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RENT-SEEKING FOR A RISKY RENT

A MODEL AND EXPERIMENTAL INVESTIGATION

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ABSTRACT

Rent-seeking models have been used to predict and explain a wide variety of political decisions. This paper extends Tullock's classic rent-seeking model to the case of a *risky* rent, where the winner of the rent-seeking contest does not receive the rent for sure, but only probabilistically. We derive the 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, consistent with previous experimental results. We conclude by discussing implications of our results for a variety of rent-seeking settings.

KEY WORDS • experiment • inefficiency • political decision-making • rent-seeking

1. Introduction

Rent-seeking (the spending and transferring of resources to privately capture value) is a common problem in many settings. Originally, this situation was described in the context of lobbying in order to obtain a monopoly rent (Tullock, 1967; Krueger, 1974). However, the inefficient quest for personal privilege which rent-seeking models describe has been observed in a variety of political settings, including the quest by individuals to become political insiders (Hillman and Ursprung, 2000) or of presidents and other world leaders to make decisions (Boadu et al., 1992), the decisions of states when to end sanctions (Dorussen and Mo, 2001) or to go to war (Lake, 1992; Reiter and Stam, 1998), and the behavior of groups in engaging in ethnic conflict (Osborne, 2000). Collections of this and related literature can be found in Buchanan, Tollison and Tullock (1980), Rowley, Tollison and Tullock (1988), Tullock (1989) and Tollison and Congleton (1995).

While a number of models of rent-seeking have been developed, we know very little about actual rent-seeking behavior, in part because this behavior is difficult to observe (much 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 (although see Hindmoor, 1999, for a contrasting view).

This paper contributes to the literature on rent-seeking by extending Tullock's model of rent-seeking, in which the value of the final rent is predetermined, to encompass the commonly-observed dimension of a *risky* rent. Hence, in our model, in addition to the uncertainty about winning the final prize, there is also an uncertainty attached to the value of the prize sought. We solve for the equilibrium and comparative static predictions of this new model. Finally, we present the results of a controlled laboratory experiment designed to test these predictions. The results of the experiment are supportive of the comparative static predictions of the model; however, they suggest super-optimal rent-seeking expenditures relative to equilibrium predictions.

The paper proceeds as follows: The next section provides a review of the previous research on rent-seeking and experiments. Part 3 motivates and introduces the model of rent-seeking for a risky rent and generates hypotheses based on equilibrium predictions and comparative static analysis. After describing the experimental design in Part 4, results are analyzed in Part 5. The paper ends with a discussion of the implications of our results to real-world rent-seeking settings.

2. Previous Research

This paper draws from and contributes to two streams of literature in political science: rent-seeking and experiments. We review each of these briefly. We then review in more depth the few previous papers with us in the intersection of these two areas.

2.1 Rent-Seeking Theory and Extensions

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 allocation, 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. 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 allocator or allocation process, the higher the agents' capacity to secure desirable outcomes for a given level of rent-seeking expenditure.[1]

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

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

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 details of the model.[2] Other theoretical studies have attempted to identify different determinants of rent dissipation. A review of this literature can be found in Nitzan (1994).[3]

In the present study, we will present an extension of Tullock's model to a *risky* rent, assuming symmetric political influence ($\alpha_i = 1, \forall i$), fixed and known number of risk-neutral rent-seekers with no entry costs and only one winner. Our model is related to previous models of endogenous rent formation, discussed in greater depth in Section 3. We will solve for the Nash equilibrium of the new model, and derive comparative static results of that equilibrium. We then go on to experimentally test the equilibrium point predictions and comparative statics.

2.2 Experimental Political Science

We use experiments to test the accuracy of the theory's predictions. Experiments are a new and growing methodology in the toolbox of political

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1. See Ward (2004) for a game-theoretical analysis of political influence of competing interest groups.

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 Riley, 1989).

3. A related line of research models an indivisible rent-seeking game as an all-pay auction (e.g. Baye et al., 1993). 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). Rent-seeking models differ from all-pay auctions in that the highest bidder is not guaranteed the prize. For a recent experiment in all-pay auctions, see Anderson et al. (1998).

scientists. They have proven particularly useful in testing formal models of behavior, and in identifying where and under what conditions those models predict more (or less) accurately. Kinder and Palfrey (1993) present a set of political science experiments, and Morton, McGraw and Williams (forthcoming) discuss the experimental methodology and its use in political science.[4] More recently, experiments have been used to study settings as diverse as jury decision-making (Guarnaschelli et al., 2000), the timing of primaries (Morton and Williams, 1999), the quantity and impact of law (Bohnet et al., 2001), bargaining (Eckel et al., 2002), and voting and coalition formation (Wilson, 1986; Wilson and Herzberg, 1987; Herzberg and Wilson, 1988) among others.

