The effect of entry and information costs on oral versus sealed-bid auctions

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Abstract

At equilibrium with respect to bids, entry and information acquisition, oral auctions can generate significantly more revenue than sealed-bid auctions even in the case of independently-distributed privately-known values. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction:

Oral auctions get used for a great variety of goods, especially in cases where the goods being sold and/or the bidders who bid vary considerably from one auction to the next. Examples include art work, used cars, cattle, estate contents, used machinery, and miscellaneous junk. Also, the most active Internet auction sites approximate oral auctions rather than sealed-bid (first-price) auctions.

Milgrom and Weber (1981) suggest an explanation in the case of uncertain values. In oral auctions, bidders may glean information about their own value from observing when other bidders drop out. At equilibrium, this additional information — if properly gleaned and incorporated into the bids — results in higher expected revenues for the seller in oral auctions than in sealed-bid auctions. So, sellers will prefer oral auctions to sealed-bid auctions.

However, real bidders have problems with uncertain values. Bidders often fall prey to the winner’s curse in sealed-bid auctions. Bid(s) fail to adjust adequately for the fact that they do not have privately known values. In short, they do not seem to know how properly to interpret the available information. And in oral auctions with affiliated values, bidders have even more — and, arguably,
more subtle — information available than in sealed-bid auctions. Thus the equilibrium predictions for oral versus sealed-bid auctions may differ considerably from reality in the case of uncertain values and explanations which hinge on uncertainty of values leave me unconvinced.

Instead, I suggest that oral auctions may be so popular because of their simplicity. In some sense, it is simpler to bid in oral auctions than in sealed-bid auctions. For example, equilibrium bidding strategies in sealed-bid first-price auctions, even in the case of privately known values, typically depend not only on the bidder’s value, but also on a variety of other factors; such factors include the number of other bidders, the joint probability distribution of the bidders’ values, the seller’s reservation price, and auction rule details such as what happens if the winner disappears before settling up. In contrast, bidders in oral auctions with privately known values have the dominant strategy of simply bidding equal to their values.

In practice, bidders must expend effort in order to understand an auction’s rules, to estimate things like the number of competitors, and to incorporate information into their bids. Expending such effort can result in a better bid. But such effort may be costly. The improvement in the bid may not be enough to offset the cost of the effort. There is a trade off.

The trade off between the cost and benefit of effort may vary across auctions. For example, in the case of privately known values, bidders in sealed-bid auctions benefit from knowing the number of competitors, whereas bidders in oral auctions do not. Or even if, as in the case of affiliated information, bidders in both types of auctions benefit from knowing the number of competitors, the benefit and/or the effort required to determine this number may be greater in sealed-bid auctions than in oral auctions. Therefore, bidders may elect to expend more effort in one auction than another. Specifically, bidders may spend more on effort in sealed-bid auctions than in oral auctions.²

My argument then goes as follows: Bidders in oral auctions may need or want to spend less effort acquiring and interpreting information than in sealed-bid auctions. Thus, it costs less to participate in oral auctions than in sealed-bid auctions. The lower participation cost makes oral auctions more attractive to bidders. So more bidders enter. And, everything else being equal, the auction with more bidders generates higher expected revenue for the seller. Therefore, oral auctions will generate more revenue for the seller than would sealed-bid auctions . . . and will do so even in the case of independently distributed, privately known values.

An example illustrates this argument. At equilibrium with respect to entry, information acquisition and bidding, bidders in the oral auction acquire more information than do bidders in the sealed-bid auction. With entry and information costs such that an average of around two and one half bidders enter the auction, the oral auction generates twenty percent greater expected revenue than does the sealed-bid auction.

The example presumes privately known values. This facilitates the analysis. More importantly, I believe it to be the right starting point. In particular, real bidders seem to follow equilibrium predictions more closely in the case of privately known values than otherwise. Also, many auctions

²The idea that bidders may elect to expend different levels of effort in different auctions is consistent with observed behavior. For example, Kagel et al. (1987) show that bidders are better at discovering the dominant strategy equilibrium in repeated English auctions than in repeated sealed-bid second-price auctions. Here, the ‘different information flows’ make it easier for bidders to figure things out in one auction than the other. So, the trade off between the cost and benefit of figuring things out varies across the two auctions, and bidders ‘decide’ to learn at different rates (or possibly not at all) in the two auctions.
have a privately known values component to them. Even if they did not, real bidders may be bidding as if they did. So, I would like to provide an explanation that also works in the case of privately known values.\(^3\)

### 2. The example

Consider an auction with entry and optional information which develops as follows: First, the expected profit maximizing potential bidders first decide whether or not to enter the auction. Entering costs \(c_E (c_E > 0)\). Assume that the total number of bidders, as well as the number of other bidders faced by any one bidder, has a Poisson (\(\lambda\)) distribution, where \(\lambda\) will be set endogenously.\(^4\)

Second, each bidder\(^5\) decides whether or not to find out how many other bidders there are. This additional, optional information costs \(c_1 (c_1 > 0)\). Then each bidder \(i\) discovers his or her value \(v_i\) for the object. Assume \(v_1, v_2, v_3, \ldots\) to be independent draws from the standard uniform distribution.

