MICROECONOMICS II

Topic 4 - Cost curves

Julie Chytilová
julie.chytilova@fsv.cuni.cz

Long-run cost curves

Total costs (LTC)

- Use the expansion path to derive the relationship between output and long-run costs.
- Depicts minimized costs as a function of output, assumes constant input prices.

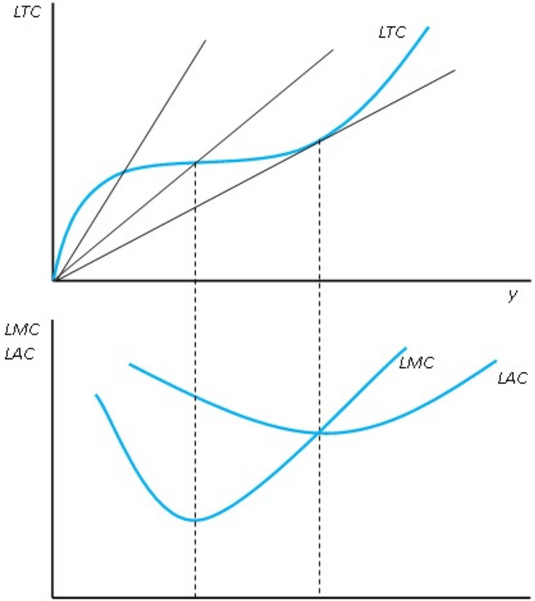
Long-run average costs (LAC)

- $LAC(y) = \dfrac{LTC(y)}{y}$

Long-run marginal costs (LMC)

- $LMC(y) = \dfrac{dLTC(y)}{dy} = \dfrac{\partial c(w, y)}{\partial y}$

Long-run cost curves

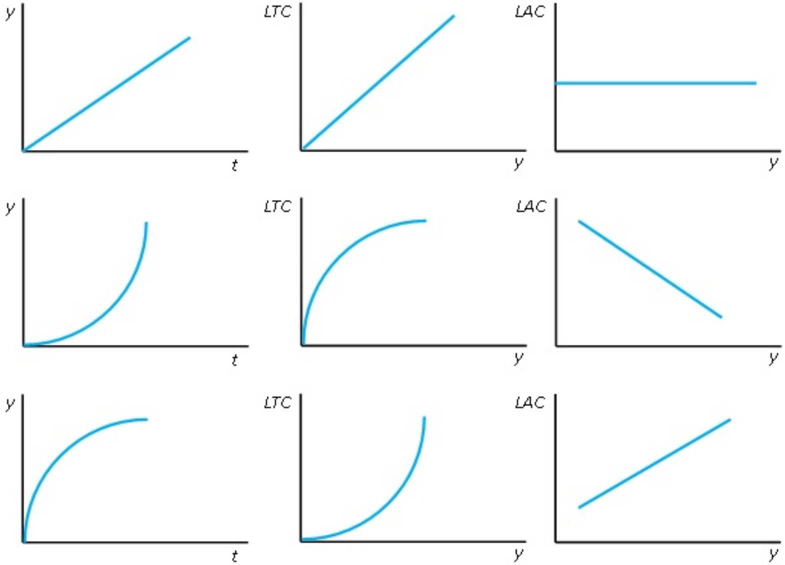


Returns to scale and economies of scale

Average cost function $AC(w_1, w_2, y) = \dfrac{c(w_1, w_2, y)}{y}$

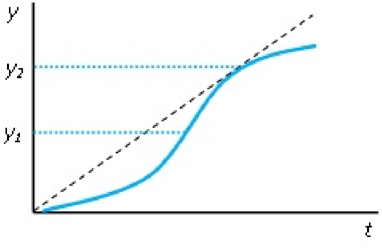
- Economies of scale
  - Average cost declining in output.
  - Increasing returns to scale.
  - If inputs are doubled, output is more than doubled. To double output, less than double amount of inputs is needed.
- Zero economies of scale
  - Average cost does not change with output.
  - Cost function linear in output: $c(w_1, w_2, y) = yc(w_1, w_2, 1)$
  - Constant returns to scale.
- Negative economies of scale
  - Average cost increasing in output.
  - Decreasing returns to scale.

