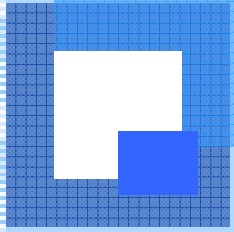


# Chapter 8

## *The Theory and Estimation of Cost*

*Managerial Economics: Economic  
Tools for Today's Decision Makers, 4/e  
By Paul Keat and Philip Young*



# The Theory and Estimation of Cost

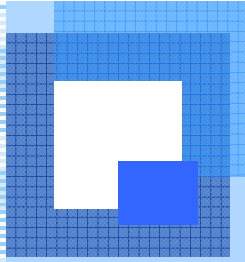
- Definition of Cost
- The Short Run Relationship Between Production and Cost
- The Short Run Cost Function
- The Long Run Relationship Between Production and Cost
- The Long Run Cost Function
- The Learning Curve
- Economies of Scope
- Other Methods to Reduce Costs



## Definition of Cost

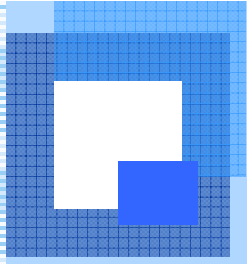
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- A cost is **relevant** if it is affected by a management decision. A cost is **irrelevant** if it is not.
- **Historical cost** is the cost incurred at the time of procurement.
- **Replacement cost** is the cost necessary to replace inventory
- Are historical costs relevant?



# Definition of Cost

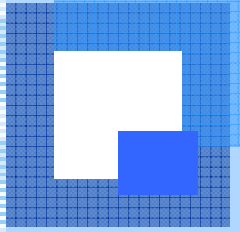
- **Opportunity cost** is the value that is forgone in choosing one activity over the next best alternative.
  - indirect cost
  - implicit cost
- **Out-of-pocket costs** are actual transfers of value that occur.
  - direct cost
  - explicit cost



## Definition of Cost

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- **Incremental cost** varies with the range of options available in the decision making process.
- **Sunk cost** does not vary with decision options.
- Is sunk cost relevant?



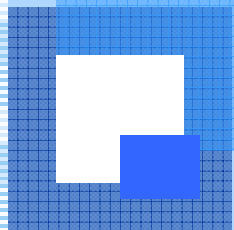
# SR Relationship Between Production and Cost

- A firm's cost structure is intimately related to its production process.
- Costs are determined by the production technology and input prices.
- Assume the firm is a “price taker” in the input market.

# SR Relationship Between Production and Cost

- In order to illustrate the relationship, consider the production process described in the table.

Total Input (L)	Q (TP)	MP
0	0	
1	1,000	1,000
2	3,000	2,000
3	6,000	3,000
4	8,000	2,000
5	9,000	1,000
6	9,500	500
7	9,850	350
8	10,000	150
9	9,850	-150



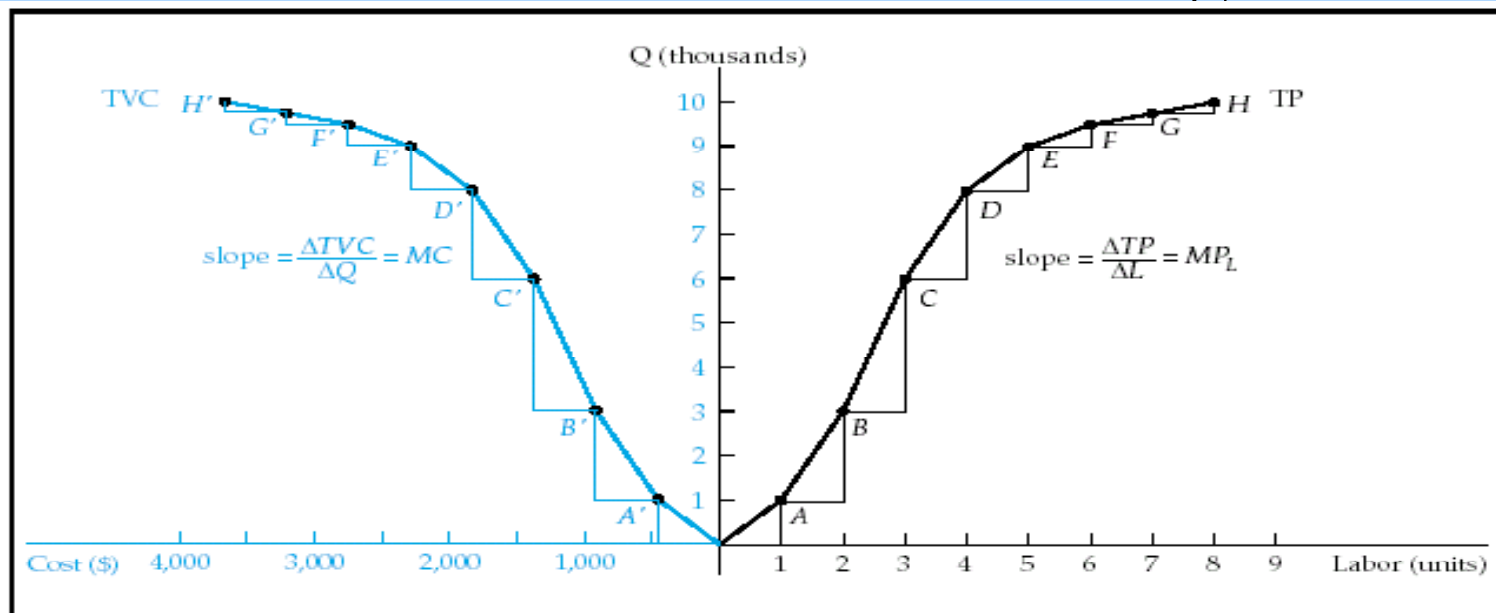
# SR Relationship Between Production and Cost

