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Abstract. This paper studies the effect of power asymmetry on resolution of social dilemmas in repeated play of linear public good games. The experiment uses a 2X2 design that crosses power symmetry or asymmetry in payoff-equivalent provision and appropriation games with positive (provision) or negative (appropriation) externalities. Power asymmetry combines privileged access to information with extended opportunity sets that allow for taking a public good provided or not-appropriated by others. Our data suggest that power asymmetry has a detrimental effect on efficiency, with the effect being more pronounced in the asymmetric-power appropriation game. Individual allocations to the public good increase in others' allocations, suggesting that individual allocations are not strategic substitutes. With power asymmetry, first movers earn less than the second mover in the appropriation game but not in the provision game.

JEL Codes: C73, C52, H41

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1. Introduction

There is a very large experimental literature on voluntary contributions to public goods with symmetric power and known finite horizon (Ledyard 1995; Chaudhuri 2011). There is also a large literature on symmetric-power, dynamic games of social dilemmas with known, common probability of termination (Dal Bó and Fréchette 2018, Lugovskyy et al. 2017). These papers make important contributions that increase our understanding of public good games with symmetric power.

Some naturally-occurring public goods financed by voluntary contributions are characterized by power asymmetry and incomplete information about the duration of the repeated game. Economically important examples include repeated contributions to religious organizations[1] and repeated, voluntary contributions of union dues in right-to-work states[2]. Many religious organizations have members with power to control contributed resources who can, and some do, take others' contributions for themselves (Bote 2019). Many unions have leaders with power to take for themselves the contributions by ordinary members, and some do (Shannon 2018). Neither voluntary donations by congregants nor voluntary dues contributions to unions are made according to a known finite horizon, nor is there a known, common probability that an individual's participation will come to an end.[3]

Our experimental treatments with payoff-equivalent provision and appropriation games include both symmetric power and asymmetric power in which an informed second mover has an extended opportunity set that allows taking amounts put in or left in the Group Fund by first movers. Our primary research question is the effect of power asymmetry on resolution of social

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[1] Total contributions to religious organizations in the U.S. in 2021 was $135.78 billion (Giving USA 2022), with 67% coming from people who gave money to their local churches (https://balancingeverything.com/church-giving-statistics). While secularly declining, 43 percent of individuals attended church or synagogue 1 – 4 times per month in 2022 (Statista Research Department, June 2, 2023). Repeated attendance is characterized by recurring donations in pledges and irregular amounts placed in collection plates that support religious services for congregants and other ministries. "Not only do recurring donations help churches maintain facilities, staff, and other ongoing needs, but they also make it possible to support their community through ministries" (Donor Box Org).

[2] In a right-to-work state, a worker can join the union and pay dues or not join. In 2022 there were 27 right-to-work states in the U.S. (National Right to Work Legal Defense Foundation). In wage bargaining with an employer, a union with an exclusive representation contract must bargain equally for wages for both members and non-members (https://www.flra.gov/exclusive_representation). This allows workers with this type of job to benefit from the local public good of company-wide negotiated wage increases whether or not they contribute dues.

[3] Individuals or families may stop contributing to a specific religious organization because of family events or socio-economic occurrences with unknown future timing that may require relocation. Similarly, individuals may stop contributing to a specific union because of a new job opportunity, marriage or divorce necessitating relocation with unknown future timing.

dilemmas in repeated play of linear public good games with incomplete information about the horizon.[4] Compared to well-studied power symmetry in simultaneous-move linear public good games, power asymmetry is presented along two dimensions: (i) second movers have an extended opportunity set; and (ii) they know the first movers' choices before making their decisions.[5] In a second contribution to the literature, we explore whether effects of power asymmetry on play depends on the type of game, provision or appropriation. The crossing of the two games with power asymmetry is of particular interest because in the appropriation game the opportunity set of the high-power player expands but the action set remains "take." In contrast, in the provision game the feasible set of the high-power player expands by adding "take" actions to the "give" opportunity set.[6] As a third contribution to the literature, data from our experimental design contribute to an ongoing discussion on whether individual's voluntary allocations to a public good are strategic substitutes, as commonly assumed in the literature (and also predicted by unconditional altruism) or complements that can be consistent with reciprocity (*i.e.*, conditional altruism). Note that, in case of strategic substitutes, the sequential implementation provides more incentives for the first movers to lower their contributions to the Group Fund (or increase their appropriations from the Group Fund) and free ride on the second mover's contribution or appropriation decision. Fourth, our data on earnings are informative on whether, with power asymmetry, there is an advantage to moving first or second, and whether the advantaged player prefers sequential implementation with asymmetric power over symmetric-power, simultaneous implementation.

We find that asymmetric power elicits more free riding and greater appropriations from the Group Fund in the appropriation game, and lower contributions to the Group Fund but similar free-riding in the provision game. In the appropriation game, the rate of full cooperation is twice as

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[4] During the first 10 rounds of central interest, subjects are not informed about the number of rounds. At the beginning of round 11, subjects are informed that round 15 is the last round. Data analysis is based on data for the first 10 rounds (except for footnote reports).

[5] Sonnemans, et al. (1998) reports experiments from finitely repeated step-level public goods/bads games that are payoff equivalent. Early studies testing Varian's (1994) model of simultaneous vs. sequential choice in public good games include Andreoni, et al. (2002) and Gächter, et al. (2010) who report experiments on simultaneous and sequential play in two-player nonlinear public good games with induced, decreasing, selfish best-response functions. None of these papers look at the power asymmetry that combines privileged access to information with extended opportunity sets that allow for taking a public good provided or not-appropriated by others.

[6] List (2007) and Bardsley (2008) add take opportunities to giving scenarios in dictator games. Cox et al. (2013) add take opportunities to one-shot provision and appropriation games. Khadjavi and Lange (2015) add take opportunities in repeated public good games with symmetric power.

high with symmetric power than with power asymmetry. No such doubling is observed in the provision game. Asymmetric power that adds take opportunities in provision games creates less inefficiency than a similar extension of take opportunities in appropriation games. Another finding is that individual's voluntary allocations to a public good are not strategic substitutes, which is inconsistent with a traditional assumption in the literature. In the provision game, second movers' contributions are observed to increase in total contributions of others and first movers' contributions increase with an increase in the previous round total contributions of others. Similarly, in the appropriation game, second movers' appropriations are found to decrease with a decrease in appropriation by others and first movers' appropriations decrease with a decrease in the previous round total appropriation by others. We also find that first movers earn significantly less in appropriation games with power asymmetry than with power symmetry. With power asymmetry, there is an advantage to moving second in the sequential appropriation game but not in the sequential provision game. Finally, both first movers and second movers receive higher payoffs in symmetric power games.

2. Relation to the Literature

Symmetric power in a wide range of provision and appropriation games is well studied. Andreoni (1995) and Khadjavi and Lange (2015) report known-horizon finitely repeated-play experiments with pairs of payoff-equivalent provision and appropriation games with symmetric power. Cox, et al. (2023) report one-shot experiments with pairs of payoff-equivalent, symmetric-power games with endogenous contractions of feasible sets.

Examples of studies that experiment with asymmetric power games include Khadjavi, et al. (2017), Khadjavi and Tjaden (2018), Gächter and Renner (2018) and Mansour et al. (2021). The first paper examines the impact of transparency and punishment on cooperation in the provision of public goods where one player (the official) may embezzle from an existing public good while three others (citizens) can only contribute. Khadjavi and Tjaden (2018) examine an asymmetric public good setting where groups are formed endogenously. Motivated by immigration requirements, Group A (citizens) choose between contributing to the public good or taking. Group B (migrants) are outsiders and do not initially receive benefits from the public good but face minimum contribution requirements to join set by members of Group A. Gächter and Renner (2018) examine four-player public good games with and without a randomly selected leader who makes a contribution to the public good before others (the followers). In Mansour et al. (2021), one of the members of the group is empowered to select funding of a self-serving (inefficient) public good or a fair and efficient (in equilibrium) public good.

To the best of our knowledge, Cox, et al. (2013) was the first paper to report one-shot experiments with pairs of payoff-equivalent provision and appropriation games with symmetric and asymmetric power. That paper reports two distinct asymmetric treatments, the "boss game" and the "king game." A boss moves second, after observing the choices of the first movers, which allows the boss to be a conditional cooperator in a one-shot game if so inclined. A king moves second, after observing the choices of the first movers, but has an expanded opportunity set that allows taking amounts provided or *not* appropriated by first movers. The boss treatment is not included in the repeated game treatments reported in the present paper because it has been previously studied (e.g. Andreoni et al. 2002; Gächter et al. 2010).

