

# 11



## Output and Costs

What do General Motors, Hydro One, and Campus Sweaters, have in common?

Like every firm,

- They must decide how much to produce.
- How many people to employ.
- How much and what type of capital equipment to use.

How do firms make these decisions?

# Decision Time Frames

*profit maximization.*

All decisions can be placed in two time frames:

- The short run - is a time frame in which the quantity of one or more resources used in production is fixed.
  - capital, called the firm's *plant*,
- The long run - is a time frame in which the quantities of *all* resources—including the plant size—can be varied.

# Short-Run Technology Constraint

- Product Schedules
  - To increase output in the short run – labour

Three concepts describe this relationship

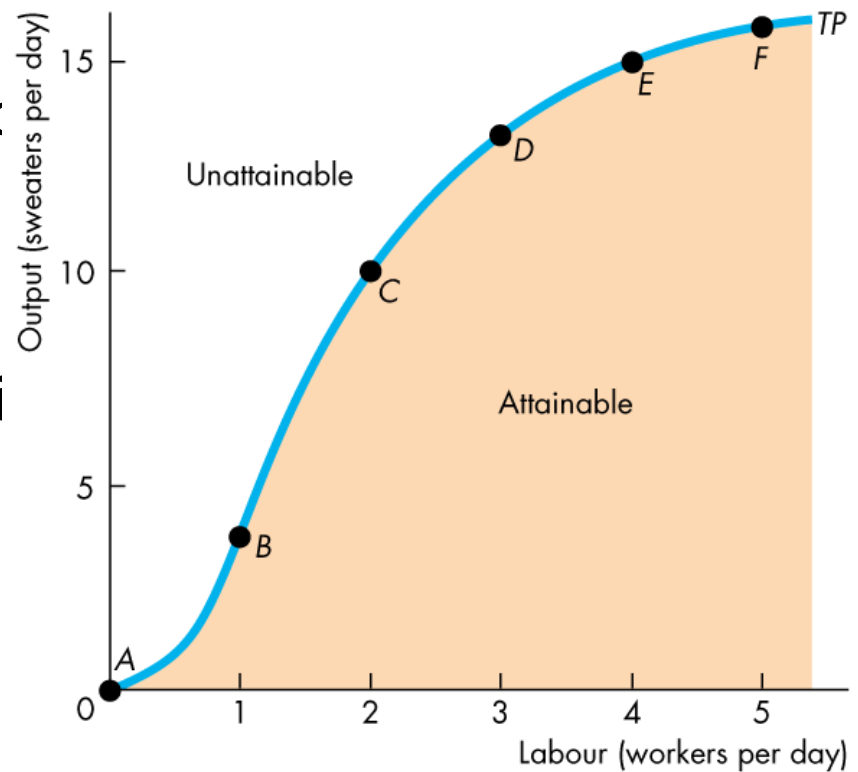
- **Total product**
- The **marginal product** of labor
- The **average product** of labour

**TABLE 11.1** Total Product, Marginal Product, and Average Product

	Labour (workers per day)	Total product (sweaters per day)	Marginal product (sweaters per additional worker)	Average product (sweaters per worker)
A	0	0	..... 4	
B	1	4	..... 6	4.00
<b>C</b>	<b>2</b>	<b>10</b>	..... <b>3</b>	5.00
<b>D</b>	<b>3</b>	<b>13</b>	..... 2	<b>4.33</b>
E	4	15	..... 1	3.75
F	5	16		3.20

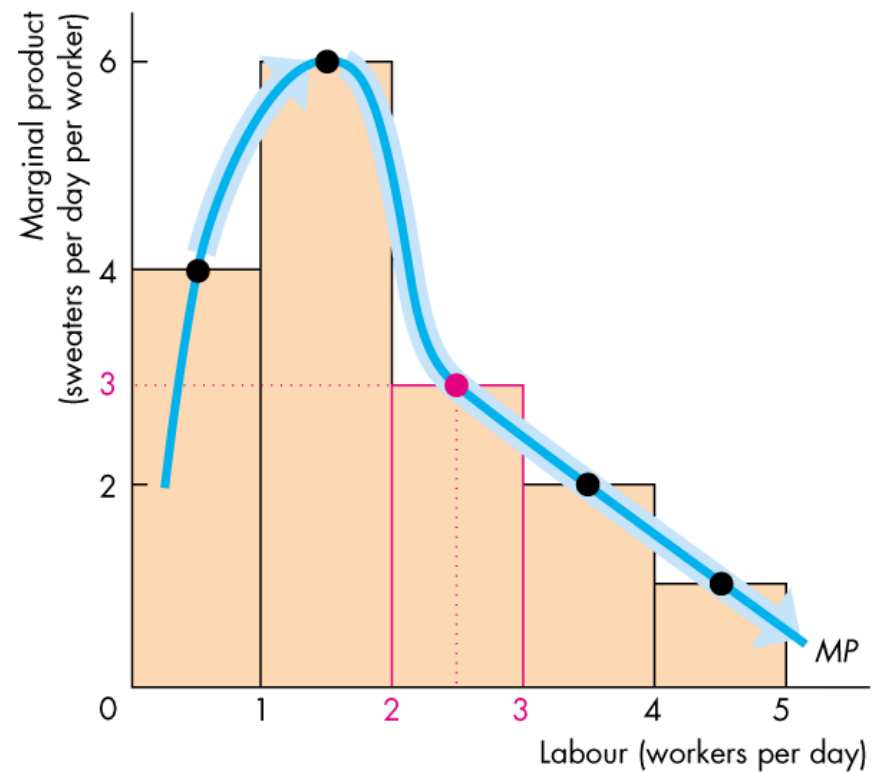
# Short-Run Technology Constraint

- The total product curve shows how total product changes with the quantity of labour employed
- It separates attainable output levels from unattainable output levels in the short run.



# Short-Run Technology Constraint

- The firm experiences **diminishing marginal returns**.