Probably the largest impact of this methodology has been in the domain of social dilemma behavior (nicely reviewed in Ostrom, 1998; see also van de Kragt et al., 1983; Orbell et al., 1984; Dawes et al., 1986; Orbell and Dawes, 1991; Morikawa et al., 1995 and many others). Rent-seeking shares many similarities with social dilemmas. In each case there is an incentive to defect (here, seek more rent) but social surplus is maximized when individuals cooperate (engage in less rent-seeking). Interestingly, the results from these two domains are quite different, despite the structural similarity of the problems. In general, research in social dilemmas finds that individuals can sustain cooperation under appropriate conditions, while experimental rent-seeking research finds excessive rent-seeking relative to equilibrium predictions.

2.3 Experimental Rent-Seeking

In contrast to theoretical work, experimental analysis of rent-seeking behavior is a relatively new approach. A small but growing literature (nine previous papers) have experimentally explored individual behavior in rent-seeking games, and compared that behavior to theoretical predictions. These papers are organized by their overall findings on this comparison.

Six papers have found that individuals rent-seek more than would be predicted by equilibrium analysis. The first paper in this area, Millner and Pratt (1989), examines the effectiveness of rent-seeking (i.e. the parameter α_i) on the final outcome in Tullock's (1980) rent-seeking game. 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) that more risk-averse individuals dissipate more of the rent. They conclude, in contrast to the model's

4. See also McDermott (2001) for a comprehensive review on the impact of behavioral experiments on the study of political sciences.

predictions, that relatively more risk-averse subjects dissipate *less* of the final rent, although there is excessive rent-seeking overall.

Davis and Reilly (1998) compare behavior in rent-seeking games with that in all-pay auctions. In the former, the probability of achieving the rent is probabilistic as in the aforementioned Tullock model (with symmetric α_i). In the latter, whoever allocates more to the rent-seeking activity wins for sure. This experiment finds rent-seeking expenditures are significantly higher than those predicted by equilibrium analysis in both settings. In contrast, Potters, de Vries and van Winden (1998) also compare rent-seeking behavior in traditional rent-seeking games and in all-pay auctions. They find over-expenditure in the rent-seeking treatment relative to the equilibrium prediction, but behavior consistent with theoretical predictions in the all-pay auction.

Anderson and Stafford (2003) test Gradstein (1995) by experimentally varying the entry fee and cost heterogeneity of the players. They find, consistent with predictions, that these factors decrease participation, but that rent-seeking expenditures are significantly higher than those predicted by the theory.

Schmitt, Shupp, Swope and Cadigan (2004) examine the question of carry-over. They analyze a multi-period game in which rent-seeking expenditures in period t increase the efficacy of rent-seeking expenditures in period $t + 1$. In this paper, the authors find that, as predicted, individuals spend more when there is positive carryover, but they also find that rent-seeking expenditures exceed the equilibrium predictions.

One paper finds rent-seeking expenditures that are consistent with the equilibrium prediction. Shogren and Baik (1991) theoretically analyze the rent-seeking game with an exit option (allowing players not to participate). In their experiment which uses a payoff matrix approach, results are consistent with the theory when $\alpha_i = 1$.

Finally, two recent papers find rent-seeking expenditures that are less than the equilibrium predictions. Shupp (2004) and Schmidt, Shupp and Walker (2004) compare rent-seeking when the prize varies between being a single indivisible prize, a set of multiple but smaller prizes (Shupp, 2004) and a perfectly divisible prize where each individual receives a share of the rent based on their expenditures (Schmidt et al., 2004). Both these papers find less rent-seeking expenditures than predicted by equilibrium.

Of these nine papers, six of them show more rent-seeking behavior than the theory predicts (Millner and Pratt, 1989, 1991; Davis and Reilly, 1998; Potters et al., 1998; Anderson and Stafford, 2003; Schmitt et al., 2004), while one shows no significant differences between theoretical predictions and observed behavior (Shogren and Baik, 1991) and two show the opposite effect (Shupp, 2004; Schmidt et al., 2004).

