ABSTRACT

Risk Aversion and Probabilistic Punishment

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This paper studies the intersection between risk aversion and willingness to punish in an experimental Voluntary Contributions Mechanism (VCM) game. The analysis focuses on the differences between high and low risk averse subjects and how they respond to varying uncertainties of proposed punishment being carried out. Both selfish and altruistic punishment will be studied in this context. I find that subjects are more willing to incur the cost to punish in a selfish setting than an altruistic one, and that there is a significant relationship between high risk aversion and probability of punishment. People that are more risk averse are willing to punish greater amounts only when there is greater certainty attached to the situation. I do not, however, find supporting evidence that high and low risk averse people act differently with respect to uncertain punishment itself.

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RISK AVERSION AND PROBABILISTIC PUNISHMENT

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CHAPTER ONE

Review of Existing Literature

Historically, economics has been aimed at explaining how and why people make rational decisions as well as the consequences of such decisions. More recently, however, it has become apparent that people will not always act rationally and both the reasons for this and the implications of it must also be studied in close conjunction with traditional economics. In a way, psychology comes into play in this respect. The junction of these two subjects has led to a still developing, yet powerful field now termed behavioral economics. Current findings in this area have certainly illuminated the reasons behind an array of human behaviors. One of the most relevant fields to which behavioral economics may be applied is law.

The intersection of law and traditional economics deals primarily with regulations, consumer choices, and transaction costs (Kovač & Vandenberghe, 2015). It is often thought that laws are necessary in some situations in order to achieve any result apart from what is optimal for an individual or group of individuals. By contrast, behavioral economics seeks to expand upon these findings and fill in the missing reasoning that is not included in general economic analysis. In their article “Using Experimental Economics to Peek Into the "Black Box" of Jury Behavior: A Proposal for Jury Research Reform,” authors Daniel R. Cahoy and Min Ding state:

> Behavioral law and economics melds the well-studied behavioral responses characterized by the field of psychology into economic analysis. It is a relatively new movement that calls on scholars to consider behavioral influences that may prevent individuals from making rational economic decisions. Behavioral law and economics attempts to explain and incorporate into the analysis the psychology behind the decisions people make that cannot be explained by rational desire for wealth maximization. (55)

Thus, the topics explored in this field have always been relevant to everyday life but have only recently been examined more closely.

One issue that arises in any type of experiment is "hypothetical bias." This is the idea that people will act differently in a lab setting because they do not believe that their actions will have any real and meaningful impact or consequences. For example, if an experimenter recreates a court scene in which the "jurors" are asked to decide a case, there is some bias introduced because the subjects will often act differently under the assumption that their rulings will have no real effect on the people on trial. To circumvent this bias, Cahoy and Ding suggest that the jury is told that they will in fact have a real effect on people at another point in time. Although this still cannot yield completely accurate results, it allows for a fairly authentic representation of the decision-making that occurs in the courtroom (Cahoy & Ding, 2004). Another possible way to avoid hypothetical bias is to pay subjects for their decisions in order to motivate them and connect their decisions to the "natural world."

Risk and Trust

One important consideration with respect to behavioral economics is how risk aversion affects people's everyday decisions. For example, there may be commonly held beliefs in society about risk preferences that lead people to act a certain way. It has indeed been found that women are generally more risk averse than men (Eckel & Grossman, 2002). The implications of this finding are numerous. For one, if people carry the assumption that women are more risk averse, they may offer them less risky options while they offer men more risky ones. The areas in which this may be manifested are healthcare with treatment options, investment advising, and employment offers. Whether a doctor is offering a woman a less risky treatment or an employer is offering a lower starting salary, it is clear that the common belief that women are more averse to risk affects many aspects of life (Eckel & Grossman, 2002).

In general, risk preferences can be extracted in a lab setting, evidenced by numerous studies. Using a simple lottery-type design, it is possible to discover whether subjects are risk averse, risk neutral, or risk seeking. It seems as though more people tend to be risk averse than risk seeking and that risk aversion increases as payoffs increase (Holt & Laury, 2002). There are a variety of risk elicitation tasks that vary based on the target subject pool. For example, the Balloon Analogue Risk Task (BART) uses a visual model to extract risk preferences. It involves an electronic simulation of pumping air into a balloon until it appears that it cannot get any bigger without popping (Charness, Gneazy, Imass, 2013). Finally, there is the Eckel and Grossman test that requires subjects to only make one decision versus the 10 made in a Holt and Laury risk task. The main conclusions from this original study, as stated previously, relate to women being more

risk averse than men (Eckel & Grossman, 2002). Risk aversion may also be able to be examined in a simple survey with various questions about willingness to participate in certain situations.

Similarly, trust games play a role in determining willingness to participate in risky situations. For example, there is a difference between risk and uncertainty which is manifested by the difference between having an outcome determined by another human versus a computer. So, it may be concluded that people are inherently risk averse even in non-social situations and therefore only marginally more so in social situations. In essence, some of the social risk aversion may be explained by the non-social aversion already present (Lauharatanahirun et al., 2012). Again, when one subject is given 10 ECUs and is allowed to allocate it as he or she sees fit, there actually appears to be a negative correlation that arises between risk aversion and willingness to reciprocate in a trust game. This means that people that enjoy risky situations usually returned less money back to the other participant (Eckel & Wilson, 2004). Again, there are many implications to these studies in the natural world and it is important to uncover trends such as these in order to understand why people make the decisions that they do.

Punishment

Again assuming that every person in a population is rational and makes decisions based on the best possible option to maximize utility, there would be no need for any further motivation to do so. However, as stated previously, this is not the case. Therefore, when norms are violated, particularly cooperation or social norms, people feel the need to punish or seek justice of some sort. This leads to the topic of punishment which has been introduced into voluntary contributions mechanism (VCM) games to allow subjects to

express disapproval of other people's actions. In general, a person is faced with a decision that is beneficial individually but harmful socially. This means that he or she would reap a benefit of *b* but, with probability *p,* incur a punishment of *l* (Ouss & Peysakhovich, 2015). People that do not follow the social norms and contribute less than what is deemed socially acceptable are considered "free riders" since they benefit from the cooperation of others but do not themselves cooperate. Results show that participants that had contributed a high amount inflicted harsh punishments on the free riders. Also, there was a pattern that arose in which the further a subject was below the average contribution, the tougher the punishment that was inflicted on him or her (Fehr & Gächter, 2002).

In general, public goods games (or VCM games) aim at finding out how contribution to a group account generally works. In the natural world, this type of experiment is the equivalent to a project where there is a possibility of either contributing to it or not. For example, if there is a common space that multiple people share, each person has the option to contribute to it in some capacity. However, if one person does nothing to contribute anything, he or she will still derive the benefits of other people's efforts to do so. Similarly, in an experimental setting, subjects are assigned to groups of 4 people and given the option to contribute all, none, or some moderate amount of an initial endowment. Then, traditionally, it is such that each person in a group receives 40% of the group total at the end. As in the example above, it is possible to give absolutely nothing and still gain from others' generosity. It is thus in the best interest of all players to contribute all of their ECU's, however, since it is unlikely that this will actually happen, the second best option is rather to keep them all (Masclet, Noussair, Tucker, & Villeval,

2003).

Punishment clearly serves as a motivator to cooperate with group members and to contribute a socially acceptable amount of currency to a group project. Indeed, it has been found that punishment is a relatively effective motivator to contribute more in experimental settings. So, contribution is generally higher in rounds of VCM games with the possibility of punishment versus those without. Also, people that are punished by others appear to punish more in future rounds (Fehr & Gächter, 2002).

Increased contribution may not be the only motivation for punishment, however. It may rather be due to the desire for fairness. If one person in a group does not give anything from his or her initial endowment, he or she will still gain from the other contributing members of the group. Therefore, this free rider will have a higher payoff than the other group members and the people that contributed may see this as unfair. It could be believed, then, that people are striving for equality as their main motivation rather than increased cooperation (Fowler, Johnson, & Smirnov, 2005).

Conclusions

It is clear that behavioral and experimental economics has opened up a whole new world of opportunity for exploration within the discipline of economics. Everything from demographics to risk aversion to punishment and the law may be examined in light of economic principles. There is nevertheless still plenty of room for growth in this area. One such area of possible expansion is in the intersection between risk aversion and punishment. The following research examines the response of people to probabilistic punishment at varying levels of risk aversion. The hope is to find out if risk aversion has any influence on a person's willingness to punish without a certain guarantee of the

punishment actually being carried out. This particular study has relevant implications to not only society as a whole but also to the legal system specifically.

CHAPTER TWO

Experimental Design and Rationale

The motivation for this design is to mimic the uncertain aspects in the legal system in America. Many experiments prior to this one have included the option for players to punish other members of a public goods game who contribute less than they do (e.g., Fehr & Gächter, 2002; Masclet et al., 2003; T. Johnson et al., 2009). This act is considered "free riding," since someone that contributes a very small amount to a group account can still benefit greatly from the contributions of others. Most prior experiments (e.g., Fehr & Gächter, 2002; Masclet et al., 2003) include a treatment with costless punishment and another with costly punishment to compare the subjects' willingness to punish in each scenario. However, the legal system does not ensure that punishment will be carried out with certainty, and it definitely is not costless. Therefore, it is necessary to introduce a new experiment that accounts for the limited understanding currently of the aspects of risk in this setting. Punishment must still be costly, however, there must also be some element of uncertainty that is introduced into the treatments, since this is an accurate representation of the natural world. Measures of risk aversion are also important in order to determine if there is any correlation between risk preferences and willingness to take the risk in punishing someone given that it is not guaranteed to happen.