- **Total variable cost (TVC)** is the cost associated with the variable input, in this case labor. Assume that labor can be hired at a price of  $w = \$500$  per unit. TVC has been added to the table.

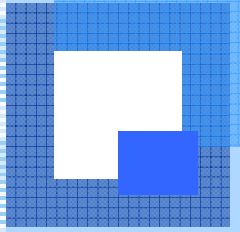
Total Input (L)	Q (TP)	MP	TVC (wL)
0	0		0
1	1,000	1,000	500
2	3,000	2,000	1,000
3	6,000	3,000	1,500
4	8,000	2,000	2,000
5	9,000	1,000	2,500
6	9,500	500	3,000
7	9,850	350	3,500
8	10,000	150	4,000
9	9,850	-150	4,500

# SR Relationship Between Production and Cost

- Plotting TP and TVC illustrates that they are mirror images of each other.
- When TP increases at an increasing rate, TVC increases at a decreasing rate.



**Figure 8.1**  
Short-Run Production and Cost



# SR Relationship Between Production and Cost

- **Total fixed cost (TFC)** is the cost associated with the fixed inputs.
- **Total cost (TC)** is the cost associated with all of the inputs. It is the sum of TVC and TFC.
- $TC - TFC = TVC$



# SR Relationship Between Production and Cost

- **Marginal cost (MC)** is the change in total cost associated a change in output.

$$MC = \frac{\Delta TC}{\Delta Q}$$

- MC can also be expressed as the change in TVC associated with a change in output.

$$MC = \frac{\Delta TC}{\Delta Q} = \frac{\Delta(TFC + TVC)}{\Delta Q} = \frac{\Delta TFC}{\Delta Q} + \frac{\Delta TVC}{\Delta Q} = 0 + \frac{\Delta TVC}{\Delta Q}$$

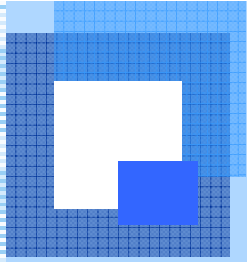
# SR Relationship Between Production and Cost

- Marginal Cost has been added to the table.

- When MP is increasing, MC is decreasing.

- When MP is decreasing, MC is increasing.

Total					
Input				TVC	
(L)	Q	MP	(wL)	MC	
0	0		0		
1	1,000	1,000	500	0.50	
2	3,000	2,000	1,000	0.25	
3	6,000	3,000	1,500	0.17	
4	8,000	2,000	2,000	0.25	
5	9,000	1,000	2,500	0.50	
6	9,500	500	3,000	1.00	
7	9,850	350	3,500	1.43	
8	10,000	150	4,000	3.33	
9	9,850	-150	4,500		

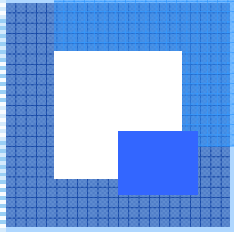


## SR Relationship Between Production and Cost

- The relationship between MP and MC can be seen mathematically in the following equations.

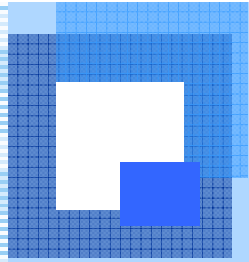
$$MC = \frac{\Delta TVC}{\Delta Q} = \frac{w \cdot \Delta L}{\Delta Q} = w \cdot \frac{\Delta L}{\Delta Q} = w \cdot \frac{1}{MP} = \frac{w}{MP}$$

- The law of diminishing returns implies that MC will eventually increase.



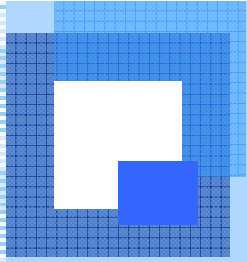
# The Short Run Cost Function

- A firm's short run cost function tells us the minimum cost necessary to produce a particular output level.
- For simplicity the following assumptions are made:
  - the firm employs two inputs, labor and capital
  - labor is variable, capital is fixed
  - the firm produces a single product
  - technology is fixed
  - the firm operates efficiently
  - the firm operates in competitive input markets
  - the law of diminishing returns holds



# The Short Run Cost Function

- The following average cost functions will be useful in our analysis.
- **Average total cost (AC)** is the average per-unit cost of using all of the firm's inputs.
- **Average variable cost (AVC)** is the average per-unit cost of using the firm's variable inputs.
- **Average fixed cost (AFC)** is the average per-unit cost of using the firm's fixed inputs.