We contribute to this literature by experimentally investigating rent-seeking for *risky* rents, i.e. rents with unknown values. In this paper we test both the baseline predictions from our extended model and its comparative statics (on the influence of group size and initial endowments). We find, consistent with the majority of the aforementioned papers, excess rent-seeking expenditures relative to equilibrium predictions even in the setting of a risky rent. We also find support for the comparative static predictions of the model.

3. Experimental Model and Hypotheses

This section motivates and describes our extension of Tullock's (1980) model and compares it with other theoretical extensions. 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.

The extension that we consider was motivated by the intuition that in many rent-seeking situations, the value of the rent sought is not certain and known in advance, but is instead risky, and may depend on the rent-seeking decisions that players make. For example, imagine a candidate (or a campaign worker) expending effort in a primary race.[5] The rent they are seeking is the elected position to which they aspire. Assume for simplicity that the candidate has a fixed amount of resources (money, time, or volunteer effort) that they can spend on their campaigns. These resources must be divided between the primary election and the final race.[6]

The problem that the candidate faces is slightly different than the traditional rent-seeking problem. On the one hand, if they don't win the primary, they will never achieve the rent. On the other hand, if they spend all their resources on winning the primary (and no additional resources are forthcoming), then they will similarly not win the rent. Thus they face a *risky* rent-seeking problem. They need to decide how many of their resources to spend in the primary to increase their chances of getting to the second stage. But in the second stage, the probability of achieving the rent (and thus its expected value) is positively related to the resources that remain. Our model and subsequent experiment capture exactly this tension.

5. Theilmann and Wilhite (1995), among others, have argued that political campaigns can be modeled as rent-seeking games.

6. Note that the model can be easily generalized to the case where additional resources are generated after the candidate wins the primary. As long as the inflow of these resources is known in advance, all our results continue to hold. Nevertheless, we should emphasize that this simplistic primary/final race model is used solely as an illustrative example, not necessarily as a realistic one.

As a second example, consider the question of making campaign contributions in hopes of implementing agricultural subsidies.[7] Members of special interest groups have fixed resources which they can allocate toward campaign contributions or toward agricultural production. If they allocate all their resources toward achieving the subsidy, they have no resources left to produce, and thus do not capture the benefits of the subsidy (the rent). Similarly, if they allocate no resources toward rent-seeking, then no subsidy is generated. The expected value of this rent is thus positively related to the amount of resources they have left after achieving it.

These two examples share the property of a two-stage decision. They differ slightly in the realization in the second stage, but both have the property that the expected value of the rent is higher when less is spent in the first stage. Our model generalizes this second stage implementation to capture this increased expected value (which these two examples share).

Consider the following two-stage game: In the first stage, players participate in a rent-seeking contest in order to win a risky rent. In the second stage, the winner of Stage I competes against nature, which determines the actual value of 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. Using the lottery framework proposed by Tullock, we model the expected utility of player i as

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

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. This model differs slightly from Tullock's model in the sense that if none of the players invest in rent-seeking in Stage I, they all have equal chances of progressing to Stage II.

Returning to the election example above, this can be interpreted in the following way: The probability of a candidate winning the primary is a linear ratio of their expenditure to the total rent-seeking expenditure. If the candidate wins the primary, then the probability of winning the main election and collecting the rent (R) is the proportion of the resources remaining to be spent on the ongoing campaign, assuming there is no access to new resources.

7. Lopez (2001), among others, has argued that campaign contributions are rent-seeking activities which influence agricultural subsidies in particular.

Note that this extension of the model makes the (expected) value of the rent endogenous to the players.[8] A small previous literature has examined other ways of endogenizing the rent. For example, in a recent paper Lambsdorff (2002) assumes that the size of the rent is positively dependent on the total rent-seeking expenditures (p. 103, equation 3). Unlike this literature (originally designed to explain lobbying for tariffs and other protectionism), in our model the expected value of the rent is *negatively* related to an individual's rent-seeking expenditure.

Solving for the Nash equilibrium in the n-person simultaneous game, gives the following best-response function:[9]

$$x_i(x^*_{-i}) = \sqrt{w_i \sum_{j \neq i} x^*_j + \left(\sum_{j \neq i} x^*_j \right)^2} - \sum_{j \neq i} x^*_j, \quad \text{for } i = 1, \ldots, n$$

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 prize if one wins the contest.

