Competitive strategies in commodity oligopolies

L 01: Theories of oligopolistic competition

Prof. Dr. Ulrich Pidun

Perfectly competitive markets

Assumption 1: Price taking

- Because many firms compete in the market, each firm faces a significant number of direct competitors for its products
- Because each individual firm sells a sufficiently small portion of total market output, its decisions have no impact on market price
- Consequently, each firm takes the market price as given

Assumption 2: Product homogeneity

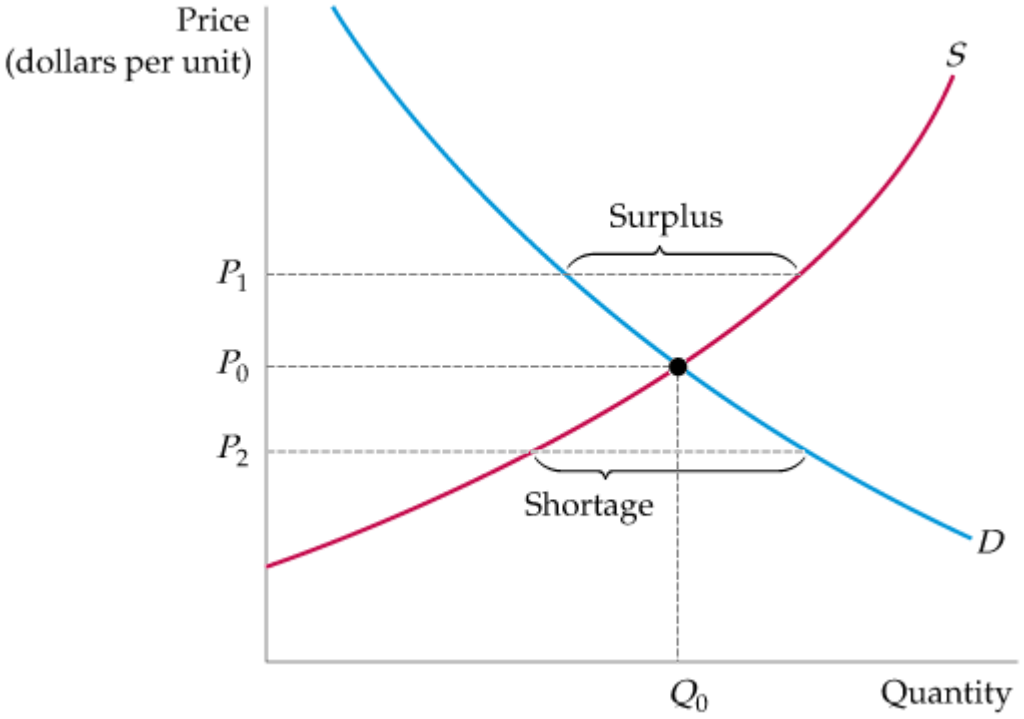
- Price taking behavior typically occurs in markets where firms produce identical, or nearly identical, products
- When the products of all firms in a market are perfectly substitutable with one another (i.e., homogeneous products or commodities), no firm can raise the price of its product above the price of other firms without losing all or most of its business
- The assumption of product homogeneity is important because it ensures that there is a single market price, consistent with supply-demand analysis

Assumption 3: Free entry and exit

- There are no special costs that make it difficult for a new firm either to enter an industry and produce, or to exit if it cannot make a profit
- As a result, buyers can easily switch suppliers, and suppliers can easily enter or exit a market
- The assumption of free entry and exit is important for competition to be effective

Market mechanism in perfectly competitive markets

Supply and demand



The demand and supply curve intersect at the **equilibrium** or **market-clearing price** P_0 and quantity Q_0

The **market mechanism** is the tendency in a free market for the price to change until the market clears, i.e., until the quantity supplied and the quantity demanded are equal

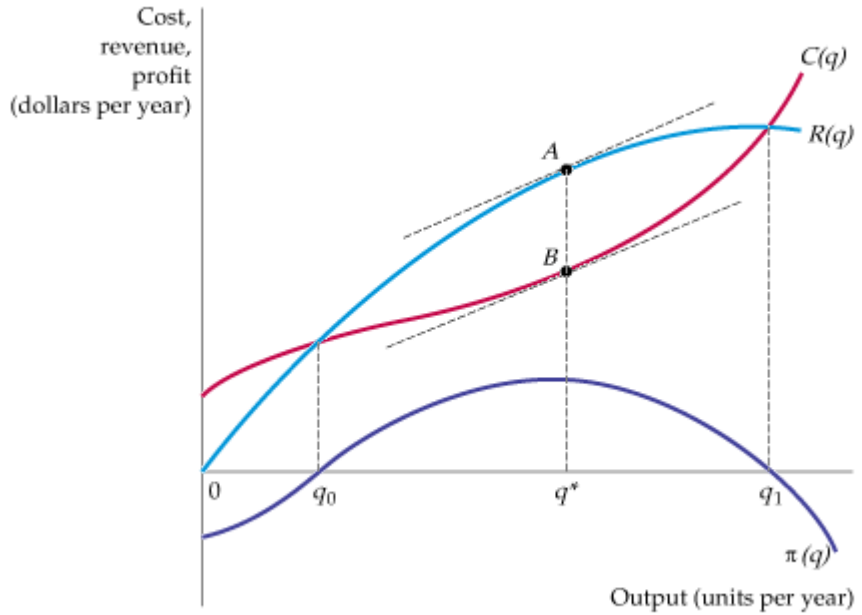
In case of a **surplus** (quantity supplied > quantity demanded) the price will fall, increasing demand and lowering supply

