

10



Organizing Production

All firms have to 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?

The Firm and Its Economic Problem

A **firm** is an institution that hires factors of production and organizes them to produce and sell goods and services.

The Firm's Goal

A firm's goal is to maximize profit.

If the firm fails to maximize its profit, the firm is either eliminated or bought out by other firms seeking to maximize profit.

The Firm and Its Economic Problem

Accounting Profit

Accountants measure a firm's profit to ensure that the firm pays the correct amount of tax and to show it investors how their funds are being used.

Profit equals total revenue minus total cost.

Accountants use Internal Revenue Service rules based on standards established by the Financial Accounting Standards Board to calculate a firm's depreciation cost.

The Firm and Its Economic Problem

Economic Profit

Economists measure a firm's profit to enable them to predict the firm's decisions, and the goal of these decisions is to maximize economic profit.

Economic profit is equal to total revenue minus total cost, with total cost measured as the opportunity cost of production.

The Firm and Its Economic Problem

A Firm's Opportunity Cost of Production

A firm's opportunity cost of production is the value of the best alternative use of the resources that a firm uses in production.

A firm's opportunity cost of production is the sum of the cost of using resources

- Bought in the market
- Owned by the firm
- Supplied by the firm's owner

The Firm and Its Economic Problem

Resources Bought in the Market

The amount spent by a firm on resources bought in the market is an opportunity cost of production because the firm could have bought different resources to produce some other good or service.

The Firm and Its Economic Problem

Resources Owned by the Firm

If the firm owns capital and uses it to produce its output, then the firm incurs an opportunity cost.

The firm incurs an opportunity cost of production because it could have sold the capital and rented capital from another firm.

The firm implicitly rents the capital from itself.

The firm's opportunity cost of using the capital it owns is called the **implicit rental rate** of capital.

The Firm and Its Economic Problem

The implicit rental rate of capital is made up of

1. Economic depreciation
2. Interest forgone

Economic depreciation is the change in the *market value* of capital over a given period.

Interest forgone is the return on the funds used to acquire the capital.

The Firm and Its Economic Problem

Resources Supplied by the Firm's Owner

The owner might supply both entrepreneurship and labour.

The return to entrepreneurship is profit.

The profit that an entrepreneur can expect to receive *on average* is called **normal profit**.

Normal profit is the cost of entrepreneurship and is a cost of production.

The Firm and Its Economic Problem

The Firm's Decisions

To maximize profit, a firm must make five basic decisions:

1. What to produce and in what quantities
2. How to produce
3. How to organize and compensate its managers and workers
4. How to market and price its products
5. What to produce itself and what to buy from other firms

The Firm and Its Economic Problem

The Firm's Constraints

The firm's profit is limited by three features of the environment:

- Technology constraints
- Information constraints
- Market constraints

The Firm and Its Economic Problem

Technology Constraints

Technology is any method of producing a good or service.

Technology advances over time.

Using the available technology, the firm can produce more only if it hires more resources, which will increase its costs and limit the profit of additional output.

The Firm and Its Economic Problem

Information Constraints

A firm never possesses complete information about either the present or the future.

It is constrained by limited information about the quality and effort of its work force, current and future buying plans of its customers, and the plans of its competitors.

The cost of coping with limited information limits profit.

The Firm and Its Economic Problem

Market Constraints

What a firm can sell and the price it can obtain are constrained by its customers' willingness to pay and by the prices and marketing efforts of other firms.

The resources that a firm can buy and the prices it must pay for them are limited by the willingness of people to work for and invest in the firm.

The expenditures a firm incurs to overcome these market constraints will limit the profit the firm can make.

Technology and Economic Efficiency

Technological Efficiency

Technological efficiency occurs when a firm produces a given level of output by using the least amount inputs.

There may be different combinations of inputs to use for producing a given good, but only one of them is technologically inefficient.

If it is impossible to produce a given good by decreasing any one input, holding all other inputs constant, then production is technologically efficient.

Technology and Economic Efficiency

Table 10.2 sets out the labour and capital required to produce 10 TVs a day by four methods *A*, *B*, *C*, and *D*.

Which methods are technologically efficient?

TABLE 10.2 Four Ways of Making
10 TVs a Day

		Quantities of inputs	
		Labour	Capital
A	Robot production	1	1,000
B	Production line	10	10
C	Hand-tool production	1,000	1
D	Bench production	100	10

Technology and Economic Efficiency

Economic Efficiency

Economic efficiency occurs when the firm produces a given level of output at the least cost.

The economically efficient method depends on the relative costs of capital and labour.

The difference between technological and economic efficiency is that technological efficiency concerns the quantity of inputs used in production for a given level of output, whereas economic efficiency concerns the cost of the inputs used.

Technology and Economic Efficiency

An economically efficient production process also is technologically efficient.

A technologically efficient process may not be economically efficient.

Table 10.3 on the next slide illustrates how the economically efficient method depends on the relative costs of resources.

Technology and Economic Efficiency



When the wage rate is \$75 a day and the rental rate is \$250 a day, Method *B* is the economically efficient method.

When the wage rate is \$150 a day and the rental rate is \$1 a day, Method *A* is the economically efficient method.

When the wage rate is \$1 a day and the rental rate is \$1,000 a day, Method *C* is the economically efficient method.

TABLE 10.3 The Costs of Different Ways of Making 10 TVs a Day

(c) Wage rate \$1 a day; Capital rental rate \$1,000 a day

Method	Inputs Labour	Capital	Labour cost (\$1 per day)		Capital cost (\$1,000 per day)		Total cost
A	1	1,000	\$1	+	\$1,000,000	=	\$1,000,001
B	10	10	10	+	10,000	=	10,010
C	1,000	1	1,000	+	1,000	=	2,000

Markets and the Competitive Environment

Economists identify four market types:

1. Perfect competition
2. Monopolistic competition
3. Oligopoly
4. Monopoly

Markets and the Competitive Environment

Perfect competition is a market structure with

- Many firms
- Each sells an identical product
- Many buyers
- No restrictions on entry of new firms to the industry
- Both firms and buyers are all well informed about the prices and products of all firms in the industry.

Markets and the Competitive Environment

Monopolistic competition is a market structure with

- Many firms
- Each firm produces similar but slightly different products—called **product differentiation**
- Each firm possesses an element of market power
- No restrictions on entry of new firms to the industry

Markets and the Competitive Environment

Oligopoly is a market structure in which

- A small number of firms compete.
- The firms might produce almost identical products or differentiated products.
- Barriers to entry limit entry into the market.

Markets and the Competitive Environment

Monopoly is a market structure in which

- One firm produces the entire output of the industry.
- There are no close substitutes for the product.
- There are barriers to entry that protect the firm from competition by entering firms.



Where we are going

Our goal in the remaining section of this course is to develop a model that allows us to predict firm's input and output conditions.

To do so, we need to know about the influences on their costs and revenues.

We will begin by considering cost conditions. These are similar for all firms.

Then we will consider revenue conditions, which depend on market structure or market types.

11



Output and Costs

Understanding the structure of firms' costs is a vital prerequisite for understanding firms' input and output choices.

Structure of costs is the same for all firms, regardless of market structure (competitive, monopoly, oligopoly, etc.)

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 labour, 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 current decisions.

Short-Run Technology Constraint

Assume that the firm used only two inputs: capital and labour.

In the short-run the amount of capital is fixed.

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

We are interested in describing the relationship between output and the quantity of labour employed in the short-run

This depends on the firm's technology.

Short-Run Technology Constraint

Three useful concepts:

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

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

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

Short-Run Technology Constraint

As the quantity of labour employed increases:

- Total product increases.
- Marginal product increases initially but eventually decreases.
- Average product increases initially but eventually decreases.

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
C	2	10	 3	5.00
D	3	13	 2	4.33
E	4	15	 1	3.75
F	5	16		3.20

Short-Run Technology Constraint

Product Curves

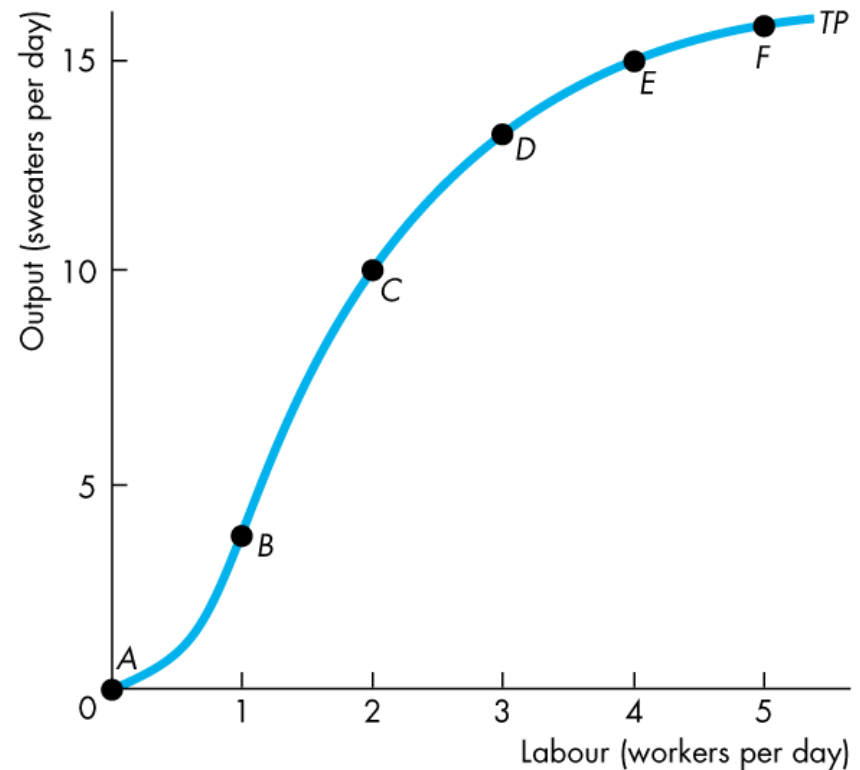
We can graph these three relationships.

These graphs show how total product, marginal product, and average product change as the quantity of labour employed changes.

