Managerial Economics
Unit 6: Oligopoly

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OBJECTIVES

- Explain how managers of firms that operate in an oligopoly market can use strategic decision-making to maintain relatively high profits

- Understand how the reactions of market rivals influence the effectiveness of decisions in an oligopoly market

Oligopoly

- A market with a small number of firms (usually big)

- Oligopolists "know" each other

- Characterized by interdependence and the need for managers to explicitly consider the reactions of rivals

- Protected by barriers to entry that result from government, economies of scale, or control of strategically important resources

Strategic interaction

- Actions of one firm will trigger re-actions of others

- Oligopolist must take these possible re-actions into account before deciding on an action

- Therefore, no single, unified model of oligopoly exists

  - Cartel
  - Price leadership
  - Bertrand competition
  - Cournot competition

COOPERATIVE BEHAVIOR: Cartel

- Cartel: A collusive arrangement made openly and formally
  - ▶ Cartels, and collusion in general, are illegal in the US and EU.
  - ▶ Cartels maximize profit by restricting the output of member firms to a level that the marginal cost of production of every firm in the cartel is equal to the market's marginal revenue and then charging the market-clearing price.
    - ★ Behave like a monopoly
  - ▶ The need to allocate output among member firms results in an incentive for the firms to cheat by overproducing and thereby increase profit.

Cartels

- Adam Smith (1776) already noticed that
  - people of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in same contrivance to raise prices ....
- Illustration: newspaper industry in Detroit
  - in 1989, Detroit Free Press and Detroit News were allowed to merge although they formed a monopoly as Free Press was about to fail
  - the two papers further appeared as two entities, but the firm merged on all other aspects like cost, setting rates, advertising and so on.
  - firm acted as a monopoly and we observed a change in profits: each lost about 10 Mill. a year, afterwards profits were high as 150 Mill

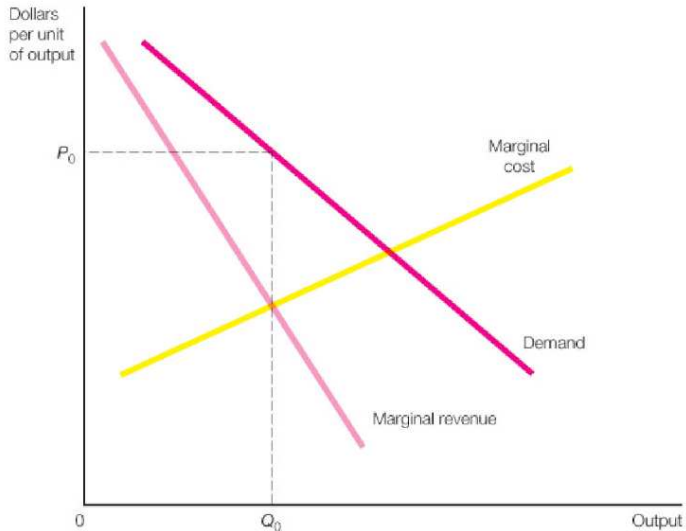## Price and Output Determination by a Cartel

FIGURE 10-01

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Cartel

- Cartels act like multiplant monopolies.

- Profit of cartel is maximized if marginal costs among members of cartel are equalized ($MC_1 = MC_2$)

- Would mean that high-cost firms produce less in optimum
  - firms may still agree on equal quotas
  - use of side payments

- Examples
  - Lysine (The informant!, movie with Matt Damon), DRAM industry, US school milk markets, elevators, Lombard club, Steel for railways
 - OPEC, Coffee cartel
  - Worker unions, Firm associations

