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Policy making and rent-dissipation: An experimental test

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Abstract We present a transfer-seeking model of political economy that links the theory of Becker (1983) with Tullock-type models of politically contestable rents. In our model the size of the transfer is determined endogenously, and over-dissipation of rents is predicted even under conditions of risk-neutrality and perfect rationality. We implement an empirical test of this model by collecting behavioral data in a laboratory experiment. We confirm the existence of behavior that leads to over-dissipation of rents in games with both symmetric and asymmetric political power. To the extent that the transfer-seeking costs are social costs, our findings imply that the total costs of running government might be greatly underestimated if the value of the rent is used as a proxy for the rent-seeking cost. We also confirm the hypotheses that lowering the political power of one player can lead to smaller rent-seeking expenditures and to larger transfers

Keywords Rent-dissipation · Rent-seeking · Transfers · Experimental economics

JEL Classification C91, D72

1 Introduction

Governments shape economic policies in response both to the concerns of the general electorate, and to the pressure applied by special interest groups. A large literature

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has developed that models these processes, and a number of different approaches exist regarding the role given to interest groups. Hillman (1989) reviews much of this literature. We focus on models in which opposing groups compete for government favors. In particular, we introduce a variation of the tax-subsidy competition model by Becker (1983), in which no player has a guaranteed zero payoff option. Players who do not participate in the competition will be exploited by those who do. In this model, the size of the prize that groups are competing for is determined endogenously. We ask whether the costs incurred in this competitive process exceed the expected benefits, leading to so-called rent dissipation.

Experimental examinations of political competition have in large part been motivated by Tullock's (1980) imperfectly discriminatory rent-seeking game, and by the many papers that subsequently discussed the possibility of the over-dissipation of rents (Tullock, 1980, 1984, 1985, 1987, 1989).[1] All of these experiments assume a fixed prize, although both Cason and Mui (2002, 2003) and Davis and Reilly (1998) include groups that oppose the awarding of the prize, and therefore in these models a zero prize is possible. A limitation of Tullock-type fixed-prize models, however, is that in real-world political economies, groups lobby not only over who will pay for or receive a transfer, but also over how large that transfer will be. That is, the size of the prize is often determined endogenously within the machinations of the political system. Because of the ample evidence that in the real world the sizes of government transfers are determined endogenously within the lobbying system, it is worthwhile examining the rent-dissipation question within a model in which transfer size is endogenous. We develop and test experimentally a policy making model in the spirit of Becker (1983, 1985) in which the level as well as the direction of the transfer are determined endogenously, with the level being a continuous variable.

This model is interesting for a number of reasons. First, many policies cannot be modeled as a discrete variable, with only one, fixed level. Even many monopoly licenses, the standard example of a fixed rent-seeking prize, are not truly fixed prizes, since it may be possible for a monopoly rent-seeking process to affect the extent or the domain of the monopoly. An example would be private garbage companies that can gain monopoly access to residential neighborhoods, but where the same municipal government may be able to grant one or more neighborhoods to the same company. Second, the competition between interest groups for an endogenously determined transfer creates a game that mimics a prisoner's dilemma, or a public goods game. The amounts of participant cooperation in public goods experiments have differed greatly among those experiments. There are conflicts between incentives to obtaining large private earnings and to creating a bigger pie for everyone. We therefore anticipate that the rent-seeking game tested here may display a similar conflict between the private incentives to receive subsidies (and avoid taxes), and the joint benefits from avoiding large rent-seeking outlays. Finally, and perhaps most interestingly, our model can predict rent-seeking expenses that are many magnitudes larger than the subsidy actually received. In the language of the rent-dissipation literature this implies that there is very significant over-dissipation of rents. In fact, we will show that in a

[1] We will use the term "over-dissipation" to mean a situation in which rent-seeking expenditures exceed the rent. In the experimental literature this term is sometimes used to refer to cases in which the observed rent-dissipation exceeds the predicted. This is not how we use it here.

symmetric version of a policy-making game, expenses in rent-seeking may be large and significant, but the equilibrium prediction is for there to be a zero prize. The implication of this model is that government sectors can be very large, administering the rent-seeking process, even though the resulting transfer policies are quite small.

We consider two questions: first, to what extent can rent-seeking expenditures exceed the rents sought and cause so-called over-dissipation of rents, and second, to what extent does the relative lobbying effectiveness of the competing groups affect the outcome of rent-seeking competition? It is curious that while Becker's model has been cited hundreds of times in other branches of the political economy literature (c.f., Sobel (1999), Dixit et al. (1997), Jeong et al. (1999)), references to it are rare in the rent-dissipation literature. Linking Becker-type and Tullock-type models to examine rent-dissipation is long overdue. We show that a key theoretical result of linking these models is a prediction of over-dissipation, even under risk-neutrality and perfect rationality. Our experimental tests confirm these predictions. This result contrasts sharply with theoretical results from Tullock-type fixed-prize models.

In the next section we give a brief review of the theoretical and experimental literature on rent- and transfer-seeking. After that we discuss the prediction of over-dissipation that arises out of Becker-type tax-subsidy competition models, and then we introduce the models tested here. Finally, we introduce our experimental design and discuss our results.

