LECTURE 10

AUCTIONS

What is an auction?

- Economic markets:
  - Many buyers & many sellers ***traditional markets***
  - One buyer & one seller ***bargaining***
  - Many buyers & one seller ***auctions***

- A public sale in which property or merchandise are sold to the highest bidder.

  - IPOs
  - Emissions permits
  - Oil drilling lease
  - Mineral rights
  - Treasury bills
  - Wine
  - Art
  - Flowers
  - Fish
  - Electric power


Pine Ridge
Vineyards
NAPA VALLEY
157
177
8
194
234
99
165
156

Terminology and auction types

- Terminology:
  - Bids B,
  - Bidder's valuation V,
  - Next-highest rival bid R
  - Small in/decrement in current highest bid: *e*
- Classifying auctions:
  - Open or sealed
  - Multiple or single bids
  - Ascending or descending
  - First-price or second-price
  - Private or common-value

Sources of uncertainty

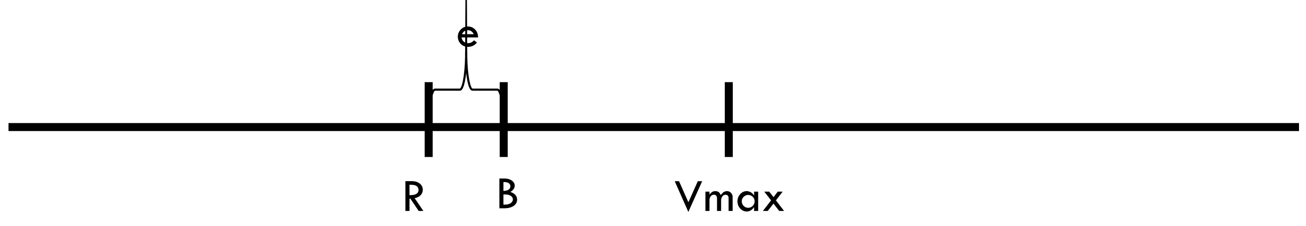
- Private Value Auction
  - Bidders differ in their values for the object
  - e.g., memorabilia, consumption items
  - Each bidder knows only his value for the object
- Common Value Auction
  - The item has a single though unknown value
  - Bidders differ in their estimates of the true value of the object
  - e.g. drilling for oil

Four standard types of auction (private value auctions)

- Open Auctions (sequential)
  - English Auctions
  - Dutch Auctions
- Sealed Auctions (simultaneous)
  - First Price Sealed Bid
  - Second Price Sealed Bid

English Auction (Ascending Bid)

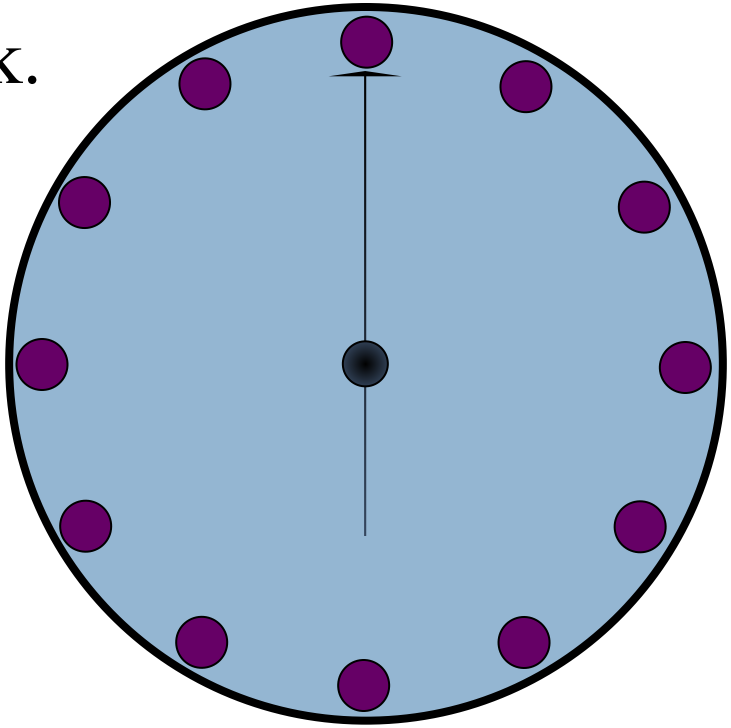
- Bidders call out prices
- Highest bidder wins the item
- Auction ends when the 2nd highest bid R is made, and the bidder with Vmax will bid extra e and wins
- Winner's profit is Vmax-(R+e)>0



- Strategy: keep bidding up to your valuation V.

