

# OLIGOPOLY

Reference:

Pindyck-Rubinfeld, Chapter 12

# Chapter overview

1. Oligopoly, definition, introduction
2. Cournot duopoly
3. Price competition
4. Competition versus collusion: prisoner's dilemma
5. Cartels
6. Limitations of market power

# 1. Oligopoly

- Characteristics:
- small number of firms
- differentiated products (in some cases undifferentiated products)
- barriers to entry:
  - economies of scale, patents, access to a technology, brand recognition, reputation, strategic actions

# Oligopoly: examples

- Examples :
  - automobile industry
  - mobile telephony in France (4 service providers)
  - aeronautical sector (Airbus & Boeing)
  - oil drilling
  - etc.

# Oligopoly

- Challenges:
  - Strategic actions to prevent the entry of new competitors:
    - A firm can threaten to flood the market and lower prices in case of entry, this is achieved by keeping excess capacity.
  - Reactions to the behavior of competitors:
    - Because of the small number of firms, each has to consider the reactions of its competitors to its own actions and vice versa.

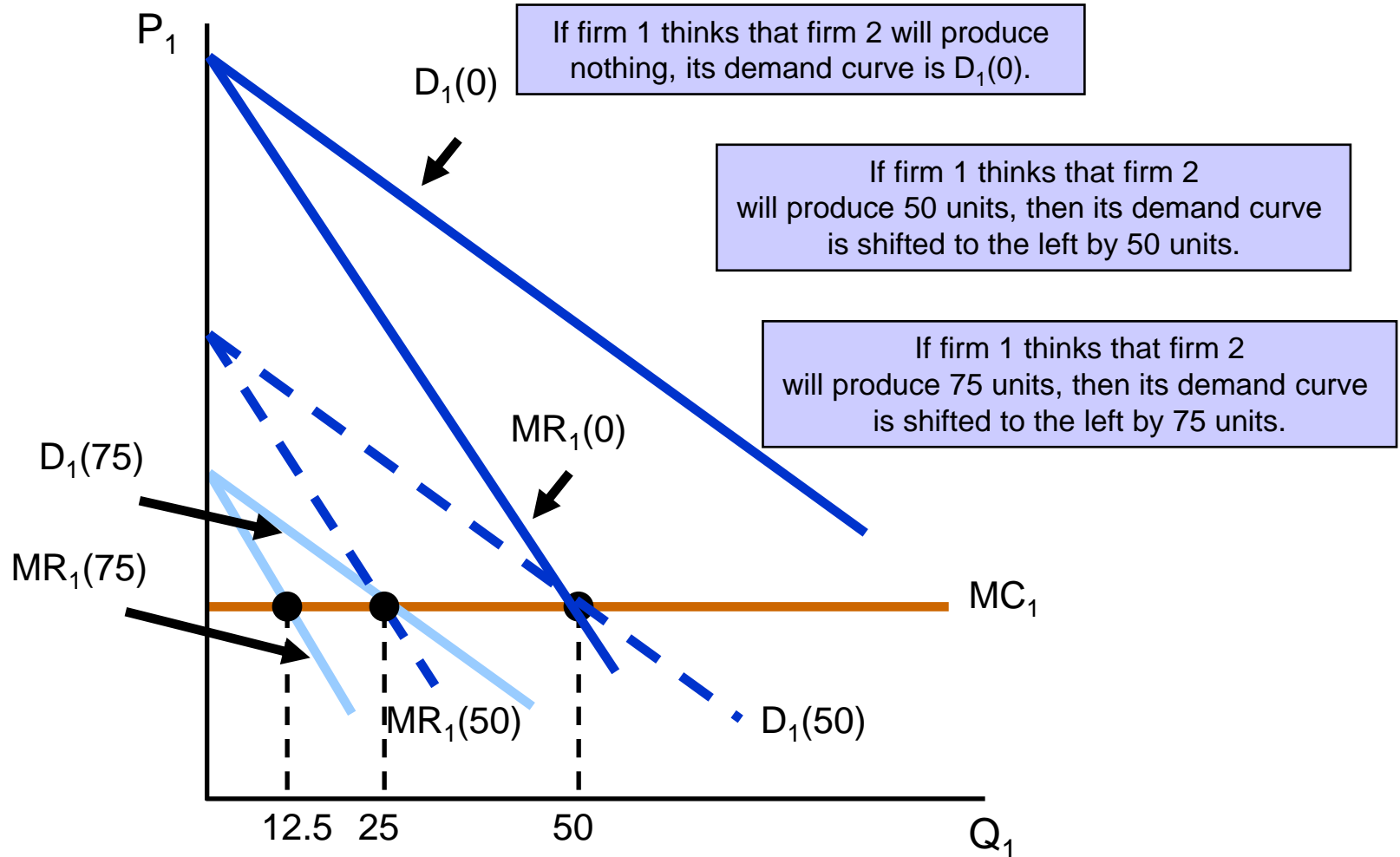
# Oligopoly: Nash equilibrium

- Definition of an equilibrium:
  - When the market is in equilibrium, the firms have made their best possible choices and do not have an interest to change their prices or their quantities.
- Nash equilibrium:
  - When a market **is in a Nash equilibrium, each firm makes optimal decisions given the behavior of its competitors.**
- We focus our attention on **duopolies**, i.e. on markets with only two firms.

## 2. Oligopoly: the Cournot model

- The **Cournot model** is an oligopoly model in which **each company produces a homogeneous good and assumes that the quantity produced by its competitor is fixed when it takes its production decision..**
  - All firms decide simultaneously which quantities to produce, but each firm takes into account the quantity that it thinks its competitor produces.
  - Remark: this model gives the same results as a model of a two stage game in which the firms first choose capacities and then choose the price. One can interpret the Cournot model as a model of capacity choice and then price competition. (Kreps and Scheinkman model).

