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Classroom Games
Rent-Seeking and the Inefficiency of Non-Market Allocations

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Economics is often taught at a level of abstraction that can hinder some students from gaining basic intuition. However, lecture and textbook presentations can be complemented with classroom exercises in which students make decisions and interact. The approach can increase interest in and decrease skepticism about economic theory. This feature offers short descriptions of classroom exercises for a variety of economics courses, with something of an emphasis on the more popular undergraduate courses. Suggestions for future columns and comments on past ones should be sent to Charles Holt, c/o *Journal of Economic Perspectives*, Department of Economics, University of Virginia, Charlottesville, Virginia 22903-3288.

Introduction

The competition for many political prizes involves large expenditures of real resources, and the scale of political lobbying indicates that the probability of success is sensitive to such expenditures. In fact, the rent-seeking costs for all participants may be so large as to be a high fraction of the value of the prize—that is, the economic rent may be largely dissipated (Tullock, 1967). Before switching to auctions, for example, the U.S. Federal Communications Commission (FCC) awarded hundreds of regional cellular telephone licenses by lottery, and there were over 320,000 applications for 643 licenses in the late 1980s. Each application for a license had an equal probability of winning. Many investor groups submitted applications for multiple licenses. The real resources used in filing lottery applications added up to about $400 million, for licenses with an estimated market value

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of approximately $1 billion at that time (Hazlett and Michaels, 1993). Moreover, efforts to reduce the costs of rent-seeking activities may have the unintended effect that the contestants simply exert more effort. For example, making a waiting area more comfortable may induce people to arrive at a queue earlier (Holt and Sherman, 1982). These costs of rent-seeking behavior will be most burdensome when the lobbying activities have little or no social value, like waiting in line, filling out lottery applications, or lobbying for "pork barrel" projects.[1]

This paper describes a simple classroom exercise that illustrates the extent to which economic rent can be dissipated. The exercise can be used as a launching pad for discussions of lotteries, auctions, fixed allocation rules, and possible ways for enlightened bureaucrats and administrators to lower the social costs of rent-seeking behavior. The exercise is appropriate for microeconomics courses at any level, and for courses in applied areas such as public economics, development, and regulation. In more technical courses like game theory, the incentive structure can also be used to illustrate calculations of a Nash equilibrium.

Procedures

Playing cards and envelopes can be used to collect the students' decisions quickly and privately. The game will take about 50 minutes, including discussion. The only advance preparation is to obtain one or more decks of playing cards and to make copies of the instructions in the Appendix, which with appropriate font size will fit on the front and back sides of a single sheet of paper.

Students will have an easier time understanding the social costs of effort-based competitions if you put the exercise into a specific economic context. The FCC lottery for cellular telephone licenses works particularly well, in the sense that the resources put into applying for licenses are readily understood as a social cost, and students seem to find it reasonably easy to generalize from this example to other cases of rent-seeking. The example also allows you to discuss the lottery method relative to the bandwidth auctions later used by the FCC. However, the instructions in the Appendix could be adapted to a different context that is more appropriate to the subject content of a particular course. Some possibilities include lobbying for a favorable location of a military base or a monopoly import license.

Begin by dividing students into teams of "investors" of up to three students each. In any given round of bidding, there will be four investor teams competing for each prize or "license." To allow broad participation in a medium-sized class, one way to proceed is to put the four investor teams who will bid against each other for a particular license in the same row (or adjacent rows) of desks, and have a separate deck of cards for each group of four investor teams. In larger classes, it

[1] Other types of effort-based competition, like working hard to gain a promotion, may produce desirable outcomes, as discussed in the economic literature on tournaments.

helps to have a volunteer to handle the distribution of cards for each group of investors, as explained below.

