Decision Time Frames

– The firm makes many decisions to achieve its main objective: *profit maximization*.

– All decisions can be placed in two time frames:

– The short run

– The long run

Decision Time Frames

- The Short Run
  - The **short run** is a time frame in which the quantity of one or more resources used in production is fixed.
  - For most firms, the capital, called the firm's *plant*, is fixed in the short run.
  - Other resources used by the firm (such as labor, raw materials, and energy) can be changed in the short run.
  - Short-run decisions are easily reversed.

Decision Time Frames

- The Long Run
  - The **long run** is a time frame in which the quantities of *all* resources—including the plant size—can be varied.
  - Long-run decisions are not easily reversed.
  - A **sunk cost** is a cost incurred by the firm and cannot be changed.
  - If a firm's plant has no resale value, the amount paid for it is a sunk cost.
  - Sunk costs are irrelevant to a firm's decisions.

Example

With regard to economic decision making for firms, the short run is

- A) a definite number of months.
- B) a period over which the quantities of all factors of production and technology are variable.
- C) a period over which the quantity of at least one significant factor of production is fixed.
- D) a period over which the quantities of all factors of production are variable but technology is fixed.
- E) less than one year.

Example

With regard to economic decision making for firms, the long run is a period in which
- A) all factors of production are variable.
- B) technology is variable.
- C) only some of the factors of production are variable.
- D) technology may be variable, but some factors of production are fixed.
- E) only capital is variable.

Example

Sandra has plans to go to an opera and already has a $100 non-refundable, non-exchangeable, and non-transferable ticket. Now Victor, whom Sandra has wanted to date for a long time, asks her to a party, Sandra would prefer to go to the party with Victor and forgo the opera, but she doesn't want to waste the $100 she spent on the opera ticket.

From the perspective of an economist, If Sandra decides to go to the party with Victor, she has just:

- Correctly ignored a sunk cost
- Made a choice that was not optimal
- Incorrectly allowed a sunk cost to influence her decision

6

Short-Run Technology Constraint

– To increase output in the short run, a firm must increase the amount of labor employed.

– Three concepts describe the relationship between output and the quantity of labor employed:

- Total product
- Marginal product
- Average product

Short-Run Technology Constraint

❑ **Total product** is the total output produced in a given period.

❑ The **marginal product** of labor is the change in total product that results from a one-unit increase in the quantity of labor employed, with all other inputs remaining the same.

❑ **MP=change in TP / change in Labor**

❑ The **average product** of labor is equal to total product divided by the quantity of labor employed.

