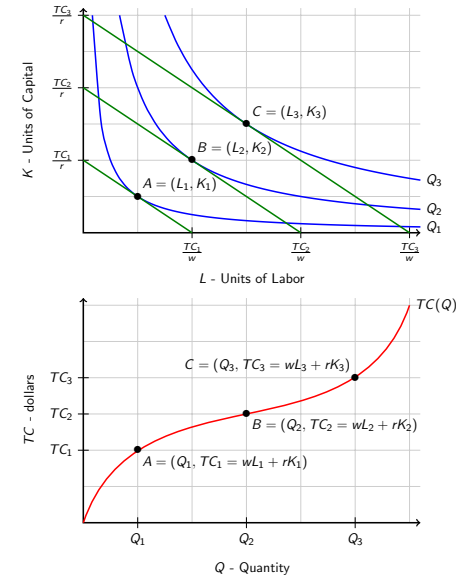


Agenda

1. Long-run Total Cost curves
2. Exercise: Finding the Long-Run Cost Curve
3. Economics of Scale
4. Short-Run Cost Curves
5. Long-Run vs. Short-Run Cost Curves
6. Exercise: Cost Curve Comparison

Long-Run Total Cost Curve

- ▶ **Long-Run Total Cost Curve:** A curve that shows how total cost varies with output, holding input prices fixed and choosing all inputs to minimize cost.
- ▶ Example:
 - ▶ Fixed level of w and r .
 - ▶ Determine optimal L, K combo for different levels of output.
 - ▶ Plot using Q vs TC .
- ▶ Properties of TC :
 - ▶ Must be increasing in Q .
 - ▶ $TC(0) = 0$.

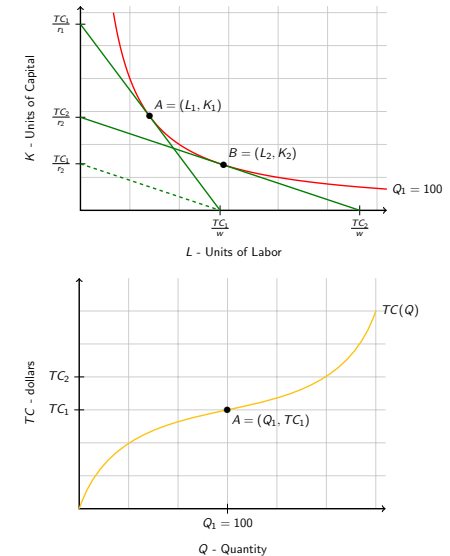


Long-Run Total Cost Curve Example

- ▶ $Q(L, K) = 3L^{1/4}K^{1/4}$
- ▶ $w = 4$ and $r = 9$

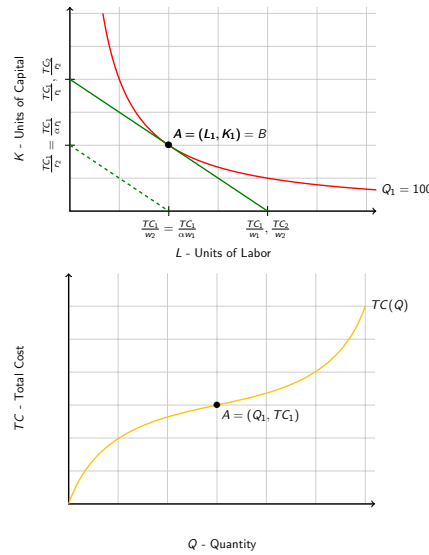
Change in One Price

- ▶ **Example:** Firm wants to produce Q_1 .
- ▶ Price of capital increases from r_1 to r_2 .
 - ▶ At w and r_1 .
 - ▶ Optimal basket: A
 - ▶ Cost TC_1 .
 - ▶ At w and r_2 .
 - ▶ $r_2 > r_1 \Rightarrow$ flatter isocost lines.
 - ▶ Can no longer produce Q_1 at TC_1 .
 - ▶ Optimal basket: B
 - ▶ Cost $TC_2 > TC_1$.
- ▶ Total cost curve