(b) Marginal product

# Short-Run Technology Constraint

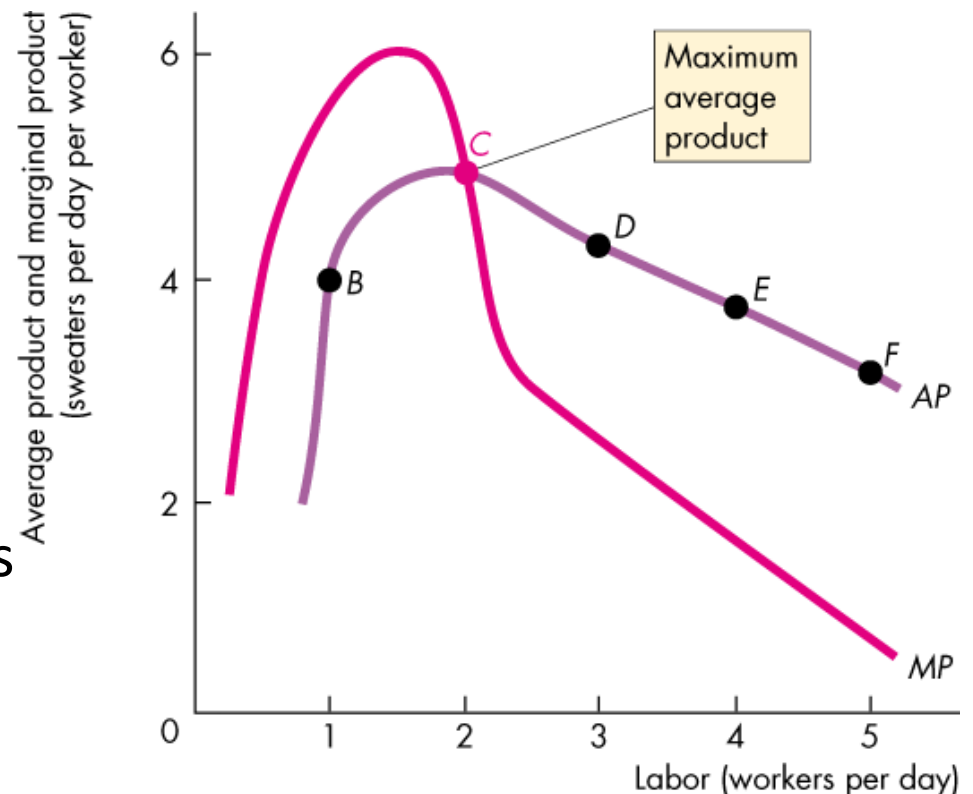
- Diminishing marginal returns arises from the fact that employing additional units of labour means each worker has less access to capital and less space in which to work.

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*.

# Short-Run Technology Constraint

- When marginal product *exceeds* average product, average product \_\_\_\_\_.
- When marginal product *is below* average product, average product \_\_\_\_\_.
- When marginal product equals average product, average product is at its \_\_\_\_\_.





# Short-Run Cost

To produce more output in the short run, the firm must increase its costs.

cost curve:

- 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.
- **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:

$$TC = TFC + TVC$$

$$ATC = AFC + AVC$$

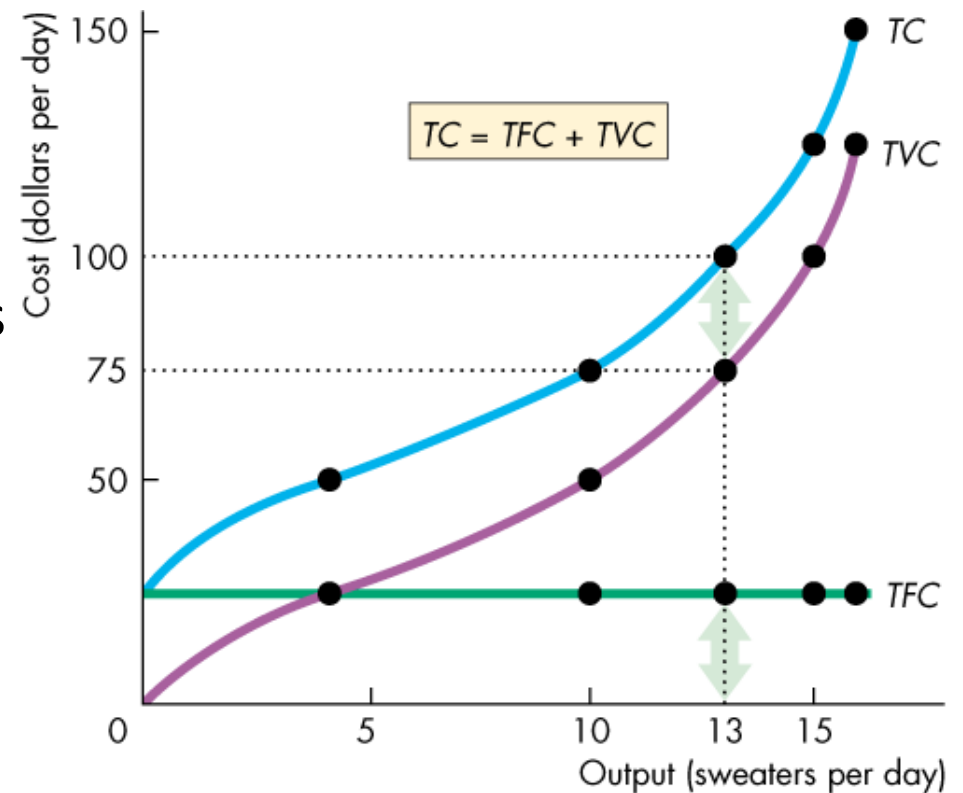
**Average fixed cost** (AFC) **Average variable cost** (AVC) **Average total cost** (ATC)

**Marginal cost** (MC) is the increase in total cost that results from a one-unit increase in total product.

# Short-Run Cost

Total fixed cost is the same at each output level.

Total variable cost increases as output increases.