❑ **AP= TP / quantity of Labor**

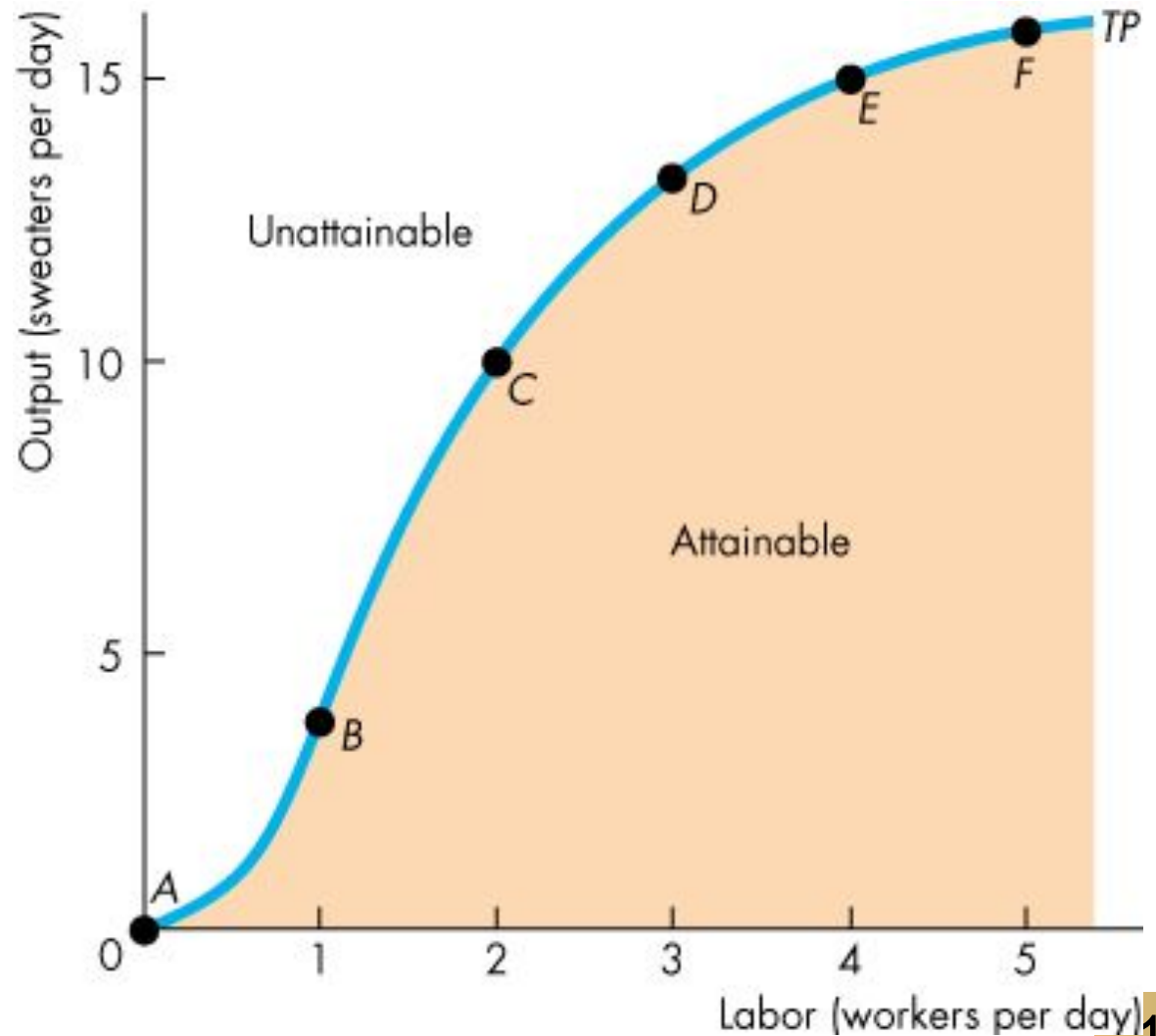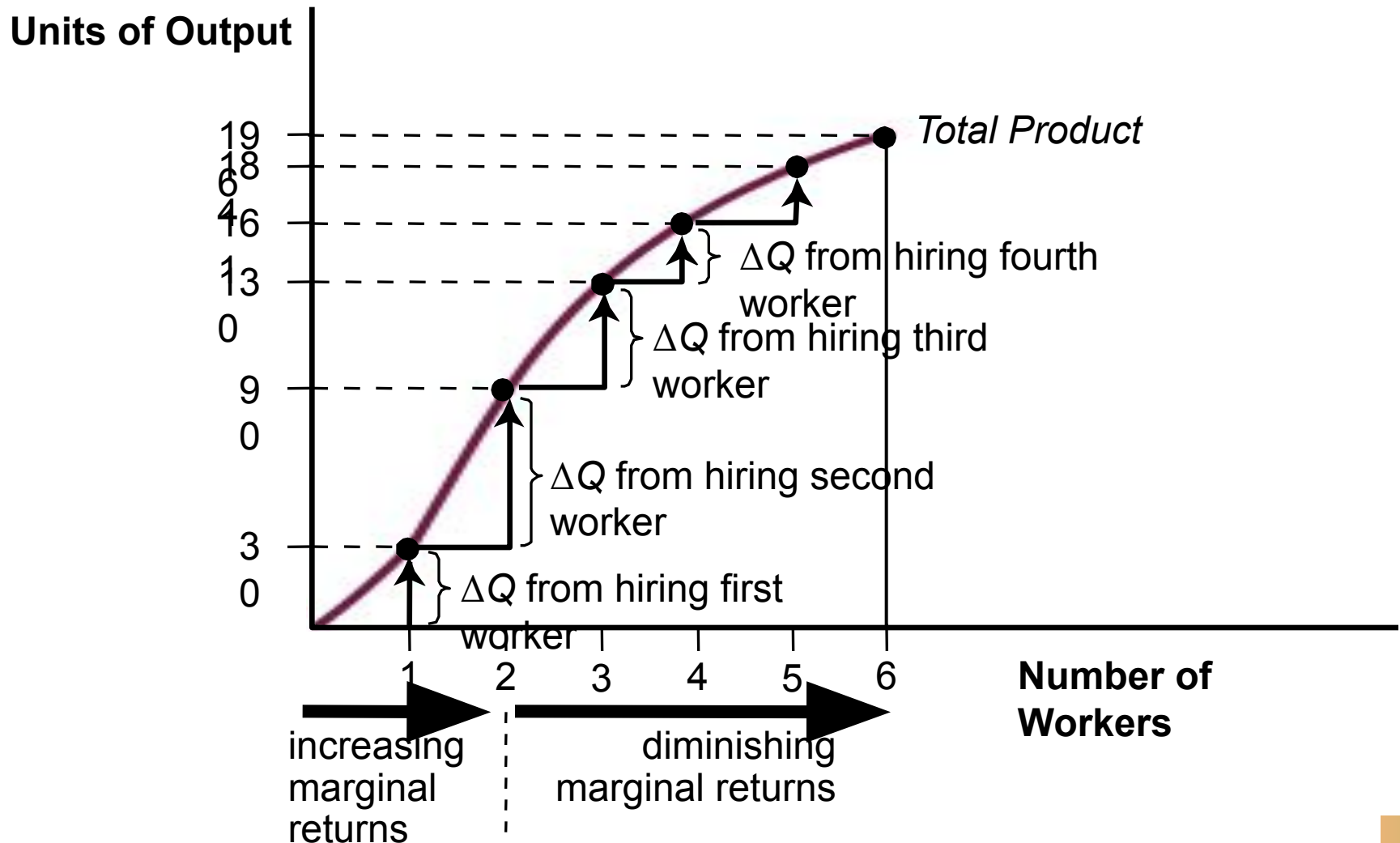# Total Product, Marginal Product, Average Product

	Labor	TP	MP	AP
A	0	0		
B	1	4		
C	2	10		
D	3	13		
E	4	15		
F	5	16		

Total Product

- It separates attainable output levels from unattainable output levels in the short run.

Figure 4: Total and Marginal Product

Short-Run Technology Constraint

– **Initially increasing marginal returns**

- When the marginal product of a worker *exceeds* the marginal product of the previous worker, the marginal product of labor *increases* and the firm experiences *increasing marginal returns*.

– **Eventually diminishing marginal returns**

- When the marginal product of a worker is *less* than the marginal product of the previous worker, the marginal product of labor *decreases* and the firm experiences **diminishing marginal returns.**

Short-Run Technology Constraint

- *Increasing marginal returns* arise from increased specialization and division of labor.

- *Diminishing marginal returns* arises from the fact that employing additional units of labor means each worker has less access to capital and less space in which to work.