Proportional Change in Both Prices

- ▶ **Example:** Firm wants to produce Q_1 .
- ▶ Both prices increase proportionally, for $\alpha > 1$,
 - ▶ $w_2 = \alpha w_1, r_2 = \alpha r_1$.
 - ▶ At w_1 and r_1 .
 - ▶ Optimal basket: A
 - ▶ Cost TC_1 .
 - ▶ At w_2 and r_2 .
 - ▶ Isocost lines have same slope, $\frac{w_1}{r_1} = \frac{\alpha w_1}{\alpha r_1} = \frac{w_2}{r_2}$
 - ▶ Can no longer produce Q_1 at TC_1 .
 - ▶ Optimal basket: B
 - ▶ Cost $TC_2 = \alpha TC_1$.
- ▶ Total cost curve shifts

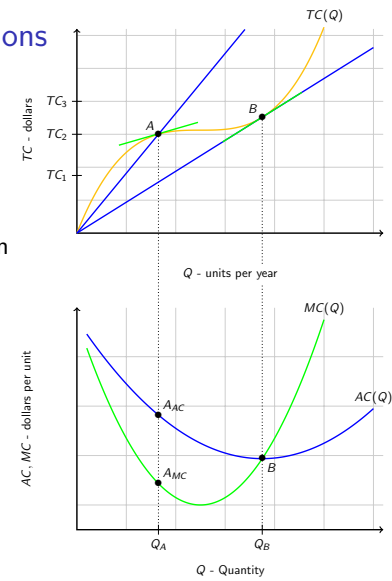


Long-Run Average and Marginal Cost Functions

- ▶ **Long-Run Average Cost:** The firm's total cost per unit of output.

$$AC(Q) = \frac{TC}{Q}$$
- ▶ **Long-Run Marginal Cost:** The rate at which long-run total cost changes with respect to change in output.

$$MC(Q) = \frac{dTC}{dQ}$$
- ▶ Relationship between AC & MC:
 - ▶ $MC < AC \Rightarrow AC$ decreases
 - ▶ $AC < MC \Rightarrow AC$ increases



Exercise: A firm faces production function $Q(L, K) = 20LK$.

1. Calculate long-run total cost function (function of Q, w, r)
2. Calculate the long-run average cost and long-run marginal cost curves.
3. Assume the firm is stuck with $\bar{K} = 5$ in the short-run, what is the short-run total cost curve?

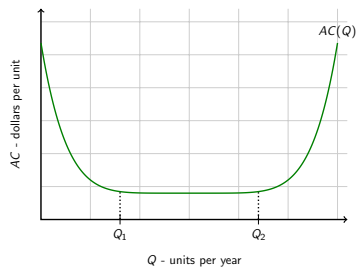
Solution

Economies of Scale

▶ **(Dis)Economies of Scale:** A characteristic of production in which average cost (in)decreases as output goes up.

▶ In graph:

- ▶ $Q < Q_1$:
- ▶ $Q > Q_2$:
- ▶ Minimum efficient Scale: Smallest Q at which LRAC is minimized.



▶ Example: $TC(Q) = 80Q - 16Q^2 + 2Q^3$

Output Elasticity of Total Cost

▶ **Output Elasticity of Total Cost:** The percentage change in total cost per 1 percent change in output.

$$\epsilon_{TC,Q} = \frac{dTC}{dQ} \frac{Q}{TC}$$

▶ Implications:

$$\epsilon_{TC,Q} > 1$$

$$\epsilon_{TC,Q} < 1$$

▶ Examples:

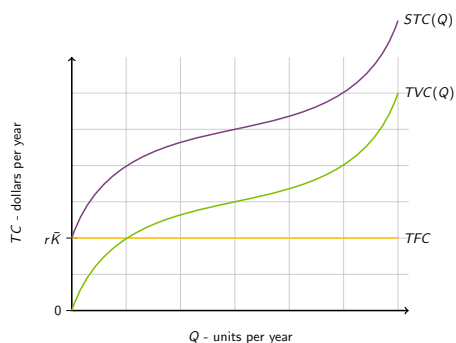
Industry	$\epsilon_{TC,Q}$	Industry	$\epsilon_{TC,Q}$
Iron and Steel	0.553	Cotton textiles	1.211
Cement	1.162	Electricity and gas	0.3823

Short-Run Total Cost Curve

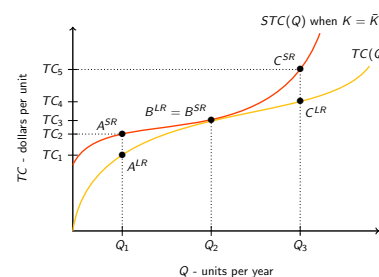
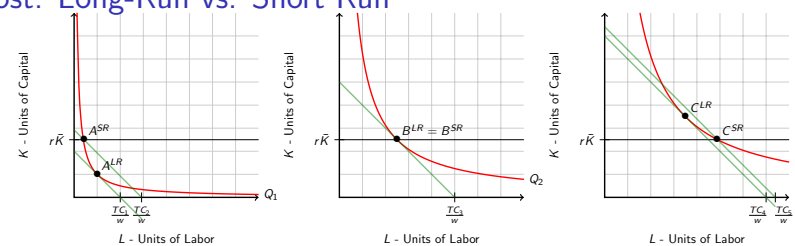
▶ **Short-Run Total Cost Curve:** A curve that shows the minimized total cost of producing a given quantity of output when at least one input is fixed.

▶ **Total Variable Cost Curve:** A curve that shows the sum of expenditures on variable inputs at the short-run cost-minimizing solution.

▶ **Total Fixed Cost Curve:** A curve that shows the cost of fixed inputs and does not vary with output.

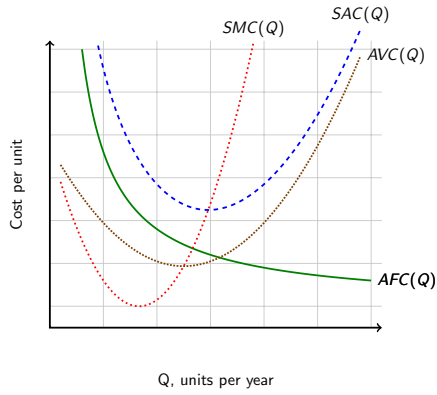


Total Cost: Long-Run vs. Short Run



- ▶ Short-Run - Fixed level of Capital \bar{K} .
- ▶ Production Q_1
- ▶ Production Q_2
- ▶ Production Q_3

Short-Run Average and Marginal Cost Curves



▶ **Short-Run Average Cost:** The firms total cost per unit of output, with one or more fixed inputs.

$$SAC(Q) = \frac{STC(Q)}{Q}$$

▶ **Short-Run Marginal Cost:** The slope of the short-run total cost curve.

$$SMC(Q) = \frac{dSTC}{dQ}(Q)$$

▶ **Average Variable Cost:** Total variable cost per unit of output.

$$AVC(Q) = \frac{TVC}{Q}$$

▶ **Average Fixed Cost:** Total fixed cost per unit of output.

$$AFC(Q) = \frac{TFC}{Q}$$

▶ Also, $SAC(Q) = AVC(Q) + AFC(Q)$

Exercise

▶ Fill in the remaining blanks with appropriate numbers based on the given numbers.

Q	TC	TVC	TFC	AC	MC	AVC
1	18					
2						10
3					16	
4	66					
5			10	18		
6		108				

Solution

Q	TC	TVC	TFC	AC	MC	AVC
1	18					
2						10
3					16	
4	66					
5			10	18		
6		108				