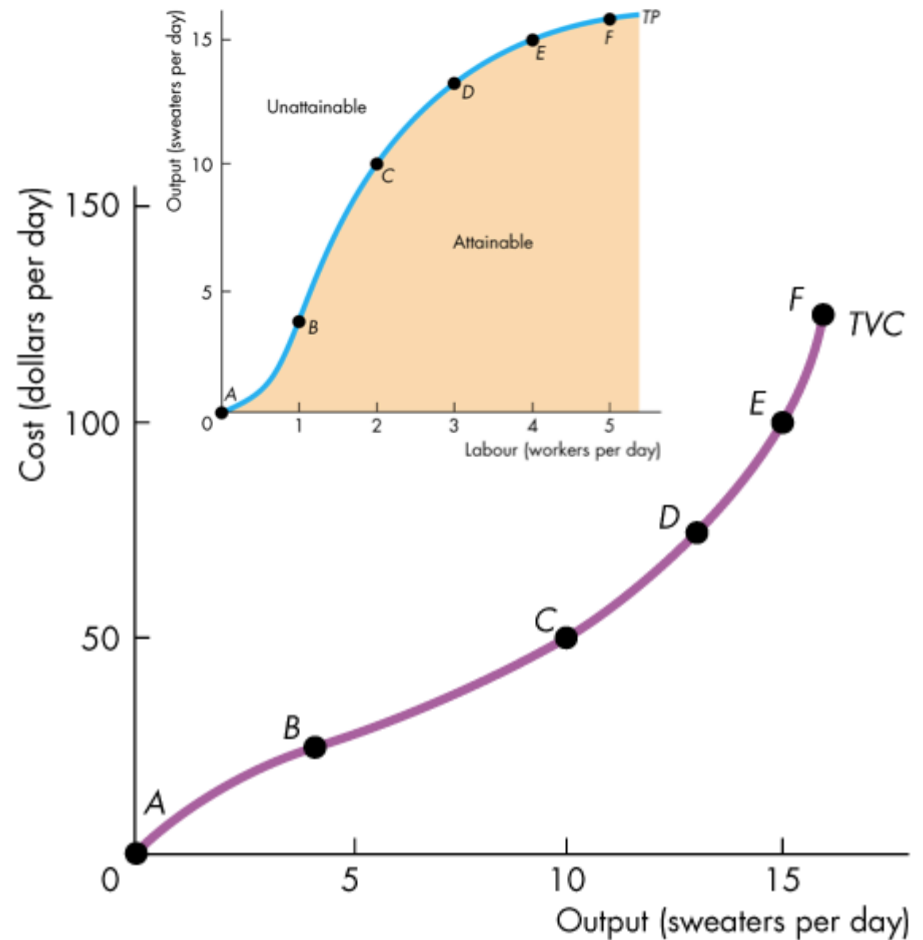


# Short-Run Cost

The total variable cost curve gets its shape from the total product curve.

Notice that the *TP* curve becomes steeper at low output levels and then less steep at high output levels.

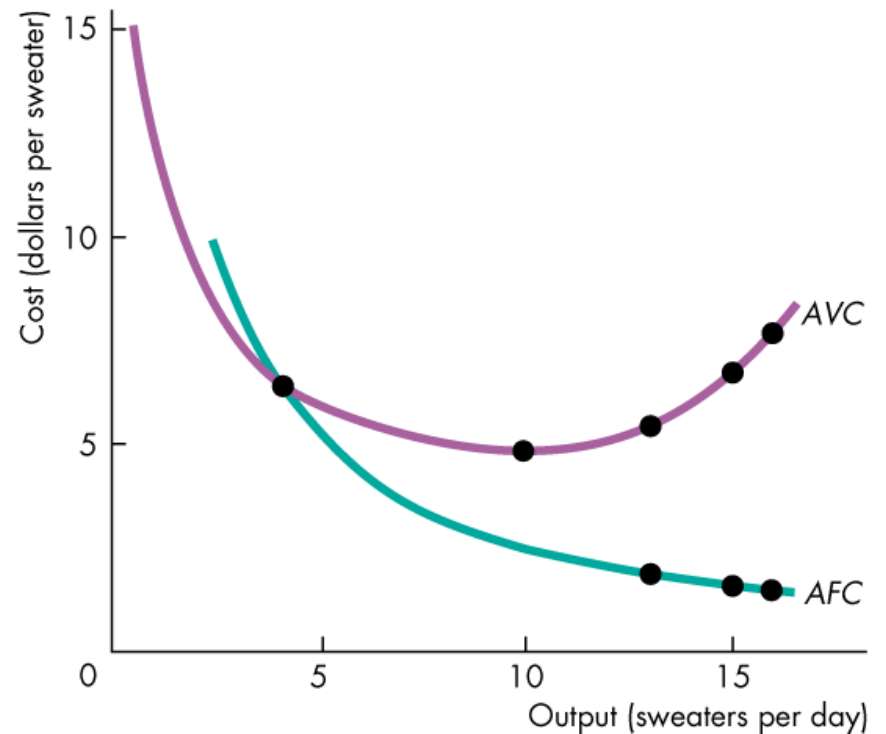
In contrast, the *TVC* curve is the opposite.



# Short-Run Cost

The *AFC* falls as output increases.

The *AVC* curve is U-shaped. As output increases, average variable cost falls to a minimum and then increases.



# Short-Run Cost

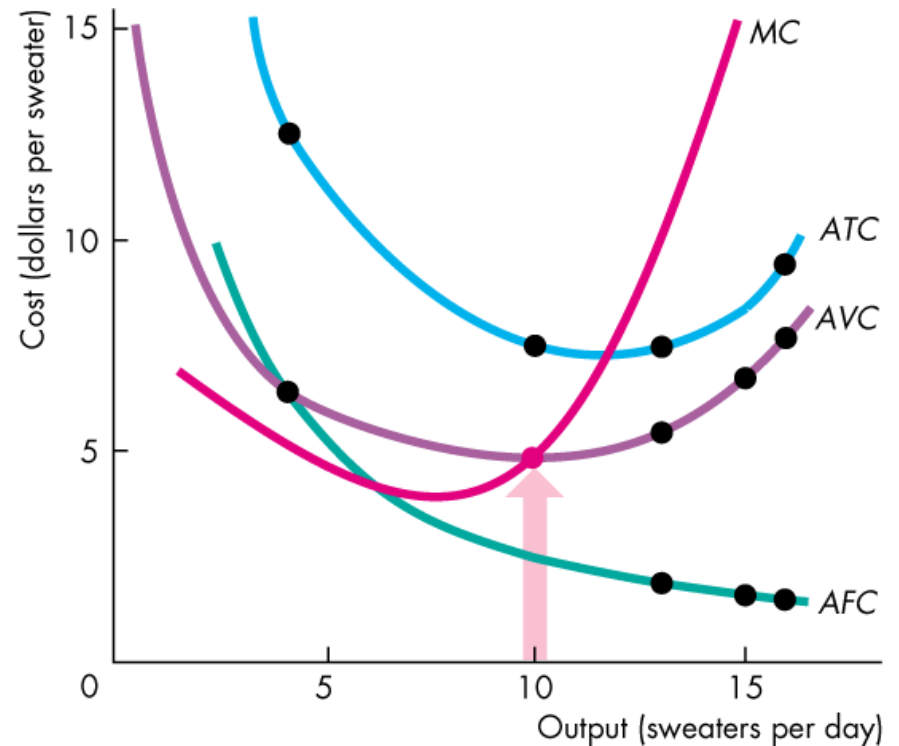
The *ATC* curve is also U-shaped.

The *MC* curve is very special.

The outputs over which *AVC* is falling, *MC* is below *AVC*.

The outputs over which *AVC* is rising, *MC* is above *AVC*.