2 Rent-seeking and transfer-seeking models

Rent-seeking and transfer-seeking models are distinguished based on the absence or presence of players who can oppose the awarding of the prize, so called rent-defending players (Hillman, 1989). Much attention has been paid in the theoretical and experimental rent-seeking literature to Tullock's (1980) rent-seeking game where the probability of winning the competition for the fixed prize is determined by the lobbying expenditures of the players. In these games, over-dissipation of the rents is not predicted.[2]

The experimental tests of fixed-prize models generally do not find evidence of over-dissipation of rents, although some players spend more in the rent seeking competition than predicted.[3] In an interesting contrast to our finding that disadvantaged agents

[2] See Baye et al. (1994) for a summary of the structure of Tullock's game. The only predictions of over-dissipation under conditions of fixed prizes and risk-neutrality of which we are aware are found in Anderson et al. (1998), whose predictions are based on a logit equilibrium that allows players to make decisions with errors, and in Hillman and Riley (1989, p. 36), who briefly comment on the possible over-dissipation when transfers are defined in the presence of deadweight costs. Potters et al. (1998) report predictions of dissipation that are less than complete on average, but for which there still will be a positive incidence of over-dissipation.

[3] Davis and Reilly (1995) do find strong evidence of dissipation greater than predicted levels. They conclude that dissipation is greater in perfectly discriminatory games (where the prize is awarded to the player with the highest rent seeking expenditures) than in imperfectly discriminatory games (where the prize is awarded probabilistically according to relative rent-seeking expenditures), and is lower in a transfer-seeking game (one that incorporates rent-defending buyer) than in their baseline rent-seeking game. Anderson and Stafford (2003) report over-dissipation on average in imperfectly discriminatory competitions. Potters et al. (1998) also find instances of over-dissipation, although on average dissipation is less then complete. Millner and

overspend in an asymmetric game, Schotter and Weigelt (1992) find that disadvantaged agents either drop out of the game entirely, or overspend. On average, however, they do not observe over-dissipation. In our game, as will be explained below in more detail, the option of dropping out of the game does not exist.

Little attention has been paid in the rent dissipation literature to another prominent model of transfer-seeking, formulated by Becker (1983, 1985). In Becker-type models lobbying expenditures *affect the size and the direction of the transfer itself*, such that the prize is not fixed but determined within the model's game. Endogeneity of the size of the prize provides some interesting twists to the rent dissipation literature. Specifically, we will show that under certain very plausible parameterizations of Becker-type models, the Nash equilibrium results in over-dissipation of rents. This result contrasts directly with the predictions of the fixed-prize model, be they rent- or transfer-seeking, or perfectly or imperfectly discriminatory. The intuition behind our result is that in the endogenous prize model it is possible for the lobbying efforts of one player to counterbalance the lobbying efforts of another. The result is small transfers; government taxes and subsidizes the players by only a small amount (or not at all). Nevertheless, players lobby to defend themselves against other players' lobbying since they do not have the option of guaranteeing themselves a zero payoff by not participating in the game. Thus, more can be spent on lobbying than on transfers.

Coggins (1995) also presents a Becker-type non-cooperative game in which players use lobbying expenditures to influence the price of a good. Similar to the results we obtain, Coggins shows that the Nash equilibrium of his game can be characterized by over-dissipation of rents if players' possess roughly symmetric degrees of political power and initial wealth. Coggins concludes:

> "If it is true . . . that rational rent seekers never spend more in total than the value of the *monopoly* prize they seek, this paper has shown that the same cannot be said of rent seeking for a *price* policy" (p. 164).

Our model suggests that Coggins' conclusion can be broadened, for the pertinent issue here is not so much whether the players lobby for a monopoly prize or a price policy, but rather whether the size of the prize is fixed or depends on lobbying expenditures.

In our model there are two players 1 and 2, each of whom is given an endowment of E_i and must choose a lobbying expenditure a_i from some set of possible lobbying expenditure choices $A_i \subseteq \mathrm{R}_+ (i = 1, 2)$. Lobbying expenditures determine what Becker calls political influence, the absolute value of which we will call the "size of the government," $I = I(a_1, a_2)$. We say that if $I > 0$ player 1 is subsidized and player 2 is taxed to finance the subsidies, if $I < 0$ player 1 is taxed and player 2 is subsidized, and that if $I = 0$ neither player is taxed or subsidized.

Let Tr_i $(i = 1, 2)$ represent transfers to/from player i (subsidy if positive, tax if negative). Deadweight and administrative costs are assumed to accompany the taxation

Pratt (1989) test behavior in an imperfectly discriminatory, fixed-prize model where under-dissipation is predicted for risk-neutral players. Nevertheless, they observe average dissipation rates significantly above predicted levels, but overall lower than complete rent-dissipation. Using a similar game, Shogren and Baik (1991) give subjects complete information about expected payoffs in a normal-form game and find that play is not significantly different from the risk-neutral Nash equilibrium prediction of under-dissipation. Hillman and Katz (1984) find that risk-loving behavior could lead to over-dissipation, and Anderson et al. (1998) show that relaxing the perfect rationality assumption can lead to over-dissipation.

and subsidization processes. Thus, the government is assumed to receive less than the taxed player pays, and the subsidized player is assumed to receive less than the government spends. Furthermore, deadweight and administrative costs may grow with the size of government. Formally, these conditions imply $Tr_1(a_1, a_2) = f(I(a_1, a_2))$ and $Tr_2(a_1, a_2) = g(I(a_1, a_2))$, where $0 < f' \leq 1$ for $I \geq 0$, $f' \geq 1$ for $I < 0$, $f'' \leq 0$ for all I, $0 > g' \geq -1$ for $I < 0$, $g' \leq -1$ for $I > 0$, and $g'' \leq 0$ for all I.