Another 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.[10]

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 derived from the corresponding best-response functions:

$$x^*_S = \frac{w(n-1)}{2n-1}, \quad \text{for } 1, \ldots, n$$ [11]

8. In the original Tullock model, the final prize R is exogenously determined, even though the final earnings depend also on rent-seeking expenditures.

9. In this extended model, the optimal rent-seeking contribution is independent of the final prize. Therefore we cannot draw any general conclusions about how much rent-dissipation takes place. For instance, for a two-person symmetric game with $w_i = w_j = 15$, the total rent-seeking expenditure will be \$10. The rent will be over-dissipated if it's below \$10, exactly dissipated if it's \$10 and under-dissipated if it's more than \$10.

10. See Roth and Malouf (1979) for a description of binary lottery procedure.

11. Appendix A provides the derivation, precise functional forms and proofs of optimal rent-seeking expenditures in both symmetric and asymmetric games.

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^*_{iS} of rent-seeking expenditure.*

3.2 The Asymmetric Game

In an asymmetric game, when endowments of the players are unequal, the optimal expenditure of player i can be similarly derived from the best-response functions. This is done in Appendix A. The equilibrium strategy x^*_{iA} is again Pareto-inferior to $x_i = 0, \forall i$. Note that the symmetric game solution 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 Number of Players Our second and third hypotheses address comparative static predictions of the equilibrium. First, equilibrium rent-seeking behavior varies depending on the number of players competing over the prize. Taking the derivative of the optimal expenditure, x^*_i, with respect to the number of players, n, we can show that expenditure increases with group size in both symmetric endowment and in asymmetric endowment settings:[12]

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

$$\frac{\partial x^*_{iA}}{\partial n} > 0 \quad \text{for } n \geq 1$$

These results lead us to Hypotheses 2S and 2A:

HYPOTHESIS 2S: *Subjects' rent-seeking expenditure will increase with an increase in the number of players in the symmetric endowment treatments.*

12. Appendix B provides the derivation and proofs of all the comparative static predictions (number of players and wealth levels) in both symmetric and asymmetric games.

HYPOTHESIS 2A: *Subject's rent-seeking expenditure will increase with an increase in the number of players in the asymmetric endowment treatments.*

3.3.2 Own Endowment The third set of hypotheses involves the comparative static effect of variations in the initial wealth allocation. The impact of changing the symmetric wealth structure to an asymmetric one or increasing one's own wealth in an already asymmetric game is intuitive, an increase in one's own endowment level increases the optimal rent-seeking expenditure:

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

This result leads us to Hypothesis 3:

HYPOTHESIS 3: *Subject's rent-seeking expenditures will increase with an increase in their own endowment, keeping the opponents' endowment levels constant.*

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

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

This result leads us to Hypothesis 4:

HYPOTHESIS 4: *Subject's rent-seeking expenditures will increase with an increase in their opponent's endowment, but not as much as with an increase in one's own.*

We go on to test these hypotheses in a laboratory experiment. A complete discussion of experimental economics methodology can be found in Morton, McGraw and Williams (forthcoming), and in Friedman and Sunder (1994).

4. Experimental Design and Parameters

The experiment designed to test these hypotheses consisted of two sessions, one in the US ($n = 174$) and the other in Turkey ($n = 127$). The US subject pool was drawn from undergraduate students enrolled in an introductory course in public economics. The subject pool in Turkey was recruited from

Table 1 Experimental Treatments and Equilibrium Predictions (in chips)

Treatment	Group Size (no. of players)	Initial Endowment for each player (w_i)	Predicted Rent-Seeking Expenditure for each player (x_i^*)
I 80 subjects	$n = 2$	(30, 30)	(10, 10)
II 80 subjects	$n = 4$	(30, 30, 30, 30)	(13, 13, 13, 13)
III 66 subjects	$n = 2$	(30, 60)	(11, 17)
IV 68 subjects	$n = 4$	(30, 30, 60, 60)	(14, 14, 23, 23)

undergraduate students majoring in business administration at Bogaziçi University. None of the participants had studied or played in rent-seeking games before the experiment.[13]

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 C; a Turkish copy is available from the authors upon request.

