

ECON-C5100 Digital Markets

Iivo Vehviläinen

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Aalto University

iivo.vehvilainen@aalto.fi

Lecture 5: Market design

Last week

- Industry structure
- Auction theory

This week

- Designing markets, the case of ad auctions
- Online markets

Uses of game theory in market design

- Study existing markets
 - Identify “the rules of the game,” the incentives for the participants, and how they behave. Then try to understand why the market functions well, or not so well.
- Design new markets
 - Identify the economic problem to be solved, the players and their incentives and information. Then try to understand what sort of market rules would lead to a desired outcome.
- Economic theory provides a conceptual framework, but need to use data and experiments to test hypotheses, and identify things models may have missed.

- Game theory is helpful in describing the rational strategic interactions between agents.
- Mechanism design turns the question around:

Assuming that the agents will play a strategic interaction game, what should the rules for the game be?

Revelation principle

Given the vast amount of possibilities, is there hope to determine the best possible design? Somewhat surprisingly: Yes!

- Definition of the game:
 - Suppose that we have buyers with a type (private value) v_i and a seller able to commit to some mechanism Γ to sell an item
- Alternative game: Direct mechanisms
 - When reported type v , the seller allocates the good with probability $q(v)$ if the buyer pays $t(v)$
- The *Revelation principle*:
 - Given Γ , a buyer with type v_i chooses the best response $\sigma(v_i)$
 - For every Γ and equilibrium σ there is a *direct* mechanism Γ' which 1) gives the same expected allocation and payoffs as with σ and 2) it is optimal for the buyer to report the true type
 - Task to design allocation and payment rules that are *incentive compatible* and *individually rational*.
- Deeper look in the theory left for further classes.

- From last week, what to expect in a Nash equilibrium:
 - In an efficient allocation the high value bidder wins.
 - Expected revenue is the same in many auction methods.
- Is there a potential to improve the expected revenue for the seller? Yes, in particular by
 - Introducing reserve prices.
 - Increasing competition.

Effect of reserve prices to revenues

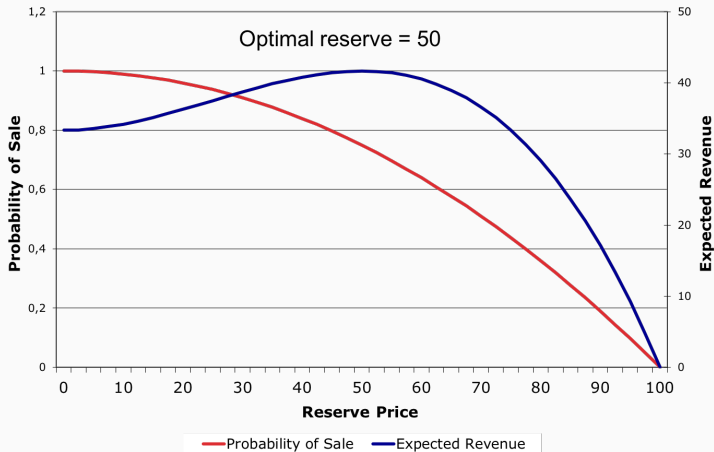


Figure. Optimal reserve price for $N=2$ in an ascending price auction.

- Myerson (1981): Expected revenue maximizing auction is the second price auction with a reserve price.
 - With some assumptions on buyer valuations (independently drawn from a regular distribution).
- But reserve prices can introduce inefficiency:
 - If the reserve price is not met, then there is no trade even though some buyer might have been willing to buy above cost.
- Trade-off between efficiency and extracting information.

Trade-off between reserve prices and competition

- What if the number of buyers is not fixed? Is more competition or optimal reserve prices better?
- Bulow-Klemperer (1996) find:
 - The expected revenue of the second-price auction on $n + 1$ agents is at least the expected revenue of the optimal auction on n agents.
- For the seller, it is better to recruit one more bidder for a second-price auction without a reserve price than to run the optimal auction with reserve price.