In case of a **shortage** (quantity supplied < quantity demanded) the price will rise, lowering demand and increasing supply

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 2

Profit maximization by a firm

Profit maximization by a firm



A firm will set prices and output level with the objective to **maximize its profits**

Profit π is the difference between total revenue R (price of the product P times volume sold q) and total cost C (which will also depend on the total output q):

π(q) = R(q) – C(q)

A firm chooses output q*, so that the difference between revenue R and cost C is maximized

At that output, **marginal revenue** (the slope of the revenue curve) and **marginal cost** (the slope of the cost curve) are equal:

dπ / dq = 0

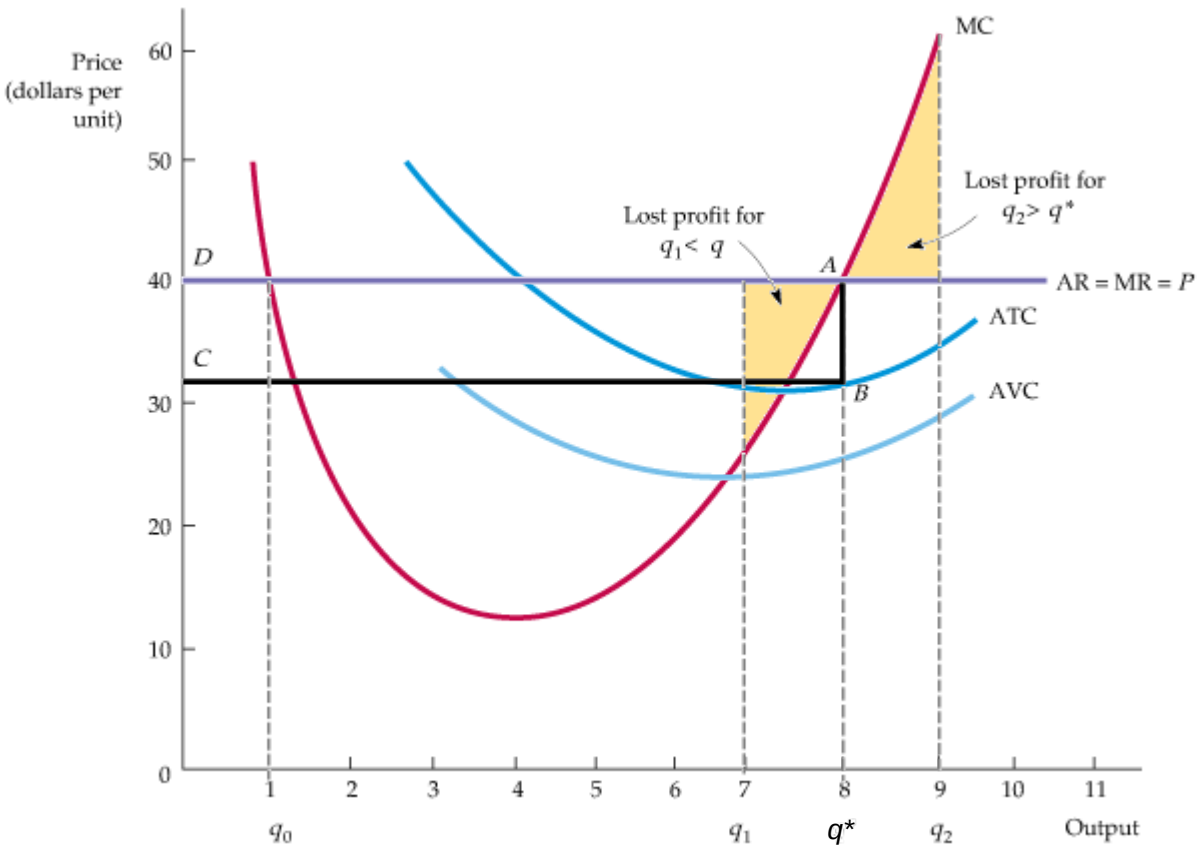
dR / dq – dC / dq = 0

MR(q) = MC(q)

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 8

Profit maximization by a firm in a perfectly competitive market

Profit maximization by a competitive firm



Because it is a price taker, the **demand curve d facing an individual firm in a perfectly competitive market is a horizontal line**. This demand curve is both its average revenue curve and its marginal revenue curve.

Consequently, a firm in a perfectly competitive market should choose its output so that marginal cost equals price:

MC(q) = MR = P

In the example, ATC (average total cost) are below MC (marginal cost) at the equilibrium output q* so that the firm earns a profit that is measured by the rectangle ABCD.

