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Hierarchial structures in modern corporations and the incentives generated by them have all the characteristics of a rank order tournament. As the organizational pyramid narrows, workers compete for a smaller and smaller set of promotions. Only top–ranked agents move to the next level. When the organization treats identical agents equally, tournaments are symmetric, and their unique pure strategy equilibrium defined by each stage of the hierarchy (taken in isolation) dictates that all agents exert equal amounts of effort. At the equilibrium, chance determines who gets promoted. Rank order tournaments were studied theoretically by Lazear and Rosen (1981), Green and Stokey (1983), Nalebuff and Stiglitz (1983), and O'Keeffe, Viscusi, and Zeckhauser (1984). Bull, Schotter and Weigelt (1987) (BSW 1987) studied symmetric rank order tournaments experimentally and found that <u>on average</u> subjects in such symmetric tournaments behaved as predicted by the theory.[1]

Tournaments can be asymmetric in two ways. Using the terminology of O'Keeffe et.al. (1984) a tournament is "uneven" if agents have different preferences or costs i.e., if agents have different cost–of–effort functions. In "unfair" tournaments agents are identical but the rules favor one of them; for example, in order to be promoted or receive a bonus, an agent's output must exceed another's by some fixed amount, k. One question that immediately arises is how these two types of asymmetries affect agents' behavior. We find the answer to this question depends on the degree and the type of asymmetry. In short, in uneven laboratory tournaments, the behavior of subjects conforms to the theory if the degree of disadvantageousness is not too severe. If the asymmetry is severe, however, then one of two things happen. Either the disadvantaged agents "drop out" and supply zero effort, or they oversupply it, i.e. supply more effort than predicted by the Nash equilibrium. In unfair laboratory tournaments there is also

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[1]The term <u>on average</u> means that while the mean effort level of subjects converged to its theoretical mean as the experiment was iterated, the variance of effort levels chosen remained substantial. Hence there was only a weak form of substantiation for the theory.

a general tendency for subjects to oversupply effort. As a general rule across all of our experiments, subjects seem to oversupply effort; in the sense that, except in severely uneven tournaments, effort levels are at least as high as predicted equilibrium levels and rarely, if ever, below them. We call this result the "oversupply phenomenon".

Society has enacted different forms of social policies to remedy these types of asymmetry. For instance, an unfair tournament is one in which equals are treated unequally by the (explicit or implicit) rules of the tournament. Predjudice leads to preferential treatment for certain types of workers; i.e., a discriminated against group member's performance must exceed the performance of a member of the favored group by k in order for the discriminated against member to win the big prize (get a promotion). In such situations, society has forced tournament organizers (employers) not to favor one group of subjects (i.e. $k = 0$) through the use of equal opportunity laws.

Uneven tournaments are different: here, one group of agents within the organization may have a higher cost of effort than another. This differential might result from historical discrimination against a group which manifests itself in lower levels of education and hence lower levels of human capital acquisition. Because of these lower levels, work becomes more onerous and effort more costly. To compensate for previous societal discrimination, organizations institute affirmative action programs. In effect, these programs induce unfair tournaments by using unfair rules ($k > 0$) to give cost disadvantaged groups preferential treatment. In short, equal opportunity laws force tournament organizers to run symmetric tournaments, while affirmative action programs define unfair, uneven tournaments so that the rules favor cost disadvantaged groups.

In this paper we investigate the behavioral impact of these interventions. We find that in the laboratory both interventions do increase the probability of winning for disadvantaged groups. Further, equal opportunity laws are quite effective in increasing the effort levels of subjects and hence the profits of the tournament organizer. The results of affirmative action programs are mixed. Affirmative action programs reduce the effort levels of both types of agents (and hence the profits of the tournament organizers) when the degree of cost disadvantageouness is not too severe. However, when the degree of cost disadvantageousness is great, these programs significantly increase effort levels (and hence profits) because while cost disadvantaged subjects tend to "drop–out" and supply zero effort in extremely uneven tournaments, no such drop out behavior is seen after an affirmative action program is instituted.

We proceed as follows: In Section 2 we review the theory of symmetric and asymmetric tournaments and present the relevant characteristics of the equilibria of the games they define. In Section 3 we present our experimental design. Experimental results are presented in Section 4 along with a discussion of the oversupply phenomenon for unfair tournaments discussed above. The results of our equal opportunity laws and affirmative action programs are presented in Section 5. Finally, in Section 6 we offer concluding comments and discuss implications of our results.

Section 2: Tournaments and their Equilibria

Consider the following two–person tournament. Two identical agents i and j have the following utility functions that are separable in the payment received and the effort exerted.

$$u_i(p,e) = u(p) - c(e), \qquad (1)$$
$$u_j(p,e) = u(p) - \alpha c(e),$$

where p denotes the nonnegative payment to the agent, e, a scalar, is the agent's nonnegative effort, and $\alpha > 1$ is a constant. Note that agent j's costs are α times those of agent i, $\alpha > 1$. The positive and increasing functions u(.) and c(.) are, respectively, concave and convex. Agent i provides a level of effort that is not observable and which generates an output y_i according to,

$$y_i = f(e_i) + \epsilon_i, \qquad (2)$$

where the production function f(.) is concave and ϵ_i is a random shock.[2] Agent j has a similar technology and simultaneously makes a similar decision. The payment to agent i is $M > 0$, if $y_i > y_j + k$, and $m < M$ if $y_i < y_j + k$, where k is a constant.[3] A positive k indicates that j is favored in the tournament while a negative k indicates that i is favored. Agent j faces the same payment scheme. Given any pair of effort choices by the agents, agent i's probability of winning M, $\pi^i(e_i,e_j,k)$, is just equal to the probability that $(\epsilon_i - \epsilon_j) > f(e_j) - f(e_i) + k$. Thus i's expected payoff from such a choice is,

$$Ez^i(e_i,e_j) = \pi^i(e_i,e_j,k)u(M) + [1-\pi^i(e_i,e_j,k)]u(m) - c(e_i),$$

while agents j's is (3)

$$Ez^j(e_i,e_j) = \pi^j(e_i,e_j,k)u(M) + [1-\pi^j(e_i,e_j,k)]u(m) - \alpha c(e_j)$$

The above equations specify a game with payoffs given by (1) and a strategy set E given by the set of feasible choices of effort. The theory of tournaments restricts itself to the pure strategy Nash equilibria of this game. If the distribution of $(\epsilon_i - \epsilon_j)$ is degenerate either because there are no random shocks to output or because such shocks are perfectly correlated across agents, and k is not too large, then the game has no pure strategy Nash equilibrium.

With suitable restrictions on the distribution of the random shocks and the utility functions a unique, pure strategy Nash equilibrium will exist. This is the behavioral outcome predicted by the theory of tournaments. Testing the theory requires the specification of the utility function, the production function, the distribution of $(\epsilon_i - \epsilon_j)$ and the prizes M and m. One simple specification is the following.

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[2]O'Keeffe et.al (1984) point out that one can interpret the random shock not only as true randomness in the technology but alternatively as random measurement error in the principal's monitoring of output.

[3]Some rule is necessary to deal with cases in which $y_i = y_j + k$. For simplicity of exposition we ignore this possibility.

$$U_i(p_i,e_i) = p_i - e_i^2/c \qquad (1')$$
$$U_j(p_j,e_j) = p_j - \alpha e_j^2/c$$

$$y_\ell = e_\ell + \epsilon_\ell, \quad \ell = 1, j \qquad (2')$$

where $c > 0$ and ϵ_1 is distributed uniformly over the interval $[-a, a]$, $a > 0$, and independently across the agents. e_i and e_j are restricted to lie in [0, 100]. In this particular case, the agents' expected payoff in the tournament is given by,

$$Ez_i(e_i,e_j) = m + \pi^i(e_i,e_j,k)[M-m] - e_i^2/c \qquad (3')$$
$$Ez_j(e_i,e_j) = m + \pi^j(e_i,e_j,k)[M-m] - \alpha e_j^2/c$$

If a pure strategy Nash equilibrium exists and is in the interior of [0, 100], each agent's first order condition must be fulfilled,

$$\frac{\partial Ez_i}{\partial e_i} = \frac{\partial \pi(e_i^*,e_j^*,k)}{\partial e_i}[M-m] - 2e_i^*/c = 0$$

$$(4)$$

$$\frac{\partial Ez_j}{\partial e_j} = \frac{\partial \pi(e_i^*,e_j^*,k)}{\partial e_j}[M-m] - \alpha 2e_j^*/c = 0$$

The concavity of the agent's payoff function ensures that (4) is sufficient for a maximum.[4]

Given the distributional assumptions on ϵ_i and ϵ_j, the probability of winning functions with $k > 0$ can be shown to be,

$$\pi^j(e_i,e_j,k) = 1/2 + (e_j-e_i+k)/2a - (e_j-e_i+k)^2/8a^2 \qquad (5)$$
$$\pi^i(e_i,e_j,k) = 1/2 + (e_i-e_j-k)/2a + (e_i-e_j-k)^2/8a^2$$

with,

$$\frac{\partial \pi^j(.)}{\partial e_j} = \frac{1}{2a} - \frac{(e_j-e_i+k)}{4a^2} \qquad (6)$$

4Naturally we must check for a corner solution.

$$\frac{\partial \pi^i(.)}{\partial e_i} = \frac{1}{2a} + \frac{(e_i - e_j - k)}{4a^2} \tag{7}$$

Plugging (6) and (7) into (4) and solving for e_i^* and e_j^*, we find,

$$e_j^* = \frac{[(1/2a)-(k/4a^2)]\ (c(M-m)/2\alpha)}{1 + [(1-\alpha)/4a^2]\ (c(M-m)/2a)}$$

$$e_i^* = \alpha e_j \tag{8}$$

When $k = 0$ and $\alpha = 1$, (8) defines the equilibrium of a symmetric tournament with

$$e_i^* = e_j^* = \frac{c(M-m)}{4a}. \tag{9}$$

When $\alpha = 1$ and $k > 0$, (8) defines the equilibrium of an unfair tournament with

$$e_i^* = e_j^* = [(1/2a)-(k/4a^2)]\ (c(M-m)/2) \tag{10}$$

Note that despite j's advantage, at equilibrium both agents choose the same effort levels. Finally, when $\alpha > 1$ and $k = 0$, (8) defines the equilibrium of an uneven tournament,

$$e_j^* = \frac{c(M-m)/4a\alpha}{1+[(1-\alpha)/4a^2](c(M-m)/2a)}$$

$$e_i^* = \alpha e_j \tag{11}$$

To investigate the effects of an affirmative action program we need only compare the equilibrium of an uneven tournament ($\alpha > 1$, $k = 0$) (equation 11) to that of an appropriately defined affirmative action tournament ($\alpha > 1$, $k > 1$) (equation 8). Imposing an affirmative action program upon a previously uneven tournament leads to lower equilibrium effort levels for the new rules advantaged (but cost disadvantaged) agent. Since the cost advantaged agent's effort is proportional to this effort level, both efforts drop. For most realistic sets of parameters, and all those investigated here, these decreases in effort levels increase the probability of cost disadvantaged agents receiving M. Hence, the impact of an affirmative action program upon a previously uneven tournament is; lower equilibrium effort levels for both agents, lower profits for the tournament organizer, and an increased probability of winning for cost disadvantaged agents.

To investigate the effect of equal opportunity laws we need merely compare equations (9) and (10). Here the ceteris paribus removal of discrimination (reduction of k from $k > 0$ to $k = 0$) increases the equilibrium effort levels of both agents and hence the profits of the tournament organizer. Again, the probability of winning for the discriminated against agent increases. However, equal opportunity laws can decrease the welfare of discriminated against agents because these agents are expected to exert more effort at equilibrium. A negative welfare gain can result if the cost of this increased effort exceeds the expected benefits of winning. Welfare gain is, of course, always expected to be negative for previously favored agents.

Section 3: The Experiment

3.1: Uneven Tournaments

We recruited subjects from economics courses at New York University. As they entered the room, they each chose 20 envelopes from a pile of 1000. Each envelope had a random number enclosed in it that was generated from a uniform distribution over the integers between $-a$ and $+a$ (including 0). Subjects were randomly assigned seats, subject numbers, and another subject as their "pair member". The physical identity of the pair member was not revealed. We told subjects that the money amount they earned was a function of their decisions, their pair member's decisions, and the realization of a random variable. Subjects were then given written instructions with payoff sheets and two cost–of–effort functions; one function indicated the subject's costs and the other that of their pair member. (See Appendix A for a sample of this material). Hence, it was common knowledge that one subject in each pair was cost advantaged relative to his pair member.

The experiment then began. Each subject was asked to pick an integer between 0 and 100 (inclusive), called their "decision number", and to enter their choice on the work sheet. Corresponding to each decision number was a cost listed in their cost–of–effort function table. These functions took the form $c(e_i) = e_i^2/c$, $c(e_j) = \alpha e_j^2/c$, $\alpha > 1$, where c was a scaling factor used to insure that payoffs were of reasonable size, and α was the disadvantageousness parameter indicating how much higher the disadvantaged agent's effort cost was. After subjects recorded their decision numbers, they opened one of their envelopes containing a random number. Subjects entered this random number on their work sheet, and added it to their decision number to yield a "total number" for that round. This information was recorded on a slip of paper which we then collected. We compared the total numbers for each subject pair and announced which member had the highest total in each pair.[5] The pair members with the highest and lowest total numbers were awarded, respectively, "fixed payments" M and m, $M > m$. Subjects then calculated their payoff for the round by subtracting the decision number cost from the fixed payment. Notice that all of the tournament's parameters, though not the physical identity of each subject's pair member, were common knowledge.