3. Power Symmetry and Asymmetry in Our Public Good Games

To control for other-regarding preferences, we focus on payoff equivalent pairs of public good games that consist of a provision game and an appropriation game.

3.1 Symmetric Power Simultaneous-Move Provision Game

The simultaneous-move provision game is a contributions game in which n agents (simultaneously) choose amounts they will contribute from their endowed Individual Funds to a Group Fund that yields a surplus to be shared equally among all group members. Each agent is endowed with e "tokens" in an Individual Fund, that each have value 1, and can choose an amount $g_j \in X = \{0,1,2,\cdots,e\}$ to contribute to the Group Fund. Contributions to the Group Fund create surplus: each "token" added to the Group Fund increases the value of the Group Fund by m, where $n > m > 1$, but it decreases the value of the Individual Fund of the contributor by 1. The monetary payoff to agent i equals the amount of her endowment that is retained in her Individual Fund (i.e. *not* contributed to the Group Fund) plus an equal ($1/n$) share of the value of the Group Fund, which equals m times the total amount, $G = \sum_{j=1..n} g_j$ contributed to the Group Fund by all agents. There is a social dilemma because $n > m > 1$. With notation, $\gamma = m / n$, player i's monetary payoff is

(1) $$\pi_i^p = e - g_i + \gamma G$$

3.2 Asymmetric Power (king) Sequential-Move Provision Game

In the king-provision game, n-1 agents simultaneously move first. Subsequently, the "king" (agent n) observes their choices and then decides how much to contribute or how much to take from the other agents' contributions. Each first mover, $j \in \{1, \cdots, n-1\}$ chooses the number of tokens to contribute $g_j \in X$, from the same feasible set as in the provision game. The king can choose to contribute any number of tokens, up to his endowment *e,* to the Group Fund. Alternatively, the king can choose to take (in integer amounts) any part of the tokens contributed by the n-1 first movers. That is, the king can choose an amount x_N (to take or contribute) from the feasible set $K_{PG} = X \cup \{-G_{-n}, -G_{-n} + 1, \cdots, 0\}$ where $G_{-n} = \sum_{j=1}^{n-1} g_j$.

3.3 Appropriation Games

In the simultaneous-move appropriation game, n agents decide how much to extract from a Group Fund. The n agents are jointly endowed with $E = ne$ tokens in a Group Fund that has value mE. Each agent can choose to extract any amount $z_j \in Z = \{0, 1, 2, \cdots, e\}$ from the Group Fund. Extractions from the Group Fund destroy surplus: each token removed from the Group Fund increases the Individual Fund of the extractor by 1 but reduces the value of the Group Fund by m where, as above, $n > m > 1$. Agents share equally the remaining value of the Group Fund after all extractions. The monetary payoff to player i equals the end value of her Individual Fund plus an equal (1/n) share of the remaining value of the Group Fund after the extractions by all agents. The monetary payoff to player i is:

$$\text{(2)} \qquad \pi_i^a = z_i + \gamma(E - \sum_{j=1..n} z_j)$$

Payoff equivalence of the provision and appropriation games follows from the one-to-one mapping, $g_i = e - z_i$ and specifications (1) and (2):[7]

$$\pi_i^p = e - g_i + \gamma \sum_{j=1..n} g_j = e - (e - z_i) + \gamma \sum_{j=1..n} (e - z_j) = z_i + \gamma(E - \sum_{j=1..n} z_j) = \pi_i^a$$

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[7] In the data analysis, we use $g_i = e - z_i$ the amount left in the Group Fund, as a player's choice in the appropriation game.

One observes that any n-vector of agents' payoffs that is attainable in the provision game is also attainable in the paired appropriation game.

In the king-appropriation game, n-1 agents simultaneously move first. Subsequently, the king observes their choices and then decides how many of the remaining tokens (if any) to extract. Each first mover $j \in \{1, \cdots, n-1\}$ chooses an amount to extract, $z_j \in Z$. The king chooses an amount to extract from the extended set $K_{AG} = Z \cup \{e, \cdots, ne - \sum_{j<n} z_j\}$.

4. Benchmark Predictions

A stylized fact from the previous literature, with one-shot and finitely repeated games, is that positive levels of public good provision are observed in studies of simultaneous linear public good games where full free riding (contributing nothing) is the dominant strategy for players with self-regarding (*homo economicus*) preferences. A common pattern in these games is for cooperation to be sustained across decision rounds but to decline near the end of a known finite horizon. One of the explanations put forward in the literature is altruism.[8] Altruistic players may have a positive demand for the public good [9] but, in the sequential game, they may still free-ride on the second mover to provide the public good. If so, there will be less public good in a Stackelberg (sequential) equilibrium than in a Nash (simultaneous) equilibrium of the public good game (Varian 1994). In the following section, we illustrate this for quasi-linear preferences, commonly assumed in the literature, $u_i(G \mid G_{-i}) = (e - g_i) + f_i(\gamma G) = [e - (G - G_{-i})] + f_i(\gamma G),$ for $G_{-i} = \sum_{j \neq i} g_j$ and some well-behaved concave increasing function $f_i(\cdot)$. For such preferences, the individual demand for the public good does not vary with income (nor with others' contributions).

4.1 Implications of Altruism for Play in the Stage Game

With quasi-linear preferences, let G_i denote player i's demand for the public good and let

[8] Cox and Sadiraj (2007) show that an egocentric other-regarding preferences model can explain all four "stylized facts" (Ledyard 1995) of behavior in linear public good games with symmetric power. Ambrus and Pathtak (2011) provide a model for behavior in repeated public good games with symmetric power that includes both selfish players and players who reciprocate others' contributions. Selfish players influence future contributions of reciprocal players, when sufficiently many rounds remain in the game.

[9] See Appendix A.1 for an example of (altruistic) preferences defined over money payoffs.

$\widehat{G} = \max\{G_i : i = 1, \cdots, n\}$ be the highest demand by any of the players. The interesting scenario is when $\widehat{G} > 0$. Otherwise, every player contributes 0, which is inconsistent with data (even in the last round of a finitely repeated public good game).

Simultaneous game. In the simultaneous game, the equilibrium level of public good provision is $\widehat{G}$. If there is only one player with demand $\widehat{G}$ then in the Nash equilibrium she is the only contributor, and all other players free ride. Otherwise, there are many Nash equilibria, where all players with demand $\widehat{G}$ coordinate in contributing the total amount, $\widehat{G}$.

(King) Sequential game. There can be only two cases: the second mover (player *n*) is or is not one of the highest demand players.

Case 1. Player *n*, the second mover is among the ones with the highest demand for the public good, that is $G_n = \widehat{G}$. Then all first movers free ride and let player *n* contribute $\widehat{G}$. So, compared to the simultaneous game, the number of free riders can only increase but the level of public good provision is the same.

Case 2. Player *n*, the second mover, is not among the players with highest demand, $G_n < \widehat{G}$. We distinguish between two subcases, depending on whether player *n*'s demand for the public good is positive.

2.a. G_n is positive. The equilibrium total public good provision is G_n ($< \widehat{G}$) and all first movers free ride. This is so, because all first movers with less public good demand than *n* get their desired level of the public good and a higher payoff from the Individual Fund. Any first mover with a higher demand than player *n* will also free-ride as any contribution above G_n will be taken by the second mover. So, there will be less public good and (weakly) more free-riding than in the game with symmetric power.

2.b. G_n is not positive. Player *n* will appropriate all there is in the Group Fund, so again, all first movers contribute 0, so does the king, and there is no public good provision. Compared to the simultaneous game we have: (i) less public good (in fact, none) and (ii) all first movers contribute less (actually 0).

Our first set of hypotheses about the power asymmetry effect on behavior is:

H1: Prevalence for free riding by first movers is higher in a king sequential game than in a simultaneous public good game.

H2: Contributors in a simultaneous public good game decrease their contributions when they move first in a king sequential game.

H3: Public good provision is larger in a game with symmetric power than with asymmetric power.

4.2 Implications for Play in the Repeated Game

If full cooperation can be sustained by selfish players, then it will be sustained by altruistic players. So, we look at whether full cooperation can be an equilibrium outcome with selfish players. In infinitely repeated games,[10] allocating the full endowment *e* to the Group Fund in every round can be supported in an equilibrium with trigger strategies if the discount factors, δ_i of all players are sufficiently large: (*) $\delta_i > \frac{1-\gamma}{\gamma(n-1)}$, where γ is the marginal per capita rate of return.