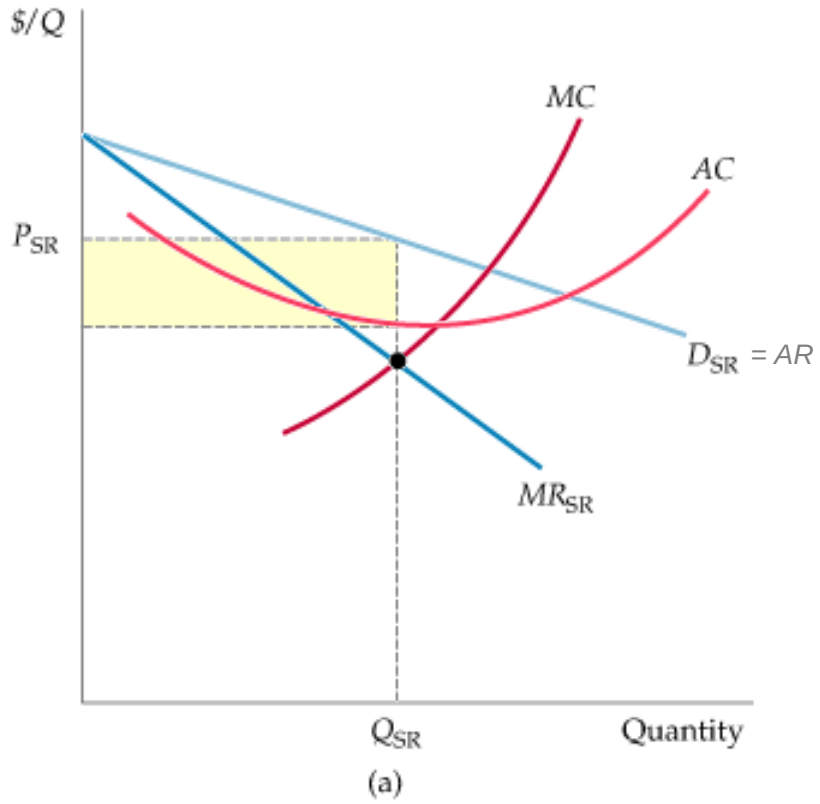
Any change in output, whether lower at q_1 or higher at q_2, will lead to lower profit.

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 8

Profit maximization by a monopolistically competitive firm

Short run

Profit maximization by a monopolistically competitive firm (short run)



Characteristics of a monopolistically competitive market:

- Firms compete by selling **differentiated products** that are highly substitutable for one another but not perfect substitutes
- There is **free entry and exit**

In contrast to perfect competition, firms in monopolistic competition face **downward sloping demand curves** (and correspondingly downward sloping marginal revenue curves)

The profit maximizing output Q_{SR} is found at the intersection of the marginal revenue and marginal cost curves.

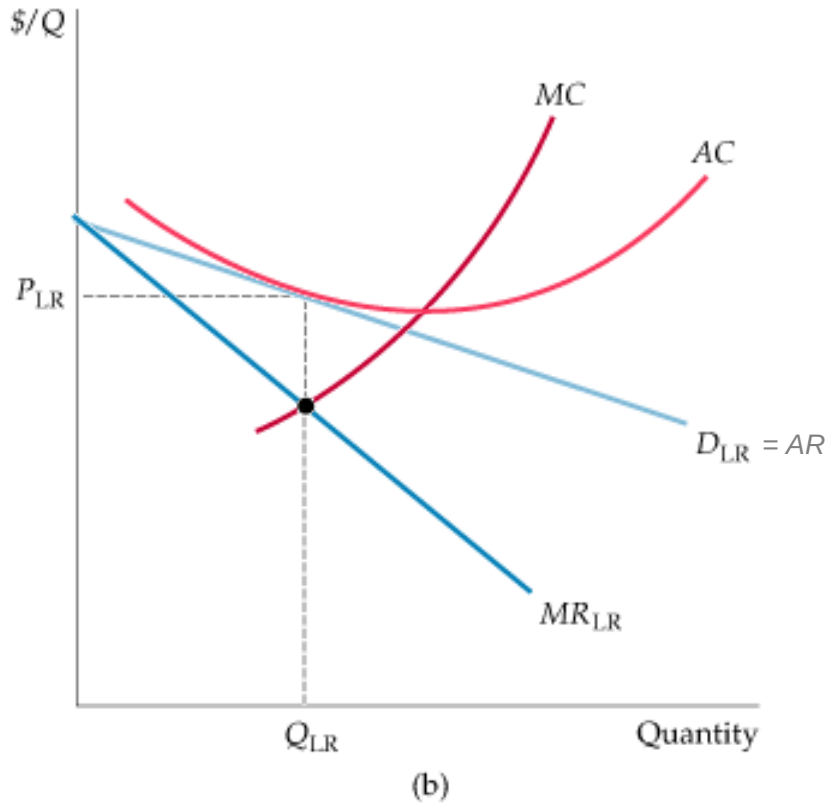
In the short run, the firm may earn a profit because the corresponding price P_{SR} exceeds average cost AC

