Single-Parameter Ascending Auctions

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Ausubel and Milgrom observed that the Vickrey auction, while elegant in theory, is not prevalent in practice. We discuss some advantages of open-outcry, ascending (*a.k.a.* English) auctions over sealed-bid auctions. We then characterize ascending auctions in general, and describe several specific instances.

"The Lovely by Lonely Vickrey Auction" is the title of a paper by two prominent economists, Ausubel and Milgrom,[1] who note that the Vickrey auction is indeed lovely in theory but rarely used in practice.[2] On the contrary, most auction houses sell their wares via an open-outcry, ascending (*a.k.a.* English) auction. Why is this?

[1] Lawrence M. Ausubel and Paul Milgrom. The Lovely but Lonely Vickrey Auction. Discussion Papers 03-036, Stanford Institute for Economic Policy Research, August 2004

[2] A notable exception were stamp auctions during the 19th century, in which bids were sent via post to auctioneers in sealed envelopes.

David Lucking-Reiley. Vickrey auctions in practice: From nineteenth-century philately to twenty-first-century e-commerce. *Journal of Economic Perspectives*, 14(3):183–192, September 2000

One likely reason is the fact that bidders rarely have a precise number in mind that articulates what a good might be worth to them. Indeed, for companies bidding on contracts of some sort, it may be computationally intensive to compute such a number. On the other hand, even without knowledge of a precise number, it may still be possible to answer (so-called demand) queries of the form, "Are you willing to pay x for a good?". Hence, such auctions may be less challenging and hence more inviting to bidders; and remember, attracting bidders is essential to running a profitable auction.

Second, and arguably even more powerful, bidders tend to engage in bidding wars during English auctions. Even if bidders knew their precise value for the good at hand, they still might bid beyond that value. This behavior is rooted in our psychology; in particular, "losses loom larger than gains".[3] Applied to auctions, this maxim suggests that a bidder can become attached to a good while they are winning that good, and might therefore be willing to bid higher than his value to hold on to his tentative winnings. Furthermore, some might associate shame with losing, and pride with winning, especially when auction results are made public.

[3] Amos Tversky and Daniel Kahneman. Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics*, 106(4):1039–1061, 1991

Remark. It has been said that "the only thing worse than losing an auction is winning." Winning bidders often regret having won an auction, because upon winning, it is revealed to them that their bid was greater than everyone else's bid, and hence everyone else's value (assuming no overbidding). If they are unsure of their own value, even if it is not definitively greater than their bid, then they may experience **buyer's remorse**, a feeling of post-purchase regret, stemming, for example, from the fact that other alternatives are no longer available, because of a reduction in puchasing power.

Finally, if there are any doubts about an auctioneer's integrity, an English auction is preferable to a sealed-bid auction. Since they are more transparent, bidders can trust the outcome of an open-outcry mechanism much more readily than that of a sealed-bid mechanism. Although auctioneers can, and sometimes do, hire shill (i.e., fake) bidders to artificially raise the price of a good, it is riskier to do so in an open-outcry than in a sealed-bid environment, as these shill bidders would be on display for all to witness.

In sum, the following three phenomena help explain why English auctions are more common than Vickrey auctions:

1. greater transparency
2. potentially more revenue, because bidding wars can arise, and simpler auction formats are more attractive to bidders
3. less information revelation of bidders' values, to other bidders and the auctioneer alike

Since the Vickrey auction is rarely used in practice, an alternative model of auctions is needed. In search of such an alternative, we now turn our attention to indirect mechanisms, specifically ascending auctions, in which prices are adjusted over time.

For our purposes, an ascending auction is an iterative algorithm that operates as follows:

- The auction proceeds in discrete rounds, $t \in \{0, \ldots, \}$.
- At each round t, the auction maintains a **state** $\mathbf{s}^t = (\mathbf{x}^t, \mathbf{p}^t)$, consisting of the current (tentative) allocation $\mathbf{x}^t$ and price vector $\mathbf{p}^t$.
- An **allocation** $\mathbf{x}^t$ at round t is an assignment of goods to bidders.
- **Prices** are per good (as opposed to per bundle[4]), and can only increase as the auction proceeds (i.e., $\mathbf{p}^{t+1} \geq \mathbf{p}^t$, for all $t \in \{0, \ldots, \}$). The amount by which the price increases at round t is called the **price increment**, and it is denoted ϵ^t. So, if the price of good j increases during round $t+1$, then $p_j^{t+1} = p_j^t + \epsilon^t$. In general, the price increment need not be constant across rounds.
- Given the current state, queries can take the form of **demand queries**, in which bidders are asked what bundle of goods they prefer, or **value queries** (as in sealed-bid auctions), in which bidders are asked their value(s) for a bundle(s) of goods.
- The final allocation and prices may be any (even randomized) function of the auction's history (i.e., the sequence of states).
- Initially, the good(s) is (are) allocated to the seller, while prices are initialized at reserve values, often zero (e.g., $\mathbf{p}^0 = \mathbf{0}$).

