Multiple Buyers, Rent-Defending and the Observed Social Costs of Monopoly

by

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Abstract

This paper uses analytical and experimental methods to assess the effects of fracturing the interests of agents seeking to maintain the competitive status quo in a rent-seeking contest for a monopoly franchise. Theoretically, we show that while "rent-defending" can ameliorate the social costs of rent-seeking, these beneficial effects deteriorate quickly as the interests of those seeking to maintain the status quo become fractured. Experimental results indicate that overbidding is persistent when bidders have different sharing rules. In fact, the observed social costs of rent-seeking often increase just when rent-defending has the greatest predicted ameliorative effect.

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1. Introduction

In many economies, both primitive and modern, administrative or legislative decree, rather than economies of scale, is commonly viewed as the primary source of monopoly power. Gordon Tullock’s (1967) seminal insight that political contributions, gifts and even outright bribes intended to influence administrative and legislative outcomes could increase substantially the social cost of monopoly has spawned a burgeoning theoretical and empirical literature on such “rent-seeking” activity.

One important branch of the relevant theoretical literature analyzes the effects of competition for a monopoly franchise as an auction, where “bids” are the socially wasteful gifts, contributions and/or bribes of franchise-seekers. An intriguing result in this literature is Ellingson’s (1991) observation that “rent-defending” activity on the part of those interested in maintaining the status quo can reduce substantially the total social costs of rent-seeking. Intuitively, this result follows because buyers of a potentially-regulated product value the competitive status quo more than any potential franchise winner values operating the franchise and earning monopoly profits.

Figure 1 illustrates. A monopolist with unrestricted franchise rights may enjoy profits equal to area $T$ by raising price from a break-even price $P_c$ to $P_m$. Area $T$ thus represents the value of winning the auction to any potential franchise winner. However, as a result of the price increase, buyers of the monopolized product not only transfer $T$ to the sellers, they also forego the standard deadweight loss $H$.\(^1\) Thus, the auction is worth more to the affected consumers (collectively) than to any potential franchise winner. In the case that a single agent represents all affected consumers, rent-defending behavior decreases the social cost of rent-seeking, for two reasons: First, the consumers’ agent often deters monopoly successfully, since
this agent can profitably bid more than his or her rent-seeking counterparts. Second, the possibility that the franchise may not be granted reduces ex ante the expected value of the auction to those vying for the franchise, thus lowering their optimal bids. Hence rent-defending expenditures are socially beneficial, even if the franchise is granted. This result differs dramatically from predictions of earlier commentators, particularly Wenders (1987) who concludes that rent-defending activities only increase total dissipation over the levels that arise when only those vying for the franchise engage in rent-seeking.

However, for at least two reasons, rent-defending activities often may not substantially reduce social costs. First, a single agent may not always represent all affected consumers. Even if consumers win or lose collectively in a particular contest, their interests may be represented by multiple groups, who, while sharing a common interest in the franchise not being granted, differ in other dimensions. For example, while both the Christian Coalition and the Gay and Lesbian Alliance may oppose imposition of a monopoly franchise for, say, taxi-services in an urban area, these groups would probably not pool resources to engage in unified rent-defending activities. Fracturing consumer interests into multiple groups reduces the optimal rent-defending bid, since the different consumer groups have an incentive to free-ride off of each other's efforts.²

Second, the ameliorative role of rent-defending may be smaller behaviorally than predicted. There has been limited empirical work on rent-seeking behavior. For perhaps obvious reasons, little naturally occurring data bears usefully on the extent of rent-seeking: Rent-seeking does not generally take place in well-defined settings. Moreover, the effects of rent-seeking on decision-makers (and thus the probability that particular “bids” affect outcomes) is unobservable. Laboratory investigation provides a much more direct way to
evaluate theoretical predictions.

The most relevant previous experimental work is by Davis and Reilly (1998), who examine the behavioral properties of six rent-seeking auctions analyzed by Ellingsen (1991). Included in the experiment were four auction-types where one bidder had an asymmetrically high valuation for a prize. Results indicate that the presence of an asymmetric bidder generally diminishes social costs, as predicted, but that social costs persistently exceed Nash predictions, even when the agents have some experience with the institution.\textsuperscript{3} The ameliorative effects of rent-defending were weakest in a one-stage lottery contest, where a single bidder with an asymmetrically high valuation for the prize bid along with a number of rivals with identical, but lower prize valuations. The contest winner was determined stochastically, with each bidder’s probability of winning equaling the sum of his or her individual bid as a percentage of the total sum of bids. In this context experimental results provide only marginal support for the proposition that rent-defending reduces social costs, even when participants have some experience with the institution. An important open question from this previous research is whether a more extensive experience profile would generate results more consistent with Nash predictions.

This paper analyzes the effects of fracturing rent-defending interests on optimal rent-seeking behavior in a rent-seeking lottery contest. Then the results of an experiment designed to examine the predictions of the model, as well as the effects of an increased experience profile on bidding in both symmetric, and asymmetric variants of the contest follow. Below, section 2 develops the model, section 3 explains the experimental design and procedures, and section 4 presents results. Section 5 concludes.
2. Optimal Rent-Seeking in a Lottery Contest with Fractured Representation of Rent-Defending Interests

Consider a lottery contest with two types of bidders: \( i; i = 1...n \) “type-S” bidders, and \( j; j = 1...m \) “type-B” bidders. Type-S bidders each bid to win exclusively the prize \( T \). For type-S bidders the probability of winning is determined as their bid as a percentage of the total amount bid. Type-B bids are combined to determine a joint probability of winning. In the event the type-B bidders win, the franchise is not granted, so they avoid both \( T \) and the deadweight loss of monopoly, \( H \). However, the benefits of winning are divided equally among the bidders, so the per-bidder return is \((H + T)/m\). Independent of type, all bidders may submit any desired bid, as long as it is non-negative. Thus, the objective functions for the type-S and type-B bidders are

\[
\pi_i = \frac{b_iT}{s_b} - b_i \quad (1)
\]

and

\[
\pi_j = \frac{\sum b_j}{s_b} \frac{T + H}{m} - b_j \quad (2)
\]

where \( s_b \) is the sum of bids. It follows that optimal bids for type-S bidders and type-B bidders collectively are, respectively,

\[
b_i = s_b - s_b^2 \frac{T}{T} \quad (3)
\]

and

\[
\sum b_j = s_b - m \frac{s_b^2}{(T + H)} \quad (4)
\]

