COGS 402 Report: Investigating Privacy Preferences with the Public Goods Game

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Abstract

This paper investigates privacy preferences surrounding salary and unequal distribution of resources using a variation of the Public Goods Game with Punishment. The version used in this paper was inspired by "The Competitive Advantage of Sanctioning Institutions," (Gürerk et al., 2006). While Gurek et al. allowed participants to choose between the 'sanction' or 'no sanction' conditions, both experimental conditions in this paper have the ability to sanction (2006). This study presented participants with the choice between the public and private conditions to identify their privacy preferences. Individuals who chose the public condition could also see players' initial endowments as well as their contributions, while individuals in the private condition could only see the other group member's contributions.

Acknowledgements

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Ethics Statement

This study was covered by a preexisting IRB ethics approval for Economic Game Studies that existed in the lab, contact Dr. Shariff or Dr. Green for more information. Data is fully anonymized and stored on an encrypted drive.

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1 Introduction

While we may not realize it, privacy plays a central role in our daily lives. People are constantly having to decide how much information to share with others, which is often defined by their relationship with others as well as the information in question. For example, a person's name and occupation tend to be considered public information that needs to be treated with minimal regard to privacy. On the other end of the spectrum exists information that people tend to want to keep private. This could include potentially embarrassing information, such as keeping a children's toy collection well into adulthood, or information that you would only trust a significant other with. In the middle of this spectrum exists a grey area of sorts, where information is kept private due to social norms or lack of ideal circumstances to share it. For example, while historically salary was considered to be entirely private information, shifting norms have resulted in individuals, especially younger individuals, being more willing to share this information. This is furthered by the fact that so much information is now available on the internet through various services such as glassdoor (https://www.glassdoor.ca/index.html).

The increase in technology in recent years has changed the privacy landscape for people around the world. This new landscape has necessitated a shift away from one central definition of privacy to several different definitions, such as international privacy, psychological privacy, and expressive privacy, whose definitions may overlap but do depend on context (Stuart et al., 2019, p. 2). Along with these definitions, there are also several scopes at which privacy can be investigated. While a context-dependent scope exists, two important distinctions for this study are individual privacy preferences and group-based preferences (Stuart et al., 2019, p. 3). Stuart et al., 2019 also noted that taking international privacy involves the separation, "of people into spaces, including physical or digital" (p. 4). In the context of this study, each participant is being forced into the digital space of privacy. In a 2021 paper, Shariff et al., hypothesized that this landscape shift has created the, "privacy paradox," which is defined as the fact that while, "people express serious concerns about their privacy, these same people do little to protect it," and continued to posit that this is due to an evolutionary mismatch between the, "ancestral environment that [differs] radically from the digital environment in which those intuitions are now being tested," especially intuitions surrounding personal information (Shariff et al., 2021, p. 1). Linking this to context dependant scope identified in Stuart et al., Shariff et al., posited that the, "abrupt switch from face-to-face to digital has stripped the social environment of the cues required to trigger our privacy violation intuitions" (p. 3).

The primary distinction this study drew upon was group-based privacy. Stuart et al., 2019 referred to the group as an entity roughly equal with an individual by stating that, "groups can persist across contexts," and, "selective access [...] can concern a group entity," they did not discuss individual people's privacy choices within this group. This is something that this study attempts to consider (p. 4). While the two groups in this study have differing privacy norms, they were set by an outside entity (the researchers) instead of naturally rising through interactions of in-group members. However, as we were investigating privacy from an individual perspective rather than a group perspective, this has little impact on the results of this study. Further research could be conducted to determine what ideal group norms surrounding privacy are. Further details on what this kind of research could constitute can be found in section 5.2 of this paper.

This study uses the Public Goods Game, a methodology initially developed by experimental economists and now commonly used both by economists and social psychologists, to investigate individuals' privacy preferences surrounding the unequal distribution of resources and salary. Details of some findings of studies using the public goods game as well as other economic games are discussed in sections 2.1 to 2.4.

2 Background

2.1 Public Goods Games

Historically the Public Goods Game has been used as a model for how individuals choose to cooperate with group members in pursuit of a common goal or for the benefit of the group. Research has found that the best strategy from a group perspective is for each player to contribute their entire endowment to the collective

pot. This strategy ensures all players maximize their payout, due to the common pot being multiplied by a factor greater than 1 before being redistributed evenly among all players. However, because of this, it is better for each player to become a 'Free Rider,' a term signifying any player that does not contribute to the common pot (Tomassini and Antonioni, 2020). Free Riders do so in the hopes of maximizing their total payoff for the round since they will then receive a share of the common pot on top of the amount of their endowment. Free riding has been investigated and discussed in much of the research conducted using both the public goods game as well as other economic games.

Consider the following small-scale of how free riding can affect each group member's payoff. In this example, the group has 5 members, each of which has an initial endowment of 20, and there is no sanctioning stage. Table 1 shows each player's payoff if each player prioritizes the group over their own payoff, while table 2 shows each player's payoff where just one of the players Free Rides. The individual and group motivations become especially clear in the case of player 1, who in table 1 contributed their entire endowment, but in table 2 did not contribute anything. In the case where player 1 did not contribute anything, they received a payoff significantly greater than the other group members. Of course, this difference will be affected by factors such as group size, endowment amount, and the contributions of other players, but there Free Rider's total payoff will tend to be larger.

Player	Endowment	Contribution	Payoff
1	20	20	40
2	20	20	40
3	20	20	40
4	20	20	40
5	20	20	40
Total	100	100	200

Table 1: Group of 5 where all players contribute their entire endowment

Player	Endowment	Contribution	Payoff
1	20	0	52
2	20	20	32
3	20	20	32
4	20	20	32
5	20	20	32
Total	100	80	180

Table 2: Group of 5 where one player does not contribute anything

Research has shown that once one player begins to 'Free Ride' the number of other players who chose to Free Riders increases as well (Andreoni, 1988, 1; Tomassini and Antonioni, 2020, 2; Dong et al., 2016, 1). Thus while Free Riding can provide short-term payoffs while the number of Free Riders remains low, the benefits will quickly deteriorate and all players in the group will bear the consequences, regardless of individual contributions or intentions. Potential research projects to investigate personal motives are discussed in section 5.2.

Walker and Halloran (2004) investigated contributions in a series of single-round public goods games with varying conditions. Each of game investigated a different decision situation, such as certain reward, where "[tokens] could be used to increase of another group member by 20 cents," and the uncertain reward, where " [tokens] could be used to increase the earnings of another group member but with uncertain results" (Walker and Halloran, 2004, p. 237 - 238). Walker and Halloran had several significant findings surrounding contribution choices. For instance, while in the baseline condition, "subjects, on average, allocate half of their endowments to the group account," this was because, "the most common behaviour is either for individuals to place their entire endowment," or to, "contribute no tokens to the group account and retain their endowments"

(Walker and Halloran, 2004, p. 240). Additionally, they found that individuals have very little variability in their contributions across different decision scenarios (Walker and Halloran, 2004, p. 241). However, there has been research showing that past contributions to the collective account are, "probably the most important determinant for individual effort" (Grund et al., 2018, p. 314).

2.1.1 Sanctioning within the Public Goods Games

Positive and negative sanctions in the public goods game have also been researched. In variations that include sanctioning, once all players have contributed, players are given the ability to sanction other players in their group. In some cases, these sanctions are positive (rewards), and in some negative (punishments), each of which has an effect on the receiving player's payoff for that round. In studies such as Gurek et al., (2006) and this one, negative sanctions have a much higher impact than positive sanctions. Additionally, while both types of sanctioning serve as an incentive for players to contribute, negative sanctions are the main driving force behind the two (Dong et al., 2016, 2). Furthermore, Sefton et al., found that individuals who contributed more were much more likely to give out sanctions, and corroborated the conclusions of Fehr and Gächter that, "subjects are more heavily sanctioned the further their own allocation to the group account falls below the average allocation of the rest of their group" (Fehr and Gächter, 2000; Sefton et al., 2007, 681). This could partially be due to the larger impact negative sanctions have on players' overall payoff for the round, especially considering the cognitive bias of Loss Aversion, which posits that people act to avoid losses more than they pursue gains.

While sanctioning may serve to incentivize larger contributions when the number of rounds is greater than one, Walker and Halloran (2004) found that in single round scenarios sanctioning, "does not have a statistically significant effect on allocations to the group account," but that, "a subject tends to receive a larger reward the larger [their] group allocation relative to the average" (p. 241 - 242).

2.1.2 Grouping within the Public Goods Game

There has been some research in regards to group formation within economic games including the public goods game. For example, Grund et al., (2018) conducted a study investigating group cooperation in groups of varying cooperation. This study was motivated by the fact that, "usually only homogeneous groups are studied in literature," as well as the fact that, "recent experimental research suggests that temporary group membership significantly lowers cooperation," (Grund et al., 2018, p. 307). This paper also found that overall contributions were lower for groups with temporary members as compared to groups where members do not change across rounds (Grund et al., 2018, p. 307). Interestingly, as the groups that initially contained strangers continued through several rounds together contributions increase as compared to the initial introduction of the stranger into the group (Grund et al., 2018, p. 310).

