Public Choice **110:** 67–78, 2002.

Efficient rent-seeking in experiment

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Accepted 9 August 2000

Abstract. In a series of experiments we show that people learn to play the efficient outcome in an open-ended rent-seeking game. This result persists despite quite different experiment environments and designs, like different propensities of competition, group sizes etc., and is interpretable as a resolution of the so-called Tullock paradox which states that real-world rent-seeking expenditures are much lower than what the standard rent-seeking model predicts.

1. Introduction

It lies in the nature of institutions like the parliament and the government and their agencies that they generate rent, i.e., their decisions have impact on the interests of a lot of groups of people. Trade protection, industrial regulation, environmental law, decisions on tax and public expenditures are examples that come immediately to mind. So, potential winners tend to invest a great deal of resources in an attempt to sway the decision in their way. In general, these investments are considered pure social waste if they are not pure transfers like briberies. The main question raised in the theory of rent seeking is how much the total expenditure might be, since the same resource could be otherwise used for productive rather than distributive purposes.

There is no doubt that a thorough understanding of the rent-seeking process is essential for any serious evaluation of the economic performance of a political system. Unfortunately, however, in the literature there seems to be more striking paradoxes than clear-cut answers to the question how rent seeking really works. Our attention in what follows is directed at one of these paradoxes. In the early literature, rent seekers are price takers in a perfect competition model which implies that the total amount of rent will be eaten up by the expenditures, i.e., there is a full dissipation of the rent as shown in Posner (1975).[1]

A more realistic model can be traced back to Tullock (1980) where the political process of rent seeking is described as a lottery. Rent seekers invest their efforts to influence the policy decision, but who will be the winner is uncertain, all else equal, a higher effort always means a higher chance to win. Suppose that the rent in a policy issue has the value of V. Let X and Y denote the two rent seekers and x and y their sunk effort levels, respectively. Their winning chances in the Tullock lottery are most commonly given as

$$f(x, y) = \frac{x^r}{x^r + y^r} \text{ and } g(x, y) = \frac{y^r}{x^r + y^r}, \tag{1}$$

respectively. Hence, their respective payoffs are $f(x, y)V - x$ and $g(x, y)V - y$. The parameter r measures the rent-seeking sensitivity, or intensity, of the policy issues. In fact, with $r = 0$, there is no reaction to rent-seeking efforts at all as all participants get an equal chance to win the rent regardless of their investment levels. If $r = \infty$, the marginally higher effort will win the contest for sure. The latter extreme case is commonly called the all-pat-winner-take-all auction.

In a one-shot simultaneous-move game, it can be shown straightforwardly that the nash equilibrium expenditure for $r \leq 2$ is $rV/2$. For $r > 2$, only a mixed-strategy equilibrium exists.[2] Note that a full dissipation of the rent is expected in the case of $r = 2$ as predicted in Posner's famous full-rent-dissipation hypothesis. So, this model fits the traditional belief of wasteful rent seeking quite well. However, Tullock (1989) presents some empirical observations showing that, contrary to the full dissipation hypothesis, real-world rent seeking induces only very small amounts of expenditures. This finding is commonly called the Tullock paradox of rent seeking. Since then, several different approaches have emerged to tackle this problem. A useful survey can be found in Nitzan (1994). In what follows we will concentrate on one particular approach that spurred our experiment.

