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Changing Endowments in the Public Goods Game

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Abstract:

The public goods game examines how people make decisions about contributing money for group welfare. In the experiment, participants receive a number of tokens with a monetary value and choose how many to contribute to a public fund. The public fund tokens are increased in value and are divided equally amongst group members, and each participant individually receives the value of their own tokens that are not contributed. Therefore, participants have an incentive not to contribute to the public fund, even while they wish that other group members contribute generously.

This public goods experiment studied how changing endowments, between a low and high number of tokens, affected individual contributions levels. Each group member received an endowment of 10 tokens in one game and an endowment of 50 tokens in the other game. It was hypothesized that there would be a difference in the proportion of the endowment contributed to the public fund between the high and low endowment level, with the low endowment of 10 tokens resulting in a higher proportional contribution rate than the high endowment of 50 tokens. It was found that there was a statistically significant difference in contribution rate by endowment level, with the 10 token endowment yielding higher proportional contribution rates. This experiment is significant because it examines how people's propensity to give changes with changing asset levels.

1 Introduction

This study investigates how people's propensity to give is affected by asset levels by varying the endowment levels in a public goods game. The public goods game is an experiment designed to mimic the decisions that people must make regarding contributions to public welfare at personal expense. A public good is a good that benefits everyone but is both non-excludable, meaning that even if people do not contribute to the cost of providing the good, they can still reap the benefits it provides, and non-rival, meaning that one person's use of the good does not take it away from anyone else. An example of a public good is a public park. There is a cost to maintain the park but once this cost is covered, anyone is able to enjoy the park regardless of how much or how little they personally paid to maintain it. One additional person being in the park does not diminish any other person's enjoyment of the park, making it non-rival.

Traditional economic theory of a maximizing rational non-altruistic individual would suggest that these goods would be underfunded because people would be unmotivated to contribute to the public good when they could still benefit from the goods without paying. People only have a certain amount of money that could be contributed, which is considered their endowment. The group would benefit the most from having everyone contribute to the public good. However, since public goods are non-excludable, each individual would be best off if they personally did not contribute but everyone else did. In this case, they would still have access to the public good but would not have paid for it. This is known as free-riding, when the individual relies on their group members to contribute without reciprocating themselves. Therefore, each player has an incentive to keep their entire endowment, so individual interests conflict with the group interest (Ledyard 112, 1995). The public goods experiment was designed to test this theory and to explore the factors that affect contributions.

The public goods game is set up with small groups of participants who are each given a designated number of tokens. These tokens hold a small monetary value. Each round, participants anonymously choose a number of tokens to contribute to a public fund. All tokens in this public fund are multiplied by a predetermined number and then equally distributed amongst participants. Any tokens that are not contributed to the public fund are kept in the private fund for that individual player. Those private tokens retain their original value but are not shared with other group members. Therefore, each participant earns a total of what he or she retains in the private fund in addition to his or her share from the public fund.

For example, consider a game in which groups of 5 participants each receive 50 tokens, which make up their endowment. The tokens are valued at $0.10 in the private fund and are worth $0.25 in the public fund, meaning that each participant would receive $0.05 for each token contributed to the public fund. If a participant chooses to contribute 20 tokens to the public fund, she would keep 30 tokens in her private fund. If the other four group members contributed nothing to the public fund, the total public fund would be worth 20 tokens, valued at $5. Each participant would receive $1 as their share of the public fund. The participant who had 30 tokens remaining in her private fund would get $3 from her private fund. This means her total earnings for that round would be $4. Each of the other group members would have $5 from their private funds, and they would receive $1 from the public fund, for total earnings of $6 each. The next round, the participants would all receive the same number of tokens and make the decision regarding how many tokens to contribute to the public fund again.

The theory of the maximizing rational non-altruistic individual predicts that no participants would contribute anything to the public fund, since each token kept in the private fund gives that participant a higher payoff than a token that he or she contributes to the public

fund. Therefore, if all participants are evaluating how many tokens to contribute on a solely rational basis, the public fund should always have zero tokens. Several rounds are played with the same conditions, including the same group members, in order to test how participants act over time and with experience.

Despite the theoretical prediction that participants would not contribute to the public fund, historically experiments have found that initially, the majority of participants do contribute. At the beginning of the game, participants typically contribute a portion of their tokens, with the expectation that others will do the same. However, with repeat trials, this contribution rate tends to decline, which suggests that participants learn that they can earn a higher payoff when they keep all their tokens in their private fund and let other group members pay into the public fund. As some participants contribute less, the overall contributions quickly decline because those who are left contributing decide that they do not want to be the only ones paying in to the public fund. This change suggests that once a sense of cooperation is broken, or if a sense of cooperation is never established, and it is clear that not all participants will contribute to the public fund in order to generate group returns, the participants who were still contributing decide that they would rather just keep their tokens. This creates a trend towards the predicted result (no contributions to the public fund) despite the benefit to all of those contributions.

This public goods experiment examined how changing the endowment level affected the proportion of the endowment that was contributed to the public fund. Participants played two games. In one game they received a low endowment of 10 tokens and in the other game they received a high endowment of 50 tokens. The average contribution rates across twelve rounds of the game were compared to determine if there was a statistically significant difference in

contribution rates between the endowment levels. It is hypothesized that there will be a difference in contribution rates by endowment level.

2 Literature Review

The public goods game has been studied in many different forms. Despite the theoretical expectations, the literature on public goods experiments reveals that in early stages of the game, participants provide somewhere between 30 and 70 percent of their endowments (Ledyard, 1995, p. 170). One early study examining public goods looked at conditions that motivated free riding, or individuals not contributing to the public good while still reaping the benefits of other group members participating. The experiment found that under a wide variety of conditions, free riding was lower than expected, with participants contributing approximately 50 percent of their tokens (Marwell and Ames, 1980). Because of its stark contrast with the theorized outcome, this experiment helped to lay the groundwork for future studies in public goods. Since then, there have been many versions of this game used to test how different circumstances affect contribution decisions. While there is a substantial range in these variations, this review will focus on the study of inequality and changes to participants' initial endowments.

