Firm supply and industry supply

Varian: Intermediate Microeconomics, 8e, chapters 22 a 23

In this lecture you will learn

- why a firm cannot do what it wants with the price and quantity
- what perfect competition is
- what a supply of a firm and industry in the SR and LR looks like
- what a supply of electricity producers looks like
- how much firms in perfect competition earn
- how much taxi drivers earn
- what the economic rent is and how to get it

Firm's constraints

A firm decides how much to produce what is the selling price.
The firm faces two constraints:

Technological constraints

- = only some production plans are technologically feasible.
- summarized by the **cost functions**

Market constraint

- = firm can only sell as much as people are willing to buy.
- summarized by **demand curve facing the firm** = the relationship between price and quantity that the firm sells.

Market structure

Market structure influences the relationship between the market demand and the firm.

When in the market

- one firm (monopoly) – market demand = demand of a firm.
- more firms – many possible outcomes. It depends on how consumers and other firms react to the change in price or quantity.

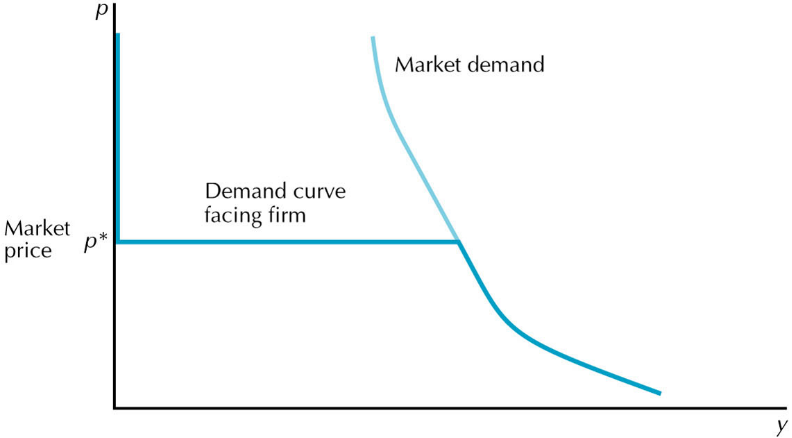
Market environment – how firms react when they decide about prices and outcome.

In this lecture we will deal with the basic market environment – **perfect competition**.

Perfect competition

The market is **competitive** if each firm assumes that the market price is independent of its own actions (level of output).

Firms are **price takers**.



What may a competitive market look like?

Many subjects offer identical product:

- markets for agricultural products (wheat, corn, soy, ...)
- some commodities and stock markets

A few subjects offer an identical product (willing to reduce the price):

- market for fresh fish, market for cut flowers, ...
- a street full of kebab restaurants, two hot-dog sellers in Joštová, ...



Decision-making firms under perfect competition

Firm chooses output y that maximizes its profit at a given price p.
The maximization problem facing a competitive firm:

$$\max_y py - c(y)$$

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The first-order condition (FOC):

$$p - MC(y^*) = 0 \iff p = MC(y^*)$$

The second-order condition (SOC):

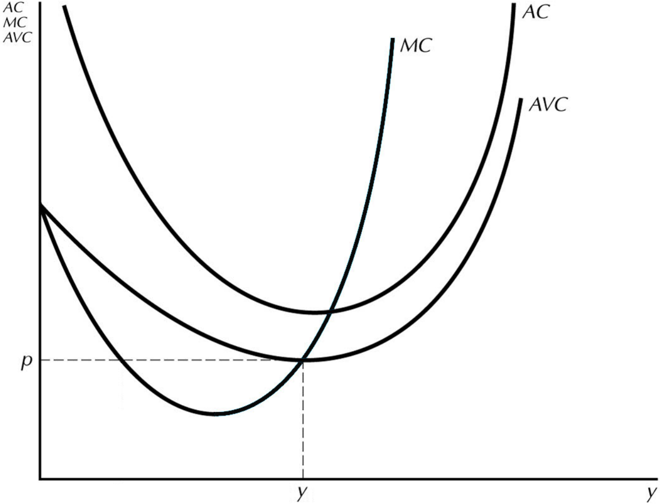
$$-MC'(y^*) < 0 \iff MC'(y^*) > 0$$

A profit-maximizing firm will consider the output y^* at which

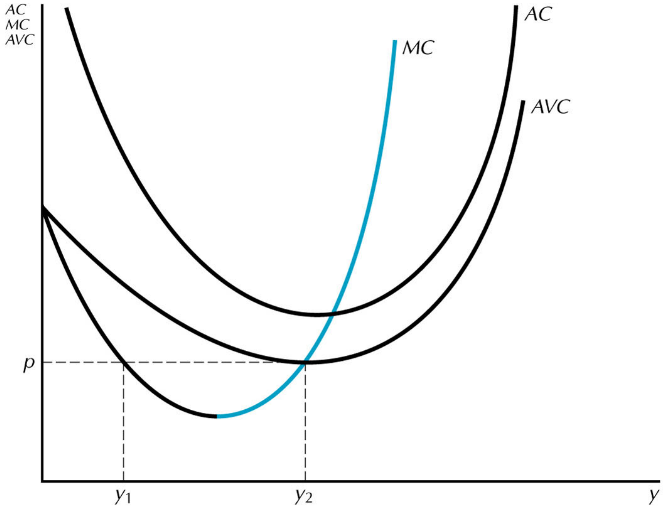
- price equals marginal cost (FOC),
- marginal cost function is increasing (SOC).

Why must price equal to marginal costs?

If $p > MC(y)$, the profit increases when y increases.
If $p < MC(y)$, the profit decreases when y increases.

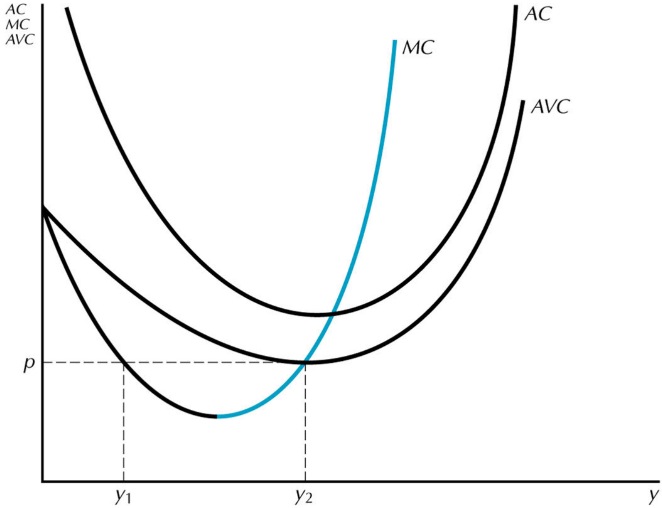


Why marginal costs have to be increasing?