# The Short Run Cost Function

- Mathematically,

$$AVC = TVC/Q$$

$$AFC = TFC/Q$$

$$ATC = TC/Q = (TFC + TVC)/Q = AFC + AVC$$

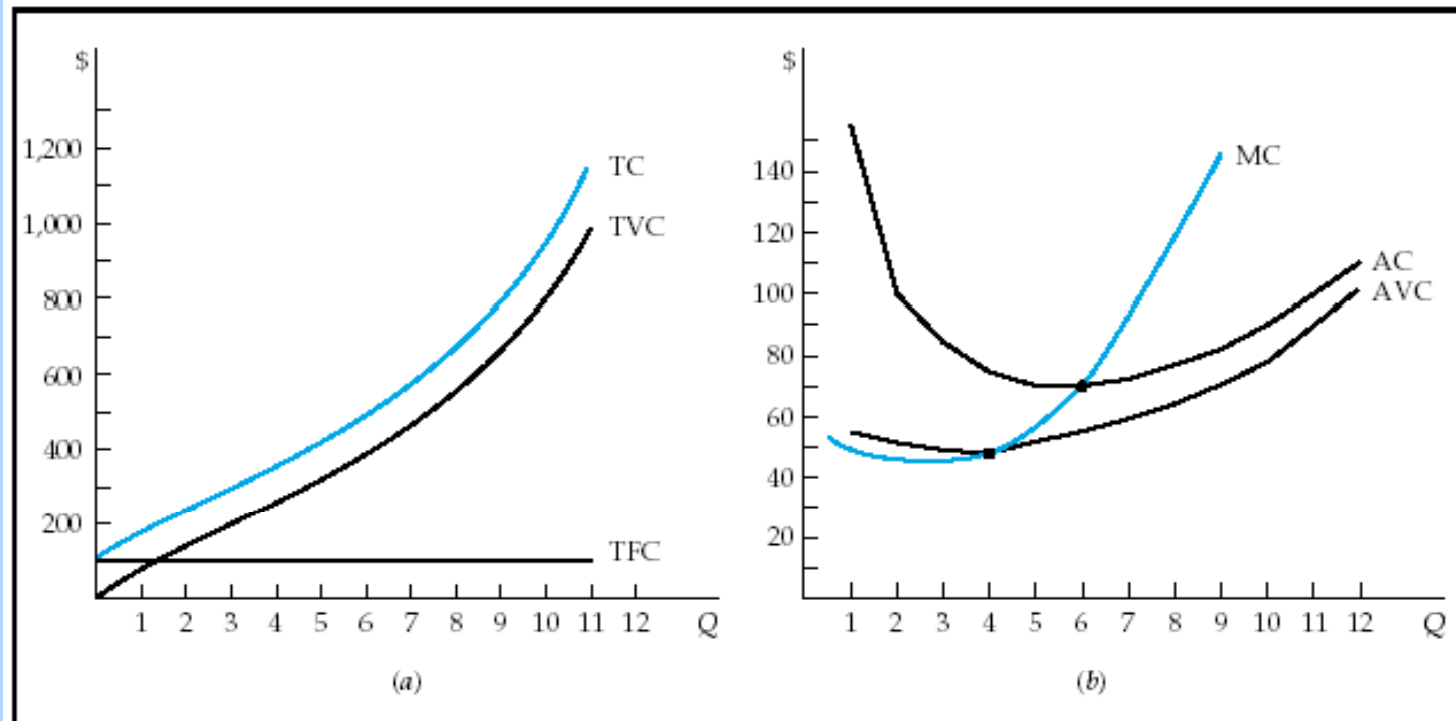
# The Short Run Cost Function

- Table 8.2 illustrates how the short run cost measures can be calculated.

QUANTITY (Q)	TOTAL FIXED COST (TFC)	TOTAL VARIABLE Cost (TVC)	TOTAL Cost (TC)	AVERAGE FIXED COST (AFC)	AVERAGE VARIABLE COST (AVC)	AVERAGE TOTAL COST (AC)	MARGINAL Cost (MC)
0	100	0.00	100.00				
1	100	55.70	155.70	100.00	55.70	155.70	55.70
2	100	105.60	205.60	50.00	52.80	102.80	49.90
3	100	153.90	253.90	33.33	51.30	84.63	48.30
4	100	204.80	304.80	25.00	51.20	76.20	50.90
5	100	262.50	362.50	20.00	52.50	72.50	57.70
6	100	331.20	431.20	16.67	55.20	71.87	68.70
7	100	415.10	515.10	14.29	59.30	73.59	83.90
8	100	518.40	618.40	12.50	64.80	77.30	103.30
9	100	645.30	745.30	11.11	71.70	82.81	126.90
10	100	800.00	900.00	10.00	80.00	90.00	154.70
11	100	986.70	1,086.70	9.09	89.70	98.79	186.70
12	100	1,209.60	1,309.60	8.33	100.80	109.13	222.90

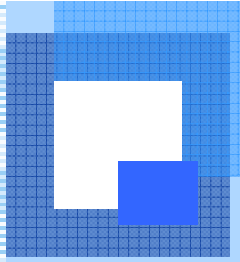
# The Short Run Cost Function

- Graphically, these results are depicted in the figure below.