Solving for the sum of bids,
\[ s_b = nb_i + \Sigma b_i = \frac{nT(T+H)}{(T+H)n+mT}. \] (5)

Inserting (5) into (4), and solving the condition \( \Sigma b_i > 0 \) for \( m \) demonstrates that type B bidders will make positive bids if and only if

\[ m < \frac{n}{(n-1)} \frac{(T + H)}{T}. \] (6)

When (6) is violated, \( \Sigma b_i = 0 \), and the analysis reverts to the standard case of \( n \) type-S bidders.

Two observations about equilibrium bidding are pertinent at this point. First, note that a multiplicity of bid-combinations by type-B agents are consistent with the first order condition (4). Any combination of bids among the \( m \) type-B agents that satisfies (4) constitutes an equilibrium. Thus, fracturing type-B interests creates an equilibrium selection problem that may be difficult for bidders to resolve behaviorally. Second, notice that (6) is a fairly restrictive condition. Even with relatively little fracturing of type-B interests the inequality will be violated unless \( H \) is quite large relative to \( T \). That (6) may often not be satisfied sharply limits the range of instances where participation by type-B agents may reduce the social costs of rent-seeking. Although rent-defending activity may reduce social costs, in a wide variety of instances, such behavior is individually irrational.

For completeness, observe that when (6) is not satisfied, submitting a bid of zero is a Nash equilibrium for each of the \( m \) type-B agents.\(^5\) This is verified by showing that for any type-B bidder the expected benefit of a unilateral deviation from zero will be positive only when (6) holds. The expected return to a type-B bidder of submitting a non-zero bid is an \( m^{th} \) share of the prize weighted by the probability of winning. The sum of equilibrium bids by type-S bidders, conditional on the expectation that all type-B agents bid zero is readily obtained
from (3) by substituting \( nb_i \) for \( sb \), solving for \( bi \), and multiplying the result by \( n \). Denoting this sum by \( s \), we have

\[
s = \frac{n-1}{n} T \quad (7)
\]

Thus, for a type-B bidder, the expected return from unilaterally submitting a bid of \( d > 0 \) exceeds the expected cost (the expected benefit is positive) if and only if

\[
\frac{d}{s+d} \frac{T+H}{m} = \frac{d}{(n-1)T/n+d} \frac{T+H}{m} > d \quad (8)
\]

Solving for \( m \), it follows that (8) holds only when (6) is satisfied.

When optimal type-B bids exceed zero, type-B bidders reduce the expected social cost of the auction under fairly general conditions. With positive type-B bids, the expected social cost of the auction, \( C_b \), is the sum of bids, plus the expected deadweight loss from the S-bidders winning the auction.\(^6\) That is,

\[
C_b = s_b + P_s H \quad (9)
\]

where \( P_s \) is the probability that some type-S agent wins. Noting that \( P_s = (nb_i/sb) \), substitute the definition of \( b_i \) from (3) and obtain

\[
C_b = s_b \frac{T-nH}{T} + nH, \quad (10)
\]

When buyers bid zero, the expected social cost, \( C \), is

\[
C = s + H. \quad (11)
\]

From (10) and (11), \( \Delta C = C_b - C < 0 \) when

\[
- s_b \frac{nH - T + (n-1)H - s}{T} < 0 \quad (12)
\]

Solving for \( s_b \) (and recalling the definition of \( s \) in (7)), it follows from (12) that \( \Delta C < 0 \) if and
For the range of instances where type-B bids exceed 0, the effects of fracturing type-B interests follows directly as a series of comparative static results. First, taking the partial derivative of \( s_b \) in (5) with respect to \( m \)

\[
\frac{\partial s_b}{\partial m} = \frac{-n(T+H)T^2}{[n(T+H)+mT]^2} < 0 \tag{13}
\]

where the inequality follows since all variables on the left-hand-side are positive. Thus fracturing type-B interests uniformly reduces total bids.

Despite the reduction in total bids, social costs generally increase. Taking the derivative of \( C_b \) with respect to \( m \) and solving,

\[
\frac{\partial SC_b}{\partial m} = \frac{\partial s_b}{\partial m} \frac{T-nH}{T} \tag{14}
\]

which, by (13), is positive as long as the rightmost term is negative, or as long as \( n > T/H \). Thus, fracturing collective type-B interests increases social costs as long as the presence of type-B bidders exerts an ameliorative effect.

Consider finally bidding behavior. Taking the derivative of optimal bids in (3) and (4) with respect to \( m \), it is further seen that both type S and type B bids diminish as type-B interests are fractured. First, for type S bidders,

\[
\frac{\partial b_i}{\partial m} = \frac{\partial s_b}{\partial m} \frac{T-2s_b}{T} \tag{15}
\]

which, when \( \Sigma b_i > 0 \) and \( n > 1 \), is positive by (6). Thus type-S bids rise as the number of type-B bidders increase. For type-B bidders, observe first that \( \Sigma b_i = s_b - nb_i \). Thus,

\[
\frac{\partial \Sigma b_i}{\partial m} = \frac{\partial s_b}{\partial m} - n \frac{\partial s_b}{\partial m} \frac{\partial b_i}{\partial m} \tag{16}
\]
which, by (13) and (15), is negative when $\sum b_j > 0$ and $n > 1$. Thus total type-B bids fall as the number of type-B bidders increase. Taken together, (15) and (16) explain why expected social costs increase with fracturing of type-B interests, despite the decrease in overall bids: The decrease in overall bids is offset by a change in the composition of the bids which increases the probability that a type-S bidder will win the auction and thereby increasing social costs by $H$. In summary, although rent-defending activity reduces expected social costs relative to the lottery auction without type-B bidders, the benefits of participation by type-B bidders fall as type-B interests become fractured. Due to the incentive of type-B bidders to free-ride off the bids of other type-B bidders, fracturing reduces total bids. Expected costs increase, however, since the increased probability that a type-S bidder wins the auction more than offsets the benefit of a reduction in total bids.