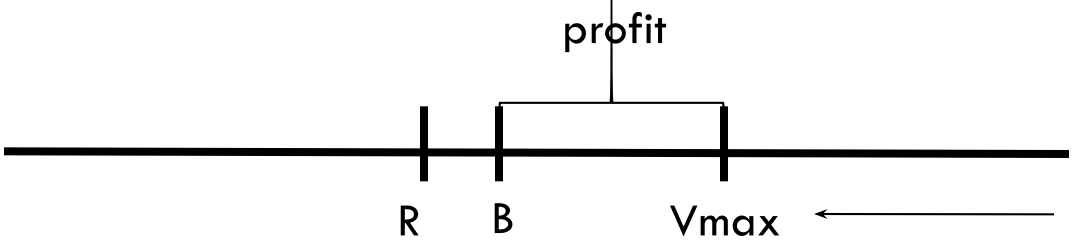
Dutch auction

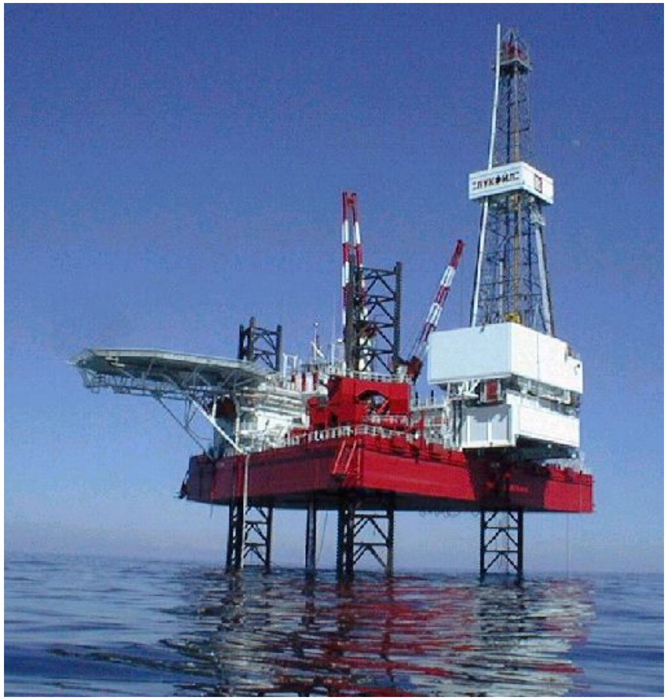
- “Price Clock” ticks down the price.
- First bidder to “buzz in” and stop the clock is the winner.
- Pays price indicated on the clock.



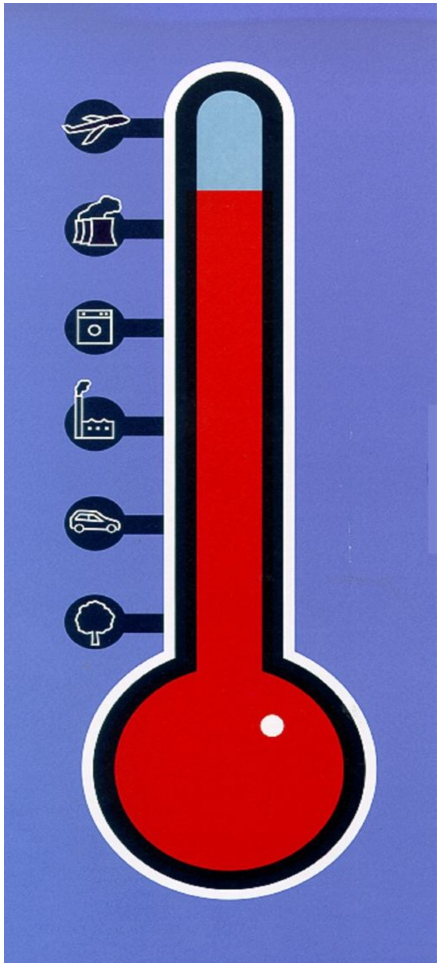
Dutch auction

- Strategy: Buzz in after price falls sufficiently below V, and make a positive profit.
- “Shading”: waiting longer may increase the profit, but also increases the chance of losing the auction.





