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

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**Abstract:** Social dilemmas characterize 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 under-provide public goods and over-extract common pool resources. Previous research has not focused on the implications of power asymmetries in paired public good and common pool resource environments. In our baseline treatments, we experiment with *simultaneous move* games in which *paired comparisons* can be made across environments with public goods and common pool resources. In our central treatments, we experiment with *pairs* of *sequential move* 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 resource environments.

## 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 the context in which decision makers interact—including institutional rules and resulting individual and/or group incentives (Camerer 2003; Casari and Plott, 2003; Cox, Ostrom, Walker, et al., 2009; Fehr and Gächter, 2000; Fehr and Schmidt, 1999; Ostrom and Walker, 2003).

The presence of social dilemmas and the degree of predicted suboptimality depend on three components of the decision situation: (1) the existence of domains in which the actions of one individual impart gains or losses on others, such as externalities in production or consumption; (2) modes of behavior in which individuals make decisions based on individual gains rather than group gains or losses; and (3) institutional settings that do or do not create incentives for internalizing group gains or losses into individuals' decision calculus.

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—including inadequate public services, deforestation and destruction of other natural resources, and global warming—are substantial. A careful sorting out of how key underlying factors affect behavior and outcomes is essential to provision of a good foundation for better 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, such field research does not allow for the level of control that would enable 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, size 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 as the core contextual attribute of agent power asymmetry is varied as an experiment treatment.

At a general level, the findings from laboratory experiments are that subjects faced with the public good game and the common pool resource 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, 2007).

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, there has been very little research that examines whether there are important behavioral differences between public good and common pool settings when subjects face the same pecuniary incentives.

## II. Previous Research on Public Goods and Common Pools

The literature on public good and common pool research 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 resource games described below in sections II.A and II.B. As summarized in section II.C., the experiment reported in this paper investigates how creating dilemma situations that incorporate private property or common property endowments interacted with different types of agent power asymmetry may affect behavioral outcomes.

*II.A. Public Good Games*

The most commonly examined form of this game includes N players, who make decisions simultaneously (Isaac, Walker, and Williams, 1994). Each player in a 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 that 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 pecuniary self-interest is to allocate nothing to the group fund.

*II.B. Common Pool Resource Games*

Similar to the public good game, the most commonly examined form of common pool resource game includes N players who make decisions simultaneously (Ostrom, Walker, and Gardner, 1992). In one type of such 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 into 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 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. The commonly accepted conclusion, roughly derived from the "tragedy of the commons" (Hardin, 1968), is that allocation is much less efficient when property rights are defined as *common* property than when they are defined as *private* property. This frequently accepted presumption is, however, a misleading oversimplification and confuses "open access" with "common property." 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, 2007; Walker and Ostrom, 2007).

In previous research (Cox, Ostrom, Walker, et al., 2009), we examined two isomorphic versions of the investment (or trust game) and found that common property endowments lead to marginally greater cooperation or trust than do private property endowments. Subjects more frequently leave the full joint fund untouched in the Common Property Trust Game than they contribute the maximum in the Private Property Trust Game. Second movers respond by returning marginally more to the first movers in the Common Property Trust Game than in the Private Property Trust Game. In terms of overall earnings, however, the Common Property Trust Game leads to only a 5 percent increase over the Private Property Trust Game. The overall results are intriguing since many scholars presume that owners of common property will be less trusting and cooperative than owners of private property.

Building on our previous research, we here report an experiment designed to contrast public good and common pool resource settings with 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 own decision and, in addition, can exercise a sovereign right to appropriate surplus created by others. More specifically, we ask how efficient are 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 ask how efficient are allocations made by voluntary participation in common pool resource maintenance 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 just 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 resource (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 both workers 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 resource 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 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

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 $i$ is

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

*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 chooses an amount to contribute or confiscate $x_4$ from the feasible set $K_{VCM} = \{-\sum_{j=1}^{3} x_j, -\sum_{j=1}^{3} x_j + 1, -\sum_{j=1}^{3} x_j + 2, \cdots, 10\}$.

*III.B. Common Pool Resource Games*

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 subject *i* is

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

*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 $\text{Z} = \{0, 3, 6, \cdots, 30\}$.

*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 to extract $z_4$ from the feasible set $\text{K}_{CPR} = \{0, 3, 6, \cdots, 120 - \sum_{j=1}^{3} z_j\}$.

*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. 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.

## IV. Experiment Results

Experiment sessions were conducted at both Georgia State University and Indiana University. All groups were of size 4. 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.

In the VCM treatment, each individual is endowed with 10 tokens worth $1 each in their Individual Fund. Their decision 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 ¼ 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 their 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 ¼ 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 subgame Nash Equilibrium for the special case of self-regarding 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.