Leininger and Yang (1994), LY henceforth, challenge the appropriateness of the common practice of using a one-shot, simultaneous-move model for the analysis of rent seeking. They argue that a salient characteristic of any real-world rent seeking is that it always lasts for some time in which the contentants have a chance to react to each other's moves. Most importantly, therefore, the black-box nature of the political decision process of rent seeking dictates that no contestant can be sure of having some sort of the "last word" in this process. Put differently, when making a move, nobody can at any time preclude the possibility that the opponents may increase their bids subsequently. In the model discussed by LY, to reflect these facts, the players move, i.e., increase their own bids, alternately until one of them stops; otherwise, the bidding process goes on forever. The winner is determined by the Tullock lottery (1) using the final, or limit, bids as the inputs. LY prove that the threat of escalation can be strong enough for efficient outcomes to be sustainable in subgame perfect equilibrium. To be precise, they only show that the first mover can preempt by bidding V/2. The outcome with both players bidding zero would be sustainable with the same subgame perfect equilibrium strategies, too, if the winning chance were 1/2 each rather than zero each. To exploit this property, Yang (1993) extends the model by introducing some uncertainty about the value of the rent and assuming in addition that some small minimum bid is necessary. He shows that players then only make the minimum bid in subgame perfect equilibrium. Note that, unlike in the one-shot game, this efficient subgame perfect equilibrium outcome does not depend on the sensitivity parameter r, nor on who the first mover is. This suggests that the efficient rent-seeking outcome is a robust result as long as the crucial feature of the open-ended contest remains valid. Also, as a further extension by Yang (1999) shows this efficiency result also holds if the contestants have different reservation values for the rent. This amounts to the *conjecture* that the *indeterminacy of the last effective move* in a dynamic environment leads to an efficient rent-seeking outcome, which in turn solves the Tullock paradox.

In the present paper we intend to test experimentally whether the conjecture above holds if the task is given to real subjects. The theory by LY certainly has no bite if an empirical rejection occurs here. Note, however, that it is virtually impossible to design an experiment in the exact form of the LY model since an infinite horizon game could theoretically last forever.[2] Even if this never happens, the expected length of play could be so long as to prevent us from collecting sufficient samples within our project budget. The most common substitute feasible in this case is the random-stopping procedure that preserves the open-endedness spirit of the infinite horizon model and still provides a test of the above conjecture.[2] As already emphasized by LY, they chose the infinite mode only for technical reasons and believe that the uncertainty about the retaliation opportunity is the only factor that drives the efficiency result. So, this random stopping procedure is what we follow in our experiment.

2. Experimental design

The following experiments were conducted with students majoring mainly in economics and business administration at the Universities of Bochum (series I) and Magdeburg (series II) in Germany. The same sequential rent-seeking game was played in both places, but the exact experimental designs and environments are quite different which provide a nice robustness test. Throughout the experiments, we have V=100 lab dollars (LD). We also set $r = 8$ to have sufficient sensitivity in bid responses which provides a higher static incentive to overbid the opponent as compared to the more benign value of $r = 1$. (Note that LY's results are only proved for $r > 2$.) To avoid aggregated negative individual payoffs and their distortive effect, we also set the bid upper limit for each contest at 200LD. Though the theoretical effect of a budget constraint is ambiguous, it is quite realistic and necessary for most feasible experimental designs.

2.1. *Series I*

Each group consists of 10 persons who participate in the experiment conducted in a computer lab. Altogether five groups played the alternating bid, open-ended rent-seeking game 10 rounds each. At the beginning of each round, the computer randomly determines five pairs and who in each pair is to make the first move. Communication between matched partners occurs only via the computer, and the identity of the opponent is unknown at any time. Within each pair, players make their bids, i.e., purchase Tullock lottery tickets, alternately.

We feel that it is necessary that subjects be informed about the exact way in which expected payoffs are calculated as our story is told in the term of a lottery game. This alone is rather confusing. So we take pains to ensure that subjects understand the payoff structures. For this purpose a printed payoff matrix of A3 size is provided. In addition, subjects are instructed in how to find out the payoff consequences for different action combinations via a simulation on the computer.[3] From stage to stage, a player's bid cannot decrease, i.e., they cannot sell any lottery ticket they have already bought in previous stages. The maximum (accumulated) bid in each round allowed is set at 200LD as mentioned. There are two ways to end the game in a round: either both players subsequently decide not to increase their bids further, or a computer device steps in to end the game randomly. The subjects know that the random stopping device can step in as early as after the third bid in a round. After one round ends, the very last bids are used to calculate the payoffs. In order to avoid additional complications with differences in risk attitudes, and for the ease of implementation, no lottery is really carried out and the players get exactly their expected Tullock payoffs, at an exchange rate of 20LD = 1DM (Deutsche Mark). The computer also makes sure that each subject is assigned the role of the first mover as often as that of the second mover.

