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Awareness of Deductions and Their Re-allocations

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Abstract
We conducted a public goods experiment to test the effect of the awareness of deductions on additional voluntary contributions as well as the behavioral effect of varying values of tax re-allocations. The results show a strong support for our alternative behavioral model and suggest that awareness of deductions reduces individual voluntary contributions. We also found that the quantity of public goods supplied is always the same regardless of the amount of tax revenues reinvested to the public goods by the government once such deductions are made from individuals. The results have far-reaching implications for tax policy reforms and the re-allocation of tax revenues.

Introduction

In economics, a public good is a good that is both non-rival and non-excludable. This means that consumption of the good by one individual does not reduce the availability of the good to others, and the good cannot be limited to those who have paid for it. A good example is clean air: your neighbor's enjoyment of clean air will not decrease your own ability to enjoy it and no matter who pays to improve air quality, no one can be excluded from enjoying it. The government is the largest provider of public goods and spends billions of dollars every year to provide public goods such as transport facilities, healthcare, and educational services. However, the government is not the only provider of public goods; private investors may provide some public goods, or private actors may make contributions to a public good that is primarily government-funded (e.g., an individual making a donation to a National Park). Private contributions to public goods differ radically based on the circumstances.

An intuitive interpretation is that government contributions crowd-out private contributions to public goods. That is, individuals are less likely to contribute to a public good if they know the government is already funding it. Consistent with this view that government contributions decrease the incentives of individuals to contribute to public goods, Warr (1982, 1983), Roberts (1984, 1987), Bernheim (1986), and Bergstrom, Blume, and Varian (1986) suggest that voluntary contributions by individuals to public goods are completely crowded out by government contributions to the same public goods, dollar for dollar. In other words, for every dollar that the government contributes towards a public good, an individual will be willing to contribute one less dollar. However, research on the effect of government contributions on private contributions to public goods has yielded contradictory findings. Abrams and Schmitz (1978, 1984), Clotfelter (1985), Kingma (1989), and Andreoni (1993) suggest that crowding-out is incomplete and likely to be small (5–28 percent) such that for every \$100 the government contributes to a public good, an individual will be willing to contribute between \$72 and \$95. Furthermore, relaxing the assumptions of the neoclassical model,[7] a few theoretical papers predict that there may be crowding-in instead (Rose-Ackerman, 1986; Seaman, 1980), which means that government contributions to public goods encourage voluntary private donations. Lastly, Brooks (2000) provides an alternative hypothesis, suggesting that at low levels of subsidies, government support may crowd-in private giving, but at higher levels, it crowds out private giving instead.

The present research will focus on the work of Bergstrom et al. (1986), Andreoni (1993), and Chan, Godby, Mestelman, and Muller (2002), whose models will shed light on the alternative model proposed in this work.

Bergstom et al.'s model

Bergstrom et al. (1986) concluded in their theoretical paper that crowding-out by the government is complete, which means for every dollar that the government contributes towards a public good, an individual will be willing to contribute one less dollar. They described the conventional model of individuals' allocation of resources between private and public goods, in which the individual chooses g_i as the contributions to pubic goods and keeps x as his or her private consumption. Let w_i be the individual's income, to solve the problem

$$\max_{x_i, g_i} u_i(x_i, G) \tag{1}$$

subject to the budget constraint $x_i + g_i = w_i$, the public goods identity $G = G_{-i} + g_i$, and the non-negativity constraint $g_i \geq 0$. G_{-i} denotes allocations of all other individuals except i.

Defining the level of payoff to individual i to be

$$U_i = x_i + G + x_i G \tag{2}$$

where G indicates total contributions to the public good, the best response function for individual i is

$$g_i = \max\left(\frac{w_i - G_{-i}}{2}, 0\right) \tag{3}$$

If **(2)** is an accurate and complete representation of individuals' preferences, Bergstrom and colleagues verified that a unique Nash equilibrium exists wherein each player will have an

[7] The neoclassical model is an economic model of individual behavior in the market place that assumes that individuals are rational utility-maximizers with complete information. Mainstream economics (particularly microeconomics) relies heavily on neoclassical assumptions.

individual incentive to chose an outcome that will ultimately be worse for everyone overall, yet no one has an individual incentive to change moves. This model has been tested in a laboratory environment by other researchers (e.g., Chan, Mestelman,,Moir, Muller, 1996) and is supported by the data when incomes are equally distributed among participants in three-person groups.

Andreoni's model

In the laboratory environment, Andreoni (1993) conducted an experiment where an involuntary transfer resembling a tax was levied on individuals and the resulting revenue was transferred to the provision of public goods. He found that crowding-out was incomplete and that the act of giving might be associated with a non-monetary value, a phenomenon he dubs "warm-glow giving."

Andreoni obtained two groups of participants who were presented with different payoff matrices. The first group was presented with a payoff table based on the Cobb-Douglas utility function (to obtain an interior equilibrium, so that the equilibrium is neither none nor all of the tokens), where each participant could contribute from zero to seven tokens to the public good. The payoff was determined by the individual contribution, together with the contribution of the other group members. The second group was presented with a payoff matrix that was essentially the same, except that it required a minimum contribution of two tokens per participant, thus simulating a tax of two tokens on all participants that would then be donated to the public good.

According to Andreoni, if individuals experience a private profit from contributing to the public good, **(1)** should be modified to

$$\max_{x_i, g_i} u_i(x_i, G, g_i) \tag{4}$$

The utility function of individual *i* in **(4)** would thus be expressed as

$$U_i = x_i + G + x_i G + f(g_i) \tag{5}$$

where $\dfrac{df(g_i)}{dg_i} > 0$ and $\dfrac{d^2 f(g_i)}{dg_i^{\,2}} < 0$, the best response function for individual *i* is

$$g_i = \max(\frac{w_i - G_{-i}}{2} + \frac{1}{2}\frac{df(g_i)}{dg_i}, 0) \tag{6}$$

Comparing **(3)** and **(6),** Andreoni contends that, *ceteris paribus*, caring about giving leads to increased contributions. In the experiments, the participants contributed, on average, 2.78 tokens in a no-tax condition and 3.35 tokens in a tax condition (including the 2 tokens taxed and allocated by the government). The difference of 0.57 tokens indicates that the government contribution does not completely crowd-out the individual contributions.

Chan et al.'s model

In another laboratory experiment, Chan et al. (2002) further tested Andreoni's (1993) notion of warm-glow giving. Their paper extends Andreoni's analysis by presenting the participants with three different tax treatments and by providing them with larger endowments of resources to allocate, paying careful attention to the boundary effects.

Participants were each given endowments of twenty tokens and could contribute between zero and twenty tokens to the public good. Participants were combined into small groups and were asked to indicate the amount of their contribution under one of three conditions (which were the same for all group members): no minimum contribution, a three token minimum contribution, and a five token minimum contribution.

According to Chan and colleagues, the functions **(2)** and **(5)** in Andreoni's Model become

$$U_i = x_i + (G+T) + x_i(G+T) \tag{7}$$

$$U_i = x_i + (G+T) + x_i(G+T) + f(g_i) \tag{8}$$

where T is the sum of the lump-sum taxes collected from all the individuals. The best response functions **(3)** and **(6)** become

$$g_i = \max(\frac{w_i - G_{-i} - T_{-i}}{2} - t_i, 0) \tag{9}$$

$$g_i = \max(\frac{w_i - G_{-i} - T_{-i}}{2} - t_i + \frac{1}{2}\frac{df(g_i)}{dg_i}, 0) \tag{10}$$

where t_i is the tax paid by individual i and $T_{-i} = T - t_i$. The average total contribution was 5.18 in the no-tax condition, 6.16 in the 3-token tax condition, and 6.23 in the 5-token tax condition. While the participants did contribute more as the taxes were increased, suggesting an incomplete crowding-out, increased crowding-out was observed when the voluntary contribution was small, suggesting that the model of warm-glow giving needed to be further restricted.