Risk Elicitation

"Risk Aversion and Incentive Effects" is a risk elicitation task and analysis that uses safe and risky lotteries to test people's risk preferences. Prior to the Holt & Laury study in 2002, there was a minimal amount of literature surrounding the topic of risk aversion and its implications. The treatment uses real monetary payoffs and presents subjects with the decision between a safe option A that has a high payoff of $2.00 and a low payoff of $1.60 as well as a risky option B with a high payoff of $3.85 and a low payoff of only $0.10. The probability of the high payoff begins at 1/10 and increases by 1/10 in each subsequent period. Thus, the expected payoff for selecting option A is positive in the first 4 periods and negative thereafter. As stated previously, a rational person making ten choices between A and B would choose A until the expected payoff becomes negative. At that point, the rational player should switch to B for the remaining rounds. This decision is denoted as risk neutrality and would logically be manifested by a person's decision to select option A for four rounds and then option B for six (Holt, Laury, & others, 2002, pp. 1645–1646). There is motivation for one to answer truthfully and in a way that represents his or her true preferences. The fact that this treatment of the game has low monetary payoffs allows for the experimenters to actually pay subjects for one, randomly selected, round of the game.

The results of this study specifically show that most people are logical in that once they switch over to option B, they do not return to option A. There are, however, small numbers of subjects that are inconsistent with their choices and switch back. There is an even smaller number that switch around multiple times. This makes it somewhat difficult to decide how to determine a person's risk aversion. The experimenters decide to

add up the total number of option A choices that a person makes and use that number as a measure of his or her risk aversion. Surprisingly, subjects appear to be more risk averse than expected (Holt & Laury, 2002).

This experiment reiterates the issue with using hypothetical payoffs. People will often act differently in a situation where they are aware that they will definitely not reap any benefits, nor incur any costs, from their decisions. Furthermore, any risk elicitation study should warn against always assuming that subjects are risk neutral, as is commonly thought in economic theory. The results of this study, among others, show otherwise, and so it is important to remember that the risk preferences of participants may have an impact on the results of other, unrelated areas of study. For this reason, it is imperative to use a risk elicitation task in a costly punishment setting in order to understand if risk preference is driving people's decisions. This is why a basic, low real-payoff Holt & Laury risk task will be implemented at the beginning of the following study.

Selfish Punishment

In society, behaviors that are deemed abnormal or unacceptable are often "punished" in a sense by sanctions. Thus, approval or disapproval is normally a driving factor of behavior in the natural world and must be effective in some capacity. Researchers have therefore experimented with this idea in a lab setting to isolate people's exact behaviors. In one specific case, Masclet et al. implement a Voluntary Contributions Mechanism (VCM) game to examine subjects' willingness, or unwillingness, to contribute to a group account (Masclet, Noussair, Tucker, & Villeval, 2003). Once again, punishment is introduced in hopes of finding the effect on contributions as well as subjects' emotions pertaining to these contributions.

The following study will also use a VCM game very similar to the one above. This type of public goods game is widely accepted and used, and thus provides a good baseline experiment for the relevant objective. The results from this paper show that any type of punishment, monetary or nonmonetary, increases contribution levels initially, however, monetary punishment is more effective in sustaining cooperation over time (Masclet et al., 2003). The conclusion that must be reached given these results is that sanctions, despite the different forms they may take, are useful tools to heighten people's awareness of their actions and to induce cooperation in a group setting. Therefore, the following experiment will use monetary punishment in the design as it provides a more realistic and sustainable approach to implementing true punishment. Furthermore, when subjects are able to personally gain from the act of punishing, the punishment may be considered selfish. When there are multiple rounds of the VCM game played, and subjects remain in one group for these rounds, they are able to benefit from increased future contributions of their peers.

Altruistic Punishment

It is obviously in the benefit of everyone in a group setting to have a low contributor punished, however, no one wants to be the person to do it. In an altruistic setting, the main difference from the classic VCM game is that players continually switch groups after each round. Therefore, it is known that subject A will never interact with subject B more than one time. Punishment, then, is not beneficial personally, since any effort to influence someone to increase his or her contribution in the future will never benefit the punishing player directly. Nevertheless, players still decide to punish (Fehr & Gächter, 2002). The entire motivation of this type of study can be summarized with the

description presented by Fehr and Gachter: “Thus, the act of punishment, although costly for the punisher, provides a benefit to other members of the population by inducing potential non-cooperators to increase their investments. For this reason, the act of punishment is an altruistic act” (Fehr & Gächter, 2002). The desire to punish low contributors is motivated by the negative emotions that people feel when others free ride off of the system. The following study will also include two rounds of altruistic punishment in the experiment in order to determine if the actions of players change when they know that they will not interact with the same group members after one round.

Design

Given the above descriptions of three major topics in the field of experimental economics, the question of how people will act in a probabilistic setting with punishment capabilities arises. This question is directly related to the uncertain aspects of the legal system in America, since the decision to take someone to court does not automatically result in punishment. Also, risk preferences may relate more strongly to willingness to contribute and punish than people have thought previously. Therefore, the current study seeks to combine the above three topics, with a few modifications, in order to understand people’s economic decision making in a setting with probabilistic punishment.

Risk Preference Task

In the first part of the experiment, a risk elicitation task will be performed in order to test people’s risk aversion. For simplicity, the task designed by Holt and Laury will be used exactly in the same way as it was in their study. The instructions and parameters will be verbatim from the Holt and Laury (2002) paper. The low payoffs will be used in

the risk elicitation task since it is preferable to provide subjects with real payoffs. Below is a sample decision table that subjects will fill out. Again, it is apparent that the probability of the high payoff begins at 10% and increases by 10% in each subsequent decision.

Option A	Option B	Choice (A or B)
1/10 of $2.00, 9/10 $1.60	1/10 of $3.85, 9/10 of $0.10	
2/10 of $2.00, 8/10 $1.60	2/10 of $3.85, 8/10 of $0.10	
3/10 of $2.00, 7/10 $1.60	3/10 of $3.85, 7/10 of $0.10	
4/10 of $2.00, 6/10 $1.60	4/10 of $3.85, 6/10 of $0.10	
5/10 of $2.00, 5/10 $1.60	5/10 of $3.85, 5/10 of $0.10	
6/10 of $2.00, 4/10 $1.60	6/10 of $3.85, 4/10 of $0.10	
7/10 of $2.00, 3/10 $1.60	7/10 of $3.85, 3/10 of $0.10	
8/10 of $2.00, 2/10 $1.60	8/10 of $3.85, 2/10 of $0.10	
9/10 of $2.00, 1/10 $1.60	9/10 of $3.85, 1/10 of $0.10	
10/10 of $2.00, 0/10 $1.60	10/10 of $3.85, 0/10 of $0.10	

Table 1: Risk Elicitation Decisions

VCM Game

The second, and very integral, part of the experiment will involve a VCM game as in the Masclet et al. (2003) paper. Their instructions are verbatim with only slight modifications. In the Masclet et al. (2003) design, each player, given his or her 30 ECUs, must make a decision of how much of this endowment to contribute to the group fund. Thus, the amount in the group fund is then allocated to each group member at a rate of 40% of the total. All ECUs that are not contributed to the common fund are kept by each respective subject and added to the total received from the group account. In this design, each subject will receive 10 tokens rather than 30 or 20 to make this portion of the game slightly more simple. Also, the exchange rate used will be 10 tokens = $1. Again, this is

different from the rate used by Masclet, however, the underlying mechanisms are the same.

In the original design, there are ten sessions that are played in this manner where players simply decide how much to contribute and then are informed of their payoffs for each round (Masclet et al., 2003, p. 369). In the next ten rounds, the option to punish is introduced. Therefore, subjects play the VCM game as previously described, however, they are then informed of the contributions of their group members and are given the chance to punish each one based on this information. This experiment will introduce punishment from the very beginning and thus will have no rounds lacking the possibility to punish. The amount of punishment points possible ranges from 0 to 10, and the cost of punishment is symmetrical. There is neither the possibility of a subject knowing who he or she is punishing nor who is punishing him or her. This allows for an unbiased study of punishment to take place since there can be no targeting of a specific group member. As stated previously, traditional economic theory would posit that people should, in theory, contribute zero ECUs to the group account and they should also assign zero punishment points to all other players in order to maximize their payoffs (Masclet et al., 2003, p. 370).

The VCM game itself will be split into two treatments, one of which examines selfish punishment and another that targets altruistic punishment. The subjects will be randomly assigned to participate in either the selfish or altruistic treatment first and will play the other treatment second. In both the selfish and altruistic punishment portions of the game, subjects will be divided evenly into groups of 4 just as in the Masclet et al. (2003) and Fehr and Gachter (2002) studies. The initial endowment given to each person

will be equal to 10 tokens, the equivalent of 1 US dollar. Again, subjects are free to contribute as much as 10 tokens or as little as 0 tokens, in increments of 2, to the group account, with the payoff structure equivalent to that of the two aforementioned studies. Once every subject has submitted his or her desired contribution, the contributions of all players become public knowledge. At this point, punishment is enforced. Below is a sample decision table that subjects will fill out in order to indicate their desired contribution to the group account.

	Contribute 0	**Contribute 2**	**Contribute 4**	**Contribute 6**	**Contribute 8**	**Contribute 10**
	Keep 10	**Keep 8**	**Keep 6**	**Keep 4**	**Keep 2**	**Keep 0**
Put and X in the box corresponding to your preferred contribution						

Table 2: Contribution Selection

Punishment

The punishment structure will be slightly different than those included in studies preceding this one. This is due to the fact that these modifications are the distinguishing factors of this study. Instead of making the decision to punish after the decision of how much to contribute, subjects are asked to fill out a punishment table at the same time as the above contribution table via the strategy method. The other way in which the punishment differs from other studies is that subjects are only allowed to punish the lowest contributor as opposed to all three of the other group members.