When subjects completed a round and recorded their payoffs, the next round began. All rounds were identical. Each group of subjects repeated this procedure for 20 rounds.

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[5]If both members of a pair had the same total number then a coin was tossed to decide which pair member was to be designated as having the highest total number.

After subjects completed the last experimental round, they calculated their payoffs for the entire experiment by adding up their payoffs for the twenty rounds and subtracting $7.00. Experiments lasted approximately seventy five minutes and subjects earned between $7.02 and $23.85 (mean earnings equalled $15.41). These incentives seemed more than adequate.[6]

These experiments replicated the simple examples of tournaments given in the previous section. The decision number corresponds to effort, the random number to the random shock to productivity, the total number to output, and the decision cost to the disutility of effort.

3.1b: Unfair Tournmaments

In unfair tournaments, the experiment run was identical to the one described above except that all subjects had identical cost function and one subject had to realize an output k units greater than his pair member before he/she would earn the bigger fixed payment. This subject was disadvantaged.[7] The magnitude of k was common knowledge as were subjects' cost functions.

Several points need to be made about our experimental procedures. First, great efforts were made in the instructions never to use value–laden terms. For instance, instead of calling subjects with high total numbers "winners" we simply called them "high number people". Similarly, M and m were never called "prizes" but simply "fixed payments". We wanted to remove any possible emphasis on the experiment's game–like nature and reduce the possibility that winning might affect subject decisions independently of their payoffs. However, as is shown in Section 4.4, despite our efforts

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The subjects were informed of this tie–breaking procedure before the experiment began.

[6]To check that these incentives were adequate, BSW (1987) ran our baseline experiment with payoffs quadrupled so that subjects could, and did, win over $40. The results of the experiment did not differ substantially from the baseline.

[7]See Appendix B for sample instructions.

agents exhibited an apparently irreducible taste for winning. Second, subjects performed the experiment once and with only one set of parameters so that no carry—over effects from previous sets of parameters could occur. Third, in recruiting subjects we took steps to minimize subject contamination. For instance we recruited from each class only once to try to minimize experienced/new subject communication.

Although the theory of tournaments deals with one—shot rather than repeated tournaments, the experimental tournaments were repeated 20 times. We did this because the subjects' decision task was quite complex and so the first few decisions might have been error ridden simply because subjects had not understood fully the problem they faced. Such repetition is common experimental practice. Our experimental design does introduce dynamic elements into a test of a static theory. However, the only subgame perfect Nash equilibrium to the 20 round repeated game involves the choice of Nash equilibrium effort levels to the one—shot game in each round. Thus the theory's predictions for the experimental game are independent of finite repetition.

3.2: Choosing Parameters

Experimental parameter choice was restricted first of all by equations (8) through (11): These equations indicate the relationship between equilibrium effort levels and parameter choices. A more severe constraint on our parameter choice was that while equations (8) — (11) present necessary conditions for an interior equilibrium, they do not rule out the existence of corner solutions in which the subject predicted to choose the lower effort level finds it more advantageous to choose zero and "drop out".

3.3: Experimental Design

We performed seven separate experiments to investigate the impact of tournament asymmetries on the behavior of laboratory subjects. Experimental parameters are presented in Table 4. Each experiment differs from some other by a ceteris paribus change in just one parameter. Hence, comparisons of results between relevant experiments are not confounded by simultaneous parameter changes. Experiment 1 is a symmetric baseline experiment: equilibrium requires that both subjects choose effort levels of 73.75. To investigate the impact of unfairness in this tournament, we changed its rules in Experiments 2, and 3, to require that one subject have output levels which exceed their pair member's by at least 25, and 45 respectively, before he (or she) could win the big fixed amount. Since this is the only experimental parameter changed, comparisons to the baseline demonstrate the impact of the discrimination treatment in isolation.

Experiments 4 and 5 investigate unequal tournaments in that these tournaments are identical to the baseline except that the costs of one pair member is a multiple α of the other's. In Experiment 4 $\alpha = 2$ and in Experiment 5 $\alpha = 4$. Finally, Experiments 6 and 7 present our laboratory version of affirmative action programs. In Experiment 6 we take the parameters of Experiment 4 with $\alpha = 2$ and introduce a $k = 25$ favoring the cost disadvantaged subject. In Experiment 7 we have $\alpha = 4$ and $k = 25$. Equal opportunity laws are replicated by comparing the results of Experiment 1 (the symmetric baseline) with Experiments 2 and 3.

Section 4: Results

Experimental results are presented in Figures 4.1–4.7, and Tables 4.1 and 4.2. Figures 4.1–4.7 present the period by period mean effort levels chosen by each type of subject in our seven experiments. Table 4.1 presents the mean and variances of these effort levels in the first half and second half of each experiment (i.e., in periods 1–10 and 11–20). It also shows the final period means and variances. Table 4.2 presents the predicted and observed effort levels, probability of winning, total tournament effort, and mean payoffs for the seven tournaments. To avoid problems of terminal effects, we will use the pooled data from the last 10 rounds of the experiments for purposes of statistical tests. To further our discussion, we separate our analysis first into an investigation of symmetric and then of unfair and uneven tournaments. Section 5 follows with a discussion of the impact of affirmative action programs and equal opportunity laws .

4.1: Symmetric Tournaments

In short, the results of our symmetric baseline experiment are in conformity to those previously reported by BSW (1987) where we demonstrated that for a variety of parameter values, symmetric tournaments are robust in their ability to yield behavior consistent with the predictions of the theory. This baseline replicates the results of BSW (1987) with our new set of parameter values. Figure 4.1 demonstrates this fact. While the theory predicts that all subjects choose effort levels of 73.75, we observe a mean effort level in rounds 11–20 of 77.9. In addition, in no round was the observed mean effort level more than 9 decision numbers different than that predicted, while the mean deviation from the predicted mean was only 5.3 over the last 10 rounds. For rounds 11–20, we conducted a Wilcoxon signed rank test for every round, and could not reject the hypothesis that observed effort levels came from a population with a mean of 73.75 in any round.[8] [9]

4.2: Unfair Tournaments

We ran two tournaments to test the effects of unfairness. In general, unfair tournaments' effort levels tend to be equal to or above those predicted. For instance, the mean effort levels chosen by subjects of both types over the last 10 rounds of Experiments 2 and 3 were at least as great as those predicted by the theory. While the

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[8]The Wilcoxon signed rank test requires that the distribution from which the data was drawn was symmetric. Using a Kolmogorov–Smirnov test, we could not reject the hypothesis that the data in any round were drawn from a normal, hence, symmetric distribution. For a discussion of this procedure see Pratt and Gibbons (1981).

[9]All statistical tests in this paper use a significance level of 5%.

theory predicts effort level choices of 58.39 and 46.09 for both types of subjects in Experiments 2 and 3 respectively, in these experiments we observed effort level means over the last 10 rounds of 58.65 and 59.29 for disadvantaged subjects and 74.5 and 48.65 for advantaged subjects. Using the round by round data generated by the last ten rounds of each experiment, we conducted a Wilcoxon signed rank test. In Experiments 2 and 3, only in the case of advantaged subjects in Experiment 2 (mean effort level = 74.5), could we reject the hypothesis that the observed effort levels came from a population with the predicted mean. Furthermore, since the theory predicts equal effort levels for both advantaged and disadvantaged subjects, we tested whether this hypothesis was true. In Experiment 2, using a median test we could reject the hypothesis that the effort levels of advantaged and disadvantaged subjects were equal in each of the last 10 rounds, as in some rounds, advantaged subjects chose effort levels significantly higher than their disadvantaged counterparts. In rounds 11 – 20 of Experiment 3 (k = 45), we could not reject the hypothesis that the effort levels of advantaged and disadvantaged subjects were equal in any round. Figures 4.2–4.3 clearly demonstrate our conclusion. Figure 4.2 shows that in Experiment 2 (k = 25), the mean effort level of advantaged subjects is significantly above the predicted level of 58.4, while the mean effort level of disadvantaged subjects is only slightly higher than predicted (although in round 20 the mean effort levels are reasonably close). In Experiment 3 (k = 45) the mean effort level of both advantaged and disadvantaged subjects are slightly higher than predicted. Note that in these unfair tournaments, the observed mean effort levels of all subjects is higher than the predicted equilibrium effort level. Thus, in unfair tournaments subjects seem to "over–supply" effort.

This oversupply phenomenon has a number of consequences. First, because subjects supply effort levels above predicted levels, total tournament effort, which is predicted to be 116.8 and 92.2 respectively, rises to a mean of 133.15 and 107.94 over the last 10 rounds. Since the tournament cost to the principal is constant at M + m, the profits of a ficticious principal running this tournament would rise above their predicted values. Note though, that these effort levels (and hence profits of the principal) are significantly lower than those in the symmetric version ($k = 0$) of the same tournament (see Experiment 1). In terms of the probability of winning, it appears that due to the relatively greater oversupply of effort on the part of advantaged subjects, they had a higher than predicted probability of winning. For instance, in Experiment 2, while advantaged subjects were predicted to win with probability .687, their expected probability of winning given their observed effort levels was .898.[10] In Experiment 3 their expected probability of winning was .827 instead of the predicted .805

In summation, subjects in unfair tournaments tend to choose effort levels which are greater than predicted, but below those of an analogous symmetric tournament. However, because of the relative oversupply of effort by advantaged subjects their probability of winning increases. While the profits of tournament organizers are above those predicted, profits in unfair tournaments are still below those realized in the symmetric (fair) version of the same tournament.

4.3: Uneven Tournaments

While unfair tournaments led subjects to mutually oversupply effort, the results of uneven tournaments seem to bifurcate. If the degree of asymmetry is not too great ($\alpha = 2$), subjects tended to supply those effort levels predicted by the theory. In Experiment 4 ($\alpha = 2$) while the theory predicts effort levels of 74.26 and 37.13, we observed mean effort levels over the last 10 rounds of 78.13 and 37.06. Using a Wilcoxon signed rank test we could not reject the hypothesis that observed mean effort levels came from a population with the predicted means. In terms of the probabiilty of

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[10] These probabilities are calculated using the observed mean effort levels and equation (5).

winning, we again see consistency with the theory. While advantaged and disadvantaged subjects can expect to win M with probabilities .762 and .238 respectively, we observed expected winning probabilities of .79 and .21. Over the last 10 rounds, using a binomial test (corrected for continuity) these observations were not significantly different from predicted levels. Finally, since effort levels are at their equilibrium values, the profits of the tournament organizer are also.

When the degree of asymmetry is large (as in Experiment 5 $\alpha = 4$), however, then one of two things happened. Either a disadvantaged subject would "drop out" and supply approximately zero effort, or he would significantly oversupply effort.[11] Over the last ten rounds of Experiment 5 half the disadvantaged subjects (8 of 15) dropped out and had median effort levels ranging from 0 to 4 (mean 8.16) while the other half had median effort levels ranging from 20 to 50 (mean 30.24) which was above the predicted effort level of 19.02. This data is presented in Table 4.3.

Figures 4.8a and 4.8b show the period by period mean effort levels of tournament pairs in a split sample of those disadvantaged subjects who dropped out by period 20 and those who did not. The difference in behavior is clear. While over the first six rounds, the drop–outs chose mean effort levels approximately equal to those subjects who eventually did not drop out (27.2 v.s. 38.7), in periods 7–20 effort levels diverged significantly. In period 20 the mean effort levels of the seven subjects who dropped out was 2.4 while the mean for those who did not was 34.1 (significantly above the predicted level of 19.06 using a Wilcoxon signed rank test). The responses of their

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[11]An identical experimental result was found by Bull, Schotter, and Weigelt (1986) in an earlier unpublished set of experiments on this same topic. In those experiments the parameters were –– $M - m = .\$80$, $c = 25{,}000$, $a = 40$, and $\alpha = 4$. Final period mean effort levels for that half of the disadvantaged subject group that dropped out was 1.17 while for those who did not drop out it was 43.29. The predicted effort level is 14.3.

advantaged opponents was also interesting. The advantaged subjects paired with the non—drop out subjects had a mean effort level of 64.74 over the last ten rounds, while the advantaged subjects paired with the drop—outs had a mean effort level of 85.3. Surprisingly, the advantaged opponents of disadvantaged drop—outs continued to choose high effort levels even after their opponents dropped out.

This result becomes less surprising when one hypothesizes that perhaps it was the extremely aggressive play of opponents in early rounds that originally forced disadvantaged drop outs to become discouraged and drop out. This hypothesis is given support when we note that there was a difference in the win history between disadvantaged subjects who eventually dropped out and those that did not. While eventual non drop—outs won on average 28.7% of their tournaments in the first six rounds (with 3 of the 7 winning two or more), drop outs won only 8% of theirs. Since the cost—of—effort was quite high, these losses were costly and could easily have discouraged subjects. This experience may have made them sufficiently pessimistic and caused them to play their mini—max strategy of choosing zero, i.e., dropping out.

While in Experiment 4 the observed probability of winning was approximately that which was predicted, in Experiment 5 the story is more complex. While at equilibrium, disadvantaged subjects can expect to win the big fixed payment with probability .138 and receive an expected payoff of \$0.92, using the <u>total</u> sample of tournament pairs over the last ten rounds, we observed their expected probability of winning given their mean effort choices was .130 and their expected payoff \$0.92. However, the results were dramatically different when we break up the sample into drop—out and non drop—out pairs. For drop—out pairs the observed expected probability of winning for disadvantaged subjects was .09 and their expected payoff \$0.92. Their advantaged opponents could expect to win with probability .91 and had an expected payoff of \$1.53. For non drop—out pairs, we observed an expected probability of winning of .191

for disadvantaged subjects (.809 for advantaged ones). With these probabilities and efforts we expect payoffs of \$0.85 and \$1.53 for our non drop–out disadvantaged and advantaged subjects respectively. Consequently, dropping out, actually yielded higher payoffs (though a lower probability of winning) than not dropping out for disadvantaged subjects.

