Rent-Seeking for a Risky Rent: A Model and Experimental Investigation

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Abstract
This paper extends Tullock's (1980) rent-seeking model to the case of a risky rent. We derive equilibrium and comparative static predictions from our extended model and present the results of an experiment with subjects from the US and Turkey to test it. Results are consistent with the comparative static predictions of the model, although we observe significantly more absolute levels of rent-seeking than the model predicts.

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1. Introduction

Rent seeking (the spending and transferring of resources to privately capture value) is a prevalent problem in many settings. Typically, this problem has been described in the context of lobbying in order to obtain a monopoly rent (Tullock 1967). However, the inefficient quest for personal privilege which rent-seeking models describe can be observed in multiple settings and organizations, from pesticide legislation (Wise and Sandler 1994) to value formation in the art markets (Mossetto 1994).

While a number of models of rent-seeking have been developed (e.g. Becker 1968, Krueger 1974, Posner 1975, Tullock 1980), we know very little about actual rent-seeking behavior, in part because this behavior is difficult to observe (some is even illegal). What we do know, suggests that the use of political influence over policy-makers leads to high levels of inefficiency and social waste. Empirical estimates of social costs of rent-seeking range from 7% of GNP (Kreuger 1974) to 30-45% of GNP (Mohammad and Whalley 1984).

This paper contributes to the literature on rent-seeking in a number of ways. First, we present a framework to organize different types of rent-seeking problems. Second, we develop a model of one of these problems, seeking a risky rent, and its equilibrium and comparative statics predictions (section 3). Finally, we present the results of an experiment designed to test these predictions (sections 4 and 5). The results of the experiment are consistent with of the comparative statics predictions of the model, however they suggest super-optimal rent-seeking expenditures.

1.1 The Framework

Rent-seeking activities have been observed and described in a variety of circumstances. Our taxonomy of such activities distinguishes two features of the nature of the rent which we believe characterize different rent-seeking activities.

First, the rent can be all-or-none or shared. For example, when competing for an all-or-none rent, like having a public park in one's neighborhood, the winner gets the whole prize at the end. No sharing is involved or possible. Alternately, there are some situations where rent-seekers compete for a share from a common pool, such as the allocation of the public budget among bureaus.

A second feature of the rent is whether it is certain or risky. For example, when competing for a certain rent, like the aforementioned park, the payoff to the winner is certain and known to be so. In contrast, when competing for a risky rent, the value of the rent to the winner is not known for sure. A recent paper suggests that all rents which stem from the government might be uncertain in that funds allocated to a group from a governmental budget (perhaps the result of some rent-seeking game) may not be disbursed (Kahana and Nitzan 1998).

Figure 1 shows examples for each possible outcome. The local park is a riskless, all-or-none rent; the community's value for the park is presumably known in advance, and only one community can get it. In contrast, an allocation of a budget is a riskless, shared rent. The bureaus know their value from receiving the budget, but each gets a share of the budget rather than the whole thing. The process of a political appropriation is an example of a risky, all-or-none rent, in which a process of rent-seeking may determine whether a group receives a budget line, but the actual appropriation process is uncertain.

Finally, participating in a primary campaign is a risky, shared rent. If the candidate is elected, the campaign workers would share in the rents gained, however the election itself is uncertain.

Insert Figure 1 about here

This paper presents a new theoretical and experimental investigation of rent-seeking expenditures for risky, all-or-none rents (the upper-right cell of Figure 1). We derive and compare equilibrium and comparative static predictions with experimental results.

The paper proceeds as follows: The next section provides a review of the previous research on rent-seeking. Section 3 introduces the experimental model and the hypotheses on equilibrium predictions and comparative statics. After describing the experimental design in section 4, results are analyzed in section 5. The paper ends with a discussion and suggestions for possible extensions.

2. Previous Research

In this section we briefly review two main categories of previous research in this area; theoretical and experimental.

2.1 Theoretical Research

Tullock (1980) proposed a model of rent-seeking which we will later extend to the case of risky rents. In Tullock's model, *n* players (who can be viewed as individuals or interest groups composed by members with homogeneous interests) have well-defined preferences over the allocation of some social resources. In order to influence the policymaker's decision, each player can invest some amount $\$x_i$ in unproductive activities. The probability of obtaining player i's preferred policy is assumed to be the following function of x_i:

$$\pi_i = \frac{x_i^{\alpha_i}}{x_i^{\alpha_i} + \sum_{j \neq i} x_j^{\alpha_j}}, \ \alpha_j \geq 0$$

where α_i reflects the marginal effect of rent-seeking expenditure on the probability of getting one's preferred outcome. [1] This parameter α_i can be seen as a basic notion of political influence. The higher an individual's or group's political influence over the social planner, the higher the agents' capacity to secure desirable outcomes for a given level of rent-seeking expenditure.

Using this framework, each player solves the following decision problem in a noncooperative environment:

$$\underset{x_i}{Max} EU_i = \frac{x_i^{\alpha_i}}{x_i^{\alpha_i} + \sum_{j \neq i} x_j^{\alpha_j}} \cdot u(R) + u(w_i - x_i)$$

where R is an indivisible fixed rent; x_i is the rent-seeking expenditure and w_i is the initial wealth of player i. After solving for the set of Nash equilibria, Tullock concludes that there may be over, complete or under-dissipation of the rent by rent-seeking activities, depending on the number of players involved.[2] Nitzan (1994) presents a survey of other rent-seeking results.

In the present study, we extend Tullock's model to a risky all-or-none rent (the upper right-hand cell of Figure 1), assuming symmetric political influence (α_i=1 $\forall$i). We solve for the Nash equilibrium of the new model, and derive some comparative statics results of that equilibrium. We then go on to experimentally test the equilibrium point predictions and comparative statics.

2.2 Experimental Research

In contrast to theoretical work, experimental analysis of rent-seeking behavior is a relatively new approach. The first paper in this area, Millner and Pratt (1989), examine the effectiveness of rent-seeking (i.e. the parameter α_i) on the final outcome in Tullock's (1980) rent-seeking game. Focusing on the two symmetric cases of α_i=1 and α_i=3, their results indicate that increases in the marginal effectiveness of rent-seeking leads to higher dissipation of the final prize as predicted by the Nash equilibrium, but the average dissipation rate is higher than predicted by Nash solution for α_i=1 and lower for α_i=3.