Inequality can have a profound effect on the perceived fairness of the game. If participants are aware that they have more money than their group members, it can change how they make their decisions regarding contributions. A clear example of this result was found by Buckley and Croson (2006) in an examination of differing endowment levels. In this experiment, half of the group members received 25 tokens at the beginning of each round while the other half received 50 tokens. All participants contributed roughly the same number of tokens to the public fund in absolute terms. This means that the high income participants contributed a much lower percentage of their endowment (Buckley and Croson, 2006). Since the endowment distribution

was explained to all participants before the game began, the high income participants knew that they had more control over how many tokens were in the public fund. However, this clearly did not translate into a greater sense of responsibility to proportionally increase the total amount in the public fund. If these individual contributions are not private, however, then even lower total contributions are observed. In conditions of equality (all participants initially receive the same number of tokens), slight inequality (all participants receive different endowments but have a small range of possible endowments), and high inequality (participants have a wide range of possible endowments), participants in both conditions of unequal endowments all contributed less when it was known how much the high income participants contributed compared to the low income participants (Anderson et al., 2008). This suggests that low income participants behave differently when they are aware that they would be contributing a higher percentage of their endowment than the high income participants. Creating this impression of unfairness could be what prompts overall lower contributions to the public fund. On the other hand, the low contribution rates may be dependent on the degree of inequality. Another study with three conditions of endowments-- equal, slightly unequal, and strongly unequal-- found that only the strongly unequal endowment group had differing percentages of contributions (Keser et al., 2013). There are some differences found between the groups in which the endowment level is only slightly different, so the effect of different endowment levels is still unclear.

Additionally, inequality can enhance or negate the effects of other factors on participants' decisions. For example, it was found that working on a task with group members before playing the game creates a sense of group identity and promotes higher contributions to the public fund. However, if the endowment level of participants differed, meaning that some participants had a higher number of tokens than others, the effect of group identity disappeared. In the unequal

endowment groups, participants that received a higher initial endowment contributed a lower percentage of their tokens despite the impact of group identity (Charness et al., 2014). The high endowment participants were less impacted by other factors guiding their decisions.

These effects are not only seen in the public goods game. It is worth considering the impact of a change in endowment in similar games. Two games that involve similar decisions about monetary contributions are the ultimatum game and the dictator game. The ultimatum game consists of two players: a proposer and a responder. The proposer is given an amount of money and must propose a split to the responder. The responder is then able to accept the money offered to him or her or to reject it. If the responder rejects the proposed split, then neither player receives any money. In the dictator game, one player, the dictator, is able to choose how a given amount of money is split. The other player simply receives the amount allocated by the dictator, with no ability to reject the money and thereby punish the dictator. A meta-analysis of 31 studies of the ultimatum and dictator games compared the relative difference between high and low stakes in these games. The high stakes games involve a higher amount of money, which could lead to more pressure in making the correct or optimal decision. It was found that the amount of money played with didn't affect the offers made in the ultimatum game. However, as the amount increased in the dictator game, the dictator gave continuously lower amounts (Larney et al., 2019). This could be due to the chance of getting nothing in the ultimatum game, whereas there is no such risk in the dictator game.

While the literature on the public goods game has a great deal detailing the effect of differing endowments between group members, little has been said about changing endowment levels. Because experimental results have differed from economic theory in many public goods

experiments, it is important to test how changes in income compare to theorized outcomes (Ledyard, 1995, p. 113).

Furthermore, public goods often need to be privately funded through charitable giving when government funding is insufficient. In order to get these goods funded, it is important to understand the conditions that influence peoples' likelihood of supporting charities and public goods when they could easily free ride. Andreoni and Payne (2013) provide a valuable overview of the many factors that affect charitable giving. One factor that has been emphasized in charitable giving research but needs to be examined for public goods is income level. While the likelihood of giving to charities has been found to increase as income increases, available data suggest that poorer households that do donate money give at a higher percentage of their income than any other income bracket (List, 2011). The following experiment will extend the behavioral economics literature on contributions to public goods by endowment level by examining if people's propensity to give stays constant as a percentage of income or stays at relatively similar levels of absolute donations. This is significant because it could help elaborate on how changes in income impact communities' ability to fund public goods.

Based on the existing research, there does seem to be a difference between unequal endowments within a group. Therefore, it would be expected that there will also be a difference between high and low endowments when all group members have the same endowment. The finding that people with lower incomes donate a higher percentage of their income suggests that subjects will contribute a higher proportion of their endowment when they have a low endowment compared to when they receive a high endowment. It is therefore expected that there will be a significant difference in contribution rates to the public fund based on endowment level,

with the low 10 token endowment yielding higher contribution rates than the high 50 token endowment.

3 Method

This experiment consisted of six sessions with a total of 39 undergraduate student participants. Each group playing the games was made up of five subjects. The same five subjects remained in a group for both games. Subjects played two games, which each consisted of twelve rounds. In one game, the subjects had an endowment of 10 tokens. In the other game, subjects received an endowment of 50 tokens. The order in which the two games were played varied randomly by experimental session. Twenty subjects played a game with 10 tokens followed by a game with 50 tokens. Nineteen subjects played a game with 50 tokens followed by a game with 10 tokens. In this experiment, tokens were valued at $0.06 each in the private fund. In the public fund, the value of each token was increased to $0.15 before being divided equally amongst group members. This means that the value of a public fund token to each individual group member was $0.03.

Before the first game began, subjects received an information sheet establishing their consent for the experiment (see Appendices, Research Information Sheet). They next received a set of instructions about the game procedure (see Appendices, Instructions for Public Goods Experiment). These instructions were read aloud and subjects were able to ask questions at any point (see Appendices, Public Goods Experiment Instructor Script). The instructions explained the game format, describing how the endowment level would differ between the two games, the decision that the participants would make for each round about how many tokens to contribute to the public fund, and how the tokens would be valued in both the private and the public fund. An example round was shown with five players all contributing different amounts. Each

participant's earnings from the example round were included in the table. Participants were told that their contribution decisions would not be observed by their group members, and that after each round they would be able to see their own decision as well as the total number of tokens contributed to the public fund by the entire group and their individual earnings for the round. They also knew that the game would be played online and that they would not be allowed to discuss the results from any round until the experiment was complete. Finally, they were told that the number of tokens they contributed would only affect that one round, meaning that they would restart each round with the same number of tokens. Their endowment did not change due to their decision in the previous rounds.

The instructions also informed participants about how they would be paid. Each subject was paid $5 for participating in the experiment. Additionally, participants were paid for one randomly selected round from each game. The purpose of taking one round from each game was to guarantee that participants were paid for one round in which they had an endowment of 10 tokens and one round in which their endowment was 50 tokens. Participants knew that the two paid rounds would be randomly selected at the end of the experiment by rolling a 12-sided die. This was an integral part of the experiment: if participants knew in advance which rounds they would be paid for, there would be no way to ascertain their motivation in the other rounds. Since the participants did not know in advance which rounds they would be paid for, it can be assumed that participants were not choosing how many tokens to contribute to the public fund at random. This is a standard practice in the public goods game experiment (Ledyard, 1995).

