

# **Theory of Production**

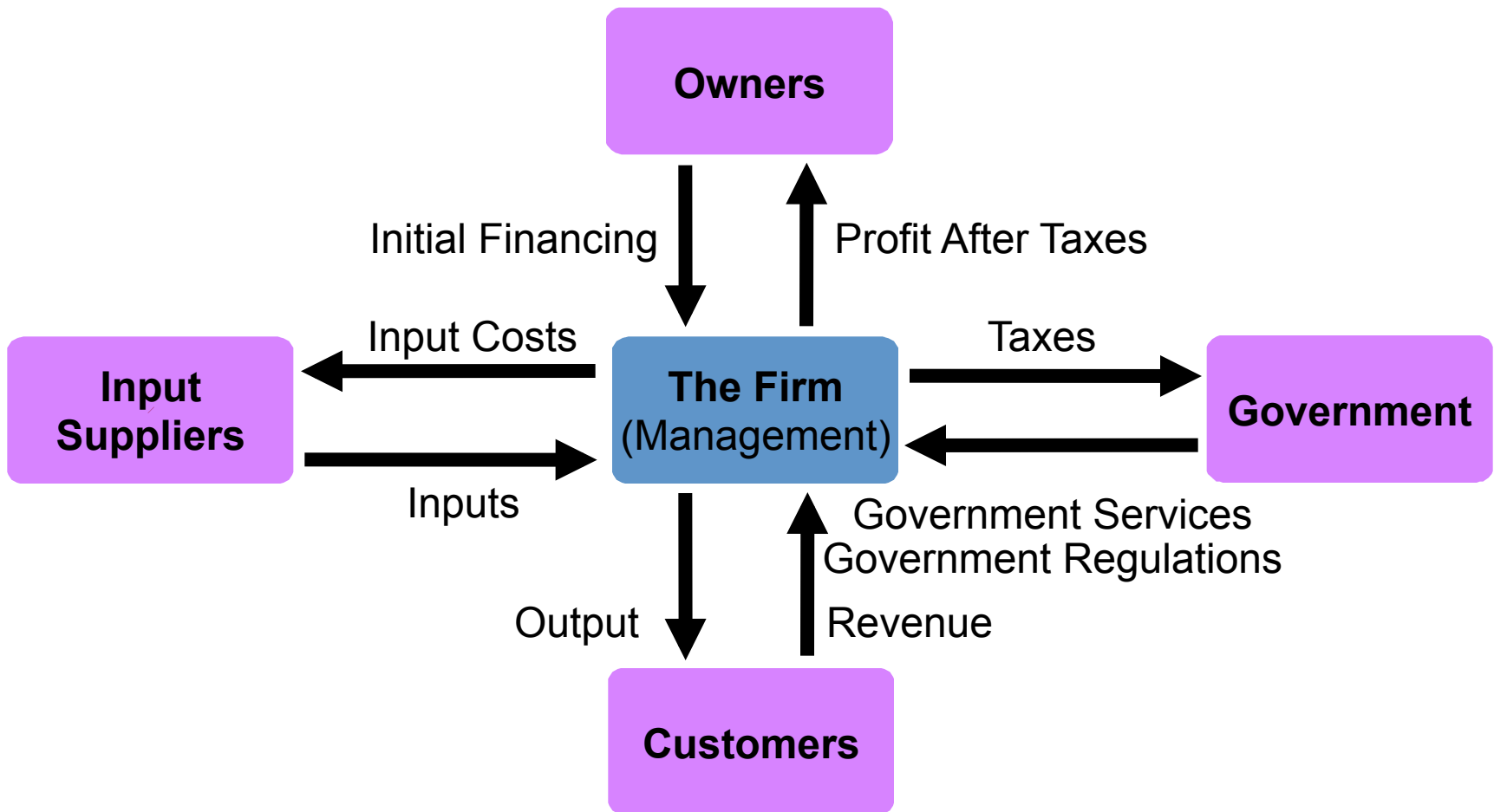
## **Lecture #4**

### **Microeconomics**

# Topics

1. How firms produce goods and services.
2. Production in the short run.
3. Costs or factors of production.
4. Economies of scale and production in the long run.

# Production of Goods and Services



# Thinking About Production

- Production involves using inputs to produce an output
- Inputs include resources
  - Labor
  - Capital
  - Land
  - Raw materials
  - Other goods and services provided by other firms
- Way in which these inputs may be combined to produce output is the firm's technology.

