Classroom Games

Voluntary Provision of a Public Good

Charles A. Holt and Susan K. Laury*

Abstract: This paper describes a simple public goods game, implemented with playing cards in a classroom setup. Students choose whether to contribute to the provision of a public good in a situation where it is privately optimal not to contribute, but socially optimal to contribute fully. This exercise motivates discussion of altruism, strategies for private fund-raising, and the role of the government in resolving the public goods problem.

Keywords: public goods, altruism, voluntary contributions, experimental economics, classroom experiments.

Introduction

The provision of a public good is a social dilemma that is universally covered in microeconomics classes. This paper describes a simple card game that can be used to introduce students to the conflict between individual incentives to free-ride and social incentives to contribute toward the provision of a public good. This exercise is a natural way to motivate discussion of altruism, strategies for private fund-raising, and the role of the government in resolving the public goods problem. The card game described below can be used in a variety of classes, including introductory economics, public economics, and game theory. We have also conducted this exercise in an applied statistics class to generate data that were used to test hypotheses about the effects of gender, group discussion, and monetary incentives on the amount of observed cooperation.

Procedures

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A deck of playing cards can be used to collect students' decisions quickly and privately. It only takes a few minutes to distribute the cards and read the instructions contained in the Appendix. The instructions are short enough to fit on a single page, together with the Earnings Record Form.[1] Photocopying this page and sorting the cards (as described below) are the only advance preparations required. The entire exercise and the follow-up discussion can be completed in about thirty minutes, although somewhat more time may be required in a larger class.

Begin by passing out the instruction sheets and giving each student four cards, two red (hearts and diamonds) and two black cards (clubs and spades). Each student will be asked to play two cards by putting them on top of a stack in your hand as you come around the room. Students "earn" four dollars for each of their own red cards that they keep. They also earn a dollar for each red card placed in the stack, by themselves or by anyone else. In other words, a student's dollar earnings are calculated:

$$\begin{aligned} \textit{earnings} &= \$4 \times (\textit{number red cards kept by the student}) \\ &\quad + \$1 \times (\textit{number of red cards played by all}). \end{aligned}$$

Earnings can be hypothetical, but to heighten interest we prefer to choose one student at random, ex post, who will be paid a small percentage of earnings.

A pure public good, such as national defense, exhibits both non-rivalry (the consumption of the good by one individual does not inhibit another's benefit from this good) and non-excludability (it is impossible to prevent an individual from enjoying the benefits of this good even if this individual has paid nothing toward its provision). Note that playing a red card amounts to making a contribution to a public good. Black cards do not affect earnings and are provided to keep the individual's contribution decisions private. This allows students to play two cards (face down) regardless of how many red cards they play. To avoid confusion, use cards with cover patterns that are neither red nor black.

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[1] You might have to adjust the font and margins to keep everything on the same page.

This process is repeated in a series of rounds. After the contribution decisions are made in each round, collect the two cards from each student, count the total number of red cards played, announce this number, and return the cards. An easy way to ensure that each student receives the same cards that were originally played is to return the cards in reverse order, giving each student the top two cards from the stack. You may find it helpful to give each student four identical cards, i.e. four Jacks, so that mistakes in returning the cards to the right student after each round can be easily corrected.

You will have to prompt the students to record their earnings after the first round. Subsequent rounds will go very quickly; we have been able to complete fifteen rounds in less than twenty minutes. Repetition allows learning and gives students the chance to experiment with different strategies. The subsequent classroom discussion is enriched by allowing some changes in the setup during the exercise. For example, you could change the value of keeping a red card from four dollars to two dollars, which typically increases contributions. Also, you may allow a "communication period" of several minutes, which will encourage students to think more carefully about the dilemma, share ideas, and attempt to coordinate a higher level of contributions.

One pattern that we have followed is to do five rounds with the four-dollar value for each red card kept; then switch to five rounds with the two-dollar value without a discussion break, then have a communication period, followed by five more rounds with the two-dollar value. With this pattern and a fairly typical class of eight students, the average contribution was .48 cards per person in the first five rounds. Contributions then increased to .63 cards in the next five rounds, when the value of keeping a red card was reduced from four to two dollars. In this class, the group discussion preceding the 11th round resulted in an agreement that everyone would contribute until someone did not, at which point people could contribute or not as they wished. The result was that in round eleven, three-fourths of the students contributed both red cards, but the other students contributed nothing. This failure to achieve conformity was followed by a dramatic reduction of contributions in the pre-discussion levels. Another common pattern is for contributions to decline in the latter part of each five-round cycle. Of course, behavior can vary widely from class to class.

