ECO101: Introduction to Microeconomics

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SECTION: 11

LECTURE 13

TOPIC: OUTPUT AND COSTS

Decision Time Frames

- To study the relationship between a firm's output decision and its costs, we distinguish between two decision time frames:

■ The short run: The **short run** is a time frame in which the quantity of at least one factor of production is fixed. For most firms, capital, land, and entrepreneurship are fixed factors of production and labor is the variable factor of production.

- Short-run decisions are easily reversed. The firm can increase or decrease its output in the short run by increasing or decreasing the amount of labor it hires

■ The long run: The **long run** is a time frame in which the quantities of *all* factors of production can be varied. To increase output in the long run, a firm can change its plant as well as the quantity of labor it hires.

Short-Run Technology Constraint

- To increase output in the short run, a firm must increase the quantity of labor employed. We describe the relationship between output and the quantity of labor employed by using three related concepts:

1. Total product: **Total product** is the maximum output that a given quantity of labor can produce.

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

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

TABLE 11.1 Total Product, Marginal Product, and Average Product

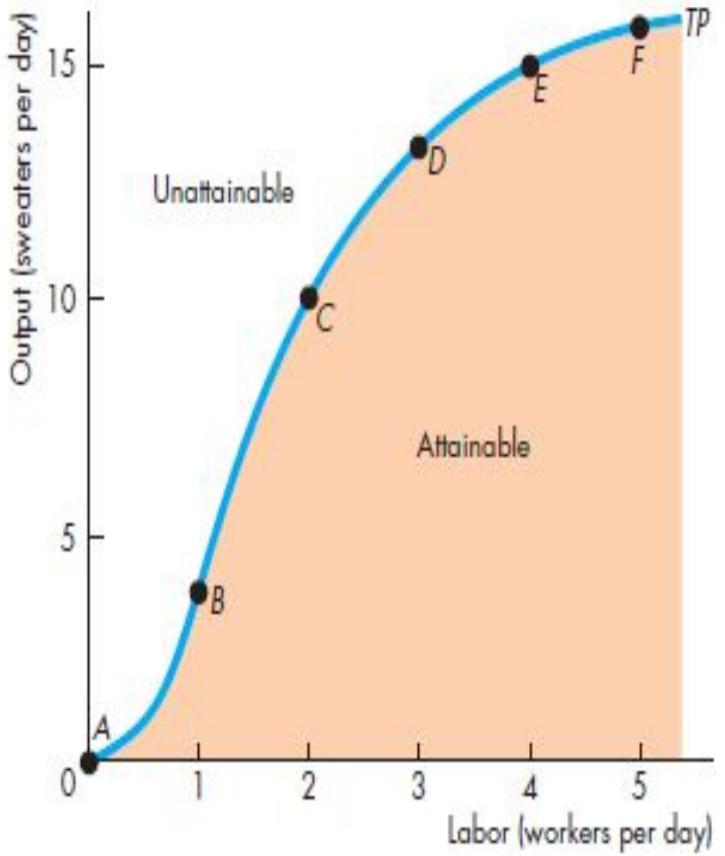
	Labor (workers per day)	Total product (sweaters per day)	Marginal product (sweaters per additional worker)	Average product (sweaters per worker)
A	0	0		
			4	
B	1	4		4.00
			6	
C	2	10		5.00
			3	
D	3	13		4.33
			2	
E	4	15		3.75
			1	
F	5	16		3.20

Total product is the total amount produced. Marginal product is the change in total product that results from a one-unit increase in labor. For example, when labor increases from 2 to 3 workers a day (row *C* to row *D*), total product increases from 10 to 13 sweaters a day. The marginal product of going from 2 to 3 workers is 3 sweaters. Average product is total product divided by the quantity of labor employed. For example, the average product of 3 workers is 4.33 sweaters per worker (13 sweaters a day divided by 3 workers).

Total Product Curve

- The total product curve is similar to the *production possibilities frontier*.
- It separates the attainable output levels from those that are unattainable.
- As employment increases from zero to 1 worker a day, the curve becomes steeper. Then, as employment increases to 3, 4, and 5 workers a day, the curve becomes less steep.
- Only the points *on* the total product curve are technologically efficient.

