

ECON301: Managerial Economics

Topic 10: Oligopoly

Instructor: Professor Ben Grodeck

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What is Oligopoly

- A return to Market Structures:

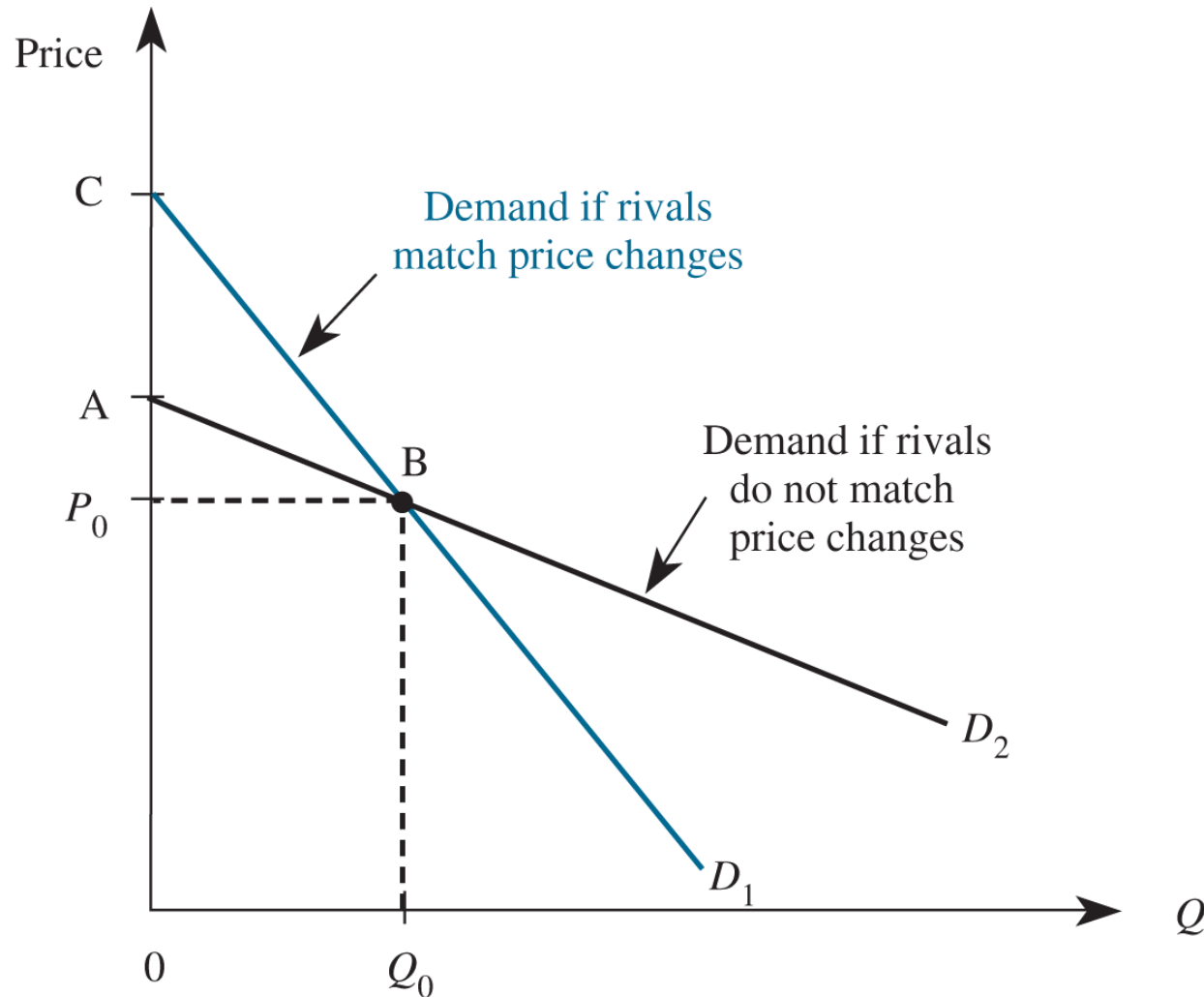
Oligopoly market structures are characterized by only a few firms, each of which is large relative to the total industry.

- 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 their decisions on the decisions of other firms in the market.
 - Game theory!

Models of Oligopoly

- We will look at 4 different models of Oligopoly. Where the timing and structure of the market can lead to different outcomes.
- The four models are
 1. Sweezy
 2. Cournot
 3. Stackelburg
 4. Bertrand