Our design and behavioral model

Andreoni's (1993) and Chan's (2002) experimental designs fail to provide a precise simulation of real-life government contributions in several ways. First, the between-subjects design, while useful to avoid possible order effects, may not be an appropriate way to investigate actual behavior. In the real world, where tax rates and government contributions to certain public goods constantly change, each individual is faced with varying "payoff matrices," and it is therefore essential to determine the impact of these changes on the behavioral responses of the same people through a within-subjects experimental design.

Another, perhaps more problematic, issue with Andreoni's and Chan's designs is that the concept of taxation was not fully revealed to the subjects. For instance, the second group in Andreoni's experiment was not informed that their group was actually taxed and that their payoff matrix was actually a "taxed form" of another payoff matrix. This design clearly misestimates the real taxation concept. In reality, all individuals recognize their pre-tax and post-tax wealth or income, and they make their decisions on their voluntary contributions *knowing* exactly how much of their wealth has been taxed. While Andreoni's and Chan's designs allow them to find a theoretical prediction of individuals' actions when they are unknowingly taxed, very little can be deduced from their experiments regarding whether these individuals would react in a similar manner in a real taxed world. In particular, when subjects *know* that they are taxed, they may think that they have already performed their "duties," and they may find it less necessary to make additional voluntary contributions. In other words, borrowing Andreoni's term, the warm-glow giving effect may be reduced significantly when an individual takes into consideration that he has been taxed.

Finally, in Andreoni's and Chan's experiments, participants were mostly students majoring in economics. Although they claim that their participants were not familiar with economic experiments, economics students tend to be more familiar with making calculations and using payoffs, utility theory and, for some, game theory. Limiting the subjects to economics students may therefore introduce biases to the results of the experiments.

Our experiment kept the spirit behind this past research but introduced some critical changes. First, we employed a within-subjects design instead of the between-subjects design to measure the dynamic effect of taxes or government contributions that more closely resembles the every-day experiences people have with taxation. Second, the participants were specifically informed when a tax was levied on their endowment to measure the effect of the awareness of deductions on individual contributions. Third, the participants in our experiment were university students of various majors, thus avoiding the possible bias related to using only economics majors. In addition, our experiment also aimed to test the hypothesis of possible crowding-in at low levels of government contributions and crowding-out at higher levels as mentioned theoretically by Brooks (2000), which had not been experimentally tested before.

In this paper, we propose an alternative behavior model that represents the reluctance of individuals to make additional voluntary contributions when they are aware of the deductions made from their wealth. We hypothesize that the awareness of deductions decreases the warm glow obtained from giving. In other words, we believe that when people know that they are being taxed, they will be less inclined to voluntarily contribute to the public good.

Taking into consideration the awareness of deductions, equation **(10)** becomes

[illegible] **(11)**

which represents the new best response function under the awareness of deductions. α represents the extent to which the involuntary contributions in the form of tax decreases the warm glow in Andreoni's (1993) model and therefore drives down the voluntary contributions made by the individual. In other words, our hypothesis states that if a person were aware of the deductions made from his income, he would be less willing to contribute to public goods than if he were unaware of the deductions.

Method

Participants

Thirty undergraduate and graduate students participated in this study (14 females, 16 males) for a chance to be entered into a raffle in which they could earn compensation commensurate with their performance. Students ranged in age from 18-24. The majority of students were majoring or intending to major in the social sciences (such as government, history, sociology, and economics; 20 students); the next most frequent major category was the natural sciences (such as chemistry, neuroscience and behavior, and physics; 9 students), followed by the humanities (such as film and French; 3 students). Specifically, ten were economics or mathematics-economics majors. Since a large number of students double major, students were counted in each category. For example, a double major in French and history was counted both as a social science major and as a humanities major. Invitations to participate in the experiment were sent out to randomly selected students through e-mails and a social networking site. Fifteen minutes before each session started, invitations were also extended to students in a computer lab and a café next to the classroom where the experiment was conducted.

At the end of the experiment, 10 participants were randomly selected to receive payment based on their performance in the experiment; the selected participants received $13.57 on average.

Materials and procedure

This experiment was conducted in two sessions. Each participant was given a booklet containing the instructions for the experiment and the payoff tables. Only information printed in the booklet was given to participants; no further information was given with regard to the scenario and intent of the experiment. Prior to the start of the experiment, the instructions were read aloud to all participants and they completed a practice round. All participants completed four rounds of the experiment. In each round, they were asked to indicate how much they would contribute under a different payoff structure. The potential payoffs to the individual for each round were determined by the payoff matrices, generated from the Cobb-Douglas utility function $U_i = A[(w - g_i)^{1-\alpha}G^{\alpha}]^{\gamma}$, where g_i is the number of tokens played by the individual, $G = g_1 + g_2 + g_3$ is the total number of tokens played by the group, and w is an underlying level of "income"; the parameters A, α, γ, and w were chosen to meet specifications of the Nash equilibrium outcome, Pareto efficient outcome,[8] equilibrium payoff levels, and concavity of utility. Participants were asked to mark their contributions in their booklets. After four rounds were completed, participants were randomly assigned to groups of three to determine the outcome of the experiment. Thus, the grouping information was not available to the participants during the experiment. This was necessary to avoid possible biases due to social networks and status discrimination.

In Round 1, each participant was given seven tokens. Participants could choose to contribute from zero to seven of these tokens towards the public good. The individual payoff was dependent on the number of tokens contributed by the other two group members, as given by the Payoff Matrix A, where payoffs are denominated in U.S. dollars. According to the setting of the parameters of the utility function, the unique Nash equilibrium is for each participant to contribute three tokens and the symmetric Pareto efficient point is for each participant to contribute six tokens in this round.

[8] The Pareto efficient outcome is the outcome in which no participant could make a different decision without someone being worse off than before.

Payoff Matrix A –no-taxed wealth (Andreoni, 1993)

Contribution of other two members	Your contribution: 0	1	2	3	4	5	6	7
0	0	0.2	0.6	1.2	1.8	2	2.2	2
1	0.2	0.8	1.6	2.2	2.8	3	3	2.8
2	1	1.8	2.8	3.6	4	4.2	4	3.4
3	2.4	3.4	4.4	5.2	5.6	5.6	5	4.4
4	4.2	5.6	6.6	7.2	7.4	7	6.4	5.4
5	6.8	8	9	9.6	9.4	8.8	7.8	6.4
6	9.8	11.2	12	12.2	11.8	10.8	9.4	7.6
7	13.6	14.8	15.4	15.2	14.4	12.8	11	8.8
8	18	19	19.2	18.6	17.2	15.2	12.8	10.2
9	23	23.6	23.4	22.2	20.4	17.8	14.8	11.6
10	28.6	28.8	28	26.2	23.8	20.6	17	13.2
11	35	34.6	33.2	30.6	27.4	23.6	19.4	15
12	42	41	38.6	35.4	31.4	26.8	21.8	16.8
13	49.6	47.8	44.6	40.6	35.6	30.2	24.4	20.6
14	58	55.2	51.2	46	40.2	33.8	27.2	20.6

Three more rounds of experiments were conducted, each with different payoff matrices. The participants would thus experience different treatments with different levels of tax re-allocation.