Short-Run Technology Constraint

Total Product Curve

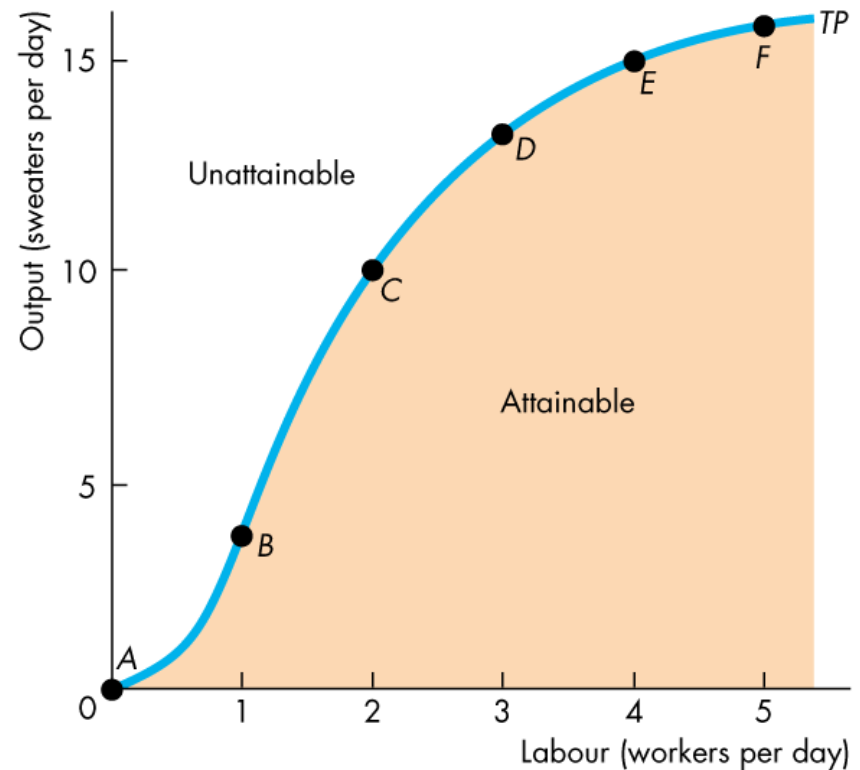
The total product curve shows how total product changes with the quantity of labour employed.



Short-Run Technology Constraint

The total product curve is similar to the *PPF*.

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



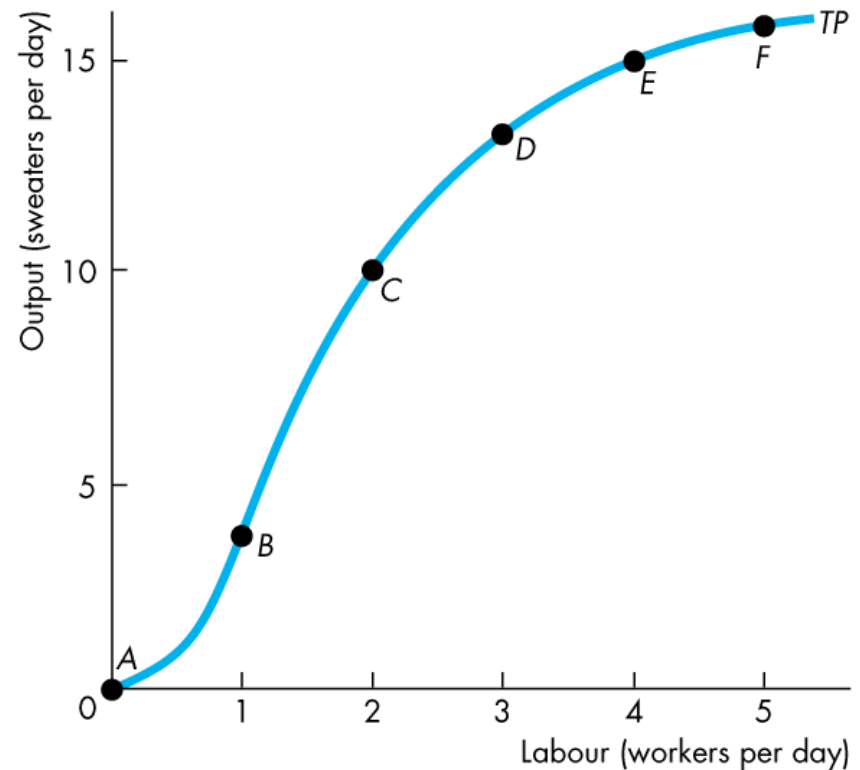
Short-Run Technology Constraint

Total Product Curve

The shape of this curve is no accident.

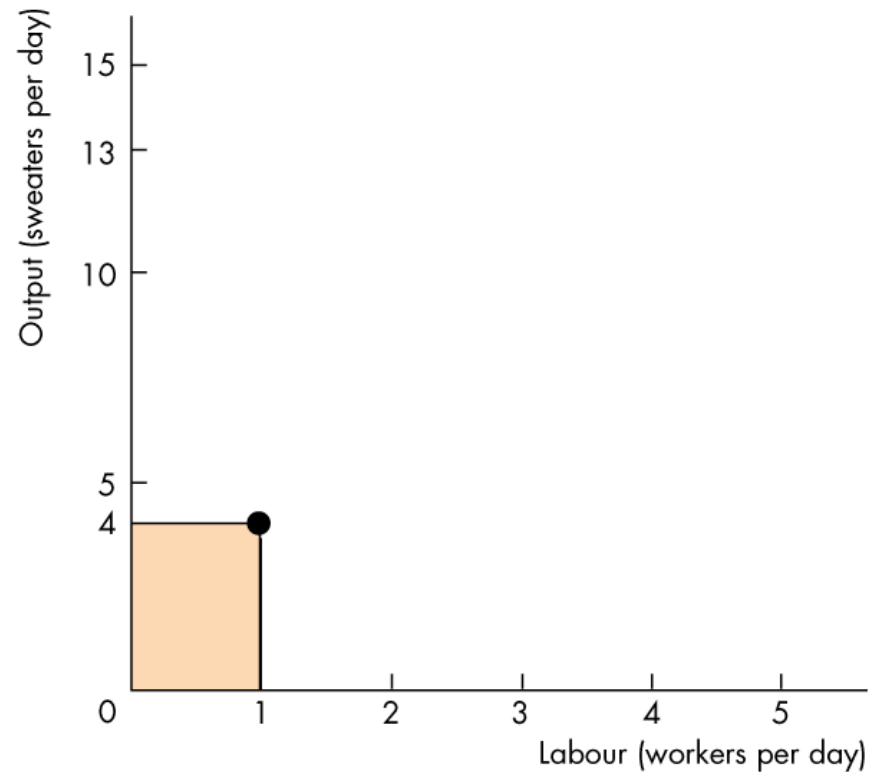
Positively sloped because labour is productive (more labour = more output)

It is first steep, and then gets flatter. Why?



▶ Short-Run Technology Constraint

The first worker hired produces 4 units of output.



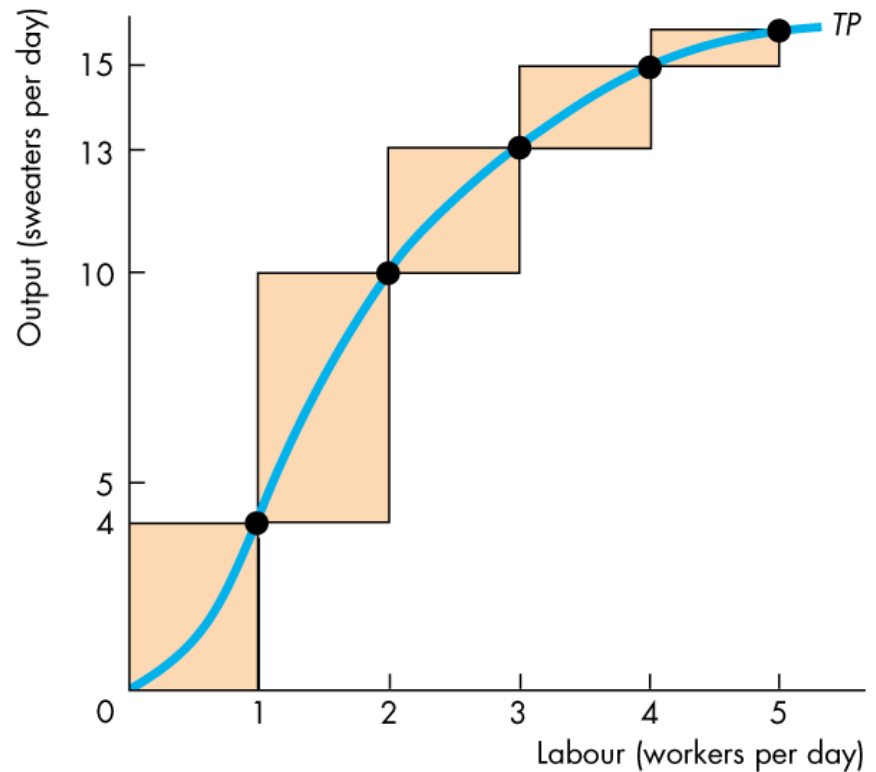
(a) Total product

Short-Run Technology Constraint

The second worker hired produces 6 units of output and total product becomes 10 units.

The third worker hired produces 3 units of output and total product becomes 13 units.

And so on.



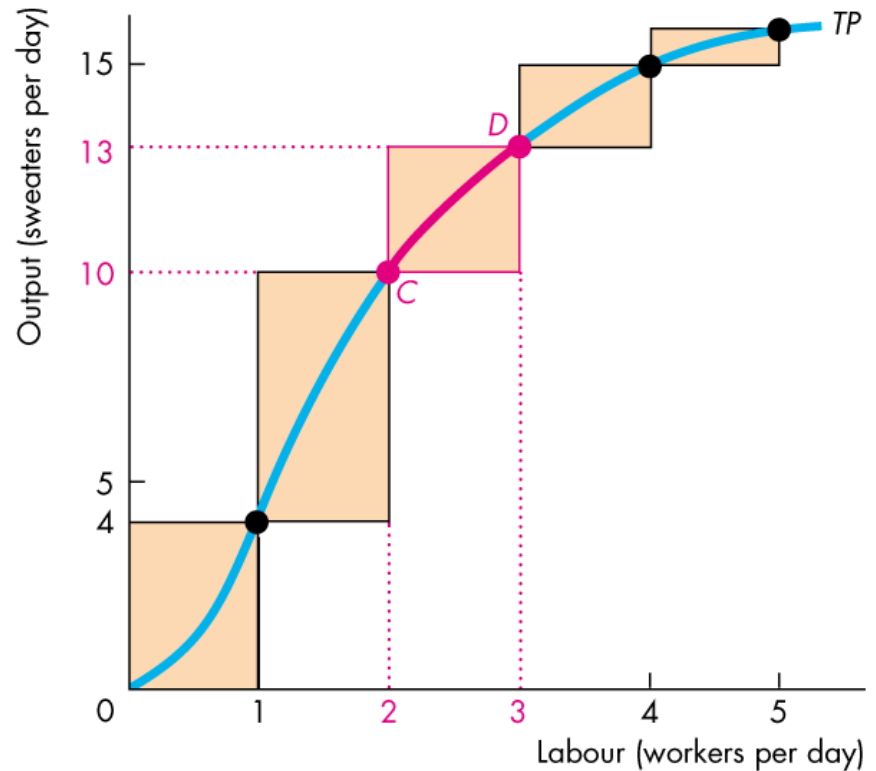
(a) Total product

Short-Run Technology Constraint

The height of each bar measures the marginal product of labour.