Why marginal costs have to be increasing?

Profit of the firm at the quantity y_1 is minimal because $MC'(y_1) < 0$.



Firm supply in the SR

A competitive firm in the SR has two options:

- to produce y^* and have a profit $py^* - c_v(y^*) - F$
- to produce $y = 0$ and have a profit ?

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The firm produces zero if

$$py^* - c_v(y^*) - F < -F.$$

Shut-down condition in the SR:

$$p < AVC(y^*)$$

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Shut-down condition in the SR:

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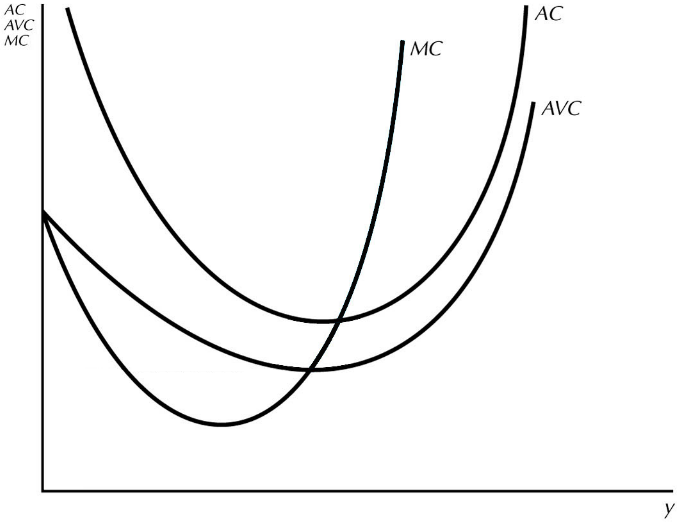
For the points on the supply curve, it is true that:

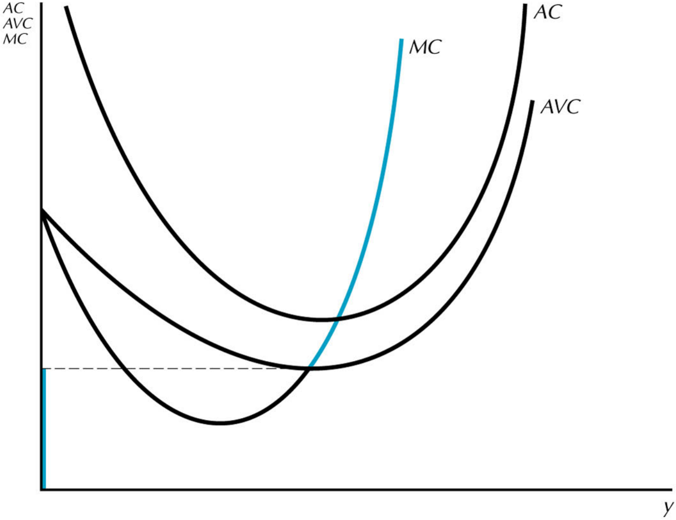
- $p = MC(y^*)$ for $MC'(y^*) > 0$ if $p \geq AVC(y^*)$
- $y = 0$ if $p < AVC(y^*)$

Firm supply in the SR (graph)

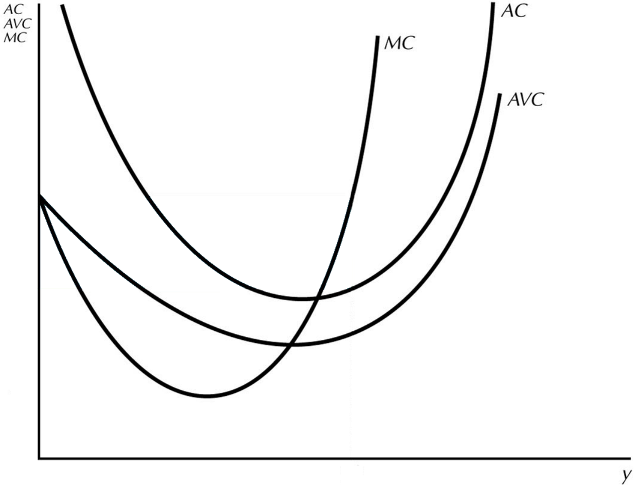


Firm supply in the SR (graph)

= the increasing part of the MC curve above the AVC curve.



Profit of a competitive firm in the SR



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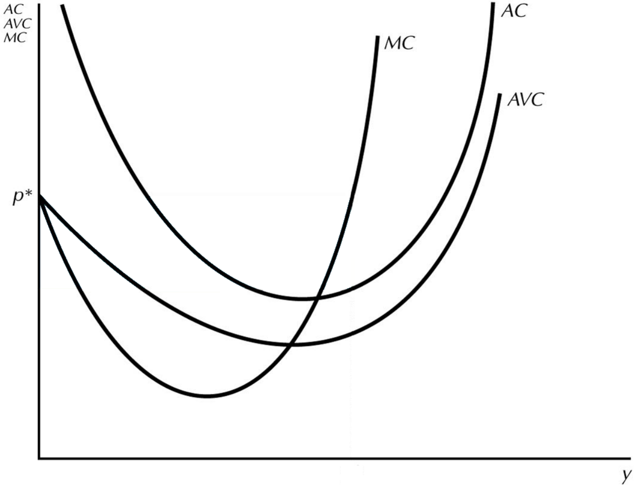