In the sequential game, the condition for defection to be non-profitable for the king is: (**) $\delta_n > n\left(\frac{1-\gamma}{n-1}\right)$.[11] Note that, the threshold for (**) is *m* times the threshold of (*), where $m > 1$ is the multiplier. The larger the multiplier, the higher the cost of not cooperating, the less likely the cooperation emerges in the asymmetric power game. So, if the king's discount factor does not satisfy (**) but all players discount factors satisfy (*) then, with repetition, full cooperation can emerge in the simultaneous game but not in the sequential king game. We have the following hypothesis for infinitely repeated games:

H4: Full cooperation can be sustained with sufficiently patient players but power asymmetry raises the threshold.

[10] For details see Appendix A.2.

[11] No FM would deviate from contributing all of the endowment, *e* because that triggers SM to switch to "take all," so there are no immediate gains. In addition note that, cooperation can happen because $m > 1$ implies $n\left(\frac{1-\gamma}{n-1}\right) = \frac{n}{n-1}\left(\frac{n-m}{n}\right) < 1$.

5. Experimental Design and Protocol

Experiment sessions were conducted at both Georgia State University and Indiana University, Bloomington. In each session, subjects were recruited from subject databases that included undergraduates from a wide range of disciplines. Via the computer, the subjects were privately and anonymously assigned to four-person groups, that remained fixed during the experiment. Subjects were not informed which of the others in the room were 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.[12] In addition, an experimenter reviewed the instructions publicly.

5.1 Experiment Parameters

In the provision game, in each round each individual is endowed with 10 tokens worth 1 experimental currency unit (ECU) each in what is referred to in the experiment as an Individual Fund. The decision task of each individual 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 king-provision game are allowed choices as described above (Section 3.2).

In the appropriation game, each group is endowed with 40 tokens worth 3 ECUs each in their Group Fund. The decision task 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 ECUs and increase the value of the Individual Fund of the decision maker by 1 ECU. 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 king-appropriation game are allowed choices as described above (Section 3.3).[13]

5.2 Repeated Rounds

In all treatments in the experiment, subjects were informed that there would be multiple decision rounds but not the specific number of rounds. Following decision round 10, a public announcement

[12] Complete subject instructions for the experiment are available at http://excen.gsu.edu/jccox/subjects.html. In the instructions for the asymmetric power treatments, first movers were referred to as Type X players and second movers were referred to as Type Y players.

[13] All values reported below are in ECUs. The exchange used to pay subjects was $1 = 10 ECUs.

was made that the experiment would end after 5 more decision rounds.[14] We are primarily interested in how behavior varies across treatments during the first 10 rounds in which there is no known end period. Behavior in the last five rounds is of secondary interest because here there is a known finite horizon that has been extensively studied in previous literature.

This raises the question of whether a relevant model for analyzing data from the first 10 rounds is finite or infinite horizon. Here, we adopt the position of Osborne and Rubinstein (1994, pg. 135). They maintain that "A model with an infinite horizon is appropriate if after each period the players believe that the game will continue for an additional period, while a model with a finite horizon is appropriate if the players clearly perceive a well-defined end period." Our subjects were recruited for 2 hours. Each period took 5 minutes. Hence, it is reasonable to suppose the subjects believed the game would continue for an additional period during each of the first 10 periods. There are many equilibria of games with infinite horizon. Equilibria of the stage games are included, hence the above hypotheses H1 – H3 are relevant to analyzing data from the experiment. Other relevant hypotheses come from analysis of predictions of full cooperation vs. defection with an infinite horizon, as in hypothesis H4.

Between rounds, subjects had access to a history table that displayed the decisions by each group member for all prior rounds, with each subject's decision identified by an ID letter that remained the same across rounds. In the repeated king-provision game and repeated king-appropriation game treatments, a second mover (king) was informed of choices by the first movers in a round before making their own choice in that round. The experiments were conducted using a double anonymous (or double blind) payoff protocol.[15]

6. Experiment Results

<u>*6.1 Total Group Fund Allocations*</u>

In all four treatment conditions, the efficient allocation is for the group to allocate all tokens to the Group Fund, resulting in a payment of 120 to the group. Table 1 presents summary results for the four treatment conditions for the first 10 rounds of primary interest. Average group fund values in

[14] Lugovskyy et al. (2018) examines a public good setting where groups are fixed within stages but randomly rematched at the end of each stage. The length of each stage of the game is known with certainty or determined probabilistically (with a known probability). They do *not* find consistent evidence that overall cooperation rates are affected by whether the number of decision rounds is known or determined probabilistically.

[15] Each subject used a mailbox key to collect their payoff envelope in private. Mailbox key numbers that were subjects' private information were the only way subjects' responses were identified.

implementations with asymmetric power are well below the ones observed in symmetric power implementations: 79 (provision) and down to 69 (king-provision); and also down from 78 (appropriation) to 43 (king-appropriation).[16]

Table 1. Summary Results for Repeated Game Settings (Rounds 1 to 10)*

	Provision		Appropriation	
Power	**Symmetric**	**Asymmetric**	**Symmetric**	**Asymmetric**
Group Level				
Average Group Fund Value	78.86	69.01	78.26	43.35
Median Group Fund Value	82.5	67.5	82.5	30
Individual Level				
Full Allocations (g=10)	44%		50%	
First Movers (g=10)		38%		27%
Second Movers (g=10)		49%		22%
Free ride (g = 0)	13%		20%	
First Movers (g = 0)		11%		35%
Second Movers (g<=0)		15%		49%
Nr of Groups (Individuals)	15 (60)	17 (68)	16 (64)	16 (64)

*Maximum possible Group Fund Value = 120; g is individual contribution (provision game) or tokens left (the appropriation game) in the Group Fund.

Figure 1 presents Group Fund allocations in the first 10 rounds with unknown horizon (as well as the final 5 rounds with known horizon). Observations in each round are pooled within treatments. The patterns, visible in Figure 1, are persistent across the first 10 rounds, and robust across types of (provision or appropriation) games. Figure 1 suggests some learning taking place (in early rounds) and the usual negative end-game effects in the last two rounds of the known-horizon part of the experiment. Ignoring early (two) rounds and the late (three) rounds, with symmetric power (top solid lines), public good value levels seem to stabilize around 82 (provision) and 78 (appropriation). With asymmetric power (bottom dotted lines), these levels decrease to 70 (king-provision) and 42 (king-appropriation).

[16] These figures for the last 5 rounds are: 78 (provision), 62 (king-provision), 74 (appropriation) and 30 (king-appropriation).

A more formal statistical analysis supports these visual patterns. Table 2 presents the results from an OLS regression analysis with period 1-10 data that incorporates dummy variables for power asymmetry and game form, with the simultaneous provision game serving as the

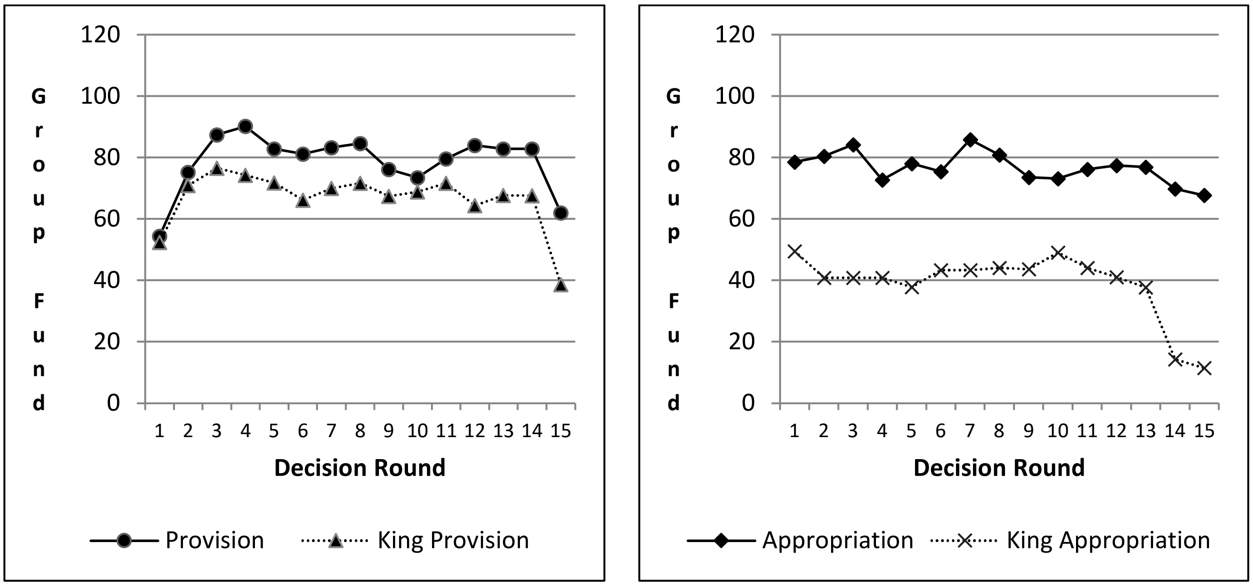


Figure 1. Group Fund Values across Decision Rounds: Group Level

baseline treatment condition. The average Group Fund Values in all treatments are statistically greater than 0 but below full cooperation (120). Consistent with hypothesis H3, the estimated effects of asymmetric power on the amount of the public good are negative: -9.84 (p-value=0.003) in the king-provision treatment and are even lower, at -34.91 (-35.51 - (-0.60); (p-value<0.001) in the king-appropriation treatment.[17] The king-appropriation treatment yields less public good than the king-provision treatment.[18]

Our first result is consistent with findings in previous literature whereas the second result provides support for hypothesis H3.

