An Experimental Analysis of Rent Seeking Under Varying Competitive Conditions*

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Abstract:

We test several predictions of Gradstein's (1995) rent seeking model using an experimental design that includes a variable number of participants, cost heterogeneity, and an entry fee. Consistent with theoretical predictions, cost heterogeneity and the entry fee decrease the number of participants. Overall, participation is much lower than predicted. Also consistent with Gradstein's model, we find that rent seeking expenditures increase with the number of competitors and decrease with the addition of an entry fee. Experimental results do not support the prediction that cost heterogeneity generally decreases expenditures in rent seeking contests.

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I. Introduction

Anne Krueger (1974) initially coined the term "rent seeking" to describe competition for government favors but today economists apply the term to any situation in which an individual expends resources in an attempt to acquire something of value. Examples of rent seeking behavior include competition for monopoly power, a political position, or even a position on a team. Rent seeking is inefficient because it results in a net cost to society as real resources are spent pursuing a prize that is merely a transfer of resources. Even if the rent seeking activity does result in some societal benefit, the activity is inefficient as long as there is a net cost to society. Individuals find it in their best interest to rent seek, however, as long as the cost to themselves is less than their expected gain.

The literature on rent seeking behavior actually predates the coining of the term. In 1967 Gordon Tullock presented a model in which competitors vie for a single prize through the expenditure of resources. The more an individual spends, the greater his chance of winning the prize. Specifically, in a two person contest the probability of person A winning the prize is equal to $x_a^r/(x_a^r + x_b^r)$, where x_a and x_b are the expenditures of players A and B, respectively. The parameter r determines the impact of differences in expenditures on probabilities of winning. For example, in a contest with constant returns to expenditures (r=1), each competitor's chance of winning the prize is equal to his share of total expenditures. If the return on expenditures is infinite the contest is a discriminative auction, and the competitor who spends the most wins the prize.

A large number of theoretical papers emerged as extensions of Tullock's basic rent seeking model.[1] The experimental analysis presented here was motivated by one of

these extensions. Gradstein (1995) developed a model consistent with the empirical observation that most rent seeking contests consist of only a few participants by adding a fixed fee to enter the contest and an asymmetric cost structure. The addition of these two elements decreases the number of rent seekers as well as the level of rent dissipation. The experiments in this paper were designed to test the predictions of Gradstein's model. Unlike the theoretical literature on rent seeking, the experimental literature on rent seeking is relatively small. This paper builds on the existing experimental literature reviewed below by introducing an entry fee and a heterogeneous cost structure into the standard rent seeking framework.

II. Rent Seeking Experiments

The first strand of experimental rent seeking papers began with Millner and Pratt (1988) and was based on Tullock's basic model. Subjects were offered the opportunity to buy chances at winning a prize and the cost of competing was the same across competitors. The competitors were always broken into groups of two, but the composition of the groups changed from period to period. The return to expenditures (the parameter r in the model above) was either 1 or 3. Finally, expenditures were announced as they were made and subjects were allowed to adjust them in a decision-making period. The authors found that subjects spent more than the Nash prediction with r = 1 and less than the Nash prediction with r = 3.

Shogren and Baik (1991) replicated the Millner and Pratt (1988) experiment but only used r = 1. In addition, individuals were always matched with the same person and subjects were given a matrix that showed payoffs for all possible levels of expenditures

by both people. Shogren and Baik reported that expenditures were not significantly different from Nash predictions. Millner and Pratt (1991) also replicated the r = 1 treatment of their own 1988 experiment and added a pretest for risk aversion. They found that the less risk averse group spent more than the Nash prediction and expenditures in the more risk averse group were not significantly different from the Nash prediction. Potters et. al. (1998) used r = 1 and r = ∞ with two person groups, a full payoff matrix and random pairing each period. They found that subjects spent more than the Nash prediction with r = 1 and spending was not different from the Nash prediction with r = ∞.

A handful of additional rent seeking experiments have examined behavior in different theoretical frameworks. Isaac and Reynolds (1988) developed a research and development application. Their groups were composed of either four or nine competitors. In some cases, the winner of the competition got the entire prize. In other cases, the winner got most of the prize and each loser got a small fraction of the prize. They found significant differences from the Nash spending predictions in just one case: spending was lower than predicted when the winner took the entire prize in the nine person groups.

