Auction Design and Strategy:
Principles and Practice

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Agenda

- Introduction
- Auctioning a single item
- Basic principles of auction design
- Auctioning many items
- Ascending vs. sealed-bid auctions

Electricity Restructuring: Where are auctions used?

Generation ⇒ Transmission ⇒ Distribution

- Divesting generation assets
- Divesting power purchase agreements
- Capacity entitlements
- Electricity markets coordinated by ISO
  - Energy, reserves, capacity
- Transmission congestion contracts (TCC, FTR)
- Identify suppliers of "standard" service during transition period
- Emission Permits (SO2, CO2)

Advantages of Auctions

- Most open and objective assignment method
  - Criteria specified in advance
  - Reason for assignment is publicly observed
- Determine market prices
- Promote efficient allocation and investment
- Assign resource quickly
- Can incorporate public policy goals

Auction Rules Matter

Auction rules will affect:

- Efficiency of assignments
- Revenues
- Other policy objectives, such as promoting new entry and competition

Auctioning a Single Good

Auctions typically take one of four simple forms:

Dynamic		Sealed Bid
English (↑ price)		2nd Price
Dutch (↓ price)	≡	1st Price

Simple Auctions

- *English*: price increases until only one bidder is left; the remaining bidder gets the good and pays the highest bid.
- *Dutch*: prices decreases until a bidder accepts the price; this bidder gets the good and pays the price at acceptance.
- *Second Price*: each bidder submits a bid in a sealed envelope; the highest bidder gets the good and pays the second highest bid.
- *First Price*: each bidder submits a bid in a sealed envelope; the highest bidder gets the good and pays the amount of his bid.

Auction Exercise

- Bid for single object
- Common value = $1 per bean
- On slip of paper write:
  - Name
  - Estimate (# of beans × $1)
  - Bid in first-price sealed-bid auction
  - Bid in second-price sealed-bid auction

Common-Value Auction Outcome

- Value of object = _____
- English auction

  Price = _____

  Profit = _____
- First-price auction

  Price = _____

  Profit = _____

  Second-price auction

  Price = _____

  Profit = _____

Winner's Curse

I won. Therefore, I overestimated the most. My bid only matters when I win, so I should condition my bid on winning (i.e., that I overestimated the most).

- Winning is bad news about my estimate of value. No one else was willing to bid as much.

Basic Principles of Auction Design

Auction Design Pitfalls

- Auction design can force bidders to make guesses
  - In a simultaneous *sealed-bid* auction bidders must guess about the bids of others
  - In sequential auctions bidders must guess about future prices
- Bidder uncertainty
  - Increases likelihood of inefficient or low-value assignments
  - Can often be reduced
  - Makes bidding difficult, undermines confidence, and can lead to defaults

Auction Design

- Trading mechanism where rules are stated in advance
- Design issues
  - Simultaneous vs sequential
  - Sealed bid vs ascending bid
  - Single items vs package bids
  - Fully transparent vs hide bidder identities

Auctions are Transparent

- Basis for assigning resources specified in advance
- Investors, regulators and other stakeholders can observe reason for assignment
- Prices are publicly and transparently determined by open competition

Well-Designed Auctions Are Efficient

- Winner's curse is minimized
- Substitute properties fetch similar prices
- Bidders given ample opportunity to assemble optimal package of properties
- Threat of collusion is mitigated

Auctions Can Be Designed to Accommodate Other Goals

- Revenue maximization
- Limits on concentration
- Other objectives

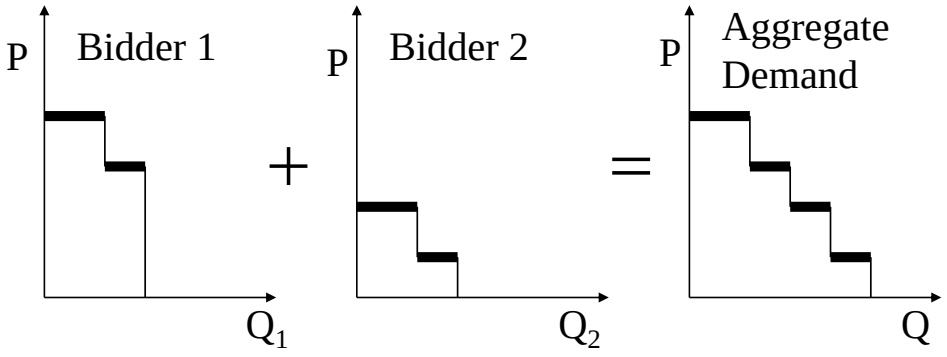
Auctioning Many Similar Items

Examples of auctioning similar items

- Treasury bills
- Electric power
- Capacity entitlements
- Emissions permits
- Privatization (shares of stock)
- Telecommunications spectrum

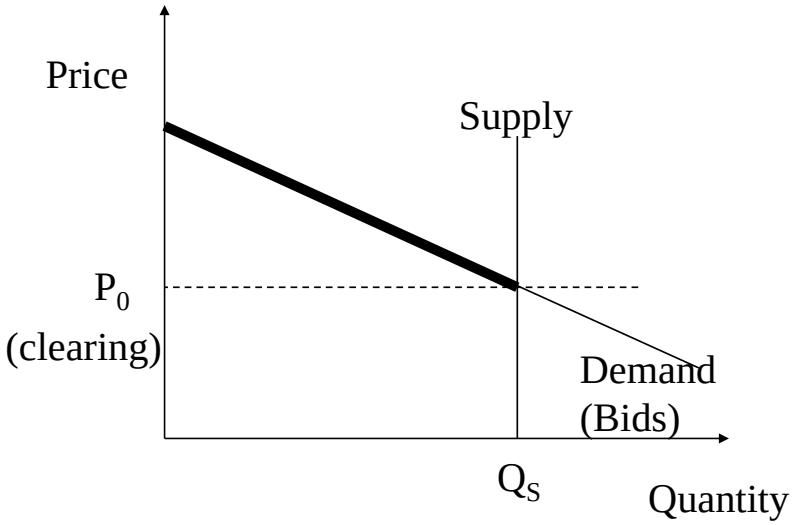
Ways to auction many similar items (Auction to Sell)

- Sealed-bid: bidders submit demand schedules
  - pay-as-bid auction (traditional Treasury practice)
  - Uniform-price auction (Milton Friedman 1959)
  - Vickrey auction (William Vickrey 1961)

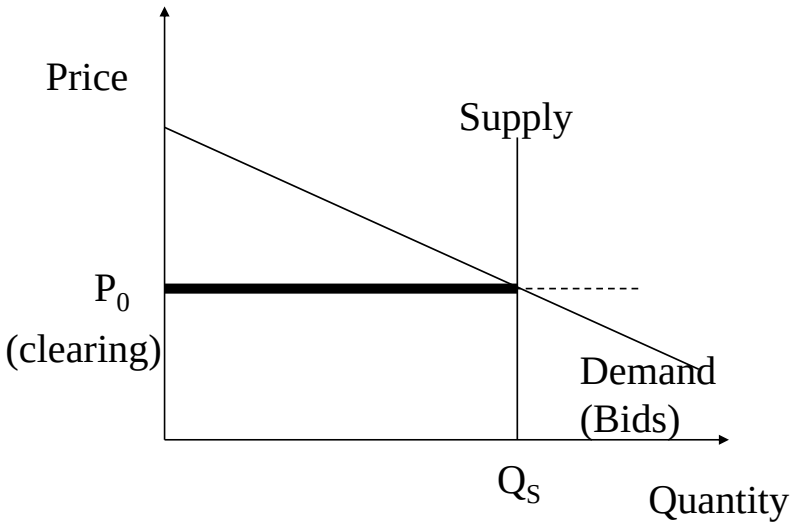


Pay-as-Bid Auction:

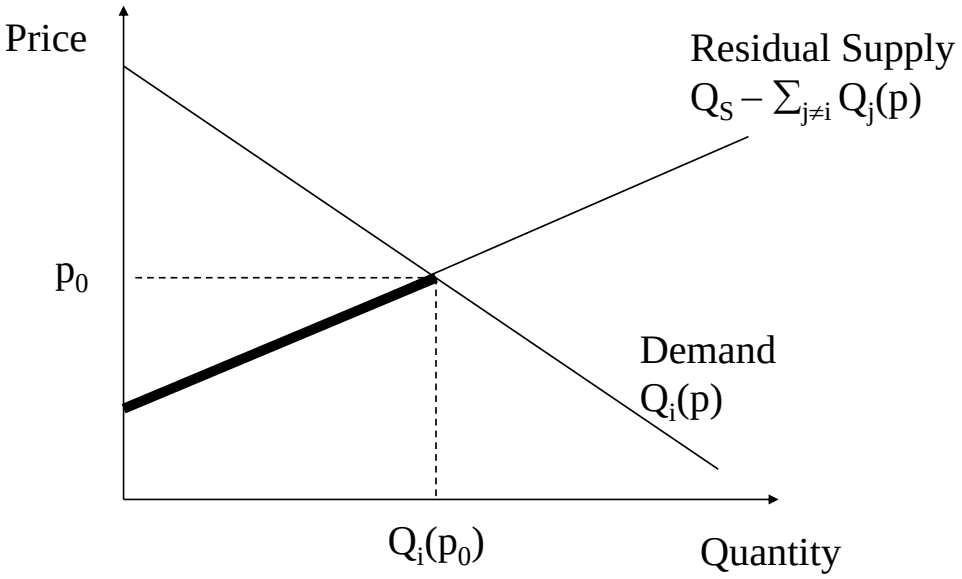
All bids above P_0 win and pay bid



Uniform-Price Auction:
All bids above P_0 win and pay P_0



Vickrey Auction:
All bids above P_0 win and pay opportunity cost

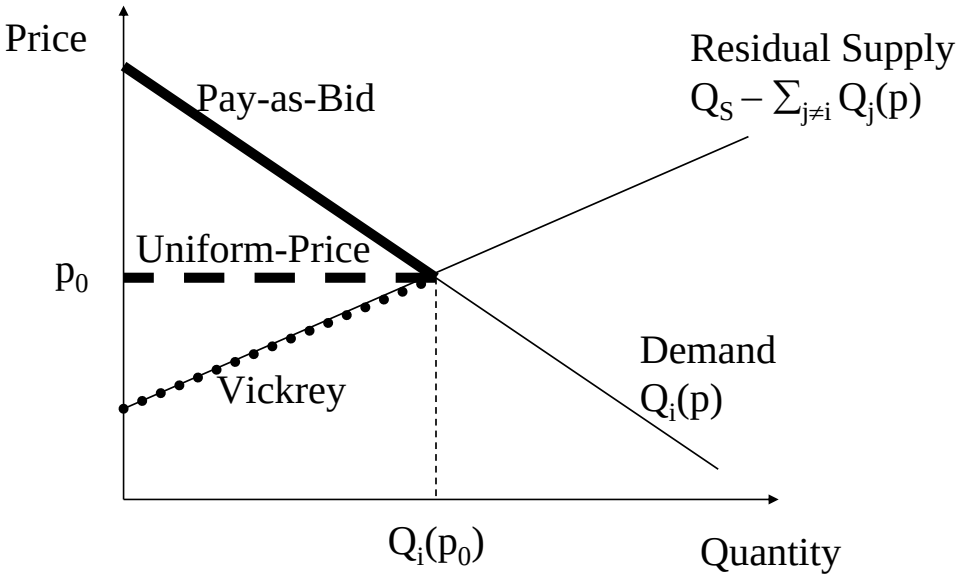


Vickrey Auction: m Discrete Items

- Allocate m items efficiently: m highest marginal values
- Winning bidder pays k^{th} highest *losing* bid of *others* on k^{th} item won
- Payment = social opportunity cost of items won

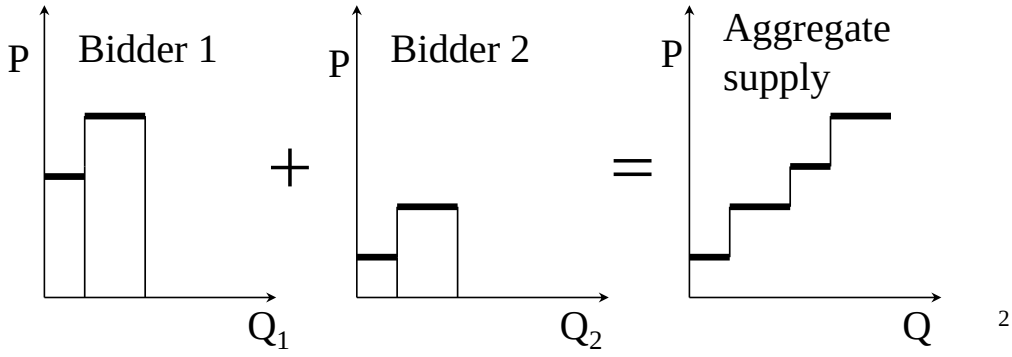
3 bidders, 3 items marginal values			
	A	B	C
1st	10 (5)	8 (6)	4
2nd	6	7 (4)	2
3rd	3	5	1

Payment rule affects behavior



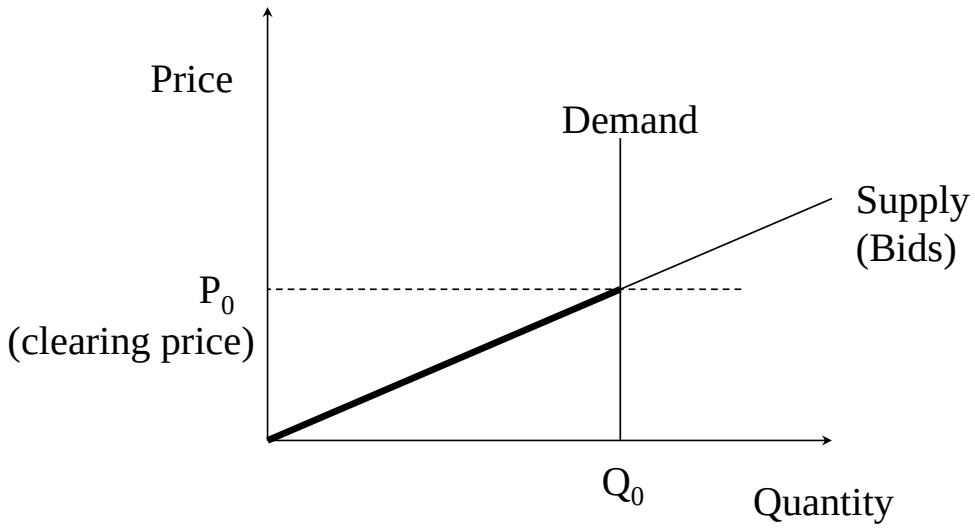
Ways to auction identical items (Auction to Buy)

- Sealed-bid: bidders submit supply schedules
  - Pay-as-bid auction (traditional Treasury practice)
  - Uniform-price auction (Milton Friedman 1959)
  - Vickrey auction (William Vickrey 1961)