Result 1: Across decision rounds, average Group Fund allocations are well above the minimum allocation of 0, but also well below the maximum allocation of 120.

[17] For the last five rounds data the estimated coefficients are: -16.23** (king-provision), -4.74 (appropriation), -48.54*** (king-appropriation).
[18] -35.51 is statistically smaller than -9.84 (Wald test, p-value < 0.01).

Result 2: Average Group Fund allocations in games with asymmetric power are smaller than in the symmetric power treatments. Furthermore, the king-appropriation treatment yields less public good than the king-provision treatment.

The results presented above represent treatment average public good levels across rounds, which in the case of asymmetric power treatments is a function of decisions by both first movers and second movers within groups.

Table 2. OLS Regression Analysis of Aggregate Data (Rounds 1 to 10)

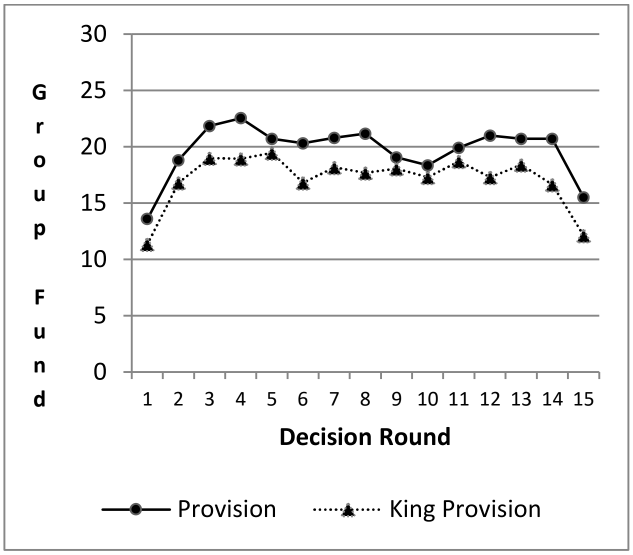
Dep. Var: Average Group Fund Values within each period	(1)	(2)
King-Provision	-9.84***	-9.84***
	(3.006)	(3.043)
Appropriation	-0.60	-0.60
	(3.006)	(3.043)
King-Appropriation	-35.51***	-35.51***
	(3.006)	(3.043)
Periods 1 to 5		-0.75
		(2.152)
Constant	78.86***	79.23***
	(2.126)	(2.406)
Observations	40	40
R-squared	0.836	0.837

The unit of observation is the average Group Fund Value of all groups who participated in each treatment taken at every period. Y_{it}=average(3G(j,t): of all group j in Treatment i at period t}. Baseline is the Provision game. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

6.2 First and Second Mover Decisions

The analysis presented in this section explores the decisions of first and second movers. Figure 2 presents across rounds (group average) data for first movers in all 4 treatment conditions in all 15 periods.

First Mover Choices. There are three first mover subjects in games with asymmetric power and four subjects in symmetric-power (simultaneous) games. We use data for first movers in asymmetric power treatments and all symmetric-power treatment subjects to get group *average* allocations in the Group Fund. Recall that a fully cooperative choice would imply a Group Fund value allocation of 30 per person. Consistent with hypothesis H2, average allocations in the first 10 rounds in the king treatments appear consistently below the ones in the symmetric power treatments, in particular in the appropriation treatment (see Figure 2). Given the low level of Group Fund allocation values in the king-appropriation treatment, it is important to note that this behavior occurred even though Group Fund allocation values by first movers in



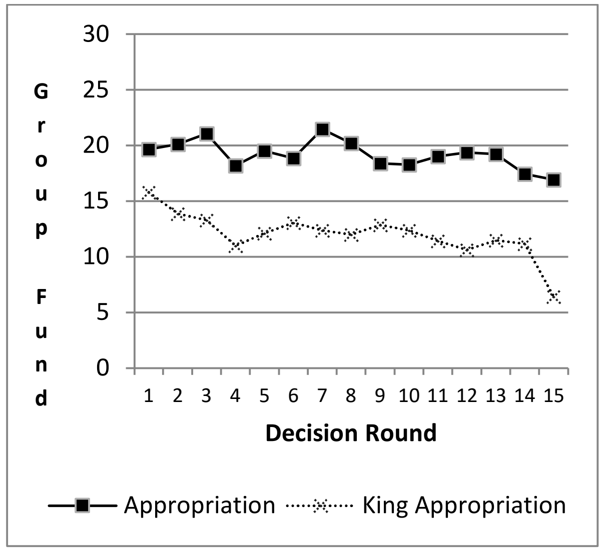


Figure 2: Average First Mover Allocation Values

this treatment begin in period 1 (15.8 tokens) at higher levels than in provision (13.6 tokens) and king-provision (11.3 tokens) treatments. Furthermore, in king-provision, first movers allocated a total of 0 tokens to the Group Fund in only 2 of 170 group observations in the first 10 rounds. In contrast, in king-appropriation first movers' appropriation left 0 tokens in the Group Fund in 23 of 160 cases.[19] The fraction of first movers free-riding in king-appropriation treatment is 35% (Table 1, g=0 rows), up from 20% in the symmetric power appropriation treatment.[20]

To estimate treatment effects on free riding behavior we adopt a probit regression (Table 3, first three columns) whereas for treatment effects on positive allocations we use generalized least-squares estimators (Table 3, last three columns).

In all specifications we have dummies for each treatment, for each round and a dummy for location (GSU). In model specifications (2) and (3), in the list of regressors we add the rate of free

[19] For data from the last five rounds these figures are: 4 (out of a total of 85 group observations) in king-provision treatment and 23 (out of 80) in king-appropriation treatment.
[20] For the last five rounds data, these free-riding fractions are: 50% (king-appropriation) and 27% (appropriation).

riders or total allocations of others in the previous round, respectively. Examining first the probit regressions, in the appropriation treatments we observe an increase in free riding with the power asymmetry in king-appropriation.[21] In the provision treatments (first row), however, free riding is similar in symmetric and asymmetric power (king) treatments.

Table 3. Treatments Effects at Intensive and Extensive Margins: First Movers' Allocation Choices in treatments with Asymmetric Power and all Allocation Choices in treatments with Symmetric Power (Rounds 1 to 10)

	Random Effects Probit Regression[a] **Dep. Var:** Full Free Riding (1 if g= 0; 0 if g > 0)			**Random-Effects GLS Reg.**[b] **Dep. Var:** Positive Allocations		
	(1)	(2)	(3)	(1)	(2)	(3)
King-Provision	0.06	0.07	-0.10	-1.01**	-1.03**	-0.79*
	(0.266)	(0.230)	(0.270)	(0.502)	(0.498)	(0.424)
King-Appropriation	1.27***	0.76***	0.81***	-0.89*	-0.92*	-0.559
	(0.279)	(0.236)	(0.284)	(0.532)	(0.554)	(0.481)
Appropriation	0.49*	0.39*	0.55**	0.44	0.36	0.22
	(0.267)	(0.231)	(0.272)	(0.436)	(0.438)	(0.400)
Free Rider Rate (t-1		1.83***			- 2.47***	
		(0.246)			(0.434)	
Others G (t-1)			-0.05**			0.10***
			(0.008)			(0.0118)
GSU	0.61***	0.46***	0.60***	0.12	0.30	0.24
	(0.183)	(0.153)	(0.182)	(0.356)	(0.367)	(0.321)
Observations	2,230	2,007	2,007	1,800	1,618	1,618
Number of clusters	223	223	223	214	214	214

[a] Includes all allocation choices in symmetric power treatments and First Mover allocation choices in asymmetric power treatments. [b] Includes only positive allocation choices in symmetric power treatments and First Mover positive allocation choices in asymmetric power treatments. Number of observations in columns (2) and (3) do not include round 1 data. Omitted Category is the Provision game. Others G(t-1) is total of others' group fund allocation in the previous period. Model specification in each column includes Indicators for each round and an indicator for experiments in GSU. Robust standard errors (clustered at subject level) in parentheses.*** $p<0.01$,** $p<0.05$,* $p<0.1$

[21] 1.27 (0.76) is statistically larger than 0.49 (0.39) at 1% (10%) significance level; 0.81 and 0.55 are not statistically different (p-value=0.284)

Our data from appropriation games are consistent with hypothesis H1. We conclude that:

Result 3: Power asymmetry elicits more free riding by first movers in the king-appropriation treatment than in the symmetric power appropriation treatment.

