Strategic Bidding in Auctions

Phil Haile
Yale University
Prevalent Auction Types

- **Ascending Auction** (a.k.a. English auction)
  - antiques, art, cattle, used cars, eBay, timber, radio spectrum

- **First-Price Sealed-bid Auction**
  - offshore drilling rights
  - public and private procurement (bidders are sellers, low bidder wins)

- **Descending Auction** (a.k.a. Dutch Auction)
  - flowers, fish, plants
Why hold an auction?

- Seller uncertain what the good is worth
  - unique items (antique, Monet painting)
  - items difficult to evaluate (timber/oil rights)
  - demand shocks (financial markets)
- Important to sell quickly (fresh fish, flowers)
- Seller wants to allocate efficiently
  (or at least, to bidder willing to pay the most
e.g., FCC spectrum auctions)
Auction 1

- For sale: contents of envelope
  - golf tees worth 1 cent each
  - if X tees, $X/100 in envelope
- Ascending Auction
- Winner of the auction (high bidder)
  - gets the envelope
  - pays me his final bid b
  - (net profit = $X/100 – $b)
556 tees
Auction 2

- For sale: empty envelope
- student ID card: last 3 SID numbers = your valuation of the envelope in cents
  - e.g., mine = $5.08
- I pay the winner his/her valuation
- Winner pays me his/her final bid b
  - net profit = winner’s valuation – b
What was different about these two auctions?
A Key Distinction

Do other bidders have information that would be useful to you in determining your own valuation for the good?

- **YES:** “common values auction”

- **examples**
  - our first auction
  - oil drilling rights (?)
A Key Distinction (2)

Do other bidders have information that would be useful to you in determining your own valuation for the good?

- **NO**: “private values auction”

- **examples**:
  - our second auction
  - many eBay auctions (?)
Common Values and the Winner’s Curse

- **Example: Auction for oil drilling rights**
  - given quantity of oil in the ground
  - prices, extraction costs same for all bidders
  - bidders have different estimates ("signals")
  - signals are noisy but correct on average

- **Suppose bidder with highest signal bids most**
  - highest signal = most optimistic signal
  - most optimistic = *overly* optimistic (usually)
A bidder who ignores the fact that he wins only when his signal is unusually optimistic may regret his bid when he wins -- e.g., pay more than he needed to or more than the true expected value of the good to him.

$@#$%!  I paid too much!
Avoiding the Winner’s Curse

Rational bidders avoid the winner’s curse by thinking strategically

- “Why are the others letting me win at this price?”
- “Do I really want to pay this much, even if no one else is?”
- “What do I think the good is worth to me, assuming others’ information tells them to bid less than I bid?”
Adverse Selection

Winner’s curse just one example . . . others:

- Used car market: “Why is the owner willing to sell the car at this price”?
- Insurance market: “Why does this customer want to buy so much insurance?”
- Dating: “Why is s/he willing to go out with me?”

In theory, AS can lead to inefficiencies, even to missing markets (Akerlof 2001 Nobel Prize). In an auction, it can make bidders hesitant to bid aggressively.
Strategic Thinking by Bidders: Theory

- Account for the winner’s curse (if a common values auction)

- How much to bid?
  - Ascending auction with private values: optimal to bid up to valuation (dominant strategy)
  - First-price sealed bid auction: shade bid below valuation… but how much?
    - MB: pay less when win
    - MC: may not win

Bayesian Nash equilibrium: each bidder shades optimally, knowing that all others are too

Bid $1 less, saves a dollar if wins must balance

depends on Pr(next highest bid is just below mine)
Strategic Bidding: Empirical Evidence

- **Oil drilling rights auctions (FPSB)**

  - **Data:** bids, realized value of oil; theory requires
  - bids are below expected values
  - bidders don’t bid aggressively against better informed competitors
  - bidders optimally trade off MC and MB of bid shading
Strategic Bidding by Bidders: Empirical Evidence (2)

USFS timber auctions (FPSB)
Haile, Hong & Shum, 2003

- Data: bids, auction characteristics
- in theory, winner’s curse more severe when face more competitors in common values auction
- Does this hold in practice?

Most optimistic out of 2 isn’t “extremely” overly optimistic

Most optimistic out of 10 is!
USFS timber auctions (2)

- Expected value of winning against n-1 competitors in equilibrium: \( v_i^*(n) \)
- Bidder’s expected payoff: \([v_i^*(n) - b] \Pr(b \text{ wins } | n)\)
- Maximize wrt b:
  \[ [v_i^*(n) - b] \frac{d}{db} \Pr(b \text{ wins } | n) = \Pr(b \text{ wins } | n) \times 1 \]

MB: raise probability of winning  
MC: pay more when win
USFS timber auctions (3)

- How to measure empirically?
- FOC:

\[ [v_i^*(n) - b] \frac{d}{db} \Pr(b \text{ wins } | n) = \Pr(b \text{ wins } | n) \times 1 \]

So we can estimate this! can estimate using bid data observable

Rational bidding requires \( v_i^*(n) \) to decrease with \( n \)

So test this. (results: yes when bidders face common uncertainty and have opportunity to acquire signals)
Auctions as Testing Ground

- data + equilibrium relations from theory can reveal unobservable things determining how markets work
- trust in results requires trust in equilibrium relations from theory
- with auctions, unusually close match between theoretical model and actual market
- \[ \therefore \] ideal for testing, learning about things that are hard to assess in other markets (e.g., subprime crisis, front-running)
Strategic Thinking for Sellers

- What kind of auction to hold if want to . . .
  - maximize revenue (minimize cost)
  - ensure efficient allocation
- What is optimal reserve price?
- Sell units all at once, one by one, in bundles. . . ?
- How to prevent collusion?

Answers require anticipating strategic bidding, and often depend on details of demand and information structure.
Example: Treasury Bill Auctions

- Multi-unit auctions: bidders offer a “demand curve” of price-quantity pairs

![Graph showing a demand curve with p* as the price and Q as quantity]
Example: Treasury Bill Auctions

- **Uniform price auction:** price $p^*$ for all units
Example: Treasury Bill Auctions

- Discriminatory auction: “pay your bid” on each unit

Note: offers will not the same as in uniform price auction because bidders are strategic!
Which auction maximizes revenue?

- **Theory:** ambiguous, depends on bidder valuations
- **Experiments:** clouded by simultaneous changes in macroeconomy, regulations, financial markets
- **Empirical approach:** estimate the primitives determining demand, then simulate what would happen under each type of selling mechanism
- **Results so far:** (Hortacsu et al) it matters very little!
Revenue Equivalence

- For some cases, theory tells us many auctions (including first-price, Dutch, and ascending) should give the same expected revenue.
Revenue Equivalence

- For **some cases**, theory tells us many auctions (including first-price, Dutch, and ascending) should give the same expected revenue
  - symmetric independent private values
- Vickrey Nobel Prize in 1996
Revenue Equivalence: Intuition

- Ascending auction: bid up to valuation
  - so price = 2\textsuperscript{nd} highest valuation

- First-price auction
  - shade bid below valuation
  - optimal bid = best guess of next highest valuation, assuming your own bid will win
  - this assumption is correct for winner
  - so price = unbiased guess of 2\textsuperscript{nd} highest valuation
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Want to learn more?

- **Theory**

- **Empirical work**