Finally, the auction occurs. As Vickrey (1961) suggests, approximate the outcome of the oral auction by that of a sealed-bid second-price auction (but still refer to it as the oral auction). Bidders submit sealed bids. The highest non-negative bid wins.\(^6\) The winner pays an amount equal to either the winning bid or the highest losing bid.

Now derive the equilibria, first for oral auctions and then for sealed-bid auctions. Specifically, in the oral auction, bidders have the dominant strategy of bidding equal to their values; this bidding strategy does not depend on the number of other bidders \(k\). Assume that bidders so bid. Then bidders derive no benefit from knowing \(k\). And, since \(c_1 > 0\), all bidders will refrain from buying the information at equilibrium.

Fix \(\lambda\). Let \(II(\lambda)\) (see Eq. (A.1) in Appendix A) denote each bidder’s expected profit from the auction with fixed \(\lambda\). Note that \(II(\lambda)\) is a continuously decreasing function of \(\lambda\) which goes to zero as \(\lambda\) goes to infinity. Note also that throughout this paper, expected ‘profits’ (and ‘gains’ or ‘losses’) will be gross of entry and information costs without further comment. Similarly, let \(R(\lambda)\) (Eq. (4)) denote the seller’s expected revenue.

Next consider the sealed-bid auction. We consider two candidates for symmetric equilibria. In one, all of the bidders acquire the information about \(k\). In the other, none do.\(^7\)

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\(^3\)This is not my first attempt to provide such an explanation. For example, Engelbrecht-Wiggans (1989) argues that bidders concerned about money left on the table might bid more aggressively in oral auctions than in sealed-bid auctions.

\(^4\)This may be viewed as the limiting case of \(n\) potential bidders, each independently entering with probability \(p\). The total number of bidders would have a Binomial\((n,p)\) distribution, while the number of other bidders faced by any one bidder would have a Binomial\((n - 1,p)\) distribution. Let \(n\) go to infinity with \(p = \lambda/n\). Both Binomial distributions converge to the same Poisson\((\lambda)\) distribution. For further discussion of games with Poisson distributed numbers of players, see Myerson (1998).

\(^5\)Since individuals who enter may bid without incurring any additional costs, entrants will be assumed to bid and will be referred to as bidders hereafter.

\(^6\)Non-trivial reservation prices complicate the analysis without substantively changing it.

\(^7\)There may also exist mixed strategy equilibria in which bidders acquire the information with probability between zero and one. The effect that I wish to demonstrate persists, though perhaps to a lesser degree, so long as the probability is strictly positive. So, showing that a probability equal to one results in an equilibrium, while a probability of zero does not, suffices for our purposes.
The appendix (Eqs. (A.4) and (A.5)) presents the unique monotonic differentiable symmetric equilibrium bidding strategy corresponding to each of these two possibilities as a function of \( \lambda \).

The expected profit and expected revenue at equilibrium, in both cases, will be the same as in the oral auction. Specifically, Vickrey showed that the oral and sealed-bid auction generate the same expected revenue for any fixed number of bidders. Both auctions have the same probability of any given number of bidders. Therefore the oral auction generates the same expected profit and expected revenue as does the sealed-bid auction when bidders know the number of bidders. Harstad et al. (1990) establish that the oral auction generates the same expected profit and expected revenue as does the sealed-bid auction when bidders do not know the number of bidders. And, the oral auction generates the same expected profit and expected revenue when bidders know the number of bidders as when they do not.

Now, endogenize \( \lambda \). At equilibrium, any bidders must have zero profit net of entry and information costs. Therefore, if the entry cost \( c_E \) is greater than one half — the mean value for the object — then \( \lambda = 0 \). Otherwise, if no bidder acquires the optional information, then \( \lambda \) is defined uniquely (though implicitly) by setting the expected profit \( \Pi(\lambda) \) equal to the entry cost \( c_E \). Denote this \( \lambda \) by \( \lambda_{E-1} \). Similarly, if the \( c_E \) plus the information cost \( c_1 \) together exceed one half, then no bidder acquires the information. If all bidders do acquire the information, then \( \lambda \) is defined uniquely (though implicitly) by setting the expected profit \( \Pi(\lambda) \) equal to \( c_E + c_1 \). Denote the corresponding \( \lambda \) by \( \lambda_{E+1} \).