Önçüler and Croson (1998) presented a theoretical model of a two-stage rent seeking game. In the first stage subjects chose expenditures. The winner of the first stage advanced to the second stage in which he could potentially win a prize. The probability of receiving a prize decreased with the amount of money spent in the first stage. Group size was either two or four, and initial endowments varied across subjects. Finally, each person participated in just one contest. Overall they found that subjects

spent more than predicted by theory, and this overspending was worse in the groups of four and for subjects with higher initial endowments.

Davis and Reilly (1998) compared a lottery contest with $r = 1$ to a discriminative auction ($r = \infty$) with group size of either four or five. Additionally, they included a "strategic buyer" who had a higher prize value than other subjects. The role of the strategic buyer with randomly assigned each period by the throw of a die. The authors found that subjects generally spent more than predicted by theory, expenditures were relatively higher in the discriminative auction than in the lottery contest, and having the strategic buyer reduced expenditures. In a second set of experiments Davis and Reilly (2000) showed that adding more strategic buyers increased expenditures relative to having only one.

Our paper adds to the experimental rent seeking literature in several ways. First, we look a richer set of group sizes (i.e., groups of one to five participants and groups of ten participants). We also introduce varying degrees of cost heterogeneity across competitors. Finally, we incorporate an entry fee for participating in the contest. The theoretical model on which our experimental design was based and the model's predictions are discussed in the next section. Section IV discusses experimental design, section V presents results, and section VI concludes.

III. Theoretical Model

This section presents a modified version of Gradstein's (1995) rent seeking model. Consider n possible competitors for a prize of value V. For simplicity, we assume that each competitor's probability of winning the prize is a function of his own effort or

expenditure level and the effort or expenditure levels of the other competitors. Specifically, competitor i's expected profit can be expressed as:

$$E[\pi_i] = \frac{\left(x_i / c_i\right)}{\sum_j \left(x_j / c_j\right)} \cdot V - x_i$$

where x_i is the total expenditure of competitor i and c_i is the marginal cost of effort of competitor i. Thus (x_i/c_i) measures competitor i's effort level. Competitors are assumed to be risk-neutral profit maximizers. Solving for the first order conditions, we get

$$\left(V / c_i\right) \frac{\sum_j \left(x_j / c_j\right) - \left(x_i / c_i\right)}{\left[\sum_j \left(x_j / c_j\right)\right]^2} = 1 \text{ if } x_i > 0 \text{ and}$$

$$\left(V / c_i\right) \frac{\sum_j \left(x_j / c_j\right) - \left(x_i / c_i\right)}{\left[\sum_j \left(x_j / c_j\right)\right]^2} \leq 1 \text{ if } x_i = 0.$$

Let P be the set of participants, that is those competitors with strictly positive effort levels. Then the optimal level of expenditure for participant i (where i is an element of P) can be represented as:

$$x_i^* = \frac{Vc_i(p-1)}{\sum_{j\in P} c_j}\left[1-\frac{c_i(p-1)}{\sum_{j\in P} c_j}\right]$$ where p is the number of participants in P.

Thus total expenditure is:

$$X^* = \sum_{j\in P} x_j^* = V(p-1)\left[1-(p-1)\frac{\sum_{j\in P} c_j^{\,2}}{\left(\sum_{j\in P} c_j\right)^2}\right].$$

To determine whether competitor i will participate, order all players by cost, c, from lowest to highest. Then i will participate if and only if:

$$c_i < \frac{\sum_{k=1}^{i-1} c_k}{i-2}.$$

Since the value of the prize enters into the optimal contribution function linearly, if the value of the prize doubles, optimal expenditures double. When costs are the same across competitors, all competitors participate. If costs are asymmetric, some higher cost competitors may drop out. It can be shown that the number of participants is (weakly) decreasing in the level of cost heterogeneity. Also, total expenditures are increasing in the number of competitors and decreasing in the level of cost heterogeneity. Individual

expenditures are decreasing in the number of competitors. The effect of heterogeneity on an individual's expenditures depends on his cost relative to the costs of the other competitors.

