ELSEVIER

Journal of Economic Behavior & Organization
Vol. 52 (2003) 115–131

JOURNAL OF
Economic Behavior
& Organization

www.elsevier.com/locate/econbase

Only for my own neighborhood? Preferences and voluntary provision of local and global public goods

Calvin Blackwell [a,*], Michael McKee [b]

[a] *Department of Economics, School of Business and Economics, College of Charleston, 66 George Street, Charleston, SC 29424, USA*
[b] *Department of Economics, University of Tennessee, Tennessee, SC 29424, USA*

Received 15 December 2000; accepted 19 November 2001

Abstract

While public goods are defined as non-rival and non-excludable, there are degrees of excludability. This paper reports on the results of a series of experiments designed to investigate the role of preferences on individual willingness to contribute to the provision of a group (excludable) versus a global (non-excludable) public good. The results of this experiment show that when the average per capita return (APCR) to society of the global public good exceeds the APCR to society of the group public good, individuals contribute more to the global good but do not reduce their contributions to the group public good.

JEL classification: C9 design of experiments; H4 publicly provided goods

Keywords: Public goods; Experiment; Voluntary contribution mechanism

1. Introduction

Pure public goods are defined as being non-rival in consumption and non-excludable (Samuelson, 1954); however, there are *impure* public goods due to the possibility of exclusion with space or distance often being the factor that determines exclusion. Some classes of goods are globally public, and others are only nationally or even locally public. In the limit, global public goods are available to the entire population of the world while local public

* Corresponding author. Present address: School of Business and Economics, College of Charleston, 66 George St., Charleston, SC 29424, USA.
E-mail address: blackwellc@cofc.edu (C. Blackwell).

0167-2681/02/$ – see front matter
PII: S0167-2681(02)00178-6

goods may be available only to the residents of a very small neighborhood. The spatial limits of the property rights to consumption of these goods determine whether the good is local, national, or global. Within the political process of budget determination, individuals will choose among contributions (e.g. assigning their tax payments) to global, national or local public goods.

A bias toward contributing to local needs has been noted by others. Indeed, Hirshleifer's (1983) motivation for his "weakest link-best shot" analysis was the observation that individuals respond more quickly to aid disaster victims when the victims are local. In Smith (1976, p. 383), he states, "Though our effectual good offices can seldom be extended to any wider society than that of our own country, our good will is circumscribed by no boundary, but may embrace the immensity of the universe." Smith accepts that while our sympathies may be broad, our capacity to do good is limited and we will devote it to those closer at hand.

The theoretical discussion in the literature has been unable to provide clear answers to the question of relative propensity to give to local or global public goods. Thus, it is useful to investigate the issue empirically. This paper reports on laboratory experiments designed to investigate individual voluntary contributions or donations to public goods when people can choose the good that receives their contributions. The goods differ as to the group that benefits. The experimental setting has two public goods, a pure (global) public good and an impure (excludable) public good. The behavioral data are examined to determine what happens to voluntary contributions when the relative return to the pure public good changes. The objective is to investigate the effects of the relative payoffs (preferences) between local and global public goods on individual willingness to contribute to these goods. The question that this research addresses is whether relatively higher payoffs to the global public good will induce higher voluntary contributions. A related question is whether individuals who provide for local public goods also contribute to global public goods.

The results of this experiment show that when the average per capita return (APCR) to society of the global public good exceeds the APCR to society of the local public good, individuals substitute contributions away from the local public good toward the global public good. That is, individuals can be persuaded to overcome the tendency to contribute to local public goods.

2. The institutional setting

Group and global public goods will be substitutes when each provides a similar service. For example, feeding the hungry can be accomplished through local, national, and global actions. Although the recipients may differ by scale, a given reduction in the overall level of hardship can be achieved via different geographic levels of contribution. The choice of where to contribute will depend, in part, on the expectation that the program will be sufficiently subscribed, making it effective. This conjecture will be affected by the marginal per capita return (MPCR) of the competing programs for hunger reduction.

In the United States, there are over one million registered non-profit charitable organizations. In 1999, these organizations had revenues of over US$ 600 billion, or 6.2% of

US GDP.[1] In addition to furnishing free services to the needy, many of these organizations provide goods with "public" aspects (i.e. goods that are to some degree non-rival and non-excludable). For example, the American Cancer Society uses much of its donations to fund research to improve cancer treatment. The information that comes out of this research is a public good—it is freely available to all (non-excludible), and some people consuming this information does not affect others' consumption. On the other hand, many charities provide benefits that are much more excludable and only accrue to residents of a neighborhood or community. One example is a treatment hospice for local individuals needing long term care.[2]

Andreoni (1988) argues that individuals derive utility simply from the act of giving. If that were the case, individuals would be indifferent between making contributions to the local or to the global public good. The results observed in the present experiments suggest that contributions are affected by expected returns and that, while some giving is motivated by "warm glow," that is not a complete explanation. If it is accepted that individuals have altruistic tendencies, the question that fundraisers confront is why an individual would choose to contribute to one charity over another. There may be innate biases toward organizations that provide local support. Alternatively, global organizations may enjoy greater status and thus receive more contributions.