A Firm's Demand Depends on Actions of Rivals



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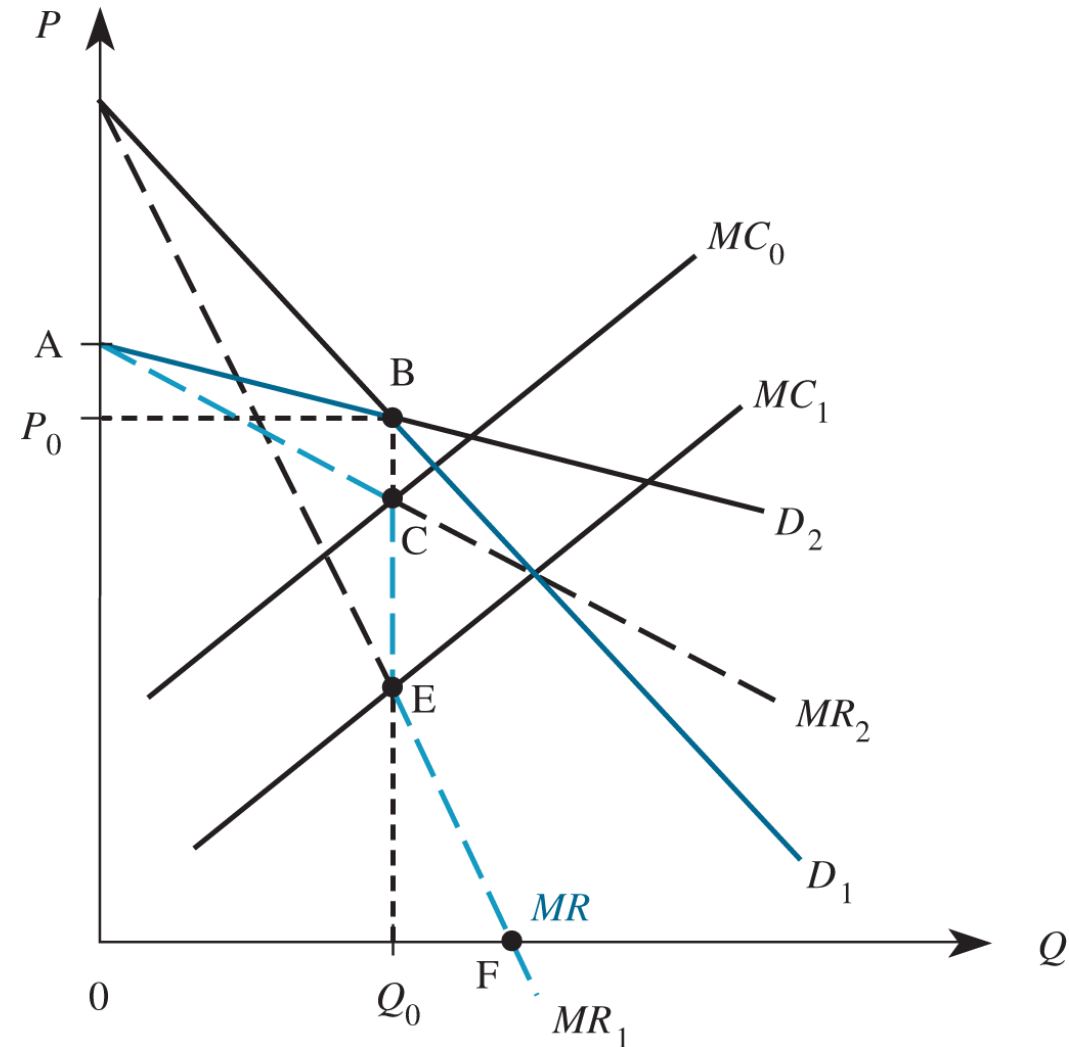
1. Sweezy Oligopoly

The Sweezy model is based on a very specific assumption regarding how other firms will respond to price increases and price cuts.

Sweezy oligopoly characteristics:

- 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



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1. Sweezy Oligopoly

- Implication: There will be a range (between C and E) over which changes in MC do not affect the profit-maximization level of output.
 - This is contrast to competitive, monopolistically competitive, and monopolistic firms.
 - All Increase output when MC decreases
- Reason: No incentive to lower prices, since other firms will also lower prices
- Limitation: Sweezy model does not explain, how this kink in the demand curve comes about.

Cournot Oligopoly

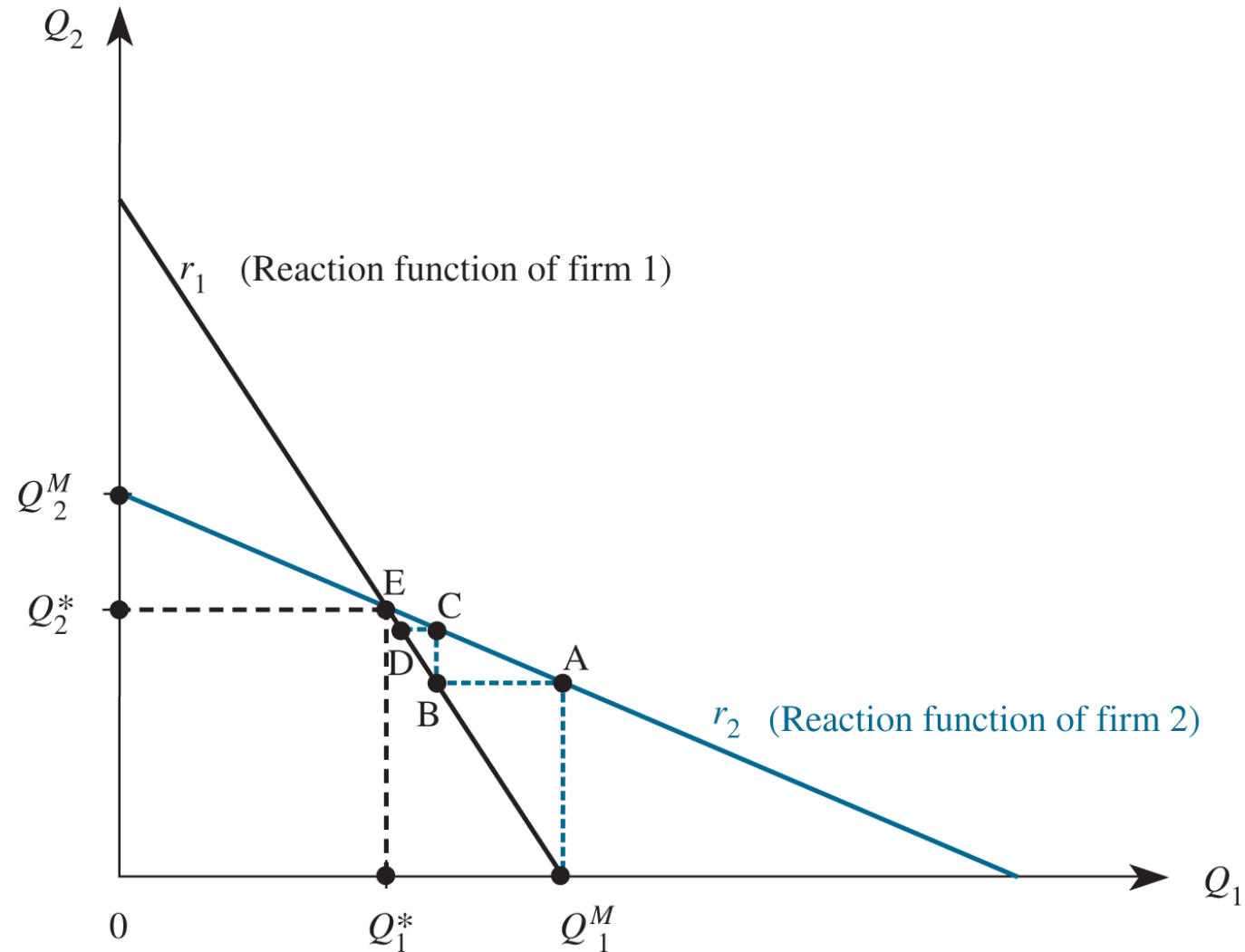
Cournot oligopoly characteristics

- 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 output constant when the other changes its own output level.
- Implication: Each firm's marginal revenue is impacted by the other firm's output decision.
- The relationship between each firm's profit-maximizing output level is called a ***best-response or reaction function***.