Next, we extend this model to a two-stage game. In stage one, potential competitors determine whether or not to enter the competition. To enter, the competitors must pay a fixed entry fee, F. In the second stage, competitors who have paid the fee (participants) compete for the prize as in the one-stage game. Obviously competitors will only participate in the competition if the expected profit from the second stage exceeds the entry fee because otherwise the competitor could increase total profit by not entering. Thus all participants in the second stage will be active in the competition. Let P now represent the set of competitors that pay the entry fee (i.e., the participants) and let p represent the number of participants. Then the optimal expenditure in stage 2 is

$$x_i^* = \frac{Vc_i(p-1)}{\sum_{j\in P} c_j}\left[1-\frac{c_i(p-1)}{\sum_{j\in P} c_j}\right]$$ and the expected profit from entering is

$$E[\pi_i] = V\left[1-\frac{c_i(p-1)}{\sum_{j\in P} c_j}\right]^2 - F\,.$$

Order all players from lowest cost to highest cost. From the equation for expected profit, it is clear that if it is profitable for competitor i to enter in stage 1, it is profitable for all participants with lower costs than i to enter in stage 1. Thus i will enter if and only if:

$$\left[1-\frac{c_i(i-1)}{\sum_{k=1}^{i} c_k}\right]^2 > \frac{F}{V} \text{ which can be rewritten as } c_i < \sum_{k=1}^{i-1} c_k \left(\frac{1-\sqrt{\frac{F}{V}}}{i-2+\sqrt{\frac{F}{V}}}\right).$$

As long as the entry fee is less than the value of the prize,

$$\sum_{k=1}^{i-1} c_k \left(\frac{1-\sqrt{\frac{F}{V}}}{i-2+\sqrt{\frac{F}{V}}}\right) < \frac{\sum_{k=1}^{i-1} c_k}{i-2}$$

Thus the number of participants in the two-stage game will be less than or equal to the number of participants in the one-stage game. Since there are fewer competitors, expenditures (not including the entry fees) in the two-stage game will be less than or equal to expenditures in the one-stage game. If the entry fee is a pure transfer, rather than a true cost, including an entry fee in the competition will at least weakly decrease the dissipation of rents. However, if the entry fee does involve resource costs, the dissipation of rents in the two-stage game can exceed the dissipation of rents in the one-stage game. Additionally, the number of participants is (weakly) decreasing in F/V.

IV. Experimental Design

Subjects were recruited from undergraduate classes at The College of William and Mary. At the beginning of each session, the instructions (presented in the appendix) were read aloud. Subjects were told that they would make decisions for several possible

scenarios and that only one would actually determine their earnings. The scenario that determined earnings was chosen at the end of the session by the throw of a die. For each scenario, subjects were separated into groups to compete for a monetary prize by purchasing colored "markers."[2] All markers purchased by the group were placed in the group cup and one marker was drawn to determine the winner for the group. The prize amount, the number of possible scenarios, group size and the cost per marker for the group members varied in the experiment.

In the "low payoff" treatment, subjects were given a $5 initial balance and competed for a $5 prize. The low payoff sessions lasted 40 minutes and subjects were asked to make purchasing decisions for three possible scenarios. Thirty-one subjects participated in the low payoff treatment and the average payoff was $ 4.39. In the "high payoff" treatment, both the initial balance and the prize were doubled to $10. The high payoff sessions lasted one hour and subjects were asked to make purchasing decisions for six possible scenarios. Forty-seven subjects participated in the high payoff treatment and the average payoff, not including the show-up fee, was $9.89.[3]

All subjects made purchasing decisions under a homogeneous cost structure in which everyone paid $0.25 per marker. In addition, subjects made purchasing decisions under a variety of heterogeneous cost structures which are described in Table 1.[4] Table I also reports expenditures predicted by the theoretical model.[5] For every scenario, subjects were told all of the possible marker costs for their group and each subject was told his specific marker cost. Finally, in at least one scenario subjects had to pay a fee of $1 to enter the competition.