All investor teams should receive an instruction sheet (from the Appendix) that they can use to record decisions and group earnings. Each team is given 13 cards of the same suit and credited with an initial $100,000. A team can play any of its 13 cards by putting them in an envelope, so that no one else sees how many cards are played by the other teams. Each card that is played can be thought of as a lottery ticket in a drawing for a license that is worth $16,000. Each lottery ticket costs the team $3,000, that is, it costs this much to prepare the paperwork to file an application for the license lottery. Up to 13 applications are allowed. (The values of the prize amount and application cost are selected to facilitate the equilibrium calculations for courses where this topic would be discussed.) The probability of winning the prize is determined solely by the number of cards a team plays, independent of which particular cards are played.

In these procedures we describe four variations, and you should plan for one or two repetitions of each variation. In the first variation, the lottery ticket cost is $3,000, as indicated above. When all teams have placed the cards they wish to play in their private envelopes, the volunteer for that row can collect the envelopes and put the cards that are played in a stack to be shuffled and cut. Announce the total number of cards in the stack, and draw the top card to determine which team wins the license value of $16,000. In addition, the earnings of each team are decreased by $3,000 for each card played. Students record their decisions and earnings on the instruction sheet, which can be checked by the volunteer who distributes the cards. For simplicity, let them delete the three zeros after each number. Earnings can be hypothetical.[2] After the winner of the first license has been determined, sort the cards by suit and return them to the appropriate team, without revealing how many cards each team played. Since each team has only cards of one suit, there should be no confusion about the distribution of cards. While cards are being sorted and returned to one row, the four teams in the next row can be making their decisions. Each round of decisions should take about five minutes.

After one or two rounds, you should proceed to the second variation, by decreasing the cost associated with filing a lottery application from $3,000 to $1,000. You can explain this as an efficiency move by the FCC that lowers the amount of paperwork and documentation required for an application. This decrease will lead to an increase in the number of cards being played, and so the total social cost of the applications may not decrease as much as the lower costs might seem to predict. In larger classes, you may not have time to go through both license costs for all bidders. One solution is to have the competitors for licenses in some rows start with the $1,000 cost variation.

A third variation is to assign different prize values to the licenses, to reflect the

[2] It is also possible to select a student at random after the game and pay that person a fraction of earnings, as explained in previous columns. This practice is probably not necessary in a game as competitive as the present one.

fact that some investor teams might be more efficient at providing cellular service than others. Useful values are $13,000, $15,000, $17,000, $19,000, which can be inserted in the bottom rows of the instruction/record sheet. If the license is awarded to the team with the highest value, this asymmetric-values lottery can be repeated. In most cases, two rounds should be enough to ensure that the license is not always awarded to the team with the highest license value, which will facilitate later discussion of inefficiencies. Keeping the values relatively close together will help ensure that this lottery does not always select the team with the highest value.

The fourth and final variation is an auction in which you, as auctioneer, begin calling out successively higher prices until only one bidder remains. This should be done as a standard "English auction" of the type used for antique and used car auctions. The winner has to pay the final bid, and the losers do not have to pay for a license that they do not win. There is no application fee for participating in the auction. The top two values should be separated by $2,000 (as in the values given above), so that you can raise the price in $1,000 increments and have the high-value team win the auction. The discussion of net rents for the final-round auction will be clearer if you designate one or more non-bidding members of the class as recipients of the revenue. The instructions refer to these people as "the poor." (You should have no trouble finding volunteers for this role.) The allocation of auction revenues to this group should make it clear that the bids are transfers, not expenditures of real resources.

To summarize: 1) obtain a deck of cards and four envelopes for each group of four teams; 2) make a copy of the instructions for each team; 3) write the asymmetric license values in the appropriate place for rounds three to five; 4) assign the students to teams and form groups of four teams that compete for one license, and designate somebody to represent "the poor;" 5) read the instructions out loud, take questions; and 6) start the first lottery. The best preparation for doing a classroom experiment is to read the instructions aloud before class, perhaps letting a teaching assistant or colleague listen and ask questions.