In an attempt to examine the effect of individual preferences on the final outcome, Millner and Pratt (1991) present a different experiment in which they test the theoretical predictions of Hillman and Katz (1984). They conclude, in contrast to the model's predictions, that relatively less risk-averse subjects dissipate *more* of the final rent.

In other work, Shogren and Baik (1991) theoretically analyze the rent-seeking game with an exit option (allowing players not to participate). They show there is no Nash equilibrium when α_i>2 for all i. In addition, they design an experiment using an explicit one-shot payoff matrix, in which results are consistent with the theoretical prediction when α_i =1.

Finally, in two recent papers Davis and Reilly theoretically and experimentally examine the effect of adding a strategic buyer who engages in rent-defending activities. In Davis and Reilly (1998a) they show that the introduction of such a buyer reduces social costs.[3] In Davis and Reilly (1988b), they show that adding multiple buyers ameliorates the benefits of adding one.

In this paper, we test both the baseline predictions from our extended model and its comparative statics (the influence of group size and initial endowments) in an experimental setting. In addition, we examine cultural factors and their influence on rent-seeking expenditures, using data from both the US and Turkey.

3. The Model and Experimental Hypotheses

This section describes our extension of Tullock's (1980) model. Subsections describe the equilibrium strategies for symmetric and asymmetric games, and derive the comparative statics of the model. These theoretical results provide our hypotheses for the experiment.

Consider the following two-stage game. In the first stage, players participate in a rent-seeking contest in order to win a risky all-or-none rent. In the second stage, the winner of Stage I competes against nature to determine the probability of receiving the rent. The expected value of the rent is a (positive) function of the winner's endowment remaining after rent-seeking expenditures have been made.

Returning to the example of political appropriations, this can be interpreted in the following way: In the first stage, interest groups compete against each other in order to get funds from the Appropriations Committee. Once the funds are allocated, in the next stage, there is some chance they will not be disbursed. The probability of disbursement is related to the budget these interests groups have remaining. The winning group can then spend their remaining resources to secure their promised allocation.

Using the lottery framework proposed by Tullock, we model the expected utility of player *i* as

$$EU_i = \begin{cases} \frac{1}{n} \cdot u(R) & if\, x_i = 0, \forall i \\ \frac{x_i}{x_i + \sum_{j \neq i} x_j} \cdot \frac{w_i - x_i}{w_i} \cdot u(R) & otherwise \end{cases}$$

where x_i is player i's rent-seeking expenditure in the first stage, $\sum_{j \neq i}^{n} x_j$ is the aggregate rent-seeking expenditure of the opponents; w_i is player i's initial endowment; w_i-x_i is the amount left for the second stage and $R is the prize in monetary terms.[4]

This formalization has a number of interesting properties. First, the probability of winning the *contest* is as in Tullock's model with $\alpha_i = 1$. However, the rent earned is no longer certain but instead probabilistic. The probability of earning the *rent* is exactly the percentage of the individual's endowment remaining. Thus rent-seeking expenditures must be balanced against a reduced expected value of the prize if one wins the contest.

A second nice property of this model of risky rent for purposes of experimentation is that it implements a binary lottery procedure, and thus, in theory, we need not concern ourselves about risk preferences of our subjects. Further discussion of the binary lottery procedure is presented below and in Roth and Malouf (1979).

In our model, each individual thus faces the following problem:

$$\underset{x_i \in [0, w_i]}{Max} EU_i(x_i, x_{-i}) = \frac{x_i}{x_i + \sum_{j \neq i} x_j} \left[\left(\frac{w_i - x_i}{w_i} \right) u(R) \right], for \;\; i = 1, ..., n$$

where *R>0* is a pre-determined and publicly known rent, expressed in monetary terms.

For a fixed $\sum_{j \neq i} x_j$, the first-order condition yields:

$$\left(x_i + \sum_{j \neq i} x_j \right)(w_i - x_i) - x_i (w_i - x_i) - x_i \left(x_i + \sum_{j \neq i} x_j \right) = 0, \, for \;\; i = 1,\ldots,n$$

The corresponding best-response function can be derived from this set of first-order conditions:

$$x_i^*\left(x_{-i}^*\right) = \sqrt{w_i \sum_{j \neq i} x_j^* + \left(\sum_{j \neq i} x_j^* \right)^2} - \sum_{j \neq i} x_j^*, \, for \;\; i = 1,\ldots,n$$

In this extended model, the optimal rent-seeking contribution is independent of the final prize R. Therefore we cannot draw any general conclusions about how much rent-dissipation takes place.[5]

3.1 The Symmetric Game

For a symmetric game in which all players have equal endowments ($w_i = w \; \forall i$), the equilibrium strategies can be straightforwardly derived from simultaneously solving the set of best-response functions, which yields the equilibrium level of rent-seeking expenditure:

$$x_S^* = \frac{w(n-1)}{2n-1}, \; for \; i = 1,\ldots,n$$

It should be noted that while $(x_i, x_{-i}) = (0,0)$ is not an equilibrium outcome, it is Pareto-efficient.

In the symmetric endowment treatments of our experiment, then, we expect subjects to choose the equilibrium amount of rent-seeking expenditures.

Hypothesis 1S: When players' endowments are symmetric, we expect subjects to choose x_S* of rent-seeking expenditure.

3.2 The Asymmetric Game

For asymmetric games where $w_i \neq w_j$, the same set of best response functions can be simultaneously solved, yielding an equilibrium prediction of:

$$x_{iA}^{*} = .22(2nw_i + \sum_{j\neq i} w_j) + \frac{16n^2w_i^2 + 20nw_i\sum_{j\neq i} w_j + 4\left(\sum_{j\neq i} w_j\right)^2}{.14\left(128n^3w_i^3 + 240n^2w_i^2\sum_{j\neq i} w_j + 123nw_i\left(\sum_{j\neq i} w_j\right)^2 + 16\left(\sum_{j\neq i} w_j\right)^2\right)^{1/3}}$$

The equilibrium strategy x_{iA}^* is again Pareto-inferior to $x_i=0\ \forall i$. Note that the symmetric game solution above is simply a special case of the asymmetric game with $w_i=w\ \forall i$.