# Production in the Short Run

- When firms make short-run decisions, there is nothing they can do about their fixed inputs
- Fixed inputs
  - An input whose quantity must remain constant, regardless of how much output is produced
- Variable input
  - An input whose usage can change as the level of output changes
- Total product
  - Maximum quantity of output that can be produced from a given combination of inputs.

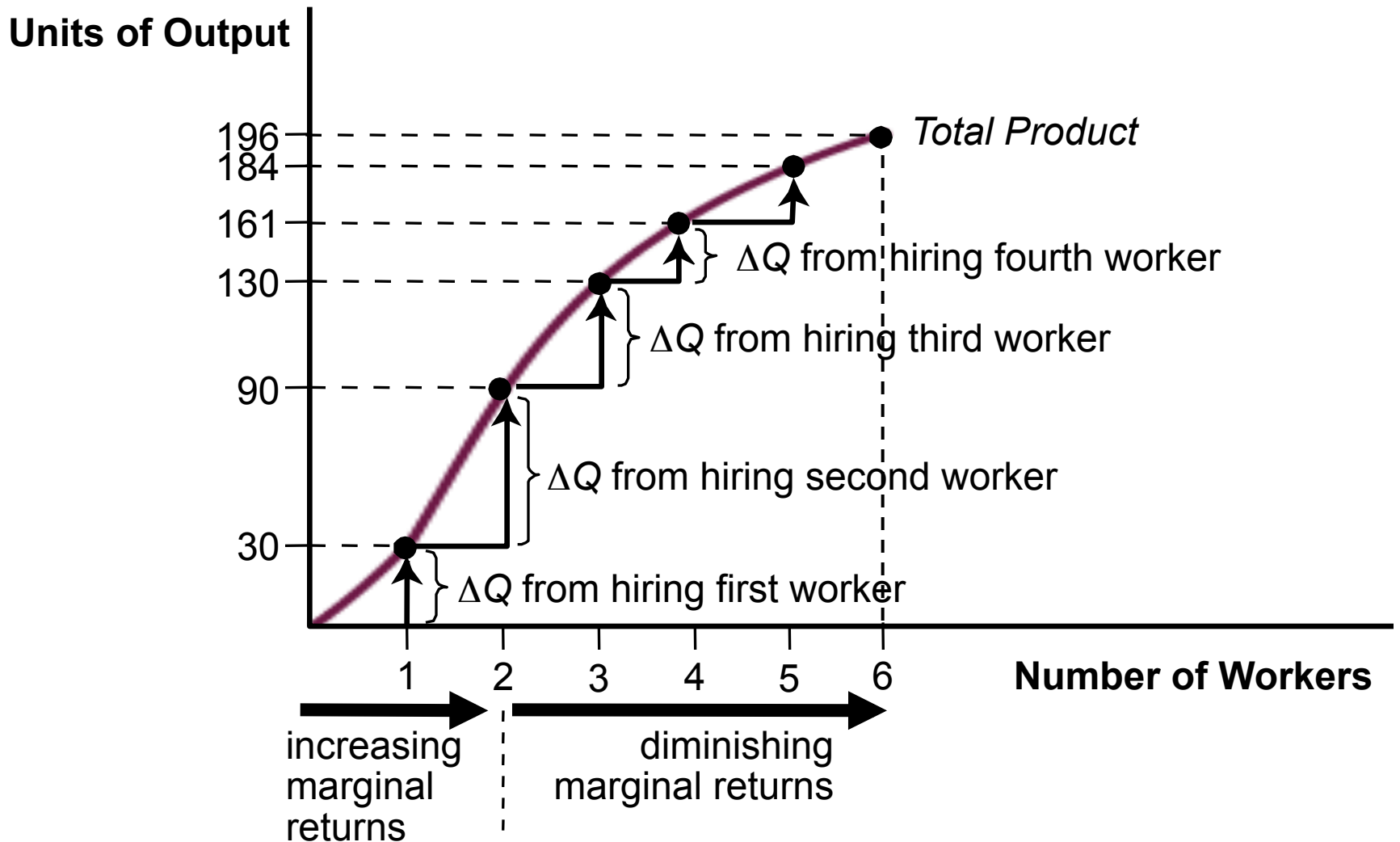
# Production in the Short Run

- Marginal product of labor (MPL) is the change in total product ( $\Delta Q$ ) divided by the change in the number of workers hired ( $\Delta L$ )

$$MPL = \frac{\Delta Q}{\Delta L}$$

- Tells us the rise in output produced when one more worker is hired, leaving all other inputs unchanged.

