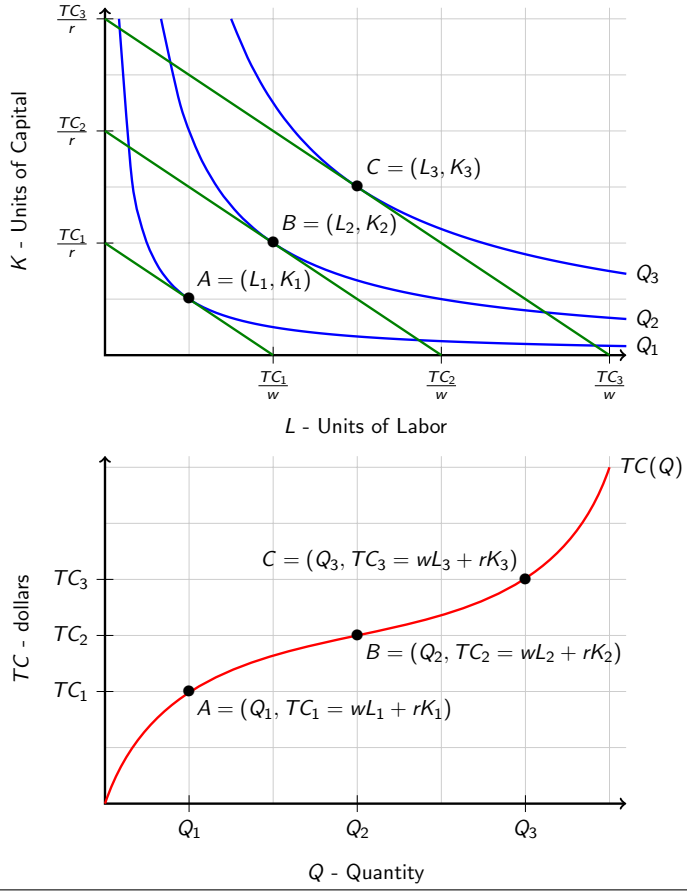
Agenda

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.
  - $TC(0) = 0$.