Finally consider the question of information acquisition in sealed-bid auctions. To do so, consider the problem from the perspective of one bidder \( i \) and calculate the benefit to that bidder of acquiring the information and therefore knowing how many other bidders there are. Specifically, imagine that each of the other bidders knows the number of bidders and bids according to the equilibrium strategy for the case when all bidders know \( k \). Imagine that bidder \( i \) has a value of \( v \) for the object and bids \( \beta \) independent of \( k \). Let \( \Pi^-(\beta; v, \lambda) \) (Eq. (8)) denote the expected profit to bidder \( i \). Then the expected loss to bidder \( i \) from not knowing \( k \) when others do is

\[
\Delta^-(\lambda) = \Pi(\lambda) - \int_v \max_\beta \Pi^-(\beta; v, \lambda) dv
\]

If \( \Delta^-(\lambda_{E+1}) > c_1 \), then bidder \( i \) should acquire the information and there exists a symmetric equilibrium in which all bidders acquire the information.

Similarly, consider the possibility that none of the other bidders know the number of bidders. Imagine that bidder \( i \) has a value \( v \) for the object and knows the number \( k \) of other bidders. Imagine that all bidders, including \( i \), bid according to the equilibrium strategy for the case when no bidder knows \( k \) except that bidder \( i \) bids as if his or her value were \( x(k) \), where \( x(k) \) may vary with \( k \). Let \( \Pi^+(x(k); v, \lambda, k) \) (Eq. (9)) denote the expected profit to bidder \( i \). Then the expected gain to bidder \( i \) from knowing \( k \) when others do not is

\[
\Delta^+(\lambda) = \sum_{k=0}^\infty \{(e^{-k} \lambda^k / k!) \int_v \max_{x(k)} \Pi^+(x(k); v, \lambda, k) dv \} - \Pi(\lambda)
\]

If \( \Delta^+(\lambda_{E}) > c_1 \), then bidder \( i \) should acquire the information and there is no equilibrium in which all bidders refrain from acquiring the information.

Finally, consider the possibilities. If both \( \Delta^+(\lambda_{E}) > c_1 \) and \( \Delta^-(\lambda_{E+1}) > c_1 \), then the unique symmetric equilibrium in the sealed-bid auction has all the bidders acquiring the information. But, if
$R(\lambda) = 0.1036, 0.2707, 0.3203, 0.3846, 0.4163, 0.5275, 0.6094$

$A(\lambda) = 0.2642, 0.1485, 0.1254, 0.1000, 0.0890, 0.0568, 0.0384$

$D(\lambda) = 0.0673, 0.0408, 0.0254, 0.0218, 0.0115, 0.0062$

Table 1 shows the seller’s expected revenue $R(\lambda)$, each bidder’s equilibrium expected profit $II(\lambda)$, a bidder’s expected gain $\Delta^+(\lambda)$ from unilaterally acquiring the information when no other bidder does, and a bidder’s expected loss $\Delta^-(\lambda)$ from unilaterally deciding not to acquire the information when all other bidders do . . . all for various different fixed mean number $\lambda$ of bidders. (Remember: All profits, gains and losses are gross of entry and information costs.)

Imagine that entry costs 0.1. Then, $\lambda_e = 2.7607$. Therefore an average of 2.7607 bidders enter the oral auction, and the seller has an expected revenue of 0.3846.

Now consider the sealed-bid auction. Imagine that the information costs a hair under 0.0254. When $\lambda = 2.7607$, the gain from unilaterally acquiring the information equals 0.0254 and exceeds (just barely) the cost of the information. Therefore, bidder $i$ should acquire the information; there cannot be an equilibrium in which bidders do not acquire the optional information.

However, there does exist a sealed-bid equilibrium in which all bidders do acquire the information. Note that $II(2.3162) = 0.1254$. Therefore, there exists a sealed-bid equilibrium in which an average of 2.3162 bidders enter and the seller has an expected revenue of 0.3203.