# Total and Marginal Product



# Marginal Returns To Labor

- As more and more workers are hired
  - MPL first increases
  - Then decreases
- Pattern is believed to be typical at many types of firms.



# Diminishing Returns To Labor

- When the marginal product of labor is decreasing
  - There are diminishing marginal returns to labor
  - Output rises when another worker is added so marginal product is positive
  - But the rise in output is smaller and smaller with each successive worker
- Law of diminishing (marginal) returns states that as we continue to add more of any one input (holding the other inputs constant)
  - Its marginal product will eventually decline.

# The Irrelevance of Sunk Costs

- Sunk cost is one that already has been paid, or must be paid, regardless of any future action being considered
- Should not be considered when making decisions
- Even a future payment can be sunk
  - If an unavoidable commitment to pay it has already been made.

# Costs in the Short Run

- Fixed costs
  - Costs of a firm's fixed inputs
- Variable costs
  - Costs of obtaining the firm's variable inputs

***Fixed factor***



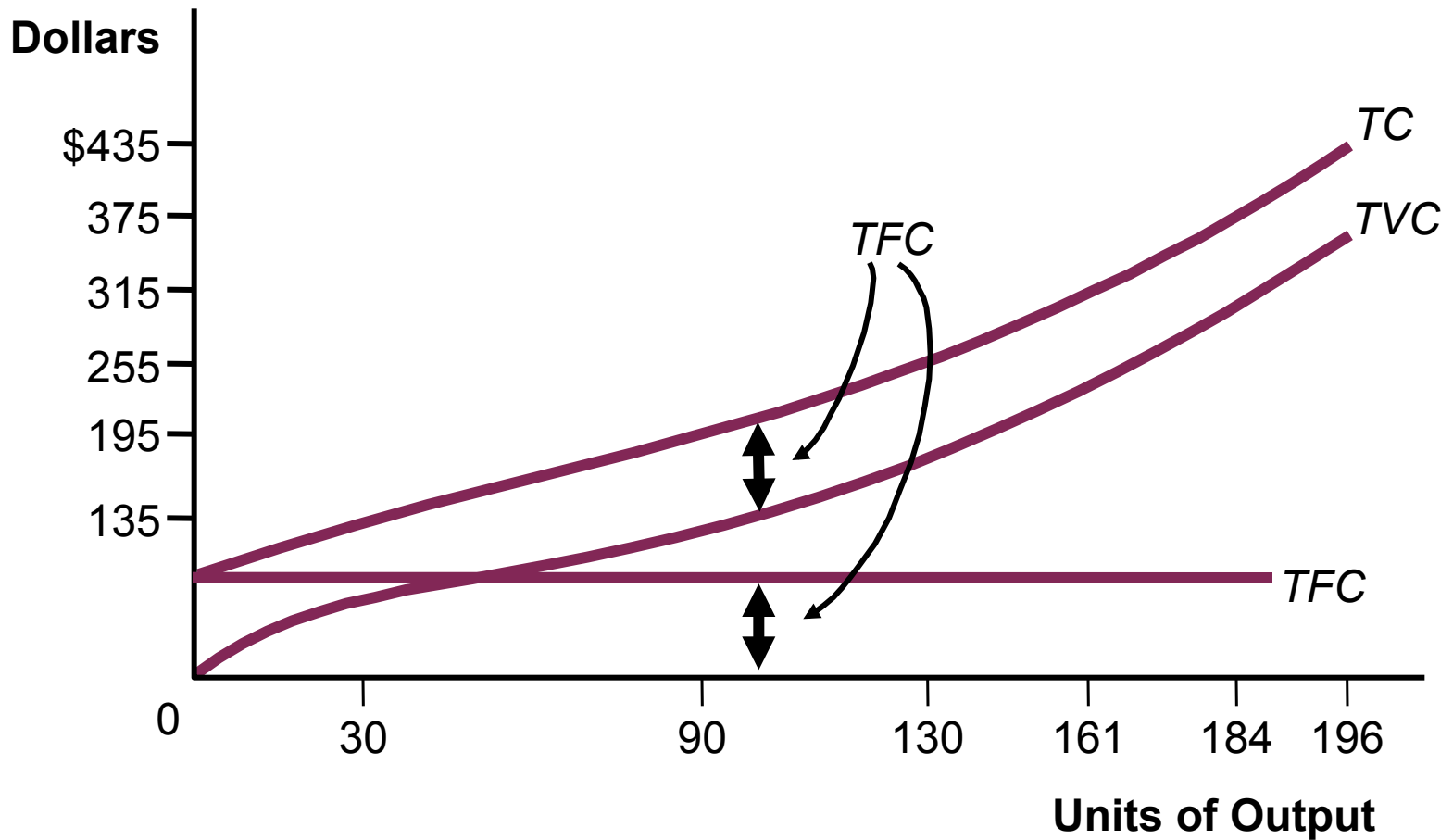
***Variable factors***



# Measuring Short Run Costs: Total Costs

- Types of total costs
  - Total fixed costs
    - Cost of all inputs that are fixed in the short run
  - Total variable costs
    - Cost of all variable inputs used in producing a particular level of output
  - Total cost