3. Experiment Design and Procedures

To evaluate the behavioral relevance of the above predictions, we report the following experiment. The primary treatment variable is the number of type-B bidders, $m$, which is set at four levels: $m = \{0, 1, 2, 5\}$. Other auction parameters are held fixed across treatments, with the number of type-S bidders $n = 3$, and $T = H = 200$. Individual bid, aggregate bid, and social cost predictions for the four treatments are summarized in Table 1. Inspection of the table provides insight into our choices of $m$. The first row, with $m = 0$, is a baseline against which results of other symmetric auctions can be compared. The case where $m = 1$, summarized in the second row, generates the maximum ameliorative effects of participation by type-B agents,
as seen in the rightmost column. This case parallels an asymmetric lottery treatment examined in a previously-conducted experiment (Davis and Reilly, 1998), and allows further examination of behavior given bidder asymmetries but absent any potential equilibrium-selection problems created by introducing multiple buyers. For \( m = 2 \), in the third row, type-B interests are split, creating multiple type-B bid combinations consistent with an equilibrium in addition to any adjustment problems caused by bidder asymmetries. Notice that when \( m = 2 \), even though social cost predictions are below those for the baseline case, the collective type-B bid is lower, type-S bids are higher, and social costs are higher than when \( m = 1 \). Finally, for \( m = 5 \) in the bottom row, the optimal type-B bid is zero, making the bids in stage-game equilibrium again unique. Predictions for the lottery variant with \( m = 5 \) revert to the \( m = 0 \) baseline.

As mentioned in the introduction, a second purpose of the experiment was to evaluate more fully the effects of experience, so participants bid both in a relatively large number of auctions within sessions, and participated in multiple sessions. Each session consisted of 30 auctions of a single type. Throughout the sessions, participants remained in the same decision-role as a type-B or a type-S bidder. Across sessions, experience was graded in three steps. Following a first tier of inexperienced sessions, a second tier of once-experienced sessions was conducted, where all participants had exactly one session’s previous experience in the treatment, and, in as much as possible, in the same decision role. The once-experienced sessions were followed by a series of twice-experienced sessions, in which all participants had two sessions’ experience in a particular role and treatment. Thus, in this experiment, a subset of participants (e.g., those twice-experienced) made decisions in 90 auctions, with participants who had exactly the same amount of experience as they had. This is both considerably more and more carefully controlled experience than in Davis and Reilly (1998). In the previous
study, only 15 auctions of a single type were conducted in a session, and after each auction type-B and type-S decision roles were randomly re-determined. Moreover, in the previous study participants were classified as “experienced” if they had been in at least one previous session, of any type. No attempt was made there to control for decision-role or auction-type history, nor for the number of previous sessions in which a participant had participated.

The interaction between treatments, and the experience profile is summarized by the session identifiers listed in the left-most column of Table 2. Each identifier is a three-part code: The first two characters distinguish treatments by the number of type-B bidders, “0B” for zero type-B bidders, to “5B” for five type-B bidders. The second pair of characters are an experience classification, with “nx” denoting a tier of inexperienced participants, “x” once-experienced participants and ‘xx” twice-experienced participants. The identifier ends with the session number in its tier. Thus for example “0B-nx-1” listed at the top of the column refers to the first of four sessions conducted in the inexperienced tier of the 0B treatment. As is evident from listing of identifiers, seven sessions were conducted in each auction treatment. Four of the sessions in each treatment used inexperienced participants, two used once-experienced participants, and a single session used twice-experienced participants.

Procedures: At the beginning of each session participants were given a $12 initial balance. This balance was theirs to keep, as was stressed in the instructions, but could be used to fund bids in the 30 auctions, or “trading periods” that followed. In each trading period, participants typed in a bid in pennies under the condition that bids were paid, independent of who won the auction. For type-S bidders the probability of winning the auction was equal to their individual bid as a percentage of the sum of all type-S and type-B bids. The value of winning the auction to a type-S bidder was 200 cents. For type-B bidders, when present, the probability of
winning was the sum of all bids entered by type-B participants as a percentage of the sum of all type-S and type-B bids. The value of winning the auction for type-B bidders was 400 cents divided by the number of type-B bidders in the auction.

Bids were submitted simultaneously. A monitor recorded all bids and announced each bidder’s contribution as a percentage of the total and each bidder’s probability of winning. (Thus, in the sessions with fractured type-B interests, bidders knew who was free riding). These probabilities were then converted into ranges of a line numbered in single unit increments from 0 to 99, which were publicly displayed, and an auction winner was determined by two draws with replacement from an urn containing 10 balls numbered 0 to 9.

Following announcement of the winner, per period earnings (or losses) were calculated for each participant, and were added to, or deducted from, their initial balance. This process was repeated 30 times each session, exactly as described, with the following two exceptions. First, for sessions in the 1B treatment, two participants alternated in and out of the type-B bidder role. This was done primarily to reduce the dependency of session results on the actions of a single powerful bidder. Rotating buyers also attenuated somewhat the extreme earnings inequities between the type-S bidders and the type-B bidder predicted in the 1B treatment. Second, participants were told that in the event of a bankruptcy, they would be required to submit a bid of zero for the remaining periods of the session.