Additional research has found that "competitive grouping based upon individuals' group contributions can significantly increase cooperation [...] in a variety of experimental environments," and that this reflects real-life scenarios where, "those willing or able to make high team contributions tend to select each other and attempt to avoid free riders" (Gunnthorsdottir et al., 2010, p. 987). This same study found that, "there is no good evidence of a consistent free rider type, and only a minority stick with full contribution," and continued to show that, "if grouping is competitively based on contribution, high levels of cooperation can be part of an equilibrium profile," in which players were grouped based off contributions (Gunnthorsdottir et al., 2010, p. 993).

Grouping plays an important role in this study since, for the majority of this study, players can choose their own groups. Thus, it may be the case that each time a new player joins a group, the players will lower their contributions that round to ensure that the new group member is not a free rider, and as group membership becomes more consistent player contributions will level off as the 'strangers', to use a term from Grund et al., become accepted as part of the group (2018).

2.2 Other Economic Games

The public goods game is not the only economic game of its kind. Other such games have been used to test various aspects of interpersonal relationships, in and out-group formation, as well as norm formation. While there are many different economic games, each of which has many variations, sections 2.2.1: The Ultimatum Game and section 2.2.2: The Dictator Game discuss two of the more commonly used games.

According to Newark and Becker, 2021, "the logic of consequences and the logic of appropriateness have long been central to understanding behaviour in organizations." and identified, "the logic of appropriateness through experimental methods," which allowed them to collect, "behavioral data, as well as qualitative data about participants considerations" (p. 201). This study used both the dictator and ultimatum games along with the trust game and prisoners dilemma, two other common economic games. This study found that, "participants employing a logic of appropriateness rejected more offers in an Ultimatum Game and were more generous when reciprocating trusting behaviours in a Trust Game" (Newark and Becker, 2021, p. 201).

Economic games such as these are often used in behavioral economics to study the processes behind decision making. Gradinaru, 2014 states that this field, "studies the way in which people take concrete decisions on a daily basis," and continues to identify several sub-fields of research such as decision making, which Walker and Halloran (2004) and Dong et. al. (2016) used economic games to study. For instance, a 2006 paper by Scheres and Sanfey focused solely on the effect of the behavioural activation scale on decision making in economic games, and a paper by Newark and Becker, which used, "the manipulation of decision making as the independent variable" (Scheres and Sanfey, 2006; Newark and Becker, 2021, p. 203).

All of these games are examples of methodologies used in experimental and psychological economics. Mazur-Wierzbicka, 2018 identifies some of the central questions of economic theory as, "making an effort to investigate the real, realistic behaviour" (p.7). Additionally, this paper identified psychological economics as focusing on, "examining the influence of psychological factors on the behaviour of decision makers and the consequences of their decisions," and experiential economics as, "focusing on the behaviour of people," specifically, "functioning of various markers, [and] individual preferences and choices" (Mazur-Wierzbicka, 2018, p. 9 - 10). The current study draws on concepts of both these research areas because we are investigating the effects of psychological privacy preferences, as well as the effects of rewards and punishments, on contribution and institution choices within the context of the game.

2.2.1 The Ultimatum Game

The ultimatum game is played in pairs and has a fairly simple structure. Each participant is assigned a role: either the proposer or the responder, the names of these roles may vary but their responsibilities do not (proposer and responder are the titles used in Rifki and Ono, 2021). At the beginning of each round, the proposer is given an allotment of tokens and is asked what amount they want to give to the responder. Once the proposer has specified an amount, the responder can either accept this proposal or reject it. If the responder accepts, they receive the proposed amount and the proposer receives however many tokens remain from their total after the proposal has been taken out. This game has been used in studies such as Rifki and Ono, 2021, Guala, 2008, Baumert et al., 2014, and Scheres and Sanfey, 2006 to study a variety of phenomena such as the formation and sustainment of fairness norms, as well as bargaining between parties with limited information about other bargainers.

2.2.2 The Dictator Game

The Dictator Game is a two-player economic game with a similar structure to the ultimatum game. Instead of the role of the proposer, one of the players has the role of dictator, and the other player is playing the role of receiver. In this game, the dictator holds all the power, begins each round with an initial endowment, and is asked how much of it they want to share with the receiver. While in the ultimatum game the receiver has a choice to accept or reject the offer, in the dictator game they are forced to accept.

A literature review of several studies using the Dictator Game noted that while standard economic theory posits that the dictator should not offer anything to the receiver, lab studies have found that in the standard game only 40% of subjects chose to do so(Guala and Mittone, 2010, p. 578-579). This study also noted

that the average dictator contributions are around 20% (Guala and Mittone, 2010, p. 578-579). These findings were corroborated by the results of Newark and Becker (2021) who found that, "dictators gave away, on average, $1.24 of the $5.00 they had been allocated," in both the logic of appropriateness and logic of consequences, which equates to 24.6% (p. 214).

2.3 Validity of Economic Games

In the literature, there has been some discussion surrounding the validity of the economic games. For example, in regards to the dictator game Guala and Mittone (2010) stated that, "one wonders whether the term 'game' is appropriate at all" due to its simple nature (p. 578). The same article continued to state that the dictator game is, "problematic from an orthodox game theoretic point of view. But treating the DG as a design of independent experimental significance is quite another matter," because while other games have, "emerged as significant designs," the DG lacks this characteristic and focuses more on, "the investigation of preferences" than, "a design of independent interest" (Guala and Mittone, 2010 p. 581). Additionally, in an article titled, "Preferences and constraints: the value of economic games for studying human behavior," Pisor et al., stated that, "[economic] games can be used to reveal individuals' privacy preferences in a way that observational and interview data cannot; furthermore [they] can be designed such that they *do* provide insides into real world behaviour" (Pisor et al., 2020. p. 1). Pisor et al. (2020), continued to state that while, "as in most experiments, the results generated by economic games are sensitive to the framing of the experiment," signalling that these games are not alone in having validity issues (p. 3). Along with this, Muniesa and Callon mention that, "the scope of experimental economics is not limited to an endogenous self-observation" and continue to mention that, "economic agents characterized with utility functions are part of the environment", and mentioned that these can be both human and computers (Muniesa and Callon, 2020, p 167). While this study does not have an explicit utility function, we can view the utility function as dealing with both privacy and payoff as primary factors in the equation. This is similar to the utility function identified in Daughetry and Reginganum which used factored in aspects such as the utility of the good, which in this study was tokens, as well as the reputation of the agent to other group members (Daughety and Reinganum, 2010, p. 197). Since each player in this study had a label that did not change, they had the opportunity to build a reputation around the amount they regularly contributed, and if they consistently sanctioned specific players they would build a reputation with those players.

Francesco Guala, an experimental economist and philosopher, noted that, "the success of a real-life (laboratory) market depends on the successful matching of the appropriate kinds of agents with the appropriate system of rules," implying that without this, experiments using economic games would not have very much external validity (Guala, 2020, p 145). In this same paper, he noted that the introduction of Induced Value Theory, which in essence is the effective use of rewards can have a determining effect on the validity of experimental results. This theory, "can be seen as a turning point in the history of experimental economics," and allowed for a greater number and range of theories to be tested using tools that had previously been much more limited (Guala, 2020, p. 143). An important distinction related to Guala's work is one discussed by Muniesa and Callon (2020), who stated that the setting of economics exists in isolation from the, "real economy," and creating the experiments was an, "operation of transformation and reduction," to ensure that the constructs fit the experiment (p. 170). However, this does not detract from the validity of experiments because the process is repeated in many disciplines ranging from natural to social sciences. Muniesa and Callon (2020) also noted that a training phase, which calibrates players to the game, is key in upholding the validity of experiments because, "experimenters rely on empirical know-how that allows calibration of the way in which the expected behavior is induced" (p. 172).

Another key factor that can affect the validity of economic experiments is the framing. However, due to the prevalence of platforms such as Amazon's Mechanical Turk and Prolific, as well as the uses of laboratory studies, experimenters can expand the population they draw their participants from, thus improving the strength of their conclusions (Muniesa and Callon, 2020, p. 184).

Due to the large amount of research and the continued use of these games suggests that while there are validity concerns surrounding the use of economic games, these concerns are not large enough to place doubt on the findings of these games. This is not to say that these games can be used to test all phenomena equally

well, it is important to put thought into the chosen game as well as its framing.