In the asymmetric endowment treatments of our experiment, then, we expect subjects to choose the equilibrium amount of rent-seeking expenditures.

Hypothesis 1A: When players' endowments are asymmetric, we expect subjects to choose x_{iA}* of rent-seeking expenditure.

3.3 Comparative Statics of the Model

3.3.1 Own Endowment

Our second and third hypotheses involve the comparative statics effect of variations in the initial wealth allocation. The impact of increasing one player's wealth leaving others' endowment constant (either changing the symmetric wealth structure to an asymmetric one or increasing own wealth in an already asymmetric game) is intuitive, an increase in own endowment level holding all else constant increases the optimal rent-seeking expenditure. Appendix A provides the derivation of all comparative statics predictions.

$$\frac{\partial x_{iA}^*}{\partial w_i} > 0 \quad for \quad n \geq 1$$

This result leads us to Hypothesis 2:

Hypothesis 2: Subjects' rent-seeking expenditures will increase with an increase in their own endowment, keeping their opponents' endowment levels constant.

3.3.2 Opponents' Endowment

A similar increase in the opponents' endowment levels holding all else constant also increases optimal rent-seeking expenditures, but not by as much as an increase in one's own endowment level:

$$\frac{\partial x_{iA}^*}{\partial w_i} > \frac{\partial x_{iA}^*}{\partial w_j} > 0 \quad for \quad n \geq 1$$

This result leads us to hypothesis 3:

Hypothesis 3: Subjects' rent-seeking expenditures will increase with an increase in their opponents' endowment, but not as much as with an increase in their own.

3.3.3 Number of Players

The final comparative statics hypothesis involves the number of players. Equilibrium rent-seeking behavior is positively related to the number of players competing for the prize. Taking the derivative of the optimal expenditure, x_S^* and x_{iA}^*, with respect to the number of players, n, we can show that expenditure increases with group size in both symmetric and asymmetric games, holding all else constant.

$$\frac{\partial x_S^*}{\partial n} = \frac{w(3n-1)}{2(2n-1)^2} > 0 \ \ for \ n \geq 1$$

$$\frac{\partial x_{iA}^*}{\partial n} > 0 \ \ for \ n \geq 1$$

These results lead us to hypothesis 4:

Hypothesis 4: Subjects' rent-seeking expenditure will increase with an increase in the number of players.

Our experimental design (as outlined in the next section) allows us to test hypotheses 1S, 1A, 2 and 3 directly. However, in the experiment we simultaneously increase both the number of players and their endowments. Since both have a positive effect on an individual's rent-seeking expenditures, we expect hypothesis 4 to hold in our experimental setting as well. The next section describes our experimental design in more detail.

4. Experimental Design and Procedures

4.1. Experimental Design

The experiment designed to test these hypotheses consisted of two sessions (one in the US and one in Turkey). There were four treatments in each session, varying in group size and initial endowment levels. Table 1 shows the parameters for each treatment, together with the equilibrium predictions for optimal rent-seeking expenditures.

Insert Table 1 about here

This experimental design allows us to test our hypotheses detailed above. First, we compare rent-seeking expenditures against the Nash equilibrium predictions in both symmetric and asymmetric groups.

To test the comparative statics hypothesis about own wealth, we compare expenditures by subjects in two-person symmetric groups whose endowments are 30 with those in two-person asymmetric groups whose endowments are 60 (this comparison keeps constant the number of players and the endowments of others). The prediction is that rent-seeking expenditures should increase by 7 units (moving from 10 to 17).

To test the comparative statics hypothesis about others' wealth, we compare expenditures by subjects whose endowments are 30 in symmetric groups with those in asymmetric groups (this comparison keeps constant the number of players and own endowment, changing only the endowment of others in the group). The increase in the equilibrium rent-seeking expenditures with an increase in opponents' endowment is positive but incremental with these parameters (moving from 10 to 11 in the two-person case and 13 to 14 in the four-person case).

To test the comparative statics hypothesis about the number of subjects, we compare expenditures by subjects in two-person groups with those in four-person groups. This comparison can be done in a way which keeps the subjects' own endowment constant (e.g. a 30-endowment subject in a two-person symmetric group versus a 30-endowment subject in a four-person symmetric group), but allows the total wealth of the others in the group to increase as well. Since our analysis of these two effects suggest both are both positive, we expect to see a significant increase in this comparison. We can compare the size of this effect and the previous one to determine the extent to which the increase in expenditures is caused by the increase in the number of rent-seekers in the group versus the increase in the endowments of others.

4.2. Experimental Procedures

Two sessions were run, one in the US (n=174) and the other in Turkey (n=127). The US subject pool was drawn from the University of Pennsylvania undergraduate students enrolled in an introductory course in public economics. The subject pool in Turkey was recruited from undergraduate students majoring in business administration at Bogazici University. Subjects were paid a show-up fee of $3 (300,000 TL in Turkey) as well as their earnings in the experiment. [6] All subjects received their earnings privately after the experiment had ended.

The experiments in Turkey were run in Turkish by the same experimenter who ran the US sessions. All instructions were translated and back-translated. A copy of the instructions in English is reproduced as Appendix B; a Turkish copy as well as the raw data from the experiment is available from the authors upon request.

The experiment used a between-subject design, thus no subject participated in more than one session. All treatments were conducted in a classroom. Subjects were seated so that that they could not communicate with one another and groups assigned randomly and anonymously.

The experimenter distributed the instructions and read them aloud to create common information (if not common knowledge). Subjects were given 10 minutes to make their decisions. A post-experimental quiz was given to check if the subjects understood the instructions and the rules of the game. Six participants from US and 11 from Turkey were excluded based on their performance, leaving 80 subjects in both of the symmetric treatments; 66 in the 2-person asymmetric treatment and 68 in the 4-person asymmetric treatment.