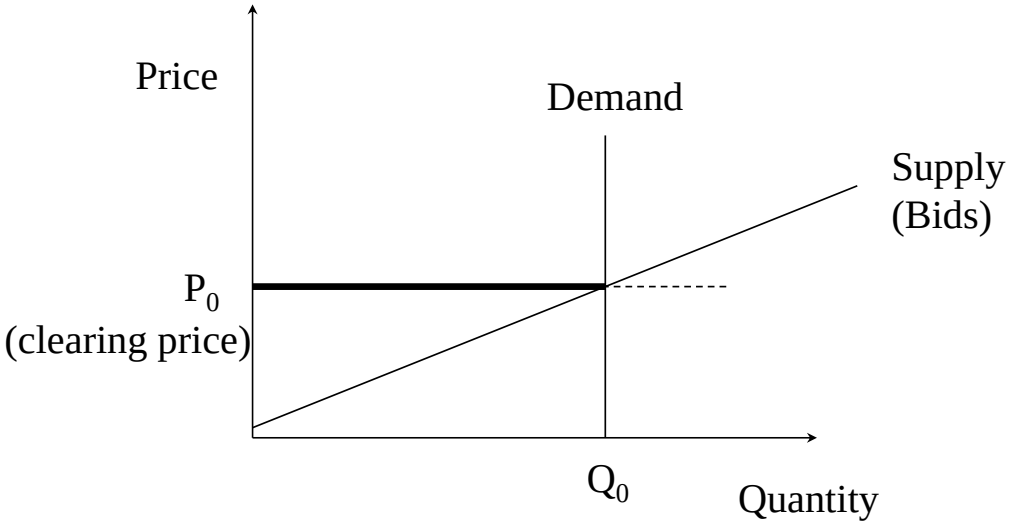
Pay-as-bid auction:

All bids below P_0 win and are paid what they bid



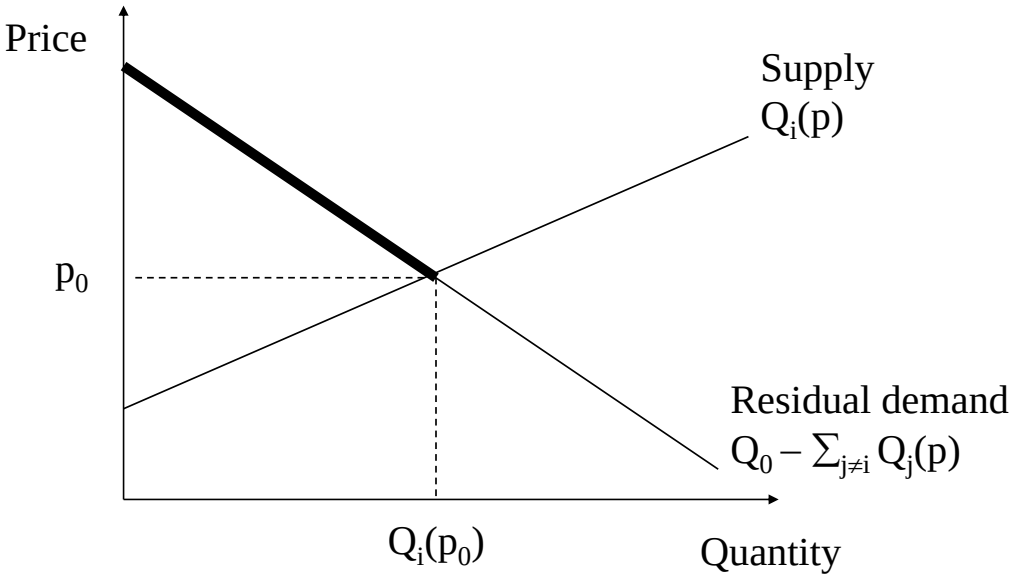
Uniform-price auction:

All bids below P_0 win and get paid P_0

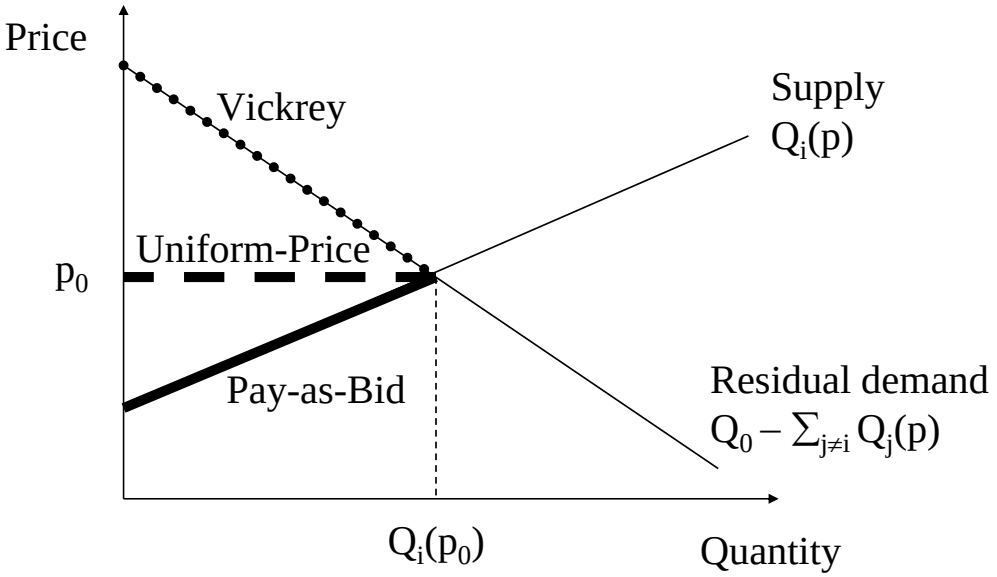


Vickrey auction:

All bids above P_0 win and paid opportunity cost



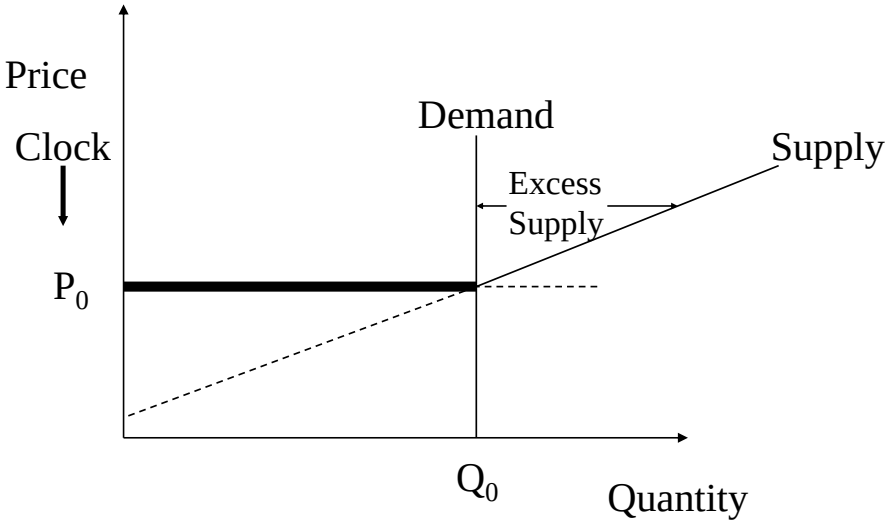
Payment rule affects behavior



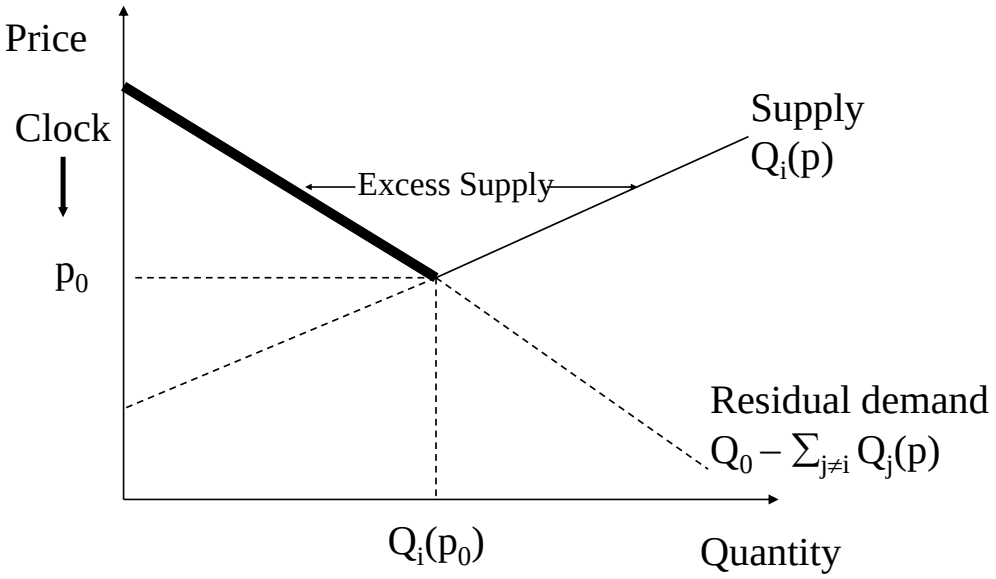
More ways to auction identical items

- Descending-clock: Clock indicates price; bidders submit quantity supplied at each price until no excess supply
  - Standard descending-clock
  - Ausubel descending-clock (Ausubel 1997)

Standard descending-clock auction:
All bids at P_0 win and pay P_0



Ausubel descending-clock:
All bids at P_0 win and paid price at which clinched



Exercise

- 2 bidders (L and S), 2 identical items
- L has a value of $100 for 1 and $200 for both
- S has a value of $90 for 1 and $180 for both
- Uniform-price auction
  - Submit bid for each item
  - Highest 2 bids get items
  - 3rd highest bid determines price paid
- Ascending clock auction
  - Price starts at 0 and increases in small increments
  - Bidders express how many they want at current price
  - Bidders can only lower quantity as price rises
  - Auction ends when no excess demand (i.e. just two demanded); winners pay clock price

How do standard auctions compare?

- Efficiency
  - FCC: those with highest values win
  - ISO: energy efficiently produced and consumed
- Revenue maximization
  - Treasury: sell debt at least cost
  - Utility: sell generation assets at highest price

Uniform-price auction fallacy

"You need only know the maximum amount you are willing to pay for different quantities."

– Milton Friedman, on strategy in the uniform price auction (*Wall Street Journal* 1991)

Uniform-price auction fallacy

"All of that is eliminated if you use the [uniform-price] auction. You just bid what you think it's worth."

– Merton Miller, on the absence of bid shading in uniform price auction (*New York Times* 1991)

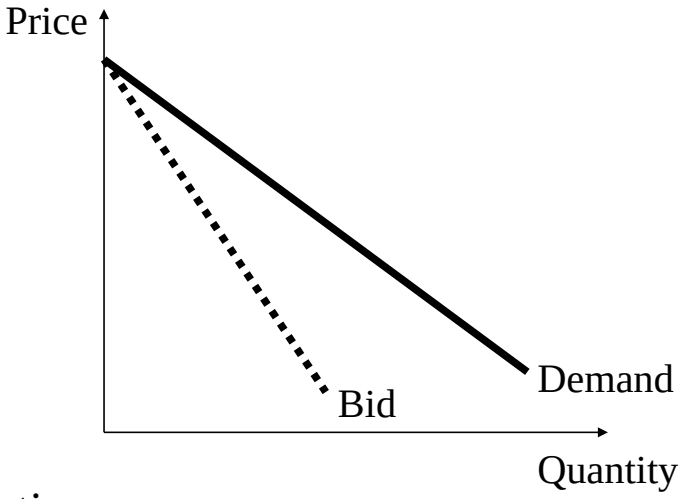
(Note: Top 5 bidders buy 50% of issue.)

Inefficiency Theorem

In any equilibrium of uniform-price auction, with positive probability objects are won by bidders other than those with highest values.

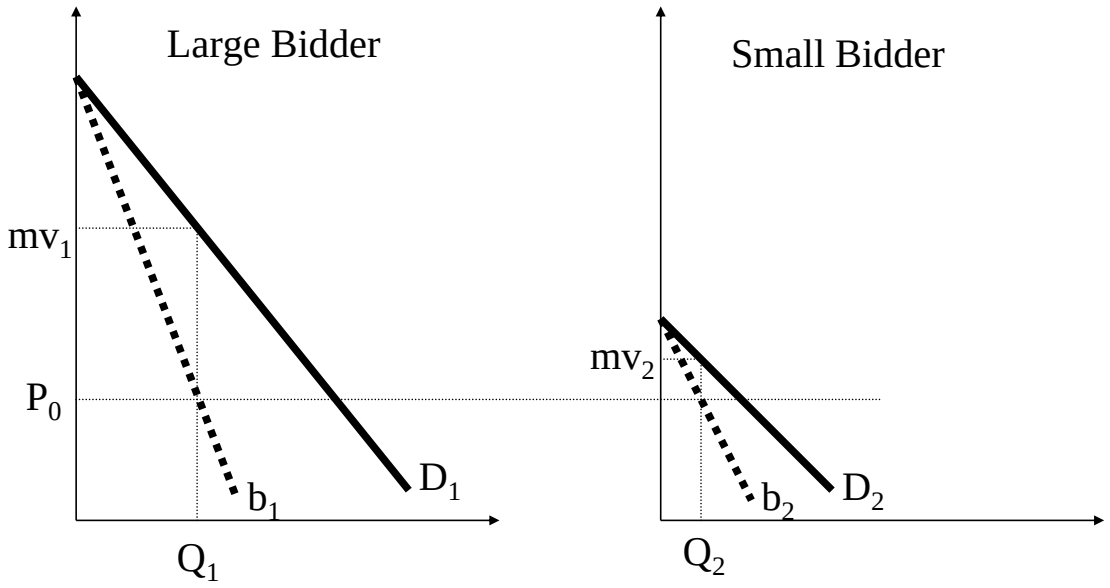
- Winning bidder influences price with positive probability
- Creates incentive to shade bid
- Incentive to shade increases with additional units
- Differential shading implies inefficiency