Cartel as a multi-plant monopoly

PRICE

MC₁

Q₁

FIRM 1

MC₂

Q₂

FIRM 2

D

MC
Supply

MR

TOTAL OUTPUT
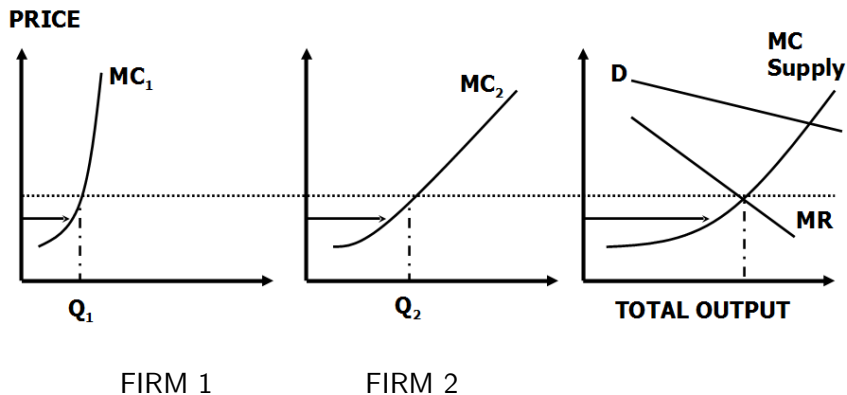
Cartel

- Instability of cartel: incentive for members to cheat
  - Incentive biggest for small members
- If a firm deviates it gets the total market at least for one period
  - Breakdown of the cartel
- Deviator compares
  - profits from one-time deviating + profits from competition later on
  - with profits from collusion
- Decision whether to deviate
- punish the deviator(s): which strategies are possible?
- See game theory later

Demand curve is much flatter (D') because only ONE firm reduces the price. Cartel Price is P^0

Instability of Cartels
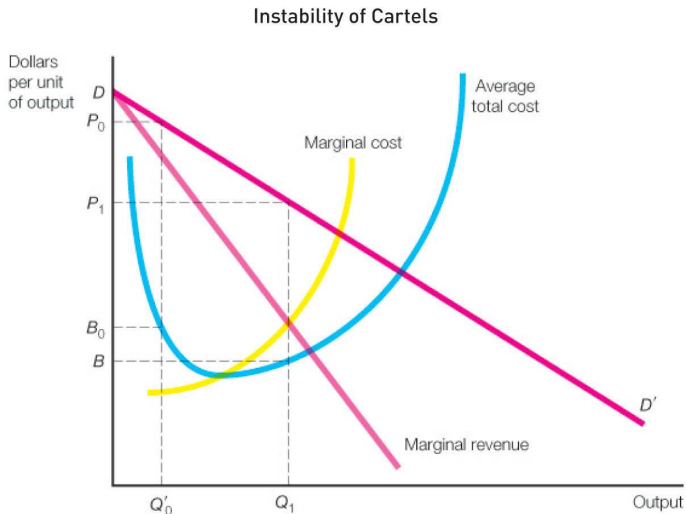
Example

- The Bergen Company and the Gutenberg Company are the only two firms that produce and sell a particular kind of machinery. The demand curve for their product is
  - $P = 580 - 3Q$
  - where P is the price of the products, and Q is the total amount demanded.
- The total cost function of the Bergen Company is
  - $TCB = 410\ QB$
- The total cost function of the Gutenberg Company is
  - $TCG = 460\ QG$
- a) If these two firms collude, and if they want to maximize their combined profits, how much will the Bergen Company produce?
- b) How much will the Gutenberg Company produce?

Example

- a) Bergen's marginal cost is always less than Gutenberg's marginal cost. Therefore Bergen would produce all the combination's output. Setting Bergen's marginal cost equal to the marginal revenue derived from the demand function, we get
  - $410 = 580 - 6Q \rightarrow QB = 28.33$
  - $(P = 580 - 3*28.33 = 495)$ and $QG = 0$.
- b) If Gutenberg were to produce one unit and Bergen one unit less, it would reduce their combined profits by the difference in their marginal costs.

Example

- If direct payments of output restrictions between the firms were legal, Gutenberg would accept a zero output quota. But if competition were to break out, Gutenberg would make zero profits and Bergen would earn $2000. Thus the most Bergen would pay for Gutenberg's cooperation is $408.33 and the least Gutenberg would accept to not produce is $0.01.
  - competition: $P = 460$
  - $460 = 580 - 3Q \rightarrow Q = 40$
  - Berger's profits: $(460 - 410)*40 = 2000$
  - Profits from cartel: $(495 - 410)*28.33 = 2408.33$

The diamond cartel

- De Beers established in South Africa in 1888 by Cecil Rhodes
  - owned all diamond mines in South Africa
  - had joint ventures in Namibia, Botswana, Tanzania
  - controlled diamond trade (mines $\rightarrow$ cutters and polishers) through "Central Selling Organization" (CSO), processing about 80% of world trade
- CSO's services for the industry
  - expertise in classifying diamonds
  - stabilizing prices (through stocks of diamonds)
  - advertising diamonds

The diamond cartel cont'd

- Huge temptation for mining companies to bypass CSO and earn high margins themselves
- In 1981, President Mobutu announced that Zaire (world's largest supplier of industrial diamonds) would no longer sell diamonds through the CSO
- Two months later, about 1 million carats of industrial diamonds flooded the market, price fell from \$3 to less than \$1.80 per carat
- Supply of these diamonds unknown, but very likely retaliation by De Beers
- In 1983, Zaire renewed contract with De Beers, at less (!) favorable terms than before

