

Voluntary Provision of Public Goods: An Experimental Economics Study

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Abstract: An economic experiment examined conditions that increase voluntary contributions to a public good. Three groups of university students participated. Points were allocated to either a fund where the points were returned at the end of the round or to a fund that could return substantially more points, but divided them equally among all players. Information about the game and about public goods increased voluntary contributions slightly. Increasing the number of players that could communicate about contribution levels increased contributions. Assurance that other players actually contributed what they promised increased contributions in some instances. The most significant increase in voluntary contributions was due to membership in a group (fraternity in this case) which gave players important ties beyond the experiment. Possible implications for public policy are discussed.

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Introduction

Public Goods have long been recognized as an example of what some call market failure. The non-rival and non-excludable characteristics of public goods make it nearly impossible for would-be producers and consumers of the good or service to interact in a market in such a way that the outcome is socially efficient (Hartwick and Olewiler). The characteristics of a public good make it possible for individual consumers to enjoy the benefits of consuming whatever amount of the good is produced without helping to pay the costs of producing the good. The likelihood of such free-riding usually leads to the conclusion that some form of coercion is needed to require those who benefit from consuming the public good to pay something toward covering the costs of producing the good. In the usual case, government with its power to tax is chosen as the agent to provide the public good and to levy taxes to pay the costs.

Yet, there are notable examples of public goods that are provided without government intervention, though admittedly not at the socially optimal level. Any time the marginal benefit to an individual exceeds the marginal cost of producing one or more units of a public good, we can expect to see that amount produced. The providing individual reaps a benefit equal to or in excess of the costs of producing that amount of the public good and the remaining interested individuals may free-ride, consuming the good without payment.

In other cases we can observe individuals paying for the provision of goods and services consumed by others. In these cases of charitable giving it is assumed that the contributors receive some satisfaction from the act of giving or the improved welfare of the recipients. Charitable giving is often associated with providing private goods and services-food, clothing or shelter-to those less financially fortunate than the contributor. But, charitable giving need not be restricted to providing private goods; provision of public goods is also supported by voluntary contribution. An example in the United State is the Public Broadcast System, which relies in significant part on voluntary contributions from individuals who, if they chose to, could watch whatever program was provided without contributing. Another example is found in contributions to organizations which provide protection for natural areas or particular species of wildlife. The continued existence of the protected objects is a public good. Many charitable acts are considered to have improved the social milieu and thus, to have provided a valued benefit to everyone. It is possible for individuals to free-ride on the provision of this social milieu whether or not they consume the particular item provided by charity-free meals or non-commercial television. (A more detailed account of concepts associated with this topic may be found in Sugden (1982 and 1993) and in Cox.)

Research Question

The observation that public goods may be provided voluntarily by individuals in certain circumstances raises the question: What conditions encourage voluntary contribution to the provision of a public good? Further, might it be possible to manipulate the conditions that lead to voluntary provision so that we may rely upon voluntary contributions to provide a broader

array of public goods? Possibly environmental qualities, such as improved water quality or air quality in specific areas, could be provided voluntarily rather than relying on coercion or developing special market-like institutions, such as traded permits enforced by coercion. Answers to these questions can be obtained in a variety of ways. We chose to begin our inquiry by conducting an economic experiment.