The output at which *AVC* is at the minimum, *MC* equals *AVC*.

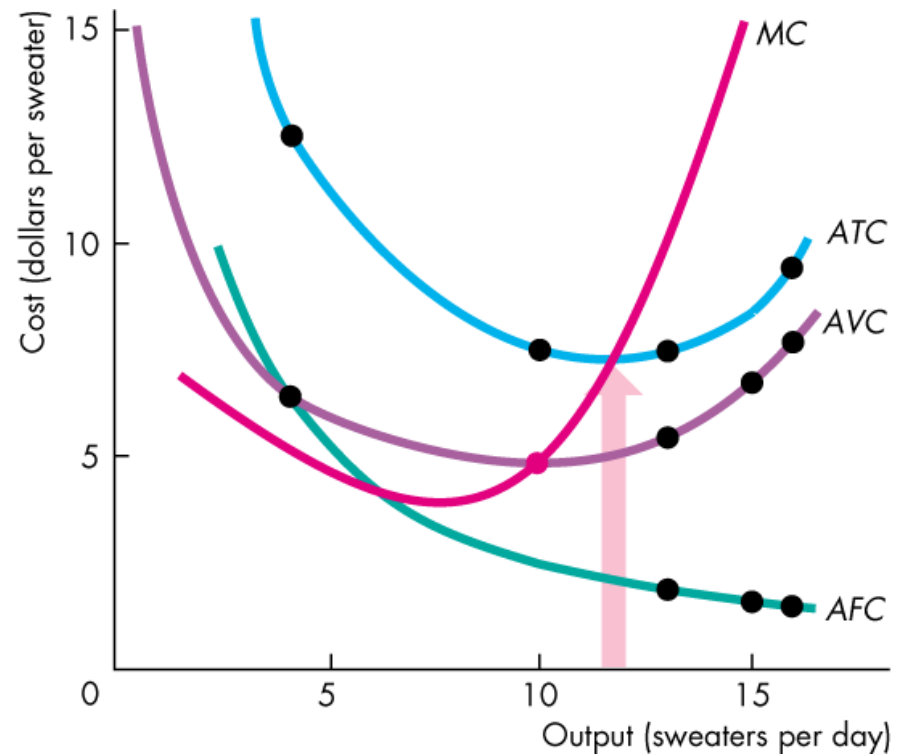


# Short-Run Cost

Outputs over which *ATC* is falling,  
*MC* is below *ATC*.

Outputs over which *ATC* is rising,  
*MC* is above *ATC*.

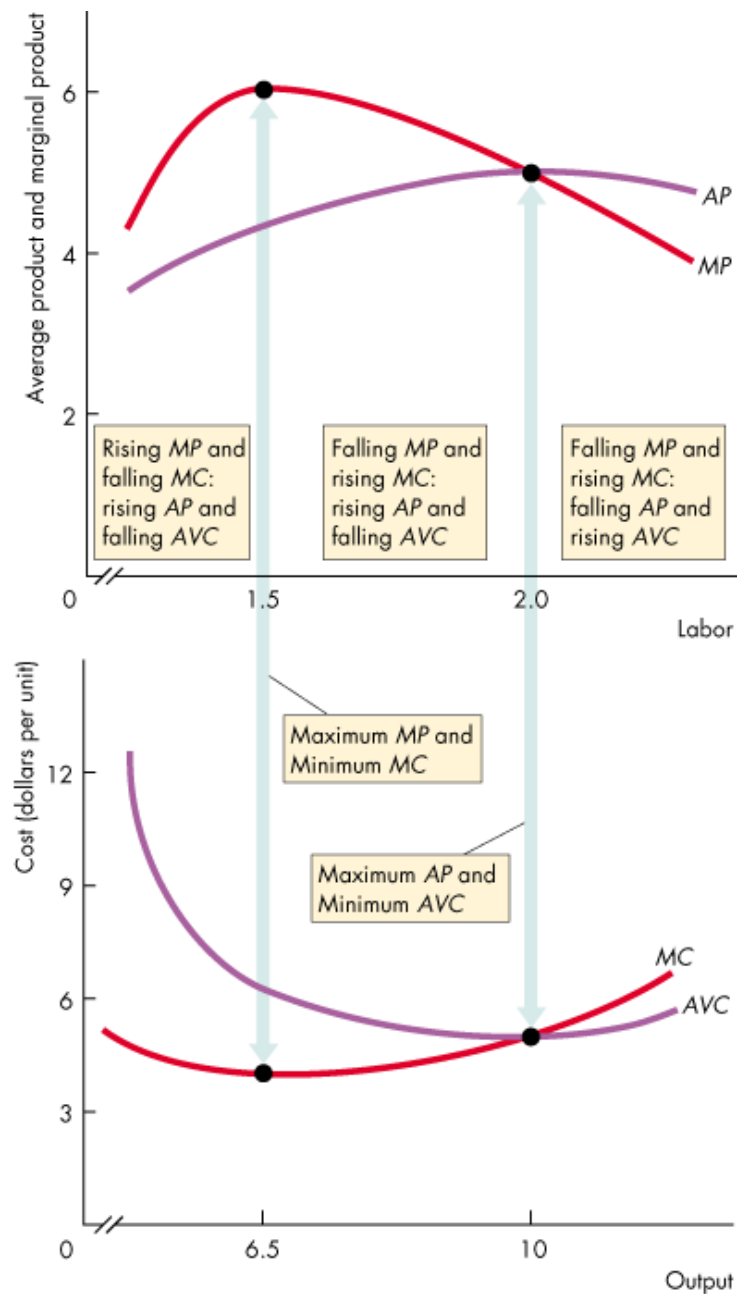
At the minimum *ATC*, *MC* equals  
*ATC*.



# Short-Run Cost

## Cost Curves and Product Curves

- The shapes of a firm's cost curves are determined by the technology it uses:



# Long-Run Cost

The firm has 4 different plants:  
1, 2, 3, or 4 knitting machines.

- A firm's production function exhibits
  - diminishing marginal returns to labour (for a given plant)
  - diminishing marginal returns to capital (for a quantity of labour).