Global ad spend estimated to be 650 billion U.S. dollars in 2020:

- 30 % to TV
- 23 % to Google
- 13 % to Facebook

- Google ad auctions were introduced in 2002. Auctions are now widely used for selling advertisement space online.
- Advertisers send their money bids by search term:
 - E.g. loans, vodka, head ache, rehabilitation.
 - Offer a payment per click.
- Google arranges separate ad auctions for *every query*.
 - Conditional on sufficient number of bidders.
- Ad space also auctioned outside Google search.
 - Various mechanisms, including first price auctions.

Example: Google search

2019 Best Personal Loans | Get \$1,000 - \$50,000 in 24 hrs

[Ad](#) www.lendingtree.com/personal ▼

Fast, Free Personal Loan Offers in Minutes. Compare Now & Find Your Best Offer! One Form, Multiple Offers. Fixed Rates. Low Interest Rates. Get The Money You Need. up to \$50,000 in 24 hrs.

[Need A Personal Loan?](#) · [Personal Loan Calculator](#) · [Start Your Loan Request](#)

[\\$1,000 Loan](#) - from \$30.00/mo - 36 Mos Term. 5.46% APR · [More](#) ▼

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[36 months Loan](#) - from \$478.00/mo - \$16,000 Loan · [More](#) ▼

10 Best Personal Loans | Get \$1,000 - \$100,000 in 24hr

[Ad](#) www.consumersadvocate.org/Personal-Loan/Comparison ▼

Read Trusted Personal Loan Company Reviews. Comparisons Trusted by 20,000,000+. Always Free.

[SoFi](#) - from \$191.00/mo - \$10,000 - 5.49% - 5 yrs · [More](#) ▼

Figure. Search for “loans” in Google (U.S.).

- Possibly several positions for sale.
- Auction mechanism is a “generalized second price” auction.
 - Positions are assigned in the order of bid.
 - Advertisers submit a single bid.
 - Advertisers pay the bid of the advertiser in the position below.
- If only one position, reduces to a second price auction.

Assumptions:

- Positions $k = 1, \dots, K$ and bidders $i = 1, \dots, N$.
- Each position gets x_k clicks per day: $x_1 > x_2 > \dots > x_K$.
- Each bidder has value v_i per click: $v_1 > v_2 > \dots > v_N$.

This leads to:

- For bidder i , the value of position k is $v_i * x_k$.
- For bidder i , the profit from buying k is $(v_i - p_k) * x_k$.

Example: Ad auctions

- Two positions: receive 200 and 100 clicks per day.
- Three bidders with values of 10, 5, 2 cents.

Bidder	Value in €	
	1st position	2nd position
1	20	10
2	10	5
3	4	2

Table. Value of positions in € for each bidder.

- In an efficient allocation, the first position goes to the highest bidder and the second position to the second highest bidder.

Example: Ad auctions

- Three bidders bid their values of 10, 5, 2 cents.
- Market clearing prices are determined by the bid (in cents) of the bidder below the winner.

Bidder	Value in €		Price in cents
	1st position	2nd position	
1	20	10	5
2	10	5	2
3	4	2	-

Table. Market clearing prices (if bidders bid their true value).

- In addition to the auction method above, Google uses a measure for “ad quality”:
 - The quality of ad affects clicks, in addition to the position.
 - Google uses its data to predict the quality of an auction, i.e. how many clicks it will receive.
- Bids are made in terms of cost per click.
- Outcome of the auction is determined by ad rank that is calculated as the cost per click (bid) times the ad quality score (Google).
- Potential loss in the efficiency of the monetary allocation.

In-class exercise: Ad auction

- Your private value for the ad position, i.e. the maximum price you are willing to pay per click is
 - Take the last two digits of your student number
 - As an example, I'd have 96 (IIRC)
- You will design an ad and place a bid to get the ad published.

