10$) in the KVCM game. A boss with selfish or malevolent preferences will be at a corner solution ($x_4 = 0$) in BVCM whereas a king with similar preferences can choose a negative contribution (unless all peasants contribute zero). Similar reasoning can explain the different average choices by bosses and kings in the BCPR and KCPR games.

VI. Concluding Remarks

In this paper we report differences in behavioral outcomes in two types of social dilemmas: public goods and common-pool resources. We examine symmetric games where everyone acts at the same time without knowing what others contribute (or extract) and two types of asymmetric games. In the boss treatment, three players act first and, subsequently, with knowledge of their decisions the fourth player decides how much to contribute or extract. In the king treatment, three players act first, and with knowledge of their decisions, the fourth player decides how much to contribute or take when given the capability of taking everything. While participants do contribute (or refrain from taking) more than predicted in the special-case "economic man" interpretation of game theory in the symmetric condition, average payoffs fall significantly when one player has asymmetric power. The presence of a fourth actor (a "king") who can take the surplus created by others' contributions to the public good or extract surplus left in a common pool by the restraint of others has a strong adverse effect on the total payoff in a game. With a king present, one witnesses outcomes that closely approximate the "tragedy of the commons."

References

Andreoni, James. 1995. "Warm-Glow versus Cold-Prickle: The Effects of Positive and Negative Framing on Cooperation in Experiments." *Quarterly Journal of Economics* 110(1): 1–22.

Ashraf, Nava, Iris Bohnet, and Nikita Piankov. 2006. "Decomposing Trust and Trustworthiness." *Experimental Economics* 9(1):193–208.

Berkes, Fikret, et al. 2006. "Globalization, Roving Bandits, and Marine Resources."*Science* 311(5767):1557–58.

Bolton, G. E. and A. Ockenfels. 2000. "ERC: A Theory of Equity, Reciprocity, and Competition." *American Economic Review* 90(1):166–93.

Bromley, Daniel W. 1989 *Economic Interests and Institutions: The Conceptual Foundations of Public Policy*. Oxford: Blackwell.

Camerer, Colin F. 2003. *Behavioral Game Theory: Experiments in Strategic Interaction*. Princeton, NJ: Princeton University Press.

Camerer, Colin F. and Ernst Fehr. 2006. "When Does 'Economic Man' Dominate Social Behavior?" *Science* 311 (January): 47–52.

Casari, Marco and Charles R. Plott. 2003. "Decentralized Management of Common Property Resources: Experiments with a Centuries-Old Institution." *Journal of Economic Behavior and Organization* 51:217–47.

Charness, Gary and Matthew Rabin. 2002. "Understanding Social Preferences with Simple Tests." *Quarterly Journal of Economics* 117:817–69.

Cox, James C., Daniel Friedman, and Steven Gjerstad. 2007. "A Tractable Model of Reciprocity and Fairness." *Games and Economic Behavior* 59(1):17–45.

Cox, James C., Daniel Friedman, and Vjollca Sadiraj. 2008. "Revealed Altruism." *Econometrica* 76(1):31–69.

Cox, James C. and Daniel T. Hall. 2010. "Trust with Private and Common Property: Effects of Stronger Property Right Entitlements." *Games* 1(4), 2010, 527-550.

Cox, James C., Elinor Ostrom, James M. Walker, et al. 2009. "Trust in Private and Common Property Experiments." *Southern Economic Journal*, 75(4), 957-975.

Cox, James C. and Vjollca Sadiraj. 2007. "On Modeling Voluntary Contributions to Public Goods." *Public Finance Review* 35(2):311–32.

Dietz, Thomas, Elinor Ostrom, and Paul Stern. 2003. "The Struggle to Govern the Commons." *Science* 302(5652):1907–12.

Dolšak, Nives and Elinor Ostrom, eds. 2003.*The Commons in the New Millennium: Challenges and Adaptations.* Cambridge, MA: MIT Press.

Fehr, Ernst and Simon Gächter. 2000. “Cooperation and Punishment in Public Goods Experiments.” *American Economic Review* 90(4):980–94.

Fehr, Ernst, Simon Gächter, and Georg Kirchsteiger. 1997. “Reciprocity as a Contract Enforcement Device.” *Econometrica* 65(4):833–60.

Fehr, Ernst and Klaus Schmidt. 1999. “A Theory of Fairness, Competition, and Cooperation.” *Quarterly Journal of Economics* 114(3):817–68.

Hardin, Garrett. 1968. “The Tragedy of the Commons.” *Science* 162:1243–48.

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

National Research Council. 1986. *Proceedings of the Conference on Common Property Management*. Washington, DC: National Academies Press.

National Research Council. 2002. *The Drama of the Commons*. Committee on the Human Dimensions of Global Change, eds. Elinor Ostrom, Thomas Dietz, NivesDolšak, Paul Stern, Susan Stonich, and Elke Weber. Washington, DC: National Academies Press.

Ostrom, Elinor. 1998. “A Behavioral Approach to the Rational Choice Theory of Collective Action.” *American Political Science Review* 92(1) (March): 1–22.

Ostrom, Elinor. 2009. “Building Trust to Solve Commons Dilemmas: Taking Small Steps to Test an Evolving Theory of Collective Action.” In *Games, Groups, and the Global Go*od, ed. Simon Levin, 207–28. New York: Springer.

Ostrom, Elinor, Roy Gardner, and James M. Walker. 1994. *Rules, Games, and Common-Pool Resources.* Ann Arbor: University of Michigan Press.

Ostrom, Elinor and James Walker, eds. 2003.*Trust and Reciprocity: Interdisciplinary Lessons from Experimental Research.* New York: Russell Sage Foundation.

Ostrom, Elinor, James Walker, and Roy Gardner. 1992. “Covenants With and Without a Sword: Self-Governance is Possible.” *American Political Science Review* 86(1):404–17.

Sell, Jane and Yeongi Son. 1997. “Comparing Public Goods with Common-Pool Resources: Three Experiments,” *Social Psychology Quarterly*, Vol. 60, No. 2 (Jun., 1997), 118-137

Sonnemans, Joep, Arthur Schram, and Theo Offerman. 1998. “Public Good Provision and Public Bad Prevention: The Effect of Framing.” *Journal of Economic Behavior and Organization* 34(1): 143–61.

Walker, James and Elinor Ostrom. 2009. “Trust and Reciprocity as Foundations for Cooperation.” In *Whom Can We Trust? How Groups, Networks, and Institutions Make Trust Possible*, ed. Karen S. Cook, Margaret Levi, and Russell Hardin, 91–124. New York: Russell Sage Foundation.