4.4: The Oversupply Phenomenon

Unlike other incentive programs, such as piece rates, tournaments have "winners" and "losers". Hence, if subjects receive utility from winning this could affect behavior and cause effort levels to diverge from that predicted since the theory only considers the monetary consequences of winning and losing. As can be seen from Figures 4.1–4.7, subjects in all experiments tended to supply effort at levels at least as great as those predicted. While such behavior apparently violates the theory it may not violate an extended version of the theory which generalizes the payoff functions of subjects to include the utility of winning. While we do not intend to offer such a generalized theory here, we do attempt to measure the revealed utility of winning exhibited by our subjects in symmetric tournaments.

Consider a subject i with a utility function $U^i(z_i(e_i,e_j),\pi(e_i,e_j,k))$, where $z_i(.)$ is i's monetary payoff function and $\pi(.)$ is the probability of winning function. Such a subject receives utility both from the monetary payoffs he receives and the winning probabilities determined by his and his opponent's actions. Given k, for any e_j one can define subject i's best monetary maximizing response. This is the effort level which, given k and e_j, maximizes his monetary return, assuming that he does not independently care about his probability of winning (i.e., he cares about it only so far as it affects his monetary payoff). If the response observed is greater than that predicted by his best monetary maximizing response, we can say that subject i exhibited a positive taste for winning since he demonstrated that he was willing to sacrifice some monetary payoff for the sake of increasing his chances of "winning" the tournament. To illustrate this taste for winning we took the data from the symmetric experiment (Experiment 1) and calculated for each subject in each round the amount of money he was willing to sacrifice in order to increase his probability of winning by 1% above what it would be at his best monetary maximizing response. For instance, for each subject i in each round, given his opponents effort choice, e_j, we calculated his best monetary maximizing effort choice. If π_i^B and U_i^B are the probabilities of winning and payoffs at i's best response to e_j, and π_i^o and U_i^o are their observed magnitudes in that round, then

$$\Delta_i = \frac{\pi_i^o - \pi_i^B}{U_i^B - U_i^o}$$

is a measure of i's taste for winning at e_j. To portray this taste for winning we calculated the mean of these Δ_i's as well as plotting their values for all subjects in all rounds 11 – 20 in Figure 4.9. On the horizontal axis, we placed the probability of winning at the best monetary maximizing best response to a subject's opponent's choice, and our taste measure, Δ, on the vertical axis. As we can see, subjects almost always exhibited a positive utility of winning. In those few instances where the measure is negative, it almost always respresents a switch of behavior by an opponent which a subject did not recognize immediately and hence did not respond to. Notice that while the taste for winning is positive, it tends to decline as the best response probability increases. Obviously, when a subject's chances of winning are sufficiently high at his best money maximizing response, his marginal utility of winning decreases.

As an alternative to measuring the taste for winning (Figure 4.9), Figures 4.10 and 4.11 present graphs depicting the best response probability of winning (monetary maximizing payoffs) of each subject to their oppponent's effort choice on the horizontal axis, and the observed probability of winning (observed monetary payoff) on the vertical. If people attempt to maximize their monetary returns only, we should observe all points along the 45° line. However, if they are deriving some positive utility from winning, we should observe all of the actual probabilities of winning (monetary payoffs) above (below) the 45° line. This is approximately what we do observe: In practically all cases subjects willingly to sacrifice monetary payments in order to increase their probability of winning. Such an observation is consistent with a taste for winning.

Section 5: Affirmative Action and Equal Opportunity

5.1: Equal Opportunity Laws

The impact of laboratory equal opportunity laws are investigated by comparing the results of Experiments 1 with those of Experiments 2 and 3. As indicated in Section 2, equal opportunity laws aim to symmetrize previously unfair tournaments by reducing k, the degree of unfairness, to zero. Since Experiments 1, 2, and 3 are identical except for changes in the k factor (i.e., in experiment 1, $k = 0$; in experiment 2, $k = 25$; in experiment 3, $k = 45$), a comparison of these experiments should be informative. Table 4.4 presents these results.

This table shows that the elimination of rule asymmetries increases the mean effort levels of subjects and hence increases their total output. This impact is greatest in those tournaments where the degree of unfairness is greatest. For instance, while the mean effort level of all subjects in the last ten rounds of Experiment 2 ($k = 25$) was 66.5, it was 77.9 during the last 10 rounds of the symmetric baseline experiment (Experiment 1). More dramatically, mean effort levels drop from a mean of 77.9 in Experiment 1 to a mean of 53.9 in Experiment 3 ($k = 45$). As a result, tournament output increases after the imposition of an equal opportunity law. Imposing equal opportunity laws also increases the probability of winning for previously disadvantaged groups. In moving from Experiments 2 and 3 to Experiment 1, the observed probability of winning for disadvantaged subjects increased from .102 in Experiment 2 and .173 in

Experiment 3 to a theoretical level of .500 in Experiment 1 (where no disadvantaged subjects existed). Finally, we can check whether despite their increased probability of winning disadvantaged subjects suffered a welfare loss after we imposed equal opportunity laws; we earlier noted that disadvantaged subjects could be worse off if the costs of their increased effort outweigh the benefits derived from higher probabilities of winning. This was not the case in either of our comparisons. In comparing the mean expected payoffs of all subjects in Experiment 1 to those of the disadvantaged subjects in Experiments 2 and 3 we see that these mean payoffs increase from $0.75 and $0.83 in Experiments 3 and 2 respectively to $1.09 in Experiment 1.[12]

In summation, it appears that our laboratory equal opportunity law increases the output of the tournament and hence the profit of the ficticious tournament organizer. In addition, it also increases the payoff and probability of winning for disadvantaged subjects. Previously advantaged subjects were obviously hurt by the imposition of such a law.

5.2: Affirmative Action

To investigate the impact of affirmative action programs we compared the results of Experiments 4 and 5 with the results of Experiments 6 and 7. In moving from Experiment 4 ($\alpha = 2$, $k = 0$) to Experiment 6 ($\alpha = 2$, $k = 25$) we are investigating an affirmative action program in which a tournament with an intermediate amount of cost asymmetry ($\alpha = 2$) is altered by imposing a rules change ($k = 25$). In moving from Experiment 5 to 7, we are investigating how the same affirmative action program would perform if the degree of previous cost asymmetry was greater (i.e., $\alpha = 4$). Clearly our point is to investigate whether the degree of previous societal discrimination matters in determining whether a given affirmative action program is successful.

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[12]Payoffs are expected in the sense that subjects should realize these payoffs based on their observed mean effort levels.

Comparing the results of Experiment 4 ($\alpha = 2$, $k = 0$) with those of Experiment 6 ($\alpha = 2$, $k = 25$), we see that the imposition of an affirmative action program had approximately the predicted results. Table 4.5 presents these results. In moving from Experiment 4 to Experiment 6 effort levels fall for the cost advantaged subjects and remain the same for cost disadvantged subjects. Using the Wilcoxon signed rank test, the observed effort levels of 36.41 and 64.17 (for cost disadvantaged–rules advantaged and cost advantaged–rules disadvantaged subjects respectively) are not significantly different from those of 29.49 and 58.99 predicted by the theory. With these effort level changes, the output of the tournament decreases as does the profits of the tournament organizer. The probability of winning for the previously cost disadvantaged group increases from .212 to .47 as does their expected payoff from participation in the tournament.

Thus, our affirmative action program was successful in increasing the probability of winning and the expected payoff for cost disadvantaged subjects. The cost of the program was that tournament output decreased. Hence, for organizations with intermediate levels of cost asymmetries amongst their agents, the imposition of an affirmative action program appears profit decreasing. This fact makes it more unlikely that such programs would be undertaken voluntarily.

Opposite findings occur when we compare results of Experiment 5 and 7. Remember that in Experiment 5 when $\alpha = 4$ there was a considerable amount of dropping out amongst the cost disadvantaged subjects. The main impact of our laboratory affirmative action program is to eliminate this drop–out behavior. As a result, mean effort levels increase as we move from Experiment 5 to Experiment 7 from 18.47 and 77.33 for cost disadvantaged and cost advantaged subjects respectively to 32.41 and 85.51 for cost disadvantaged, rules advantaged and cost advantaged, rules disadvantaged subjects respectively. These differences are statistically significant (using a Wilcoxon signed rank test). As a result, the total output of the tournament increases as do the profits of the tournament organizer. Probabilities of winning for the previously cost disadvantaged subjects rise from .130 to .293 while the expected payoffs increase from $0.92 to $0.93. In short, this experiment implies that imposing an affirmative action program upon organizations with severe cost asymmetries, is both beneficial for cost disadvantaged groups and profit increasing for the organizations. It increases profits because while disadvantaged subjects tend to drop out of tournaments in which cost asymmetries are great, they tend to participate and even exert above predicted effort levels if given a big enough advantage with respect to the rules. By not dropping out, they cause their opponents in the tournament to try harder as well. Such behavior increases the output of the tournament organizer.

Conclusion 5: Conclusions and Implications

The results of our experiments, if replicable, hold significant import for the theory of tournaments and social policies based upon it. For instance, our results indicate that the imposition of equal opportunity laws (at least our laboratory version of them) significantly increases the effort levels of all types of agents in an economic tournament.It also increases the probability of advancement (i.e."probability of winning") and equilibrium payoff of previously disadvantaged agents. In addition, if the imposition of the law leaves M and m unchanged, these laws increase the profit of tournament organizers (corporations) by causing all tournament participants to exert more effort.

Our results are less clear concerning affirmative action programs. While the imposition of our laboratory version of these programs lead to increased profits for tournament organizers and greater probabilities of advancement for cost disadvantaged subjects when the degree of disadvantageousness is great, such an effect was not observed when cost disadvantaged subjects had less severe handicaps. In general, our results imply that such programs may be of most significant benefit in situations of severe historical discrimination where disadvantaged subjects were discouraged enough to drop out. It is in preventing this drop–out behavior that affirmative action programs seem to increase total tournament effort as well as the chances for advancement of disadvantaged groups.

With respect to the theory of asymmetric tournaments, it appears that, as in the symmetric tournaments studied by Bull, Schotter and Weigelt (1987), the theory is a good predictor of subject behavior. However, there appears to be a general tendency for subjects to "oversupply" effort in these tournaments. This oversupply phenomenon, we conjecture, is a result of a "taste for winning" that subjects in our economic tournaments exhibit. This taste for winning manifests itself in torunaments (as opposed to piece rate incentive systems) since tournaments do, in fact, have winners and losers.

Since most real–world economic tournaments are multi–person and not two–person phenomena, we will attempt, in future research, to investigate whether our results generalize to multi–person laboratory tournaments. For instance, is subject behavior identical when we replicate a tournament, i.e. have a symmetric four–person tournament with two big and two small prizes, or a symmetric six–person tournament with three big and three small prizes? Do affirmative action programs and equal opportunity laws function the same way in asymmetric multi–person tournaments as they do in two–person asymmetric tournaments? These questions, and others like them, are the logical ones to attempt to answer next and that is what we plan to do in future research.

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TABLE 4

Experimental Parameters

Experiment	Decision # Range	Cost Function	Random # Range	M	m	(M-m)	Equilibrium Advan.	Equilibrium Disadvan
1	(0-100)	$e_i^2/15,000$	(-60,60)	\$2.04	.86	\$1.18	73.75	73.75
unfair tournaments								
2 k = 25	(0-100)	$e_i^2/15,000$	(-60,60)	\$2.04	.86	\$1.18	58.39	58.39
3 k = 45	(0-100)	$e_i^2/15,000$	(-60,60)	\$2.04	.86	\$1.18	46.09	46.09
uneven tournaments								
4 $\alpha = 2$	(0-100)	advantaged $e_i^2/15,000$ disadvantaged $2e_i^2/15,000$	(-60,60)	\$2.04	.86	\$1.18	74.51	37.26
5 $\alpha = 4$	(0-100)	advantaged $e_i^2/15,000$ disadvantaged $4e_i^2/15,000$	(-60,60)	\$2.04	.86	\$1.18	76.09	19.02
affirmative action tournaments								
6 $\alpha = 2$ k = 25	(0-100)	cost advantaged $e_i^2/15,000$	(-60,60)	\$2.04	.86	\$1.18	58.99	
		cost disadvantaged $2e_i^2/15,000$						29.49
7 $\alpha = 4$ k = 25	(0-100)	cost advantaged $e_i^2/15,000$	(-60,60)	\$2.04	.86	\$1.18	60.24	
		cost disadvantaged $2e_i^2/15,000$						15.06