FIGURE 11.1 Total Product Curve

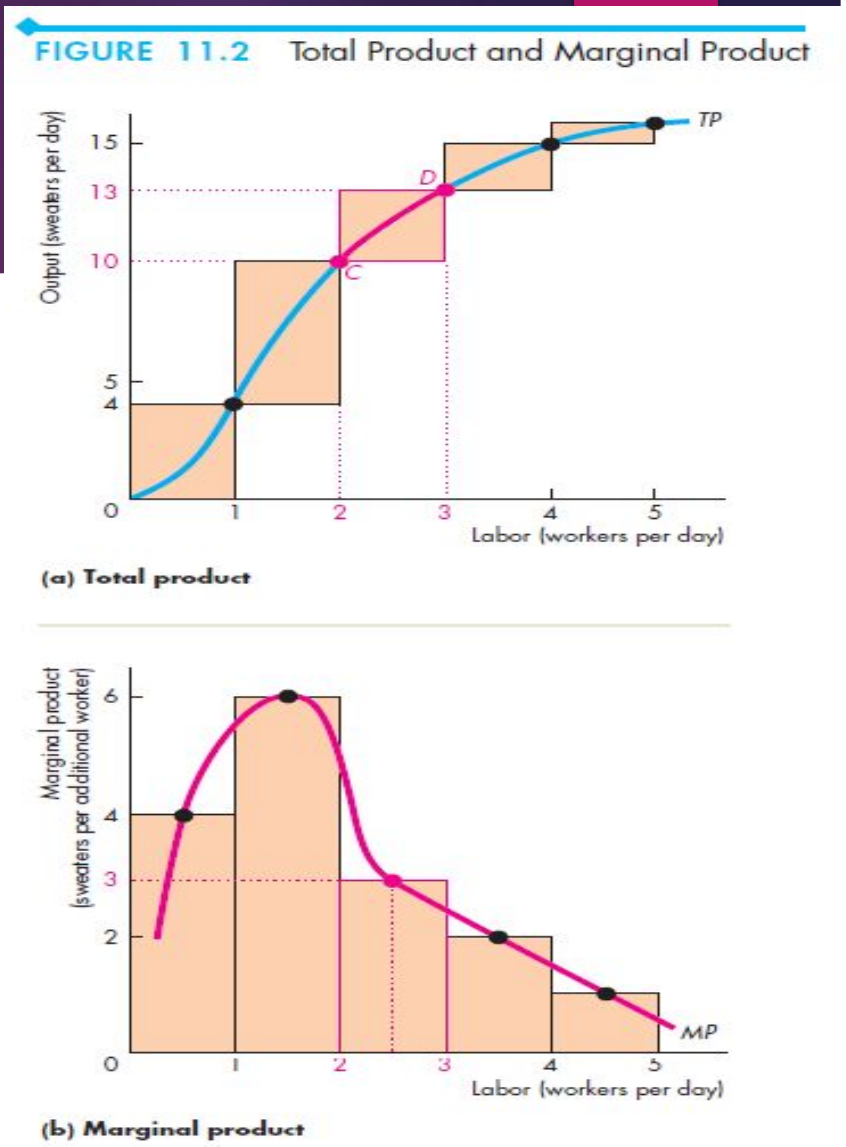


Marginal Product Curve

Almost every production process has two features:

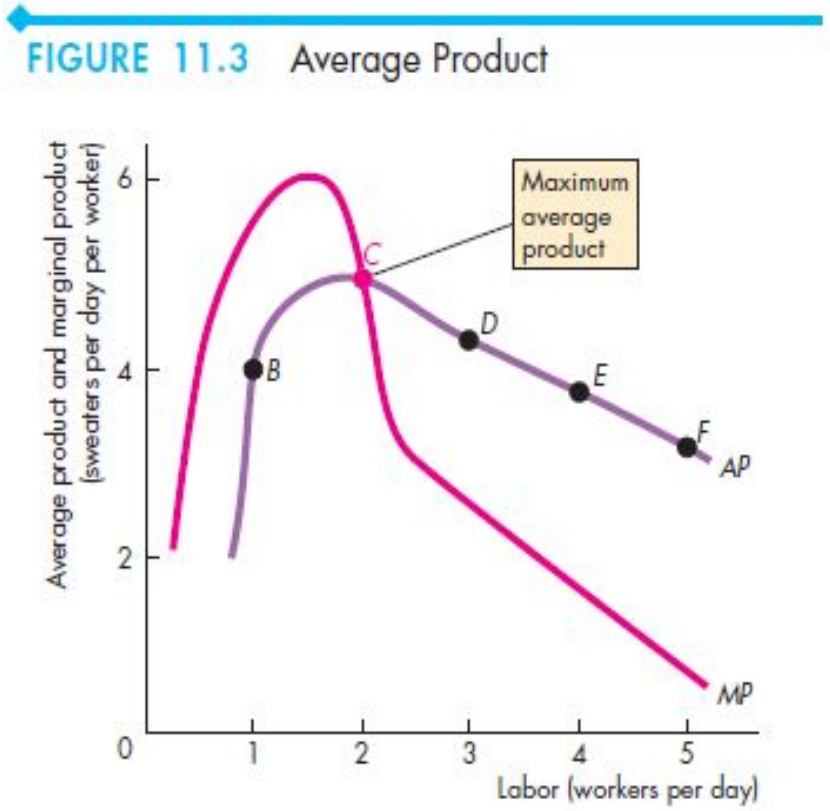
- Increasing marginal returns initially
- Diminishing marginal returns eventually

