MICROECONOMICS II

Topic 5 - Pure competition, firm supply

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Market environments

Technological constraints

- Production function
- Economic constraints summarized by the cost function

Market constraints

- Demand curve faced by a firm
- One firm: market demand
- More firms: market environment matters

Pure competition

- Market price independent of firm's level of output. Firms are price-takers who face horizontal demand curve.
- Supply of the input faced by a firm is also horizontal.
- Perfect information.
- Free entry to and exit from the industry.
- Homogenous product.

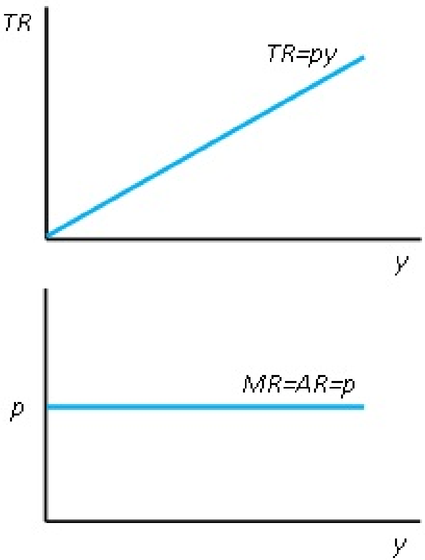
REVENUES

Profit: $\Pi = TR - TC = py - \sum_{i=1}^{n} w_i x_i$

Revenues

- Revenue function
  - $R(y) = p(y) \cdot y$, for pure competition $R(y) = p \cdot y$
- Marginal revenue
  - Rate by which revenue increases with a change in output.
  - $MR(y) = \frac{dR(y)}{dy} = \frac{d(p(y)y)}{dy} = p(y) + y\frac{dp(y)}{dy}$
  - For pure competition $MR(y) = p$
- Average revenue
  - $AR(y) = \frac{R(y)}{y} = \frac{p(y)y}{y} = p(y)$
  - For pure competition $AR(y) = p$

Revenues



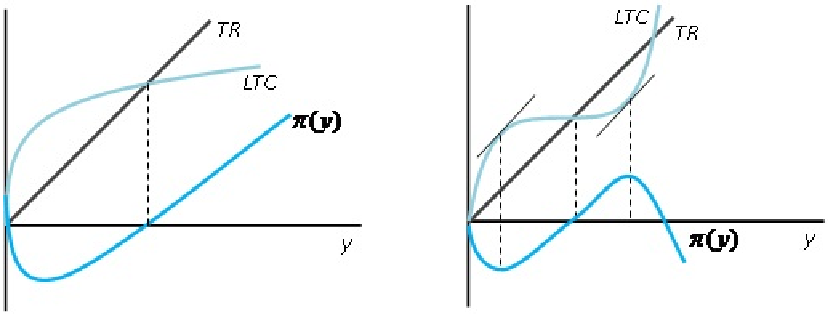
Profit maximization

Problem: $\max\limits_{y,x_1,\ldots,x_n} \Pi = R(y) - \sum_{i=1}^{n} w_i x_i$, such that $y \leq f(x_1, ..., x_n); y \geq 0; x_i \geq 0, i = 1, ..., n$

- We will use the cost function we derived earlier: $\max\limits_{y} \Pi = R(y) - c(w, y); y \geq 0$
- For pure competition: $\max\limits_{y} \Pi = py - c(w, y); y \geq 0$

Profit maximization

For profit maximum to exist, the profit function must be from some output level purely concave and decreasing in output.



Profit maximization

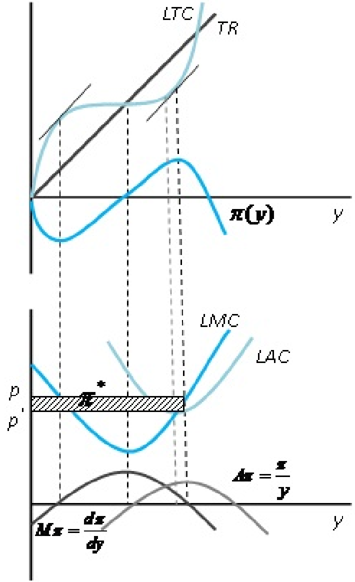
Profit maximum: additional units of output do not bring additional profit.

- $M\Pi(y^*) = \dfrac{\triangle\ \Pi}{\triangle\ y} = 0$
- First-order condition: $\dfrac{d\Pi}{dy} = \dfrac{dR(y^*)}{dy} - \dfrac{dLTC(y^*)}{dy} = p - LMC(y^*) = 0$
- $MR(y^*) = p = LMC(y^*)$.

