THE BERTRAND MODEL

Overview

- Context: You're in an industry with one competitor. If you cut your price to gain market share, how is she likely to respond? What is the outcome if you get into a spiral of competitive price cuts?
- Concepts: Bertrand model, best responses, price war
- Economic principle: the only reliable floor on price is marginal cost

Bertrand model

- Players: two firms produce identical products; each has constant marginal cost MC
- Strategies and rules:
  - Firms set prices simultaneously
  - If one firm prices lower, then it gets the whole market
  - If prices are the same, then firms split the market
- Total demand is $Q = D(p)$, where p is the low price
- Referred to as *Bertrand model* after its inventor

Bertrand game with three price levels

		Firm 2: 5	Firm 2: 4	Firm 2: 3
Firm 1	5	7.5, 7.5	0, 12	0, 7
	4	12, 0	6, 6	0, 7
	3	7, 0	7, 0	3.5, 3.5

- What are the best-response mappings?
- What is the Nash equilibrium?
- Excluding the strategy $p = 3$, does this game remind you of another game we saw earlier?

Continuous-variable strategies

- Gas stations don't just set price at 2, 3 or \$4 per gallon
- Suppose strategy is any $p \in \boldsymbol{R}_0^+$
- Cannot represent game as a payoff matrix. Instead,
  - represent payoffs by expressions $\pi_i(p_i, p_j)$
  - draw best-response mappings in the (p_1, p_2) space

Continuous-variable strategies

- Best-response mapping: value or values $p_i^*(p_j)$ such that

  $$\pi_i(p_i, p_j) \leq \pi_i(p_i^*, p_j), \text{ for all } p_i$$

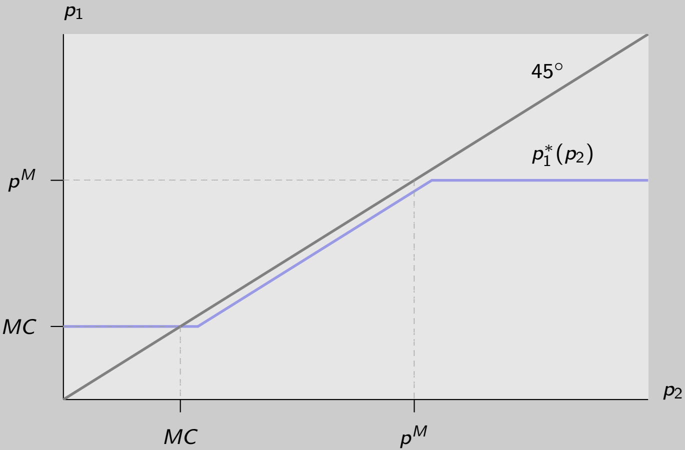
- Nash equilibrium: values $(\widehat{p}_i, \widehat{p}_j)$ such that

  $$\pi_i(p_i, \widehat{p}_j) \leq \pi_i(\widehat{p}_i, \widehat{p}_j), \text{ for all } p_i$$
  $$\pi_j(\widehat{p}_i, p_j) \leq \pi_j(\widehat{p}_i, \widehat{p}_j), \text{ for all } p_j$$

- This is equivalent to

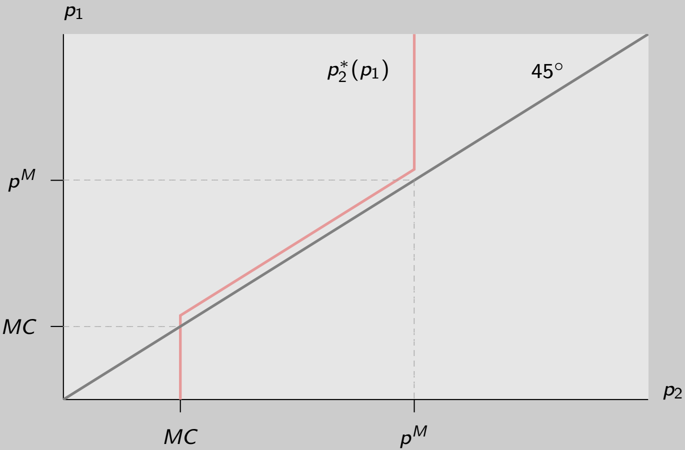
  $$\widehat{p}_i \in p_i^*(\widehat{p}_j)$$
  $$\widehat{p}_j \in p_j^*(\widehat{p}_i)$$