The game was implemented as follows. Each player received some predetermined number of cards. In the first stage, each player chose how many of the cards to spend by sending the appropriate number of cards to the experimenter. The experimenter then mixed all the cards for each group together and chose one. This determined the winner of the rent-seeking game in each group.

The winner then participated in a lottery in the second stage. For this lottery, the remaining cards of the winning player were mixed with blank ones to sum to the prespecified total of their endowment, w_i. A random draw was then made. If the card drawn was one of the player's, they won *\$R=\$20* (or 2,000,000 TL). The game ended after this drawing. Participants were paid privately and left the room.[7]

This experimental model implements a binary lottery procedure, which in theory induces risk-neutral behavior (Roth and Malouf, 1979). By normalizing *u(\$20)=1* and *u(\$0)=0*, the expected utility of the game becomes

$$EU_i = \frac{x_i}{\sum_{j=1}^{n} x_j} \cdot \frac{w_i - x_i}{w_i} \cdot 1$$

If subjects are expected-utility maximizers, we expect them to act as risk-neutral players in this game.

5. Results and Discussion

5.1 Overview

Figure 2 shows the distribution of rent-seeking expenditures for the symmetric (w_i=30) and asymmetric groups (w_i=30 and w_j=60). The optimum bids are also included to compare the results with the theoretical predictions.[8]

Insert Figure 2 about here

The results suggest than most of the subjects spent more than the predicted level of rent-seeking expenditures. In symmetric groups of 2 and 4, the average rent-seeking expenditures were 15.41 and 17.39, exceeding the equilibrium predictions of 10 and 13. The results from the asymmetric groups are similar. On average, there is excessive expenditure relative to the equilibrium prediction, for both low and high-endowment types. The next subsection presents some statistical tests of these observations.

5.2 Hypothesis 1S, 1A: Equilibrium Predictions

The first question posed by our study is the extent to which the point predictions of the rent-seeking game's equilibrium are supported by the experimental data. Table 2 presents the average rent-seeking expenditure in each treatment, and the results of a Wilcoxon signed-rank test in order to test whether the actual expenditures are significantly different from the ones predicted by the theory.[9]

Insert Table 2 about here

In the symmetric game, levels of rent-seeking expenditures are significantly higher than the Nash equilibrium predictions, for subjects in the US and Turkey, and for groups of size 2 and of size 4 ($p<.01$ for all). In the asymmetric game, average rent-seeking expenditures are significantly higher than the equilibrium prediction for both low- and high-endowment types in the 2-person treatments in both the US and Turkey ($p<.01$ for all), and for the low-endowment types in the 4-person treatments ($p<.05$ in US, $p<.01$ in Turkey). However, the mean expenditure for the high-endowment subjects in the 4-person treatment is not statistically different than the predicted value in either country. Although the overall average rent-seeking expenditures are slightly higher for the subject group in Turkey, none of the differences are statistically significant. [10]

Two further analyses of subjects' play are of interest. First, though subjects may not be playing a Nash equilibrium, they may be playing a best-response to other subjects' actions. For each subject, we calculated their best-response to the actual actions of others in their group. We then calculated the difference between their actual expenditure and their best-response. Table 3 presents the average (and standard deviation) of differences in each treatment, pooled over the US and Turkey. A similar nonparametric test confirms that these differences are significantly positive.

Insert Table 3 about here

In all treatments, the mean rent-seeking expenditure is significantly higher than the best-response predictions, indicating that subjects are over-investing in rent-seeking activities, not only above the Nash equilibrium level but even above the level of best-response to their counterpart's actions.

A second analysis involves the cost of this overexpenditure to the subjects. Table 4 presents a comparison between the expected payoff in the Nash equilibrium, and the average expected payoffs for each subject in each treatment (using the exchange rate described above). The final column presents the socially optimal payoffs, where each individual spends nothing on rent-seeking.

Insert Table 4 about here

Actual earnings are systematically less than those at the Nash prediction. The deviation from Nash strategies led to a decrease in expected payoffs between 13% and 48%.

5.3 Hypothesis 2: Comparative Statics, Own Initial Endowments

Comparative statics of our model predict that rent-seeking expenditures will increase when own initial wealth level increases. Table 5 displays the average increases in expenditures as own initial endowments increase.

Insert Table 5 about here

A direct test of this hypothesis compares the rent-seeking expenditures by subjects in two-person groups whose endowments were 30 with those whose endowments were 60, holding their counterpart's endowments constant at 30. These results indicate that an increase in one's own initial wealth level (w_i) leads to a significantly higher rent-seeking expenditure in both Turkey and the US ($p<.01$ for both).

The hypothesis also supported by data from the four-person groups, although the test is less direct. Table 5 compares rent-seeking expenditures by subjects in four-person groups whose endowments were 30 with those whose endowments were 60. In addition to the subjectsí own endowments increasing, subjects in the latter group faced competitors with increased endowments as well. Both these comparative statics hypotheses point in the same direction (increased rent-seeking) which is indeed observed in both the US and in Turkey (p<.05 for both).

5.4 Hypothesis 3: Comparative Statics, Others' Initial Endowments

Our second hypothesis involved the comparative static prediction of an increase in rent-seeking expenditures as the wealth of others in the group increases, holding own wealth constant. In Table 6 we compare the rent-seeking expenditures by subjects in two-person groups whose endowments were 30 and whose competitors' endowments were either 60 or 30. In addition, we compare rent-seeking expenditures by subjects in four-person groups whose endowments were 30 and whose competitors' endowments were either 150 (30, 60, 60) or 90 (30, 30, 30).

Insert Table 6 about here

The predicted effect of others' wealth was incremental (an increase of one unit) and was not observed in our experiment, possibly due to its small size. As Table 6 shows, an increase in the opponents' wealth level did not have a statistically significant impact on subjects' rent-seeking expenditures in either two or four person groups.

5.5 Hypothesis 4: Comparative Statics, Group Size

Comparative statics of our model predict that rent-seeking expenditures will increase with an increase in the number of rent-seekers. In our experiment, we can compare rent-seeking expenditures of subjects with the same endowment in groups of size two and four. However, this change also involves increasing the endowment of others. The model predicts each effect individually should lead to an increase in rent-seeking expenditures, which is exactly what we see.