This exercise can be done with as few as five students, and with as many as thirteen

students per deck of cards. In a very large class, it is better to use a subset of students who are seated on the aisles, as we have done with a principles section of size sixty, or to conduct the exercise in smaller discussion sections. If a teaching assistant is available, two groups could be conducted simultaneously in the same room and the results could be compared during the post-exercise discussion.[2]

With large-lecture classes of more than one hundred students, an alternative is for students to make a decision in a single round, recorded on paper instead of using cards (Leuthold, 1993). Williams and Walker (1993) describe a computerized exercise in which students make contribution decisions outside of class over several weeks. This setup makes it easy to keep track of decisions and earnings in a very large class. It would also be possible to collect decisions on paper, compute earnings after class, and report total contributions in the next class before soliciting another round of contributions.

Many other variations of this game are possible, e.g. changing the size of the group or allowing revisions to contribution decisions. A number of alternative treatments are suggested in Hoaas and Madigan (1996).

To summarize: 1) Prepare the instruction/record sheet, with enough lines to Table 1 for the anticipated number of rounds. 2) Choose the payout percentage with the number of students in mind, and write this percentage in the blank on the instructions. 3) Photocopy instruction sheets for each student. 4) Sort the cards, making sure that you have enough cards for the anticipated number of students. 5) Distribute cards and instruction sheets. 6) Read instructions aloud, and answer questions. 7) Prompt students to select the two cards they wish to play, and collect the cards in order. 8) Announce the number of red cards played, and return the cards in reverse order, as students calculate their earnings. We do not allow discussion except during a designated "communication period."

Discussion

[2] The total number of red cards contributed is almost surely increasing in the number of participants, so a smaller payout percentage is needed for a large group. There were eight students in the class exercise described above, and one with the highest earnings accumulated $143; paying two percent of earnings to a randomly selected student would cost less than three dollars.

A good starting point for classroom discussion is the set of issues that came up during the group discussion period. In particular, students frequently recognize both the increased earnings that are possible through coordinated contributions, and the incentives to back out and free-ride on others' contributions. Students are usually eager to talk about their own decisions and the strategies they used. You can begin by asking students who contributed to explain why they did so. Among those reasons frequently cited are issues of fairness, altruism, and a belief that it will serve as a signal, encouraging others to contribute. A student who contributed nothing is likely to point out that more is earned by keeping a red card than by playing it. Moreover, one can still earn a return from the cards contributed by others. After letting the students themselves articulate the public goods dilemma, it is useful to summarize: in a given round, an individual can maximize monetary earnings by not contributing, but earnings for the group as a whole are maximized when everyone contributes fully.[3] The discussion can also be focused on the characteristics of a public good: non-excludability and non-rivalry. In the classroom card game, individuals cannot be excluded from the benefits of contributions, and one person's earnings from the group contribution do not reduce anyone else's earnings.

We try to keep the focus of further discussion on factors that may foster cooperation in commonly-observed contexts, such as public radio, university fund-raising campaigns, the United Way, or volunteer efforts. When familiar examples are used, the discussion can be lively.

First, a change in the value of a red card kept can stimulate discussion of different costs of contributions. Ask for examples of situations in which people might have different contribution costs, e.g. people in different tax brackets may have different incentives to contribute to charities. It is worthwhile to point out that these costs do not always refer to monetary costs. For example, volunteers contribute time; some individuals have higher work or family commitments, or must commute farther to the volunteer site, than others.

If the group discussion period results in initially higher levels of contributions followed by a decline (as is typically the case), some time should be spent addressing why this pattern occurred. Individuals are often more willing to contribute when they believe these contributions

[3] In a game theory class, the discussion can focus more on solving for the Nash equilibrium, and how changes in exercise parameters (such as the value of a card kept) may or may not affect the equilibrium contribution. The failure of a suggested trigger strategy (if proposed during the group discussion) can also be addressed.

will be matched by others. An example of this are firms that provide "matching gifts" for fund-raising campaigns based on the amount of contributions by their employees or others. The decline in contributions as the cooperative efforts collapse can demonstrate the difficulty of sustaining contributions when people cannot commit to them.