At the outset of the inexperienced sessions, participant role assignments were randomly determined by drawing numbered cards. After determining role assignments, participants were seated at visually isolated booths, and experiment instructions were read aloud as the participants followed along on printed copies. To facilitate record-keeping and earnings calculations, participants recorded all decisions at a personal computer situated in her or his
booth. Participants recorded bids, and auction results and earnings were maintained for each participant on a spreadsheet customized with a series of macros that made the appropriate calculations and prompted responses.

Sessions in the once-experienced and twice-experienced sessions were conducted similarly, except that role assignments were not random. In the once-experienced sessions buyers and sellers were drawn from the pool of participants with appropriate treatment and, inasmuch as possible, appropriate role-experience. In the twice-experienced session buyers and sellers were drawn from the pool of participants who had been in two previous sessions with appropriate role and treatment experience.¹⁰

In total, 84 different subjects participated in the experiment; 41 of whom participated in more than one session, and 21 of whom participated in three sessions. Participants were volunteers from undergraduate business and economics classes at Virginia Commonwealth University. In addition to salient earnings and the initial cash balance, they were given a $6 fee for meeting their appointment. Earnings for the sessions, which lasted about 90 minutes, ranged from, $6 to $37.50.¹¹ Median earnings were $18.75. As a precursor to reporting auction results, note that median earnings exceeded by only 75 cents the $18 endowment and participation payments that participants could have earned by bidding nothing in each auction. Realized earnings were more than 20% below the average (session and role weighted) expected earnings of $23.47.

4. Results

The ex ante social cost averages for the first and second session halves shown in the upper and lower panels of Figure 2 provide an overview of experiment results.¹² In each
panel, the four bar-clusters illustrate results of the seven sessions conducted in each auction treatment: inexperienced sessions are shown as white bars, once-experienced sessions as gray bars, and twice-experienced sessions as black bars. Perhaps the most striking feature of the figure is the very high mean social costs. Costs not only often exceed (dotted line) Nash predictions, but, in many instances the (dashed line) point of full dissipation as well. As seen by comparing the upper and lower panels, social costs tend to drop somewhat in periods 16-30. Even here, however, dissipation remains above Nash predictions in 25 instances, and is more than complete on average in six instances. Thus, as we found in our previous experiment, over-dissipation is a prominent feature of these lottery auctions.

The mean aggregate bid and bid standard deviation data reported by session halves in Table 2 also provide useful overview information. In particular notice the standard deviation of bids. For the 0B treatment aggregate bidding is relatively stable on average, particularly in periods 16-30 where the average standard deviation of bids is 36.39. Bidding becomes even more stable in this treatment when subjects had some experience. In contrast, variation is much more marked in the other auction configurations. The average standard deviation of bids for periods 16-30 of the 1B, 2B and 5B treatments are 78.33 cents, 68.40 cents and 65.02 cents, respectively; all on the order of half of the respective aggregate equilibrium bid predictions. Thus, in these treatments performance was persistently volatile.

Despite the variability of outcomes, insights into the learning, experience and type-B bidder effects that are the principle research focus of this paper can also be seen on closer inspection of the data presented in Figure 2 and Table 2. Consider these results in turn. We start with within-session learning effects.
**Finding 1:** Within sessions, both social costs and bids tend to fall. However, Nash predictions have little drawing power. Overall, social costs for the second session halves are no closer to Nash predictions than to the point of full dissipation.

Support: Consider first the social cost data illustrated in Figure 2. Reductions in the size of the social cost bars in the lower panel relative to the upper panel provide some evidence of learning. For ease of identification, dots are printed in the lower panel above the social cost bars in each instance where mean social costs fell across session-halves. As suggested by the prevalence of dots (in 23 of the 28 sessions) the null hypothesis of no change in social costs across session halves can be rejected at a 99% confidence level, using a Wilcoxon matched pairs test ($W = 77$, is less than the 99% c.v. of 91 [28 d.f., 2-tailed test]). Aggregate bids also decreased across session halves, as can be seen by comparing mean bids for periods 1-15 and periods 16-30 in Table 2. Parallel to the notation used in Figure 2, dots are printed in the right side of the periods 16-30 column to highlight the instances where mean aggregate bids fell across session halves. As with social costs, the prevalence of dots (in 22 of 28 instances) suggests that the null hypothesis that aggregate bids remained unchanged across session halves can be easily rejected ($W = 64$, exceeds 99% c.v. of 91 [28 d.f., 2-tailed test]). Because of this tendency for dissipation rates to fall somewhat within sessions, we will use only data from the second session halves in evaluating the other findings below.

It is important to observe, however, that within-session learning does not drive auction outcomes to Nash predictions. Returning to the bottom panel of Figure 2, notice the “N” and “F” letters printed in each bar: “N” indicates that mean social costs are closer to Nash predictions than to the point of full dissipation, while “F” indicates that mean social costs are closer to the point of full dissipation. As indicated by the relative paucity of “N” markings (in
only 11 of the 28 sessions) the null hypothesis that social costs are no more closely drawn to Nash predictions than to the point of full dissipation cannot be rejected at conventionally accepted confidence levels (W = 156, is not less than the 85% c.v. of 138 [28 d.f., two-tailed test]).