Discussion

Students are going to want to talk about relative earnings, so ask which teams ended up with more capital than the $100,000 initial endowment after the three lottery rounds. The next task is to pose a series of questions that force students to determine whether the lottery competition overdissipated the rent. With a $3,000 application cost, for example, the teams in one class averaged 3.25 applications for each team, for a total cost of $3.25 \times 3{,}000 \times 4$ teams = $39,000, which is more than twice the license value of $16,000.[3] Ask how can it be possible that giving away

[3] This class was a section of economic statistics at the University of Virginia. There were eight two-person teams, divided into two groups. Teams in one group purchased 12 tickets and the teams in the other group purchased 14 tickets. We obtained similar results in Michael Butler's Spring 1997 industrial

licenses with significant value can actually make some (or all) of the contestants worse off. Compare the total value of resources at the start—the initial cash endowments for each group and the value of the licenses—with the value at the end. This should lead to a discussion of the real costs of rent-seeking efforts.

One common misconception is that the cost of preparing the paperwork associated with the applications is not a waste, sometimes phrased as "accountants need money, too." You probably have to argue that the paperwork inputs in the application process have real opportunity costs, and that this activity is privately valuable, but not socially valuable. Be alert for students who provide examples of competitions that do not necessarily involve duplicated and wasteful expenditures of real resources, like research and development tournaments.

Next lead the discussion to what happens if the costs of filing an application are reduced, and ask what they expect the effect to be. Make sure that the discussion is related to the observed change in behavior when the application cost was reduced; that is, the total number of applications almost always rises as the cost of an application falls, so total application costs may not fall as much as anticipated. For the class mentioned above, the average number of applications per team rose from 3.25 with the $3,000 cost to 6.4 with the $1,000 cost, so a two-thirds reduction in application cost only reduced total expenditures per team by one-third, from about $9,750 to $6,400. The response here can also be used to review the concept of demand elasticity.

The responsiveness of the number of applications to the cost of an application raises one of the most important lessons that students can take from the study of economics: the awareness that naïve extrapolations are inappropriate when behavior responds to incentives. Let the students provide other examples, and supply some yourself. For example, when the National Science Foundation and other agencies have imposed strict page limits on "pre-proposals," the numbers of applications have soared. The increased paperwork, of course, may not be socially wasteful if large numbers of applications make it possible to improve the grant selection process.

The asymmetric value lotteries, in which the private values of the license differ, can illustrate another inefficiency, in addition to the dissipation of rents, that arises when prizes are awarded through an effort-based competition: the prize may not always go to the contestant for whom it has the highest value. (The teams with the highest value did not win the lottery in either of the two groups in our class.) Ask how this problem can be corrected, and hope for a response that mentions auctions—that is, the bidder with the highest value can outbid the others in the ascending bid auction. Note that this solution illustrates how the price system allocates goods and services to those who value them the most, and allocates

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organization class at Texas Christian University. The teams in this latter class participated in four lotteries with the $1,000 cost, four lotteries with the $3,000 cost, and one lottery with asymmetric values. There was no clear time trend in applications over the four-lottery sequences, so we decided that a single lottery is often sufficient to make the main points.

production to those who can produce most efficiently. Finally, focus on how an auction leads to the elimination of rent-seeking costs, since in the auction format the winning bid is just a transfer to "the poor."

A good way to move the discussion to broader issues is to note that the FCC has switched to an auction system that raised more than $10 billion in its first year.[4] Ask why auctions are not used more widely, say as a way to distribute computers to academic departments or course registration rights to students. This should raise issues of fairness. For example, if students could bid with money for the right to register early for classes, then the wealthier students would have an advantage. You could request suggestions on improving such a procedure, and you might later mention that a number of business schools give students equal budgets of "points" that they can use in computerized auctions to bid for access to particular classes. Nevertheless, lotteries are generally perceived to be fairer. If a lottery is used, steps can be taken to reduce the real cost associated with lottery applications, for instance by only requiring personal information and by limiting the number of applications.