    - Cost of all inputs—fixed and variable
    - $TC = TFC + TVC$

# Figure 5: The Firm's Total Cost Curves



# Average Costs

- Average fixed cost (AFC)
  - Total fixed cost divided by the quantity of output produced

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

- Average variable cost (TVC)
  - Total variable cost divided by the quantity of output produced

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

- Average total cost (TC)
  - Total cost divided by the quantity of output produced

$$ATC = \frac{TC}{Q}$$

# Marginal Cost

- Marginal Cost
  - Increase in total cost from producing one more unit or output

- Marginal cost is the change in total cost ( $\Delta TC$ ) divided by the change in output ( $\Delta Q$ )

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

- Tells us how much cost rises per unit increase in output
- Marginal cost for any change in output is equal to slope of total cost curve along that interval of output.

# Basic Formulas #1

- ◆ **Average Total Cost:**

$$ATC = \frac{TC}{Q} = \frac{TFC + TVC}{Q} = AFC + AVC$$

- ◆ **Average fixed cost:**

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

- ◆ **Average variable cost:**

$$AVC = \frac{TVC}{Q} = \frac{w \cdot L}{Q} = \frac{\frac{w \cdot L}{L}}{\frac{Q}{L}} = \frac{w}{\frac{Q}{L}} = \frac{w}{AP}$$



# Basic Formulas #2

- ◆ **Marginal cost:**

$$MC = \frac{\Delta TC}{\Delta Q} = \frac{\Delta TFC + \Delta TVC}{\Delta Q} = MFC + MVC$$