We will next turn our attention to experience-profile effects. But before proceeding, consider the extent to which bidders converge on a pattern of consistent behavior within sessions. The standard deviation of aggregate bids for periods 1-15 and periods 16-30, shown in columns on the right side of Table 2 provide some relevant evidence. Parallel to the convention used in evaluating social costs and mean bids, dots are printed in the right-most column to indicate instances where the standard deviation of bids fell across session halves. As suggested by the relative paucity of dots (in 16 of the 28 sessions), the evidence that bidding generally tends to “settle down” within sessions is fairly weak. In particular, the presence of dots aside only two of the seven 2B sessions suggests that perhaps the equilibrium-selection problems created by the addition of the second buyer complicate seriously the adjustment process. However, closer inspection of the entries suggest that it is the asymmetry of the bidders rather than the multiplicity of equilibria that induce the persistent instability. The pattern of reductions in the standard deviation of bids for the 5B sessions (where type-B bids of zero constitute a unique Nash equilibrium) is very similar to that in the 2B sessions. Further, although the standard deviation of bids fell across session halves in five of the seven 1B sessions, the mean standard deviation of bids for periods 16-30 (78.33 cents) is by far the highest overall treatment average for any of the second session-halves. As can be seen in Figure 2, many of the one-buyer sessions are characterized by very high social costs in periods 1-15. The subsequent decrease in both mean social costs and in standard deviation of bids indicates that bidders merely learned to avoid extravagantly (and unsustainably) high levels of speculative overbidding in the early periods.
The 0B treatment is the only instance where the null hypothesis of no change in the standard deviation of bids across session-halves can be rejected for a separate treatment ($W = 3$, equal to the 90% c.v. [7 d.f., two-tailed test])$^{13}$, and the reduction in the standard deviation of bids here does indicate some tendency toward behavioral stability. Evidence of convergence in the 0B treatment is even more marked across experience levels, which is the subject of our second finding.

**Finding 2** For all auctions except the 0B treatment, experience does not reduce importantly either social costs or the variability of bids. In the 0B treatment, however, experience effects are pronounced, and convergence to stable behavioral outcomes in the area of the Nash predictions is substantially complete.

Support: Glancing back at mean social costs for periods 16-30, shown in the bottom panel of Figure 2, it is clear that as a general matter experience does not reduce social costs: In the 1B treatment, for example, mean social costs for the (gray bar) once-experienced sessions fall relative to the (white-bar) inexperienced sessions, only to rise above the point of full dissipation in the (black bar) twice-experienced session. In the 2B treatment, results suggest, if anything, that the drawing power of Nash predictions weakens with experience. As experience increases, mean social costs move almost uniformly away from the Nash prediction and towards complete dissipation. In the 5B treatment, social costs are relatively close to the Nash prediction in two of the three experienced sessions. However, social costs were yet closer to Nash predictions in two of the inexperienced sessions. For the 1B, 2B and 5B treatments pooled together, the null hypothesis that social costs do not fall with experience may not be rejected at any conventional confidence level ($\text{Mann-Whitney } U = 51$ exceeds the 95% c.v. = 30 [9, 12 d.f., one-tailed test]).
Unlike social costs, aggregate bids do decrease somewhat with experience in these treatments: The null hypothesis that mean bids do not fall with experience may be rejected at a 95% confidence level using the nonparametric Mann-Whitney test ($U = 30$ equals the 95% c.v. [9, 12 d.f., one-tailed test]). Nevertheless, the change in the composition of bids for the 1B, 2B and 5B treatments was not complemented by a reduction in bidding variability, as can be seen in the standard deviation of bids results for periods 16-30, shown in the rightmost column of Table 2. Again using the Mann-Whitney test, it is not possible to reject the null hypotheses that the standard deviation of bids decreases with experience ($U = 44$, exceeds the 95% c.v. $= 30$ [9, 12 d.f., one-tailed test]).

In notable contrast, much more pronounced and consistent experience effects were observed in the 0B baseline. Returning to the bottom panel of Figure 2, notice that for periods 16-30 in the 0B treatment social costs for the once and twice-experienced sessions are uniformly below social costs for the inexperienced sessions. Even with the very limited sample size, the null hypothesis that social costs do not fall with experience can be rejected at a 95% confidence level, with the Mann-Whitney test ($U = 0$ equals the 95% c.v. [3, 4, d.f., one-tailed test]). These experience effects for social costs translate transparently to the bid data for periods 16-30 listed in Table 2, since bids and social costs vary mechanically by a constant of 200 in the 0B treatment.

Consider finally the standard deviation of bids for periods 16-30 of the 0B sessions, listed in the top seven rows in the right-most column of Table 2. As suggested by the smaller standard deviations in the once- and twice-experienced sessions, the null hypothesis that social costs do not fall with experience in the 0B treatment can be rejected at a 95% confidence level with the Mann-Whitney test ($U = 0$, equals the 95% c.v. [3, 4 d.f., one-tailed test]). The effect of experience on
The tendency for bidders in the symmetric all-pay contests (the 0B baseline) to converge to a behaviorally stable outcome in the range of Nash predictions is an extension of the learning behavior observed by Davis and Reilly (1998), and is consistent with experimental evidence reported by Shogren and Baik (1991), Schotter and Weigelt (1992) and Rutström and Bullock (1997) in symmetric two-bidder environments. However, the incomplete adjustment of bidders in the asymmetric configurations indicates that stable behavioral outcomes are not a general characteristic of such contests. Differences in outcomes across the different value configurations are the focus of three additional findings.

**Finding 3:** Despite some similarity in social cost outcomes, results of the 5B and the 0B sessions differ importantly. Aggregate bids in the 5B treatment are both much higher on average, and much more volatile than in the 0B treatment. Contrary to Nash predictions, type-B bidders in the 5B treatment do not withdraw from bidding.

Support: Examining average social costs for periods 16-30 of the 5B sessions, shown in the bottom of Figure 2 suggests that Nash predictions also have some drawing power in this case. Although experience effects are less pronounced than in the 0B treatment, average social costs for the 5B treatment are closer to the Nash prediction than the point of full dissipation in four of seven instances. Further, two of these instances involved experienced participants.

But despite some similarity in social cost outcomes, performance in the two treatments differs in important respects, as is evident from inspection of the summary statistics of bidding...
behavior listed in Table 2. Mean aggregate bids in the 5B treatment are much higher than in the 0B treatment. For periods 16-30, the average bid in the 5B treatment (216.25 cents) is more than 36 cents above the average bid in the 0B baseline (169.47 cents). The combination of comparatively high bids and relatively low social costs suggest that type-B bidders did not withdraw from bidding, as would be consistent with Nash predictions. More direct evidence of continued type-B participation in the 5B treatment is illustrated in the mean deviations from Nash predictions for periods 16-30 shown in bottom panel of Figure 3. As shown under the heading 5B-B, the aggregate type-B bid deviation (from 0) for the 5B treatment averaged more than 50 cents, even in the experienced sessions.