Turning to the GLS specifications, in terms of first movers' positive allocations our data suggest a negative effect of power asymmetry, which is robust to game form: -0.79 (p-value= 0.062, king-provision), and the null hypothesis that the estimated coefficients of king-appropriation (-0.56) and appropriation (0.22) are equal is rejected at 10% significance level (chi2=2.47, one-sided p-value= 0.058). We have the following result that is consistent with hypothesis H2.

Result 4: Power asymmetry induces lower positive allocations to the public good by first movers in the provision game.

We observe that the greater the free riding in the previous round, the lower are public good allocations in the current round and the greater the public good allocation by others in the previous round, the higher are allocations in the current round, suggesting increasing best response functions if previous allocations by others serve as a proxy for others' current allocations. It should be noted that increasing best response functions are consistent with (sufficient) reciprocal behavior but not with conventional unconditional altruism (see Appendix A.1) or the conventional assumption in the literature that treats individual's public good allocations as strategic substitutes (Bergstrom, Blume, and Varian 1986). Second movers' choices are more informative on this issue as kings do observe others' total allocations to the Group Fund in the same round.

Second Mover Choices. Figure 3 presents across round data for second movers in asymmetric power treatments for all 15 rounds. Recall that a fully cooperative choice by second

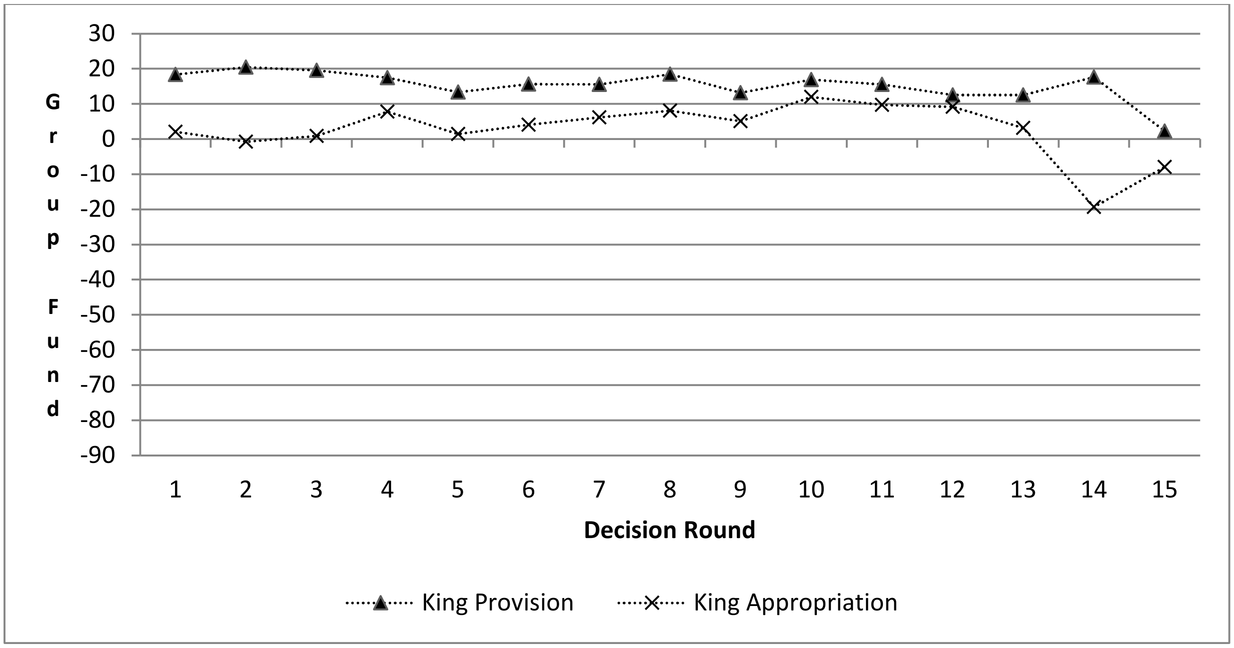


Figure 3: Average Second Mover Allocation Values: King-Provision and King-Appropriation

movers (SMs) would imply a Group Fund allocation with value 30, and negative values correspond to taking from the Group Fund created (or left) by first movers. Table 4 reports results of a data analysis for rounds 1-10, similar to Table 3, but for SM behavior. Positive Group Fund allocations by SMs in the king-provision treatment increase with the FMs' total Group Fund allocations, 0.18 (p-value<0.01) and are similar to the king-appropriation treatment, -0.20 (p-value=0.78). Absent reciprocity, contributions are strategic substitutes, so if first movers (FMs) decrease their allocations to the Group Fund then our (altruistic) SMs should increase theirs. The implication for (sufficient) reciprocal behavior is the opposite (see Appendix A.1).

Table 4. Treatments Effects at Intensive and Extensive Margins: Second Movers' Allocation Choices (Rounds 1 to 10)

	Random Effects Probit Regression[a] **Dep. Var:** Full Free Riding (1 if g<=0, 0 if g > 0)			**Random-Effects GLS Regression**[b] **Dep. Var:** SM's Positive Allocations		
	(1)	(2)	(3)	(1)	(2)	(3)
King-Appropriation	1.44***	1.03**	1.13***	-0.33	0.14	-0.20
	(0.501)	(0.475)	(0.393)	(0.994)	(0.899)	(0.719)

(FM) Free Rider Rate		1.54***			-3.32***	
		(0.455)			(0.973)	
(FM) Others G			-0.07***			0.18***
			(0.017)			(0.032)
GSU	-0.09	-0.24	-0.23	0.37	0.74	0.74
	(0.479)	(0.423)	(0.379)	(1.024)	(0.962)	(0.772)
Observations	330	330	330	225	225	225
Number of ID	33	33	33	30	30	30

[a] Includes all second mover allocation choices in asymmetric power treatments. [b] Includes only second mover's positive allocation choices in asymmetric power treatments. Omitted Category is King-Provision game. FM represents first mover decisions. Others G represents total of others' group fund allocation in the current period. Model specification in each column includes Indicators for each round. Robust standard errors (clustered at subject level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1

We have the following result.

Result 5: Second mover positive allocations increase with respect to first movers' allocations.

Further analysis of second mover choices within king-appropriation and king-provision treatments yields additional insight into how behavior varied across the two game forms. Figure 4 displays the percentage of second movers, within each game form and across all 15 decision rounds, who made positive allocations to the Group Fund.

