AUCTIONS OF COMPANIES

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Auctions of companies are conducted in ways that contradict received auction theory. The major puzzles are: (1) sellers restrict the number of bidders; (2) sellers restrict the number of bidders; (3) bidders are screened by an initial round of non-binding bids; and (4) bidders offer—and sellers sometimes accept—preemptive bids. Puzzles (1), (2), and (4) are explained by assuming that some information concerning the company can, if released, reduce the value of the company. Puzzle (3) is explained as a way for sellers to select the highest-valued bidders; equilibrium is maintained by using the initial bids to set a reserve price for the final bidding round.

I. INTRODUCTION

From 1989 to 1998, 19,593 private companies were reported to be bought and sold in the United States, many through an auction process. The total value of these transactions was in excess of $315 billion.1 In addition, from 1989 to 1998, there were 13,134 reported divestitures of divisions, subsidiaries, or product lines; the value of these transactions was in excess of $900 billion. Perhaps not surprisingly, an industry of advisors/auctioneers exists to facilitate these transactions, and the institutional framework by which auctions of companies are conducted has become somewhat standardized. The purpose of this article is to apply auction theory to explain this standardized institutional framework. The article proceeds as follows: section II describes the standardized process used for selling private companies or divisions of public companies; points out how these practices conflict with certain aspects of received auction theory; and presents initial arguments that explain the rationality of the practices. In section III, a more formal model is developed to show how some of the standard corporate auction practices can be explained. Section IV deals with what may be the most intriguing institutional practice—the use of preliminary, nonbinding indications of interest. Section V concludes the article with a preliminary discussion of entry fees and preemptive bidding.

II. THE “TYPICAL” AUCTION PROCESS AND CONSISTENCY WITH AUCTION THEORY

The typical process for selling a private company or division of a public company runs as follows.2 Upon making the decision to sell, the selling company will retain (or will already have retained) an advisor who will serve as de facto auctioneer. The auctioneer, drawing on knowledge of the selling company, will draw up a preliminary list of potential bidders; this list will probably include competitors, suppliers, customers, and acquisition-oriented conglomerates or leveraged buyout houses. The advisor will also exercise his judgment at this time as to whether or not a prospective bidder will be willing and able to complete a transaction at a “satisfactory” price. If a negative judgment is made, that potential bidder

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1. Mergerstat Review, 1999. I purposely exclude tender offers for entire publicly traded companies as the auction process for such transactions is not as structured as for private transactions.

2. Much of my information on this process derives from my experience as a management consultant. Macy (1990) contains a description of some aspects of the process. I also have on file two documents produced by investment banks that describe the divestiture process.
will likely be excluded from further participation. The remaining prospective bidders will receive a very cursory description of the selling company and will be offered a more in-depth offering memorandum if they sign a confidentiality agreement. Although the first cursory description may not even include the selling company’s name, the offering memorandum will be quite detailed, including the sort of information that would typically be in a public corporation’s Securities and Exchange Commission 10-K filing as well as traditionally confidential information on current issues at the selling company, overview of costs, plans for market and product developments, and so on. The next step is for the prospective bidders to submit preliminary, nonbinding “indications of interest” for the selling company. These indications will be either a number or a range of numbers that are supposed to represent “bidders’ first approximations of their estimates of the value of the target.”

The preliminary indications are then used by the auctioneer to further reduce the number of bidders who will proceed further. “Only the top bidders on their list are permitted to go forward.” Although the screening is clearly not as straightforward as the preceding passage presumes, there is no doubt that the likelihood of admittance to the next round increases with the preliminary bid—even though that bid is nonbinding.

Since explaining this institutional practice of requiring submission of preliminary, nonbinding indications of interest is a primary purpose of this paper, it is important to establish that the practice is indeed common. Besides the references to Macy (1990), I have spoken with numerous investment bankers who confirm that a round of preliminary indications of interest is standard practice. A representative quote is as follows: “When our firm is engaged by a selling company to conduct an auction, we always ask potential buyers to submit preliminary, nonbinding indications of interest. These indications are typically ranges of values, and those potential buyers with low ranges are more likely to be excluded from the ensuing auction than buyers with higher ranges, ceteris paribus. This is standard practice at all investment banks with which I am familiar.” I have also reviewed two documents from major New York City investment banks that spell out a typical auction process. The process as described in these documents is entirely consistent with the description given here.

For those potential buyers who sign confidentiality agreements and are qualified by their preliminary indications, the next round of the selling process ensues with more extensive dissemination of information. This process includes visits with and presentations by senior management of the selling company; plant and site visits; and review of financial, legal, and other documents that are assembled by the selling company and its advisor in a “data room.” Information released in this phase of the selling process is quite detailed and definitely of use to potential buyers in their valuation of the selling company. Some of the headings in one investment bank’s “Information Request” (given to the selling company to prepare for visits with potential buyers) are as follows:

- Other market trends, including changes in unit pricing
- Historical and projected volume of units sold for each major product and/or product line
- A descriptive list of the company’s key customers, which includes dollar amount and percentage of sales attributable to each, and special concessions given
- Description of any products and/or product lines presently in development stage, including expected dates of introduction, results of any testing, and expected financial results
- Description of each major component of cost-of-sales and a detailed list of direct general, selling, and administrative expenses attributable to each major product

3. Macy (1990), 95.
5. Bidders themselves will also choose to not participate in the auction; such self-selection can occur at any stage of the process. Presumably bidders will opt out when they perceive the costs of participating as being greater than the expected benefits. Thus, there is an implicit a priori equilibrium along the lines of French and McCormick (1984), wherein the number of potential bidders who participate in each step of the auction process is endogenously determined. Although this aspect of the process is not modeled here, the idea is important, for it implies that there is not an unlimited number of willing bidders and that bidders who enter the process have positive expected profit.