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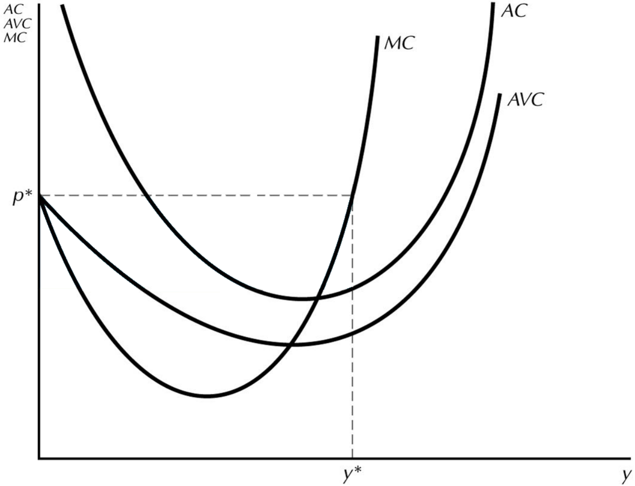
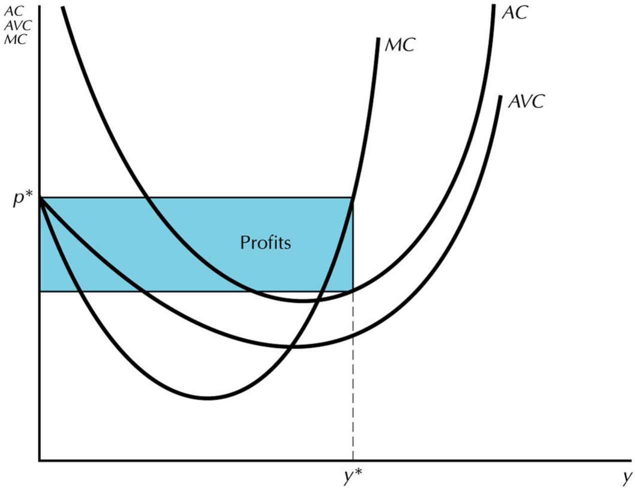


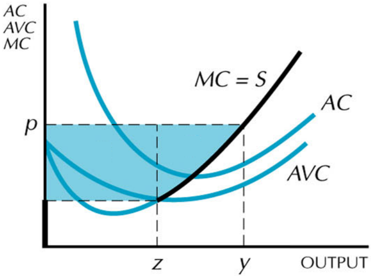
Profit of a competitive firm in the SR

$$\text{Profit } \pi = \begin{cases} py - c(y^*) = (p - AC(y^*))y^* & \text{if } p \geq AVC(y^*) \\ -F & \text{if } p < AVC(y^*) \end{cases}$$



Producer's surplus in the SR

Producer's surplus = the difference between the supply curve and the market price (= the area to the left of the supply curve)



Producer's surplus in the SR

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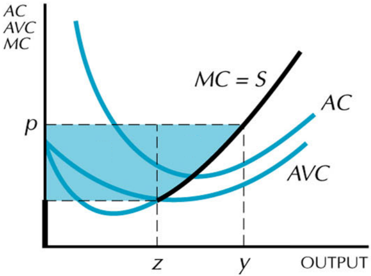
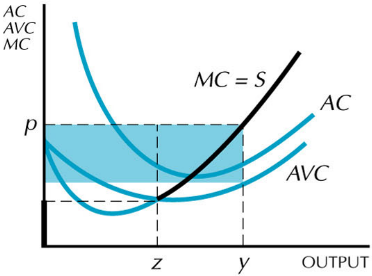
At the same time:

- total revenue minus variable costs: $r(y) - c_v(y)$
- profit plus fixed costs: $\pi(y) + F$





Firm supply in the LR

A competitive firm has two options in the LR:

- produce y^* and have a profit of $py^* - c(y^*)$
- to go out of business and have a profit of 0

A firm goes out of business if:

$$py^* - c(y^*) < 0 \iff p < AC(y^*)$$

For the points on the supply curve, it is true that:

$$p = MC(y^*) \text{ and } MC'(y^*) > 0 \quad \text{if} \quad p \geq AC(y^*)$$

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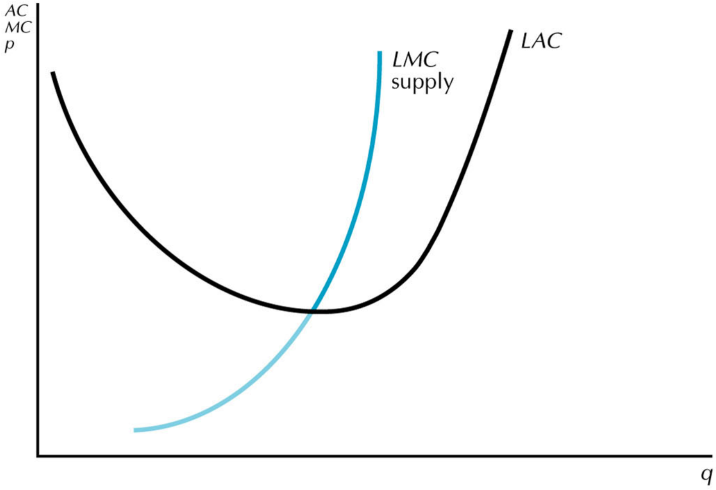
The profit of a competitive firm in the LR is

$$\pi = py^* - c(y^*) \quad \text{if} \quad p \geq AC(y^*).$$

Firm supply in the LR (graph)

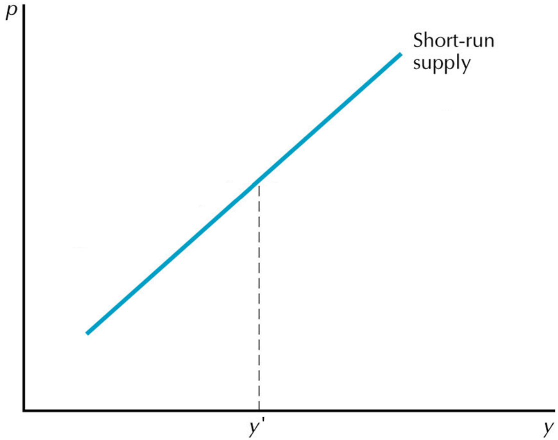
$=$ the increasing part of MC curve that lies below the AC curve.



Example – firm supply in the SR and LR

In the short run a firm has a fixed amount of capital k.
A cost-minimizing firm would choose k at the output y'.

What is the shape of the long-run supply curve?