**Figure 8.2**

Total Cost, Total Variable Cost, Total Fixed Cost, Average Cost, Average Variable Cost, and Marginal Cost

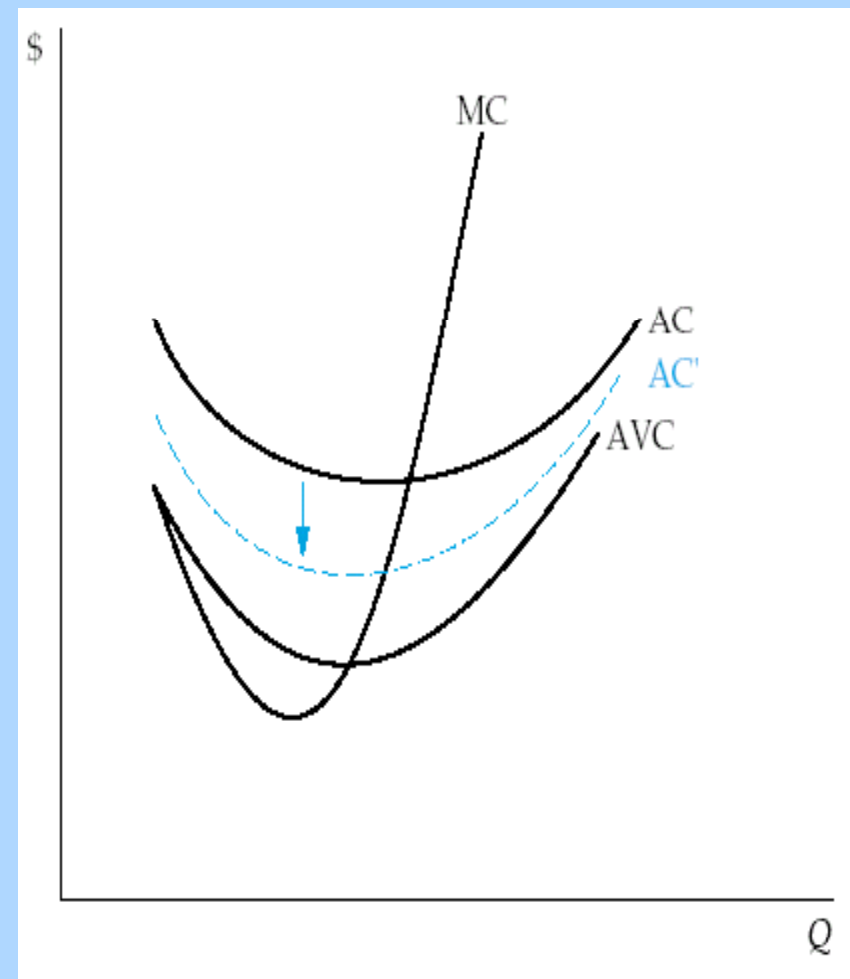


# The Short Run Cost Function

- Important Observations
  - AFC declines steadily over the range of production.
  - In general, AVC, AC, and MC are u-shaped.
  - MC measures the rate of change of TC
  - When  $MC < AVC$ , AVC is falling  
When  $MC > AVC$ , AVC is rising  
When  $MC = AVC$ , AVC is at its minimum
  - The distance between AC and AVC represents AFC