Assume that each player's objective is to choose lobbying expenditures to maximize income, so for $i = 1, 2$, player i's objective is to solve (1):

$$\max_{a_i \in A_i} E_i + Tr_i(a_1, a_2) - a_i. \tag{1}$$

Define player 1's set of best responses as $B_1 = \{(a_1, a_2) \in A_1 \times A_2\colon a_1 = \arg\max_{a_1 \in A_1}(E_1 + Tr_1(a_1, a_2) - a_1)\}$. Similarly, define player 2's set of best responses as $B_2 = \{(a_1, a_2) \in A_1 \times A_2\colon a_2 = \arg\max_{a_2 \in A_2}(E_2 + Tr_2(a_1, a_2) - a_2)\}$. A necessary and sufficient condition for (a_1, a_2) to be a Nash equilibrium is that $(a_1, a_2) \in B_1 \cap B_2$; that is, a_1 must solve (1) for $i = 1$ given the value of a_2, and a_2 must solve (1) for $i = 2$ given the value of a_1.[4]

2.1 Over-dissipation in Becker-type models

If we assume a symmetric game,[5] then player 1's set of best responses B_1 is the transformation across the 45-degree line of player 2's set of best responses B_2. An illustration is provided in Fig. 1. That is, $(x, y) \in B_1$ if and only if $(y, x) \in B_2$. This implies that in a symmetric game if (a_1, a_2) is a pair of non-cooperative Nash equilibrium lobbying expenditures, then $a_1 = a_2$. But then in equilibrium there is neither taxation nor subsidization of either group: $Tr_1(a_1, a_2) = Tr_2(a_1, a_2) = I(a_1, a_2) = 0$. Since lobbying expenditures are nonnegative and there are no rents in equilibrium, there are two possibilities for an equilibrium degree of rent-dissipation for the symmetric model: that positive lobbying expenditures are made ($a_1 = a_2 > 0$) but no transfers occur, implying over-dissipation, or that no lobbying expenditures are made and no transfers occur.[6] Which of these two possibilities occurs depends on model specifications.

2.2 A symmetric game

We next present an example of a symmetric model used in our experiments. In the equilibrium lobbying expenditures are positive, but neither taxes nor subsidies are

[4] Of course, in the very general form of the model presented so far, existence and uniqueness of a Nash equilibrium is not assured. These may be assured by imposing appropriate structure on the functions and on the sets of possible lobbying expenditures A_1 and A_2.

[5] More formally, a symmetric game is one in which (i) $E_1 = E_2$, (ii) $A_1 = A_2$, (iii) $g(I) = f(-I)$ for all $I \in R$, and (iv) $I(x, y) = -I(y, x)$ for any (x, y) in $A_1 \times A_2$.

[6] It should be emphasized that symmetry in the Becker game is not a necessary condition for over-dissipation. One can easily imagine an asymmetric game which is in some sense not "too asymmetric," so that in equilibrium transfers are not zero, yet still are smaller than the sum of lobbying expenditures. One of the games we present has these properties.

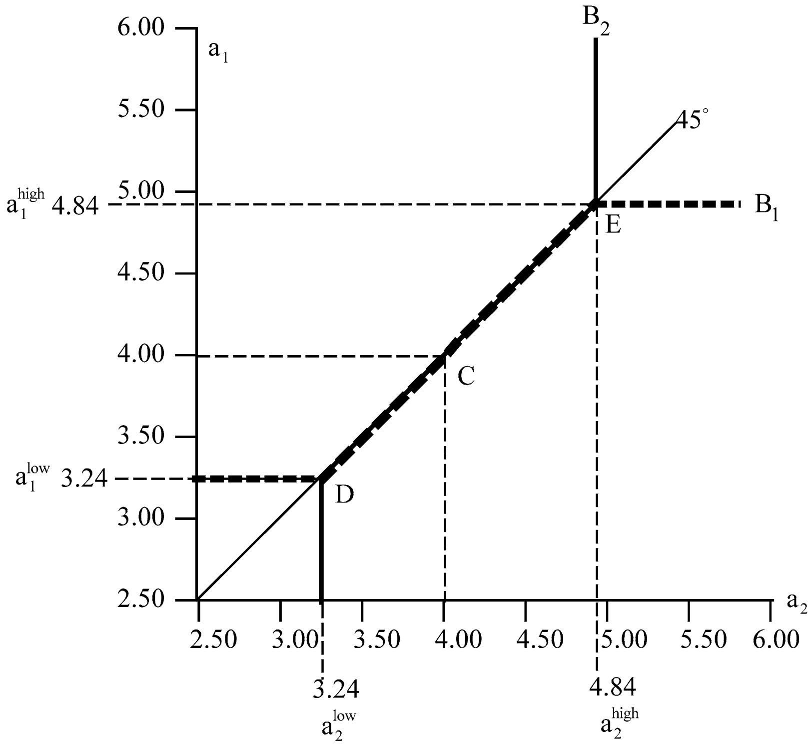

Fig. 1 Best-response sets for the symmetric Game 1 (*Explanation:* a_i is the lobbying expenditure by agent i. The reaction functions (B_i) are piece-wise linear with minimum expenditures at \$3.24 (point *D*) and maximum expenditures at \$4.84 (point *E*). Any expenditure between these two is part of the support for the Nash equilibrium. The set of Nash equilibria lies on the 45 degree line, due to the symmetry of the two agents. This means that in all Nash equilibria both agents spend the same, and that therefore the lobbying efforts will be exactly off-setting, leading to zero transfers. Point *C* corresponds to the unique Nash equilibrium in the discrete version of the model implemented in the experiment.)