# Oligopoly: firm 1's decision

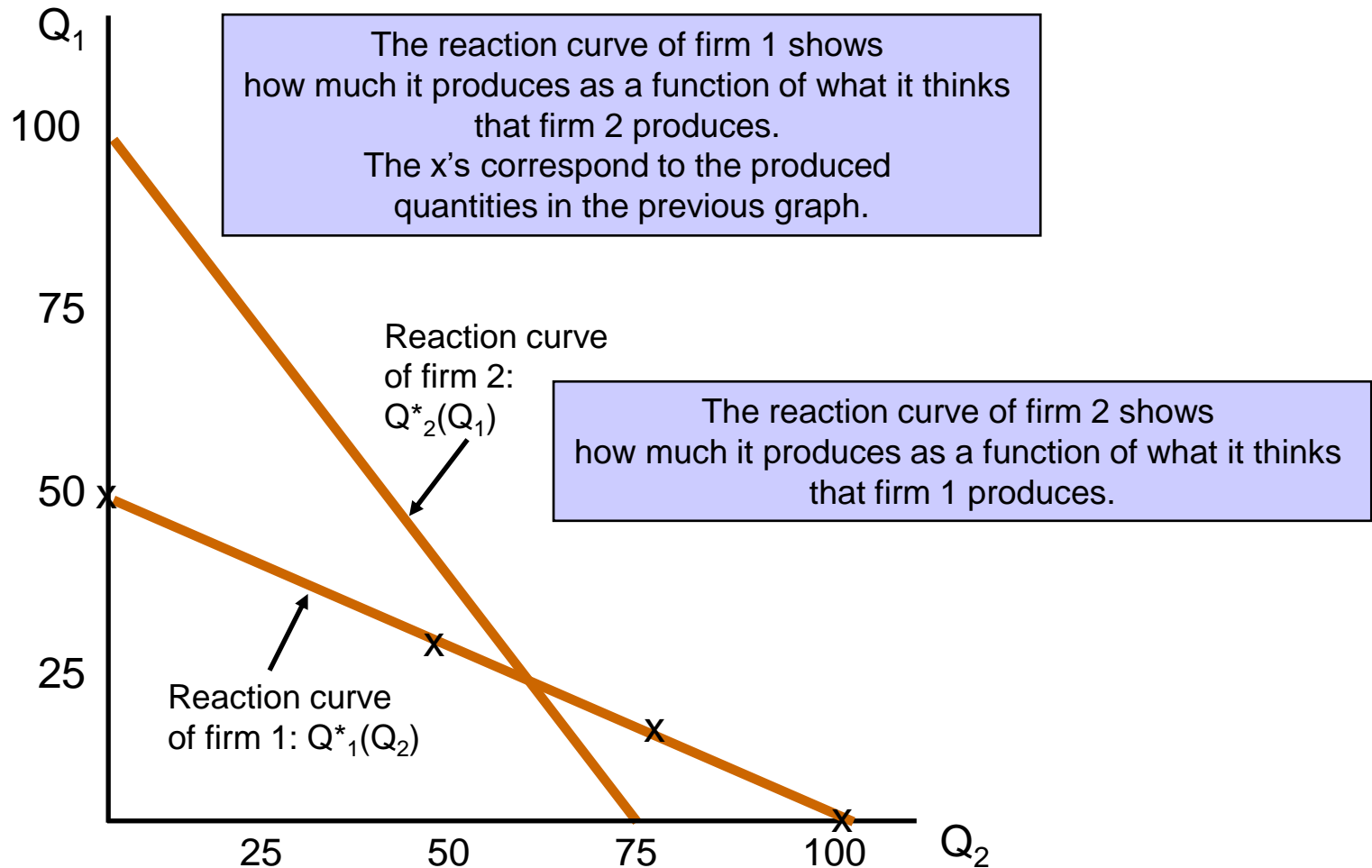




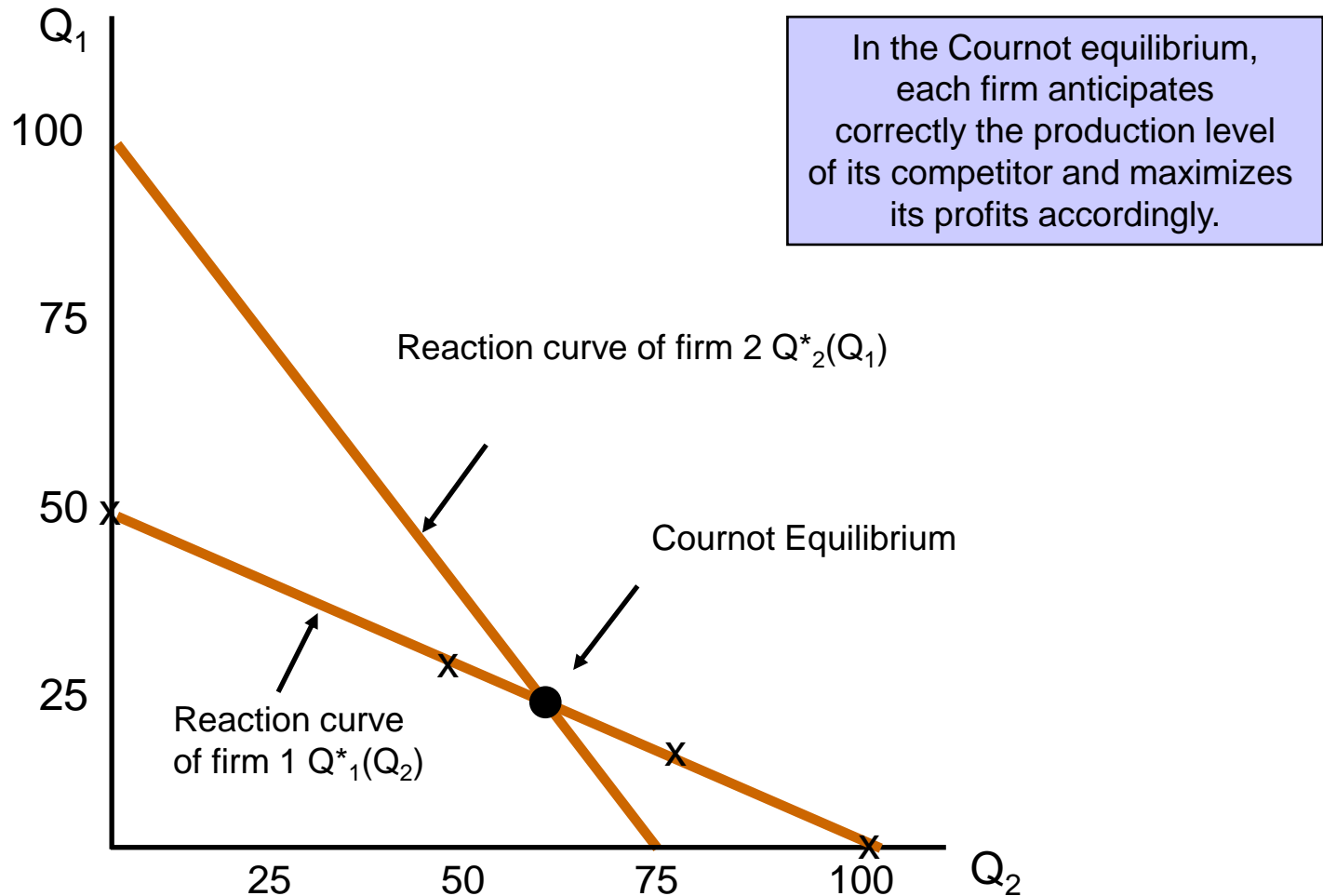
# Oligopoly: the reaction curve

- The **reaction curve of firm 1** represents the (negative) relation between the optimal production of firm 1 and the predicted production of firm 2..
- The **reaction curve of firm 2** represents the (negative) relation between the optimal production of firm 2 and the predicted production of firm 1.

# Oligopoly: the reaction curve and the Cournot equilibrium



# Oligopoly: the reaction curve and the Cournot equilibrium



# Oligopoly: the Cournot model

- Each reaction curve gives the optimal quantity (capacity) of production for a firm as a function of its competitor's quantity (capacity).
- In the **Cournot** equilibrium, each firm chooses its production based on its reaction curve. The equilibrium quantities are given by **the intersection of the two reaction curves**.
- The Cournot equilibrium is an example of a Nash equilibrium (=the Cournot-Nash equilibrium). Note that it doesn't say anything about the adjustment dynamics.