In-class exercise: Ad auction

Bidding rules:

- The ad can be shown in one of two slots.
- You will place a bid in terms of ¢ per click.
- These bids will be multiplied with ad quality.
 - Ad quality is determined by the votes that your ad gets.
- The highest quality weighted bid will get the first slot and the second highest the second slot.
- The winners pay the minimum amount needed to retain their positions.
- Payoff is the difference between the payment and your value, times the number of clicks.

In-class exercise: Ad auction

As an example Ivo V. could bid of 96 ¢ for his ad as follows:

Economics is your new superpower, click to learn more! (96).

Use the vote in Presemo presemo.aalto.fi/digimar to place bids.

Discussion.

- Always a balance between what tasks are left to the competition/game in the marketplace to decide and what is decided by the rules.
- Choice of implementation detail will depend on the desired outcomes.
- There needs to be sufficient enforcement mechanisms in place to ensure that the actual outcomes meet desired outcomes.

Reading assignment 3:

- **Ad auctions.** Easley, David and Jon Kleinberg (2010), Chapter 15 from “Networks, Crowds, and Markets: Reasoning about a Highly Connected World”. Read at least Sections 15.1, 15.5, and 15.7.
- **Online markets.** Levin, Jonathan (2011) “The Economics of Internet Markets”, NBER Working Papers 16852. Read Section 4.
- **Macro impacts.** Cavallo, Alberto (2018) “More Amazon effects: Online competition and pricing behaviors”, NBER Working Paper 25138. Sections I Introduction and VI Conclusions enough.

Online markets

- Frictions between buyers and sellers
- Use of data
- Macro impacts

Appendix

- Recall the ascending auction example with two bidder whose values are v_1 and v_2 .
- Values are assumed to follow an uniform distribution $[0, 100]$.
- So the expected revenue for the seller is $33 \frac{1}{3}$.
- What happens is the seller sets a reserve price of r ?

- Seller sets reserve price r and runs an ascending auction.
- Bidding starts from r .
- Three cases
 - Both bidder values below $r \rightarrow$ no sale.
 - One value above r , one below $r \rightarrow$ sale at r .
 - Both values above $r \rightarrow$ sale at lower value.

Impact of competition

N	No reserve price		Optimal reserve price	
	P(sales)	E[revenue]	P(sales)	E[revenue]
1	1	0	0.5	25
2	1	33	0.75	42
3	1	50	0.88	53
4	1	60	0.95	61
5	1	67	0.97	67

Table 1: Impact of competition to sales.

Regardless of the number of bidders, the optimal reserve price in the example is always $r = 50$.

Example from eBay auctions

Home > Buy > Search results for TAYLORMADE BURNER 09 DRIVER ...

Refine search

In Golf Clubs

Flex

Regular (12)

Stiff (15)

Choose more...

Condition

New

Used

Not Specified

Choose more...

Price

\$ to \$

Club Type

Brand

Dexterity

Seller

Categories

Sporting Goods (31)

Golf (31)

Preferences

Bidding formats

Auction

Buy It Now

Choose more...

31 results found for TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW *10*... [Save this search and alert me later]

View as: [Grid] [List] [Custom view] Sort by: Time ending soonest

				Price + Shipping to \$4295	Time Left
	TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW 10.5" RH	Top-rated seller	7 bids	\$104.83 + \$7.00 shipping	3h 21m
	TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW 10.5" RH	Top-rated seller	9 bids	\$81.00 + \$5.00 shipping	3h 22m
	TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW 10.5" RH	Top-rated seller	Buy It Now	\$124.99 + \$5.00 shipping	6h 9m
	TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW 10.5" RH	Top-rated seller	Buy It Now	\$124.99 + \$7.00 shipping	6h 9m
	TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW 10.5" RH	Top-rated seller	7 bids	\$70.01 + \$5.00 shipping	8h 53m
	TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW 10.5" RH	Top-rated seller	Buy It Now	\$124.99 + \$5.00 shipping	9h 41m
	TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW 10.5" RH	Top-rated seller	Buy It Now	\$124.99 + \$7.00 shipping	9h 41m
	TAYLORMADE BURNER 09 DRIVER 2009 GOLF CLUB NEW 10.5" RH	Top-rated seller	12 bids	\$91.00 + \$7.00 shipping	11h 7m

RIVER-2009-GOLF-CLUB-NEW-10-5-RH/259471001772?pt=5GF_CubsShash=item3a16bbea

Figure: Einav et al. 2012.