For the point to be maximum, marginal profit must be decreasing in output (profit a concave function).

- Second-order condition: $\dfrac{d^2\Pi(y^*)}{dy^2} = \dfrac{d^2R(y^*)}{dy^2} - \dfrac{d^2LTC(y^*)}{dy^2} = \dfrac{dp}{dy} - \dfrac{dLMC(y^*)}{dy} < 0$
- $\dfrac{dLMC(y^*)}{dy} > 0$;
- The firm will choose output only on the upward sloping portion of the LMC curve.

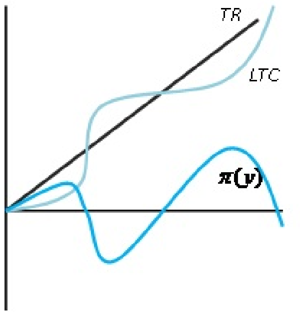
PROFIT MAXIMIZATION



PROFIT MAXIMIZATION

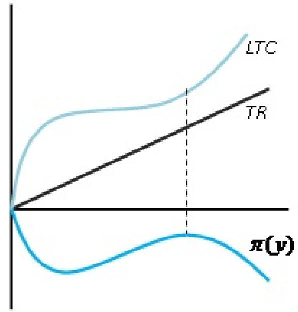
Shape of the profit function given by the shape of the cost function.

- There may be more local maxima of the profit.
- Compare and choose the point with the highest profit.



Profit maximization - corner solution

In the maximum, the profit may be negative.



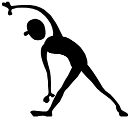
The firm chooses not to produce and have zero profits.

The first- and second-order conditions are not satisfied in point $y^* = 0$

Profit is decreasing in output: $M\Pi(0) = \dfrac{d\Pi(0)}{dy} = p - \dfrac{dLMC(0)}{dy} < 0$;

$p < LMC(0)$

Profit maximization



Exercise

$LTC(y) = 2y^3 - 30y^2 + 150y$

What output would be produced at price $p = 6$?

Long-run supply curve

The long-run supply is a function which assigns to every price the output level which maximizes profit of the firm at that given price.

- The upward-sloping part of the long-run MC curve.
- Plus, the profit must be non-negative, $TR(y^*) \geq LTC(y^*)$

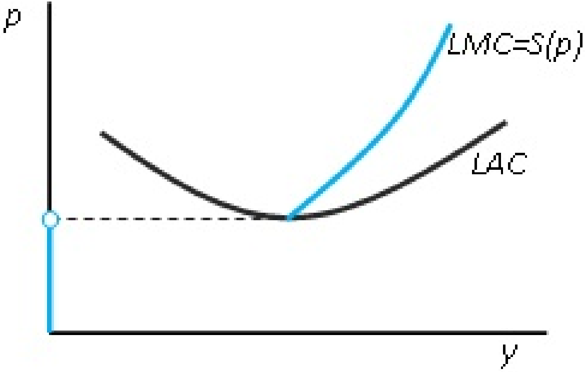
The lowest output the firm is willing to supply:

$$LMC(y) = p \wedge \frac{dLMC(y)}{dy} > 0 \wedge TR(y) = LTC(y)$$

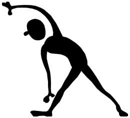
- $\frac{TR}{y} = \frac{LTC(y)}{y}; p = LAC(y)$
- The minimum of LAC curve.

LONG-RUN SUPPLY CURVE

Inverse supply function: $p = LMC(y^*) = S^{-1}(y^*)$



Long-run supply curve



Exercise

$LTC(y) = 2y^3 - 30y^2 + 150y$

- Derive the inverse supply function.
- Derive the supply function.

LONG-RUN SUPPLY CURVE

Constant returns to scale

- Supply curve = LMC curve = LAC curve
- Horizontal line, constant average cost.