# A linear Cournot model

- An example with linear demand:
  - Each of the two firms faces a linear demand curve, this makes it simpler to compare the social optimum to the collusive equilibrium.
  - Market demand:  $P = 40 - Q$ .
  - $Q =$  total production of the two firms:
$$Q = Q_1 + Q_2.$$
  - Let's also assume  $TC_1 = TC_2 = 10 Q$ .

# A linear Cournot model

- Firm 1's reaction curve:

Firm 1's profit

$$\begin{aligned}\Pi_1 &= PQ_1 - TC(Q_1) = (40 - Q)Q_1 - 10Q_1 \\ &= (40 - Q_1 - Q_2)Q_1 - 10Q_1\end{aligned}$$

# A linear Cournot model

Profit maximization of firm 1:

$$\frac{d\Pi_1}{dQ_1} = 40 - 2Q_1 - Q_2 - 10 = 0$$

$$40 - 2Q_1 - Q_2 = 10$$

$$\underbrace{\hspace{10em}}_{\text{MR}} = \underbrace{\hspace{10em}}_{\text{MC}}$$

Reaction curve of firm 1:

$$Q_1 = 15 - \frac{1}{2}Q_2$$

Similarly, the reaction curve of firm 2:

$$Q_2 = 15 - \frac{1}{2}Q_1$$

# A linear Cournot model

- If the two firms compete:

Cournot equilibrium:

$$Q_1 = Q_2 \quad Q_1 = 15 - \frac{1}{2} \left( 15 - \frac{1}{2} Q_1 \right)$$

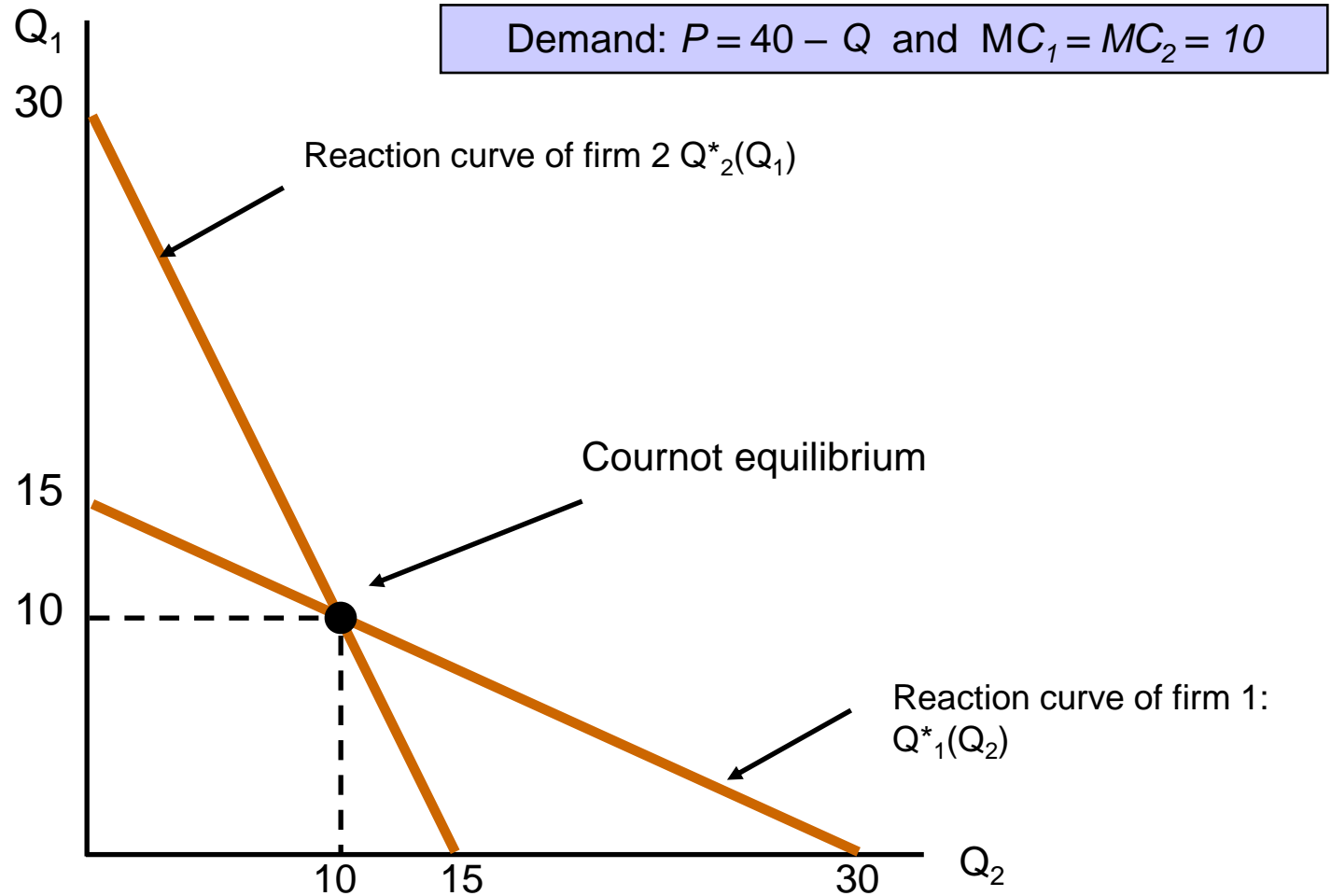
$$Q_1 = Q_2 = 10$$

$$P = 40 - Q = 20$$

$$\Pi_1 = \Pi_2 = 100$$



# A linear Cournot model



# Oligopoly with collusion

- If the two firms collude, they behave as a monopolist:

$$\Pi = PQ - CT(Q) = (40 - Q)Q - 10Q$$

$$\frac{d\Pi}{dQ} = 40 - 2Q - 10 = 0$$

$$40 - 2Q = 10 \quad Q = 15$$

$$\underbrace{40 - 2Q}_{\text{MR}} = \underbrace{10}_{\text{MC}}$$

# Oligopoly with collusion

- The collusion curve yields all the pairs of quantities  $Q_1$  and  $Q_2$  that maximize total profit:

$$Q = Q_1 + Q_2 = 15$$

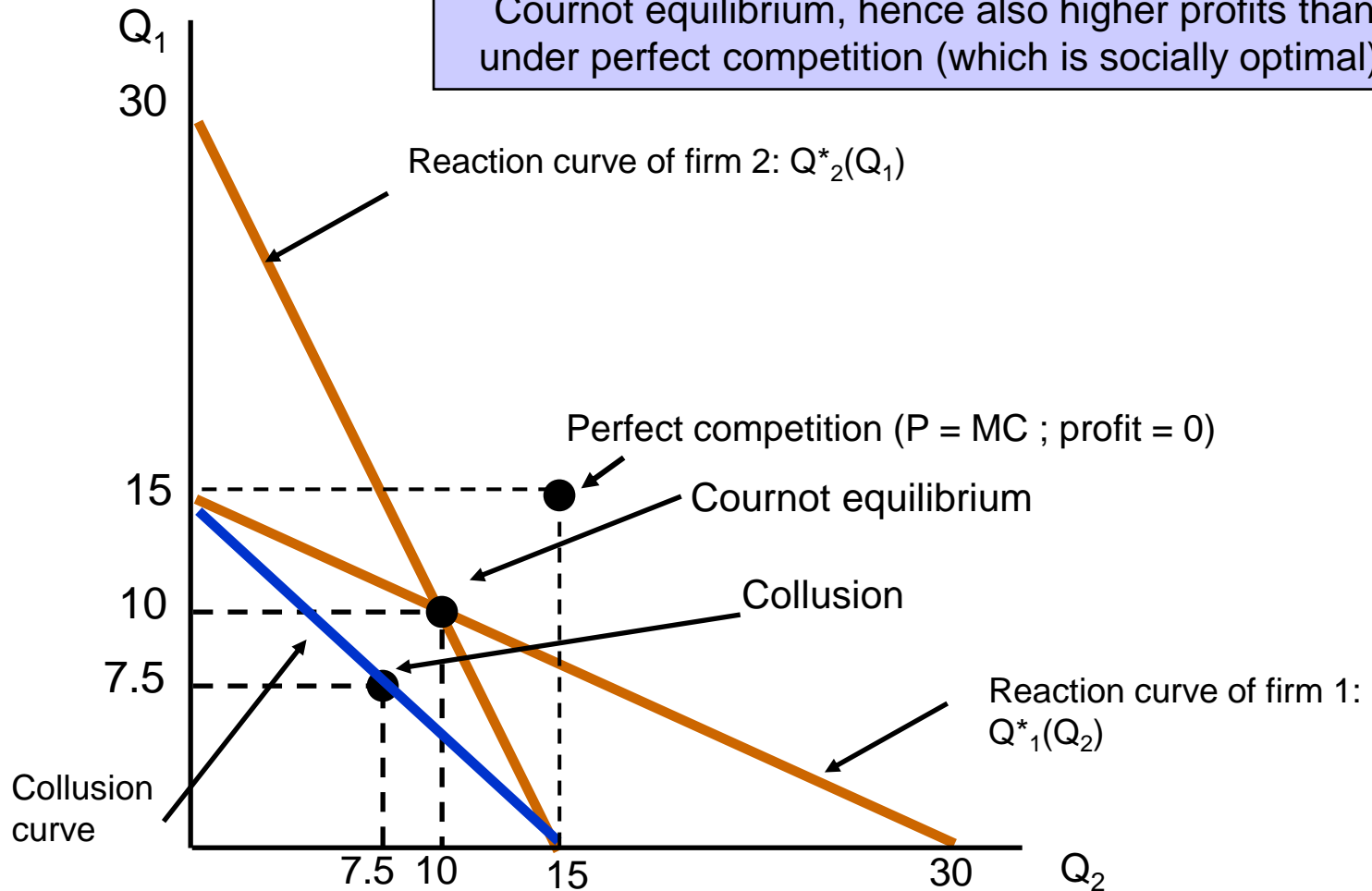
- If the two firms agree to share profits evenly:

$$Q_1 = Q_2 = 7.5 \qquad \Pi_1 = \Pi_2 = 112.5$$

This means less production and higher profits than in the Cournot equilibrium.

# Oligopoly with collusion

For a firm, collusion leads to higher profits than in the Cournot equilibrium, hence also higher profits than under perfect competition (which is socially optimal).



# 3. Price competition

- In many industries, firms compete in prices rather than quantities.
- The **Bertrand model** is an oligopoly model in which **firms produce a homogeneous good and consider prices of their competitors as given, before deciding simultaneously about prices (instead of quantities).**

# Price competition: the Bertrand model

- Assumptions
  - Homogeneous good.
  - Market demand:  $P = 40 - Q$  avec  $Q = Q_1 + Q_2$ .
  - $MC_1 = MC_2 = 10$  euros.
- For comparison, the Cournot equilibrium is:
  - $Q_1 = Q_2 = 10$ .
  - $P = 20$  euros.
  - Profit of each company: 100 euros.

# Price competition: the Bertrand model

- Assume that the firms compete in choosing prices instead of quantities.
- If the good is homogeneous, the consumers will only buy the good from the firm with the lower price.
  - We assume that if the two firms set the same price, half of consumers will buy from each firm.

# Price competition: the Bertrand model

- Nash equilibrium:
  - $P = MC \Rightarrow P_1 = P_2 = 10 \text{ €}$
  - $Q = 30 \Rightarrow Q_1 = Q_2 = 15$
  - Zero profits
- To see that this is an equilibrium: if  $P_2 = 10$  and firm 1 chooses  $P_1 < 10$ , it will make losses. If it chooses  $P_1 > 10$ , it will not sell anything and its profits are 0.
- To see that this is a unique equilibrium: if  $P_2 > 10$ , firm 1 can slightly decrease its price and get all the demand. If  $P_2 < 10$ , firm 1 can set a price  $P_1 \geq 10$  and avoid losses while firm 2 makes losses.