2.4 Simulational Approaches

Recently there has been some research attempting to model the behaviours often shown using economic games using mathematics and other simulational approaches. One such paper is "Fairness Norms through social networks: a situational approach," which modelled social networks as graphs with individuals as nodes and the connections as edges (Rifki and Ono, 2021). An important point raised in this paper is that its focus on, "game theoretic approaches to [social networks]" was partially based on the fact that, "an increasing number of related studies have been reported in recent years" (Rifki and Ono, 2021, p. 1). On page 2, Rifki and Ono (2021) also identified fairness as an important aspect in human societies, which is a common thread in much of the research done using economic games, and additionally identified the ultimatum game as their chosen game. Additionally, Daughetry and Reginganum (2010) created a mathematical model in regards to agent's actions at varying levels of privacy. A key distinction that this study drew on was that of an agent having multiple types, one that is private and one that is public (Daughety and Reinganum, 2010). These can be the same, but do not necessarily have to be, which is an important distinction, especially in the context of waivable privacy, which is an important distinction in this study as well. Our study gives players the choice of waving their privacy around the possibility of receiving a bonus or not by choosing either the public or private condition.

3 Methodology

To investigate people's ideal level of privacy surrounding salary and unequal distribution of resources we used a variation of the public goods game. The coding for the public goods game used in this study was completed in oTree, a programming language primarily used for surveys and running experiments involving human subjects, such as those usually conducted in psychology and economics (Chen et al., 2016). In the version of the game used in this study each player starts the round with an endowment of 20 tokens, and also had a roughly 33% chance to receive a bonus of 20 tokens, according to table 3. The one exception to the bonus amount was in groups with only 2 players, where the bonus recipient received a slightly reduced bonus amount. This was to help balance the maximum payoff for the players in such groups.

Group Size	Number of Bonus Recipients
1	0
2 - 4	1
5 - 8	2
9 - 11	3
12 - 14	4
15 - 18	5
19 - 21	6

Table 3: Group Size and Number of Bonus Recipients

In the traditional public goods game, there is only one stage: the contribution stage. In this stage, each participant is asked how much of this endowment they want to contribute to the common pot. Once all players have contributed all contributions are totalled, doubled, and then evenly distributed among the players, regardless of their contribution. Appendix A.1 shows the contribution stage used in our study.

In some variations, including the one used in this study, there is also a sanctioning stage (also known as the punishment stage). In this stage, each player is shown their other group member's contributions and is given an additional 20 tokens, which can be used to sanction other group members. Appendix A.2 displays the page where participants are asked how much they want to sanction other group members. Tokens used as positive sanctions have a 1 to 1 ratio, meaning positively sanctioning another player five tokens will increase

their total payoff by five tokens. Negative sanctions have a 1 to 3 ratio, meaning that for each token the giving player pays the receiving player will have 3 tokens subtracted from their payoff. Any sanction tokens that a player does not use to sanction are added to their payoff for that round. Thus each participant's total payoff for each round is calculated using the following equation:

$$\text{Payoff} = \frac{2 \times \Sigma(\text{Group Member's Contribution})}{\text{Number of players in the group}} + \text{ remaining contribution tokens} +$$
$$\Sigma(\text{Positive Sanctions Received}) - 3 \times \Sigma(\text{Negative Sanctions Received}) + \text{ unused sanction tokens}$$

Participants were shown their total payoff, how it was calculated, and which players sanctioned them after the sanctioning stage, the display format of this can be found in Appendix A.3.

Players received different information during the sanctioning stage based on their condition: public or private. All players were shown a table with the contributions of all the participants in their condition. Along with this, players in the public condition were shown the initial endowment of each group member, as well as any bonuses they may have received. Appendix A.2 shows the table that is displayed in each condition.

What this study added was a third stage, where participants could choose either the 'Public' or 'Private' condition, shown in Appendix A.4. All participants were shown a table with statistics such as group size, average payoff, and total sanctions given out for all groups across all rounds. On this page, participants were asked to choose if they wanted to play in the public or private condition during the next round.

Each condition played a separate game each round, meaning that the contributions and sanctions in one group will have no bearing on the outcome of the other. This provides the opportunity to track statistics for both groups, such as size and total contribution and average payoff, for each round.

The first two rounds of the game served as practice, similar to the training phase discussed in Muniesa and Callon (2020), in the first round all players played in the public condition, while in the second round all players played in the private condition. Beginning in the third round, players are asked to select their preferred condition: public or private. Once all players have selected their conditions for the round, they move through the contributions and sanctioning stages. The standard information provided to a player, regardless of condition choice, was a table displaying the contribution of each player in their condition, as well as the amount each group member positively or negatively sanctioned the participant. Additionally, in the public group, the table displaying each group member's contribution also displayed the endowment and bonus of the other group members.

OTree allows the programmer to set a time limit for each page, which is visible to participants, and specify what the participant would be forced to do once the time limit was reached. This was used in several places throughout the game. First, if players reach the time limit on the contribution page, they are forced to submit their entire endowment that round, regardless of if they intended to or not. Secondly, on the page where players are presented with data on both groups across all rounds and chose their condition for the next round. If participants failed to choose their condition before the time limit was reached, they were placed in a third group, which functioned as a penalty. Players in this group were forced to skip the round and did not receive a payoff and were able to reenter the game in subsequent rounds by choosing a condition at the beginning of the next round. This information was made clear to the players, along with the fact that they would be able to reenter the game in later rounds by choosing a condition. Appendix A.5 displays the message shown to players who failed to choose a condition within the specified time limit.

There were 10 rounds total with a maximum of 4 players per group, due to players moving conditions between rounds.

Additionally, a short survey, shown in Appendix B, was presented after all rounds of the game were completed, and it was comprised of two short questions. The first question asked which of the two groups, if any, the participant preferred, and the second question asked why. Each of the two questions offered several predefined options, but the second question also had a free response option allowing players to explain their motivation.

4 Results

All data from the public goods game was recorded as numeric values. With the exception of the free-response comments, all data collected from the post-game survey was numerically encoded. The encoding pattern was fairly simple with responses being coded with sequential integers beginning with 1, with 1 being the first option presented and increasing from there. Additionally, all data analysis was conducted in the R programming language, code for which can be found in Appendices C.1 and C.2 (R Core Team, 2021).

4.1 Data Analysis

Disclaimer

Due to data being obtained via convenience sampling, any conclusions drawn may not accurately reflect the privacy preferences of the general public. The initial plan was to complete data collection via random sampling using Amazon Mechanical Turk with groups of 18 participants at a single time. However, this proved impractical, and recruiting a group of 18 simultaneous MTurk workers drew out the data collection processes and was not yielding results. Therefore, we changed our plan and recruited friends and family to run games with groups of 4 participants at a time.

Initial hypotheses were that during the first few rounds participants would migrate towards the public condition because they want the most information possible about their fellow participants, and were willing to give out the same level of information about themselves as a trade-off. However, as bonus recipients are negatively sanctioned for not contributing more of their total endowment, players will begin to move towards the private condition to hide their bonuses. This is because bonus recipients would be able to hide their larger endowment, and thus would be less likely to receive negative sanctions as a result of their relatively lower contributions. A second hypothesis was that bonus recipients will not contribute more than the standard endowment due to a perceived sense of luck and fairness (e.g 'I was lucky that I got the bonus, so I'll contribute as much as anybody else but not more').

Another hypothesis is that there will be greater use of both rewards and punishments in the public condition than in the private condition. This is due to the participant's ability to see how much each participant contributed in direct relation to their initial endowment, while in the private condition they are only able to see the contribution.

Data does not support the hypothesis that participants would move to the private condition in later rounds of the game. As shown in figure 1 after the practice rounds were over, the public institution was the larger of the two conditions in 3 of the rounds while the private group was larger in 4 of the remaining rounds. However it is true that the majority of participants did chose the public institution in 2 of the 3 rounds following the practice stage lending some support for the hypothesis for participants initially preferring the public condition. Additionally, the number of players who chose the private condition tended to decrease in latter rounds of the game, while the size of the public condition tended to increase in latter rounds.

This fact that there was no equilibrium reached in terms of group size could be explained by a number of reasons. For example, in the first few rounds players could have been moving between the conditions attempting to figure out the difference between the two conditions instead of choosing based on preference. Additionally, There may have been some players that picked their condition based on what they believed would maximize their profit. For example, one player may have consistently attempted to pick the smaller group because they believed there would be less chance of getting sanctioned, while another may have constantly picked the larger group due to the expectation that a greater number of players meant a larger communal pot and individual share.

