Bidding Strategy & Auction Design

- Auctions as mechanisms for selling goods & services date back to ancient Greece and Rome
- A formal economic analysis of auctions began 1961
- Economists have tried to understand auctions from the standpoint of buyers (bidding strategy) and sellers (auction design)
- "Auctions" are a blanket term for any transaction where the final price of an object is arrived at by competitive bidding
- Auctions have several characteristics of interest, most crucial is asymmetric information between seller and buyer

Types Of Auctions

Auction Rules

The seller generally determines the rules of the auction without knowledge of the bidders' willingness-to-pay. The four major categories of auctions can be broken down into two groups.

1. **Open outcry** - Bidders call out or otherwise make their bids in public

2. **Sealed bid** - Bidding is done privately and bidders cannot observe any of the bids made by others.

Open Outcry Auctions

A generic google search of "auctioneer" gives you about fifty guys wearing Stetsons.

- **Ascending**, or **English auction** - a conventional auctioneer starts at a low price and calls out successively higher prices for an item, waiting to receive a bid at each price before going up
- **Descending**, or **Dutch auction** - the auctioneer starts at an extremely high price and calls out successively lower prices until one of the bidders accepts the price and makes a bid

Sealed Bid Auctions

Within sealed-bid auctions there are two rules for determining the price paid by the high bidder:

- In a **first-price**, sealed-bid auction, the highest bidder wins the item and pays a price equal to their bid
- In a **second-price**, sealed-bid auction, the highest bidder wins the auction but pays the price of the second highest bidder

A second-price auction is useful for eliciting *truthful* bidding; such auctions are termed **Vickrey auctions**.

Auction Environments

There are a number of ways in which bidders may value an item up for auction. The main distinction is based on the difference between *common-* and *private-value* objects.

- In a **common-value**, or **objective-value**, auction the value of the object is the same for all bidders, but each bidder generally knows an imprecise estimate of it. This leads to an environment in which bids are *correlated* with each other.

- In a **private-value**, or **subjective-value**, auction bidders each determine their own value for an object.

How much would you value this work of art at?

The Winner's Curse

The **winner's curse** occurs often in common value auctions where the winner of the auction pays more for an object than it is worth.

Suppose you are a corporate raider bidding for Targetco. Your experts estimate the value of the company to be between 0 and $10B with all values equally likely. Current management knows the precise figure.

You believe that if you own Targetco it will be worth 50% than what it's worth today. Given your own knowledge, you believe Targetco to be worth, on average $5B, so $7.5B dollars under your management.

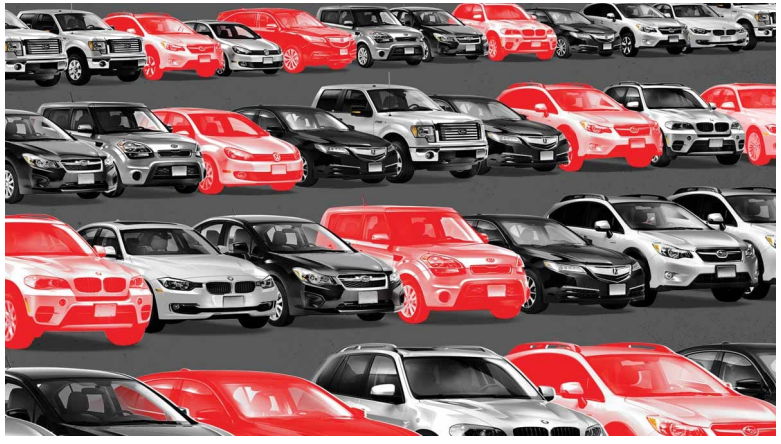
The Winner's Curse

You will view any bid b between \$5B and \$7.5B as profitable.

- If Targetco is worth more to current management than your bid, then it will be rejected. You only receive the company if its true worth is toward the lower end of the range.
- Your bid is accepted if the company is worth between 0 and b. On average, you can accept the company to be worth $b/2$ if your bid is accepted.
- The company is, therefore worth to you $(1.5)(b/2) = 0.75$. Because this is always less than b, you would win the takeover battle only when it's not worth winning.