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 the optimal rent-seeking expenditure. For instance, in Treatment 1, there were two players, each endowed with 30 chips at the beginning of the experiment. The predicted individual expenditure on rent-seeking, x^*, is 10 chips for each player.

The experiment used a between-subject design, thus no subject participated in more than one session. All of the treatments were conducted in a classroom. Subjects were seated so 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. This left 80 subjects in both of the symmetric treatments; 66 in the two-person asymmetric treatment and 68 in the four-person asymmetric treatment. Each participant received a show-up payment of $3 (300,000 TL

13. Like in other non-cooperative economic experiments in the literature, we do not expect to have a significant subject pool effect in using economics and business students.

in Turkey)[14] and winners were paid their earnings privately at the end of the session.

The game was implemented as follows. Each player received some predetermined number of chips. In the first stage, each player chose how many of the chips to spend by sending the appropriate number of chips to the experimenter. The experimenter then mixed all the chips 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 chips of the winning player were mixed with blank ones to sum to the pre-specified total of their endowment, w_i. A random draw was then made. If the chip drawn was one of the player's, they won $\$R = \$20$ (or 2,000,000 TL). The game ended after this drawing.[15] Participants were paid privately and left the room.

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

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

5. Results and Discussion

5.1 Overview

Figure 1 shows the distribution of rent-seeking expenditures for the four treatments. The optimum bids predicted by the Nash equilibrium are also included on the histograms in order to compare the experimental results with the theoretical predictions.[16]

The results suggest than most of the subjects spent more than the predicted level of rent-seeking expenditures. In symmetric groups of two and four, the average rent-seeking expenditures were 15.29 and 17.26, exceeding the

14. The exchange rate was approximately $\$1 = 100{,}000$ TL at the time of the experiment.

15. For instance, in the treatment with $n = 2$ and $w_1 = w_2 = 30$, suppose Player 1 submits five chips 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 chips are mixed with five blank chips and a second draw is made in Stage II. The probability of her winning this stage is $25/(25 + 5) = .83$.

16. Although the overall average rent-seeking expenditures are slightly higher for the treatments in Turkey compared to those in the US, none of the differences are statistically significant. Hence, we pool the data in the following analysis.