2.2. *Series II*

In Magdeburg, improved software with a graphic interface is used. A group in this setting consists of six subjects. Each group now plays the same game 30 rounds. While there is role alternation in the first 10 rounds as in Bochum,

Table 1. Design differences

	Number of repetitions	Group size	2/3 Stage pre-play	Fixed payment	Exchange rate
Series I					
(Bochum)	10	10	Yes	No	20 LD = 1 DM
Series II					
(Magdeburg)	30	6	No	10,– DM	60 LD = 1 DM

subjects keep a fixed role as either the first or the second mover for the last 20 rounds. The exchange rate is set at 60LD = 1DM, but each subject receives a fixed payment of 10DM. The fixed payoff is meant to mitigate any potential payoff difference accountable to the fixed-role property. There is some concern, however, that this may make the contest less competitive, though subjects are not told of its exact amount before the end. Moreover, in Bochum, subjects play both a two-stage and a three-stage sequential-rent-seeking game 10 rounds each previously to the open-ended one described above.[4] In Magdeburg, each group plays only the open-ended game. The main differences in features between series I and II can be summarized in Table 1.

Note that the large difference in designs was chosen purposely. After the Bochum sessions, we were so convinced of the dependence between open-endedness and efficiency, that we wanted to have a robustness test with the Magdeburg experiment. For this purpose, differences in designs that keep the crucial determinant in place were welcome, though this is a risky research strategy in general since one might end up with nothing if the conjecture of interest can not get reaffirmed.

3. Results

Figure 1 depicts the average rent-seeking expenditure in both series and compares them with the results of a two-stage game taken from Weimann, Yang, and Vogt (2000). The only difference between the two-stage version and the open end game of series II is the number of possible bids. Everything else is identical. Evidently, in the open-end experiments it does not take long for the total expenditure to fall drastically within 10% of the total rent. In series II, for rounds 16–30, the mean is 5.8 LD with a standard deviation of 3.9. In series I after round 5, the mean is 6.1 LD and the standard deviation is 2.1. In the two-stage version expenditures stay on a very high level of more than

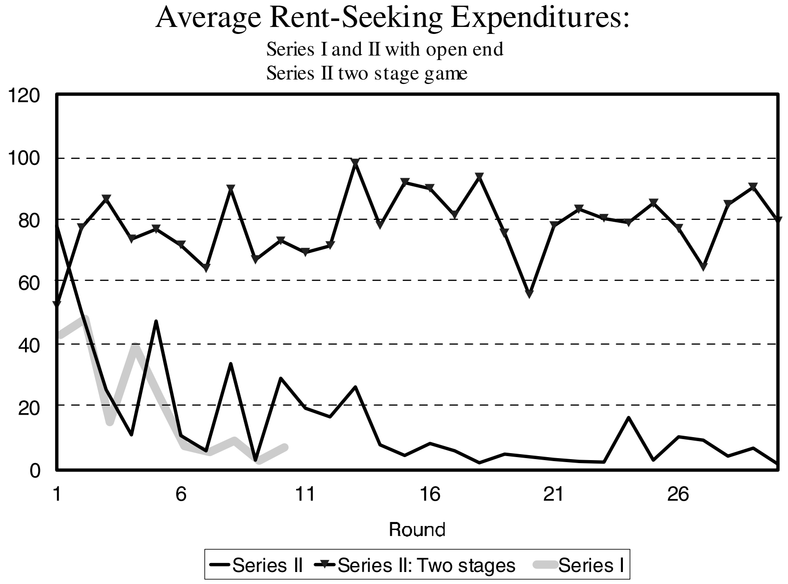

Figure 1. Rent-seeking expenditures: Averages in series I and II.