Cournot Reaction Functions: Nash Equilibrium at E



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Deriving the Reaction Functions

- Given a linear (inverse) demand function

$$P = a - b(Q_1 + Q_2)$$

- and cost functions, $C_1(Q_1) = c_1 Q_1$

$$C_2(Q_2) = c_2 Q_2$$

- Key Feature: Quantity, $Q = Q_1 + Q_2$
- Total Revenue of Firm 1 = $P * Q_1 = [a - b(Q_1 + Q_2)] * Q_1$
- $TR = a Q_1 - b Q_1^2 - b Q_1 Q_2$

Deriving the Reaction Functions

$$\text{Marginal Revenue} = a - 2bQ_1 - bQ_2$$

$$\text{Marginal Cost} = c_1$$

Profit Maximizing condition is when $MR = MC$

$$a - 2bQ_1 - bQ_2 = c_1$$

Rearrange in terms of Q_1

$$\text{Reaction Function of Firm 1 is, } Q_1 = r(Q_2) = \frac{a - c_1}{2b} - 0.5Q_2$$

Deriving the Reaction Functions

Reaction Function of Firm 1 is, $Q_1=r(Q_2)=\frac{a-c_1}{2b}-0.5Q_2$

Reaction Function of Firm 2 is, $Q_2=r(Q_1)=\frac{a-c_2}{2b}-0.5Q_1$

- Implication. Firm 1 and 2's quantity output decision (to maximize profits) directly depends on how much the other firm decides to produce.
- Nash Equilibrium occurs when these reaction functions intersect with each other.

Mathematical Example

Each firm faces a demand curve of $P=10-Q$, where $Q=Q_1+Q_2$

If $\text{Costs}=0$, how much output will each firm produce?

Mathematical Example

Each firm faces a demand curve of $P=10-Q$, where $Q=Q_1+Q_2$

Mathematical Example

Mathematical Example

Mathematical Example

What if they colluded?

- What would happen if the two firms colluded, acted as a monopoly and split the profits?

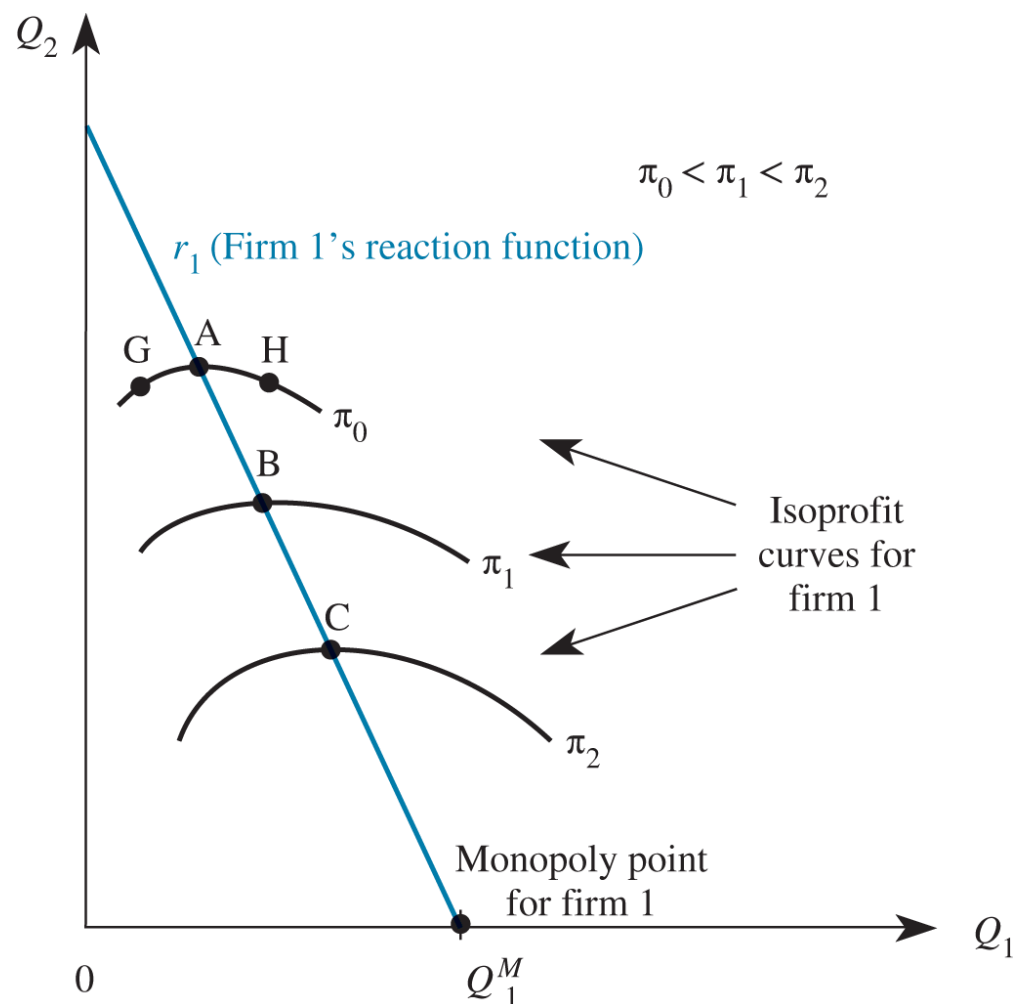
What if they colluded?