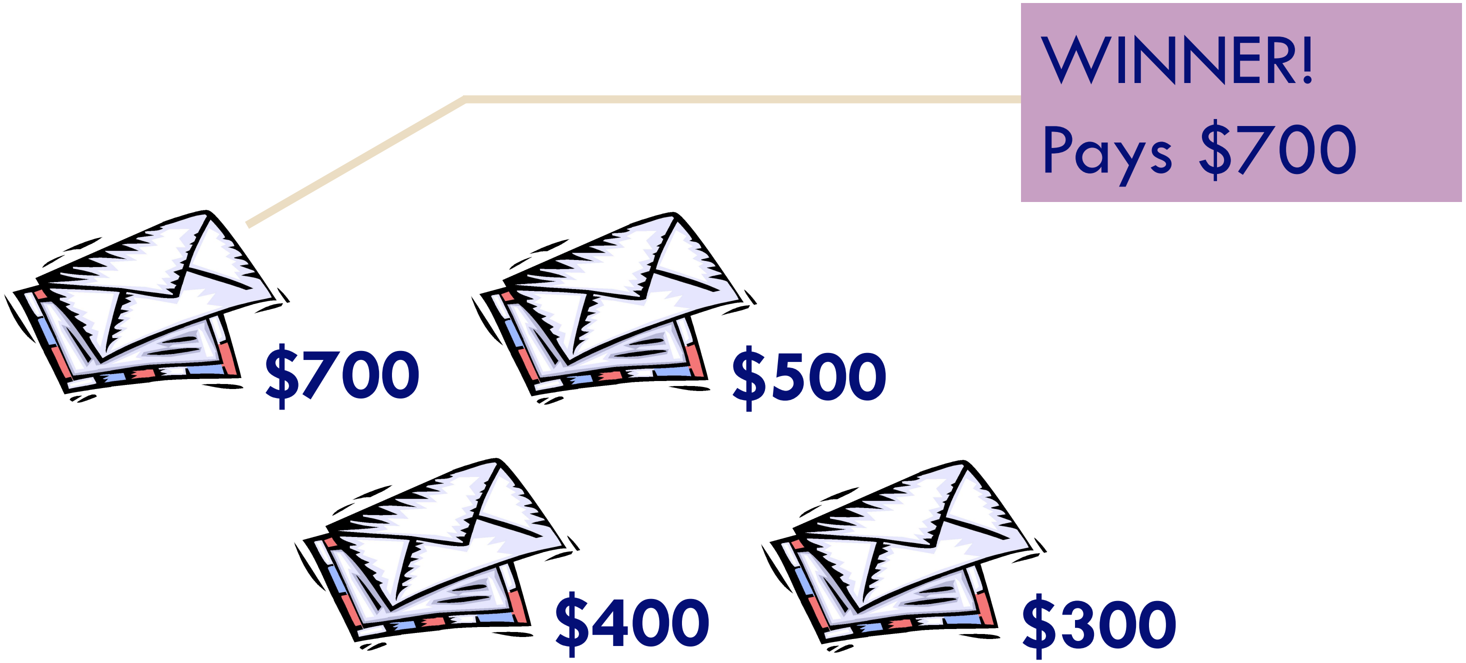
Dutch auction for British CO_2 emissions



- Greenhouse Gas Emissions Trading Scheme Auction, United Kingdom, 2002.
- UK government aimed to spend £215 million to get firms reduce CO_2 emissions.
- Clock auction used to determine what price to pay per unit, which firms to reward.
- The clearing price was £53.37 per metric ton.

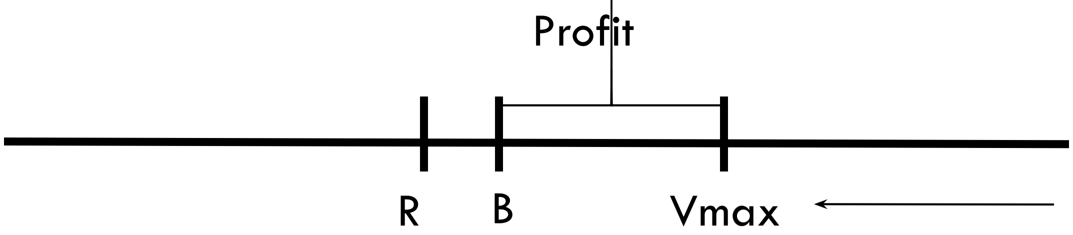
First Price Auctions

- All buyers submit bids simultaneously.
- The bidder who submits the highest bid wins, and the price he pays is the value of his bid.