Round 2 tested the effect of the awareness of deductions. Participants in this round were also given seven tokens. They were then informed that two of each of their tokens would automatically be contributed to a public fund. This was meant to represent a universal tax toward the public good. Participants could then input from zero to five of their remaining tokens into the project, with the payoff indicated by Payoff Matrix B.

Payoff Matrix B was generated from the matrix of Round 1 by making the minimum possible contribution of each subject two tokens, rather than zero. The choices were relabeled to start at zero in order to present the game in terms of voluntary contributions to the public good. The Nash equilibrium for Round 2 is for individual participants to contribute one token, in accordance with pre-set parameters. The Pareto efficient outcome is for each participant to contribute four tokens. The effect of the taxation does not alter or eliminate the equilibrium outcome or any of the Pareto efficient allocations.

Payoff Matrix B –taxed wealth with 100% government contributions (Andreoni, 1993)

Contribution of other two members	Your contribution: 0	1	2	3	4	5
0	6.6	7.2	7.4	7	6.4	5.4
1	9	9.6	9.4	8.8	7.8	6.4
2	12	12.2	11.8	10.8	9.4	7.6
3	15.4	15.2	14.4	12.8	11	8.8
4	19.2	18.6	17.2	15.2	12.8	10.2
5	23.4	22.2	20.4	17.8	14.8	11.6
6	28	26.2	23.8	20.6	17	13.2
7	33.2	30.6	27.4	23.6	19.4	15
8	38.6	35.4	31.4	26.8	21.8	16.8
9	44.6	40.6	35.6	30.2	24.4	18.6
10	51.2	46	40.2	33.8	27.2	20.6

Rounds 3 and 4 were designed to test the crowding-in and crowding-out effect of different levels of government contribution through varying levels of tax revenue re-allocation. In Round 3, each participant was given seven tokens. Participants were then informed that two tokens would again be collected from each of them, but would not be contributed to the public fund. The participant could then input from zero to five of the remaining tokens into the project, with the payoff indicated by Payoff Matrix C.

Payoff Matrix C was generated from the payoff matrix in Round 1 by subtracting the extra two tokens on the individual contribution side and the extra four tokens on the group contribution side. This was meant to simulate a tax of two tokens on all participants that would not be contributed to the specific public good. The Nash equilibrium under this tax condition is three tokens for all participants; likewise, the Pareto efficient allocation is six tokens.[9]

Payoff Matrix C –taxed wealth with 0% government contributions

Contribution of other two members	Your contribution: 0	1	2	3	4	5
0	0	0.2	0.6	1.2	1.8	2
1	0.2	0.8	1.6	2.2	2.8	3
2	1	1.8	2.8	3.6	4	4.2
3	2.4	3.4	4.4	5.2	5.6	5.6
4	4.2	5.6	6.6	7.2	7.4	7
5	6.8	8	9	9.6	9.4	8.8
6	9.8	11.2	12	12.2	11.8	10.8
7	13.6	14.8	15.4	15.2	14.4	12.8
8	18	19	19.2	18.6	17.2	15.2
9	23	23.6	23.4	22.2	20.4	17.8
10	28.6	28.8	28	26.2	23.8	20.6

Round 4 simulated a condition where individuals are taxed and the tax receipts are only partially contributed to the provision of the public goods. In this round, each participant was given seven tokens. Participants were then informed that two tokens would be collected from each participant but only one of the two would be contributed into the project. They could then input from zero to five of their remaining tokens into the project, with the payoff indicated by Payoff Matrix D.

Payoff Matrix D was generated in a way similar to Payoff Matrix B, but the minimum possible contribution of each participant became one instead of two. The choices were then relabeled to start from zero in order to represent voluntary choices to input to the public good. The Nash equilibrium is now for each participant to contribute two tokens, and the Pareto efficient allocation becomes five tokens for each participant.

[9] The Pareto efficient allocation is cropped from the payoff matrix, but this should not affect the result, as we expect very few subjects to have the intention to contribute six tokens in this round.

Payoff Matrix D –taxed wealth with 50% government contributions

Contribution of other two members	Your contribution: 0	1	2	3	4	5
0	1.8	2.8	3.6	4	4.2	4
1	3.4	4.4	5.2	5.6	5.6	5
2	5.6	6.6	7.2	7.4	7	6.4
3	8	9	9.6	9.4	8.8	7.8
4	11.2	12	12.2	11.8	10.8	9.4
5	14.8	15.4	15.2	14.4	12.8	11
6	19	19.2	18.6	17.2	15.2	12.8
7	23.6	23.4	22.2	20.4	17.8	14.8
8	28.8	28	26.2	23.8	20.6	17
9	34.6	33.2	30.6	27.4	23.6	19.4
10	41	38.6	35.4	31.4	26.8	21.8

Results and Discussion

The data containing the contributions of the individual participants in all four rounds can be found in Appendix A. The descriptive statistics of the results are shown below in Table 2.

TABLE 2
Descriptive statistics

	Round 1	Round 2	Round 3	Round 4
Mean	3.83	1.13*	2.87*	2.2*
Median	3*	1*	3*	2*
Mode	3*	0	3*	2*
Std. Dev.	1.79	1.43	1.41	1.4

* Mean is not statistically different from the Nash equilibrium; median and mode coincide with the Nash equilibrium

Note: The contributions reported in the tax conditions do not include the tax.

Awareness of deductions reduces contributions

One of the most important findings in this paper is that the results support our alternative model as described by equation (11). The mean total contribution[10] made under the no-tax condition (Round 1) was higher than that under the tax condition (Round 2) at $t(29) = -2.13$, $p < .05$. This finding is inconsistent with previous research. In Andreoni's (1993) and Chan et al.'s (2002) experiments, participants' total contributions under the "tax" condition were significantly higher than their no-tax contributions.

Since our experimental design for Round 1 is similar to Andreoni's (1993), this striking difference may be the result of awareness of deductions in Round 2. In fact, the reluctance to contribute due to this awareness overshadows the potential "warm glow" of additional voluntary contributions. In equation (11), this can be represented by a value of αt_i that is higher than $\frac{1}{2}\frac{df(g_i)}{dg_i}$, causing the whole term on the left-hand side to be lower than the term in (9), which

[10] Total contributions = amount of tax re-allocated + total private contributions.

means that government contributions not only crowd-out voluntary contributions, but also reduce the total contributions made by the individuals.

Mean contribution under the no-tax condition exceeds the Nash equilibrium

TABLE 3
Real contributions to the public good for the no-tax and tax conditions

Major	No-tax condition Round 1	Tax condition Round 2	Difference (Round 1-Round 2)
ECON	2.89	2.78	-0.11
Non-ECON	4.24	3.29	-0.95
Average	3.83	3.13	-0.7

Note: The contributions reported in the tax condition include the tax.

Table 3 shows the comparison of contributions made by an average economics major and an average non-economics major under tax and no-tax conditions. Fifteen participants contributed more under the no-tax condition, ten participants contributed equally under the two conditions, and only five participants contributed more under the tax condition.

Participants' contributions to the public good under the no-tax condition exceeded the Nash equilibrium. The mean contribution was 3.83, which is significantly higher than 3, $t(29) = 2.55$, $p < .01$. This finding contradicts that of Andreoni (1993), who found that participants made an average contribution of 2.78, lower than the Nash equilibrium.

Since our experimental design for round 1 is similar to Andreoni's experiments, a reasonable explanation for the difference is the background of participants. Andreoni's subjects were all economics majors, whereas the participants in our experiment were of various majors. When separate analyses on the contributions of economics majors and non-economics majors[11] a striking difference between the two groups was found.