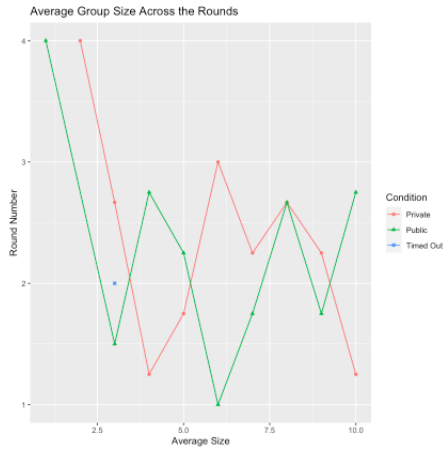

Figure 1: Graph of the Average Size of Each Condition Across Each Round

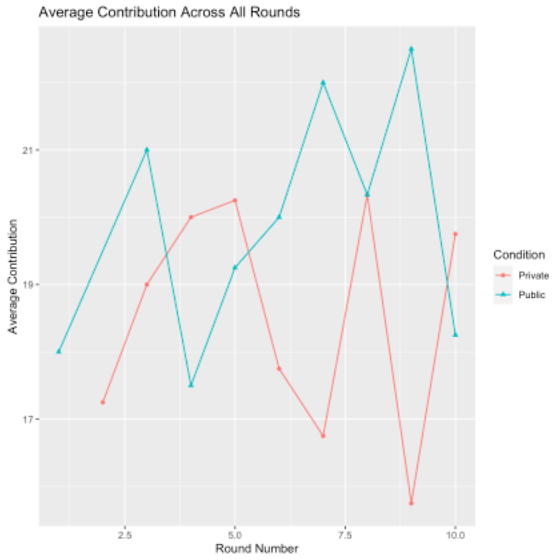

Figure 2: Average Contribution In Each Round

It does appear that the average contribution tended to be greater in the public condition than the private condition, especially in the later rounds of the game. The fact that the average contribution was over 20 in several rounds can be partially attributed to the contribution of the bonus recipient. However, this is not the only factor at play, the other group members must have contributed a significant amount of their endowment in order for the average contribution to be as high as it is. Additionally, while the average contribution in the public group did lower in the fourth round, it increased again in subsequent rounds. This could be attributed to the presence of punishments and rewards, which reached their maximum during this round as well, shown in figures 4: Average Rewards and 5: Average Punishments.

While the average contribution in the public group did tend upwards as the game progressed, there is a drop in the last round. This could be due to several of the players in the group using this last round as an attempt to 'free ride' on the contributions of their other group members. Since participants only faced the chance of being sanctioned in that round and not repeated sanctions in further rounds from group members seeking some form of retribution for being taken advantage of, some participants may have drastically reduced

their contribution that round. Added evidence for the lack of free riders in the public condition during the majority of the game is the size of the average contribution. Since the bonus recipient would have to make a contribution equal in magnitude to any deficit a free rider created while being unsure if their contribution is being matched by other group members, it is unlikely that the average contribution would be so high in the presence of free riders.

Additionally, the data does support the hypothesis that the contributions of the bonus recipients would not drastically because they had a larger endowment. As the average contribution in the public never exceeded 22, it is clear that while the bonus recipients occasionally contributed more than 20 tokens, they never contributed an amount significantly greater than the group average. This could be due to them receiving negative sanctions when their contributions were less than 20. However, due to the low use of sanctions, it may be the case that the players who did not receive bonuses only made use of them in an attempt to raise the bonus recipients to slightly above the average. Furthermore they may have considered it aversive to use sanctions, especially punishment, to increase contributions much higher than the average.

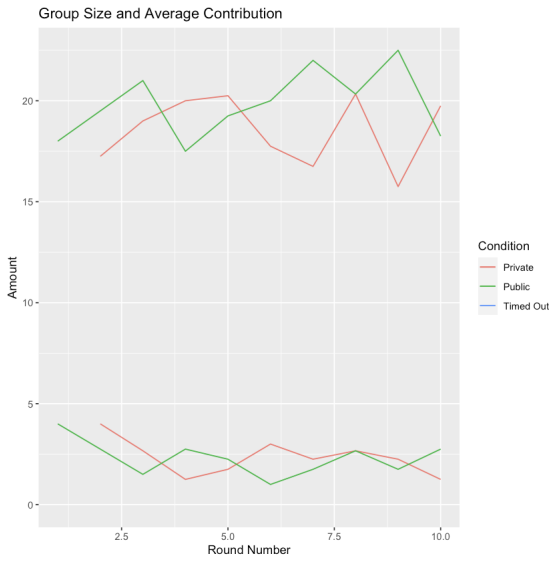

Figure 3: Group size and contribution in each round

As shown in figure 3, group size fluctuated much less than the average contribution, which indicates several different things. Firstly, participants appear not to have solidified their condition preferences enough to consistently choose their preferred condition. Along with this, while there appears to be some correlation between group size and the average contribution, it is not the case that the average contribution increased with group size. This indicates that participants tended to contribute similar amounts across rounds, and suggests fluctuations in average contributions across rounds may be due to different group membership or be affected by different contributions across different rounds.

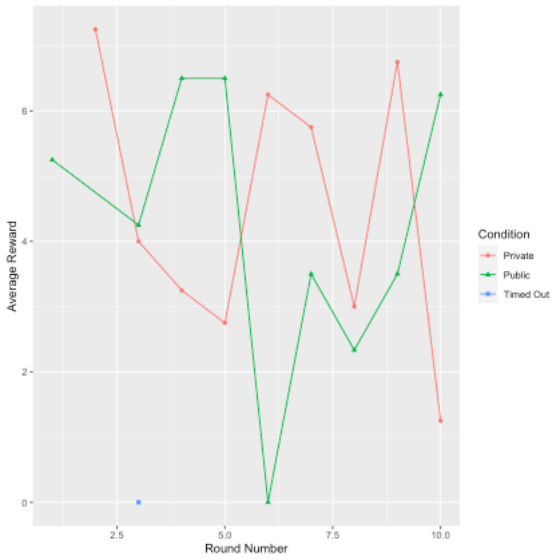

Figure 4: Average Reward Across Each Round

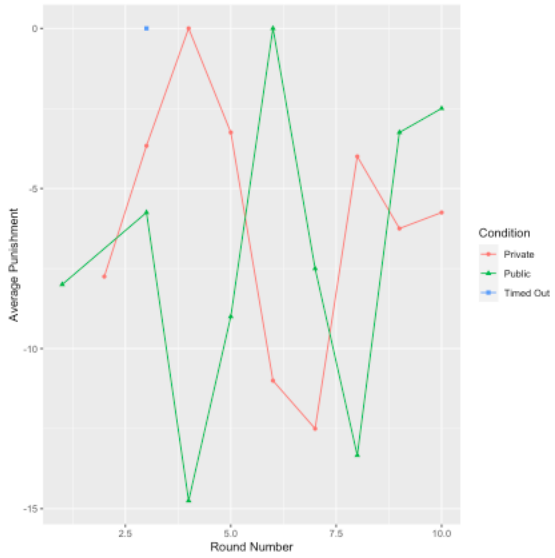

Figure 5: Average Punishment Across All Rounds

The number of tokens used for both sanctioning and rewards was lower than hypothesized, which could be due to a number of factors. For example, while sanctioning other players can be advantageous in further rounds by providing an incentive to contribute more of their endowment, participants may find punishments aversive in some way. In cases such as these participants must either cause themselves discomfort by sanctioning in the hopes of a higher payoff or remain more comfortable in their decisions by either not sanctioning or allocating fewer tokens towards sanctioning. In studies where participants receive monetary compensation tied to their performance in the game, they may have chosen to accept this discomfort in order to increase their total compensation. While participants can increase their total compensation by not rewarding or punishing at all, these tokens are not multiplied like the common pot is. Therefore it is in each participant's

best interest to use their sanctioning tokens to increase the contributions of other players.

While both rewards and punishments were used sparingly used in both conditions, there was no round where they were not used at all. While data seems to suggest that punishments were used much more than rewards, this is due to the 1 to 3 ratio. Additionally, while the data does suggest that punishments were higher in the public condition, rewards tended to be higher in the private condition. However, these were only higher by a small number of tokens, thus indicating that while the sanctions could have impacted the contributions in subsequent rounds, it was not a significant factor. Along with this, there is not enough evidence to strongly support the impact of condition choice or preferred condition on the use of sanctions.

4.1.1 Debrief Survey Analysis

As shown in Figure 6, 7 out of the 16 participants (43.75 %) preferred the public condition over the private one, while 4 participants (25%) participants preferred the private condition. Along with this, an additional 4 participants stated that they had no preference between the conditions. Finally, one participant (6.25%) declined to respond to this question by selecting the "Prefer Not to Answer" response option.