Hypotheses

1. Knowledge of the nature of public goods and the benefits which may accrue to the provision of greater amounts of a particular public good may encourage people to contribute voluntarily. Further, information about the contribution process, in this case the procedures of the experiment, is expected to encourage a greater level of voluntary contribution. **We, therefore, hypothesize that increased levels of information and knowledge will lead to greater voluntary contribution to a public good.**
2. Communication among participants can be a source of information as individuals share their knowledge of the provision of public goods. Communication among participants may also be used for psychological purposes to create an atmosphere conducive to giving or to build a feeling in others of an obligation to contribute. **We hypothesize that increased levels of communication among the group will lead to greater voluntary contribution to a public good.**
3. Many people have a strong sense of fair play. They resent cheating, especially if others gain advantage over them by not following the rules or agreements. Many people are more likely to contribute to the provision of a public good if they can be certain that others are also contributing. **We hypothesize that providing assurance that others are contributing will increase the level of voluntary contributions to a public good.**
4. Some of the highest levels of voluntary contribution to the welfare of others are observed among members of groups which provide mutual help and an extensive web of relationships among members. This includes certain religious groups whose members live close to each other and have very limited contact with people outside their community. In such communities, failure to conform to the group standard on one issue endangers all of one's relationships in the community. A serious breach of expectations may result in having the rest of the community sever all ties with the violating individual. Exile and shunning are examples of such punishment. **We hypothesize that groups with an extensive web of relationships will exhibit greater levels of voluntary contribution to a public good.**

The Experiment

The economic experiment employed a game in which participants allocated points so as to increase their monetary reward from participating in the game. Hypotheses were tested by

combinations of controls on the membership of the groups playing the game and the rules under which the game was played. We recruited three groups of undergraduate students at Penn State University. For each group we recruited nine participants, though in two cases fewer participants showed up for the experiment even though we had recruited extra members to allow for no-shows. Thus, we had one group of nine participants, one group of eight and one group of seven. We were able to rearrange the experimental setting to accommodate the smaller groups and maintain the essential elements of the experiment.

In recruiting participants, we promised that each person chosen to participate in the experiment would be guaranteed to receive \$10 for about two hours of their time. They were told that their play of the game could result in a significantly higher reward, but they would receive at least \$10 regardless of their play. Two of the groups were recruited from an undergraduate course that introduced students to environmental and resource economics (course groups). These students were promised a nominal number of extra credit points for the course in addition to the \$10 guarantee. While these students were all from the same course, the course enrollment was large and most of the students in the course either did not know each other or had only a few common student organization memberships. (The experiment took place before the topic of public goods was discussed in the course.) The third group was recruited from a social fraternity at Penn State (fraternity group). The members of this group had a variety of academic interests and did not have any particular connection to environmental issues. A fraternity group was chosen to provide a group with a significant web of relationships outside of the experiment. A fraternity provides a number of communal decisions where individuals contribute; in some cases the contribution is required and the amount specified, while in other cases contribution is voluntary. Thus, the members of this group were also experienced in voluntary contribution to public goods, though it is doubtful that any of them would have used the economic terms to describe their experience.

We varied the rules of the game and the information we provided to test other characteristics hypothesized to determine levels of contribution. Each group had an opportunity to play a few rounds of the game before the experiment started. For two of the groups, information about public goods and the advantages of contributing to the provision of public goods was provided in a short hand-out and discussion. One of the course groups served as the control on information—they were provided only a brief introduction to how the game is played, but no information about public goods. The second course group was given instruction on how the game is played and information about how contributing to the public good can increase one's reward. The information included three short examples where the participants were led through a calculation of the number of points they would receive under various levels of their contributions and those of other players. The fraternity group was given the basic introduction to how the game is played plus a short presentation reminding them of situations in fraternity life that are similar to public goods.

Variation in the levels of communication and the assurance that others contributed was provided by systematically varying the rules of play during the experiment for each group. The

level of communication was expanded in three steps during the experiment and a method of assurance about the level of each participant's contribution was introduced near the end of the experiment.

Rules of the Game

The experiment was presented as a game. Each group met at a different time and each group was seated around a U-shaped table with three participants on each of the three sides of the table. Each person was identified by a placard with a letter at his or her position. Letters were from A to I inclusive for the group with nine participants. The letter I was removed for the group with eight participants and the letters H and I were removed for the seven person group. Movable chairs were provided for the participants. This permitted them to shift easily from a spacing where each person could write without neighboring players being able to read what was written to a spacing where three players on one side of the U-shaped table could converse without being heard by players in other sub-groups.