Inefficiency theorem and bid shading



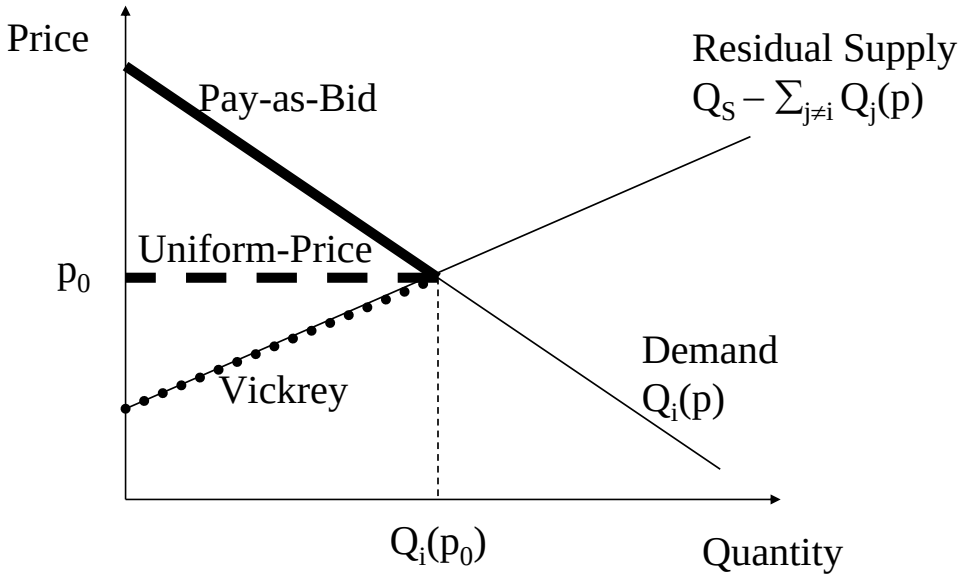
- Exceptions:
  - Pure common value
  - Bidders demand only a single unit

Inefficiency from differential shading



Large bidder makes room for smaller rival

What about seller revenues?



Efficient auctions may yield high revenues

Theorem. *With flat demands drawn independently from the same regular distribution, seller's revenue is maximized by awarding good to those with highest values.*

Competitive Bidding Behavior in Uniform-Price Auction Markets

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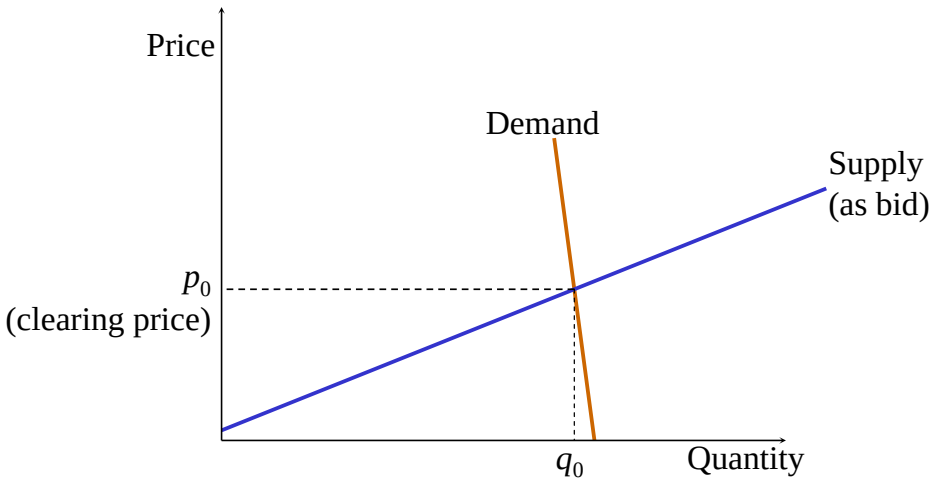
Summary

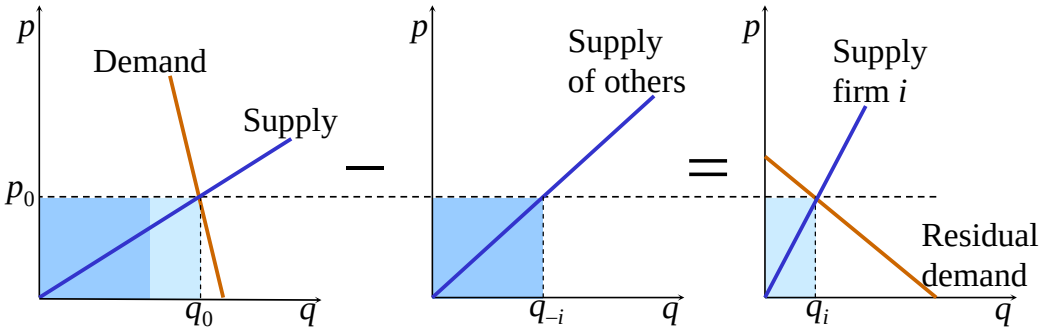
- Marginal cost bidding is a useful benchmark, but not a norm of behavior
- Profit maximization is an appropriate norm of behavior in markets
- Profit maximization should be expected and encouraged
- Market rules should be based on this norm

Uniform-price auction:

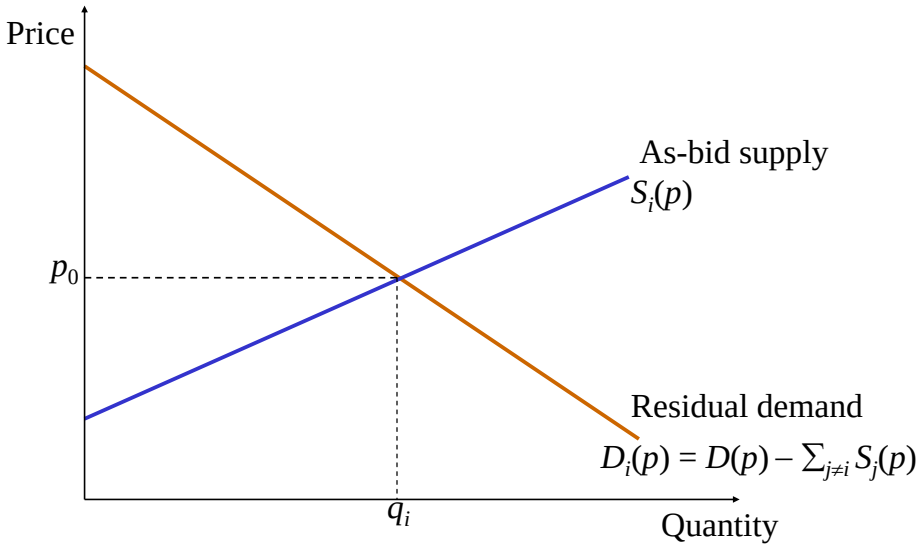
All bids below p_0 win and get paid p_0



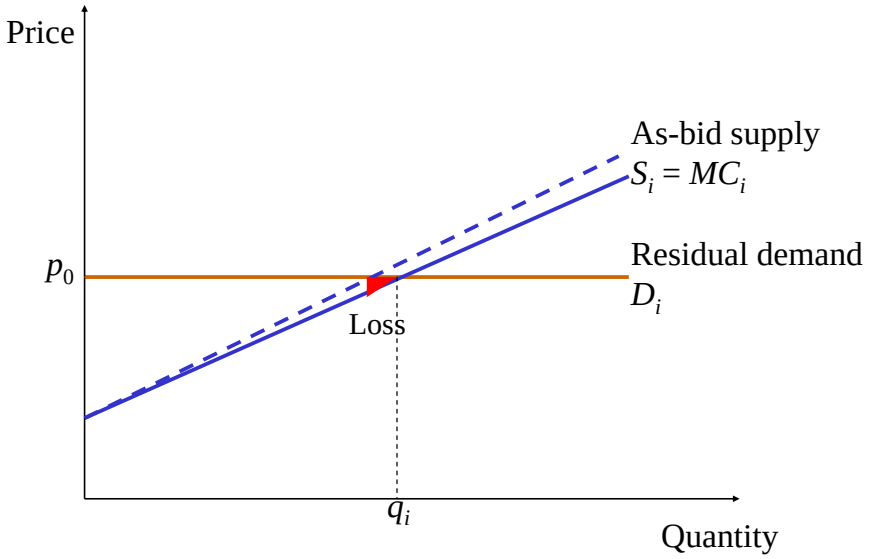
Residual demand removes supply of other bidders



