Charitable Giving in the Laboratory:
Advantages of the Piecewise Linear Public Goods Game

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4.1. Introduction

The vast majority of US households make significant charitable contributions. When examining the effectiveness of the mechanisms fundraisers use to solicit such funds, it is often essential that researchers elicit or control the donor's return from giving. While much can be gained from examining data on actual donations, insights on giving increasingly result from laboratory studies. An advantage of the laboratory is that it permits control of the donor's return from giving and thus facilitates the identification of donor motives as well as their responses to different fundraising or solicitation strategies (see Vesterlund 2016 for a review).

Economists have traditionally modeled charitable giving as a voluntary contribution to a public good. The reason for this modeling choice is that charitable donations benefit everyone who cares about the charity's mission and output. Thus, the benefit from the sum of donations is nonrival and nonexcludable and can be treated as a public good. To introduce similar incentives in the laboratory, past studies have primarily examined giving in the classic linear public goods game, also known as the voluntary contribution mechanism (VCM). Participants in the VCM are paired in groups and are each given an amount of money to individually allocate between a private and a public account. Money in the private account benefits only the individual, while money in the public account benefits all members of the group. Using a linear payoff structure, the returns from the private and public accounts are held constant and are set to ensure that it is a dominant strategy for the individual to allocate all money to the private account (i.e., give nothing), but group-payoffs are maximized by allocating all money to the public account (i.e., give everything). Although the linear structure makes the game simple and easy to explain to participants, the VCM has the important drawback that all deviations from equilibrium are consistent with other-regarding behavior. While clever experimental manipulations have made clear that some contributions in the VCM are made in error (see, e.g., Andreoni 1995; Anderson, Goeree, and Holt 1998; and Houser and Kurzban 2002), the linear structure of the VCM does not make it possible, in the game, to determine whether a contribution is intentional or a mistake. Thus, it is not possible to determine whether overcontributions in the VCM result from other-regarding behavior.

If instead the equilibrium and the group-payoff-maximizing outcome were moved away from the two boundaries and into the interior of the strategy set, then it would be easier to identify choices that are dominated from both an individual and a group perspective, and one could potentially evaluate whether overcontributions in the VCM result from errors being truncated in the VCM. Initial studies of pubic goods games with an interior equilibrium, however, reveal behavior that is not too different from that observed in the classic VCM (e.g., Keser 1996; Sefton and Steinberg 1996; Isaac and Walker 1998; Laury, Walker, and Williams 1999; and Willinger and Ziegelmeyer 1999, 2001). Contributions in excess of equilibrium are also observed in public goods games with an interior equilibrium. Of concern, however, is that, consistent with a high degree of subject confusion, these studies document a low frequency of equilibrium play, typically ranging between 0 and 33 percent. In addition, average contributions are rather insensitive to the location of the equilibrium and often fall in the middle of the strategy set. A possible explanation for the limited sensitivity to the location of the equilibrium may be that standard nonlinear functions were used to secure the necessary concave payoff function. Drawbacks of using standard nonlinear functions are that the incentive for equilibrium play decreases as play approaches the equilibrium and that it results in a less transparent payoff structure.

We examine instead a piecewise linear public goods game (henceforth PL-PG game), where an interior equilibrium is secured through a transparent and easier to understand piecewise linear payoff structure. We describe the properties of the PL-PG game, showcase its flexibility, and analyze data from a number of different implementations of the game. Behavior in the PL-PG game demonstrates high rates of equilibrium play; a limited number of mistakes; and importantly, that the mean, median, and modal contributions all track the equilibrium with repeated play. While the contributions by some participants can be characterized as other-regarding, most choices are consistent with maximizing own payoffs.

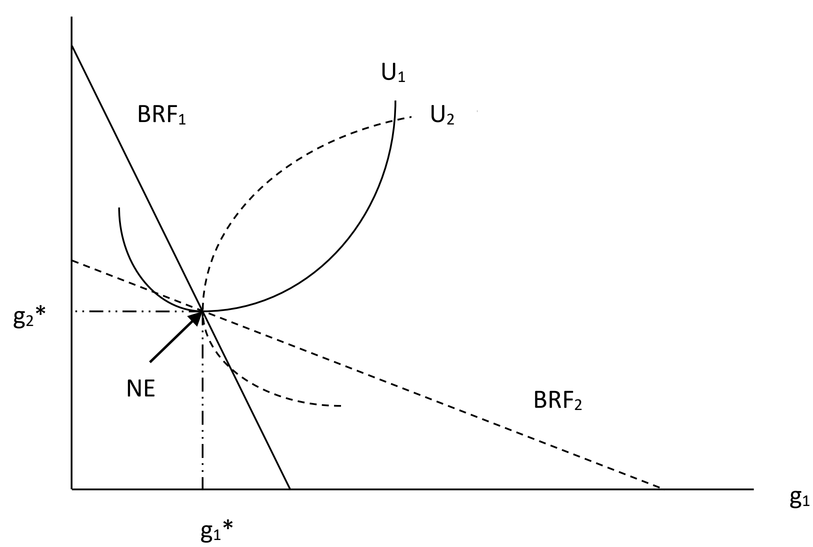
Section 4.2 describes the standard voluntary contribution game and outlines how the classic linear VCM captures the incentives of this model. Section 4.3 provides an overview of previous public goods games with an interior equilibrium, and section 4.4 presents the PL-PG game and examines behavior in several different implementations of the game. Section 4.5 provides examples of charitable-giving applications of the framework, and section 4.6 concludes.

4.2 Voluntary Contribution and the Linear VCM

We first review how economists traditionally model charitable giving and demonstrate how the classic VCM maps onto that model. The motive for donating to a charity is thought to be a concern for the well-being of those who receive services from the charity. That is, the motive for giving is one of altruism, with the donor's return from giving arising from the effect donations have on the well-being of the recipients. With the benefit from giving resulting from the impact of the gift, an individual's donation benefits the recipient and the donor, as well as anyone else who is concerned for the recipient's well-being. Thus, when donors are altruistically inclined, the recipient's well-being is a public good (Becker 1974).

To model voluntary contribution to a public good, assume that *n* individuals care about private consumption x_i and the total provision of a public good *G*. Let individual *i*'s contribution to the public good be g_i and the provision of the public good be the sum of these contributions: $G=\sum_{i=1}^{n} g_i$. With consumption of the public good being nonrival and nonexclusive, everyone benefits from the total provision of the public good. Denoting income by *w* and normalizing prices such that $p_G = p_x = 1$, *i*'s budget constraint is given by $g_i + x_i \leq w$. Representing preferences by a continuous and strictly quasiconcave function $U_i(x_i,G)$, *i*'s preferred provision level is given by the continuous demand function $G^* = q_i(w + G_{-i})$, where $G_{-i} = \sum_{j \neq i} g_j$ is the amount given by others to the public good. As shown by Bergstrom, Blume, and Varian (1986), there exists a unique equilibrium $(g_1^*, g_2^*,.., g_n^*)$ of this game when both the public and the private goods are normal goods, where *i*'s gift is given by $g_i^* = \max\{0, -G_{-i} + q_i(w + G_{-i})\}$. As an illustration, consider the two-person example in figure 4.1. Contributions by individuals 1 and 2 are measured on the horizontal and vertical axis, respectively, and the intersection of the two downward sloping best response functions, BRF_1 and BRF_2, demonstrates the resulting Nash equilibrium (g_1^*, g_2^*). Looking at the individuals' indifference curves through (g_1^*, g_2^*) and recalling that utility is strictly increasing with the contributions of others, it is apparent that there exist contributions that are preferred by both contributors and result in greater overall provision of the public good. Thus, the classic free-rider problem results, and the voluntary provision of the public good $(G^* = g_1^* + g_2^*)$ is inefficiently low.

Figure 4.1 Voluntary contribution equilibrium.



Source: Vesterlund (2016), figure 1.

To capture the incentive to free ride, numerous studies have used the linear public goods game (i.e., VCM) to study giving in the laboratory. The classic VCM, by Isaac, Walker, and Thomas (1984), examines giving in an environment where participants are paired in groups of *n* people and each is given an endowment *w*, which they must distribute between a private and a public account.[1] Payoffs are linear, with the private account generating an individual return of *r* and the public account generating a return of *m* to every member of the group. Thus, an allocation to the public account, g_i, constitutes a contribution to a public good. The individual return from giving, *m/r* , is referred to as the marginal per capita return (MPCR), and the individual's payoff from contributing g_i equals

$$\pi_i = r(w - g_i) + m\sum_{i=1}^{n} g_i$$

The individual's return from the public good is $m \sum_{i=1}^{n} g_i$. The conflict between self and others arises in the social dilemma setting where $1/n < m/r < 1$, when it is socially optimal to give yet costly for the individual to do so. Placing the VCM in the context of the voluntary contribution game in figure 4.1, note that deviations from equilibrium always improve group payoffs. The dominant strategy and the group-payoff-maximizing outcome are at opposite boundaries of the strategy set. With a dominant strategy equilibrium that predicts that the entire endowment is placed in the private account, nothing is placed in the public account and there is zero provision ($G^*=\sum_{i=1}^{n} g_i^*=0$). In contrast to the group-payoff-maximizing outcome is one where everything is placed in the public account and there is full provision ($G= \sum_{i=1}^{n} w$).