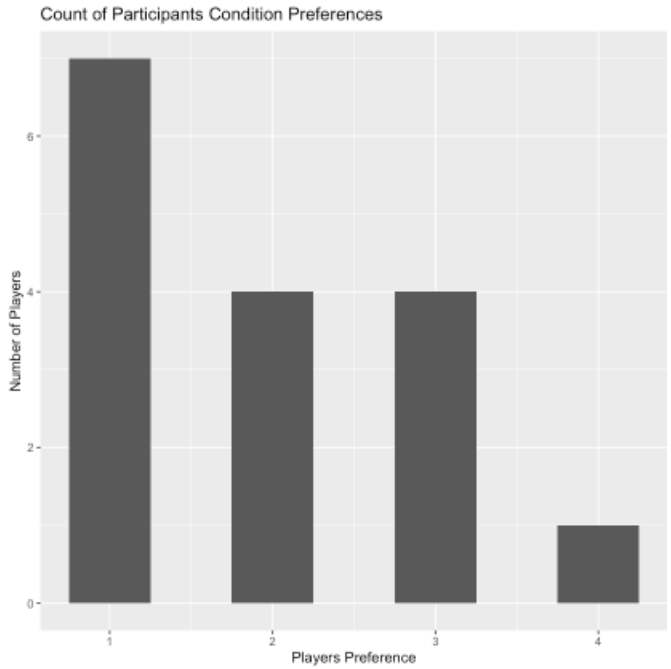

Figure 6: Participant's Condition Preferences

As we can see from figure 7, 3 out of the 7 participants (42.86%) preferred the public institution because there were more positive sanctions given out, and 2 out of the 7 (28.57%) preferred the public institution because there were higher payoffs. Additionally, the one participant that left a comment to explain their group choice indicated that they chose the public condition because it seemed to do better overall. Interestingly as shown in figure 8, 3 out of the 4 (75%) players who preferred the private condition indicated that they chose the private condition due to higher payoff as well. This could be due to several factors, such as norm formation in the institutions or risk aversion. For example, the participants who preferred the private condition may have reached an in-group norm during their game where each participant contributed almost all their endowment each round and additionally did not use the majority of their sanction tokens. The lack of sanctioning is especially noteworthy because it ensured that each participant received a similar payoff, without having to worry about their payoff being lowered by punishments. An added benefit of these norms

for the participants is that they would not receive large punishments as a result of other participants seeking a sort of revenge for what they felt was too harsh a punishment in an earlier round.

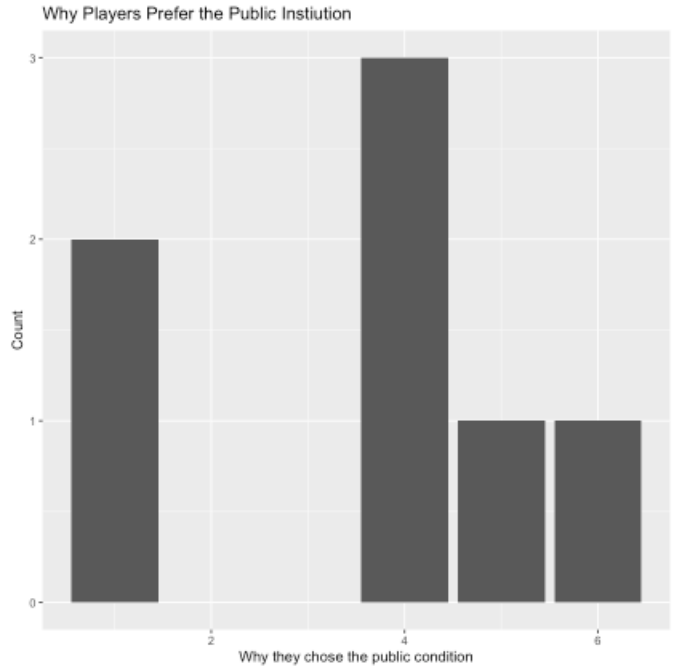

Figure 7: Why Participants Preferred the Public Institution

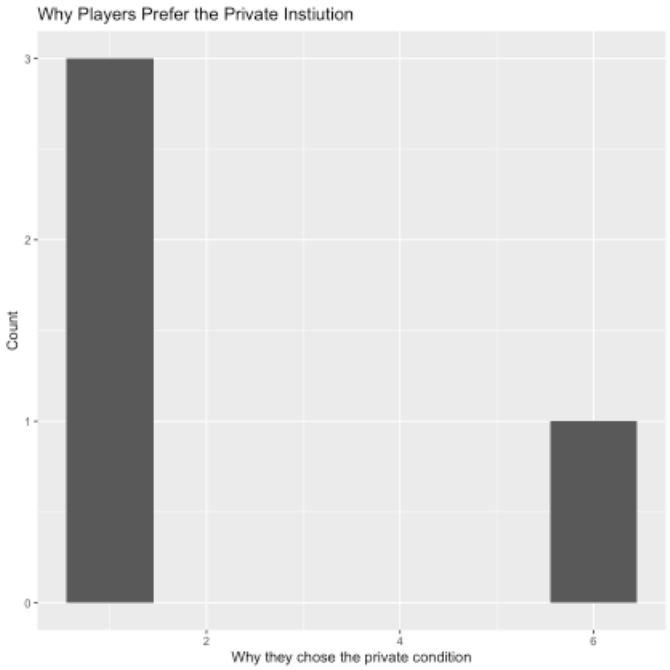

Figure 8: Why Participants Preferred the Private Institution

5 Discussion

Influences were drawn from "The Competitive Advantage of Sanctioning Institutions," by Gürek et al (2008), which investigated people's preferences between a sanctioning and non-sanctioning condition. Interestingly, this paper found that while initially players gravitated towards the non-sanctioning condition, the majority of players ended up consistently choosing the sanctioning condition in the later rounds of the game. We expected to find something similar; individuals would initially be drawn to the private condition, but would then choose the public condition in later rounds and would remain there.

We chose to have roughly one third of each group receive a bonus each round, according to table 3, to ensure that all players had a roughly equal chance of receiving a bonus regardless of group size. Of course, it would have been ideal if all players had an exactly equal chance regardless of group size, but due to some limitations of the programming language, coupled with the fact that being a recipient is a binary value (recipient or not), meaning that groups not evenly divisible by three will always have to be rounded to an integer, this approximation will have to do.

5.1 Confounds

One potential confound that impacts the validity of this data is that players may have been drawn to the public group due to larger average payoffs instead of their privacy preferences. This effect could be due to the fact as more players continued to choose the public group, there would be a greater amount of contributions, and as such a greater overall payoff. As mentioned in the introduction, while privacy norms surrounding salary are gradually becoming relaxing, there are still many individuals who treat salary as a very private piece of information or are still in the process of figuring out how to apply these new norms to their own lives. This fact coupled with the fact that participants were told they would receive monetary reward directly tied to their performance, could have led participants to forsake their own, possibly changing, morals in the pursuit of a higher payoff. Another possible reason participants may have tended towards the public condition is to test out their new morals in a fairly low stakes, high anonymity environment.

Another confound is that the tokens of the game are shown in terms of points instead of dollars. This may remove some of the real-life aspects of the game, since players may not view the points in the same way they do if the phrasing was in terms of dollars instead of points. This is especially true in the case of this study each token was worth less than a dollar and the percentage of their total payoff each participant would earn was not known to them. I posit that this leads to an undervaluation of the points, so players are more willing to donate a larger amount of tokens because the difference on their total payout is negligible.

A further confound in the study is that the participants were presented with a large amount of information at once during several stages of the game, especially during the introductions. This could potentially overwhelm participants and mean that participants spent the majority of rounds attempting to understand the rules of the game instead of choosing their condition based on privacy preferences. Adding to this, even if participants fully understood the rules of the game, there is no guarantee that participants chose their condition based on privacy preferences. Participants may have chosen their condition based on profit maximization instead, thus skewing the results of this study.

Another aspect of the game that may have skewed results is that each stage of the game had a timer that forced players to move on to the next page. Due to the length of the instructions participants, especially those unfamiliar with the public goods game, may not have had enough time to fully comprehend the instructions. This could affect the results of the study since participants who did not fully understand the game and its framing were much less likely to be making choices based on privacy choices, instead putting less effort into institution choice and possibly making random choices.

5.2 Further Research

Multiple further studies could be done using the same piece of software developed for this study, both as it as well as with some slight changes. For instance, we could use this piece of software to test some of the other aspects of privacy discussed in Stuart et al., 2019. To do this, only the final survey would have to be

changed. Along with the questions listed currently, a third question could be presented, asking people about what their ideal condition would look like. This could be done in one of two ways; a ranking question with a few preset options, or an open response question allowing participants to describe their ideal condition, if it did not match one of the two already present in the study. For instance, we could present condition aspects such as hiding individual contributions, hiding sanction choices, or even include a free response area allowing players to describe what they would feel is an ideal level of privacy.

Another follow-up study would be to do a series of public goods games each adding a new stage to the game, building up to the version of the game that was used in this study. This would ensure that participants were more familiar with the rules of each part of the game before adding the ability for participants to change groups.

Keeping the version of the public goods game identical limits subsequent research that can be done. Other variations of the post-game survey could allow for a fair amount of qualitative data to be collected, such as preferences about group norms as well as investigating the reasoning behind why participants made the choices that they did at each stage in the game: condition choice (which is already included) as well as at the contribution and sanctioning stages. For the contribution and sanctioning stages, it would be worthwhile to insert these questions into each round, instead of waiting until the entire game was over. This approach has two advantages over having a single question at the end, first, it increases the amount of qualitative data collected, and instead of participants having to remember all rounds, they only need to remember the previous round, thus reducing the chance that memory bias will affect the data quality.

