CHAPTER 9

Basic Oligopoly Models
Chapter Outline

• Conditions for Oligopoly
• Role of beliefs and strategic interaction
• Profit maximization in four oligopoly settings
  – Sweezy oligopoly
  – Cournot oligopoly
  – Stackelberg oligopoly
  – Bertrand oligopoly
• Comparing oligopoly models
• Contestable markets
Introduction

- Chapter 8 examined profit-maximizing behavior in perfectly competitive, monopoly, and monopolistically competitive markets. One distinguishing feature is the absence of strategic interaction among the firms:
  - In perfectly competitive and monopolistically competitive markets so many firms are competing that no individual firm has any effect.
  - In monopoly markets, strategic interaction is irrelevant since only one firm exists.

- This chapter focuses on how managers select the optimal price and quantity in the following oligopoly market (a market with only few large firms) environments:
  - Sweezy
  - Cournot
  - Stackelberg
  - Bertrand
Key Conditions

• Oligopoly market structures are characterized by only a few firms, each of which is large relative to the total industry.
  – Typical number of firms is between 2 and 10.
  – Products can be identical or differentiated.

• An oligopoly market composed of two firms is called a *duopoly*.

• Oligopoly settings tend to be the most difficult to manage since managers must consider the likely impact of his or her decisions on the decisions of other firms in the market.
Conditions for Sweezy Oligopoly

• There are few firms in the market serving many consumers.
• The firms produce differentiated products.
• Each firm believes its rivals will cut their prices in response to a price reduction but will not raise their prices in response to a price increase.
• Barriers to entry exist.
Sweezy Oligopoly

Profit Maximization in Four Oligopoly Settings
Conditions for Cournot Oligopoly

• There are few firms in the market serving many consumers.
• The firms produce either differentiated or homogeneous products.
• Each firm believes rivals will hold their output constant if it changes its output.
• Barriers to entry exist.
Cournot Oligopoly: Reaction Functions

• Consider a Cournot duopoly. Each firm makes an output decision under the belief that its rival will hold its output constant when the other changes its output level.
  – Implication: Each firm’s marginal revenue is impacted by the other firms output decision.

• A function that defines the profit-maximizing level of output for a firm given the output levels of another firm is called a best-response or reaction function.
Cournot Oligopoly: Reaction Functions Formula

- Given a linear (inverse) demand function
  \[ P = a - b(Q_1 + Q_2) \]
  and cost functions, \( C_1(Q_1) = c_1Q_1 \) and \( C_2(Q_2) = c_2Q_2 \), the reactions functions are:
  \[ Q_1 = r_1(Q_2) = \frac{a - c_1}{2b} - \frac{1}{2}Q_2 \]
  \[ Q_2 = r_2(Q_1) = \frac{a - c_2}{2b} - \frac{1}{2}Q_1 \]
Cournot Reaction Functions

Firm 1’s Reaction Function
\[ Q_1 = r_1(Q_2) \]

Firm 2’s Reaction Function
\[ Q_2 = r_2(Q_1) \]
Cournot Oligopoly: Equilibrium

• A situation in which neither firm has an incentive to change its output given the other firm’s output.
Cournot Oligopoly: Isoprofit Curves

• A function that defines the combinations of outputs produced by all firms that yield a given firm the same level of profits.
Cournot Oligopoly In Action: Problem

• Suppose the inverse demand function in a Cournot duopoly is given by
  
  \[ P = 10 - (Q_1 + Q_2) \]

  and their costs are zero.

  – What are the reaction functions for the two firms?
  – What are the Cournot equilibrium outputs?
  – What is the equilibrium price?
Cournot Oligopoly In Action: Answer

• The reaction functions are:
  \[ Q_1 = r_1(Q_2) = \frac{10}{2} - \frac{1}{2} Q_2 \]
  \[ Q_2 = r_2(Q_1) = \frac{10}{2} - \frac{1}{2} Q_1 \]

• Equilibrium output is found as:
  \[ Q_1 = 5 - \frac{1}{2} \left( 5 - \frac{1}{2} Q_1 \right) \Rightarrow Q_1 = \frac{10}{3} \]

Since the firms are symmetric, \( Q_2 = \frac{10}{3} \).

• Total industry output is
  \[ Q = Q_1 + Q_2 = \frac{10}{3} + \frac{10}{3} = \frac{20}{3} \]
  
  So, the equilibrium price is: \( P = 10 - \frac{20}{3} = \frac{10}{3} \).
Firm 1’s Best Response to Firm 2’s Output

Firm 1’s profit increases as isoprofit curves move toward $Q_1^M$
Firm 2’s Reaction Function and Isoprofit Curves

Quantity$_2$

Monopoly point for firm 2

$Q^M_2$

Firm 2’s profit increases as isoprofit curves move toward $Q^M_2$

$r_2$ (Firm 2’s reaction function)
Cournot Equilibrium

Profit Maximization in Four Oligopoly Settings
Effect of Decline in Firm 2’s Marginal Cost on Cournot Equilibrium

Due to decline in firm 2’s marginal cost
Cournot Oligopoly: Collusion

• Markets with only a few dominant firms can coordinate to restrict output to their benefit at the expense of consumers.
  – Restricted output leads to higher market prices.

• Such acts by firms is known as *collusion*.