generated. Hence rents are over-dissipated. We specify the influence function as

$$I\ (a_1, a_2) = \gamma_1 [a_1]^{\varepsilon_1} - \gamma_2 [a_2]^{\varepsilon_2}, \tag{2}$$

where $\varepsilon_1, \varepsilon_2, \gamma_1$, and γ_2 are parameters describing the relative ability of interest groups to affect the size of government and the direction of transfers with their lobbying expenditures.[7] We assume that deadweight costs accruing in both the taxation and subsidization processes are simply 10% of the size of government:

$$Tr_1(a_1, a_2) = f(I(a_1, a_2)) = I(a_1, a_2) - 0.1ABS[I(a_1, a_2)], \tag{3}$$

$$Tr_2(a_1, a_2) = g(I(a_1, a_2)) = -I(a_1, a_2) - 0.1ABS[I(a_1, a_2)], \tag{4}$$

[7] We assume that $0 < \varepsilon_1 < 1$, $0 < \varepsilon_2 < 1$, in order to satisfy functional form requirements set forth in the appendix of Becker (1983).

Let Game 1 have specifications (1), (2), (3) and (4), with $E_1 = E_2 = 10$. Assume in Game 1 that each player's lobbying expenditures can take on any nonnegative value (i.e., $A_1 = A_2 = R_+$). Then in Game 1, the set of (a_1, a_2) representing player 1's best-response a_1 to lobbying expenditures of a_2 by player 2 is shown in (5) for $i = 1$. The set of (a_1, a_2) representing player 2's best-response a_2 to lobbying expenditures of a_1 by player 1 is shown in (5) for $i = 2$:

$$B_i = \left\{ \begin{array}{l} (a_1, a_2) : a_i = [(0.9)\,\gamma_i \varepsilon_i]^{\frac{1}{1-\varepsilon_i}} \text{ for } 0 \le a_j \le a_j^{low}, \\ a_i = \left[\dfrac{\gamma_i}{\gamma_j} \right]^{\frac{1}{\varepsilon_i}} [a_j]^{\frac{\varepsilon_j}{\varepsilon_i}} \text{ for } a_j^{low} \le a_j \le a_j^{high}, \\ a_i = [(1.1)\,\gamma_i \varepsilon_i]^{\frac{1}{1-\varepsilon_i}} \quad \text{for } a_j^{high} \le a_j \end{array} \right\}, i = 1, 2; j = 1, 2; i \ne j, \tag{5}$$

where $a_i^{low} = [(0.9)\gamma_j \varepsilon_j]^{\frac{\varepsilon_j}{(1-\varepsilon_j)\varepsilon_i}} [\gamma_j/\gamma_i]^{\frac{1}{\varepsilon_i}}$, $a_i^{high} = [(1.1)\gamma_j \varepsilon_j]^{\frac{\varepsilon_j}{(1-\varepsilon_j)\varepsilon_i}} [\gamma_j/\gamma_i]^{\frac{1}{\varepsilon_i}}$, $i, j = 1, 2, j \ne$ i.

Finally, we can make Game 1 symmetric by assuming $\varepsilon_1 = \varepsilon_2$ and $\gamma_1 = \gamma_2$. In particular, we assume $\varepsilon_1 = \varepsilon_2 = 0.5$, and $\gamma_1 = \gamma_2 = 4$. The best-response sets for Game 1 can be obtained from (5), and are shown in Fig. 1 as B_1 and B_2. The best-response sets intersect at all points between D and E, all of which lie on the 45-degree line, but none of which are (0, 0).. Thus, in Game 1 any Nash equilibrium implies over-dissipation of rents.

Our symmetric game is a variation of a prisoners' dilemma game. Previous experimental tests of the prisoners' dilemma game have found a fairly large proportion of cooperative play. Andreoni and Miller (1993) and Cooper et al. (1996), for example, report cooperation in both repeated and non-repeated games of about 20%. Furthermore, experimental tests of public goods games, which are also variations of prisoners' dilemma games, show that cooperation rates are quite high, at least initially.[8] We therefore hold, as an alternative hypothesis to the Nash equilibrium prediction of our game, the cooperative prediction that subjects will choose much smaller levels of rent-seeking expenditures.

2.3 An asymmetric game

The symmetric Becker game described as Game 1 above can be made asymmetric simply by altering the assumptions that $\varepsilon_1 = \varepsilon_2$ and $\gamma_1 = \gamma_2$. If, say, $\varepsilon_1 < \varepsilon_2$, or if $\gamma_1 < \gamma_2$, then player 2 is politically stronger than player 1. This changes the best-response functions for both players. We will specify Game 2 as an asymmetric game by setting $\varepsilon_1 = 0.1$, $\varepsilon_2 = 0.5$, and $\gamma_1 = \gamma_2 = 4$. It can be shown that the Nash equilibrium for this game is $a_1 = \$0.402$ and $a_2 = \$3.24$, resulting in a subsidy of \$3.19 to player 2 and a tax of \$3.90 on player 1. Thus, again, we have aggregate lobbying expenditures greater than the size of the subsidy, so rents are over-dissipated. Because player 1 is

[8] Good reviews of public goods experiments can be found in Ledyard (1995) and Plott and Smith (2004).