V. Results

Participation

We consider the effects of three treatment variables (group size, cost heterogeneity, and the existence of an entry fee) on each of three rent seeking outcomes (participation in the rent seeking contest, total group expenditures, and individual expenditures). First consider the results with respect to participation. The model predicts that all competitors will participate (i.e. spend some money competing for the prize) when costs are homogeneous and when there is no fixed participation fee. Table 2 lists the percent of subjects who spent money in the contest for each group size, scenario and prize value. Notice that participation was not always 100 percent under the homogeneous cost structure. In the $5 sessions, participation in groups of four and ten was not complete, and in the $10 sessions, participation was less than 100 percent for all group sizes.

The model also predicts that introducing cost heterogeneity decreases participation. Comparing the "cost homogeneity" rows to the "cost heterogeneity" rows in Table 2, note that introducing cost heterogeneity did decrease participation in all but one case: participation increased with cost heterogeneity with a group size of four in the $10 session. Overall, participation rates were closer to the predicted levels when costs were heterogeneous. Under the homogeneous cost structure, sixteen percent (20 out of 125) of competitors opted out of the contest when participation was optimal. Under the heterogeneous cost structure, only 11 percent (14 out of 125) of competitors opted out of the contest when participation was optimal.

The effect of the entry fee on participation is also consistent with theoretical predictions. Comparing the rows labeled "cost heterogeneity" and "cost heterogeneity and entry fee" in Table 2, notice that participation decreased in groups of two, five, and ten in the $5 treatment and there was no change in participation rates for groups of three and four. In the $10 treatment participation decreased in groups of two, three, and four, and there was no change in the participation rate for groups of five. Participation only increased with heterogeneity in groups of ten in the $10 treatment. As with the case of cost heterogeneity, the addition of the entry fee also served to decrease the number of competitors who did not participate when it was optimal to do so. With the entry fee and cost heterogeneity, only 8 percent (10 out of 125) of competitors opted out when participation was optimal.

To better analyze the participation decision, we ran a probit regression on the participation decision. The results are shown in Table 3. Consistent with the theoretical model, the coefficients on Costs, Variance of Costs and Entry Fee are all negative and statistically significant. Contrary to theory, the coefficient on Group Size is negative and statistically significant. Since predicted individual expenditures are lower in larger groups, decision error might explain this group size result. Specifically, a computational error by someone in a larger group could result in them mistakenly failing to enter the contest while the same error in a smaller group would reduce the amount spent, but not to zero.

The coefficient on Value of Prize is also negative and statistically significant. According to the model the value of the prize should only affect participation if there is an entry fee, in which case the effect should be positive.[6] Recall that in this experiment

the value of the prize and initial endowments were always the same. Thus the negative coefficient on Value of Prize might be reflecting lower participation in sessions with the $10 initial endowment rather than a $5 endowment. However, if the negative coefficient is due to a lower initial endowment, the result appears inconsistent with Önçüler and Croson's (1998) observation that higher initial endowments increased overall spending.

Group Expenditures

Next consider the results of the experiment with respect to group expenditures. Consistent with the findings of a number of the studies reviewed above, mean group expenditure exceeded the mean predicted group expenditure for all treatments in the experiment.[7] Moreover, in the majority of treatments, mean group expenditure exceeded the value of the prize (i.e., overdissipation of rents).[8] According to the model, group expenditures should be increasing with group size, and Table 4 shows that this is generally the case. For example, with a prize value of $5 and cost homogeneity group expenditures increase from $4.83 to $6.00 as group size grows from two to three. In all but four instances, mean group expenditure increased as group size increased.

Although the model predicts that group expenditures will be decreasing in the degree of cost heterogeneity, we do not see this in the experimental data. For example, when the prize is $5 and the group size is two, mean group expenditures are $5.08 with heterogeneous costs and $4.83 with homogeneous costs. Introducing heterogeneity decreased mean group expenditures in just two of the five group sizes with the $5 payoff and in three of the five group sizes with the $10 payoff. However, adding the entry fee reduces group expenditures in all treatments, as the model predicts.[9]

To further analyze the determinants of group expenditures, we ran a simple linear regression of actual group expenditures on group size, the value of the prize, heterogeneity of costs, and presence of an entry fee. Results from this regression are presented in Table 5. As expected, the coefficients on Group Size and Value of Prize are positive and significant. Because our model predicts that heterogeneity should have a larger negative effect on group contributions the larger the size of the group, we included both the variance of costs and the variance of costs interacted with group size in the regression.[10] For groups of three or less, the net effect of these variables on group expenditure is negative, but for groups of five or more, the net effect is positive.[11]

