Managerial Economics

Unit 8: Auctions

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Summer Term 2018

Objectives

- Explain how managers can apply game theory to the analysis of auctions
- Describe the importance of auction mechanisms and their use in strategic decisions related to negotiations and monopoly markets

History of Auctions

- Ancient Greece, Babylon: Mineral rights, women
- Roman authorities:
  - Collecting debt by auctioning off goods
- Candle auctions:
  - Auction is limited in time until the candle burned out
- Procurement auctions
  - Construction sector, oil lease auctions
- Auction use expanded rapidly with the development of the Internet and e-commerce in the 1990s.

Types of Auctions I

- **English Auction** (ascending-bid):
  - Initial bid set at seller's reservation (reserve) price
  - Auctioneer bids up using a fixed step size
  - bidders indicate whether they accept the offer
  - the last bidder gets the good at her bidding price
  - you get information about willingness to pay of others
  - sometimes time limits
    - ⋆ Sniping: When bidders use programs to ensure that they submit the last-second best bid
- **Other ascending auctions:** Clock or Japanese auctions
- **Examples:** Art auctions, livestock, eBay - online-auctions

Types of Auctions II

- **Dutch Auction** (descending-bid):
  - starts with high initial price
  - price is lowered at time intervals
  - first bidder gets the good
  - used for Dutch flower auctions
  - very fast format
  - convenient when it is important to auction goods quickly

Types of Auctions III

- **Sealed-bid auctions:**
  - one bid per person in a sealed envelope
  - First-price sealed bid auction: bidder with the highest bid receives the good at her stated price
  - Reverse sealed-bid auctions
    - ⋆ bidder with lowest cost wins
    - ⋆ public procurement: construction (highway)
  - Mineral rights auctions, oil leases

Types of Auctions IV

- **Second-price sealed-bid auction:**
  - Vickrey auction
    - ⋆ http://nobelprize.org/economics/laureates/1996/index.html
  - The highest bidder receives the good, but she has to pay only the price of the second-highest bidder

Why should you want to use an auction to sell something?

- Rules of the auction can easily be influenced
- Goods in limited quantities (often unique, but not necessarily)
- Way to elicit willingness to pay from consumers
- Online auctions easily done

Baseline model

- Bidders are symmetric:
  - Bidders with identical reservation prices who observe the same signal will submit the same bids.
  - Bidders select bid from the same distribution of possible bids
  - But do not necessarily chose the same
- Bidders are risk-neutral
- Bids are based on signals from an independent distribution
  - My value does not influence yours

Taxonomy of auctions

- Private-value auctions:
  - Auctions in which reservation prices are a function of information and utility
  - Everybody values the good differently
  - Art, Paintings
- Common-value auctions:
  - Auctions in which all bidders value the good similarly
  - Each bidder forms expectations about the true value
  - Oil field

Auction mechanism and revenue generation

- **Revenue equivalence theorem:** type of auction does not affect the expected total surplus and hence does not affect the expected revenues for the seller
  - Notation
    - ★ b = bid
    - ★ p = price paid by winning bidder
    - ★ Pr_W = probability of winning the auction
    - ★ Expected profit = $Pr_W(b - p)$
    - ★ Expected profit is the same for the four types of auctions.

Bidding strategies

- If there is a dominant strategy: Bidders should always be willing to bid up to their reservation prices.
  - If the current bid is higher than or equal to your reservation price, don't bid.
  - If the current bid is lower than your reservation price, increase the bid.

Bidding strategies

- Only in **English auction** bidders learn more about reservation prices of the others
- But dominant strategy:
  - Always bid up to the reservation price (in fact bid one cent above the last bid of the others)
  - Good is sold at reservation price of the second-highest bidder (plus 1c or the minimum additional step size)
- Same prediction in **second-price sealed bid auction:**
  - Dominant strategy to bid exactly the reservation price
  - Vickrey auction is a truth-telling mechanism:
    - ⋆ Structure gives an incentive to reveal the true willingness-to-pay.