First Price Auctions

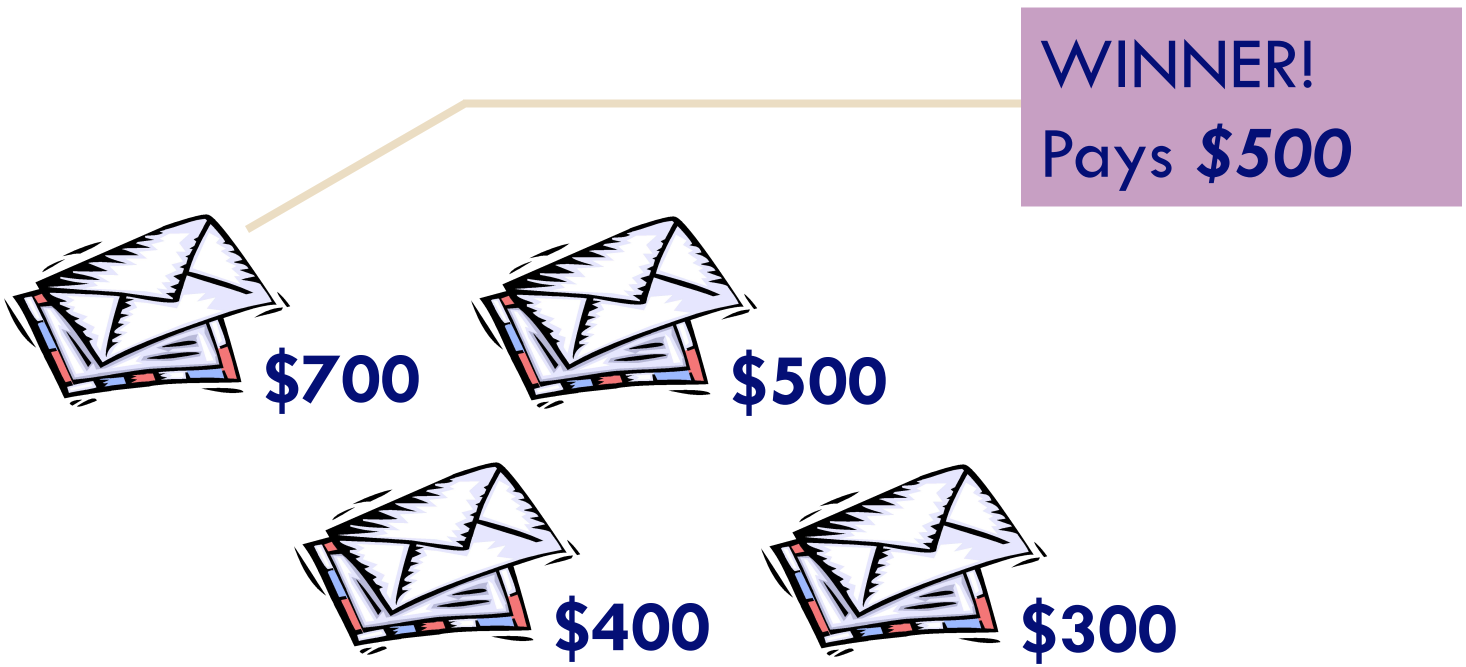
- Profit is V*max - B*



- Shading: B must be below V to generate profit.
- Amount of shading is trade-off between risk of losing and greater profit (similar to Dutch auction).
- Shading depends on risk attitude and beliefs about other bidders' Vs.

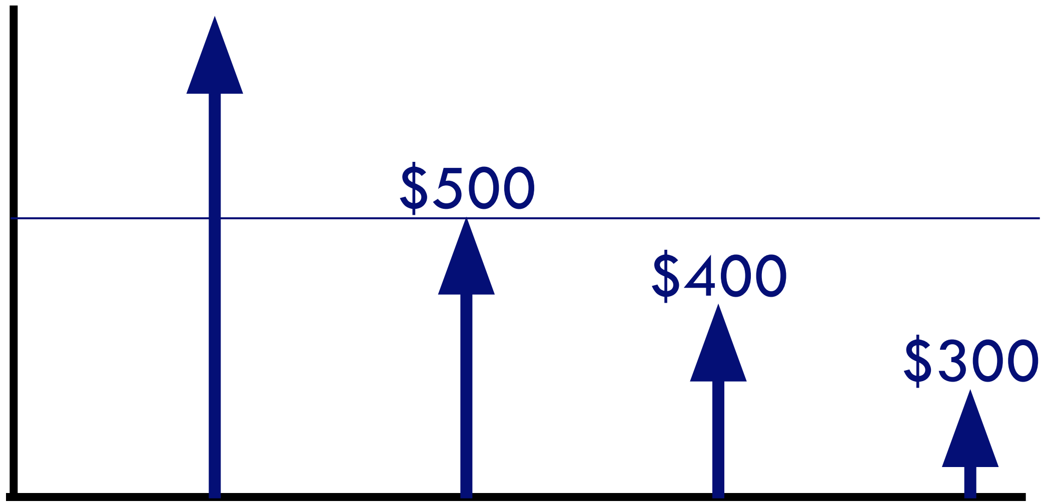
Second Price Auctions

- All bidders submit bids simultaneously.
- The bidder who submits the highest bid wins, and the price he pays the second highest bid.



