MANAGERIAL ECONOMICS

LECTURE 7: OLIGOPOLY

Rudolf Winter-Ebmer
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Aims of this lecture

■ How managers of firms that operate in an oligopoly market can use strategic decisions to maintain relatively high profits

■ How the reactions of competitors influence the effectiveness of strategic decisions in an oligopoly market

You should read Chapter 11 in Allen et al., *Managerial Economics* (8th ed.).

Oligopoly

- A market with a small number of (usually big) firms
- The market is protected by barriers to entry that result from government, economies of scale or control of strategically important resources
- Oligopolists "know" each other
- Each decisions impacts on all competitors in the market
- Managers must consider the potential reactions of competitors for their optimal decisions

Strategic interactions

■ Assume: One firm's decision will result in other firms' re-actions

■ Oligopolist must take these possible re-actions into account *before* deciding on a strategy

■ No single unified model of oligopoly exists
  □ Cartel
  □ Price leadership
  □ Bertrand competition
  □ Cournot competition

Cooperative behavior: Cartel

Cartel

is an open and formal collusive arrangement.[1]

- Cartels, and collusion in general, are illegal in the US and EU
- Firms form a cartel to maximize profits
- Cartels maximize profit by restricting the output of member firms
- Output of each firm is set to a level where the marginal cost of production of every firm in the cartel is equal to the market's marginal revenue
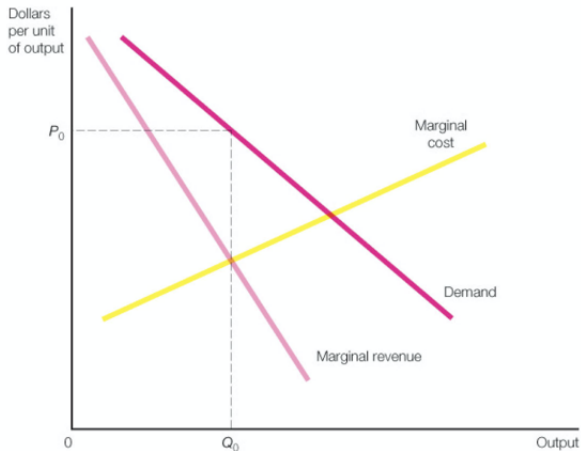- The price is set to the market-clearing price, i.e., the cartel acts as a monopoly

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[1]See the survey by Feuerstein.

Cartels

Adam Smith (1776)

> *"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 some contrivance to raise prices"*

Prices and output of a cartel

Notes: A cartel maximizes profits as if it were a monopoly. Figure 11.1 in Allen et al., *Managerial Economics* (8th ed.), p412.
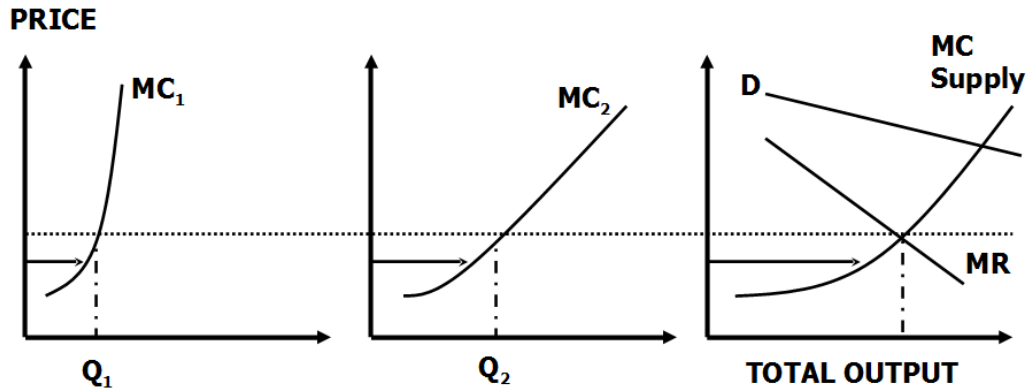
Cartel

- Cartels act like multiplant monopolies
- Profits are greatest, if the marginal costs of the members, $i = 1, 2, .., n$, are equal: $MC_1 = MC_2 = \cdots = MC_n$ and restrict output of each firm to its level
- This implies that firm whose costs are greater produce less
- BUT: firms may still agree on equal quotas and use side payments (Why?)