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 12

Profit maximization by a monopolistically competitive firm

Long run

Profit maximization by a monopolistically competitive firm (long run)



In the **long run**, the profits of a monopolistically competitive firm will **attract new firms** with competing brands

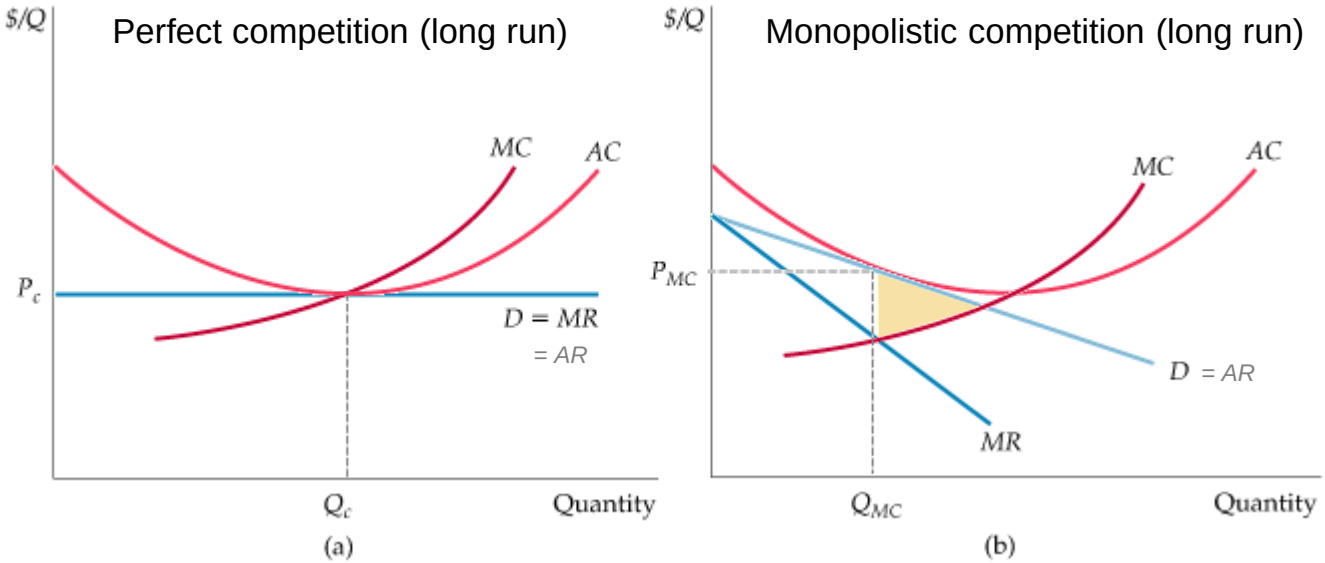
The firm's **market share falls**, and its demand curve shifts downward

In the long-run equilibrium, **price equals average cost**, so the firm earns zero profit even though it has monopoly power

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 12

Monopolistic competition and economic efficiency

Long-run profit maximization by a monopolistically competitive firm



Two sources of **inefficiency** in a monopolistically competitive industry:

- Unlike perfect competition, with monopolistic competition the **equilibrium price exceeds marginal cost**. This means that the value to consumers of additional units of output exceeds the cost of producing these units.
- For the monopolistically competitive firm, **output is below that which minimizes average cost**

However,

- In most monopolistically competitive markets, **monopoly power is small**
- Any inefficiency must be balanced against an important benefit from monopolistic competition: **product diversity**

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 12

Oligopoly

Definition of oligopoly:

- Market in which only few firms account for most or all of total sales

Characteristics of oligopoly:

- Products may or may not be differentiated
- In some oligopolistic markets, some or all firms earn substantial profits over the long run because barriers to entry make it difficult or impossible for new firms to enter

Sources of barriers to entry

- Natural barriers e.g., scale economies, patents, access to important resources, importance of reputation
- Strategic actions to deter entry e.g., overcapacities, threat of a price war

Challenges of managing in an oligopoly:

- Because only a few firms are competing, each firm must carefully consider how its actions will affect its rivals, and how its rivals are likely to react (strategic considerations)

Equilibrium in an oligopolistic market

In **perfectly competitive and monopolistically competitive markets**, each firm can take price or market demand as given and largely ignore its competitors.

In an **oligopolistic market**, however, a firm sets price or output based partly on strategic considerations regarding the behavior of its competitors.

How can we define market equilibrium in such a situation?

Remember how we described an equilibrium in perfectly and monopolistically competitive markets: When a market is in equilibrium, **firms are doing the best they can** and have no reason to change their price or output.

