

# The Carrot or the Stick: Rewards, Punishments and Cooperation\*

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## Abstract

We examine demands for rewards and punishments in a simple proposer-responder game. The proposer first makes an offer to split a fixed-sized pie. According to the  $2 \times 2$  design, the responder is or is not given a costly option of increasing or decreasing the proposer's payoff. We find substantial demands for both punishments and rewards. While rewards alone have little influence on cooperation, punishments have some. When the two are combined the effect on cooperation is dramatic, suggesting that rewards and punishments are complements in producing cooperation. Providing new insights to what motivates these demands is the surprising finding that the demands for rewards depend on the availability of punishments.

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# 1 Introduction

The importance of altruism and fairness can be seen in our everyday lives. We seem to care about the unwritten social contract that kindness and consideration should be shared, and we are often willing to pay to enforce these ideals. For instance, every time we take a taxi or sit in a restaurant we entrust our happiness to another person. If that trust is protected then we may reward it with a generous tip, but if not we may punish by leaving less than the usual, or nothing at all. Likewise we may shun unfriendly colleagues but invite the friendly ones to our homes, and secretaries may perform more promptly for those who are polite or bring gifts and less promptly for those who are rude or unfriendly. Altruism, fairness and trust are often seen as the lubricants that make the wheels of commerce move more smoothly. In absence of complete contracts voluntary punishments and rewards are often the mechanisms we use to sustain cooperation.

Social scientists have grown increasingly interested in individuals' concerns for others, or what economists frequently refer to as other-regarding preferences. Sociologists and political scientists, for instance, have incorporated these into models of social cohesion; anthropologists and development economists have linked them to market organization and economic growth; evolutionary psychologists have looked for the roots of these behaviors in our genetic history; and game theorists have developed abstract models of altruism and fairness in strategic interactions. All of this research is ultimately aimed at designing institutions that can harness other-regarding behavior to improve social well-being.

In economics, much of the interest in this topic has been driven by economic laboratory experiments. In static allocation games, there is a great deal of evidence that many individuals have an altruistic desire to share a surplus with others. Moreover, individual attitudes toward fairness are very heterogeneous—some individuals are perfectly selfish while others seem to have a strong aversion to inequality.<sup>1</sup> In sequential games, our understanding of preferences and motives is far less clear. Many studies show that individuals are clearly willing to reward those who share and to punish those who have not shared enough. Sometimes adding these rewards and punishments results in greater efficiency, although often not.<sup>2</sup> But preferences for rewards and punishments have not always appeared consistent across different experiments, and theoretical models that have predicted well in static settings are often not successful in dynamic settings. Thus, there seems to be a clear need for a literature that looks specifically at general features of preferences in sequential games when the second-mover can reward or punish a first-mover. Studying such games will help us understand the reciprocal second-stage responses, and inform the broader literature on other-regarding preferences.

In this paper we begin a systematic look at both punishments and rewards and their effect on cooperation in economic laboratory experiments.<sup>3</sup>

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<sup>1</sup>See Andreoni and Miller (2002) for a discussion of this literature.

<sup>2</sup>To keep the exposition simple we will refer in two-stage games to a punishment as a decrease in payoff that a second-stage player imposes on a first-stage player. Similarly we refer to a reward as an increase in payoffs at the second stage. As examples of punishments see Güth, Schmittberger, and Schwarze (1982), Forsyth, Horowitz, Savin, and Sefton (1994), Bolton and Zwick (1995), Fehr and Gächter (2000), and Andreoni, Castillo and Petrie (2000). Examples of a demand for rewards are Berg, Dickhaut, and McCabe (1995), McKelvey and Palfrey (1992), Fehr, Kirchsteiger and Riedl (1993), Charness (1996), Charness and Haruvy (1999), Charness, Haruvy, and Sonsino (2000).

<sup>3</sup>To our knowledge we are the first to study these questions in a simple proposer-

We study a series of two-person proposer-responder games with costly punishments and rewards. Proposers choose how much to share of a fixed pie. Responders are in one of four conditions: punish or reward, reward only, punish only, or neither. By considering two-person games we avoid free-riding on punishments by others, and by randomly changing partners we avoid any repeated game effects. By looking at rewards and punishments both separately and jointly we can identify any interaction or complementarity.

We find substantial demands for both rewards and punishments. As expected, an increase in the offer by proposers, on average, decreases the punishment and increases the reward. Interestingly, while the average demand for punishment appears to be independent of the reward option, we find that the demand for rewards is significantly larger when the responder doesn't have the option of punishing. We also find that, on average, the proposed offer is largest when a combination of rewards and punishments are available, and smallest when neither option is available. Although the average offer of the rewards-only treatment exceeds that of punishments-only, we find that rewards are much less effective in moving the proposers away from the minimum possible offer. This suggests that the absence of a reward is not equivalent to a punishment. Thus designing an institution around rewards only and omitting an option for punishments may be a mistake, even if in the end the punishments are rarely used.

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responder setting. Dickinson (1999) examines a team production problem where subjects may be exogenously rewarded or punished. He finds that this mechanism increases efficiency. Sefton, Shupp, and Walker (2000) examine repeated linear public goods games and find that combined use of rewards and punishments result in the most generous public good contributions. In sequential public goods games Andreoni, Brown, and Vesterlund (1999) find that subjects punish small contributions but seldom reward generous contributions.

In the next section we provide a theoretical framework for the study. We present the experimental design in Section 3 and the results in Section 4. Section 5 discusses the implications of the findings and concludes the paper.

## 2 Background

A number of experiments examine the effects of either rewards or punishments. In this paper we limit our attention to two-player games where a proposer and responder must split a pie of size  $\Pi$ . The proposer first offers the responder a division  $(\pi_P, \pi_R)$  such that  $a_R\pi_R + a_P\pi_P = \Pi$ , where  $a_R > 0$  and  $a_P > 0$ . Having observed the offer the responder, at a cost to himself, may punish or reward the proposer by choosing a vector  $(p, r)$ , where the costs per unit are, respectively,  $c_p > 0$  and  $c_r > 0$ . The final payoffs of the game are  $(w_P, w_R) = (\pi_P + r - p, \pi_R - c_p p - c_r r)$ . Thus, each game  $\gamma$  can be characterized by the parameters  $(a_P, a_R, \Pi, c_p, c_r)$ , and the standard subgame perfect equilibrium prediction for this type of game is simple and independent of the parameters: for all  $\pi_R$  the responder chooses  $(p, r) = (0, 0)$ , and the proposer offers  $\pi_R = 0$  or some minimum required transfer.

Most prior work on proposer-responder games of this type have allowed the responder to either punish or reward the proposer, but not both.<sup>4</sup> We can easily incorporate such games in our framework by denoting the cost of the excluded action as infinite. Notice, however, that excluding one or even both of the responder's options does not change the equilibrium prediction.

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<sup>4</sup>One exception is Offerman (2000) who examines a proposer-responder game where a proposer chooses between a hurtful or a helpful action, and the responder must select one of three possible payoffs: a cool response, a reward, or a punishment.