After all of this information was explained, participants had to fill out the highlighted boxes in the table at the end of the instructions. This quiz question was created to verify subjects' understanding of the game and the payoffs. Subjects were able to ask questions and use the

example round to help them answer these questions. Before beginning the game, all participants had to correctly answer these questions.

It should be noted that one subject played the game twice, simultaneously participating in two groups at once. This was necessary because subjects did not always show up when they were scheduled to participate. Despite overbooking experimental sessions, additional participants were required during four of the six sessions to maintain groups of five. In one of these sessions, only nine participants were present. Rather than turning away four participants, one subject participated in both groups. One of the subject's data points was randomly selected and dropped, so that she would only count in the results as one participant. Therefore, despite having eight groups of five participate in the experiment, there are only 39 subjects.

Subjects were given a code to the online platform Vecon Experimental Economics Laboratory. This code allowed for all subjects to log into the same group. Subjects submitted their decisions regarding how many tokens from their endowment they wanted to invest in the public fund. These decisions were selected from a drop down menu ranging from zero to the entirety of their endowment. Subjects could choose any integer amount within their endowment range. Any tokens they did not invest were kept in their private fund for that round. After all group members submitted their decisions, each subject was able to see how many total tokens were invested in the public fund, how many tokens they individually chose to invest in the public fund, how many tokens they chose to keep in their private fund, and the dollar value of each of these contributions. This means that each subject only knew their own decision and the total number of tokens contributed by all other group members. As a result, subjects had no way of knowing how much any particular group member contributed, or if the same people were

contributing from round to round. Each subject's decisions were therefore anonymous from their group members.

After twelve rounds, the first game concluded and subjects were reminded that the only difference in the next twelve rounds was that their endowment level had changed. After all of the 24 rounds of the two games had been completed, the participants were thanked for their time and their payment was determined.

4 Results

4.1 Contribution Rate at Different Endowment Levels

To determine if there was a difference between the proportion of the endowment contributed to the public fund when participants had an endowment of 10 tokens and when the participants had an endowment of 50 tokens, a paired t-test was conducted. A paired t-test was used because the two samples were both made up of the same population, being all participants in the study. Each participant's proportion of the endowment contributed to the public fund was compared at the two endowment levels. On average, participants contributed 35.0% of their 10 token endowment and 31.0% of their 50 token endowment (Table 1). The resulting test statistic of 1.795 corresponded to a p-value of 0.081. This is statistically significant at the 10% level. There is support for the hypothesis that there is a difference in the contribution rate between a low and high endowment level. In this experiment, the low endowment level of 10 tokens yielded a higher average contribution rate.

Graph 1 illustrates the proportion of the endowment contributed to the public fund by each participant when they had an endowment of 10 tokens compared to their contribution when they had an endowment of 50 tokens. The majority of participants contributed a higher

proportion when they had an endowment of 10 tokens, as can be seen from the 10 token line being higher than the 50 token line, with several exceptions.

4.2 Contribution Rate at Different Endowment Levels without Last Round

However, there could be an issue with including the last round of each game in this analysis, as participants have less incentive to preserve a relationship with their group members at the end of a game. Therefore, another paired t-test was conducted excluding the 12th round of each game. The average proportions contributed changed, such that the 10 token endowment resulted in a 34.6% contribution rate and the 50 token endowment resulted in a 31.1% contribution rate (Table 1). The test statistic is 1.697, resulting in a p-value of 0.098. This difference is still statistically significant at the 10% level.

4.3 Contribution Rate at Different Endowment Levels without First or Last Round

Additionally, the first round of the game could be attributed to learning and deciding on a strategy. For that reason, another paired t-test was conducted excluding both the 12th and the first round. The average proportion of the endowment contributed over 10 rounds for the 10 token endowment decreased to 34.5% while the 50 token endowment stayed the same at a 31.1% contribution rate (Table 1). The contribution rate is still higher in the 10 token endowment condition, but the resulting test statistic is 1.500, which corresponds to a p-value of 0.142. By excluding both the first and the 12th round, there is no longer a statistically significant difference in the average proportion of the endowment contributed to the public fund between the 10 token and the 50 token endowments.

4.4 Contribution Rate by Game Order

In order to verify that this effect was not the result of game order, additional tests were conducted. A paired t-test was used to determine if the first game had a different average

contribution rate than the second game, regardless of endowment amount. In the first game, there was an average contribution rate of 33.8%. In the second game, the average contribution rate was 32.2% (Table 1). The test statistic of 0.712 provided a p-value of 0.481. This means that there is no evidence that there is a difference in the average proportion of the endowment contributed to the public fund by game order. This is important because it suggests that the difference in contribution rates by endowment level is likely not the result of differences in the first and second games.

4.5 Contribution Rate by Initial Endowment Level

However, there could be a difference based not on the first and the second game, but on which endowment level was received first. In other words, people may contribute a different proportion if they received a 10 token endowment followed by a 50 token endowment compared to people who received a 50 token endowment first and a 10 token endowment second. To address this possibility, two independent t-tests were conducted. The first compared the average proportion of the endowment contributed from the 10 token endowment between participants who received the 10 token endowment first and participants who received the 50 token endowment first. An independent t-test was used because the 39 participants were no longer being compared at two separate points. Instead, 20 participants who had an initial endowment of 10 tokens were compared to 19 participants who had an initial endowment of 50 tokens. Those with an initial endowment of 10 tokens had an average contribution rate of 34.0% during the 10 token endowment game. Participants with an initial endowment of 50 tokens had an average contribution rate of 36.1% during the 10 token endowment game. The resulting test statistic of 0.295 yielded a p-value of 0.770 (Table 1).

The second independent t-test compared the average proportion of the endowment contributed during the 50 token endowment game between those with an initial endowment of 10 tokens and those with an initial endowment of 50 tokens. The 20 participants who received an initial endowment of 10 tokens contributed an average of 28.5% of their endowment during the 50 token game. The 19 participants who received an initial endowment of 50 tokens contributed an average of 33.6% of their endowment during the 50 token game. This gave a test statistic of 0.711, which corresponded to a p-value of 0.482 (Table 1). Neither of these comparisons were statistically significant. This means that there is no evidence of a difference in contribution rate based on which endowment amount was received first.