6. Quote by Alex Fuchs of Morgan Stanley & Co., Inc.
• Description of the terms of any long-term supply contract or any other major commitment regarding the purchase of raw materials
• Major items of equipment and facilities used in the production process, including age and condition, total available production capacity, and amount of capacity used
• Specialized projected income statements for the next five years by product and/or product line and by geographic region

Although much of this information will be presented in the offering memorandum in a way designed by the selling company’s advisor, original documents (for example, internal accounting data and actual supply contracts) will be available in the data room for review by potential buyers.

It is important to note that although the information given to potential buyers is extensive, it is not complete. Throughout the auction process, potential buyers may ask for information that the selling company will view as too confidential to reveal. The divestiture manual I reviewed notes this and adds that such information will generally be “that which is believed to be advantageous to competitors, or cost information believed to threaten relations with suppliers or employees.”

The final step in the auction is for bidders to submit sealed bids for the purchase of the company. Because these bids may not be purely cash bids, choosing the best bid might represent a valuation problem for the selling company. Also, it is important to note that any time during this process a bidder might make a preemptive bid to short-circuit the sale. The most likely time for a preemptive bid, however, is before the last round of intensive information gathering.

There are aspects of this auction process that are interesting as they stand, but the process calls more strongly for explanation because it conflicts with standard results in auction theory and/or what would appear to be rational behavior on the part of bidders. More explicitly, let me arrange the stylized facts of the auction process in this manner:

**Stylized Fact #1:** Sellers restrict the number of bidders.

**Stylized Fact #2:** Sellers restrict the flow of information to bidders.

**Stylized Fact #3:** Sellers choose the set of final-round bidders by staging an initial round of nonbinding bidding; the probability of getting into the final round increases with the initial round bid.

**Stylized Fact #4:** Bidders sometimes offer preemptive bids that sellers sometimes accept.

Stylized Fact #1 contradicts a basic tenet of auction theory: having more bidders increases the expected selling price. Although there are auction models where it pays the seller to restrict bidders by charging entry fees, these do not explain the practice observed in corporate auctions because no entry fees are charged in these auctions. Also, standard auction models imply an optimal reserve price for the seller that implicitly limits the number of bidders (those with value less than the reserve price will not bid) but the limitation in these models is passive: bidders elect to participate or not; they are not told by the seller that they cannot participate. In the absence of entry fees, existing auction models give no rationale for excluding bidders.

Stylized Fact #2 contradicts a result by Milgrom and Weber (1982) on prices and information that has been conveniently restated by McAfee and McMillan (1987): “The seller can increase his expected revenue by having a policy of publicizing any information he has about the item’s true value.” The intuition for this price-increasing effect is that divulging information tends to reduce the variance of bidders’ value estimates, and this variance gives bidders the incentive to strategically reduce their bids. Yet in corporate auctions we see sellers purposely withholding relevant information.

Stylized Fact #3 is difficult to understand in the face of bidder rationality. If getting into the final round has any value at all (and it cannot be negative, for the bidder could always elect to drop out), then why not bid

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7. In the model of French and McCormick (1984), for instance, a seller could increase revenues by charging an entry fee and thereby restricting the number of bidders, but it would never pay the seller to restrict bidders without an entry fee. See also the discussion in Macy (1990).

high enough in the first round to ensure participation in the final round? But if everyone does this, the initial round bidding must escalate indefinitely, and the seller would not be able to use the initial-round bids to select bidders any more efficiently than random selection. Perhaps the most commonly heard rationale for existence of equilibrium is that "reputation effects" keep bidders from bidding "too high." But for many bidders an auction of this sort is likely to be a one-shot affair, so concern over reputation should be minimal. Also, determining when "cheating" has occurred—when a bidder opportunistically bids high just to get in the final round—must be extremely difficult; after all, the initial round bids must be nonbinding to allow for the possibility that, after seeing more information, a bidder decides the company is worth less than he or she originally thought. Yet bids in these initial rounds do appear to represent some measure of a bidder's valuation, and sellers do select bidders on the basis of their initial-round bids.

Stylized Fact #4—preemptive bidding—contradicts a finding by Riley and Samuelson (1981) that the seller cannot improve expected revenue by employing multiple rounds of bidding. Preemptive bidding, after all, can be thought of as another initial round of bids; the seller stands ready to accept a bid in this initial preemptive round if it is high enough. Although it may seem profitable for a seller to use multiple rounds, with declining reservation prices, it turns out that after accounting for how bidders will behave in the initial round (i.e., they will bid low because they anticipate a next round), the seller's expected revenue will actually decline with such a scheme. Yet we see preemptive bids made and accepted.

In this article, I argue that the overall process by which companies are sold represents a balance between the benefits of getting more bidders and of releasing more information against what I term the competitive information cost. The idea is very simple: to accurately value a selling company, a potential buyer needs more than just projections or summary statistics, such as aggregate sales, profits, or valuations done by third parties. Because many potential buyers will be involved in the same industry as the selling company (as a competitor, supplier, or customer) the question will often be how the selling company will fit in with the buyer's existing operations. Thus, financial details on products and product lines, geographic distribution of sales, research and development plans, state of production facilities, and contracts with suppliers, customers, and employees, will be critical—just the sort of information noted above as being in a typical information request. Information such as the "recipe" for a product would probably not be critical to a buyer's valuation, for the effect of the recipe can be seen in summary statistics, such as sales data, and the recipe itself would be available on conclusion of the purchase. Where the product is sold, to whom, and for how much will be much more important, for a buyer may want to get, for example, a marketing/distribution network that is complementary to its own network.