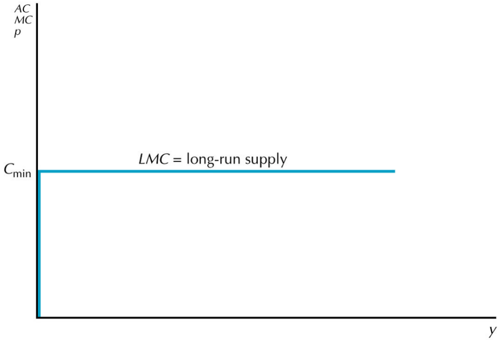


FIGURE 22.10 Constant average costs

PROFIT MAXIMIZATION IN THE SHORT-RUN

Problem: $\max_{y} \Pi = py - STC(y); y \geq 0$

First-order condition

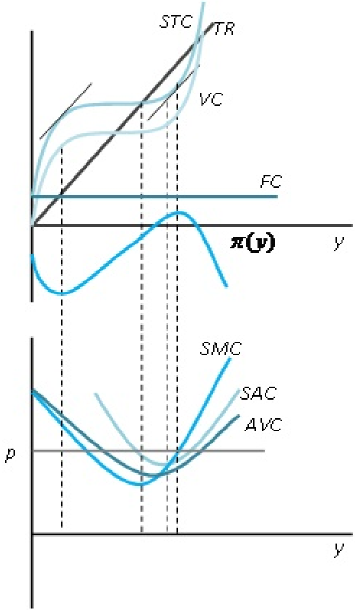
- $p = SMC(y)$ for $y^* > 0$
- $p \leq SMC(y)$ for $y^* = 0$

Second-order condition

- $\frac{dSMC(y)}{y} > 0$

The supply curve must lie along the upward-sloping part of the MC curve.

Profit maximization in the short-run



Profit maximization in the short-run

Zero production can be optimal

- Compare local profit maxima with zero output level.
- Profits from zero production $-F$
- Profits from positive production $py - c_v(y) - F$
- Going out of business if $-F > py - c_v(y) - F$

Shut-down condition: $AVC(y) > p$

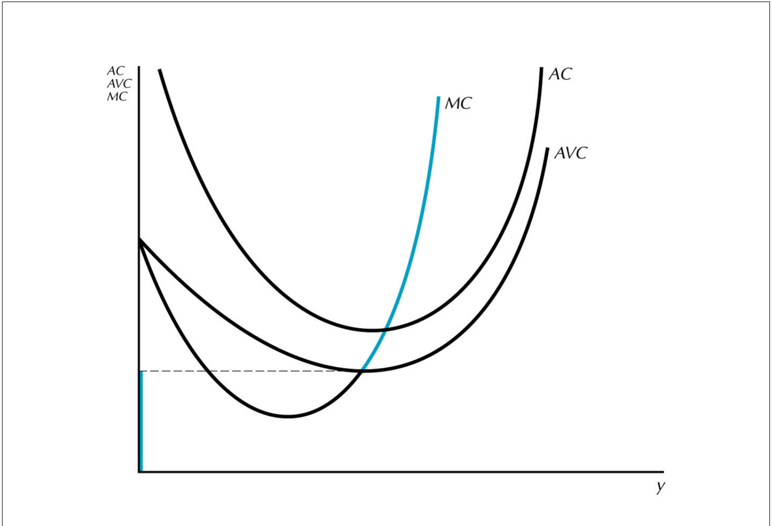
- Average revenues do not cover average variable costs

The short-run maximized profit can be negative.

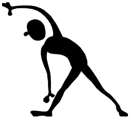
- $0 \geq \Pi(y^*) \geq \Pi(0) = -FC(y)$

Short-run supply curve

Inverse supply function: $p = MC(y)$



Short-run supply curve



Exercise

$STC(y) = y^2 + 30y + 400$

- What output level and price define the shut-down point?
- Derive the short-run supply function.
- Find the point where the cost equals revenues.

PROFIT

Revenues minus total costs

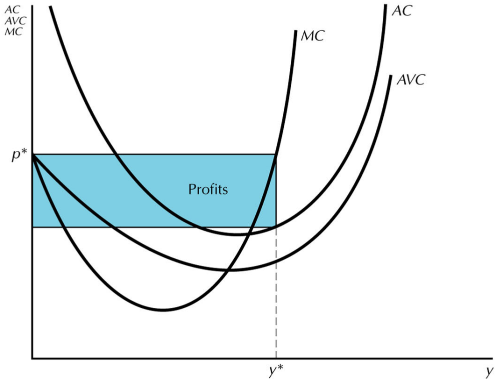


FIGURE 22.4 Profits

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PRODUCER'S SURPLUS

Revenues minus variable costs (profit plus fixed costs).

- Change in surplus=change in profits

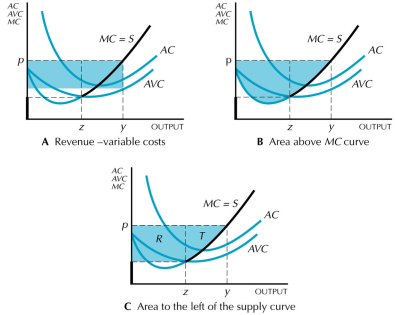
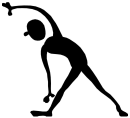


FIGURE 22.5 **Producer's surplus**

Profit and producer's surplus



Exercise

$c(y) = y^2 + 1$

- Derive the supply function.
- Derive profit.
- Derive producer's surplus.