• Collusion, however, is prone to cheating behavior.
  – Since both parties are aware of these incentives, reaching collusive agreements is often very difficult.
Incentive to Collude in a Cournot Oligopoly

*Assuming both firms have the same cost structure
Incentive to Renege on Collusive Agreements in Cournot Oligopoly
Conditions for Stackelberg Oligopoly

• There are few firms serving many consumers.
• Firms produce either differentiated or homogeneous products.
• A single firm (the leader) chooses an output before all other firms choose their outputs.
• All other firms (the followers) take as given the output of the leader and choose outputs that maximize profits given the leader’s output.
• Barriers to entry exist.
Stackelberg Equilibrium

Profit Maximization in Four Oligopoly Settings
Stackelberg Oligopoly: Equilibrium Output Formulae

- Given a linear (inverse) demand function
  \[ P = a - b(Q_1 + Q_2) \]
  and cost functions \( C_1(Q_1) = c_1Q_1 \) and \( C_2(Q_2) = c_2Q_2 \).
  
  - The follower sets output according to the reaction function
    \[ Q_2 = r_2(Q_1) = \frac{a - c_2}{2b} - \frac{1}{2}Q_1 \]
  
  - The leader’s output is
    \[ Q_1 = \frac{a + c_2 - 2c_1}{2b} \]
Stackelberg Oligopoly In Action: Problem

• Suppose the inverse demand function for two firms in a homogeneous-product, Stackelberg oligopoly is given by

\[ P = 50 - (Q_1 + Q_2) \]

and their costs are:

\[ C_1(Q_1) = 2Q_1 \]
\[ C_2(Q_2) = 2Q_2 \]

Firm 1 is the leader, and firm 2 is the follower.

– What is firm 2’s reaction function?
– What is firm 1’s output?
– What is firm 2’s output?
– What is the market price?
Stackelberg Oligopoly In Action: Answer

- The follower’s reaction function is: \( Q_2 = r_2(Q_1) = 24 - \frac{1}{2} Q_1 \).

- The leader’s output is: \( Q_1 = \frac{50 + 2 - 4}{2} = 24 \).

- The follower’s output is: \( Q_2 = 24 - \frac{1}{2} (24) = 12 \).

- The market price is: \( P = 50 - (24 + 12) = $14 \).
Conditions for Bertrand Oligopoly

- There are few firms in the market serving many consumers.
- Firms produce identical products at a constant marginal cost.
- Firms engage in price competition and react optimally to prices charged by competitors.
- Consumers have perfect information and there are no transaction costs.
- Barriers to entry exist.
Bertrand Oligopoly: Equilibrium

• The conditions for a Bertrand oligopoly imply that firms in this market will undercut one another to capture the entire market leaving the rivals with no profit. All consumers will purchase at the low-price firm.

• This “price war” would come to an end when the price each firm charged equaled marginal cost.

• In equilibrium, $P_1 = P_2 = MC$.
  – Socially efficient level of output.
Comparing Oligopoly Outcomes

- Consider the following inverse market demand function:

\[ P = 1,000 - (Q_1 + Q_2) \]

and the cost function for each firm in this market is identical, and given by

\[ C_i(Q_i) = 4Q_i \]

- Under these condition, the different oligopoly outputs, prices and profits are examined.
Comparing Oligopoly: Cournot Outcome

• The Cournot oligopoly reaction functions are

\[ Q_1 = 498 - \frac{1}{2} Q_2 \]

\[ Q_2 = 498 - \frac{1}{2} Q_1 \]

• These reaction functions can be solved for the equilibrium output. These quantities can be used to compute price and profit.

- \( Q_1 = Q_2 = 332 \)
- \( P = $336 \)
- \( \pi_1 = \pi_2 = $110,224 \)
Comparing Oligopoly: Stackelberg Outcome

- The Stackelberg leader’s output is
  \[ Q_{\text{leader}} = \frac{1,000 + 4 - 2 \times 4}{2 \times 1} = \frac{1,000 + 4 - 8}{2} = \frac{996}{2} = 498 \]
  \[ Q_{\text{follower}} = 498 - \frac{1}{2} \times 498 = 249 \]

- The market price is: \( P = 1,000 - 498 - 249 = $253 \)
- \( \pi_{\text{leader}} = $124,002 \)
- \( \pi_{\text{follower}} = $62,001 \)
Comparing Oligopoly: Bertrand Outcome

• Since $P = MC$, $P = $4.

• Total output is found by: $4 = 1,000 - Q$
  
  – Solving yields: $Q = 996$
  – Given symmetric firms, each firm gets half the market, or 498 units.
  – $\pi_1 = \pi_2 = $0
Comparing Oligopoly: Collusion Outcome

• Since the output associated with collusion is the same as monopoly output, the inverse market demand function implies that monopoly marginal revenue function is:

\[ MR = 1,000 - 2Q \]

• Setting marginal revenue equal to marginal cost yields:

\[ 1,000 - 2Q = 4 \]

  – Solving this: \( Q = 498 \) units. Each firm will produce half of these units.

• Price is: \( P = 1,000 - 498 = $502 \)

• Each firm earns profits of $124,002.
Contestable Markets: Key Conditions

• Contestable markets involve strategic interaction among existing firms and potential entrants into a market.

• A market is contestable if:
  – All producers have access to the same technology.
  – Consumers respond quickly to price changes.
  – Existing firms cannot respond quickly to entry by lowering price.
  – There are no sunk costs.

• If these conditions hold, incumbent firms have no market power over consumers.
Conclusion

• Different oligopoly scenarios give rise to different optimal strategies and different outcomes.

• Your optimal price and output depends on ...
  – Beliefs about the reactions of rivals.
  – Your choice variable (P or Q) and the nature of the product market (differentiated or homogeneous products).
  – Your ability to credibly commit prior to your rivals.