Examples

- 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

MC$_1$

Q$_1$

MC$_2$

Q$_2$

D

MC Supply

MR

TOTAL OUTPUT

Notes: A cartel acts like a multiplant monopoly. Overall production is set where $MC = MR$ (right diagram). Firm 1 produces Q_1 (left) and firm 2 produces Q_2 (center). $MC_1 = MC_2 = MC = MR$.

Stability of cartels

- Cartel are not stable: members have an incentive to produce more ("to cheat")
- If a firm produces more, it could get total market demand (at least for one period), if capacity allows it
- Smaller members have greatest incentives

- Cartel may "self-destruct":
  - A deviating firm compares the profits from deviating in period t and the profits from competition thereafter
  - with the profits from collusion

Cartels are not stable
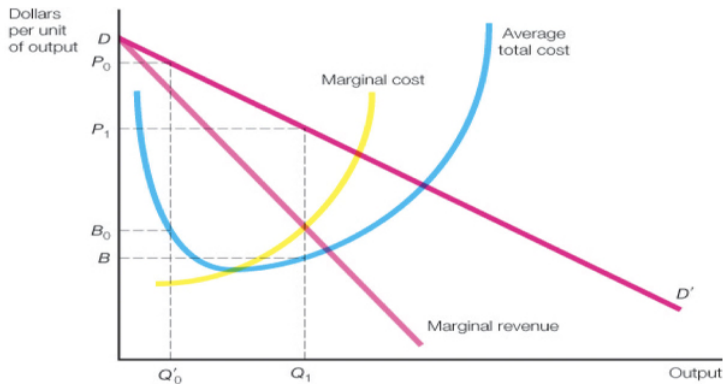
Notes: The cartel price is P_0 and the firm's output quota is Q'_0. If the firm leaves the cartel and produces where its MC are equal to overall MR, it obtains extra revenues: Compare $Q'_0 \times P_0$ (revenues in the cartel) and $Q_1 \times P_1$ (revenues when deviating). Costs increase, too: $B_0 \times Q'_0$ is less than $B \times Q_1$. Overall, profits are greater when deviating. Figure 11.2 in Allen et al., *Managerial Economics* (8th ed.), p413.

Price leadership by a dominant firm

A dominant firm in the market can behave almost like a monopolist

- But it has to take reaction of small firms into account (capacity constraints)
- Many small followers with no big influence on the market
- "Stackelberg-Model"

Price leadership

Assumptions

- A single firm, the price leader, sets the price in the market.

- Small firms behave as price takers and produce a quantity at which marginal cost is equal to price.

- Their supply curve is the horizontal summation of their marginal cost curves.

- The price leader faces the *residual demand curve* that is the (horizontal) difference between the market demand curve and the followers' supply curve.

- The price leader behaves as monopolist and produces a quantity at which the residual marginal revenue is equal to marginal cost. Price is then set to clear the market.

- The price leader takes reactions of followers into account!!

Price leadership
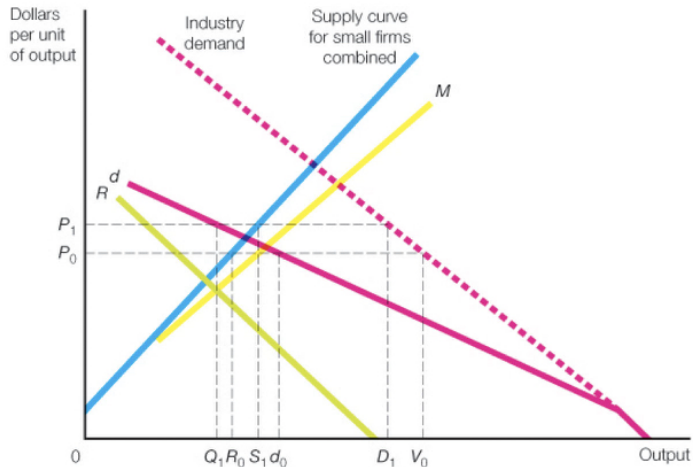
Notes: The dominant firm (the price leader) faces residual demand (d) and the associated marginal revenues, R. The dominant firm supplies Q_1.

First movers

Assume:

- 2 firms, one enters the market first ("first mover"):
    - ☐ E.g., technology first, has set up production plan first, etc.
    - ☐ First-mover sets quantity first
    - ☐ The other firm follows and adapts optimally to first firm's quantity — but not in a situation of perfect competition, but of a monopoly

Examples

- Example 1: Price cuts for breakfast cereals
  - In April 1996, Kraft Food cut prices on its brands of breakfast cereals by 20 percent as demand stagnated
  - Market shares: Kraft Food increased from 16 to 20%; Kellog (largest competitor): dropped from 36 to 32%
- Example 2: Cranberries
  - Market is dominated by a very large 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

Competition of the few

In the standard textbook model of competition, we typically assume that there are many small firms.