TABLE 11.3 The Production Function

Labour (workers per day)	Output (sweaters per day)			
	Plant 1	Plant 2	Plant 3	Plant 4
1	4	10	13	15
2	10	15	18	20
3	13	18	22	24
4	15	20	24	26
5	16	21	25	27
Knitting machines (number)	1	2	3	4

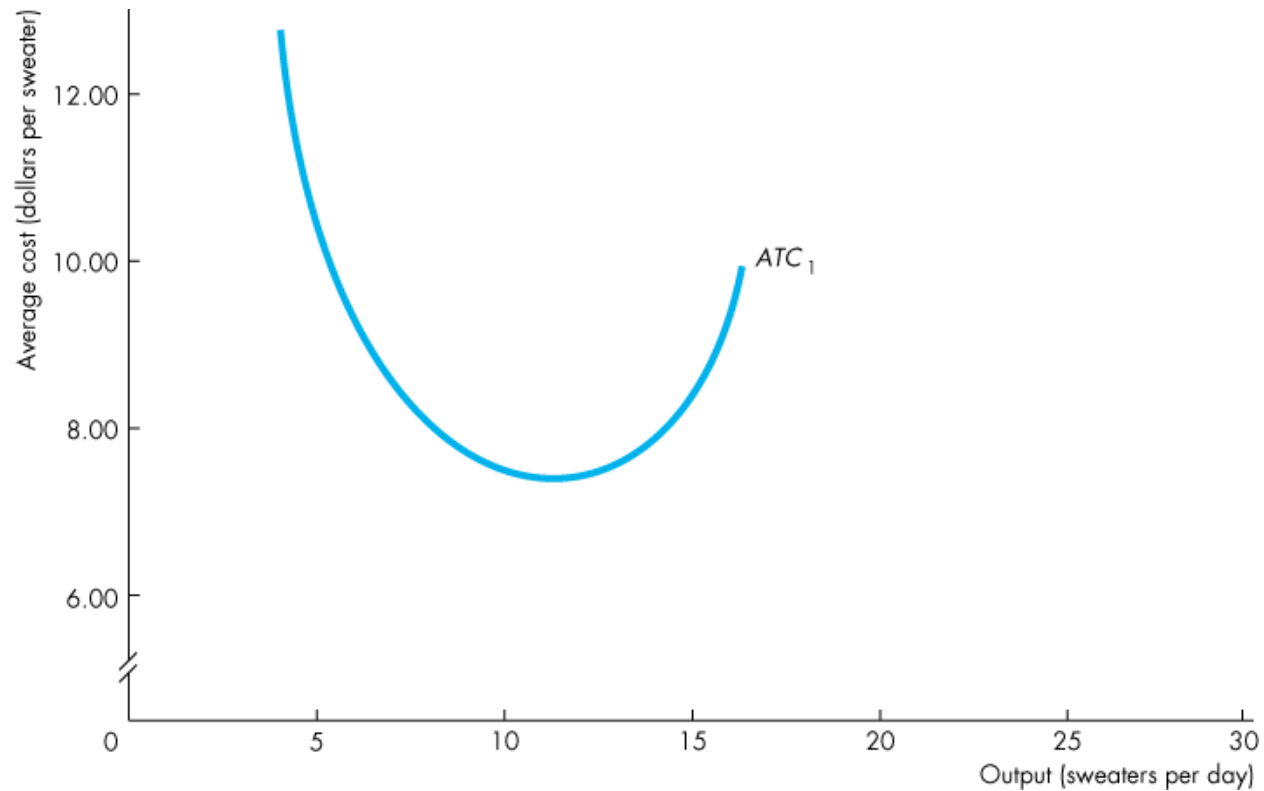


# Long-Run Cost

- **Short-Run Cost and Long-Run Cost**
- In the long run a firm decides which plant to use – invests capital.
- In the short run a firm decides (given the plant) how much labour to employ.
  - Each plant has a short-run *ATC* curve.
  - The firm can compare the *ATC* for each output at different plants.
  - The larger the plant, the greater is the output at which *ATC* is at a minimum. - ?

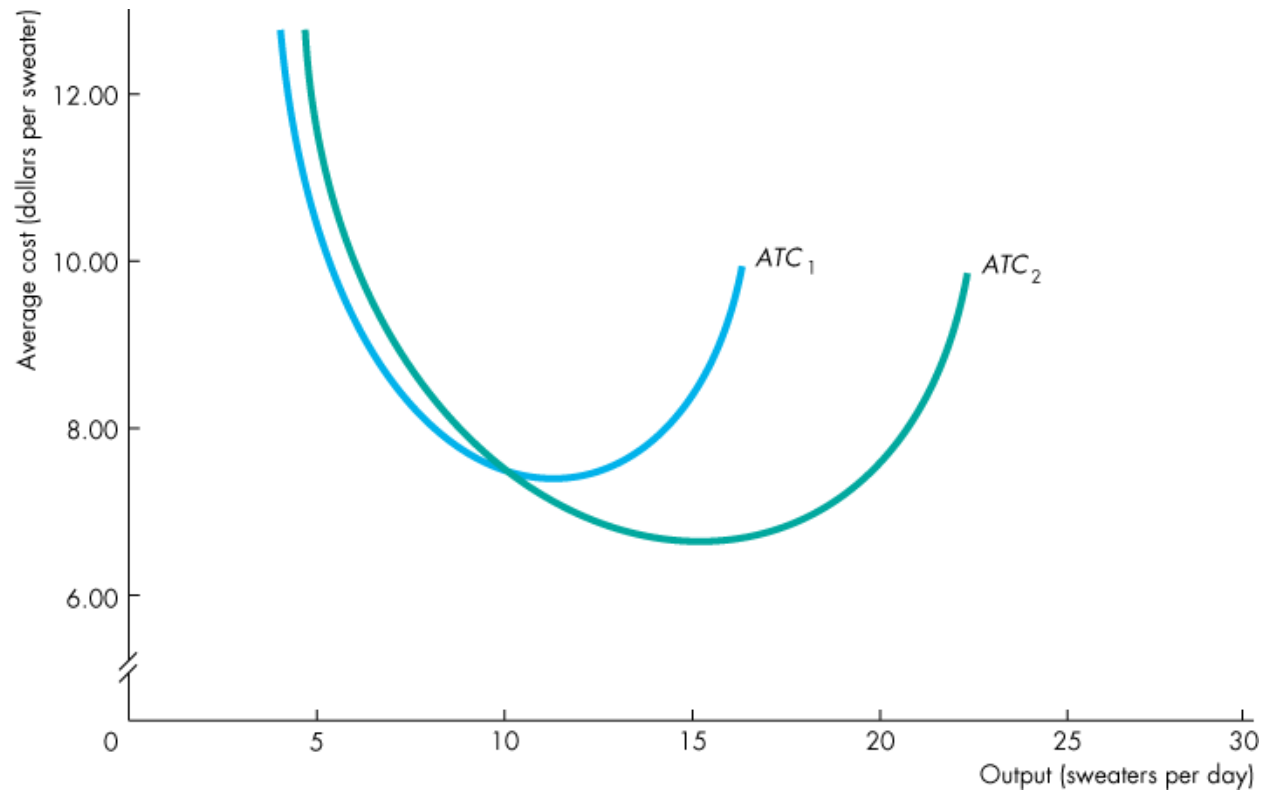
# Long-Run Cost

$ATC_1$  is the  $ATC$  curve for a plant with 1 knitting machine.