Returns to scale and economies of scale



Returns to scale and economies of scale

Returns to scale may vary for different levels of output.



Elasticity of cost with respect to output

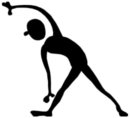
Measures responsiveness of cost to output changes.

$$e_y^c = \frac{\% \bigtriangleup c}{\% \bigtriangleup y} = \frac{\frac{dc}{c}}{\frac{dy}{y}} \approx \frac{\frac{\partial c(w,y)}{\partial y}}{\frac{c(w,y)}{y}} = \frac{LMC(y)}{LAC(y)}$$

The link between returns to scale and economies of scale

- $e_y^c < 1 \Leftrightarrow e_s^y > 1$
- $e_y^c = 1 \Leftrightarrow e_s^y = 1$
- $e_y^c > 1 \Leftrightarrow e_s^y < 1$

ELASTICITY OF COST WITH RESPECT TO OUTPUT



Exercise

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

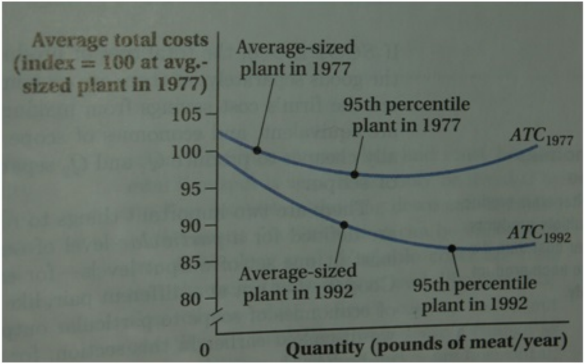
Find the output level at which economies of scale change into negative economies of scale.

Find the output level at which *LTC* changes from concave to convex.

ECONOMIES OF SCALE, APPLICATION

MacDonald and Ollinger, 2000. Scale Economies and Consolidation in Hog Slaughter, *American Journal of Agricultural Economics*.

Why have pork meat packing plants become so much larger? Potential explanation: change in nature of economies of scale.

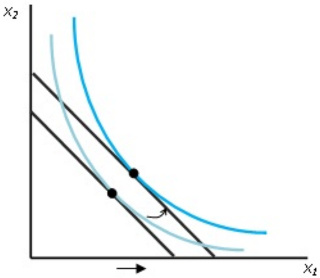


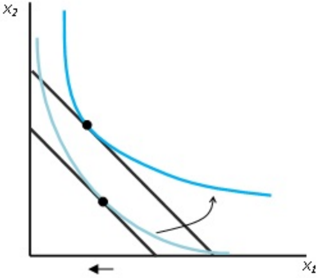
COMPARATIVE STATICS

Change in conditional factor demands with change in output

Depends on technology

- Positive for normal inputs $\frac{\partial x_i(w,y)}{\partial y} > 0$
- Negative for inferior inputs $\frac{\partial x_i(w,y)}{\partial y} < 0$





Comparative statics

Change in conditional factor demands with change in input prices

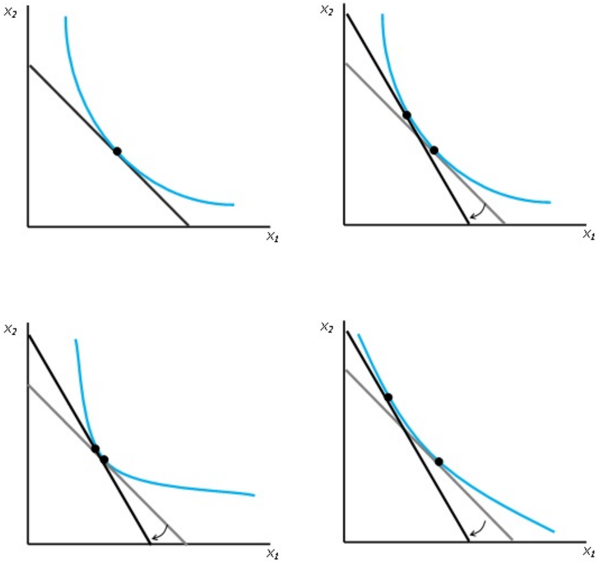
- No change when all prices change proportionally: $x(kw, y) = x(w, y)$
- Substitution effect of own price change is never positive: $\dfrac{\partial x_i(w,y)}{\partial w_i} \leq 0$
  - Shephard's lemma $\dfrac{\partial c(w,y)}{\partial w_i} = x_i(w,y)$ and concavity of the cost function in input price $\dfrac{\partial^2 c(w,y)}{\partial w_i^2} = \dfrac{\partial x_i(w,y)}{\partial w_i} \leq 0$