Also, as indicated by the standard deviation of bids for periods 16-30 listed in the rightmost column of Table 3, performance in the 5B treatment is more volatile than in the 0B treatment, and in fact much more closely resembles results of the 1B and 2B treatments in this respect. The null hypothesis that bid standard deviations do not differ across the 0B and 5B treatments may be rejected at a 95% confidence level using the Mann-Whitney test (U = 8, equal to the 95% c.v. [7, 7 d.f., two-tailed test]). The same null may not be rejected for pair-wise comparisons of the 5B and the 1B treatment, or the 5B and the 2B treatment (U = 14 and 23, respectively, in excess of 90% c.v., of 11, [7,7, d.f., two tailed test]). Thus, unlike the 0B treatment it is difficult to argue either that Nash outcomes were observed, or that even with time and experience some sort of behavioral stability was attained in the 5B treatment.

We turn now to behavior in the one-buyer and two-buyer sessions relative to the zero-buyer baseline, which is our fourth finding.
Finding 4  When participation by type-B agents is rational, aggregate bids increase, as predicted. Social costs, however, do not fall. In fact, social costs often increase.

Support: As suggested by the treatment averages of mean bids for periods 16-30 shown in Table 2, mean bids for both the 1B and the 2B sessions (271.99 cents and 227.65 cents, respectively) tend to exceed bids in the 0B sessions (169.47 cents). Using a Mann-Whitney test, the null hypothesis that the introduction of type-B bidders does not increase bids may be easily rejected (U = 15, 97.5% c.v. = 22 [7, 14 d.f., one-tailed test]). This result holds with equal strength when attention is confined to once and twice experienced sessions (U = 0, 97.5% c.v. = 1 [3, 6 d.f., one-tailed test]).

However, the observed (and predicted) bid increases do not translate into the predicted social cost reductions. Turning to the mean social cost data, shown in the bottom panel of Figure 2, average social costs for periods 16-30 of the 0B treatment (369.47 cents), lie between comparable averages for the 1B treatment (386.25 cents) and the 2B treatment (352.75 cents). Using the Mann-Whitney test, the null hypothesis that social costs do not decrease with the addition of type-B bidders cannot be rejected at any conventionally accepted level of confidence (U = 71, exceeds by a considerable margin the 95% c.v. of 26, [7, 14 d.f., one-tailed test]). In fact some support exists for rejecting the opposite null, that social costs do not increase with the addition of type-B bidders (U = 27, just exceeds the 95% c.v. 26, [7, 14 d.f., one-tailed test]) suggesting that the addition of type-B bidders may actually raise social costs. Due to the experience effects in the 0B treatment this result is even slightly stronger when attention is confined to experienced sessions (U = 2, equals the 95% c.v. = 2 [3, 6 d.f., one-tailed test]).

The incapacity of type-B bidders to generate predicted social cost savings, despite
considerable experience within and across sessions is an important result of this experiment. This result is even more extreme than the guarded comparative statics results for single-stage lottery contests that we observed in our previous experiment.

One possible explanation for the difference in outcomes across experiments may have to do with the way that the experience profile was lengthened. Unlike our previous experiment, where the role of the asymmetrically endowed bidder was randomly predetermined prior to each auction, type-B bidders not only maintained the same position throughout a single session, but throughout subsequent sessions as well. Aware of this continuing inequity, bidders here in the “disadvantaged position” may have overbid out of a rivalistic desire to reduce the disparity in relative earnings. Examination of experimental results in light of this conjecture gives rise to our fifth and final finding.

**Finding 5.** Bidding by agents in disadvantaged positions suggests that rivalistic behavior may drive the observed overbidding.

Support: Consider first the mean deviations from Nash predictions for aggregate type-B and type-S bids for periods 16-30, shown in Figure 3. Although no “disadvantaged bidder” effect is evident in the inexperienced sessions of the 2B treatment, shown in the upper panel of the figure, “disadvantaged” type-S bidders (i.e., those with lower expected earnings under Nash predictions) deviate further from Nash predictions than do type-B bidders in the 1B treatment. Similarly, the “disadvantaged” buyers overbid more than sellers in the 5B treatment. As suggested by the lack of vertical overlap in the 95% confidence bands about bids, this difference in the 5B treatment is significant. Turning to the once-experienced and twice-experienced sessions, shown in the bottom panel, the “disadvantaged bidder” effect is both
larger and more consistent: In the 1B, 2B and 5B sessions, the agents with the lowest expected Nash earnings deviate significantly further from Nash predictions than their counterparts. The change in the composition of bids explains the failure of social costs to fall as experience increases, despite some decrease in overall bids: Overcompensating bids by type-S bidders in the 1B, and 2B treatments are socially wasteful.

Overbidding by disadvantaged bidders has also been observed by Rutström and Bullock (1997) in an asymmetric rent-seeking contest with an endogenous prize, as well as by Schotter and Weigelt (1992) in an asymmetric variant of a two-player “tournament” game, where “effort” or bidding costs for one player were four times higher than for another. Rutström and Bullock suggest that the overbidding they observed was a rational response to bids by the advantaged bidders. Earnings for the disadvantaged bidders not only exceeded predicted levels (albeit slightly, and insignificantly), but disadvantaged bidders earned as much as bidders earned in the symmetric variant of their game. The bidding behavior observed by Schotter and Weigelt was somewhat more complex. On average, disadvantaged bidders bid the Nash prediction, in the latter half of their 20-period sessions. Bids, however, were bi-modal, with one group persistently overbidding, and the other withdrawing from the bidding altogether. Schotter and Weigelt suggest that the different bidding patterns were a result of the bidders’ experiences within the sessions: The disadvantaged bidders that eventually withdrew from bidding tended to be paired with more aggressive advantaged bidders than the disadvantaged bidders who did not withdraw. Moreover, the disadvantaged bidders that withdrew were relatively less lucky than their more persistent counterparts and ended up winning disproportionately few of the early contests.
The overbidding observed here bears elements consistent with the comments made by the authors in both papers. In the 5B treatment, “disadvantaged” type-B bidders surmounted a free rider problem and increased earnings rather substantially over Nash predictions. For example, confining attention the once- and twice-experienced sessions, type-B bidders in the 5B treatment earned an average of $21.90, or $3.90 over the Nash prediction. Earnings for these buyers was significantly higher than for the type-S bidders in the 5B treatment, who earned $17.83 on average (Mann Whitney U = 34, equals 95% c.v. of 34 [15,9 d.f., 2-tailed test]). In fact, earnings for once- and twice-experienced type-B bidders in the 5B treatment do not significantly differ from average earnings of $23.83 for type-S bidders in the symmetric 0B treatment (U = 41, exceeds 90% c.v. of 39[9,15 d.f. 2-tailed test]).