After making their contribution decisions, subjects are given a table with columns representing the entire space of applicable decisions first, the range of possible contributions from the lowest contributor and second, rows detailing the probability of punishment being enacted from 0% to 100%. Therefore, there are six columns that range from 0 tokens to 10 tokens contributed by the lowest person. The rows include the possible probabilities that punishment will actually be enforced. The lowest value is 0% and increases in increments of 20%, all the way to 100%. For each level of contribution and corresponding probability of punishment, subjects must fill in a number of tokens that they would be willing to pay to have that same number of tokens taken away from the lowest contributing member of the group. If a subject does not wish to express any disapproval at a given probability and contribution, he or she must write a 0 in that cell. Thus, the punishment of the free rider consists of the sum of all punishment values by the other three group members. Below is the table used for this portion of the experiment.

					Experiment ID #	
	0	2	4	6	8	10
	tokens contributed by lowest contributor	tokens contributed by lowest contributor	tokens contributed by lowest contributor	tokens contributed by lowest contributor	tokens contributed by lowest contributor	tokens contributed by lowest contributor
0% chance of lowest contributor being punished						
20% chance of lowest contributor being punished						
40% chance of lowest contributor being punished						
60% chance of lowest contributor being punished						
80% chance of lowest contributor being punished						
100% chance of lowest contributor being punished						

Table 3: Punishment Selection

Selecting Punishment Value

These values remain private until all decisions have been made and submitted. Subjects are then informed of their group members' contributions. At that point, the decision sheets regarding punishment are then used to determine the true punishment for that round. In order to do so, there is a fair, 6-sided die that will be rolled by one randomly selected subject. One of the subjects rolls the die to avoid the bias of the experimenter being the one to do so. This die roll will determine the probability level of punishment. For example, a 1 corresponds to a 0% chance, a 2 to a 20% chance, a 3 to a 40% chance, a 4 to a 60% chance, a 5 to an 80% chance, and a 6 to a 100% chance. The

column value will have already been determined by the number of tokens that the lowest contributor gave.

Once the die is rolled, another randomly selected participant will roll a fair, 10-sided die in order to decide if punishment is actually carried out. As probability increases, the number of sides on the die corresponding to punishment also increases. For example, if the probability value 40% is chosen, the numbers 1-4 will represent punishment and numbers 5-10 will result in no punishment for the free rider. Likewise, if 80% is selected, numbers 1-8 would denote punishment and only 9 and 10 would allow the lowest contributor to escape the cost of punishment. If either 0% or 100% is selected, there will be no second die roll since the outcome is certain to be no punishment and guaranteed punishment, respectively.

If it is determined that the subject will be punished, tokens are taken away from the punishers and the punished group member based on the decisions made during the game. In Fehr and Gachter's (2002) design, the cost structure was one monetary unit taken from the punisher and three taken from the punished. However, in this experiment, the relevant cost ratio is 1:1. Therefore, for every one token taken from the punisher, there will be one taken from the punished. If no punishment is selected, the lowest contributor is nevertheless informed of the number of tokens that other players attempted to remove from him or her. Therefore, all knowledge becomes public once the game is fully complete and all decisions have been made. Regardless of whether punishment is carried out or not, people that assigned punishment values above 0 in the selected cell of the table will have this number of tokens taken away from them. This is an important element of the experimental design as it is representative of the criminal justice system in

which punishment cost is paid regardless of the outcome. Subjects will remain with the same members of their group for the 2 selfish rounds of the game.

Altruistic Punishment

In the altruistic portion of the experiment, the game will be played exactly as it is in the selfish part. The methods from above are still applicable for this treatment. The one change that is made is that subjects must switch groups after each round. Therefore, no one subject will play with the same subject for more than one round of the game. All participants will again play 2 rounds of the game in this manner, switching groups after each round. The purpose of this treatment is again to look at how people will punish given that they have no personal incentive to do so, and cannot reap the future benefit of influencing someone's contribution in their group. The results from this treatment will be compared to those of the first treatment to see if there is any difference between the two.

Methods

For the experiment, 32 students at Baylor University participated, with 16 subjects in each of the treatment groups. All of these students were registered on the Department of Psychology and Neuroscience's SONA system at Baylor. Specifically, in the system, they stated that they were willing to partake in economic experiments at Baylor and had received the information regarding the system from Economics flyers. The reason for sessions with 16 people is that in order to have 3 random reassignments of groups, one of which includes completely new groups of 4 people, the minimum number would need to be 16. The participants were seated at tables with one spot in between each

of them. Dividers were also put up to ensure that each person could not see any other person's decisions throughout the experiment.

Upon arrival, subjects were checked in and given a number between 11 and 26 which served as their experimental number for the remainder of the experiment. Therefore, there is no record tying a subject's name to his or her experimental number to ensure anonymity. From the start of the experiment to the end, it was slightly over 2 hours in duration. After 4 rounds of the game were played (2 selfish, 2 altruistic), the subjects were asked to take a short survey regarding their demographics and beliefs. The entire experiment was conducted on paper. All of the decisions that subjects made were recorded on printouts of the decision tables and transferred onto an electronic spreadsheet.

At the end, subjects were paid according to one round of the Holt and Laury decision table as well as one round of the VCM game. Both of these were determined by the roll of a 10-sided die. The Holt and Laury portion was determined by two die rolls, since the first roll decided the round and the second decided the whether the payoff would be high or low. Finally, following each round, subjects were fully informed of their decisions, their groupmates' decisions, and their payoffs for that round prior to the beginning of the next round.

CHAPTER THREE

Selfish Punishment Results

The main objective of this paper is to find if there exists a relationship between risk aversion and punishment decisions of subjects in a Voluntary Contributions Mechanism game. As stated in the previous chapter, the punishment structure may be broken down into two general categories: selfish punishment and altruistic punishment. This chapter focuses on the rounds of the experiment that simulate a selfish environment. For example, in the first session, only the first round of the game will be considered as being a selfish environment since the subjects remain with the same group members for the second round of the game as well. For the second session, only the third round of the game will be used as the two altruistic rounds were carried out in rounds 1 and 2 during this session. The importance of splitting up the data in this manner is to allow for a complete analysis of each aspect of the design while controlling for differences between the two treatment groups. In the end, these two groups will themselves be compared in hopes of eliciting any differences between them. In the subsequent section, all relevant hypotheses are detailed with rationale. Hypotheses I, II, and III will be considered in the forthcoming section. As stated previously, the data used in this section purely consists of subjects' decisions in selfish rounds.

Hypotheses

I. *People that are more risk averse in the Holt and Laury task will be less willing to punish monetarily.*

People that are risk averse do not generally want to engage in uncertain situations since there is risk inherently present. Therefore, especially in this experiment with the added element of uncertain punishment, risk averse subjects will likely require a higher probability of punishment being carried out to pay the cost of attempting to punish.

II. *People that are more risk averse in the Holt and Laury task will be more willing to contribute greater amounts to the group account.*

Since there is an added risk of being punished by other group members because of a small contribution amount, a risk averse subject will likely avoid this risk and contribute a higher amount. However, the group account is also somewhat risky in that there is an element of uncertainty present in the payoff structure. Being the highest contributing member in a group of low contributors is not beneficial to a subject, and so this is also a risky choice. Therefore, these two decisions may cancel each other out, however, I nevertheless conjecture that risk averse participants will contribute more.

III. *People that are more risk averse will increase punishment as probability increases whereas low risk averse people's punishments will remain constant.*

Subjects that are considered to be more risk averse may not be as willing to incur the cost to punish at lower probabilities since this, by nature, is a riskier decision itself. Thus, I predict that the more risk averse subjects will punish less at lower probabilities than they will in a situation with greater certainty. By contrast, more risk seeking people's punishment may remain constant over the range of probabilities. The decision to punish

at a relatively low probability that the punishment will come to fruition requires a risk seeking attitude. In fact, this punishment structure is very similar to the Holt and Laury task in that it indirectly tests aversion to risk with increasing certainties.

IV. *Values in the punishment table will overall be lower in an altruistic setting than in a selfish one.*

In general, people will likely be more willing to incur the cost of punishment in a setting where they are able to benefit personally from punishing a free rider. Therefore, I hypothesize that, as a whole, subjects will fill in the punishment table with lower values in the altruistic setting than in the selfish one.

Results

In total, there were 32 subjects that participated in this study. Of these individuals, 23 of them were female and 9 male. There were fourteen that identified as freshmen, eight sophomores, five juniors, four seniors, and one 5th year undergraduate student. With regard to risk preferences, 14 of the subjects can be considered highly risk averse and 18 low risk averse. These numbers are derived by using an approximately median split of the data. Low risk aversion, then, includes anyone that made 5 or less safe choices in the Holt and Laury risk elicitation task. High risk aversion includes subjects that made more than 5 safe choices in this portion of the experiment.

Looking only at subjects that are highly risk averse, the mean contribution is 4.8 tokens, and for low risk averse mean contribution is 6 tokens in selfish rounds. The overall mean contribution for selfish rounds is 5.63 tokens. The subjects that participated in the selfish rounds first contributed 5.5 tokens on average for round one, while the subjects that participated in the altruistic rounds first gave 5.75 tokens on average for the

third round. Again, only the first and third round are considered in this situation because these are the only two rounds that had purely selfish punishment. Therefore, only the first round is considered to be relevant for the session with selfish punishment first and only the third is relevant for the group that participated in altruistic punishment first. There is no significant difference in punishment when the order is switched. Therefore, the differences between the two sessions may be rendered insignificant for the following analysis.

Table 4 details the mean and standard deviation of various demographic characteristics of all 32 subjects that participated in this experiment. For example, the average student is a Sophomore girl attending Baylor University. In fact, 72% of the sample is comprised of female students. Furthermore, a mean of 4.31 in father's education corresponds to a level of education between a Bachelor's and a Master's degree. The average education of subjects' mothers is a Bachelor's degree. Average GPA in the sample is approximately a 3.5. Religious attendance tends toward 2-3 times per month, on average.