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2007

"for having laid the foundations of mechanism design theory"

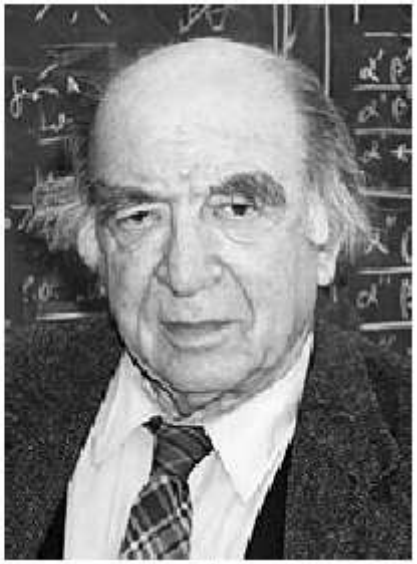

Photo: Dong Oh

Photo: Cliff Moore

Photo: Univ. of Chicago

Leonid Hurwicz

1/3 of the prize

USA

University of Minnesota
Minneapolis, MN, USA

b. 1917
(in Moscow, Russia)

Eric S. Maskin

1/3 of the prize

USA

Institute for Advanced Study
Princeton, NJ, USA

b. 1950

Roger B. Myerson

1/3 of the prize

USA

University of Chicago
Chicago, IL, USA

b. 1951

Dutch and sealed-bid auction

- Should you write your true WTP in the envelope in a first-price sealed-bid auction?
- Dutch and first-price sealed bid auction are strategically similar
  - No dominant strategy; you have to consider what the others are bidding
  - E.g. Dutch, you should not bid your reservation price, because then no surplus available any more.
  - If distribution of valuations is known, bidders can anticipate bidding.
  - Nash strategy: assume others are behaving rationally; then you should maximize your expected profit

Dutch and sealed-bid auction II

- Nash-strategy:
  - Estimate the reservation price of the second-highest bidder and bid it.
  - How to do it?
  - Number of bidders n is important: the more bidders, the closer you should bid to your own reservation price
  - Example: If distribution of bids is uniformly distributed between L (low end) and v (bidders reservation price):
  - $B = v - [(v - L)/n]$

Example

- Descending auctions or first-price sealed-bid auctions (Continued)
  - Example
    - ★ $v = 3$
    - ★ $L = 0$
    - ★ $B = 3 - [(3 - 0)/2] = €1.50$ *for* $n = 2$
    - ★ $B = 3 - [(3 - 0)/3] = €2.00$ *for* $n = 3$

Efficiency vs. Expected revenues

- a seller aims at getting the highest possible revenues
- another aim is to sell the item to the bidder with the highest valuations
- consider procurement auctions with the government as the seller:
  - E.g. construct a highway
  - Aim is to guarantee lowest construction cost
  - Bidder with lowest cost estimate should get the deal.
- with symmetry, all four auction formats are efficient

Strategy for Seller

- Auctions similar to third-degree price discrimination
- Example:
  - Four units to sell, $MC = 0$
  - Six consumers with WTP (90, 60, 50, 40, 20, 15)
  - What is the result of an auction vs.
  - Seller posts a price of €40

TABLE 12.1

Auction

Consumers	Reservation Price	Winning Bid
1	$40	$21
2	20	
3	15	
4	90	61
5	60	51
6	50	41
Total consumer surplus		66
Total seller surplus		174
Total available surplus		240

TABLE 12-01

TABLE 12.2

Posted Price

Consumers	Reservation Price	Price Paid
1	$40	$40
2	20	
3	15	
4	90	40
5	60	40
6	50	40
Total consumer surplus		80
Total seller surplus		160
Total available surplus		240

TABLE 12-02

Use of auctions to gather more information about buyers

- Example: Repurchase Tender Offer (company wants to buy back shares from current shareholders)
  - Typically priced at a premium over market price
- One possibility: fix a price, wait how many shares will come back
- Or: modified Dutch auction: firm announces a price range; shareholders have to provide a supply schedule
- Price is set afterwards