Akerlof & The Market For Lemons

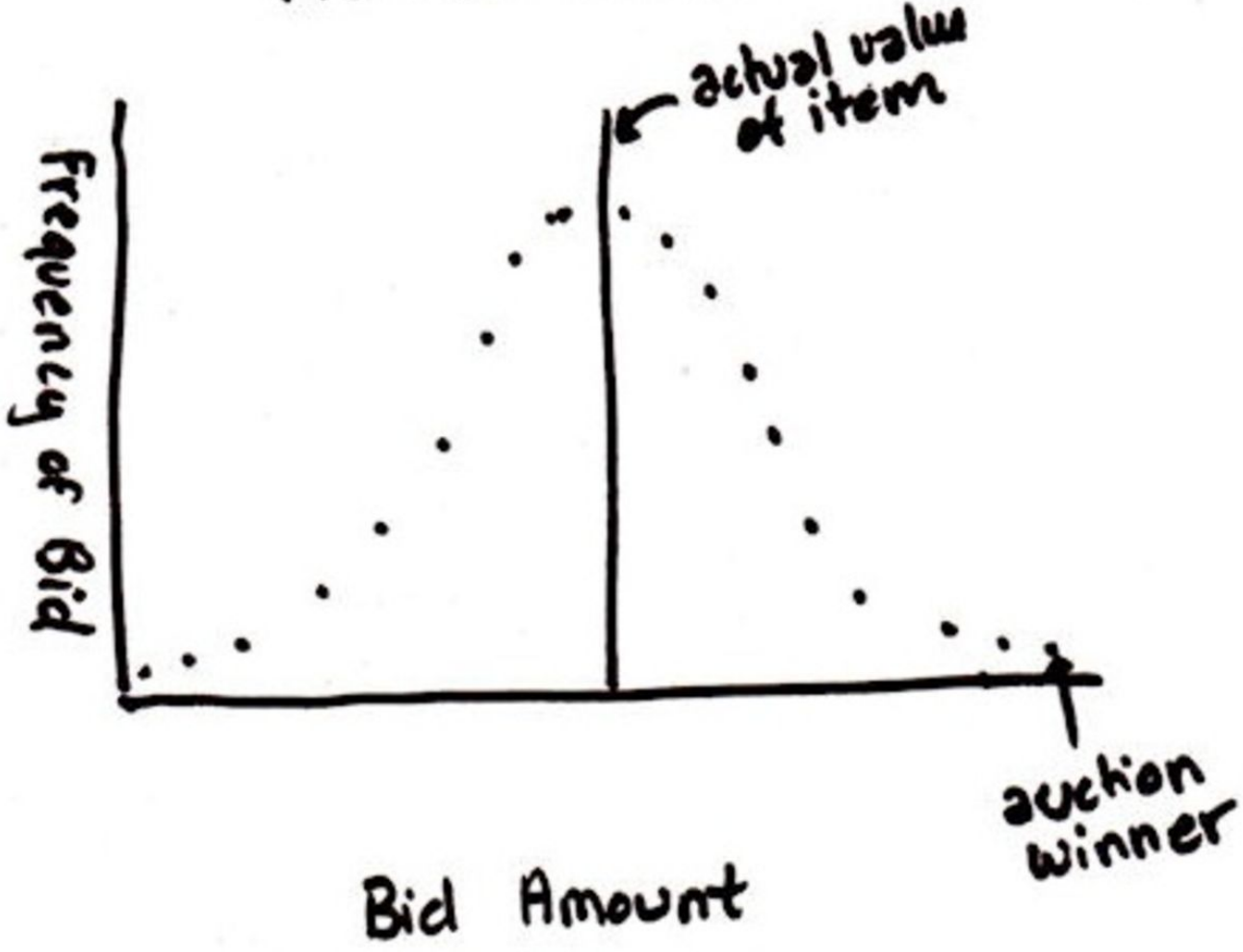
Let's make it even simpler. Suppose there are two types of cars good (H) and bad (L) which are equally distributed.