Experimental results have not confirmed this prediction. For example, in the frequently-studied \$10 dictator game, where  $(a_P, a_R, \Pi, c_p, c_r) = (1, 1, 10, \infty, \infty)$ , the average offer is often found to be 25%.<sup>5</sup> In the ultimatum game, the responder is given an option of rejecting the proposer’s offer, which decreases both payoffs to zero. If we restrict  $p$  to equal either 0 or  $\pi_P$ , then the \$10 ultimatum game has the parameters  $(a_P, a_R, \Pi, c_p, c_r) = (1, 1, 10, \frac{\pi_R}{\pi_P}, \infty)$ . Studies commonly find average offers of about 40% of the pie, and that responders are more likely to reject low than high offers. While rejections in the ultimatum game are evidence of punishments, the game is not well suited for studying the demand for punishments. First, the responder’s choice set is not convex—one can only accept or reject the offer—thus a lot of information on preferences is lost.<sup>6</sup> Second, when an offer is increased it increases both the perceived generosity and the cost of punishing, making it difficult disentangle the two influences on demands for punishment.

In games that offer options for rewards we also see evidence of positive demands for these. For example, in the trust game the proposer and the responder are each endowed with \$10, and the proposer is asked to make an offer to the responder. For every dollar transferred the responder receives three dollars, hence  $a_P = 1$  and  $a_R = 1/3$ . The responder may subsequently return any of the money received to the proposer, therefore if we restrict  $\pi_R \geq 10$  the trust game is described by the following parame-

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<sup>5</sup>See for example Forsythe, et al. (1994). Andreoni and Miller (2002) compare a series of games  $(a_P, a_R, \Pi, \infty, \infty)$ , which enables them to determine demands for  $\pi_R = f(a_P, a_R, \Pi)$ .

<sup>6</sup>This may be one of the reasons why most fairness models are consistent with the evidence from the ultimatum game (e.g. Bolton and Ockenfels, 2000, Fehr and Schmidt, 1999, Dufwenberg and Kirchsteiger, 1998, Falk and Fischbacher, 1998, and Rabin, 1997). See Andreoni, et al. (2000) for an analysis of the convex ultimatum game.

ters:  $(a_P, a_R, \Pi, c_p, c_r) = (1, 1/3, \frac{40}{3}, \infty, 1)$ . In the original investigation of the trust game by Berg, et al. (1995) proposers pass an average of \$5.16, and responders return an average of \$4.66. Furthermore there is a positive correlation between the amount sent and the amount returned.

Taken together these results show that responders are willing to punish and reward, and that an increase in the initial offer,  $\pi_R$ , generally causes a decrease in punishments and an increase in rewards. Unfortunately these studies are not well suited for determining the demands. In some studies, the offer itself changes other parameters of the game, and even when these are held constant it is generally the case that only one game is examined, thus we are unable to determine what other factors may affect the demand for punishments and rewards.<sup>7</sup>

In this paper we report results from an experiment designed to identify some of the factors that affect demands for rewards and punishments. By studying rewards and punishments separately and jointly we can determine the possible interaction between the two. Furthermore by including a treatment where the responder can neither punish nor reward we can also determine precisely how these tools affect the proposer's initial offer.

### 3 Experimental Design

We consider four variations of the general class of games described above. In the first stage of each variation a proposer decides what portion of \$2.40 he wants to transfer to the responder; where  $a_R = a_P = 1$ . The only difference

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<sup>7</sup>Another example where the cost of punishing is dependent on the level of cooperation is Fehr and Gächter (1998). In their examination of the public goods game, subsequent punishments are a percentage of the individual's payoff, thus it is cheaper to punish those who are less generous.

between the four treatments is in the responder's ability to punish or reward at the second stage. We refer to the treatments as: *Dictator*, *Carrot-Stick*, *Carrot*, and *Stick*. In the Dictator treatment the responder can neither punish nor reward. In the Carrot-Stick treatment the responder can at a cost of one cent increase or decrease the proposer's earnings by 5 cents. In the Stick treatment the responder can at a cost of one cent decrease the proposer's earnings by 5. Finally, in the Carrot treatment the responder can at a cost of one cent increase the proposer's earnings by 5 cents.<sup>8</sup>

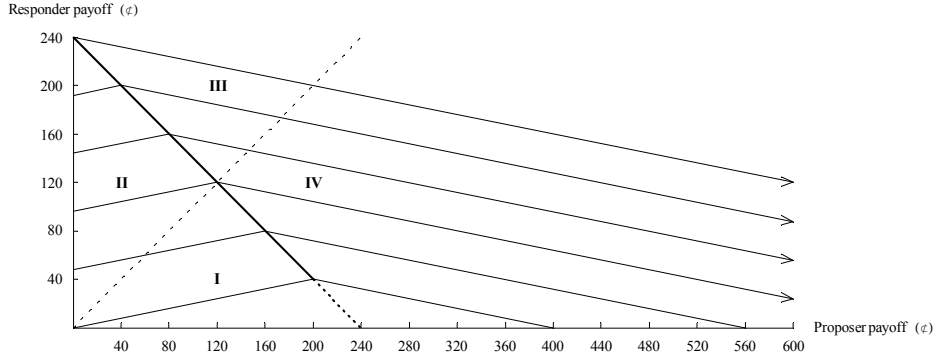


Figure 1: Possible Payoffs in the Carrot-Stick

The set of payoff combinations that are available in the Carrot-Stick game is illustrated in Figure 1. The proposer's payoff is measured on the horizontal axis and the responder's payoff on the vertical axis. The proposer chooses an offer along the bold solid line, and conditional on that offer the responder has the option of choosing any point on the reward and punishment lines originating at the proposer's offer. These choices are indicated by

<sup>8</sup>Using the notation from before, the parameters of the Dictator treatment are  $(a_P, a_R, \Pi, c_p, c_r) = (1, 1, 2.40, \infty, \infty)$ ; Carrot-Stick:  $(1, 1, 2.40, 1/5, 1/5)$ ; Carrot:  $(1, 1, 2.40, \infty, 1/5)$ ; and Stick:  $(1, 1, 2.40, 1/5, \infty)$ .



the lighter solid lines. To secure the responder the opportunity of decreasing the proposer's payoff to zero, we do not allow the proposer to make offers below 40 cents. The dashed portion of the bold line shows the proposals excluded by this rule.

The 45°-line, shown with light dashes, indicates the possible payoff combinations that result in equal payoffs to the responder and proposer. While the responder decreases her payoff by choosing any outcome off of the bold line, note that moves into areas I and III result in a more equal distribution of payoffs than under the original proposal. We refer to responders who choose outcomes in these two areas as equalizers. In contrast, subjects who pick outcomes in areas II and IV could have chosen an outcome which both resulted in a larger personal payoff as well as a more equal distribution of payoffs.

The feasible payoff combinations in the Carrot treatment include all points on or to the right of the bold line, the Stick treatment include points on or to the left of the bold line, while the Dictator treatment only includes points on the bold line. If it is common knowledge that all individuals seek to maximize their personal payoff, then the subgame perfect equilibrium outcome is the same for all treatments. The responder should neither reward nor punish, and given this response the proposer should choose the minimum required transfer of \$0.40.