80 LD. It is clear that subjects learned fairly well how to avoid escalations in the open ended rent-seeking game. In comparison, they fail to cooperate in the experiment of Weimann, Yang, and Vogt (2000) where the game has exactly two stages.[5] Therefore, efficiency is not the result of cooperation in a repeated game, but the consequence of the threat of escalation in the open-end experiment. Realizing the retaliation potential of the opponents, players reevaluate the situation and settle for low expenditure outcomes. It is also striking how fast they "learn their lessons" and come to a common understanding as predicted by the theory. (Series I players seem to have learned it much sooner, however.) This result suggests that the efficient outcome of rent seeking is a natural phenomenon, i.e., interest groups will learn to settle for it sooner or later, if the open-endedness as discussed can be accepted as an appropriate description of real-world rent-seeking contests.

Figure 2 shows the average payoffs for the first and second movers in the open-end experiments. Evidently, there is no significant difference as confirmed by the Mann-Whitney U-test.[6] This proves the hypothesis that in our open-ended context the arbitrary assignment of who moves first has no effect on the outcome of the game. Hence, the change of mode after 10 rounds in series II should not have any relevant effect in how players behave in the game.

However, we observe clearly from Figure 2 that series I players learned much faster to settle for the cooperative outcomes: series II players needed

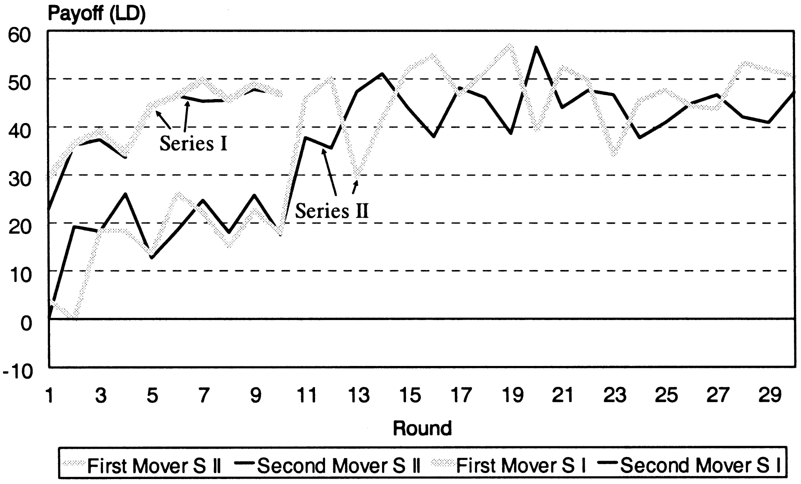

Figure 2. Payoffs first and second moves: Series I and II.

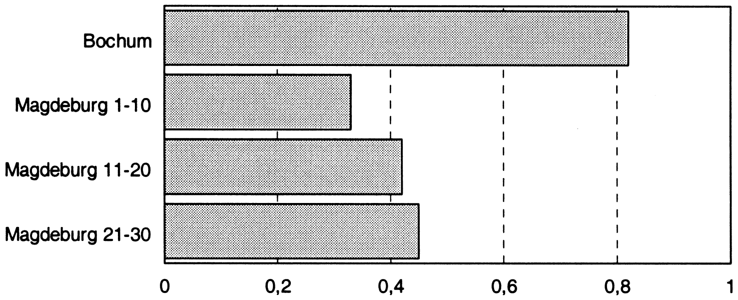

Figure 3. Explicit cooperation (in % of all moves).

about 10 rounds more to get there. The reason is that players in Magdeburg behaved more competitively. Figure 3 compares the percentages of plays that were stopped with explicit cooperative moves, i.e., both players subsequently stuck with their previous small bids. In other plays, either someone made a prohibitive high bid to force the opponent to give in or the random device had to stop the game while players will still fighting actively. Although the data shows that more Magdeburg subjects seemed to be more interested in relatively superior payoffs than some equal sharing through cooperation, this stronger competitiveness, however, does not prevent the efficient rent-seeking outcome from prevailing! Looking at the individual histories of play, it is evident that subjects learned to reduce the level of competition quite fast: they reduced the starting level and used smaller amounts to overbid the opponents.