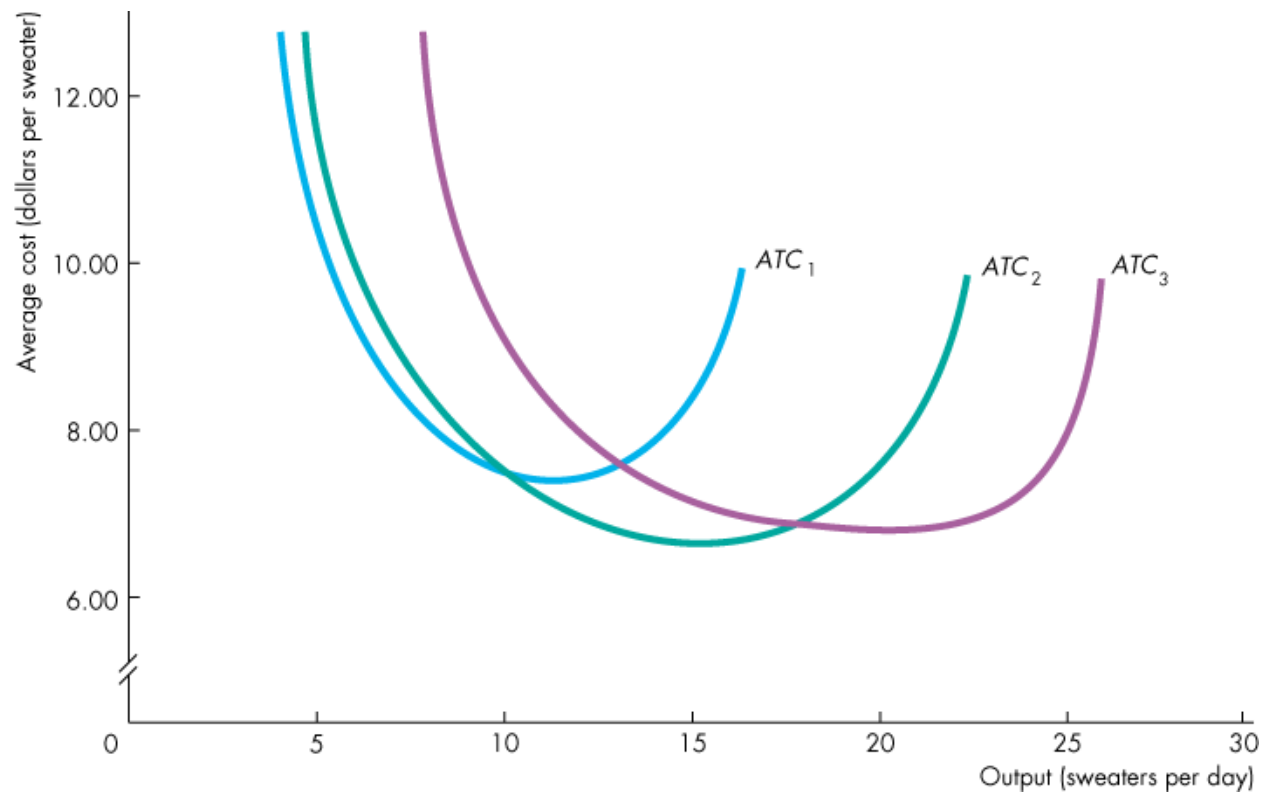
# Long-Run Cost

$ATC_2$  is the  $ATC$  curve for a plant with 2 knitting machines.



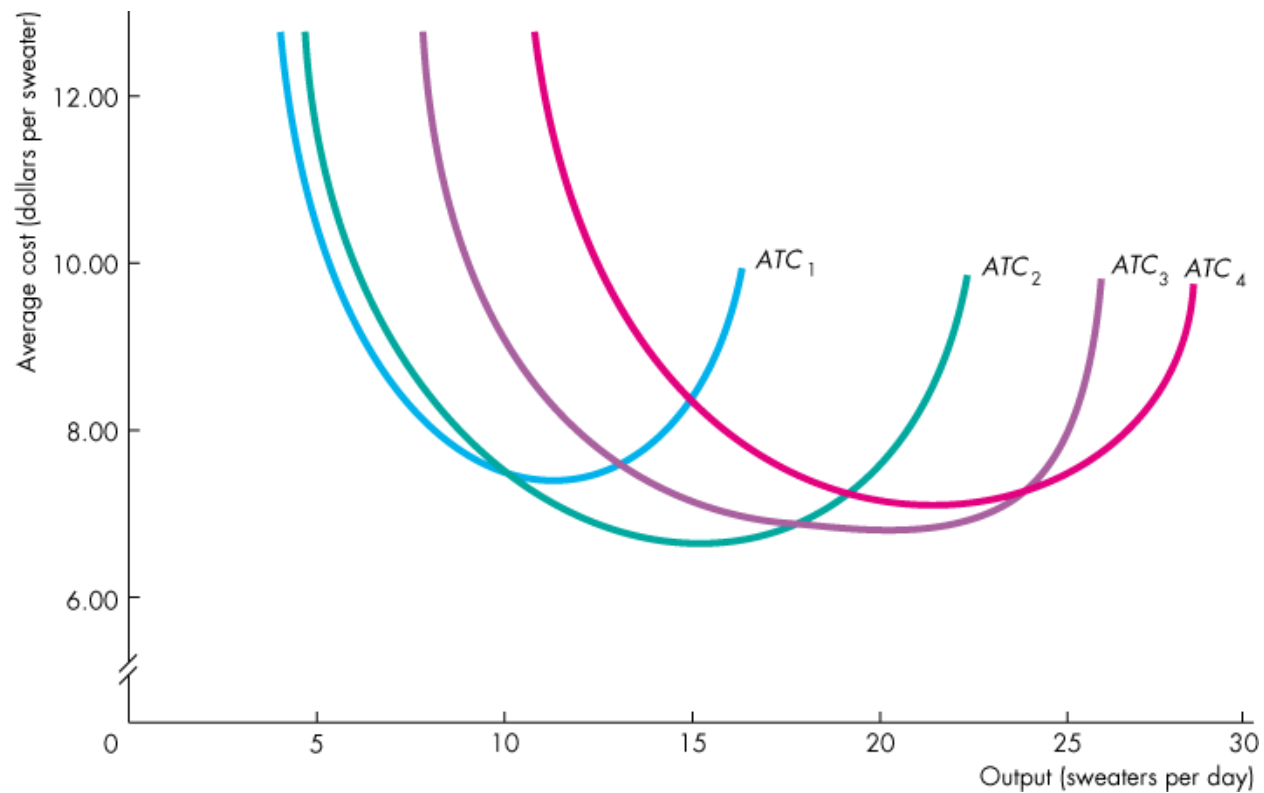
# Long-Run Cost

$ATC_3$  is the  $ATC$  curve for a plant with 3 knitting machines.