Price leadership by a dominant firm

- Dominant firm in the market can behave almost like a monopolist
  - But has to take reaction of small firms into account
- Many small followers with no big influence on the market
- "Stackelberg-Model"

Price Leadership - Assumptions

- single firm, the price leader, that sets price in the market.
- follower firms who behave as price takers, producing a quantity at which marginal cost is equal to price.
  - ▶ Their supply curve is the horizontal summation of their marginal cost curves.
- price leader faces a residual demand curve that is the horizontal difference between the market demand curve and the followers' supply curve.
  - ▶ Price leader takes reaction of followers into account!!
- price leader behaves as monopolist:
  - ▶ produces a quantity at which the residual marginal revenue is equal to marginal cost. Price is then set to clear the market.
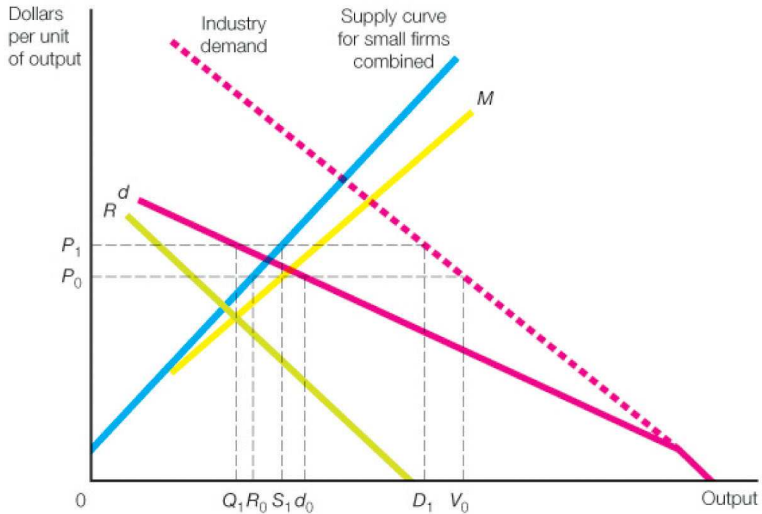
Price Leadership by a Dominant Firm

Dollars per unit of output

- Industry demand
- Supply curve for small firms combined
- M
- R
- d
- P_1
- P_0

0 $\quad Q_1 R_0 \; S_1 d_0 \qquad D_1 \; V_0 \qquad$ Output

FIGURE 10-03

First-mover advantage

- Stackelberg: Dominant big firm and many small followers

- Similar idea: 2 Firms, Dominant firm has "first-mover advantage",

  - E.g. technology first, has set up production plan first, etc.

  - First-mover sets quantity first,

  - Follower adapts optimally to this quantity (not in a situation of perfect competition, but of a monopoly)

Examples

- Example 1: Price cuts for breakfast cereals

  - In April 1996, the Kraft Food Division of Philip Morris cut prices on its Post and Nabisco brands of breakfast cereal by 20 percent as demand stagnated

  - Market shares: PM $16 \rightarrow 20$, Kellog: $36 \rightarrow 32$

- Example 2: Cranberries

  - Market is dominated by a giant growers' cooperative

  - Ocean Spray has 66 percent market share and sets prices each year in fall based on anticipated and actual supply and demand conditions

  - Based on this price other firms decide on how much they wish to harvest for sale, for inventory, but for use in other products or leave in the bogs

How can a few firms compete against each other?

- Many different models possible

- Some simplifying assumptions:
  - Identical product
  - 2 firms (can easily be extended to more)
  - Same (constant) cost functions
  - Firms know the (linear) demand function
  - Firms act simultaneously

Price Competition (Bertrand)

- Example

  - Two firms with identical total cost functions: $TC_i = 500 + 4q_i + 0.5q_i^2$

  - Market demand: $P = 100 - Q = 100 - q_A - q_B$

  - Marginal cost: $MC_i = 4 + q_i$

  - If firms compete over prices, every price which is higher than marginal cost will be underbid by the rival

Price Competition (Bertrand)

- Set $MC_A = P$ to get firm A's reaction function:

  $4 + q_A = 100 - q_A - q_B$

  $\rightarrow q_A = 48 - 0.5 q_B$

- Set $MC_B = P$ to get firm B's reaction function:

  $4 + q_B = 100 - q_A - q_B$

  $\rightarrow q_B = 48 - 0.5 q_A$

- Solve the reaction functions simultaneously:

  - $q_A = q_B = 32$, $P = 36$, and each firm earns a profit of \$12

- Bertrand means: even two firms can drive price down to marginal costs!