In contrast to the equilibrium prediction of zero giving, experimental investigations of the public goods game demonstrate substantial contributions. In the VCM, average contributions typically start off at around 50 percent of endowment, then decrease with repetition (see, e.g., Ledyard 1995 and Chaudhuri 2011 for reviews). To illustrate the contributions typically observed in the VCM, we present data from a VCM treatment conducted by Recalde, Riedl, and Vesterlund (2018) (henceforth, RRV) in figures 4.2 and 4.3. For 11 rounds, 40 participants made contribution decisions in groups of 4.[2] In each round, they decided how much of an $8 endowment to contribute, in $1 increments, to a group account in which the money contributed was doubled and was split equally among group members. Money not placed in the group account was kept in a private account, with a dollar for dollar return. That is, the marginal per capita return (MPCR=*m/r*) was 0.5. Participants were randomly rematched after every round and received feedback after every decision round. Specifically, they learned the total and average contributions made by other group members as well as their earnings and the average earnings of other group members. One choice made by participants was randomly selected to be paid at the end of the experiment.

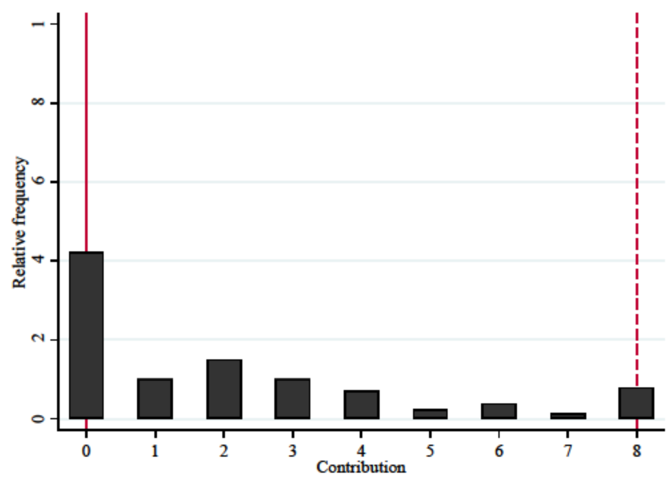
Figure 4.2 presents a histogram of the contribution decisions observed across all rounds of play. The solid vertical line indicates the location of the dominant strategy equilibrium prediction, and the dashed vertical line indicates the location of the group-payoff-maximizing contribution. Figure 4.2 shows that the modal contribution choice is the dominant strategy equilibrium prediction of 0 contribution to the group account. The rate of equilibrium play is 42.3 percent

[1] See also Dawes, McTavish, and Shaklee (1977); Marwell and Ames (1979, 1980, 1981), and Isaac, McCue, and Plott (1985).

[2] Decisions made in period 1 were made without the knowledge that another ten periods would follow of the same game. After period 1 was completed, participants were informed that there would be an additional ten periods of the same game.

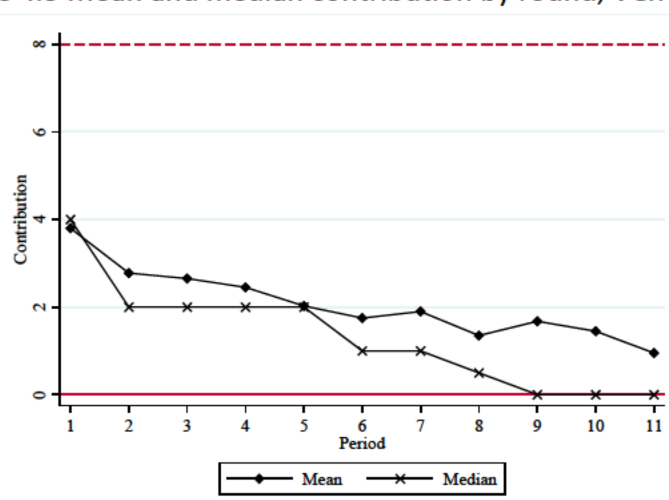
across all decisions and rounds. This aggregate rate of equilibrium play, however, masks the learning that occurs across rounds. Figure 4.3 demonstrates how play progresses with repetition by showing the mean and median contributions in every round. As is standard in the literature, the mean and median contributions start close to 50 percent of the endowment in the first decision round and decrease with experience. While the mean contribution remains positive in the last round of play, the median reaches the equilibrium prediction by round 9. The rate of equilibrium play increases from 20 percent in the first decision round to 70 percent in the last decision round.

Figure 4.2 Histogram of contributions, VCM RRV.



Source: Recalde, Riedl, and Vesterlund (2018). Notes: The solid vertical reference line indicates the location of the dominant strategy. The dashed vertical reference line indicates the location of the group-payoff-maximizing choice. RRV, Recalde, Riedl, and Vesterlund (2018); VCM, voluntary contribution mechanism.

Figure 4.3 Mean and median contribution by round, VCM RRV.



Source: Recalde, Riedl, and Vesterlund (2018). Notes: The solid horizontal line indicates the location of the dominant strategy. The dashed horizontal line indicates the location of the group-payoff-maximizing contribution. RRV, Recalde, Riedl, and Vesterlund (2018); VCM, voluntary contribution mechanism.

While the VCM presents a transparent conflict between the individual and the group, the game fails to capture important aspects of the voluntary contribution game demonstrated in figure 4.1. In particular, it is not possible for participants to make choices that are dominated from both an individual and a group perspective. Clever experimental manipulations, however, make clear that some contributions are made in error (e.g., Andreoni 1995; Anderson, Goeree, and Holt 1998; and Houser and Kurzban 2002), and that the payoff structure of the VCM does not make it possible to identify such mistakes. An additional drawback of the VCM framework is that it is not sufficiently flexible to capture the incentives individuals face when presented with more complex fundraising mechanisms.

To better identify mistakes and to mirror the model of voluntary contributions, scholars have begun to study environments where, as in figure 4.1, there is instead an interior equilibrium. As noted below, these studies have found behavior that largely mirrors the overcontributions revealed in the VCM. While consistent with other-regarding behavior, the pattern of contributions suggests that confusion contributes to this finding.

4.3 Public Goods Games with Interior Equilibria

An interior equilibrium of the public goods game is predicted to arise when participants are given a strictly concave payoff function. This has been secured by introducing either a strictly convex cost of contributing or a strictly concave return to the public good. More precisely, assume a separable payoff function, $U(x_i, G) = u(x_i) + v(G)$, with the constraint $x_i + c(g_i) \leq w$, where $c(g_i)$ is the cost of contributing. Then the participant's objective when choosing a contribution g_i is to maximize $U(g_i, G_{-i} + g_i) = u(w - c(g_i)) + v(G_{-i} + g_i)$, where $G_{-i} = G - g_i$.[3] As made clear in the review of interior public goods games by Laury and Holt (2008), the introduction of strictly convex costs $c(g_i)$ secures the equilibrium in dominant strategies, while an interior Nash equilibrium in total contributions (nondominant strategies) is secured when instead $v(G_{-i} + g_i)$ is made strictly concave.[4] When including strict concavity of either $u(\cdot)$ or $v(\cdot)$scholars have relied on standard nonlinear functions, with the majority using a quadratic payoff function.

Often the studies conducted reveal a low frequency of equilibrium play. Mirroring the VCM, there have been several implementations in dominant strategies. Keeping $v(G_{-i} + g_i)$ linear while using quadratic payoffs for $u(w - c(g_i))$, Keser (1996) studies a public goods game with an individual-payoff-maximizing dominant strategy contribution rate of 35 percent of the individual's endowment. In 25 consecutive rounds, she studies the choices made in fixed groups of 4, and she finds an overall frequency of equilibrium play of only 27 percent. Willinger and Ziegelmeyer (2001) extend this design by varying the individual-payoff-maximizing dominant strategy equilibrium contribution rate across 35, 50, 65, and 80 percent of the endowment. The corresponding frequency of equilibrium play remains low at 17, 24, and 30 percent for the first three treatments, respectively, and reaches 40 percent in the last treatment, where the

[3] In the VCM, $u(w - c(g_i)) = r(w - g_i)$ and $v(G) = mG$.

[4] Making both $u(\cdot)$ and $v(\cdot)$ concave is, of course, possible. We illustrate the simplest approach taken by the literature, which makes utility separable, keeps one function linear, and makes the other one strictly concave.

equilibrium is close to the group-payoff-maximizing outcome. Other studies have used the dominant strategy equilibrium payoff structure to study more complex public good environments, but nonetheless report on the frequency of equilibrium play in a comparable baseline treatment. These studies also find that the frequency of equilibrium play ranges between 10 and 33 percent (Falkinger et al. 2000; van Dijk, Sonnemans, and van Winden 2002; Gronberg et al. 2012; Maurice, Rouaix, and Willinger 2013; Rouaix, Figuières, and Willinger 2015).