We ran three sessions of each treatment, each with 10 proposers and 10 responders, for a total of 30 subjects in each role in each treatment. Subjects were undergraduate business students and were randomly assigned to a treatment. Upon arriving to the experiment they were randomly assigned

to a computer terminal and were given a set of written instructions. The experimenter read the instructions aloud, after which the subjects were asked to calculate the payoffs in a specific example of the game. The answers to the quiz were collected, and the example was reviewed verbally by the experimenter. Half of the subjects were then randomly assigned to be proposers and half to be responders. They remained in that role throughout the experiment.

They played 10 iterations of the game. In each iteration they were randomly and anonymously paired with another subject, with the stipulation that no one played another subject more than once. Subjects' identities were never revealed to one another. After the 10 rounds, subjects' earnings for all 10 rounds were tallied and added to a \$5 show-up payment. While waiting for their payment, subjects answered a questionnaire. They were paid anonymously with cash in envelopes which were handed out by subject number. The experiment typically lasted less than an hour, and including the show-up fee the average earnings were \$17.41 (standard deviation of 4.80, maximum of \$49.35, and minimum of \$6.70).<sup>9</sup> A copy of the instructions for the Carrot-Stick game can be found in the Appendix. The instructions were kept as neutral as possible by referring to the punishments and rewards simply as changes to the proposer's payoff.

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<sup>9</sup>The subject with the highest earnings was a proposer in the Carrot treatment. That subject made generous offers and received total rewards of \$36. The subject with the lowest earnings was a proposer in the Stick treatment. This subject never made an offer below 200, and indicated in the questionnaire that her main objective was to avoid punishments.

## 4 Results

In this section we first examine whether the observed behavior is consistent with the standard subgame perfect equilibrium prediction. Next we examine how the responder's options affect the cooperative behavior of the proposer, and discuss the demands for rewards and punishments. Finally, we examine the motives for these demands in light of recent models of fairness.

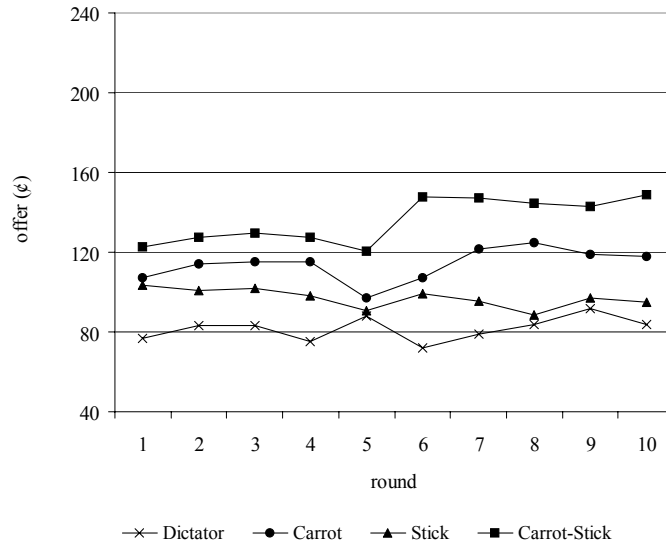


Figure 2: Average Offers

### 4.1 Equilibrium Predictions

Figure 2 shows the average offers in each of the ten rounds for the four treatments. In each treatment and in each of the ten rounds we reject the hypothesis that the average offer equals 40 cents.<sup>10</sup> Furthermore offers are

<sup>10</sup>Treating each proposer as an observation we test if the average proposal equals 40. Across the ten rounds the  $t$ -statistic is 12.6 for Carrot, 10.7 for Carrot-Stick, 9.6 for Stick, and 8.0 for Dictator. The results for the last round and the last five rounds are similar.

not independent of treatment. The average offer is largest in the Carrot-Stick treatment and smallest in the Dictator treatment.<sup>11</sup> As expected the offers do not decrease towards the end of the experiment, indicating that the proposers correctly understood the one-shot nature of the interactions.

Next we turn to the responders' decisions. Here we find statistically significant evidence of both punishments and rewards.<sup>12</sup> In fact the willingness to reward and punish is quite substantial. Across the three treatments responders changed the proposer's payoff 43 percent of the time, and over the ten rounds 80 percent of the responders chose at least one change of the proposer's payoff. During the last five rounds, 75 percent of the responders changed the proposer's payoff.

Figure 3 shows the proportion of offers that were either increased or decreased by the responder in a given round, and the responder's expenditures on changing the proposer's payoff.<sup>13</sup> Once again we observe differences across treatments.<sup>14</sup> During the last five rounds the average responder in the

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<sup>11</sup>Treating each proposer as an observation, we use a  $t$ -test to determine if average offers differ across treatments. Differences are significant at the five-percent level for the ten rounds, at the ten-percent level for the last five rounds, and with exception of the Dictator-Stick comparison at the ten-percent level for the last round.

<sup>12</sup>For all three treatments we reject the hypothesis that rewards and/or punishments are zero. Treating each responder as an observation we test if responders on average chose not to change the proposer's payoff. Over the ten rounds the  $t$ -statistic is 4.6 for Carrot, 7.5 for Carrot-Stick, and 5.9 for Stick. The results for the last round and the last five rounds are similar.

<sup>13</sup>Given random matching and a heterogeneous population one should expect some variation in these numbers. Suppose for example that there are two types of people, equal-dividers and free-riders. Free-riders never change the payoff and always offer 40, equal-dividers always offer 120, and as responders they choose a change that equalizes the payoff of the two participants. If free-riders are matched with free-riders and equal-dividers with equal-dividers, then the average change of proposer's payoff is zero. However if subjects are matched with their opposites, then the average change is 100.

<sup>14</sup>Note neither the likelihood nor the expenditure on changes decreases over time. This suggests that both proposers and responders behaved in a manner consistent with the one-shot interaction. This contrasts with the repeated game result of Sefton, et al. (2000).