It may be necessary to point out that it is impractical or unethical to auction off certain things; for example, the government does not sell to congresspeople the right to have a new defense base located in their own congressional districts. Even where auctions are feasible, bureaucrats and administrators may prefer to award a license or other prize on the basis of subjective judgement or in response to lobbying. Let students explain why bureaucrats may enjoy being the focus of lobbying attention, or alternatively why administrators may have their own sincere beliefs and preferences for how licenses or other prizes should be allocated. In these discussions, you need to remind students that not all effort-based competitions involve effort that is a pure social waste. It is useful to conclude with some personal experiences. One of us, for example, is a department chair who is frequently lobbying university officials and committees for fellowships, teaching prizes, and so on. A considerable amount of costly rent-seeking behavior could be avoided if things like computer budgets were just allocated on the basis of some pro rata formula, instead of being given out in competitions or to departments who make special cases.

The competition for a prize via costly lottery applications is a concrete physical process that students easily visualize. It is harder, but very important, to convey to students that the lottery setup can be viewed as a more general model that economists use to think about effort-based competitions. Suppose that there are several more-or-less equally qualified contestants for a license or government contract, and that the administrator or panel making the award decision is influenced by fancy presentations, extensive paperwork, early applications, and other costly inputs. If all contestants spend an equal amount of money on lobbying, then they should each have an equal chance of winning the prize, just as in a lottery

[4] For years, political pressures from communications companies led Congress to oppose the use of auctions for this purpose. In this journal, McMillan (1994) describes the role of economic analysis in the design of these auctions for communications licenses.

where each purchases the same number of tickets. The lottery model also has the property that the probability of obtaining the prize is increasing in one's own expenditure and decreasing in the expenditures of others.

This exercise can also be used to illustrate the calculation of a Nash equilibrium in more advanced courses. For the $3,000 application cost lottery, the Nash equilibrium is to play one card.[5] To understand the intuition behind this insight, one approach is to calculate expected net rents for deviations from the equilibrium. When all others are playing a single card, then playing only one card results in a $1/(1+1+1+1) = 1/4$ chance of winning, and the expected payoff is: $16 \times (1/4) - 3 = 1$, when the application cost is 3 (with all numbers here understood to be thousands of dollars, in the context of the overall problem). Reducing the number of applications to zero will yield a lower expected payoff, $0. Similarly, a unilateral increase in one's own applications, to 2, will raise the probability of winning to $2/(2+1+1+1) = 2/5$, but the expected payoff will go down from 1 to: $16 \times (2/5) - 2 \times 3 = 32/5 - 6 = 2/5$. To make sure that students understand these calculations, let them show that the equilibrium number of applications increases to 3 when the cost of applications falls to 1. This makes a good homework problem, along with a question about what happens to total expenditures on applications (it does not change, so the demand elasticity is unity). When the cost of application is $3,000, the expected payoff is $1,000 per team, so the total net rent for all four teams is $4,000. This net rent is only 25 percent of the prize value, so rents are somewhat dissipated, but not completely, in a Nash equilibrium.[6]

Further Reading

The magnitude of the social cost caused by rent-seeking behavior was first estimated by Krueger (1974) for various developing countries. For example, she found that in India the annual welfare costs of rent-seeking induced by price and quality controls was about 7 percent of GNP. Posner (1975) estimated that the social cost of regulation in the United States to be up to 30 percent of sales for some industries, an estimate that is may be on the high side today, as a result of the wave of deregulation since the late 1970s. For the FCC cellular telephone bandwidth lotteries, the estimates in Hazlett and Michaels (1993) indicate that application

[5] This can be verified in a straightforward manner. Suppose that the other three teams use their equilibrium numbers of applications, denoted by N^* for each of them. Then the probability of winning the lottery with N applications is $N/(N + 3N^*)$. The expected payoff, in thousands of dollars, is: $16N/(N + 3N^*) - 3N$. First take the derivative of this with respect to N and equate it to zero. Then impose symmetry by setting $N = N^*$, and solve to obtain $N^* = 1$.

[6] Whenever players can ensure a nonnegative payoff—for instance, by not filing applications—net rents cannot be negative with perfectly rational players. Anderson, Goeree and Holt (1998) consider a model of rent-seeking in which players can make decision errors, and this can lead to overdissipation. The degree of rent dissipation is higher with larger numbers of players and with higher cost of the rent-seeking activity.

preparation expenses dissipated nearly 40 percent of the rents associated with the regional phone licenses being distributed. In contrast, the FCC switch to auction allocations in 1995 seemed to produce little rent-seeking activity, and the auctions raised over $10 billion.