4.6 Contribution Strategies

One interesting aspect of this game is the difference in contribution strategies used by participants and how these strategies varied by endowment. The strategies were evaluated in both games, which resulted in a total of 78 games examined for contribution strategy. These 78 contribution strategies were sorted into 7 categories. An example of each of these strategies is shown in graph 2. Altruistic players contributed 80% or more of their endowment in all twelve rounds. Rational maximizers had the opposite contribution strategy, in which players never contributed more than 30% of their endowment. Imperfect maximizers never contributed more than 60% of their endowment.

There were also players who ranged in contribution rates from 0 to 100% of their endowment. Some of these players rotated each round between lower and higher contribution rates, which is classified as mixed strategy cyclical. There were also midrange contributors, who contributed 50% of their endowment with slight variation on both sides. Maximizers with altruistic bursts contributed 50% or less of their endowment with no more than three rounds

going above 50% contribution rates. This can be seen with the example game in graph 2. This participant contributed nothing to the public fund for nine rounds, but then had one round in which they contributed 70% of their endowment and two rounds in which they contributed their entire endowment. The exact opposite of this strategy was the altruistic with maximizing bursts. Participants adopting this strategy contributed 50% of their endowment or more in at least nine of the twelve rounds. In the example game, this participant only contributed less than 50% in one round.

5 Discussion

These results indicate that there is a difference in the proportion of the endowment contributed to the public fund based on the endowment level. This supports the experimental hypothesis. On average, participants contributed significantly higher proportions of their tokens when they had an endowment of 10 tokens compared to when they had an endowment of 50 tokens. This difference was statistically significant when all twelve rounds of the games were compared as well as when the last round of each game was removed. However, the difference in contribution rates was no longer significant when both the first and the last round of each game was removed. Overall, these results suggest that participants are willing to contribution a higher proportion of their endowment when they have a lower endowment and that they contribute less to the public good when they have a higher endowment.

There is no evidence that this difference in proportional contribution rate by endowment level was dependent on which endowment level was received in the first game. The first game contribution rates were not significantly different from the second game contribution rates regardless of endowment level. Additionally, there was no significant difference in contribution rate in the 10 token endowment game between participants who received a 10 token endowment

in the first game and those who received a 50 token endowment in the first game. The same result of no significant difference was found when examining the contribution rate in the 50 token game between participants who had an initial endowment of 10 tokens and those who had an initial endowment of 50 tokens. The fact that there was no significant difference in any of these comparisons means that the difference found in the contribution rates of the high and low endowments are likely not a result of which endowment level came first. It appears that participants did not simply change their behavior between the first and second game due to factors other than the endowment level.

The contribution strategies provided further insight into differences and similarities between the games. The majority of participants kept the same strategy for both games. However, there was variation in the strategies adopted by people based on initial token endowment. Graph 3 shows the number of players that used each strategy based on initial endowment amount. Graph 4 shows the number of players that used each strategy based on token endowment. It is clear that there are both certain strategies that were employed more often as well as strategies that were more common based on initial endowment and game endowment type. These graphs illustrate that the most common strategies used were rational maximizer and imperfect maximizer. On the other hand, only two players, for a total of four games, used the altruistic strategy. This is interesting because it means that many players chose to keep the majority of their endowment in their private fund.

There are few differences between graph 3 and graph 4, which means that the variation between game strategy doesn't change when looking at game endowment and initial game endowment level. The general patterns are similar. However, there are still differences between these graphs. One interesting difference is that all of the maximizers with altruistic bursts had an

initial endowment of 50 tokens, but had an even split between games with 10 tokens and games with 50 tokens. This is because the same players used this strategy for both games they played. This was the case for many players, which resulted in equal numbers of participants choosing a strategy when comparing by current game endowment level as opposed to initial game endowment level.

6 Conclusion

This public goods game experiment examined how contribution rates change based on endowment amount. The results support the hypothesis that people contribute a higher proportion of their endowment when they receive a lower endowment. This is expected based on the existing literature, which has found that higher endowments don't lead to higher contribution rates. However, this study examined how contribution rates changed when participants went from a high to a low endowment level or a low to a high endowment level. This allowed for comparison between the same participants with changing endowment levels as opposed to comparing participants with unequal endowments within the same group. This was important to increase understanding of how public goods are funded and the role of income level. These results indicate that, all other things equal, people will contribute a higher proportion of their income to goods that benefit the group when they are receiving a lower income. These results have policy implications as well, regarding methods of increasing the provision of public goods.

There were limitations to this experiment. The small sample size limits the significance of the results. Additionally, since the subjects were all undergraduate students, it is possible that these results will not apply to other populations. Further research should use participants from a population that better represents the general population while still examining how different endowment levels impact contribution rates. Another limitation is that the high endowment is

only five times larger than the low endowment. The major income inequality in the United States means that those with a high income have far more than five times the income of people of a lower socioeconomic status. A future experiment could test a larger gap between endowment levels to better represent the difference in income levels.