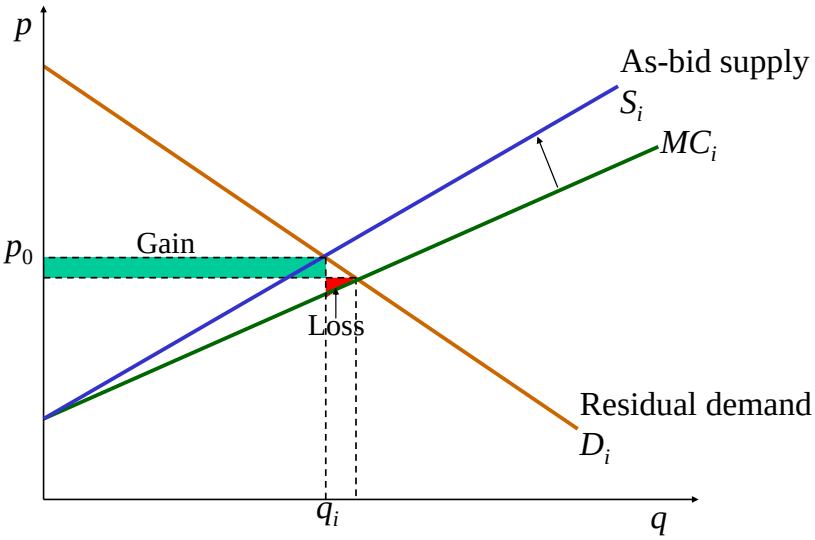
Residual demand curve



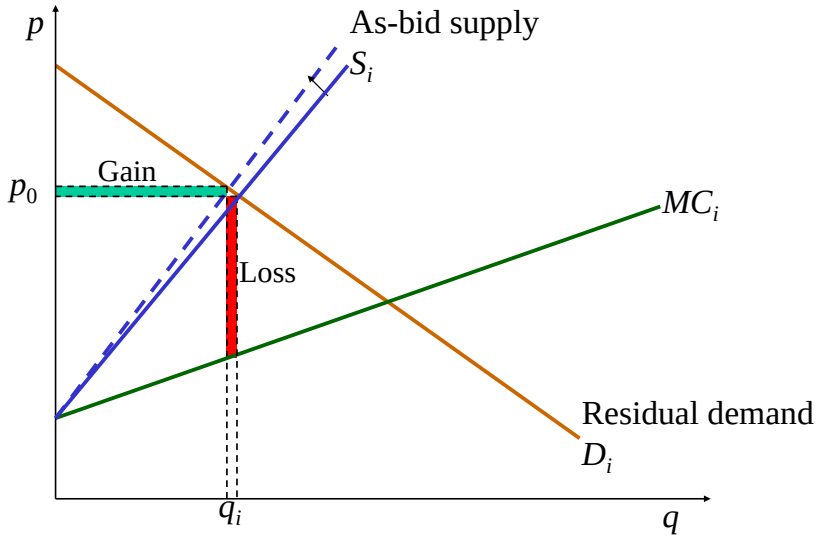
Bidding strategy with perfect competition



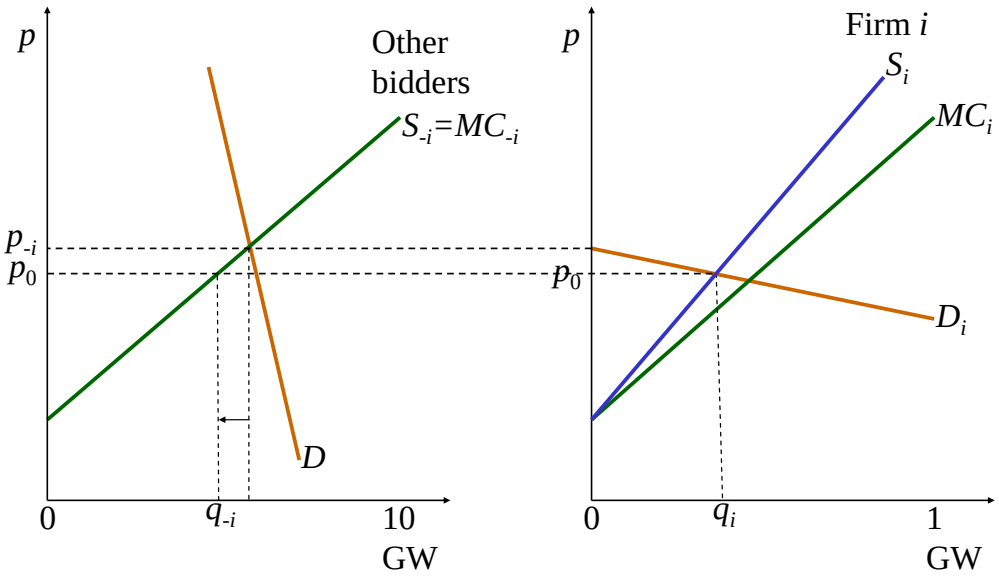
Incentive to bid above marginal cost: tradeoff higher price with reduced quantity



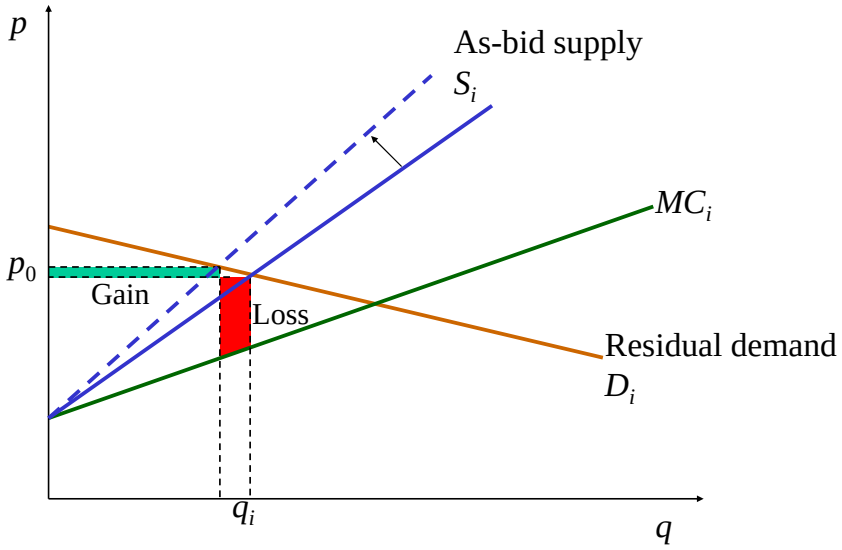
Optimal bid balances marginal gain and loss



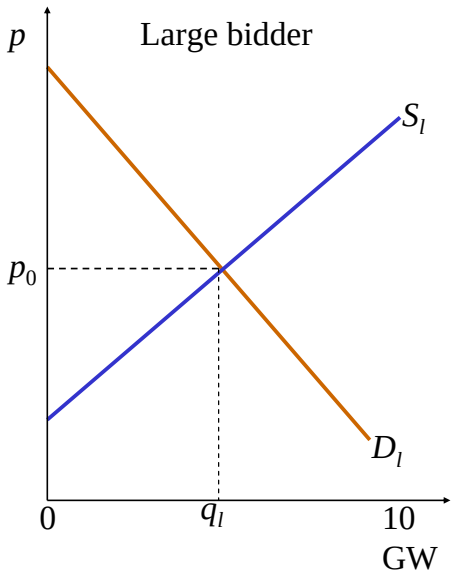
Still bid above marginal cost when others bid marginal cost