Several studies examine instead behavior in games where the return from the public good is concave and the interior equilibrium is not in dominant strategies. Guttman (1986) uses a root function to secure strict concavity of $v(G_{-i} + g_i)$. Varying group size and whether there is heterogeneity in preferences, in comparable homogeneous treatments he finds substantial overcontribution.[5] Andreoni (1993) uses a public goods game with an interior equilibrium to study crowd-out. Participants are rematched in groups of 3 after a sequence of 4 rounds of repeated play, for a total of 20 decision rounds. Payoffs are given by a Cobb-Douglass function and presented in a payoff table. The frequency of equilibrium play across two different treatments is 24 percent (tax treatment) and 34 percent (no-tax treatment). Isaac and Walker (1998) use a quadratic function to make $v(\cdot)$ concave and vary across treatments the location of the symmetric Nash equilibrium in nondominant strategies. Examining treatments with symmetric equilibria at 19.4, 50, and 80 percent of the endowment, the corresponding frequency of symmetric equilibrium play is merely 12, 14, and 20 percent for the three respective treatments. Other papers using similar nonlinear public goods games with an interior symmetric equilibrium in nondominant strategies include Chan et al. (1996, 1999, 2002), Laury, Walker, and Williams (1999), and Sutter and Weck-Hannemann (2004). These studies also report baseline treatments with homogeneous agents, perfect information, and no taxes or subsidies; they reveal a frequency of equilibrium play that typically ranges between 0 and 33 percent.[6]

Sefton and Steinberg (1996) compare behavior in public goods games in which the interior symmetric equilibrium is or is not in dominant strategies. Keeping the equilibrium fixed at 25 percent of the endowment, they find with random rematching of groups of 4, over 10 consecutive rounds, that the frequency of equilibrium play is quite similar: 18 percent (dominant strategies) and 12 percent (nondominant strategies).

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[5] The paper does not report the rate of equilibrium play. The symmetric Nash equilibrium in nondominant strategies in the environment with homogeneous preferences is for subjects to contribute 42.9 percent of their endowment when group size is 3, and 21.4 percent of the endowment when it is 6. Guttman finds in these treatments overcontribution relative to the symmetric Nash prediction of 67 to 100 percent.

[6] Harrison and Hirshleifer (1989), Cason, Saijo, and Yamato (2002), and Croson, Fatas, and Neugebauer (2005) also examine contributions in a nonlinear public goods games with interior solutions in nondominant strategies, but they do so in different environments. Harrison and Hirshleifer (1989) vary across three treatments the public goods production function technology $v(\cdot)$, making it either linear, weakest link, or best shot. The weakest link function generates multiple symmetric Nash equilibria consistent with all possible contribution choices, while the best shot technology generates multiple asymmetric Nash equilibria and no symmetric interior solution. Croson, Fatas, and Neugebauer (2005) compare contributions in a linear and weakest link public goods game. Cason, Saijo, and Yamato (2002) use instead a Cobb-Douglass production function to generate a unique interior symmetric Nash equilibrium in nondominant strategies, but they implement a two-stage game that has subjects first decide whether they want to contribute and then how much to contribute, with feedback after the first stage.

When using standard nonlinear functions to secure public goods games with an interior equilibrium, we have found low rates of equilibrium play across studies that vary both the location and the type of equilibrium. What raises concern is the low frequency of equilibrium play along with the fact that, similar to the classic VCM, we find for many of these games average contribution rates close to 50 percent of the endowment. What is particularly striking is that this average contribution pattern appears to be relatively insensitive to the location of the equilibrium. For example, as seen in the review by Laury and Holt (2008), the average contribution rate remains around 50 percent of the endowment when the equilibrium prediction is a contribution rate of 35 percent (Keser 1996), 25 percent (Sefton and Steinberg 1996), or 20 and 50 percent (Isaac and Walker 1998).

Below we report on data revealing that greater sensitivity to the location of the equilibrium and a higher frequency of equilibrium play is secured when instead a piecewise linear payoff structure is used to secure an interior equilibrium.

4.4 The Piecewise Linear Public Goods (PL-PG) Game

Instead of using standard nonlinear functions to secure an interior equilibrium of the public goods game one can instead use a simple piecewise linear approximation of a concave payoff function. The class of piecewise linear public goods games, PL-PG games, secures very flexible concave payoffs ($U(g_i, G_{-i} + g_i) = u(w - c(g_i)) + v(G)$), wherein the researcher easily controls the complexity of the payoff structure, the marginal incentives, the location of the equilibrium, and the group-payoff-maximizing contribution, as well as the payoffs associated with different contribution levels. For example, Menietti, Morelli, and Vesterlund (2012) (MMV) and Bracha, Menietti, and Vesterlund (2011) (BMV) examine contributions in two-person PL-PG games, where an interior equilibrium is implemented in dominant strategies by maintaining a linear return from the public good, $v(G) = mG$, and introducing a piecewise linear convex cost function $c(g_i)$, such that $u(g_i) = w - c(g_i)$ is concave. Placing both the equilibrium and the group-payoff-maximizing contribution in the interior, they include two kinks in the piecewise linear cost function $c(g_i)$:

$$c(g_i) = \begin{cases} k_1 g_i & if \quad 0 \leq g_i \leq g^* \\ k_1 g^N + k_2(g_i - g^*) & if \quad g^N < g_i \leq g^{GM} \\ k g^N + k_2\left(g^{GM} - g^*\right) + k_3(g_i - g^{GM}) & if \quad g^{GM} \leq g_i \end{cases} \qquad (4.1)$$

Let $k_1 < k_2 < k_3$be constants, and g^* and g^{GM}denote the dominant strategy equilibrium and group-payoff-maximizing contribution level, respectively. Then the monetary payoffs individuals receive is given by

$$U(g_i, G_{-i} + g_i) = \begin{cases} w + \alpha g_i + mG_{-i} & if \quad 0 \leq g_i \leq g^* \\ w + \alpha g^* + \beta\left(g_i - g^*\right) + mG_{-i} & if \quad g^* < g_i \leq g^{GM} \\ w + \alpha g^* + \beta(g^{GM} - g^*) + \gamma\left(g_i - g^{GM}\right) + mG_{-i} & if \quad g^{GM} < g_i \end{cases} \qquad (4.2)$$

where $\alpha = m - k_1, \beta = m - k_2, \gamma = m - k_3$. To secure an interior unique dominant-strategy equilibrium contribution g^* and an interior group-payoff-maximizing contribution g^{GM}, it must be that $\alpha > 0 > \beta > \gamma$ and $\beta + m(n-1) > 0$ and $\gamma + m(n-1) < 0$. With two kinks in the cost function, both g^* and g^{GM} are placed in the interior. Cason and Gangadharan (2015) extend this setting to groups of four people, while Robbett (2016) uses the PL-PG game with only one kink to generate either an interior dominant strategy or an interior group-payoff-maximizing contribution in a three-person setting with heterogeneous agents. RRV construct instead a PL-PG game with three kinks to hold features constant across treatments. Specifically, RRV vary the location of the equilibrium while keeping constant the group-payoff-maximizing choice, the payoffs associated with corner solutions and equilibrium play, as well as the costs of deviating from equilibrium toward the middle of the strategy set. In a robustness check, RRV introduce an additional kink in the payoff function on $v(\cdot)$ rather than $u(\cdot)$ to make contributions in excess of g^{GM} dominated from an individual and other-regarding perspective. Finally, Menietti (2012) studies the PL-PG case where instead $v(\cdot)$ is concave, to secure an interior equilibrium provision level in nondominant strategies. Thus, the PL-PG game is flexible in providing the researcher precise control over the payoff structure while permitting a relatively simple payoff structure. While it is straightforward to summarize the participant's marginal return from actions, these can also be presented using transparent payoff tables or by presenting both the marginal returns and the associated payoff table.[7]

To examine behavior in the PL-PG game, we use data from all treatments we have conducted in which decisions are made simultaneously without a time limit, preferences are constant across group members, and where there is no uncertainty in payoffs. To make it clear how the treatments and studies included in this analysis differ, we summarize in table 4.1 the characteristics of each of the examined PL-PG game environments.

Table 4.1 PL-PG games included in the analysis

Study	*Treatment*	*Label*	*w*	g^*	g^{GM}	*N*	*T*
BMV	Simultaneous move, no threshold	BMV	10	3	7	2	14
MMV	No threshold	MMV12	12	3	7	2	14
MMV	Re-run, no threshold	MMV10	10	3	7	2	14
RRV	Low	RRV Low	10	3	9	4	11
RRV	High	RRV High	10	7	9	4	11
RRV	Modified-Low	RRV Modified-Low	10	3	9	4	11
RRV	Modified-High	RRV Modified-High	10	7	9	4	11

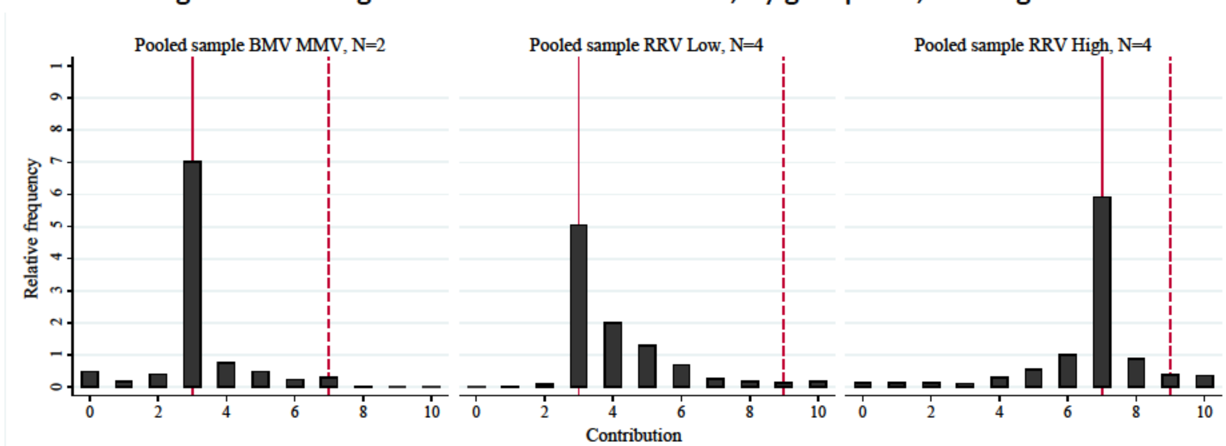
Note: w denotes the endowment, g^* and g^{GM} denote the dominant and group-payoff maximizing contribution, respectively; n denotes group size; and T is the number of one-shot replications (rounds). All studies randomly rematch participants into new groups after every round. BMV, Bracha, Menietti, and Vesterlund (2011); MMV, Menietti, Morelli, and Vesterlund (2012); RRV, Recalde, Riedl, and Vesterlund (2018).