Individual Expenditures

Finally, let us consider the predictions for individual expenditures. When costs are homogeneous, the model predicts that individual contributions decrease as group size increases. As shown in Table 6, under cost homogeneity the coefficient on Group Size is negative, as expected, and significant. The coefficient on Value of Prize is positive and significant, also as expected. The predicted effect of heterogeneity on individual expenditures depends on the costs of the individual relative to other competitors and the number of competitors. For example, as shown in Table 1, in groups of two increasing heterogeneity implies decreasing individual expenditures for both competitors regardless of the competitors' costs. In groups of four, individual expenditures increase for competitors with costs below average and decrease for competitors with costs above average. In many cases, competitors drop out of the competition if their costs are high relative to the costs of their competitors. Since the imposition of an entry fee also causes competitors to drop out, in general individual expenditures decrease when the entry fee is

added. However, in some cases the decrease in the number of participants can serve to increase the level of competition (and expenditures) because the remaining participants have relatively low costs.

Table 6 presents the results of a linear regression on individual expenditures for all treatments. Once again, the coefficient on Group Size is negative (and significant) and the coefficient on Value of Prize is positive (and significant). The coefficient on Cost is negative and significant, indicating that the higher a competitor's cost the lower his expenditure. For groups of four or less, the net effect of heterogeneity (as measured by Variance and Variance*Size) is negative, while for groups of more than five the net effect is positive. We also included Gender in the regression. For both specifications, the coefficient is positive, indicating that female competitors spent more than male competitors, although the coefficient is only significant for the regression on all treatments.[12]

VI. Summary

We experimentally test the effects of group size, cost heterogeneity, and the existence of an entry fee on rent seeking behavior. Consistent with theoretical predictions, we find that cost heterogeneity and an entry fee decrease participation. Group size also is negatively related to participation, although the model does not predict such a relationship. In addition, we find that participation in the rent seeking contest is generally lower than the theoretical model predicts. Moreover, while participation is lower than predicted, group expenditures are generally much higher than predicted.

The effects of group size and the addition of an entry fee on group expenditures are also consistent with theoretical predictions: expenditures increase with the size of the group and decrease with the entry fee. Individual expenditures are negatively related to group size and the individual's cost, as expected. Also, adding an entry fee generally decreases expenditures at the individual level. Experimental results do not appear to support the theoretical predictions with respect to cost heterogeneity. Under some conditions heterogeneity is inversely related to expenditures, as predicted, but in other cases expenditures increase with the degree of cost heterogeneity.

Notes

[1] See Tullock (1995) for a survey of theoretical rent seeking papers.

[2] The markers were craft beads purchased at Wal Mart.

[3] This average does not include a show-up fee ($5 to $10 depending on the sessions) that was paid to all subjects in the $10 payoff session. The $5 payoff session was conducted during a colleague's class period and subjects were not paid a show-up fee.

[4] The mean of all cost distributions is 0.25 and costs are distributed symmetrically about the mean. Thus, the standard deviation of the distribution can be used to characterize heterogeneity.

[5] Predicted expenditure levels reported in Table 1 are calculated based on the assumption that expenditures are continuous. In the actual experiment, subjects could not purchase fractions of markers.

[6] Participation is weakly increasing in (F/V) and thus weakly decreasing in V.

[7] There are thirty treatments: for each of the two prize values there are five group sizes and three cost structures (homogeneous costs, heterogeneous costs, heterogeneous costs with entry fee).

[8] Overdissipation of rents occurred in 11 of the 15 treatments (73%) with a $5 prize and 10 of the 15 treatments (67%) with a $10 prize.

[9] Group expenditures do not include the $1 entry fee.

[10] As stated previously, the mean of all cost distributions is 0.25 and costs are distributed symmetrically about the mean. Thus, the variance deviation of the distribution can be used to characterize heterogeneity.

[11] The coefficient on Variance is approximately 4 times larger than the coefficient on Variance*Size. Thus when group size is less than (greater than) 4, the combined effect of Variance and Variance*Size is negative (positive).