- Increasing marginal returns occur when the marginal product of an additional worker exceeds the marginal product of the previous worker.
- Increasing marginal returns arise from increased specialization and division of labor in the production process.
- Diminishing marginal returns occur when the marginal product of an additional worker is less than the marginal product of the previous worker.



Average Product Curve

- Average product is largest when average product and marginal product are equal.
- That is, the marginal product curve cuts the average product curve at the point of maximum average product.
- For the number of workers at which marginal product exceeds average product, average product is *increasing*.
- For the number of workers at which marginal product is less than average product, average product is *decreasing*.



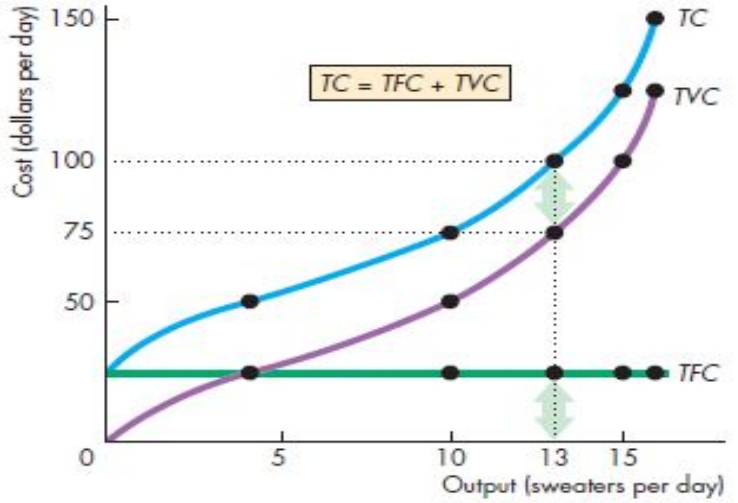
Short-Run Cost

- To produce more output in the short run, a firm must employ more labor, which means that it must increase its costs. We describe the relationship between output and cost by using three cost concepts:
  - Total cost
  - Marginal cost
  - Average cost

Total Cost

- A firm's **total cost** (*TC*) is the cost of *all* the factors of production it uses.
- *TC* = *TFC* + *TVC*
- **Total fixed cost** (*TFC*) is the cost of the firm's fixed factors.
- The quantities of fixed factors don't change as output changes, so total fixed cost is the same at all outputs.
- **Total variable cost** (*TVC*) is the cost of the firm's variable factors.
- Total variable cost changes as output changes.

FIGURE 11.4 Total Cost Curves



	Labor (workers per day)	Output (sweaters per day)	Total fixed cost (*TFC*)	Total variable cost (*TVC*)	Total cost (*TC*)
			(dollars per day)		
A	0	0	25	0	25
B	1	4	25	25	50
C	2	10	25	50	75
D	**3**	**13**	**25**	**75**	**100**
E	4	15	25	100	125
F	5	16	25	125	150

Marginal Cost

- A firm's **marginal cost** is the increase in total cost that results from a one-unit increase in output.
- We calculate marginal cost as the increase in total cost divided by the increase in output.
- At small outputs, marginal cost decreases as output increases because of greater specialization and the division of labor.
- As output increases further, marginal cost eventually increases because of the *law of diminishing returns*.
- To produce an additional unit of output, ever more workers are required, and the cost of producing the additional unit of output— marginal cost—must eventually increase.