Carrot treatment spends 20.4 cents changing the proposer's payoff. In comparison, the number in the Carrot-Stick is 14.7, and in the Stick treatment it is only 5.9.<sup>15</sup>

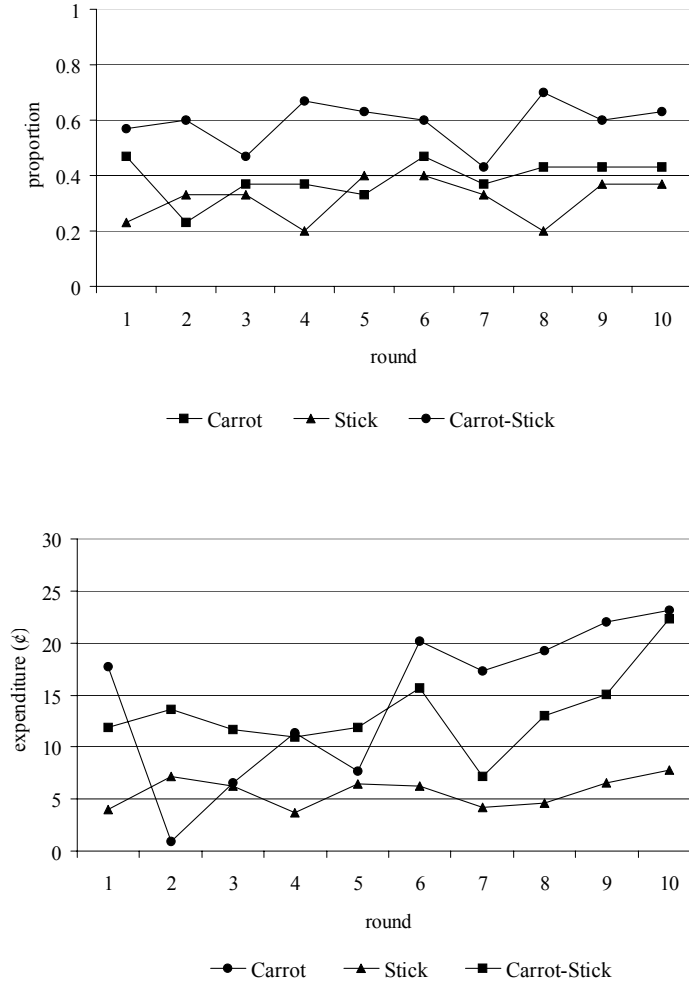


Figure 3: Average Responses

<sup>15</sup>Over all ten rounds the average cost of changing payoffs are 14.7 in Carrot, 13.3 in Carrot-Stick, and 5.7 in Stick. Treating each responder as an observation we test for treatment differences. The  $t$ -statistic is 0.35 for the Carrot and Carrot-Stick comparison, 2.68 for the Carrot and Stick comparison, and 3.75 for the Carrot-Stick and Stick comparison. The results for the last round and the last five rounds are similar.

Given the significance of both rewards and punishments, we next ask how this affected payoffs across the conditions. Table 1 shows that the proposer’s payoff is largest in the Carrot treatment, and the responder’s payoff is largest in the Carrot-Stick treatment. By design the average joint payment of the Dictator treatment equals 240, however that is not the case in the other treatments. In the Carrot treatment the proposer and responder jointly receive 298 cents per round. In comparison the joint payment is 249 in the Carrot-Stick treatment and only 206 in the Stick treatment.<sup>16</sup> There are also substantial differences in the relative payoffs to the proposer and responder. Relatively speaking the payoffs are more equally distributed in the Carrot-Stick treatment, and most unequal in the Carrot treatment.

Table 1: Average Per-Period Earnings, in Cents

Treatment	All Ten Rounds		Last Five Rounds	
	Proposer	Responder	Proposer	Responder
Carrot-Stick	126	123	123	132
Carrot	199	99	224	98
Stick	115	91	116	89
Dictator	158	82	158	82

Next we examine these treatment differences more closely. First, we determine how the availability of punishments or rewards affects the proposer’s offer to the responder.

<sup>16</sup>With exception of the Carrot-Stick versus Dictator comparison the sum of payoffs differ across treatments. Treating each responder as an observation all differences are significant at the five-percent level over the ten rounds. Similar results are found for the last five rounds, where the joint payoff in Carrot is 321, and only 254 and 205 in the Carrot-Stick and Stick treatments respectively. In the last round the difference between the Carrot-Stick and Carrot treatment is not significant.

## 4.2 Cooperation Production Function

We saw in Figure 2 that the proposers' offers differ across treatments, with Carrot-Stick offers the highest (136 on average), followed by Carrot (114), then Stick (97) and Dictator (82).<sup>17</sup> This seems to indicate that punishments alone are the least effective in moving the proposer away from the minimum possible offer. However, when examining the distribution of offers we find a much more subtle and interesting relationship between rewards, punishments and cooperation.

Figure 4 shows the distribution of offers over the last five rounds. Notice that the modes of the distributions differ substantially across treatments. The most frequent offer in the Dictator is 40, the minimum possible. Adding just rewards leaves the modal offer at 40, but greatly increases the variance in offers. A sizable minority of people, 10 percent, actually share everything by offering 240 (and hence raise the average in this treatment). But, except for this small group of generous individuals, most of the proposers actually behave as in the dictator game. This indicates that for most subjects, rewards alone are not effective. The Stick treatment, however, moves the behavior dramatically. The modal offer is now 120, with virtually no offers above 120. Hence, punishments can move people from the selfish to the equitable offer. Finally, the Carrot-Stick has a substantial effect, further increasing the mode all the way to 240, the maximum possible offer. Overall, the distribution of offers in the Carrot-Stick treatment first-order stochastically dominates that of the three other treatments. Thus, while

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<sup>17</sup>The data for the last five rounds is similar, with 146 for Carrot-Stick, 118 for Carrot, 95 for Stick, and 82 for Dictators.

adding rewards only had little effect, adding rewards to punishments has a profound effect. In other words, rewards and punishments seem to act as complements in encouraging proposers to increase their offers.

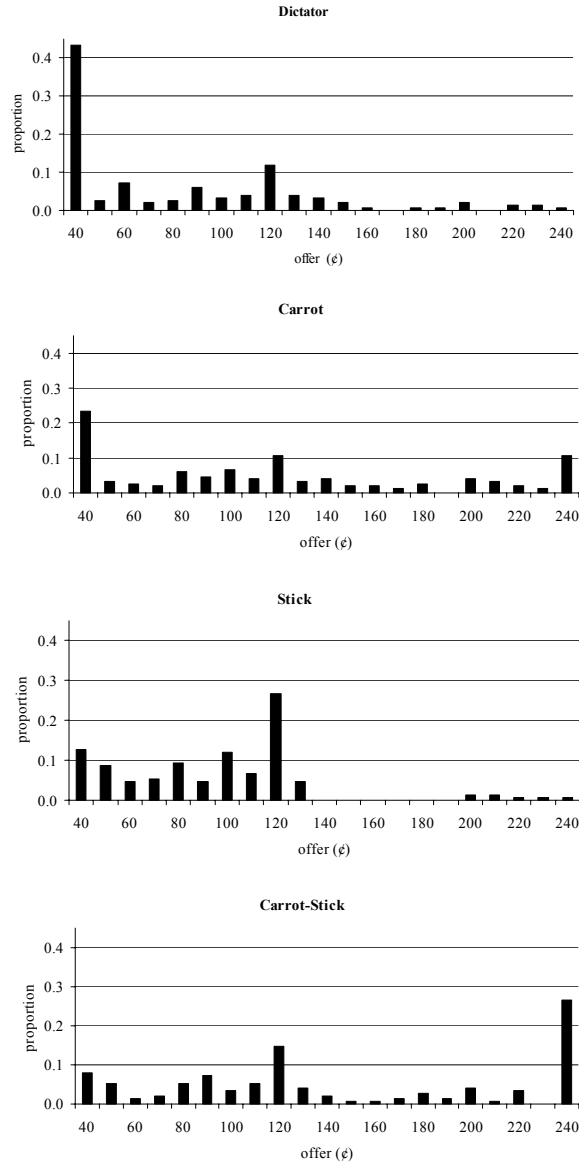


Figure 4: Distribution of Offers for Last 5 Rounds



### 4.3 Demands for Punishments and Rewards

Punishments and rewards are common. More than half of the offers in excess of 120 result in an increase in the proposer’s payoff, and more than 40 percent of the offers below 120 result in a decrease in the proposer’s payoff.<sup>18</sup> In this section we examine how these punishments and rewards differ with proposals as well as with the treatment.