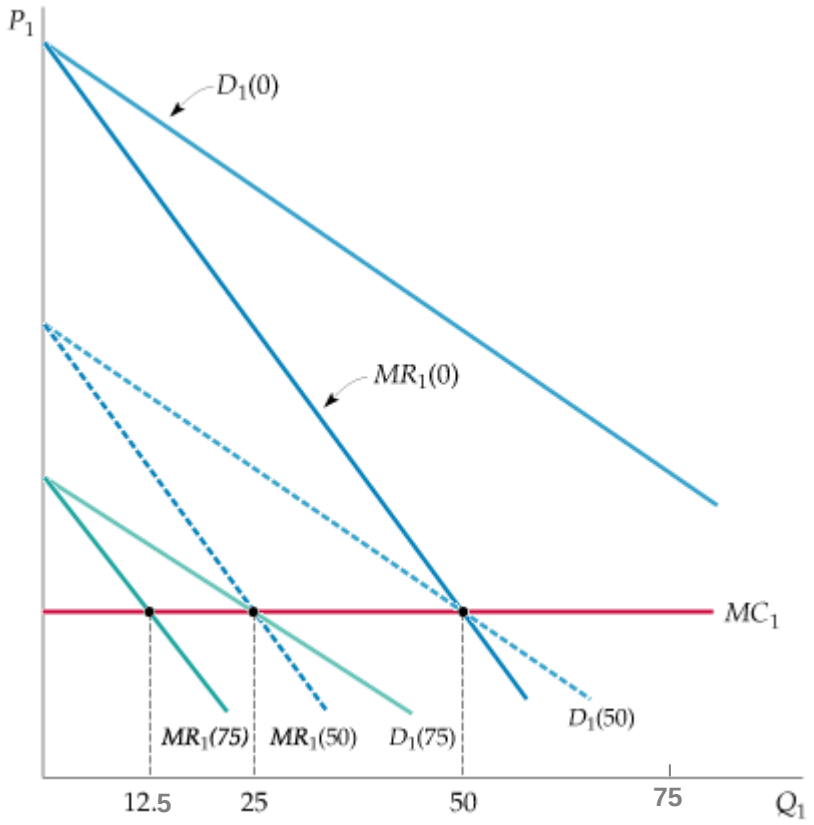
With some modification we can apply the same principle to an oligopolistic market:

Nash equilibrium: Each firm is doing the best it can given what its competitors are doing

Cournot model of oligopolistic competition (I)

Augustin Cournot
(1801-1877)

Firm 1's output decision



Model:

- Two firms producing a homogeneous good (commodity duopoly)
- Each firm must decide how much to produce, and the two firms make their decisions at the same time

Solution:

- Each firm treats the output level of its competitor as fixed when deciding how much to produce

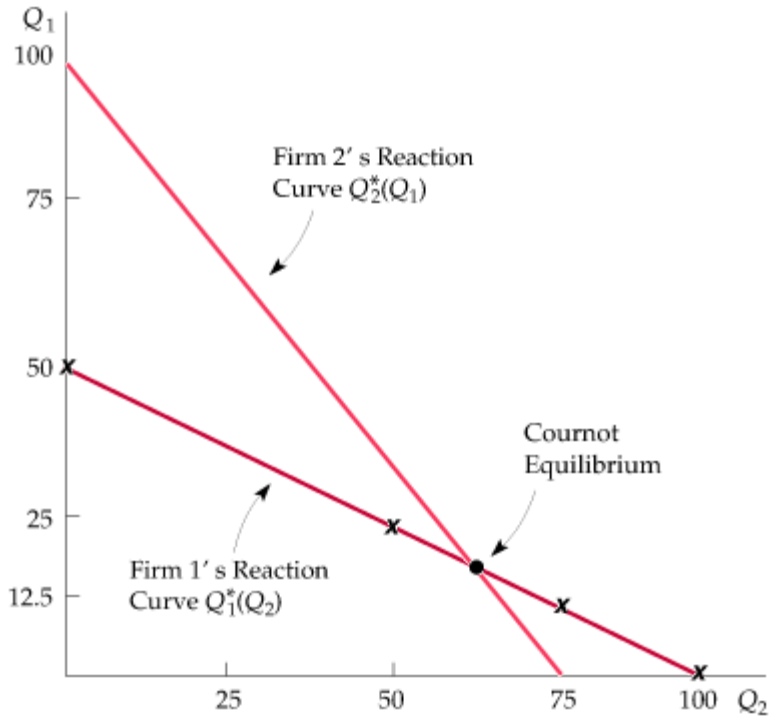
Firm 1's output decision:

- Firm 1's profit-maximizing output depends on how much it thinks that Firm 2 will produce
- Depending on Firm 2's expected output, the demand curve D for Firm 1 will look differently
- The corresponding marginal revenue curve MR will intersect the marginal cost curve MC at different points of optimal output

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 12

Cournot model of oligopolistic competition (II)

Reaction curves



Firm 1's profit-maximizing output is thus a decreasing schedule of how much it thinks Firm 2 will produce.

We call this schedule Firm 1's **reaction curve** and denote it $Q_1^*(Q_2)$.

In the same way, Firm 2's reaction curve $Q_2^*(Q_1)$ shows its output as a function of how much it thinks Firm 1 will produce.