Comparative statics

Change in conditional factor demands with change in input prices

- Cross-substitution effects have the same sign and magnitude.
  - Shepard's lemma and smoothness of the cost function:
    $$\frac{\partial x_i(w,y)}{\partial w_j} = \frac{\partial^2 c(w,y)}{\partial w_i \partial w_j} = \frac{\partial^2 c(w,y)}{\partial w_j \partial w_i} = \frac{\partial x_j(w,y)}{\partial w_i}$$
- The effect of the change in relative prices $\frac{w_i}{w_j}$ on the proportion of inputs depends on the curvature of the isoquant of production.

Comparative statics



Comparative statics in the short-run

The case with one fixed and one variable input.

- Fixed factor does not change with changes in input prices and output level.
- Conditional demand for the variable factor is increasing in output, regardless whether it is normal or inferior.
- Conditional demand for the variable factor is independent on input prices.

Comparative statics, application

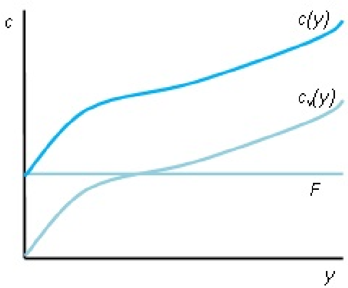
Acemoglu and Finkelstein, 2008. ”Input and Technology Choices in Regulated Industries: Evidence from the Health Care Sector.” *Journal of Political Economy*.

- Medicare - government paid medical insurance system in US.
- In 1983 change in payment: Relative price of labor increased.
  - Before: portion of hospital’s total costs reimbursed.
  - After: capital expenditures reimbursed as before, everything else by a flat rate based on a patient’s diagnosis.
- On average, 10% increase in capital-to-labor ratio within the first three years.
- Another test: hospitals with different share of patients on Medicare.

Short-run cost curves

Total costs

- The sum of variable and fixed costs
- Minimized costs as a function of output (we assume specific and constant input prices and fixed costs).
- $c(y) = c_v(y) + F$



SHORT-RUN COST CURVES

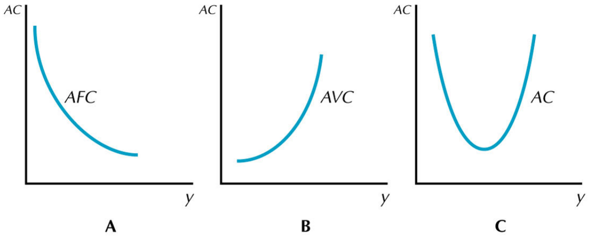


FIGURE 21.1 Construction of the average cost curve

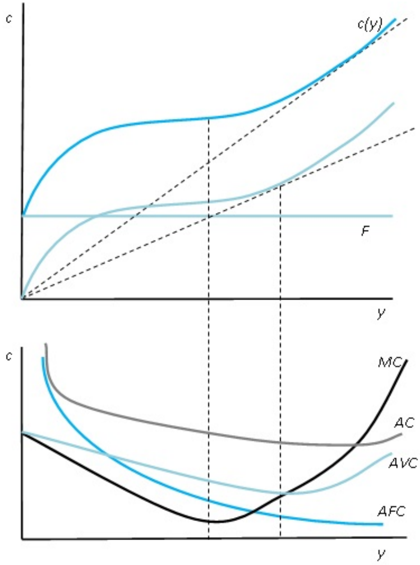
Intermediate Microeconomics, 8th Edition