Treatment I
Group size = 2
Symmetric endowment
(w_i = 30)
n = 80

Treatment II
Group size = 4
Symmetric endowment
(w_i = 30)
n = 80

Treatment III
Group size = 2
Asymmetric endowment
(w_i = 30 and w_j = 60)
n = 66

Treatment IV
Group size = 4
Asymmetric endowment
(w_i = 30 and w_j = 60)
n = 68

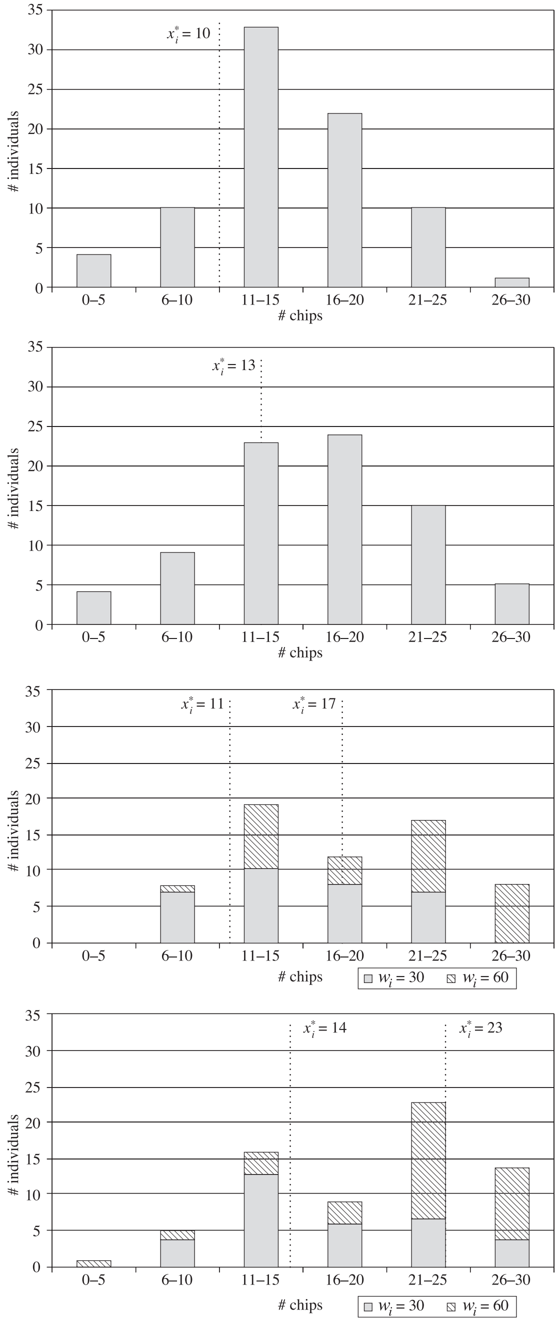

Figure 1. Distribution of Rent-Seeking Expenditures

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

	Average Rent-Seeking (in chips)
Symmetric	
Treatment I	15.29**
$n = 2, x^* = 10$	(5.28)
Treatment II	17.26**
$n = 4, x^* = 13$	(6.28)
Asymmetric	
Treatment III – low	15.52**
$n = 2, w = 30, x^* = 11$	(4.86)
Treatment III – high	21.58**
$n = 2, w = 60, x^* = 17$	(6.20)
Treatment IV – low	18.50**
$n = 4, w = 30, x^* = 14$	(3.80)
Treatment IV – high	22.21
$n = 4, w = 60, x^* = 23$	(6.47)

** $p < .01$

equilibrium predictions of 10 and 13. The results from the asymmetric groups are similar and summarized in Table 2 above. On average, there is excessive expenditure relative to the equilibrium prediction, for both low and high-endowment types, consistent with previous experimental studies of rent-seeking behavior. The next subsection presents some statistical tests of these observations.

5.2 Hypothesis 1S, 1A: Equilibrium Predictions

The first question posed by the 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 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.[17]

In the symmetric game, levels of rent-seeking expenditures are significantly higher than the Nash equilibrium predictions, for both groups of size two and of size four ($p < .01$ for all). In the asymmetric game, average rent-

17. Since the Shapiro–Wilk test shows that the two-person asymmetric treatment in Turkey and the four-person asymmetric treatment in the US are not normally distributed ($p < .05$), non-parametric tests are used for all subsequent analysis.

seeking expenditures are significantly higher than the equilibrium prediction for both low- and high-endowment types in the two-person treatments ($p < .01$ for all), and for the low-endowment types in the four-person treatments ($p < .01$). Only the mean expenditure for the high-endowment subjects in the four-person treatment is not statistically different than the predicted value.

5.3 Hypotheses 2S, 2A: Comparative Static, Group Size

Comparative statics of our model predict that rent-seeking expenditures will increase with an increase in the number of rent-seekers. Actual experimental results support this prediction. When the group size increases from $n = 2$ to $n = 4$, individual rent-seeking expenditures also increase, in both symmetric and asymmetric groups.

To test for this increase statistically, a Wilcoxon nonparametric test was conducted to examine the difference between the mean expenditures for two-person and four-person groups. The results reveal that in both the symmetric and asymmetric endowment cases, the difference is statistically significant ($p < .01$). These results are reported in Table 3.

5.4 Hypothesis 3: Comparative Static, Own Initial Endowments

Comparative statics of our model also predict that rent-seeking expenditures will increase when one's own initial wealth level increases. Table 4 displays the average increases in expenditures as one's own initial endowments increase.

The results indicate that an increase in one's own initial wealth level (w_i)

Table 3. Effect of Group Size on Rent-Seeking Expenditures

	Difference in Average Rent-Seeking Expenditures
Symmetric Endowment	
Treatment II – Treatment I	1.97**
$(n = 4) - (n = 2)$	
Asymmetric Endowment	2.28**
Treatment IV – Treatment III	
$(n = 4) - (n = 2)$	

** $p < .01$

Table 4. Effect of Own Initial Wealth on Rent-Seeking Expenditures

	Difference in Average Rent-Seeking Expenditures
Group Size = 2	
Treatment III – Treatment I	6.29**
$(w_i = 60) - (w_i = 30)$	
Group Size = 4	4.95*
Treatment IV – Treatment II	
$(w_i = 60) - (w_i = 30)$	

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

leads to a significantly higher rent-seeking expenditure in both two-person and four-person cases ($p < .05$ for both).