The problem, however, is that the information relevant to an accurate valuation may also be valuable to potential buyers in their role as competitors, suppliers, or customers of the selling company. Releasing information to a set of potential buyers that includes competitors, suppliers, and customers may in fact reduce the value of the selling company. This is what I refer to as the competitive information effect: a negative relationship between the amount of information given out, the number of bidders that information is given out to, and the selling company's value to any one of the bidders. For a competitive information effect to exist, the selling company and the bidders must be competing on some front, and that competition must be imperfect due to uncertainty. Disclosure of information in the auction process can then affect that competition, benefiting the bidders and destroying value of the selling company. Many game-theoretic models of competition involving the selling company and bidders would yield a competitive information effect. One possibility would be the following: Envision the selling company as procuring inputs via a sealed bid process. If one of the input suppliers finds out another supplier's current bid (through the selling company's disclosure), it could use that information to its advantage and the selling company's disadvantage. Entry models could also yield

9. Bulow and Klemperer (1996) show that an auction of a company is always preferable to a negotiation so long as the auction attracts at least one additional bidder. They do not, however, consider the potential cost of releasing proprietary information, which is the crucial assumption of this article. From discussions with investment bankers, the decision to negotiate rather than auction does seem to hinge on the existence of proprietary information that, if released, could damage value.

10. For a competitive information effect to exist, the selling company and the bidders must be competing on some front, and that competition must be imperfect due to uncertainty. Disclosure of information in the auction process can then affect that competition, benefiting the bidders and destroying value of the selling company. Many game-theoretic models of competition involving the selling company and bidders would yield a competitive information effect. One possibility would be the following: Envision the selling company as procuring inputs via a sealed bid process. If one of the input suppliers finds out another supplier's current bid (through the selling company's disclosure), it could use that information to its advantage and the selling company's disadvantage. Entry models could also yield
Given this, the selling company will find it optimal to limit both the number of bidders and the amount of information it divulges; this explains Stylized Facts #1 and #2. Furthermore, the seller will increase profits if he can limit the number of bidders in a way that screens out low-valued bidders and admits high-valued bidders. I find that an initial round of nonbinding bids can serve this purpose if the seller also uses the initial-round bids to set a reserve price for the final-round auction. In this way, bidders are discouraged from bidding too high in the first round: the higher the bid in the first round (for any bidder) the higher the reserve price in the final round, and hence the lower the expected profits for the bidder. Indeed, it turns out that the seller can elicit honest revelation of bidders’ initial value estimates by a suitable choice of functional relationship between initial round bids and the final round reserve price.

This idea is just a formalization of a basic business tenet that I believe most people would subscribe to: “When buying something, do nothing to make the seller think that the item is worth a lot to you.” In either a negotiated or auction context, if the seller believes that the item is worth a lot to a buyer, then the seller will generally find it optimal to raise the reservation price or to bargain harder. Thus, bidders in the initial round of a corporate auction must balance the benefits of a higher bid (increased probability of entry in the final round) against the costs (increased reserve price in the final round). Of course, there are certain conditions that must hold for an equilibrium to obtain; these are detailed below.

The final issue is that of preemptive bidding. Preemptive bidding can also represent rational equilibrium behavior for bidders and the seller in the presence of a competitive information cost. If the cost of releasing information in the final round is large, then the seller may find it better to accept any preemptive bid exceeding a critical level. In doing this, the seller forgoes the benefit of price determination via auction but also forgoes the value reduction due to information disclosure.12

I turn to a more formal model for explaining the restrictions placed on number of bidders and disclosure of information (Stylized Facts #1 and #2). The following section will deal with preliminary indications of interest—Stylized Fact #3.

III. A FORMAL MODEL FOR MANAGEMENT OF BIDDERS AND INFORMATION DISCLOSURE

A. Assumptions on Bidders, Valuations, and Information

There will be N potential bidders for the company being sold. A bidder’s value for the company being sold will depend on both a bidder-specific variable (the bidder’s type) and on a common state-variable that defines the condition of the selling company’s assets.

More formally, I make the following assumptions.

Assumption 1. Bidder’s value for the selling company is given as

\[ V(x; z) = \text{Value to bidder } i \]

where \( V(\bullet) \) is a common valuation function; \( x, \in [x, \bar{x}] \) is a variable denoting the bidder’s type known only by bidder \( i \), and \( z, \in [z, \bar{z}] \) is a random state variable, with probability distribution \( G(z) \), known by bidder \( i \) only after

11. This mechanism works only if all bidders, even those with the lowest \textit{ex ante} valuation, have positive expected profits in the final round auction. This is not the case in the standard auction model. The assumptions laid out below do allow all bidders to have positive expected profits; besides permitting equilibrium to hold in the model here, the assumptions that lead to positive expected profits for all bidders are of interest on their own.

12. Fishman (1988, 1989) also addresses the issue of preemptive bidding, but his analysis differs from mine. In Fishman’s models, preemptive bidding arises out of a desire by one bidder to deter other bidders from investing in information concerning the target. Fishman’s analysis and mine share the prediction that it will be high-valued bidders who make successful preemptive bids.
purchase of the company. Bidder $i$ therefore has an ex ante expected value for the selling company given as:

$$(2) \quad \text{Bidder } i\text{'s Prior } \equiv EV_i(x_i) = \int V(x_i; z)dG(z).$$

Each bidder views his competitors’ types as independent draws from a probability distribution $F(x)$.\(^{13}\)

**Assumption 2.** The seller has observations $y = (y_1, \ldots, y_N)$ on $N$ random variables $(y_1, \ldots, y_N)$ that are also correlated with $z$. If the seller discloses $m$ of these observations to the bidders, the bidder would update his beliefs on $z$ using the conditional probability distribution $G(z|y_1, \ldots, y_m)$.