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Note that $R(2.7607)/R(2.3162) = 0.3846/0.3203 = 1.20$. In words, the seller’s expected revenue at the dominant bidding strategy equilibrium in the oral auction exceeds that at the unique monotonic differentiable symmetric equilibrium in the sealed-bid auction by twenty percent

3. Discussion

Earlier, I argued as follows: Bidders in oral auctions may need or want to spend less effort acquiring and interpreting information than in sealed-bid auctions. Thus, it costs less to participate in oral auctions than in sealed-bid auctions. The lower participation cost makes oral auctions more attractive to bidders. So more bidders enter. And, everything else being equal, the auction with more bidders generates higher expected revenue for the seller. Therefore, oral auctions will generate more revenue for the seller than would sealed-bid auctions . . . and will do so even in the case of independently distributed, privately known values. And I provide an equilibrium example illustrating how this works.

In practice, the gap between oral and sealed-bid auctions may be even greater than illustrated by the
example. In particular, the example considers only one specific type of effort, the effort of determining the number of competitors. Other types of effort may have similar effects. And the effects may add.

Similar arguments may hold in other settings. For example, even in the case of common values, the benefit from knowing the number of competitors may be less in oral auctions than in sealed-bid auctions. And it may be easier to obtain a critical minimum amount of information about the number of competitors in oral auctions than in sealed-bid auctions. So, at equilibrium, bidders may still elect to expend less effort in oral auctions than in sealed-bid auctions.

More generally, similar arguments may hold for comparing other auctions. For example, consider oral auctions versus the contingent bidding of Harstad et al. (1990). Even if bidders benefit from knowing the number of competitors in oral auctions, they may elect to spend little effort in estimating the number. In the contingent bidding scheme, bidders have no choice but to submit more complex bids (and it may be more difficult to learn from certain ‘mistakes’ in earlier bids). So bidders may prefer oral auctions to the contingent bidding scheme.

The argument does hinge on individuals entering with the right probability and making the correct information acquisition decisions. However, anecdotal evidence suggests that bidders in sealed-bid auctions do recognize the value of additional information and acquire it to the extent that they reasonably can. Also, anecdotal evidence exists that potential bidders are more willing to attend oral auctions than bid in a sealed-bid auction. For example, I have met several individuals who have made major real estate purchases at oral auctions, but will not bid in sealed-bid auctions. In short, real bidders may get the entry and information acquisition decisions right — or nearly right so to make my argument go through — even if they can not (or elect not to) correctly interpret and use the information, for example, revealed by others’ bids in oral auctions with uncertain values.

My argument differs fundamentally from others. I suggest that bidders may prefer oral auctions because they are, in some sense, easy to bid in . . . for reasons not normally modeled. Real bidders may simply say that they are ‘more comfortable’ bidding in oral rather than sealed-bid auctions. I provide an, admittedly very stylized, equilibrium example in which ‘comfort’ may be may be equated with ‘less need to know, and to expend effort in pinning down, the number of competitors.’ As a result, oral auctions attract more bidders, generate higher revenue, and are preferred by sellers.

This is in stark contrast with what happens in the model of Milgrom and Weber (1981). With a fixed number of bidders, oral auctions generate higher revenue than do sealed-bid auctions. Since both auctions allocate the object efficiently, bidders make less profit in oral auctions than in sealed-bid auctions. So, in the case of entry, more bidders would enter sealed-bid auctions than oral auctions. Indeed, Levin and Smith (1994) show that such entry can result in sealed-bid auctions generating greater expected revenue than oral auctions.

Whether or not bidders find oral auctions more attractive than sealed-bid auctions can be tested empirically. In an informal experiment, I announced that two identical bottles of wine would be auctioned, one in Room A via an oral auction and one in Room B via a sealed-bid auction, starting in 5 min. The oral auction attracted roughly fifty percent more people and resulted in a price roughly ten percent higher than did the sealed-bid auction. Many experiments have been run with fixed number of

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*While it may be easier in an oral auction than in a sealed-bid auction to estimate the number of competitors, it may still be non-trivial due to, for example, telephone bids and audience members who have no intention of bidding on a particular item.
bidders. To get at the entry question, one could try to determine how much people prefer one auction to another in such settings. Or one could also address the question of how entry affects revenue and, for example, run a more structured version of my informal experiment.

Finally, note that sealed-bid auctions persist in some settings. For example, consider construction contracts and the procurement of relatively standard but somewhat specialized supplies. Here, the same set of bidders may compete repeatedly for similar contracts and may already have a variety of information. Any additional information may be too costly — or illegal — to acquire. If so, then bidders end up with the same information — and spend the same amount on information — in both types of auctions . . . and revenue equivalence prevails in the case of privately known values.

A small twist to my model then has the seller preferring sealed-bid auctions. For example, the cost of entering an oral auction may in fact be slightly greater than that of submitting a sealed-bid, and/or an oral auction may be more costly to run than a sealed-bid auction. Such additional considerations would tilt the balance in favor of sealed-bid auctions.