Table 1 Payoffs in Game 1 (Symmetric Game, with E_1=E_2=\$10.00, ε_1=ε_2=0.5, γ_1=γ_2=4)

	a_1 = \$0.00	a_1 = \$0.50	a_1 = \$1.00	a_1 = \$2.00	a_1 = \$4.00	a_1 = \$6.00
	Payoffs to column player (Player 1) = $E_1 + Tr_1(a_1, a_2) - a_1$					
a_2 = \$0.00	\$10.00	12.05	12.60	13.09	13.20	12.82
a_2 = \$0.50	6.89	9.50	10.05	10.55	10.65	10.27
a_2 = \$1.00	5.60	8.21	9.00	9.49	9.60	9.22
a_2 = \$2.00	3.78	6.39	7.18	8.00	8.11	7.73
a_2 = \$4.00	1.20	3.81	4.60	5.42	6.00	5.62
a_2 = \$6.00	0.00	1.83	2.62	3.44	4.02	4.00
	Payoffs to row player (Player 2) = $E_2 + Tr_2(a_1, a_2) - a_2$					
a_2 = \$0.00	\$10.00	6.89	5.60	3.78	1.20	0
a_2 = \$0.50	12.05	9.50	8.21	6.39	3.81	1.83
a_2 = \$1.00	12.60	10.05	9.00	7.18	4.60	2.62
a_2 = \$2.00	13.09	10.55	9.49	8.00	5.42	3.44
a_2 = \$4.00	13.20	10.65	9.60	8.11	6.00	4.02
a_2 = \$6.00	12.82	10.27	9.22	7.73	5.62	4.00

less politically powerful than player 2, in equilibrium player 1 pays a tax to finance a subsidy to player 2. In the asymmetric game the disadvantaged agent (player 1) ends up spending less than in the symmetric game because his political expenditures are less effective at the margin. As lobbying expenditures are not very effective for one player, the sum of lobbying expenditures is smaller in the asymmetric game than in the symmetric game.

3 Numeric implementation and experimental design

We implemented a symmetric transfer-seeking game much like Game 1 as a computerized one-shot normal form game in the experimental laboratory. The only difference between Game 1 and the symmetric game in the laboratory was that in the experiment we offered the players only a finite number of lobbying expenditure choices: $A_1 = A_2 = \{\$0.00, \$0.50, \$1.00, \$2.00, \$4.00, \$6.00\}$. This allows us to present the payoff consequences of all possible actions to subjects in a simple way, as a matrix. Corresponding to these discrete expenditure choices we calculated payoffs for each subject according to the objective functions in (1).

Table 1 shows the particular payoffs employed in our symmetric treatment, together with the parameter values that generated them. The Nash equilibrium in the symmetric game corresponds to expenditures of \$4.00 for each player and a payoff of \$6.00 for each. This equilibrium is shown as point C in Fig. 1. Table 2 shows the corresponding payoffs for the asymmetric treatment, corresponding to Game 2. The Nash equilibrium is at \$0.50 expenditures for the column player and \$4.00 for the row player, with payoffs of \$4.81 and \$9.84, respectively.[9] For both games we predict over-dissipation because the subsidy is less than the combined transfer-seeking costs.

[9] This discrete strategy equilibrium corresponds to the continuous strategy equilibrium indicated earlier.

Table 2 Payoffs in Game 2 (Asymmetric Game, with $E_1=E_2=$ \$10.00, $\varepsilon_1= 0.1, \varepsilon_2= 0.5, \gamma_1=\gamma_2= 4$)

	a_1 = \$0.00	a_1 = \$0.50	a_1 = \$1.00	a_1 = \$2.00	a_1 = \$4.00	a_1 = \$6.00
Payoffs to column player (Player 1, the disadvantaged player) = $E_1 + Tr_1(a_1, a_2) - a_1$						
a_2 = \$0.00	\$10.00	12.86	12.60	11.86	10.14	8.31
a_2 = \$0.50	6.89	10.31	10.05	9.31	7.59	5.76
a_2 = \$1.00	5.60	9.21	9.00	8.26	6.54	4.71
a_2 = \$2.00	3.78	7.38	7.18	6.49	4.83	3.04
a_2 = \$4.00	1.20	4.81	4.60	3.92	2.25	0.46
a_2 = \$6.00	0.00	2.83	2.62	1.94	1.00	0.00
Payoffs to row player (Player 2, the advantaged player) = $E_2 + Tr_2(a_1, a_2) - a_2$						
a_2 = \$0.00	\$10.00	5.89	5.60	5.28	4.95	4.74
a_2 = \$0.50	12.05	8.51	8.21	7.90	7.56	7.35
a_2 = \$1.00	12.60	9.24	9.00	8.68	8.35	8.14
a_2 = \$2.00	13.09	9.73	9.49	9.23	8.96	8.78
a_2 = \$4.00	13.20	9.84	9.60	9.34	9.06	8.89
a_2 = \$6.00	12.82	9.46	9.22	8.96	8.68	8.51

All subjects were seated at private computer terminals, separated by screens. Each player's computer terminal displayed both his/her own and the other player's payoffs simultaneously, although no player knew the identity of the player with whom he or she was matched since we used an anonymous random matching process. We used a between-subject design for the symmetric and the asymmetric treatments, and subjects only played the game one time for money. Subjects were asked to make a choice over expenditures, displayed as row or column choices that would result in specific transfers between themselves and the other player and result in the payoffs shown in the matrix. All subjects made their decisions simultaneously and anonymously. Subjects were given detailed game instructions on the computer screen and in hard copy. The concept of an influence function was never introduced, but subjects were told that the payoffs corresponded to the net of their initial endowment (\$10), their spending decision, and the resulting transfers.[10]

During the experiment, subjects could also view matrices indicating the transfer amounts resulting from the expenditure choices, calculated in accordance with Eqs. (3) and (4).[11] The option of viewing the transfer matrices was activated with a simple keystroke, and almost all subjects exercised this option.