In words, then, a bidder’s valuation depends on a component $x$, that is independent and specific to himself and on a component $z$ that is common to everyone but unknown. Bidders begin with no information on $z$, but the seller has potential to give them considerably more by disclosing all or part of his information $(y_1, \ldots, y_N)$. The seller’s information can be thought of as that which he puts into the data room and which he provides through plant visits and management meetings.

There are two other characteristics to this seller’s information set that are crucial, however. First, I assume that disclosure of the seller’s information to more than just the winning bidder has the effect of reducing the value of the selling company to all of the bidders. As discussed above, the rationale for this is that much of the seller’s information is of a competitive nature so that its disclosure to nonowners would lessen the economic viability of the company. The second characteristic is a logical corollary to the first: that the seller’s information is itself of value to the bidders. That is, if the seller’s information is competitive in nature, then the bidders would be willing to pay to get it.

In more formal terms:

**Assumption 3.** If $(y_1, \ldots, y_m)$ is observed by $n$ bidders, then the net value of the selling company to bidder $i$ becomes

$$(3) \quad \text{Net value to bidder } i = V(x_i, z) - f(n, m)$$

where $\partial f/\partial n > 0$ and $\partial f/\partial m > 0$.

**Assumption 4.** The competitive value to bidder $i$ of observing $(y_1, \ldots, y_m)$ is $d$. Thus, all bidders place the same value on the information.\(^{14}\)

**B. Expected Sales Prices and the Optimal Number of Bidders and Information Disclosure**

The expected price that the seller receives if it auctions the company will depend on $m$, its information disclosure; $n$, the actual number of bidders; and the auction rule (open, sealed bid, etc.) used. In the example that follows shortly, I will assume an open auction, but the results of the article are not at all dependent on the specific auction form used.

Because of the way information is assumed to affect valuations—it simply reduces every bidder’s value by the fixed amount $f(n, m)$—it is straightforward to show that for any auction rule used, the competitive information cost reduces the seller’s proceeds by exactly $f(n, m)$. It will therefore be convenient to talk about the gross sales price as the price before considering the competitive information effect and the net sales price as being the gross price less $f(n, m)$. The gross expected price will be denoted as $E_A(p|n, m)$, where the subscript $A$ is simply a reminder that the expected price will depend on the auction rules used.

13. Though this set-up is similar to that of Milgrom and Weber (1982), it differs in that no restrictive assumptions are placed on the $V(x_i, z)$ function. In particular, Milgrom and Weber assume that the $V(*)$ function is nondecreasing in all its variables. This precludes reversals in the ranking of bidders’ valuations: if $x_i > x_j$, then $V(x_i, z) > V(x_j, z)$ for all $z$. As will be seen below, it is critical in the model here that the ranking of bidders’ valuations depend on the state. The model as set up bears some resemblance to “almost common-values” assumptions—see, for instance, Klemperer (1998). In “almost common-values” auctions one bidder is given a slight valuation advantage. In the model here, one bidder will be given a slight advantage; the additional twist is that which bidder has the advantage depends on the state.

14. It would be more realistic to have $d$ as an increasing function of $m$ and, possibly, a declining function of $n$. These changes would complicate the model but would not alter the essential conclusions.
Following well-known results in auction theory, we know that having more bidders raises the gross expected price, so if $n_1 > n_2$, then

$$E_A(p|n_1, m) \geq E_A(p|n_2, m).$$

Another well-known result in auction theory is that disclosure of information also raises the expected price. Some benefit to the seller of information disclosure is critical to the analysis here in order to create a tension between disclosure versus withholding of information by the seller. (If there is no benefit to the seller of disclosing information, and if there is any cost at all to disclosure, then no disclosure would be the best policy. This certainly conflicts most strongly with observed practice.) Although the intuitive reasons for the price-enhancing effects of disclosure are clear, the effect is assured only with certain valuation and informational assumptions— if the $x_i$ variables and $z$ were affiliated, and if $V(x_i; z)$ had certain features, as in Milgrom and Weber (1982). As will be made clear below, we do not wish to constrain the $V(x_i; z)$ function in the way that would ensure the price-enhancing effect of disclosure. This said, the assumptions we make do not preclude a price-enhancing effect of disclosure. This said, the assumptions we make do not preclude a price-enhancing effect of disclosure and in the numerical example provided a price-enhancing effect does exist. Also in this regard, there is another very important legal benefit to sellers from disclosing information: withholding relevant information could be grounds for a claim of fraud. This legal aspect by itself would create the tension between the benefits and costs of disclosure at the heart of this article.

We will then assume that disclosure of information has a (gross) benefit to the seller: if $m_1 > m_2$, then

$$E_A(p|m_1) \geq E_A(p|m_2).$$

With this groundwork established, the institutional facts of how companies are sold are easy to justify. Although adding more bidders does increase the “gross” expected selling price, the net price—after subtracting the information cost—may actually decline. Indeed, because it is likely that the gross selling price increases at a decreasing rate in the number of bidders, there is likely to be an interior optimum with the actual number of bidders less than the total available. Similarly, as the seller reveals more information, the marginal benefit of disclosure is likely to fall, so that there will be an optimum level of disclosure that is less than complete.

Two extreme cases are worth mentioning at this point, for they emphasize that the explanation given here for the “typical” auction process assumes a significant but not overwhelming importance of the competitive information cost. At one extreme, there would be little or no competitive information cost, so the optimal policy for the seller would be to have as many bidders as possible and to disclose fully. At the opposite extreme, the competitive information cost would be so high that the most attractive option for the seller would be to negotiate solely with one bidder but to give complete information. Because only the sole bidder receives the information, there is no cost to giving him everything, and this is likely to increase the price that can be negotiated. Thus, with companies where disclosure of even little information could reduce the value of the company significantly, we should not be surprised to see negotiated one-on-one sales. Section V discusses this idea further along with the related one of preemptive bidding.