- Current value of the company: $14 per share
- Company assumes share is worth $20
- Expectations about supply schedule of shareholders under three scenarios
- Profit = (20 - share price) $*$ shares traded

Price	Strong	Profit	Medium	Profit	Weak	Profit
$15	400,000	$2,000,000	310,000	$1,550,000	280,000	$1,400,000
16	415,000	1,660,000	400,000	1,600,000	315,000	1,260,000
17	600,000	1,800,000	415,000	1,245,000	400,000	1,200,000
Probability of shareholder's willingness to tender						
	0.40		0.30		0.30	

Table 16.3 Shareholder Supply Schedule

Managerial Economics, 6th Edition

Expected profit if firm does not know supply schedule

- Firm has to set a price:
- $EV(15) = 2.0 * 0.4 + 1.55 * 0.3 + 1.4 * 0.3 = \$1.685$
- $EV(16) = 1.66 * 0.4 + 1.6 * 0.3 + 1.26 * 0.3 = \$1.522$
- $EV(17) = 1.8 * 0.4 + 1.245 * 0.3 + 1.2 * 0.3 = \$1.453$
- \$15 is chosen

Expected profit if auction is chosen

- Price selected only after the auction
- In strong supply case \$15 is chosen, in medium \$16 and in weak \$15
- $EV(auction) = 2.0 * 0.4 + 1.6 * 0.3 + 1.4 * 0.3 = \$1.700$
- Profit possible, because firm can set a higher price in one of the cases
- How does it work?
  - You need a truth-telling mechanism, so that shareholders reveal the right supply schedule
  - Contract is needed: shareholders cannot sell more share at the specified price (otherwise they would lie)

- www.priceline.com
- Auction for airline seats
- Airline seats are perishable goods, marginal costs are very low, empty seats bring no cash
  - Giving official discounts does not make sense, because price structure would suffer
- Buyers name price they are willing to pay, priceline is auctioning: if an airline is accepting, the sale is done(!)

ANALYZING MANAGERIAL DECISIONS

The Use of Sophisticated Pricing within an Auction Format

Priceline.com is a good example of how managers can use sophisticated pricing policies within an auction format. The company was launched in April 1998 after Priceline managers helped develop software for a computer reservation system. The software gave airline managers the ability to make real-time adjustments to prices based on various factors, like unoccupied seats or competitor prices. Each airline sees only its own prices, but managers at Priceline are able to see prices across all member airlines.

Airline seats are perishable goods: Once the plane departs, empty seats are worthless, since they cannot be used again. And the marginal cost of flying a plane with one more passenger is almost zero, so any price is profitable for the airline. As Brian Ek of Priceline.com states, "The airlines fly with up to 700,000 empty seats a day. Naturally they would love to sell those seats if they could without affecting their retail fare structure." Priceline.com developed an auction mechanism to allow airlines to do just that. The company has sold over 5 million airline tickets since 1998.

Priceline.com uses a reverse auction mechanism. In reverse auctions, buyers name the price they are willing to pay for a good or service. The seller then decides whether to accept or reject this price. Priceline's auction operates as follows: A consumer specifies a departure date, the departing and destination airports, the price each is willing to pay for a ticket, and a credit card number. All sales are final. If Priceline finds a ticket at or below that price, the consumer is obligated to purchase it. After receiving a consumer's price, managers at Priceline examine their database to determine if any airline is offering tickets at or below that price. If there are tickets, Priceline buys them. The profit to Priceline is the difference between what the consumer is willing to pay for the ticket and the price Priceline was charged.

Although Priceline claims it has increased the market power of consumers (since they are free to name their own price), many disagree with the claim. Basically, Priceline's reverse auction allows the firm to practice price discrimination. Like airlines, Priceline sells tickets on the same airplane at different prices depending on the price quoted by the consumer. Say I submit a price of $300 for a ticket from New York to Chicago. If my friend submits a price of $250, she would buy an identical product at a cheaper price (assuming airlines were willing to sell tickets for $250). Basically, Priceline's reverse auction gets consumers to name their reservation price, then Priceline charges them this price. So the reverse auction does not guarantee that consumers receive a product at the lowest price, it simply guarantees them the chance to purchase a product at *their* reservation price.