	Mean	Standard Deviation
Classification	2.06	1.1897
Female=1	0.72	0.4568
Father's Education	4.31	1.5951
Mother's Education	4	1.2181
GPA	4.5	0.8424
Religious Attendence	5.75	2.1553
Contribution in Selfish Rounds	5.625	2.8483
Punishment in Selfish Rounds	1.546	2.5882

Table 4: Sample Characteristics for Selfish Rounds

The summary statistics for punishment measures show that the mean of all punishment in the selfish rounds is 1.55 tokens. Splitting up the data by round, I find that round one punishment for selfish rounds is 1.13 tokens and for the third round, it is 1.96 tokens. A Mann-Whitney test of this data yields a p-value of 0.376 which is insignificant at all significance levels. Mean punishment for highly risk averse people is 0.74 tokens and for low risk averse people it is 2.17 tokens. A Mann-Whitney test of these two values produces a p-value of 0.187 which is also insignificant at all levels. Thus, there appears to be no systematic difference in either contribution or punishment between the selfish first and altruistic first sessions as stated previously. This proves that the data may be considered sufficiently random.

Hypothesis I

In order to test hypothesis I regarding differences in punishment values for more risk averse versus less risk averse subjects, it is necessary to define the two groups. I begin by creating a dummy variable for risk aversion based off of the number of safe choices selected in the Holt and Laury task. In order to ensure a relatively equal number of observations in each group, I use a median split of the data. The mean number of safe choices is 5.28 and the median is 5. Therefore, all subjects that chose a number of safe choices less than or equal to 5 will be considered as low risk averse and those that chose 6 or more safe options will be considered highly risk averse. These definitions will hold for the remainder of the analysis. Summarizing this dummy variable shows that there are 14 high risk averse and 18 low risk averse subjects in the total sample. I will henceforth refer to these two groups as high risk averse and low risk averse.

It is also necessary to define the types of punishment that will be used for this analysis. The range of punishment probabilities, as stated previously, begins at 0% and increases in increments of 20% all the way to 100%. Therefore, the 0% punishment level may be considered to be *symbolic* in that there is absolutely no possibility of any enactment of punishment. In fact, all punishment levels include symbolic punishment. This is due to the fact that the lowest contributing members of each group are notified of the punishment that they will receive if the punishment is actually carried out regardless of it is or not. In essence, in a round where punishment is not carried out, the lowest contributing member will nevertheless be informed of the number of tokens that other members attempted to take away from him or her. Subjects that desire to influence the contributions of other group members may find that symbolic punishment satisfies their desire to express disapproval. Regardless, the 0% punishment level will be considered separately from the others. This type of punishment is comparable to the non-monetary punishment presented in the existing literature (Masclet et al., 2003).

The middle probabilities, those ranging from 20-80% will thus be considered *uncertain* punishment as there exists varying certainty that the punishment will be carried out. As stated previously, this punishment still includes symbolic punishment, especially if it is not enacted. Finally, there is *certain* punishment which is equivalent to the conventionally used definition of punishment in this type of setting (Masclet et al., 2003). Punishment in this setting takes place with 100% probability. Therefore, there is no need for the die roll to determine if punishment will be carried out since this is always the case. Therefore, these three groups will generally be used to look at subjects' willingness to punish under different conditions. The main punishment of interest is uncertain

punishment as this is the only form of punishment that has not previously been studied in some capacity.

Subjects' values from the punishment table are recorded as long as they are rational. In essence, if a subject contributes only 2 tokens but writes positive values in the punishment table for someone that contributed 4, 6, 8, or 10 tokens, this is considered "cheap talk." In this instance, the subject that contributed 2 tokens is aware that he or she will in fact be the lowest contributor in the prior instance assuming all group members contributed at or above 2 tokens. Therefore, it is illogical for subjects to assign any punishment values above their personal contribution level for the round. Due to this fact, these values are not recorded in the final dataset. Some subjects will thus have only one punishment value (from contributing 0 tokens in that given round) while others will have up to ten values if they contributed all 10 tokens that round. The punishment variable itself accounts for this fact and takes on the appropriate average at each possible value.

The first step in testing the relevant hypotheses is to examine a summary of the data. Plotting the number of "safe" choices in the risk elicitation task against average punishment yields the following figure (Figure 1). Averages for certain, uncertain, and symbolic punishment are all presented separately. It can be seen that most of the observations lie in the middle range, between 3 and 7 safe choices. There was one person that chose the option at either extreme, however. Examining the data more closely, there appear to be various trends that appear within each type of punishment. Symbolic punishment, for example, takes on a unimodal shape which implies that subjects with preferences lying around risk neutral tend to punish more than subjects that are either more risk averse or risk seeking. By contrast, both certain and uncertain punishment

structures show that more risk averse subjects tend to punish lower amounts than low risk averse individuals. Thus, at first glance, it appears that the data should correctly align with the hypothesized result. However, it also appears that the data is quite noisy, perhaps due to the small sample size. It is nevertheless necessary to test these interactions statistically in order to determine if there is a significant trend within these groups.

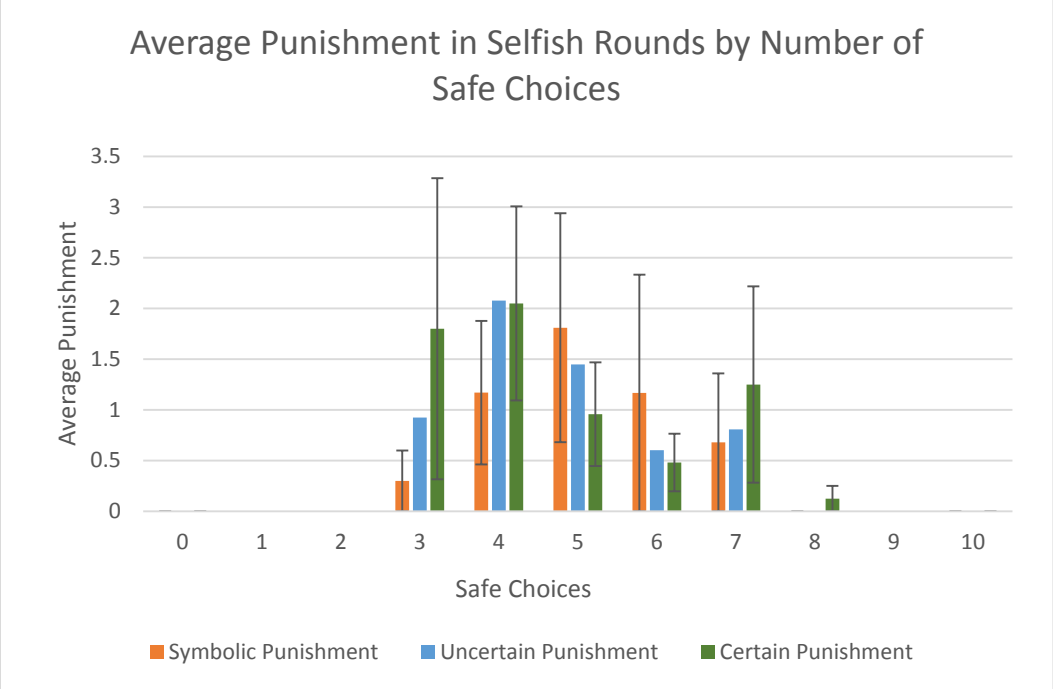


Figure 1: Holt Laury Safe Choices and Selfish Punishment

It is also relevant to separate symbolic punishment out of the uncertain and certain punishment splits. Plotting the same data as Figure 1 but with the symbolic element removed yields Figure 2. There are again 10 potential values of safe choices that may have been chosen by subjects. They remain consistent throughout the entirety of the analysis, however, since subjects only made these decisions one time. These choices appear along the horizontal axis. The vertical axis, then, shows the average punishment given at each of level of safe choices. It may also be seen that Figure 2 differs from

Figure 1 in that it contains negative values of punishment. This is due to the fact that the symbolic punishment is subtracted out of each of the relevant punishment splits (uncertain and certain). Therefore, if the symbolic punishment in rounds 1 and 3 is larger than the average uncertain (or certain) punishment, this value will be negative. This is the case at both 5 and 6 safe choices. Finally, Figure 2 differs from Figure 1 in that there is no symbolic punishment present. This is because the symbolic punishment is used to subtract out the figurative element from the other two types of punishment. Essentially, symbolic punishment is 0 in all cases since it is a value minus itself. Looking at the figure below, the certain punishment values seem to be larger, on average, than the uncertain values. However, both splits take on very similar patterns overall.