# Bertrand competition and Cournot competition

- Bertrand model: the assumption of price competition is realistic. But the prediction is strange: two firms are enough to achieve perfect competition (profits=0, social welfare is maximized).
- Cournot model: the assumption of firms setting quantities rather than prices is unrealistic. But the prediction is reasonable: an oligopoly results in an intermediate result between perfect competition and monopoly (in terms of prices and social welfare, etc.)

# Monopolistic competition

- This paradox is resolved in models of monopolistic competition
  - Situations of imperfect competition (several products are imperfect substitutes) are called monopolistic competition.
- Examples:
  - toothpaste, soap, shampoo...
  - sports articles
  - retail products.
- Another case between competition and monopoly
  - This is a competitive market, with goods which are almost homogeneous. This approximates a model with perfect competition.
  - One can view them as many monopolies with a high price elasticity.
  - There is price competition, but sellers have monopoly power.

# 4. Competition versus collusion

- If firms could collude, they could have higher profits.
- Because collusion is illegal, the majority of business owners prefer to avoid it. But why not cooperate without explicitly colluding?
- Such a situation would be difficult to maintain in practice (temptation to cheat to get higher profits).

# Competition versus collusion

- Difficulty for colluding firms: the competitor probably won't choose the collusive price.
- Indeed, the competitor can do better by setting a lower price, even knowing that the other firm will choose the collusive price.
- For Cournot competition: the competitor can do better by setting a lower quantity, even knowing that the other firm will choose the collusive quantity.
- We can better understand this using the previous example: Cournot competition.

# Competition versus collusion: prisoner's dilemma

- Assume that firm 1 produces the collusive quantity  $q=7.5$
- The best response of firm 2 would be to produce a larger quantity  $q=15-7.5/2=11.25$ .
- In this case, firm 2 would obtain a profit of ca. 126.5 and firm 1 would obtain a profit of 84.5

# Payoff matrix of the game

		<i>Firm 2</i>	
		Produce $q=7.5$ (cooperate)	Produce $q=11.25$ (deviate)
<i>Firm 1</i>	Produce $q=7.5$ (cooperate)	112.5 €, 112.5 €	84.5 €, 126.5 €
	Produce $q=11.25$ (deviate)	126.5 €, 84.5 €	100 €, 100 €

# Competition versus collusion

- One can now find why a firm does not cooperate.
- The payoff matrix shows that each firm always gains by deviating from collusion, no matter what its competitor does.
- Unless the firms sign a contract to collude (which would be illegal), the firms produce the Cournot quantities.

# Competition versus collusion: prisoner's dilemma

- The problem that oligopolistically competing firms face corresponds to an example in game theory: **the prisoner's dilemma**:
  - Two prisoners are accused of having committed a crime together.
  - They have been placed in separate cells and cannot communicate.
  - The police are trying to make them confess.
  - The police can prove that they committed a minor crime, but cannot prove the major crime.
  - If a prisoner confesses, he will get leniency for the minor crime.



# Payoff matrix of the prisoner's dilemma

		<i>Prisoner B</i>	
		Confess (deviate)	Don't confess (cooperate)
<i>Prisoner A</i>	Confess (deviate)	-5, -5	-1, -10
	Don't confess (cooperate)	-10, -1	-2, -2

# Competition versus collusion: the prisoner's dilemma

- Conclusions :
  1. Collusion increases profits.
  2. Implicit and explicit collusion are possible.
  3. Once there is collusion, there is also an incentive to « deviate » from this collusion and lower the price (or increase the quantity).

# Competition versus collusion: the prisoner's dilemma

1. In some oligopolistic markets, firms can observe the pricing behavior of their competitors and adjust their decisions over time to establish a predictable environment where tacit collusion will be established (through repeated interaction).
2. In other oligopolistic markets, companies are very aggressive, do not trust their competitors and collusion is not possible.

# 5. Cartels

- The cartel producers enter into explicit cooperation in fixing prices and quantities.
- It is not necessary that all the producers of a branch enter the cartel: the other producers benefit from the choices of the cartel.
- If the demand is sufficiently inelastic, it is enough for a sufficient number of producers to join the cartel so that prices can be set well above pure competition prices.