Priceline's price-discriminating auction also improves on the traditional price discrimination schemes by making discounts less transparent to both consumers and rivals. Airlines need not post any special rates, which reduces the probability that rivals could engage in a disastrous price war. Also, the company is able to practice price discrimination selectively. For example, there is some evidence that Priceline will accept lower prices from first-time customers. When those consumers subsequently bid the same price for the same product, they find their bids are rejected.

Risk aversion

- In second-price auctions risk-aversion does not matter. Why?
- What in a first-price auction or Dutch auction?
  - No dominant strategy
  - Higher bids increase probability of winning
  - If risk-averse bidders want to avoid losing, they will increase their bid
- If bidders can be assumed to be risk-averse, then sellers should chose first-price auctions!!

Asymmetries

- In second-price auctions it does not matter whether bidders are asymmetric. Why?
- What in a first-price auction or Dutch auction?
  - No dominant strategy
  - Bidders with higher valuations shade their bids more than bidders with lower valuation
  - bidders with lower valuations may win $\rightarrow$ inefficient
- If bidders can be assumed to be asymmetric, then sellers should chose ascending auctions
  - However: in ascending auctions it is easier to collude

Number of bidders

- Expected bid (sale) = reservation price of the second-highest bidder.
- More bidders will increase profit for the seller
- Assume reservation price of bidders is uniform between 0 and €100, expected revenue for seller:
  - $REV = (N-1)/(N+1) * (\textit{highest res. price})$