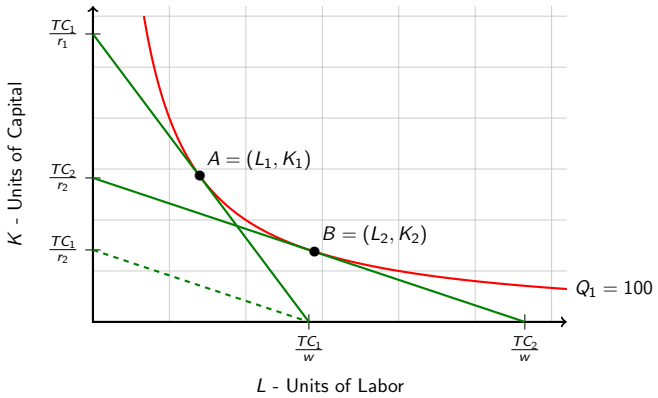


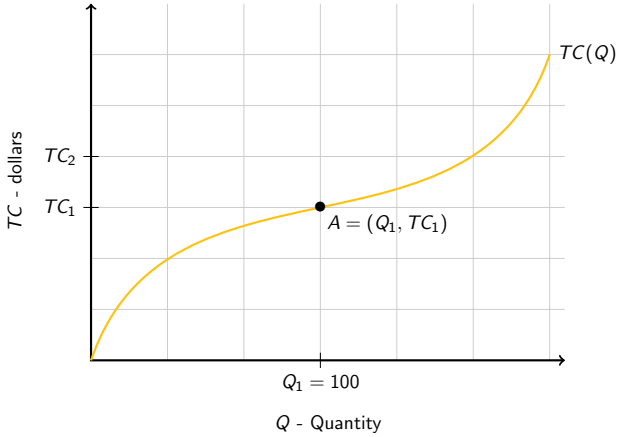
Long-Run Total Cost Curve Example

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

Change in One Price

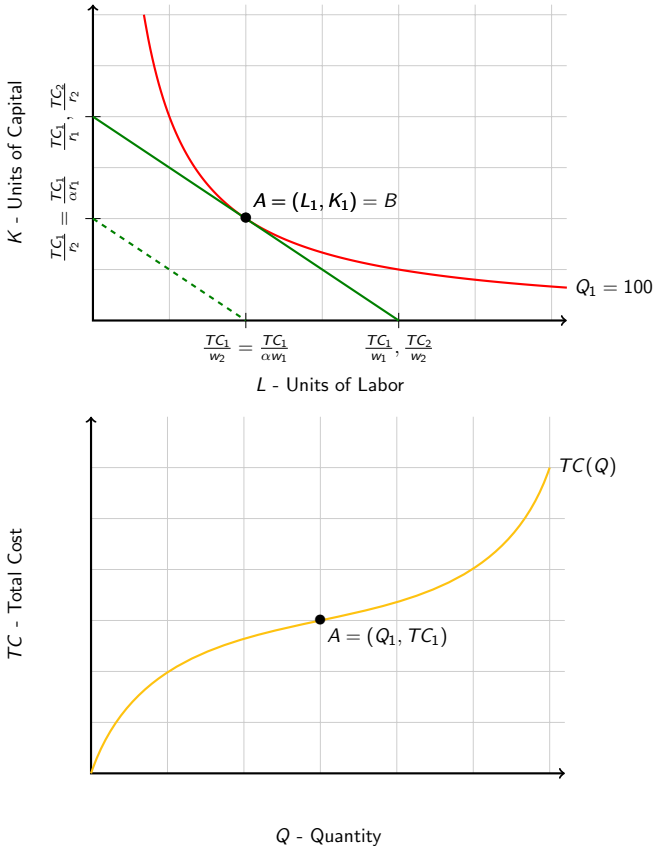
- **Example:** Firm wants to produce Q_1.
- Price of capital increases from r_1 to r_2.
  - At w and r_1.
    - Optimal basket: A
    - Cost TC_1.
  - At w and r_2.
    - $r_2 > r_1 \Rightarrow$ flatter isocost lines.
    - Can no longer produce Q_1 at TC_1.
    - Optimal basket: B
    - Cost $TC_2 >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

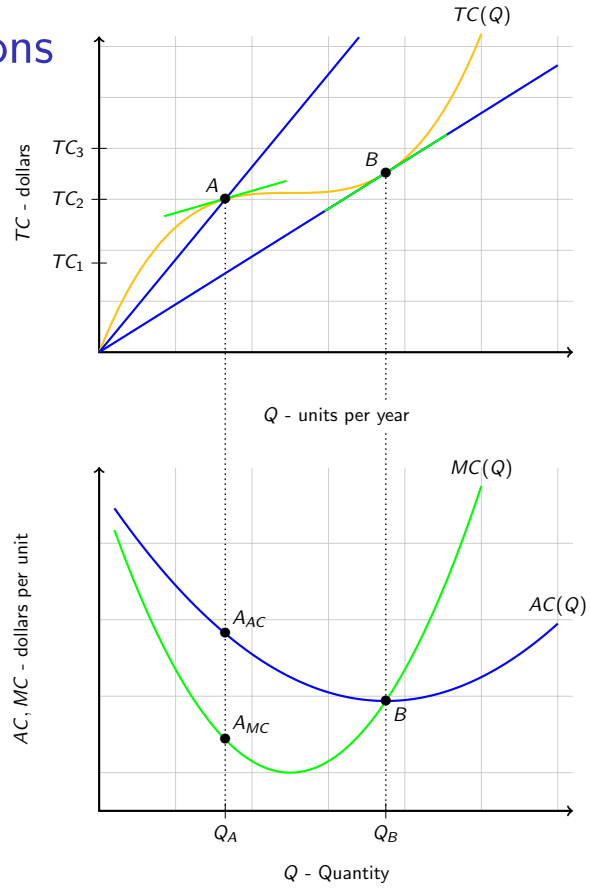
- **Long-Run Average Cost:** The firm's total cost per unit of output.

$$AC(Q) = \frac{TC}{Q}$$

- **Long-Run Marginal Cost:** The rate at which long-run total cost changes with repsect to change in output.

$$MC(Q) = \frac{dTC}{dQ}$$

- Relationship between AC & MC:
  - $MC < AC \Rightarrow AC$
  - $AC < MC \Rightarrow AC$



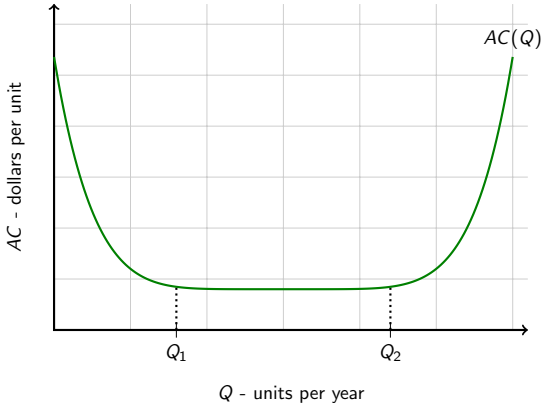
Exercise: A firm faces production function $Q(L, K) = 20LK$.