However, we could change the framing of the version presented in this study so that the contributions and common pot are moved away from monetary values to a number of other topics to aid in the investigation of privacy. Variations on the current study could be done in terms of other public goods. This type of framing can serve to highlight the differences between individualistic and collectivist cultures in terms of privacy preferences. This could be done in one of two ways: first participants could be specifically drawn from both individualistic and collectivist cultures and are presented with the same methodology of this study and an expanded version of the debrief questionnaire to ask participants about their demographics and cultural practices. Studies such as these would allow conclusions around the influences of cultural norms and practices on an individual's privacy preferences. Relating this to existing literature, Daughetry and Reginganum (2010) found that, "when an activity contributed to a public good, but generates social approval (or contributes to a public bad but generates social approval), then a policy of privacy of action is preferred," but continued to discuss a policy they titled, "waivable privacy, wherein an agent can choose to make his actions observable" and then continued to mathematically find an equilibrium point around this policy (p. 192). Using this idea, further research could be conducted with the code from this study, to test this equilibrium around many different scenarios with a sample drawn from human subjects.

Additional re-framing provides several other studies that could also be completed to test privacy preferences. For example, framing could be done in terms of other public goods such as food or water usage, as well governmental resources such as food subsidies and access to free or reduced-price health care prices. While studies such as these would be more difficult due to the controversial nature of these issues in most populations and cultures, with correct framing to minimize negative impacts to participants studies such as these could produce interesting results. This is especially notable due to possible negative connotations associated with receiving governmental aid, especially in the face of possible sanctioning from other group members.

5.3 Contributions and Timeline

My main role in the project was to develop the app in oTree, a framework built on top of Python, HTML and Django. In total, the codebase was 1,756 lines of code. Along with this, when discussing with Dr. Green how to deal with participants stepping away from the game, and thus potentially holding up the game for their entire game session, I suggested using oTree's page timer functionality as well as adding a third group, which made players sit out for the round and recive no payout.

The first few weeks of the semester involved getting up to speed with oTree, which involved learning python and HTML. After some readings of the documentation and looking over some example code, I began coding the framework of the public goods game in mid to late September. In mid-October, I presented a

draft of the game to Dr. Green, who then gave me a series of improvements to make. The main task of these improvements was to allow the players to select their condition for each round, move the players into these groups part way through the round based on their condition choice, and give each player a unique display name that would not change across the rounds. Assigning players different names proved to be a pretty simple task, but the movement of players across different groups proved to be a much more difficult task which, along with some other bug fixes, took the majority of the next three weeks.

I then presented a revised draft to both Dr. Shariff and Dr. Green in early November, at which point a potential confounding variable was identified. Soon after, I completed my midterm check-in with Dr. Mole, where I discussed the possible confound and the effect this would have on this paper. While we tried to find a way to eliminate the confound, I continued to review the code and design documents, to ensure that the functionality was consistent with the design documents written by Dr. Green, and investigate new possible functionality that could improve participant experience while preserving data quality.

Although we did not find a solution to eliminate the confound, in the end Dr. Green and I agreed to pilot the study as it stood close to the end of November. However due to some scheduling conflicts and choosing to add a debrief survey to the game delayed the deployment for data collection. Fortunately, the survey addition was a relatively simple process and did not cause a significant delay. However, due to data collection issues, once the study was launched on Mechanical Turk, I had to collect data using a sample drawn from my friends and family instead of a true random sample.

5.4 Challenges

There were two main challenges for this project. The first was that I had trouble moving players between groups. At first, the documentation and example oTree projects seemed to suggest that all groups in a session had to be the same size. However, once it was clear that I could use a built-in method to create groups of different sizes, this became much easier. An additional point of confusion was that OTree has a constant called num_groups, which must hold a value for the game to run. Since the functionality of the game necessitated that there be three groups, I initially had set num_groups to 3. However, when it came time to deploy to Mechanical Turk, it became apparent that this constant would immediately divide the players into three equal groups of size $\frac{n}{3}$ where n = total number of players. However, one caveat to this was that the total number of players had to be evenly divisible by the number of groups in order for the game to start.

These errors were not ideal. First, we would then need to ensure that our total number of participants was a multiple of the number of groups so that no errors would come up when the game started. Additionally, we wanted players to start off in the same group so that they had a chance to interact with all other players in the session during the practice round. Due to this, I had to refactor the code with num_groups set to 1 to meet this specification and ensure that the study could be run with any number of participants.

A related error was based on the way that oTree stores and checks groups. Groupings are stored in a 2D array, where the outer array contains all the players in the game session and each inner array represents a group in the game, holding the unique ID numbers of all the players in that group. At first, what I tried was to always have the public group be the first row in the matrix and the private group be the second group in the matrix. However, built into the logic of oTree is that the first row in the matrix could not be empty, which means that the code would not function if all players selected the private group.

To solve this, I created a method called get_group_by_label(subsession, name) that iterated over each group in the game session and compared this to the group label, which was one of public, private, or timed out. If it was, the group was returned. This allowed me to cover the case where all players selected one group, and place this group first in the group matrix.

The second large issue was deploying to Mechanical Turk. This was due to multiple factors. First, Dr. Green and I had very limited experience deploying experiments to Mechanical Turk, especially economic games that required multiple people having to take the experiment at the same time, whereas most experiments that other members of the lab only had experience with experiments that require a single participant at once. There was a lab member with some experience with deploying economic games, however they used qualtrics which did not necessitate the same steps as this project, namely setting up a server using Heroku, a

cloud-based platform used to scale software projects to large number of users and handle the amount of data, and creating a session specifically for Mechanical Turk on the oTree admin panel.

Related to this, data collection took much longer than expected once the study was launched on Mechanical Turk and in the end did not return any data. While the exact cause of this was unknown, I believe one possible cause was players leaving the waiting room for the game after waiting for a few minutes, or even less, since they were not getting paid. Thus even if 18 total players entered, if they did not arrive pretty much simultaneously, then the game would not run. Along with this, it may be the case that once a player enters and leaves no other player can take that slot even though it is now empty. Thus once enough players enter and leave, there will be no way for the current game session to start, and a new session will have to be created and deployed onto mechanical turk.

In the end, data was not collected on Mechanical Turk as initially planned, rather it was collected using a convenience sample. While not ideal, the data collected allows conclusions to be drawn about the sample rather than the general population would. It is still unclear why data collection on Mechanical Turk did not function as intended, but I believe that this is mainly due to the above issue.

While my coursework in computer science has provided me with back-end programming experience I have not taken a course on internet computing which I believe would have been helpful in navigating and using Heroku. Additionally, since this is the first time using oTree for Dr. Green and myself, we had to rely on outside resources to figure out the process to deploy to Mechanical Turk (Accounting Experiments, 2021). While I had run the app throughout the semester to ensure it ran smoothly and to test that the functionality was correct, this only necessitated a single command input to the terminal.

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A Stages of the Public Goods Game

A.1 The Contribution Stage

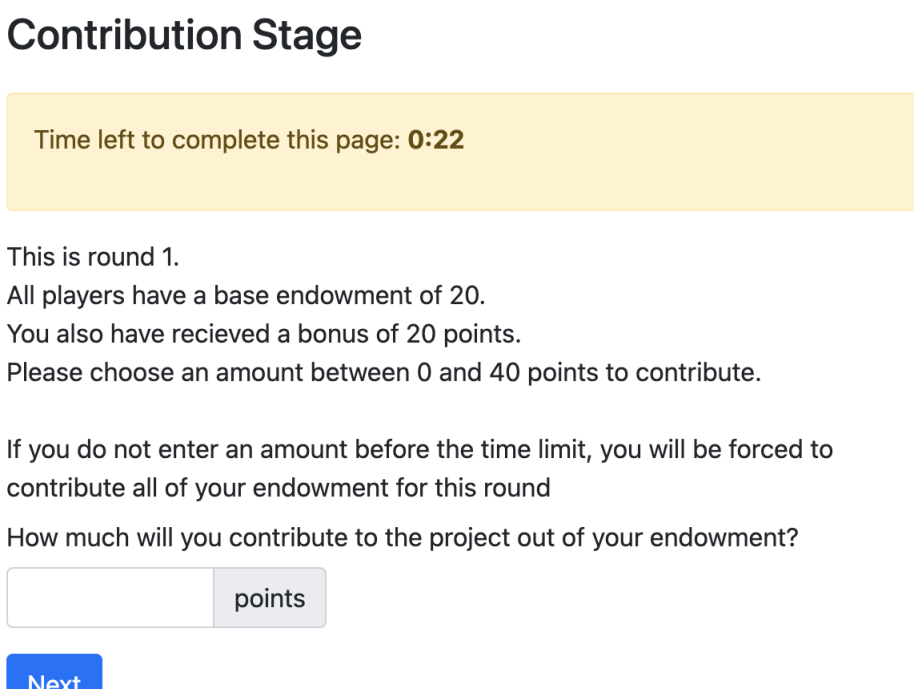

Figure 9: This is an image of the contributions page, which is identical in both the public and private conditions.