For example, when labour increases from 2 to 3, total product increases from 10 to 13,

so the marginal product of the third worker is 3 units of output.

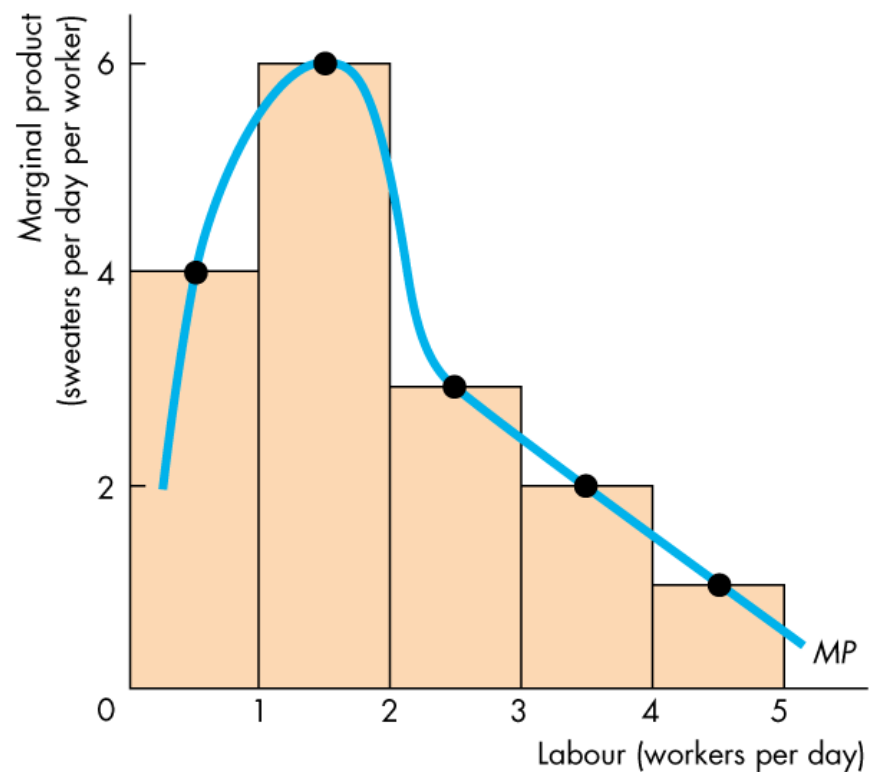


(a) Total product

Short-Run Technology Constraint

To make a graph of the marginal product of labour, we can stack the bars in the previous graph side by side.

The marginal product of labour curve passes through the mid-points of these bars.

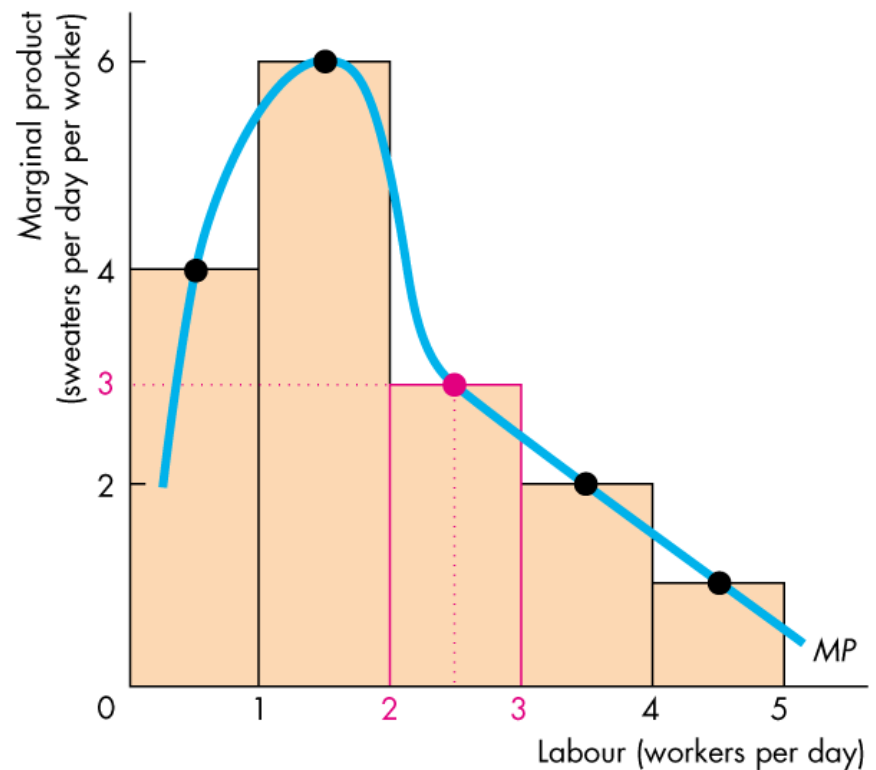


(b) Marginal product

Short-Run Technology Constraint

Almost all production processes are like the one shown here and have:

- Increasing marginal returns initially
- Diminishing marginal returns eventually

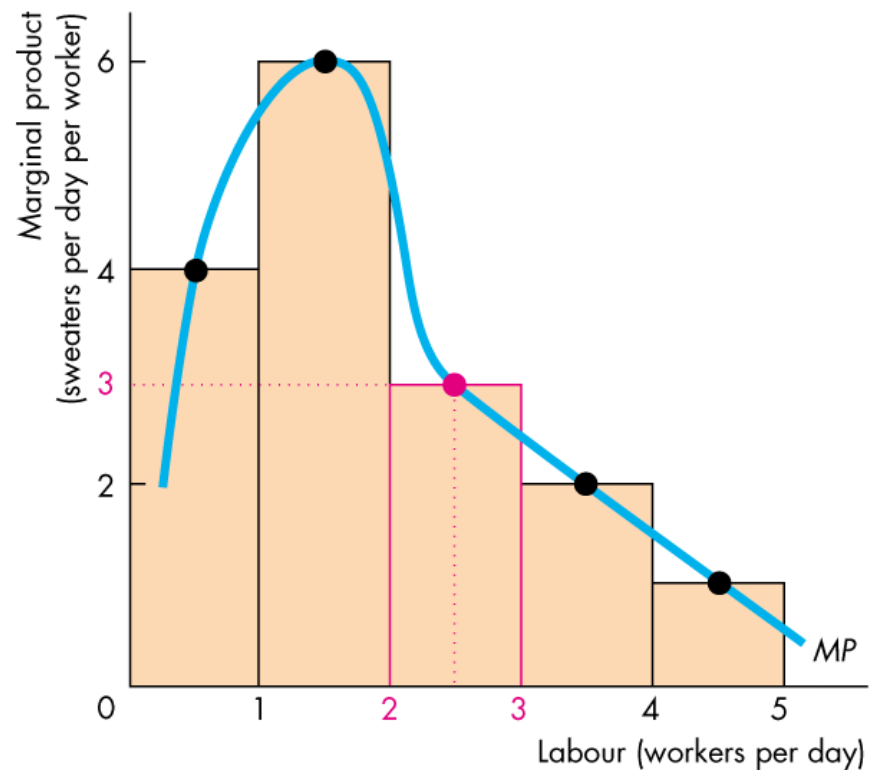


(b) Marginal product

Short-Run Technology Constraint

Increasing Marginal Returns Initially

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



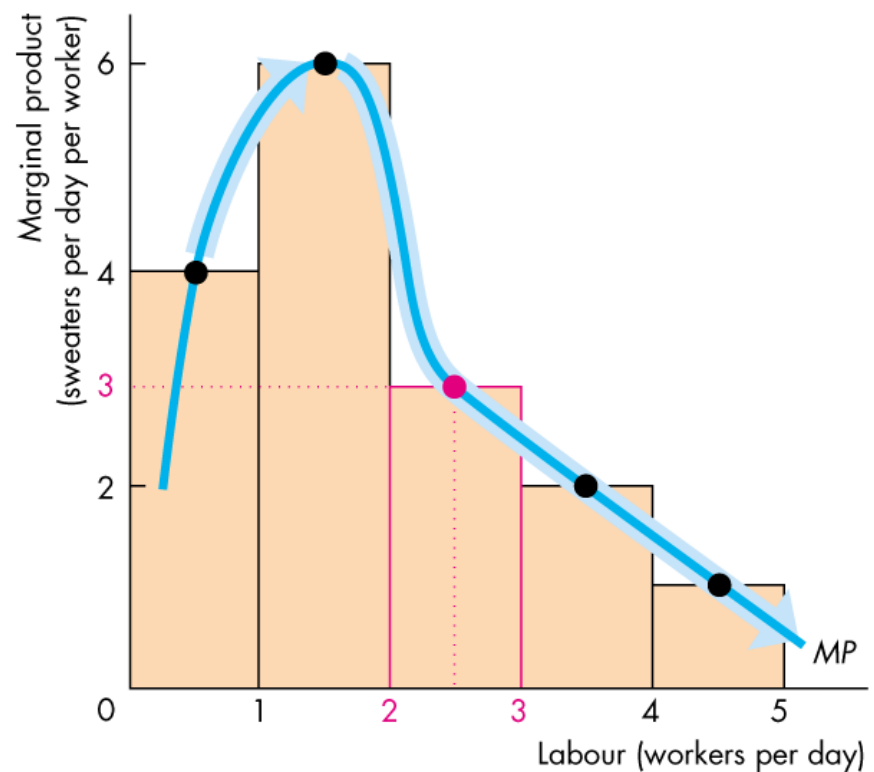
(b) Marginal product

Short-Run Technology Constraint

Diminishing Marginal Returns Eventually

When the marginal product of a worker is *less* than the marginal product of the previous worker, the marginal product of labour *decreases*.

The firm experiences **diminishing marginal returns**.



(b) Marginal product

Short-Run Technology Constraint

Increasing marginal returns arise from increased specialization and division of labour.

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.

Diminishing marginal returns are so pervasive that they are elevated to the status of a “law.”