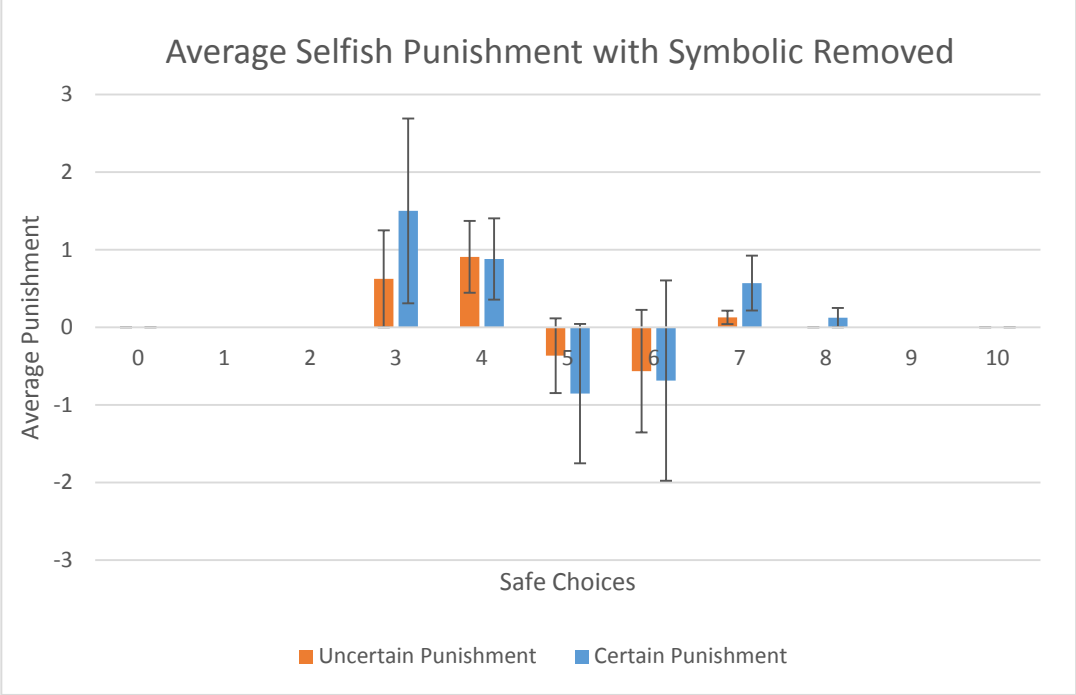
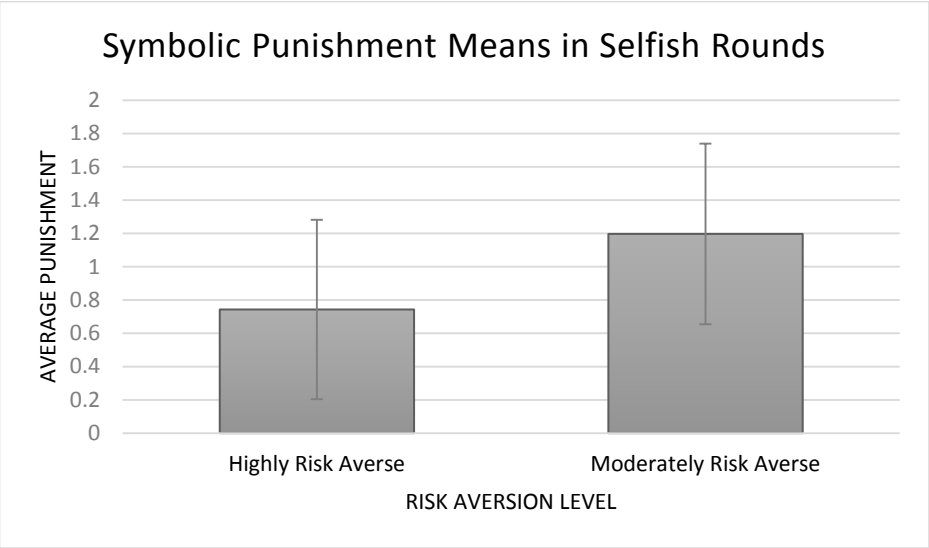
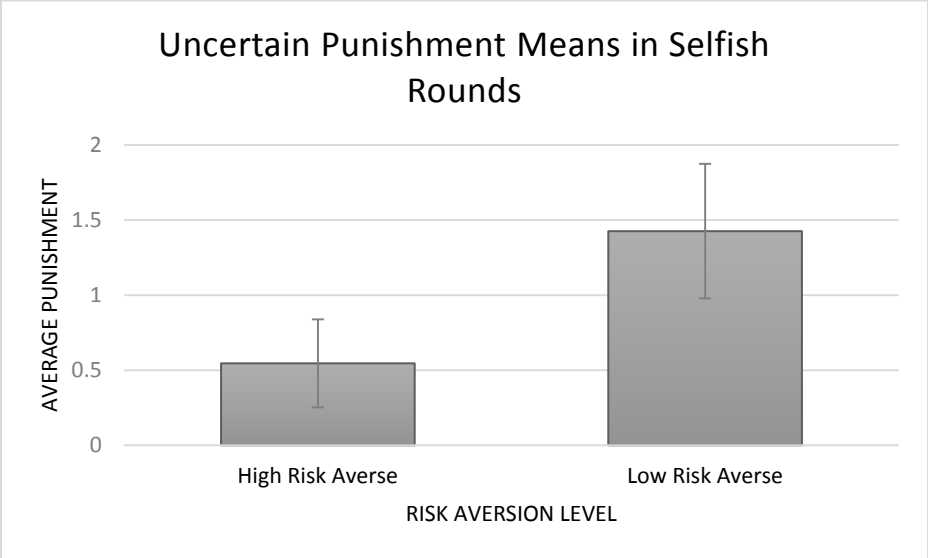


Figure 2: Holt Laury Safe Choices and No Symbolic, Selfish Punishment

It is relevant to then split the data into the two appropriate groups: highly risk averse and low risk averse. With everything else unchanged, the following statistics are produced.

The following three graphs summarize the average punishment amounts for high and low risk averse individuals. Subjects that have lower risk averse tendencies appear to punish larger amounts in all three punishment splits, evident in Figure 2.





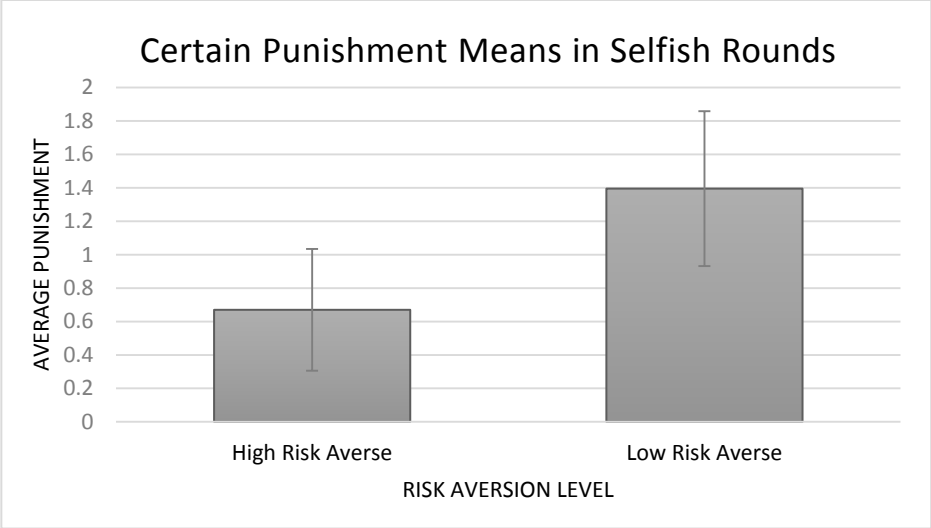


Figure 2: Risk Averseness and Punishment in Selfish Rounds

Hypothesis Testing

In order to test the assumption that highly risk averse people will punish less on average than low risk averse people, a Mann-Whitney test is run for a difference between the two groups. In order to do this, the above punishment split (symbolic, uncertain, and certain) is used to maximize the accuracy of the assessment of the subjects' decisions. Beginning with symbolic punishment, the mean is 0.473 for high risk averse subjects and 1.197 for low risk averse subjects. The associated p-value is 0.1799 which negates the assumption that highly risk averse subjects punish differently than low risk averse subjects in a symbolic setting. Similarly, with uncertain punishment in the selfish rounds, the means are 0.546 and 1.426 for high and low risk averse people, respectively. The p-value is 0.2154 which is again highly insignificant. Finally, certain punishment means lie at 0.67 and 1.395 for high and low risk aversion and the p-value is 0.1992. Although this p-value is relatively low, it is nevertheless insignificant also. Combining all types of punishment and only looking at highly risk averse versus low risk averse subjects'

punishment values, the mean punishment for high risk averse subjects is 0.742 and for low risk averse subjects it is 2.171. The p-value from the Mann-Whitney test is 0.1874. Thus, the difference between these two groups of people is rendered insignificant once again.

Table 5 presents a linear regression of the various types of punishment on the number of safe choices in the risk preferences survey. As seen in Table 5, there is always a negative correlation between punishment and safe choices. Included in this regression model is contribution since this value may have an impact on punishment. In the prior description of punishment, it was determined that any punishment above a subject's contribution should be considered "cheap talk." Therefore, assuming that individuals are rational and desire to maximize their payoffs, contribution should have an impact on punishment decisions. Again, all regressions run in this manner prove to be insignificant.

There are various explanations as to why the difference between these groups may be insignificant. For one, as stated previously, the standard errors are very large. Therefore, the data is very noisy and the difference would need to be much larger to be statistically significant. Since all of the differences are marginal and the errors are quite extensive, a significant difference cannot be detected. Furthermore, for both the symbolic as well as certain punishment rounds, there is no risk involved. The probability of punishment is fixed at 0% and 100%, respectively. In these cases, risk preferences naturally do not play as large of a role as they would in the uncertain scenarios. However, this does not explain why the uncertain punishment in selfish rounds similarly yields insignificant results.

Non-Symbolic Punishment

As stated previously, symbolic punishment is present in all probabilities. Therefore, it is necessary for probabilities ranging from 20% to 100% to be stripped of the symbolic punishment inherently present in this data. In order to do this, a new variable is generated that removes the 0% punishment from each respective probability level between 20% and 100%. Then, an average is taken of the punishment values at each of these probabilities and a Mann-Whitney test is conducted to determine if there is a significant difference between high and low risk averse subjects' decisions. The overall mean of the no symbolic punishment is 0.05 which is significantly lower than the other punishment values since it is a difference. The mean of high risk averse subjects' punishments is -0.17 and low risk averse is 0.22. For the high risk averse subjects, this means that the average symbolic punishment was greater than the average of the 20-100% punishments. The Mann-Whitney test shows that this difference is highly insignificant (p-value = 0.846). Thus, the hypothesis that symbolic punishment may be playing a role in the difference between highly and moderately risk averse subjects can be rejected for the selfish punishment portion of the experiment.

Hypothesis II

Hypothesis II posits that more risk averse subjects will have greater overall contributions to the public good in all rounds. For now, only selfish rounds will be examined to test this hypothesis. The difference in means between these two groups can be summarized in the following figures. Figure 3 presents the data with the risk aversion dummy variable for high and low whereas Figure 4 includes each possible amount of safe choices from 0 to 10.