A.2 Display Pages

Public Display Page

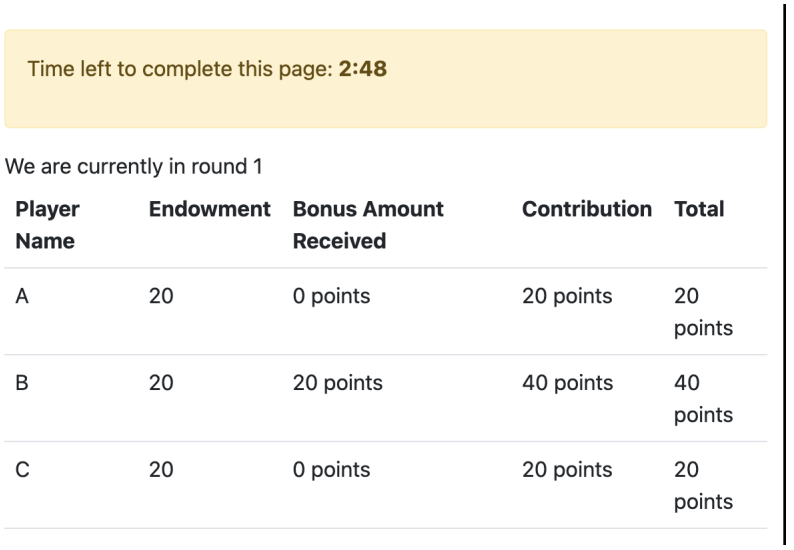

Figure 10: This is the table shown to the participants in the public institution during the sanctioning stage

Private Display Page

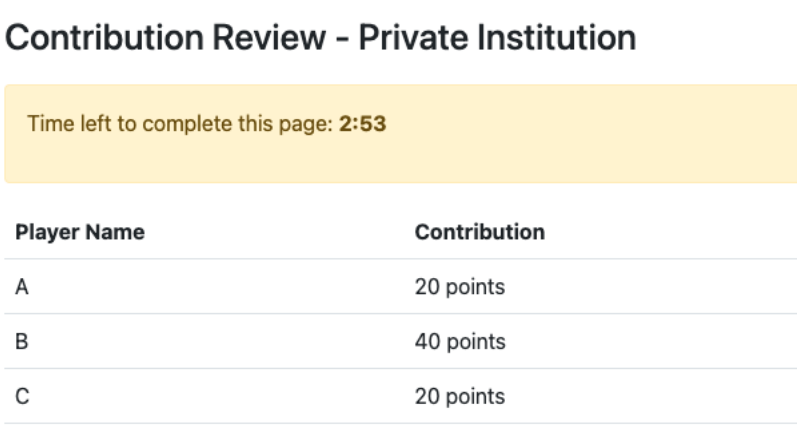

Figure 11: This is the table shown to the participants in the private institution during the sanctioning stage

A.3 Sanction Fields

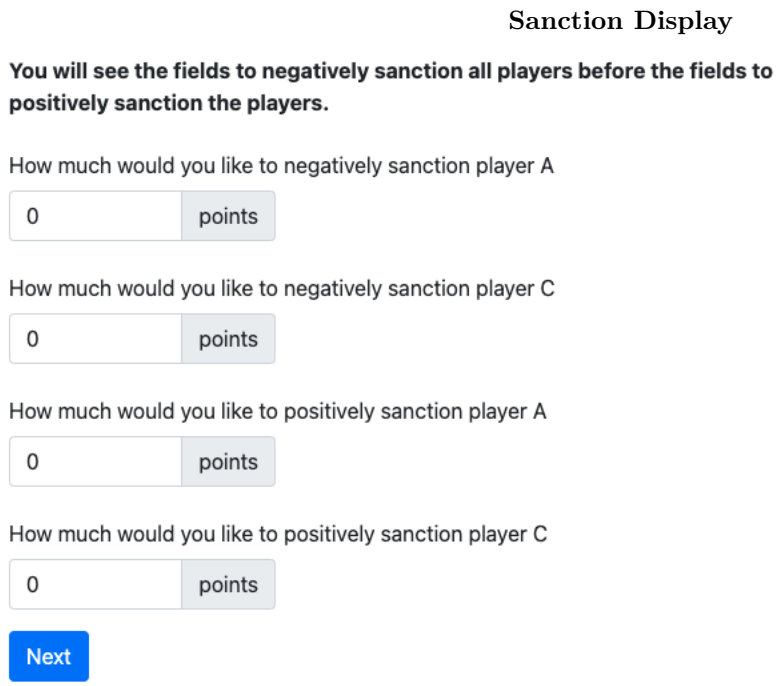

Figure 12: These are the sanction fields shown directly under the contribution display tables shown above

A.4 Results Page

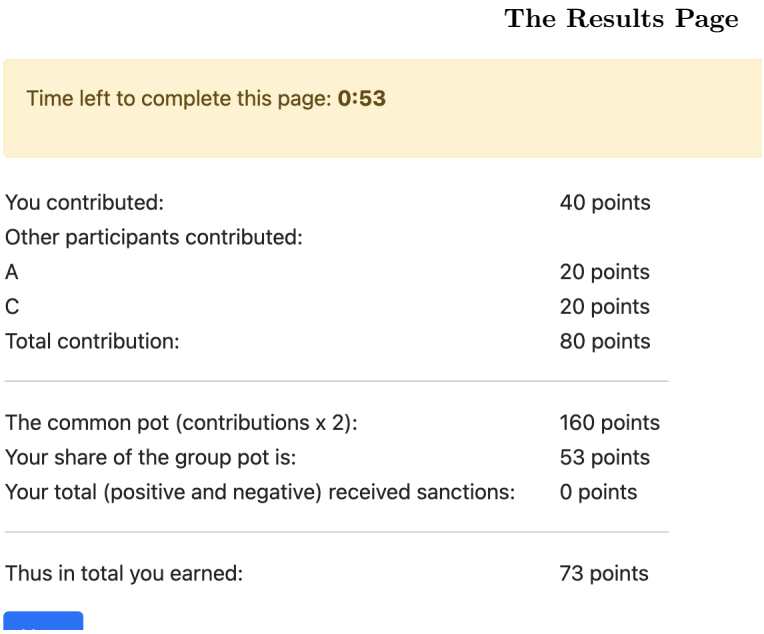

Figure 13: This is an example of the results page that is displayed to each participant. In this particular instance all players have contributed their entire endowment and have not sanctioned other players.

A.5 Condition Choice

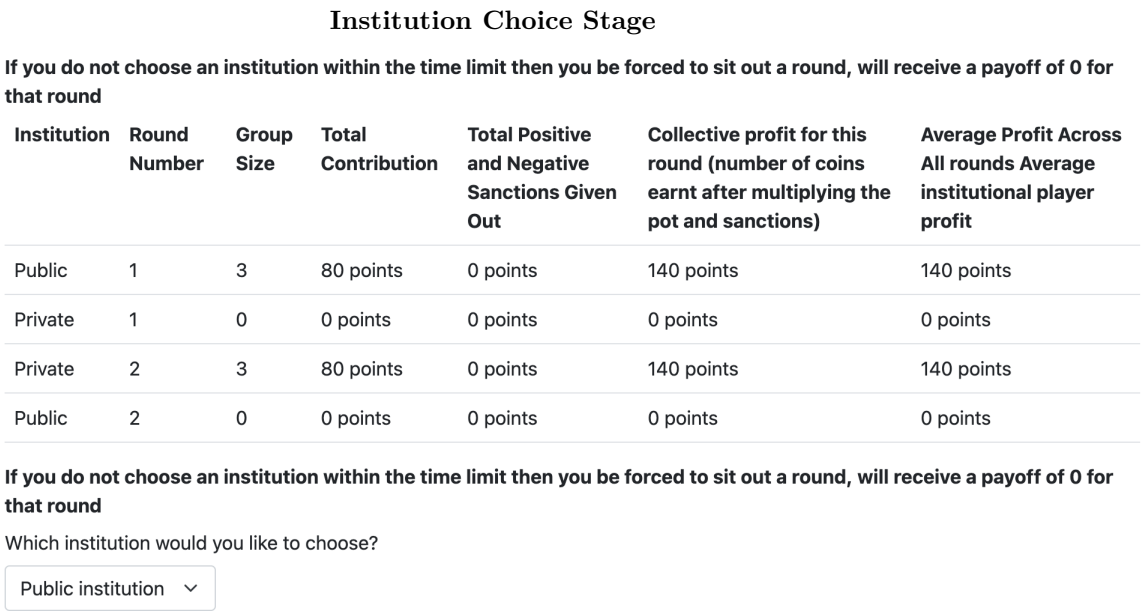

Figure 14: Page where participants choose their condition for the round.

A.6 Timed Out

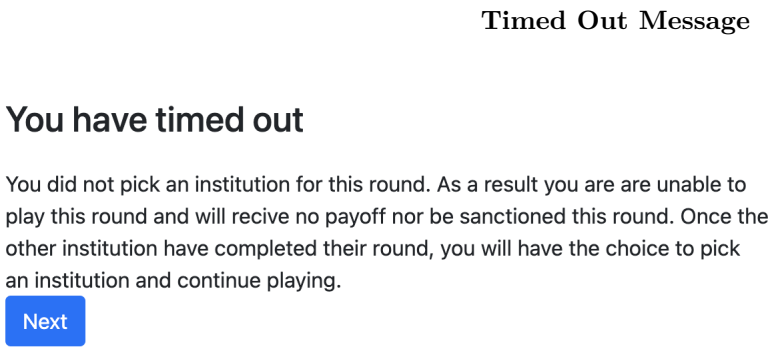

Figure 15: This page was shown to any participants that failed to choose a condition at the beginning of a round.