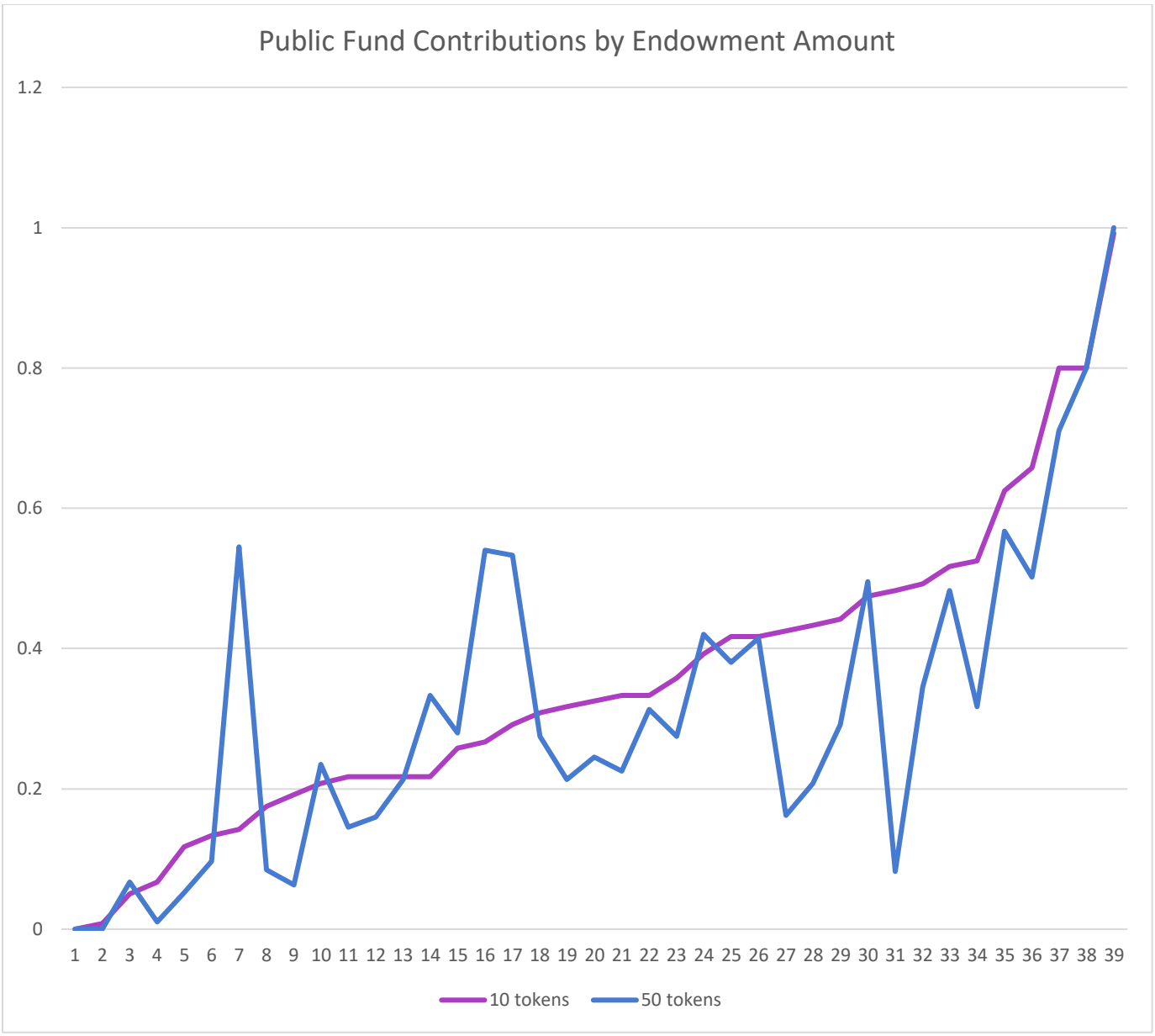
Appendices

Chart 1:

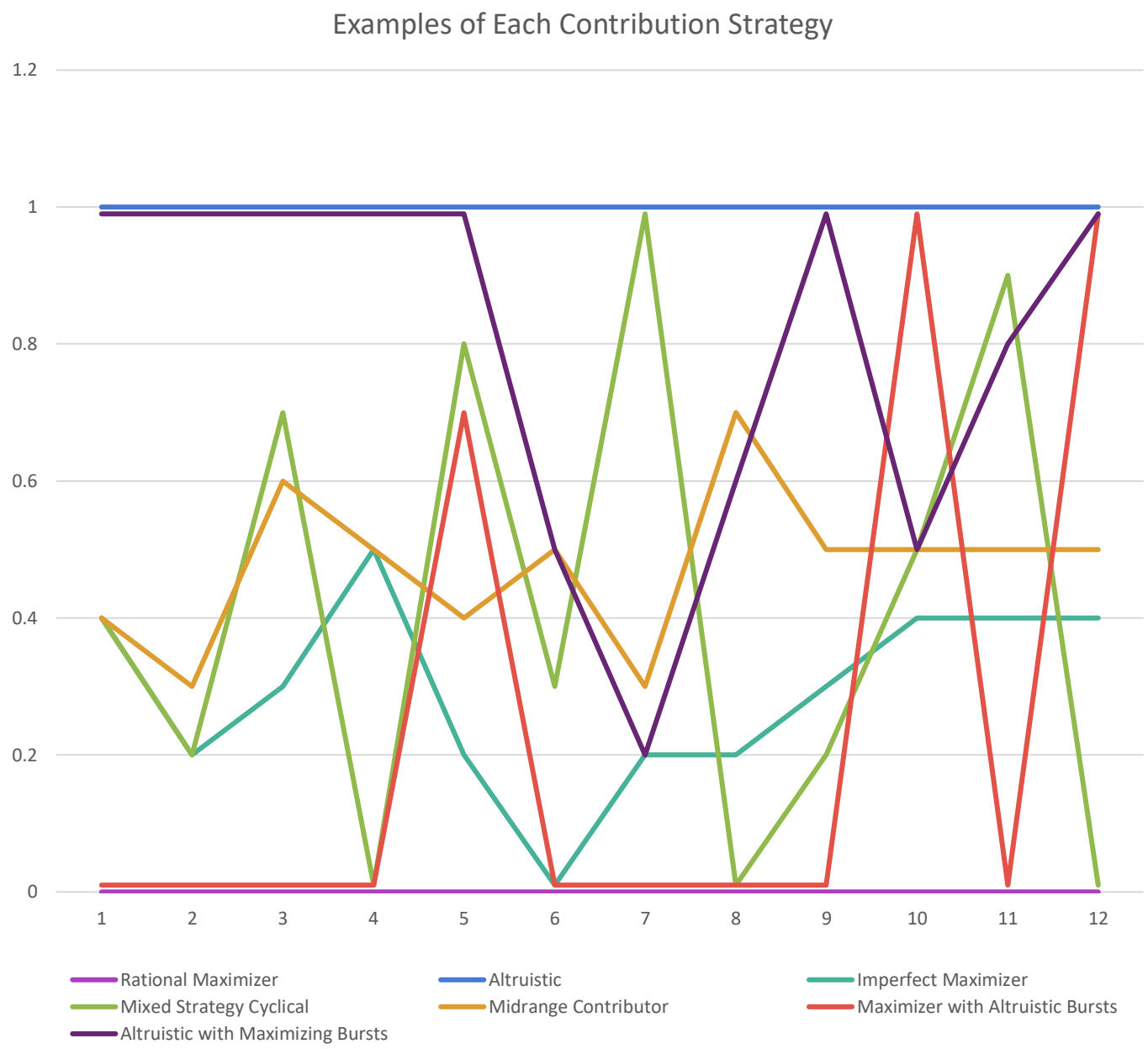
Average Proportion Contributed by Group

Variable	Number of Subjects	Average Proportion Contributed	Test Type	p-value
Endowment of 10 tokens	39	35.0%	Paired t-test	0.081
Endowment of 50 tokens	39	31.0%		
Endowment of 10 tokens without 12th round	39	34.6%	Paired t-test	0.098
Endowment of 50 tokens without 12th round	39	31.1%		
Endowment of 10 tokens without 1st or 12th round	39	34.5%	Paired t-test	0.142
Endowment of 50 tokens without 1st or 12th round	39	31.1%		
First game regardless of endowment	39	33.8%	Paired t-test	0.481
Second game regardless of endowment	39	32.2%		
Endowment of 10 tokens if initial endowment was 10 tokens	20	34.0%	Independent t-test	0.770
Endowment of 10 tokens if initial endowment was 50 tokens	19	36.1%		
Endowment of 50 tokens if initial endowment was 10 tokens	20	28.5%	Independent t-test	0.482
Endowment of 50 tokens if initial endowment was 50 tokens	19	33.6%		