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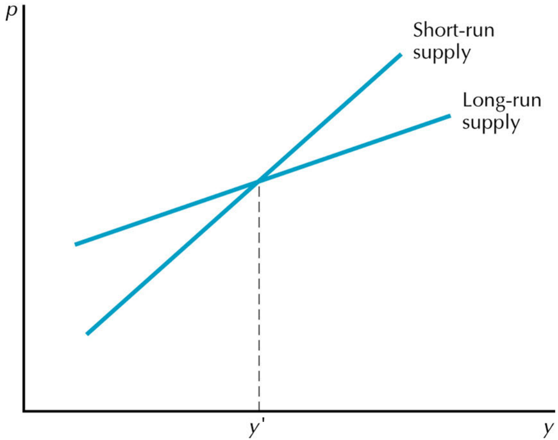

EXAMPLE: Fixed costs in the route Praha-Ostrava

LEO: specially adapted train sets – most of the costs fixed

RJ: can sell its sets at a loss – only part of the cost if fixed

Let's assume that LEO's trains are more expensive and have lower operating costs.

If both firms maximized profits and had the same prices and occupancy rate, who is more likely to stay in the industry?

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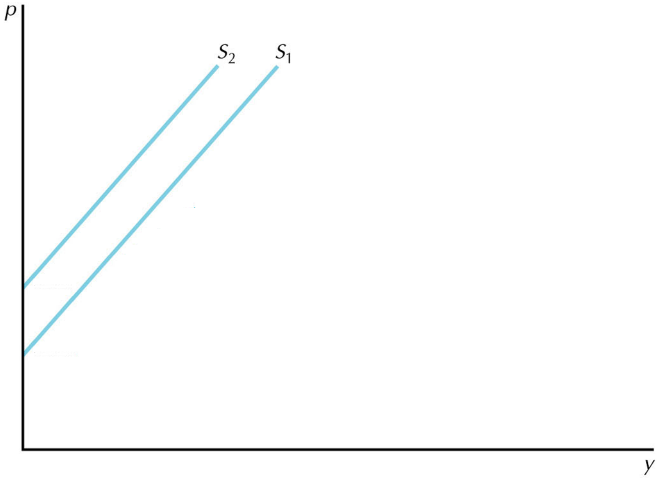
Fixed (sunk) costs in the SR should not influence the decision about going out of business. Only operating profits matter.

Industry supply in the SR

A horizontal sum of SR supply curves of n firms: $S(p) = \sum_{i=1}^{n} S_i(p)$



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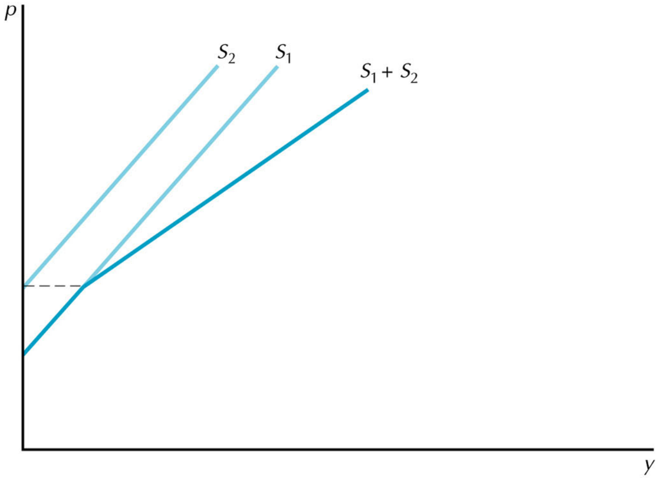
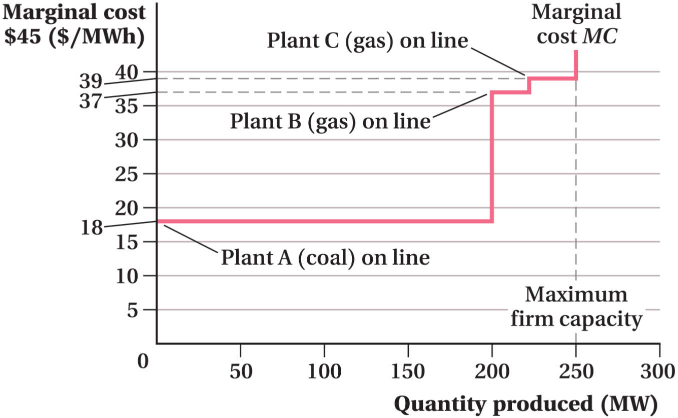


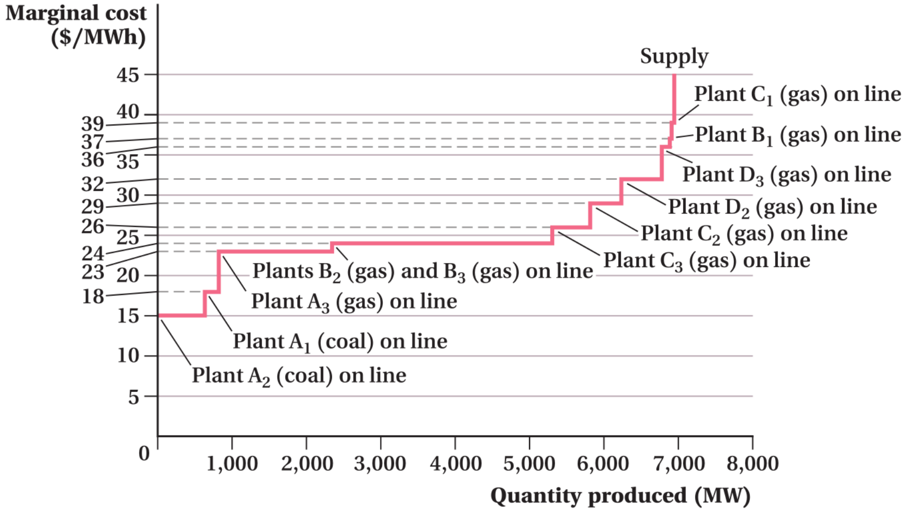
APPLICATION: The firm supply of a power plant

Hortaçsu and Puller (RAND, 2008): a supply of a firm in the Texas electricity industry



Zdroj: Goolsbee et al. (2013): *Microeconomics*, Worth Publishers, New York, str. 316