Expected Revenue versus Number of Bidders

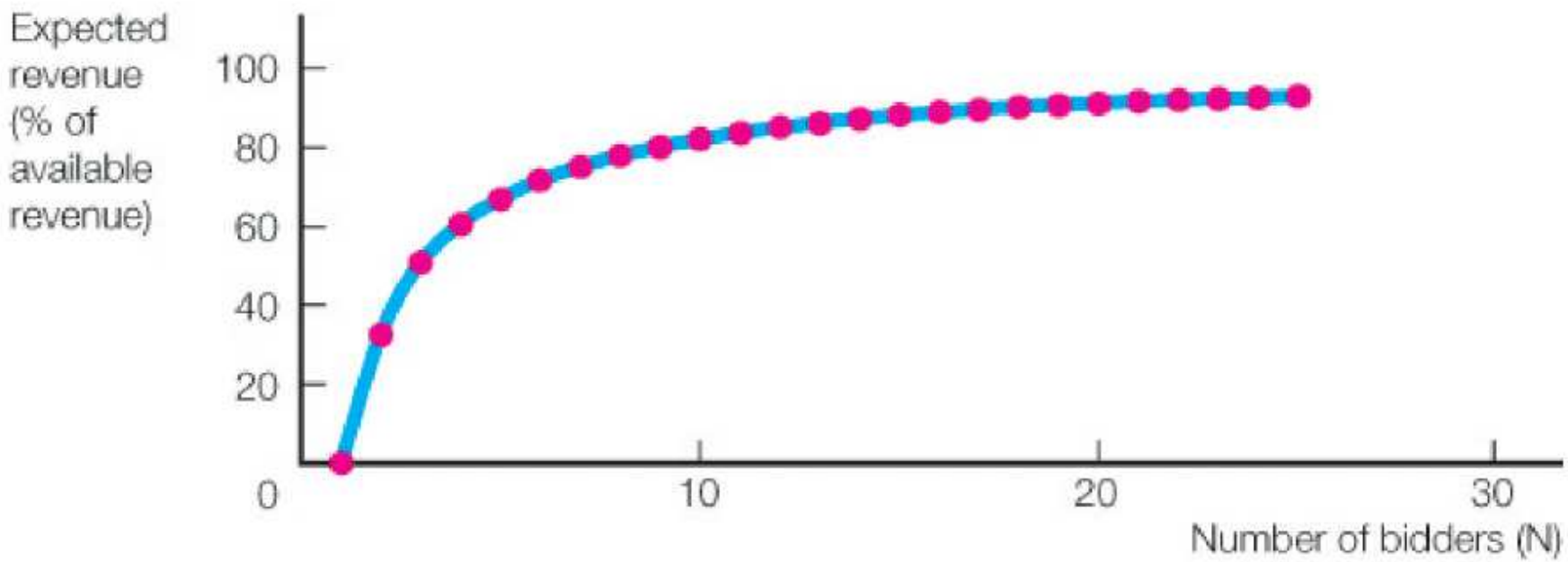

FIGURE 12-02

Winner's curse

- Is it always good to win the auction?
- Be aware in common value auctions!
  - True value of the good not known for sure, but common to all (e.g. oil field)
  - Sealed-bid first price auction:
    - ★ Most optimistic bidder wins
  - Same problem for project procurement (reverse auction)