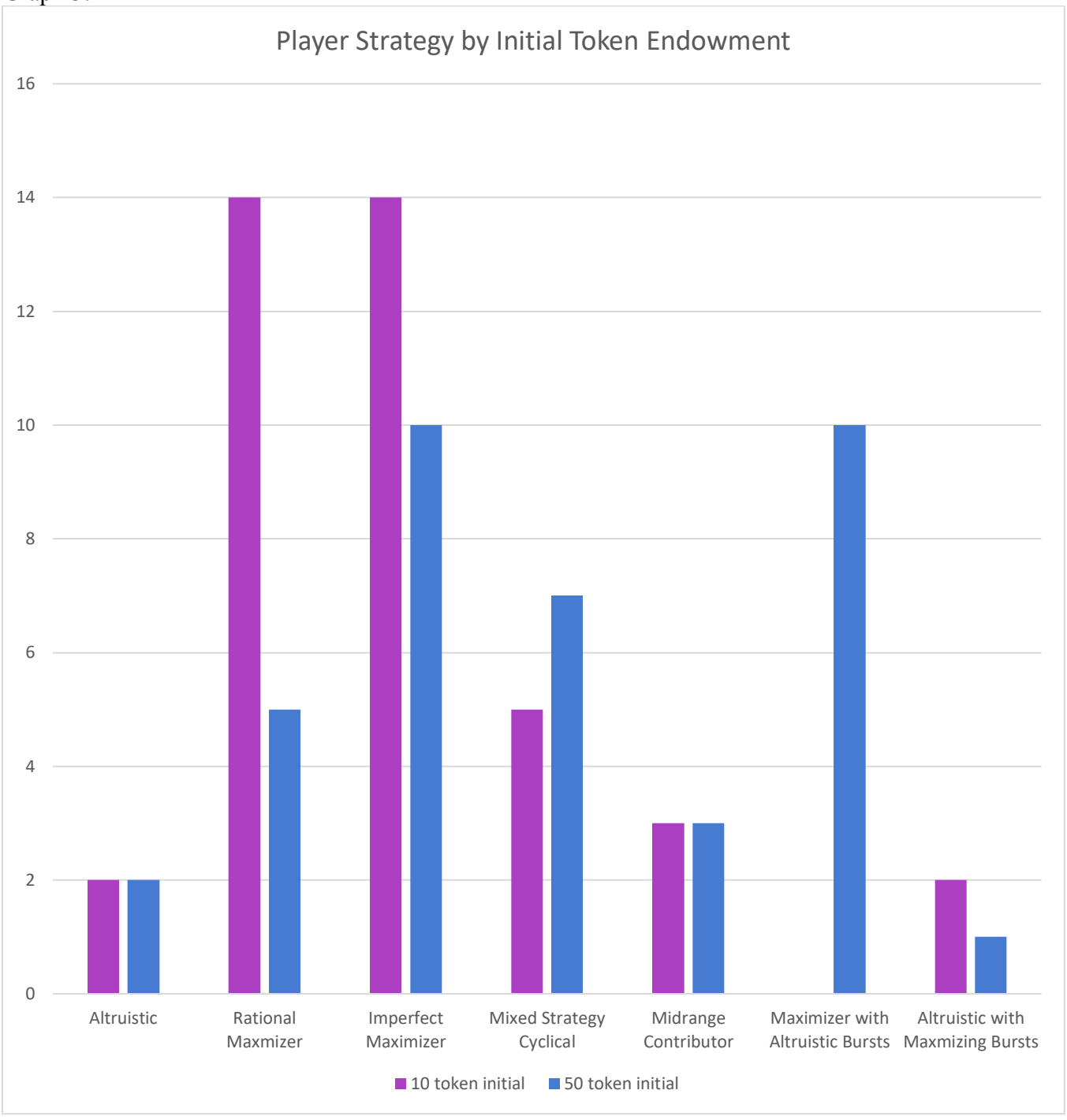
Graph 1:


Public Fund Contributions by Endowment Amount
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
10 tokens
50 tokens