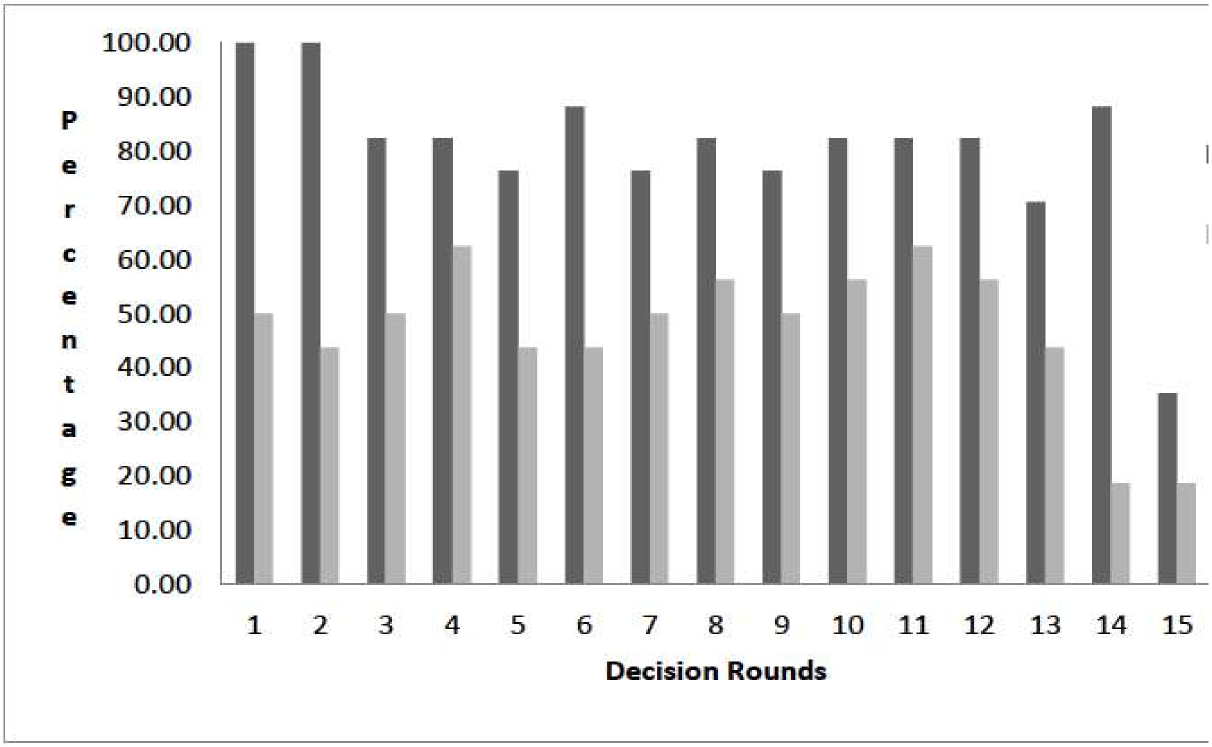


**Figure 4: Percentage of Positive Second Mover Group Fund Allocations:
King Provision (Black) and King Appropriation (Grey)**

For comparison to FM data analysis in Table 4 we report probit estimates for periods 1 – 10 for "free riding" denoted by a dummy variable equal to 1 if SMs did not add to the Group Fund. As with first movers, king-appropriation elicits more free riding behavior by second movers, 1.13 (p-value =0.004) than king-provision. Stating this in terms of non-free riding behavior, we have the following result.

<u>Result 6:</u> The percentage of positive Group Fund allocations of second movers in the king-appropriation treatment is well below that in the king-provision treatment.

Second Mover Take Behavior. The opportunity for a specific second mover to remove tokens allocated by first movers in a given decision round depends on the decisions of the first movers with whom that second mover is matched. Further investigation of second movers' behavior in rounds 1-10 of games with asymmetric power is revealing. In the king-provision treatment there were 168 choices (out of 170) in which first movers made positive allocations to the Group Fund. In these 168 cases, second movers chose to remove tokens from the Group Fund in 14 instances (8%). When they removed tokens, they removed on average 79% of the tokens. In contrast, in the king-appropriation treatment there were 137 choices (out of 160) in which first movers left tokens in the Group Fund. In these 137 cases, second movers chose to remove tokens from the Group Fund in 45 instances (33%). When they removed tokens, they extracted on average 75% of the tokens. While it is awkward to classify "taking less" as an altruistic behavior, it is nevertheless an indicator of decreased selfishness.

Result 7: Limiting the analysis to rounds in which second movers removed Group Fund token allocations of first movers, there is little difference in the average level of removal between king appropriation and king provision treatments. However, second movers removed tokens at a much higher frequency in king appropriation than in king provision.

6.3 Full Contributions across Treatments

For the parameters used in our experiment, full cooperation can be sustained with selfish players in the repeated symmetric power games if individual discount rates exceed 1/9 whereas with asymmetric power one needs the second mover's discount rate to exceed 1/3, which is three times as high as the threshold in the symmetric-power game. Neither threshold is particularly high, so it is not surprising we see significant cooperation in our experiment.

Overall, the percentages of almost full contributions (9 or 10) are: 53.12% (Appropriation), 49% (Provision), and down to 43.38% (King Provision) and 27.81% (King Appropriation).[22] Compared to king-appropriation, the odds of almost full cooperation are about 3.1 times higher (p-value=0.035) in king-provision, 5.4 times higher (p-value=0.002) in provision, and 7.9 times higher (p-value<0.001) in appropriation.[23]

Result 8. Across treatments, the odds of almost-full cooperation are ordered: Appropriation > Provision > King Provision > King Appropriation.

A closer look at SMs' choices indicates a pronounced game effect with 22.5% and 51% of SMs' Group Fund allocations were almost full (9 or 10 tokens), respectively, in the king-appropriation and king-provision treatments. Similarly, these figures for FMs were 29.6% and 40.8% in king-appropriation and king-provision. In simultaneous games, on the other hand,

[22] Refer to Table 1 for figures on full contributions, that is g=10.
[23] Random effects logistic regression with standard errors clustered at subject level.

percentages of almost full Group Fund allocations are double in the appropriation treatment (53%) but similar in the provision treatment (49%).

6.4 Further Analysis across Periods

Recall that our experimental environment called for initially informing the subjects that there would be multiple decision rounds but not telling them how many rounds. After decisions were entered by the subjects in round 10, a public announcement was made that there would be five more decision rounds, after which the experiment would end. In this section, we focus on decision making in rounds 1, 10, and 15. In round 1, subjects had no prior history of decisions by other group members. Round 10 is the final round in which there was an unknown number of future rounds. Round 15 was the known final round.

The top panel of Figure 5 displays the average Group Fund allocation values for first movers in each of the four treatment conditions for rounds 1, 10, and 15, while the bottom panel displays the average Group Fund allocation values for second movers in the two king treatment conditions.

In round 1, the second movers, on average, allocated much more to the Group Fund in king-provision (18.4) than in king-appropriation (2.1).[24] The first movers behaved quite differently; on average they allocated less to the Group Fund in king-provision (11.4) than in king-appropriation (15.8).[25] By round 10, the first movers and second movers were more coordinated. In round 10, first movers allocated on average about five dollars more to the Group Fund in king-provision (17.3) than in king-appropriation (12.4). Similarly, in round 10 second movers' average

[24] z = -2.08 (p-value=0.037, Mann-Whitney test). The difference between distributions of allocation values is significant at 5% according to Kolmogorov-Smirnov test (D=0.50, two-sided p-value=0.032, N=33). P-value reported by Epps-Singleton is 0.137.

[25] The difference between distributions is significant at 5% according to Kolmogorov-Smirnov test (D= - 0.504, two-sided p-value=0.031, N=33, i.e., one observation per group). P-value reported by Epps-Singleton is 0.05.