On the other hand, results of the 1B and 2B treatments are more in the vein of the observations of Schotter and Weigelt, particularly when these results are evaluated in light of the asymmetric treatments we reported in our earlier experiment. In Davis and Reilly (1998), “advantaged” buyers overbid significantly relative to Nash predictions, and bids by the disadvantaged sellers fell toward Nash predictions, as experience levels increased. In contrast, buyer bidding here falls toward Nash predictions, and disadvantaged sellers overbid. The difference, of course, is that Schotter and Weigelt observed differences within a single experiment, while we observe differences in behavior across experiments, suggesting that relatively subtle changes in experiment design (i.e. the rotation vs. constancy of the advantaged bidder’s role) can motivate the different bidding patterns, as well as different experiences within sessions.

The pervasiveness of this tendency for disadvantaged bidders to overbid in this type of auction, as well as the effects of procedural details and institutional characteristics on bidding
behavior clearly merits further attention. But in any event, it is worth emphasizing that overbidding by type-S bidders in the 1B and 2B treatments here was not profitable. Average earnings for once- and twice-experienced type-S bidders in the 1B and 2B treatments were $15.41 and $15.52, respectively. These earnings were not only significantly below Nash-predicted earnings ($19.22 and $21.75, respectively), but were less than the $18.00 sellers could each have earned by bidding nothing throughout the sessions.15

5. Discussion

Although “rent-defending” activity can reduce the social costs of rent-seeking, in the context of the single-stage contests examined here, the range for such benefits, as a theoretical matter, is limited. Even when type-B interests are quite narrowly represented, participation by type-B agents is not rational unless the deadweight loss of monopoly power exercise (H) is quite large relative to the magnitude of the potential transfer from consumers to the monopolist (T). As type-B interests become more fractured, incentives to engage in rent-defending activity are further undermined by incentives to free-ride.

Even more prominently, however, it appears that predictions of the relevant theory fare very poorly in practice. When bidders are inexperienced with the lottery contest, social costs tend to be exceedingly high (and dissipation often more than complete), independent of the structure of type-B and type-S valuations. With additional experience social costs consistently tend to Nash predictions only in the symmetric 0B case.

In asymmetric variants of the single-stage lottery contest bidders encounter persistent difficulties in adjusting to Nash predictions, even given very considerable opportunities to learn within and across sessions. Inspection of bidding patterns suggests that relative earnings
considerations may explain some of the adjustment problem. Agents with lower Nash equilibrium earnings deviate from Nash predictions by the largest amount, perhaps out of a rivalistic desire to equalize relative earnings. For this reason social costs not only fail to fall when type-B bidders are predicted to reduce dissipation rates, but in many instances actually increase.

In natural contexts the way that the gifts, political contributions and bribes that constitute rent-seeking “bids” affect administrative and legislative decisions is difficult to identify with any precision. However, agents may be frequently expected to approach these contests from asymmetric positions. The persistence of complete and even more than complete dissipation in the simple asymmetric lotteries examined here heightens concerns about the social costs of rent-seeking. Social costs consistently exceed even Nash predictions. Even with considerable experience, over-compensating behavior by disadvantaged “bidders” appears to exacerbate the social costs of rent-seeking. Parallels to lobbying groups and political action committees are both obvious and disturbing.

In closing, we note that bid and social cost outcomes are undoubtedly sensitive to details of the contest structure. In our previous experiment, for example, comparative-static results much more consistent with Nash bidding and social cost predictions were observed in a two-stage variant of the lottery contest. In the first stage of this contest, type-S bidders compete amongst themselves for a monopoly franchise right, while in the second stage the franchise-winning type-S agent competes with a rent-defending type-B bidder to remain an unregulated monopolist. Perhaps this or related institutions are both theoretically and behaviorally less sensitive to fracturing type-B interests than the single-stage lottery contest examined here. In our future research we will investigate behavior in these related contexts.
Notes

1 Deadweight loss $H$ need not be less than the transfer $T$. Fixed costs and increasing marginal costs can magnify the size of $H$ relative to $T$. See Davis and Reilly (1998) or Ellingsen (1991) for relevant illustrations.

2 Incentives to free-ride when rent-seeking bids are pooled and the prize is distributed according to an egalitarian rule have been observed previously in somewhat different contexts (e.g., Baik and Shogren, 1995, Berry, 1993, and Nitzan, 1991). Baik (1993) is the most closely related theoretical work.

3 Related experimental papers involve two-bidder environments. Shogren and Baik (1991), Schotter and Weigelt (1992) and Rutström and Bullock (1997) all observe bidding that conforms to Nash predictions in two-bidder contests, when the players are symmetric. (Interestingly, however, in the Rutström and Bullock environment, the size of the transfer is endogenous, and over-dissipation is predicted as a Nash equilibrium.) Bidder asymmetries impaired the drawing power of Nash predictions in asymmetric variants of the auctions evaluated by Schotter and Weigelt (1992), and Rutström and Bullock (1997). Millner and Pratt (1989, 1991) also investigated rent-seeking behavior in the laboratory in a sequential environment that differs rather markedly from both the other papers, and the game modeled here.