To test for this increase statistically, a Wilcoxon nonparametric test was conducted to examine the difference between the mean expenditures for 2-person and 4-person groups. The results reveal that in all cases, the difference is statistically significant ($p<.05$). These results are reported in Table 7.

Insert Table 7 about here

The question about which change is causing the increase in expenditures, the increase in group size or the increase in others' endowment, can be answered by comparing the size of this effect to that in the previous subsection, where only others' endowment was changed. We saw no significant effect of others' endowment on subjects' expenditures, but we do see a significant effect when we change both group size and others' endowment. We conclude, then, that the change in group size itself has a significant effect on individual rent-seeking expenditures.

5.6 Summary of Results and Discussion

Results from this experiment were surprisingly consistent with the comparative statics predictions of the risky-rent seeking model we developed above. Rent seeking expenditures increased significantly as the player's own wealth level increased, as predicted by the model, in all the treatments. In addition, rent-seeking expenditures increased as the number of players (and their endowments) increased, although a simple increase in the endowment of others did not affect expenditures.

However, the model's Nash equilibrium point prediction of rent-seeking expenditures was not observed. Instead, most subjects in both countries spent significantly more toward rent-seeking activities, leading to more rent dissipation than predicted by the model.[11] We find that subjects' deviations from equilibrium result in lower payoffs than could have been achieved had they played the equilibrium (ranging from expected losses of 13% to 48%). Finally, we cannot explain the data by assuming that individuals play a best-response to their counterparts' play; their expenditures are still higher than the best-response predicts.

Instead, we conjecture that in this two-stage game, individuals engaged in a myopic competition, focused mostly in winning the initial stage of political contest without taking into account the costs of winning in terms of expected value of the prize later on. Some arguments given in the post-experiment questionnaire reveal this rationale for overexpenditure in the lobbying stage. One subject wrote:

> Like a potential monopolist, I want to make it through the first stage. I'm willing to spend more now so that I can clear out my competition for later.

Another told us

> I can control the percentage of winning in Stage II (given the total size of 30 chips). However, I don't know what my opponents will submit in the first stage.

If rent-seekers in the real world are indeed myopic, we expect to see much rent-seeking in the first stage of appropriation games, but not enough left in the second stage, to guarantee the disbursement of funds. Thus we expect many funds to be allocated but not disbursed. For instance, in 1996 fiscal year, the US Congress authorized $6 billion for the privatization programs of the Department of Energy (DOE) but failed to appropriate most of these funds. Following this failure, DOE called only for $500 million in the 1999 fiscal year. This sharp decline in DOE's request may be a result of a shift in their policy: Instead of engaging in a myopic rent-seeking game against other departments, DOE might have decided to spend their resources for the actual disbursement of their share.

6. Conclusion

Theoretical models (e.g. Tullock, 1980) as well as empirical work (e.g. Kreuger 1974, Mohammad and Whalley 1984, Mossetto 1994, Wise and Sandler 1994) have demonstrated the inefficient use of resources caused by rent-seeking expenditures. This paper models rent-seeking expenditures for a risky rent and analyzes an experimental rent-seeking game of the same type.

In our study, rent-seeking expenditures were found to be significantly higher than the theoretical predictions, creating more inefficiency than predicted. We conjecture that this result may have been caused by myopia on the part of the subjects. This conjecture is supported by anecdotal evidence.

Additional analysis focused on testing the comparative statics properties of this rent-seeking model. These were generally supported by the experimental results. Expenditures were significantly and positively related to group size and one's own wealth level.

The experiment used subjects from two different countries: US and Turkey. Average expenditures were found to be somewhat higher in Turkey, although this difference was not statistically significant. Further empirical studies on cross-cultural differences may provide further insight to the question whether cultural differences play a role in determining the level of lobbying expenditures.

Several additional questions (and follow-up studies) are suggested by our findings. One fundamental question is how to reduce the inefficiency associated with the observed, super-optimal, rent-seeking. For example, are there institutional arrangements which can reduce this inefficiency? Perhaps allowing for communication and/or collusion between the parties may lead rent-seekers toward a more efficient allocation of resources. Although in other settings like markets, collusion is often seen as reducing efficiency, in this setting it could help by allowing players to collude on low rent-seeking expenditures.

Another institutional arrangement open for investigation is moving from a one-shot to a finitely repeated game. This may represent a more realistic situation where lobbying groups interact repeatedly in the legislative arena. This move would open the door for two changes. First, collusion on low rent-seeking expenditures might be easier to develop and sustain in this repeated setting. Second, subjects could learn about the (in)effectiveness of rent-seeking and may even become less myopic.

A final institutional parameter which could affect the extent of observed inefficiency is the value of the risky rent, $R. Although the Nash equilibrium investment in lobbying does not depend on this rent parameter, in practice the size of the stake will likely affect the behavior of the participants.

Rent-seeking, in the form of lobbying, political action committees or bribery, has important economic and social implications, for both efficiency and equity reasons. By studying individual behavior in the laboratory, under minimal institutional contexts, we can pinpoint the similarities and differences between behavior and game theoretic predictions, and can better make predictions about the actual behavior of interest groups in different institutional settings.

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Table 1: Experimental Treatments and Equilibria

# of Players	Initial Endowments	Predicted Expenditure on Rent-Seeking
n=2	(30, 30)	(10, 10)
n=2	(30, 60)	(11, 17)
n=4	(30, 30, 30, 30)	(13, 13, 13, 13)
n=4	(30, 30, 60, 60)	(14, 14, 23, 23)

Table 2: Average Rent-Seeking Expenditures (standard deviations)

	US	TURKEY
Symmetric		
n=2, x*=10	14.94 ** (4.93)	15.87** (5.86)
n=4, x*=13	16.09** (5.67)	18.69** (6.75)
Asymmetric		
n=2, w=30, x*=11	15.02** (4.97)	15.96** (4.55)
n=2, w=60, x*=17	21.26** (6.69)	21.79** (5.89)
n=4, w=30, x*=14	17.72* (6.18)	19.56** (5.40)
n=4, w=60, x*=23	21.78 (5.57)	23.81 (5.42)