If time permits, we like to encourage students to think of institutions that are (or could be) used to increase contributions toward public goods. Some examples are announcing contributions (names of contributors announced on public radio, or donors listed by contribution category in a university alumni publication), a "thermometer" to show the level of contributions to date (as in a United Way campaign), or a method of committing to a contribution (church pledges). This can lead to a discussion of cases in which government intervention may be desirable, e.g., tax incentives for charitable giving or government provision of the public good.

It is important to point out that contributions are not inconsistent with economic theory if individuals care sufficiently about others' welfare. To make this point, ask students whether they would be willing to give up a dollar knowing that a wealthy alumnus would respond by giving a quarter to every student in the university. Ask those who would not give up a dollar how high the matching rate would have to be in order to induce them to contribute. This leads naturally to the point that incentives matter, even if people do care about others' welfare.

It is often of interest to talk about how women and men may contribute differently, or how contributions vary by major. This would be particularly applicable in a statistics class. In our classes, we frequently observe that women contribute less to the public good than do men (though this difference is not always large).[4] It has sometimes been observed that economics majors tend to contribute less than do other majors (Carter and Irons, 1991).

Further Reading

The classic reference on optimal provision of public goods is Samuelson (1954). Some

[4] For the group data summarized above, the contributions of women were about half as high as those of men, and the difference is significant, regardless of whether a t-test or a nonparametric Wilcoxon test was used. Similarly, Leuthold (1993) reported that women contributed slightly less than men in a classroom public goods game, although the difference is not significant. Of course, gender effects may interact with the social context in which decisions are made. The preponderance of evidence on gender effects in non-classroom public goods experiments is that there is no effect (Ledyard, 1995, Table 2.10).

of the first public goods experiments were reported by Bohm (1972). Marwell and Ames (1979) found that contributions were significant but not universal. Dozens of subsequent experiments have documented a tendency for contributions to decline with repetition when individuals have a private incentive to free ride. Nevertheless, contributions levels are affected by the value of the public good relative to the private opportunity cost of contributing (e.g. Isaac, Walker, and Williams, 1994). Interestingly, increases in group size do not increase the tendency to free ride in these laboratory contexts. Perhaps altruism has a larger effect when more people stand to benefit. Attempts to model some of these results can be found in Ledyard (1995), Anderson, Goeree, and Holt (1998), and Laury (1997). This literature is surveyed by Davis and Holt (1993, chapter 6) and Ledyard (1995).

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Appendix: Instructions

This is a simple card game. Each of you will be given four cards, two of these cards are red (hearts or diamonds), and two of these cards are black (clubs or spades). All of your cards will be the same number. The exercise will consist of a number of rounds. When a round begins, I will come to each of you in order, and you will play *two* of your four cards by placing these two cards face down on top of the stack in my hand. Your earnings in dollars are determined by what you do with your red cards. In each of the first five rounds, for each red card that you keep you will earn four dollars for the round, and for each black card that you keep you will earn nothing. Red cards that are placed on the stack affect everyone's earnings in the following manner. I will count up the total number of red cards in the stack, and everyone will earn this number of dollars. Black cards placed on the stack have no effect on the count. When the cards are counted, I will not reveal who made which decisions. I will return your own cards to you at the end of the round by coming to each of you in reverse order and giving you the top two cards, face down, off the stack in my hand. To summarize, your earnings for the round will be calculated:

earnings = $4 times the # of red cards you kept
+ $1 times the total # of red cards I collect.

After round 5, I will announce a change in the earnings for each red card you keep. Even though the value of red cards kept will change, red cards placed on the stack will always earn one dollar for each person. I will announce another change after round 10 and we will complete another 5 rounds.

Use the space below to record your decisions, your earnings, and your cumulative earnings. (Optional: At the end of the game, one person will be selected at random and will be paid ____ % of his or her actual earnings, in cash.) All earnings are hypothetical for everyone else. Are there any questions?

Earnings Record Sheet your name: _____

round	# red cards kept	$ per red card kept	earnings for cards kept	$1 x (total # red cards in stack)	your total earnings this round	cumulative earnings
1	_____	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____	_____
	(*In the remaining rounds, $ per red card kept = $2.*)					
6	_____	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____	_____
8	_____	_____	_____	_____	_____	_____
9	_____	_____	_____	_____	_____	_____
10	_____	_____	_____	_____	_____	_____
	(*break*)					
11	_____	_____	_____	_____	_____	_____
12	_____	_____	_____	_____	_____	_____
13	_____	_____	_____	_____	_____	_____
14	_____	_____	_____	_____	_____	_____
15	_____	_____	_____	_____	_____	_____