Firm 1's best-response curve

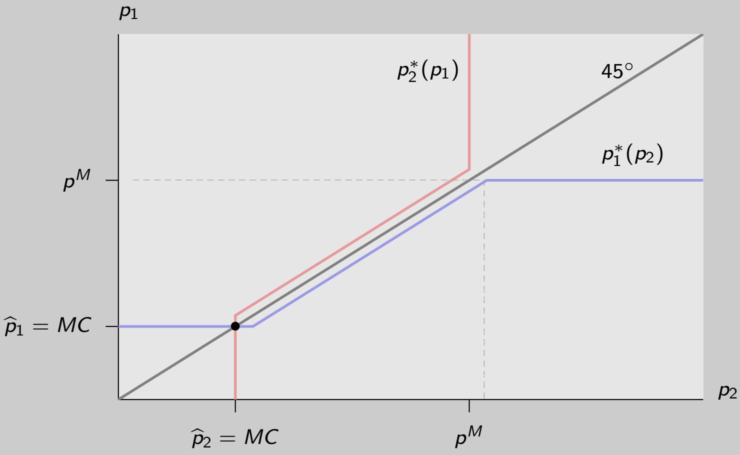


Firm 1's best-response mapping: optimal p_1 given p_2

Firm 2's best-response curve



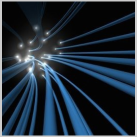
Outcome of price game



Nash equilibrium: $p_1 = p_2 = MC$

The "Bertrand trap"

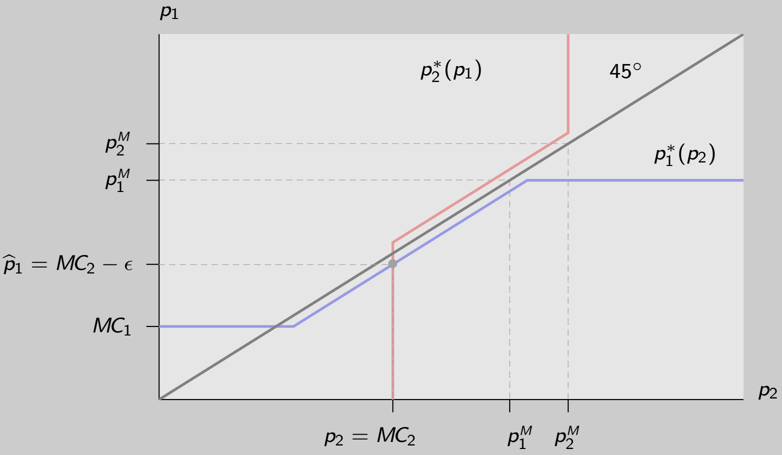
- Even with two firms, price is driven down to the competitive price (marginal cost): economic profits are zero; accounting profits could be negative if there are sunk costs
- Note that neither higher demand nor lower costs (if both firms have the same cost) increase profits
- Examples: airlines, fiber-optic cable, CD phone books
- Rule of thumb: Avoid this game if you can!



Ways out of the trap

- Product differentiation and branding (moderates impact of price competition)
- Limit capacity (the capacity game is less hazardous)
- Be the cost leader
- Implicit or explicit agreement on price
  (but how do you do this and stay out of jail?)

Benefits of low cost



Capacity constraints

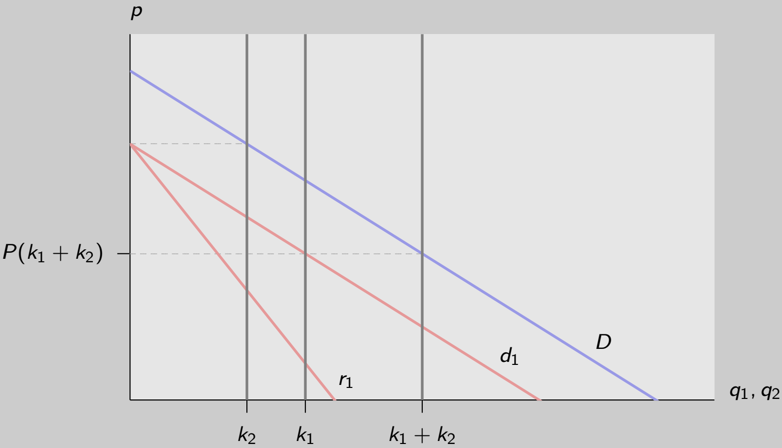
- Firm i has capacity k_i; if its demand is greater than k_i, its sales are k_i, and the rest of the demand is available for firm j
- Assumption: a capacity constrained firm keeps the customers with highest willingness to pay
- Claim: under these circumstances, if capacities are sufficiently small, then equilibrium pricing implies

$$p_1 = p_2 = P(k_1 + k_2)$$

  where $P(Q)$ is the market inverse demand curve
- Proof: in next graph, show that, given $p_1 = P(k_1 + k_2)$, the best firm 2 can do is set $p_2 = p_1$

Note for aficionados: the above proof covers the essentials but is nevertheless incomplete.

Capacity constraints



Takeaways

- Price-cutting is a dangerous game
- Price competition can be severe, even with few firms
- Avoid hazards of price competition by:
  - Lowering costs
  - Cooperating on price
  - Limiting capacity
  - Differentiating your product