SHORT-RUN COST CURVES

Marginal costs

- $MC(y) = \dfrac{\triangle\, c(y)}{\triangle\, y} = \dfrac{c(y + \triangle\, y) - c(y)}{\triangle\, y}$
- $MC(y) = \dfrac{\partial STC(y)}{\partial y} = \dfrac{\partial(w_1 x_1 + w_2 \bar{x_2})}{\partial y} = w_1 \dfrac{\partial x_1}{\partial y} = \dfrac{w_1}{MP_1}$
- Shape depending on AVC
  - For the first unit of output $MC = AVC$
  - If AVC is decreasing: $MC < AVC$
  - If AVC is increasing: $MC > AVC$
  - MC intersects AVC at its minimum point.
- Shape depending on AC
  - Same argument as in the case of AVC

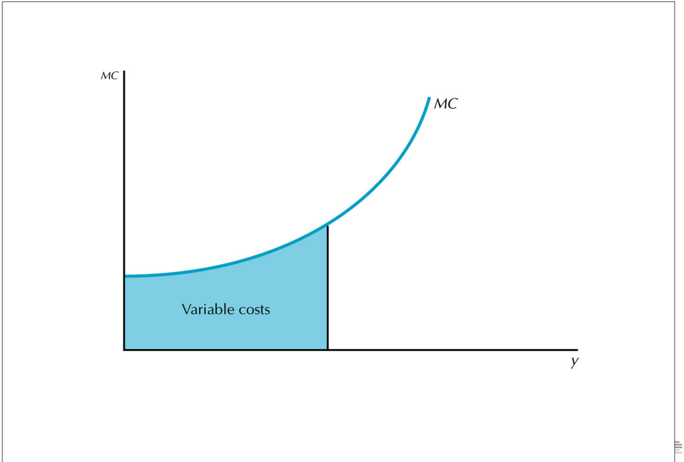
Short-run cost curves



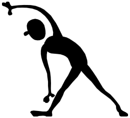
Short-run cost curves

Link between marginal and variable cost

- Add up the cost of producing each additional unit of output.
- $c_v(y) = [c_v(y) - c_v(y-1)] + [c_v(y-1) - c_v(y-2)] + \ldots + [c_v(1) - c_v(0)] = MC(y-1) + MC(y-2) + \ldots + MC(0)$



Short-run cost curves



Exercise

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

Derive

- Variable costs
- Fixed costs
- Average variable costs
- Average fixed costs
- Average costs
- Marginal costs

And draw a chart with *MC*, *AC* and *AVC*.

MARGINAL COSTS FOR TWO PLANTS

Problem: $min c_1(y_1) + c_2(y_2)$, such that $y_1 + y_2 = y^0$ and $y_i \geq 0$.

Optimum: MC the same in both plants.

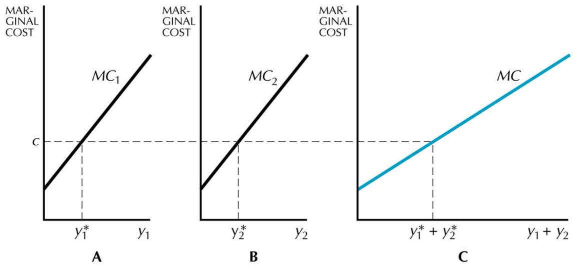
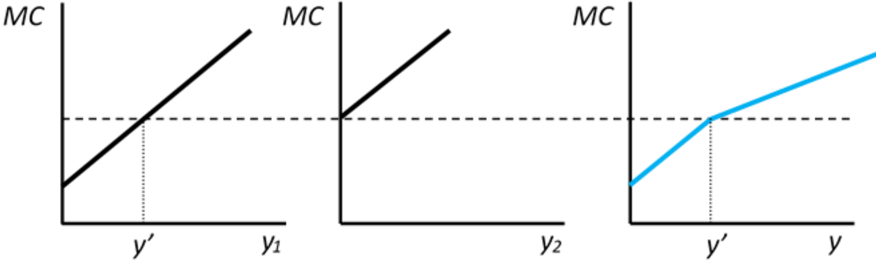