Collusion (Cartel)

- Example

  - Two firms with identical total cost functions: $TC_i = 500 + 4q_i + 0.5q_i^2$

  - Market demand: $P = 100 - Q = 100 - q_A - q_B$

  - Marginal revenue: $100 - 2Q$

  - Marginal cost: $MC_i = 4 + q_i$

  - Horizontal summation of MC: $Q = q_A + q_B = -8 + 2MC$

    $\rightarrow MC = 4 + 0.5Q$

  - Set $MC = MR$: $4 + 0.5Q = 100 - 2Q$

    $\rightarrow Q = 38.4, (q_i = 19.2)$ and $P = 61.6$

  - Total profit is \$843.20, or \$421.60 for each firm

Quantity (Capacity) Competition (Nash-Cournot-Model)

- Rivals make **simultaneous** decisions,
  - have the same estimate of market demand,
  - have an estimate of the other's cost function, and
  - assume that the **other firm's level of output is given.**

- Example 1: Assume: monopoly by firm A, i.e. firm B produces zero
  - Market demand: $P = 100 - Q = 100 - q_A$
  - Marginal revenue: $100 - 2Q$
  - Marginal cost: $MC_A = 4 + Q$
  - $MC = MR$: $4 + Q = 100 - 2Q \rightarrow Q = 32$ and $P = 68$

Quantity Competition

- Example 2: Assume: Firm B produces $q_B = 96$
  - Residual market demand to firm A: $P = 4 - q_A$
  - Optimal output is $q_A = 0$

- Example 3: Assume: Firm B produces $q_B = 50$
  - Residual market demand to firm A: $P = 50 - q_A$
  - Optimal output is $q_A = 15.33$

- These calculations are hyptothetical reactions of Firm A to potential actions of Firm B
  - Reaction function of Firm A

TABLE 10.1

Profit-Maximizing Output Responses of Managers of Firm *A* Given Their Assumptions about Firm *B* Output

If Firm *B* Produces	Then Firm *A* Produces
0	32
50	15.33
96	0

TABLE 10-01

- For each potential output of your rival, you must have a profit-maximizing answer
- Actual decision is taken by using the actual action of rival

Quantity competition (Nash-Cournot Model)

- Example 4: General solution

  - Market demand: $P = 100 - Q = 100 - q_A - q_B$

  - Marginal revenue for firm A: $MR = 100 - 2q_A - q_B$

  - Marginal cost for firm A: $MC_A = 4 + q_A$

  - $MC = MR$ yields firm A's reaction function: $4 + q_A = 100 - 2q_A - q_B$

    $\rightarrow q_A = 32 - (1/3)q_B$

  - Firm B's reaction function: $q_B = 32 - (1/3)q_A$

  - Nash equilibrium: Solving the two reaction functions simultaneously yields

    $q_A = q_B = 24$ and each firm earns a profit of \$364

  - Figure 10.4: Cournot Reaction Functions for Firms A and B
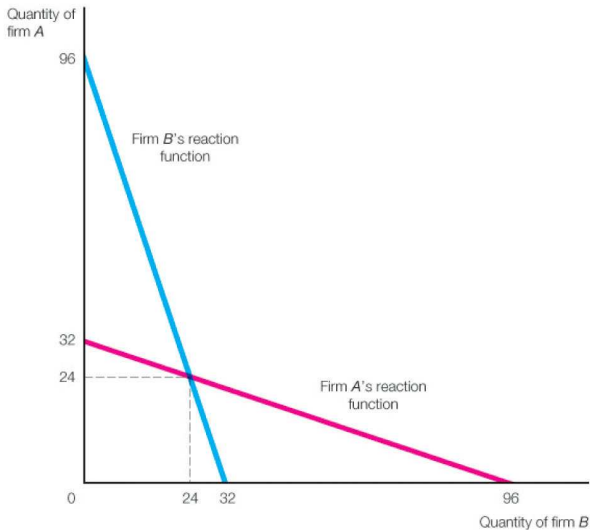
Cournot Reaction Functions for Firms A and B

FIGURE 10-04

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Cournot Reaction Functions for Firms A and B