# Long-Run Cost

$ATC_4$  is the  $ATC$  curve for a plant with 4 knitting machines.



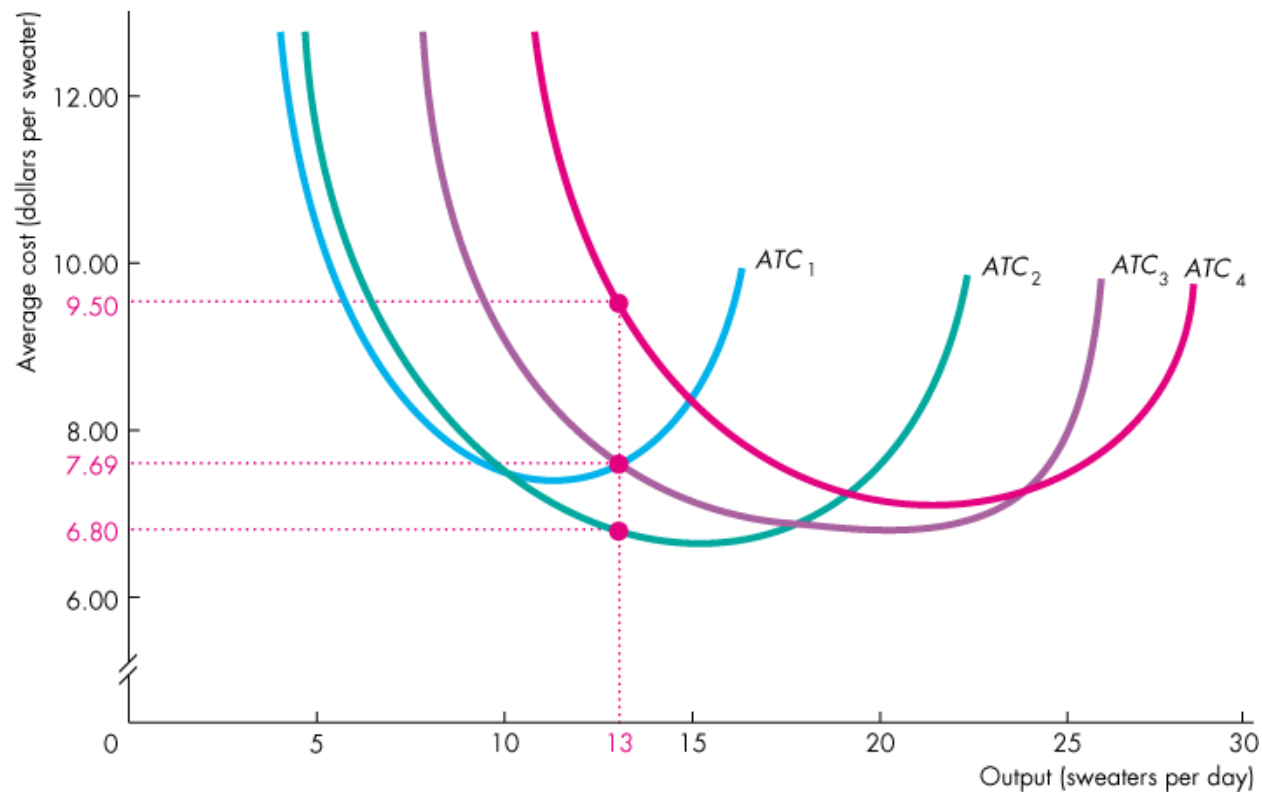
# Long-Run Cost

- Let's find the least-cost way of producing a given output level.
- Suppose that the firm wants to produce 13 sweaters a day.

# Long-Run Cost

13 sweaters a day cost \$6.80 each on  $ATC_2$ .

The least-cost way of producing 13 sweaters a day.



# Long-Run Cost

- Long-Run Average Cost Curve

- The **long-run average cost curve** -lowest attainable average total cost and output when both the plant and labour are varied.