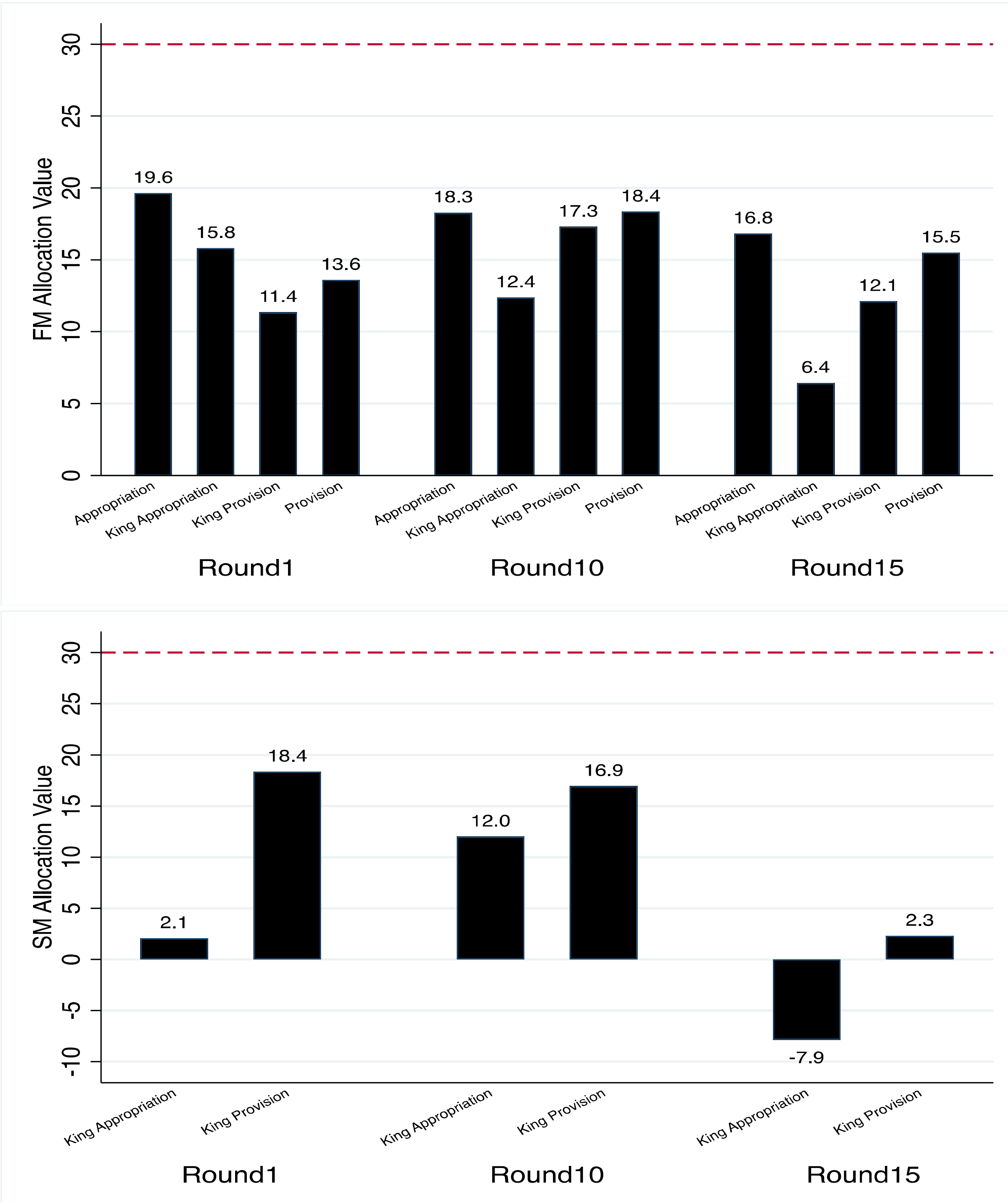


Figure 5: Average First and Second Mover Group Fund Allocations

allocation to the Group Fund was about five dollars higher in king-provision (16.9) than in king-appropriation (12.00).[26] In contrast, in the (announced) last round 15, first movers increased the value of the Group Fund on average by almost twice as much in king-provision (12.1) than in king-appropriation (6.4). The last round effect on second movers is even more pronounced: their average contributed values were only 2.3 in king-provision and they decreased the Group Fund value by about 7.9 (by *taking* from the first movers' allocations left to the Group Fund) in king-appropriation. We observe that behavior is quite different in the *known* final round (15) than in the last round with unknown horizon (10), especially for second movers.

6.5 Treatment Effects on Earnings

There is previous research (cited above) that focuses on the effects of simultaneous and sequential games on payoffs of players. We ask whether, in the first 10 periods, players who moved first in the sequential game earned more than in the simultaneous game, and how their earnings compare to the second movers' earnings.[27] Average individual earnings (in ECUs) of all subjects in simultaneous games is 231 (s.d. 48.09) whereas in treatments with power asymmetry, average earnings of both types are lower: 190.8 (s.d. 67.08) for first movers (FM) and 204.8 (s.d. 58.8) for second movers (SM).[28]

For statistical inference, we use linear regression with total earnings (over the first 10 rounds) of subjects as the dependent variable (Table 5). Comparing earnings in simultaneous symmetric-power games with earnings in power asymmetry games (left panel), first movers on average earn about 17 less in king-provision and 65 less in king-appropriation. In games with power asymmetry (right panel), average earnings of SMs and FMs are similar in king-provision but SMs earn about 27 more in king-appropriation.

Result 9. With power asymmetry, first movers earn less than the second mover in the appropriation game but not in the provision game.

[26] z = -1.77 (p-value=0.078 for SM) but distributions are not different according to Kolmogorov-Smirnov test: p-values are 0.197 and 0.302, resp., for average group contributions of FMs and SMs. Epps-Singleton test: p-values are 0.298 and 0.228.

[27] We report earnings in ECUs to maintain consistency with the unit of account used elsewhere in the paper; the earnings figures in U.S. dollars are 1/10 these amounts.

[28] The median figures are: 235 (simultaneous games), 193 (FM in king treatments) and 184 (SM in king treatments).

Table 5. Total Earnings Linear Regression (Rounds 1 to 10)

Dep. Var: Individual Total Earnings (in the first 10 rounds)	**All Data from Symmetric Power and FM Data from Asymmetric Power**		**All Data from Asymmetric Power**	
	Provision	**Appropriation**	**King Provision**	**King Appropriation**
Power Asymmetry Games	-16.69 (18.02)	-65*** (18.45)		
Second Mover			1.471 (7.622)	27.25** (9.433)
GSU	20.97 (18.71)	-42.28** (17.07)	29.10 (26.35)	-40.62 (31.50)
Constant	220.3*** (19.57)	251.6*** (11.28)	199.3*** (22.56)	185.8*** (24.17)
Observations	111	112	68	64
Nr of clusters	32	32	17	16

The unit of observation is individual total payoff in all first 10 rounds. Omitted Category in the first two columns is the symmetric power game and in the last two columns is FMs' earnings. FM represents first mover decisions. Robust standard errors (clustered at group level) in parentheses; *** p<0.01, ** p<0.05, * p<0.1

7. Concluding Comments

In the naturally occurring world of social dilemmas, it is not unusual to observe repeated settings with asymmetric power among the group of participants. An economically important American repeated-play provision game – contributions to religious organizations – is characterized by asymmetric power, as is the voluntary union dues game in right-to-work states.

We report experiments with power symmetry and asymmetry in repeated payoff-equivalent provision and appropriation games. Subjects made choices in ten rounds with unknown horizon followed by five rounds with a conventional known end period. All rounds were paid using a double anonymous (or double blind) protocol. In the asymmetric-power, king-provision and king-appropriation games, three first movers make their decisions first, and with knowledge of their decisions, the second mover (king) decides how much to contribute or take when given the capability of taking everything. In the symmetric-power provision and appropriation games, all players make choices at the same time without knowing what others contribute or extract in that decision round.

Data from the first ten rounds of central interest in our experiment support several conclusions about behavioral play in these games. Average public good allocations in games with asymmetric power are smaller than in the symmetric power games. The asymmetric-power, king-appropriation treatment yields lower public good than the asymmetric-power, king-provision treatment, and less cooperative behavior from both first movers and second movers. Consistent with previous literature, across decision rounds, public good allocations are well above the minimum allocation of zero but also well below the efficient allocation of all endowments.

Individual contributions are inconsistent with the implications of unconditional altruistic preferences. Data are also inconsistent with a common assumption in the literature that individual's public good allocations are strategic substitutes; instead, we find that first mover's allocations are increasing in others' total allocations in the previous round. Second movers' public good allocations are also increasing in total allocation of others. Both results can be explained by behavior that is sufficiently reciprocal. In terms of average earnings per subject, playing the simultaneous games is preferred to being a first mover in an asymmetric-power game. In the latter, empirically there is an earnings advantage in moving second in the asymmetric-power appropriation game but not in the asymmetric-power provision game.

Negative externalities from appropriation decisions interact with power symmetry or asymmetry to elicit mirror-image patterns of extreme behavior (see Table 1). Seventy percent of decisions are either full Group Fund allocation (50%) or full free riding (20%) in the symmetric-power, appropriation treatment. However, in the king-appropriation treatment we observe second movers choosing full Group Fund allocation (22%) or full free riding (49%). In the provision games, the rates are: (a) full free riding at 13% in the provision treatment and 15% of kings' choices in the king provision treatment; and (b) full Group Fund allocation at 44% in the provision treatment but higher at 49% of kings' choices in the king-provision treatment.

The focus of this study is one in which the asymmetric power comes in the form of opportunity to take resources (money) voluntarily contributed by others or to take from funds endowed to the Group Account not appropriated by others. Our study indicates the asymmetric take opportunity can be expected to create larger inefficiencies in appropriation games than in provision games. These results suggest the need for greater oversight in appropriation settings.

More broadly, the results of this study suggest the need for finding institutional changes that reduce asymmetry in power – that enables the taking behavior by some – which lowers total public good allocations by all.

References

Ambrus, Attila and Parag Pathak. 2011. "Cooperation over finite horizons: A theory and experiments." Journal of Public Economics, 95, 500-512.

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), 2-20.

Andreoni, James, P.M. Brown, and Lise Vesterlund. 2002. "What makes an allocation fair? Some experimental evidence." *Games and Economic Behavior* 40, 1-24.

Bardsley, Nicholas. "Dictator Game Giving: Altruism or Artefact?" *Experimental Economics* 11, no. 2 (2008): 122-133.

Bergstrom, Theodore C., Lawrence E. Blume, and Hal R. Varian. 1986. "On the Private provision of Public Goods." *Journal of Public Economics* 29, 25-49.

Bote, Joshua. "Fraud, private jets and a Lamborghini: 10 televangelists who have faced controversy". USA TODAY, June 18, 2019. https://www.usatoday.com/story/news/nation/2019/06/17/joel-osteen-kenneth-copeland-10-televangelists-trouble/1471926001/

Chaudhuri, A, 2011. Sustaining Cooperation in Laboratory Public Goods Experiments: A Selective Survey of the Literature. Experimental Economics 14, 47 – 83. https://doi.org/10.1007/s10683-010-9257-1

Cox, James C., Elinor Ostrom, Vjollca Sadiraj, and James Walker. 2013. "Provision versus Appropriation in Symmetric and Asymmetric Social Dilemmas." *Southern Economic Journal* 79(3), 496-512.