Economics majors exhibit the Nash equilibrium under the no-tax condition

The mean contribution of all economics majors ($n = 10$) in Round 1 was exactly 3, the Nash equilibrium. This result is more consistent with Andreoni's (1993) findings, which is not surprising given that his participants were primarily economics majors. The lower contribution of economics majors, as compared to the general participant pool, may be attributed to the familiarity of economics majors with game theory and public good allocation. The basic knowledge of the free-rider problem in public goods taught in the introductory classes may be sufficient to induce these subjects to contribute less than their peers who have never taken any economics classes. Even if we do not assume that non-economics majors have not taken any introductory economics classes, economics majors are certainly more familiar with such concepts as the free-rider problem, as this information is reinforced in subsequent classes and in their research. We also expect the economics majors to be faster in understanding the payoff charts, processing data, and utilizing utility theory.

[11] Economics majors include economics majors and majors from the joint program in mathematics-economics and double majors of economics or mathematics-economics and another major. Participants who have not decided their majors are excluded from this analysis ($n = 2$).

Economics majors' actions are independent of tax

Economics majors' total contributions in Rounds 1 and 2 were not statistically different (t[9]= 0.41, p > .05), which indicates that their actions were independent of tax. This may mean that the term αt_i exactly equals $\frac{1}{2}\frac{df(g_i)}{dg_i}$ in (11), which represents complete crowding-out of contributions due to the tax. This means that an average economics major reduces voluntary contribution to public goods by a dollar for every dollar that he pays involuntarily to the government in taxes.

Non-economics majors contribute more than the Nash equilibrium under the no-tax condition

Non-economics majors contributed significantly more than the Nash equilibrium. The mean contribution was 4.17, which is significantly higher than 3, $t(17) = 2.75$, $p < .01$. This suggests that including non-economics majors in the participant pool was important because the participants exhibit an entirely different behavior from economics majors. Past research overlooked the fact that findings from a participant pool consisting of only economics majors should not be generalized to the larger population. Indeed, this finding constitutes strong evidence that individuals without knowledge of economics exhibit different behaviors when making voluntary contributions to public goods.

Awareness of deductions matters for non-economics majors

Participants who did not major in economics contributed much less when they were aware of the deductions that were being made. The total contributions in Round 2 were lower than the contributions in Round 1, $t(17) = –2.45$, $p < .05$. The difference in behavior between economics and non-economics majors can most probably be accounted for by the lack of familiarity with the taxation system among non-economics majors. Whereas economics majors may understand that the tax revenue is used to fund the public good or they may perceive the deductions as a sunk cost that should not affect their decisions, non-economics majors may be less likely to perceive the new payoff matrix in the same way. This indicates that not only the awareness of tax deduction, but also the perception of tax deduction, plays an important role in determining people's behaviors in contributing to public goods.

Males contribute more under taxed condition with 100% re-allocation

Another area that had previously been unexplored is the difference between male and female participants in the level of their contributions to public goods. Whereas on average males contributed more than females in all rounds, the difference was not statistically significant in Rounds 1, 3, and 4. However, the contribution of males was higher than that of females in Round 2, t (28)= 1.79, $p < .05$.

TABLE 4
Mean Contributions of Female and Male Participants (SE in parentheses)

Gender	Round 1	Round 2	Round 3	Round 4
Female (n = 14)	3.43 (0.31)	2.64 (0.19)	2.71 (0.35)	2.92 (0.29)
Male (n = 16)	4.19 (0.53)	3.56 (0.43)	3 (0.36)	3.44 (0.39)
Male > Female†	1.14	1.79**	0.54	0.97

Notes: The contributions reported in Rounds 2, 3, and 4 include the allocation of tax to the good.

† Contributions of male subjects are statistically higher than the female subjects in each round. Numbers reported are *t*-values of the comparison; significance levels: * 90%, ** 95%, *** 99%

There are several plausible explanations for the higher contribution by male participants under the taxed condition with 100% re-allocation. For example, males may be more trustful of the government when there is evidence that the tax is fully re-allocated to the public. Consistent with this view, Andreoni and Vesterlund (2001) found that men are more altruistic when altruism is cheaper. We suggest that altruism is perceived to be cheaper in Round 2 because of the guaranteed two tokens from the complete re-allocation of taxed tokens.

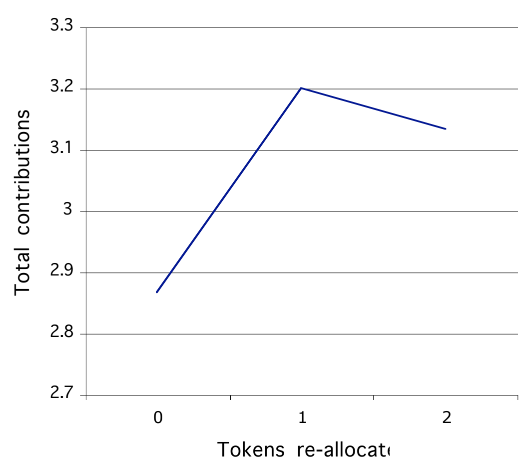
There is no evidence of crowding-in of individual contributions by government contributions

Contrary to Brooks' (2000), we found evidence that even at low levels of contributions, government contributions do not crowd-in individual voluntary contributions. Figure 1 shows that there is a slight "hump" when the government re-allocates 50% of the tax revenue (one token from each participant). However, the increase in this total contribution is not statistically significant as indicated by the following two findings.

First, the increase in total contributions from Round 3 (zero token reinvested) to Round 4 (one token reinvested) was not statistically significant, $t(29) = 1.15$, $p > .05$. Second, the decrease in total contributions from Round 4 to Round 2 were also not statistically significant, $t(29) = -0.25$, $p > .05$. The lack of statistical significance indicates that government spending does not crowd-in private charitable giving.

It is worthwhile to note that the total contributions stay roughly the same regardless of the rate of reinvestment of tax revenues by the government. This implies that approximately the same quantity of public goods will be supplied, and this behavior is independent of government contributions.

FIGURE 1
Mean Total Contributions for Different Values of Re-allocations



Heterogeneity in individual contribution decisions for different values of re-allocations

An inspection of total contributions for various values of re-allocation at the individual level shows that participants exhibited a variety of strategies. Appendix B contains the individual schedules of all 30 participants. Participants' contribution decisions can generally be characterized into six distinct categories[12], each with varied demographics including age, gender and major. These findings have two implications. First, while we have observed some general differences between male and female participants, as well as between economics and non-economics majors, there exist internal differences within these groups. For example, while an average male participant would be expected to contribute more in Round 2, a closer look on each individual's responses shows that there were a few male participants who contributed less in Round 2. The second, and more important, implication of the variety of strategies that have been observed is that, while public economists often work at the aggregate level and make simplifying assumptions about individual preferences, it is important to note that individuals may exhibit different behaviors, due to their unique preference functions and rationality. The six categories of allocation strategies are described below.

Crowding-in by government contributions at all levels.

One group of individuals (n = 4) whose schedules exhibit an increasing pattern, increase their contributions when government contributions are increased, resulting in an increase in their total contributions. In the real world, if these individuals were aware of government contributions to public good, we would expect them to increase their charitable contribution.

Crowding out by government contributions at all levels.

These individuals (n = 5), whose schedules are represented by a horizontal line, decrease their contributions when government contributions are increased, token for token, resulting in constant total contributions. For example, these individuals would donate exactly one fewer token in Round 4 than in Round 3, because the government contribution in Round 4 is higher by one token. We would expect these individuals to decrease their charitable contributions by exactly the amount funded by the government when they are aware of government contributions to the public good.