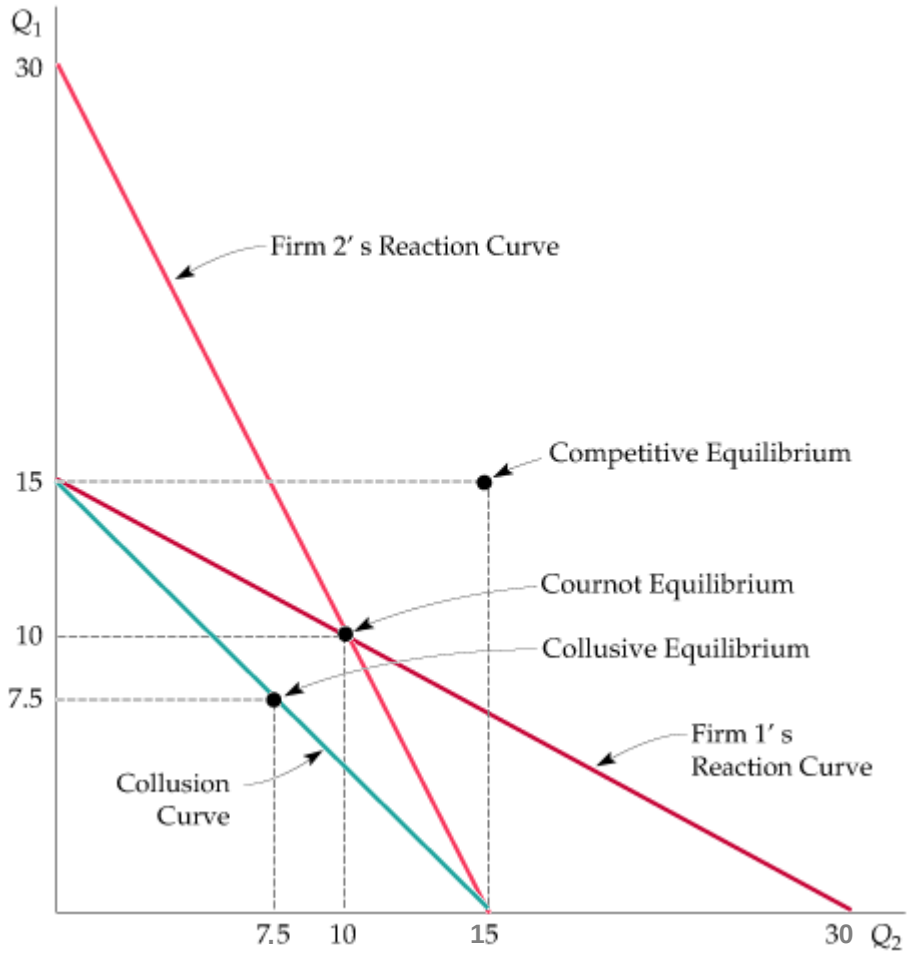
The **Cournot Equilibrium** is at the intersection of the two reaction curves: Each firm correctly assumes the amount that its competitor will produce and thereby maximizes its own profits.

The Cournot Equilibrium is a **Nash Equilibrium** because each firm is producing an amount that maximizes its profit, given what its competitor is producing, so neither would want to change its output.

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 12

Cournot model of oligopolistic competition (III)

Linear demand curve example



Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 12

Assumptions:

- Linear demand curve: $P = 30 - Q$
- Zero marginal cost: $MC_1 = MC_2 = 0$

Firm 1's reaction curve:

- $R_1 = PQ_1 = (30\text{-}Q)Q_1 = 30Q_1 - Q_1^2 - Q_1Q_2$
- $MR_1 = dR_1/dQ_1 = 30 - 2Q_1 - Q_2 = MC_1 = 0$
- $Q_1 = 15 - Q_2/2$

Cournot Equilibrium:

- Firm 2' s reaction curve: $Q_2 = 15 - Q_1/2$
- Cournot Equilibrium: $Q_1 = Q_2 = 10$

Collusion Equilibrium:

- $R = PQ = 30Q - Q^2$
- $MR = dR/dQ = 30 - 2Q$
- $MR = MC = 0 \rightarrow Q = Q_1 + Q_2 = 15$

Competitive Equilibrium:

- $P = MC = 0$
- $Q = 30 - P = 30 = Q_1 + Q_2$

Stackelberg Model: First mover advantage

Heinrich v. Stackelberg (1905-1946)

In the Cournot Model we have assumed that both firms make their output decisions at the same time. However, what happens if one of the firms can set its output first?

Stackelberg Model: Suppose Firm 1 sets its output first and then Firm 2, after observing Firm 1's output, makes its output decision. In setting output, Firm 1 must therefore consider how Firm 2 will react.

Using the setting from the previous example:

- Firm 2's reaction curve: $Q_2 = 15 - Q_1/2$

Firm 1's profit maximization:

- $R_1 = P\,Q_1 = (30 - Q)\,Q_1 = (30 - Q_1 - Q_2)\,Q_1 = 30Q_1 - Q_1^2 - Q_2Q_1$
- $R_1 = 30Q_1 - Q_1^2 - Q_1\,(15 - Q_1/2) = 15Q_1 - Q_1^2/2$
- $MR_1 = dR_1 / dQ_1 = 15 - Q_1 = MC_1 = 0 \rightarrow Q_1 = 15$

Firm 2's profit maximization:

- $Q_2 = 15 - Q_1/2 = 15 - 7.5 = 7.5$

Conclusion:

- **Going first gives Firm 1 a competitive advantage**: It produces twice as much as Firm 2 and thus also makes twice as much profit
- Reason: Announcing first creates a fait accompli – No matter what your competitor does, your output will be large. Unless your competitor views "getting even" more important than making money, it would be irrational for it to produce a large amount

Cournot vs. Stackelberg Model

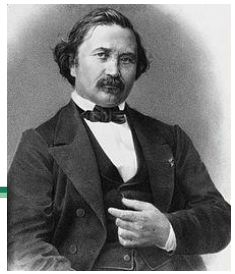
When would you apply the Cournot Model?