- The *law of diminishing returns* states that as a firm uses more of a variable input with a given quantity of fixed inputs, the marginal product of the variable input *eventually diminishes*.
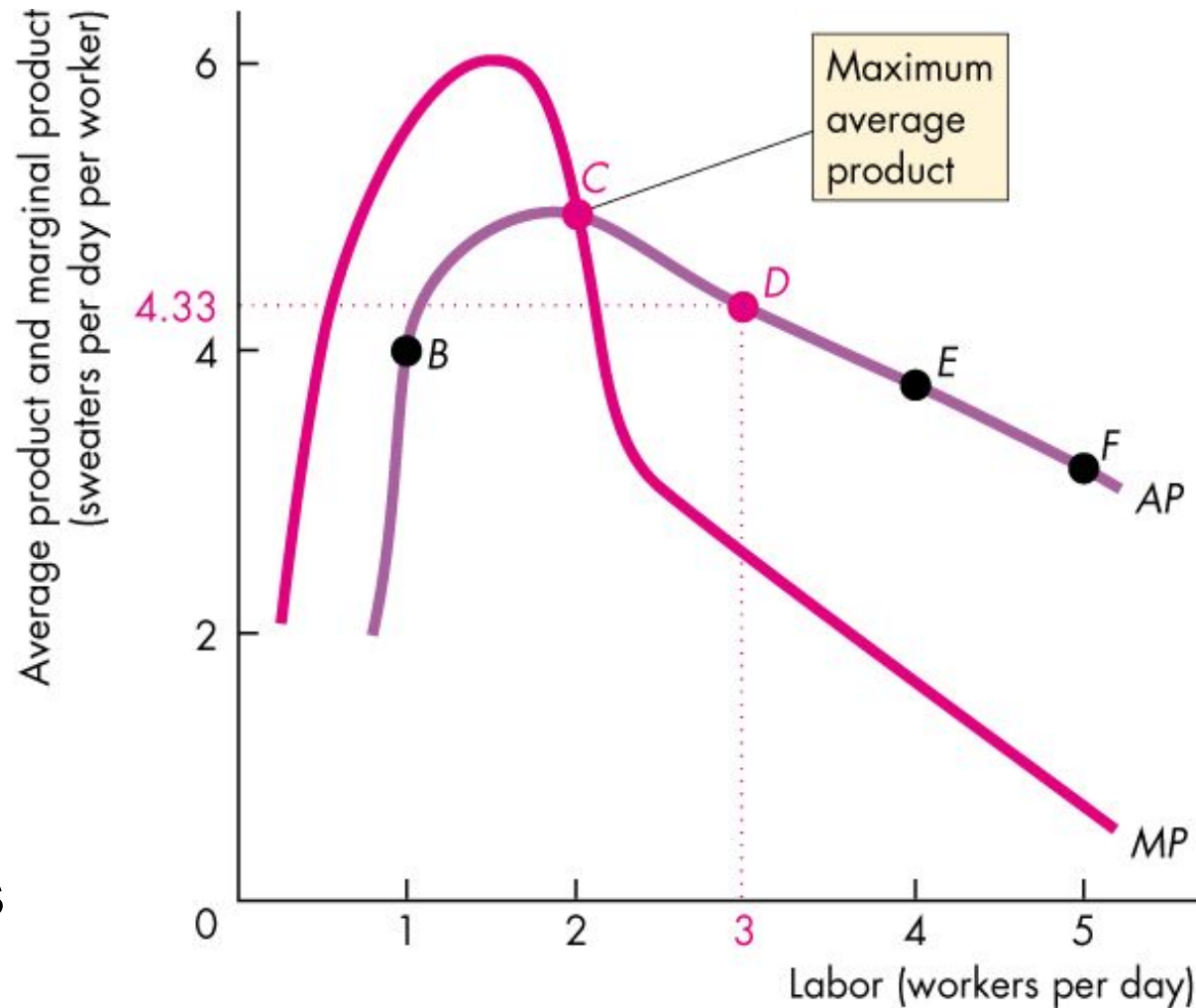
Example

The following data show the total output for a firm when different amounts of labor are combined with a fixed amount of capital. Assume that the wage per unit of labor is $10 and the cost of the capital is $50.

Labor per period	Total Output per period
0	0
1	10
2	30
3	90
4	132
5	150

1. The marginal product of labor is at its maximum when the firm changes the amount of labor hired from ____

2. The average product of labor is highest when the firm hires ____

3. Diminishing marginal productivity of labor is first observed when the firm changes the amount of labor hired from _____

Short-Run Technology Constraint

- When marginal product _exceeds_ average product, average product increases.

- When marginal product _is below_ average product, average product decreases.

- When marginal product _equals_ average product, average product is at its maximum.

Example

- Consider a basket-producing firm with fixed capital. If the firm can produce 36 baskets per day with 3 workers and 44 baskets per day with 4 workers, then we know that which of the following is true:
  - A) The marginal product of the fourth worker is 8.
  - B) The firm has passed the point of diminishing average productivity.
  - C) The marginal product is below the average product.
  - D) The firm has passed the point of diminishing marginal productivity.
  - E) all of the above

Short-Run Cost

- To produce more output in the short run, the firm must employ more labor, which means that it must increase its costs.

- We describe the way a firm's costs change as total product changes by using three cost concepts and three types of cost curve:
  - Total cost
  - Marginal cost
  - Average cost

Short-Run Cost

- Total Cost
  - A firm's **total cost** *(TC)* is the cost of *all* resources used.
  - **Total fixed cost** *(TFC)* is the cost of the firm's fixed inputs. Fixed costs do not change with output.
  - **Total variable cost** *(TVC)* is the cost of the firm's variable inputs. Variable costs do change with output.
  - Total cost equals total fixed cost plus total variable cost. That is:

$$TC = TFC + TVC$$

Total Costs of Production

|	Labor	Output (TP)	TFC	TVC	TC=TFC+TVC
A	0	0	25	0	
B	1	4		25	
C	2	10		50	
D	3	13		75	
E	4	15		100	
F	5	16		125	

Example

Larry's Performance Pizza is a small restaurant that sells low-carbohydrate pizzas in a health - conscious town. Larry's very tiny kitchen has enough room for the 4 ovens in which his workers bake the pizzas. Larry signed a lease obligating him to pay the rent for the four ovens for the next year. Because of this, and because Larry's kitchen cannot fit more than four ovens, Larry cannot change the number of ovens he uses in his production of pizzas in the short run.

On the other hand, Larry's workers tend to be students. Each Monday, Larry lets them know how many hours he'll need them for that week. In the short run, these workers are _____ inputs, and the ovens are _____ inputs.

Total Costs of Production

- Total fixed cost is the same at each output level.

- Total variable cost increases as output increases.