- What would happen if the two firms colluded, acted as a monopoly and split the profits? If they act as a monopoly, Q is no longer $Q_1 + Q_2$, but just Q

Cournot Oligopoly: Isoprofit Curves

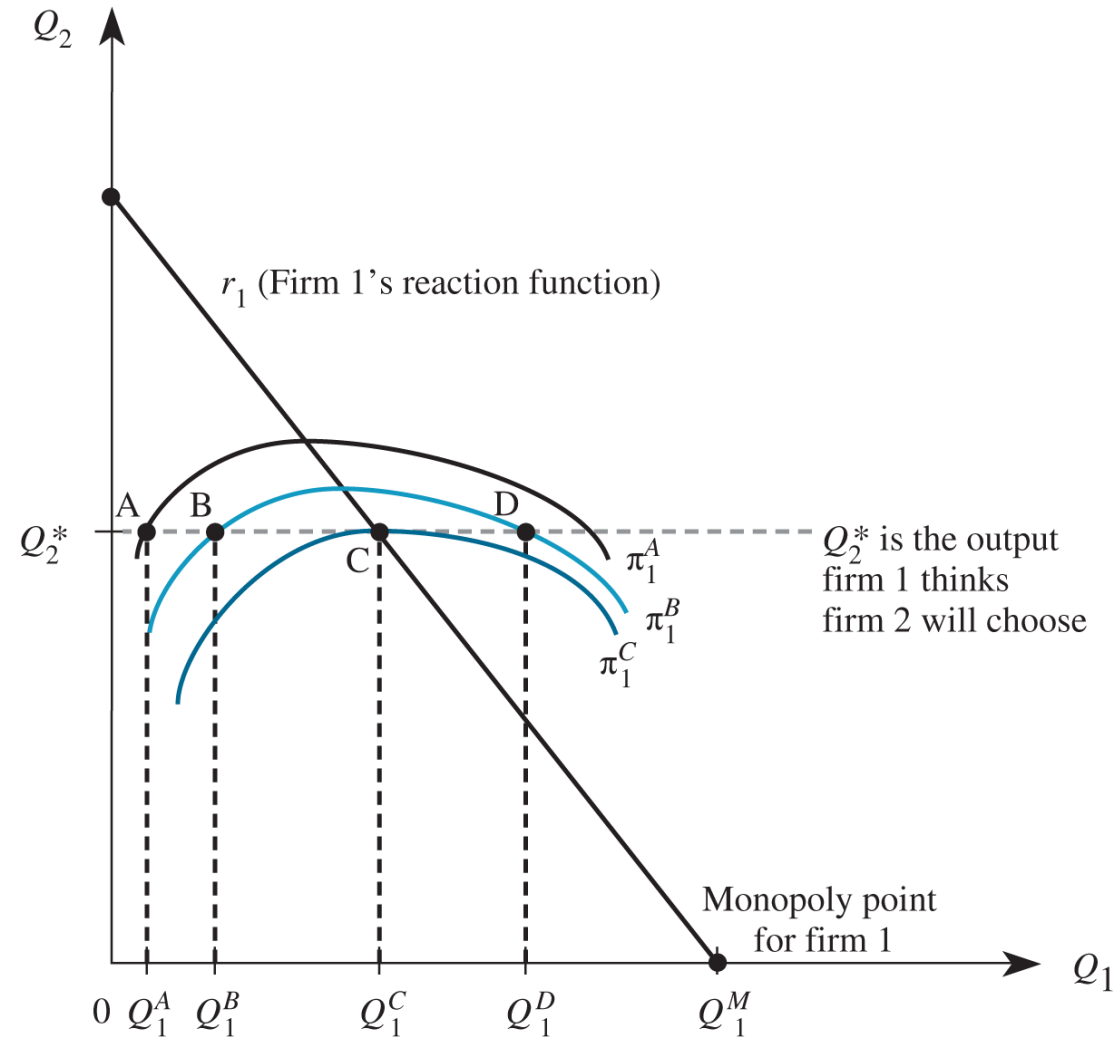
- A function that defines the combinations of outputs produced by all firms that yield a given firm the same level of profits.