APPLICATION: Industry supply – 3 firms



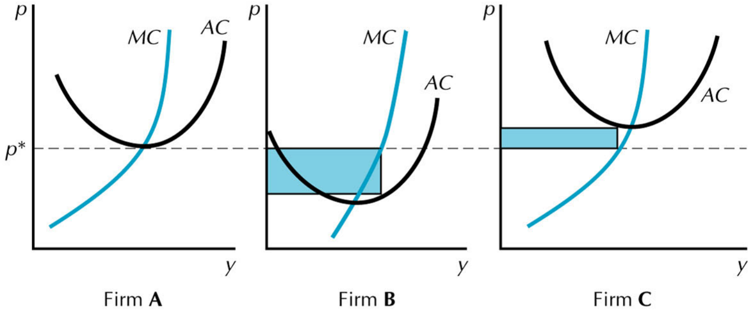
Zdroj: Goolsbee et al. (2013): *Microeconomics*, Worth Publishers, New York, str. 325

Industry equilibrium in the SR

From market supply and demand we derive the equilibrium price p^*.

Profit of firms for $p^* \geq \min AVC$:

$$\pi = (p^* - AC(y))y$$



Industry equilibrium in the LR

Firms in the long-run equilibrium can

- change the scale of inputs that were fixed in the SR,
- enter and exit the industry.

There is not much difference between these two effects. E.g. a new production plant can be built by the existing firm or by a new firm. The difference will be only in the ownership of the plant.

In a competitive industry there is **free entry and exit**.

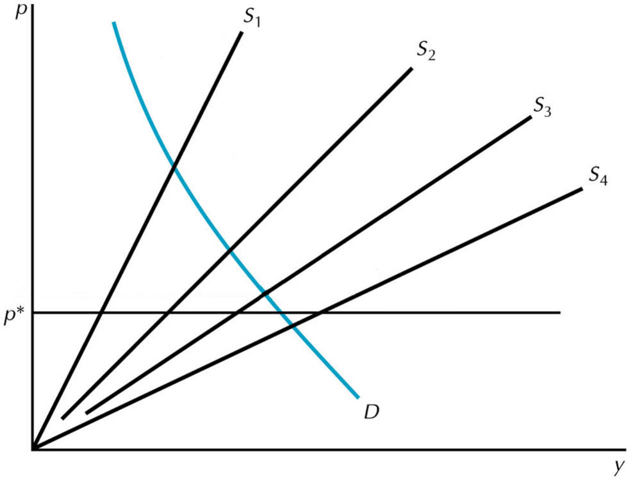
Competitive firms

- exit industry if they are in loss,
- enter industry if they expect that they will be in profit.

Industry equilibrium in the LR

All firms have the same costs – have the $\min LAC$ at the level of p^*.
S_n = short-run supply of an industry with n firms

<u>Market demand D:</u>



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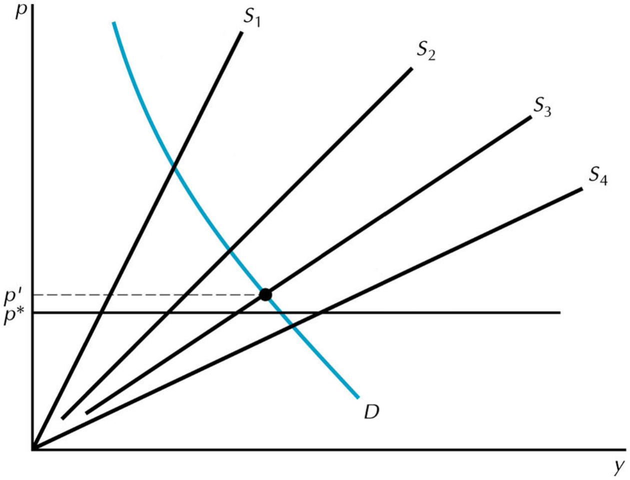

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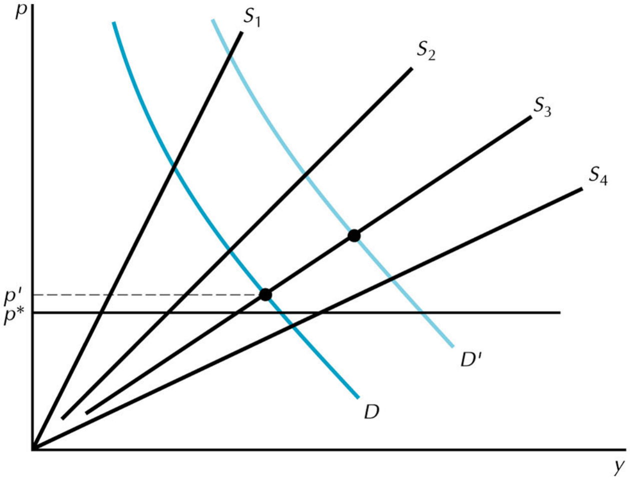

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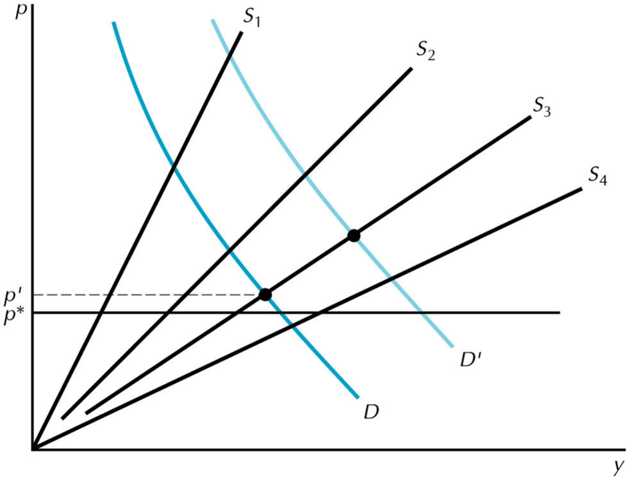
Market demand D':

At $n = 3$ the market is not in equilibrium.



