

Energy Economics

Cost curves

fixed costs

costs resulting from fixed factors (do not occur in the long-run)

variable costs

costs resulting from variable factors

sunk costs

costs which do not influence the behavior anymore

Cost curves

average cost in the short-term

- Total short-term costs are

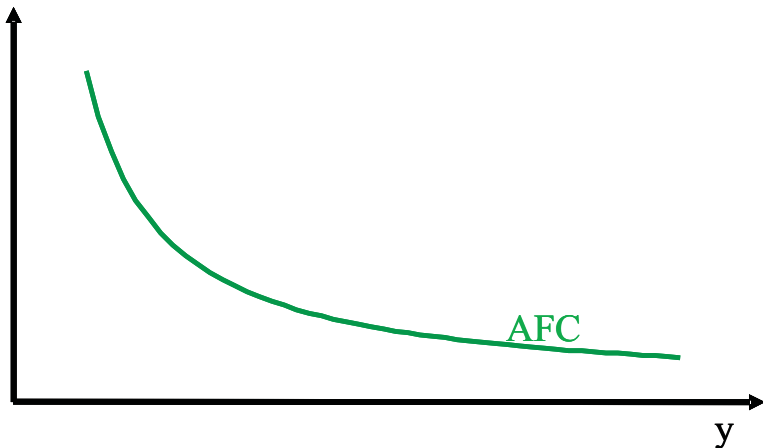
$$C(y) = C_v(y) + F$$

- average variable cost $AVC(y) = C_v(y)/y$ and
- average fixed cost $AFC(y) = F/y$ can be summed up to
- average cost

$$AC(y) = \frac{C(y)}{y} = \frac{C_v(y) + F}{y} = AVC(y) + AFC(y)$$

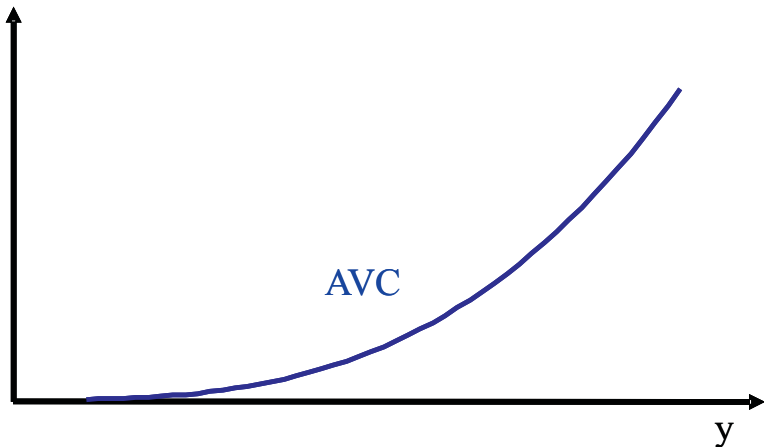
Average fixed cost

Average fixed cost (AFC) decrease with y



Average variable cost

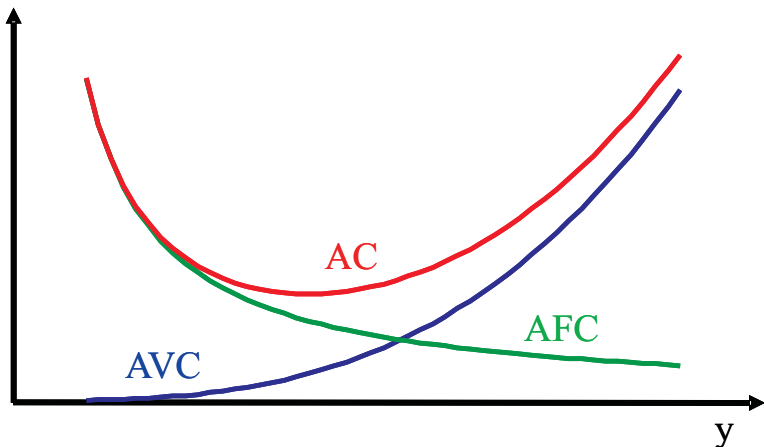
Average variable cost (AVC) increases because of assumed decreasing marginal product with increasing output



Average cost

The sum of AVC and AFC yields average cost

$$AC(y) = AVC(y) + AFC(y)$$



Marginal cost

Marginal cost indicates the change of total costs with a marginal increase of the output

$$MC(y) = \frac{\Delta C(y)}{\Delta y} = \frac{c(y + \Delta y) - c(y)}{\Delta y}$$