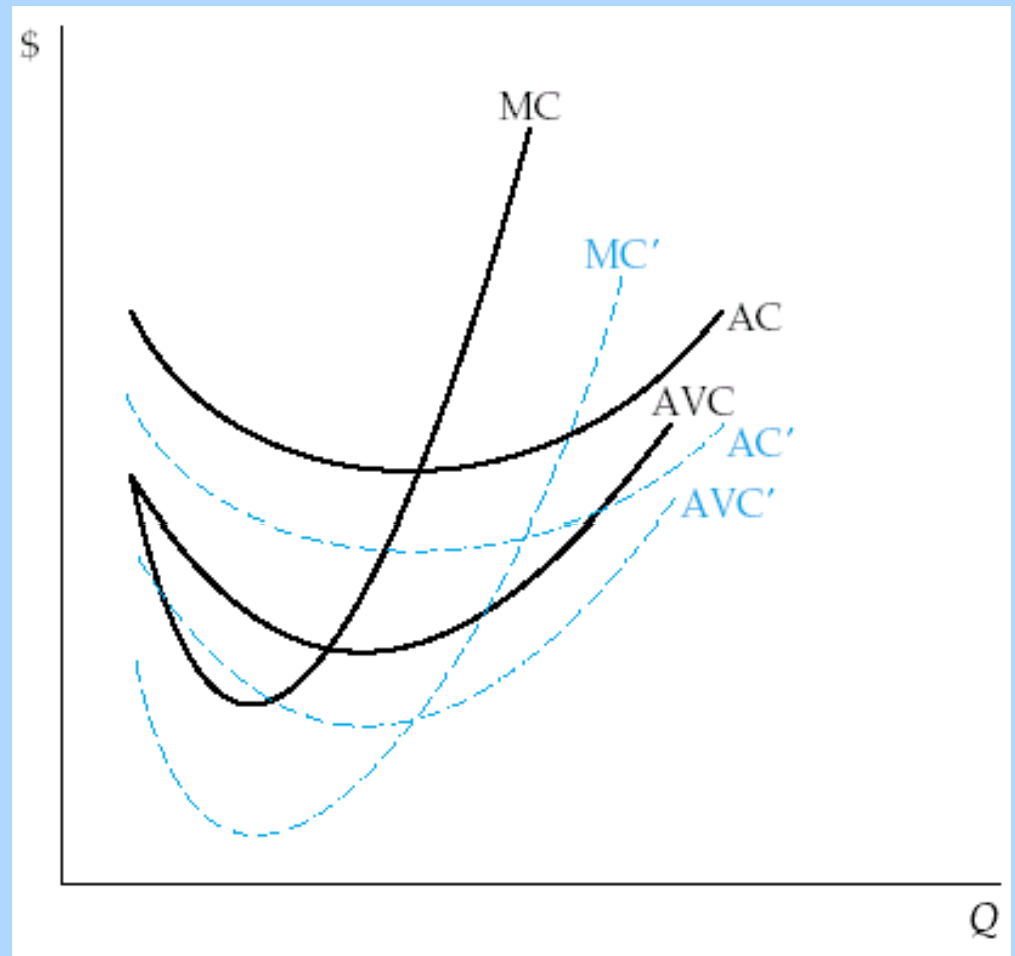
# The Short Run Cost Function

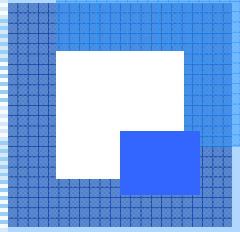
- A change in input prices will act to shift the cost curves.
- If there is a reduction in the costs associated with the fixed inputs, the average total cost will shift downward. AVC and MC will remain unaffected.



# The Short Run Cost Function

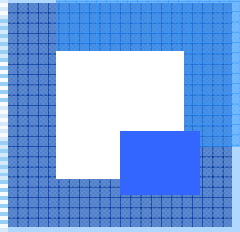
- If there is a reduction in the costs associated with the variable inputs, then the MC, AVC, and AC will all shift downward.





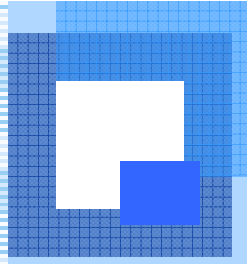
# The LR Relationship Between Production and Cost

- In the long run, all inputs are variable.
- In the long run, there are no fixed costs
- The long run cost structure of a firm is related to the firm's long run production process.
- The firm's long run production process is described by the concept of returns to scale.



# The LR Relationship Between Production and Cost

- Economists hypothesize that a firm's long-run production function may exhibit at first increasing returns, then constant returns, and finally decreasing returns to scale.
- When a firm experiences increasing returns to scale
  - A proportional increase in all inputs increases output by a greater percentage than costs.
  - Costs increase at a decreasing rate