- Industry composed of roughly similar firms, none of which has a strong leadership position
- Examples: steel, paper, energy
- Industry in equilibrium because then neither firm has an incentive to change its output

When would you apply the Stackelberg Model?

- Industry dominated by one large firm that usually takes the lead in pricing or innovation
- Examples: IBM in mainframe computers, Maersk Line in container shipping
- Industry with frequent output decisions (also changing leadership)

Bertrand Model: Price competition with homogeneous products



Joseph Bertrand (1822-1900)

In the Cournot (and Stackelberg) Model we have assumed that firms compete by setting quantities.

The **Bertrand Model** also assumes that firms produce the same homogeneous good and make their decisions at the same time. In this case, however, the firms choose **prices** instead of quantities.

Linear demand curve example:

- Market demand curve: $P = 30 - Q$
- Constant marginal cost of both firms: $MC_1 = MC_2 = \$3$
- Cournot equilibrium: $Q_1 = Q_2 = 9$, $P = \$12$, $\pi_1 = \pi_2 = \$81$ (please confirm this as an exercise)

Nash equilibrium in the Bertrand Model:

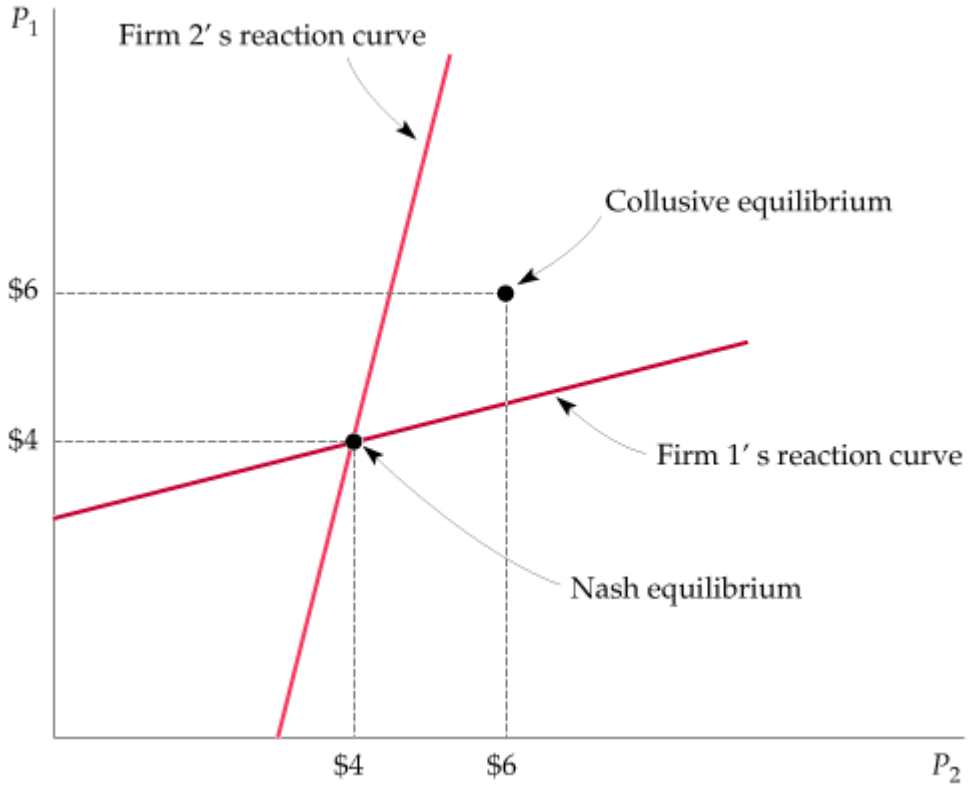
- $P_1 = MC_1 = P_2 = MC_2 = \$3$, $Q = 27$, $\pi_1 = \pi_2 = \$0$
- Reason: If the two firms charge different prices, the lower-price firm will supply the entire market and the higher-price firm will sell nothing
- Nash equilibrium: Neither firm has an incentive to change its price (higher price = no sales, lower price = loss)
- No other Nash equilibrium because each firm would undercut until a price of $3 is reached

How realistic is the Bertrand Model?