Isoprofit Curves for Firm 1



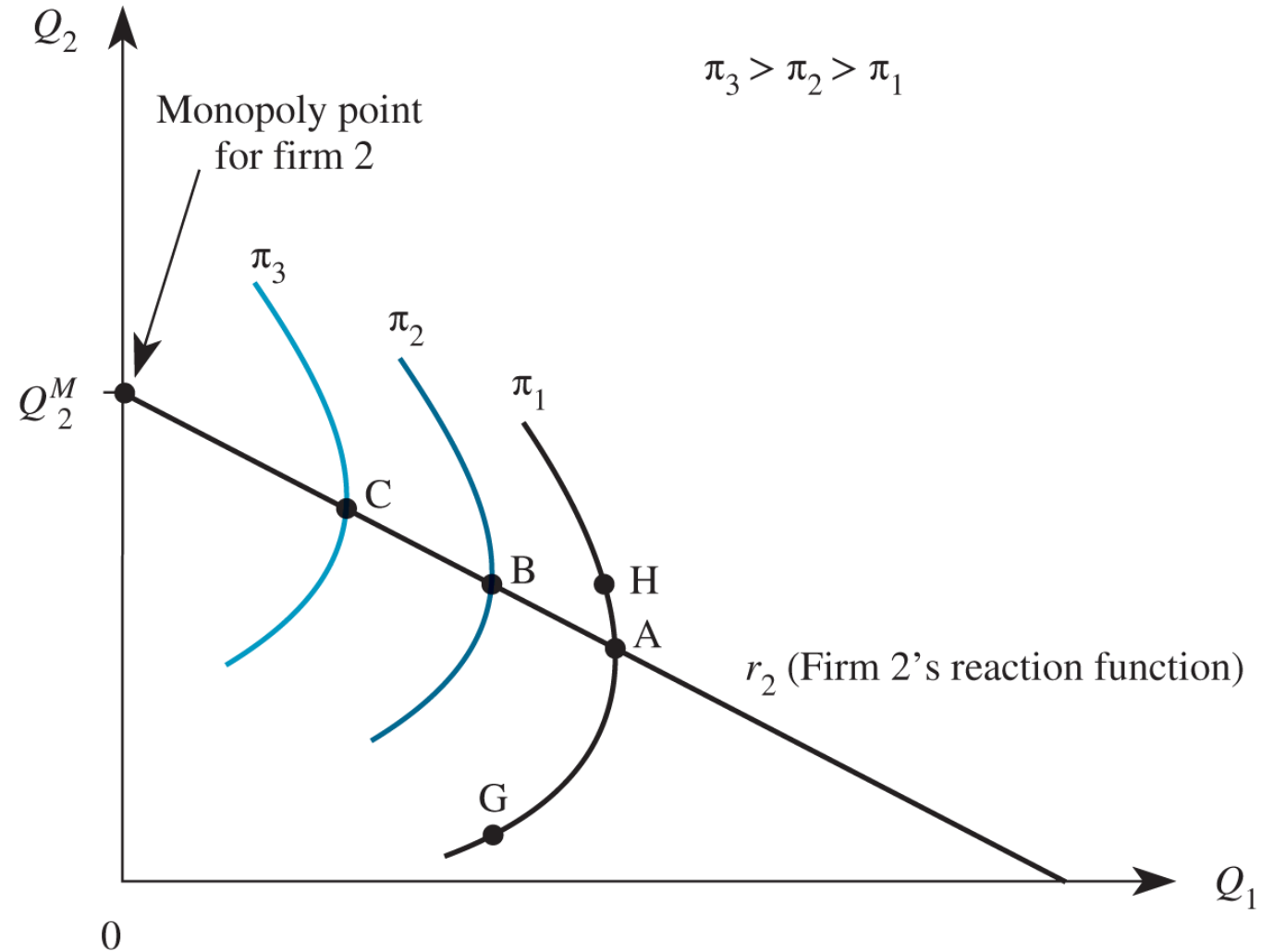
1. Every point on a given isoprofit curve yields Firm 1 the same level of profits.
2. Isoprofit curves that lie closer to Firm 1's monopoly output Q_1^M are associated with higher profits for that firm.
3. The isoprofit curves for Firm 1 reach their peak where they intersect Firm 1's reaction function.
4. The isoprofit curves do not intersect one another.

Firm 1's Best Response to Firm 2's Output

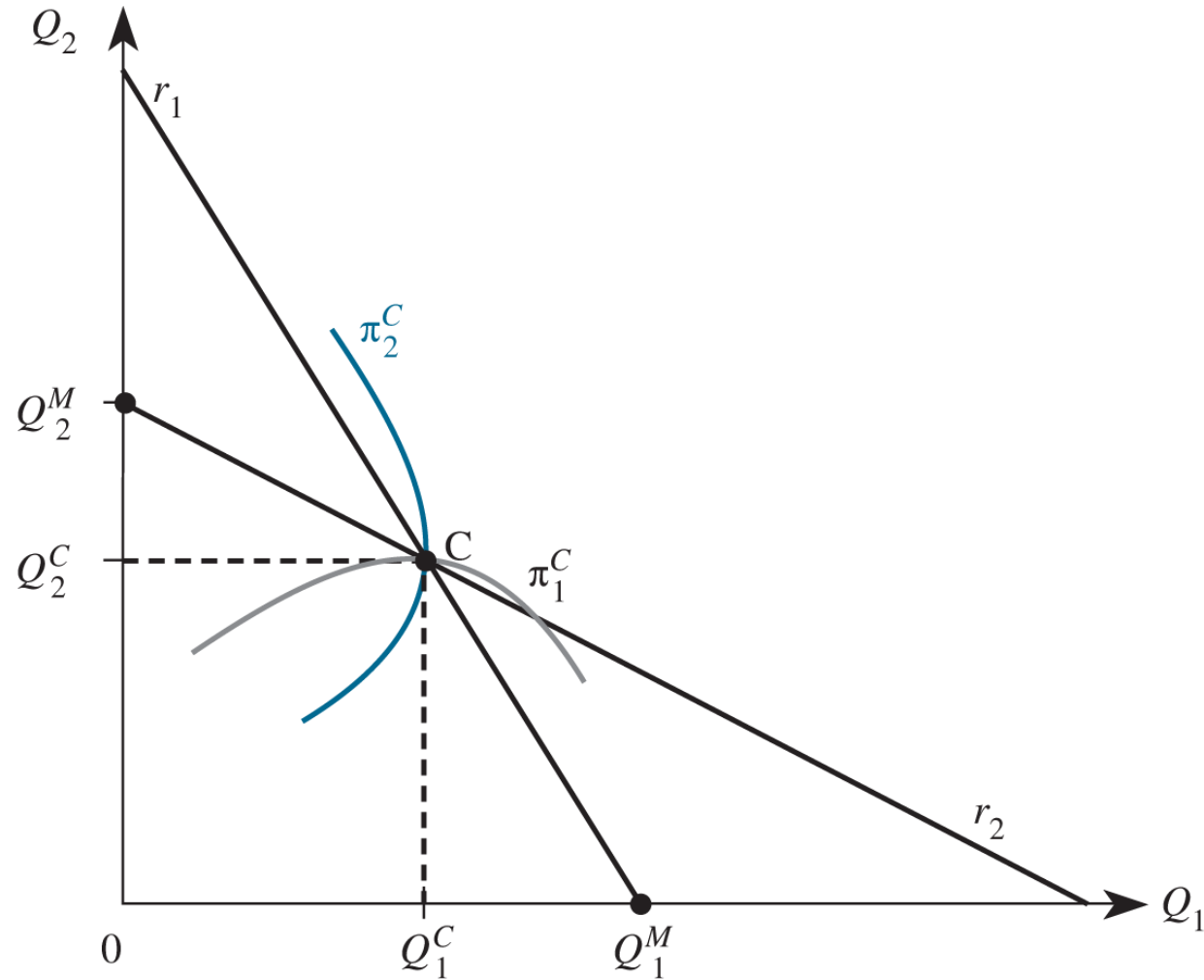


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Firm 2's Reaction Function and Isoprofit Curves