TABLE 4.1

Experimental Results: Means and Variances of Subjects' Effort Levels

Experiment	Mean Decision Number Rounds 1 - 10	Mean Decision Number Rounds 11 - 20	Mean Variance in Decision Numbers Rounds 1 - 10	Mean Variance in Decision Numbers Rounds 11 - 20	Mean Decision Number Round 20	Mean Variance in Decision Numbers Round 20	Number of Subjects
1 - symmetric	73.87	77.91	627.40	612.60	80.75	550.27	24
2 - unfair k = 25							
rule advantaged	65.88	74.50	379.49	397.80	68.22	723.00	18
rule disadvantaged	64.66	58.65	952.00	1434.00	62.44	1409.58	
3 - unfair k = 45							
rule advantaged	47.00	48.65	246.45	414.11	55.25	824.94	16
rule disadvantaged	53.67	59.29	760.19	778.40	65.00	710.00	
4 - uneven $\alpha = 2$							
cost advantaged	73.71	78.83	620.25	475.42	88.67	135.33	18
cost disadvantaged	41.70	37.06	873.29	835.06	46.89	970.77	
5 - uneven $\alpha = 4$							
cost advantaged	68.46	77.33	694.66	443.18	80.60	264.37	30
cost disadvantaged	28.18	18.47	451.68	389.40	17.20	432.96	
6 - affirm. action $k = 25$, $\alpha = 2$							
cost adv. - rule dis.	72.29	64.17	647.54	1044.73	68.43	1104.82	14
cost dis. - rule adv.	42.49	36.41	694.39	766.27	26.57	638.24	
7 - affirm. action $k = 25$, $\alpha = 4$							
cost adv. - rule dis.	61.94	85.51	894.59	383.40	87.27	365.11	22
cost dis. - rule adv.	32.62	32.41	683.44	659.00	27.45	451.34	

TABLE 4.2

Summary of Predicted and Observed Experimental Results

	Experiment 1 $(k = 0)$	Experiment 2 $(k = 25)$	Experiment 3 $(k = 45)$	Experiment 4 $(\alpha = 2)$	Experiment 5 $(\alpha = 4)$	Experiment 6 $(\alpha = 2 \mid k = 25)$	Experiment 7 $(\alpha = 4 \mid k = 25)$
Advantaged Subjects - Rounds 1-20*							
Predicted Mean Effort Level	73.75	58.39	46.09	74.51	76.09	58.99	60.24
Observed Mean Effort Level	75.89	70.19	47.82	76.27	72.90	68.23	73.72
Disadvantaged Subjects Rounds 1-20							
Predicted Mean Effort Level	73.75	58.39	46.09	37.26	19.02	29.49	15.06
Observed Mean Effort Level	75.89	61.65	56.48	39.38	23.32	39.45	32.51
Predicted Total Tournament Effort	147.50	116.78	92.18	111.77	95.11	88.48	75.30
Observed Total Tournament Effort	151.78	131.84	104.30	115.65	96.22	107.68	106.23
Advantaged Subjects*							
Expected Probability of Winning	.500	.687	.805	.762	.862	.537	.654
Observed Probability of Winning	.500	.898	.827	.788	.870	.523	.707
Advantaged Subjects*							
Expected Mean Monetary Payoff	$1.09	$1.44	$1.67	$1.38	$1.55	$1.26	$1.39
Observed Mean Monetary Payoff	$1.09	$1.55	$1.68	$1.39	$1.49	$1.21	$1.20
Disadvantaged Subjects							
Expected Probability of Winning	.500	.313	.195	.238	.138	.463	.346
Observed Probability of Winning	.500	.102	.173	.212	.130	.477	.293
Disadvantaged Subjects							
Expected Mean Monetary Payoff	$1.09	$1.00	$0.95	$0.96	$0.92	$1.29	$1.21
Observed Mean Monetary Payoff	$1.09	$0.75	$0.83	$0.93	$0.92	$1.24	$0.93

* - For affirmative action tournaments (exper. 6 & 7), advantaged subjects are the cost advantaged, rules disadvantaged subjects.

Note: Expected probabilities of winning are calculated using the observed mean effort levels and equation (5). Expected payoffs are calculated using the expected probabilities of winning and equation (3).

TABLE 4.3

Experiment 5 ($\alpha = 4$)
Effort Levels of Advantaged and Disadvantaged Subjects - Rounds 11-20

Drop-Out Group				Non Drop-Out Group			
advantaged subjects		disadvantaged subjects		advantaged subjects		disadvantaged subjects	
subject number	median effort level	subject number	median effort level	subject number	median effort level	subject number	median effort level
6	95	31	0	2	89	33	44
12	100	17	0	4	85	39	50
16	67	19	4	10	60	29	47
20	90	9	0	18	71	11	20
22	95	21	3	40	46	23	20
24	55	7	3	38	63	15	35
30	69	3	0	8	80	41	30
26	100	5	0				
mean effort level - rounds 11 - 20				mean effort level - rounds 11 - 20			
	85.3		8.16		64.74		30.24

TABLE 4.4

The Impact of Laboratory Equal Opportunity Laws

	Experiment 1 (k = 0)	Experiment 2 (k = 25)	Experiment 3 (k = 45)
Mean Effort Level of Rules Advantaged Subjects - Rounds 11-20	-	74.50	48.65
Mean Effort Level of Rules Disadvantaged Subjects - Rounds 11-20	-	58.65	59.29
Mean of All Subjects	77.90	66.50	53.90
Expected Probability of Winning - Advantaged Subjects	.500	.898	.827
Expected Probability of Winning - Disadvantaged Subjects		.102	.173
Expected Monetary Payoff - Advantaged Subjects	$1.09	$1.55	$1.68
Expected Monetary Payoff - Disadvantaged Subjects		$0.75	$0.83

Note: Expected probabilities of winning are calculated using the observed mean effort levels and equation (5). Expected payoffs are calculated using the expected probabilities of winning and equation (3).

TABLE 4.5

The Impact of Laboratory Affirmative Action Programs

	Experiment 4 ($\alpha = 2$)	Experiment 6 ($\alpha = 2 \mid k = 25$)	Experiment 5 ($\alpha = 4$)	Experiment 7 ($\alpha = 4 \mid k = 45$)
Mean Effort Level of Cost Advantaged Subjects - Rounds 11-20	78.83	64.17	77.33	85.51
Mean Effort Level of Cost Disadvantaged Subjects - Rounds 11-20	37.06	36.41	18.47	32.41
Expected Probability of Winning - Cost Advantaged Subjects	.788	.523	.970	.797
Expected Probability of Winning - Cost Disadvantaged Subjects	.212	.477	.130	.293
Expected Monetary Payoff - Cost Advantaged Subjects	\$1.38	\$1.24	\$1.49	\$1.20
Expected Monetary Payoff - Cost Disadvantaged Subjects	\$0.93	\$1.21	\$0.92	\$0.93

Note: Expected probabilities of winning are calculated using the observed mean effort levels and equation (5). Expected payoffs are calculated using the expected probabilities of winning and equation (3).

FIGURE 4.1

Experiment 1
Symmetric Tournament

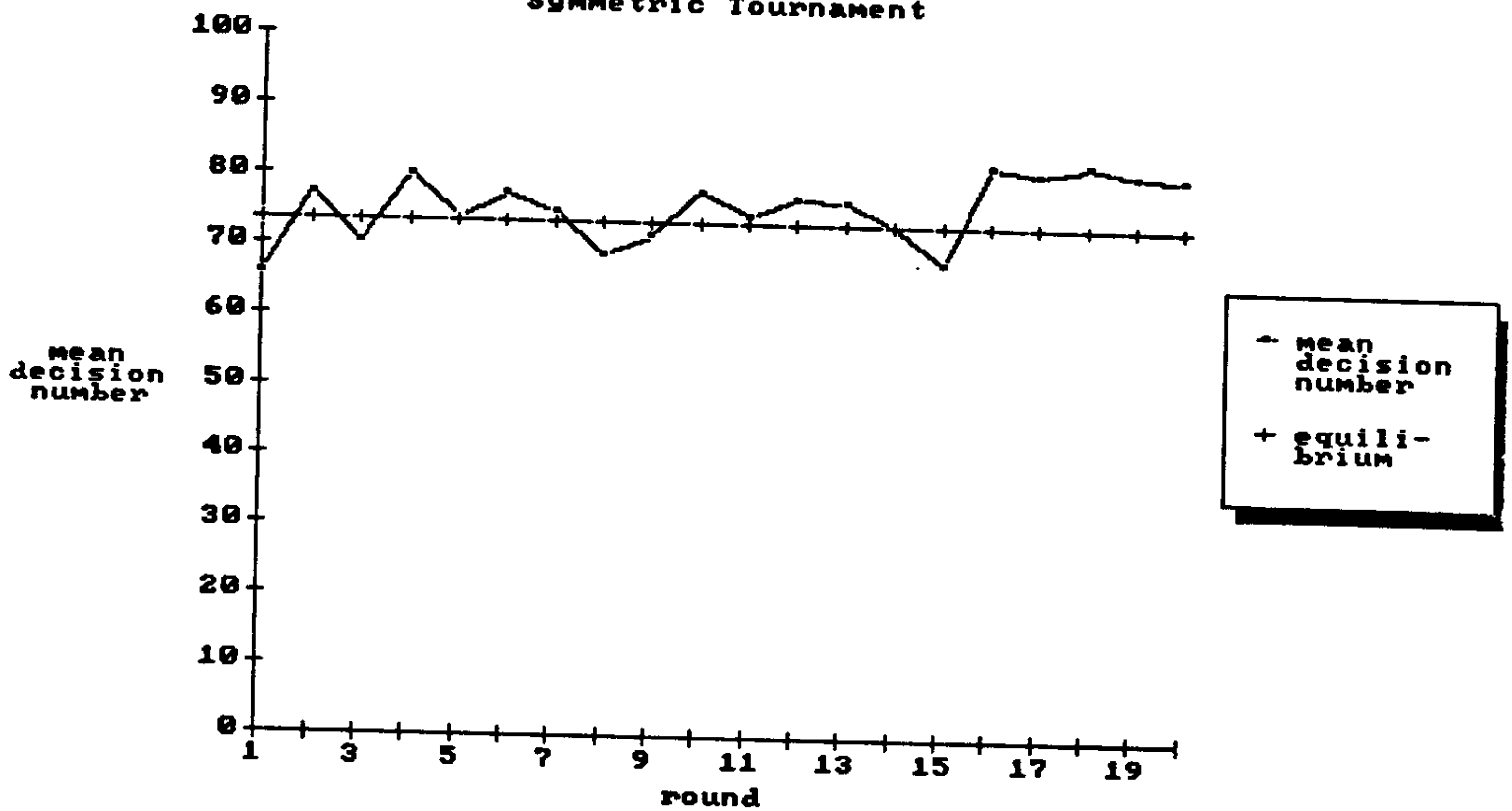


FIGURE 4.2

Experiment 2
Unfair Tournament (k = 25)

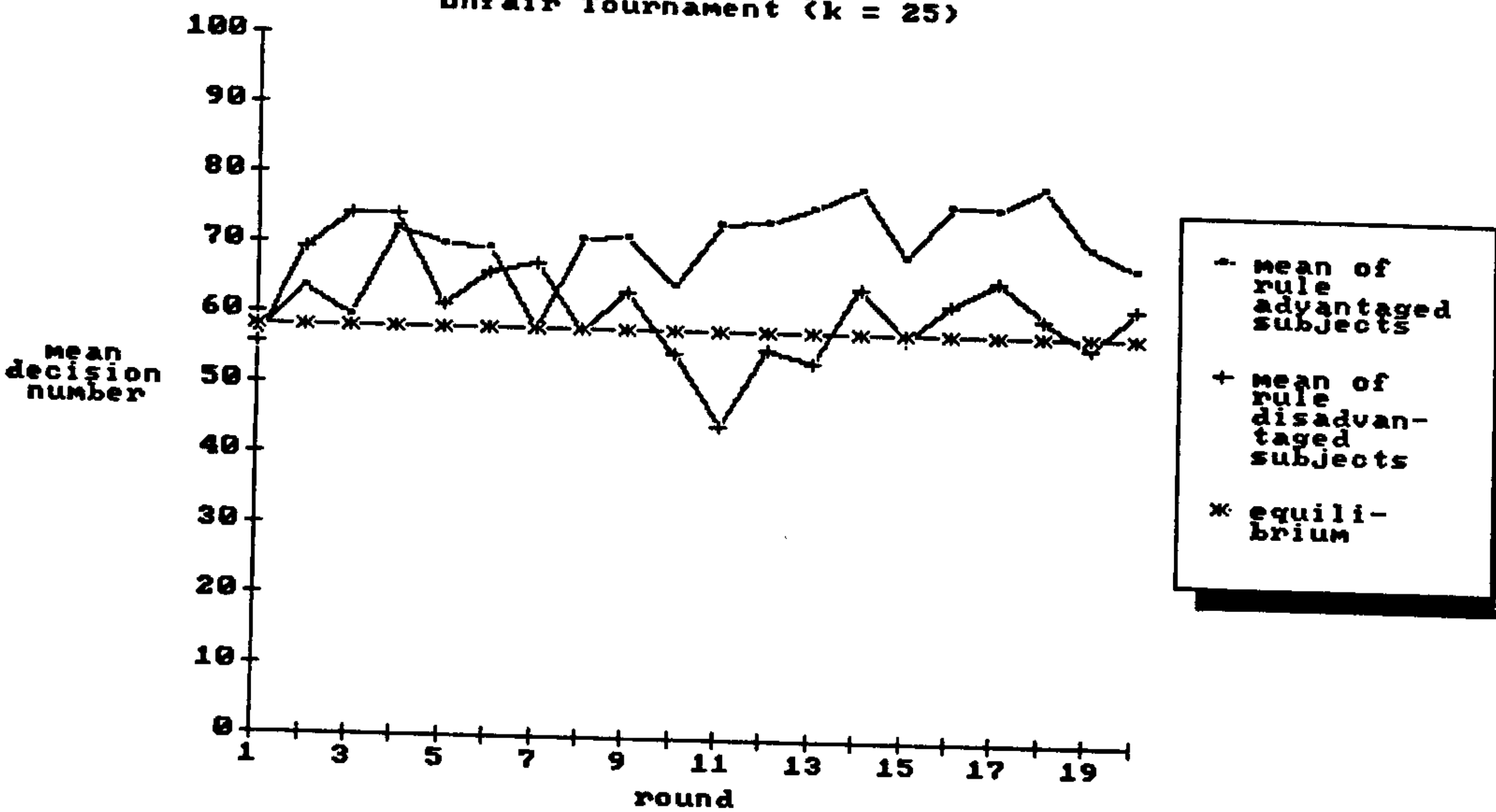


FIGURE 4.3

Experiment 3
Unfair Tournament (k = 45)