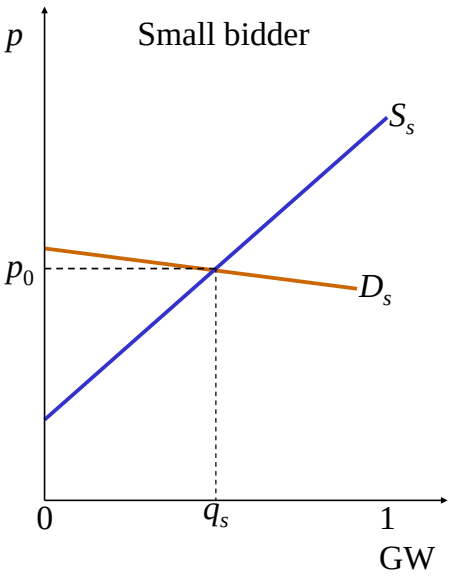


Residual demand response reduces incentive to inflate bids

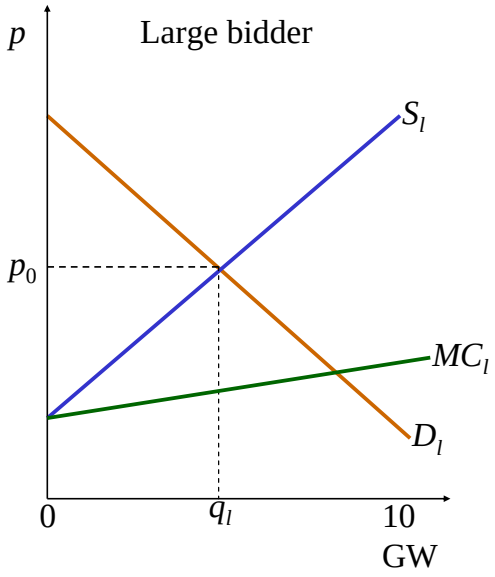


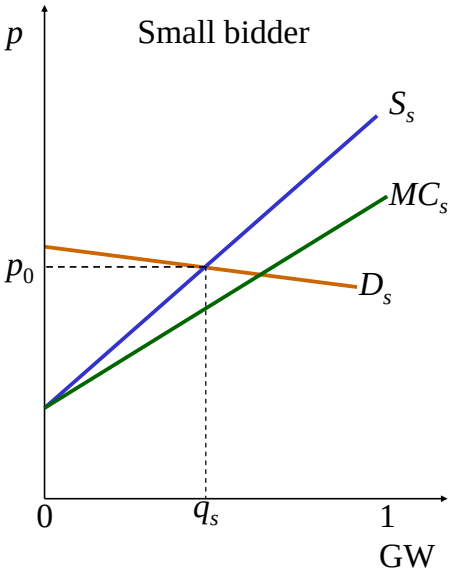
Residual demand is steeper for large bidders



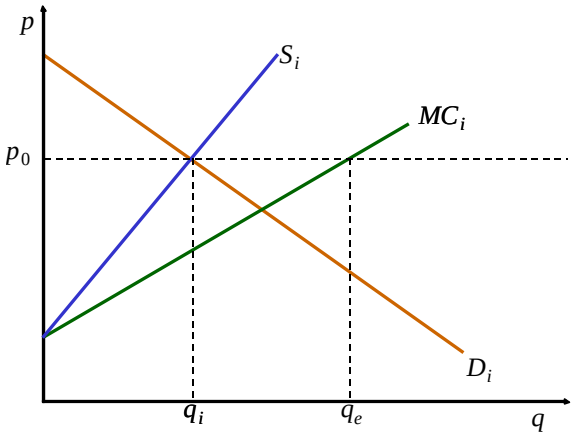


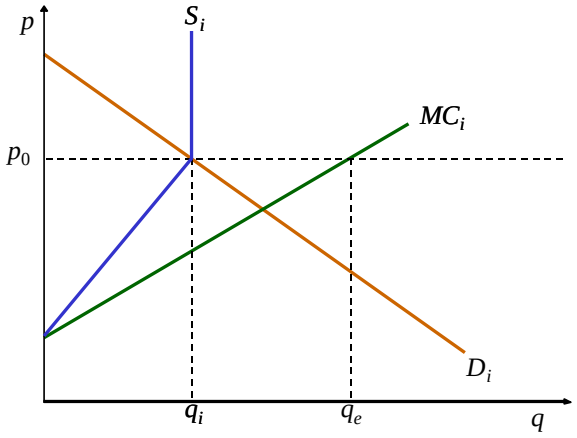
Large bidder makes room for its smaller rivals