IV. SCREENING BIDDERS VIA AN INITIAL ROUND OF BIDDING

A. Introduction

In the previous section it was suggested that an interior optimum exists for the number of bidders, but no mechanism was given for how the actual bidders would be selected. We now inquire as to whether the seller can somehow select final bidders in an efficient fashion, selecting the ones of better type (higher prior expected value, $EV_i$). One approach would be to qualitatively evaluate the potential bidders, focusing on how they might evaluate the selling company. The goal here would be to try to choose those bidders that have the most “synergy” with the selling company, that is, are most likely to place a higher value on it.

Although this kind of screening undoubtedly does occur, my focus here is on another process that could be complementary to the qualitative screening: screening bidders through the use of an initial round
of nonbinding bids. My argument is that the selling company commits itself to set a reserve price in the final round of bidding that depends (positively) on the bids received in the initial round. Because bidders’ expected profits are decreasing in the reserve price, this imposes a cost of bidding high in the first round.

Furthermore, the cost imposed by a higher reserve price falls most heavily on bidders with lower ex ante expected values, for they are more likely to have a value that is less than the reserve price. This induces low-valued bidders to put in lower first-round bids than bidders with higher ex ante expected values, thereby creating a positive relation between initial-round bids and ex ante expected values. Choosing the highest initial-round bids then will ensure the seller of having a set of final-round bidders with the highest ex ante expected values—and to the extent that higher ex ante values lead to higher ex post values, this will maximize the final selling price.

B. An Illustrative Example

Before proceeding to a general model showing the equilibrium of the first-round auction, it will be useful to develop a very simple example of a two-stage auction that clearly shows the principles at work. The example will also highlight the importance of one assumption concerning the interaction between information and bidder’s valuations.

This example will have five potential bidders, with each bidder being characterized by their type. Type will take on one of two values, call them HI and LO. There will also be a state variable, which will also take on one of two values. Table 1 shows how type and state together determine a bidder’s valuation (their value for the company being sold).

We assume that bidders’ types are privately known and that the probability of any bidder being HI or LO is 1/2. The state variable is meant to cover the economic conditions of the company being sold; state will be unknown to the bidders ex ante but will be revealed by the seller in the second round of the auction through disclosure of proprietary information. Ex ante, bidders believe each state to be equally likely. Thus, HI bidders have an expected value of the company of 110, whereas expected value for LO type bidders is 105.

Note that this set-up fits the general assumptions described above. Value to a bidder is $V(x_i; z)$ where $x_i$ is type and $z$ is the state variable.

A very important aspect of these assumptions is that the ranking of bidder’s valuations depends upon the state. As already noted (see note 13), this is unusual in auction theory. It is also critical for equilibrium in the model. For both of these reasons, the rationale for the underlying assumptions deserves discussion.

Let me turn first to why the assumption is critical for the model’s equilibrium. This article argues that preliminary, nonbinding bids
can reveal useful information to the seller (the bidder’s types—HI or LO) if there is a cost to the bidders of dishonest reporting. The cost being considered works through the setting of the reserve price in the final round: High initial bids lead to higher reserve prices. For this mechanism to work, all bidders must see the possibility of positive expected profits in the final round; otherwise an increase in the reserve price could have no impact. Yet in received auction theory, the bidder of lowest type \textit{ex ante} knows they will always be the lowest-valued bidder and must therefore have zero expected profit.\footnote{16}

With the assumptions here, neither a HI or LO bidder knows \textit{ex ante} that they will be the low-valued bidder on disclosure of the state variable—ranking of the bidders’ valuations is state-dependent. Both types of bidders therefore have the potential for positive expected profit in the final-round auctions, and there is therefore the ability of a reserve price mechanism to reduce that expected profit and induce honest revelation through initial bids.

More important than just the preservation of an equilibrium, the assumption on state/valuation interaction is economically reasonable, and it has implications for efficiency in auctions.

On the assumption’s reasonableness, note that all that is being assumed is that the state variable affects bidders differentially. Both types view state-2 as being better than state-1, but HI-type bidders view state-1 more unfavorably and state-2 more favorably than LO-type bidders. Put differently, HI-types are more sensitive to the state variable. From a general point of view, different utility functions could give rise to these valuation differences. In the context of corporate auctions, the different types of bidders could reasonably lead to valuations that exhibit such differences. Suppose the state-variable corresponds to the fundamental financial viability of the selling company, and suppose a HI-type bidder is another industrial firm while a LO-type bidder is a leveraged buyout house specializing in corporate restructuring. An industrial buyer might well be more sensitive to underlying financial viability, having a very high valuation if the company is solid and a very low valuation if the company is not viable. Or, to take another example, suppose the state variable corresponds to an underlying resource or marketing capability of the selling company. State-1, for example, could be a poor state of new product development, while state-2 could be new products almost ready for market. If new products are very important for a HI-type bidder, they would naturally have a valuation that was more sensitive to that state variable.

Numerous other situations could be envisioned: the state-variable could correspond to the state of management talent, geographic distribution of marketing and distribution resources, capacity utilization of plants, etc. For all of these variables, it would seem reasonable, if not likely, for bidder’s valuations to respond differently.