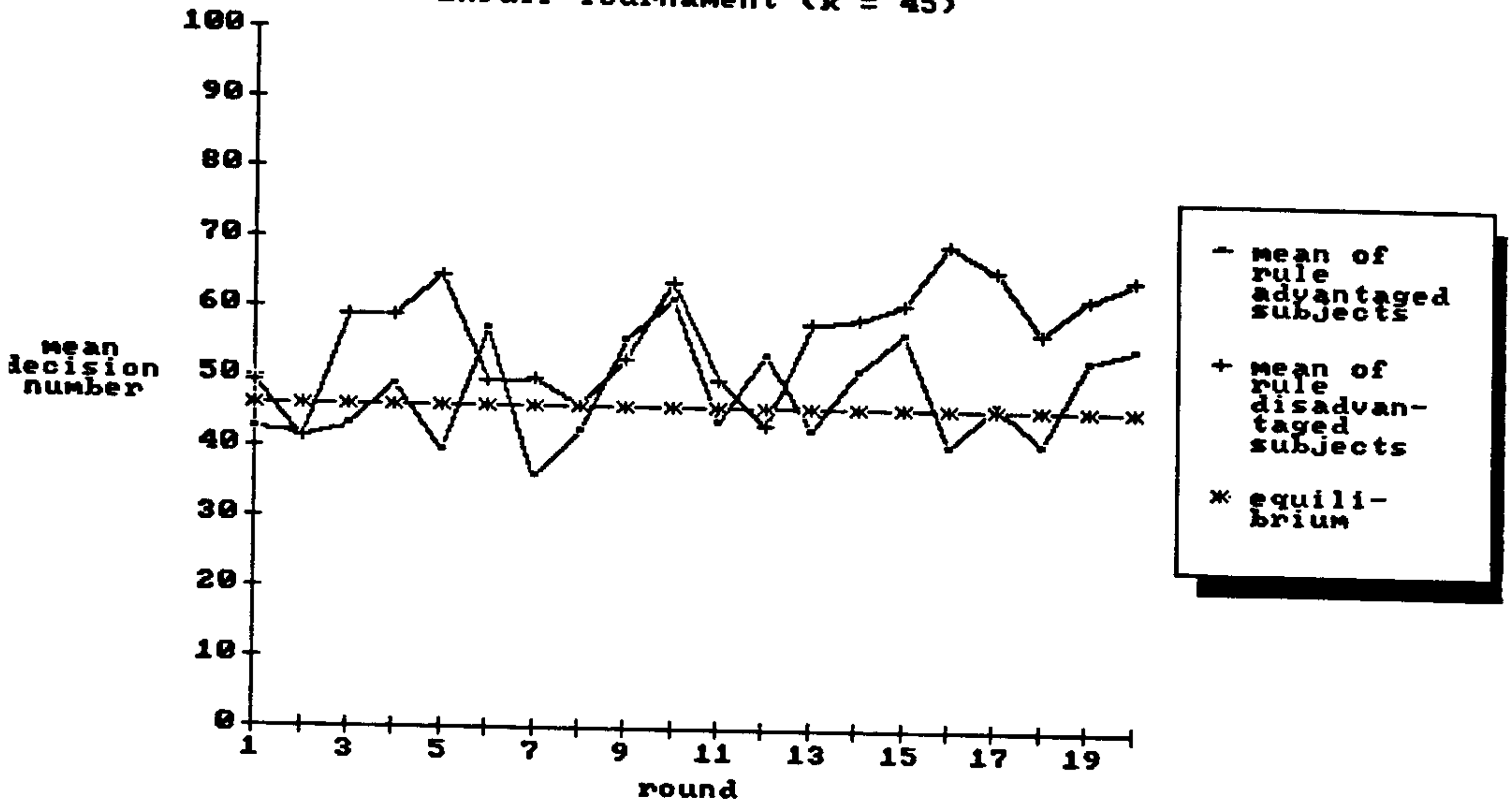


FIGURE 4.4

Experiment 4
Uneven Tournament (α = 2)

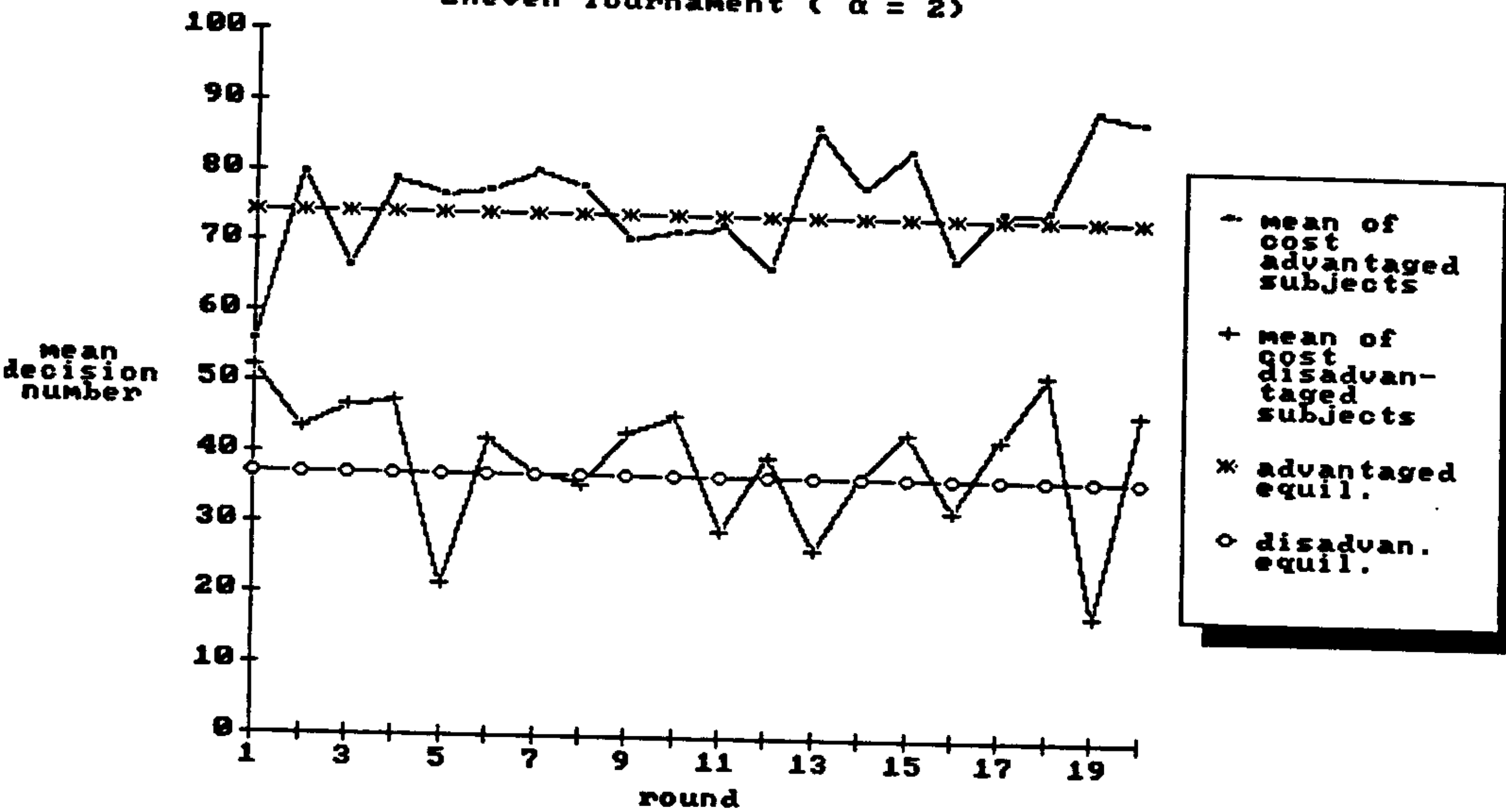


FIGURE 4.5

Experiment 5
Uneven Tournament (α = 4)

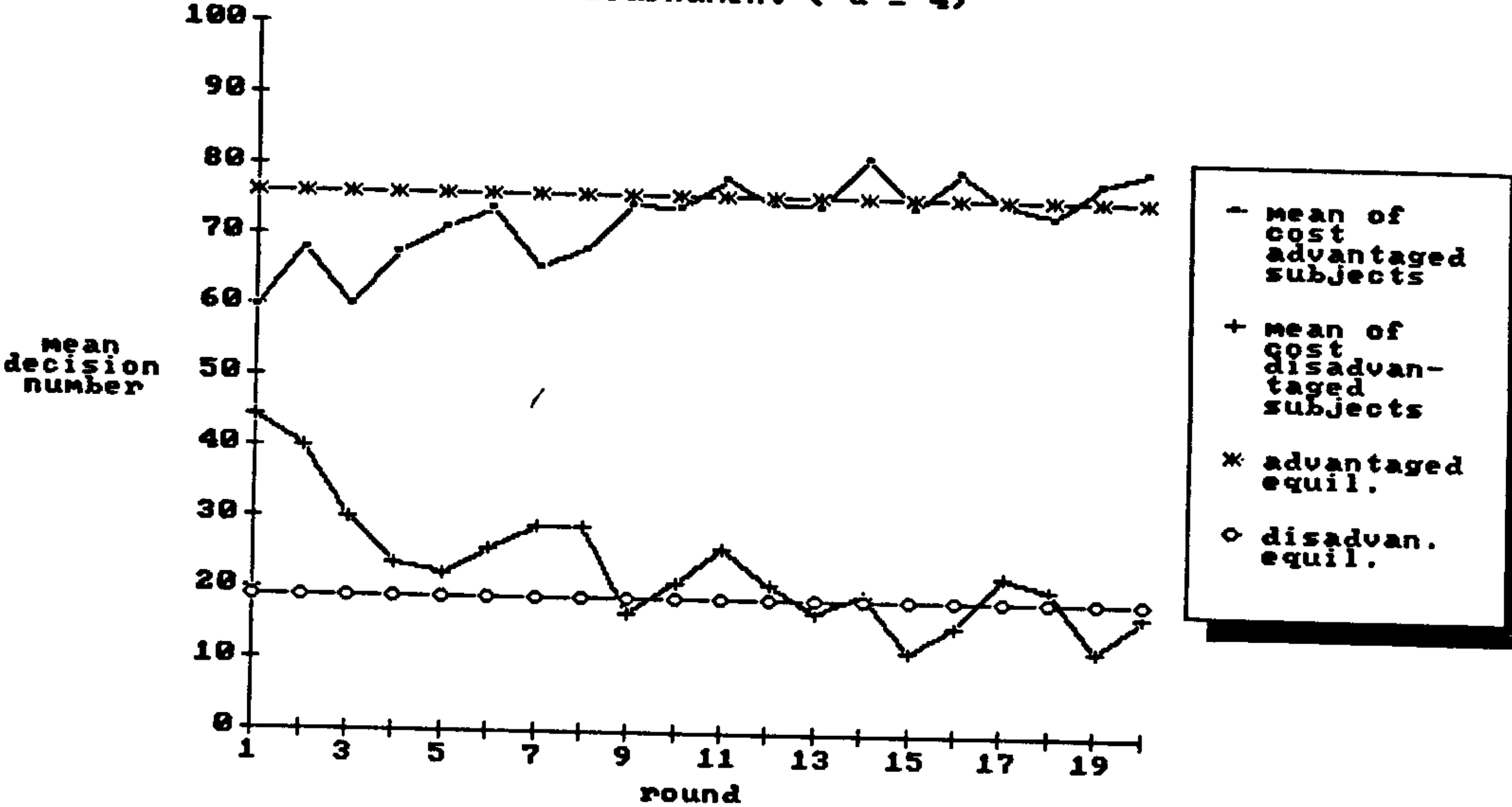


FIGURE 4.6

Experiment 6
Affirmative Action Tournament
(k = 25, α = 2)