Figure 3: Risk Aversion and Mean Contribution in Selfish Rounds

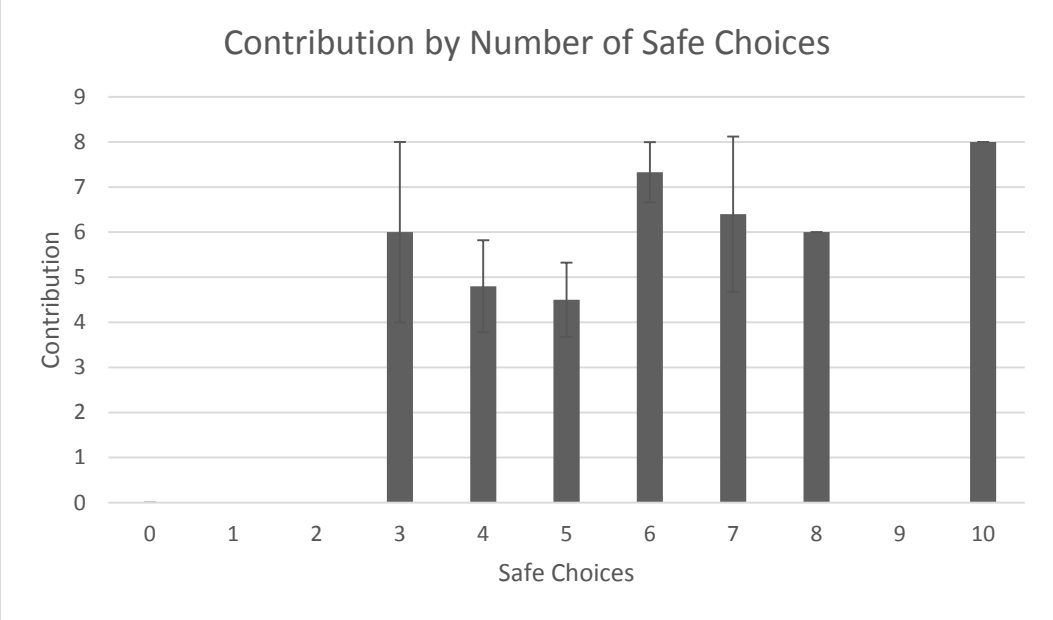


Figure 4: Risk Aversion and Continuous Mean Contribution in Selfish Rounds

For subjects that are highly risk averse, the average contribution to the group account is 6.86 tokens whereas for low risk averse subjects it is 4.67 tokens. The means

of the two groups support the aforementioned hypothesis that more risk averse subjects will contribute more overall. This difference does not appear to be significant, however, more information is needed.

As before, a Mann-Whitney test is used to test this assumption. Again, the subjects are split into two groups exactly as before. In this instance, there is actually a significant difference between high and low risk averse subjects with regard to contribution. The p-value is equal to 0.023 which suggests that highly risk averse subjects do in fact contribute more to the public good than their low risk averse counterparts. This is consistent with the hypothesis that, as stated previously, more risk averse individuals may be less willing to bear the uncertainty of being punished by others and therefore play "safe."

Furthermore, running a linear regression of risk aversion on contribution provides evidence for a moderately positive relationship between risk averseness and willingness to contribute in this setting. This regression yields a very similar p-value of 0.026, also significant at the 5% level. Therefore, while there is no evidence of a correlation between risk aversion and punishment, there does appear to be one between risk aversion and contribution.

Hypothesis III

The final hypothesis that is relevant to only the selfish punishment rounds states that as the probability of punishment increases, more risk averse subjects will likewise increase their punishment values because the level of risk decreases. Following this logic, low risk averse subjects may be willing to punish similar amounts across all probabilities of punishment. In order to test this hypothesis, it is necessary to break down the

punishment values once again. In fact, each individual probability of punishment will be used in the regression rather than compiling them as before. This ensures that individual probability differences can be extracted from the data. Thus, a panel dataset is created with the panel element consisting of the probabilities rather than the conventionally used time element. Then, a regression is run with punishment as the dependent variable and the probability as the independent variable. Another regression is run with a term interacting the risk averse dummy variable and all probabilities. This is the regression that is included in the following analysis.

The first model of interest includes all probabilities 0% to 100%. The second model includes all probabilities other than 0% as this punishment value is strictly symbolic. Finally, the last full model includes only the uncertain punishments ranging from 20% to 80%. The last two columns of Table 4 include probabilities of 20% to 100% and 20% to 80%, respectively. These two models have the symbolic aspect removed as was done previously. The results are shown in the table below. It appears that there is no significant difference between the difference probabilities for all subjects combined or for the separation of high and low risk averse subjects for the full models. For the non-symbolic punishment models, there is a significant difference between high and low risk averse subjects at the 5% significance level.

	0%-100% Punishment	20%-100% Punishment	20%-80% Punishment	20%-100% Punishment (No Symbolic)	20%-80% Punishment (No Symbolic)
Constant	3.4***	3.75***	3.76***	1.57	1.64
	(.3982)	(.4075)	(.4192)	(0.2114)	(0.2309)
RA	-1.19	-1.62	-1.54	-2.12**	-1.96**
	(0.6020)	(0.6161)	(0.6338)	(0.2564)	(0.2654)
RA*prob	-0.37	0.59	0.35	0.32	0.22
	(.0038)	(.0043)	(.0055)	(0.0077)	(0.0086)
Probability	0.22	-0.64	-0.83	-0.33	-0.51
	(.0025)	(.0028)	(.0036)	(0.0054)	(0.0059)
R^2	0.0472	0.0607	0.0655	0.0166	0.025
Observations	192	160	128	160	128
Subjects	32	32	32	32	32

Table 5: OLS regression of punishment on probability of punishment
* p<0.1. ** p < 0.05. *** p < 0.01

CHAPTER FOUR

Altruistic Punishment and Conclusions

Many of the hypotheses pertaining to selfish punishment in the previous chapter are also relevant in an altruistic setting. Therefore, the three hypotheses that were explored in a selfish punishment environment will also be explored in an altruistic setting. The final hypothesis will then seek to find the difference between subjects' actions in a selfish environment versus an altruistic one. As a reminder, the four hypotheses are stated below.

I. *People that are determined to be more risk averse in the Holt and Laury task will likely be less willing to punish monetarily.*

II. *People that are classified as highly risk averse in the Holt and Laury task will likely be more willing to contribute greater amounts to the group account.*

III. *People that are risk averse will increase punishment as probability increases whereas risk seekers' punishments will remain constant.*

IV. *Values in the punishment table will overall be lower in an altruistic setting than in a selfish one.*

Altruistic Results

In the first session of the experiment, the relevant altruistic round was round three since the subjects first participated in two selfish rounds of the game. Therefore, the third round was the one in which subjects knew that they would be switching groups after the third round and prior to the fourth. In the second session, it is the first round that is relevant since that group of subjects participated in the altruistic rounds first. It is

desirable to know how subjects react in this exact round because it would seem logical to assume that there would be less punishment points assigned by subjects. Indeed, this is what is traditionally found in the literature due to the lack of personal benefit that may be derived from the act of punishing in this situation. The relevant altruistic round in the second session was round one because in the second session, the altruistic rounds were first.

Summarizing the altruistic data, it appears that over both sessions, the average punishment amount was 1.22 tokens. For highly risk averse people, this number falls to 1.14, and for low risk averse subjects, it rises to 1.29 tokens. The mean contribution for all altruistic rounds is 5.94 tokens with a standard deviation of 2.51. Again, the data can be considered sufficiently random and further analysis may be carried out.

Hypothesis I

This hypothesis will be tested in exactly the same way as it was in a selfish setting. Therefore, I begin by providing summary statistics of the data. Again, the full data is represented in the graph below (Figure 5). All 10 possible Holt and Laury risk decisions are shown along with the three types of punishment: symbolic, uncertain, and certain. Punishment decisions in the altruistic setting appear to be very comparable to those in the selfish setting. Again, it is important to note that while there may be relevant trends in the data, it is difficult to find any significant differences due to the noise.