- ◆ **Marginal fixed cost:**

$$MFC = \frac{\Delta TFC}{\Delta Q} = 0$$

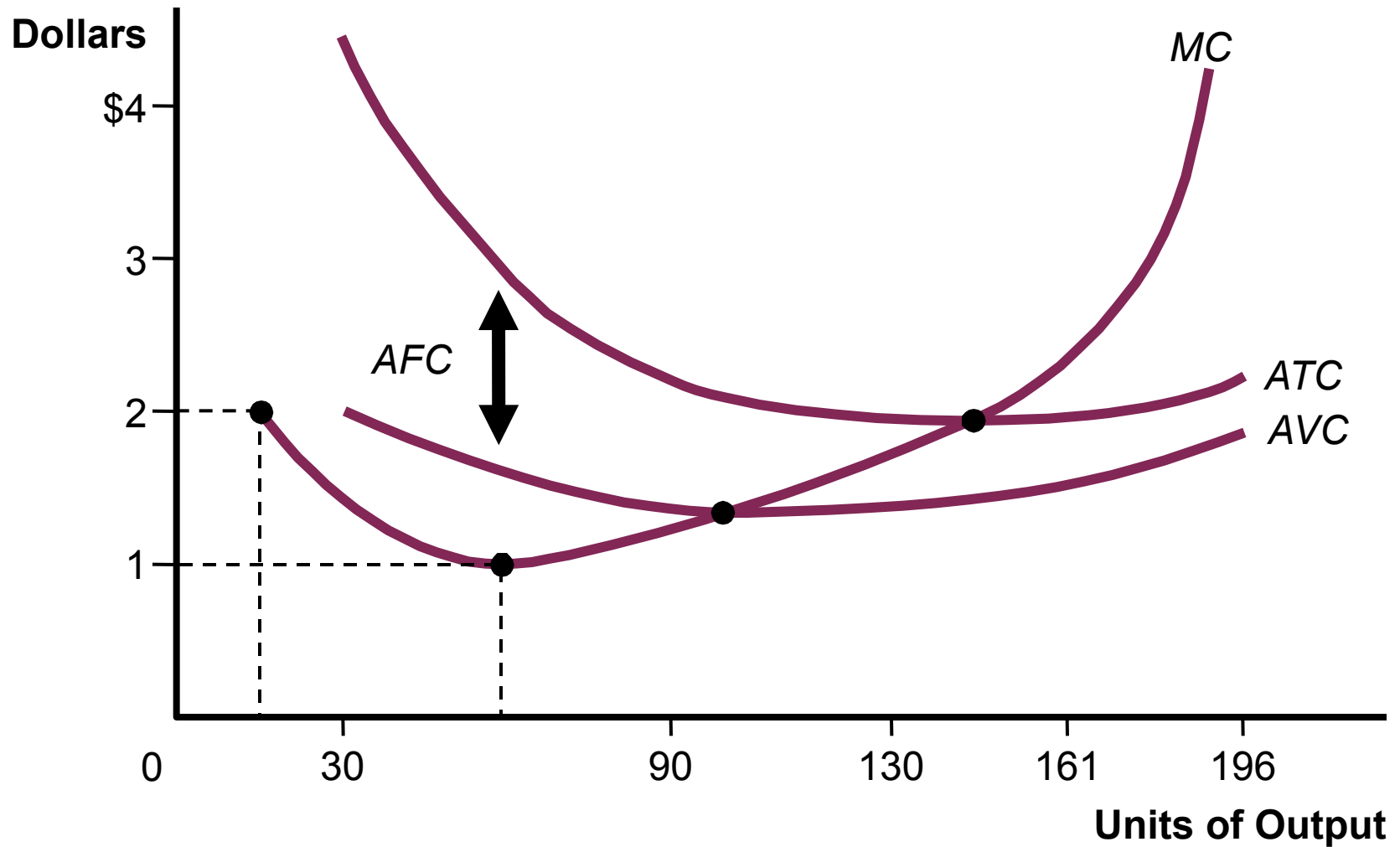
- ◆ **Marginal variable cost:**

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

**Question: The following table is composed of product items and cost items of a firm. Suppose the unit cost of capital and labour are \$10 and \$20 respectively. Fill in the missing columns..**

<b>Units of capital</b>	<b>Units of labour</b>	<b>TP</b>	<b>AP</b>	<b>MP</b>	<b>TFC</b>	<b>TVC</b>	<b>TC</b>	<b>ATC</b>
4	1	2						
4	2	5						
4	3	10						
4	4	14						
4	5	14						
4	6	12						

# Figure 6: Average And Marginal Costs



# Average And Marginal Costs

- At low levels of output, the MC curve lies below the AVC and ATC curves
  - These curves will slope downward
- At higher levels of output, the MC curve will rise above the AVC and ATC curves
  - These curves will slope upward
- As output increases; the average curves will first slope downward and then slope upward
  - Will have a U-shape
- MC curve will intersect the minimum points of the AVC and ATC curves.