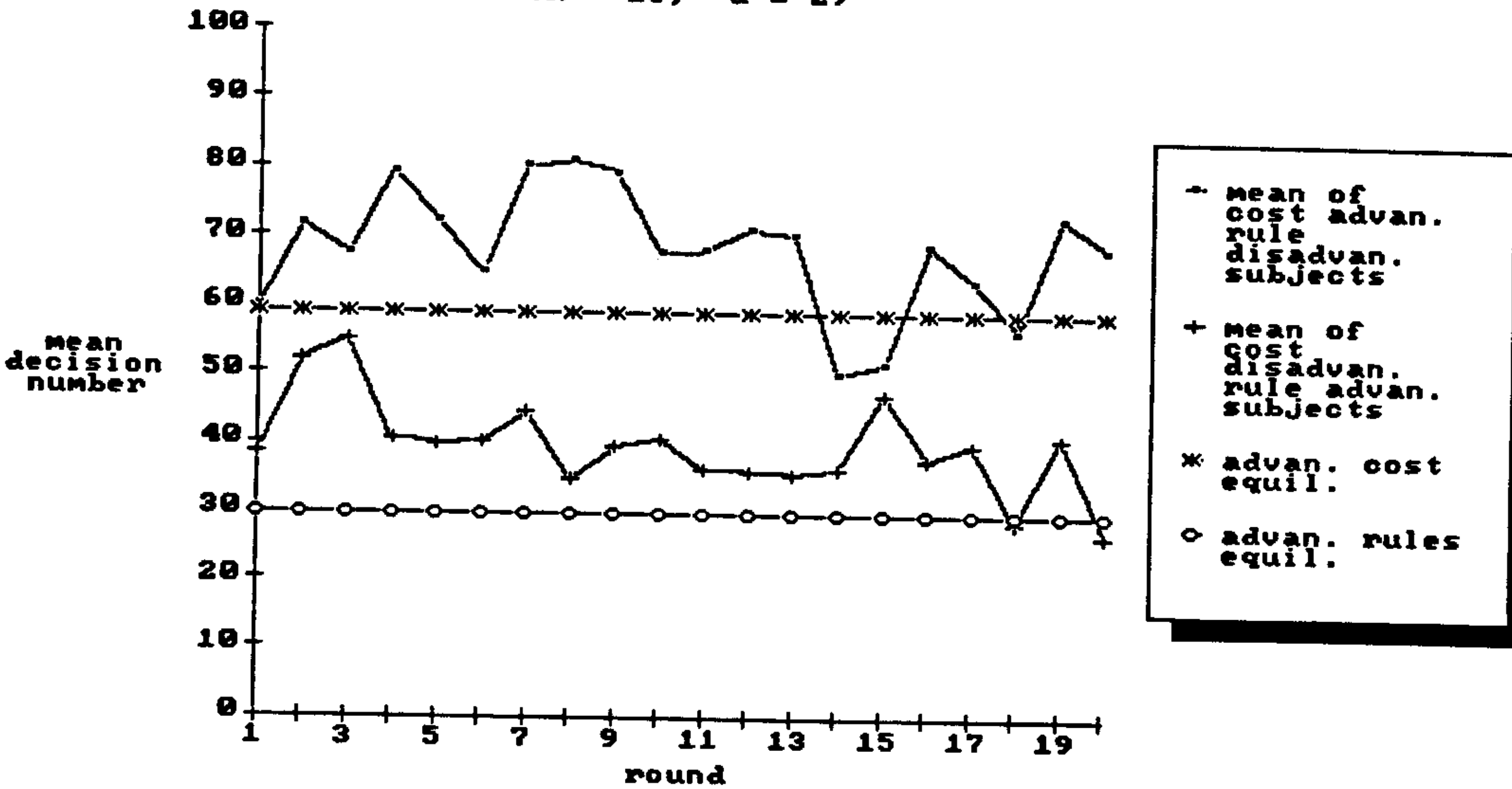


FIGURE 4.7

Experiment 7
Affirmative Action Tournament
(k = 25, α = 4)

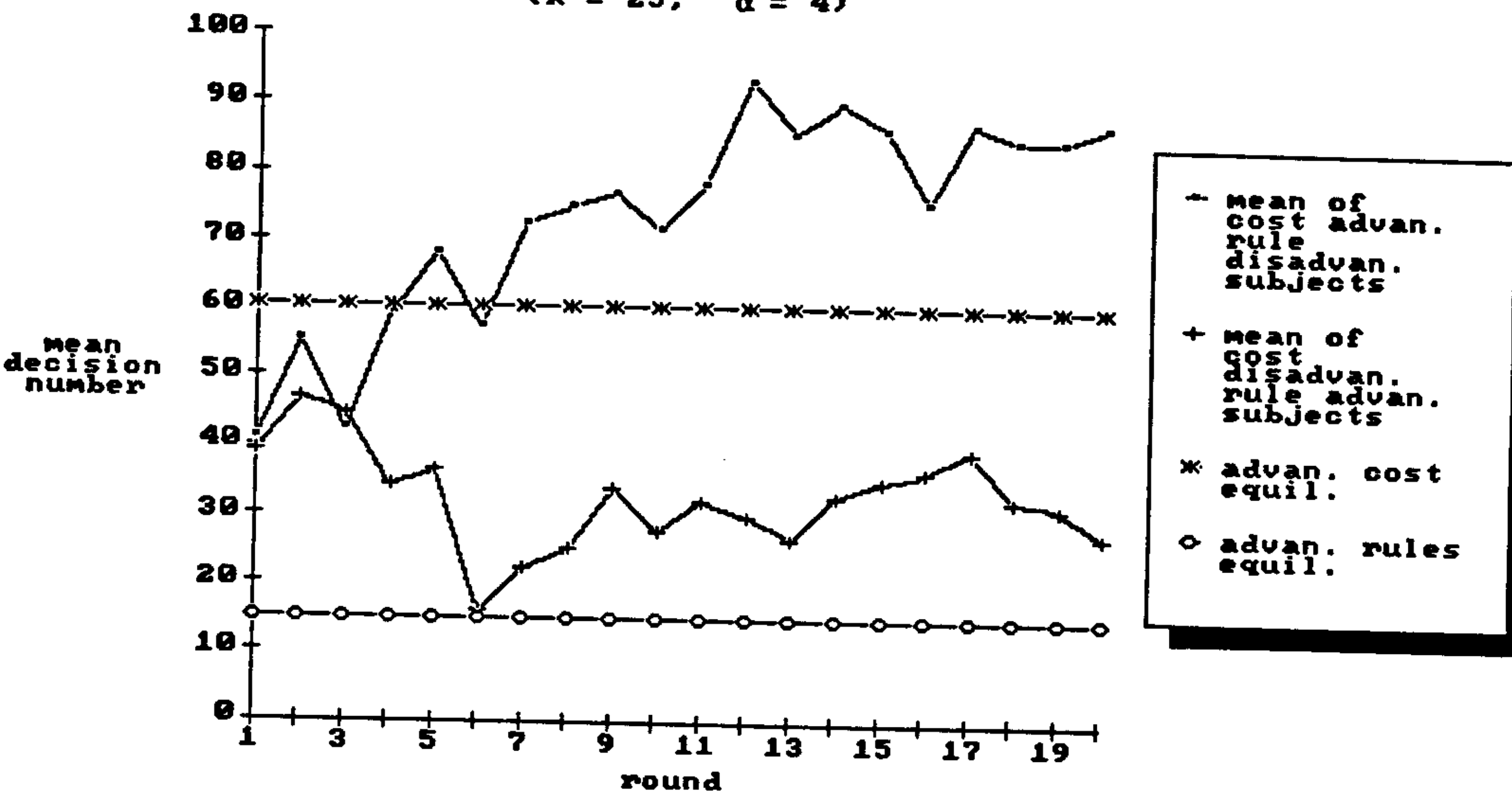


FIGURE 4.8a

Experiment 5 (α = 4) Mean Effort Levels of Pairs Where Disadvantaged Member Didn't Drop Out

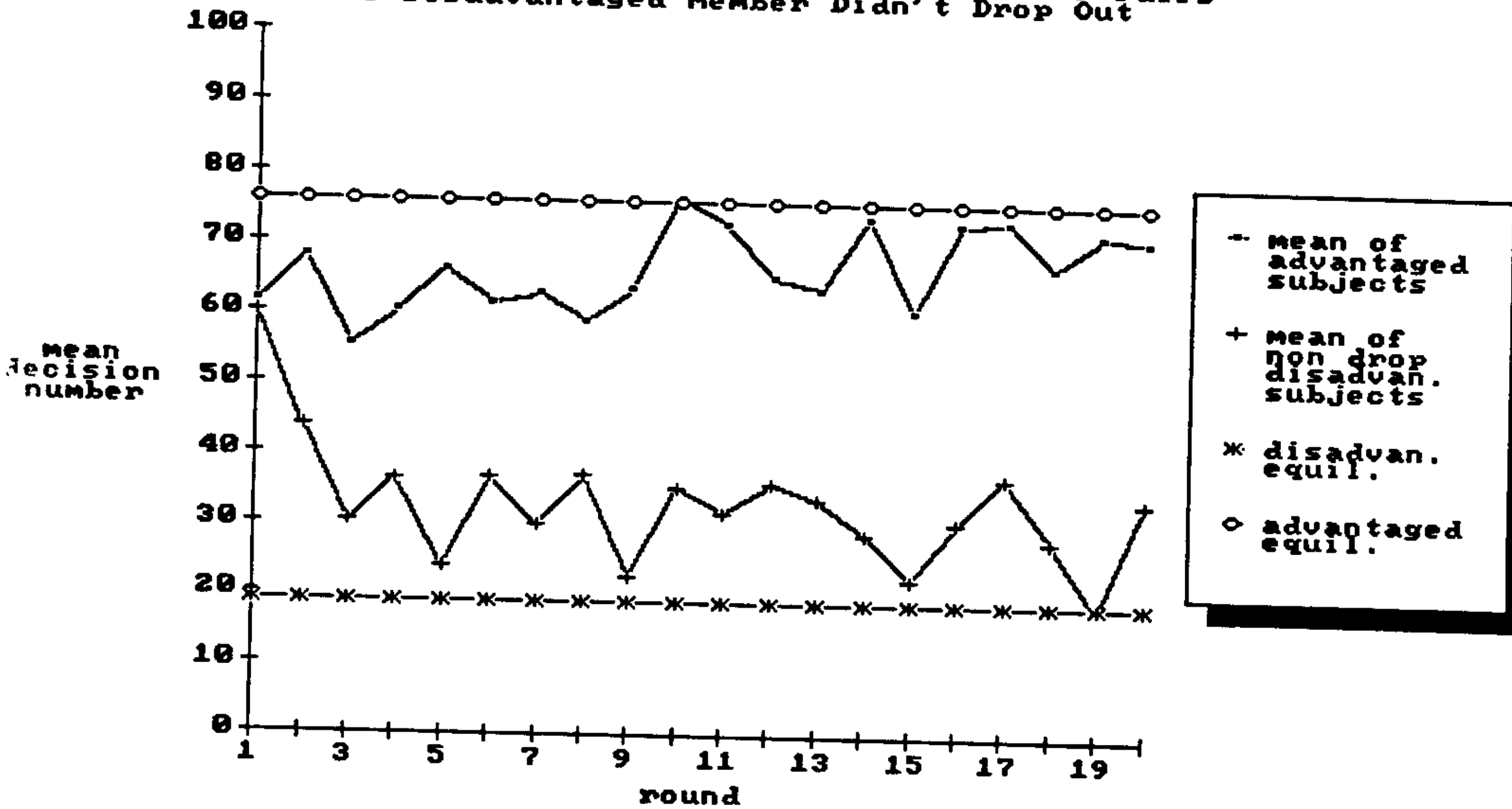


FIGURE 4.8b

Experiment 5 (α = 4) Mean Effort Levels of Pairs Where Disadvantaged Member Dropped Out