Hypercrowding out by government contributions at all levels.

These individuals (n = 3), whose schedules exhibit a decreasing pattern, also decrease their contributions when government contributions are increased, and the decrease in their contributions is higher than the increase in the government contributions. When these individuals are made aware of government contribution to public good, we would expect them to decrease their charitable contributions by an amount even larger than the government funding, resulting in decreasing total contributions to public good.

[12] By looking at the individual schedules, we are not able to predict partial crowding-out for each individual, as an increase in one token contributed by the government can only be accompanied either by an increase/no change in tokens of voluntary contribution (crowding-in), a decrease of one token of voluntary contribution (crowding-out), or a decrease of more tokens of voluntary contribution (hypercrowding-out).

Crowding-out at low levels of government contributions and hypercrowding-out at high levels of government contributions and vice versa.

These individuals show a combination of the behavior described in the two immediately preceding categories. One subset (*n* = 2) shows initial crowding-out followed by hypercrowding-out, while another (*n* = 5) shows initial hypercrowding-out followed by crowding-out by government contributions. If these individuals were aware of government contribution to public good, we would expect them to decrease their charitable contributions by an amount either equal to or larger than the government funding, depending on specific circumstances.

Crowding-in at low levels of government contributions and crowding out/ hypercrowding-out at high levels of government contributions.

These individuals (*n* = 9) exhibit behavior that is consistent with Brooks' (2000) hypothesis. Their schedules show an initial increase in total contributions, followed by a horizontal line (crowding-out) or a decreasing line (hypercrowding-out) at higher levels of government contributions. It is worth noting that this behavior is the modal behavior among participants. When these individuals are aware of government contributions, we would expect them to increase their contributions to the public good when there is a low level of government support, but decrease their contributions at higher levels of government support.

Crowding-out/hypercrowding out at low levels of government contributions and crowded in at high levels of government contributions.

These individuals (*n* = 4), whose schedules show an initial decrease or stagnancy in total contributions, followed by an increasing line at higher levels of government contributions, exhibit a behavior opposite to Brooks' (2000) prediction. When these individuals are aware of government contributions to the public good, they would be expected decrease their charitable contributions at a low level of government support, but increase their contributions at higher levels of government support.

Conclusion and Future Directions

This paper presents a public goods experiment designed to test the effect of the awareness of deductions on additional voluntary contributions as well as the behavioral effect of varying values of tax re-allocations. The results show strong support for our alternative behavioral model, in which, contrary to previous research work such as that by Andreoni (1993) and Chan et al. (2002), government contributions hypercrowd-out the individual voluntary contributions once the element of awareness of deductions is incorporated into the experimental design. What this means is that, *ceteris paribus*, a person with $700 weekly income in a no-tax situation would exhibit a different contribution behavior from a person with $1000 income under a 30% tax, and from our equation (11), it also follows that this person's behavior would, in turn, be different from a person with $1400 under a 50% tax.

In addition, while the mean total contribution is highest when there is 50% re-allocation of tax revenues (Round 4), the difference is not statistically significant. Thus, we cannot conclude that there is crowding-in at low levels of government contributions and crowding-out at higher levels, as theoretically predicted by Brooks (2000). The individual contribution schedules, on the other hand, show heterogeneity in contributions at different levels of re-allocation of the revenues obtained from the deductions. The modal behavior, however, is consistent with the prediction made by Brooks (2000).

We also find that, while there are no major differences between the contributions of males and those of females, the differences between economics and non-economics majors are often striking. Economics majors tend to contribute less than non-economics majors and their actions are less dependent on tax as compared to non-economics majors.

The concept of awareness of deductions and our experimental design involving different levels of re-allocation of tax revenues are novel and have not been explored in previous experimental research work. As a result, there are numerous possible extensions to our design for future work. First, due to limited resources, the four rounds in our experiment were conducted in the same order for all participants. While we believe that the order should not affect the outcome of the experiment, future experiments may employ the same design with varying orders of rounds to avoid possible order-related biases. Second, the experiment considered relatively small groups for tractability. Other public goods experiments have typically considered groups of 4–10 participants, with one even venturing groups of 100 (Isaac & Williams, 1990). It is important to see if our results will still hold under these more realistic environments. Third, future experiments may increase the number of rounds and tokens endowed to the subjects, allowing for more levels of tax re-allocation, as well as providing subjects with greater endowments to allocate. This will allow us to see if there is a possibility of crowding-in at lower levels of government contributions (<50%), as predicted by Brooks (2000). Fourth, future experiments may vary the deduction rate in Round 2, and thus, by running appropriate analyses, we will be able to estimate the coefficient α in our behavioral model as represented by equation (11).

The results of this paper suggest that the awareness of deductions plays an important role in determining the individual voluntary contributions to public goods. This has substantial implications for the government tax policy, welfare payments, and government funding of nonprofit activities. It would be worthwhile to examine how government actions and tax policies signal such awareness of deductions to private citizens and how this may influence their response. Therefore, further empirical studies on this subject may be conducted in the cross-country data of private charitable contributions with regard to different taxation policies. It may also be beneficial to examine time-series data of taxation laws and practices of government funding in a country that may influence the behavioral response of individuals over time. All of this may lead to a better understanding of the successful provision of public goods by the private sector.

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The authors would like to thank Tanya Rosenblat for her guidance in the research process, Kirsten Sharpes for her extensive editorial help, Martine Seiden and Kacey Wochna for further comments, and all participants of the experiment. *Correspondence may be addressed to idjanali@wesleyan.edu.*

References

Abrams, B., & Schmitz, M. (1978). The crowding out effect of government transfers on private charitable contributions. *Public Choice, 33*, 29-39.

Abrams, B., & Schmitz, M. (1984). The crowding out effect of government transfers on private charitable contributions: cross sectional evidence. *National Tax Journal, 37*, 563-568.

Andreoni, J. (1993). An experimental test of the public goods crowding-out hypothesis. *American Economic Review, 83*, 1317-1327.

Andreoni, J., & Vesterlund, L. (2001). Which is the fair sex? Gender differences in altruism. *Quarterly Journal of Economics, 116*, 293-312.

Bergstrom, T., Blume, L., & Varian, H. (1986). On the private provision of public goods. *Journal of Public Economics, 29*, 25-49.

Bernheim, B. D. (1986). On the voluntary and involuntary provision of public goods. *American Economic Review, 76*, 789-793.

Brooks, A. C. (2000). Public subsidies and charitable giving: crowding out, crowding in, or both? *Journal of Policy Analysis and Management, 19*(3), 451-464.

Chan, K.S., Mestelman, S., Moir, R., & Muller, R.A. (1996). The voluntary provision of public goods under varying income distributions. *Canadian Journal of Economics*, *29*, 54–69.

Chan, K. S., Godby, R., Mestelman, S., & Muller, R. A. (2002). Crowding-out voluntary contributions to public goods. *Journal of Economic Behavior & Organization*, *48*, 305-317.

Clotfelter, C. (1985). *Federal Tax Policy and Charitable Giving*. Chicago: University of Chicago Press.

Isaac, M. R., Walker, J. M., & Williams, A. (1994). Group size and the voluntary provision of public goods: Experimental evidence utilizing very large groups. *Journal of Public Economics*, *54*, 1-36.

Kingma, B. (1989). An accurate measure of the crowd-out effect, income effect, and price effect for charitable contributions. *Journal of Political Economy, 97*, 1197-1207.