# Production And Cost in the Long Run

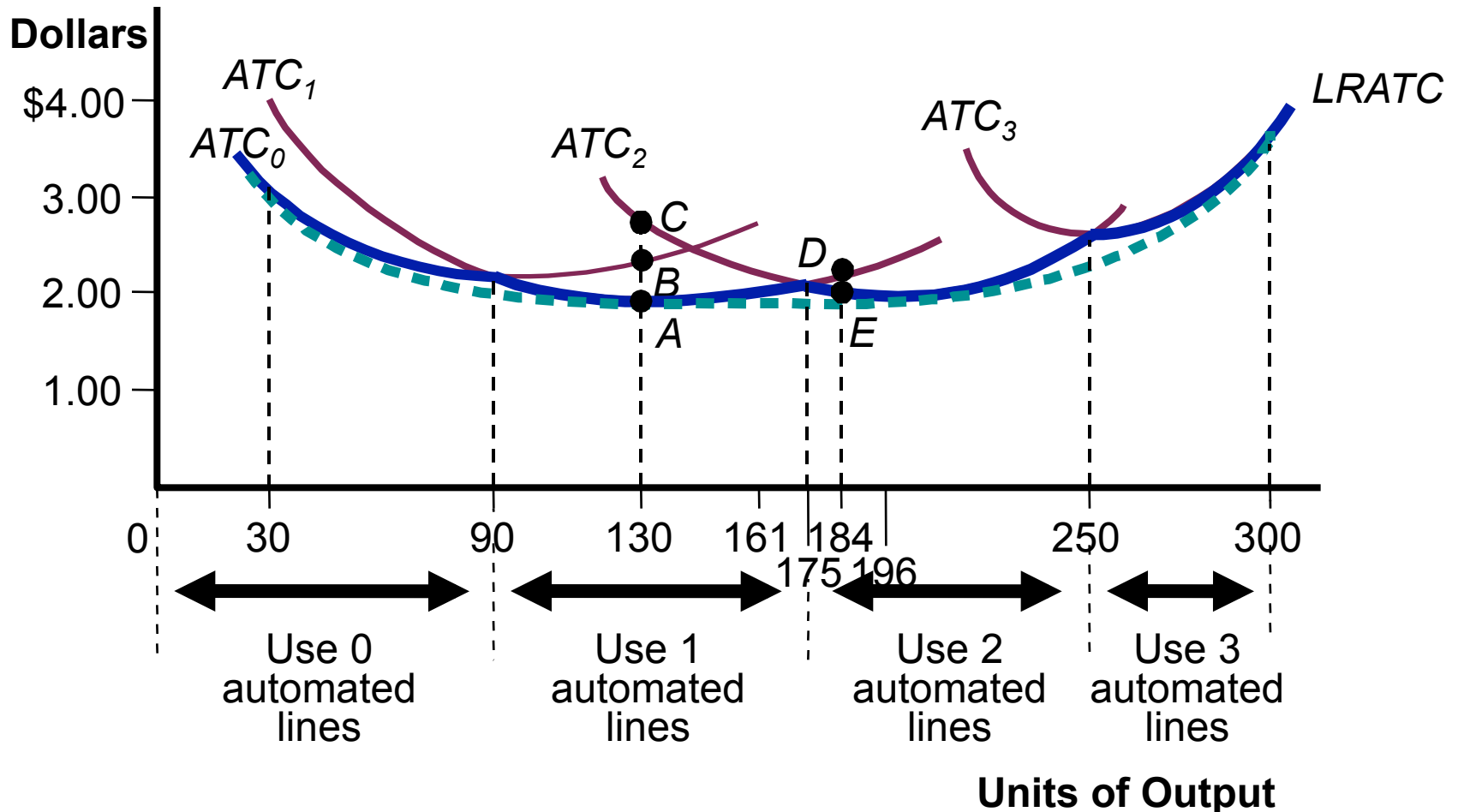
- Long-run total cost
  - The cost of producing each quantity of output when the least-cost input mix is chosen in the long run
- Long-run average total cost
  - The cost per unit of output in the long run, when all inputs are variable
- The long-run average total cost (LRATC)
  - Cost per unit of output in the long-run