- Total cost, which is the sum of *TFC* and *TVC* also increases as output increases.

$$TC = TFC + TVC$$
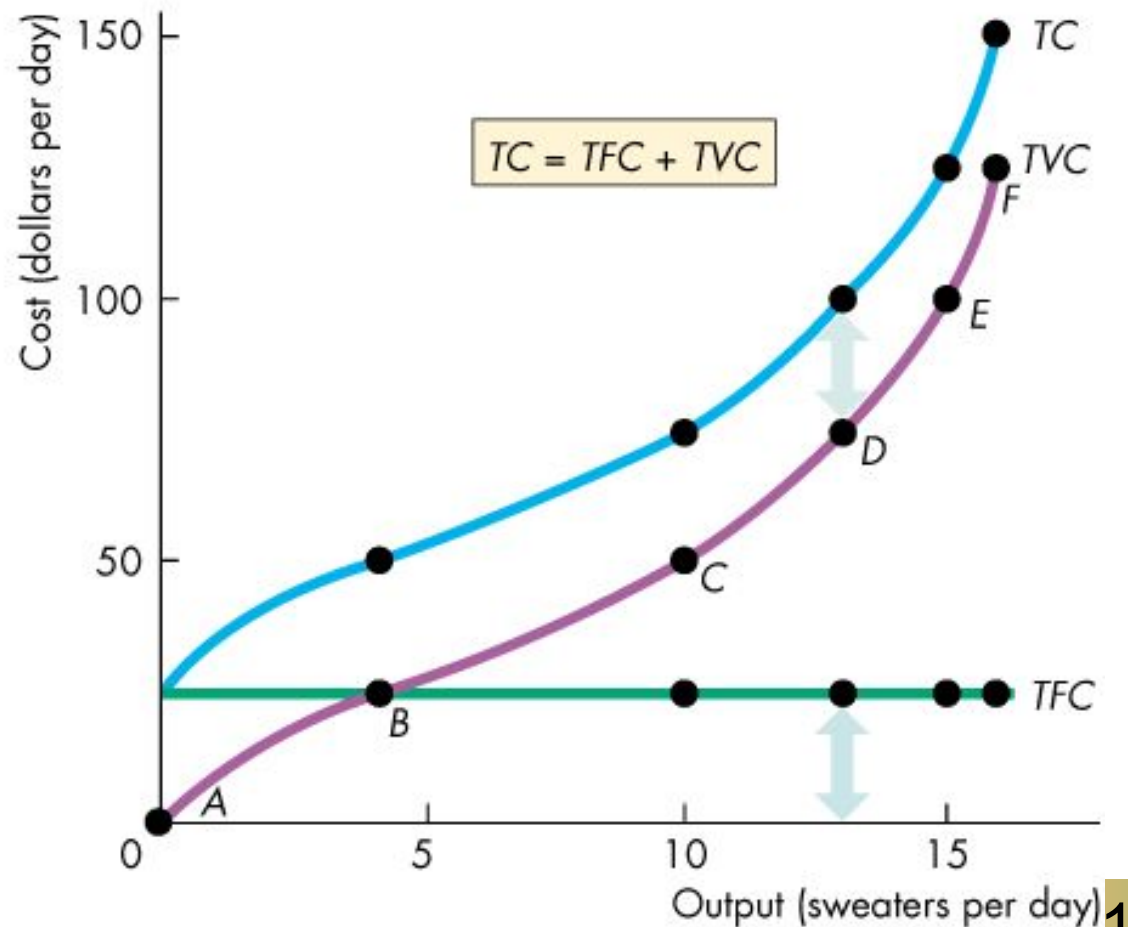
Short-Run Cost

- Marginal Cost
  - **Marginal cost** *(MC)* is the increase in total cost that results from a one-unit increase in total product.
  - Over the output range with *increasing marginal returns,* marginal cost falls as output increases.
  - Over the output range with *diminishing marginal returns,* marginal cost rises as output increases.

Short-Run Cost

- Average Cost
  - Average cost measures can be derived from each of the total cost measures:
  - **Average fixed cost** *(AFC)* is total fixed cost per unit of output.
  - **Average variable cost** *(AVC)* is total variable cost per unit of output.
  - **Average total cost** *(ATC)* is total cost per unit of output.

$$ATC = AFC + AVC.$$

Average Costs of Production

	Labor	Output	TFC	TVC	TC	MC	AFC	AVC	ATC
A	0	0	25	0					
B	1	4		25					
C	2	10		50					
D	3	13		75					
E	4	15		100					
F	5	16		125					

Average Costs of Production

	Labor	Output	TFC	TVC	TC	MC	AFC	AVC	ATC
A	0	0	25	0	25				
B	1	4	25	25	50	6.25	6.25	6.25	12.50
C	2	10	25	50	75	4.17	2.50	5.00	7.50
D	3	13	25	75	100	8.33	1.92	5.77	7.69
E	4	15	25	100	125	12.50	1.67	6.67	8.33
F	5	16	25	125	150	25.00	1.56	7.81	9.38

Example

| Output	Total Cost	Total Fixed Cost	Total Variable Cost	Average Variable Cost	Average Total Cost	Marginal Cost
0	60			—	—	
1	155					
2	220					
3	255					
4	300					
5	350					
6	450					

Example

The following data show the total output for a firm when specified amounts of labor are combined with a fixed amount of capital. When answering the questions, you are to assume that the wage per unit of labor is $25 and the cost of the capital is $100.