The rationale for the behavior of Magdeburg subjects is clear. A competitive player wants a larger share, for which he has to overbid the opponent. He also hates the prospect of a high-level escalation. From bitter experience, the best compromise is to reduce the level of overbidding. If everyone does so, the expected loss is small even if there is intensive but low-level competition before the random stopping device takes effect. In fact, a risk-loving individual would even prefer the efficient overbidding outcome to the cooperative one, provided that no high level escalation is expected from this. In this sense, efficient outcomes are perfectly consistent with competitive plays. Note that the above observation of difference between the Magdeburg and the Bochum subjects is perfectly in line with the findings by Ockenfels and Weimann (1999) that subjects in eastern Germany are more competitive and show less "solidarity" in dilemma situations than their western peers.[7]

4. Concluding remarks

Note that a major design difference between series I and II is that players in series I had to play the 2- and 3-stage sequential rent-seeking game 10 rounds each, immediately before the open-ended one. The results in these experiments are discussed in a separate paper (Weimann, Yang and Vogt, 2000). The main point, however, is that in these games players did not play the unique subgame perfect equilibrium of preemption, nor did they play the cooperative outcome. The most stable pattern observed was "tough" second movers: they punished the preemptive attempts and exploited the cooperative offers.[8] Hence, besides the learning effect regarding the payoff consequences of their bids, series I subjects should have learned that the group is not particularly cooperatively minded. Yet, despite this rather negative burden entering the last, open-ended version of the sequential rent-seeking game, they did manage to play the efficient outcome, mainly in a cooperative manner. And they did this even faster than their series II peers who did not have the "painful" experience of those finite stage games. This indicates that open-endedness as an institutional feature is so strong that learning to achieve efficiency seems to be the only outcome conceivable here.[9]

In summary, it is evident that the open-ended modeling of rent seeking brings about the efficient rent-seeking outcome not only in theory but also in experiment. Realizing that open-endedness is a natural property of real-world rent-seeking contests, it is then not surprising to observe efficient rent seeking in reality. An especially appealing aspect of our analysis is the fact that convergence towards efficient rent-seeking consistently results, despite the differences in environment. It apparently did not matter whether there were other games preceding, role changes, fixed payments, different sizes of group, etc. It did not even matter that the competitiveness attitudes of subjects proved to differ greatly. When the situation is open-ended and subjects have time to learn, and adjust to, the fact that the threat of escalation is real, they will settle for an efficient outcome.

Last but not least, we want to mention that our study is the first to show efficient rent seeking in experiment. As discussed in Nitzan (1994), there are competing theoretical models to explain the same phenomenon. Though our intuition, which was first shaped by LY and Yang (1997) and reaffirmed by the current study, is that experiments designed to test those alternative models would not be as successful in yielding the efficient rent-seeking outcome, a definite answer is possible only when more experimental studies in this regard are carried out.