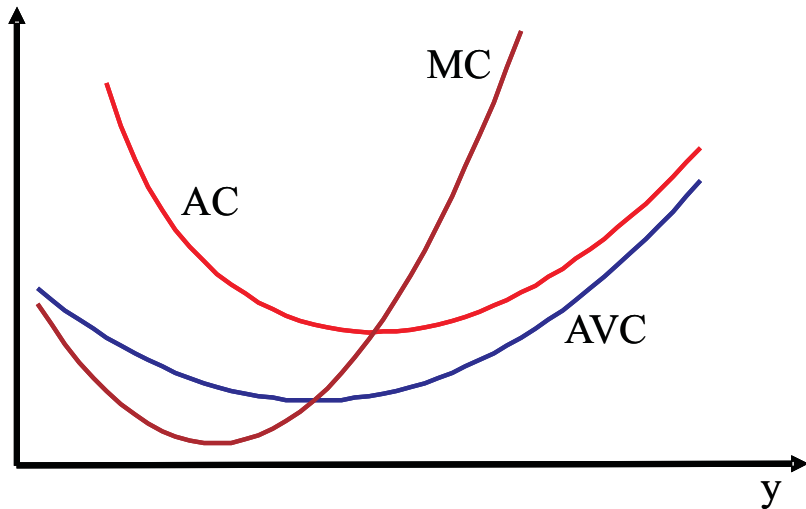
or as differential quotient

$$MC(y) = \frac{d C(y)}{d y}$$

Relationship of AC-, AVC- and MC-curves

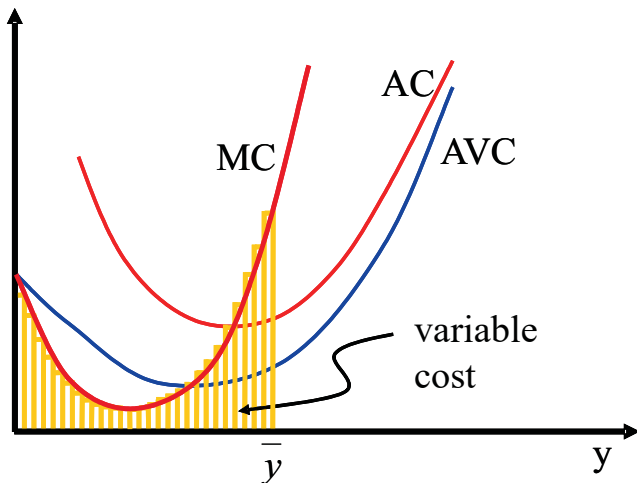
- the MC-curve intersects the AC-curve (AVC) in its minimum if available
- for $MC(y) < AC(y)$ an additional unit of output costs less than AC
- ⇒ AC are reduced by an output increase so that the AC-curve decreases with increasing y
- for $MC(y) > AC(y)$ an additional unit of output costs more than AC
- ⇒ AC increase with additional output so that the AC-curve increases with increasing y

Relationship of AC-, AVC- and MC-curves



Marginal cost and variable cost

The area below the MC-curve corresponds to variable cost



Supply of a company

profit maximization by quantity management

For a company acting as price taker we find the following objective function

$$\max_y \Pi = p y - C(y)$$

the decisive variable is the output

The solution of this maximization problem requires the fulfillment of first order conditions (FOC) and second order conditions (SOC)

- FOC

$$\frac{\partial \Pi(y)}{\partial y} = 0 \quad \Leftrightarrow \quad p - \frac{\partial C(y)}{\partial y} = 0 \quad \Leftrightarrow \quad p = MC(y)$$

Profit maximization

- SOC

$$\frac{\partial^2 \Pi(y)}{\partial y^2} < 0 \quad \hookrightarrow \quad -\frac{\partial^2 C(y)}{\partial y^2} < 0 \quad \hookrightarrow \quad \frac{\partial MC(y)}{\partial y} > 0$$

(increasing marginal costs)

FOC and SOC of a price taker are:

- price equals marginal costs
- output is in the sector of increasing marginal costs

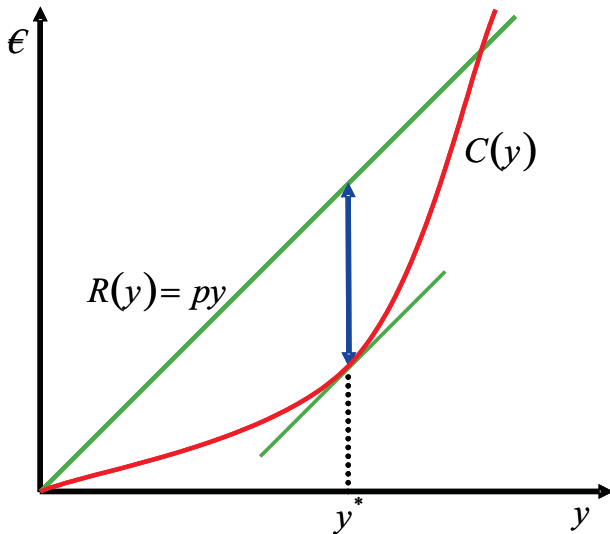
FOC analysis

$$p = MC(y)$$

In the optimum price equals marginal cost!