The play of the game consisted of three sets of 10 rounds in each set. That provided 30 rounds in total for each group. Each player received 25 points at the beginning of each set. The players were to decide in each round how many points to place in a Private Account and how many to place in a Group Account. All available points had to be allocated to an account. This allocation was indicated by writing the number of points to be contributed to each account on a form that was handed to a game marshal in each round. The points contributed to the Private Account were returned to the player at the end of the round. The points contributed to the Group Account by all of the players was totaled, multiplied by 1.5, and the resulting total divided equally among all players regardless of their level of contribution to the Group Account. Thus, the Group Account acted as a public good (non-rival and non-excludable) whose magnitude depended on voluntary contribution. The multiplication factor was chosen to provide a significant, but not overwhelming advantage to contribution to the Group Account. The amount of the Group Account payout for the round was added to each individual's contribution record, added to the number of points contributed to the Private Account in that round, if any, and returned to the appropriate player. The total number of points at the end of each round was the number of points a player had available to use in the next round. Play continued for 10 rounds. At the end of each set (10 rounds) the total points for each player were recorded and a new set of 10 rounds began with each player receiving 25 points to begin play.

The first set of 10 rounds was conducted with no communication among players. Each individual acted alone in deciding his or her level of contribution to each account. In the second set of 10 rounds the players were divided into three sub-groups of three players each. When there were fewer than nine players, some sub-groups consisted of two players. Members of a sub-group (seated together on one side of the U-shaped table) could discuss strategy about contributing to the two funds, but they moved apart to record their own decision on their contribution form. This means that there was communication among a limited set of the players, but each individual's contribution was confidential. Players had no assurance that other members of their group actually contributed according to any agreement they had reached.

In the third set of 10 rounds, players were permitted to discuss strategy with all of the other players. Again, they marked their contribution forms in secret. Up to this point, players could not be certain what other individuals contributed to the Group Account. But, several of them were able to calculate what the pay-out from the Group Account would have been had all complied with the agreed level of contribution and to note that there was free-riding, even with communication among the entire group. At the completion of round 5 of the third set, assurance was introduced for each group. It was then announced that for the remaining five rounds the contribution of each player would be posted where it could be seen by all players. In this way, players could determine if anyone did not follow any agreements reached during the discussion period.

During the entire experiment, after each round, players were asked to write their thoughts and observations on a sheet of paper provided for that purpose. Most players recorded their thoughts for at least some of the thirty rounds that they played and some provided comments after almost every round. These written comments often reveal that the individual knew the advantages to free-riding and several cases of frustration when a player realized that people were not cooperating or following agreements. At the end of the third set the points for each player were totaled and the players were paid one cent per point, with a minimum payment of \$10.