Average Cost

- Three average costs of production are
  1. Average fixed cost
  2. Average variable cost
  3. Average total cost

TC = TFC + TVC

Divide each total cost term by the quantity produced Q, to get

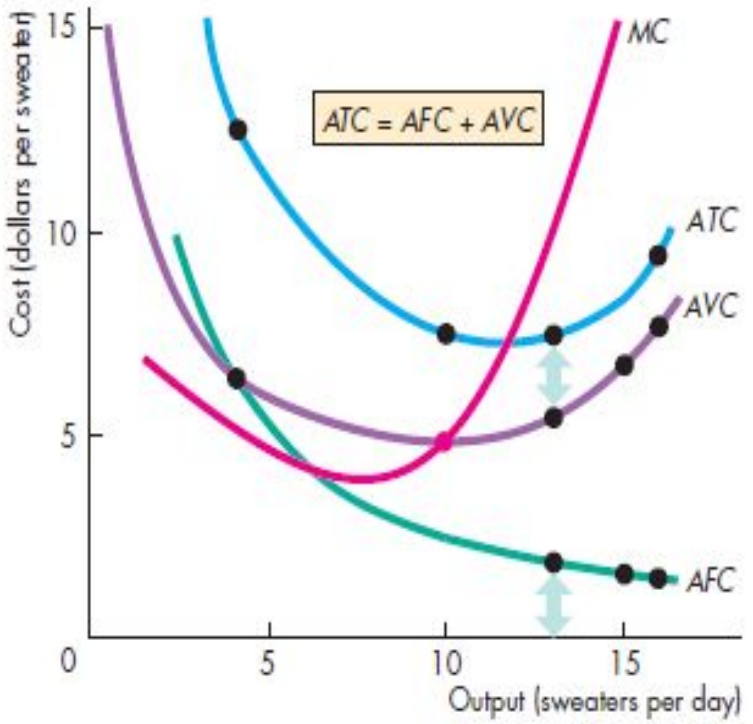
TC/Q = TFC/Q + TVC/Q

Or, ATC = AFC + AVC

Marginal Cost and Average Cost

- The marginal cost curve (*MC*) intersects the average variable cost curve and the average total cost curve *at their minimum points*.
- Average total cost is the sum of average fixed cost and average variable cost, so the shape of the *ATC* curve combines the shapes of the *AFC* and *AVC* curves.
- The U shape of the *ATC* curve arises from the influence of two opposing forces:
  1. Spreading total fixed cost over a larger output
  2. Eventually diminishing returns

FIGURE 11.5 Marginal Cost and Average Costs



	Labor (workers per day)	Output (sweaters per day)	Total fixed cost (TFC)	Total variable cost (TVC)	Total cost (TC)	Marginal cost (MC)	Average fixed cost (AFC)	Average variable cost (AVC)	Average total cost (ATC)
			(dollars per day)			(dollars per additional sweater)	(dollars per sweater)		
A	0	0	25	0	25		—	—	—
						..... 6.25			
B	1	4	25	25	50		6.25	6.25	12.50
						..... 4.17			
C	2	10	25	50	75		2.50	5.00	7.50
						..... 8.33			
D	3	13	25	75	100		1.92	5.77	7.69
						.....12.50			
E	4	15	25	100	125		1.67	6.67	8.33
						.....25.00			
F	5	16	25	125	150		1.56	7.81	9.38

Shifts in the Cost Curves

- The position of a firm's short-run cost curves depends on two factors:
  - Technology
  - Prices of factors of production

- With a better technology, the same factors of production can produce more output, so the technological advance lowers the costs of production and shifts the cost curves downward.
- An increase in the price of a factor of production increases the firm's costs and shifts its cost curves.