Notes

1. This is also implicit in the earlier paper by Tullock (1967).
2. See Hillman and Samet (1987) and Yang (1994). Also see Nitzan (1994) for a survey on simultaneous models.
3. By inserting imaginative bids for both one gets displayed the corresponding payoffs for both.
4. These finite-stage versions are also analyzed in LY. As Tullock lottery determines the final payoff, the first mover is to preempt with a rather high bid in the unique subgame perfect equilibrium.
5. For a detailed analysis of the two stage experiments see Weimann, Yang, and Vogt (2000). Their data show very complicated and intriguing behavior pattern from the subjects, far beyond deviation from the equilibrium prediction mentioned here for comparison. Since our main conjecture for this paper is an experimental resolution of the efficient rent-seeking hypothesis, we elect not to recount those interesting but presently less relevant details from their analysis.
6. For series I, the p-value (two-sided) is .631, while it is .367 for series II.
7. Note that it is theoretically conceivable that "reputation" building of some kind might be responsible for the result of efficiency. This competitive behavior shown is also an additional proof that this concern is not well founded.
8. The same holds for the subjects who played the two-stage version of the game in Magdeburg (series II). Compare Weimann, Yang and Vogt (2000).
9. Comparing the current paper with Vogt, Weimann and Yang (2000), we also see why LY favor the open-ended model as the proper one for efficient rent seeking.

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Appendix 1: Instructions (series II)

Principle of the game

All six persons present are randomly divided into three pairs. Each pair is then to play the following game. A prize of 100 laboratory dollars (LD) is given away to the winner of a lottery. Each player decides on the amount of lottery ticket he wants to purchase. All purchased lottery tickets are fed into a lottery machine which randomly determines the winner between the two participants. Formally, if x is the amount of the lottery ticket bought by player X while y that by player Y, X's and Y's chance of winning is given by

$$\mathrm{Pr(player\ X\ wins)} = \frac{\mathrm{x}^8}{\mathrm{x}^8 + \mathrm{y}^8};\ \mathrm{Pr(playerYwins)} = \frac{\mathrm{y}^8}{\mathrm{x}^8 + \mathrm{y}^8},\ \text{respectively.}$$

Do not get irritated by the factor of power 8 in the formulae. Its choice is part of the basic hypothesis to be tested in this experiment.

Notice that the lottery tickets are purchased alternately, i.e., sequentially one after another, rather than simultaneously. Moreover, it is possible that each person has a chance to increase his purchase repeatedly. Notice that there is a computer program built in to stop the purchasing process randomly from the third round on. In addition, you are not allowed to reduce the stock of your purchase on your turn. You can either increase the stock by purchasing more or just keep it. Therefore, there is another way to end the game besides that by the random generator: if both players decide to keep their stocks one following another, the lottery is ended too.

If the lottery is ended in either of the above mentioned ways, the payoff follows without really carrying out the lottery. This means each player is to get the expected payoff according to:

$$\text{payoff player X} = \frac{\mathrm{x}^8}{\mathrm{x}^8 + \mathrm{y}^8}100 - \mathrm{x};\ \text{payoff player Y} = \frac{\mathrm{y}^8}{\mathrm{x}^8 + \mathrm{y}^8}100 - \mathrm{y}$$

Each player has 200LD available for purchase in this lottery game. The whole game as described so far will be played 30 times altogether.

Course of the game

The game as described above will be repeated 10 times, first with the following properties: in each repetition, the pairs will be randomly re-matched. You will not know who your playmate in each match will be. Also, you will be given the position of the first one to move (first-mover) 5 times in the game, as often as that of the second one to move (second-mover).

Another 20 repetitions are then to follow. The only change from the last 10 rounds is your position will not change this time: If the computer gives you the position of first-mover, or that of second-mover, you are going to be given that position for all the remaining 19 rounds as well. For the sake of securing data against program breakdowns, these 20 rounds will be carried out in two 10-round blocks.

To assist your decision-making, a payoff matrix is provided, from which you can find payoffs for all possible combinations of both players' decisions. Moreover, you can simulate those decisions with the computer to see their payoff consequences.

To get you acquainted with the program, four trial rounds will be played first without any real payoff consequence to you. The sum of lab dollars you earn in the 30 "real" rounds will be exchanged at a rate of 60LD=1DM, i.e., you get one Deutsche Mark for 60 lab dollars. Besides this income, which may be negative depending on how you played, each person will also receive a fixed amount. You will be informed of how much at the end of experiment.

Good luck