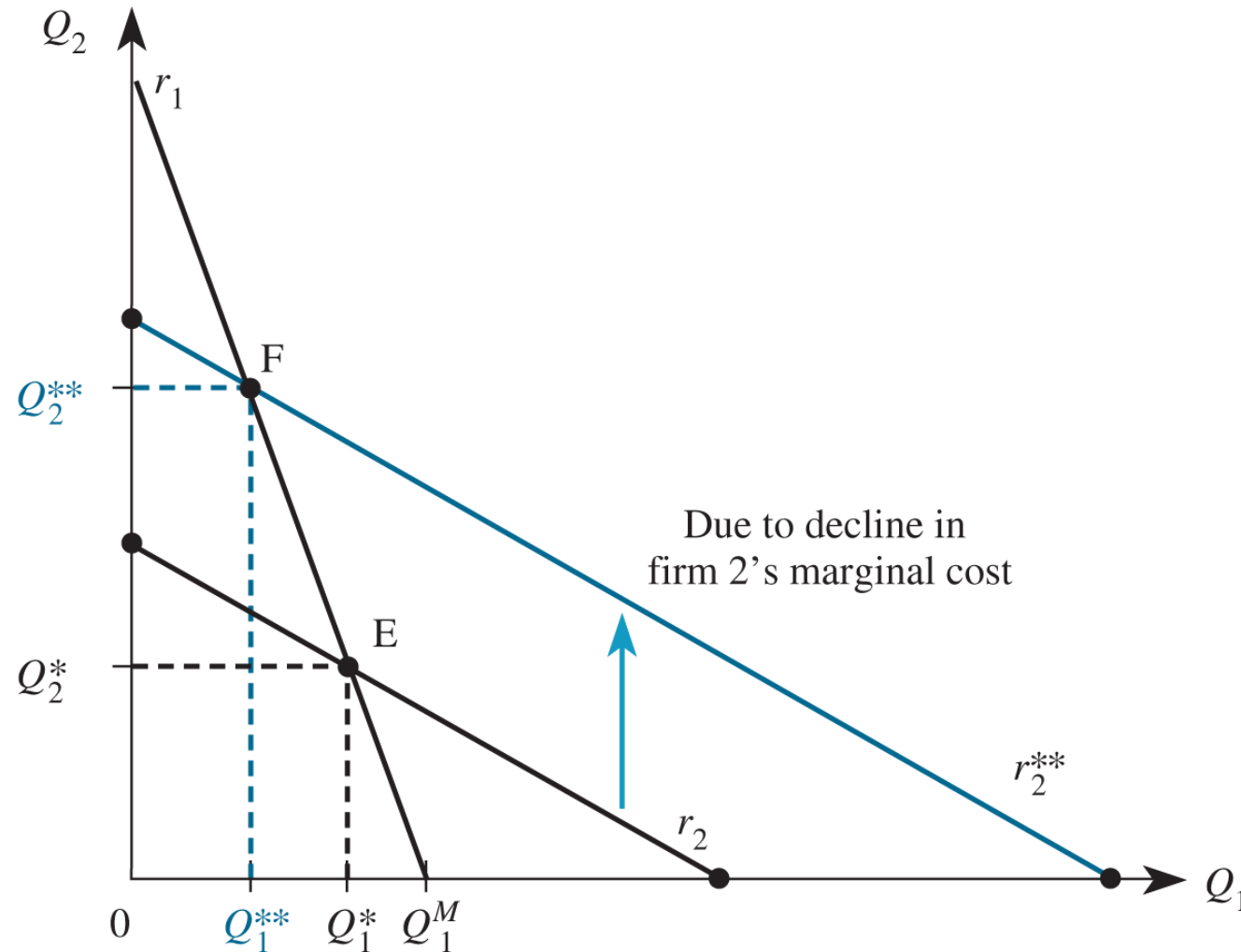


Cournot Equilibrium



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Effect of Decline in Firm 2's Marginal Cost on Cournot Equilibrium



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Cournot Oligopoly: Collusion