* p <.05
** p <.01

Table 3: Average Differences: Actual Expenditures - Best-Response Expenditures

		Asymmetric	
	Symmetric	w_i=30	w_i=60
n = 2	5.06** (2.15)	4.81** (1.38)	5.62** (1.81)
n = 4	5.97** (2.66)	5.26** (1.99)	5.88** (2.07)

*   p <.05
** p <.01

Table 4: Expected Payoffs

Initial Endowment	Expected Payoff under Nash	Expected Payoff Observed (US)	Expected Payoff Observed (Turkey)	Social Optimum Payoff
30,30	$6.67	$4.58	$4.49	$10
30,60	$3.51	$2.25	$1.81	$10
30,**60**	$4.98	$4.02	$3.72	$10
30,30,30,30	$8.70	$6.88	$6.78	$5
30,30,60,60	$2.02	$1.76	$1.53	$5
30,30,**60**,60	$3.83	$3.17	$3.15	$5

Table 5: Effect of Own Initial Wealth on Rent-Seeking Expenditures

	US	**TURKEY**
n=2		
$(w_i = 60) - (w_i = 30)$	6.32**	5.92**
n=4		
$(w_i = 60) - (w_i = 30)$	5.69*	5.12**

* $p < .05$
** $p < .01$

Table 6: Effect of Opponents' Initial Wealth on Rent-Seeking Expenditures

	US	TURKEY
n=2		
$(w_j = 60) - (w_j = 30)$	.08	.09
n=4		
$(w_j = 60) - (w_j = 30)$	1.63*	.87

* $p < .05$
** $p < .01$

Table 7: Effect of Group Size on Rent-Seeking Expenditures

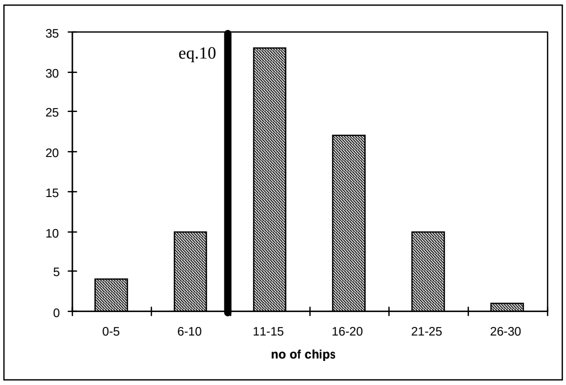
	US	TURKEY
Symmetric		
(n=2) - (n=4)	1.15**	2.82**
Asymmetric (n=2) - (n=4)		
low-endowment	.94*	.96*
high-endowment	4.13**	4.40**

*   p <.05
** p <.01

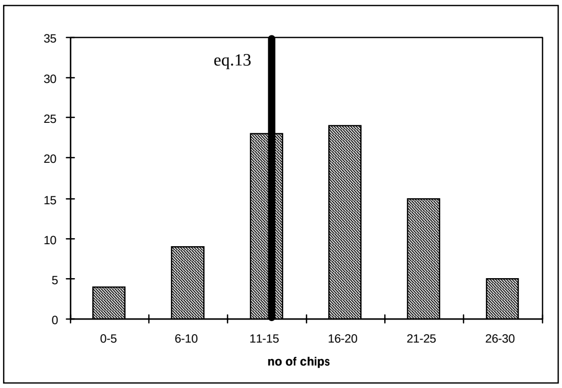
Figure 1: A Taxonomy of Rent-Seeking

	Riskless Outcome	**Risky Outcome**
All-or-None Rent	siting a local park	political appropriation
Shared Rent	allocation of budget among divisions	working on a primary campaign

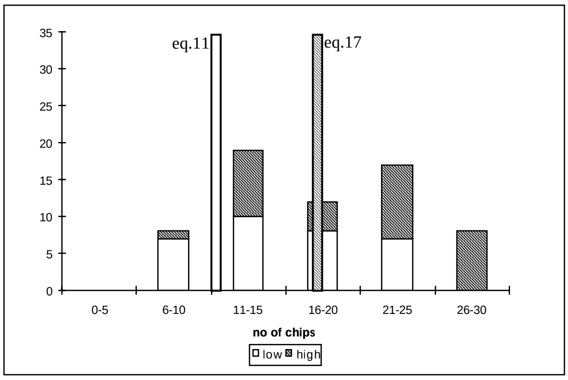
Figure 2: Distributions of Rent-Seeking Expenditures



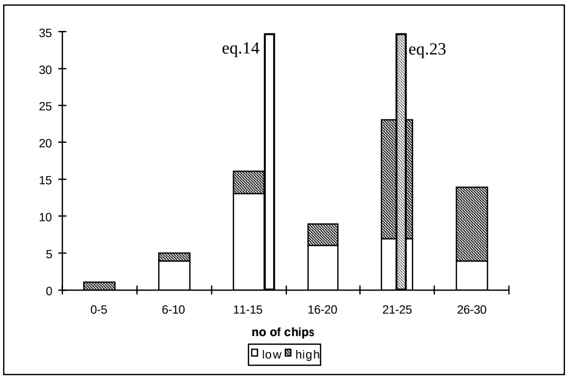
Group Size=2
n=80 individuals



Group Size=4
n=80 individuals



Group Size=2
n=66 individuals



Group Size=4
n=68 individuals

Appendix A: Derivation of Comparative Statics[12]

A.1. Own Endowment

Taking the derivative of x^*_{iA} with respect to w_i yields

$$\frac{\partial x^*_{iA}}{\partial w_i} = \frac{n\left(14628.6n^4w_i^4 + 36571.4n^3w_i\sum_{j\neq i} w_j + 31200n^2w_i^2\left(\sum_{j\neq i} w_j\right)^2 + 10800nw_i\left(\sum_{j\neq i} w_j\right)^3 + 1114.29\left(\sum_{j\neq i} w_j\right)^4\right.}{\left[128n^3w_i^3 + 240n^2w_i^2\sum_{j\neq i} w_j + 123nw_i\left(\sum_{j\neq i} w_j\right)^2 + 16\left(\sum_{j\neq i} w_j\right)^3\right]^{4/3}}$$

Since $n,\ w_i,\ \sum_{j\neq i} w_j \geq 0$, this expression is non-negative for all i and therefore as one's endowment increases, the equilibrium rent-seeking will also increase.