Second Price Auctions

- It is strategically equivalent to an English auction



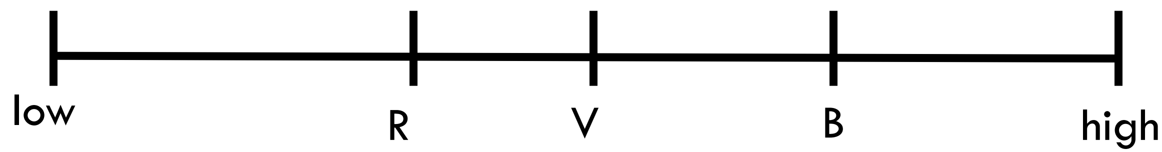
Second Price Auctions

- Possible bids: B>V or B=V or B<V: which is best?
  - Bidding V is a dominant strategy
  - Second price auctions makes bidders reveal their true valuations
- Why bid V?
  - The amount a bidder pays does not depend on his bid, so no reason to bid less than V.

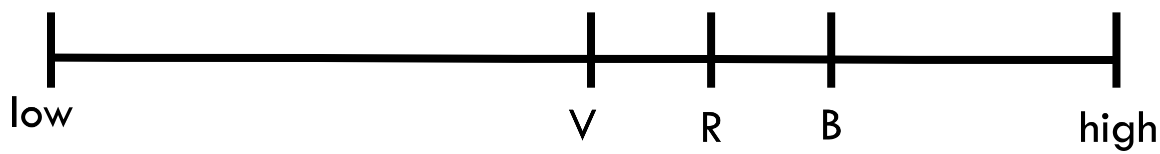
Second Price Auctions

Bidding higher than my valuation

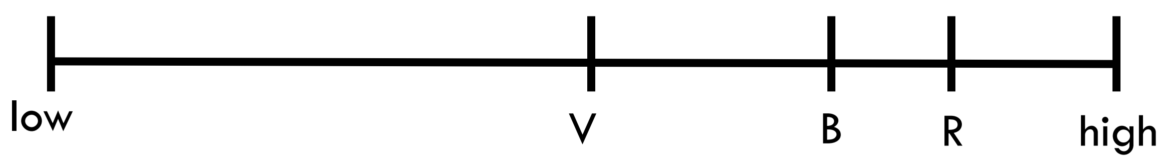
- B wins, pays R, profit is V-R, same result if B=V



- B wins, pays R, negative profit



- B loses, profit is 0, same result if B=V



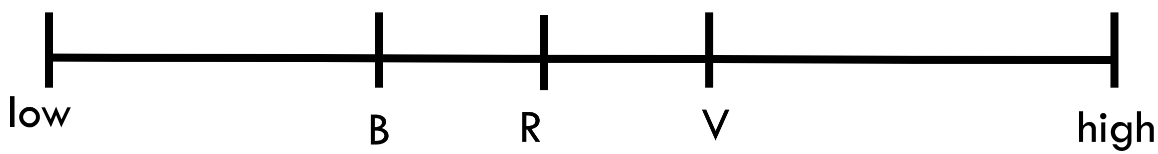
To bid higher than V yields either an equal or lower payoff than to bid V □ Prefer B=V to B>V

Second Price Auctions

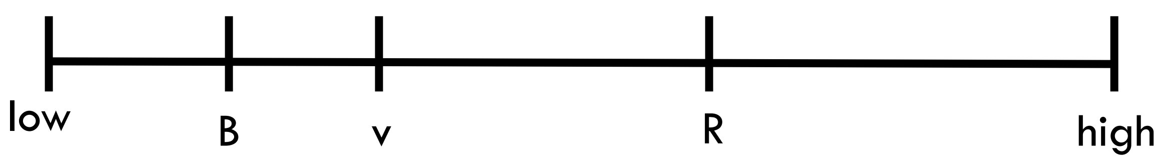
Bidding lower than my valuation

- B wins, pays R, profit is V-R, same result if B=V

- B loses, while bidding B=V would have won a profit



- B loses, same result if B=V



To bid lower than V yields either an equal or lower payoff than to bid V □ Prefer B=V to B<V

Second Price Auction

- In a second price auction, always bid your true valuation (Vickrey's truth serum).
- Winning bidder's surplus: Difference between the winner's valuation and the second highest valuation.