Another view on the assumption being made further supports its economic rationale and its importance to economic efficiency. As pointed out, an implication of the interaction between state and value interaction is that the identity of the highest-valued bidder depends upon the state. Again, from a general utility/preference point of view this would not seem surprising: who is the highest-valued user of a resource cannot be ascertained without knowing the state (characteristics) of the resource itself. But in regard to economic efficiency, there is now a social value to information disclosure that is absent in received auction models (for an extreme example, consider the common-value model, where information has no allocative role to play since all bidders have the same valuation no matter the state). That information in auctions can be important to allocative efficiency seems intuitively appealing, but it cannot be unless the identity of the high-valued bidder depends upon the state.\footnote{17}

Proceeding then with analysis of a two-stage auction under those assumptions, we assume that in the initial round each bidder 17. As a further twist on this, it is easy to see that with assumptions that permit ranking of valuations to depend on the state, disclosure of information may reduce the seller’s expected price. In the example, and with just two bidders, one HI and one LO, expected price in a second-price auction is 105 without disclosure of state and is 100 with disclosure. Thus, a tension exists between a seller’s revenue and economic efficiency in relation to disclosure of information.
puts in a nonbinding bid of either 105 or 110. The actual value of the bids is immaterial, but we choose them to equal the two bidders’ *ex ante* expected values. Five initial bids will be received, and the seller will select the four highest to proceed into the second and final round. Ties will be broken randomly. Before the final round, the seller discloses proprietary information that reveals the state variable; in the final round bidders therefore know their valuation (still privately). The final-round auction will be an open auction (for ease of computing prices and profits). Most important, there will be a reserve price in the final round that depends on the initial bids: The reserve price will equal 80 if three or fewer initial bids come in at 110, but the reserve price will jump to 90 if four or more initial bids come in at 110.

With these auction rules, LO-type bidders will elect to put in a bid of 105 in the initial round and HI-type bidders will put in an initial bid of 110. Thus, the auction elicits honest revelation of bidders’ *ex ante* expected values. LO-types do not mimic HI-types because the expected increase in the reserve price from a high initial bid affects the LO-types too much. To confirm this equilibrium, we must check that honest revelation is optimal for both types. This verification entails assuming that all other bidders are following the proposed equilibrium strategy and seeing if unilateral defection pays for one bidder.

First consider a HI-type. A HI-type can earn profit in the final round only if he or she is the only HI-type. Assuming equilibrium behavior by the other bidders, this implies that the other four bidders must all be LO-types, and it also implies that the reserve price will be 80 in the final auction. By not honestly revealing in the initial round, this HI-type would only forfeit a certainty of entry into the final round in the one instance where he could make a profit, for if he dishonestly reported 105 in the initial round, he would be indistinguishable from the other four LO-types. And there is absolutely no benefit in other situations for an initial bid of 105: Although this would reduce the reserve price in some cases, there were already zero expected profits in those cases because of the presence of other HI-types. A HI-type is therefore strictly better off with an initial bid of 110.

Next consider a LO-type bidder. A LO-type, by bidding 110 instead of 105 in the initial round, may increase the likelihood that they get into the final-round auction. The only case, however, where a LO-type can make a profit is when they are the only LO-type in the final round. By bidding 110 in the initial round rather than 105, a LO-type can increase the likelihood that he or she gets into those final-round auctions with three HI-types (with two LO-types and three HI-types, a defecting LO-type assures entry in the final round.) The problem is that with four initial bids of 110 in these cases, the reserve price becomes 90, eliminating the possibility of a LO-type making a profit. Thus, there is only a net cost to bidding 110 instead of 105, and a LO-type will honestly report his *ex ante* valuation in the initial round. (There are other cases where defection by a LO-type increases their likelihood of entry into the final round, but with other LO-types present in the final round, there is no profit in these cases.)

In this example, then, the seller can select four out of five bidders to receive additional proprietary information and participate in a final round auction. The two-stage process limits the number of bidders in the final round so as to reduce potential for value destruction through disclosure of competitive information, and it ensures that the higher-valued bidders are selected—a HI type is always selected over a LO type.

19. An important characteristic of the example is that LO-types win against HI-types in State 1, which is the low-value state for both types of bidders. Because the reserve price is binding only in the low-value state, this causes the LO-types to put in the lower initial-round bids.

20. The last question would be whether, in this example, the seller is indeed better off with the two-stage procedure than with just selling without disclosure but with all five bidders. The first thing to note here is if there is a legal cost to nondisclosure, then the two-stage procedure could definitely be better. Without a legal cost to nondisclosure, the question comes down to any price-enhancing effect of disclosure and any benefit to selection based on initial bids. In this example, there is a price-enhancing effect of disclosure; in the absence of a reserve price, the sellers expected revenue is higher with four bidders and disclosure than with five bidders and no disclosure. However, the reserve price affects this, for
C. A More General Formulation

Let me turn then to a more general characterization of this process of screening bidders via an initial round of nonbinding initial bids. The model will be set up as an honest revelation game; we will determine the actions that the seller must take to elicit as initial bids the true initial expected values from the bidders. There will be \(N\) potential bidders, each of whom has a valuation function as described earlier. The seller asks for initial bids, each of whom has a valuation function to be released in final round. Derivative of equation (7) with respect to price in the final round and the reserve occurs in state 1 with at least four HI bidders, so the seller does not sell the item (this could occur in state 1 with at least four HI bidders, so the reserve price is 0.0). The seller is better off with the two-stage procedure (versus nondisclosure but five bidders) because he got a high signal for the unknown state variable. That is, in the model, all bidders start with common information on \(z\). In a more general formulation, bidders could start with private information on \(z\); this would allow for the interesting possibility of selecting bidders through initial bids who are just overestimating value—the classic winner’s curse.