[7] See appendix B for sample instructions from RRV.

As table 4.1 shows, there is variation in the characteristics of the treatments included in this analysis. In two of the studies (three treatments) subjects interact in groups of two, and in one study (four treatments) they interact in groups of four. The equilibrium is in dominant strategies in all studies, and at least one treatment in each study examines contributions in a scenario where the equilibrium contribution is located below the midpoint of the strategy set, specifically, at $g_i^* = 3$. All treatments randomly rematch subjects after every round and have subjects make choices simultaneously. We exclude treatments with a threshold or sequential moves to limit attention to the most basic scenario, making the treatments directly comparable to the classic VCM as well as to previous studies on interior equilibria.[8]

Figure 4.4 presents histograms of the contributions made by subjects in the pooled sample of PL-PG games. The left panel shows the contributions made by subjects in MMV and BMV. The middle and right panels show behavior in RRV, distinguishing among contributions by the location of dominant strategy Nash prediction. The support of the distribution ranges between 0 and 10 in all panels, even though the endowment of subjects in one treatment of MMV (MMV12) was 12, because no subject ever made a choice above 10 in MMV12. The solid vertical line in each panel represents the location of the dominant strategy. The dashed vertical line indicates the location of the group-payoff-maximizing contribution. Choices below the dominant strategy are dominated from both an individual and other-regarding perspective and can thus be classified as mistakes, as alternative contributions simultaneously secure higher payoffs for the individual and for all other group members. Contributions in excess of the group-payoff-maximizing choice are dominated from a group perspective.[9]

Figure 4.4 Histogram of contribution choices, by group size, PL-PG game.



Notes: The solid vertical reference line in each panel indicates the location of the dominant strategy. The dashed vertical reference line in each panel indicates the location of the group-payoff-maximizing choice. Due to the difference in number of rounds and sessions in each of the studies, 2,156 decisions are included in the pooled sample of BMV and MMV, while 1,320 decisions are included in each of the pooled RRV samples (Low and High). BMV, Bracha, Menietti, and Vesterlund (2011); MMV, Menietti, Morelli, and Vesterlund (2012); PL-PG, piecewise linear public goods; RRV, Recalde, Riedl, and Vesterlund (2018).

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[8] Treatments with sequential decisions, fixed costs or thresholds, and exogenous manipulations of available decision time (RRV) are not included.

[9] Full contribution choices also constitute mistakes in RRV Modified-Low and Modified-High.

Across all panels, we can see that behavior responds to incentives. The modal choice is always the dominant strategy equilibrium prediction in the pooled sample of studies depicted in figure 4.4 and when differentiating the analysis by treatment (see figure 4.A1). The rate of equilibrium play is 70.4 percent in the two-person PL-PG games we analyze, 50.5 in the pooled sample of four-person PL-PG games with a low dominant strategy, and 59.3 percent in the pooled sample of four-person PL-PG games with a high dominant strategy. The high rates of equilibrium play documented in the four-person groups suggest that the high frequency of equilibrium play documented in the two-person PL-PG games are not an artifact of the small group size.[10]

We also find a low frequency of choices that can be characterized as dominated from an individual and a group perspective. In games with two-person groups, we find that 11 percent of choices fall below the dominant strategy and that less than 1 percent exceed the group-payoff-maximizing contribution. In RRV Low, these numbers are 1 and 2 percent, respectively, and in RRV High, we find 24 percent of contributions being below the dominant-strategy and 4 percent being in excess of the group-payoff-maximizing contribution.

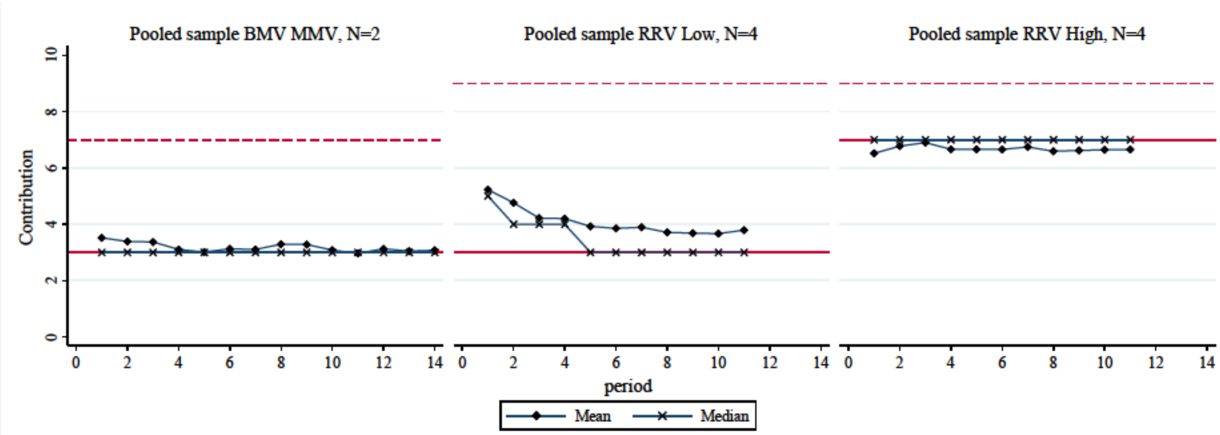
The histograms presented in figure 4.4 mask the learning that takes place as subjects make repeated decisions in the experiment. To illustrate what happens with repetition, figure 4.5 presents graphs of the mean and median contribution choices by group size and location of the dominant-strategy-equilibrium prediction. The horizontal solid line in each panel indicates the location of the dominant strategy, and the horizontal dashed line indicates the location of the group-payoff-maximizing contribution. See figure 4.A2 in appendix A for the mean and median contributions by treatment.

The first thing that becomes evident when looking at the two-person PL-PG games panel of figure 4.5 is that, unlike the standard linear VCM scenario, there is little deviation from the dominant strategy over the course of the experiment. The median contribution coincides exactly with the dominant-strategy-equilibrium prediction in every round of play. This is true for the pooled sample (figure 4.5) and when analyzing data for each of the studies separately (figure 4.A2). Average contributions start slightly above the equilibrium prediction but converge very quickly to the dominant strategy. Session-level tests in fact fail to reject the null hypothesis that average contributions coincide with the equilibrium prediction once we reach the fourth round of play. We also fail to reject that average play in the pooled sample of all rounds equals the predicted equilibrium (mean contribution = 3.18, two-sided t-test $p = 0.163$).[11]

[10] Another difference between groups with two and four participants is whether payoffs only were presented in payoff tables (groups with four) or whether they were accompanied by a description of the payoff function (groups with two). When describing the payoff function, one might be concerned that the cutoffs were made focal to the participants. However, the consistently high frequency of equilibrium play across games suggests that equilibrium play is high even when only a payoff table is used to present payoffs. Subjects in RRV completed a tutorial on how to read payoff tables and were only presented with payoff information via payoff tables displayed on the screen that subjects used to make choices. That is, payoff functions, kinks, and cost cutoffs were never mentioned to subjects in RRV.

[11] All tests, unless otherwise noted, are two-sided session-level one-sample t-tests of the null hypothesis that average contributions equal the Nash prediction.

Figure 4.5 Mean and median contribution, by group size, PL-PG game.



Notes: The solid horizontal reference line in each panel indicates the location of the dominant strategy. The dashed horizontal reference line in each panel indicates the location of the group-payoff-maximizing contribution. There are 154 participants (11 sessions) in the pooled sample of BMV and MMV, and 120 participants (6 sessions) in each of the pooled RRV samples (Low and High). BMV, Bracha, Menietti, and Vesterlund (2011); MMV, Menietti, Morelli, and Vesterlund (2012); PL-PG, piecewise linear public goods; RRV, Recalde, Riedl, and Vesterlund (2018).

In four-person groups, the mean and median also converge to the equilibrium prediction, but the story is slightly different. When the dominant strategy is to contribute below the midpoint of the strategy set, mean and median contributions start at approximately 50 percent of the endowment and decline over rounds. This is similar to the result typically documented in the standard linear VCM. The median converges to and reaches the equilibrium prediction by round 5 of the pooled sample of games with a low dominant strategy. Average contributions initially exceed the equilibrium by a substantial amount, and although overcontribution decreases over time, it persists across rounds. In fact we can reject that mean contributions equal the equilibrium prediction (mean contribution = 4.08, two-sided t-test $p < 0.01$ both across and within rounds).