Long-run and short-run supply curve

The long-run and short-run supply curves coincide at y^* where the fixed factor associated with the short-run MC is the optimal choice.

- Long-run supply curve: $p = MC(y, k(y))$
- Short-run supply curve: $p = MC(y, k)$

The long-run supply curve is more elastic.

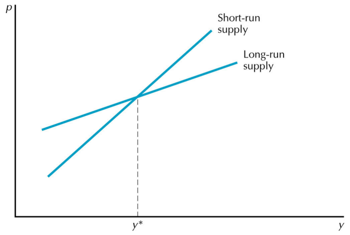


FIGURE 22.8 **The short-run and long-run supply curves**

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Comparative statics

Supply function $y^* = y(p,w)$

- $\max_y \Pi(p,w,y) = py - c(w,y); y \geq 0$
- First-order condition: $\dfrac{\partial \Pi(p,w,y^*)}{\partial y} = p - \dfrac{\partial c(w,y^*)}{\partial y} = 0$
- Second-order condition: $\dfrac{\partial^2 \Pi(p,w,y^*)}{\partial y^2} = -\dfrac{\partial^2 c(w,y^*)}{\partial y^2} < 0;$
  $\dfrac{\partial LMC(w,y^*)}{\partial y} > 0$
- Solve the first equation for output levels for which the second condition is fulfilled, and profit is non-negative.

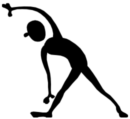
Marshal factor demand functions $x_i^* = x_i(p,w)$

- Plug-in the supply function $y^* = y(p,w)$ into conditional demand functions $x_i^* = x_i(w, y(p,w))$

Profit function $\Pi(p,w)$

- Use the supply function and Marshall factor demand functions
- $\Pi(p,w) = py^* - \Sigma w_i x_i = p \cdot y(p,w) - \Sigma w_i x_i(p,w,) =$
  $p \cdot y(p,w) - c(w, y(p,w))$

Comparative statics



Exercise

Production function $f(x) = \sqrt{3x_1^{\frac{1}{3}} x_2^{\frac{2}{3}}}$

Conditional factor demands: $x_1(w,y) = \frac{y^2}{3}\left(\frac{w_2}{2w_1}\right)^{\frac{2}{3}}$ and $x_2(w,y) = \frac{y^2}{3}\left(\frac{2w_1}{w_2}\right)^{\frac{1}{3}}$

Cost function: $c(w,y) = \frac{y^2}{2^{\frac{2}{3}}} w_1^{\frac{1}{3}} w_2^{\frac{2}{3}}$

- Derive the supply function $y(p,w)$.
- Derive the Marshall factor demands $x_1(p,w)$ and $x_2(p,w)$.
- Derive the profit function $\Pi(p,w)$.

Comparative statics

Properties of the profit function

- Increasing in output price p if $y > 0$ and non-decreasing in p if $y \geq 0$.
- Decreasing in input prices w_i if $x_i > 0$ and non-increasing if $x_i \geq 0$.
- Non-increasing in input prices w.
- $\Pi(kp, kw) = k\Pi(p, w)$
- Continuous in p and w.
- Smooth in p and w.
- Convex in p and w.
- Hotelling's lemma
  - $\dfrac{\partial \Pi(p,w)}{\partial p} = y(p,w)$
  - $\dfrac{\partial \Pi(p,w)}{\partial w_i} = -x_i(p,w)$

Comparative statics

Properties of the Marshall demand functions

- Non-increasing in own price w_i.
  - From convexity of the profit function and the Hotelling's lemma: $\dfrac{\partial^2 \Pi(p,w)}{\partial w_i^2} = -\dfrac{\partial x_i(p,w)}{\partial w_i} \geq 0$
  - No parallel to the Giffen good.
- $x_i(kp, kw) = x_i(p, w)$

Comparative statics

Properties of the supply function

- Non-decreasing in output price.
  - From convexity of the profit function and the Hotelling's lemma: $\dfrac{\partial^2 \Pi(p,w)}{\partial p^2} = \dfrac{\partial y(p,w)}{\partial p} \geq 0$
- $y(kp, kw) = y(p, w)$.
  - Firms do not suffer from money illusion.