### (6) \( r = h(b_1) + \cdots + h(b_N) \)

where \(b_i\) is the \(i\)-th bidder’s initial bid. The seller also commits to an entry policy that specifies a relationship between a bidder’s initial bid and the likelihood of that bidder being admitted to the final round. This relationship will be described by the function \(p(b)\), where \(p(b)\) is the probability of final-round entry given an initial bid of \(b\). It is assumed that \(p(b)\) is increasing in \(b\).

Initial round bids will be chosen by bidders to maximize

### (7) \( \text{Bidder } i \text{'s expected profit} = p(b_i)(E(\pi_i|EV_i, b_i) + d) \)

where \(EV_i\) is bidder \(i\)’s ex ante expected value, itself a function of the bidder’s type \(x_i\); \(E(\pi_i|EV_i, b_i)\) is bidder \(i\)’s expected profit in the final round conditional on his type and initial bid; and \(d\) is expected value of information to bidder released in final round.

Equation (7) is a compressed version of the typical bidder’s overall expected profit. It is important to note that \(E(\pi_i)\) is itself a function of \(b_i\), for \(b_i\) affects the expected reserve price in the final round and the reserve price affects expected profit. Taking the first derivative of equation (7) with respect to \(b_i\) and setting to zero, we have

### (8) \( (dp(b_i))/(db_i)(E(\pi_i|EV_i, b_i) + d) + p(b_i)(dE(\pi_i|EV_i, b_i))/(db_i) = 0 \)

or

### (9) \( (dE(\pi_i|EV_i, b_i))/(db_i) = (-dp(b_i))/(db_i)(E(\pi_i|EV_i, b_i) + d))/(p(b_i)) \)

Equation (8) has a simple interpretation. The first term represents the marginal benefit of raising the initial bid: A higher bid increases the probability of receiving \((E(\pi_i|EV_i, b_i) + d)\). The second term of (8) depicts the marginal cost of raising the initial bid: \(p(b_i)\) multiplied by the reduction in final-round expected profit due to the expected higher reserve price. Note that the marginal cost of bidding higher will be decreasing in \(EV_i\). For higher-value bidders, the impact of a higher reserve price is lower. Thus, bidders with higher \(EV_i\) will choose to put in higher initial bids because the marginal cost of higher bids is lower.21

To elicit honest revelation, that is, \(b_i = EV_i\); the seller must set \(p(b)\) and \(r = h(b_1) + \cdots + h(b_N)\) such that equation (9) holds for all values of \(EV_i\) when bidders set \(b_i = EV_i\). If we make the substitution \(b_i = EV_i\) in (9), and assume for now an arbitrary \(p(b)\) function, then equation (9) becomes a first-order differential equation that, when solved, yields the \(h(b)\) function that elicits honest revelation. This can be seen by noting that Leibniz’s Rule allows us to write

### (10) \( (dE(\pi_i|EV_i, b_i))/(db_i) = E[(d\pi_i(EV_i, b_i))/(dr)] \)

\[= E[(d\pi_i(EV_i, b_i))/(dr)((dr)/(db_i))] \]

where the last step is made possible from the definition \(r = h(b_1) + \cdots + h(b_N)\), so that

21. Note that with the model as formulated, there is no possibility of a bidder having a high \(EV\), simply because he got a high signal for the unknown state variable. That is, in the model, all bidders start with common information on \(z\).
$dr/db_i = dh/db_i$, and this is independent of other bids.

Thus, we can rewrite equation (9) (with the honest revelation condition $b_i = EV_i$) as

\[
(11) \frac{dh(b_i = EV_i)}{db_i} = \left[\frac{d\bar{\pi}}{d\bar{r}} \frac{E(V_i | \bar{r}, b_i = EV_i)}{E(V_i)} + \frac{d\bar{r}}{db_i} \frac{E(V_i | b_i = EV_i)}{E(V_i)} + \frac{d\bar{r}}{db_i} \right] \\
\left[\frac{p(b_i = EV_i)}{E(V_i | b_i = EV_i)} \frac{E(V_i | b_i = EV_i)}{E(V_i)} \right]
\]

Equation (11), a first-order differential equation, is the main incentive-compatibility constraint for the direct revelation game for the first-round auction. For a given $p(b)$, equation (11) can be solved to yield the $h(b)$ function, which will induce each bidder to report his true prior expected-value, $EV_i$, as his first-round bid. Note that $dp/db$ is assumed to be positive and $d\bar{\pi}/dr$ must be negative, hence $dh/db$ must be positive: The reserve price increases with the initial bids. As is often true in auction theory, it is not possible to analytically solve (11) for the general form of the $h(b)$ function. However, as the example illustrates, reserve price functions consistent with incentive compatibility can be found for specific cases.

One important caveat remains to be explored, however, that will further develop the incentive-compatibility constraints for this model. I have implicitly assumed that all bidders find an interior optimum according to equation (11). This may not always be the case. Suppose a bidder considered raising his initial bid beyond $b_i = EV_i$. Doing so increases the expected reserve price and reduces expected final-round profits, $E(\pi_i | EV_i, b_i)$. There may come a point where a bidder’s expected final-round profit goes to zero as higher initial bids are contemplated. If this occurs, then higher initial bids serve to increase overall expected profit, for they simply increase the chance of getting the competitive information value, $d$. In such a case, the bidder would have to compare overall expected profit with initial bid $b_i = \bar{b}$, where $\bar{b}$ is the highest possible initial bid, in order to determine the overall best bid. (Overall expected profit in the latter case will be just $p(\bar{b})d$.)

Figure 1 can be used to develop the condition that ensures that the corner solution $b_i = \bar{b}$ does not yield greater overall profit to any bidder than $b_i = EV_i$. This analysis also tells us something about how much the seller can differentiate between bidders in regard to their entry into the final round.