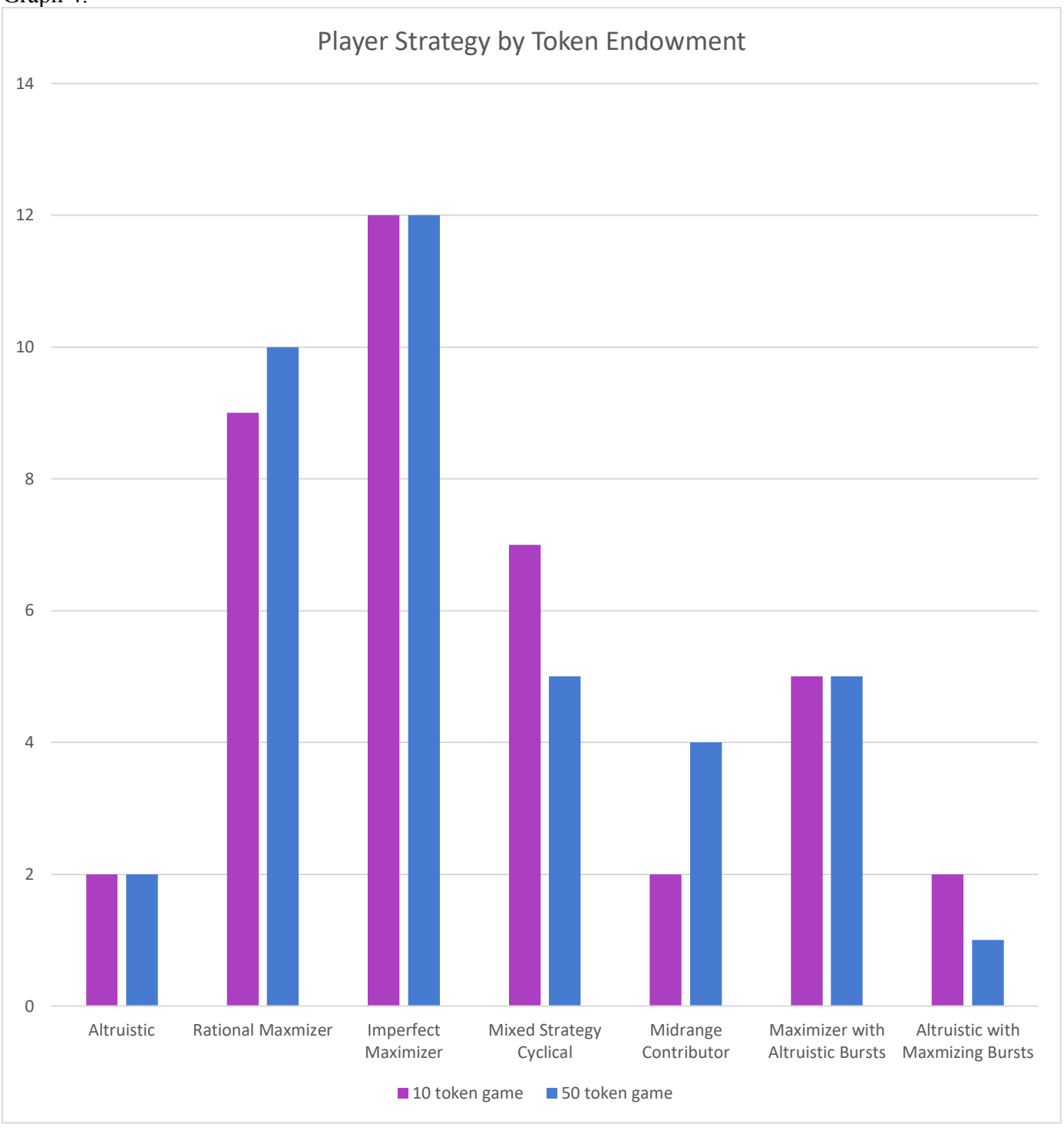
Graph 2:


Examples of Each Contribution Strategy
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
10
11
12
Rational Maximizer
Altruistic
Imperfect Maximizer
Mixed Strategy Cyclical
Midrange Contributor
Maximizer with Altruistic Bursts
Altruistic with Maximizing Bursts

Graph 3:


Player Strategy by Initial Token Endowment
16
14
12
10
8
6
4
2
0
Altruistic
Rational Maxmizer
Imperfect Maximizer
Mixed Strategy Cyclical
Midrange Contributor
Maximizer with Altruistic Bursts
Altruistic with Maxmizing Bursts
10 token initial
50 token initial

Graph 4:


Player Strategy by Token Endowment
14
12
10
8
6
4
2
0
Altruistic
Rational Maxmizer
Imperfect Maximizer
Mixed Strategy Cyclical
Midrange Contributor
Maximizer with Altruistic Bursts
Altruistic with Maxmizing Bursts
10 token game
50 token game

Research Information Sheet

Title of Study: Public Goods with Changing Endowments

Principal Investigator (PI): Madeleine Bowe

Faculty Sponsor: Dr. Sara Solnick

Funder: University of Vermont Honors College, University of Vermont Economics Department, University of Vermont College of Arts and Sciences

Introduction
You are being invited to take part in this research study because you are an undergraduate student age 18 or older at the University of Vermont. This study is being conducted by Madeleine Bowe at the University of Vermont.

Purpose
The purpose of this study is to learn more about individual's choices about contributing to a group.

Study Procedures
If you take part in the study, you will be asked to play a game online. You will be randomly assigned to a group of five players. There will be two games, each consisting of 12 rounds. Each player will receive 10 tokens in one game, and 50 tokens in the other game. Tokens are each worth $0.06. Each round, you will be asked how many tokens you would like to invest in a public fund, and how many you would like to keep. Each token in the public fund is increased in value to $0.15. All tokens in the public fund at the end of each round are divided equally amongst all five group members. This means that each player will receive $0.03 for each token in the public fund.

At the end of each round, you will receive feedback about the total number of tokens invested by all other group members as well as your total round earnings, comprised of both the amount from your personal fund and the amount you received from the public fund. No other players will know the amount you invested. Once all players indicate that they are ready to move on, the next round will begin. Between the games, you will be notified of the change in the number of tokens you receive. The second game will automatically begin once all players have finished reading the instructions.

The experiment should take about 45 minutes. It will require one in-person session.

Benefits
As a participant in this research study, there may not be any direct benefit for you; however, information from this study may benefit other people now or in the future.

Risks

We will do our best to protect the information we collect from you during this study. Because we will need your name and UVM net ID to pay you, there is the risk of an accidental breach of confidentiality.

Costs
There will be no costs to you for participation in this research study.

Compensation
For taking part in this research study, you will be reimbursed for your time and inconvenience. You will receive $5 for completing the experiment. Additionally, you will be paid the amount from two randomly selected rounds. A 12-sided die will be rolled twice. The first roll will determine which round of game one is paid and the second roll will do the same for game two. You will be asked to sign for the payment, using your UVM net ID and signature. You will be given your total earnings before leaving the experiment location.

Confidentiality
All information collected about you during the course of this study will be stored with a code name or number so that we are able to match you to your answers.

Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used.

To minimize the risks to confidentiality, we will store all data using participant numbers instead of names. The information regarding which number has been assigned to each participant will not be shared with anyone other than the principle investigator and the faculty advisor.

The sponsor(s) or their appointed designees as well as the Institutional Review Board and regulatory authorities will be granted direct access to your original research records for verification of research procedures and/or data.

If your record is used or disseminated for government purposes, it will be done under conditions that will protect your privacy to the fullest extent possible consistent with laws relating to public disclosure of information and the law-enforcement responsibilities of the agency.

Please note that email communication is neither private nor secure. Though we are taking precautions to protect your privacy, you should be aware that information sent through e-mail could be read by a third party.

When the research is completed, our research team may save the study data for use in future research done by myself or others. We will retain this study information for at least five years after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

Voluntary Participation/Withdrawal
Taking part in this study is voluntary. You are free to not answer any questions or withdraw at any time. You may choose not to take part in this study, or if you decide to take part, you can change your mind later and withdraw from the study. Your data will have to be removed from the study. Due to logistical challenges, if you withdraw before the end of the experiment, we will be unable to pay you for participation.