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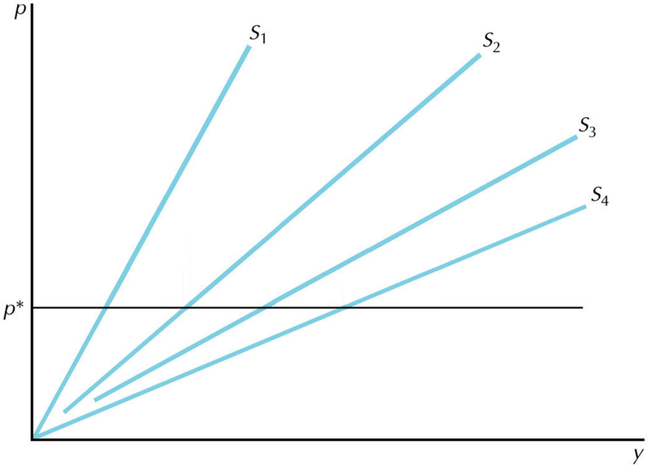
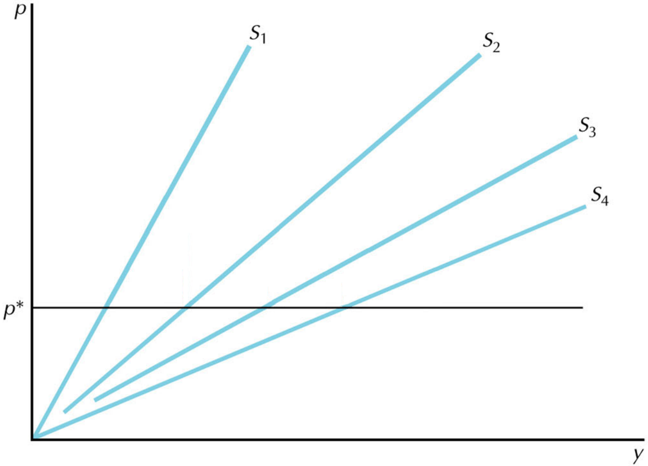
We can exclude all points on the curves $S_n(p)$ that



Industry supply in the LR

We can exclude all points on the curves $S_n(p)$ that

- are below the level of $p^* = \min LAC$,
- correspond to quantities $y > S_{n+1}(p^*)$ (then another firm enters).



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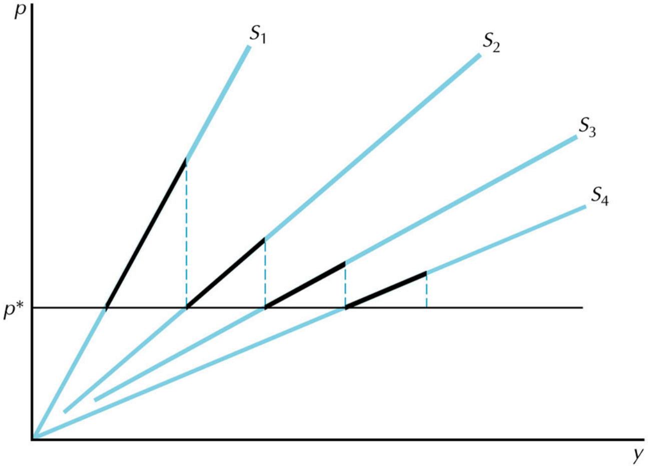
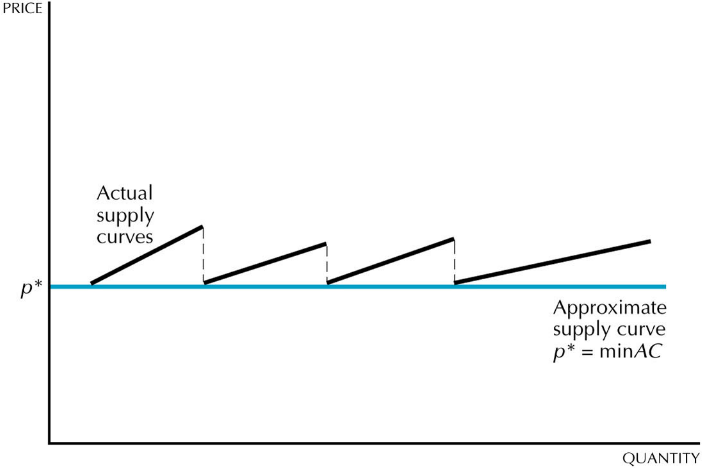


Nabídka odvětví v LR (cont'd)

A large number of firms n – the curve is flat (almost a zero slope).
Approximation of the LR industry supply – blue line in the graph.



Example – situation of a firm in the SR

Cost function: $c(y) = y^2 + F$, where $F = 1$

What is the firm's supply, profit function and producer's surplus?

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$MC(y) = 2y$ and $AVC(y) = y \implies MC(y) > AVC(y)$ for all y.
The inverse demand function: $p = 2y$.

Firm's supply:

$$S_i(p) = y(p) = \frac{p}{2}$$

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Profit for all price levels:

$$\pi(p) = py(p) - c(y(p)) = p\frac{p}{2} - \left(\frac{p}{2}\right)^2 - 1 = \frac{p^2}{4} - 1$$

Producer's surplus = area of a triangle (base = $p/2$, hight = p):

$$PS(p) = \frac{1}{2}\frac{p}{2}p = \frac{p^2}{4}$$

Example – situation in the industry in the SR

Market demand: $D(p) = 30 - p$
Number of firms: $n = 18$
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What is the market price, firm's profit and producer's surplus?

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Industry supply: $S(p) = nS_i(p) = 18 \times \frac{p}{2} = 9p$

Market equilibrium:

$$D(p) = S(p)$$

$$30 - p = 9p$$

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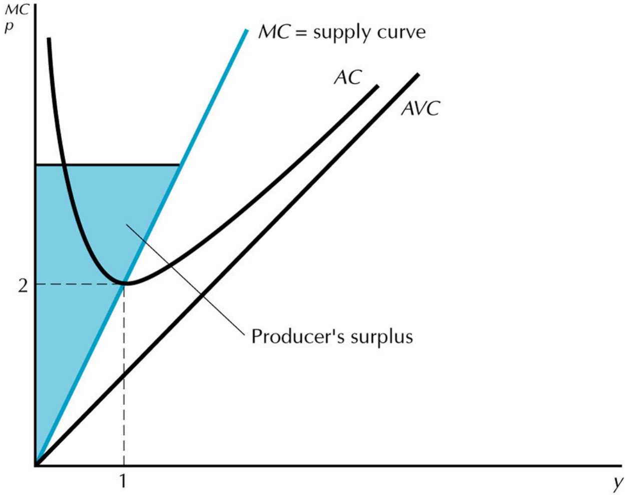
Firm's profit: $\pi(p) = \frac{p^2}{4} - 1 = 5/4$

Producer's surplus: $PS(p) = \frac{p^2}{4} = 9/4$

Example – situation of a firm in the SR (graph)



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What is the equilibrium number of firms in the LR?