Stronger convergence is seen when looking at behavior in the pooled sample of PL-PG games in which the dominant strategy is to contribute an amount above the midpoint of the strategy set. The median contribution level coincides with the dominant strategy in all rounds of play, and we find that average contributions across rounds only differ slightly from the dominant strategy (mean contribution = 6.67, two-sided t-test $p < 0.10$ across all rounds of play).[12] Thus, in four-person PL-PG games, we find that average contributions converge to equilibrium, but while close, fail to reach it by the end of the repeated play.[13]

The rate of equilibrium play increases with repetition in all treatments. It starts at 66.1 in round 1 of the pooled sample of two-person PL-PG games and increases to 75.9 in round 14 (the last

[12] Within rounds, the null hypotheses that mean contributions equal the dominant strategy Nash prediction ($g_i = 7$) can be rejected in rounds 1, 8, and 11, where the two-sided t-test p = 0.021, 0.077, and 0.079, respectively. In 3 additional rounds, deviations are marginally insignificant. Two-sided one-sample t-tests provide $p < 0.15$ in a total of 6 rounds.

[13] If the average deviation from the Nash prediction on RRV High is entirely due to error, then extrapolating across treatments suggests that only 30 percent of the average overcontribution in RRV Low can be explained by error.

round of MMV and BMV). The rate of equilibrium play in the four-person games starts lower (at 30 and 33 percent, respectively, in the Low and High designs), but it increases quickly with repetition to levels similar to those seen in the two-person environment by the end of the experiment. In round 11 of RRV (the last round), the rate of equilibrium play is 64.2 and 74.2 percent, respectively, in the four-person Low and High designs. Figure 4.A3 shows the rate of equilibrium play documented in each treatment by round.

Examining participant behavior in various implementations of the PL-PG game, we find that play is very sensitive to the location of the equilibrium. Across studies we find a high and increasing frequency of equilibrium play; a low rate of mistakes; and importantly, that mean, median, and modal contributions track the equilibrium. Relative to previous studies, we find evidence consistent with incentives being well understood, which is essential when studying giving in the laboratory, and in particular when the goal is to study more complex contribution environments. Below we provide examples of using the PL-PG framework to study charitable giving.

4.5 Using the PL-PG Game to Study Charitable Giving

The PL-PG game was used by MMV to study questions in the context of philanthropy. They asked theoretically and experimentally how a goal for a charitable campaign could affect overall giving. Specifically, they examined an environment where donors can pledge funds but where contributions are collected only when a goal or threshold is reached. Of central concern was how a fundraiser would wish to set his or her goal. Using a simple model, they show that the fundraiser will set the goal or threshold at an inefficiently high level. This raises the question of whether inefficiently high provision indeed can result in the context of the environment presented. By mere design, the VCM is not suited for examining this question in the laboratory. MMV conduct instead a laboratory experiment with two treatments that varied in a two-person simultaneous-move PL-PG game whether or not there existed an inefficiently large threshold, under which the public good would not be provided and contributions would be refunded. Consistent with the theoretical prediction, they show that a threshold can raise contributions to an inefficiently high level. In contrast to our standard understanding of charitable giving, it need not be the case that underprovision results. If the fundraiser is able to commit to a sufficiently high goal, then contributions to the public good may instead be inefficiently large.

BMV instead use the PL-PG game to examine why nonprofit organizations announce seed donations in fundraising campaigns. Andreoni (1998) showed theoretically that seed donations, and thus sequential contributions, can increase public good provision in environments where fixed costs give rise to multiple contribution equilibria. In a game with multiple equilibria (zero and positive provisions), sequential moves permit coordination on a positive provision outcome. BMV tested this predicted comparative static by conducting a laboratory experiment using a two-person PL-PG game in a 3 × 2 between-subject design that varied the size of a fixed cost in the payoff function (none, small, or large), and the timing of decisions (sequential versus simultaneous). Consistent with the theory put forward by Andreoni (1998), they find that sequential giving secures provision in environments where sufficiently high fixed costs gives rise to a coordination problem and contribution failure in the simultaneous game. When the fixed costs are instead low, participants overcontribute relative to the Nash prediction in the simultaneous move environment, and this overcontribution disappears with sequential moves.

Menietti (2012) relies on the PL-PG game to study how fundraising goal announcements can reduce the uncertainty about public good provision and generate a threshold that increases donations relative to an environment without goal announcements. He used a two-person PL-PG game to conduct a laboratory experiment with three treatments, varying the presence of a goal in an environment with uncertainty and whether or not the goal reduced such uncertainty. Results show that goal announcement increases donations relative to a no-announcement treatment, but that the reduction in uncertainty generated by the goal announcement does not increase contributions relative to an environment with goal announcement but no reduction in uncertainty. The reduction in uncertainty, however, does facilitate coordination on the symmetric equilibrium and thus increases the average earnings of participants relative to the treatment with goal announcement and no reduction in uncertainty.

RRV use a series of four-person PL-PG games to determine whether response time (how fast individuals make choices) in the public goods game can be used to identify whether the act of giving is intuitive or deliberate. Past studies have examined contributions in the VCM and have found that individuals with fast decision times are more generous than those with slow decision times, and these studies argue that the intuitive response is to be other-regarding. RRV explore this claim by examining contributions in two PL-PG treatments that vary the location of the dominant-strategy-equilibrium prediction, with one lying below the midpoint and the other above the midpoint of the strategy set. RRV's results show that fast decisions are not associated with selfish or generous choices but rather with mistakes, which fall on average in the middle of the strategy set.[14] With deliberation, contributions move on average in the direction of the dominant strategy equilibrium prediction. Thus, when the equilibrium prediction is at the bottom of the strategy set, RRV find that fast decision makers are more generous than slow decision makers, and when the equilibrium prediction is toward the top of the strategy set, they find instead that fast decision makers are less generous than slow decision makers. This study clearly demonstrates the false inference that may be drawn in the classic VCM, where mistakes cannot be identified. The inference on the extent to which giving is intuitive or deliberative has natural consequences for the manner in which fundraisers best solicit donations.

4.6 Conclusion

This chapter has described the advantages of a recently introduced payoff structure for studying charitable giving in the laboratory. Using piecewise linear payoffs, the PL-PG games allow the researcher to move both the equilibrium and group-payoff-maximizing contribution off the boundary and into the interior of the strategy set, while also presenting participants with an easy to understand payoff function. Not only do these payoffs make it easy to identify clearly dominated choices, they also generate behavior that suggests limited confusion with repeated

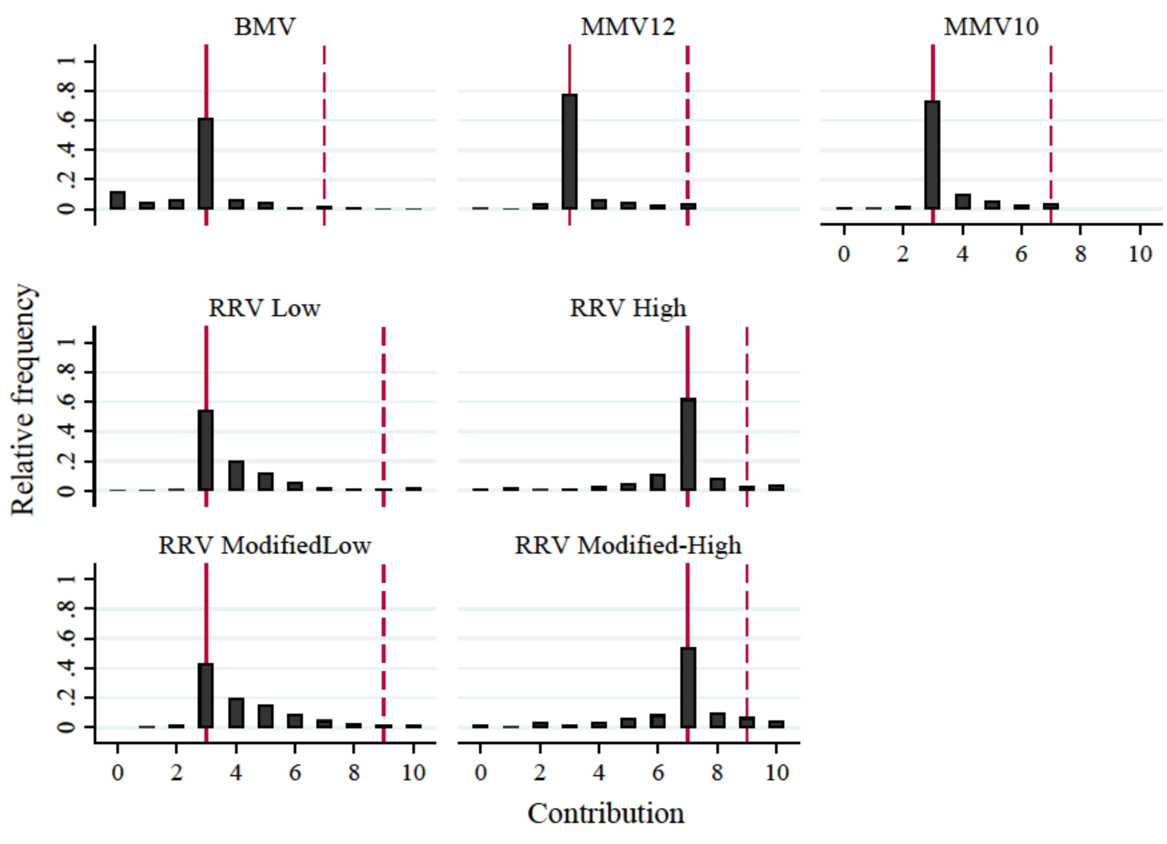
[14] Neither a selfish nor a generous person would select actions that decrease both the earnings of the individual and the earnings of other groups members, RRV therefore classify such actions as mistakes.

play. Reviewing behavior in these games, we find that play is very sensitive to the location of the equilibrium. We find a high frequency of equilibrium play across implementations. In fact, with the frequency of equilibrium play ranging between 51 and 70 percent, such play dominates that seen in the VCM as well as in other types of public goods games with an interior equilibrium. We also document a low rate of mistakes; and that mean, median, and modal contributions track the equilibrium. As scholars begin to examine increasingly complex fundraising mechanisms in the laboratory, they may benefit from considering the flexible and transparent PL-PG games.