- No answer to the question: What share of sales goes to each player if both set the same price?
- When firms produce a homogeneous good, it is more natural to compete by setting quantities rather than prices

Price competition with differentiated products

Price competition with differentiated products



Assumptions:

- Fixed costs of \$20, zero variable costs
- Firm 1 demand curve: $Q_1 = 12 – 2P_1 + P_2$
- Firm 2 demand curve: $Q_2 = 12 – 2P_2 + P_1$

Firm 1's reaction curve:

- $\pi_1 = P_1 Q_1 – 20 = 12P_1 – 2 P_1^2 + P_1P_2 – 20$
- $d\pi_1/dP_1 = 12 – 4P_1 + P_2 = 0$
- $P_1 = 3 + P_2/4$, similarly: $P_2 = 3 + P_1/4$

Nash Equilibrium (both firms move at the same time)

- Intersection of the two reaction curves
- $P_1 = P_2 = 4$; $Q_1 = Q_2 = 8$; $\pi_1 = \pi_2 = 12$

Collusion Equilibrium:

- $\pi_T = \pi_1 + \pi_2 = 24P – 2P^2 – 40$
- $d\pi_T/dP = 24 – 4P = 0$
- $P = 6$; $Q_1 = Q_2 = 6$; $\pi_1 = \pi_2 = 16$

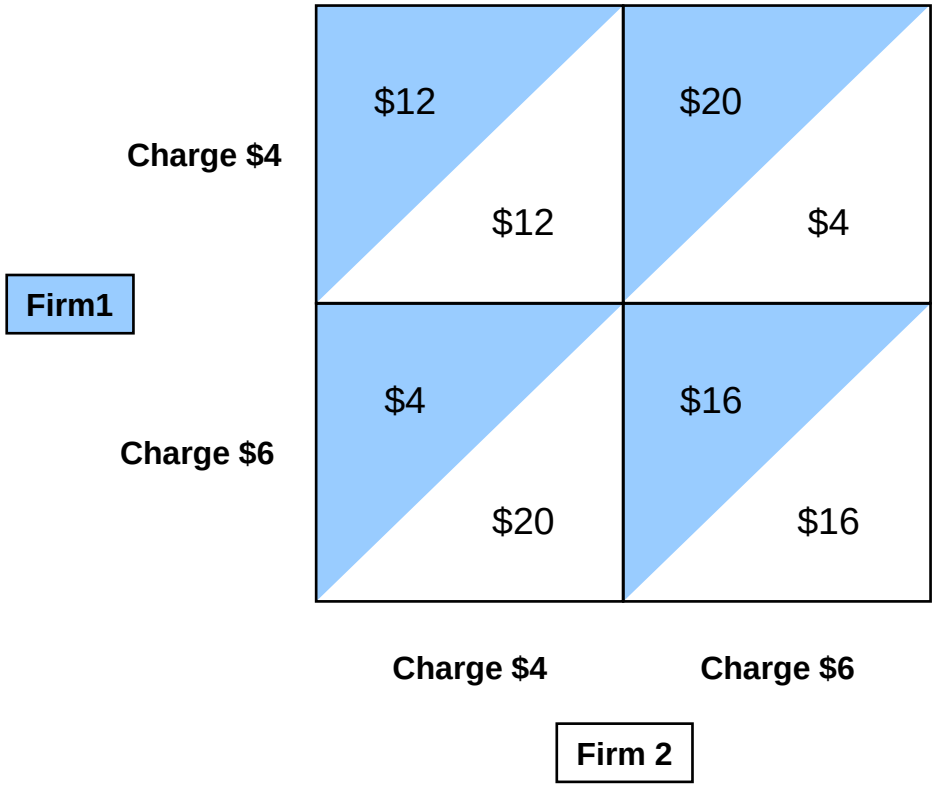
Firm 1 moving first is at a disadvantage:

- $\pi_1 = P_1 Q_1 – 20 = 12P_1 – 2 P_1^2 + P_1P_2 – 20$
- Firm 2 reaction curve: $P_2 = 3 + P_1/4$
- $\pi_1 = 12P_1 – 2 P_1^2 + 3P_1 + P_1^2/4 – 20$
- $d\pi_1/dP_1 = 15 – 7/2P_1 = 0$
- P_1=60/14; P_2=57/14; Q_1=105/14, Q_2=114/14
- $\pi_1 = 12.14$; $\pi_2 = 13.15$
- Firm 2 can undercut slightly and thereby capture a larger market share

Source: R.S. Pindyck, D.L. Rubinfeld: Microeconomics, 8th International Edition 2013, Chapter 12

Competition vs. collusion

Competition vs. collusion



Under normal circumstances, collusion is illegal. But if cooperation can lead to higher profits, why don't firms cooperate *without* explicitly colluding?

Why not just set the profit maximizing (collusion) price and hope your competitor will do the same?

The problem: Your competitor would do better by choosing a lower price, even if it knew that you were going to set the price at the collusive level

Using the example from the last slide:

- $P_1 = P_2 = \$4 \rightarrow \pi_1 = \pi_2 = \$12$
- $P_1 = P_2 = \$6 \rightarrow \pi_1 = \pi_2 = \$16$
- $P_1 = \$6, P_2 = \$4 \rightarrow \pi_1 = \$4, \pi_2 = \$20$

The resulting situation is also known as the Prisoner's Dilemma (we will hear much more about this in later lectures)