Roberts, R. D. (1984). A positive model of private charity and public transfers. *The Journal of Political Economy*, *92(1)*, 136-148.

Roberts, R. D. (1987). Financing public goods. *The Journal of Political Economy, 95(2)*, 420-437.

Rose-Ackerman, S. (1986). Do government grants to charity reduce private donations? In S. Rose-Ackerman (Ed.), *The economics of nonprofit institutions* (pp. 313-329). New York: Oxford University Press.

Seaman, B. A. (1980). Economic models and support for the arts. In W. S. Hendon, J. L. Shanahan & A. J. MacDonald (Eds.), *Economic policy for the arts* (pp. 80-95). Cambridge, MA: Abt Books.

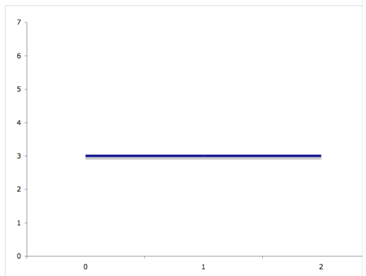
Warr, P. (1982). Pareto optimal redistribution and private charity. *Journal of Public Economics, 19*, 131-138.

Warr, P. (1983). The private provision of a public good is independent of the distribution of income. *Economics Letters, 13*, 207-211.

APPENDIX A.
Individual results

ID	Round 1	Round 2	Round 3	Round 4	Gender	Age	Class	Major
1	4	1	3	2	M	18	2010	UNDECIDED
2	2	0	4	2	M	19	2010	CSS
3	7	0	5	5	M	21	2008	CSS/GOVT
4	3	0	5	2	F	21	2009	E&ES
5	3	2	3	5	F	19	2009	NS&B
6	3	1	0	1	F	22	2008	CSS/E&ES
7	4	5	0	2	M	20	2009	ECON
8	1	1	2	1	M	20	2009	MECO
9	3	2	3	1	F	21	2007	NS&B
10	3	1	5	2	F	21	2008	CSS
11	7	5	5	5	M	19	2009	EAST
12	3	1	3	2	F	21	2007	FILM
13	7	2	3	3	M	22	2007	HIST/LAST
14	3	0	3	1	F	22	2007	AFAM/SOC
15	6	2	3	9	M	27	GRAD	PHYS
16	6	4	4	4	M	23	2009	ECON/PHYS
17	3	0	3	2	F	21	2007	SOC
18	7	0	2	1	F	22	2007	CHEM
19	5	0	3	2	F	19	2010	CHEM
20	6	1	1	3	M	19	2010	CSS
21	3	0	2	1	M	20	2009	ECON
22	2	0	3	1	F	19	2010	SISP
23	5	3	4	5	M	19	2010	FREN/NS&B/SISP
24	0	0	1	0	M	20	2009	MECO
25	4	1	1	3	F	20	2009	MECO
26	3	0	5	2	M	20	2009	MECO
27	3	0	3	2	M	20	2009	ECON
28	3	1	3	3	F	20	2009	NS&B
29	3	1	2	2	M	21	2009	FREN/MECO
30	3	0	1	2	F	21	2008	ECON

APPENDIX B
Individual Response Graphs



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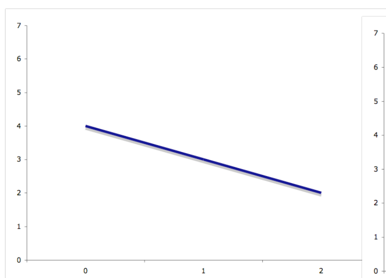

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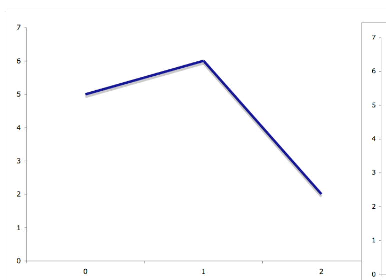

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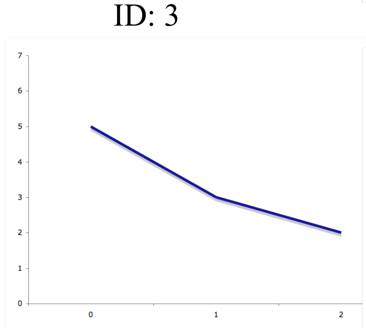

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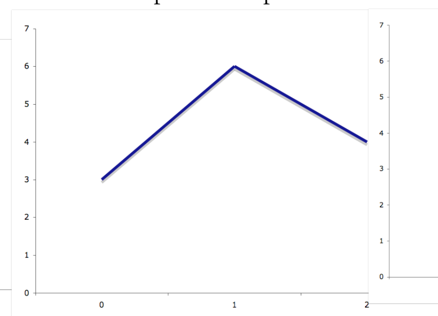

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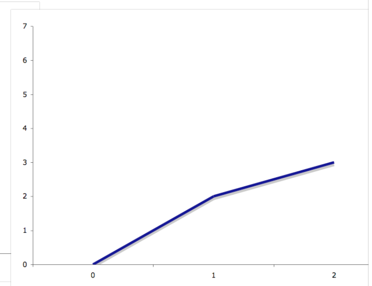

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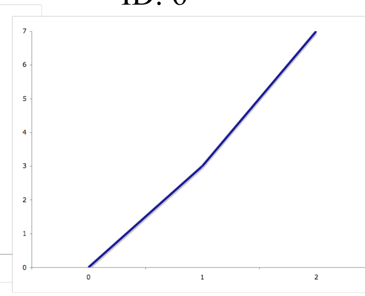

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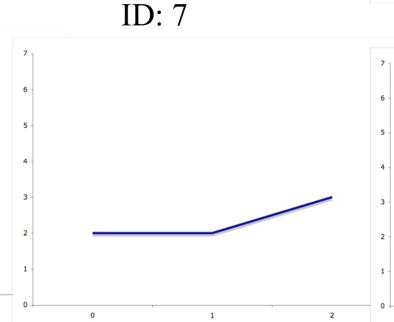

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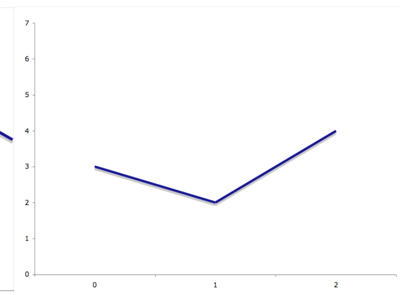

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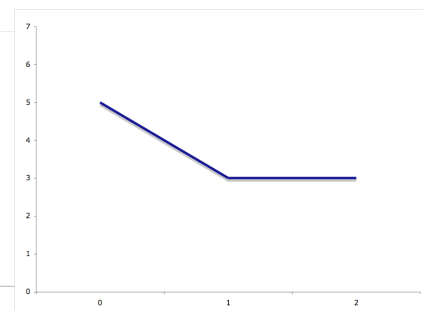

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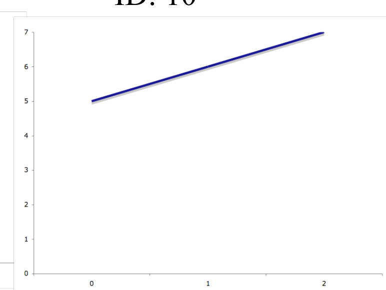