As part of the on-screen instructions we also included a test of their ability to read the payoff and transfer matrices, and to relate these matrices to their decisions. After all subjects had successfully finished the instructions and the test, they played the game for five training periods for which they were not paid. Re-matching during the training rounds was based on a random strangers protocol. They then played the game one time for money against a randomly selected other player. In addition to the payoff from the game, they also received a \$5 participation fee that was independent of performance. We used the same payoff matrices throughout all training and actual periods,

[10] The instruction text is included in the Appendix that can be found in ExLab (http://exlab.bus.ucf.edu).

[11] These matrices are included in the Appendix in ExLab.

and subjects remained in the initial positions assigned, i.e., either as advantaged or disadvantaged.

4 Results

Seventy graduate and undergraduate students from the Moore School of Business at the University of South Carolina participated as subjects. Twenty-eight of these participated in the symmetric treatment, and fortytwo in the asymmetric treatment, twenty-one in each position.[12] Subjects only made one decision for money and our data analysis is based on this single observation.

We first look at the degree to which our subjects cooperated in the symmetric game, a possibility that is based on the cooperative patterns found in public goods and prisoners' dilemma experiments. The complete distribution of observations on transfer-seeking expenditures in the symmetric game (Game 1) is shown in the top part of Fig. 2 by grey bars. Summary statistics of expenditures, as well as transfers, earnings and rent dissipation are displayed in Table 3.[13] Out of our 28 subjects in the symmetric game, only one chose the $0 spending level and only one other chose a positive spending which was less than the Nash equilibrium prediction. On average participants spend 57 cents more than the predicted $4, with about 28% of players spending an extra $2. It is therefore straightforward to reject cooperative play in these games. Using a sign-test we reject that the median expenditures are equal to prediction, in favor of higher expenditures. One important aspect of our design, which may provide part of the explanation to the lack of cooperation, is that our instructions gave the subjects a story of how the payoffs depend on transfers generated by the spending decisions undertaken by both players:

> "Your decision in the experiment will concern how much money to spend on a process that will result in transfer payments between you and the other player. The process is such that the more you spend in relation to the other player, the more transfers you will receive from him or her. If the other player spends more than you, however, it will be you who make a transfer payment to him or her".

We find strong support for over-dissipation of rents in the symmetric game. Expenditures are on average $4.57 per person or $9.14 per pair, which can be compared to the average transfer received of $1.35. Since the expenditures vastly exceed the value of the rent received, rent-dissipation exceeds 100%.

We next turn to look at how the lobbying process is affected by asymmetric relative lobbying effectiveness. The bottom panels of Fig. 2 show the distributions of expenditures for the disadvantaged and advantaged players in the asymmetric game (Game 2). Table 3 again displays summary statistics of expenditures, transfer payments,

[12] All data and statistical codes can be found in ExLab.

[13] We reject normality for the distributions using a Shapiro-Wilk test (see Shapiro and Wilk (1965)). Probabilities are 0.00038, 0.00016, and 0.00000 for expenditures, earnings and transfers, respectively. We therefore present our results based on a non-parametric sign test of the difference between the observed value and the predicted value. See Snedecor and Cochran (1989) for a discussion of this test.

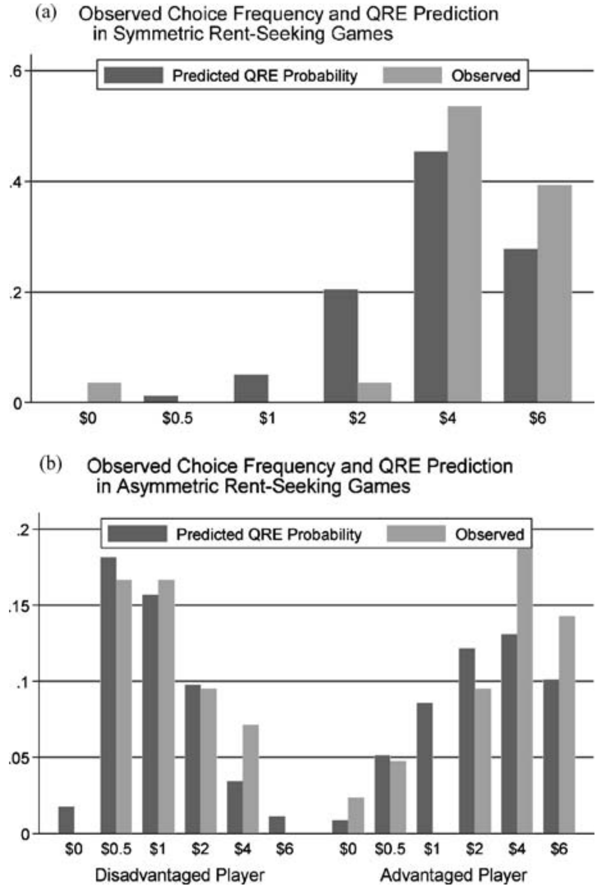

Fig. 2 *QRE prediction and observed choices* for each player in the symmetric game (top), in the asymmetric game for the disadvantaged players (bottom left), and in the asymmetric game for the advantaged players (bottom right)

earnings, and rent dissipation.[14] Again we can easily reject cooperative behavior. The disadvantaged players spend significantly more than predicted, while the play of the asymmetric players is not significantly different from the predicted $4. Expenditures by disadvantaged players are on average almost a dollar higher than predicted, with over 30% of them spending at least $2, which is 4 times over prediction. The effect of the deviation from prediction by disadvantaged players is smaller transfers, i.e. lower taxes for the disadvantaged players and smaller subsidies for the advantaged players. The consequence to the latter is significantly smaller earnings, while the former receive higher earnings that are weakly significant.