Andreoni (1995, p. 891) argues that individuals have some charitable motivation when playing the public goods games, and he calls upon experimentalists to focus more on preferences for giving: "the focus on errors and 'learning' in experimental research should shift to include studies of preferences for cooperation as well." The idea of preferences including a taste for cooperation is powerful, and has not been fully explored by economists to date. One means of investigating the role of preferences is to require individuals to choose among contributions to more than one class of public goods, an aspect that has been largely ignored in the literature. This paper would appear to be the first to examine such a situation. At least three issues that previous research has addressed will be re-examined in this new environment. The first issue is changing the return to the public good, the second issue is changing group size, and the third is the effect of group identity.

3. Theoretical arguments

In this paper, we explore players' behavior in a multiple public goods setting. The institution developed to address this question is a finitely repeated game with identical stage games. We first describe the stage game and the theoretical predictions made by traditional game theory and other theories, and then we describe how the theoretical predictions change when the game is repeated. This discussion is primarily targeted to answer the following question: how will players' behavior change as the return to the global public good rises?

[1] These data are reported in Independent Sector, 2000, http://www.independentsector.org/.

[2] Other examples include support for food programs for local residents versus those that provide food for persons living in other countries.

3.1. The stage game

Consider a setting in which an individual chooses an allocation of wealth over a private good, a group public good, or a global public good. Both the group and the global public good are produced according to an additive production function. The return to the private good is higher than for either of the public goods. Thus, the dominant strategy is to contribute nothing to the public goods.

Define the following variables:

x_i: contribution of person i to his/her personal account,
g_i: contribution of person i to his/her group account,
G_i: contribution of person i to the global account,
α_g: individual return to the group public good, $0 \leq \alpha_g \leq 1$,
α_G: individual return to the global public good, $0 \leq \alpha_G \leq 1$, and $\alpha_G \leq \alpha_g$,
n: number of individuals in the local group,
N: number of total individuals, $n < N$.

If the individual seeks to maximize his/her individual payoff, subject to a budget constraint:

W_i: initial allocation of tokens,
W_i: $x_i + g_i + G_i$,
T_i: payoff to individual i,
T_i: $x_i + \alpha_g \sum_{j=1}^{n} g_j + \alpha_G \sum_{k=1}^{N} G_k$.

Players in this game do not have perfect information. They know their own allocations to each of the three accounts, but have only indirect knowledge of other players' contributions to these accounts. Specifically, each player knows only the aggregate level of contribution to each account in the form of a return from each account.

The Nash equilibrium for the stage game has each individual keeping all of his/her initial allocation of tokens and contributing zero to both of the public goods. The individual's return to contributing to either the global or group fund is never as large as the return to the personal fund. Therefore, it is a dominant strategy for every player to put all one's tokens in the personal account. Increasing the number of players who benefit from either the group or global public good has no effect on equilibrium contributions to either of those goods. Similarly, changing the return to either public good will have no effect upon contributions unless the return to the public good surpasses the return to the private good. This equilibrium result is as far as traditional game theory goes in making predictions about the stage game. However, as noted earlier, previous experimental results do not agree with these theoretical predictions.

There is an extensive literature reporting on the results of laboratory experiments investigating individual contribution toward public goods. Schneider and Pommerehne (1981) found that individuals tended to contribute to public good provision even when the dominant strategy Nash equilibrium was to contribute zero. Subsequent research has tended to confirm some positive levels of contribution even in settings where such behavior is plainly discouraged by the institutional design (Isaac et al., 1985; see also Ledyard, 1995, for a discussion).

Subjects in one-shot public goods games may behave differently from the traditional game theory prediction for at least three reasons: altruism, learning, and non-zero conjectures

regarding other players' contributions. Because many linear public goods games have the stage game Nash equilibrium at one end of the strategy space, there is always the issue of learning and mistakes. However, Andreoni (1995) shows that although mistakes do lead to contributions above the Nash equilibrium predictions, altruism also explains above Nash contributions.

A subject's altruism is conditional upon the public goods institution. Andreoni and Miller (2002) show that altruism is sensitive to cost, with many experimental subjects willing to give more when the cost of giving declines. Earlier research shows that subjects do respond to changes in the return to public goods. That is, altruism is conditional. Isaac et al. (1984) and Isaac and Walker (1988) looked at the effect of changing the return to the public good. In both these studies the authors found that increasing the marginal per capita return (MPCR, which in this setting is α_G or α_g) to the public good increased contributions to the public good. More recently, Brown-Kruse and Hummels (1993) confirmed this finding. These results strongly suggest that an increase in the return to one of the public goods will, all else being equal, increase contributions to that public good.

Anderson et al. (1998) examine altruism and learning in a linear public goods game with a single public good. They use McKelvey and Palfrey's (1995) 'quantal response equilibrium' approach to show that if players make logistic errors, then an increase in the return to the public good will cause an increase in equilibrium contributions to the public good. The quantal response approach predicts an impact from changing the return of the public good by weighting player's mistakes. The more painful the mistake, the less likely a player is to make that mistake. This result should apply in the multiple public goods game as well; when the return of one of the public goods rises, the cost of a "mistake" (contributing to that public good) falls, so players are more likely to contribute to that public good.

Anderson et al. (1998) go on to show that if players are altruistic, an increase in the number of players increases the equilibrium level of contributions to the public good. While Anderson et al.'s (1998) data confirm this prediction, not all research does; although Isaac et al. (1994) found evidence that with very large groups individual contributions increase, Isaac et al. (1984) found no support for a group size effect with small groups.