Look first at punishments in the Carrot-Stick and Stick treatments. The demands for punishments during the last five rounds are shown in Figure 5. First note that the average punishment decreases with the size of the proposer’s offer. This is similar to the ultimatum game, where the cost of punishing is not independent of the offer. Second, the decrease in punishment is rather steep—after the equal split there are essentially no punishments. Of the offers of 120 approximately 15% result in some decrease in the proposer’s payoff.<sup>19</sup> Finally, the responder’s ability to reward has limited effect on the demand for punishments.<sup>20</sup> The punishments of medium-sized offers are the same across treatment, and although the punishments of low

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<sup>18</sup>Across all ten periods the proportion of offers above 120 that are rewarded is 54 percent in the Carrot and 59 percent in the Carrot-Stick. Of offers below 120 the proportion rewarded is 31 percent in Carrot and 11 percent in Carrot-Stick. Of offers below 120 the proportion punished is 43 percent in the Stick and 51 percent in the Carrot-Stick, and of offers above 120 the proportion punished is 8 percent in the Stick and 2 percent in the Carrot-Stick.

<sup>19</sup>During the last five rounds the proportion of 120-offers punished is 17% in the Stick and 13% in the Carrot-Stick.

<sup>20</sup>We use a conservative approach to labeling observations as censored when testing if the demand for punishment depend on the availability of rewards. We denote any observation that results in zero payoffs to the proposer, and any observation where the responder chose not to change the proposer’s payoffs as censored. Using a random effects model for censored data we regress the truncated demand for punishments on the offer, a dummy for the Stick treatment, and an interaction between the two, and account for censoring as described above. Looking across all ten rounds, or just the last five rounds, we cannot reject the hypothesis that the demands for punishments are the same across treatments. As expected an increase in the proposer’s offer significantly decreases punishments.

offers appear larger in the Carrot-Stick treatment, this difference is only significant at the end of the experiment.<sup>21</sup> This finding is surprising. One would not expect rewards of small offers, yet it is for small offers that the availability of rewards appears to affect the demand for punishments.

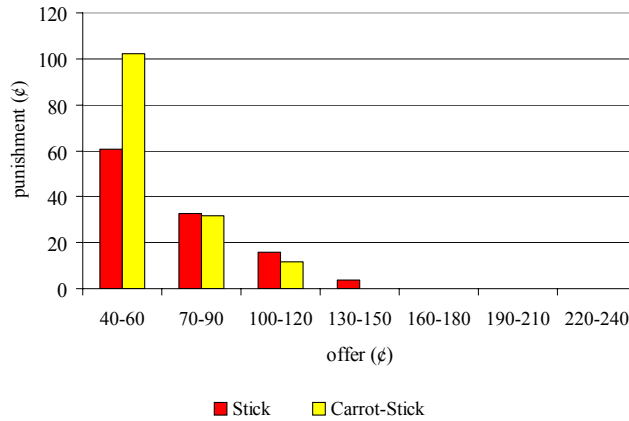


Figure 5: Average Punishments for Last 5 Rounds

Next we examine the demand for rewards in the Carrot-Stick and Carrot treatments. The demands for rewards in the last five rounds are shown in Figure 6. Similar to the evidence from the trust game, a higher offer on average leads to a larger reward. But the data reveal a result which one may not have expected based on the results from trust games: average rewards at or below equal-split offers are quite substantial.<sup>22</sup> Another puzzling finding is the substantial difference in the demand for rewards between the Carrot

<sup>21</sup>Counting each responder as an observation we test if the option of rewarding increases average punishments of low offers. Across the last five rounds the  $p$ -value of the test is 0.21, and for the last round the  $p$ -value is 0.10. Note that in each of the last five rounds the punishment of low offers exceeds that observed in absence of rewards.

<sup>22</sup>Such choices cannot be revealed in the trust game, where all transfers result in the responder receiving more than half the pie.

and Carrot-Stick treatments.<sup>23</sup> Conditional on the offer, the average reward given in the Carrot treatment is larger than in the Carrot-Stick treatment.<sup>24</sup> Even for very large offers, where we know there is no demand for punishment, we see that the absence of the ability to punish results in substantially larger average rewards.

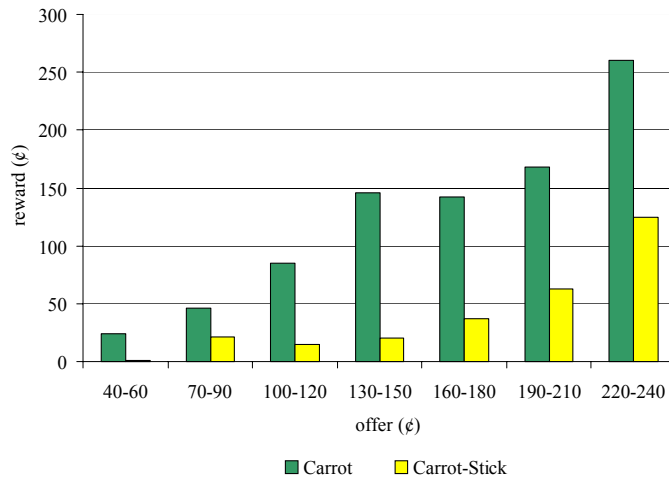


Figure 6: Average Rewards for Last 5 Rounds

While punishments are unaffected by the availability of rewards, we find that the rewards are larger when there is no option of punishing. Note that

<sup>23</sup>To determine if the responders' demands for rewards change when punishments are available, we take a conservative approach to labeling observations as censored. We denote any observation that results in zero payoffs to the responder, and any observation where the responder chose not to change the proposer's payoffs as censored. Using a random effects model we regress the truncated demand for rewards on the offer, a dummy for the Carrot treatment, and an interaction term between the two, and account for censoring as described above. The joint hypothesis that there is no effect from the punishment option is rejected with a  $p$ -value of 0.04 over the ten rounds, and 0.03 over the last five rounds. As expected an increase in the proposer's offer significantly increases rewards.