A.2. Opponents' Endowment

Taking the derivative of x^*_{iA} with respect to $\sum_{j\neq i} w_j$ yields

$$\frac{\partial x^*_{iA}}{\partial \sum_{j\neq i} w_j} = .22 + \frac{142.857nw_i + 57.1429\sum_{j\neq i} w_j}{\left(128n^3w_i^3 + 240n^2w_i^2\sum_{j\neq i} w_j + 123nw_i\left(\sum_{j\neq i} w_j\right)^2 + 16\left(\sum_{j\neq i} w_j\right)^3\right)^{1/3}}$$

$$- \frac{57.1429\left[4n^2w_i^2 + 5nw_i\sum_{j\neq i} w_j + \left(\sum_{j\neq i} w_j\right)^2\right]\cdot\left(40n^2w_i^2 + 41nw_i\sum_{j\neq i} w_j + 8\left(\sum_{j\neq i} w_j\right)^2\right)}{\left(128n^3w_i^3 + 240n^2w_i^2\sum_{j\neq i} w_j + 123nw_i\left(\sum_{j\neq i} w_j\right)^2 + 16\left(\sum_{j\neq i} w_j\right)^3\right)^{4/3}}$$

By simplifying and rounding to the nearest whole number we get

$$\frac{\partial x_{iA}^*}{\partial \sum_{j\neq i} w_j} \cong .22\left(128n^3w_i^3 + 240n^2w_i^2\sum_{j\neq i} w_j + 123nw_i\left(\sum_{j\neq i} w_j\right)^2 + 16\left(\sum_{j\neq i} w_j\right)^3\right)^{4/3}$$

$$+\left(9143n^4w_i^4 + 20800n^3w_i^3\left(\sum_{j\neq i} w_j\right) + 17800n^2w_i^2\left(\sum_{j\neq i} w_j\right)^2 + 4685nw_i\left(\sum_{j\neq i} w_j\right)^3 + 457\left(\sum_{j\neq i} w_j\right)^4\right)$$

Since this expression is positive for $n, w_i, \sum_{j\neq i} w_j \geq 0$, we can conclude that

$\partial x_{iA}^* \big/ \partial \sum_{j\neq i} w_j \geq 0 \;\; for \; \forall i.$ Hence, an increase in opponents' endowment leads to an increase in one's rent-seeking expenditures.

A.3. Number of Players

A.3.1 Symmetric Case

The equilibrium rent-seeking expenditure in the symmetric case is

$$x_S^* = \frac{w(n-1)}{2n-1}, \;\; for \;\; i = 1,...,n$$

Taking the derivative with respect to *n* gives

$$\frac{\partial x_S^*}{\partial n} = \frac{w}{(2n-1)^2} > 0 \;\; for \;\; all \;\; w > 0$$

Therefore, the equilibrium rent-seeking expenditure increases with an increase in the number of players.

A.3.2 Asymmetric Case

Taking the derivative of x^*_{iA} with respect to *n* yields

$$\frac{\partial x^*_{iA}}{\partial n} = \frac{w_i(14628.6n^4w_i^4 + 36571.4n^3w_i\sum_{j\neq i} w_j + 31200n^2w_i^2\left(\sum_{j\neq i} w_j\right)^2 + 10800nw_i\left(\sum_{j\neq i} w_j\right)^3 + 1114.29\left(\sum_{j\neq i} w_j\right)^4}{\left[128n^3w_i^3 + 240n^2w_i^2\sum_{j\neq i} w_j + 123nw_i\left(\sum_{j\neq i} w_j\right)^2 + 16\left(\sum_{j\neq i} w_j\right)^3\right]^{4/3}}$$

For $n, w_i, \sum_{j\neq i} w_j \geq 0$, $\frac{\partial x^*_{iA}}{\partial n} \geq 0 \quad for\ \forall i$, which indicates that the equilibrium rent-seeking expenditure increases with an increase in the number of players.

Appendix B: Experimental Instructions (English)
n=4, symmetric, w_i = 30

You are about to participate in an experiment about individual decision-making. If you follow the instructions carefully and make a good decision, you will have the opportunity to win $20.

Instructions

You are randomly grouped with three of your classmates. You will not be told who the other members of your group are. All the decisions will be made privately. Please do not speak to anyone during the experiment.

Each of the group member is given an empty yellow envelope and a white envelope with 30 index cards inside. The index cards are identified with a group number and a letter assigned to you as an identification within your group. For instance, 7B means you are player B in group 7.

Please take your index cards out of the envelope and look at your ID number and your own individual letter. Record these on this sheet **now**. This information is for your private use only.

Group number ____________
Individual letter ____________

When you finish, please turn over to the next page.

We now explain the experimental procedure. In the first stage, you will put some of your cards into the yellow envelope that is provided and return the yellow envelope to the instructor. Note that you cannot observe your opponents' contribution. You are going to keep the rest of your index cards in the original white envelope.

The instructor will then mix both your and your opponents' contributions and pick one card. If it is one of yours, you will have the opportunity to participate in the lottery. If it is not, you will gain nothing and one of the other group members will play the lottery. Your probability of being a finalist depends on the ratio of cards you submit to the total number of cards submitted. In other words, if you submit X cards and your opponents submit a total of Y, the probability of you winning this bidding is $\frac{X}{X+Y}$. If there is a tie (i.e. both you and some other group member submits the same amount of cards), you will have an even chance of being chosen.

In the next stage, the finalist will participate in a lottery to win $20. The procedure of the lottery is as follows: The finalist will give his/her white envelope with the remaining cards to the instructor. The instructor will then add blank cards to the finalist's cards in order to add up to a total of 30 index cards. Then one draw will be made. If the card is one of the finalist's, he/she will get $20. If not, he/she will get nothing. Therefore, the probability of winning the lottery is determined by the ratio of the number of the remaining index cards of the finalist to 30.