Anderson et al.'s (1998) model shows that altruistic players should increase their giving when that giving benefits more individuals. This result implies that altruistic players will have a preference to contribute to the global public good because $n < N$. Furthermore, if these altruists truly wish to benefit "society," then they will contribute more to the public good that provides the most social benefit. The total social return of a token contributed to the group public good is $n\alpha_g$, while the total social return of that token to the group public good is $N\alpha_G$. Altruists will contribute more to the global public good when $n\alpha_g < N\alpha_G$.

Cornes and Sandler (1996) discuss the implications for this type of public goods game if non-zero conjectures about other players' contributions are allowed. In the Nash equilibrium, the individual player should expect all other players to play their dominant strategy. If there is a chance that the other players may not play their dominant strategy, then the individual willingness to contribute is an increasing function of the conjectures that others will contribute. This arises from the fact that utility is increasing in the volume of the public good provided. As previously described, both field and laboratory observations suggest that individuals do not typically contribute zero to the provision of public goods. Since the return to each of the public goods is increasing in the level of total contributions,

individuals will prefer to contribute to the good that they conjecture will receive the wider support. As $\alpha_G < \alpha_g$, there may be more uncertainty as to the level of support for the global good. Thus, the behavioral prediction is that as α_G increases, this uncertainty will decrease, causing contributions to the global public good to increase.

3.2. The repeated game

In this experiment, the stage game is repeated with the same players in the same groups. Players do not know how many iterations of the stage game will be played, thus the probability that another round will be played is unknown to the players, although they know that this probability is non-increasing with the number of rounds played. Playing the stage game repeatedly dramatically expands the strategy space and introduces some other potential issues as well. Traditional game theory suggests that repeating the game transforms the 'competitive' nature of the stage game into a coordination game with multiple equilibria. Repeating the game also introduces the issues of reciprocity and fairness while increasing the potential effects of non-zero conjectures.

When the stage game is repeated the Folk Theorem[3] comes into play, and application of the Folk Theorem introduces multiple equilibria. Given how the set of equilibria expand with the repetition of the stage game, it may be more useful to think of the game as less a form of the prisoner's dilemma, and more as a coordination game. A trigger strategy can support multiple equilibria, with a continuum of contributions to the public good from 0 to 100%.[4] In the situation where there are multiple equilibria, some sort of refinement is necessary to make meaningful predictions. We propose several refinements: Pareto ranking, risk dominance, and focal equilibria.

The first potential refinement is to Pareto rank the equilibria. In our experimental setting, they can be Pareto ranked; the best equilibrium involves 100% contribution to one of the two public goods. This refinement predicts players will contribute to the public good that has the highest overall return. The parameters used in the experiment are such that $n\alpha_g \leq N\alpha_G$, implying that contributing 100% to the global account is always the Pareto efficient equilibrium. Note that a purely altruistic person would clearly be attracted to this equilibrium as it maximizes others' payoffs. The Pareto criterion does not seem to predict actual behavior well. Mehta et al. (1994) point out that coordination becomes more difficult as the strategy space expands, and this game has a large strategy space. In most repeated public goods experiments subjects fail to reach the Pareto efficient equilibrium. For example, van Huyck et al. (1990) show that in a weakest link coordination game, subjects are unable to coordinate on the Pareto efficient equilibrium. Seely et al. (1999) find that even when the Pareto efficient equilibrium is pointed out to players, they sometimes have trouble coordinating on that equilibrium.

van Huyck et al. (1990) also show that when choosing between Pareto dominance and risk dominance, subjects prefer risk dominance as an equilibrium refinement. In this game, risk dominance predicts that players will pick the least efficient equilibrium, the stage game

[3] See Fudenberg and Tirole (1991, Chapter 5) for a discussion of various Folk Theorems. The theorem states that essentially any set of strategies can be supported as an equilibrium if players are patient enough.

[4] See Pecorino (1999) for an application of the Folk Theorem to a repeated public goods game.

Nash equilibrium of 100% contribution to the personal account. The least likely equilibrium is the Pareto efficient equilibrium because it involves the most cost to the individual if other players do not also pick that equilibrium. In addition, the experimental parameters are such that $\alpha_G \leq \alpha_g$, so the costliest mistake is also to contribute to the global public good because it always has the lowest return to the individual.

Focal points of multiple equilibria (in the sense of Schelling (1960)) may offer better predictions. In this game, some potential focal points might be 100% contribution to personal account, 100% contribution to highest returning public good, equal contributions to all three accounts, and 100% contribution to group account. The last focal point seems particularly likely given our experimental protocol that has subjects assigned to a particular group and identified to all as a member of that group. When experimenters have attempted to induce a sense of group identity among experimental participants, subjects have responded by increasing contributions to the public good. Orbell et al. (1988) and Brown-Kruse and Hummels (1993) report this result, although they use different methods to create this sense of group identity. We predict this group identity effect should act as a focal equilibrium and concentrate contributions into the group account. Focal equilibria, risk dominance and Pareto ranking predict mutually exclusive outcomes; the first refinement predicts 100% contribution to the global public good, while the second predicts zero contributions for either public good, and the third predicts 100% contributions to the global public good.