# Cartels

- Examples of cartels that succeeded:
  - OPEC
  - International Bauxite Association
  - Mercurio Europeo.
- Examples that did not succeed:
  - leather
  - tin
  - coffee
  - tea
  - cocoa.

# The conditions for the success of a cartel

1. A stable cartel: the members have to agree on prices and quantities and to adhere to this agreement.
  - However, cartel members have different costs, or different assessments of demand, or different goals.
  - Each member of the cartel is tempted to "deviate" by slightly lowering its prices in order to capture a larger share of the market than that attributed to it.

# The conditions for the success of a cartel

## 2. Some monopoly power.

- Even if a cartel succeeds in solving its organizational problems, it will not be able to significantly increase its prices if it faces a highly elastic demand.
- If the potential gains from cooperating are high, the cartel members will have more incentives to deal with their organizational problems.

# Cartel pricing

- Cartel members must take into account the competitive supply of non-cartel producers when making price decisions.
- Cartel pricing can be hence analyzed with the model of the firm in a dominant position:
  - OPEC: cartel (leader = Saudi-Arabia) of gasoline that succeeded.
  - CIPEC : copper cartel (Chile, Peru, Zambia, DR Congo) that didn't succeed.



# Conditions for the success of a cartel

- To succeed:
  - Total demand should not be too price elastic.
  - The cartel must control almost the entire world supply or, if it does not, the supply of non-cartel producers must not be too price-elastic.

# 6. Limitations of market power: anti-trust law

- Antitrust laws are rules and regulations designed to foster the emergence and sustainability of a competitive economy by:
  - prohibiting any practices that restrict or are likely to restrict competition
  - limiting the permitted forms of market structure.
- Monopoly power can come from different sources, each of which is covered by antitrust law.

# Antitrust Enforcement (Europe and the United States)

- The development of the European Union has been accompanied by a strengthening of the means of application of antitrust laws:
  - The Directorate-General for Competition of the EU and the separate antitrust authorities are responsible for enforcing these laws. European antitrust laws are comparable to those of the United States, but with procedural differences (civil sanctions only) and substantial differences: faster merger authorizations, but lower thresholds of evidence for monopoly.
- US antitrust laws are more stringent than most other countries and their scope is broader:
  - Some think they have disadvantaged the US industry in international markets.

# Anti-trust law (Europe)

- The development of the European Union has been accompanied by a strengthening of the means of application of antitrust laws:
  - The Directorate-General for Competition (DG COMP) of the European Commission and the separate national antitrust authorities are responsible for enforcing these laws. European antitrust laws are comparable to those of the United States, but with procedural differences (civil sanctions only) and substantial differences: faster merger authorizations, but a lower threshold of evidence for monopoly power.
- In Europe antitrust laws are organized in two jurisdictions: national and local.

# Anti-trust laws (France)

- In France, the “Conseil de la concurrence” takes decisions and, if necessary, imposes sanctions. These sanctions are subject to appeal to the Paris Court of Appeal (competition section) (“Cour d'appel de Paris (section concurrence)”) and the “Cour de cassation”).
- The Directorate General for Competition, Consumer Affairs and Fraud Control (“Direction générale de la concurrence, de la consommation et de la répression des fraudes”, DGCCRF) is the authority responsible for competition investigations, conducted on behalf of the Minister or at the request of the “Conseil de la concurrence”. It is also responsible for merger control.
- With the law LME (Loi de Modernisation de l'Economie) of August 4, 2008, the “Conseil de la concurrence” becomes the “Autorité de la Concurrence” by its merger with the DGCCRF.

# Anti-trust laws (Europe)

- Article 81 EC lays down the principle of the **prohibition of cartels**
- Article 82 EC prohibits abuse of dominant position.
- Examples:
  - charging too high prices to the detriment of consumers
  - prices too low to exclude competitors from the market or to block access to new entrants
  - granting discriminatory benefits to certain customers.

# The application of antitrust laws (Europe)

- Two examples in Europe:
  - Microsoft was sentenced in 2004 to pay a fine of 497 million euros (bundling of Windows and application software, such as Windows Media Player and Internet Explorer).
  - Coca-Cola has signed an agreement to avoid being fined for abuse of dominant position: its market share is 50% against 10% for Pepsi-Cola, its main competitor