5.5 Hypothesis 4: Comparative Statics, Other's Initial Endowments

Our final hypothesis involved the comparative static prediction of an increase in rent-seeking expenditures as the wealth of others in your group increases. In the previous subsection we demonstrated that own wealth is influential in determining rent-seeking expenditures, however the predicted effect of others' wealth was not observed.

In particular, as Table 5 shows, an increase in the opponent's wealth level did not have a statistically significant impact subjects' rent-seeking expenditures. Some conjectures of why this may be so are presented in the discussion section below.

Table 5. Effect of Opponent's Initial Wealth on Rent-Seeking Expenditures

	Difference in Average Rent-Seeking Expenditures
Group Size = 2	
Treatment III – Treatment I	.23
$(w_j = 60) - (w_j = 30)$	
Group Size = 4	1.24
Treatment IV – Treatment II	
$(w_j = 60) - (w_j = 30)$	

5.6 Summary of Results and Discussion

Results from this experiment were surprisingly consistent with the comparative static predictions of the risky-rent seeking model we developed earlier. Rent-seeking expenditures increased significantly as the number of players in the game increased, in both the asymmetric and symmetric games. In addition, rent-seeking expenditures increased significantly as the player's own wealth level increased, as predicted by the model, in all the treatments.

However, the model's comparative static prediction involving the change in rent-seeking expenditures with changes in one's opponent's wealth were not supported. There may be several possible explanations for this insensitivity: One possible reason is that individuals may be modeling other players as random variables rather than as strategic actors. Thinking in such probabilistic terms may cause subjects to be insensitive to other players' action space, and lead to the results we observed. Another explanation is due to the beliefs about the other players' actions – if one believes that her opponent will always spend the same amount on rent-seeking activities, no matter what his budget is, than she would be insensitive to his initial endowment level. It would be worthwhile to test these different conjectures in a future experiment.

In addition, the model's Nash equilibrium point prediction of rent-seeking expenditures was not observed. Instead, most subjects in both countries spent too much toward rent-seeking activities, leading to even more rent dissipation than predicted by the model. This result is consistent with previous experimental results, which have found excessive rent-seeking in different settings.

We conjecture that one reason for overspending in the first stage of the game is that players engage in a myopic competition, focusing mostly on winning the initial stage of the 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 over-expenditure 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.

These heuristics are consistent with empirical findings on myopic decision-making: individuals are short-sighted in evaluating (risky) outcomes over time, showing a preference for short-term benefits and forgoing larger benefits in the future (Benartzi and Thaler, 1995; Gneezy and Potters, 1997).

This type of myopia has important implications for real-world, multi-stage rent-seeking settings like political campaigns and agricultural subsidies described earlier. In particular, if political actors suffer from the same biases that we observe in our subjects, we might see excess rent-seeking and subsequent social welfare loss (relative to equilibrium predictions) in two-stage settings. Political campaigns are likely to overspend in the primaries (although there may be other reasons for doing this not captured in our model) and lobbying groups are likely to overspend on lobbying and underspend on subsequent production.[18]

6. Conclusion

Theoretical models as well as field studies 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.

We also tested the comparative static 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. However, expenditures did not increase significantly when one's opponent's wealth level increased. We suggest that subjects may be thinking of their counterparts as random variables rather than as strategic actors. Instead of seeing the rent-seeking contest as a strategic game, they may interpret it as an individual decision problem under uncertainty. This sort of mental model would cause subjects to be insensitive to others' endowments and actions.

The experiment used subjects from two different countries: the US and Turkey. Turkey was chosen because it exhibits one of the highest incidence of rent-seeking in the world (Krueger, 1974). Average rent-seeking 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 insight to the question whether cultural differences play a role in determining the level of lobbying expenditures.

18. In a statistical analysis, Cohen et al. (2003) show that the correlation between the share of delegates won in the US presidential election and the share of each candidate's endorsement level is .89. This leads to an 'invisible primary' – an initial phase of rent-seeking activities in which candidates travel throughout the country to impress party officials.