Experimental studies support the proposition that, in addition to material gain, players value fairness, prompting numerous theorists to continue to work on theories incorporating it. Rabin (1993), Bolton and Ockenfels (2000), and Konow (2000) are good examples of these theories. In the context of this game, fairness will be difficult to explore because of the limited amount of information players have about each other's payoffs.[5] Players may have some beliefs about each other's payoffs, but have no way of actually acquiring the information. The fairness models above rely upon knowledge of all players' payoffs in order to make predictions about the future strategies chosen; in this experiment that information is unavailable. However, because $n < N$, players with a preference for fairness should prefer giving to the global public good. This giving would seem to spread the benefits of the public good more equally.

Not all information relevant to fairness is hidden from the players. For example, players can discover if at least one other player also contributed to either public good. This knowledge allows players to detect reciprocal behavior. Fehr and Gächter (2000) point out that reciprocity is not strategic; a player responds even if no material gain is expected. In Fehr and Schmidt's (1999) model of Fairness, Competition and Cooperation, the return to the public good has a (weak) positive relationship with contributions to the public good.[6]

The group public good and the global public good differ along two variables: number of individuals affected, and return to contributions made. These differences may have a

[5] For example, Bolton and Ockenfels's (2000) ERC theory requires that subjects know the average payoffs of the others players in the game.

[6] The conditions to make this statement true include a sufficient number of altruists within the group. If this critical mass does not exist, Fehr and Schmidt (1999) show that in a public goods game the ability to punish non-cooperators is necessary to enforce positive contributions to the public good. Without the ability to punish non-contributors, eventually even altruistic subjects negatively reciprocate and contribute zero.

dramatic effect when combined with a simple reciprocity model.[7] As noted previously, if subjects have non-zero conjectures about other players' contributions, the equilibrium can be moved from zero contributions to some positive amount. Suppose an individual believes that a one token contribution in the current round will induce the other members of the group each to contribute γ (where $0 \leq \gamma \leq 1$) tokens in response in the next round. Then the return to contributing to the group account in the next round will be $\gamma n\alpha_g$, while the return to contributing to the global public good will be $\gamma N\alpha_G$. The experimental parameters are such that $n\alpha_g \leq N\alpha_G$, implying there will be a general preference for the global public good, and as α_G increases, contributions to the global public good should increase as well.

In summary, a variety of theoretical approaches make differing hypotheses about the multiple public goods environment. Most of the theory and experimental results reviewed here (especially altruism and learning-based research) indicate that as the return to the global public good increases, contributions to that account will increase. Once subjects understand the game and its repeated nature, multiple equilibria are possible. Research on coordination generally predicts that it will be difficult for subjects to coordinate on a Pareto superior equilibrium. Arguments associated with focal equilibria and group identity predict that subjects will contribute more to the group public good than the global public good. At this point theories seem to point in different directions, making empirical exploration necessary.

4. Experimental design and setting

The focus of the laboratory setting is on public goods that differ by exclusion. One public good, called the global public good, is a pure public good and is totally non-exclusive. The second public good, which is designated the group public good, is exclusive to persons outside the local group.

Subjects are undergraduate students recruited from introductory economics classes at the University of New Mexico to participate in an experimental session. Each individual is assigned to a group identified by a color (red, blue, and black). A tag in front of each person identifies his or her group color. Each individual is also a member of the global group consisting of all subjects in the experiment. Individuals are endowed with a sum of money each period. They may keep the income for their personal account, allocate to the group (color) public good, or allocate to the global public good. They are informed of the payoff to each of these options. The experimental currency is tokens and the subjects are told that tokens will be converted to dollars at a particular rate at the end of the experiment. Subjects receive an initial income of 100 tokens each round, and the conversion rate at the end of the experiment is 100 tokens = US$ 1. All subjects know their own initial endowments and the endowments of all other subjects. In addition, the subjects know they all earn the same returns from the (group and global) public goods.

In all sessions, there are four persons per color group, and there are three color groups in the session. The instructions describe the accounts as follows. The first account, named the personal account, yields a one-to-one return in tokens. The second account, designated

[7] The authors thank James Konow for initiating the discussion that led to this section.

Table 1
Experimental treatments

Treatment (# of sessions, # of subjects)	Payoff to global public good		Payoff to group public good	
	MPCR to individual	APCR to society	MPCR to individual	APCR to society
1 (1, 12)	0.1	0.1	0.3	0.1
2 (1, 12)	0.15	0.15	0.3	0.1
3 (1, 12)	0.2	0.2	0.3	0.1
4 (1, 12)	0.3	0.3	0.3	0.1

the local account, is essentially a linear public good with a constant individual return of 0.3 tokens per token contributed and 1.2 tokens to the group. Thus, the marginal per capita return (MPCR) to the individual is 0.3, but the effective average per capita return (APCR) to the society of all subjects is only 0.1 (1.2 tokens divided by the 12 individuals that make up "society"). Although this return is not actually distributed to the entire society, it is a useful concept for the comparison of the relative payoffs to the group and the global public goods. The third account, the global account, has a return that varies across treatments, taking on four possible values. For the individual these values are 0.1, 0.15, 0.2, and 0.3. For this account then, the MPCR to the individual varies from 0.1 to 0.3, while the APCR to society also varies from 0.1 to 0.3. The experimental parameters are reported in Table 1.