Inverse industry supply: $p = \min LAC$

Find y that minimizes $LAC(y) = y + 1/y$:

$$1 - \frac{1}{\hat{y}^2} = 0$$

$$\hat{y} = 1$$

Substituting back into $LAC = \hat{y} + 1/\hat{y} = 2$. The inverse supply: $p = 2$

Market equilibrium:

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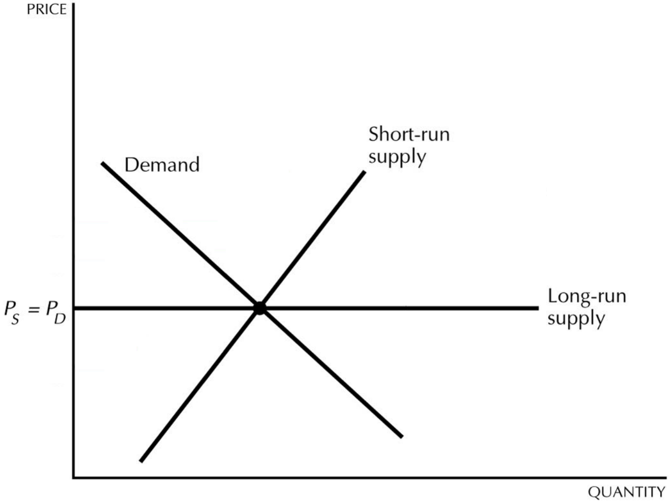
Example – taxation in the SR and in the LR



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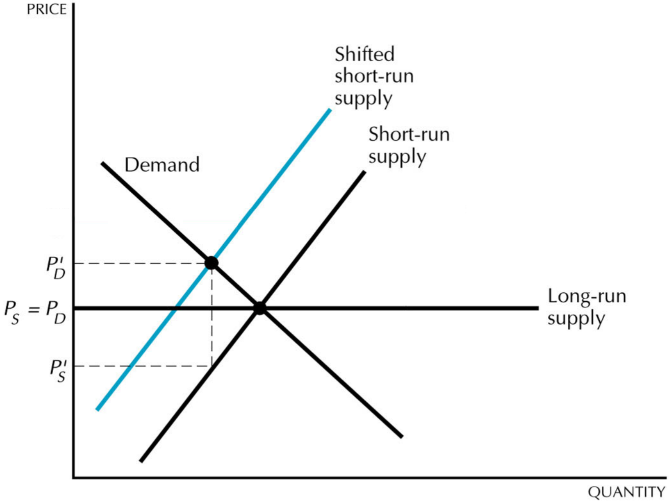
SR – the tax increases the demand price from p_D to p'_D.



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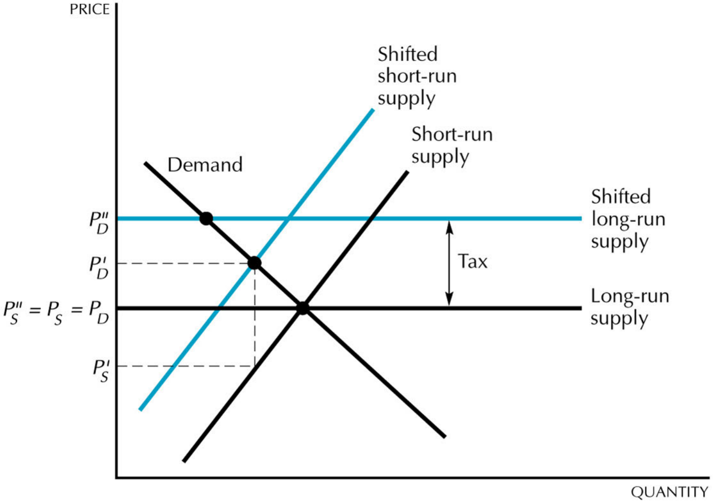
SR – the tax increases the demand price from p_D to p'_D.
LR – some firms exit the industry $\implies$ a rise in price from p'_D to p''_D.



Zero profit and fixed inputs

Free entry and exit leads to zero profit in the long run.

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Some factors of production might be available in fixed supply

- for natural reasons (land, resources, talent, ...),
- for legal reasons (licences, permits, ...).

If new firms cannot enter because of the fixed inputs, the incumbent firms will try to buy the fixed inputs currently present in the industry.

This way, they increase the price of fixed inputs and drive economic profit to zero.

Economic rent

Economic rent any payment to a factor of production in excess of the cost needed to bring that factor into production.

Examples of economic rent:

- taxi licences
- land rent
- oil extraction

CASE: Taxi licenses in New York City

Taxi licences in New York sold for about $100,000 a year in 1986.
Taxi drivers made about $20,000 a year.

The regulator argued that this wage was too low to attract skilled drivers and therefore taxi fares should be raised.

Who benefits from a fare increase generating extra $10,000 a year?

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If the ROI of the licence owners stayed the same (17%), the licence value would increase by

$$\frac{10{,}000}{0.17} \approx 60{,}000 \ \$.$$

Taxi drivers would earn the same.

Rent seeking

What happens if the regulator decides to increase the number of licences? Each cab earns less and the value of a licence goes down.

The beneficiaries of the artificial scarcity will oppose any attempts to enlarge the industry. Resources spent in the fight are deadweight loss.

Efforts directed at keeping or acquiring claims to factors in fixed supplies are sometimes referred to as **rent seeking**.

CASE: Energy policy

In 1974 OPEC increased the price of oil. Congress felt that it was unfair that the domestic producers should profit on OPEC's decision.

To keep the prices of oil products down, Congress adopted a policy known as „two-tiered“ oil pricing.