B Final Survey

B.1 Survey Questions

The Debrief Survey

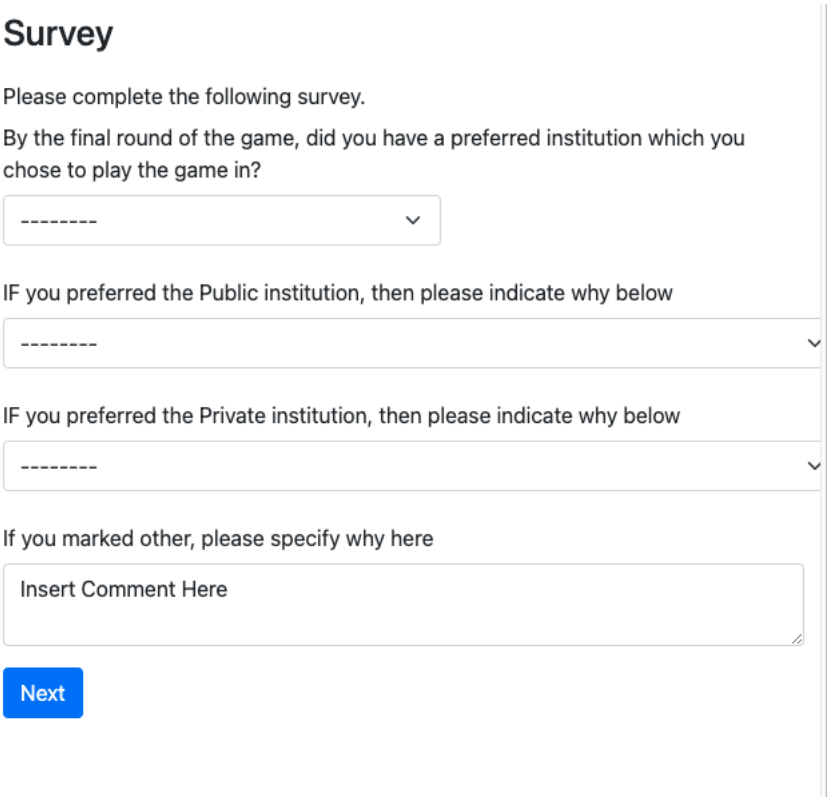

Figure 16: The Debrief Survey shown after the end of the Public Goods Game

B.2 Response Options for Survey Questions

Response Options for Question 1

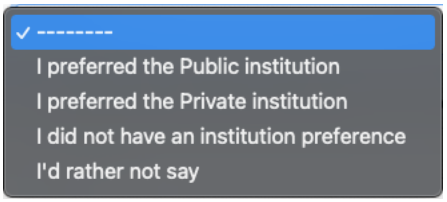

Figure 17: Response options for question 1

Response Options for Questions 2 and 3

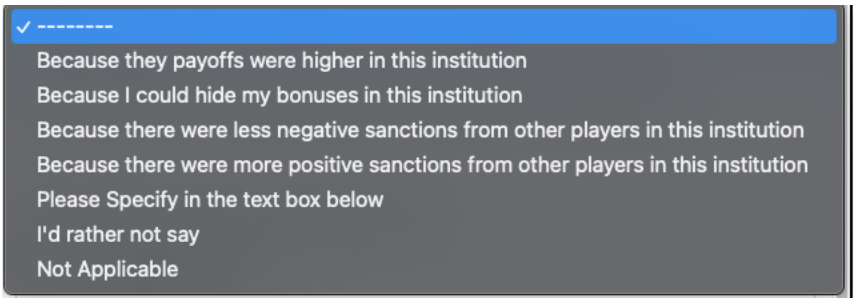

Figure 18: Options for why participants preferred either the public or private institution

C R code used for data analysis

C.1 R Code for analysis of Public Goods Game Data

```
library(tidyverse)
groups <- read.csv("./data/final_game_data_analyze.csv")
colnames(groups) <- make.names(colnames(groups))
selected <- groups %>% select(Condition, Size, Round_Number, Average_Contribution,
                    Average_Punishment, Average_Reward)
#Plots the group size across all conditions, averaged across all games played
size <- selected %>% select(Condition, Size, Round_Number) %>%
             group_by(Condition, Round_Number) %>%
             summarize(Mean_Size = mean(Size, na.rm=TRUE)) %>%
             ggplot(aes(x=Round_Number, y=Mean_Size, shape=Condition, color=Condition)) +
             geom_point() +
             geom_line() +
             labs(x = "Average Size", y = "Round Number") +
             ggtitle("Average Group Size Across the Rounds")

#Plots the average contribution for each condition, averaged across all games played
contributions <- selected %>% select(Condition, Average_Contribution, Round_Number) %>%
  group_by(Condition, Round_Number) %>%
  filter(Condition == "Public" | Condition == 'Private') %>%
  summarize(Mean_Contribution = mean(Average_Contribution, na.rm = TRUE)) %>%
  ggplot(aes(x = Round_Number, y = Mean_Contribution,
  shape=Condition,color=Condition))+
  geom_line() +
  geom_point() +
  labs(x = "Round Number", y = "Average Contribution") +
  ggtitle("Average Contribution Across All Rounds")

 #Plots the average punishment for each condition, averaged across all games played
punishments <- selected %>% select(Condition, Average_Punishment, Round_Number) %>%
  group_by(Condition, Round_Number) %>%
  summarize(Mean_Punishment = mean(Average_Punishment,na.rm = TRUE)) %>%
  ggplot(aes(x = Round_Number, y = Mean_Punishment, shape=Condition, color=Condition)) +
  geom_line() +
  geom_point() +
  labs(x = "Round Number", y = "Average Punishment")

#Plots the average reward for each condition, averaged across all games played
rewards <- selected %>% select(Condition, Average_Reward, Round_Number) %>%
  group_by(Condition, Round_Number) %>%
  summarize(Mean_Reward = mean(Average_Reward, na.rm = TRUE)) %>%
  ggplot(aes(x = Round_Number, y = Mean_Reward, shape=Condition, color=Condition)) +
  geom_line() +
  geom_point() +
  labs(x = "Round Number", y = "Average Reward")

 #Plots the Rewards and Sanctions on the Same Axis
 plot1 <- ggplot(summarized_table, aes(x = Round_Number)) +
 labs(x="Round Number", y = "Token Amount") + ggtitle("Contributions and Punishments")
```

```
plot1 <- plot1  + geom_line(aes( y=Average_Punishment, color=Condition))
plot1 <- plot1 +  geom_line(aes(y=Average_Contribution, color=Condition))


#Plots the Group Size and
plot2 <- ggplot(summarized_table, aes(Round_Number)) +
labs(x="Round Number", y = "Amount") + ggtitle("Group Size and Average Contribution")
plot2 <- plot2  + geom_line(aes(y=Size, color=Condition))
plot2 <- plot2  +  geom_line(aes(y=Average_Contribution, color=Condition))


```

C.2 R code for analysis of Survey Data

```
library(tidyverse)

data <- read_csv("./data/final_survey_data_analyze.csv")
colnames(data) <- make.names(colnames(data))
selected <- select(data, player.preference, player.public_options,
                player.private_options, player.comments)

# values coded as:
#   Q1: 1 = Public, 2 = Private, 3 = No Preferance, 4 = Not Say
#   Q2 and Q3: 1 = Higher Payoffs, 2 = Hide Bonuses, 3 = Less Neagative
#   4 more positive, 5 = Specify in the comments, 6 = Rather Not Say
#   7 = N/A

#Overall Preference
overall_preference <- selected %>%
                      ggplot(aes(player.preference)) +
                      geom_histogram(bins=7) +
                      labs(x='Players Preference', y = "Number of Players") +
                      ggtitle("Count of Participants Condition Preferences")

#displays the preferences
public_preference <- selected %>%
  filter(player.preference == 1) %>%
  ggplot(aes(x = player.public_options)) +
  geom_bar() +
  labs(y = 'Count',
       x = 'Why they chose the public condition',
       fill = "Answer Choice") +
  ggtitle("Why Players Prefer the Public Instiution")

#displays the preferences
private_preference <- selected %>%
  filter(player.preference == 2) %>%
  ggplot(aes(x = player.private_options)) +
  geom_bar() +
  labs(y = 'Count',
       x = 'Why they chose the private condition',
       fill = "Answer Choice") +
  ggtitle("Why Players Prefer the Private Instiution")

  no_preference <- selected %>%
  filter( player.preference == 3) %>%
  summarize(total = n())
```