In short, I would expect to see sellers choose oral auctions when dealing with appropriately inexperienced bidders — bidders who would have good reason to acquire more information in a sealed bid auction than in an oral auction — and would not be surprised to see sellers use sealed-bid auctions with sufficiently experienced bidders.

Appendix A

This appendix derives the expressions needed to compute the expected profit, revenue, gains and losses shown in the table. The derivations use the fact that the order statistics of a uniform distribution are evenly spaced.

To calculate the expected profit per entrant, consider the perspective of bidder \( i \). Conditional on there being \( k \) other bidders, bidder \( i \) has a \( 1/(k+1) \) chance of winning. In the case of uniformly distributed values, the \( k+1 \) bidders’ expected profit equals \( 1/(k+2) \). Thus, bidder \( i \) has an expected profit of \( 1/((k+1)(k+2)) \). Averaging over \( k \) gives an expected profit of\(^\text{10}\)

\[
\Pi(\lambda) = \sum_{k \geq 0} \left( e^{-\lambda} \frac{\lambda^k}{k!} \right) \frac{1}{((k+1)(k+2))} = \frac{1 - e^{-\lambda} - \lambda e^{-\lambda}}{\lambda^2}. \tag{A.1}
\]

Note that this profit per bidder is a decreasing function of \( \lambda \) and goes to zero as \( \lambda \) goes to infinity.

To calculate the expected revenue, start by conditioning on the total number \( k \) of bidders. The expected revenue to the seller conditional on there being \( k \) bidders is zero if \( k \) equals zero or one, and equals \( (k-1)/k \) otherwise. Averaging over \( k \) gives an expected revenue of

\[
R(\lambda) = \sum_{k \geq 2} \left( e^{-\lambda} \frac{\lambda^k}{k!} \right) \frac{(k-1)(k+1)}{(k+2)} = (1 - \frac{1}{\lambda})(2/\lambda). \tag{A.2}
\]

Note that this expected revenue is an increasing function of \( \lambda \).

Now consider the sealed-bid auction. To derive the bidding equilibrium, consider the problem from the perspective of any one bidder \( i \). Let \( H \) denote the distribution of the highest other bidder’s value. If bidder \( i \) knows the number \( k \) of other bidders, then \( H(x) = x^k \). Otherwise, \( H(x) = \sum_{k \geq 0} x^k e^{-\lambda} \frac{\lambda^k}{k!} = e^{\lambda(x-1)} \).

\(^{10}\)Eqs. (A.1)–(A.5) can easily be generalized to any value distribution.
Standard techniques (see, for example, Milgrom and Weber (1981)) show that, for any fixed $\lambda$, the unique monotonic, differentiable, symmetric Nash equilibrium has each bidder bidding

$$b(v) = \int_{t/0 \leq t \leq v} t \, dH(t)/H(v) \quad (A.3)$$

If each bidder knows the number $k$ of other bidders, then the equilibrium strategy (A.3) becomes

$$b(v) = v \, k/(k + 1); \quad (A.4)$$

otherwise, the equilibrium strategy (A.3) becomes

$$b(v) = v - 1/\lambda + 1/(\lambda \, e^{\lambda v}) \quad (A.5)$$

Now calculate the expected profit to a bidder who unilaterally deviates from either of the two possible symmetric equilibria in the sealed-bid auction. First, calculate the expected profit to a bidder $i$ who acquires the information when no other bidder does. Specifically, if each of the other bidders know the total number $k + 1$ of bidders and bid according to the strategy given in Eq. (A.4), and $i$ bids $\beta$ independent of $k$ when $i$ has a value $v$ for the object, then $i$ has an expected profit of

$$\Pi^- (\beta; v, \lambda) = \sum_{k=0}^{\infty} (e^{-\lambda} \, \lambda^k/k!) (v - \beta) \min\{1, (\beta(k + 1)/k)^k\}. \quad (A.6)$$

Second, calculate the expected profit to a bidder $i$ who does not acquire the information when all other bidders do. Specifically, imagine that bidder $i$ has a value $v$ for the object and knows the number $k$ of other bidders. If all bidders, including $i$, bid according to the strategy given by Eq. (A.5), except that bidder $i$ bids as if his or her value were $x(k)$, then bidder $i$ has an expected profit of

$$\Pi^+ (x(k); v, \lambda, k) = (v - (x(k) - 1/\lambda + 1/(\lambda \, e^{\lambda x(k)})) \, x(k))^k. \quad (A.7)$$

References