Again, our findings support over-dissipation of rents. Since the transfers are smaller and the expenditures by disadvantaged players are higher than predicted, over-dissipation is significantly greater than what is predicted. These results are consistent with Schotter and Weigelt (1992), who found that some of the disadvantaged players in

[14] We reject normality for the distributions using a Shapiro-Wilk test. For disadvantaged agents probabilities are 0.00124, 0.04001, and 0.02101 for expenditures, earnings and transfers, respectively, and for advantaged agents the corresponding probabilities are 0.8716, 0.00000, 0.00454. Thus the only distribution for which we cannot reject normality is the one for advantaged agents expenditures.

Table 3 Summary of observations

	Expenditures	Transfer payments[a]	Earnings	Rent dissipation[b]
Symmetric game (28 observations)				
Nash prediction	4.00	0.00	6.00	8.00
Observed mean (Median)	4.57 (4.00)	1.35 (0.00)	5.32 (5.62)	7.76 (8.1)
Probability of Sign[c] test for positive difference	0.01	0.0002	1.00	0.0898
Probability of Sign[c] test for negative difference	1.00	1.00	0.0007	0.9805
Asymmetric game, disadvantage players (21 observations)				
Nash prediction	0.5	−4.69	4.81	0.23
Observed mean (Median)	1.45 (1.0)	−3.48 (−4.4)	5.07 (4.81)	1.40 (1.00)
Probability of Sign[c] test for positive difference	0.0001	0.5	1.00	0.0001
Probability of Sign[c] test for negative difference	1.00	0.6682	0.0946	1.000
Asymmetric game, advantaged players (21 observations)				
Nash Prediction	4.0	3.84	9.84	0.23
Observed mean (Median)	3.67 (4.0)	2.77 (3.60)	9.20 (9.46)	1.40 (1.00)
Probability of Sign[c] test for positive difference	0.7095	0.9867	0.9993	0.0001
Probability of Sign[c] test for negative difference	0.5	0.0392	0.0036	1.000

[a]Transfer Payments - Deadweight costs are not netted out, but are included here. Transfers are not measured as the absolute amount, so transfers payments are negative and transfer receipts are positive.
[b]Rent dissipation is calculated as Rent Seeking Expenditures – Rent. Rent is defined as I (the size of the government) in Eq. (2).
[c]The sign test is based on the hypothesis that the probability of a positive difference between the observed and the predicted choice is as likely as a negative difference, namely 0.5.
Sources: lobbc1.log, rent1.log, asym0trans-earn.log, asym-recoded-rentdiss-nodwcost.log. All files available in ExLab.

uneven tournaments overbid compared to the riskneutral Nash equilibrium prediction. We also find that the overspending by disadvantaged agents is significantly higher than the overspending by symmetric agents, by an average of 40 cents, or 70% of the symmetric overspending. This is quite significant.[15] Nevertheless, even though this behavior increases rent dissipation in the asymmetric game compared to prediction, we still find rent dissipation to be significantly lower than in the symmetric game since the spending by the disadvantaged player does not get close to that of the symmetric player.

In summary, we cannot reject over-dissipation in either of the two games investigated. In fact, players in our experiments appear to spend even more on transfer-seeking than predicted by the Nash equilibrium, except when they are in an advantageous position.

We estimate a Quantal Response Function in order to see whether decision errors may explain why rent seeking expenditures exceed the Nash prediction. In a quantal response equilibrium (QRE) formulation players act with less than perfect rationality

[15] Wilcoxon-Mann-Whitney (WMW) ranksum test rejects equality (prob = 0.0000). Aggregate rent-seeking expenditures are significantly lower in asymmetric than in symmetric games. Average expenditures are $4.57 in the symmetric and $2.56 in the asymmetric game. WMW ranksum test rejects equality (prob = 0.0001).

and are modeled as noisy decision makers via a logit probabilistic choice function.[16] This approach is attractive as a complement to the standard Nash equilibrium predictions since it provides a statistical structure for estimation using experimental (or field) data. In contrast to the Nash approach, which makes strong deterministic predictions, the QRE model makes statistical predictions. The logistic quantal response function is defined as:

$$\rho_{ij}(u_i) = \frac{e^{\lambda u_{ij}}}{\sum_{k=1}^{J_i} e^{\lambda u_{ik}}} \tag{6}$$

where ρ_{ij} is the equilibrium probability for strategy j for agent i; u_{ij} is the utility payoff for strategy j and agent i, and λ is a parameter that is inversely related to the level of error. $\lambda = 0$ implies that choice is purely random, and $\lambda = \infty$ implies that there are no errors. In equilibrium players hold beliefs about other players' action choices which are confirmed by actual play. Since the prediction offered by this theory is simply a smoothing out of the strategy choices predicted by the Nash equilibrium, over-dissipation is still predicted. Caution should be used whenever testing equilibrium models like QRE or Nash equilibrium on one-shot data even after some periods of practice. The assumption of equilibrium in behavior and beliefs is very strong. Nevertheless, these models still provide us with a structure for organizing the data.[17]