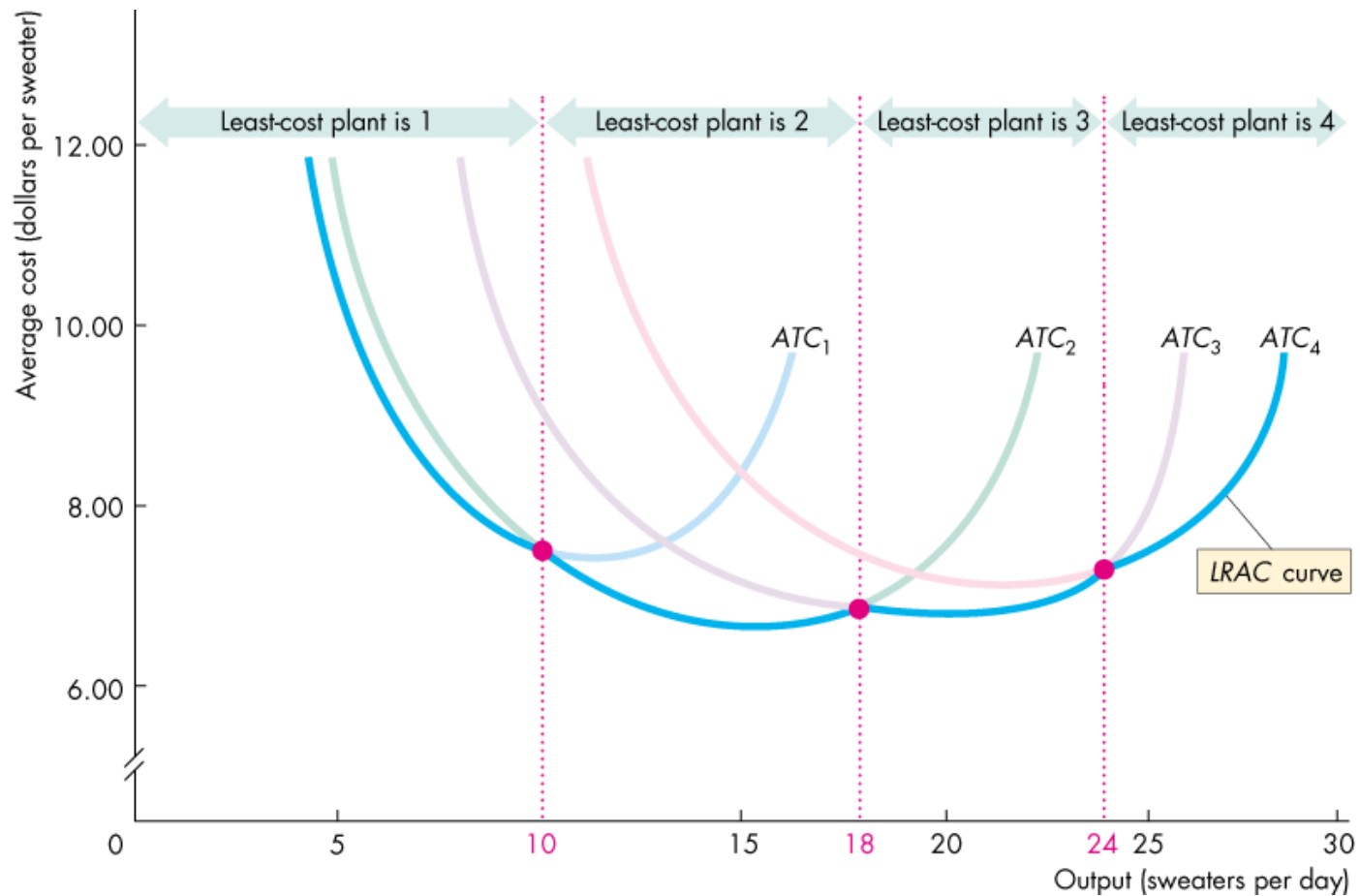
The long-run average cost curve is a planning curve

- Once the firm has chosen its plant
- the firm incurs the costs that correspond to the *ATC* curve for that plant.



# Long-Run Cost

Figure 11.8 illustrates the long-run average cost (*LRAC*) curve.

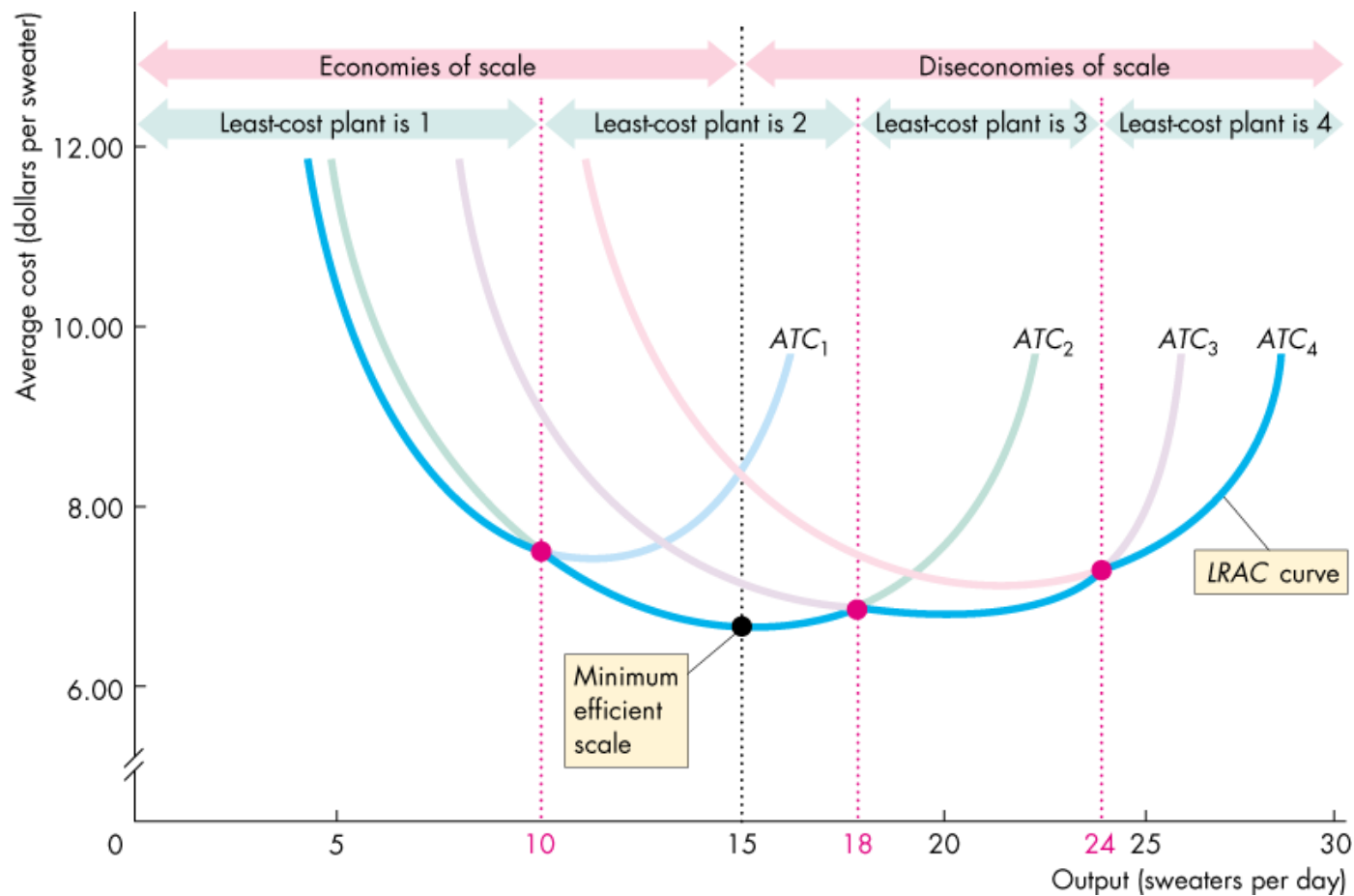


# Long-Run Cost

- 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.
  - **Diseconomies of scale** are features of a firm's technology that lead to rising long-run average cost as output increases.
  - **Constant returns to scale** are features of a firm's technology that lead to constant long-run average cost as output increases.

# Long-Run Cost

Figure 11.8 illustrates economies and diseconomies of scale.



# Long-Run Cost

- **Minimum Efficient 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.