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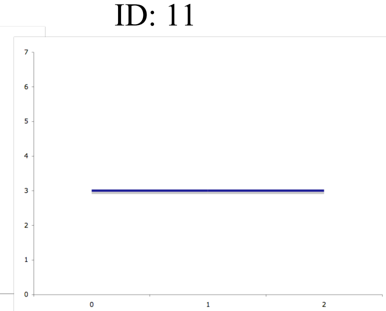

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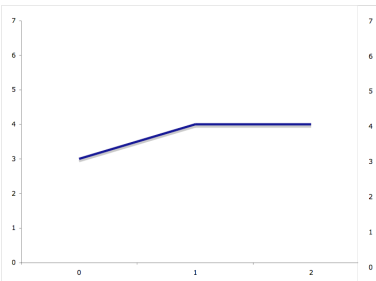
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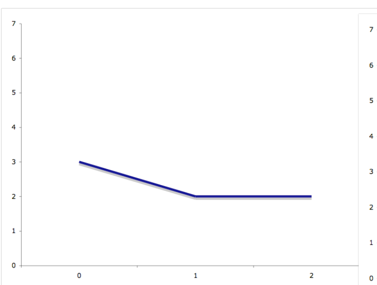
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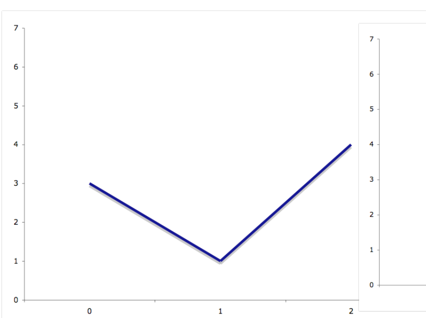
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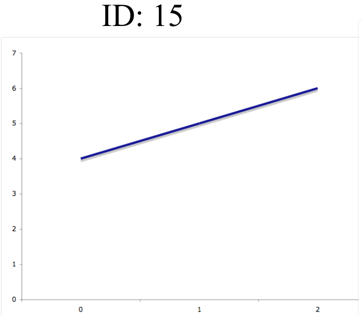
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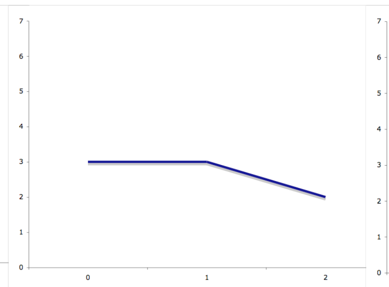
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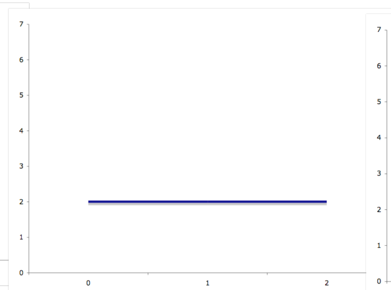
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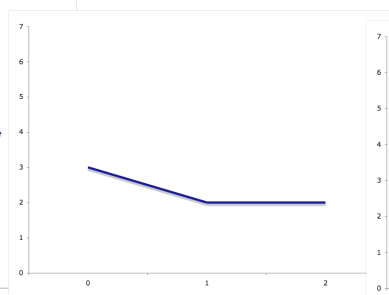
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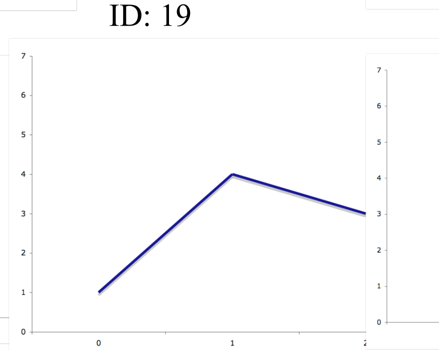
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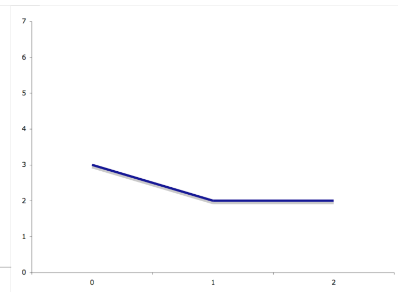
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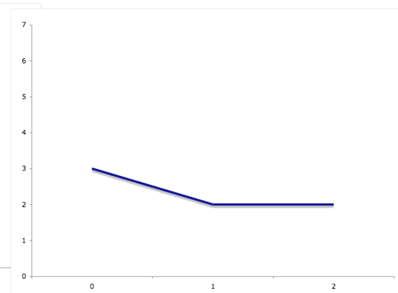
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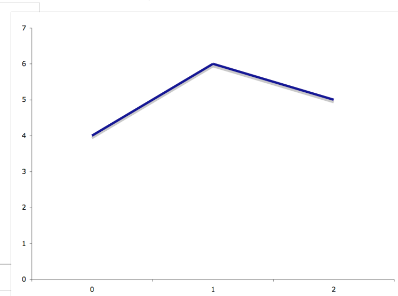
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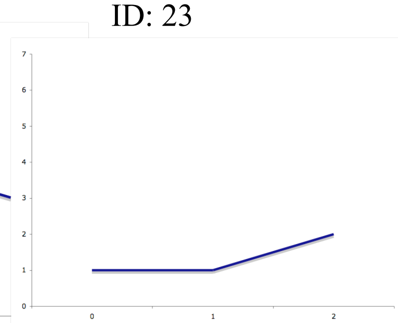
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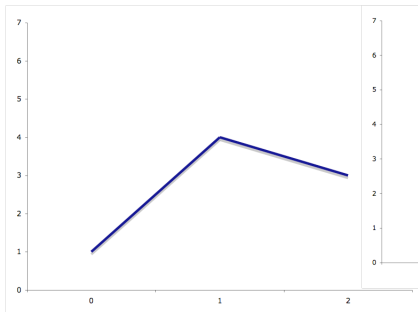

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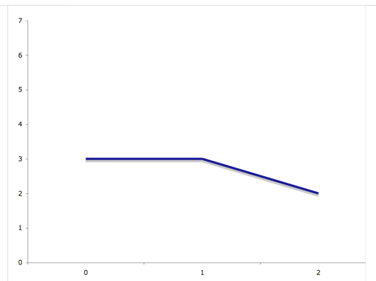

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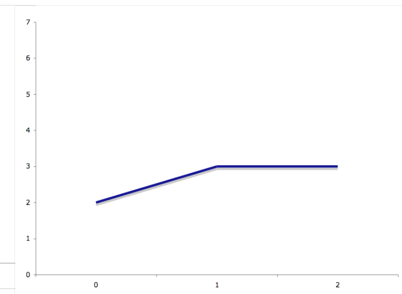

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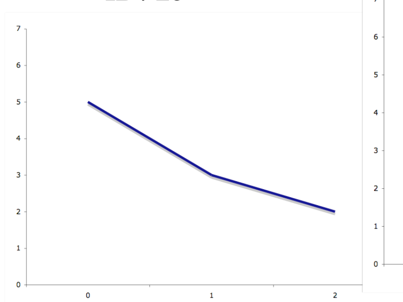

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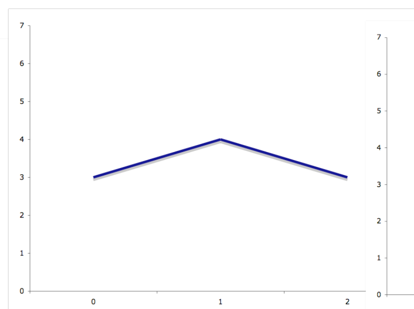

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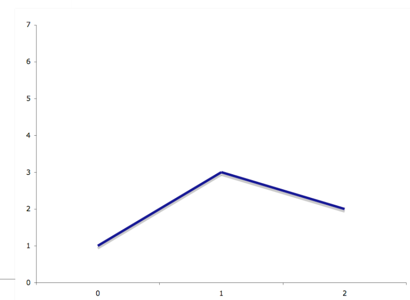

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APPENDIX C
Experimental materials

Introduction

Thank you for your presence. You are now taking part in an economic experiment, conducted for our final project in ECON311, Experiments and Strategic Behavior. If you study the following instructions carefully, you can, depending on your decisions, earn a considerable amount of cash. It is therefore very important that you pay fullest attention to these instructions.
The instructions, which we distributed to you, are solely for your private information. You are prohibited to communicate with the other participants during the experiment. Should you have any questions, please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments.