4 Actually, restricting type-B bidders to an identical sharing rule (and thus, implicitly, to identical values) may be unnecessary. For the risk-neutral case Baik (1993) shows that when the values of type-B bidders are unequal, only the bidder with the highest prize value bids.
The intuition underlying this result is straightforward. When values are asymmetric, the equilibrium condition for type-B bidders, defined below in equation (4), would be rewritten as a series of \( j \) equations, each reflecting a bidder’s different inverse value of the prize. Any type-B bidder \( j \) will submit a bid \( b_j > 0 \) if their first order condition is strictly satisfied, and \( b_j = 0 \) otherwise. But when a series of first-order conditions differ only by a constant, only one of the conditions can be satisfied strictly. In this case, the satisfied condition would be the first-order condition for the bidder with the highest value. Effectively, the possibility of asymmetric prize values allows \( m \) to take on non-integer values. With asymmetric values, the equilibrium bid for the type-B bidder with the highest value, \( v_h \), equals the predicted sum of type-B bids in a contest with \( m = \frac{T + H}{v_h} \) type-B bidders with values \( v_h \). Type-B bidder values are held equal here for consistency with our subsequent experimental implementation.

5. Equilibrium existence under these conditions contradicts results by Nitzan (1991). See Davis and Reilly (1999) for a more formal demonstration of equilibrium existence when bidders use different sharing rules.

6. Measures \( C_b \) or \( C \) identify imperfectly the social costs of rent-seeking. Either measure overstates the social costs of rent-seeking to the extent that some element of the “bids” are a transfer from the bidders to legislators or administrators. For example, while expenses on presentations, hearings and demonstrations are largely or entirely social costs, gifts and bribes undoubtedly involve at least some element of transfer. On the other hand, \( C_b \) and \( C \) understate the social costs of rent-seeking by failing to account for the relative price distortions that the rent-seeking auction induces in other markets. Here we assume that both of these effects are of secondary importance. In any event, these second effects may be expected to largely cancel
each other out when assessing the social costs changes, as in (12).

7 In an extensively repeated game of this sort, results are also potentially affected by the repeated interactions of agents. One way to control for repeated-game effects would be to conduct sessions involving a number of simultaneously conducted auctions each decision period. After each period, agents drawn from pools of type-B and type-S participants would be anonymously reshuffled into new groups. Administering simultaneously enough auctions to eliminate repeated game effects was, for us, infeasible. (For example, four simultaneous auctions per period is probably not sufficient to eliminate repeated-game effects. Yet in the 5B treatment even this modification would require reshuffling 32 bidders each period.) In any case, repeated game interactions are of interest to us, and, as discussed below, a game where a stable set of bidders interact repeatedly is certainly not without parallels in natural contexts.

8 Due to recruiting difficulties, a single type-B bidder made all 30 decisions in one of the once-experienced sessions in the 1B treatment (session 1B-x-2).

9 In fact, this constraint was never binding. Only one participant ever ran up against the bankruptcy constraint. In session 5B-nx-2 a type-S bidder exhausted his initial balance after period 23. The bidder was privately invited to bid out of his $6 appearance fee, which he did in two of the seven remaining periods.

10 Although participants always had appropriate level of experience, matching role assignments across experience-levels was not always possible. Seven of the 41 participants in the once-experienced sessions switched decision roles across sessions. The role-changes were distributed across five sessions, and no more than two participants switched in any single session. There were, however, no role changes in any of the twice-experienced sessions.
Actually, the single type-B bidder who made decisions in all 30 auctions of session in 1B-x-2, earned $66.75. However, adjusting this buyer’s earnings to make them comparable with others making similar decisions in other sessions produces an adjusted earnings figure of $36.75. (Make the adjustment by halving earnings net of the $6 appearance fee, and then adding $6.)

Here we report expected social costs given the bids rather than realized social costs. This practice reduces noise in the series by eliminating the effects of stochastic draws.

For the 1B, 2B and 5B treatments $W = 9, 19$ and 18, respectively. The 85% c.v. = 4 [7 d.f., two-tailed test].

Confidence intervals are based on 60 observations for the inexperienced sessions (15 periods for 4 sessions), and 45 observations for the experienced sessions (15 periods for 3 sessions). Since individual bids are not independent, the confidence intervals shown in Figure 3 should be viewed as only descriptive.

Significance was marginal for comparisons against default earnings. For comparisons against Nash predictions, Wilcoxon test values are $W = 0$ and $W = 3$ for type-S bidders in the 1B and 2B treatments, respectively. Both test values equal or exceed the 99% c.v. of 3 [9 d.f., 1-tailed test]). For comparisons against default earnings, $W = 10$ in both the one-buyer and two-buyer treatments, equal to the 90% c.v. [9 d.f., 1-tailed test]).
References


Table 1. Individual Bids, Aggregate bids, and Social Costs

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<th>Type-S Bid, $b_i$</th>
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* Average bid or average standard deviation of bids for periods 16-30 is smaller than the comparable measure for periods 1-15
Figure 1. Profit and Deadweight Loss from an Unregulated Monopoly Price
Figure 2. Social Costs in 15-Period Increments. Key: White bars = inexperienced sessions, Grey Bars = once-experienced sessions, Black bars = twice-experienced sessions. Dotted lines = Nash predictions, Dashed lines = Point of full dissipation. "*" denotes drop in social costs over session halves; "F" = average costs are closer to full dissipation; "N" average costs are closer to Nash prediction.
Deviations from Nash Bidding Predictions

Inexperienced Sessions

Experienced Sessions

Figure 3. Mean Bid Deviations for Aggregate Seller Bids and Aggregate Buyer Bids, and 95% Confidence Intervals about the Mean Deviations. Key: Each bar is a 95% confidence interval about the bolded-line mean deviation from the Nash Prediction observed in periods 16-30 each treatment