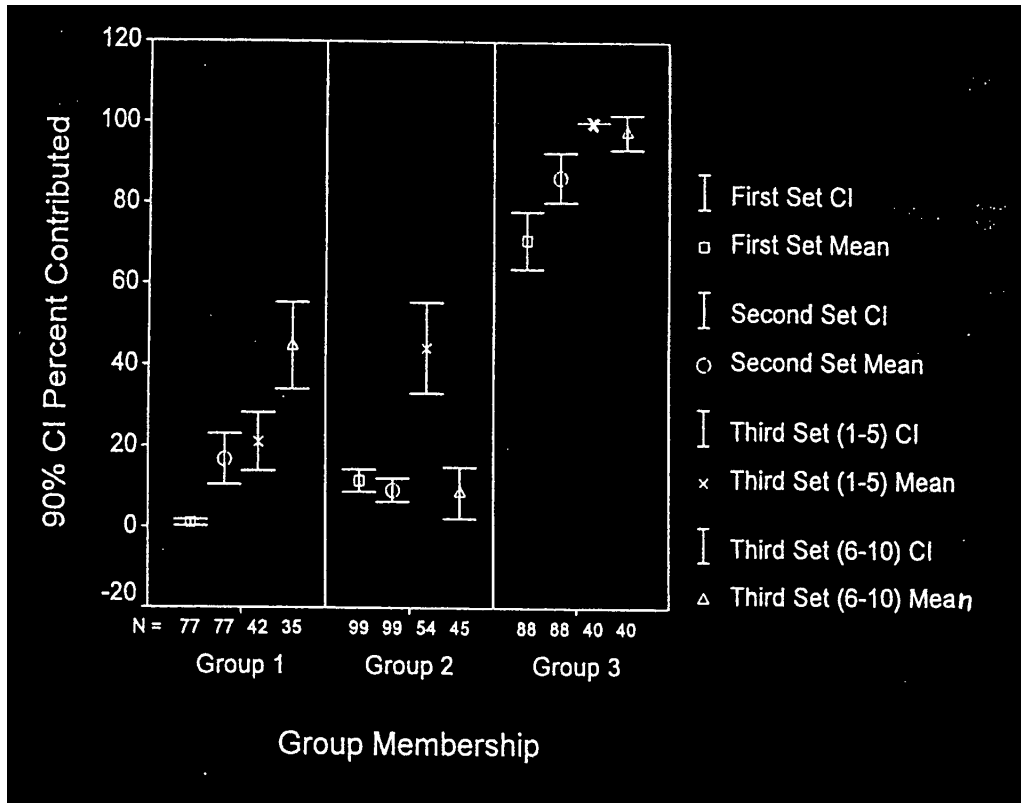
Results of the Experiment

The results of the experiment are shown in Figure 1. (While the hypotheses are worded in a positive manner in this paper, the statistical analysis was conducted on null hypotheses in each case.) The most immediately obvious result is the much higher levels of contribution to the Group Account by the members of Group 3. Starting with the first set the mean contributions of Group 3 to the Group Account were statistically significantly higher than for either of the other two groups in any set. (Non-overlapping confidence intervals was used as the statistical test.) In the third set (rounds 1-5) every member of Group 3 contributed 100 percent of his points to the Group Account. The slightly lower mean for rounds 6-10 of Set 3 (with posting of the contributions of each player) is explained by a few players' actions during Set 2. In the last round of Set 2 four members placed their point allocation entirely in the Private Fund. Player commentary diaries indicate that they realized they could make more money by waiting until the last round of the set to renege. In Set 3, one player remembered what had happened in Set 2, assumed that other players might renege in the last round of Set 3 as well, and determined to beat the other players to free-riding by placing all of his points in the Private Account in the ninth round. He announced this intention during the group discussion, but most players did not believe him. When he did as he announced and his allocation was posted, significant discussion erupted. His decision made it possible for him to end the game with substantially more points than the other players. It is probably sufficient to note that he was strenuously reminded of his obligations as a member of the fraternity. His remedy was to put all of his points into the Group Account in the final round, which restored everyone's point total to what it would have been had he not been a free-rider in Round 9.

All of the outcomes with Group 3 compared to Groups 1 and 2 suggest that prior experience with voluntary contributions to a public good and a network of relationships among those in the group leads to significantly higher levels of contribution during the experiment. Tests of other hypotheses compare outcomes both within and across groups.

The role of information about public goods and the advantages of contributing to the Group Account in this experimental game is reflected in the difference in the mean contributions in Set 1 for the three groups. The Set 1 average contribution to the Group Account for Group 2 is significantly higher than for Group 1. Set 1 was played immediately after Group 2 received brief instruction about public goods. Group 1 received no information. The information given to Group 3 was to point out the public goods nature of some of their fraternity activities and the similarity of the Group Account to some of their fraternity activity funds. The mean contribution for the members of Group 3 in Set 1 is significantly higher than that of either Group 1 or Group 2. Whether this is due to an interaction of the information with experience or just the effect of experience cannot be determined with the available data.

If one examines the difference in mean contributions between Set 1 and Set 2 within a given group, we notice that Group 1 significantly increased their contributions in Set 2, although still not at a very high level. Comments made by some of the players indicate that even though they had some practice rounds before beginning Set 1, they really did not understand how the rules of the game could be used to their advantage until they had experimented a bit during Set 1. This type of learning may account for the insignificant difference between the average contribution of Group 1, Set 2 and Group 2, Set 1 (which followed instruction on public goods and the game).