Which auction is better for the seller?

- In a second price auction
  - Bidders bid their true value
  - Seller receives the second highest bid
- In a first price auction
  - Bidders bid below their true value
  - Seller receives the highest bid

Revenue Equivalence

- All 4 standard auction formats yield the **same expected revenue**
- Any auctions in which:
  - The prize always goes to the person with the highest valuation
  - A bidder with the lowest possible valuation expects zero surplus

…yield the same expected revenue

- The seller is indifferent between the 4 standard auctions.

Revenue Equivalence

	Winner pays	Optimal bid
English	Second highest V	Raise bid until V
Dutch	Vmax-shading	Shading (<V)
First-price	Vmax-shading	Shading (<V)
Second-price	Second highest V	Bid V

- On average, Vmax-shading = 2nd highest V.
- The optimal shading strategy is such that the winner ends up paying the 2nd highest V.

Are all auctions truly equivalent?

- For sellers, all 4 standard auctions are theoretically equivalent. However, this may not be the case if bidders are risk-averse or inexperienced.
- Risk Aversion
  - Does not affect the outcomes of 2nd price auctions and English auctions.
  - However, in 1st price auctions and Dutch auctions, risk-averse bidders are more aggressive than risk-neutral bidders. Bidders 'shade' less, so bid higher than if risk-neutral!
  - Risk aversion 1st price or Dutch are better for the seller, because bidders shade less.

Are all auctions truly equivalent?

- Inexperienced bidders
  - In second-price auctions, it is optimal to bid V.
  - Inexperienced bidders tend to overbid in 2nd price auctions (B>V), in order to increase their odds of winning.
  - With inexperienced bidders □ second-price auctions increase the revenue of the seller.

Collusion in auctions

- In second-price auctions, bidders may agree not to bid against a designated winner.
  - e.g. there are 10 bidders, John's valuation is $20, others have valuation of $18.
- Bidders agree that the designated winner John bids any amount more than $18, others bid $0 - no incentive for anyone to do differently. The bidder wins the item for $0.
- In first-price auctions, instead, if John bids $18, he pays $18 to the seller.

Collusion in auctions

- Collusion is also possible in English auctions. Bidders may be able to signal their true valuations the way that they bid in early stages.
- Bidders who realize that they do not have the highest valuations may collude with the Vmax bidder by accepting not to raise their bid.

Number of Bidders

- Having more bidders leads to higher prices.
- Example: Second price auction
- Two bidders
  - Each has a V of either 20 or 40.
  - There are four possible combinations:

$$\Pr\{20,20\}=\Pr\{20,40\}=\Pr\{40,20\}=\Pr\{40,40\}=\tfrac{1}{4}$$

$$\text{Expected price} = \tfrac{3}{4}(20)+\tfrac{1}{4}(40) = 25$$

Number of Bidders

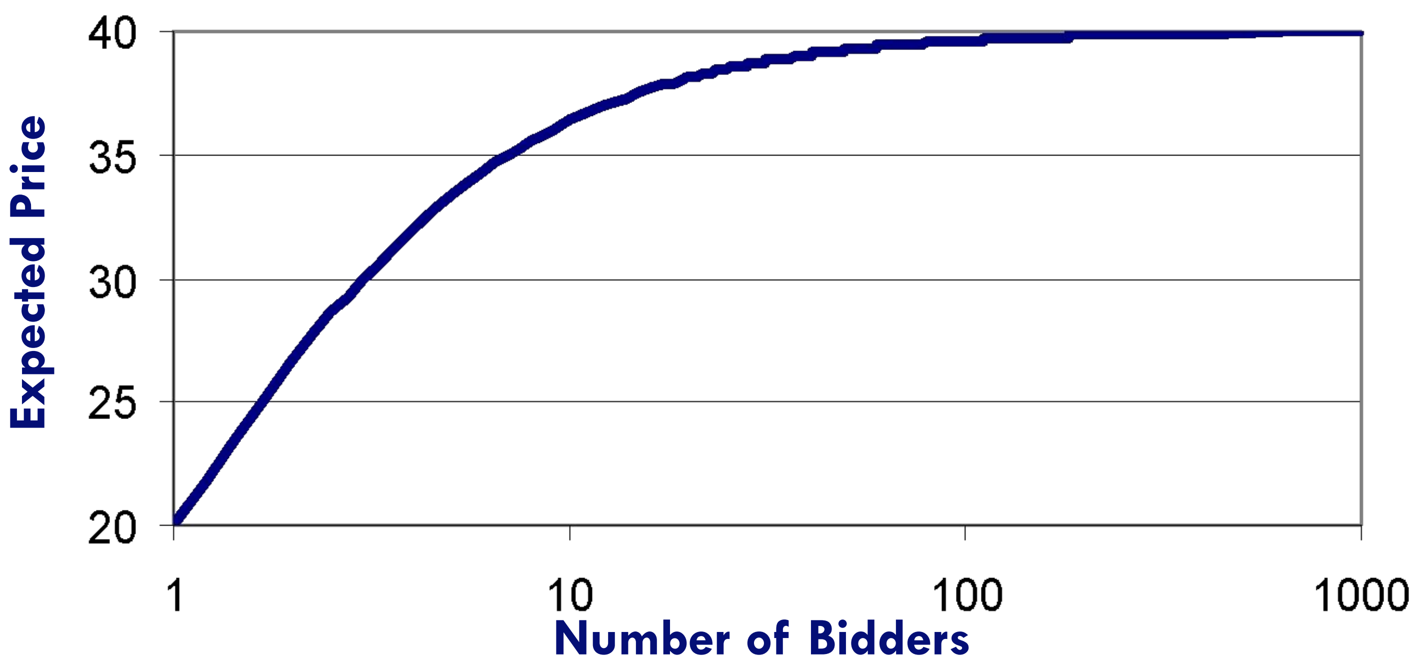
- Three bidders
  - Each has a V of either 20 or 40
  - There are eight possible combinations:

$$\begin{aligned}
&\Pr\{20,20,20\}=\Pr\{20,20,40\}=\Pr\{20,40,20\} \\
=\ &\Pr\{20,40,40\}=\Pr\{40,20,20\}=\Pr\{40,20,40\} \\
=\ &\Pr\{40,40,20\}=\Pr\{40,40,40\}= 1/8
\end{aligned}$$

Expected price = ½ (20)+ ½ (40) = 30

Number of Bidders

- Assume more generally that valuations are drawn uniformly from [20,40]:



The European 3G telecom auctions

- The 2000-2001 European auctions of 3G mobile telecommunication licenses were some of the largest in history. The total revenue raised was above $100bn, with enormous variations between countries.
- UK
  - 5 licences; 4 incumbents. At least one new entrant would win a license.
  - Used English auction. New entrants knew they had a chance so they bid aggressively, forcing incumbents to do the same.
  - Revenue: 39bn euros.

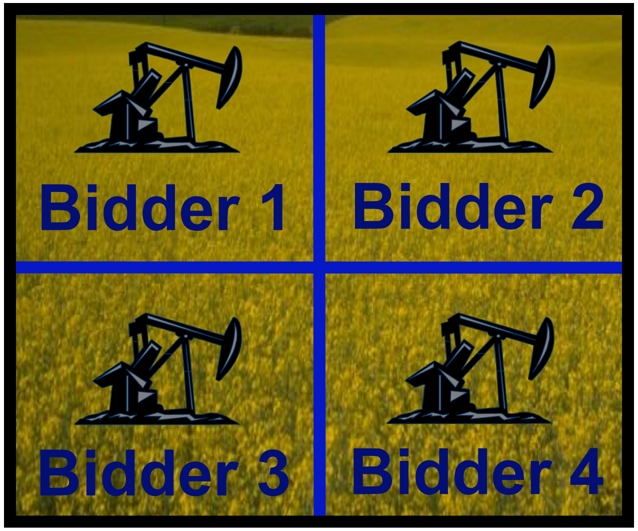
The European 3G telecom auctions

- Netherlands
  - 4 licences; 4 incumbents.
  - Potential entrants could not realistically compete with the incumbents. Therefore they decided to collude with them. They let them win against compensation.
  - Used English auction. Raised only 3bn euros.
- Another problem is the sequencing. Because the auction took place after the UK one, bidders had learned how to collude.
- The same problem occurred in countries that organized auctions later, e.g. Italy and Switzerland. Bidders had learned how to collude.

Common Value Auctions

- Common Value Auction
  - The item has a single though unknown value, and bidders differ in their estimates.
- Example: Oil drilling lease
  - Value of oil is roughly the same for every participant.
  - No bidder knows for sure how much oil there is.
  - Each bidder has *some* information.