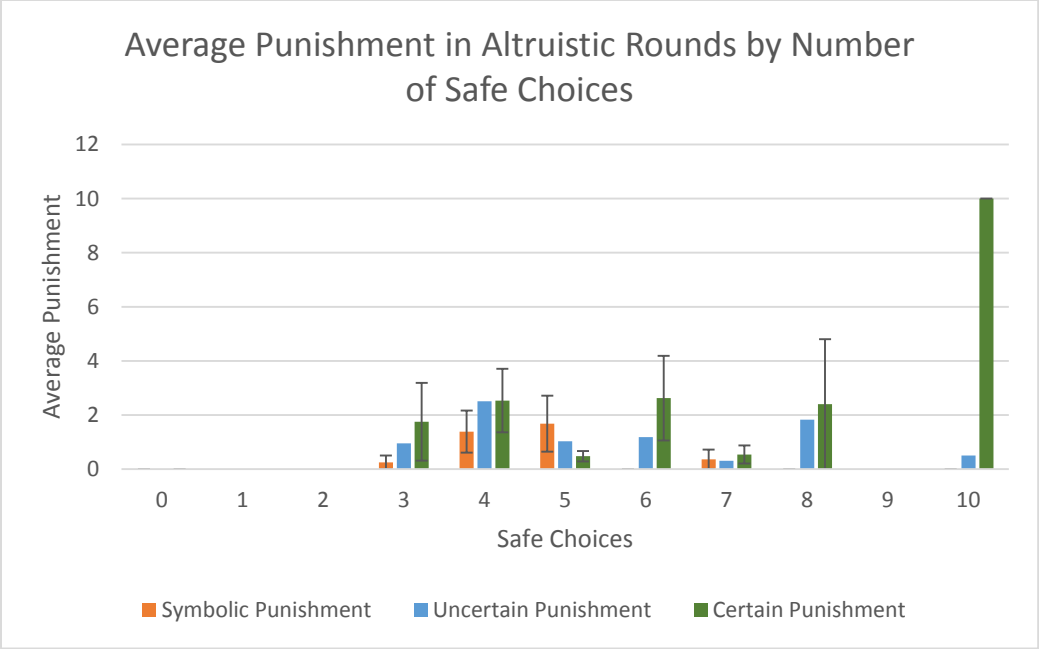
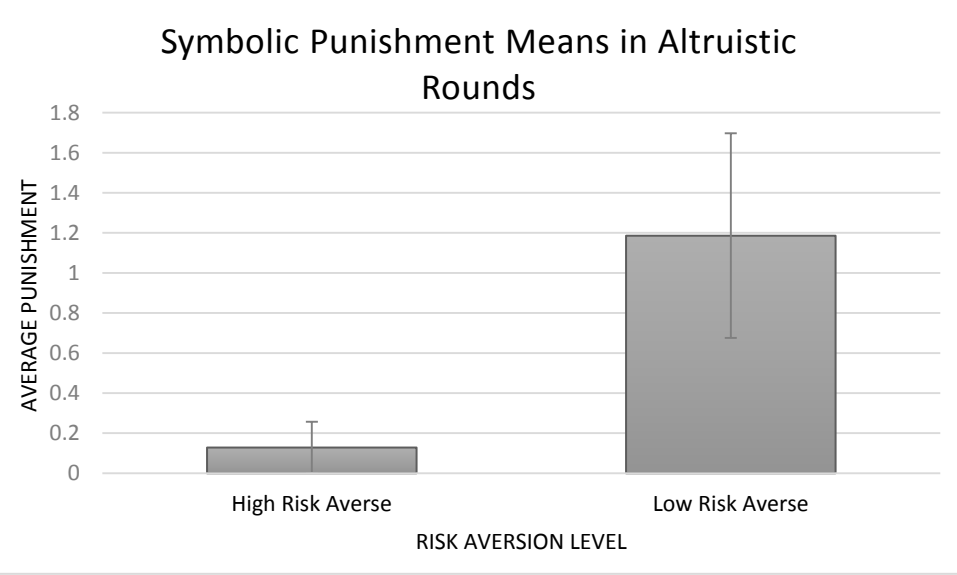
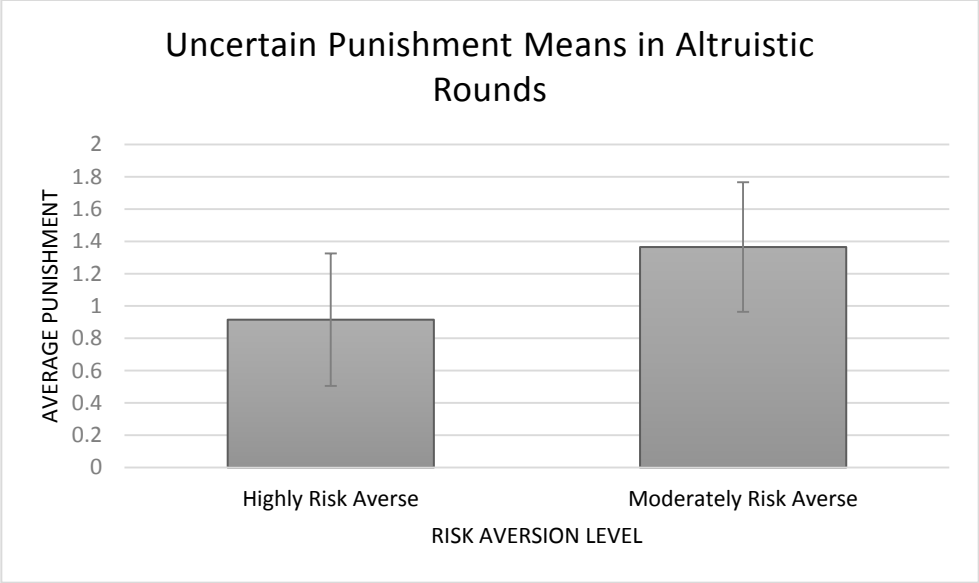


Figure 5: Holt Laury Safe Choices and Altruistic Punishment

Then, the data is again split into high and low risk averseness based on the number of safe choices chosen by each subject individually.





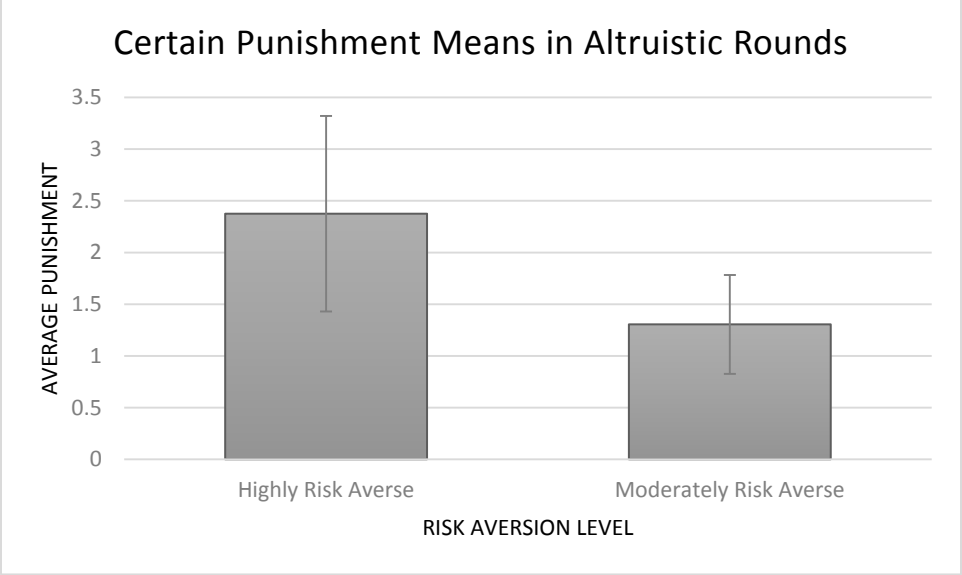


Figure 6: Risk Averseness and Punishment in Altruistic Rounds

Hypothesis Tests

Again using the three punishment splits, three separate Mann-Whitney tests are run for comparison between high and low risk averse subjects. There is no significant difference between these groups for either uncertain or certain punishment (p-values of 0.51 and 0.6, respectively). However, for symbolic punishment, the difference is significant at the 5% level, denoted by a p-value of 0.043. In this case, low risk averse people are much more willing to punish symbolically than high risk averse people. The same holds in an uncertain environment despite the fact that this difference is highly insignificant. Both of these outcomes support the hypothesis that less risk averse people are more likely to incur the cost of punishment even when it is uncertain. However, in a certain environment, the opposite is true and highly risk averse subjects have greater willingness to punish on average.

Although it seems illogical that risk averse subjects would punish more, the fact that they are only doing so in a certain environment supports the relevant hypothesis. Risk aversion is, in essence, irrelevant once punishment is guaranteed to be carried out. Therefore, there is no logical reason that high and low risk averse people should differ significantly at a 100% probability of punishment being successful. The results appear to align with this rationale in both a selfish and altruistic setting.

Just as in the case with selfish punishment, it is relevant to remove the symbolic element from the uncertain and certain results. Thus, the relevant 0% probability punishment values are subtracted from each respective probability between 20% and 100%. This isolates the uncertain aspect of these rounds of punishment. Regardless, the p-value remains insignificant even after these changes have been made. In the original

case of uncertain punishment where symbolic punishment was still included in the values, the p-value was 0.51 and in the no symbolic case it is 0.21. Therefore, the p-value decreases slightly with the removal of the symbolic punishments, however, it is still insignificant. It may be concluded, then, that high and low risk averse individuals do not differ in their decisions to punish under uncertain circumstances.

Hypothesis II

I will again test whether or not there is a significant difference in contribution amounts between high and low risk averse subjects in an altruistic environment. The two sample means may be summarized in the following figure. It is obvious that there is no significant difference between the willingness of a highly risk averse subject and a moderately risk averse subject to contribute to the public good. In fact, the means are even closer together in the altruistic setting than in the selfish one, although highly risk averse subjects still tend to contribute slightly higher amounts on average.