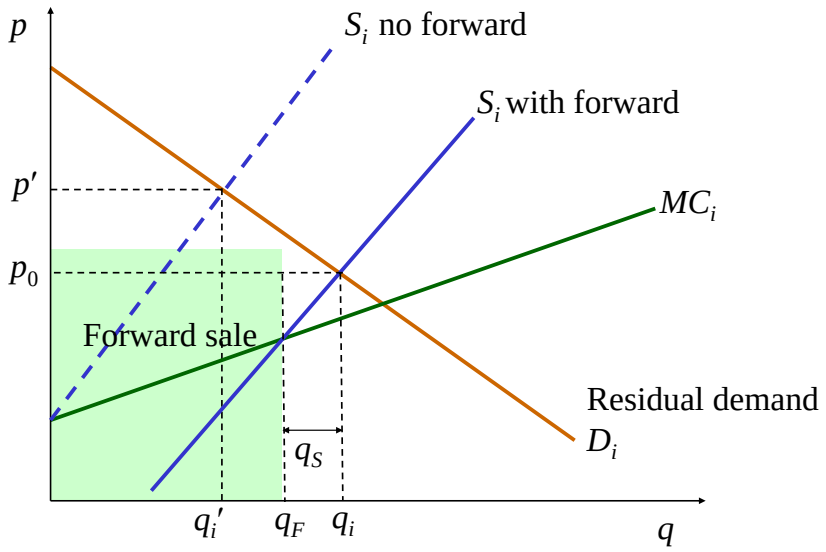


Economic vs. Physical Withholding





Forward contracts mitigate incentive to bid above marginal cost



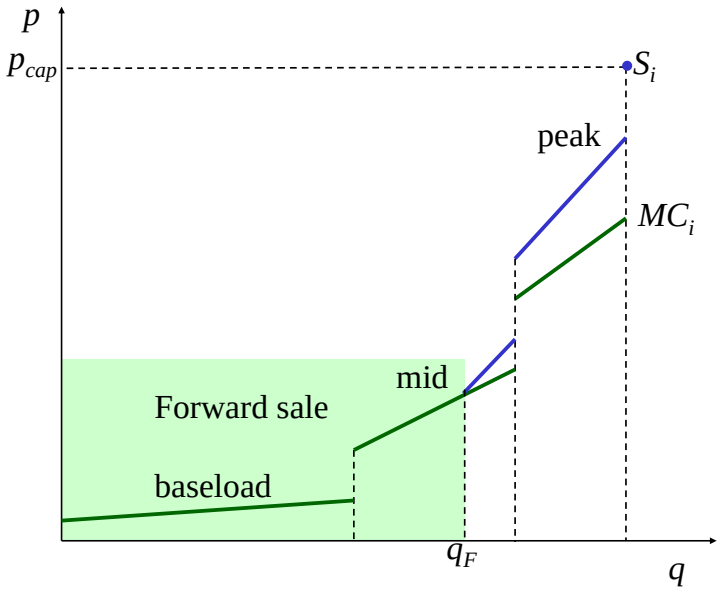
California not more concentrated

California		New York		PJM		New England	
Owner	Share	Owner	Share	Owner	Share	Owner	Share
PG&E	17%	NYPA	17%	PSE&G	20%	PG&E NEG	17%
AES	9%	NRG Power	12%	PECO	17%	NRG	8%
Reliant	8%	LIPA	12%	PP&L	16%	Sithe	7%
Mirant	8%	Reliant	7%	GPU	13%	Notheast Util	6%
Duke	7%	Keyspan	6%	PEPCO	11%	Northeast Gen Serv	6%
SCE	6%	Constellation	5%	BG&E	11%	FP&L Energy	5%
Dynergy	6%	Entergy	5%	Connectiv	9%	Mirant	5%
Other	39%	Mirant	5%	Other	3%	Calpine	4%
		Dynergy	5%			Wisvest	4%
		AES	4%			Duke Energy	4%
		Sithe	3%			Other	33%
		Other	20%				
Total MW	44,682	Total MW	36,342	Total MW	65,067	Total MW	26,441
as of July 1999		as of January 2002		as of January 2000		as of January 2001	

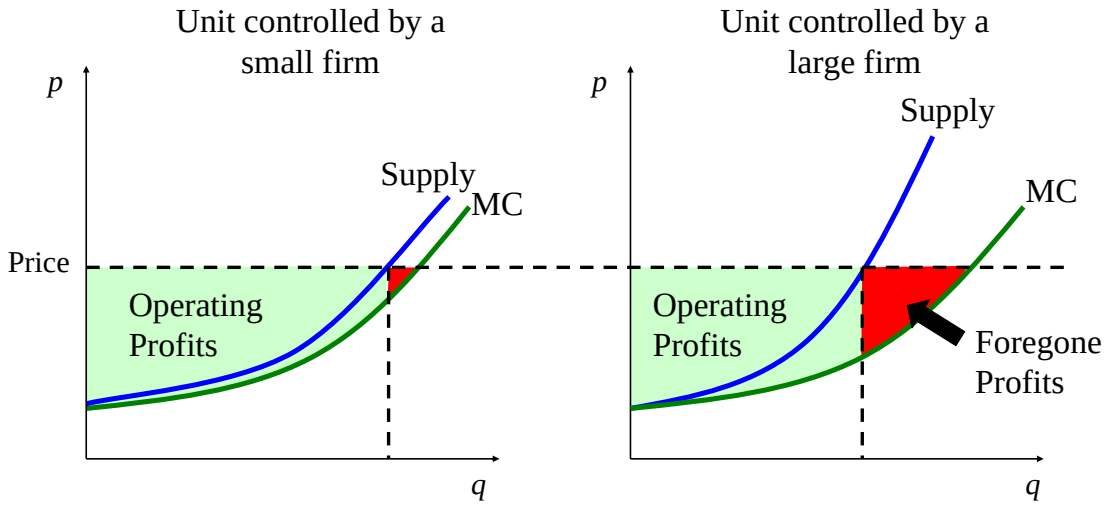
Sources

Borenstein et al. (2002) NYISO Load and Capacity Data Singh and Jacobs (2000) Bushnell and Saravia (2002)

Hockey stick bids arise from forward contracts and discontinuities



Firms with market power do all the work to push up prices, but all firms benefit: Creates incentive for forward contracting



Benefits of profit maximization

- Promotes investment
- Drives markets to long-run efficiency
- Identifies problems in market rules

Market design should assume profit maximizing bidding

- Resource adequacy alternatives
  - ACAP or ICAP markets
    - Doesn't help with market power so add AMP
  - Forward purchase of portfolio of energy options (Chao and Wilson 2003)
    - Must bid obligation assures resource adequacy
    - Contracting when supply more responsive
    - Adds demand response mitigating market power
    - Reduces dependence on AMP

Greed over the grid is good! --- Shmuel Oren

"It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest." --- Adam Smith

Divestiture Auctions

Past Divestiture Experience

- NEES $1.6B: Initial round determines packages
  - USGen wins all 6 initial packages (2 final packages)
- PG&E $.5B: Can bid on any package of plants
  - Duke wins all 3 plants
- Boston Edison $.5B: Can bid on any combination
  - Sithe wins all 5 sites
- SCE $1.1B: Can bid on any plants
  - 10 of 12 sold in 4 bundles; remaining 2 pending
  - market power constraint may have prevented full fleet
- ComEnergy & EUA $.5B:
  - Southern Co. wins full fleet

Standard Investment Bank Approach: 2-Stage Sealed Bid

- Utility advertises plants
- Bidders submit indications of interest
  - Non-binding initial bids
- Utility selects short-listed bidders
- Short-listed bidders conduct due diligence
- “Final” bids submitted
  - Possibly further negotiation or additional bids

Critique of Investment Bank Approach

- Secret process with information controlled by IB
  - Not transparent
  - Incentives of rate payers and IB not aligned
- Encourages full fleet sales
  - Does not address market power concerns
  - Optimal bundles of plants not found with sealed bids
- Sealed bid may not maximize revenues

Simultaneous Ascending Auction

- All assets on the block at the same time
- In each round, can raise bid on any asset
- Auction ends when no new bids on any asset

Ascending vs. Sealed Bid

Why ascending bid?

"Who should get items and at what prices?"

- Price discovery process
  - Open and transparent (legitimate)
  - Reliable market prices (learning)
  - Efficiency
    - Single item: quite general; strategically simple
    - Many items: arbitrage and packaging possible

Why ascending bid?

- Revenue maximization
  - Efficient auctions raise a lot of revenue
    - May be optimal to award to those with highest values
    - Devices to increase revenues often impractical
      - Reserve prices and handicaps
    - Efficiency looks even better in general model
      - Endogenous participation
      - Resale

Revenue maximization

- Reduces winner's curse
  - Milgrom & Weber (1982)
- Others willing to pay nearly as much
- Not raising is a confession of inferiority

  "If its worth $x to them, why isn't it worth that much to us? Aren't we a good company?"
- Budget constraints can be relaxed

Why sealed bid?

- Implementation
  - Don’t have to bring parties together
  - Simple
  - Difficult bid evaluation OK
    - Procurement: Quality of job important

Why sealed bid?

- Ex ante asymmetries
  - If know high valuer wins, then no incentive to bid

Why sealed bid?

- Risk aversion
  - First-price better in IPV (Maskin & Riley 1985)
  - But not true with affiliated values
    - Aggressive bidding risky due to winner's curse
  - Not true if bidder is agent
    - Leaving money on the table is risky

Why sealed bid?

- Avoid collusion
  - Dynamic process of ascending auction can be used to *identify* and enforce collusive outcome
    - Zero-price equilibria
    - Can be designed to minimize problem
  - Can't punish deviations in current auction
  - But can punish outside or in another auction
  - Sealed bid not immune from collusion

Simultaneous ascending auction

- Advantages
  - Reduces uncertainty (winner's curse)
  - Can react to prices in setting bids across items
    - Similar items sell for similar prices
    - Efficient packaging
- Disadvantage
  - May "negotiate" a split of items at low prices
  - But can eliminate undesirable bid signaling

Conclusion

- Ascending bid typically better than sealed bid on both efficiency and revenue grounds
- Concerns
  - May allow bidders to identify and enforce low revenue equilibrium
  - May do worse if weak competition or ex ante asymmetries