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:

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

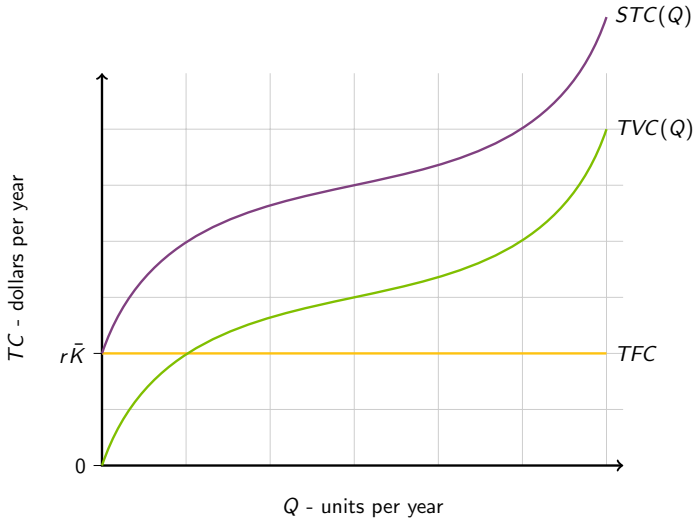
$$\epsilon_{TC,Q} < 1$$

- Examples:

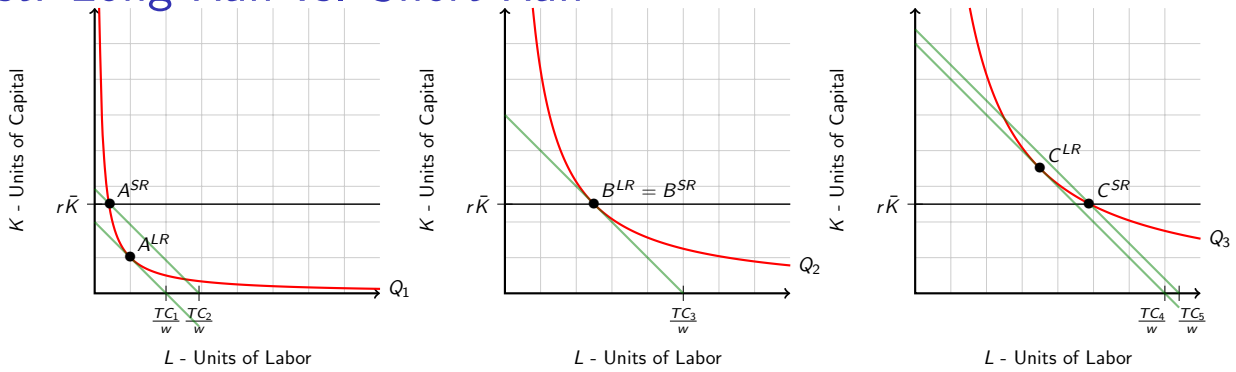
Industry	$\epsilon_{TC,Q}$	**Industry**	$\epsilon_{TC,Q}$
Iron and Steel	0.553	Cotton textiles	1.211
Cement	1.162	Electricity and gas	0.3823

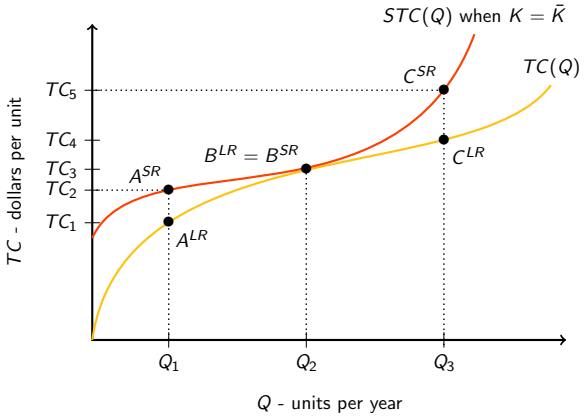
Short-Run Total Cost Curve

- **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.



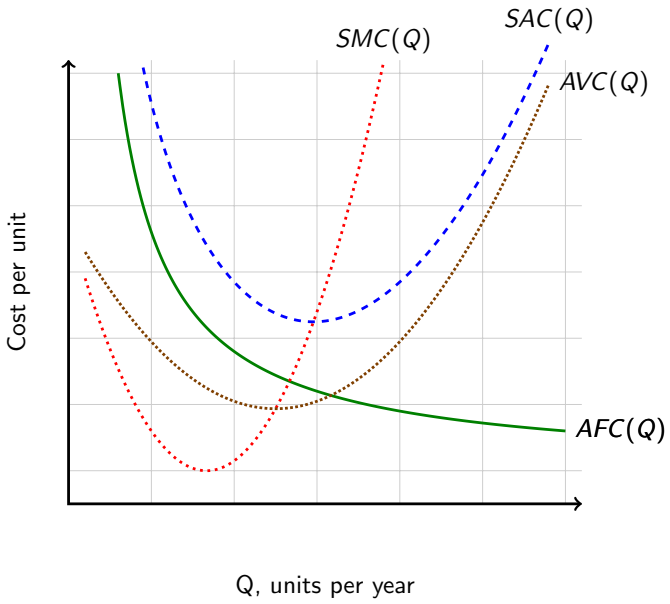
Total Cost: Long-Run vs. Short Run





- 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**				