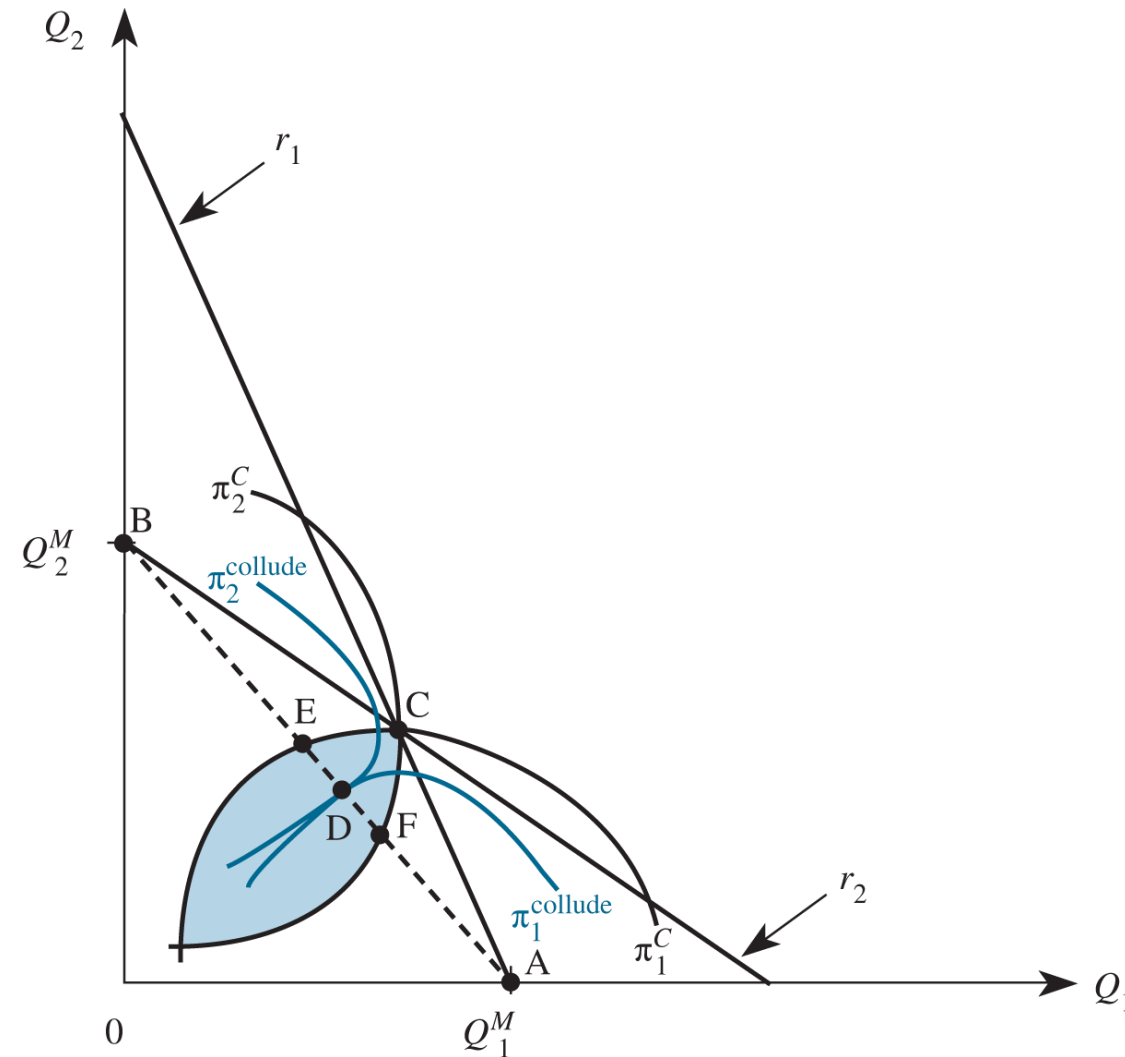
- Markets with only a few dominant firms can coordinate to restrict output to their benefit at the expense of consumers.
- Restricted output leads to higher market prices.

Such acts by firms are known as ***collusion***.

Collusion, however, is prone to cheating behavior.

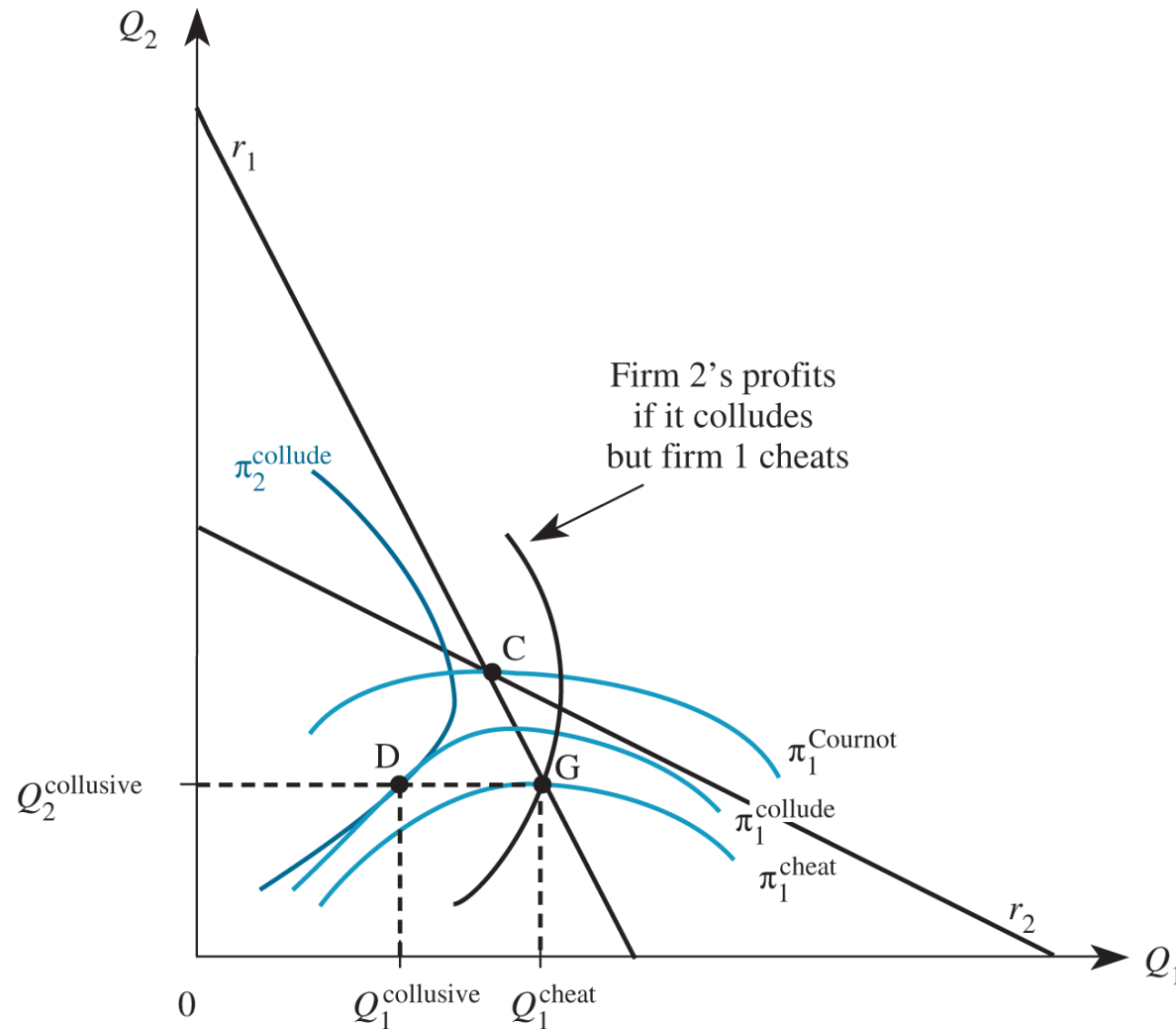
- Since both parties are aware of these incentives, reaching collusive agreements is often very difficult.