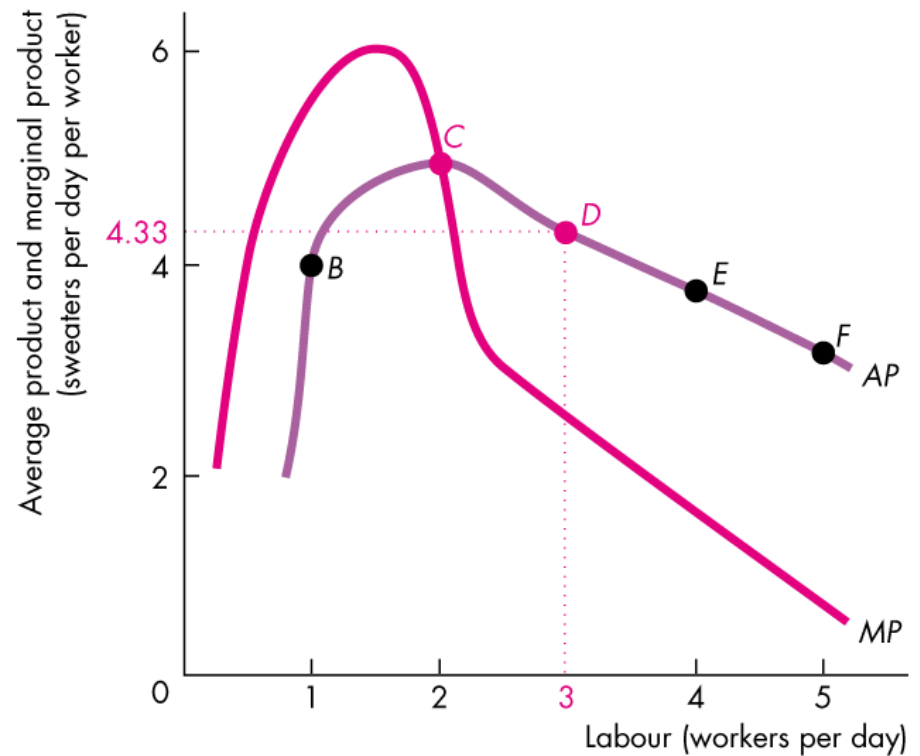
The **law of diminishing returns** states that:

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

Average Product Curve

Figure 11.3 shows the average product curve and its relationship with the marginal product curve.

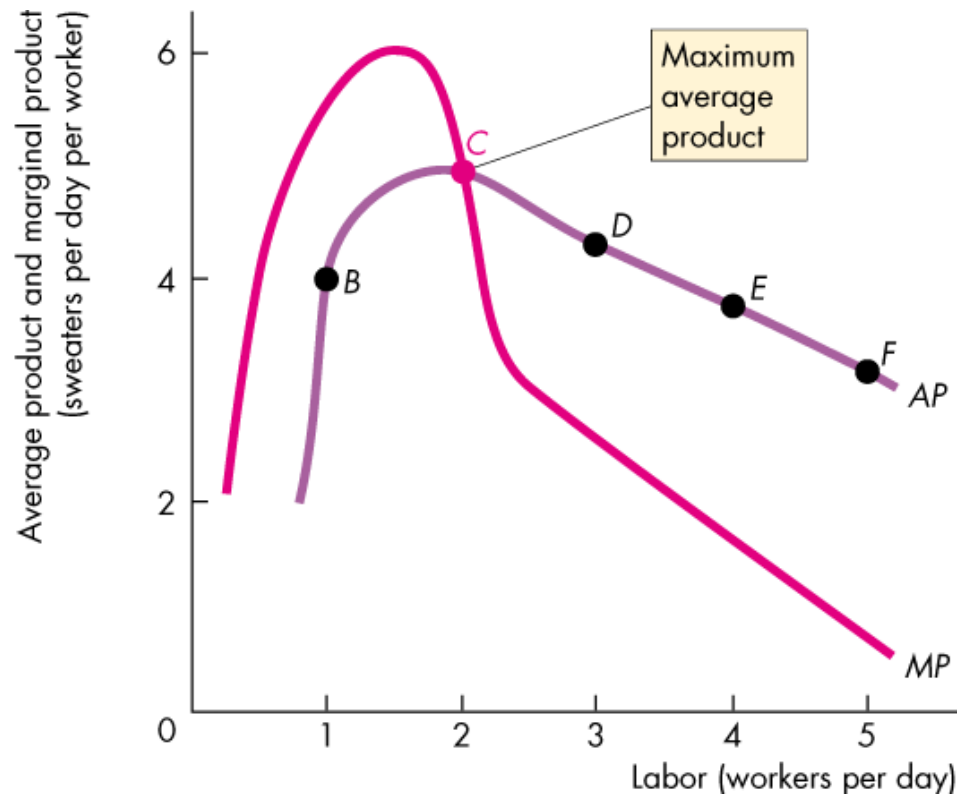


Short-Run Technology Constraint

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.





We have characterized the firms short-run technology, by graphing the firms total product curve, its marginal product curve and its average product curve.

We now want to figure out what the implications of this technology is for the first cost structure.

By cost structure, we mean the relationship between the quantity of output and the cost of production.

Short-Run Cost

To produce more output in the short run, the firm must employ more labour, 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:

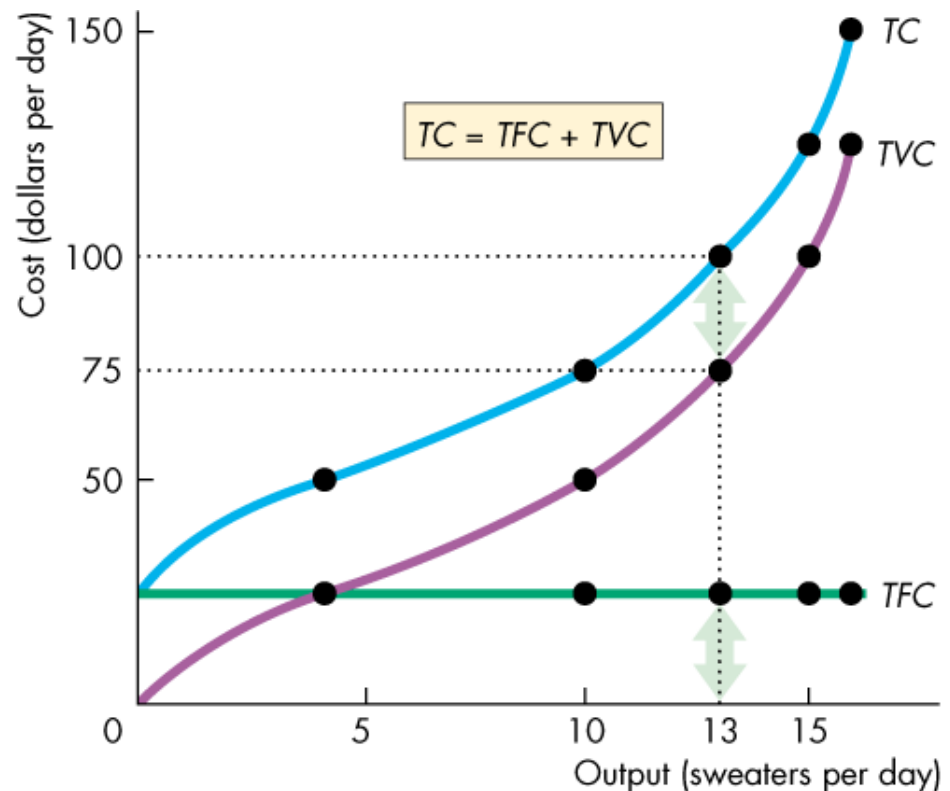
$$TC = TFC + TVC$$

Short-Run Cost

Total fixed cost is the same at each output level.

Total variable cost increases as output increases. (Why?)

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

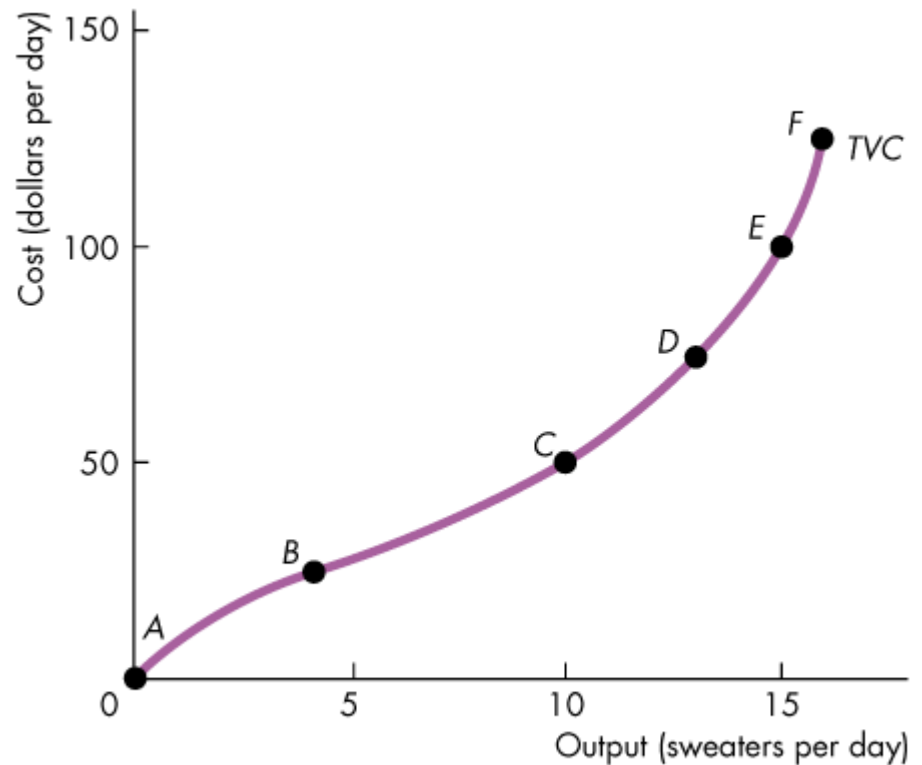


Short-Run Cost

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 becomes less steep at low output levels and steeper at high output levels.