These are hand-run experiments. The subjects enter their choices of allocation among the three options on a ballot that is collected by the person running the experiment. The allocations are entered into a spreadsheet program that computes the payoff to each of the separate accounts as well as the total for the subject for the round. The person running the experiment records these payoffs on the subjects' ballots, and the ballots are returned to the subjects so that they are informed of the outcomes. The subjects have a minute to review the information before a new round begins. The experimental session lasts for several decision rounds, and the individuals receive feedback, at the end of each round, as to their individual payoff from the group and the global public good. Subjects do not know the number of rounds they will play, and the issuing of new ballots each round reinforces this uncertainty. However, subjects are informed the experiment lasts approximately 1 h. In our session, two practice rounds and ten recorded rounds were run in each treatment.

5. Experimental results

5.1. Hypotheses

Three main propositions will be tested. Previous laboratory experimental studies (see Ledyard) have shown that individuals do generally contribute to the public good. Thus, proposition one is that contributions to both public goods will not be zero. The second proposition refers to how individuals within groups behave. To the extent that the subjects identify as being a member of their "color" group, they will have a preference for contributing to the group good. Smaller groups are expected to be more cohesive (the color identification

was designed to help create a group identity), leading to larger contributions to the group public good. Free riding in the smaller (color) group is also easier to detect and hence less likely to occur. For both of these reasons, individuals should contribute more to the group public good.

Further, as discussed earlier, we predict that as the relative payoff of the global public good to the group public good increases, so will subjects' contributions. Thus, proposition three is that the total contributions to the two public good accounts will be higher when the return is higher. From these propositions, a set of specific hypotheses is constructed:

Hypothesis 1. Individuals will contribute positive amounts to public goods.

Hypothesis 2. Individuals will prefer contributing to a group account.

Hypothesis 3. Individuals can be encouraged to contribute to global public goods by increasing the social returns to these goods.

Finally, contributions will fall over time as some (potentially selfish) individuals learn the dominant strategy in the stage game and as the likelihood of continued play diminishes. Other experiments have generally found that contributions decline over rounds.

5.2. Graphical presentation of results

The round-by-round results of these experiments are presented in Figs. 1–4. Fig. 1 reports contributions to the group account for each of the treatments. For three of the treatments the overall contribution levels to the group account are similar and are approximately 15 percent of the aggregate income. This result suggests that the group identity does matter and that the design of the experiment has established this identity. Further, the contributions to the group good appear to be unaffected by the return to the global good. These results are consistent with previous findings and provide additional support for a baseline

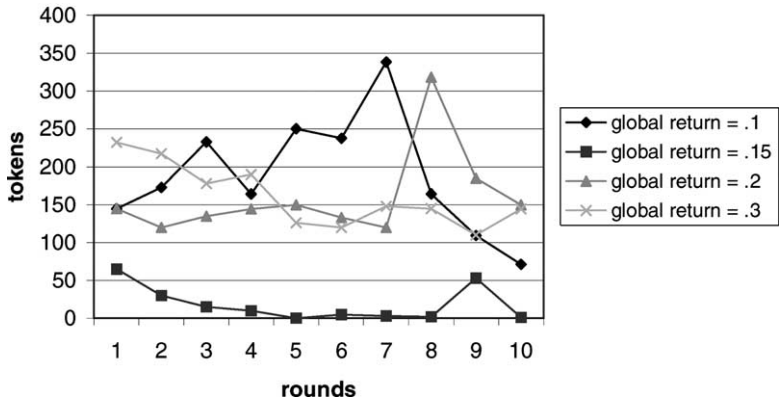

Fig. 1. Contributions to group account by global return.

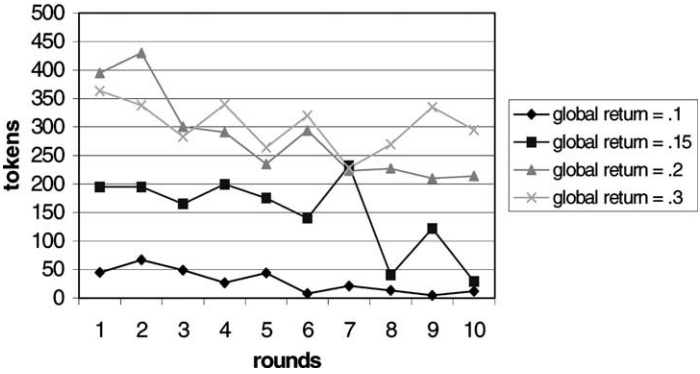

Fig. 2. Contributions to global account by global return.

level of giving. The typical erosion in contributions is weakly observed (except where the MPCR is 0.1).

Fig. 2 depicts the contributions to the global account. These clearly vary by the returns provided by the public good. The contributions to this account also decline over the rounds. The return to individual contributions rather than group identity would appear to be more of a determinant of contributions to the global account. The maximum contributions are 1200 tokens (12 subjects with incomes of 100 tokens each). It is clear that contribution levels to the global good are higher as the MPCR increases. In no treatment do contributions ever fall to zero. This figure shows there is a reluctance to contribute to the global account that arises when the return to the global and group accounts are the same. In fact, the aggregate contributions to the global good never exceed five percent of the total income of the subjects when the MPCR is 0.1. With larger relative returns to the global account, aggregate contributions increase substantially. Reluctance to contribute to a global account can be overcome through a higher individual return to this account.