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

| VCM | Boss VCM (BVCM) | King VCM (KVCM) | CPR | Boss CPR (BCPR) | King CPR (KCPR) |
|---|---|---|---|---|---|
| 32<br><br>(8 groups) | 28<br><br>(7 groups) | 76<br><br>(19 groups) | 36<br><br>(9 groups) | 32<br><br>(8 groups) | 76<br><br>(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; and (3) choices by second movers in the four sequential treatment conditions.

*IV.1. Payoffs*

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 (from their private property endowments) in the three public good conditions and not to destroy surplus (contained in their common property endowments) in the three common pool resource 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 average group payoffs across the six treatment conditions.

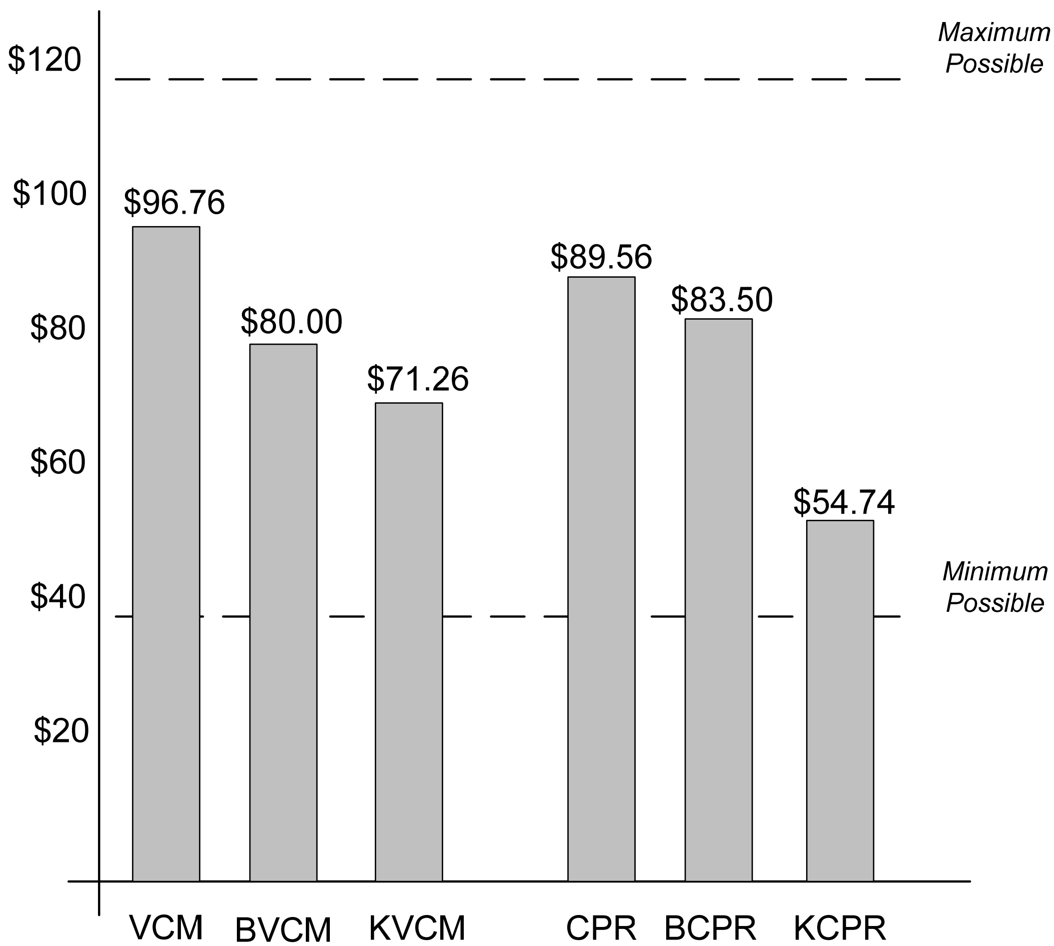


**Figure 1. Average Group Payoff by Treatments**

**Result 1:** Average group payoffs across the two baseline conditions (VCM and CPR) are very similar. Payoffs are well above the minimum predicted by subgame 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 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 Boss VCM and Boss CPR treatments than in the baseline VCM and CPR treatments, and are even lower in the King VCM and King CPR 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:** A Generalized Least Squares (GLS) analysis of total group token allocations to the Group Fund leads to the following summary results related to selective tests of equality, for N=70 Groups: 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.

Payoff differences between treatments in public good settings are significant at 5 percent for VCM vs. BVCM and for VCM vs. KVCM. Payoff differences between treatments in common pool settings are significant at 5 percent for CPR vs. KCPR and for BCPR vs. KCPR. Payoffs are significantly lower for KCPR than for KVCM.