[12] Eckel and Grossman (2001) review experimental studies that examine gender differences in behavior.

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Table 1: Predicted Expenditures in the One-Stage Game when the Prize is $5

N	SD of costs	Costs					Predicted Expenditures					X*
2	0.00	$c_1 = 0.25$	$c_2 = 0.25$				$x_1 = 1.25$	$x_2 = 1.25$				2.50
2	0.07	$c_1 = 0.20$	$c_2 = 0.30$				$x_1 = 1.20$	$x_2 = 1.20$				2.40
2	0.14	$c_1 = 0.15$	$c_2 = 0.35$				$x_1 = 1.05$	$x_2 = 1.05$				2.10
3	0.00	$c_1 = 0.25$	$c_2 = 0.25$	$c_3 = 0.25$			$x_1 = 1.11$	$x_2 = 1.11$	$x_3 = 1.11$			3.33
3	0.05	$c_1 = 0.20$	$c_2 = 0.25$	$c_3 = 0.30$			$x_1 = 1.24$	$x_2 = 1.11$	$x_3 = 0.80$			3.15
3	0.10	$c_1 = 0.15$	$c_2 = 0.25$	$c_3 = 0.35$			$x_1 = 1.20$	$x_2 = 1.11$	$x_3 = 0.31$			2.62
4	0.00	$c_1 = 0.25$	$c_2 = 0.25$	$c_3 = 0.25$	$c_4 = 0.25$		$x_1 = 0.94$	$x_2 = 0.94$	$x_3 = 0.94$	$x_4 = 0.94$		3.75
4	0.06	$c_1 = 0.20$	$c_2 = 0.20$	$c_3 = 0.30$	$c_4 = 0.30$		$x_1 = 1.20$	$x_2 = 1.20$	$x_3 = 0.45$	$x_4 = 0.45$		3.30
4	0.09	$c_1 = 0.15$	$c_2 = 0.20$	$c_3 = 0.30$	$c_4 = 0.35$		$x_1 = 1.24$	$x_2 = 1.18$	$x_3 = 0.36$	$x_4 = 0$		2.78
5	0.00	$c_1 = 0.25$	$c_2 = 0.25$	$c_3 = 0.25$	$c_4 = 0.25$	$c_5 = 0.25$	$x_1 = 0.80$	$x_2 = 0.80$	$x_3 = 0.80$	$x_4 = 0.80$	$x_5 = 0.80$	4.00
5	0.08	$c_1 = 0.15$	$c_2 = 0.20$	$c_3 = 0.25$	$c_4 = 0.30$	$c_5 = 0.35$	$x_1 = 1.25$	$x_2 = 1.11$	$x_3 = 0.69$	$x_4 = 0$	$x_5 = 0$	3.05
10	0.00	$c_1 = 0.25$	$c_2 = 0.25$	$c_3 = 0.25$	$c_4 = 0.25$	$c_5 = 0.25$	$x_1 = 0.45$	$x_2 = 0.45$	$x_3 = 0.45$	$x_4 = 0.45$	$x_5 = 0.45$	4.50
		$c_6 = 0.25$	$c_7 = 0.25$	$c_8 = 0.25$	$c_9 = 0.25$	$c_{10} = 0.25$	$x_6 = 0.45$	$x_7 = 0.45$	$x_8 = 0.45$	$x_9 = 0.45$	$x_{10} = 0.45$	
10	0.07	$c_1 = 0.15$	$c_2 = 0.15$	$c_3 = 0.20$	$c_4 = 0.20$	$c_5 = 0.25$	$x_1 = 1.15$	$x_2 = 1.15$	$x_3 = 0.61$	$x_4 = 0.61$	$x_5 = 0$	3.52
		$c_6 = 0.25$	$c_7 = 0.30$	$c_8 = 0.30$	$c_9 = 0.35$	$c_{10} = 0.35$	$x_6 = 0$	$x_7 = 0$	$x_8 = 0$	$x_9 = 0$	$x_{10} = 0$	

Note: All expenditures double when the value of the prize doubles to $10.