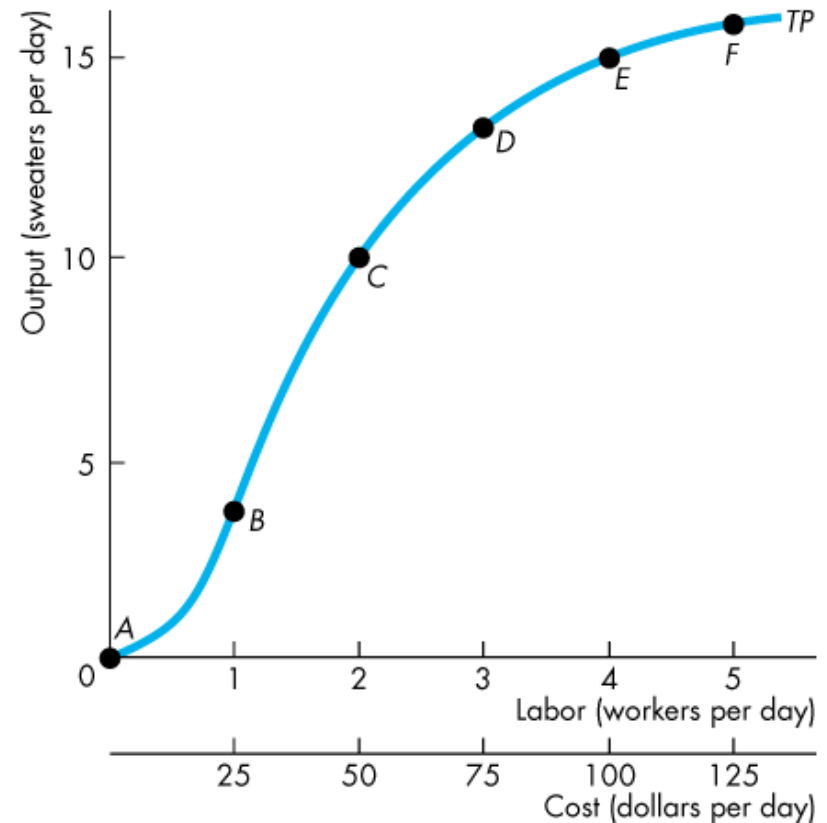


Short-Run Cost

To see the relationship between the TVC curve and the TP curve, let's look again at the TP curve.

But let us add a second x-axis to measure total variable cost.

1 worker costs \$25; 2 workers cost \$50: and so on, so the two x-axes line up.

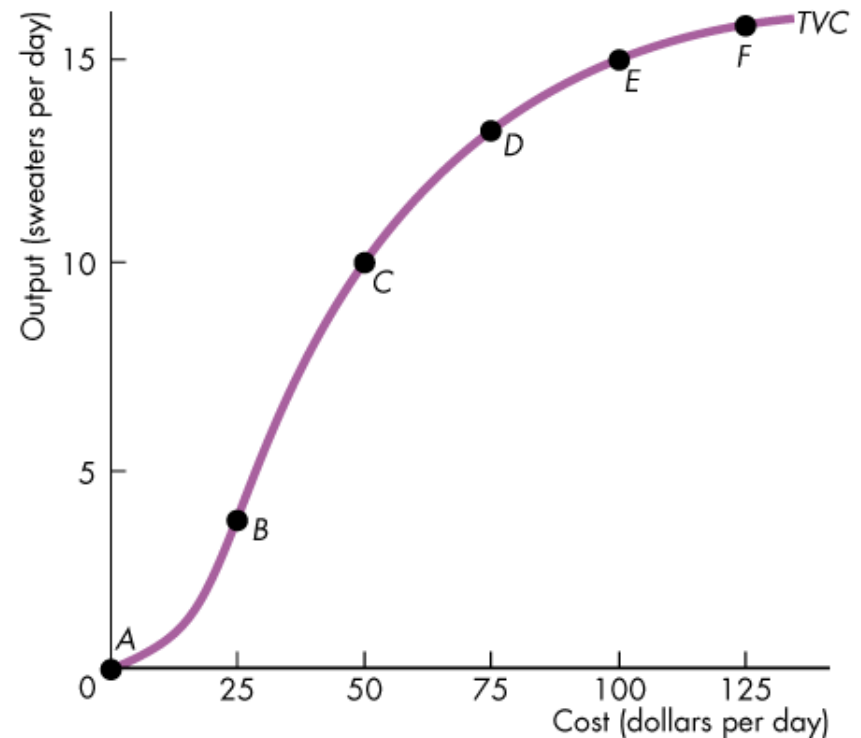


Short-Run Cost

We can replace the quantity of labour on the x-axis with total variable cost.

When we do that, we must change the name of the curve. It is now the *TVC* curve.

But it is graphed with cost on the x-axis and output on the y-axis.

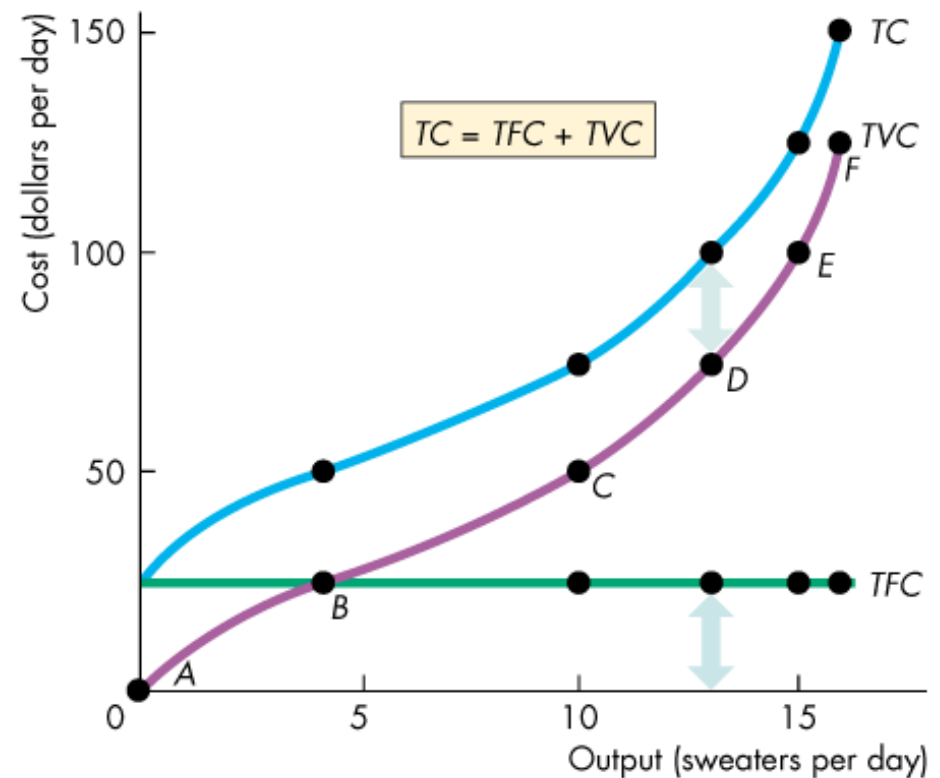


Short-Run Cost

Redraw the graph with cost on the y-axis and output on the x-axis, and you've got the *TVC* curve drawn the usual way.

Put the *TFC* curve back in the figure,

and add *TFC* to *TVC*, and you've got the *TC* curve.



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.

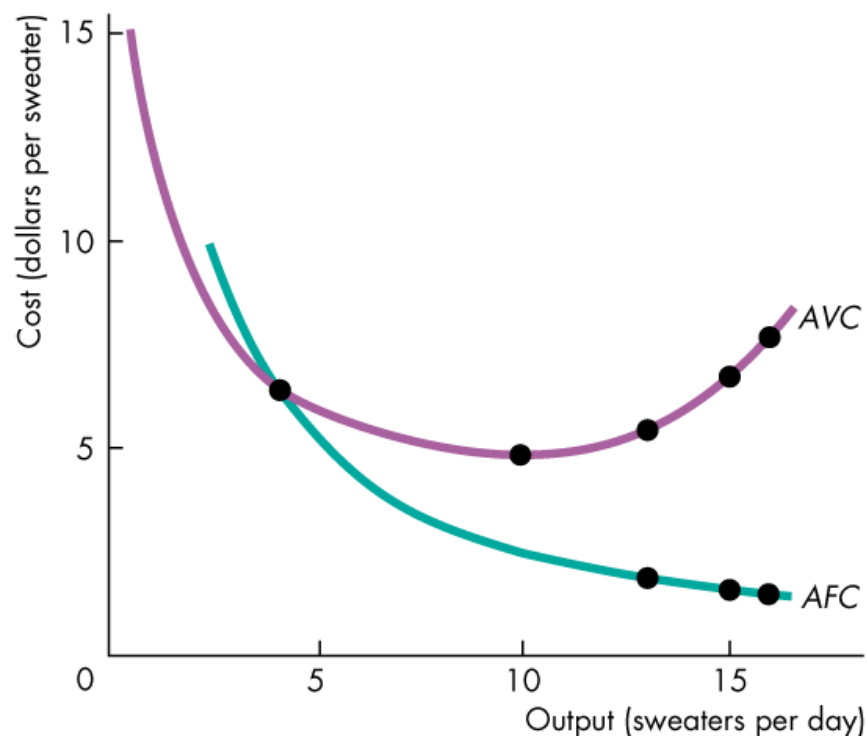
$$ATC = AFC + AVC.$$

Short-Run Cost

Figure 11.5 shows the MC , AFC , AVC , and ATC curves.

The AFC curve shows that average fixed cost 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

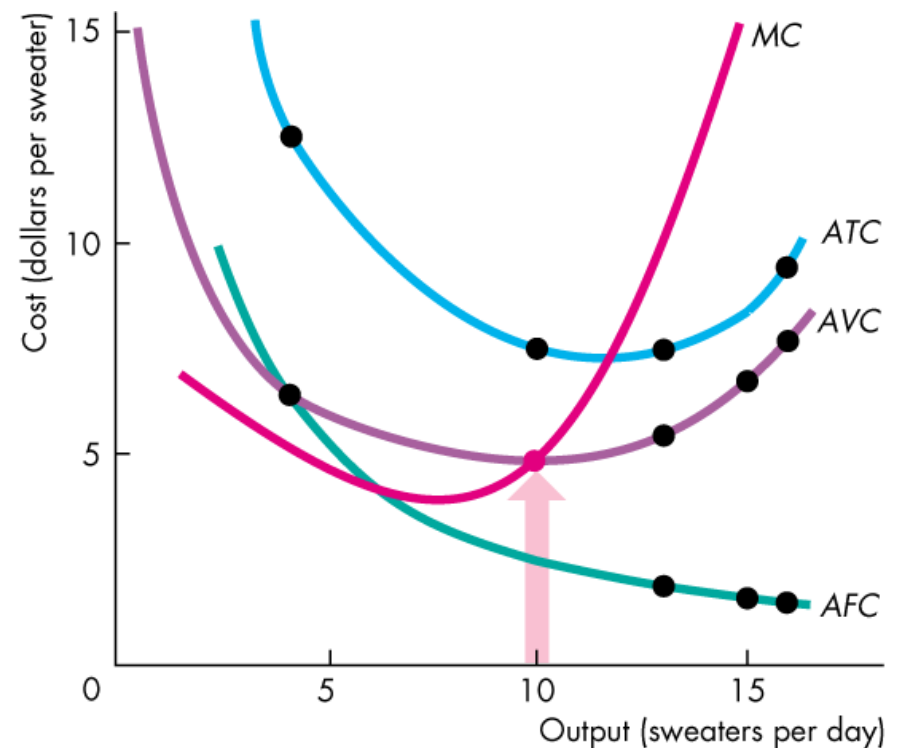
The ATC curve is also U-shaped.