Which ones are the lemons?

- Buyers unaware of the true type will be willing to pay $(1/2)H + (1/2)L < H$
- Only sellers of type L are willing to transact at this price; thus, we have a market of lemons

The Winner's Curse, in Picture Form:



Bidding Strategies - English Auction

Suppose you are interested in purchasing a particular lot of Chateau Margaux 1952 Bordeaux wine.

In the English auction your strategy is straightforward given that you know your valuation V. Start at any step in the bidding process.

- If the last bid made by a rival r is at or above V, you don't bid any higher. ($r - V \leq 0,$ No bueno)
- If the last bid is below V, bid $b = r +$ "smallest increment allowed". If the bidding ends there, your payoff is $V - b \geq 0$.
- If bidding continues repeat the process until r (the new last bid of r) $= V$ and then cease bidding

The winning valuation should get close to the second-highest valuation

First-Price, Sealed-Bid, And Dutch Auctions: The Incentive To Shade

Suppose you believe you are a very high value bidder. You need to decide to bid V or something other than V.

You should not bid V and guarantee yourself a 0 payoff. Your optimal bid strategy entails **shading** your bid.

Abstracting from the calculus, the optimal shading involves balancing the loss in probability from obtaining the item and the increased payoff from winning.

Dutch auctions converge to first-price, sealed-bid auctions with the same strategy.

Second-Price Sealed-Bid Auctions: Vickrey's Truth Serum

Here, you do not improve your profit by shading. This revelation is good for the sellers.

Vickrey showed that if rules were modified to make the auction similar to a public outcry auction, bidders would bid their truthful private value. Here every bidder has a ***dominant bidding strategy***.

The gain in information does come at the cost of some foregone profit for the seller.

- $b > V > r \rightarrow \text{payoff} = V - r > 0$
- $r > b > V \rightarrow \text{payoff} = 0$
- $b > r > V \rightarrow \text{payoff} = V - r < 0$

Bidding more than V is weakly dominated by V

- $V > b > r \rightarrow \text{payoff} = V - r > 0$
- $V > r > b \rightarrow \text{payoff} = 0$
- $r > V > b \rightarrow \text{payoff} = 0$

Bidding less than V is weakly dominated by V

All-Pay Auctions

All-pay auctions may seem like an odd convention at first glance but they often happen. Consider in political contests, all candidates spend time and money and the losers do not receive a refund for these efforts. So, what is the optimal strategy in an all-pay auction?

- Because a losing bid is wasted money, participants often bid very aggressively, but this clearly cannot be an equilibrium
- Conversely consider not bidding at all. This, too, cannot be an equilibrium strategy
- The optimal strategy must lie in mixed strategies

All-Pay Auctions

Consider an auction with n bidders and suppose the common-value object is worth 1, and bids are restricted $x \in [0, 1]$.

- The equilibrium strategy can be expressed as $P(x)$, the probability that your bid takes on a value less than x, e.g. $P(1/2) = 0.25$ would mean that your equilibrium strategy entailed bids below $1/2$ one-quarter of the time
- Each bidder must be indifferent about the choice of any particular value of x. The expected payoff from bidding x is $[P(x)]^{n-1} \times 1 - x$, and you want to be indifferent between that and bidding nothing at all
- So we get

$$[P(x)]^{n-1} - x = 0 \Rightarrow [P(x)]^{n-1} = x \Rightarrow \mathbf{P(x) = x^{1/(n-1)}}$$

All-Pay Auctions

Let's make this concrete. Suppose $n = 2$, then $P(x) = x$, so your equilibrium mixed strategy should be random and uniformly distributed between 0 and 1.

$\rightarrow n = 3 \Rightarrow P(x) = \sqrt{x}$ when $x = 1/4$, $P(x) = 1/2$
$\rightarrow n = 4 \Rightarrow P(x) = x^{1/3}$
$\dots$
$\rightarrow n = 10 \Rightarrow P(x) = x^{1/9}$ when $x = 1/512$, $P(x) = 1/2$

As n becomes larger the equilibrium bids become smaller. (The precise bid is actually $1/n$.)