Table 2: Participation in Rent Seeking Contests

Prize Value	Scenario	Group Size 2	3	4	5	10
$5	Cost Homogeneity	100%	100%	75%	100%	90%
$5	Cost Heterogeneity	83%	100%	50%	100%	80%
$5	Cost Heterogeneity and Entry Fee	67%	100%	50%	80%	40%
$10	Cost Homogeneity	86%	87%	70%	87%	70%
$10	Cost Heterogeneity	79%	87%	85%	73%	67%
$10	Cost Heterogeneity and Entry Fee	43%	73%	60%	73%	76%

Table 3: Results of Probit Regression of Participation

(N=375)	Coefficient	Standard Error
Constant	3.88*	0.52
Group Size	-0.08*	0.02
Value of Prize	-0.09*	0.04
Cost	-6.87*	1.29
Variance of Costs	-29.47*	17.86
Entry Fee	-0.60*	0.16
Gender (1=Female)	0.24	0.15

* Significant at the 95% level using a one-tailed test for all variables other than gender and group size.

Table 4: Mean Group Expenditures

Prize Value	Scenario	Group Size 2	3	4	5	10
$5	Cost Homogeneity	$4.83	$6.00	$9.00	$14.25	$13.25
$5	Cost Heterogeneity	$5.08	$7.48	$3.50	$10.10	$20.15
$5	Cost Heterogeneity and Entry Fee	$2.90	$5.95	$3.00	$6.60	$11.70
$10	Cost Homogeneity	$8.96	$13.25	$14.06	$24.17	$22.17
$10	Cost Heterogeneity	$7.15	$13.04	$15.30	$16.90	$28.48
$10	Cost Heterogeneity and Entry Fee	$3.89	$8.94	$9.70	$15.43	$17.75

Table 5: Results of Linear Regression of Group Expenditures

(N=93)	Coefficient	Standard Error
Constant	-2.39	2.55
Group Size	1.49*	0.33
Value of Prize	1.07*	0.24
Variance of Costs	-308.44	189.95
Variance*Size	75.52	64.59
Entry Fee	-4.13*	1.21

* Significant at the 95% level using a one-tailed test for all variables.

Table 6: Results of Linear Regression of Individual Expenditures

	Cost Homogeneity		All Treatments	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**
Constant	1.86*	0.92	6.19*	0.77
Group Size	-0.25*	0.07	-0.26*	0.06
Value of Prize	0.28*	0.10	0.22*	0.06
Cost			-15.67*	2.01
Variance of Costs			-118.89*	43.78
Variance*Size			23.36*	10.72
Entry Fee			-1.07*	0.27
Gender (1=Female)	0.55	0.44	0.85*	0.24

* Significant at the 95% level using a one-tailed test for all variables other than gender.

Appendix: Instructions from $10 prize session.

Your color:_____

Your ID Number _____

General Instructions

This experiment is a study of individual behavior. The instructions are simple. If you follow them carefully and make good decisions you may earn a considerable amount of money, which will be paid to you privately, in cash, at the end of the experiment today. At this time, you will be paid $10 for showing up for the experiment today.

You will be asked to make decisions under six possible scenarios. After everyone has made decisions for all six scenarios, we will throw a 6-sided die to determine which scenario will be used to determine your earnings. If the throw of the die is 1, we will use scenario 1 to determine your earnings. If the throw of the die is 2, we will use scenario 2 to determine your earnings and so on. Note that you will only be paid for one of the six scenarios, but no one will know which one until you have made decisions for all six. Therefore, you should think carefully about your decisions for all six possible scenarios since they are all equally likely to determine your earnings.

The basic structure of the six scenarios is the same. You will be randomly assigned to a group of people. The other members of your group are in this room, but you **will never** be told who they are. The number of people in your group varies across the six scenarios and you **will** be told this number for each scenario.

In each scenario, you are competing with the other members of your group for a monetary prize of $10. To compete for the prize you may purchase colored markers. The more markers you purchase, the greater your chance of winning the prize as will now be explained: Each member of your group has been assigned a color. Your color is written in the upper right hand corner of this page. The markers that you purchase match the color that you have been assigned. Each marker that you purchase will be placed in your group cup. There is a different cup for each group. Once all purchased markers are placed in a cup, we will draw one marker from each group cup. If the marker we draw from your group cup matches your color, you win the prize for your group. Since there is a separate cup for each group and each color is assigned to only one person in your group, you cannot win the prize if you do not purchase any markers because none of your colored markers will be in the cup when we draw.