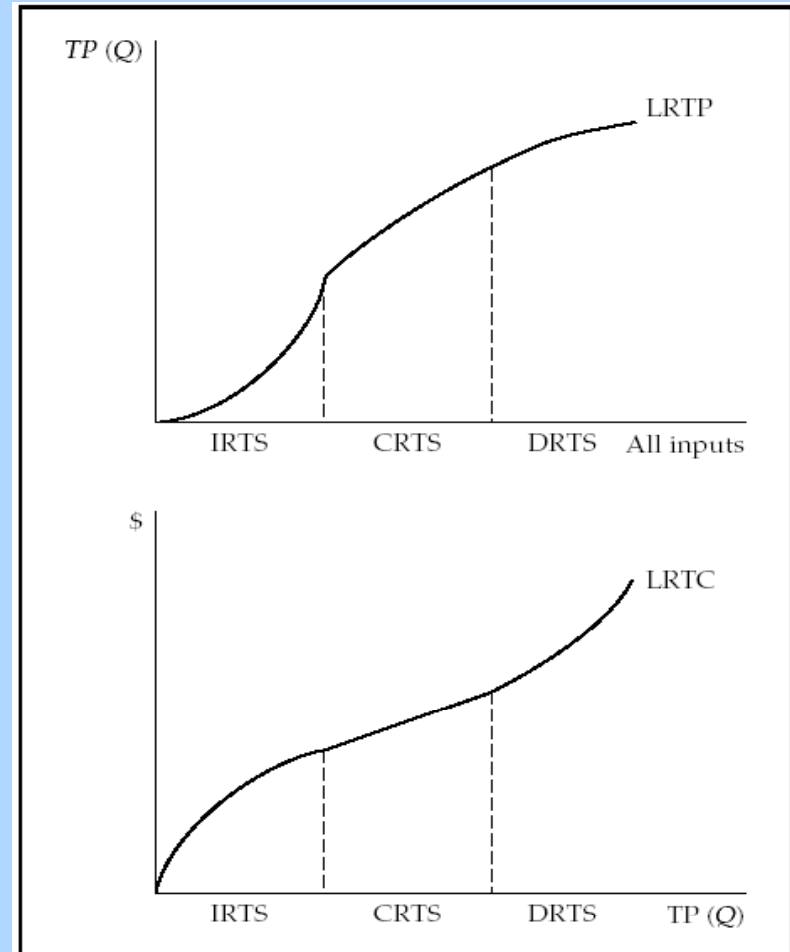


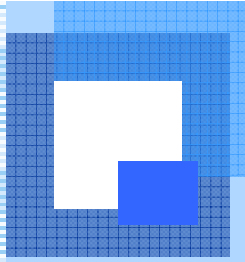
# The LR Relationship Between Production and Cost

- When a firm experiences constant returns to scale
  - A proportional increase in all inputs increases output by the same percentage as costs.
  - Costs increase at a constant rate
- When a firm experiences decreasing returns to scale
  - A proportional increase in all inputs increases output by a smaller percentage than costs.
  - Costs increase at an increasing rate

# The LR Relationship Between Production and Cost

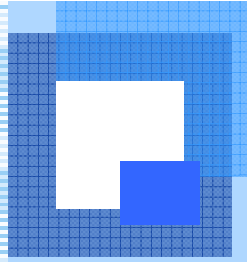
- This graph illustrates the relationship between the long-run production function and the long-run cost function.





## The Long-Run Cost Function

- **Long run marginal cost (LRMC)** measures the change in long run costs associated with a change in output.
- **Long run average cost (LRAC)** measures the average per-unit cost of production when all inputs are variable.
- In general, the LRAC is u-shaped.

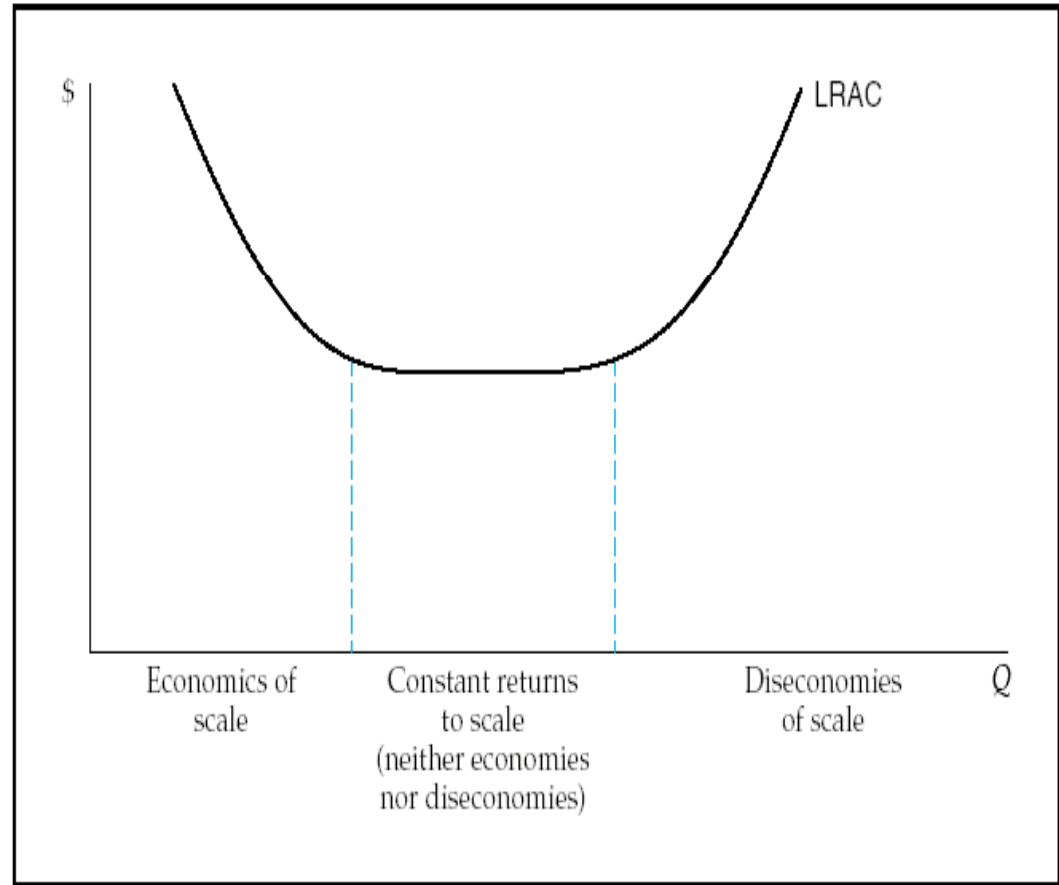


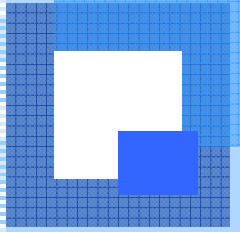
# The Long-Run Cost Function

- When LRAC is declining we say that the firm is experiencing **economies of scale**.
- Economies of scale implies that per-unit costs are falling.
- When LRAC is increasing we say that the firm is experiencing **diseconomies of scale**.
- Diseconomies of scale implies that per-unit costs are rising.