Example from eBay auctions

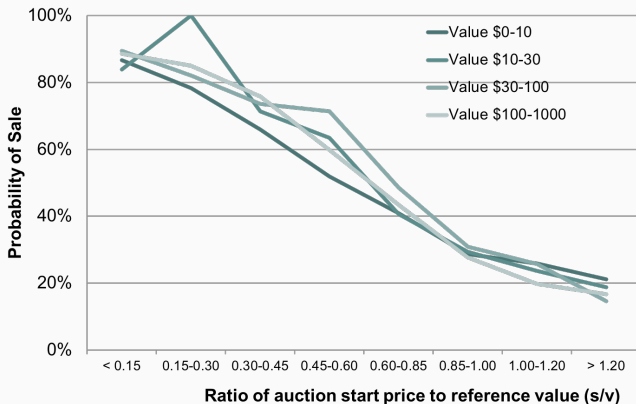


Figure. Impact of reserve price to sales probability.

Figure: Einav et al. 2012.

Example from eBay auctions

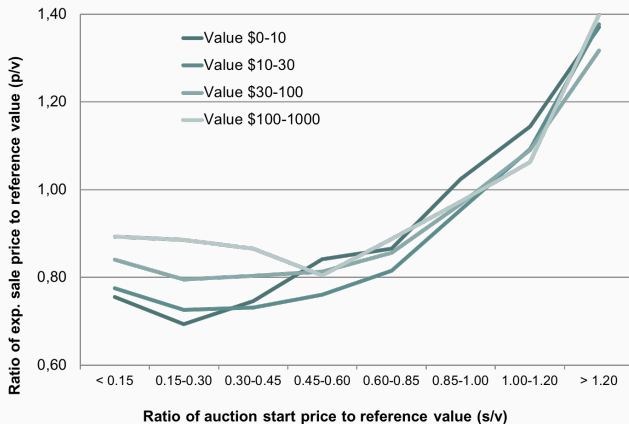


Figure. Impact of reserve price to revenues.

Figure: Einav et al. 2012.

Does it matter if auction scheme is not optimal in theory?

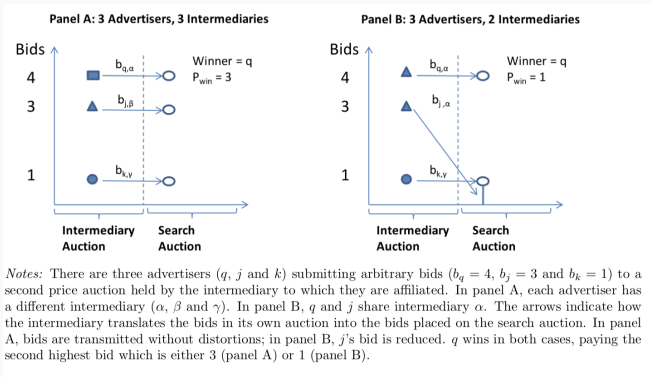


Figure. Example of how an ad intermediary can affect auction outcomes.

Further detail on auctions

- Generalized second price auction
 - Adopted early, dominant in search ad auctions.
 - “Easy” to understand.
 - Exposed to collusive bidding strategies.
- Vickrey-Clarke-Groves (VCG)
 - The winning bidder pays the cost their presence imposes on the other bidders.
 - Flexible, e.g. sell only 1 big ad for 3 slots.
 - Strategy proof: Always optimal to bid truthfully.
 - Collusion less of a concern.
 - More complex to understand.
- All auction forms have advantages and disadvantages, no single best mechanism.