*IV.2. Type X Decisions*

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 settings or dollar amounts left in the Group Fund in common pool settings. In the notation of 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.

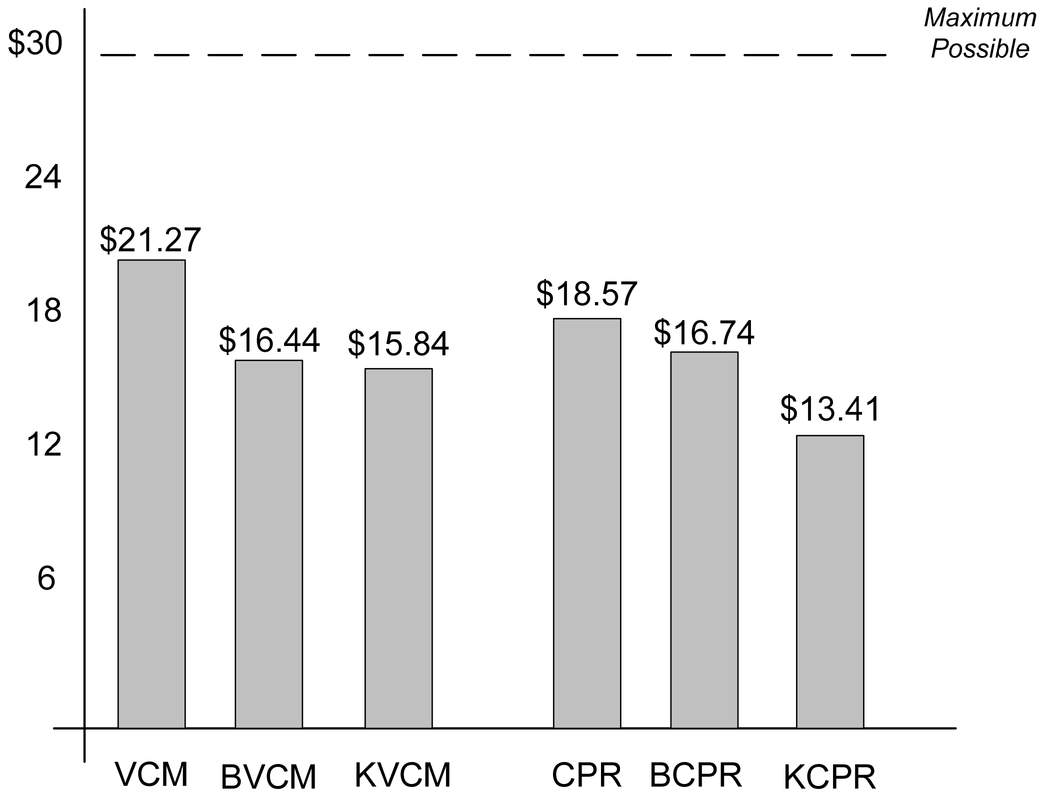


**Figure 2. Average Individual Type X Decisions Represented as $ in Group Fund**

**Result 4:** A Generalized Least Squares (GLS) analysis of Type Y token allocations to the Group Fund leads to the following summary results related to selective tests of equality for the N=227 Type X decision makers: 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.

In the public good setting, first mover (Type X) payoffs are significantly lower for the king treatment (KVCM) than for the baseline treatment (VCM). In the common pool setting, first mover payoffs are significantly lower in the king treatment (KCPR) than in the baseline treatment (CPR).

*IV.3. Type Y Decisions*

The figure below displays the decisions of the second movers (Type Y) for the four treatments with sequential decision making. As above, decisions are represented as average dollar amounts contributed to the Group Fund (VCM setting) or left in the Group Fund (CPR setting). In terms of the notation of section III, the bar graph shows the average value across Type Y subjects of $3x_4$ in public good games and $30 - z_4$ in common pool games.