# The Long-Run Cost Function

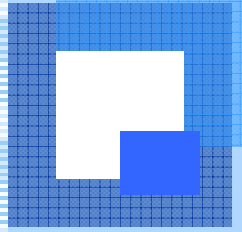
- The figure illustrates the general shape of the LRAC.





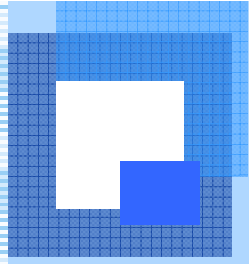
# The Long-Run Cost Function

- Reasons for Economies of Scale
  - Increasing returns to scale
  - Specialization in the use of labor and capital
  - Indivisible nature of many types of capital equipment
  - Productive capacity of capital equipment rises faster than purchase price



# The Long-Run Cost Function

- Reasons for Economies of Scale
  - Economies in maintaining inventory of replacement parts and maintenance personnel
  - Discounts from bulk purchases
  - Lower cost of raising capital funds
  - Spreading promotional and R&D costs
  - Management efficiencies



# The Long-Run Cost Function

- Reasons for Diseconomies of Scale
  - Decreasing returns to scale
  - Disproportionate rise in transportation costs
  - Input market imperfections
  - Management coordination and control problems
  - Disproportionate rise in staff and indirect labor

# The Long-Run Cost Function

- In the short run, the firm has a fixed level of capital equipment or plant size.
- The figure illustrates the SRAC curves for various plant sizes.
- Once a plant size is chosen, per-unit production costs are found by moving along that particular SRAC curve.

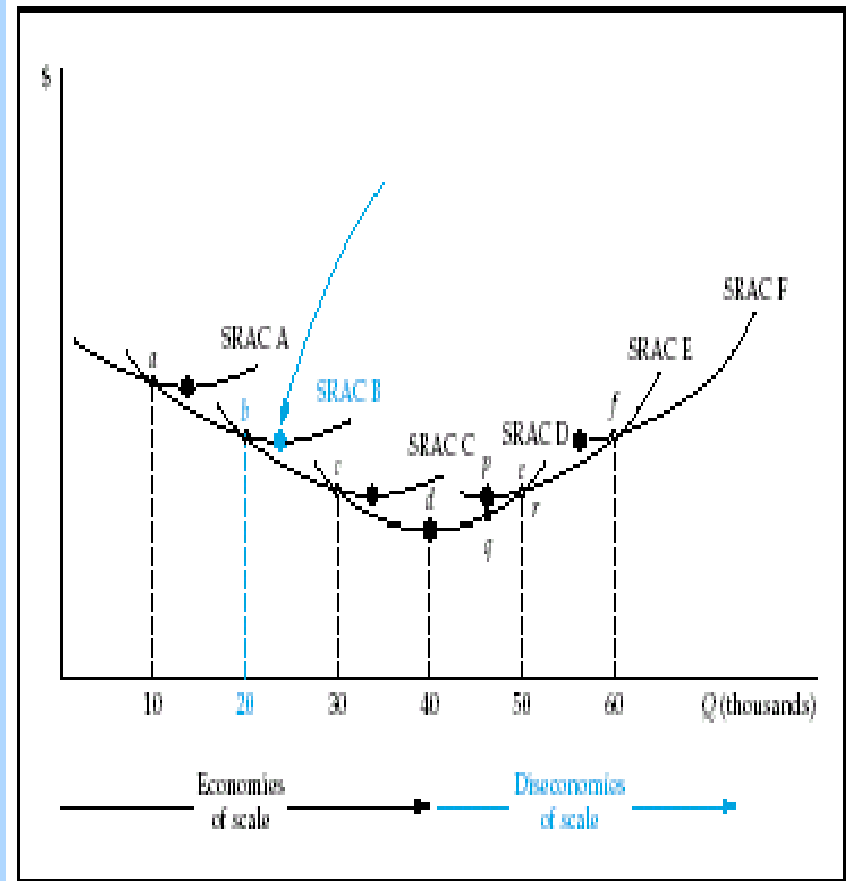
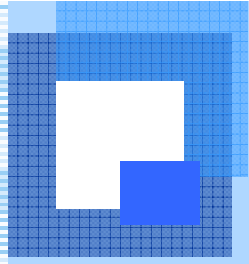


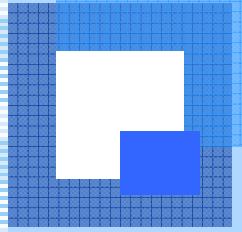
Figure 8.9  
Capacity Level and Short-Run Average Cost



# The Long-Run Cost Function

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- In the long run the firm is able to adjust its plant size.
- LRAC tells us the lowest possible per-unit cost when all inputs are variable.
- What is the LRAC in the graph?