- If the price exceeds marginal cost, expanding production will increase the profit.
 - If the price is below marginal cost, reducing production will increase the profit.
- ⇒ The profit-maximizing output is determined by the output which results in $MC = p$

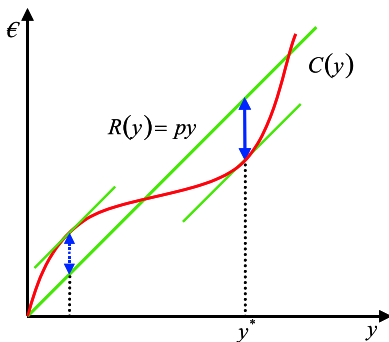
Revenue, cost and FOC



Revenue, costs and SOC

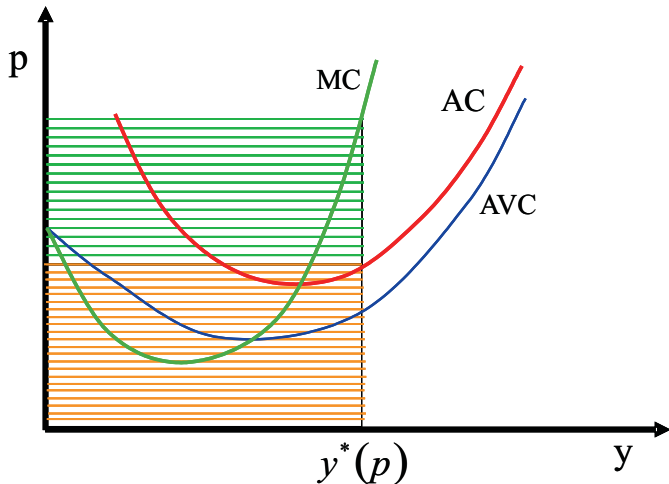
$$\frac{\partial^2 C(y)}{\partial y^2} > 0 \quad \text{oder} \quad \frac{\partial MC(y)}{\partial y} > 0$$

The SOC states that MC is increasing in the optimum.