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 .

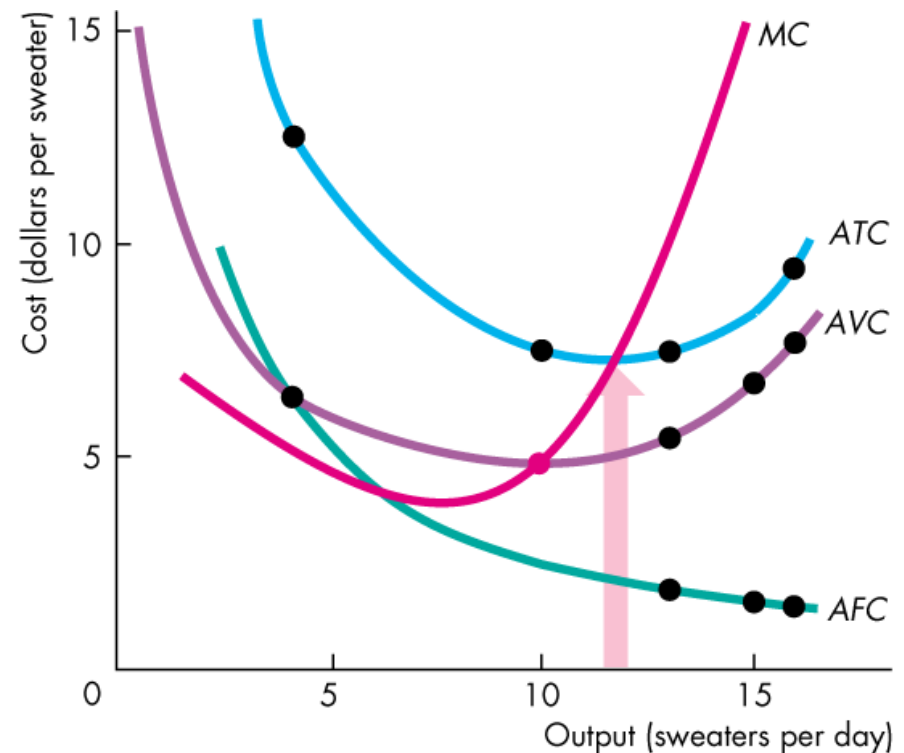


Short-Run Cost

Similarly, the outputs over which ATC is falling, MC is below ATC .

The outputs over which ATC is rising, MC is above ATC .

At the minimum ATC , MC equals ATC .



Short-Run Cost

Why the Average Total Cost Curve Is U-Shaped

The *AVC* curve is U-shaped because:

Initially, marginal product exceeds average product, which brings rising average product and falling *AVC*.

Eventually, marginal product falls below average product, which brings falling average product and rising *AVC*.

The *ATC* curve is U-shaped for the same reasons. In addition, *ATC* falls at low output levels because *AFC* is falling steeply.

Short-Run Cost

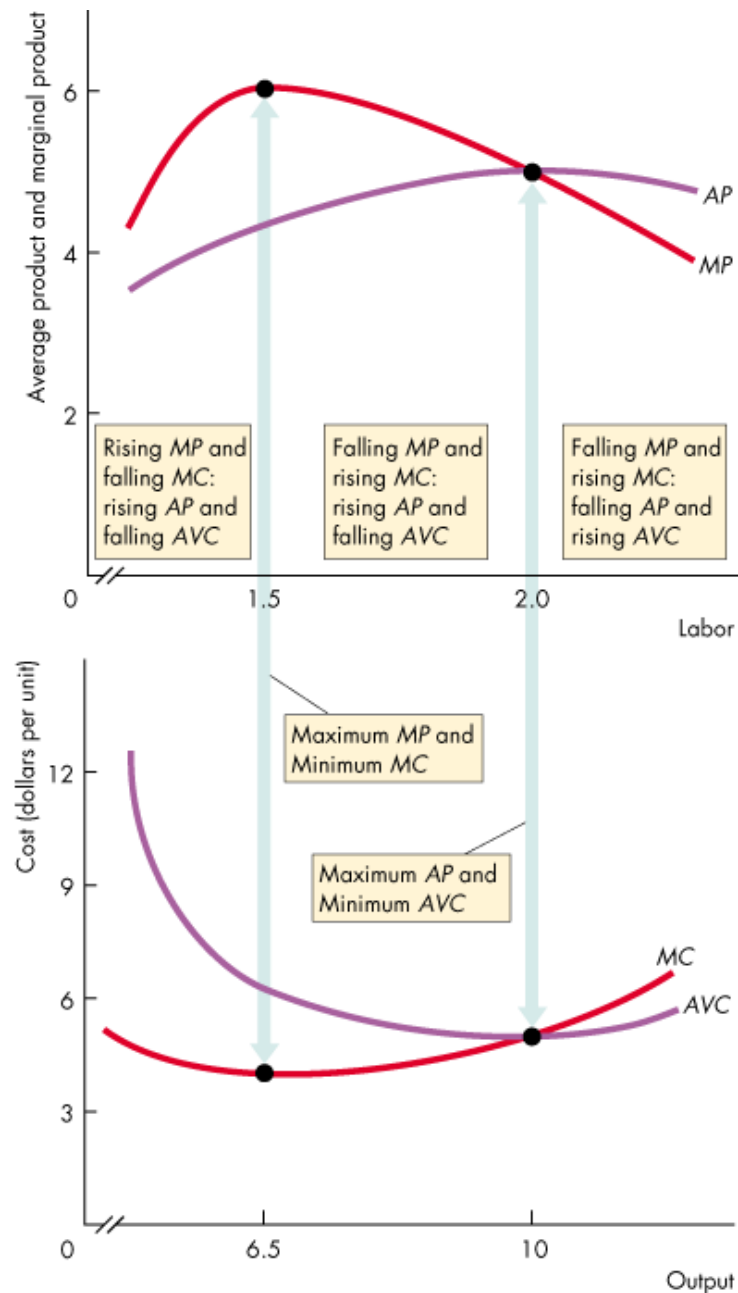
Cost Curves and Product Curves

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

- MC is at its minimum at the same output level at which marginal product is at its maximum.
- When marginal product is rising, marginal cost is falling.
- AVC is at its minimum at the same output level at which average product is at its maximum.
- When average product is rising, average variable cost is falling.

Short-Run Cost

Figure 11.6 shows these relationships.



Short-Run Cost

Shifts in Cost Curves

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

- Technology
- Prices of factors of production

Short-Run Cost

Technology

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 labour 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

Prices of Factors of Production

An increase in the price of a factor of production increases costs and shifts 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.

Long-Run Cost

In the long run, all inputs are variable and all costs are variable.

The Production Function

The behavior of long-run cost depends upon the firm's production function.

The firm's *production function* is the relationship between the maximum output attainable and the quantities of both capital and labour.

Long-Run Cost

Table 11.3 shows a firm's production function.

As the size of the plant increases, the output that a given quantity of labour can produce increases.

But as the quantity of labour increases, diminishing returns occur for each plant.

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

Diminishing Marginal Product of Capital

The *marginal product of capital* is the increase in output resulting from a one-unit increase in the amount of capital employed, holding constant the amount of labour employed.

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

For *each* plant, diminishing marginal product of labour creates a set of short run, U-shaped costs curves for *MC*, *AVC*, and *ATC*.

Long-Run Cost

Short-Run Cost and Long-Run Cost

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

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

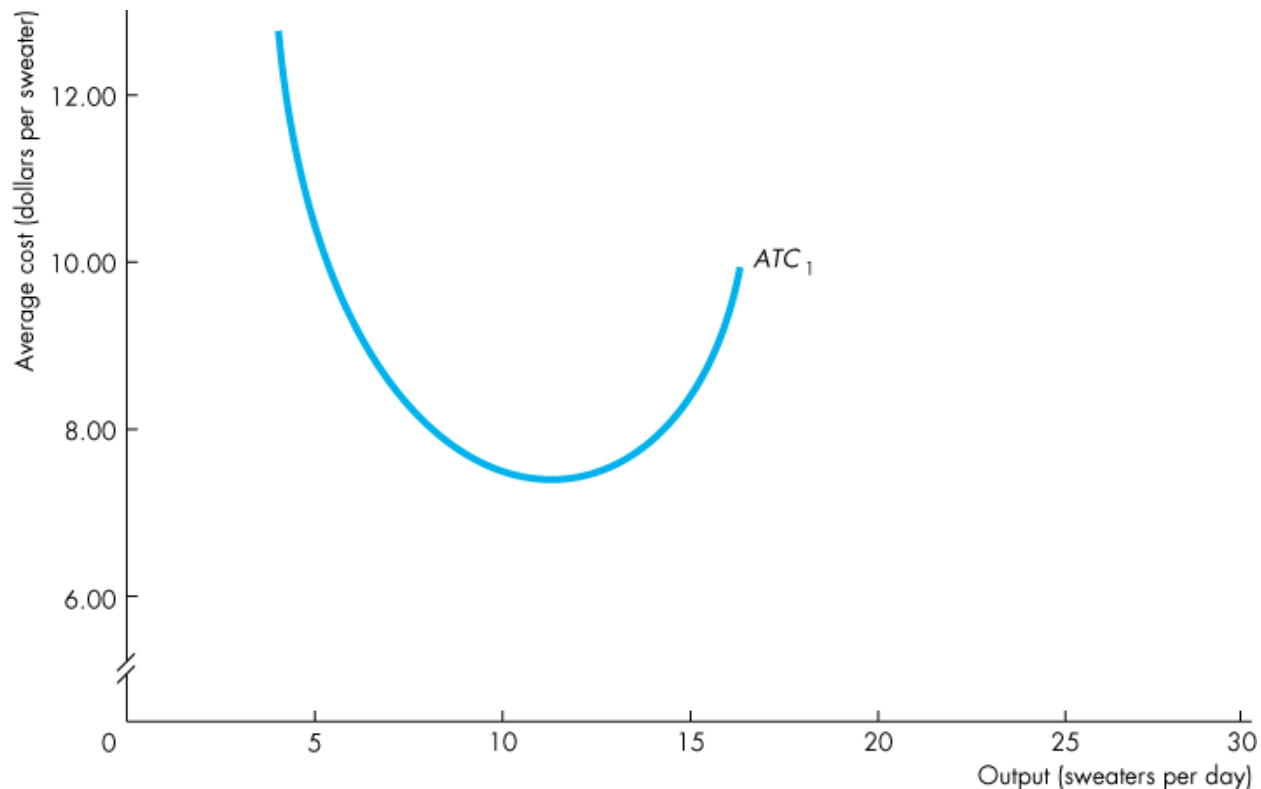
The firm has 4 different plants: 1, 2, 3, or 4 knitting machines.