Labor per unit of time	Total Output
0	0
1	25
2	75
3	175
4	250
5	305

1. Average fixed costs for 305 units of output is approximately ____
2. Average variable costs for 175 units of output is approximately ____
3. The average total cost for 250 units of output is approximately ____
4. The total cost of producing 175 units of output is ____
5. The average total cost of producing 75 units of output is ____
6. The total variable cost of producing 305 units of output is ____
7. The total fixed cost of producing 305 units of output is ____

Average And Marginal Costs
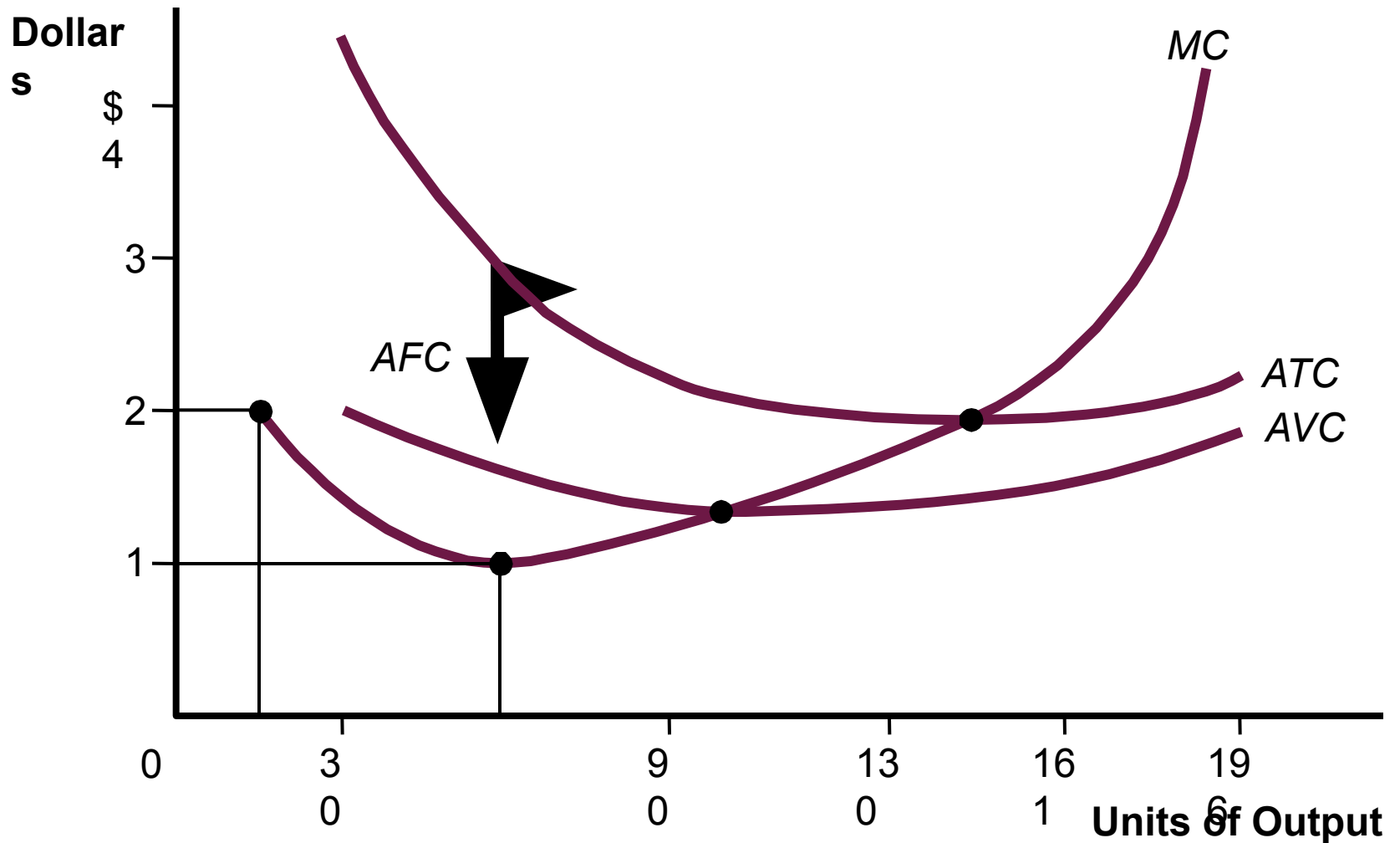
The Relationship Between Average And Marginal Costs

- 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

Example

Suppose a firm producing digital cameras is operating such that marginal costs are higher than average costs. If the firm produces one more camera, average costs will

- A) rise.
- B) fall.
- C) reach a point of diminishing returns.
- D) remain constant.
- E) reach their maximum.

Short-Run Cost

- Shifts in Cost Curves

  The position of a firm's cost curves depend on two factors:

  – Technology

  – Prices of productive resources

Short-Run Cost

Technological change influences both the productivity curves and the cost curves.

- An increase in productivity shifts the average and marginal product curves upward and the average and marginal cost curves downward.

- If a technological advance brings more capital and less labor into use, fixed costs increase and variable costs decrease.

- In this case, average total cost increases at low output levels and decreases at high output levels.

Short-Run Cost

- Changes in the prices of resources shift the cost curves.

    - An increase in a *fixed* cost shifts the total cost (*TC*) and average total cost (*ATC*) curves upward but does *not* shift the marginal cost (*MC*) curve.

    - An increase in a *variable* cost shifts the total cost (*TC*), average total cost (*ATC*), and marginal cost (*MC*) curves upward.

Example

- In the short run, when capital is a fixed factor, a rise in the cost of labor
  - A) shifts the marginal cost curve upwards.
  - B) shifts the *AVC* curve down.
  - C) shifts the total product curve downwards.
  - D) leaves the *MC* curve unchanged.
  - E) leaves the *ATC* curve unchanged.

Production And Cost in the Long Run

- In the long run, costs behave differently
  - Firm can adjust all of its inputs in any way it wants
    - In the long run, there are no fixed inputs or fixed costs
- The firm's goal is to earn the highest possible profit
  - To do this, it must follow the least cost rule
    - To produce any given level of output the firm will choose the input mix with the lowest cost

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

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

Long-Run Cost

- The average cost of producing a given output varies and depends on the firm's plant size.

- The larger the plant size, the greater is the output at which *ATC* is at a minimum.

- Cindy has 4 different plant sizes: 1, 2, 3, or 4 knitting machines.

- Each plant has a short-run *ATC* curve.

- The firm can compare the *ATC* for each given output at different plant sizes.