Finally, each of you begins the experiment today with a starting balance of $10. You may use some or all of this money to purchase markers. Alternatively, you may keep all of this money in your account, in which case it will be paid to you in cash at the end of the experiment today. You cannot buy more markers than your starting money balance will allow. You have $10 to spend in <u>each</u> scenario, since only one scenario will actually be used to determine your earnings. In other words, you do not have to spread your $10 starting balance over the six scenarios. Your cost for each marker varies across scenarios and **will** be told to you in the descriptions of the scenarios that follow.

Please read the information for each scenario on the next page and fill in your decisions in the blanks provided. Be careful not to let others see what you write on your Record Sheet. This information should be private. Anyone caught trying to look at someone else's Record Sheet will be asked to leave the experiment and will not be paid. Once you have made all of your decisions, turn over your sheet and wait quietly until everyone has recorded their decisions. If you have a question, raise your hand and we will come to your desk to answer it.

Record Sheet

Scenario 1:

- You are in group _____.
- There are _____ people in your group.
- The cost for each marker is _25¢_ for you and for every member of your group for this scenario. Therefore you can buy up to __40__ markers with your $10 initial balance.
- Recall that the prize amount is $10 for this scenario.

- Please enter the number of markers that you wish to purchase for **scenario 1** here: _____

Scenario 2:

- You are in group _____.
- There are _____ people in your group.
- The cost for each marker is _25¢_ for you and for every member of your group for this scenario. Therefore you can buy up to __40__ markers with your $10 initial balance.
- Recall that the prize amount is $10 for this scenario.

- Please enter the number of markers that you wish to purchase for **scenario 2** here: _____

Scenario 3:

- You are in group _____.
- There are _____ people in your group.
- The cost for each marker varies across the members of your group. The possible costs are _____. Your cost is _____¢ per marker. Therefore you can buy up to _____ markers with your $10 initial balance.
- Recall that the prize amount is $10 for this scenario.

- Please enter the number of markers that you wish to purchase for **scenario 3** here: _____

Scenario 4:

- You are in group _____.
- There are _____ people in your group.
- The cost for each marker varies across the members of your group. The possible costs are _____. Your cost is _____¢ per marker. Therefore you can buy up to _____ markers with your $10 initial balance.
- Recall that the prize amount is $10 for this scenario.

- Please enter the number of markers that you wish to purchase for **scenario 4** here: _____

Scenario 5:

- You are in group _____.
- There are _____ people in your group.
- In this scenario you must pay a fixed entry fee of $1 to be able to enter the competition. If you choose to pay this fee, it will be deducted from your $10 initial balance and will reduce the amount you have available to buy markers. If you choose not to pay this fee, you will not participate in the competition and we will pay you the $10 initial balance amount at the end of the experiment today if scenario 5 is chosen by the throw of the die.
- The cost for each marker varies across the members of your group. The possible costs are _____. Your cost is _____¢ per marker. Therefore, you can buy up to _____ markers with your remaining balance of $9 (= $10 minus $1 entry fee).
- Recall that the prize amount is $10 for this scenario.

- Please check here if you want to pay the fixed entry fee of $1 to participate in the **scenario 5** competition: _____

- Please enter the number of markers that you wish to purchase for **scenario 5** here: _____

Scenario 6:

- You are in group _____.
- There are _____ people in your group.
- In this scenario you must pay a fixed entry fee of $1 to be able to enter the competition. If you choose to pay this fee, it will be deducted from your $10 initial balance and will reduce the amount you have available to buy markers. If you choose not to pay this fee, you will not participate in the competition and we will pay you the $10 initial balance amount at the end of the experiment today if scenario 6 is chosen by the throw of the die.
- The cost for each marker varies across the members of your group. The possible costs are _____. Your cost is _____¢ per marker. Therefore, you can buy up to _____ markers with your remaining balance of $9 (= $10 minus $1 entry fee).
- Recall that the prize amount is $10 for this scenario.

- Please check here if you want to pay the fixed entry fee of $1 to participate in the **scenario 6** competition: _____

- Please enter the number of markers that you wish to purchase for **scenario 6** here: _____