<sup>24</sup>Treating each responder as an observation we test if the average reward is larger in the Carrot. The  $p$ -values for the last five rounds and for each of the seven offer ranges are from smallest offer to largest: 0.04, 0.30, 0.07, 0.03, 0.12, 0.17, and 0.05. The insignificant results are generally found for offers where there are fewer observations.

it is the combination of these results that makes them puzzling. If one were presented simply with the reward results, then it might be tempting to argue that the difference is caused by a simple substitution effect. Suppose that rewards and punishments are viewed as substitutes, then it may be that the demand for either one is decreasing in own cost and increasing in the cost of the other input, i.e.,  $\frac{\partial p}{\partial c_p} < 0$  and  $\frac{\partial p}{\partial c_r} > 0$ , and similarly  $\frac{\partial r}{\partial c_r} < 0$  and  $\frac{\partial r}{\partial c_p} > 0$ . If a particular offer is perceived in a similar way across treatments, then excluding one of these substitutable tools simply suggests that rewards should be larger in the Carrot than in the Carrot-Stick treatment,  $r_C(\pi_R) > r_{CS}(\pi_R)$ . That is, if subjects are limited to only using one of two tools, then they may use the available tool more. In contrast to our experimental evidence, this also implies that the demands for punishments will be larger in the Stick than in the Carrot-Stick treatment,  $p_S(\pi_R) > p_{CS}(\pi_R)$ . Therefore a simple substitution argument cannot explain the combined results.

To summarize, holding cost constant we see the expected result that an increase in the proposer's transfer on average decreases the punishment and increases the reward. But we also see three unexpected results. First, the rewards of small offers are substantial; second, rewards are larger when there is no punishment option; and third, the reward option has little effect on the demand for punishments. To shed light on what motivates these demands we will next examine the distribution of final payoffs and determine whether recent fairness models can help explain our findings.

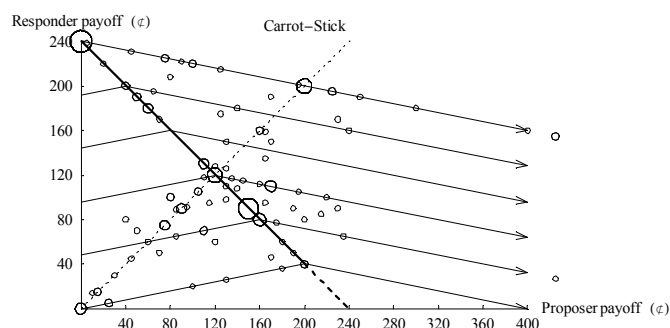
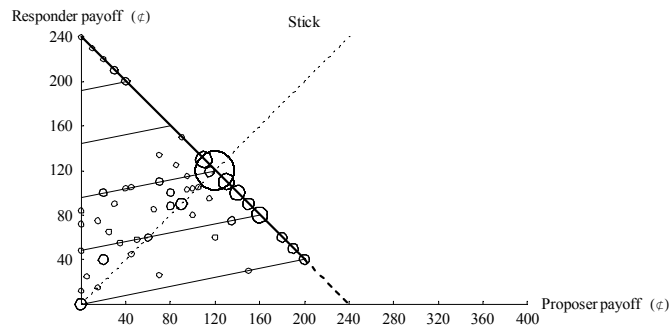
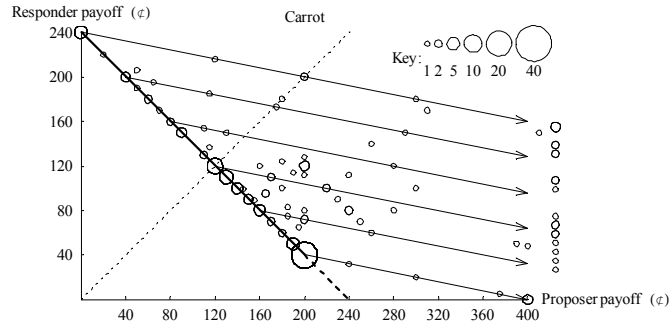


Figure 7: Final Payoff Distribution for Last 5 Rounds

#### 4.4 Understanding Motives for Rewards and Punishments

The substantial demand for rewards and punishments clearly demonstrates that subjects are not selfish, subgame perfect money-maximizers. What does our study suggest motivates these demands? The recent literature on fairness has suggested that individuals may benefit from getting close to some individual reference point for a preferred distribution of payoffs. If their current payoff standing is inferior to the reference point then they may wish to decrease the payoffs of others, while if it is superior to the reference point then they may prefer to increase the payoffs of others.

One way of assessing motives is to examine the payoff distributions in the Carrot, Stick, and Carrot-Stick treatments. Figure 7 shows the payoffs during the last five rounds in each of the three treatments. The bold line illustrates the set of possible proposals, and the thin lines illustrate the possible changes that the responders can choose when given a particular proposal. The circles illustrate the observations, where the area of the circle shows the number of observations as indicated by the key. Circles on the right edge of the figure indicate observations where the proposer's payoff exceeds \$4.00.

In the Carrot-Stick treatment, 90 percent of responders chose to either punish or reward at least one time, and 60 percent of all choices involved a punishment or reward. We also observe a substantial number of responders choosing outcomes that simultaneously decrease equality and decrease their personal payoff - areas II and IV of Figure 1. A total of 23 percent of the observations during the last five rounds are in this area, corresponding to more than half the subjects choosing at least one outcome which decreases

both their absolute and relative payoffs.

The substantial treatment differences between the Carrot and Carrot-Stick treatments are apparent when comparing the distributions of final payoffs. Relative to the Carrot-Stick treatment, the Carrot treatment shows much larger rewards overall, as well as larger rewards of low offers. Here 35 percent of all responses make relative payoffs more unequal, which corresponds to 70 percent of the subjects making at least one choice which decreases both their absolute and relative payoffs.

Comparing the outcomes of the Stick and the Carrot-Stick treatments reveals that more punishments in the Stick treatment result in a final outcome where the responder's payoff exceeds that of the proposer's. Thus, responses appear more extreme when only one tool is available.

Table 2 summarizes the extent to which equalizing payoffs may be a motive of our subjects. This table assigns subjects into one of three groups. First is responders who never changed the proposer's offer. We refer to this group as payoff maximizers. The second group consists of those who always either chose no change or a change that increased equality, i.e., outcomes in area I or III. We refer to this group as equalizers. The final group includes those who chose at least one outcome that makes payoffs more unequal, i.e., areas II and IV.

Table 2 reveals that, in each treatment, only a minority of the responders can be called equalizers, and the majority of subjects are often in the "other" category. Perhaps surprisingly, this suggests that a model, in which the motive or reference point is one of equal payoffs, will have difficulty capturing

our results.<sup>25</sup>

Table 2: Categorizing Responders by Motives,  
Percent of Subjects Per Condition

	Types		
	Payoff Maximizers	Equalizers I and III	Others II and IV
<hr/>			
All ten rounds			
Carrot	20	3	77
Carrot-Stick	7	20	73
Stick	33	23	43
<hr/>			
Last five rounds			
Carrot	23	7	70
Carrot-Stick	10	37	53
Stick	43	23	33

Other aspects of our findings may help point to a new direction. In particular, we find that the availability of punishments affects the demand for rewards, which is a finding that simple models of inequality-aversion would not predict. Another class of models looks at reciprocity, which suggest that an intentionally kind act may be rewarded and an unkind act punished.<sup>26</sup> Could these account for the result? Unfortunately, these models predict that conditional on the offer the proposer’s kindness is independent of the availability of rewards or punishments. Thus these models cannot explain the differences in demands.