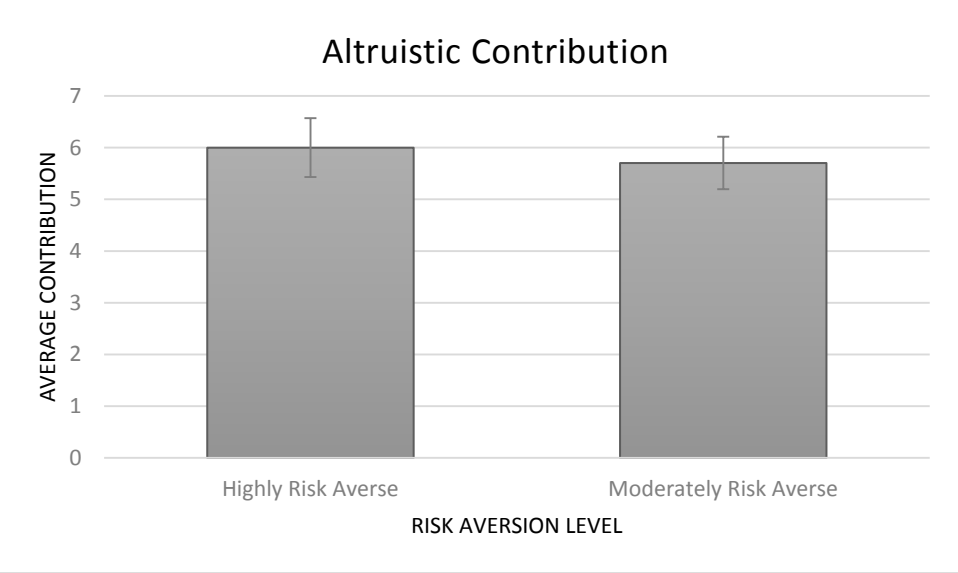


Figure 7: Risk Averseness and Mean Contribution in Altruistic Rounds

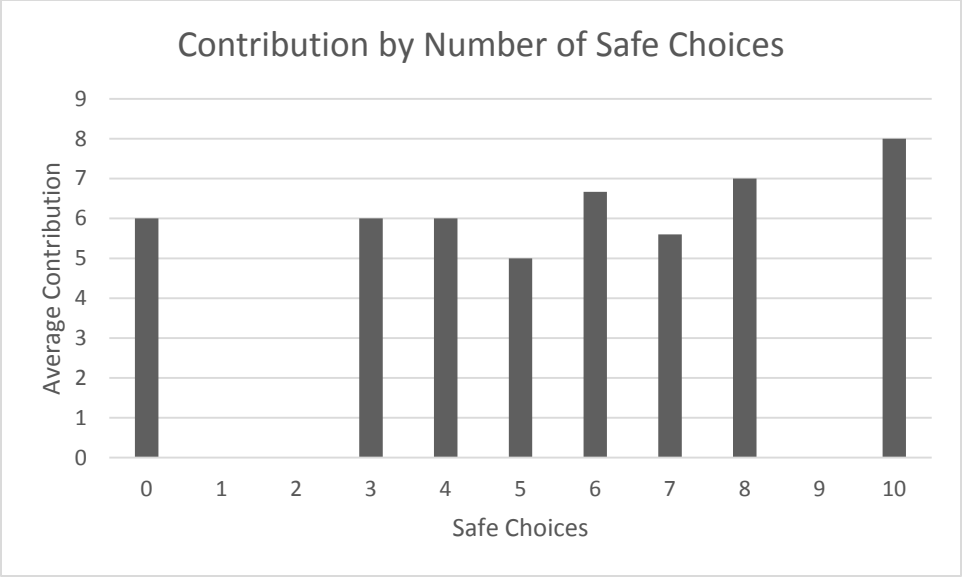


Figure 8: Risk Aversion and Continuous Mean Contribution in Altruistic Rounds

Even without the level of noise present in the data, the difference between high and low risk averse would likely be insignificant. A Mann-Whitney test confirms that there is no real difference between levels of risk averseness and contribution in an altruistic setting as the p-value is 0.22. Again, running a regression of contribution on risk aversion yields a very low R-squared value and very high p-value.

Hypothesis III

The penultimate hypothesis is as it was with regard to selfish punishment. A test will again be run to find if high risk averse subjects increase punishment as probability of success increases. To do so, a linear regression of punishment on probability, risk averseness, and the interaction of these two terms is run. The results are shown below and again include the full model as well as one model excluding 0% and another excluding both 0% and 100%. In addition, the non-symbolic punishments for the latter two models are also included in the final two columns of the table (Table 7). As seen in the table, it appears that there is significant evidence to conclude that more risk averse people punish

less overall. The interaction between risk aversion and the probability of punishment is also significant at the 1% level for the first two models and 5% for the third. In the non-symbolic models, only the 20%-100% model has a significant interaction term at the 10% significance level. This result provides evidence in favor of hypothesis III in that it appears that more risk averse subjects are willing to punish greater amounts at higher probabilities. It is interesting to note that the test of this hypothesis in selfish rounds did not yield significant results but in altruistic rounds it did. All of the other coefficients do not appear to be significantly different across punishments.

	0%-100% Punishment	20%-100% Punishment	20%-80% Punishment	20%-100% Punishment (No Symbolic)	20%-80% Punishment (No Symbolic)
Constant	3.12***	2.88***	3.1***	1	1.18
	(.0036)	(.483)	(.441)	(0.2052)	(0.154)
RA	-2.08**	-2.13**	-1.93	-1.21	-0.86
	(0.6216)	(0.7303)	(0.6668)	(0.4144)	(0.2622)
RA*prob	3.66***	3.52***	2.55**	1.93*	1.6
	(.0038)	(.0067)	(.0065)	(0.0122)	(0.0104)
Probability	0.23	-0.14	-0.01	-0.09	-0.01
	(.0036)	(.0044)	(.0043)	0.0073	(0.0071)
R^2	0.0624	0.0467	0.0356	0.0862	0.053
Observations	192	160	128	160	128
Subjects	32	32	32	32	32

Table 6: Regression of punishment on probability of punishment in altruistic rounds
* p<0.1. ** p < 0.05. *** p < 0.01

Hypothesis IV

The final hypothesis is relevant to both selfish and altruistic punishment simultaneously. This hypothesis examines whether or not there is a significant difference between subjects' willingness to punish in either setting. It is rational to assume that punishment values will be overall lower in an altruistic setting since subjects do not

derive any personal gain from the act of punishment. Therefore, there is less motivation to do so.

To test this assumption, total punishment values for both selfish and altruistic rounds are used. Again, this only includes rounds 1 and 3, conditional on whether selfish or altruistic punishment came first in a particular session. Then, a Wilcoxon signed-rank test is run on these two total values. The null hypothesis of this test is that punishment in a selfish setting is equal to that in an altruistic setting. The z-value is 4.17 for the test and the associated p-value is approximately 0. Therefore, it can be concluded that there is a significant difference between the amount punished in a selfish setting versus an altruistic one. There are more positive values for selfish punishment than negative implying that people generally punish more in selfish rounds. This is consistent with hypothesis IV.

Discussion

In the future, it would be beneficial to redo this experiment with a larger sample size in order to reduce the size of the error and increase the accuracy of the results. This would best be accomplished with a computerized experiment rather than a hand-run experiment, as the efficiency would be greatly improved. Unfortunately, due to time restraints, it was not possible to run a computerized experiment. It would also be beneficial to look at the responses of the subjects. This was not the main objective of this paper, however, it would be relevant to find if subjects truly alter their actions as a result of the punishments received by other group members. Finally, it would be interesting to obtain a more diverse subject pool. This was again difficult due to the fact that the population at Baylor is relatively homogenous in many regards. Therefore, this study

could benefit from being conducted with people from varying backgrounds and demographics in general. Again, given more time, it would be preferable to include an analysis of how differences in observables impacted the results. It appears that with a less noisy dataset, there could be significant findings with respect to uncertain punishment.

Conclusions

After analyzing the data, it is apparent that there is not one central trend that appears to be significant throughout. To summarize the results, all differences in high and low risk averse subjects' punishments were insignificant with selfish punishment. However, there is a significant difference for one punishment type, symbolic punishment, in the altruistic rounds. Similarly, contribution differences are significant in selfish rounds but not altruistic rounds. Finally, there are no significant results with regard to changing willingness to punish over the relevant probabilities in selfish rounds. However, in altruistic rounds, it seems as though there is evidence to support hypothesis III as the risk averse variable and interaction variable are both statistically significant. Therefore, this begs the question of why these differences exist.

The first discrepancy is a significant difference between high and low risk averse people in symbolic punishment for altruistic rounds where there is none in selfish rounds. Low risk averse people may be more willing to punish symbolically in an altruistic setting because there is no risk involved whatsoever. Punishing when there is a 0% chance of it being carried out is simply a way to express disapproval for what has already happened rather than an attempt to change something in the future. However, this explanation implies that there should also be a significant difference for certain

punishment. It also does not explain the difference between selfish and altruistic. Therefore, there must be another factor that is playing into subjects' willingness to punish more in this environment specifically. Further study must be done to extract what exactly this may be.

One simple explanation for the difference in contributions between high and low risk averse subjects in a selfish setting would be that there seems to be greater risk of being punished in this environment. For example, if all subjects hold the same belief as that expressed in hypothesis IV (people punish more in a selfish setting than an altruistic one), there would appear to be greater risk of punishment in selfish rounds. Therefore, a rational person that is highly risk averse would naturally respond by contributing a larger amount than normal to avoid the risk of punishment altogether. Contribution is itself somewhat risky in that by contributing a low amount to the group, a subject is aware that he or she may in fact be the lowest contributor. Therefore, risk comes in to play in not only the punishment portion of the game but also the contribution.

Finally, the fact that there is a significant interaction between the risk averse dummy and the probability of punishment in altruistic rounds means that highly risk averse people require greater certainty to punish in altruistic settings. This is proven by the positive coefficient of the interaction term in the linear regression. This is an interesting finding because it leads to the conclusion that there may actually be a relatively small difference between high and low risk averse people in a selfish setting when it comes to willingness to punish in an uncertain environment. Therefore, people may be willing to overcome the fear of the risk attached to an uncertain situation in order to hopefully influence the actions of their peers. However, this is not the case when there

is no personal benefit from the act of punishing.

The main conclusion from this experiment is that there does not appear to be a significant difference between high and low risk averse people's willingness to punish in an uncertain situation. Therefore, the implication of this is that risk preference may not actually play a large role when it comes to issues in the natural world such as someone's propensity to take an offender to court, for example. However, as stated previously, further research is needed to confirm this hypothesis and to discover if there are other factors that distinguish types of people in a probabilistic environment.

Further research in this area may expand to other types of possible punishment other than a typical legal application. For one, speeding leads to a few possible options. A person that chooses to speed may never be pulled over, he or she may receive a warning, or he or she may be punished for breaking the law. Therefore, anyone that speeds accepts that one of these outcomes will come to fruition. Some people are very willing to test their luck while others prefer to be safe and follow the rules. It would be interesting to see if people that are highly risk averse act differently in this situation than others that are not as risk averse. Another potential area of interest that this study could be applicable to is in a sports setting. Some athletes are willing to incur the risk of doping in hopes that they will not be caught while others never attempt to beat the system. Again, risk preferences must play a role in these decisions to some capacity. These experiments may be conducted with existing data along with the inclusion of risk preferences. Hopefully, all of these studies will illuminate the impact of risk aversion on current societal issues.

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