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

Cox, James C., Vjollca Sadiraj and Susan Xu Tang. 2023. "Morally Monotonic Choice in Public Good games," *Experimental Economics,* 26, 697 - 725. https://link.springer.com/article/10.1007/s10683-022-09787-2

Dal Bó, P. and G. Fréchette, 2018. "On the Determinants of Cooperation in Infinitely Repeated Games: A Survey," *Journal of Economic Literature* 56, 60-114.

Donor Box Org: https://donorbox.org/nonprofit-blog/recurring-giving-churches

Gächter, Simon & Nosenzo, Daniele & Renner, Elke & Sefton, Martin. 2010. "Sequential vs. simultaneous contributions to public goods: Experimental evidence," *Journal of Public Economics* 94, 515-522.

Gächter, Simon and Elke Renner. 2018. "Leaders as role models and 'belief managers' in social dilemmas," Journal of Economic Behavior and Organization, 154, 321-334.

Giving USA 2022: The Annual Report on Philanthropy for the Year 2021, a publication of Giving USA Foundation, 2022, researched and written by the Indiana University Lilly Family School of Philanthropy.

Khadjavi, Menusch and Andreas Lange. 2015. "Doing Good or Doing Harm: Experimental Evidence on Giving and Taking in Public Good games." *Experimental Economics* 18, 432–441.

Khadjavi, Menusch, Andreas Lange, and Andreas Nicklisch. 2017. "How transparency may corrupt − experimental evidence from asymmetric public goods games," *Journal of Economic Behavior & Organization*, 142, 468-481.

Khadjavi and Tjaden. 2018. "Setting the bar - an experimental investigation of immigration requirements," *Journal of Public Economics, 165,* 160-169.

List, John A. "On the Interpretation of Giving in Dictator Games." *Journal of Political Economy* 115, no. 3 (2007): 482-493.

National Right to Work Legal Defense Foundation: https://www.nrtw.org/right-to-work-states/

Osborne, M.J. and A. Rubinstein, 1994. *A Course in Game Theory*. Massachusetts Institute of Technology, 1994.

Ledyard, J.O., 1995. Public Goods: A Survey of Experimental Research. Ch. 2 in *The Handbook of Experimental Economics*, J.H. Kagel & A.E. Roth (eds.). Princeton University Press, Princeton, N.J. Https://doi.org/10.1021/ed024p574

Lugovskyy, V., D. Puzzello, A.Sorensen, J. Walker and A. Williams, 2017. "An Experimental Study of Finitely and Infinitely Repeated Linear Public Goods Games." *Games and Economic Behavior* 102, 286-302.

Mansour, S., Wallace, S., Sadiraj, V. and M. Hassan, 2021. "How do Electoral and Voice Accountability Affect Corruption? Experimental Evidence from Egypt." *European Journal of Political Economy* 68, 101994. https://doi.org/10.1016/j.ejpoleco.2020.101994

National Right to Work Legal Defense. *A Course in Game Theory*. Massachusetts Institute of Technology, 1994.

Shannon, Erin. “Report shows corruption continues to plague labor unions”. Washington Policy Center, Jan 22, 2018. https://www.washingtonpolicy.org/publications/detail/report-shows-corruption-continues-to-plague-labor-unions

Sonnemans, Joep, Arthur Schram, and Theo Offerman. 1998. “Public Good provision and Public Bad Prevention: The Effect of Framing.” *Journal of Economic Behavior & Organization* 34,143-61.

Appendix

A.1. A Simple Model of Altruism

Altruism is one of the explanations of why people do not free ride. Let g_i denote player *i*'s contribution and, $G = \sum_{i=1..n} g_i$ total contributions to the Group Fund. Following previous literature, let preferences be defined over payoffs, and for simplicity, suppose that player *i*'s utility is given by

$$u_i(\pi) = \pi_i + \theta_i(G_{-i})v(\sum_{j \neq i} \pi_j)$$

where $\pi_k = e - g_k + \gamma G,$ for all $k \in \{1, \cdots, n\}$, $v(\cdot)$ is a well-behaved concave increasing function, and the weight on the total payoffs of others, $\theta_i(G_{-i})$ may increase in G_{-i} as in conditional altruism (reciprocity) models, or as in unconditional social preferences, it may be a constant. Given contributions of others, write $G = G_{-i} + g_i$ and $\pi_{-i} = \sum_{j \neq i} \pi_j$, and note that player *i*'s decision problem is

$$\max_{G \in [b, G_{-i}+e]} \{e + G_{-i} - (1-\gamma)G + \theta_i(G_{-i})v\left(\pi_{-i}\right)\}$$

where the low constraint is $b = 0$, except for the second mover in the sequential game where $b = -G_{-i}$. Player *i*'s optimal demand for public good, $G^i(G_{-i})$ satisfies

$$-(1-\gamma) + \gamma(n-1)\theta_i(G_{-i})v'(z^*) \leq 0$$

where $z^* = (n-1)(e + \gamma G^i) - G_{-i}$. For interior solutions, player *i*'s demand for public good increases in total contributions of others, G_{-i} as

$$sign(\frac{\partial G^i}{\partial G_{-i}}) = sign\left(\theta_i' v' - v'' \theta_i\right)$$

It follows from $g_i = G^i - G_{-i}$, that the (best response) individual allocation of an unconditional altruistic (i.e., $\theta_i' = 0$) individual I satisfies

$$\frac{\partial g_i^*}{\partial G_{-i}} = \frac{\partial G^i}{\partial G_{-i}} - 1 = \frac{1}{\gamma(n-1)} - 1$$

which implies decreasing individual contributions for $\gamma \in (\frac{1}{n-1}, 1)$, as in our experiment. [29]

Warm glow. A quasi-linear specification of preferences in the spirit of warm glow is

$$u_i(G_{-i}, g_i) = \pi_i + f_i(g_i),$$

for some well-behaved increasing concave function, $f_i(\cdot)$. It follows from $G^i = g_i^* + G_{-i}$ that others' total contribution has a positive effect on *i*'s public good demand but no effect on *i*'s individual contribution, g_i^*.

Summarizing, for (unconditional) altruistic individuals and warm glow individuals:

a. the demand for public good increases in others' total contributions, but
b. the individual contributions do not increase in others' total contributions in games with sufficiently large mpcr, $\gamma \in (\frac{1}{n-1}, 1)$.

A.2. Cooperation in Repeated games

Consider the conventional grim trigger strategy: start contributing *e*, and continue to do so as long as the total *G* is *ne*, otherwise switch to contributing 0 forever . In king games, this remains the FMs' strategy; the SM's strategy is: "contribute *e* if total FMs' contribution is (n-*1*)*e, otherwise* take all of FM's contributions."

In simultaneous games, at any time *t*, no defection is worth $\pi^c / (1-\delta_i) = \gamma ne / (1-\delta_i)$ whereas the present value of defection is, $\pi^d + \delta_i e / (1-\delta_i) = (e + \gamma(n-1)e) + \delta_i e / (1-\delta_i)$. It follows that, defection is not profitable for player *i* if $\delta_i > \frac{\pi^d - \pi^c}{\pi^d - \pi^n} = \frac{(e+\gamma(n-1)e) - \gamma ne}{(e+\gamma(n-1)e) - e} = \frac{1}{\gamma}\left(\frac{1-\gamma}{n-1}\right)$ (*)

[29] Individual contributions increase in others' total contributions for (sufficiently) conditional altruistic agents: $\frac{\theta_i' / \theta_i}{-v''/v'} > \gamma(n-1) - 1$

In king games, SM's payoff from complying is $\gamma ne/(1-\delta_n)$, whereas defection is worth $ne+\delta_n e/(1-\delta_n)$. The condition for defection to be non-profitable is $\delta_n > n\left(\frac{1-\gamma}{n-1}\right)$. An FM would never deviate (no matter the value of δ_i), as SM switches right away to "take all," so there is no immediate gain. An implication is that with sufficiently patient players, full cooperation can be sustained in equilibrium in all our payoff-equivalent repeated games. If the king's discount factor satisfies $\frac{1}{\gamma}\left(\frac{1-\gamma}{n-1}\right) < \delta_n < n\left(\frac{1-\gamma}{n-1}\right)$ and for every other player *i*, $\delta_i > \frac{1}{\gamma}\left(\frac{1-\gamma}{n-1}\right)$ then, with repetition, full cooperation can emerge in the simultaneous game but not in the sequential king game.