FIGURE 10-04
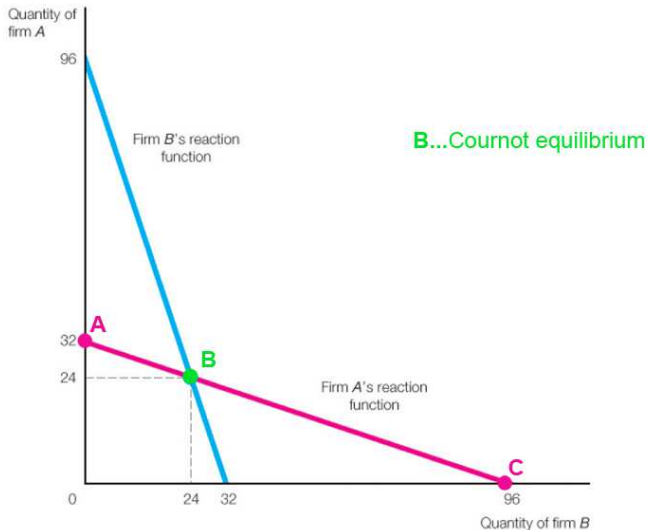
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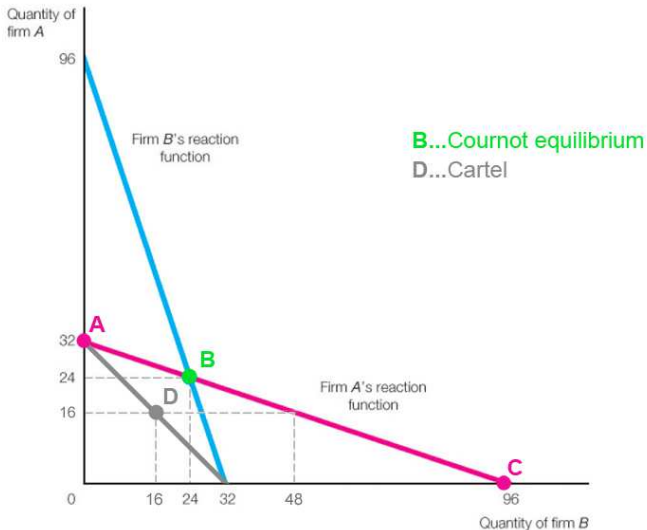
Cournot Reaction Functions for Firms A and B

FIGURE 10-04

Quantity competition

- Equilibrium in the market, when both firms "sit" on their reaction curves:
  - no surprises and
  - no incentive for any firm to change behavior
- The Nash-Cournot Scenario with More than Two Firms
  - increasing the number of firms will lead to rapidly falling prices

THE STICKY PRICING OF MANAGERS

- Asymmetrical responses to price changes are possible

  ▶ If a firm increases price, other firms do not follow, so the firm's demand is relatively elastic.

  ▶ If a firm reduces price, other firms follow, so the firm's demand is relatively inelastic.

  ▶ Reasons:

    ★ firms are allergic to the rival stealing market shares

    ★ Decreasing the price is an aggressive move

    ★ Increasing the price is hurting oneself, the others need coordination to follow

THE STICKY PRICING OF MANAGERS

- Asymmetrical responses to price changes

- Result: The firm's demand curve has a "kink" at the current price and the firm's marginal revenue curve is vertical at the quantity that corresponds to the kink.

  - Implication: Changes in marginal cost that do not move above or below the vertical section of the marginal revenue curve do not cause the optimal level of output or price to change.
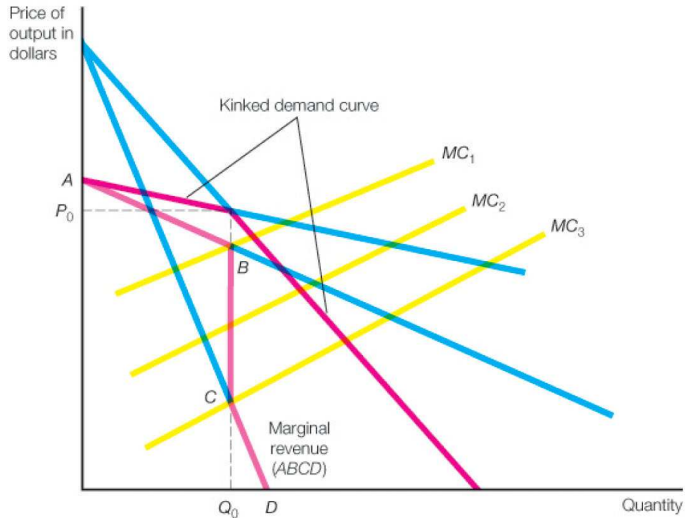
The Situation of the Kinked Demand Curve

FIGURE 10-06

too many models . . .