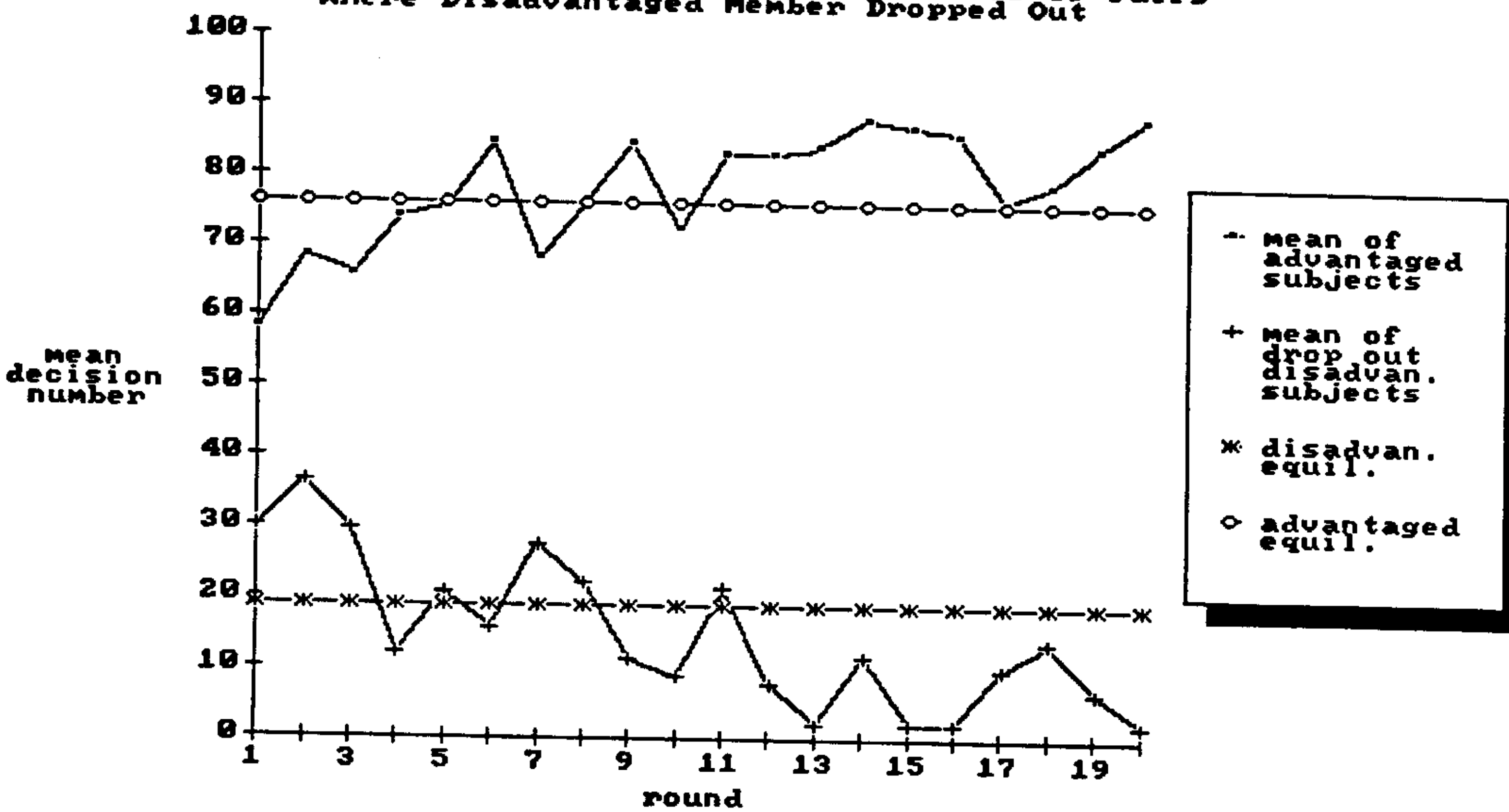


FIGURE 4.9
Subjects' 'Taste' for Winning

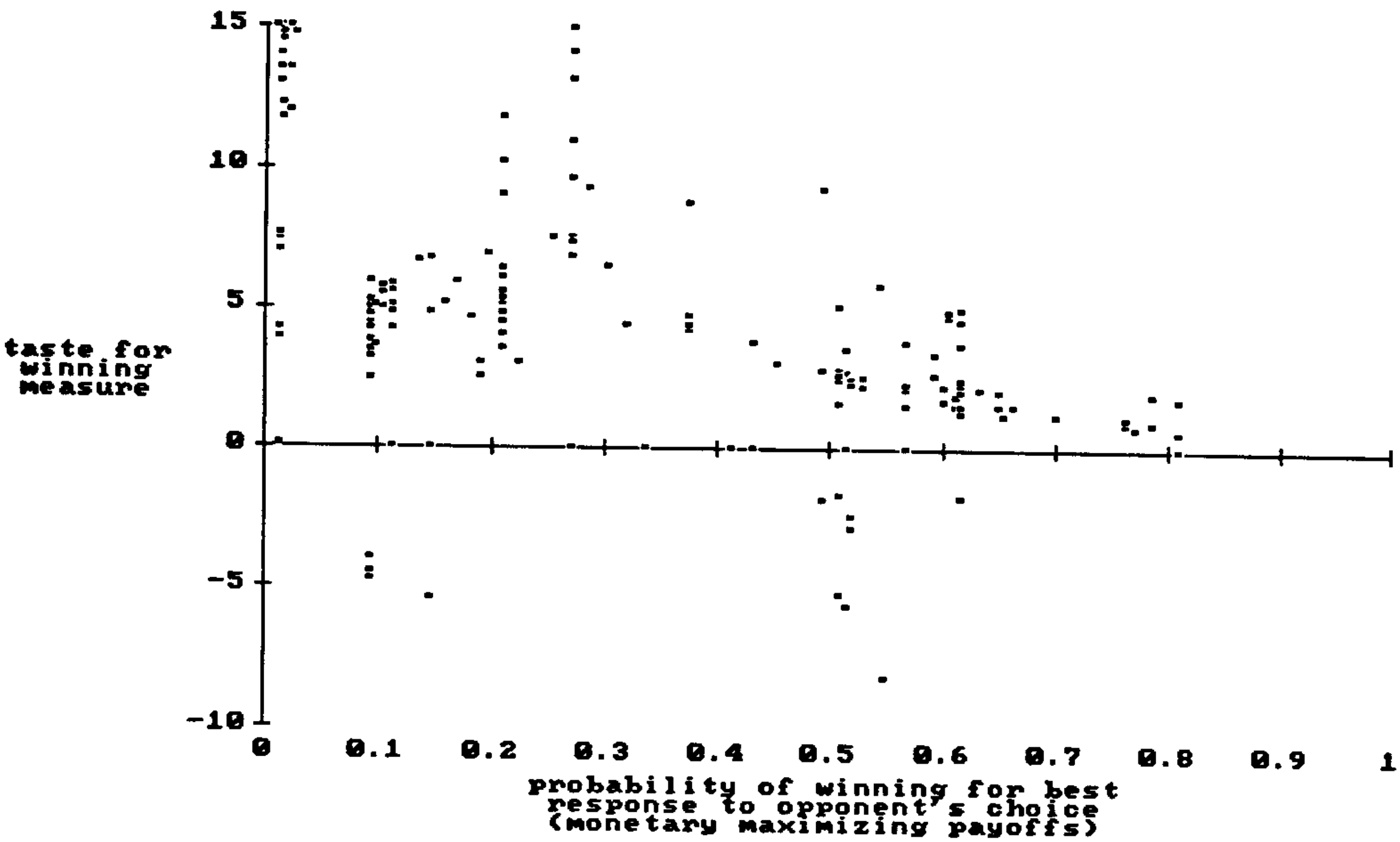


FIGURE 4.10

Subjects' Positive Utility from Winning

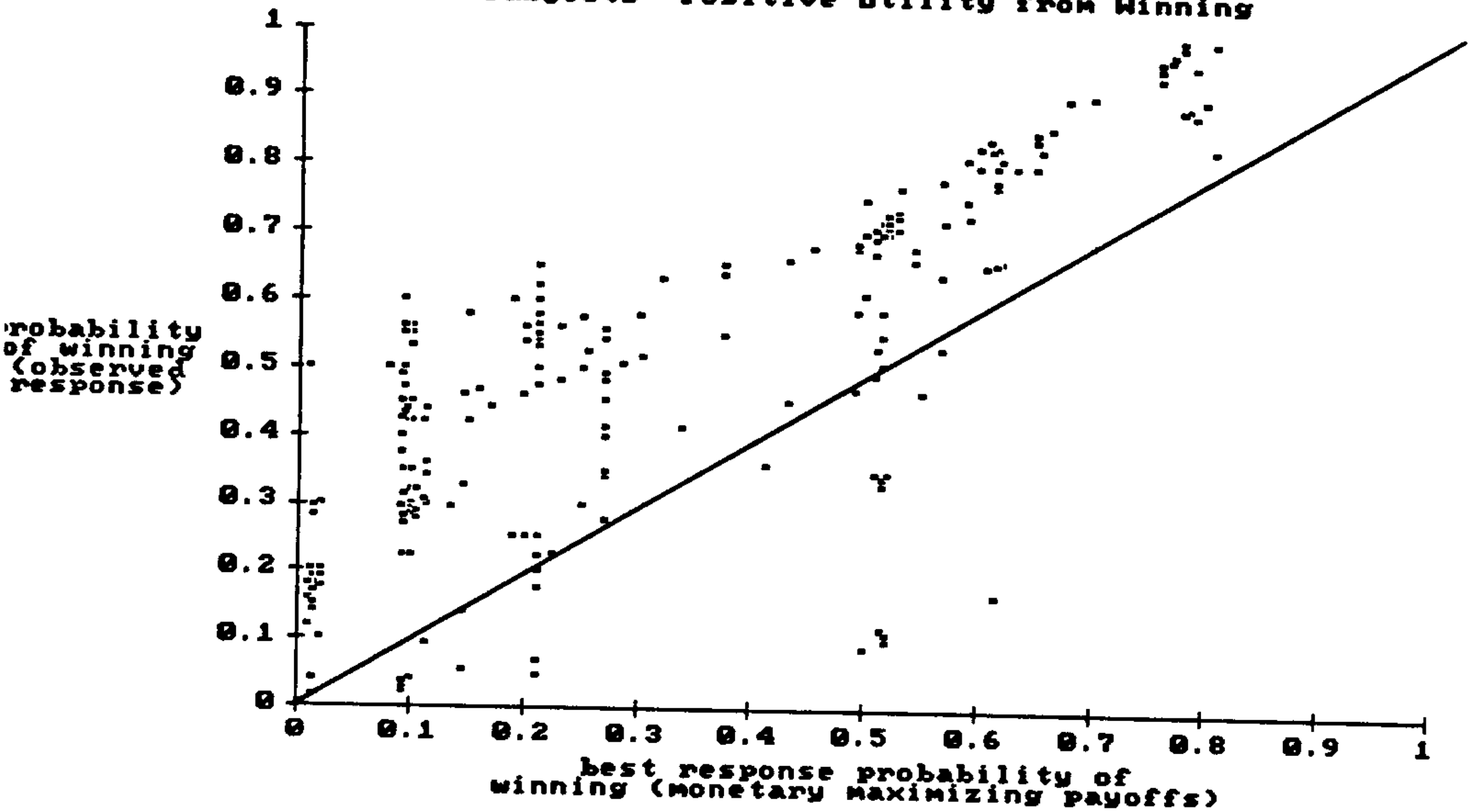
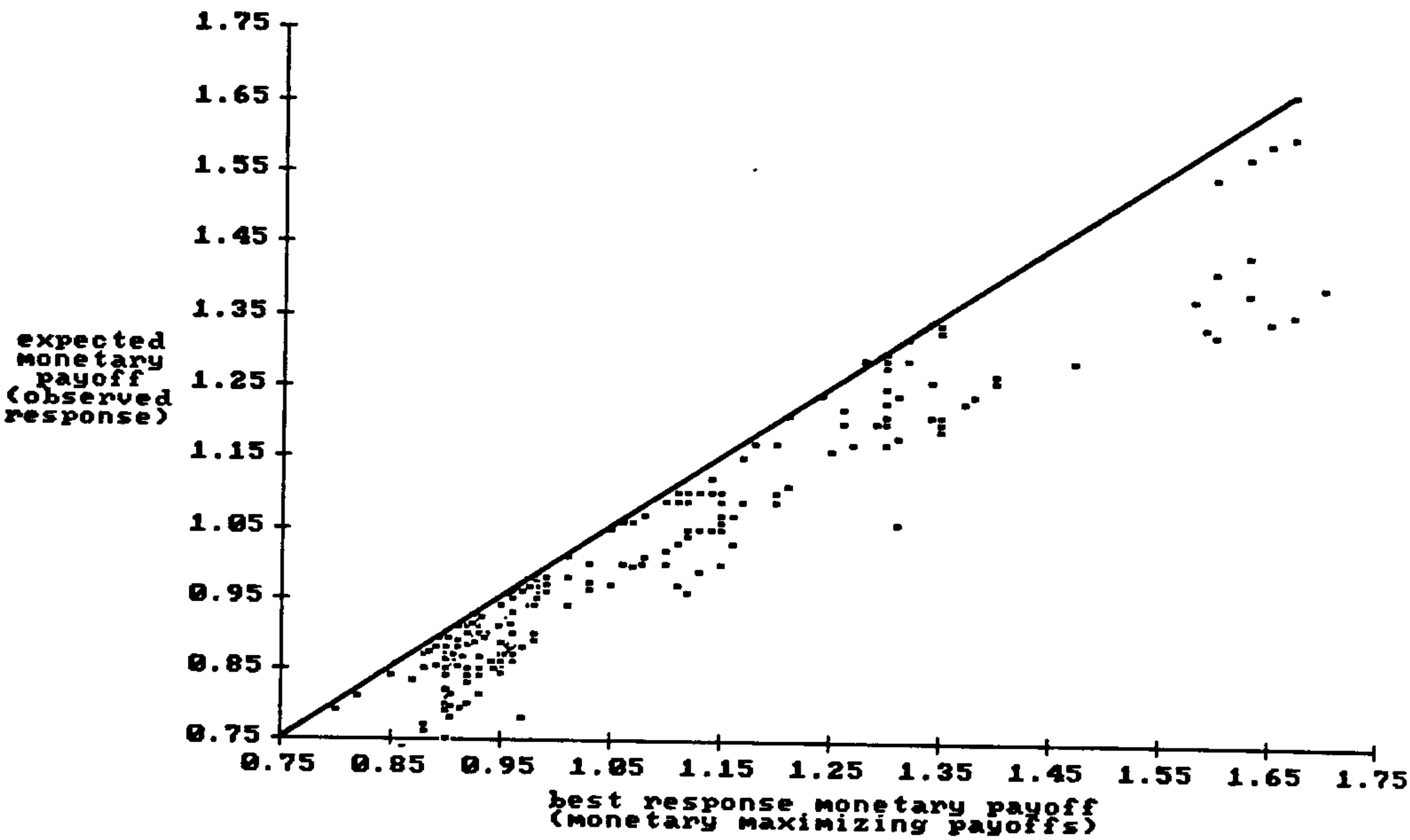


FIGURE 4.11
Subjects' Sacrifice of Monetary Payoffs to Increase Probability of Winning



APPENDIX A

Subject #_______

Instructions

This is an experiment in decision making. The instructions are simple, and if you follow them carefully and make good decisions, you could earn a considerable amount of money which will be paid to you in cash.

As you read these instructions you will be in a room with a number of other subjects. Each subject has been randomly assigned a subject number which is located in the upper right hand corner of this page.

The experiment consists of a number of decision rounds. In each decision round you will be paired with another subject by a random drawing of subject numbers. This subject will be called your pair member. Your pair member will remain the same throughout the entire experiment. The identity of your pair member will not be revealed to you.

Experimental Procedure

In the experiment you will perform a simple task. Attached to these instructions are two sheets, labelled sheet 1 and sheet 2. Sheet 1 shows 100 numbers, from 0 to 100 in column A. These are your decision numbers. Associated with each number is a decision cost, which is listed in column B. Your pair member's decision costs are different from yours, and are listed in Column C. However, note that for both you and your pair member, the higher the decision number chosen, the greater is the associated cost.