Long-Run Cost

• The long-run average cost curve is made up from the lowest *ATC* for each output level.
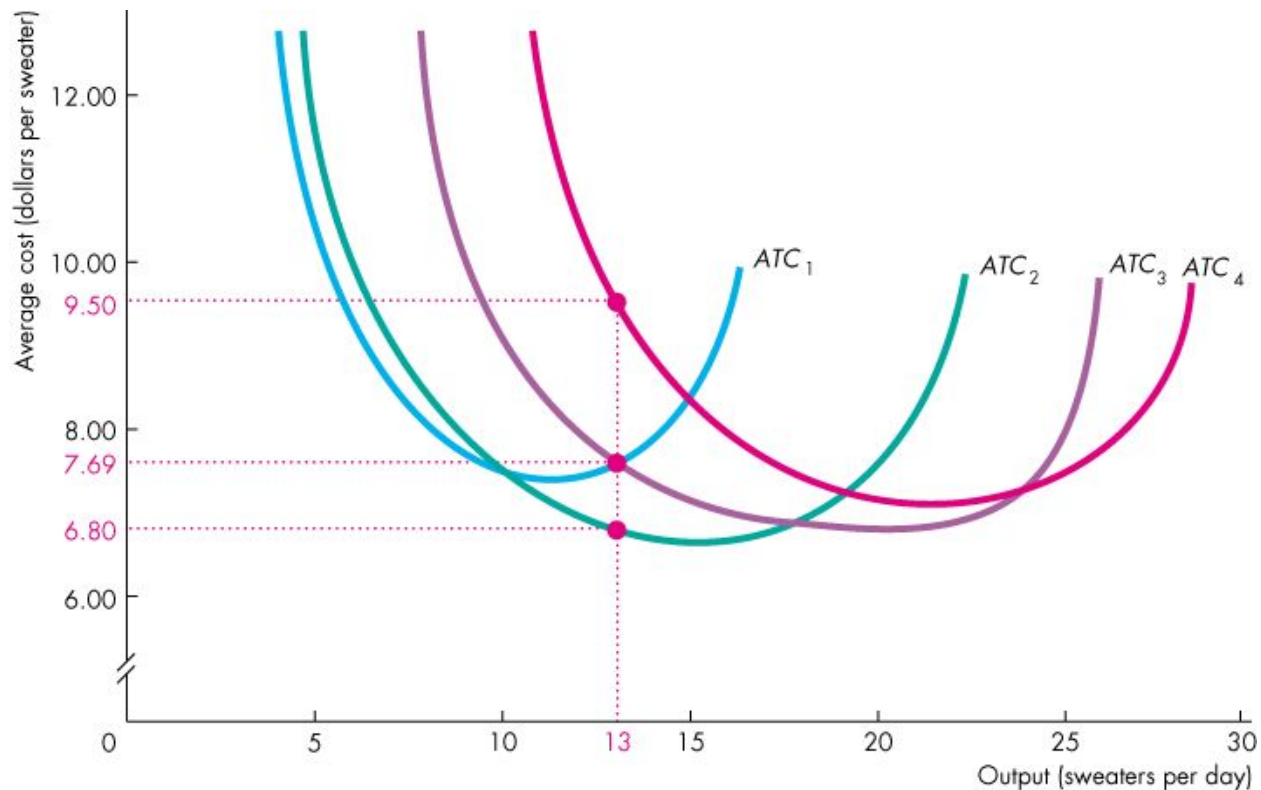
Long-Run Cost

- Long-Run Average Cost Curve
  - The **long-run average cost curve** is the relationship between the lowest attainable average total cost and output when both the plant size and labor are varied.
  - The long-run average cost curve is a planning curve that tells the firm the plant size that minimizes the cost of producing a given output range.
  - Once the firm has chosen that plant size, it incurs the costs that correspond to the *ATC* curve for that plant.

Long-Run Average Total Cost

- The long-run average cost curve is made up from the lowest *ATC* for each output level.
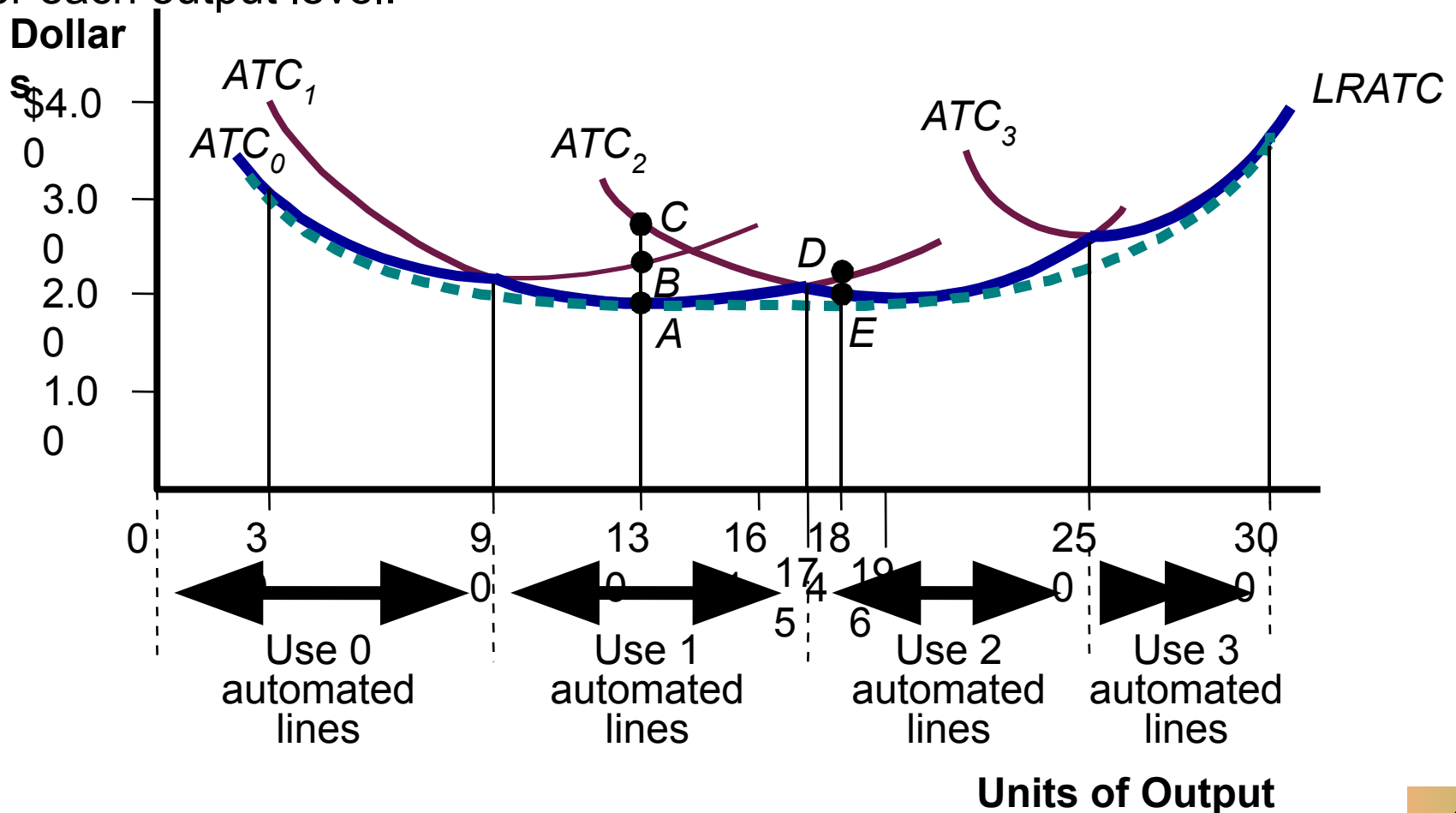
Example