For instance, suppose you submit 10 cards in the first stage and your opponents submit 5, 10 and 15. Your probability of being a finalist in this case is $\frac{10}{5+10+10+15}=\frac{10}{40}=\frac{1}{4}$

If you become the finalist, your 20 remaining cards will be mixed with 10 blank cards and a random draw will be made. Your probability of winning the $20 lottery prize, in this second stage, is $\frac{20}{20+10}=\frac{20}{30}=\frac{2}{3}$

The following table reflects your probability of winning the $20 lottery prize, if you are given the opportunity to participate in the lottery.

no of cards left	prob of winning	no of cards left	prob of winning
0	0	16	0.53
1	0.03	17	0.56
2	0.06	18	0.60
3	0.10	19	0.63
4	0.13	20	0.66
5	0.16	21	0.70
6	0.20	22	0.73
7	0.23	23	0.76
8	0.26	24	0.80
9	0.30	25	0.83
10	0.33	26	0.86
11	0.36	27	0.90
12	0.40	28	0.93
13	0.43	29	0.96
14	0.46	30	1.00
15	0.50		

Please raise your hand if you have any questions about the procedure.

Now decide how many of your index cards you are willing to submit in the first stage. Put that number of cards into the **yellow** envelope. Close the envelope and raise your hand. The monitor will come to collect the envelope. Keep the rest of your index cards inside the original white envelope.

The first stage of the experiment is now over. Once all yellow envelopes are collected, the experimenters will note the finalist from each group. Please do not go on to the next page until the monitor picks up your yellow envelope.

After all the envelopes are collected, the instructor will mix the contributions in each group and pick one card. The group number and letter of the finalists will be written on the blackboard. Once all the drawings are made, the finalists will go outside the classroom one by one to participate in the lottery.

For all the participants except the finalists, the experiment is now over. Thank you for your participation. Please wait at your desk until the monitor collects this sheet and your original white envelope with the remaining cards.

For the finalists, please step forward with your original white envelope with the remaining cards and this instruction sheet in order to participate in the lottery.

Endnotes

[1]A related line of research models an indivisible rent-seeking game as an all-pay auction (e.g. Anderson *et al.* 1998, Baye *et al.* 1993, Baye *et al.* 1996, Bliss and Nalebuff 1984, Holt and Sherman 1982). In an all-pay auction, all bidders pay their respective bids up front (as though they all invested in rent-seeking activities) and the prize (the final rent) is given to the highest bidder (the player with the highest rent-seeking expenditure). Tullock's (1980) and other rent-seeking models differ from all-pay auctions in that the highest bidder is not guaranteed the prize, but instead receives it with some probability.

[2]This result helped to organize much of the previous theoretical literature in which authors argued over whether the rent is over-dissipated by rent-seeking expenditure (e.g. Tullock, 1967), exactly dissipated (e.g. Becker 1968, Krueger 1974, Posner 1975) or under-dissipated (Hillman and Samet, 1987). Other theoretical studies have attempted to identify different determinants of rent dissipation like entry (Corcoran and Karels 1985, Higgins, *et al.* 1985), number and homogeneity of competitors (Gradstein 1994, Hillman and Riley 1989, Nitzan 1991), number of winners (Berry, 1993), risk preferences of players (Hillman and Katz, 1984), competition (Ellingsen 1991, Schmidt 1992). Recent theoretical work has focused on the endogenous formation of rents (Appelbaum and Katz 1986, Gradstein 1993, Chung 1996, Ursprung 1990, Riaz, Shogren and Johnson 1995).

[3]Interestingly, this paper also shows more rent dissipation occurs in all-pay auctions (where the highest player earns the rent for sure) than in rent-seeking games (where player's probabilities of winning the rent are a function of their rent-seeking activities).

[4]Unlike Tullock's model, here any wealth remaining after rent-seeking is not consumed directly but instead used to increase the probability of receiving the rent. Our experimental implementation will be consistent with this feature of the model. Adding an additional use of endowment (direct consumption) changes the equilibrium level of rent-seeking expenditures, but does not affect the comparative statics implications of the model.

[5]For instance, for a 2-person symmetric game with $w_i=w_j=15$, the total rent-seeking expenditure will be \$10. The rent will be overdissipated if it is below \$10, exactly dissipated if it is \$10 and underdissipated if it is more than \$10.

[6]The exchange rate was approximately \$1=100,000 TL at the time of the experiment.

[7]For instance, in the treatment with n=2 and $w_1=w_2=30$, suppose Player 1 submits 5 cards in the first stage and her opponent submits 10. The probability of Player 1 winning the first stage is 5/(10+5)=.33. After the drawing, if she becomes the finalist, her remaining 25 cards are mixed with 5 blank cards and a second draw is made in Stage II. The probability of her winning this stage is 25/(25+5)=.83.

[8]Although in asymmetric groups some subjects could allocate up to 60 tokens toward rent-seeking activities, in practice no subject allocated more than 30. We thus keep the scale of the x-axis the same in these graphs to facilitate comparisons.

[9]Since the Shapiro-Wilk test shows that the 2-person asymmetric treatment in Turkey and the 4-person asymmetric treatment in the US are not normally distributed ($p<.05$), nonparametric tests are used for all subsequent analysis.

[10]These comparisons are on the basis of absolute deviations from the Nash equilibrium. As one seminar participant suggested, we can also look at *percentage* deviations from the Nash equilibrium. For each subject we can calculate the difference between their expenditure and the equilibrium expenditure, then divide that difference by the equilibrium expenditure to calculate the percentage differences. For the symmetric games, the average percentage deviation from equilibrium is 53% (n=2) and 41% (n=4). For asymmetric games, low income players the deviation is 48% (n=2) and 44% (n=4) and for high income players the deviation is 42% (n=2) and 37% (n=4).

[11]One seminar participant suggested that subjects' risk aversion may be causing the over-expenditure. The procedure in this experiment, equivalent to a binary lottery procedure, should in theory induce risk-neutrality. However, even if it did not, it seems unlikely that risk aversion could cause overexpenditure in the first stage since both stages are risky. Overexpenditure in Stage 1 leads to a higher-risk lottery in Stage 2.

[12]The derivations in Appendix A are obtained by Mathematica 3.0.