FIGURE 21.5 Marginal costs for a firm with two plants

Marginal costs for two plants

Corner solution: one of the plants is not used when $y < y'$



Marginal costs for two plants

So far: different cost functions across plants

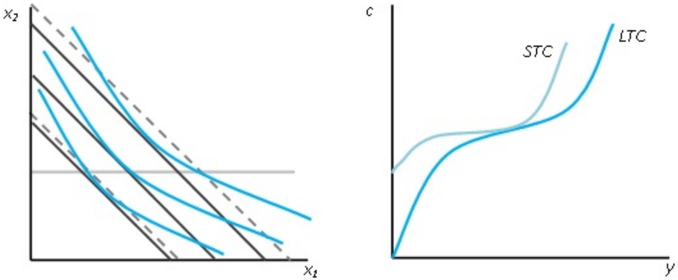
Identical purely convex cost function: produce the same output.

Identical but not purely convex cost functions: may be optimal to produce the whole output in one plant.

Short-run and long-run costs

Total costs, plant size k.

- Short-run cost function $c_s(y, k)$
- Long-run cost function $c(y) = c_s(y, k(y))$
- $c(y) \leq c_s(y, k^*)$ and $c(y^*) = c_s(y^*, k^*)$



Short-run and long-run costs

Average costs: the same property as total costs

- $AC(y) \leq AC_s(y, k^*)$ and $AC(y^*) = AC_s(y^*, k^*)$
- LAC curve is the lower envelope of the SAC curves.

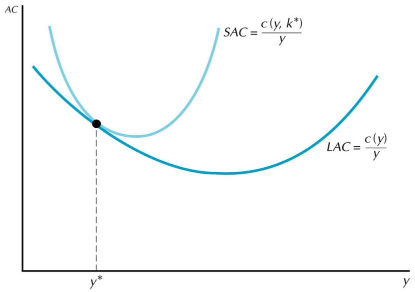


FIGURE 21.7 **Short-run and long-run average costs**

Short-run and long-run costs

Average cost, discrete level of plant size.

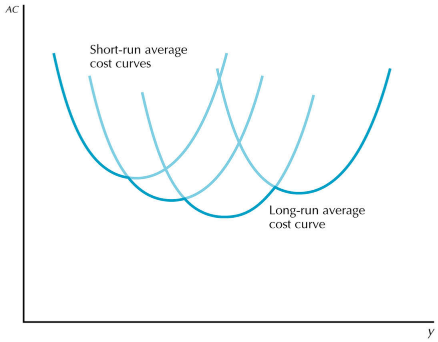


FIGURE 21.9 **Discrete levels of plant size**

Intermediate Microeconomics, 8th Edition

Short-run and long-run costs

Marginal costs: The long-run *MC* equals the short-run *MC* associated with the optimal plant size to produce the given output level.

Discrete plant size

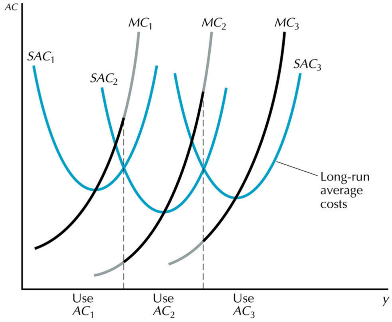


FIGURE 21.10 Long-run marginal costs

Intermediate Microeconomics, 8th Edition

Short-run and long-run costs

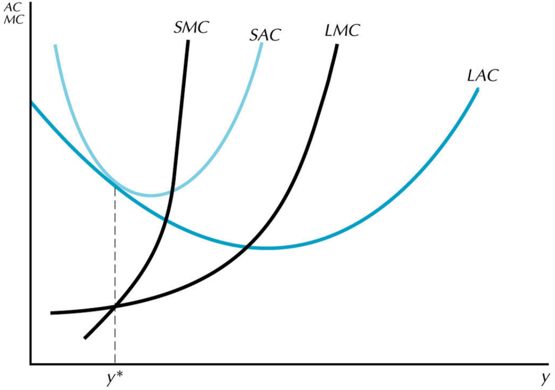


FIGURE 21.11 Long-run marginal costs

Intermediate Microeconomics, 8th Edition