How To Sell At Auction

Auctions are sequential-move games where the seller moves first in choosing the rules. What can the seller do to maximize their profit?

- In order to make sure the item does not sell for less than the seller places on the object, sellers set a **reserve price** for auctioned objects; they reserve the right to withdraw from sale the object if no bid is higher than the reserve price
- Sellers could use Vickrey's scheme to elicit truthful preferences
- The best scheme ultimately depends on bidders' apetite for risk and bidders' beliefs about the value of the object for sale

Risk-Neutral Bidders & Independent Estimates

- Risk-neutral people care only about the expected monetary value of their outcomes
- Independence in estimates means that a bidder is not influenced by the estimates of other bidders
- If these conditions hold, sellers can expect the same average revenue (over a large number of trials) from any of the four primary types of auction
- Experimental and field evidence show lower prices in Dutch auctions vs. first-price sealed bid (though Internet auctions show the opposite) & overbidding in second-price sealed bid vs English

Risk-Averse Bidders

Risk-averse bidders want to win if possible without ever overbidding

- Bidders are going to shade down their bid less than if they were risky or risk neutral
- This leads to bids being higher in first-price auctions versus second-price ones

Correlated Estimates

Suppose that in determining their own valuations of an object, bidders are influenced by estimates of other bidders. e.g. suppose someone receives a negative report on the profit potential on a specific tract of land.

With positively correlated bidder beliefs, the seller should avoid first-price auctions and use a second-price structure. Similarly, the seller should prefer English over Dutch in this event.

Depending on the number of bidders and their enthusiasm, the seller should use a certain structure.

Some Added Twists To Consider - Multiple Objects

If bidders value groups or whole packages of items higher than the sum of their values for the component items, the choice of auctioning the lots separately or together makes a big difference to bidding strategies as well as to outcomes.

Consider a real estate developer named Redd who wants to acquire 4 acres of land.

- The mayor of Cottage wants to auction off 4 acres of land as quarter-acre blocks successively starting with the corners.

- The mayor of Mansion wants to auction off 4 acres of land entirely then by 2-acre lots…if no bids exceed the reserve price

  It's immediately clear that Redd would have an easier time acquiring the land in Mansion. Cottage could amend its rules to obtain a better outcome.

Defeating The System

The best-laid plans for a profitable auction can almost always be defeated by a clever bidder or, more often, group of bidders.

- Bidders can collude and extract additional surplus even in a Vickrey auction. This bolsters the case for reserve price on the part of sellers
- In first-price sealed bid auction, bidders are engaging in a prisoners' dilemma so may limit colluding behavior
- Sellers also engage in **shilling** artificially inflating prices by submitting false bids

Information Disclosure

When the seller has private information that might affect the bidders' valuations, it is often best to reveal the information.

- If the bidders know the seller has private info, failure to disclose is seen unfavorably
- When the seller has private info on a common-value object, disclosing that info will encourage bidders to bid more closely to their actual value

Online Auctions

Internet auctions have existed for about two decades now. They sell a tremendous amount of goods using various auction rules.

- Many sites use English auctions or a similar format called **proxy bidding** where a bidder enters their reservation price and the rest is automated
- Sites rarely use Dutch auctions. Some offer auctions *called* Dutch along with a similar type, **Yankeee auction**, where multiple identical units are offered
- The Internet allows for additional creativity as well. e.g. the *lowest unmatched bid* auction was previously unheard of

The biggest difference between live and internet auctions is how they end. Internet auctions generally have some time-limit aspect. Internet auctions are waning as well.

Summary

- Auctions can be classified as open outcry or sealed bid as well as first price or second price
- Objects for bid may have a common value or many private values
- In common-value auctions winners often only win when they overbid, falling prey to the winner's curse; in private-value auctions, optimal bidding often involves shading your bid
- Vickrey showed that you can elicit bidders' true preferences using a second-price auction
- Sellers want to choose an auction method yielding them the highest profit but must be cognizant of bidders' risk aversion and correlated valuations