Appendix A

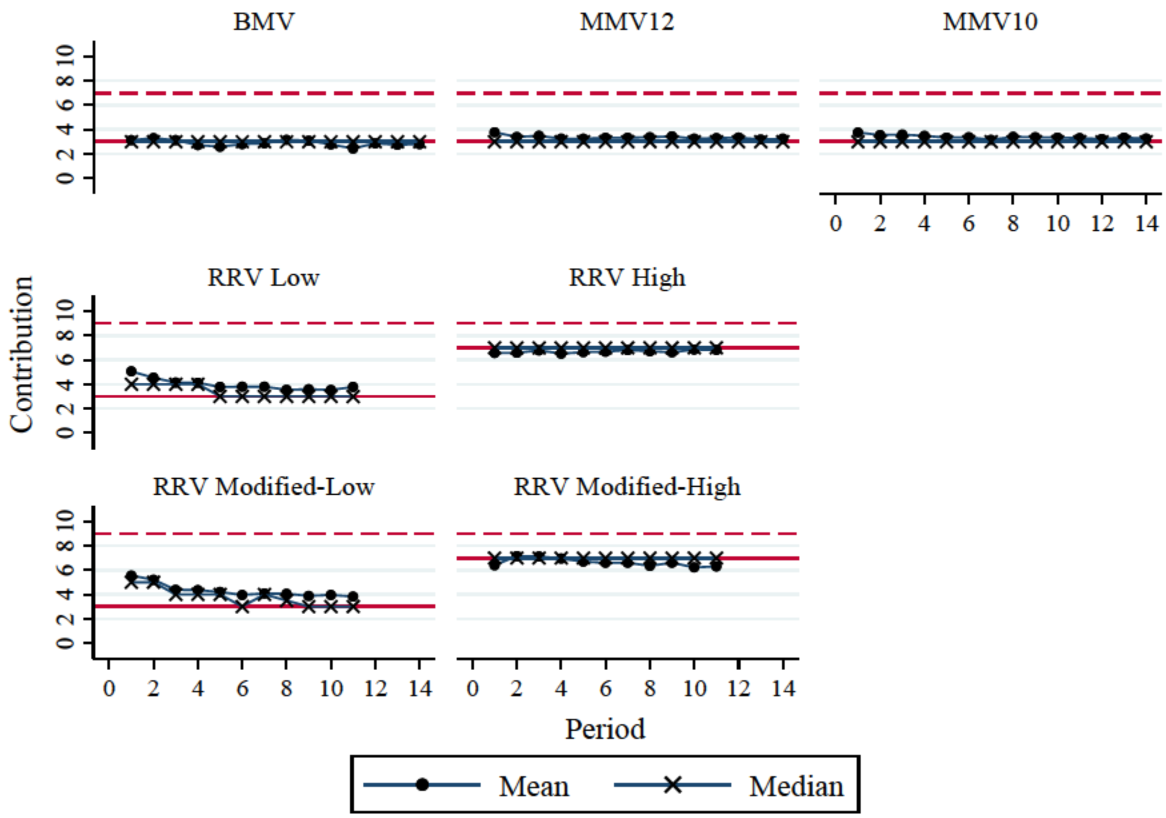
This appendix presents supporting material that disaggregates the data presented in section 4.4 by study and treatment.

Figure 4.A1 Histogram of contributions, by treatment.



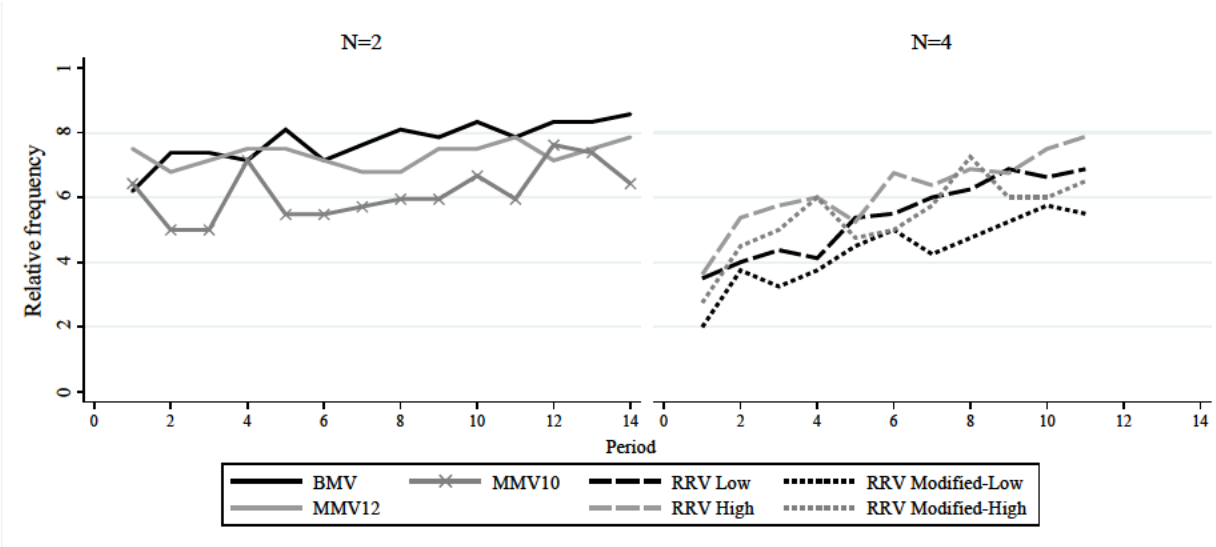
Notes: The solid reference line indicates the location of the dominant strategy. The dashed reference line indicates the location of the group-payoff-maximizing choice. Due to the difference in number of rounds and sessions the number of decisions included in each of the treatments is: 588 in BMV and MMV12, 392 in MMV10, 880 in RRV Low and RRV High, and 440 in RRV Modified-Low and RRV Modified-High. BMV, Bracha, Menietti, and Vesterlund (2011); MMV, Menietti, Morelli, and Vesterlund (2012); MMV10, MMV with endowment of 10; MMV12, MMV with endowment of 12; RRV, Recalde, Riedl, and Vesterlund (2018).

Figure 4.A2 Mean and median contribution, by round and treatment.



Notes: The solid horizontal reference line in each panel indicates the location of the dominant strategy. The dashed horizontal reference line in each panel indicates the location of the group-payoff-maximizing choice. The number of participants (sessions) in each treatment is: 42 (three) in BMV and MMV12, 28 (two) in MMV10, 80 (four) in RRV Low and High, and 40 (two) in RRV Modified-Low and Modified-High. BMV, Bracha, Menietti, and Vesterlund (2011); MMV, Menietti, Morelli, and Vesterlund (2012); MMV10, MMV with endowment of 10; MMV12, MMV with endowment of 12; RRV, Recalde, Riedl, and Vesterlund (2018).

Figure 4.A3 Equilibrium play, by round and treatment.



Notes: The number of decisions per round observed in each treatment is: 42 in BMV and MMV12, 28 in MMV10, 80 in RRV Low and RRV High, and 40 in RRV Modified-Low and RRV Modified-High. BMV, Bracha, Menietti, and Vesterlund (2011); MMV, Menietti, Morelli, and Vesterlund (2012); MMV10, MMV with endowment of 10; MMV12, MMV with endowment of 12; RRV, Recalde, Riedl, and Vesterlund (2018).

Appendix B

This appendix presents the instructions used by RRV in the treatments with PL-PG games and no time pressure or time delay.

Instructions

This is an experiment on decision making. The earnings you receive today will depend on the decisions made by you and by other participants in this room. Please do not talk or communicate with others in any way. If you have a question please raise your hand and an experimenter will come to where you are sitting to answer you in private.

Earnings

There will be two parts of the experiment. Only one of the two parts will count for payment. Once part 1 and 2 are completed we will flip a coin to determine which part counts for payment. Your earnings in the experiment will be the sum of a $6 payment for showing up on time and your earnings from either part 1 or part 2. We will first explain how earnings are determined in part 1. Once part 1 is completed we will explain how earnings in part 2 are determined. Decisions in part 1 only affect possible earnings in part 1, and decisions in part 2 only affect possible earnings in part 2. Your total earnings will be paid to you in cash and in private at the end of the experiment.

Part 1

In part 1 you will be matched in groups of four. That is the computer will randomly match you with three other participants.