With few large firms, there are many different ways to think about the problem.

Some simplifying assumptions:

- The firms produce an identical product
- There are only 2 firms (can easily be extended to more)
- They have the same (constant) cost functions (can be relaxed)
- Firms know the (linear) demand function (makes life easier, we could assume that they invest in finding out)
- Firms act simultaneously (this is more important, we rule out a "first-mover advantage")

1. Model: Firms compete on prices

Bertrand Competition

- Two firms with identical total cost functions (i.e., also same MC)

- If the firms compete over prices, every price which is above marginal cost will be underbid by the rival
- Bertrand Paradox: Even with few firms, price competition results that prices are equal to marginal cost in equilibrium.

Numerical Example

Consider these functions:

- Two firms, $i = 1, 2$, with identical total cost functions: $TC_i = 500 + 4q_i + 0.5q_i^2$
- Market demand: $P = 100 - Q = 100 - q_1 - q_2$
  (q_1 could differ from q_2 only if costs differ.)
- Marginal cost: $MC_i = 4 + q_i$

Solving for equilibrium prices

1. What is the best response firm 1 could have for any price that firm 2 charges?
   Reaction function:
   Set $MC_1 = P$ and use in demand function, $4 + q_1 = 100 - q_1 - q_2$
   $q_1 = 48 - 0.5q_2$

2. Similarly, for firm 2:
   $4 + q_2 = 100 - q_1 - q_2$
   $q_2 = 48 - 0.5q_1$

3. Use both reaction functions to solve for the equilibrium
   $q_1 = q_2 = 32$, $P = 36$, and each firm earns a profit of 12

But if they collude?

Assume the firms now form a cartel:

- Two firms with identical total cost functions: $TC_i = 500 + 4q_i + 0.5q_i^2$
- Market demand: $P = 100 - Q = 100 - q_1 - q_2$
- Marginal revenue: $100 - 2Q$
- Marginal cost: $MC_i = 4 + q_i$
- Horizontal summation of MC: $Q = q_1 + q_2 = -8 + 2MC$
  $MC = 4 + 0.5Q$
- Set $MC = MR$: $4 + 0.5Q = 100 - 2Q$
  $Q = 38.4(q_i = 19.2)$ and $P = 61.6$
- Total profit is 843.20, or 421.60 for each firm

Remember the monopoly

Assume: Firm 1 has a monopoly and firm 2 produces nothing:

- Market demand: $P = 100 - Q = 100 - q_1$
- Marginal revenue: $100 - 2Q$
- Marginal cost: $MC_A = 4 + Q$
- $MC = MR$: $4 + Q = 100 - 2Q \rightarrow Q = 32$ and $P = 68$

2. model: Firms compete on quantity

aka. 'Quantity (Capacity) Competition' or the 'Nash-Cournot-Model'

The two firms make *simultaneous* decisions about their *output*,

- 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.*

Consider the produced quantities

Assume: Firm 2 produces $q_2 = 96$:

- What's left for firm 1? Residual market demand: $P = 100 - 96 - q_1$
- Optimal output is $q_1 = 0$

Assume: Firm 2 produces $q_2 = 50$

- What's left for firm 1? Residual market demand: $P = 50 - q_1$
- Optimal output is $q_1 = 15.33$

... these calculations are hypothetical reactions, reaction functions, of firm 1 to potential actions of firm 2.

Quantity competition (Nash-Cournot Model)

General solution, using previous functions:

- Market demand: $P = 100 - Q = 100 - q_1 - q_2$
- Marginal revenue for firm 1: $MR = 100 - 2q_1 - q_2$
- Marginal cost for firm 1: $MC_1 = 4 + q_1$
- $MC = MR$ yields firm 1's reaction function: $4 + q_1 = 100 - 2q_1 - q_1$
  $q_1 = 32 - (1/3)q_2$
- Firm 2's reaction function: $q_2 = 32 - (1/3)q_1$
- Solving the two reaction functions simultaneously yields
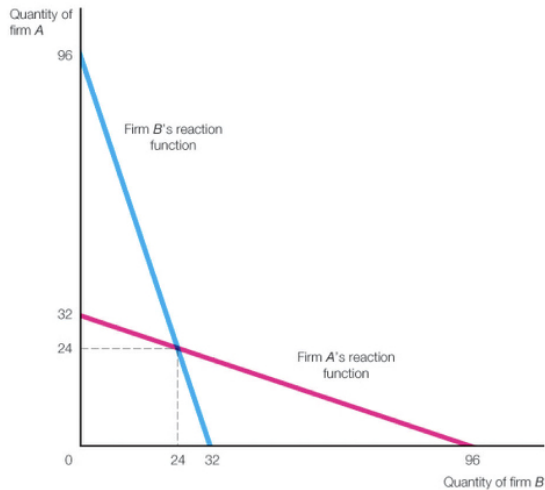 $q_1 = q_2 = 24$ and each firm earns a profit of 364