Fig. 3 reports the combined contribution (as a fraction of income) to both public good accounts. Since the difference across the portfolios of accounts is determined by the return

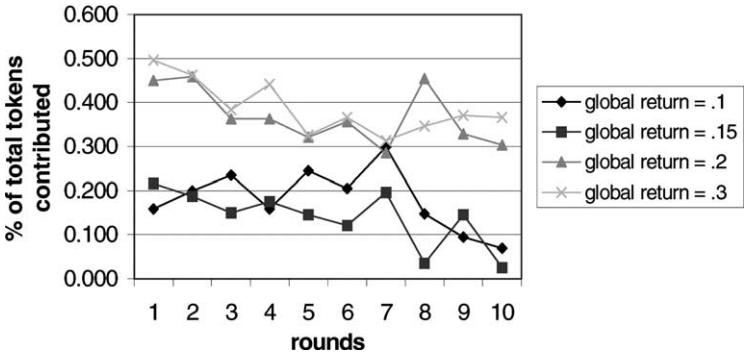

Fig. 3. Overall contribution ratio by global return.

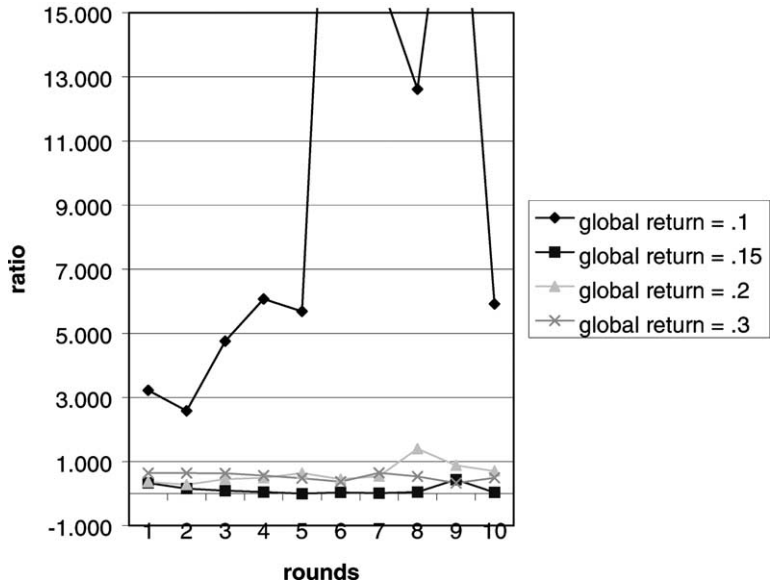

Fig. 4. Ratio of contributions between group and global accounts.

to the global account, the data are organized by this treatment. The overall contribution to public good accounts increases as the return increases relative to the private account; overall contributions rise as the payoff to contributing to public goods increases.

Fig. 4 reports the ratio of contributions between the group and global public goods contributions. The data show that there is a definite preference for the group public good when the payoffs are identical for the group and the global account. However, any advantage to the global account appears sufficient to induce the subjects to contribute to this account. Individuals choose to contribute to the good that has the higher marginal social return, and it appears that the subjects are fully cognizant of the payoffs in the different experimental settings. However, the results reported in Figs. 1 and 2 indicate that the group identity is sufficiently strong that there is not a decline in the level of contributions to the group account. The differences in the overall contribution rate are due to the effects of the global return.

5.3. Statistical results

The summary statistics of contributions by individuals to both the group and global public goods are reported in Table 2. Due to the nature of the data, the statistical tests are conducted using non-parametric analyses. A sign test (using first differences between rounds) confirms that aggregate contributions do decline over the rounds in the sessions. This test is performed by treatment on group account contributions, global contributions, and total contributions. In all cases, the hypothesis that contributions decline is not rejected.

Hypothesis 2 is tested using the relative contributions between the group and global accounts across the treatments. Given the parameters used in the experiment, contributions

Table 2
Descriptive statistics

Treatment	Statistics	Group	Global	Ratio	Contributed (%)
Overall	Mean	131.975	190.975	3.03	0.269
	S.D.	85.111	124.506	6.331	0.127
$\alpha_G = 0.10$	Mean	188.500	29.100	10.849	0.181
	S.D.	77.476	20.963	9.100	0.070
$\alpha_G = 0.15$	Mean	18.400	149.300	0.120	0.140
	S.D.	23.363	68.105	0.148	0.064
$\alpha_G = 0.20$	Mean	160.000	281.900	0.620	0.368
	S.D.	144.500	263.000	0.516	0.359
$\alpha_G = 0.30$	Mean	161.000	303.600	0.532	0.387
	S.D.	146.500	307.500	0.548	0.369

to the group public good should always be larger than contributions to the global public good. This can be expressed as $g^{\alpha_G} > G^{\alpha_G}$ for all α_G. This hypothesis is also tested with a sign test, and the results are given in Table 3. The results of this test do not support the hypothesis. There appears to be a preference for contributing to the group account only when the APCR (the return to all of society) is equal to that of the global account. When the APCR for the global good is greater than that for the group good, the subjects allocate the bulk of their public good contribution to the global good. However, they adjust by increasing their contribution to the global good while leaving their contribution to the group good unchanged.