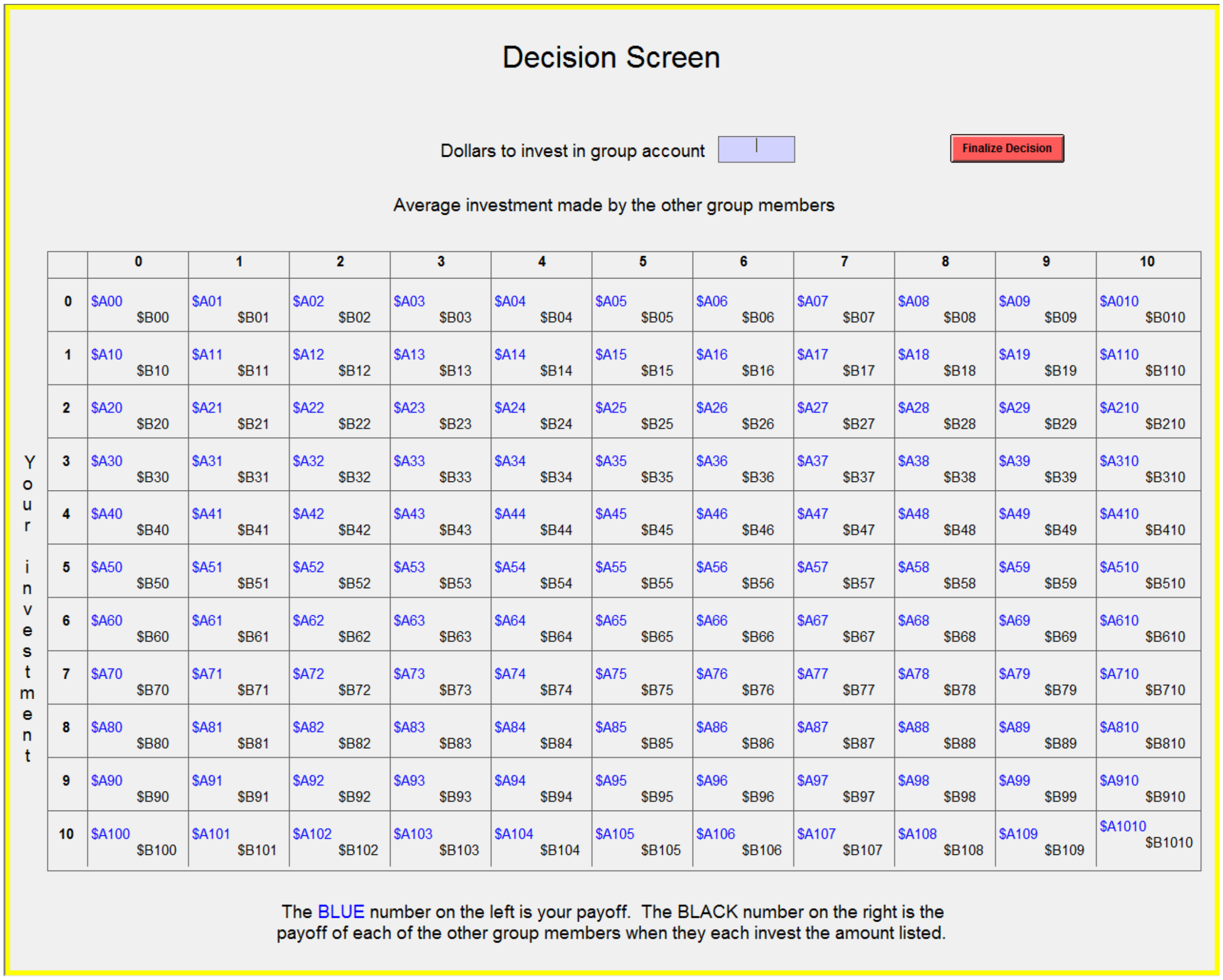
You will each have to make one decision, and earnings will depend on the decision made by you and the decisions made by other members of your group. Neither during nor after the experiment will you get to know who the other members of your group are or what decisions they make. Likewise, no one in your group will know who you are and what decision you make.

You and each of the other group members will be given $10 and asked to make an investment decision. You may select to invest any dollar amount between $0 and $10 in a group account. Investments in the group account affect both your earnings and those of the other members of the group. That is, individual earnings depend on the individual investment in the group account and the investment by the other group members.

Decision Screen

Your investment decision will be made using a decision screen. You make a decision by entering the number of dollars you wish to invest in the group account in the area labeled: *Dollars to invest in group account*. Once you have made your investment decision, please click the red *Finalize Decision* button. You will not be able to modify your decision once your choice is finalized.

A decision screen is shown below. The actual decision screen will include a payoff table with the earnings that result from the investments made by you and the three other group members. We will use the screenshot below to demonstrate how to read the table. The first column shows all possible investments by you. The first row shows all possible average investments by the other group members. If the average investment by the other group members is say $2, then it may result from each investing $2, or from one member investing $0, another investing $2, and a third investing $4.


Decision Screen

Dollars to invest in group account

Finalize Decision

Average investment made by the other group members

Your investment

	0	1	2	3	4	5	6	7	8	9	10
0	$A00 $B00	$A01 $B01	$A02 $B02	$A03 $B03	$A04 $B04	$A05 $B05	$A06 $B06	$A07 $B07	$A08 $B08	$A09 $B09	$A010 $B010
1	$A10 $B10	$A11 $B11	$A12 $B12	$A13 $B13	$A14 $B14	$A15 $B15	$A16 $B16	$A17 $B17	$A18 $B18	$A19 $B19	$A110 $B110
2	$A20 $B20	$A21 $B21	$A22 $B22	$A23 $B23	$A24 $B24	$A25 $B25	$A26 $B26	$A27 $B27	$A28 $B28	$A29 $B29	$A210 $B210
3	$A30 $B30	$A31 $B31	$A32 $B32	$A33 $B33	$A34 $B34	$A35 $B35	$A36 $B36	$A37 $B37	$A38 $B38	$A39 $B39	$A310 $B310
4	$A40 $B40	$A41 $B41	$A42 $B42	$A43 $B43	$A44 $B44	$A45 $B45	$A46 $B46	$A47 $B47	$A48 $B48	$A49 $B49	$A410 $B410
5	$A50 $B50	$A51 $B51	$A52 $B52	$A53 $B53	$A54 $B54	$A55 $B55	$A56 $B56	$A57 $B57	$A58 $B58	$A59 $B59	$A510 $B510
6	$A60 $B60	$A61 $B61	$A62 $B62	$A63 $B63	$A64 $B64	$A65 $B65	$A66 $B66	$A67 $B67	$A68 $B68	$A69 $B69	$A610 $B610
7	$A70 $B70	$A71 $B71	$A72 $B72	$A73 $B73	$A74 $B74	$A75 $B75	$A76 $B76	$A77 $B77	$A78 $B78	$A79 $B79	$A710 $B710
8	$A80 $B80	$A81 $B81	$A82 $B82	$A83 $B83	$A84 $B84	$A85 $B85	$A86 $B86	$A87 $B87	$A88 $B88	$A89 $B89	$A810 $B810
9	$A90 $B90	$A91 $B91	$A92 $B92	$A93 $B93	$A94 $B94	$A95 $B95	$A96 $B96	$A97 $B97	$A98 $B98	$A99 $B99	$A910 $B910
10	$A100 $B100	$A101 $B101	$A102 $B102	$A103 $B103	$A104 $B104	$A105 $B105	$A106 $B106	$A107 $B107	$A108 $B108	$A109 $B109	$A1010 $B1010

The BLUE number on the left is your payoff. The BLACK number on the right is the payoff of each of the other group members when they each invest the amount listed.

Each cell reports the payoff you and the other group members receive given your investment and the average investment by the other group members. Your payoff will be depicted in blue and located in the upper left corner of each cell. The average payoff of the other group members will be depicted in black and located in the bottom right corner of each cell. To determine the payoffs from a specific combination of investments you look at the cell where the row of your investment crosses the column of the average investment by the other group members. In this cell you will see your payoff on the left (in blue) and the average payoff of the other group members on the right (in black). The average payoff for the other group members refers to the payoff they each get when they invest the same amount in the group account.

Consider an example where you invest $1 and the average investment by the other group members is $4. Your earnings from this investment decision will be $A14, where the first number refers to your $1 investment and the second to the $4 average investment by the other group members. Similarly the earnings of each of the three other group members will be $B14. If you were to increase your investment to $2 you move down one row to see that your earnings would become $A24 and the average earnings of the other group members would become $B24. Likewise if the average investment of the other group members increased by $1, such that you invest $2 and the other group members on average invest $5, you move over one column to see that your earnings would become $A25 and the average payoff to the other group members would be $B25. Before we begin we will give you a tutorial on how to read the payoff table.

Results Screen

After everyone has made an investment decision you will see a results screen. The results screen will indicate the investments made by you and the other group members and will summarize the earnings you and the other group members receive if part 1 counts for payment. The average earnings for the other group members reported in the payoff table refer to the earnings that result when the three other group members make the same investment decision. In the event that they do not invest the same amount their actual average earnings may differ slightly from that reported in the table. Your own payoff from the listed investment combination will be precisely that listed in the payoff table.