The Long-Run Cost

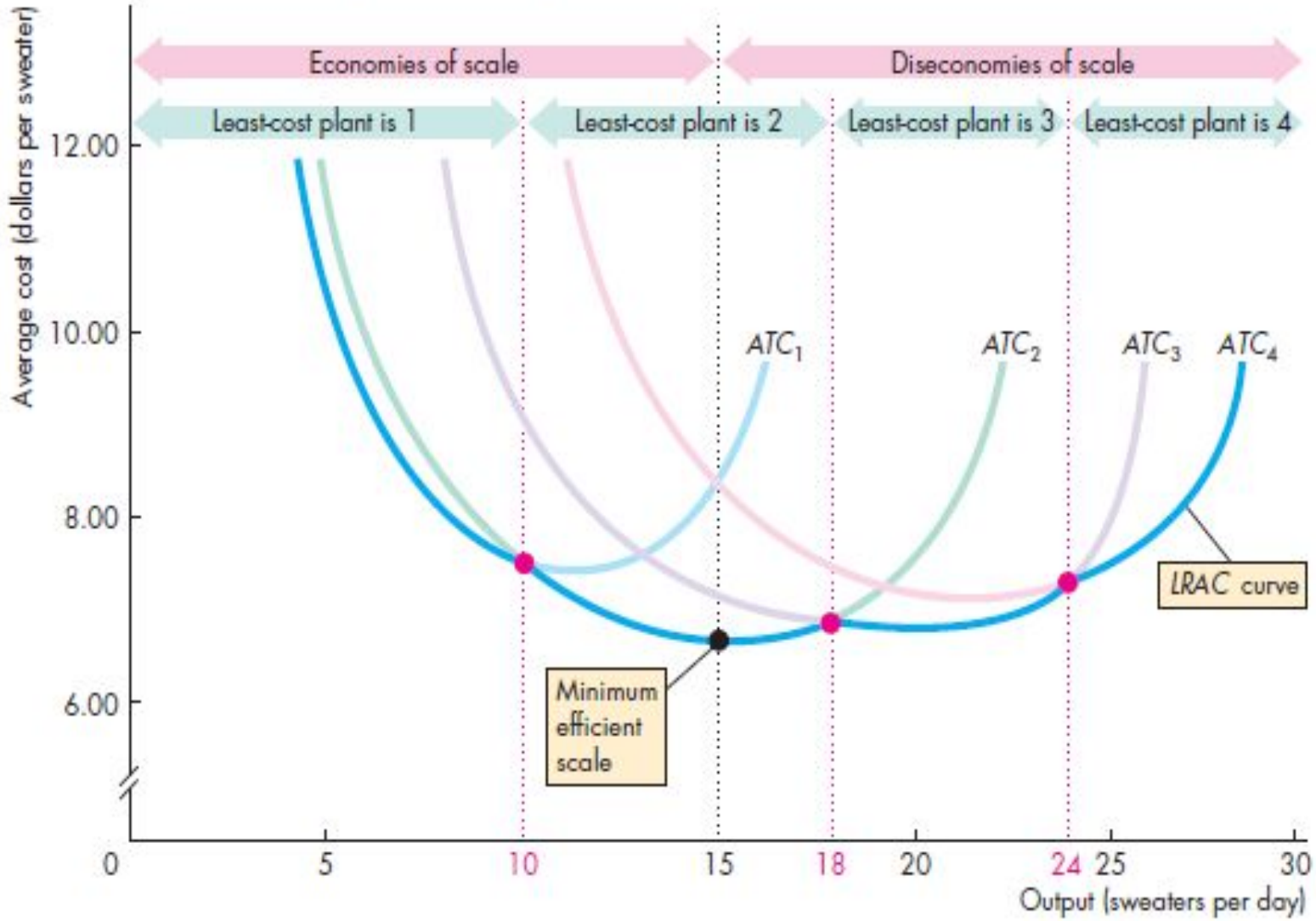
- In the long run, a firm can vary both the quantity of labor and the quantity of capital, so in the long run, all the firm's costs are variable.
- The behavior of long-run cost depends on the firm's *production function*, which is the relationship between the maximum output attainable and the quantities of both labor and capital.
- In the long run, Cindy chooses the plant that minimizes average total cost.
- When a firm is producing a given output at the least possible cost, it is operating on its *long-run average cost curve*.

TABLE 11.3 The Production Function

Labor (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

The table shows the total product data for four quantities of capital (plant sizes). The greater the plant size, the larger is the output produced by any given quantity of labor. For a given plant size, the marginal product of labor diminishes as more labor is employed. For a given quantity of labor, the marginal product of capital diminishes as the quantity of capital used increases.

FIGURE 11.8 Long-Run Average Cost Curve



The long-run average cost curve traces the lowest attainable *ATC* when both labor and capital change. The green arrows highlight the output range over which each plant achieves the lowest *ATC*. Within each range, to change the quantity produced, the firm changes the quantity of labor it employs.

Along the *LRAC* curve, economies of scale occur if average cost falls as output increases; diseconomies of scale occur if average cost rises as output increases. Minimum efficient scale is the output at which average cost is lowest, 15 sweaters a day.

Economies and Diseconomies of Scale

- **Economies of scale** are features of a firm's technology that make average total cost *fall* as output increases.
  - When economies of scale are present, the *LRAC* curve slopes downward.
- **Diseconomies of scale** are features of a firm's technology that make average total cost *rise* as output increases.
  - When diseconomies of scale are present, the *LRAC* curve slopes upward.
- **Constant returns to scale** are features of a firm's technology that keep average total cost constant as output increases.
  - When constant returns to scale are present, the *LRAC* curve is horizontal.
- A firm's **minimum efficient scale** is the *smallest* output at which long-run average cost reaches its lowest level.