The grouping

All participants will be randomly divided into groups of three members. This grouping information will be randomly determined at the end of the experiment.

The decision situation

You are a member of a group of 3 people. In each round, everyone in your group will be allocated a certain number of tokens, and each of you has to decide the number of tokens you will contribute to the group project. In each round, you will be given a different payoff table that determines your payoff, based on your and the group's actions.

Your total income

After the whole experiment, 5 people will be randomly selected to receive payments based on their performance in one of the four rounds that will also be randomly selected. The payment will be determined by the payoff table used in that round.

Practice round

Assume you are given 4 tokens and the payoff (in dollars) is determined as shown in the following table.

Contribution of other two members	Your contribution: 0	1	2	3	4
0	12.2	11.8	10.8	9.4	7.6
1	15.2	14.4	12.8	11	8.8
2	18.6	17.2	15.2	12.8	10.2
3	22.2	20.4	17.8	14.8	11.6
4	26.2	23.8	20.6	17	13.2
5	30.6	27.4	23.6	19.4	15
6	35.4	31.4	26.8	21.8	16.8
7	40.6	35.6	30.2	24.4	18.6
8	46	40.2	33.8	27.2	20.6

1) Each of you has 4 tokens at your disposal. Assume that none of the three group members (including you) contribute anything to the project. What will your total income be? What is the total income of each of the other group members?

2) Each of you has 4 tokens at your disposal. Assume that the other group members *together* contribute 3 tokens to the project.
   a) What is your total income if you contribute 0 token to the project?
   b) What is your total income if you contribute 2 tokens to the project?
   c) What is your total income if you contribute all tokens to the project?

3) Each of you has 4 tokens at your disposal. Assume that you contribute 2 tokens to the project.
   a) What is your total income if the other group members together contribute 1 token to the project?
   b) What is your total income if the other group members together contribute 7 tokens to the project?

Are there any questions for this practice round?

Round 1

In round 1, each of you is given seven tokens. You can input from zero to seven of these tokens into the project, with the payoff dependent on the number of tokens put by the other two group members, as given by *Payoff Matrix A*.

Contribution of other two members	Your contribution: 0	1	2	3	4	5	6	7
0	0	0.2	0.6	1.2	1.8	2	2.2	2
1	0.2	0.8	1.6	2.2	2.8	3	3	2.8
2	1	1.8	2.8	3.6	4	4.2	4	3.4
3	2.4	3.4	4.4	5.2	5.6	5.6	5	4.4
4	4.2	5.6	6.6	7.2	7.4	7	6.4	5.4
5	6.8	8	9	9.6	9.4	8.8	7.8	6.4
6	9.8	11.2	12	12.2	11.8	10.8	9.4	7.6
7	13.6	14.8	15.4	15.2	14.4	12.8	11	8.8
8	18	19	19.2	18.6	17.2	15.2	12.8	10.2
9	23	23.6	23.4	22.2	20.4	17.8	14.8	11.6
10	28.6	28.8	28	26.2	23.8	20.6	17	13.2
11	35	34.6	33.2	30.6	27.4	23.6	19.4	15
12	42	41	38.6	35.4	31.4	26.8	21.8	16.8
13	49.6	47.8	44.6	40.6	35.6	30.2	24.4	18.6
14	58	55.2	51.2	46	40.2	33.8	27.2	20.6

Payoff Matrix A

Are there any questions?
Enter the number of tokens you want to contribute to the group project (0-7): ____

Round 2

In round 2, each of you is given seven tokens. Two of them will be involuntarily withdrawn from you, and both tokens will be put into the group project. You can input from zero to five of your remaining tokens into the project, with the payoff dependent on the number of tokens put by the other two group members, as given by *Payoff Matrix B*.

Contribution of other two members	Your contribution: 0	1	2	3	4	5
0	6.6	7.2	7.4	7	6.4	5.4
1	9	9.6	9.4	8.8	7.8	6.4
2	12	12.2	11.8	10.8	9.4	7.6
3	15.4	15.2	14.4	12.8	11	8.8
4	19.2	18.6	17.2	15.2	12.8	10.2
5	23.4	22.2	20.4	17.8	14.8	11.6
6	28	26.2	23.8	20.6	17	13.2
7	33.2	30.6	27.4	23.6	19.4	15
8	38.6	35.4	31.4	26.8	21.8	16.8
9	44.6	40.6	35.6	30.2	24.4	18.6
10	51.2	46	40.2	33.8	27.2	20.6

Payoff Matrix B

Are there any questions?
Enter the number of tokens you want to contribute to the group project (0-5): ___

Round 3

In round 3, each of you is given seven tokens. Two of them will be involuntarily withdrawn from you, but neither of these tokens will be put into the group project. You can input from zero to five of your remaining tokens into the project, with the payoff dependent on the number of tokens put by the other two group members, as given by *Payoff Matrix C*.

Contribution of two other members	Your contribution: 0	1	2	3	4	5
0	0	0.2	0.6	1.2	1.8	2
1	0.2	0.8	1.6	2.2	2.8	3
2	1	1.8	2.8	3.6	4	4.2
3	2.4	3.4	4.4	5.2	5.6	5.6
4	4.2	5.6	6.6	7.2	7.4	7
5	6.8	8	9	9.6	9.4	8.8
6	9.8	11.2	12	12.2	11.8	10.8
7	13.6	14.8	15.4	15.2	14.4	12.8
8	18	19	19.2	18.6	17.2	15.2
9	23	23.6	23.4	22.2	20.4	17.8
10	28.6	28.8	28	26.2	23.8	20.6

Payoff Matrix C

Are there any questions?

Enter the number of tokens you want to contribute to the group project (0-5): ____

Round 4

In round 4, each of you is given five tokens. Two of them will be involuntarily withdrawn from you, but only one of these tokens will be put into the group project. You can input from zero to five of your remaining tokens into the project, with the payoff dependent on the number of tokens put by the other two group members, as given by *Payoff Matrix D*.

Contribution of other two members	Your contribution: 0	1	2	3	4	5
0	1.8	2.8	3.6	4	4.2	4
1	3.4	4.4	5.2	5.6	5.6	5
2	5.6	6.6	7.2	7.4	7	6.4
3	8	9	9.6	9.4	8.8	7.8
4	11.2	12	12.2	11.8	10.8	9.4
5	14.8	15.4	15.2	14.4	12.8	11
6	19	19.2	18.6	17.2	15.2	12.8
7	23.6	23.4	22.2	20.4	17.8	14.8
8	28.8	28	26.2	23.8	20.6	17
9	34.6	33.2	30.6	27.4	23.6	19.4
10	41	38.6	35.4	31.4	26.8	21.8

Payoff Matrix D

Are there any questions?

Enter the number of tokens you want to contribute to the group project (0-5): _____