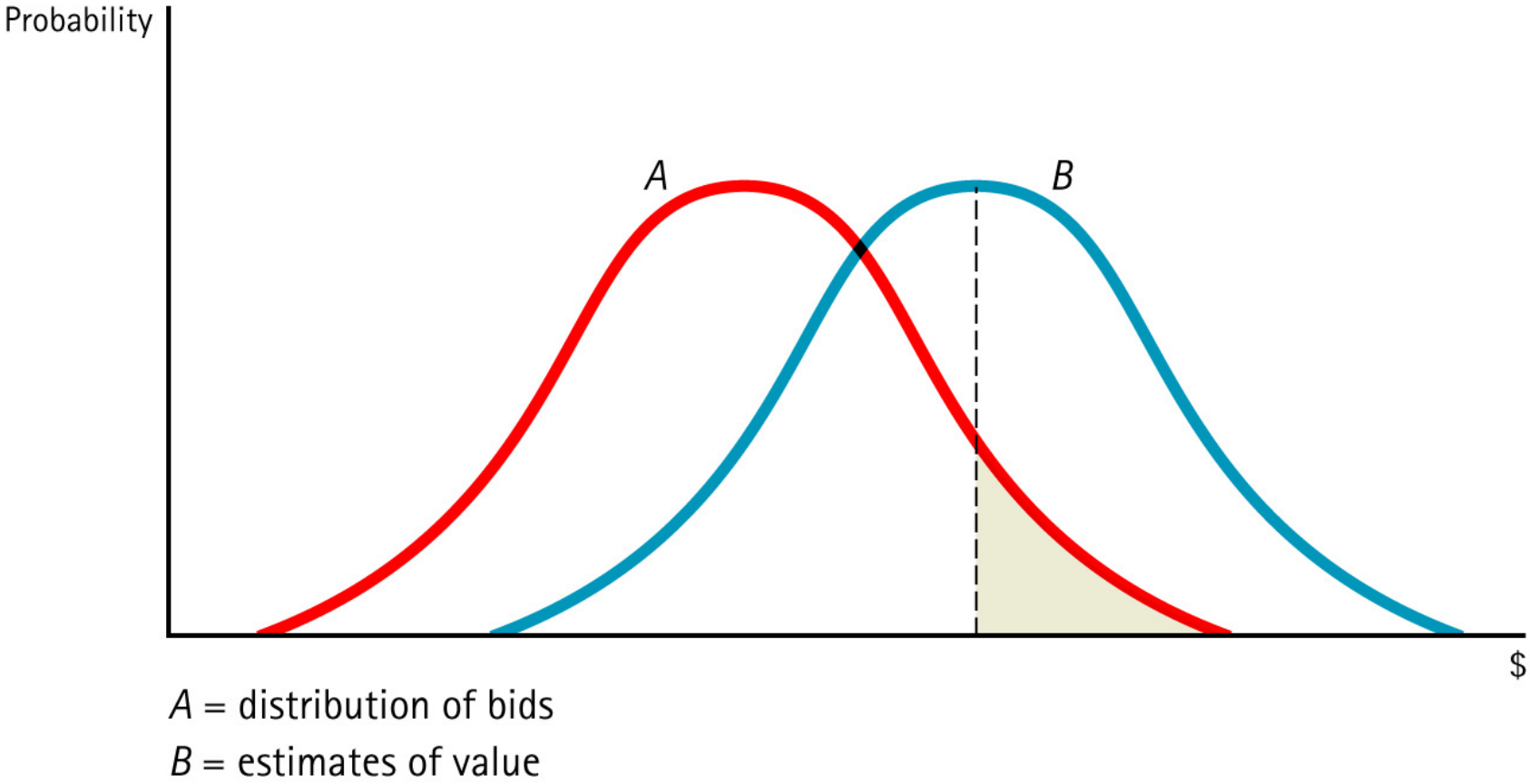

Figure 16.3 The Winner's Curse

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Winner's curse

- What can you do?
  - A bidder with relatively less information than others should bid lower.
  - A bidder with relatively little confidence in his or her estimate of the value of the good should bid lower.
  - The more bidders there are in the auction, the lower the bid should be
    - ⋆ This is the most interesting rule
  - Be also aware of the winner's curse as a seller

Concerns in auction design - for the seller

- The ability for bidders to collude is a concern to sellers.
  - Bidders form a "ring" in which no one bids against the designated bidder. The goods that are purchased are then distributed among members of the ring after the auction.
  - Colluding bidders do not bid up prices.
  - Collusion more probable in multi-unit auctions where several units of a good are sold — or if the auction is happening more often over time (highway construction lots)

Concerns in auction design - for the seller

- The ability for the seller to attract bidders is important:
  - If it is clear to all bidders that one particular bidder will win, they are less likely to participate in the auction.
  - If the seller sets a reserve price that is too high, then bidders are less likely to participate in the auction.
  - If the seller sets a reserve price that is too low, it encourages collusion.
    - ⋆ Because the expected profit is higher

Examples of collusion

- Example:
- Frequency auctions: simultaneous ascending auctions for frequencies in several regions
  - code for a certain region $= 02$, then firms used a price like 1002 to indicate their interest in this region

Concerns in auction design

- in Germany the auction design requested 10% increases when raising bids:
  - Mannesmann signaled to share the market by bidding 18.18 mio DMs on blocks 1-5 and 20.0 mio DMs on blocks 6-10 $\rightarrow$
    - ★ why different bids for equal products?
  - as an answer, managers of T-Mobil increased to 20.0 DMs on the blocks 1-5

Concerns in auction design

- public announcements
- Telekom Austria was cited in the newspapers:
  - "it would be satisfied with 2 out of the 12 blocks of frequencies on offer", but "it would bid for a 3rd block if one of its rivals did"

Collusion in auctions: paper by Paul Klemperer in Journal of Economic Perspectives, 2002

WHAT REALLY MATTERS IN AUCTION DESIGN

Paul Klemperer

In the Austrian third-generation mobile spectrum sale, for example, six firms competed for twelve identical lots in an ascending auction and not surprisingly seemed to agree to divide the market so each firm won two lots each at not much more than the very low reserve-price. Perhaps six winners was the efficient outcome. But we certainly cannot tell from the behavior in the auction. (It was rumored that the bidding lasted only long enough to create some public perception of genuine competition and reduce the risk of the government changing rules.) Firms are also permitted to make explicit statements about auction that would surely be unacceptable if made about a "normal" economic market. For example, before the Austrian third-generation spectrum auction Telekom Austria, the largest incumbent and presumably the strongest among the six bidders, said it "would be satisfied with just 2 of the 12 blocks of frequency on offer" and "if the [5 other bidders] behaved similarly it should be possible to get the frequencies on sensible terms", but "it would bid for a 3rd block if one of its rival did" (Reuters, 31/10/2000). It seems inconceivable that a dominant firm in a "normal" market would be allowed to make the equivalent offer and threat that it "would be satisfied with a market share of just $\frac{1}{6}$" and "if the other five firms also stick to $\frac{1}{6}$ of the market each, it should be possible to sell at high prices", but "it would compete aggressively for a larger share, if any of its rivals aimed for more than $\frac{1}{6}$ ".