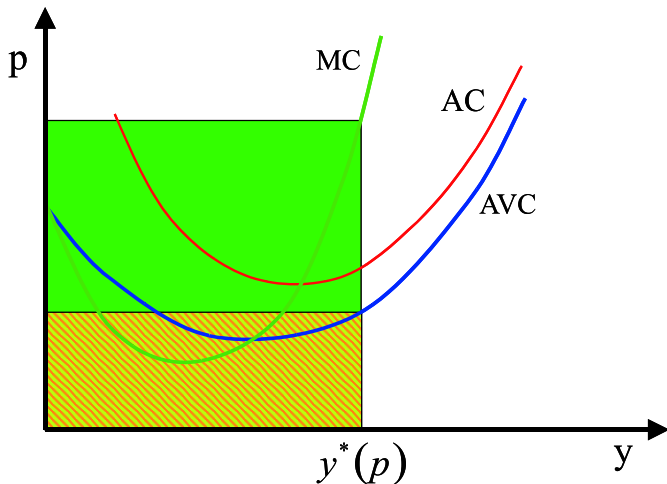
Profit

$$\text{profit} = \text{revenue} - \text{costs}$$

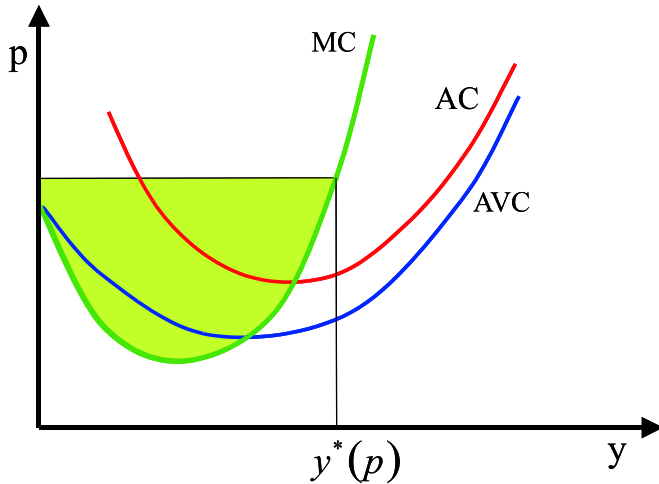


Producer surplus

producer surplus = revenue - variable costs



Producer surplus II



Profit and producer surplus

Example

The **cost function** shall be $C(y) = y^2 + 1$

supply: $p = MC(y)$

$$\text{yields } p = 2y \quad \hookrightarrow \quad y = S(p) = p/2$$

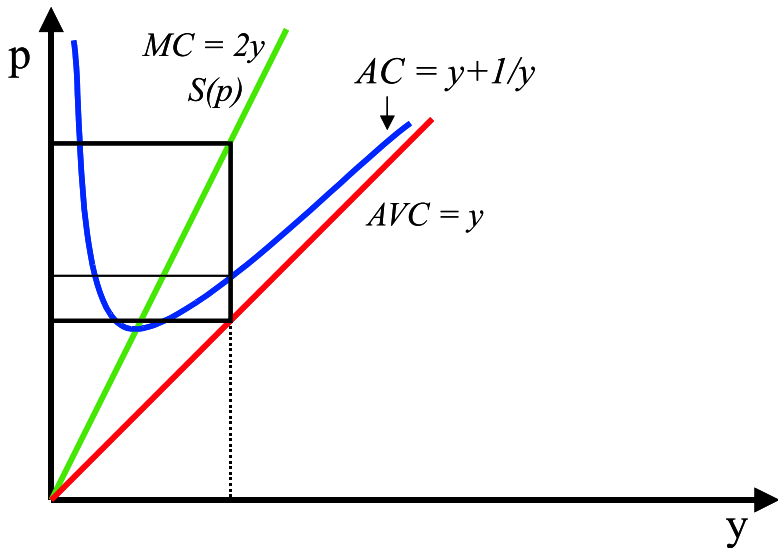
The **profit:** $\Pi = p \cdot y - C(y)$

$$\text{yields } \Pi = p \cdot p/2 - (p/2)^2 - 1 = p^2/4 - 1$$

producer surplus: $p \cdot y - AVC(y) \cdot y$

$$\text{yields } p \cdot p/2 - (p/2)(p/2) = p^2/4$$

Profit and producer surplus



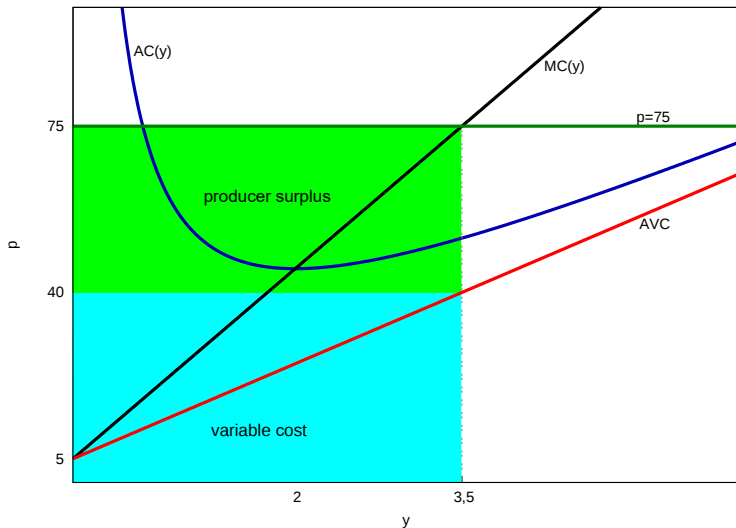
Cost curves – exercise

A company under perfect competition produces with the cost curve:

$$C(y) = 10y^2 + 5y + 40$$

- Which output level minimizes average cost?
- Which market price is necessary to allow the company to produce this output level (cost minimum)?
- Calculate the price level at which the company will stay in the market in the long-run and in the short-run.
- Determine the company's output level for a market price $p = 75$.
- Draw AVC, AC and MC in one graph together with the producer surplus.

Exercise – solution



Perfect competition

Market equilibrium

*A market equilibrium is a system of **equilibrium prices** along with rational supply and demand decisions which clear markets.*

*The respective quantities of input and output determine the **equilibrium allocation***

- Market forces cause an adjustment of prices until the equilibrium is achieved.
- in the equilibrium market participants have no incentive to change their behavior

Equilibrium – exercise

The company under perfect competition still produces with the cost curve:

$$C(y) = 10y^2 + 5y + 40$$

and faces a market demand

$$D(p) = 11 - \frac{1}{10}p$$

- a) Assume another company with identical production technology and cost structure enters the market. What are the consequences?