$$\text{LRATC} = \frac{\text{LRTC}}{Q}$$

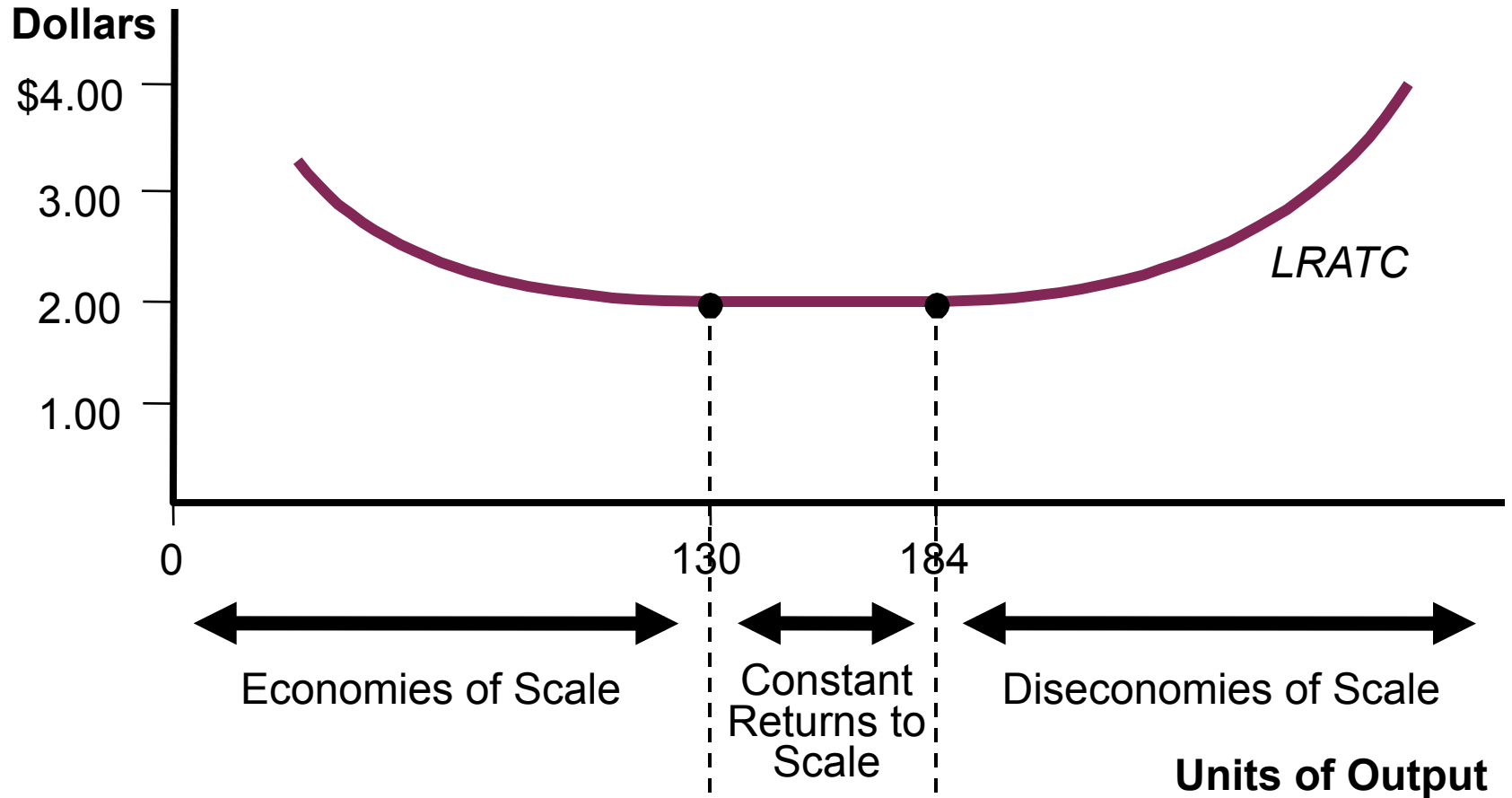
# Graphing the LRATC Curve

- A firm's LRATC curve combines portions of each ATC curve available to firm in the long run
- In the short run, a firm can only move along its current ATC curve
- In the long run it can move from one ATC curve to another by varying the size of its plant

# Figure 7: Long-Run Average Total Cost



# Figure 8: The Shape Of LRATC





# Gains From Specialization

- One reason for economies of scale is gains from specialization
- Opportunities for increased specialization occur at lower levels of output
  - With a relatively small plant and small workforce.

# Diseconomies of Scale

- Long-run average total cost \_\_\_\_\_ as output increases
- As output continues to increase, most firms will reach a point where bigness begins to cause problems
- When long-run total cost rises more than in proportion to output, there are diseconomies of scale
  - LRATC curve slopes upward
- Diseconomies of scale are more likely at higher output levels

# In sum...

- The LRATC, often shows the following pattern
  - Economies of scale (decreasing LRATC) at relatively low levels of output
  - Constant returns to scale (constant LRATC) at some intermediate levels of output
  - Diseconomies of scale (increasing LRATC) at relatively high levels of output
- This is why LRATC curves are typically U-shaped.

# Implication to Public Policy

1. If technology is defined as “ways in which inputs may be combined to produce more outputs”, how to incorporate technology in the organizations?
2. Large firms are mostly preferable for some reasons (diversification, cost-savings, etc.), but what are the limits?
3. Why in the long-run all costs are variables? What is the role of government to ensure economies of scale? What should be done if there is diseconomies of scale?