The game studied in this paper naturally applies to lobbying situations (Hillman and Samet, 1987), since the expenditures incurred in the competition for a government grant, license, or contract are usually not reimbursed. Other applications include research and development races, political contests, and promotion tournaments. Millner and Pratt (1989) conducted some two-player rent-seeking experiments in which the probability of obtaining the prize is the subject's fraction of total effort. The rate of rent dissipation in the final period was 60 percent, slightly but significantly greater than the Nash prediction of 50 percent dissipation. Millner and Pratt (1991) report that groups of less risk-averse subjects compete more aggressively and dissipate a larger fraction of the rent (68 percent versus 54 percent) than do risk-averse subjects.

Instructions Appendix

This is a simple card game. One of you has been designated to represent "the poor," and the others have been assigned to teams, which are groups of investors bidding for a local government communications license that is worth $16,000. The government will allocate the license by choosing randomly from the applications received. In the first variation of this lottery, the paperwork and legal fees associated with each application will cost your team $3,000, regardless of whether you obtain the license or not. Think of this $3,000 as the opportunity cost of the time and materials used in completing the required paperwork. Each team is permitted to submit any number of applications, up to a limit of 13 per team. Each team begins with a working capital of $100,000.

There will be four teams competing for each license. Each of the teams will be given 13 cards, all of the same suit. Your team will play *any* number of your cards by placing them in an envelope provided. Each card you play is like a lottery ticket in a drawing for a prize of $16,000. All cards that are played by your team and the other three teams will be placed on a stack and shuffled. Then one card will be drawn from the deck. If that card is one of your suit, your team will win $16,000. Otherwise, you receive nothing. In the first variation of this lottery, whether or not you win, your earnings will decrease by $3,000 for each card that you play. To summarize, your earnings are calculated:

$$\text{earnings} = \$16{,}000 \text{ if you win the lottery}$$

$$- \$3{,}000 \text{ times the number of cards you play.}$$

Table 1
Earnings Record Sheet

Variation	*Number Cards Played*	*$ Per Card Played*	*Cost of Cards Played*	*License Value*	*Your Total Earnings This Round*	*Cumulative Earnings*
						$100,000
1	—	$3,000	—	$16,000	—	—
1	—	$3,000	—	$16,000	—	—
2	—	$1,000	—	$16,000	—	—
2	—	$1,000	—	$16,000	—	—
3	—	$1,000	—	$—	—	—
3	—	$1,000	—	$—	—	—
4				$—	—	—
4				$—	—	—

Earnings are negative for the teams that do not win the lottery, and negative earnings are indicated with a minus sign in the record table above. The cumulative earnings column on the right begins with $100,000, reflecting your initial financial capital. Earnings should be added to or subtracted from this amount. Are there any questions?

After playing this lottery once or twice, we will vary it slightly. In this second variation, each team begins again with 13 cards, but the cost of each card played is reduced to $1,000. This could reflect a government efficiency move that requires less paperwork for each license application. This license is worth $16,000 as before, whether or not your team already acquired a license.

In a third variation, note that the value of the license to you has changed. It is no longer $16,000 for all teams, and the new value is already written on your scoring sheet. Teams may have different license values, reflecting the fact that some teams are more efficient than others in providing the communications service in the market where this third license is awarded. The cost of each card played is $1,000.

In the fourth and final variation, the license will be worth the same to you as it was in round 3, but there is no lottery and no application fee. Instead, I will conduct an auction by starting with a low price of $8,000 and calling out successively higher prices until there is only one team actively bidding. The winning team will have to pay the amount of its final bid. The losing teams do not have to pay anything for the license that they did not purchase; the winning team earns an amount that equals its license value minus the price paid. The revenue from the auction will be allocated to "the poor," who do not participate in the auction.

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