The table below shows 4 alternative production techniques for producing 1,000 widgets per month.

Technique	A	B	C	D
Labor	25	35	50	30
Capital	50	35	25	60

- If the price of labor is $5 and the price of capital is $10, which production technique minimizes the costs of producing 1,000 units of output?
- If the price of labor is $10 and the price of capital is $5, which production technique minimizes the costs of producing 1,000 units of output?
- If the price of both labor and capital is $10, which production technique minimizes the costs of producing 1,000 units of output?

Example

Ike's bikes is a major manufacturer of bicycles. Currently, the company produces bikes in one factory. However, it is considering expanding production to two or even three factories. The following table shows the company's short run average total cost each month for various levels of production if it uses one, two, or three factories:

			Average Total Cost		
№ of factories	Q=100	Q=200	Q=300	Q=400	Q=500
1	$200	$150	$150	$225	$350
2	300	200	150	200	300
3	350	225	150	150	200

Example

Average Total Cost					
№ of factories	**Q=100**	**Q=200**	**Q=300**	**Q=400**	**Q=500**
1	$200	$150	$150	$225	$350
2	300	200	150	200	300
3	350	225	150	150	200

1. Suppose Ike's Bikes is currently producing 500 bikes per month in its (only) factory. Its short-run average total cost is _____ per bike.

2. Suppose Ike's Bikes is expected to produce 500 bikes per month for several years. In this case, in the long run, it would choose to produce bikes using _____.

Long-Run Cost

- Economies and Diseconomies of Scale
  - **Economies of scale** are features of a firm's technology that lead to falling long-run average cost as output increases. TP increases => LRATC falls
  - **Diseconomies of scale** are features of a firm's technology that lead to rising long-run average cost as output increases. TP increases => LRATC increases
  - **Constant returns to scale** are features of a firm's technology that lead to constant long-run average cost as output increases. TP increases => LRATC no change