Hypothesis 3 states that the contributions to the global account will increase as the MPCR increases. Specifically, contributions are predicted to increase by the treatment number. Let G^{α_G} be the contributions to the public good with return α_G. Hypothesis 3 can be stated as: $G^1 < G^{15} < G^2 < G^3$. To test this hypothesis a series of sign tests are performed between the contributions for each treatment. As these are a series of pair-wise comparisons, a family-wise adjustment is made to the critical P-value to $0.05/6 = 0.0083$. The results of these comparisons are shown in Table 4. The same comparisons are made for contributions to the group good (testing $g^1 < g^{15} < g^2 < g^3$) and overall contributions to the public goods $[(g+G)^1 < (g+G)^{15} < (g+G)^2 < (g+G)^3]$. Generally, the results support Hypothesis 3 as contributions to the global account increase when the payoff increases.

Table 3
Results of sign tests for Hypothesis 2

Comparison	P-value
$g^1 > G^1$	0.0000*
$g^{15} > G^{15}$	0.9990
$g^2 > G^2$	0.9893
$g^3 > G^3$	0.9990

* Indicates significance at the family-wise $\alpha = 0.05$.

Table 4
P-value results of sign tests for Hypothesis 3

Comparison	Contributions to global account	Contributions to group account	Total contributions
$C^3 > C^1$	0.0000*	0.3770	0.0000*
$C^3 > C^{15}$	0.0010*	0.0000*	0.0000*
$C^3 > C^2$	0.0547	0.3770	0.0010*
$C^2 > C^1$	0.0000*	0.8281	0.0010*
$C^2 > C^{15}$	0.0010*	0.0000*	0.0000*
$C^{15} > C^1$	0.0000*	0.9990	0.8281

* Indicates significance at the family-wise $\alpha = 0.05$.

Table 5
Contribution behavior

Independent variable	Dependent variable = group contribution	Dependent variable = global contribution	Dependent variable = total contribution
Round	−0.1861 (0.904)	−0.8546 (3.202)	−1.0408 (3.014)
Group (lagged)	0.1458 (8.511)	−0.0197 (0.890)	0.1261 (4.388)
Global (lagged)	−0.0257 (1.934)	0.1283 (7.452)	0.1026 (4.607)
MPCR global	37.2918 (4.852)	72.2208 (7.250)	109.5126 (8.498)
R^2	0.11	0.24	0.18
F-statistics	19.12	51.45	35.86

However, except for the comparisons involving the MPCR of 0.15, the contributions to the group account are not statistically different across treatments.

Table 5 reports the results of a series of regression models investigating the determinants of contributing to the group and the global public goods. It appears that individuals do respond to the MPCR as well as the past behavior of the other participants. Contributions to the group good are increasing in the past contributions of the others in the group and are negatively related to contributions to the global good. In general, contributions to the global good decline over time but those to the group good do not. Total contributions decline over time suggesting that the global good effect dominates.

6. Discussion

Clearly, the MPCR of the global public good has an impact upon contributions to that good. This experimental design does not allow us to address the specific reasons for this phenomenon. As previously noted, theories incorporating altruism, learning, co-ordination, reciprocity and non-zero conjectures all predict a positive impact on contributions from raising the MPCR. There is evidence that some individuals may act altruistically. There is also evidence that some subjects will act strategically and reciprocate kindness. A combination of these two tendencies may explain the observed behavior.

If subjects are using this strategy of some altruism and some reciprocity, then the returns to the global public good are perceived as much higher than the returns of the group public

good. It may be these conjectured higher returns and not simply the average per capita return, that are driving the results. This explanation rests on the implicit assumption that a one token contribution by an individual induces the same level of individual response in both the group and the global public goods. Then, it follows that the larger population in the global account would yield a larger response. Future research can address the validity of this assumption.

This design makes it difficult for subjects to coordinate. The group account contributions seem most stable, even though a larger amount of contributions are made to the global account. We would expect the two public goods to be substitutes and subjects to learn which public good to coordinate on as the experiment progressed. The data show no evidence of this. Instead, contributions to the global public good decline over rounds, and the ratio of global to group stays fairly constant. Contributors to the group public good seem more cohesive, if less enthusiastic, than contributors to the global public good. None of the extant theories seem able to explain this pattern of behavior.

Some combination of learning, altruism, coordination and reciprocity explains these results, although each effect cannot be separated with this experimental design. However, this experiment shows that these effects can create surprising results in a multiple public good setting, and hence, this setting should be studied further.

7. Conclusions

There are several ways to interpret the results of this experiment. All interpretations involve a choice of exclusion in some way. One interpretation is that citizens choose to contribute to public goods that are provided locally or globally based on the returns. The original hypothesis was that individuals have an innate bias toward contributing to local public goods. A follow-up hypothesis was that this bias could be overcome if the return to the global public good is made sufficiently high. However, the evidence from this experiment seems to indicate that the relative returns to the individual do not provide much explanatory power. It could be that the change in MPCR between group and global goods is not as important as the difference between the returns to society. Or it may be that some combination of reciprocity and altruism causes the perceived returns to the local and global public goods to differ sharply. In either event, it is clear that the relative returns of the two public goods had an impact upon contributions.