It appears that only a model which allows for changes in the reference point across the three different treatments will be able to capture the puzzling interactions between rewards and punishments. The question is

<sup>25</sup>Examples of equity models are presented in Loewenstein, Thompson, and Bazerman (1989), Bolton (1991), Fehr and Schmidt (1999), and Bolton and Ockenfels (2000).

<sup>26</sup>See for example Rabin(1993) and Dufwenberg and Kirchsteiger (1998).



whether it is reasonable to assume that the reference point changes. In particular is it reasonable that the same offer be perceived differently across treatments? It certainly appears as if different norms may be present in the three games. For instance, in the Carrot-Stick treatment the offers first-order stochastically dominate those of the other treatments. Thus, for any given offer a larger fraction of offers exceed that offer in the Carrot-Stick game than in any of the other games. As a result, the same offer may be seen as less generous in the Carrot-Stick treatment than if it were made in the Carrot or Stick treatment. All else equal, this would result in smaller rewards and larger punishments in the Carrot-Stick treatment. Combined with the substitutability arguments this suggests that two opposing factors may be affecting the average demand for punishments. On one hand the absence of rewards may cause a substitution towards the punishment option, and on the other hand the lack of rewards may imply that a given offer is perceived as being more generous, suggesting less punishment. In contrast, both of these effects suggest larger rewards when there is no punishment option. Our findings are consistent with both of these effects.

## **5 Conclusion**

We have examined the demands for rewards and punishments and their effects on cooperation. We considered a simple proposer-responder environment with randomly rematched partners. In this way, our experiment allowed us to concentrate on the pure demands for rewards and punishments. By considering four conditions—punish or reward, reward only, punish only, and neither—we were able to identify the effect each has separately and

jointly.

We find, first, and perhaps surprisingly, that rewards alone are relatively ineffective in moving the modal offer away from the most selfish one possible. Second, punishments improved cooperation in that they eliminated extremely selfish offers, pushing proposers in the Stick treatment to modest degrees of cooperation. Combining rewards and punishments had a very strong effect. In this Carrot-Stick treatment the modal offer was the most generous one possible, often leading to rewards by responders. Even though generous offers were not punished, such generosity was only reached when the threat of punishments existed. This indicates that rewards and punishments act to complement one another and, even though only one can be used at a time, the availability of both tools leads to the greatest degree of cooperation.

In addition to this, we also found some surprising treatment effects in the responders' demands for rewards and punishments. While demands for punishments are unaffected by the availability of a reward option, we found that rewards are larger when there is no option of punishing. From the perspective of current theoretical models of fairness, the combination of these two findings is quite puzzling. An explanation may require that the definition of kindness changes systematically by treatment. Given the distribution of offers it may be that a particular offer is perceived as less kind in the Carrot-Stick treatment, than in the other treatments. This result suggests many productive areas for future research.

Finally, what do our results suggest about how fairness may shape economic institutions? While more work clearly needs to be done, cooperation

in our experiment is most successfully enforced in an environment in which both punishments and rewards are available. The process suggested by our data is that the stick can help by getting people to move away from perfect selfishness and to test the waters of cooperation. The carrot can then take over by encouraging further cooperation, rendering the stick a rarely used but important and necessary tool. Our results show that when devising incentive systems it is important to recognize that the absence of a reward is not equivalent to a punishment - it is important that both tools be present.

## References

- Andreoni, James and John H. Miller, "Giving According to GARP: An Experimental Test of the Consistency of Preferences for Altruism," *Econometrica*, 70, 2002, 737-753.
- Andreoni, James, Paul Brown, and Lise Vesterlund, "What Makes an Allocation Fair? Some Experimental Evidence," forthcoming, *Games and Economic Behavior*.
- Andreoni, James, Marco Castillo, and Ragan Petrie, "What do Bargainers' Preferences Look Like? Exploring a Convex Ultimatum Game," unpublished manuscript, 2000.
- Berg, Joyce, John Dickhaut, and Kevin McCabe, "Trust, Reciprocity, and Social Norms," *Games and Economic Behavior*, 1995, 10, 122-142.
- Binmore, Ken, Avner Shaked and John Sutton, "Testing Non-cooperative Bargaining Theory: A Preliminary Study," *American Economic Review*, 75, 1985, 1178-80.
- Bolton, Gary E. and Rami Zwick, "Anonymity versus Punishment in Ultimatum Bargaining," *Games and Economic Behavior*, 10, 1995, 95-121.
- Bolton, Gary E., "A Comparative Model of Bargaining: Theory and Evidence," *American Economic Review*, 81, 1991, 1096-1136.
- Bolton, Gary E., and Axel Ockenfels, "ERC, A Theory of Equity, Reciprocity and Competition," *American Economic Review*, 90(1), 2000, 166-193.
- Charness, Gary, and Matthew Rabin, "Some Simple Tests of Social Preferences," unpublished manuscript, 2000.
- Charness, Gary, "Attribution and Reciprocity in a Simulated Labor Market: An Experimental Investigation," unpublished manuscript, 1996.
- Charness, Gary and Ernan Haruvy, "Altruism, Equity, and Reciprocity in a Gift-Exchange Experiment: An Encompassing Approach," forthcoming *Games and Economic Behavior*.
- Charness, Gary, Ernan Haruvy, and Doron Sonsino, "Social Distance and Reciprocity: An Internet Experiment," unpublished manuscript, August 2000.
- Cox, James C. "Trust and Reciprocity: Implications of Game Triads and Social Contexts," unpublished manuscript, 2000.
- Dickinson, David, "The Carrot vs. the Stick in Work Team Motivation," unpublished manuscript, 1999
- Dufwenberg, Martin and Georg Kirchsteiger, "A Theory of Sequential Reciprocity," unpublished manuscript, 1998
- Dufwenberg, Martin and Uri Gneezy, "Measuring Beliefs in an Experimental