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 institutional 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, election campaigning, 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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Appendix A. Nash Equilibrium

In this appendix, we show the Nash equilibrium for the n-person simultaneous rent-seeking game described in our paper. Each individual is facing the following problem:

$$\max_{x_i \in [0, w_i]} EU_i(x_i, x_{-i}) = \frac{x_i}{x_i + \sum_{j \neq i} x_j}\left[\left(\frac{w_i - x_i}{w_i}\right) u(R)\right], \quad \text{for } i = 1, \ldots, n$$

where $R > 0$ is a pre-determined and publicly known rent, expressed in monetary terms; x_i is player i’s rent-seeking expenditure in the first stage and w_i is player i’s initial endowment. For a fixed $\sum_{j \neq i} x_j$, the first-order condition yields:

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

The corresponding best-response function can be derived from these first-order conditions:

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

For a symmetric problem, $w_i = w, \forall i$, we then solve this set of equations simultaneously, which yields the equilibrium level of rent-seeking expenditure:

$$x_{iS}^* = \frac{w(n-1)}{2n-1}, \quad \text{for } i = 1, \ldots, n$$

For asymmetric games where $w_i \neq w_j$, the same set of simultaneous equations can be solved, yielding an equilibrium prediction of:

$$x_{iA}^* = \frac{2w_i - 4\sum_{j \neq i} w_j}{9} + \frac{\sqrt[3]{2}\left(4\left(w_i - 2\sum_{j \neq i} w_j\right)^2 + 36 w_i \sum_{j \neq i} w_j\right)}{9^{16(w_i - 2\Sigma_{j \neq i} w_j)^3 - 243 w_i^2 \Sigma_{j \neq i} w_j + 216 w_i (w_i - 2\Sigma_{j \neq i} w_j)\Sigma_{j \neq i} w_j + \sqrt{4(-4(w_i - 2\Sigma_{j \neq i} w_j)^2 - 36 w_i \Sigma_{j \neq i} w_j)^3 + 16(w_i - 2\Sigma_{j \neq i} w_j)^3 - 243 w_i^2 \Sigma_{j \neq i} w_j}}}$$

Appendix B: Derivation of Comparative Statics

1. Number of Players

1.1 Symmetric Case

The equilibrium rent-seeking expenditure in the symmetric case is

$$x_{iS}^{*} = \frac{w(n-1)}{2n-1}, \quad \text{for } i = 1, \ldots, n$$

Taking the derivative with respect to n gives

$$\frac{\partial x_{iS}^{*}}{\partial n} = \frac{w}{(2n-1)^2} > 0 \quad \text{for all } w > 0$$

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

1.2 Asymmetric Case

Taking the derivative of x_{iA}^{*} with respect to n gives

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

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

2. Own Endowment

Taking the derivative of x_{iA}^{*} with respect to w_i gives

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

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.

3. Opponent's Endowment

Taking the derivative of x_{iA}^* with respect to $\sum_{j\neq i} w_j$ gives

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

$$- \frac{57.1429\left[4n^2w_i^2 + 5nw_i\sum_{j\neq i} w_j + \left(\sum_{j\neq i} w_j\right)^2\right]\cdot\left(40n^2w_i^2 + 41nw_i\sum_{j\neq i} w_j + 8\left(\sum_{j\neq i} w_j\right)^2\right)}{\left(128n^3w_i^3 + 250n^2w_i^2\sum_{j\neq i} w_j + 123nw_i\left(\sum_{j\neq i} w_j\right)^2 + 16\left(\sum_{j\neq i} w_j\right)^3\right)^{4/3}}$$

By simplifying and rounding to the nearest whole number we get

$$\frac{\partial x_{iA}^*}{\partial \sum_{j\neq i} w_j} \cong .22\left(128n^3w_i^3 + 240n^2w_i^2\sum_{j\neq i} w_j + 123nw_i\left(\sum_{j\neq i} w_j\right)^2 + 16\left(\sum_{j\neq i} w_j\right)^3\right)^{4/3}$$
$$+ \left(9143n^4w_i^4 + 20800n^4w_i^3\left(\sum_{j\neq i} w_j\right) + 17800n^2w_i^2\left(\sum_{j\neq i} w_j\right)^2\right.$$
$$\left.+ 4685nw_i\left(\sum_{j\neq i} w_j\right)^3 + 457\left(\sum_{j\neq i} w_j\right)^4\right)$$

Since this expression is positive for $n, w_i, \sum_{j\neq i} w_j \geq 0$, we can conclude that $\partial x_{iA}^*/\partial \sum_{j\neq i} w_j \geq 0$ for $\forall i$. Hence, an increase in opponents' endowment leads to an increase in one's rent-seeking expenditures.

Appendix C: Experimental Instructions (in English) $n = 4$, symmetric endowment, $w_i = 30$

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 members 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 $X/X+Y$. 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.

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