Instructions Part 2

[Distributed after Part 1 is completed]

Part 2 is very similar to part 1. The only difference is that you now must make investment decisions over a sequence of ten rounds. At the beginning of each round you will be randomly matched with three other people to form a new group of four. You will never be matched with the same three people twice in a row. It is also unlikely that you will meet the same set of three other group members twice. You will not get to know who the other members of your group are nor will you be informed of their past investment. Likewise, no one will know who you are and what investments you made in the past.

Just as for part 1 you will be presented with a decision screen which reports the earnings that you and the other group members get from the different investments. The decision screen will be the same in each round. That is, the earnings are the same for each of the ten rounds and are identical to those seen in part 1.

After each round is complete you will be shown a result screen which reports the investments made by you and the other group members in that round, as well as the earnings you and the other group members made in that round.

If part 2 is selected for payment we will randomly select a number between one and ten. The earnings for the corresponding round will be paid to the participants along with the $6 show up fee. The part that counts for payment will be determined by the flip of a coin. The round that counts in part 2 will be determined by having a participant draw a number between 1 and 10.

References

Anderson, Simon P., Jacob K. Goeree, and Charles A. Holt. 1998. "A Theoretical Analysis of Altruism and Decision Error in Public Goods Games." Journal of Public Economics 70 (2): 297–323.

Andreoni, James. 1993. "An Experimental Test of the Public-Goods Crowding-Out Hypothesis." American Economic Review 83 (5): 1317–1327.

Andreoni, James. 1995. “Cooperation in Public-Goods Experiments: Kindness or Confusion?” American Economic Review 85 (4): 891–904.

Andreoni, James. 1998. “Toward a Theory of Charitable Fund-Raising.” Journal of Political Economy 106 (6): 1186–1213.

Becker, Gary S. 1974. “A Theory of Social Interactions.” Journal of Political Economy 82 (6):1063–1093.

Bergstrom, Theodore, Lawrence Blume, and Hal Varian. 1986. “On the Private Provision of Public Goods.” Journal of Public Economics 29 (1): 25–49.

Bracha, Anat, Michael Menietti, and Lise Vesterlund. 2011. “Seeds to Succeed? Sequential Giving to Public Projects.” Journal of Public Economics 95 (5–6): 416–427.

Cason, Timothy N., and Lata Gangadharan. 2015. “Promoting Cooperation in Nonlinear Social Dilemmas through Peer Punishment.” Experimental Economics 18 (1): 66–88.

Cason, Timothy N., Tatsuyoshi Saijo, and Takehiko Yamato. 2002. “Voluntary Participation and Spite in Public Good Provision Experiments: An International Comparison.”Experimental Economics 5 (2): 133–153.

Chan, Kenneth S., Rob Godby, Stuart Mestelman, and R. Andrew Muller. 2002. “Crowding-Out Voluntary Contributions to Public Goods.” Journal of Economic Behavior & Organization 48 (3): 305–317.

Chan, Kenneth S., Stuart Mestelman, Robert Muir, and R. Andrew Muller. 1999. “Heterogeneity and the Voluntary Provision of Public Goods.” Experimental Economics 2 (1): 5–30.

Chan, Kenneth S., Stuart Mestelman, Rob Moir, and R. Andrew Muller. 1996. “The Voluntary Provision of Public Goods under Varying Income Distributions.” Canadian Journal of Economics 29 (1): 54–69.

Chaudhuri, Ananish. 2011. “Sustaining Cooperation in Laboratory Public Goods Experiments: A Selective Survey of the Literature.” Experimental Economics 14 (1): 47–83.

Croson, Rachel, Enrique Fatas, and Tibor Neugebauer. 2005. “Reciprocity, Matching and Conditional Cooperation in Two Public Goods Games.” Economics Letters 87 (1): 95–101.

Dawes, Robyn M., Jeanne McTavish, and Harriet Shaklee. 1977. “Behavior, Communication, and Assumptions about Other Peoples’ Behavior in a Commons Dilemma Situation.” Journal of Personality and Social Psychology 35 (1): 1–11.

Falkinger, Josef, Ernst Fehr, Simon Gächter, and Rudolf Winter-Ember. 2000. “A Simple Mechanism for the Efficient Provision of Public Goods: Experimental Evidence.” American Economic Review 90 (1): 247–264. doi: 10.1257/aer.90.1.247.

Gronberg, Timothy J., I. I. I. R. Andrew Luccasen, Theodore L. Turocy, and John B. Van Huyck. 2012. “Are Tax-Financed Contributions to a Public Good Completely Crowded-Out? Experimental Evidence.” Journal of Public Economics 96 (7-8): 596–603.

Guttman, Joel M. 1986. “Matching Behavior and Collective Action: Some Experimental Evidence.” Journal of Economic Behavior & Organization 7 (2): 171–198.

Harrison, Glenn W., and Jack Hirshleifer. 1989. “An Experimental Evaluation of Weakest Link/Best Shot Models of Public Goods.” Journal of Political Economy 97 (1): 201–225.

Houser, Daniel, and Robert Kurzban. 2002. “Revisiting Kindness and Confusion in Public Goods Experiments.” American Economic Review 92 (4): 1062–1069.

Isaac, R. Mark, Kenneth F. McCue, and Charles R. Plott. 1985. “Public Goods Provision in an Experimental Environment.” Journal of Public Economics 26 (1): 51–74.

Isaac, R. Marc, and James M. Walker. 1998. “Nash as an Organizing Principle in the Voluntary Provision of Public Goods: Experimental Evidence.” Experimental Economics 1 (3): 191–206.

Isaac, R. Mark, James M. Walker, and Susan H. Thomas. 1984. “Divergent Evidence on Free Riding: An Experimental Examination of Possible Explanations.” Public Choice 43 (2): 113–149.

Keser, Claudia. 1996. “Voluntary Contributions to a Public Good When Partial Contribution Is a Dominant Strategy.” Economics Letters 50 (3): 359–366.

Laury, Susan K., and Charles A. Holt. 2008. "Voluntary Provision of Public Goods: Experimental Results with Interior Nash Equilibria." In Handbook of Experimental Economics Results, vol. 1, edited by Charles R. Plott and Vernon L. Smith, 792–801. Amsterdam: North-Holland.

Laury, Susan K., James M. Walker, and Arlington W. Williams. 1999. "The Voluntary Provision of a Pure Public Good with Diminishing Marginal Returns." Public Choice 99 (1/2): 139–160.

Ledyard, John. 1995. "A Survey of Experimental Research." In The Handbook of Experimental Economics, edited by John H. Kagel and Alvin E. Roth, 111–194. Princeton, NJ: Princeton University Press.

Marwell, Gerald, and Ruth E. Ames. 1979. "Experiments on the Provision of Public Goods. I. Resources, Interest, Group Size, and the Free-Rider Problem." American Journal of Sociology 84 (6): 1335–1360.

Marwell, Gerald, and Ruth E. Ames. 1980. "Experiments on the Provision of Public Goods. II. Provision Points, Stakes, Experience, and the Free-Rider Problem." American Journal of Sociology 85 (4): 926–937.

Marwell, Gerald, and Ruth E. Ames. 1981. "Economists Free Ride, Does Anyone Else?" Journal of Public Economics 15 (3): 295–310.

Maurice, Jonathan, Agathe Rouaix, and Marc Willinger. 2013. "Income Redistribution and Public Good Provision: An Experiment." International Economic Review 54 (3): 957–975.

Menietti, Michael. 2012. "Fundraising Goals." Working paper, Social Science Research Network. doi: 10.2139/ssrn.2142765.

Menietti, Michael, Massimo Morelli, and Lise Vesterlund. 2012. "Provision Point Mechanisms and the Over-provision of Public Goods." Working paper, University of Pittsburgh/

Recalde, Maria P., Arno Riedl, and Lise Vesterlund. 2018. "Error Prone Inference from Response Time: The Case of Intuitive Generosity in Public-Good Games." Journal of Public Economics 160:132-147.

Robbett, Andrea. 2016. "Sustaining Cooperation in Heterogeneous Groups." Journal of Economic Behavior & Organization 132 (Part A): 121–138.

Rouaix, Agathe, Charles Figuières, and Marc Willinger. 2015. "The Trade-Off Between Welfare and Equality in a Public Good Experiment." Social Choice and Welfare 45 (3): 601–623.

Sefton, Martin, and Richard Steinberg. 1996. "Reward Structures in Public Good Experiments." Journal of Public Economics 61 (2): 263–287.

Sutter, Matthias, and Hannelore Weck-Hannemann. 2004. "An Experimental Test of the Public Goods Crowding Out Hypothesis When Taxation Is Endogenous." FinanzArchiv/ Public Finance Analysis 60 (1): 94–110.

van Dijk, Frans, Joep Sonnemans, and Frans van Winden. 2002. "Social Ties in a Public Good Experiment." Journal of Public Economics 85 (2): 275–299.

Vesterlund, Lise. 2016. "Using Experimental Methods to Understand Why and How We Give to Charity." In The Handbook of Experimental Economics, vol. 2, edited by John H. Kagel and Alvin E. Roth, 91–151. Princeton, NJ: Princeton University Press.

Willinger, Marc, and Anthony Ziegelmeyer. 1999. "Framing and Cooperation in Public Good Games: An Experiment with an Interior Solution." Economics Letters 65 (3): 323–328.

Willinger, Marc, and Anthony Ziegelmeyer. 2001. "Strength of the Social Dilemma in a Public Goods Experiment: An Exploration of the Error Hypothesis." Experimental Economics 4 (2): 131–144.