Your pair member has a similar sheet, with his decision costs listed in Column B, and your decision costs listed in Column C. In each round of the experiment, you and your pair member will each select a decision number separately. Record your number in column 1 of sheet 2 and record its associated cost in column 5 of sheet 2.

Upon entering this room, all subjects randomly selected 20 envelopes from a container holding hundreds of envelopes. Each envelope contains a written number, whose value will fall between -60 and +60. This number will be called your random draw number. A series of numbers between -60 and +60 was randomly selected by a computer program, with each number having an equal probability of being selected. Each of these numbers was then written on a sheet of paper, and put in an envelope.

After you have selected your decision number, and recorded it, and its cost on sheet 2, select one of your envelopes, open it, and record its enclosed number in column 2 of sheet 2. Then write this information on the slips of paper provided to you. The experimenter will collect these slips.

Calculation of Payoffs

Your payment in each round of the experiment will be computed as follows. You will add your decision number, and random draw number, and record this sum in column 3 of sheet 2. Your pair member will do the same.

Since all subjects have worked in privacy, the experimenter will then compare the totals of you and your pair member. If your total in Column 3 is greater than your pair member's total in Column 3, you receive the fixed payment X ($2.04), if not you receive Y ($0.86). Whether you receive X or Y as your fixed payment only depends on whether your total is greater than your pair member's. It does not depend on how much bigger it is.

Circle the appropriate fixed payment in column 4, and subtract from column 4, the cost associated with your decision number listed in column 5. Record this difference in column 6. This amount in column 6 is your earnings for the round. The earnings of your pair member is calculated in exactly the same way.

After round 1 is completed, you will perform the same procedure. That is, you will choose a decision number again (though of course, you may pick the same one), you will open another envelope and record your random draw number for the round, and you will calculate a new total number. When round 20 is completed, add your earnings from each of the rounds, and record the total earnings at the bottom of sheet 2. Subtract from this the stated fixed cost. The remaining amount will be paid to you, in cash, at the end of the experiment.

Example of Payoff Calculations

For example, say that pair member a_2, chooses a decision number of 65, and draws a random number of -10, while pair member a_1, selects a decision number of 50, and a random draw of 4.

Subject a_2's payoff calculation will look like this:

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
65	+	-10	=	55	($2.04)	$0.86	-	$0.28	=	$1.76

Subject a_1's payoff calculations will look like this:

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
50	+	04	=	54	$2.04	($0.86)	-	$0.67	=	$0.19

Note, the amount subtracted in column 5 (decision cost), is only a function of your decision number - i.e. your random number draw does not affect the amount subtracted. Additionally, your total earnings depend on your random draw, your selected decision number (both in its contribution to your total, and the subtraction of its associated cost from your fixed payment, either X or Y), and your pair member's selected decision number, and random draw.

Sheet 1 - Decision Costs Table

Column A Decision Number	Column B Your Cost of Decision	Column C Pair Member's Cost of Decision	Column A Decision Number	Column B Your Cost of Decision	Column C Pair Member's Cost of Decision
0	$0.0000	$0.0000	51	$0.173	$0.692
1	$0.0001	$0.0004	52	$0.180	$0.720
2	$0.0003	$0.0012	53	$0.187	$0.748
3	$0.0006	$0.0024	54	$0.194	$0.776
4	$0.001	$0.004	55	$0.202	$0.808
5	$0.002	$0.008	56	$0.209	$0.836
6	$0.003	$0.012	57	$0.217	$0.868
7	$0.004	$0.016	58	$0.224	$0.896
8	$0.005	$0.020	59	$0.232	$0.928
9	$0.006	$0.024	60	$0.240	$0.960
10	$0.007	$0.028	61	$0.248	$0.992
11	$0.008	$0.032	62	$0.256	$1.024
12	$0.010	$0.040	63	$0.265	$1.060
13	$0.011	$0.044	64	$0.273	$1.092
14	$0.013	$0.052	65	$0.282	$1.128
15	$0.015	$0.060	66	$0.290	$1.160
16	$0.017	$0.068	67	$0.299	$1.196
17	$0.019	$0.076	68	$0.308	$1.232
18	$0.022	$0.088	69	$0.317	$1.268
19	$0.024	$0.096	70	$0.327	$1.308
20	$0.027	$0.108	71	$0.336	$1.344
21	$0.029	$0.116	72	$0.346	$1.384
22	$0.032	$0.128	73	$0.355	$1.420
23	$0.035	$0.140	74	$0.365	$1.460
24	$0.038	$0.152	75	$0.375	$1.500
25	$0.042	$0.168	76	$0.385	$1.540
26	$0.045	$0.180	77	$0.395	$1.580
27	$0.049	$0.196	78	$0.406	$1.624
28	$0.052	$0.208	79	$0.416	$1.664
29	$0.056	$0.224	80	$0.427	$1.708
30	$0.060	$0.240	81	$0.437	$1.748
31	$0.064	$0.256	82	$0.448	$1.792
32	$0.068	$0.272	83	$0.459	$1.836
33	$0.073	$0.292	84	$0.470	$1.880
34	$0.077	$0.308	85	$0.482	$1.928
35	$0.082	$0.328	86	$0.493	$1.972
36	$0.086	$0.344	87	$0.505	$2.020
37	$0.091	$0.364	88	$0.516	$2.060
38	$0.096	$0.384	89	$0.528	$2.120
39	$0.101	$0.404	90	$0.540	$2.160
40	$0.107	$0.428	91	$0.552	$2.200
41	$0.112	$0.448	92	$0.564	$2.260
42	$0.118	$0.472	93	$0.577	$2.300
43	$0.123	$0.492	94	$0.589	$2.360
44	$0.129	$0.516	95	$0.602	$2.420
45	$0.135	$0.540	96	$0.614	$2.460
46	$0.141	$0.564	97	$0.627	$2.500
47	$0.147	$0.588	98	$0.640	$2.560
48	$0.154	$0.616	99	$0.653	$2.612
49	$0.160	$0.640	100	$0.667	$2.668
50	$0.167	$0.668			

Subject #______

Sheet 2 - Payoff Record Sheet

Round 1

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 2

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 3

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 4

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 5

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 6

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 7

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 8

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 9

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 10

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 11

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 12

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 13

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 14

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 15

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 16

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 17

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 18

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 19

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Round 20

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
______	+	______	=	______	$2.04	$0.86	-	$______	=	$______

Sum of Total Earnings Rounds 1-20 $______

Minus Fixed Cost $7.00

Net Earnings $______

Name ______________________________

Social Security # ______________________________

Telephone Number ______________________________

Address ______________________________

APPENDIX B

Subject #_______

Instructions

This is an experiment in decision making. The instructions are simple, and if you follow them carefully and make good decisions, you could earn a considerable amount of money which will be paid to you in cash.

As you read these instructions you will be in a room with a number of other subjects. Each subject has been randomly assigned a subject number which is located in the upper right hand corner of this page.

The experiment consists of a number of decision rounds. In each decision round you will be paired with another subject by a random drawing of subject numbers. This subject will be called your pair member. Your pair member will remain the same throughout the entire experiment. The identity of your pair member will not be revealed to you.

Experimental Procedure

In the experiment you will perform a simple task. Attached to these instructions are two sheets, labelled sheet 1 and sheet 2. Sheet 1 shows 100 numbers, from 0 to 100 in column A. These are your decision numbers. Associated with each number is a decision cost, which is listed in column B. Note that the higher the decision number chosen, the greater is the associated cost.

Your pair member has an identical sheet. In each round of the experiment, you and your pair member will each select a decision number separately. Record your number in column 1 of sheet 2 and record its associated cost in column 5 of sheet 2.

Upon entering this room, all subjects randomly selected 20 envelopes from a container holding hundreds of envelopes. Each envelope contains a written number, whose value will fall between -60 and +60. This number will be called your random draw number. A series of numbers between -60 and +60 was randomly selected by a computer program, with each number having an equal probability of being selected. Each of these numbers was then written on a sheet of paper, and put in an envelope.

After you have selected your decision number, and recorded it, and its cost on sheet 2, select one of your envelopes, open it, and record its enclosed number in column 2 of sheet 2. Then write this information on the slips of paper provided to you. The experimenter will collect these slips.

Calculation of Payoffs

Your payment in each round of the experiment will be computed as follows. You will add your decision number, and random draw number, and record this sum in column 3 of sheet 2. Your pair member will do the same.

Since all subjects have worked in privacy, the experimenter will then compare the totals of you and your pair member. If you have an even subject number, then your pair member will always have an odd subject number, and vice versa. Your payoff is determined as follows:

If Your Subject Number is Odd

If your column 3 total is greater than your pair member's, you receive fixed payment X ($2.04).

If your column 3 total is not more than 24 less than your pair member's, you receive fixed payment X ($2.04).

If your column 3 total is 25 less than your pair member's, a fair coin will be flipped to determine whether you receive fixed payment X ($2.04) or Y ($0.86).

If your column 3 total is less than your pair member's by 26 or more, you receive fixed payment Y ($0.86).

Note that your column 3 total can be up to 25 less than your pair member's, and you will still receive the fixed payment X ($2.04).

If Your Subject Number is Even

If your column 3 total is greater than your pair member's by 26 or more, you receive fixed payment X ($2.04).

If your column 3 total is greater than your pair member's by 25, a fair coin will be flipped to determine whether you receive fixed payment X ($2.04) or Y ($0.86).

If your column 3 total is greater than your pair member's by 24 or less, you receive fixed payment Y ($0.86).

If your column 3 total is less than your pair member's, you receive fixed payment Y ($0.86).

Note that you will receive fixed payment Y ($0.86) unless your column 3 total is 25 or more greater than your pair member's column 3 total.

Circle the appropriate fixed payment in column 4, and subtract from column 4, the cost associated with your decision number listed in column 5. Record this difference in column 6. This amount in column 6 is your earnings for the round. The earnings of your pair member is calculated in exactly the same way.

After round 1 is completed, you will perform the same procedure. That is, you will choose a decision number again (though of course, you may pick the same one), you will open another envelope and record your random draw number for the round, and you will calculate a new total number. When round 20 is completed, add your earnings from each of the rounds, and record the total earnings at the bottom of sheet 2. Subtract from this the stated fixed cost. The remaining amount will be paid to you, in cash, at the end of the experiment.

Example of Payoff Calculations

For example, say that pair member a_2 (with an even subject number), chooses a decision number of 65, and draws a random number of -10, while pair member a_1 (with an odd subject number), selects a decision number of 50, and a random draw of 4.

The even number subject's (a_2) payoff calculation will look like this:

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
65	+	-10	=	55	$2.04	($0.86)	-	$0.28	=	$0.58

The odd number subject's (a_1) payoff calculations will look like this:

Col. 1 Decision Number		Col. 2 Random Number		Col. 3 Total 1 + 2	Col. 4 X Amt.	Col. 4 Y Amt.		Col. 5 Minus Cost		Col. 6 Total Earnings
50	+	04	=	54	($2.04)	$0.86	-	$0.17	=	$1.87

Since a_2's (the even number subject) total number (col. 3) did not exceed a_1's total number by 25 or more, subject a_1 receives the fixed payment X ($2.04).

Note, the amount subtracted in column 5 (decision cost), is only a function of your decision number - i.e. your random number draw does not affect the amount subtracted. Additionally, your total earnings depend on your random draw, your selected decision number (both in its contribution to your total, and the subtraction of its associated cost from your fixed payment, either X or Y), and your pair member's selected decision number, and random draw.

Subject #_____

Sheet 1 - Decision Costs Table

Column A Decision Number	Column B Cost of Decision	Column A Decision Number	Column B Cost of Decision	Column A Decision Number	Column B Cost of Decision
0	$0.0000	36	$0.086	72	$0.346
1	$0.0001	37	$0.091	73	$0.355
2	$0.0003	38	$0.096	74	$0.365
3	$0.0006	39	$0.101	75	$0.375
4	$0.001	40	$0.107	76	$0.385
5	$0.002	41	$0.112	77	$0.395
6	$0.003	42	$0.118	78	$0.406
7	$0.004	43	$0.123	79	$0.416
8	$0.005	44	$0.129	80	$0.427
9	$0.006	45	$0.135	81	$0.437
10	$0.007	46	$0.141	82	$0.448
11	$0.008	47	$0.147	83	$0.459
12	$0.010	48	$0.154	84	$0.470
13	$0.011	49	$0.160	85	$0.482
14	$0.013	50	$0.167	86	$0.493
15	$0.015	51	$0.173	87	$0.505
16	$0.017	52	$0.180	88	$0.516
17	$0.019	53	$0.187	89	$0.528
18	$0.022	54	$0.194	90	$0.540
19	$0.024	55	$0.202	91	$0.552
20	$0.027	56	$0.209	92	$0.564
21	$0.029	57	$0.217	93	$0.577
22	$0.032	58	$0.224	94	$0.589
23	$0.035	59	$0.232	95	$0.602
24	$0.038	60	$0.240	96	$0.614
25	$0.042	61	$0.248	97	$0.627
26	$0.045	62	$0.256	98	$0.640
27	$0.049	63	$0.265	99	$0.653
28	$0.052	64	$0.273	100	$0.667
29	$0.056	65	$0.282		
30	$0.060	66	$0.290		
31	$0.064	67	$0.299		
32	$0.068	68	$0.308		
33	$0.073	69	$0.317		
34	$0.077	70	$0.327		
35	$0.082	71	$0.336		