The Shape Of LRATC

Dollars

$4.00

3.00

2.00

1.00

0   130   184

Units of Output

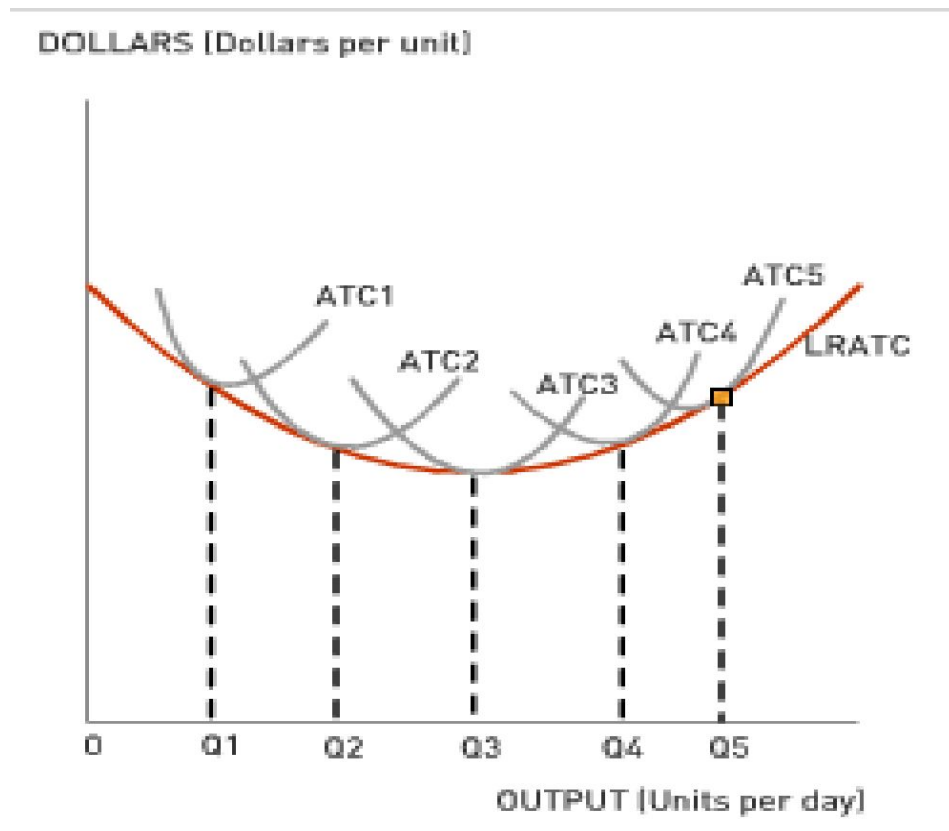Economies of Scale

Constant Returns to Scale

Diseconomies of Scale

LRATC

45
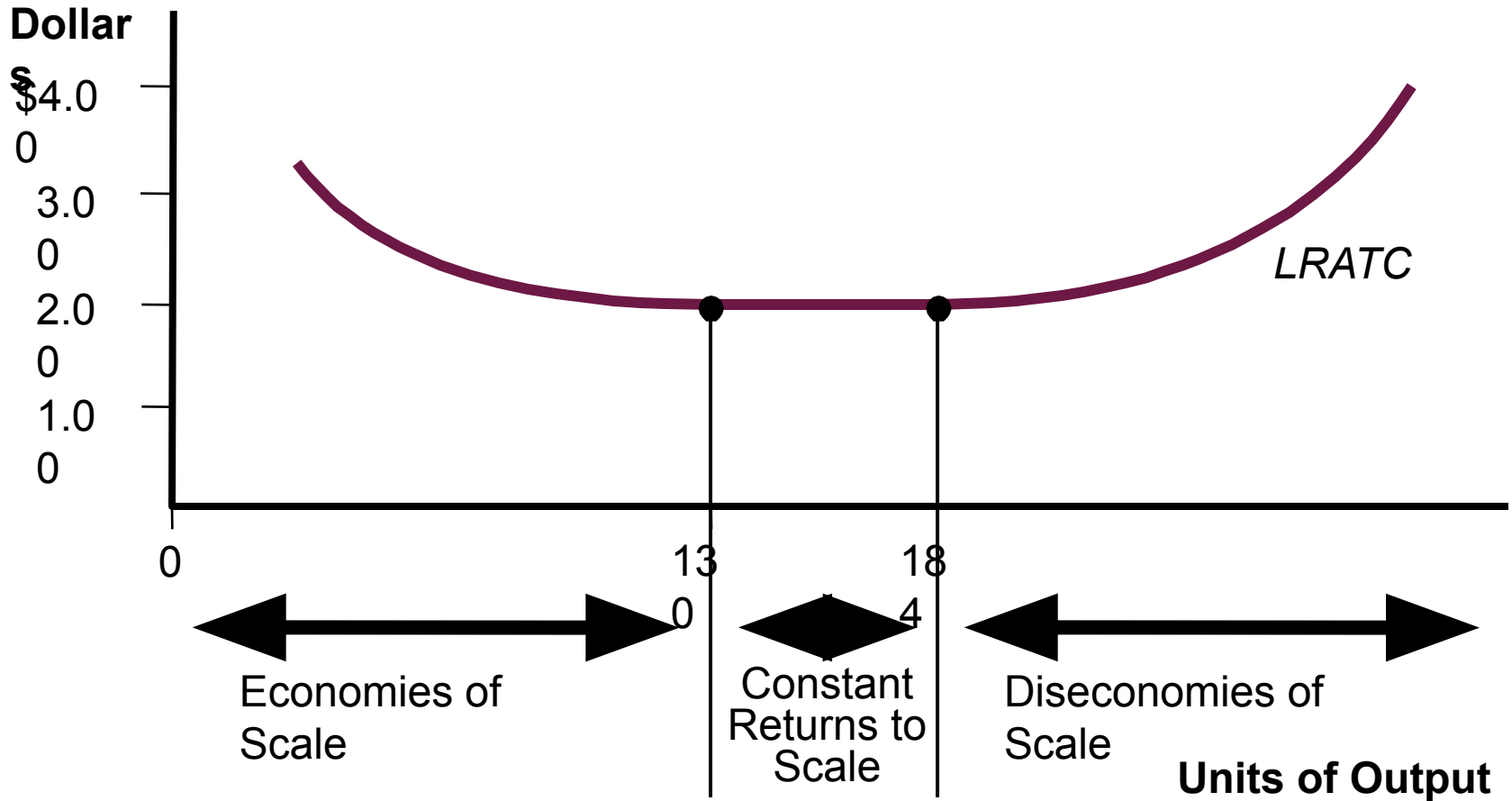
Example

Over which range of output levels do you find diseconomies of scale?

- 0 to Q3
- Greater than Q3
- 0 to Q1
- Q2 to Q4
- 0 to Q5

DOLLARS [Dollars per unit]

ATC1

ATC2

ATC3

ATC4

ATC5

LRATC

0   Q1   Q2   Q3   Q4   Q5

OUTPUT [Units per day]

Long-Run Cost

- A firm experiences economies of scale up to some output level.

- Beyond that output level, it moves into constant returns to scale or diseconomies of scale.

- **Minimum efficient scale** is the smallest quantity of output at which the long-run average cost reaches its lowest level.

- If the long-run average cost curve is U-shaped, the minimum point identifies the minimum efficient scale output level.

Returns to Scale

- In production, **returns to scale** refers to changes in output subsequent to a proportional change in all inputs.

  - If output increases by that same proportional change then there are constant returns to scale (CRTS).
  - If output increases by less than that proportional change, there are decreasing returns to scale (DRS).
  - If output increases by more than that proportion, there are increasing returns to scale (IRS)

Example

- Assume a firm is using 10 units of labor and 10 units of capital and is producing 10 units of output per hour. Now both inputs are doubled, resulting in output rising to 18 units per hour. The firm is experiencing

  – A) constant returns to scale.
  – B) increasing returns to scale.
  – C) decreasing returns to scale.
  – D) economies of scale.

Example

1. Which of the four firms in the figure is displaying decreasing returns to scale at all output levels?
2. Which of the four firms in the figure is displaying constant returns to scale at all output levels?
3. For which of the four firms in the figure is output increasing more than in proportion to inputs for all output levels?
4. For which of the four firms would the family of short-run average total cost curves lie below the LRAC?