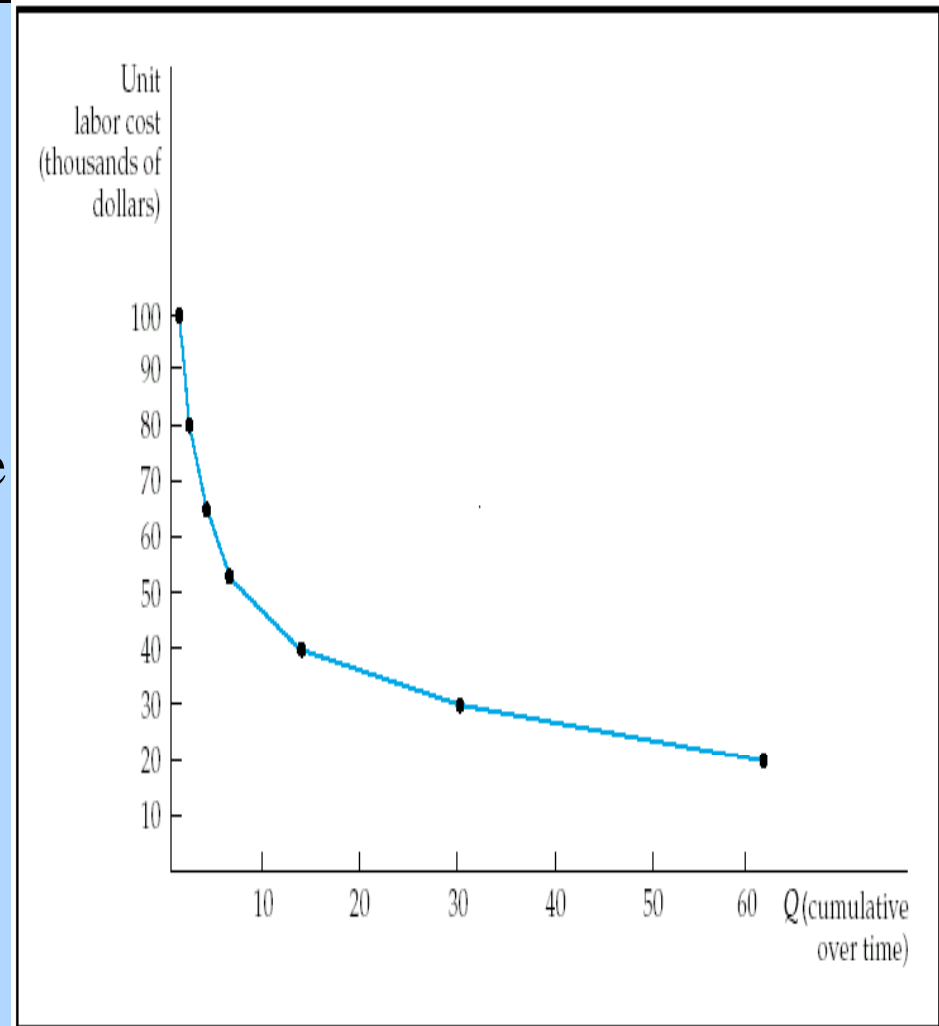
## The Long-Run Cost Function

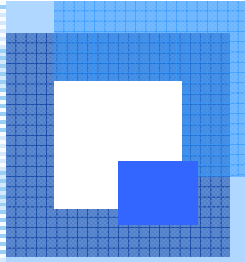
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- The LRAC is the lower envelope of all of the SRAC curves.
- **Minimum efficient scale** is the lowest output level for which LRAC is minimized.

# The Learning Curve

- Measures the percentage decrease in additional labor cost each time output doubles.
- An “80 percent” learning curve implies that each time output doubles, the labor costs associated with the incremental output will decrease to 80% of their previous level.
- The figure illustrates an 80-percent learning curve.

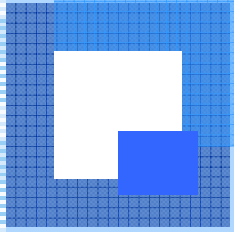




# The Learning Curve

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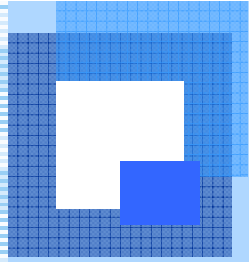
- A downward slope in the learning curve indicates the presence of the **learning curve effect**.
  - workers improve their productivity with practice
- The learning curve effect acts to shift the SRAC downward.



# Economies of Scope

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- The reduction of a firm's unit cost by producing two or more goods or services jointly rather than separately.



## Other Methods to Reduce Costs

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- The Strategic Use of Cost
- Reduction in the Cost of Materials
- Using IT to Reduce Costs
- Reduction of Process Costs
- Relocation to Lower-Wage Countries or Regions
- Mergers, Consolidation, and Downsizing
- Layoffs and Plant Closings