The Incentive to Collude in a Cournot Oligopoly



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The Incentive to Renege on Collusive Agreements in Cournot Oligopoly



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This is just another form of a Prisoner's Dilemma!

Firm A	Firm B		
	Strategy	Low price	High price
	Low price	0, 0	50, -40
	High price	-40, 50	10, 10

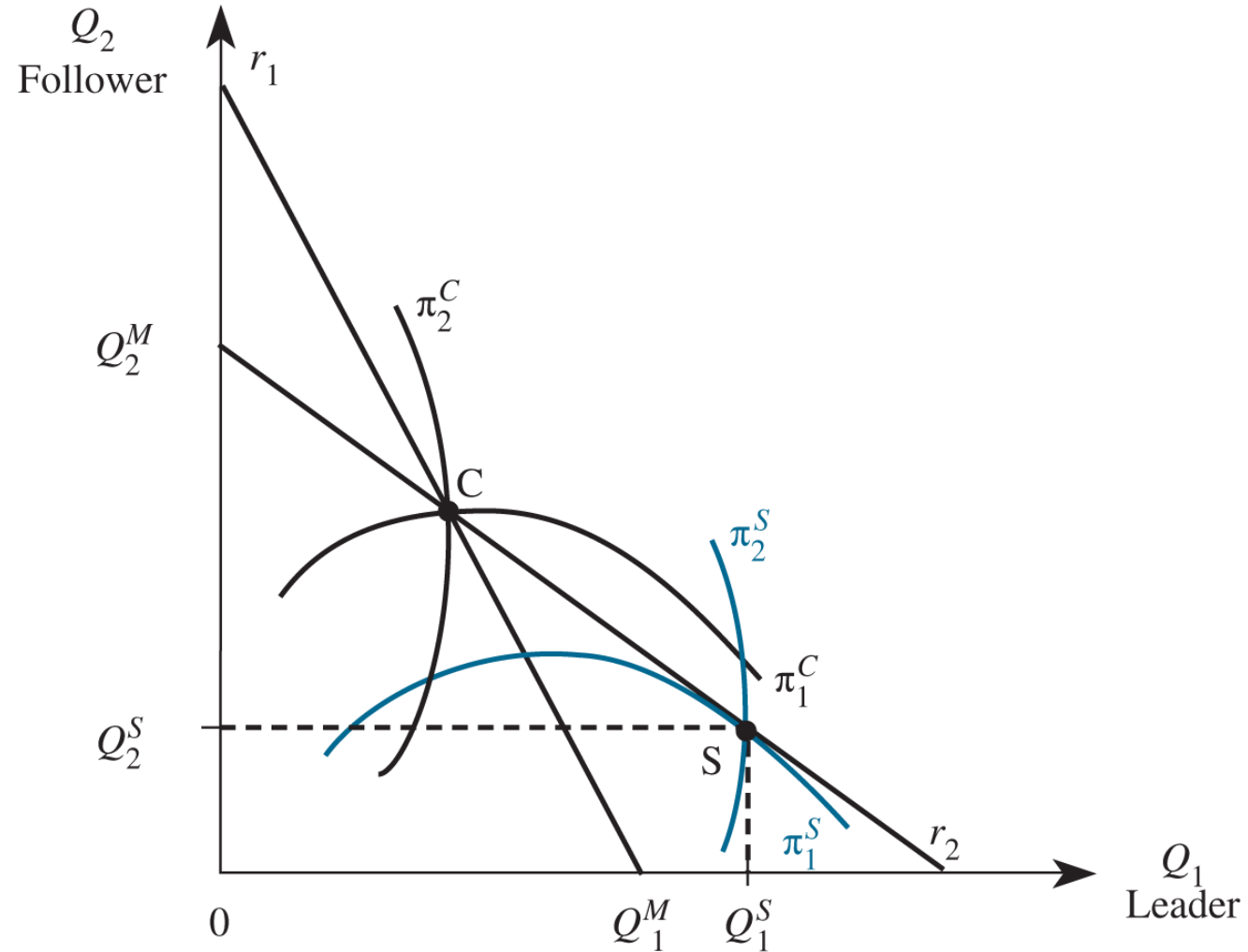
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Stackelberg Oligopoly

Stackelberg oligopoly characteristics:

- 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



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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

- The follower's reaction function is just the same as the Cournot Reaction Function
- The Leader takes into account the follower's Reaction Function to determine their total output.

$$\pi_1 = \left\{ a - b \left[Q_1 + \left(\frac{a - c_2}{2b} - \frac{1}{2} Q_1 \right) \right] \right\} Q_1 - c_1 Q_1$$

- The leader chooses Q_1 to maximize this profit expression, which 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

$$P = 50 - (Q_1 + Q_2)$$

Cost functions for the 2 firms 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: $P = 50 - (24 + 12) = \$14$

Bertrand Oligopoly

Bertrand oligopoly characteristics

- 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 Models

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

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

The Stackelberg leader's output is

$$Q_{leader} = \frac{1,000 + 4 - 2 \times 4}{2 \times 1} = 498$$

$$Q_{follower} = 498 - \frac{1}{2} \times 498 = 249$$

- The market price is: $P = 1,000 - 498 - 249 = \253 .
- $\pi_{leader} = \$124,002$.
- $\pi_{follower} = \$62,001$.

Comparing Oligopoly: Bertrand

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 (Monopoly)

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.

$$P = 1,000 - 498 = \$502$$

Each firm earns profits of \$124,002.

Contestable Markets

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.
 $P = MC$, and firms earn zero economic profits.