- Can you predict, how oligopolists will behave?
  - ▸ Cartel
    - ⋆ If market is well-arranged, all actions of the rivals are easily observable by the firms
  - ▸ Dominant firm
    - ⋆ if first mover or large size differences between firms
  - ▸ Bertrand (Price) competition
    - ⋆ Retailing, where capacity does not play any role, price competition is advertised
  - ▸ Cournot (quantity) competition
    - ⋆ If firms set production capacity first (changes are costly), then they can even compete with prices

Product Differentiation

- **Vertical differentiation:** quality
  - consumers have uniform preferences
  - Better quality is better for everyone
- **Horizontal differentiation:** design, location, . . .
  - consumers have different preferences
- by differentiation product gets unique
- small monopoly can be constructed

Hotelling Model for product differentiation

- Simple model:
    - consumers (and shops) located along a line (Linz - Landstrasse)
    - consumers would like to shop at the nearest shop (transport is costly)
    - linear model (simplification):
        - here location
        - differentiation can often be analyzed using line segments
        - "location" used as taste, preference of consumers, etc.

Linear Model, prices are the same

L

R

These customers buy from L

These customers buy from R

Firm L

Firm R
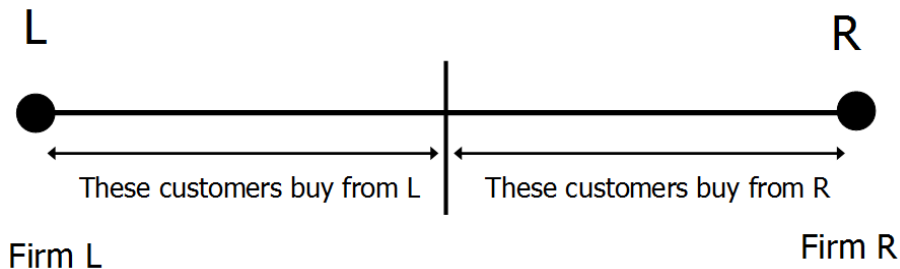
Setting Prices I

- cost of moving from L to R is c

- suppose a customer sits at a point that is the fraction x of the way from L to R

- $p_L, p_R \ldots$ prices

- customer pays: $\quad \begin{matrix} p_L + xc \text{ if shopping at L} \\ p_R + (1-x)c \text{ if shopping at R} \end{matrix}$

- and shops wherever cheaper

  - (Note: cost of moving c is used to indicate preferences of consumers)

Setting Prices II

- Marginal customer x^* who is indifferent

  $p_L + x^*c = p_R + (1 - x^*)c \quad \Rightarrow$

  $x^* = \frac{1}{2} + \frac{p_R - p_L}{2c}$

- if $p_R = p_L$ ... marginal customer in the middle

- if $p_R > p_L$ ... L has more customers

- if c is small $\rightarrow$ small price change results in big sales gains, product hardly differentiated

Setting Prices III

- disregard production costs

- L maximizes $p_L x^*$ (revenue): $\begin{aligned} p_L(\frac{1}{2} + \frac{p_R - p_L}{2c}) &\to \max_{p_L} \\ p_L^* &= \frac{1}{2}(c + p_R) \end{aligned}$

  ▸ if transport cost (differentiation) increases $\to p_L \uparrow$

  ▸ if p_R increases $\to p_L \uparrow$

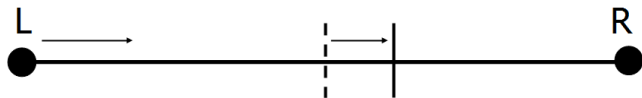- similarly for firm R: $\quad p_R^* = \frac{1}{2}(c + p_L)$

  ▸ Only partial response to price increase of competition

- $\Rightarrow p_L^* = p_R^* = c$

- Prices and profits increase the higher differentiation is

Choice of location I

- simplify: hold prices constant

- by moving right, market share increases
- both firms will locate in center
- (analogy to political parties)

Choice of location II

- if prices are flexible, it pays to be distant
- by moving away prices can rise for L
  - ▶ as a reaction competitor R will raise prices as well
  - ▶ is beneficial for firm L
- trade-off: more differentiation means
  - ▶ being close to customers is also close to competitors