Each plant has a short-run ATC curve.

The firm can compare the ATC for each output at different plants.

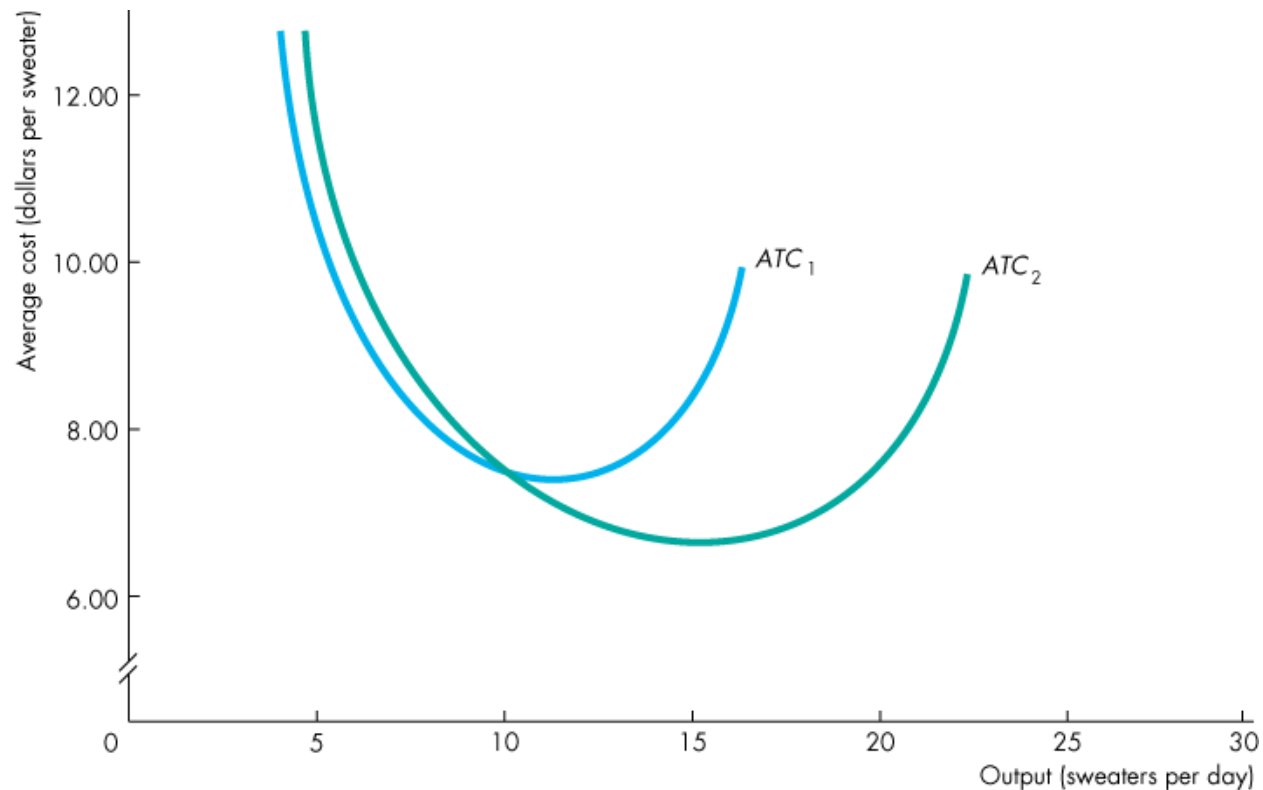
▶ Long-Run Cost

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



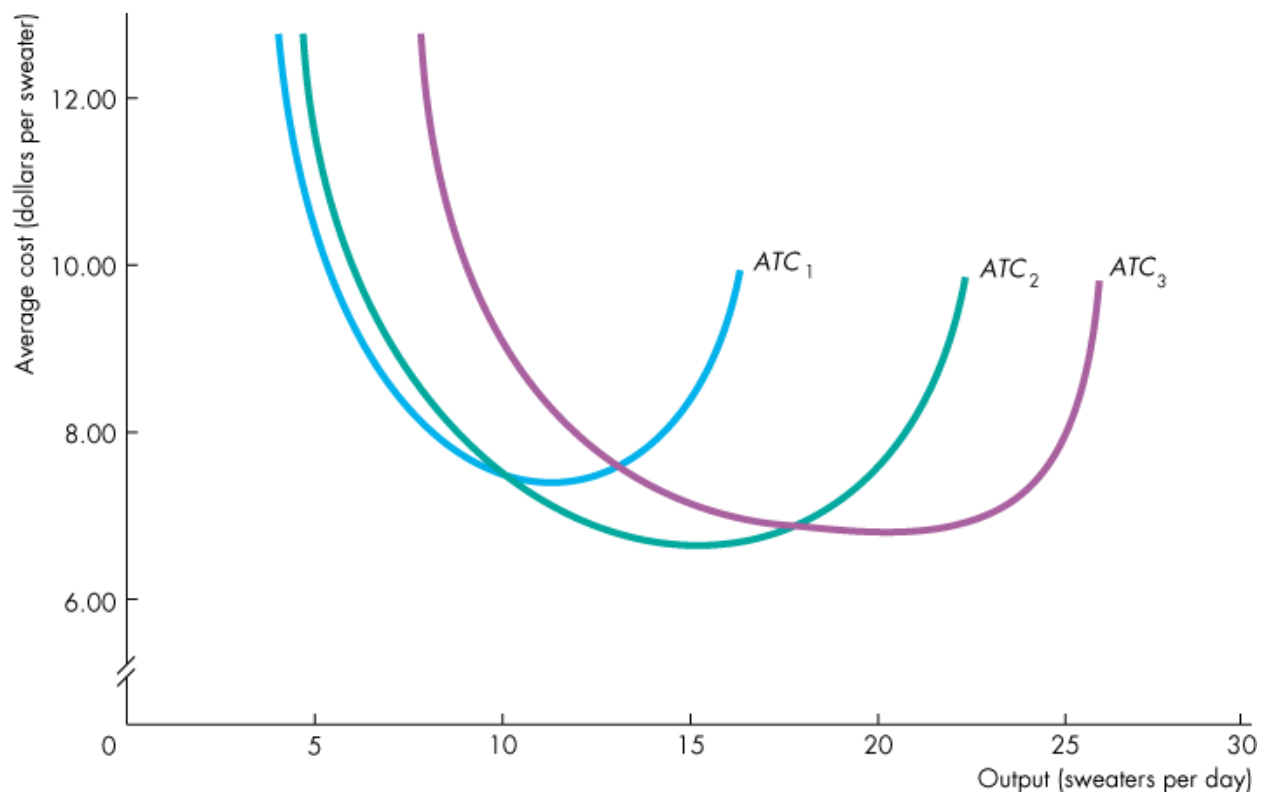
Long-Run Cost

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



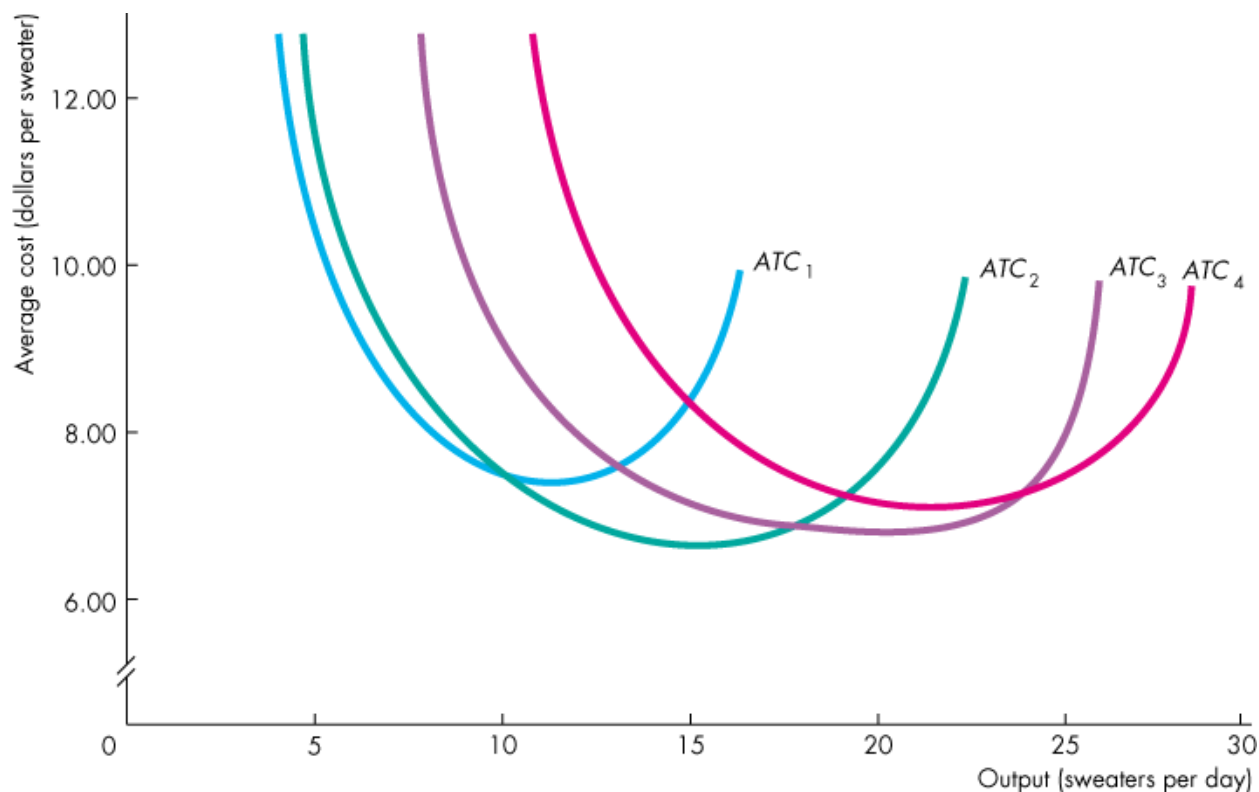
Long-Run Cost

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

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