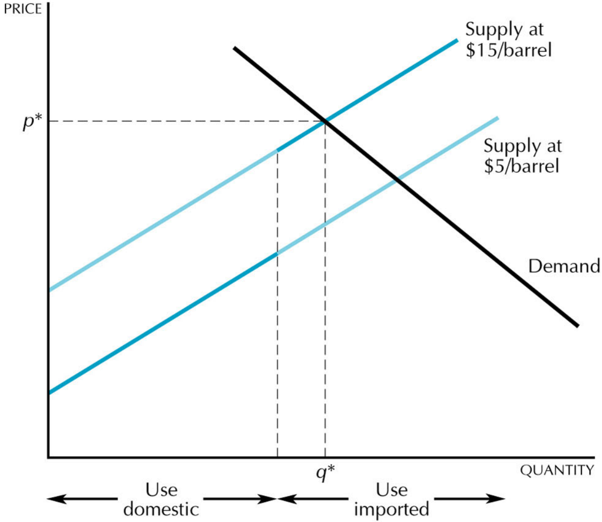
Let's consider the impact of the policy on the gasoline market.

CASE: Energy policy (cont'd)

Řešení:

Two-tiered oil pricing

- imported oil sold for market prices (15 $/barel)
- domestic oil sold for prices as before 1974 (5 $/barel)



Result:

CASE: Energy policy (cont'd)

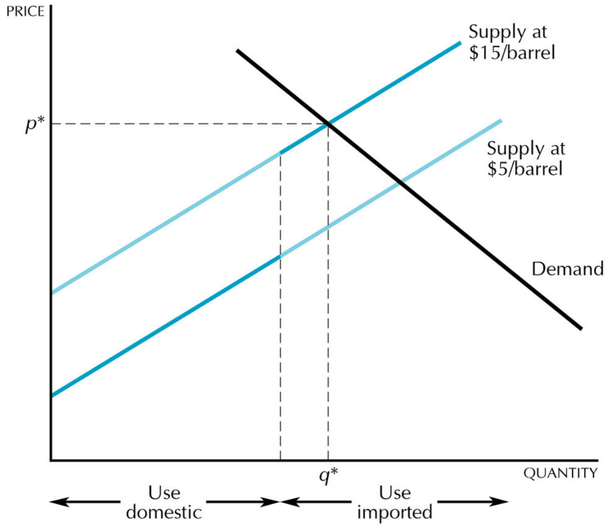
Řešení:

Two-tiered oil pricing

- imported oil sold for market prices (15 $/barel)
- domestic oil sold for prices as before 1974 (5 $/barel)

Result:

equilibrium price p^* – the rent earned by refineries



CASE: Energy policy (cont'd)

New solution – price controls

Prices regulation of gasoline – each refinery is supposed to charge a price based on production costs.

Result:

CASE: Energy policy (cont'd)

New solution – price controls

Prices regulation of gasoline – each refinery is supposed to charge a price based on production costs.

Result:

In some states the gasoline cheaper than in others $\implies$ prohibition to ship gasoline $\implies$ famous gasoline shortages of the mid-seventies.

Part of the rent earned by refineries and part by consumers (but shortages).

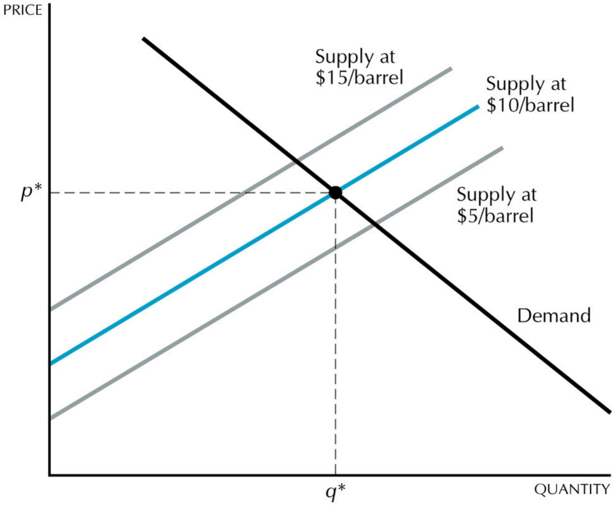
CASE: Energy policy (cont'd)

New solution:

„entitlement program“ – each time a refiner bought a barrel of expensive foreign oil he was allowed to buy x barrels of cheap domestic oil.

Graph: if $x = 1$, the price of 1 barrel is $10.

Result:



CASE: Energy policy (cont'd)

New solution:

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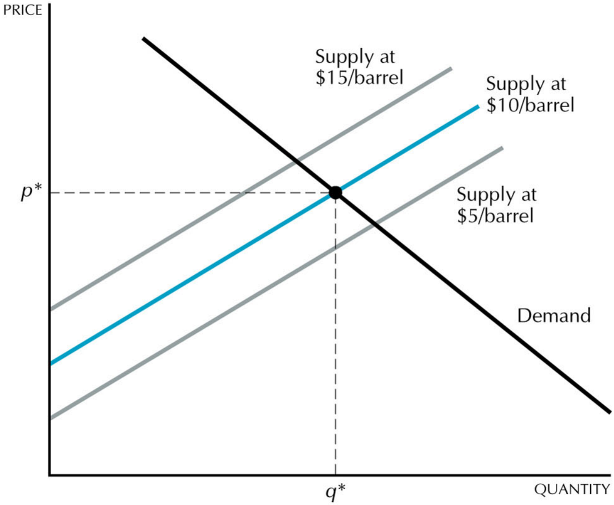
Graph: if $x = 1$, the price of 1 barrel is \$10.

Result:

Reduction in price, subsidy of foreign oil.



What should you know?

- Competitive firms are price takers.
- SR firm supply = increasing MC above AVC
  LR firm supply = increasing LMC above LAC
- SR industry supply = sum of SR firm supplies
  LR industry supply $\approx$ horizontal at minLAC
- Producer's surplus = $TR - VC$ or $\pi + F$
- In the SR profit can be positive or negative.
  in the LR firms enter or exit the industry (adjust scale of production). $\implies$ shift of supply till $p = LAC \implies$ zero profit
- The owners of fixed factors (preventing the entry of firms) earn economic rent.