Where individuals have the option of contributing to different charities, it is important to understand the basis of their choices. The results of these experiments suggest that there is a baseline level of support for local or group goods. When the payoffs to global goods are higher, the contributions to these increase, but the increase comes at the expense of the private account, not the local or group account. This is an important insight for local fundraising activities since the global goods do not appear to crowd out the local good. Thus, any complementarities in fundraising between the goods should be exploited because growth in the global good does not imply a loss of contributions to the local good. This has interesting implications for the way hunger organizations, National Public Radio, and other not-for-profit or charitable enterprises design their fundraising programs.

Acknowledgements

An earlier version of this paper was presented at the March 2000 meetings of the Public Choice and Economic Science Association meetings in Charleston, SC. We thank session participants and James Konow, in particular, for helpful comments. An anonymous reviewer provided several comments, which led to an improved final product. We also thank Therese Cavlovic, Chris Brunder and Carmen Nash for help running the experiments. Partial funding was provided by the Student Research Allocation Committee of the University of New Mexico.

References

Anderson, S.P., Goeree, J.K., Holt, C.A., 1998. A theoretical analysis of altruism and decision error in public goods games. Journal of Public Economics 70, 297–323.

Andreoni, J., 1988. Why free ride? Strategies and learning in public goods experiments. Journal of Public Economics 37, 291–304.

Andreoni, J., 1995. Cooperation in public goods experiments: kindness or confusion? American Economic Review 85, 891–904.

Andreoni, J., Miller, J.H., 2002. Giving according to GARP: an experimental test of the rationality of altruism. Econometrica 70, 737–753.

Bolton, G.E., Ockenfels, A., 2000. ERC: a theory of equity, reciprocity, and competition. American Economic Review 90, 166–193.

Brown-Kruse, J., Hummels, D., 1993. Gender effects in laboratory public goods contribution: do individuals put their money where their mouth is? Journal of Economic Behavior and Organization 22, 255–267.

Cornes, R., Sandler, T., 1996. The Theory of Externalities, Public Goods, and Club Goods, 2nd ed. Cambridge University Press, Cambridge, MA.

Fehr, E., Gächter, S., 2000. Fairness and retaliation: the economics of reciprocity. Journal of Economic Perspectives 14, 159–181.

Fehr, E., Schmidt, K., 1999. A theory of fairness, competition and cooperation. Quarterly Journal of Economics 114, 817–868.

Fudenberg, D., Tirole, J., 1991. Game Theory. MIT Press, Cambridge, MA.

Hirshleifer, J., 1983. From weakest-link to best-shot: the voluntary provision of public goods. Public Choice 46, 221–231.

Independent Sector, 2000. Nonprofit Size and Scope. http://www.independentsector.org/, Accessed 7 August 2000.

Isaac, R.M., Walker, J.M., 1988. Group size effects in public goods provision: the voluntary contributions mechanism. Quarterly Journal of Economics 103, 179–199.

Isaac, R.M., Walker, J., Thomas, S., 1984. Divergent evidence on free riding: an experimental examination of possible explanations. Public Choice 43, 113–149.

Isaac, R.M., McCue, K.F., Plott, C.R., 1985. Public goods provision in an experimental environment. Journal of Public Economics 26, 51–74.

Isaac, R.M., Walker, J., Williams, A., 1994. Group size and the voluntary provision of public goods: experimental evidence utilizing large groups. Journal of Public Economics 54, 1–36.

Konow, J., 2000. Fair shares: accountability and cognitive dissonance in allocation decisions. American Economic Review 90, 1072–1091.

Ledyard, J.O., 1995. Public goods: a survey of experimental research. In: Kagel, J., Roth, A. (Eds.), The Handbook of Experimental Economics. Princeton University Press, Princeton, NJ, pp. 111–181.

McKelvey, R.D., Palfrey, T.R., 1995. Quantal response equilibria for normal form games. Games and Economic Behavior 10, 6–38.

Mehta, J., Starmer, C., Sudgen, R., 1994. Focal points in pure coordination games: an experimental investigation. Theory and Decision 36, 163–185.

Orbell, J., van de Kragt, A., Dawes, R., 1988. Explaining discussion induced cooperation. Journal of Personality and Social Psychology 54, 811–819.

Pecorino, P., 1999. The effect of group size on public good provision in a repeated game setting. Journal of Public Economics 72, 121–134.

Rabin, M., 1993. Incorporating fairness into game theory and economics. American Economic Review 53, 1281–1302.

Samuelson, P., 1954. The pure theory of public expenditure. Review of Economics and Statistics 37, 350–356.

Schelling, T., 1960. The Strategy of Conflict. Harvard University Press, Cambridge, MA.

Schneider, F., Pommerehne, W.W., 1981. On the rationality of free riding: an experiment. Quarterly Journal of Economics 76, 689–704.

Seely, B., van Huyck, J., Battalio, R.C., 1999. Credible Assignments and Coordination Failure in Laboratory Public Goods Games. Working Paper.

Smith, A., 1976. The Theory of Moral Sentiments. Liberty Press, Indianapolis, IN.

van Huyck, J.B., Battalio, R.C., Beil, R.O., 1990. Tacit coordination games, strategic uncertainty, and coordination failure. American Economic Review 80, 234–248.