[4] David C. Parkes. iBundle: An efficient ascending price bundle auction. In *Proceedings of the 1st ACM Conference on Electronic Commerce*, pages 148–157, New York, NY, USA, 1999. Association for Computing Machinery

An ascending auction is further specified by a set of rules:

- **Allocation and pricing (i.e., payment) rules** determine the next state (i.e., allocation and price vector), given the bidders' replies to their queries. An example allocation rule might be to allocate each good to a bidder that demands it. An example pricing rule might be to increase prices on all overdemanded goods (i.e., goods for which demand exceeds supply).
- The auction's **termination rule** determines when the auction ends, which in the case of a single good auction is when prices are high enough that no good is overdemanded.
- An **information revelation policy** determines what part of the state is revealed to each bidder. For example, the current prices might be revealed to all bidders, while the tentative winners might be revealed only to the tentative winners themselves.
- There may be some additional **activity rules**, such as a bidder cannot exit the auction and then re-enter again later. The auction may also terminate if none of the bidders' replies to their queries are valid, meaning they do not satisfy the activity rules.
- Although unlikely in auctions with value queries, ties are common in auctions with demand queries, especially when the price increment is large. Thus, all auctions need a **tie-breaking rule**.

We depict the rules for three ascending auctions for a single good in the tables below: an English auction, an eBay auction, and a Japanese auction (a demand query version of the English auction with an activity rule that forbids bidders from coming and going).[5]

The eBay auction design is modelled after the English auction. Both employ value queries, and under ideal conditions (i.e., limited strategizing by bidders), yield something very close to the outcome of a Vickrey auction, namely, an efficient allocation, and a payment near the second-highest value. The primary difference between them is the termination rule. The eBay auction ends at a fixed time, while the English auction continues until quiescence.[6]

We do not elaborate on how the price increment ϵ^t at round t is determined, as it may be at the discretion of a seasoned auctioneer (i.e., heuristic!). We do note, however, that Japanese auctions are also known as clock auctions, as the incremental price increases are usually constant, and thus analogous to a ticking clock.

The Dutch sell flowers in descending auctions. The initial price in an ascending auction is low (typically, zero), while the initial price in a descending auction is very high—a price no buyer is willing to pay.

[5] We also contrast these designs with two descending auctions, the second of which is reverse: i.e., run by a buyer, with suppliers bidding to produce goods, rather than run by a seller, with buyers bidding to consume goods.

[6] An alternative auction design developed by Amazon mimicked the English auction even more closely, as it, too, proceeded until quiescence. You will explore this design in your homework.

Rules	English Auction
Information Revelation	All (even bidding) information is public
Value Queries	"Name your bid above \$x?", where \$x $\geq p^t + \epsilon^t$?
	(The parameter ϵ^t is set by the auctioneer)
Allocation Rule	A highest bidder
Pricing Rule	The highest bid
Activity Rule	None
Termination Rule	At most one reply
Tie-breaking	In favor of earlier bidders

Rules	eBay Auction
Information Revelation	The current price and the tentative winner are public
	Bids are private
Value Queries	"What is your value?"
Allocation Rule	A highest bidder
Pricing Rule	The second-highest bid plus ϵ^t
Activity Rule	None (so bids can oscillate up and down)
Termination Rule	At a set time, or after a set number of rounds
Tie-breaking	In favor of earlier bidders

Rules	Japanese Auction
Information Revelation	All (even bidding) information is public
Demand Queries	Raise your hand if \$x is acceptable, where \$x = $p^t + \epsilon^t$
	(The parameter ϵ^t is often a constant clock tick)
Allocation Rule	A random bidder with their hand up
	(If no bidders have their hands up, it is a tie)
Pricing Rule	The broadcast price, \$x
Activity Rule	You gotta be in it to win it
	(Once a bidder's hand goes down, they forfeit)
Termination Rule	At most one hand up
Tie-breaking	Uniform at random among last remaining bidders

Rules	Dutch Auction
Information Revelation	Price information is public
	Once any value information is revealed, the auction ends
Demand Queries	Put your hand up as soon as \$x is acceptable, where \$x = $p^t - \epsilon$
	(The parameter ϵ is often a constant clock tick)
Allocation Rule	A random bidder with their hand up
Pricing Rule	The broadcast price, \$x
Activity Rule	None
Termination Rule	At least one hand up

A A Descending, Reverse Auction

In a reverse auction, there is one buyer (the auctioneer) and many sellers. In a descending, reverse auction, the buyer initializes the price very high—at a price at least one seller is sure to accept—and gradually decreases it, until at most one bidder (i.e., seller) remains.

Rules	Reverse (FCC Incentive) Auction
Information Revelation	All (even bidding) information is public
Demand Queries	Hold your hands up if \$x is acceptable, where \$x = $p^t - \epsilon$
	(The parameter ϵ is often a constant clock tick)
Allocation Rule	A random bidder with their hand up
	(If no bidders have their hands up, it is a tie)
Pricing Rule	The broadcast price, \$x
Activity Rule	Once a bidder's hand goes down, they forfeit
Termination Rule	At most one hand up

It is also possible to imagine an ascending, reverse auction, where the price is initialized at a very low price at which no seller is willing to transact, so no sellers hands are raised. And then the price is incremented, until at least one seller raises their hand.

References

[1] Lawrence M. Ausubel and Paul Milgrom. The Lovely but Lonely Vickrey Auction. Discussion Papers 03-036, Stanford Institute for Economic Policy Research, August 2004.

[2] David Lucking-Reiley. Vickrey auctions in practice: From nineteenth-century philately to twenty-first-century e-commerce. *Journal of Economic Perspectives*, 14(3):183–192, September 2000.

[3] David C. Parkes. iBundle: An efficient ascending price bundle auction. In *Proceedings of the 1st ACM Conference on Electronic Commerce*, pages 148–157, New York, NY, USA, 1999. Association for Computing Machinery.

[4] Amos Tversky and Daniel Kahneman. Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics*, 106(4):1039–1061, 1991.