When bidding $b_i = EV_i$, an arbitrary bidder has overall expected profit $p(b_i = EV_i)(E(\pi_i | EV_i, b_i = EV_i) + d)$, denoted as point B in Figure 1. Let us suppose for ease of exposition that $p(b)$ is linear. Then in considering higher initial bids, this bidder finds that at some bid $b^*$, his final round expected profit, $E(\pi_i | b^*)$ becomes zero (because of the implied increase in reserve price); after this point, his overall expected profit increases linearly with $b_i$. At the highest feasible initial bid, his overall expected profit would be $p(\bar{b})d$, indicated by point C in the diagram. For the seller to elicit honest revelation, we must have the following inequality hold for all possible $EV_i$ in addition to the main incentive-compatibility constraint (equation 11):

\[
(12) \quad p(b_i = EV_i)(E(\pi_i | EV_i, b_i = EV_i) + d) \\
\geq p(\bar{b})d
\]

Equation (12) illustrates once again the importance of all bidders having positive expected profits in the final-round auction, when they honestly bid their initial expected value. If some bidders did not have positive

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22. In Hansen (1988) for example, comparison of different auction rules is accomplished entirely through comparison of the differential equations that define equilibrium bidding strategies. No general solution of the differential equations is required and, indeed, would add little to the understanding of the model.

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**FIGURE 1**

Interior Optimum Initial Bid
expected profits, then (12) could not hold and this bidder would find it most profitable to put in an initial bid equal to \( \bar{b} \) just to ensure getting into the final round to capture the value of the information to be released in that round.

Equation (12) can also be viewed as a restriction on the \( p(b) \) function, or more intuitively, on how discriminating the seller can be with his screening policy. Consider a bidder with the lowest possible \( EV_i \), who in equilibrium must submit an initial bid equal to this minimum expected value and therefore have the lowest probability of entry into the final round. For this initial bid to indeed be the global optimum for the bidder, equation (12) must hold. To make (12) hold, the seller may have to flatten the \( p(b) \) function, that is, make the difference between \( p(b) \) and \( \bar{p}(b) \) smaller. Such a flattening will eliminate the incentive for this bidder to deviate from honest revelation. However, doing so also reduces the discrimination inherent in the initial round of bids, for a low-valued bidder becomes relatively more likely to gain admittance to the final round.

V. DISCUSSION

This article does not claim that the observed set of auction practices is the single best mechanism for selling a company, only that the set of practices yield a net selling price in excess of what an unrestricted auction (in terms of bidder participation) would yield if the competitive information cost is sufficiently high. Although the practices seem to be reasonable in these terms, they should be compared to at least one other set of practices that might yield similar if not improved results: Instead of screening bidders via initial round bidding that produces no revenue by itself, why should the seller not ask bidders to submit cash bids for the right to see the second round of information and get into the final bidding round? The seller could then select only those bidders who bid above a certain amount, thereby accomplishing a reduction in the set of bidders; the seller would also receive revenues directly from this initial round auction.

There are several possible explanations for why entry into the final round is determined via a preliminary round of bidding rather than via entry fees. One likely explanation has to do with incentive-compatibility on the part of the selling company. With screening accomplished via initial bids, the seller gets no revenue unless he carries through with the final auction. If screening is accomplished via entry fees, the selling company would receive significant revenues even before selling the company. There is certainly the possibility that some companies would entertain the option of beginning an auction process only to collect entry fees. Another problem with entry fees relates to the optimal number of bidders in the final round. If entry fees are used to get the same number of final bidders as nonbinding bids, then there will necessarily be less overall expected profit for the bidders—with the same number of bidders in the final round, profits in that stage must be the same, but entry fees have already been paid. This decrease in expected profits for bidders will have to impact some decisions made by bidders on an ex ante basis. A likely area of impact is how much effort will be put into evaluation of the company in the initial round. If bidders put less resources into initial evaluations, then screening via entry fees will be less efficient at selecting final-round bidders and the selling company may be worse off overall.

Returning to another issue mentioned previously, corporate auctions are sometimes short-circuited by one bidder offering a preemptive bid. Generally, these bids will take this form: A bidder will indicate a range of prices that they are willing to pay for the selling company, subject only to review of certain information. As quid pro quo, the selling company must then negotiate exclusively with the preempting bidder; in particular, the selling company must not disclose any more information to other bidders.

This last point is what makes dealing with only one bidder potentially mutually beneficial: the competitive information effect can be avoided by disclosing the information to only one bidder. If the cost of disclosure is high, the seller should weigh the price-enhancing effects of an auction against the value destruction due to disclosure. Having

23. One must note that problems in commitment plague almost any auction rule. The point here is just that entry fees would create one more level to the selling company’s commitment.
only one bidder may well be optimal, and it could be that it is one of the bidders, through a preemptive bid, who forces the seller to consider the trade-off.

Several outstanding questions concerning preemptive bids remain, however. If the seller agrees to disclose to only one bidder and negotiate exclusively with that bidder, what keeps that bidder from behaving opportunistically ex post (offering a final price outside the lower range of the preemptive bid); how should the seller choose which bidder if any to negotiate with exclusively; and should the selling company move to a more formal "preemptive" auction, asking bidders to submit nonbinding bids for the right to negotiate exclusively? As preemptive bids certainly do occur, the general topic would be a rich one for further research.

REFERENCES


24. As a simple example, suppose with two bidders in the final auction the net price would be $0.70 (think of this as a gross expected price of $1 reduced by a competitive information effect of $0.30). If by negotiating with only one bidder the seller could avoid the competitive information effect and receive (net) anything greater than $0.70, then negotiating with one bidder would be optimal.