Hypothetical Oil Field Auction



- Each bidder knows the amount of oil in his or her quadrant

- Total value of oil field:
  Sum of the values of the four quarters

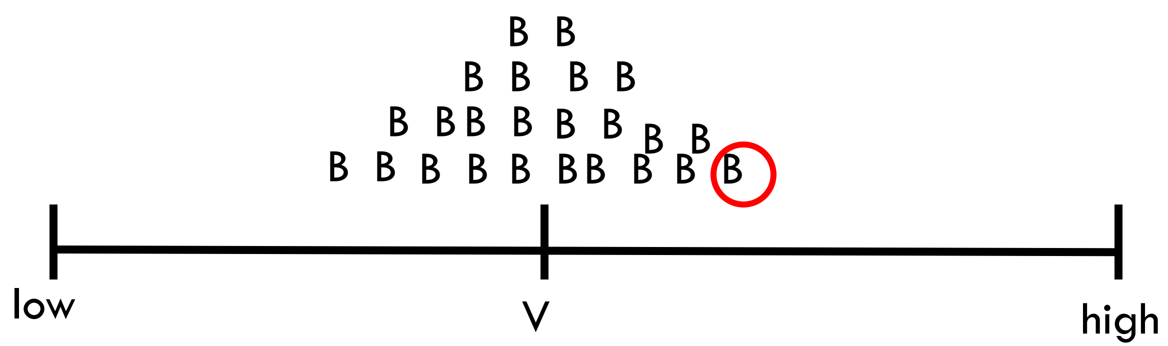
- Type of auction:
  First price sealed bid

The winner's curse

- The estimates are correct, on average

The winner's curse

Winner's curse = In common value auctions, winners are likely to overpay, and make a loss.



Dealing with the winner's curse

- Given that I win an auction …All others bid less than me …Thus the true value must be lower than I thought.

- Winning the auction is "bad news". One must incorporate this into one's bid, i.e. lower your bid. Assume that your estimate is the most optimistic.

Avoiding the winner's curse

- Bidding with no regrets:
  - Since winning means you have the most optimistic signal, always bid *as if* you had the highest signal, i.e. lower your bid.
  - If your estimate is the most optimistic –what is the item worth?
  - Use that as the basis of your bid.

All-pay auctions

- Common value first-price auction in which bidders pays the amount of their bid, even if they lose.
- Example 1: Olympic games
  - Competing cities spend vast amount of resources to win the vote.
- Example 2: Political contests (elections)
  - Candidates spend time and money, whether they win or lose.
  - In the 2012 US presidential election, total campaign spending was close to $2bn.

All-pay auctions

- Example 3: Research and development, patent race.
  - Competing pharmaceutical firms search for a new treatment/molecule; only one winner.
  - Investment in R&D is risky, since even losers lose their "bid".
- Bid is useless unless you win…hence bid aggressively or don't bid at all.
- Typically, the sum of the bids is much higher than the value of the prize, which is good for the seller.

All-pay auctions

Optimal strategy

- If everyone else bids aggressively, your best response is to bid 0
- If everyone else bids 0, your best response is to bid a small positive amount

- Equilibrium bidding strategy must be a mixed strategy.

All-pay auctions

Equilibrium

- Consider an all-pay auction with prize worth 1, n bidders.
  - Bid x between 0 and 1
- Let P(x) be the probability one's bid is not higher than x.
- Indifference principle: With mixed strategies bidders must be indifferent between the choice of x

All-pay auctions

Equilibrium

- The bidder win if all remaining bids are less than x. The expected payoff for bidding x is then:

$$1*[P(x)]^{n-1}-x$$

- Indifference condition between bidding 0 and x (the expected profit is 0):

$[P(x)]^{n-1}-x=0$, i.e. $P(x)=x^{1/(n-1)}$

All-pay auctions

Equilibrium

- When n=2, players play each value of x with equal probability.
  - $P(x)=x$ □ choose each x with equal probability
  - Expected profit: $1*x-x=0$
- As n increases, bidders bid lower.
  - For n=3, $P(x)=\sqrt{x}$
  - E.g. $x=1/4$ □ $P(x)=1/2$, i.e. the probability to bid less than ¼ is ½.
- The higher is n, the less likely bidders are to win, and the lower they bid.

All-pay auctions
Overbidding

- Class experiments: Auction of a \$20 bill
- Students start bidding \$3, \$4…
- When the price approaches \$20, the bidders realize that they could end up having to pay a lot of money and not win.
- If you had bid \$19, and another bidder bids \$20. What would you do? Is it better to bid \$21 or pay \$19 for nothing?
- These games routinely end with the winning bid being 50 percent higher than the value of the prize.

Summary

- Different types of auctions
- Bidding strategies
- Implications for sellers: Revenue equivalence
- Risk aversion /collusion
- Common value auctions: Winner's curse.
- All-pay auctions: mixed strategies, and overbidding.