The breadth of communication increased from set to set for each group. The increase in communication between Set 1 (no communication) and Set 2 (communication in sub-groups) was accompanied by increased contributions to the Group Account in Groups 1 and 3, but not in Group 2. The mean contribution by Group 2 was not significantly different between Sets 1 and 2 which seems to have been the result of players free-riding during Set 2. Of the nine players in Group 2, eight placed some or all of their points in the Private Fund in each round of Set 2. One player contributed all points to the Group Fund in the first round and then switched to placing some points in the Private Fund in each subsequent round. The free-riding was so extensive that the comments players wrote indicated either that they were taking advantage of other players (written by the free-riders) or that they knew they were being taken advantage of by other players. For the first three rounds the contributions to the Group Fund were sufficient to return more points to the contributors than they had placed in the Group Fund, even though the payout was less than if all points had been contributed by everyone. In round 4 one player decided to switch to free-riding. This dropped the payout of the Group Fund received by donors to less than the points they had contributed. All players changed their contributions to the Group Fund to zero or nearly zero for the remainder of Set 2. By the time Group 2 reached Set 3, any sense of community among the players was severely damaged. Even so, in the first few rounds some players in Group 2 contributed all of their points to the Group Fund, but many were free-riding. By round 5 everyone was placing everything in the Private Account. When the contributions of each player were posted starting in round 6, there were a few more contributions to the Group Fund, but nearly all points were contributed to the Private Fund in the last 4 rounds of Set 3.

Group 1 did not exhibit an increase between Set 2 and the first half of Set 3, but the introduction of posted contributions at round 6 of Set 3 produced a significant increase in contributions to the Group Fund. Still, the average of those contributions was barely 50% of the total points available. Group 3 had significant increases in the level of contribution from Set 1 to Set 2 and from Set 2 to Set 3. The last five rounds of Set 3 were discussed above.

Posting each player's contribution to the Group Fund had a significant positive effect on Group 1, no direct effect on Group 3 (they were at the 100% level of contribution already), and Group 2 experienced a significant drop in contribution level. The experiment developed in such a way that it did not really test the role of assurance, since Group 2 became extremely competitive and Group 3 was so cooperative that there was little room for assurance about contributions to increase the level of contribution to the Group Fund. Assurance did permit the members of Group 3 to identify the one member who did not contribute to the Group Fund in round 9. In this way assurance helped even this close-knit group maintain solidarity.

Conclusions

Hypothesis 1-the role of information. We found a statistically significant, but small, effect where information increased contributions, at least initially.

Hypotheses 2-the role of communication. Broader communication gives greater levels of contribution to the Group Account. This finding has exceptions, as Group 2 showed that even communication among a broader group does not always produce greater cooperation. In fact, some of the player comments suggest that in Set 2, where players communicated within sub-groups, some players learned the advantage to the individual from free-riding from other members of their sub-group. Even so, the contributions to the Group Fund by players in Group 2 increased significantly when communication widened during the first half of Set 3.

Hypothesis 3-assurance that others are contributing the agreed amount will increase levels of contribution. The test of this hypothesis was confounded by other factors. Group 1 showed the expected increase. Contributions in Group 2 had fallen to nearly zero as free-riding was so frequent as to destroy any expectation of cooperation in contributing to the Group Account. Group 3 was already contributing 100% of their points to the Group Account before assurance was introduced.

Hypothesis 4-experience with public good provision and a network of relationships among group members will increase contributions to the Group Account. The experiment showed this to be the variable with the strongest impact on the level of Group Account contributions. The fraternity group contributed the highest percentage of points to the Group Account in each Set and was able to avoid the poisoning effects of free-riding, although individuals occasionally experimented with free-riding. (The members of one sub-group and one additional member reneged on the last round of Set 2.) Comments recorded by the players noted

that, although they could determine that some players were free-riding or at least contributing less than they agreed, they knew from their fraternity experience that group cooperation was best for everyone. Once Group 3 reached a 100% contribution level, the members of the group were extremely vehement toward the individual who put all of his points into his Private Account in the next to last round of Set 3. The players did not take time to write down their reactions; they addressed them pointedly to the individual who had been identified in the posted contributions. Frequent reference was made by other players to the proper behavior toward one's fraternity brothers. It was clear to an outsider, as well as to the players, that membership in the fraternity and the many different relationships they shared were supposed to induce individuals to behave for the good of the group. Those appeals and the fraternal ties appear to have worked in the experiment.