We use maximum likelihood to estimate λ from the QRE model for the final period data from each of our treatments.[18] The panels of Fig. 2 compare the observed strategy choices with the QRE prediction for the estimated λ parameter. Likelihood ratio tests confirm that the QRE predictions are significantly different from both random choice and the Nash equilibrium predictions for each of the symmetric and the asymmetric games.[19]

[16] See e.g. McKelvey and Palfrey (1995, 1998), McKelvey et al. (2000), Goeree and Holt (2000, 2004, 2005), and Goeree et al. (1999, 2000) for models which explore the general properties and specific applications of this approach.

[17] We also caution that since all models of behavioral errors, such as QRE, are parametric models, they cannot provide general tests of the explanatory power of such errors.

[18] We use Gambit for calculating our predictions as well as for performing the likelihood maximization over the error rate. See McKelvey et al. (2005) for the Gambit software. Gambit only estimates one maximum-likelihood λ value for each game, so that both players are assumed to make decisions with the same λ. The actual frequencies of play of the different strategies are indicated in Figs. A1 and A2 in the Appendix in ExLab.

[19] The log likelihood values for the symmetric game are: LL $= -36.0815$ for MLE QRE $\lambda = 1.7547$, LL $= -254.1894$ for $\lambda = 26.5893$ (the NE prediction), and LL $= -49.9694$ for $\lambda = 0$ (random choice). A likelihood ratio test of the MLE/QRE prediction vs. the NE prediction gives a $\chi 2$ LR value of 511.8882 which has a p-value of 0.000 assuming 1 degree of freedom. A likelihood ratio test of the MLE/QRE prediction vs. the random choice prediction gives a $\chi 2$ LR value of 103.4483 which has a p-value of 0.000 assuming 1 degree of freedom. The log likelihood values for the asymmetric game are: LL $= -64.2875$ for the MLE QRE value of $\lambda = 0.6777$, LL$= -1979.0111$ for $\lambda = 89.7918$ (the NE prediction), and LL$= -74.9552$ for $\lambda = 0.0$ (random choice). The Appendix in ExLab summarizes these comparisons in Tables A3 and A4. A likelihood ratio test of the MLE/QRE prediction vs. the NE prediction gives a $\chi 2$ LR value of 3959.3776 which has a p-value of 0.000 assuming 1 degree of freedom. A likelihood ratio test of the MLE/QRE prediction vs. the random choice prediction gives a LR value of 151.2660 which has a p-value of 0.000 assuming 1 degree of freedom.

The observed spending behavior in both the symmetric and asymmetric games are consistent with the QRE predictions.[20] We therefore conclude that no additional psychological motivations are necessary to explain the deviations in behavior from the Nash predictions that we observe here.

5 Summary and conclusions

We consider a model of policy making competition that links the theory of Becker (1983) to Tullock-type models of politically contestable rents. Both the level and the direction of the resulting rent-transfer are endogenous in this model. Our model predicts over-dissipation of rents, i.e. rent-seeking expenditures that exceed the rent. We implement an empirical test of this model by collecting behavioral data in a controlled laboratory experiment.

Our empirical tests support the over-dissipation hypothesis. We do not observe subjects cooperating to spend less on transfer-seeking expenditures than predicted by the Nash equilibrium, contrary to other experimental tests of games of a prisoners' dilemma nature. We confirm the hypothesis that lowering the political power of one player can lead to smaller transfer-seeking expenditures and to larger transfers, and therefore to less over-dissipation.

The endogenous prize model of rent dissipation makes it clear that in equilibrium there need not be a prize for there to be lobbying, and that large lobbying efforts can accompany small prizes. Lobbying efforts by two players over *potential* subsidies and taxes may balance each other out, such that in equilibrium the size of the prize is zero or quite small. Contrary to games with fixed prizes, players cannot guarantee themselves a zero payoff by a zero lobbying strategy implying that equilibria with negative payoffs exist. There has been almost no focus in the rent dissipation literature on endogenous prize models, despite the useful insights that they provide, and despite these models being widely used in other branches of the political economy literature.

With over-dissipation of rents, even a very small government might be supported by a large transfer-seeking sector. To the extent that the transfer-seeking costs are social costs, the total costs of running government might be greatly underestimated in political economies with small governments if all of the transfer-seeking costs are not considered. Using the value of the rent as a measure of transfer-seeking costs, as suggested by Krueger (1974) among others, would result in such underestimation.

We have presented a model and experimental evidence which magnify Tullock's results on rent-dissipation. We have argued here that the rent-dissipation literature has been too narrowly focused on Tullock's model, and has not paid Tullock's *idea* the full range of attention it deserves. In our model, rent-dissipation can be huge in equilibria in which opponents "beat each other up" in expenditures while "balancing each other out" in the resulting transfers of a political game. Because of the political power balance, much more is spent in the "beatings" than what is transferred.

[20] Using a Fisher Exact test, we cannot reject the null hypothesis that the QRE and the observed frequencies are the same for the symmetric game (p-value is 0.145). Similarly, we cannot reject equality for either the advantaged or the disadvantaged player in the asymmetric game (p-values are 0.34 and 0.84, respectively).

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