Cournot equilibrium

Equilibrium in the market, when both firms "sit" on their reaction curves:

- no surprises and
- no incentive for any firm to change behavior

Increasing the number of firms will lead to rapidly falling prices

Cournot

Notes: Each firm considers how it should optimally react to different output levels of their rival, given their expectations about demand, costs, and all

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Sticky prices

Consider asymmetric responses to price changes:

- If one firm increases the price: the other firms do not follow (i.e., the firm's demand is elastic).

- If one firm reduces the price: the other firms will follow (i.e., the firm's demand is inelastic).

Why?

- Firms fear that rivals steal market shares and monitor competitors' behavior

- Decreasing the price is an aggressive move and might signal the start of a price war!

- Increasing the price is hurting oneself — coordination is needed to ensure all firms increase prices!

The consequence of asymmetric responses

The firm's demand curve has a "kink" at the current price and the firm's marginal revenue curve is vertical at the quantity of the kink.

Implication: Changes in marginal cost that do not move beyond the vertical section of the marginal revenue curve do not change the optimal level of output (or price).

Kinked demand
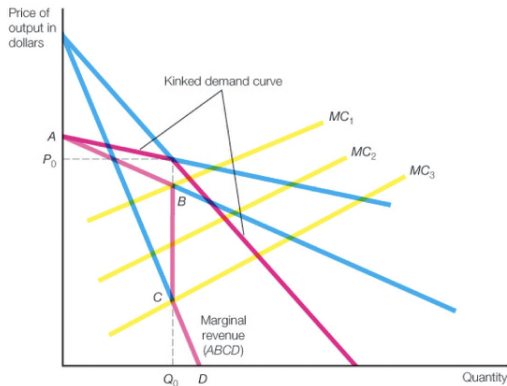
Notes: Asymmetric responses by the competition to price increases and price decreases result in a kink of the demand curve. If the equilibrium is at (Q_0, P_0), the demand is more elastic for price above this level, and relatively more inelastic below this level. Because of this kink in the demand, the marginal revenue curve is discontinuous at this level and jumps at B to C (or vice verse). Because of this kink (and the discontinuity in MR), even large changes in MC (compare MC_1, MC_2, and MC_3) do not change the initial equlibrium. Figure 11.6 in Allen et al., *Managerial Economics* (8th ed.), p439.

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

Consider the consumers, too

All numbers are based on the same functions, as used above.

Model	q_1	q_2	Q^a	Profits	Prices
Monopoly	32	0	32	1036	68
Cartel	19.2	19.2	38.4	843.2	61.6
Cournot	24	24	48	728	52
Stackelberg[b]	27.43	22.86	50.29	661.34	49.71
Bertrand	32	32	64	24	36

Notes: [a] Profits are total profits in the market. [b] Assumes that firm 1 moves first.

This provides arguments for consumers' associations, monopoly commissions, and anti-trust regulation.

Product Differentiation

Vertical differentiation
products differ by quality.

This is typically used when consumers have the same preferences (and prefer better over worse products).

Horizontal differentiation
products differ by design, location or other characteristics.

This is typically used when consumer have different preferences, some prefer red, others prefer blue.

Product differentiation can be used to create a *local* monopoly, i.e., products where substitutes are relatively rare.

Models for few firms with product differentiation

Such models typically start with the following assumptions

- consumers (and shops) are located along a linear street, e.g., the Landstrasse,
- all firms have the same costs and produce the same product, and
- consumers buy from at the nearest shop (transport is costly).

"Location" is used to describe horizontal differentiation, but it could be along other qualities (e.g., left-wing, right-wing as it is used in *political science*)

The basis for such models is Hotelling's (1929) article which opens with the words, "... one may doubt that anything further can be said on the theory of competition among a small number of entrepreneurs" (p41).