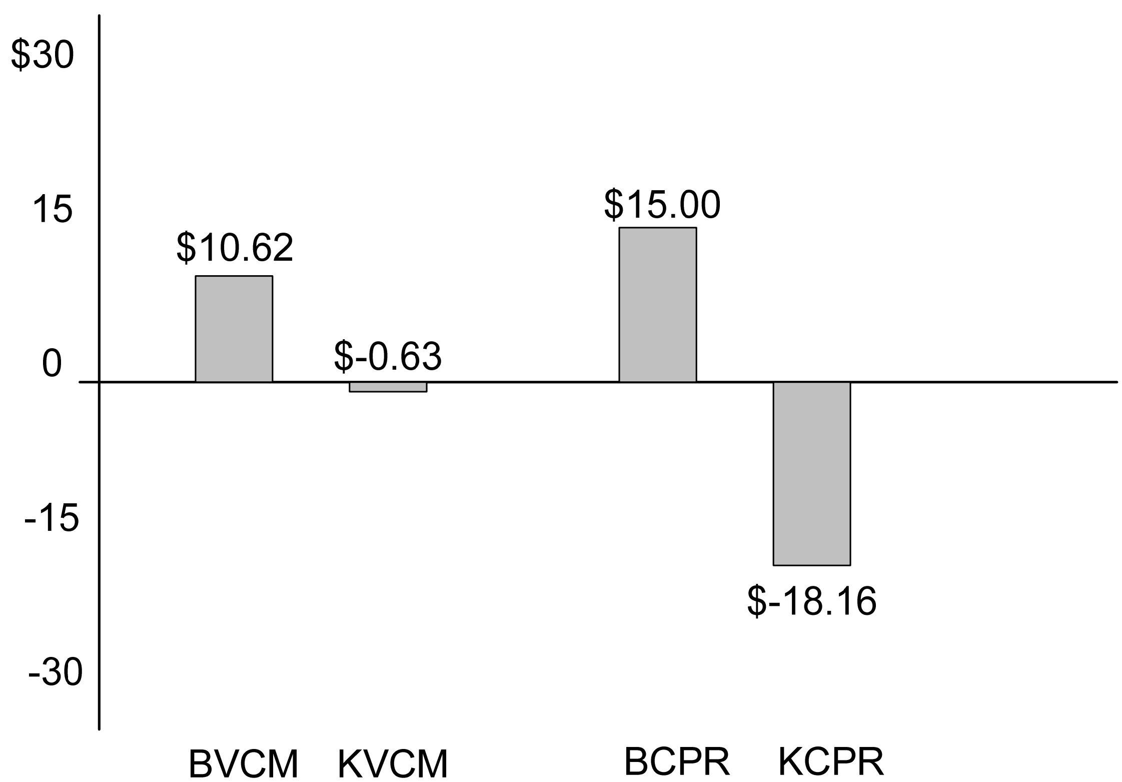


**Figure 3. Average Individual Type Y Decisions Represented as $ in Group Fund**

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

> **Result 5:** A tobit regression of Type Y token allocations to the Group Fund on the total Type X token allocation and treatment and location dummy variables produces the following coefficient estimates. DUMBCPR: 2.71. DUMKCPR: -15.47**. DUMKVCM: -7.25. DUMIU: 5.99. XSUM: -0.29. CONSTANT: 10.99.

Only one coefficient estimate is significant; the coefficient for the dummy variable for the King CPR treatment (i.e., DUMKCPR) is negative and significantly different from 0 at 5 percent. The coefficient for the King VCM treatment (i.e., 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 of amount to contribute or leave.

In summary, the analysis of data from the experiment suggests that the opportunity for second movers to exploit cooperative decisions by first movers: (a) reduces first movers' level of cooperation (and resulting efficiency) significantly; 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 Convex Preferences

Some of the observed differences between games can be modeled with straightforward reinterpretation of recent theory of reciprocal convex 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) 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 convex preference models allows us to apply the theory to the second mover's preferences for her own payoffs and payoffs 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 $30 - Z_{-4}$). The data are (weakly) consistent with this implication of the theory.

A more idiosyncratic prediction of reciprocal convex 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 2, 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 positive contribution to the public good by the peasants creates an opportunity set that is more generous to the king than is the endowed set. 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 nonzero extraction from the common pool by the peasants creates an opportunity set that is less generous to the king than is the endowed set. 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.

Convex preference theory can explain another property of the data: in both games, kings appropriate more for themselves than do bosses. 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. Convex other-regarding preferences (Cox, Friedman, and Sadiraj, 2008, pgs. 41-45) predict this different behavior by kings and bosses. In the KVCM game, the king's feasible set is a southwest expansion of the boss's feasible set; so on average the kings are predicted to return less than bosses.

## VI. Concluding Remarks

In this paper we have reported on the first effort to compare differences in outcomes systematically obtained in two broad types of social dilemmas conducted in experimental laboratories: public goods and common-pool resources. In addition we examined symmetric situations where everyone acted at the same time without knowing what others contributed (or extracted) and two types of asymmetric experiments. In the Boss experiment, three players act first and with knowledge of their decisions, the fourth player decides how much to contribute or extract (if anything). In the King experiment, three players act first, and with knowledge of their decisions, the fourth player decides how much to contribute or extract when given the capability of extracting everything. While participants do contribute (or refrain from extracting) more than predicted in classic game theory in the symmetric condition, average payoffs fall significantly when one player has asymmetric power. The presence of a fourth actor who can extract what is available in a common fund or left in a common pool resource (a King) 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."

**Endnotes**

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