- Lost Wallet Game,” *Games and Economic Behavior*, 30, 2000, 163-182.
- Eckel, Catherine C. and Philip J. Grossman, “The Relative Price of Fairness: Gender Differences in a Punishment Game,” *Journal of Economic Behavior and Organization*, 30(2), 1996, 143-158.
- Eckel, Catherine C., and Philip J. Grossman, “Altruism in Anonymous Dictator Games,” *Games and Economic Behavior*, 16, 1996, 181–191.
- Falk, Armin and Urs Fischbacher, “A Theory of Reciprocity,” unpublished manuscript, 1999.
- Fehr, Ernst and Simon Gächter, “Cooperation and Punishment in Public Goods Experiments,” *American Economic Review*, 90, 2000, 980-994.
- Fehr, Ernst, and Klaus M. Schmidt, “A Theory of Fairness, Competition and Cooperation,” *Quarterly Journal of Economics*, 114, 1999, 817-868.
- Forsythe, Robert, Joel Horowitz, N.S. Savin, and Martin Sefton, “Fairness in Simple Bargaining Games,” *Games and Economic Behavior*, 6, 1994, 347–69.
- Güth, W., R. Schmittberger, and B. Schwarze, “An Experimental Analysis of Ultimatum Bargaining,” *Journal of Economic Behavior and Organization*, 3, 1982, 367-388.
- Kahneman, Daniel, Jack L. Knetsch, and Richard Thaler, “Fairness and the Assumptions of Economics,” *Journal of Business*, 59, 1986, 285–300.
- Loewenstein, George, Leigh Thompson, and Max Bazerman, “Social Utility and Decision Making in Interpersonal Contexts,” *Journal of Personality and Social Psychology*, 57, 1989, 426-441.
- McKelvey, Richard D. and Thomas R. Palfrey, “An Experimental Study of the Centipede Game,” *Econometrica*, 60, 1992, 803–836.
- Offerman, Theo, “Hurting Hurts more than Helping Helps,” unpublished manuscript, 2000.
- Rabin, Matthew, “Incorporating Fairness into Game Theory and Economics,” *American Economic Review*, 83, 1993, 1281–1302.
- Rabin, Matthew, “Bargaining Structure, Fairness, and Efficiency,” unpublished manuscript, 1997
- Sefton, Martin, Robert Shupp, and James Walker, “The Effect of Rewards and Sanctions in the Provision of Public Goods,” unpublished manuscript, 2000.

# Appendix

Claim Check Number \_\_\_\_\_

## INTRODUCTION

### Welcome

This is an experiment about decision making. The amount of money you earn will depend on the decisions that you and the other participants make. The entire experiment should take less than an hour, and at the end you will be paid privately and in cash for your decisions. A research foundation has provided the funds for this experiment.

### Your Identity

Your identity is secret. You will never be asked to reveal it to anyone during the course of the experiment. Your name will never be recorded by anyone. Neither the experimenters nor the other subjects will be able to link you to any of the decisions you make. In order to keep your decisions private, *please do not reveal your choices to any other participant.*

### Claim Check

Attached to the top of this page is a yellow piece of paper with a number on it. This is your Claim Check. Each participant has a different number. We use claim checks to maintain secrecy about your decisions, earnings, and identity. You will present your Claim Check to an assistant at the end of the experiment to receive your cash payment.

*Please remove your claim check now, and put it in a safe place.*

### How you make money

You will make 10 separate decisions in this experiment. For each decision you will be randomly paired with one other participant. Your earnings will depend on the decisions that you and the other participant make.

For each decision you will be randomly paired with a different participant. You will never play against the same participant more than once. In each pair, one participant will be known as the *Proposer*, and one participant will be known as the *Responder*. We will tell you at the start of the experiment whether you will be a Proposer or a Responder. Your role will be the same throughout the experiment.

Your decisions will be tallied by the computer. At the end of the experiment you will receive your cash payment in a sealed envelope so that no one but you knows how much you have earned.

*Please do not talk to other participants during the experiment.*

## This Experiment

The experiment takes place in two stages. In the first stage the *Proposer* proposes a split of \$2.40 (240 cents) between the *Proposer* and the *Responder*. When the *Proposer* has entered the decision into the computer, the computer will randomly match the *Proposer* with a *Responder*. The *Proposer*'s choice will be revealed to the *Responder*. The *Responder* will then choose to either **increase**, **decrease** or make **no change** to the *Proposer*'s earnings. It will cost the *Responder* to change the *Proposer*'s earnings, as we will explain below. When the *Responders* have entered their decisions this round is finished, and the computer calculates the earnings for the two participants. The computer will inform you of the outcome of your decision. No one will be told the decisions or earnings associated with pairs other than their own.

## Proposal Stage

If you are a *Proposer*, you will propose an allocation of 240 cents between yourself and the *Responder*. You have to allocate at least 40 cents to the *Responder*. Remember that this proposal may not be the final allocation: the *Responder* is able to either **decrease** or **increase** the *Proposer*'s allocation in the second stage, if he or she wants to. Once the *Proposer* has proposed a split of the 240 cents, the *Responder* can adjust *Proposer*'s Earnings.

## Response Stage

The *Responder* determines how to respond to the proposed allocation of the *Proposer*. There are three basic choices: the *Responder* can **increase**, **decrease**, or make **no change** to the *Proposer*'s earnings. The responder has to pay a cost to adjust the *Proposer*'s earnings.

That is the *Responder* must decide to do **one** of the following:

- (1) Make **no change** in the *Proposer*'s earnings, in which case the *Proposer*'s and the *Responder*'s payoff are the same as in the proposed allocation.
- (2) **Increase** the *Proposer*'s earnings, in which case the *Responder*'s payoff **decreases** by 1 cent for every 5 cent **increase** in the *Proposer*'s earnings.
- (3) **Decrease** the *Proposer*'s earnings, in which case the *Responder*'s payoff **decreases** by 1 for every 5 cent **decrease** in the *Proposer*'s earnings.

Note that whether the *Responder* chooses to increase or decrease the *Proposer*'s earnings, it costs the *Responder* 1 cent for each 5 cent change that he/she makes to the *Proposer*'s payoff. Please see the attached table for samples of the changes that you can make as a responder.

## Sample Decisions

We will now go through an example to help you understand the experiment. This example is meant to improve your understanding, and is not intended to guide you toward making any particular decision.

### *Example 1:*

Suppose the Proposer offers to keep 120 cents and give 120 cents to the Responder. In response to this offer the Responder decides to increase the Proposer's payoff by 90 cents. It costs the Responder 1 cent for each 5 cent increase in the Proposer's earnings, hence this decision will cost the Responder  $90/5 = 18$  cents, and the Responder's earnings are  $120 - 18 = 102$  cents (\$1.02). The Proposer's earnings are  $120 + 90 = 210$  cents (\$2.10)

### *Example 2:*

Suppose once again that the Proposer offers to keep 120 cents and give 120 cents to the Responder, however the Responder now decides to decrease the Proposer's payoff by 90 cents. It costs the Responder 1 cent for each 5 cent decrease in the proposer's earnings, hence this decision will cost the Responder  $90/5 = 18$  cents, and the Responder's earnings are  $120 - 18 = 102$  cents (\$1.02). The Proposer's earnings are  $120 - 90 = 30$  cents (\$0.30)

### *Example 3:*

Finally, suppose the Responder makes no change to the 120 cent offer. In this case the Proposer's earnings are 120 cents, and the Responder's earnings are 120 cents.

## A Brief Review of the Experiment

You will be either a *Proposer* or a *Responder*. The *Proposer* makes a proposal to split the 240 cents, allocating a certain number to him or herself and the rest to the *Responder*. The *Responder* then gets a chance to change the *Proposer's* offer. The *Responder* can **increase**, **decrease**, or make **no change** to the *Proposer's* payoff. Every 5 cent change the *Responder* makes to the *Proposer's* allocation reduces the *Responder's* own allocation by 1 cent. The *Responder's* change, if any, is final and determines how much money both people get.

To make sure that you understand these instructions we will now ask you to fill out a brief quiz. Please be sure that the claim check number on your quiz is the same as that on your claim check.