Implications for Public Policy

Even if the results in this experiment were clear and overwhelmingly statistically significant, one cannot safely base policy or draw definitive conclusions from one small study. Additional research, both experimental economics and other forms of data collection and analysis, is needed before one will feel confident that the true relationships are established. Still, some interesting observations may be made relating the results of this single study to possible policy applications.

The strongest finding of the experiment is that interwoven community relationships support voluntary contributions to a public good. Examples of such community relationships that are associated with voluntary support include local fine arts presentations, such as concert series or art museums where patrons provide significant support, though usually not complete support. Applying this result to an environmental topic, one can contemplate a locally produced air or water pollution problem that affects most of the individuals. For instance, a small lake surrounded by residences that rely on septic tanks for sewage disposal and the effluent from these tanks so enriches the lake water that algae blooms are frequent and create a disagreeable situation for all residents. One could expect that such a lake community might be more likely to solve the problem with voluntary contributions to an alternative means of sewage disposal if the community is close-knit with all people participating in a variety of activities-community festivals, attend the same local church, and frequent picnics or other social gatherings among the community members.

Assurance is frequently employed in voluntary contribution efforts by posting a list of donors, usually in categories of level of support, or by announcement of the gift at the time it is made in the case of public broadcasting solicitation drives. Using the lake community example described above, one could expect that a policy of listing the names of donors-to-date would further encourage voluntary contributions to the new sewage disposal project.

Experience, communication, and knowledge of the ways voluntary contribution plans

might work as well as knowledge of the specific problem showed some association with increased voluntary contributions. Again relating this finding to the hypothetical lake community, one could expect that a close-knit community would more easily discuss significant issues since the people of such a community interact often and in a variety of ways. If a few individuals have appropriate information (such as the efficacy of a particular method of sewage disposal) and can provide it in informal settings, it is likely that the information will be received and considered more seriously than if the same information were presented by an outsider. Also, prior experience with working together as a community to achieve a goal (e.g., getting the local government to pave the road to the lake community, or crafting an agreement on how early in the morning motor boats can be used on the lake) will likely increase the ease of using voluntary contributions to fund an agreed-upon solution.

It is less likely that the voluntary approach can be used with widely dispersed groups or with individuals who have few ties with each other. The mobility of people in this country (especially as they commute to many different jobs, churches, shopping centers, and children's activities) makes it difficult to establish the broad array of interconnections that seems needed to support voluntary provision of collective or public goods. Perhaps the challenge for social scientists is to examine from a number of disciplinary perspectives the social usefulness of stronger community ties and ways to develop such ties in an otherwise disconnected society.

Comment on Method

The structure of the experiment may have influenced at least one of the results. The monetary incentive to participate was provided in two parts. One provided players a reward (one cent per point) based on the outcome of their play in the game. The other was a guarantee that they would receive at least \$10 for participating. The players in Group 2, and to a much lesser extent the players in Group 1, realized by the time they reached Set 3 that it was extremely unlikely that their payout at the end of the game would reach \$10. Thus, they would receive the guaranteed amount regardless of how they played in the last set. This may have contributed to the high level of free-riding which produced little or no return since all players were trying the same strategy.

A more incentive compatible reward mechanism would have been to establish a fixed payment for participating and allowed the play of the game to determine how much extra compensation the players received. Since a given player's payout depends heavily on the strategy and conduct of other players, the base reward must be large enough to appropriately compensate for the time spent in the experiment without obliterating the incentive to continue honest play of the game.

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