Questions
If you have any questions about this study now or in the future, you may contact me, Madeleine Bowe, at the following phone number (207) 838-8289. If you have questions or concerns about your rights as a research participant, then you may contact the Director of the Research Protections Office at (802) 656-5040.

Participation
Your participation is voluntary, and you may refuse to participate without penalty or discrimination at any time.

Public Goods Experiment Instructor Script

Checklist of materials for session:

Information sheets

Instructions (version A or B: only difference is if the first or second game uses 10 tokens)

Receipts

Pens

Money

Index cards with session names

Answer to quiz questions

Die

Subject arrives:

Please fill in this sign-in sheet.

Give index card with session name

Here is your session number. You will use this later.

You'll have to fill out some forms, do you need to borrow a pen?

Go ahead and choose a seat, we will get started when everyone arrives.

Ready to begin session:

Welcome and thank you for your interest in participating in this experiment. To begin with, you will have to carefully read through this information sheet.

Begin passing out information sheet

Please take some time now to read through the sheet and ask any questions you may have. Once everyone is ready, I will go into more detail regarding the process of this experiment.

Answer any questions

If there are no more questions, I will now hand out the instructions.

Begin handing out instructions

I will read these instructions aloud and then you will be asked to answer a few questions to guarantee that everyone understands what they will be asked to do.

Read instructions

This table shows an example round of the game. In this example, each player starts the round with 100 tokens. The value of each token is $0.06 and the public fund investments are increased to $0.15 before being divided between players. In terms of investments in the public fund, player A invested 0 tokens, player B invested 20 tokens, player C invested 65

tokens, player D invested 33 tokens, and player E invested 100 tokens. The value of the tokens remaining in the personal fund is equal to $0.06 times the number of tokens that were not invested in the public fund. For example, player B has $4.80 from his or her personal fund, because he or she kept 80 tokens each valued at $0.06. The value of tokens from the public fund is equal to the total number of tokens invested in the public fund times $0.15, divided by 5. In the table, you can see that 218 tokens were invested in the public fund. This gives a total of $32.70 when multiplied by $0.15. $0.15 is used instead of $0.06 because of the increased value of public fund tokens. This total amount of $32.70 is then divided by 5 to give each player an equal share. Each player gets $6.54 in this example. The final column shows the total value that each player earned from this round. This is the value from the public fund added to the value from the personal fund. So player A earned a total value of $12.54 from this round, player B earned $11.34, player C earned $8.64, player D earned $10.56, and player E earned $6.54.

Are there any questions about the results in this example round?

If there are no more questions, please answer the quiz questions now.

Give time for participants to answer questions, check answers

We will now set up the online accounts that you will use to make your game decisions. Please search veconlab and click on the first link. You will be registering as a participant. Use the session name on your card.

Enter your first name and last name. You don't need to create a password because we are only doing one session. The other members of your group will not see your name. Once everyone has entered this information, you will see the game instructions and have to answer two questions about the game. After that, the first round will start. If you have any questions regarding the setup or the use of the site, please raise your hand. Otherwise, please refrain from speaking with other participants during the experiment, including between rounds. This will help ensure that all decisions remain anonymous.

<u>Conclusion/payment</u>:

Thank you for completing this experiment.

Now we will determine which rounds you will be compensated for.

Choose closest seated participant.

Would you roll this die twice for me? The first roll will be for the first game, and the second roll will be for the second game. This way everyone will be compensated for one round in which they got 10 tokens and one round in which they got 50 tokens. You will each be paid however much you earned in the two randomly selected rounds plus the $5 for participating. Once the rounds to be paid are determined, you will be asked to go outside individually to collect your payment. We will need your signature and UVM net ID at that time.

Instructions for Public Goods Experiment

Game Format:

This experiment will consist of two games, each lasting a total of 12 rounds. You will play both games with the same group, which will consist of four other players. Before each round, you will each receive a number of tokens, which are each worth $0.06. In the first game, you will receive 10 tokens. In the second game, you will receive 50 tokens. You will then choose how much to invest in the public fund and how much to keep in your personal fund. All tokens in your personal fund keep their original value. All tokens in the public fund will be increase in value to $0.15. The public fund tokens will be divided equally, so each group member will receive $0.03, regardless of who invested the token.

Example:

Player	**Initial Number of Tokens**	**Contributed to Public Fund**	**Value of Remaining Tokens in Personal Fund**	**Value of Tokens coming from Public Fund**	**Total Value**
A	**100**	**0**	**6.00**	**6.54**	**12.54**
B	**100**	**20**	**4.80**	**6.54**	**11.34**
C	**100**	**65**	**2.10**	**6.54**	**8.64**
D	**100**	**33**	**4.02**	**6.54**	**10.56**
E	**100**	**100**	**0.00**	**6.54**	**6.54**
		Total = 218			
		Value = $32.70			

Group Dynamic:

In each round, the number of tokens any individual player chooses to invest will remain anonymous. The only information the group will collectively receive will be the total amount invested in the public fund each round. After this information is disclosed, the next round will begin. You will not be able to move on to the next round until all players have indicated that they are ready to continue.

Number of Tokens:

You will receive 10 tokens in the first game and 50 tokens in the next game. For each game, you will receive the same number of tokens each round. All group members will have the same number of tokens in any given round.

Each round, you will restart with your assigned number of tokens. This will not be affected by how many tokens you invested in the previous round. This means that any decision you make will only impact one round of the game.

Tokens will all retain the value of $0.06 throughout the entirety of the experiment.

Game Operation:

The game will be played online. The instructor will guide you through the website setup and usage. There will be additional instructions and questions on this website to ensure that how the game is played is understood by all group members before the game begins.

Payment:

You will be paid based on your choice in one round of each game. After all rounds have been played, one group member will roll a die twice, randomly selecting two numbers, indicating two of the rounds played. The first roll will determine which round will be paid from the first game. The second roll will determine the round from the second game to be paid.

You will then be paid according to how much you earned in those rounds between your personal fund and your share of the public fund. You will additionally earn $5 just for completing the experiment.

Quiz Questions:

In order to verify that these instructions are clear, we ask that you fill in the missing values in this table.

Player	**Initial Number of Tokens**	**Contributed to Public Fund**	**Value of Remaining Tokens in Personal Fund**	**Value of Tokens coming from Public Fund**	**Total Value**
A	**80**	**10**	**4.20**		
B	**80**	**20**			
C	**80**	**40**	**2.40**		
D	**80**	**50**			
E	**80**	**80**	**0.00**		
		Total = 200			
		Value = $30.00			

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