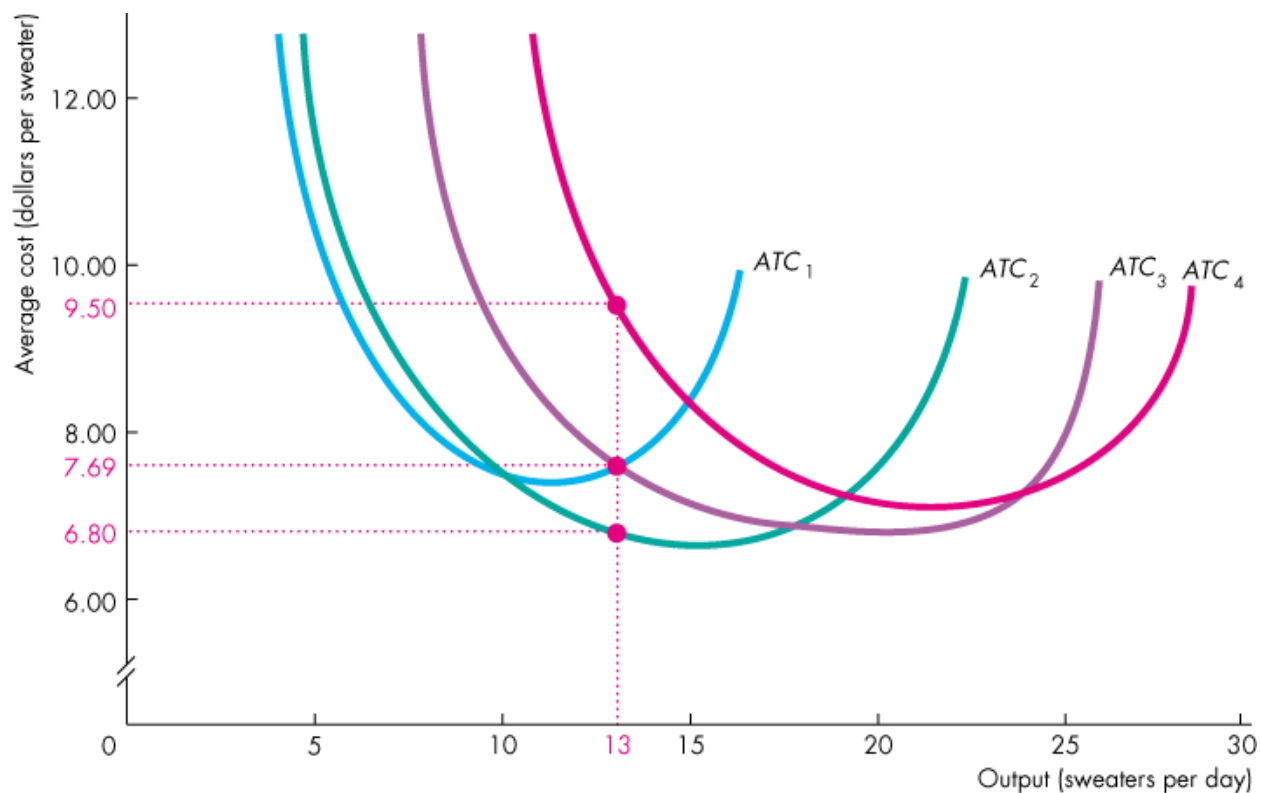
So, we want to decide which plant has the lowest cost for producing each output level.

Let's find the least-cost way of producing a given output level.

Suppose that the firm wants to produce 13 sweaters a day.

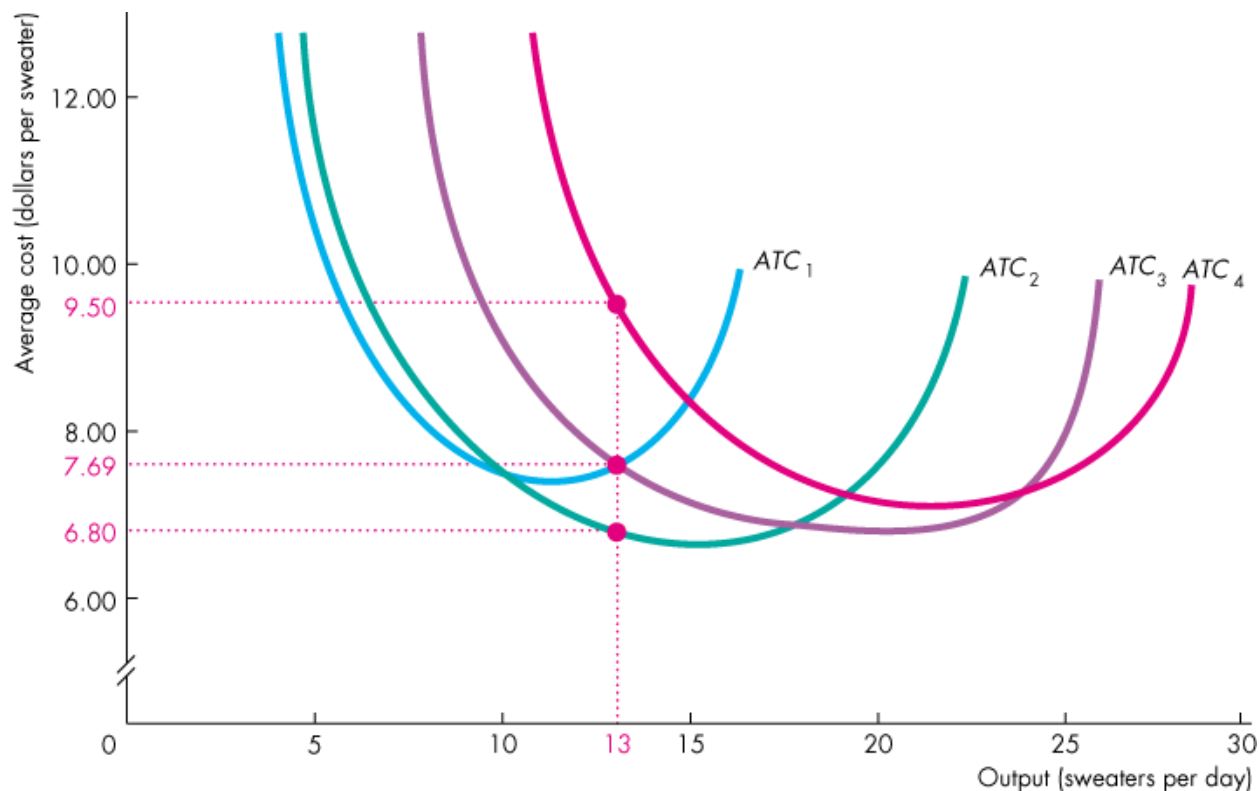
Long-Run Cost

13 sweaters a day cost \$7.69 each on ATC_1 .



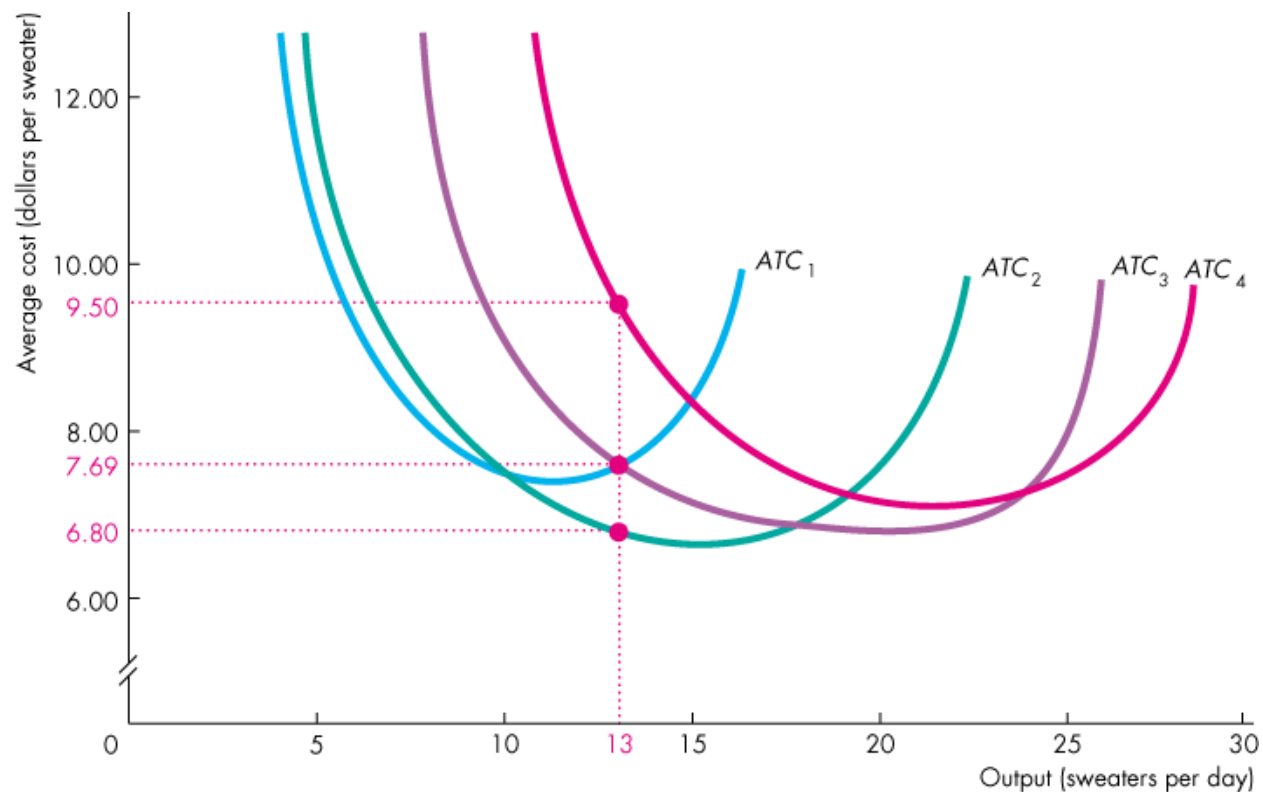
Long-Run Cost

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



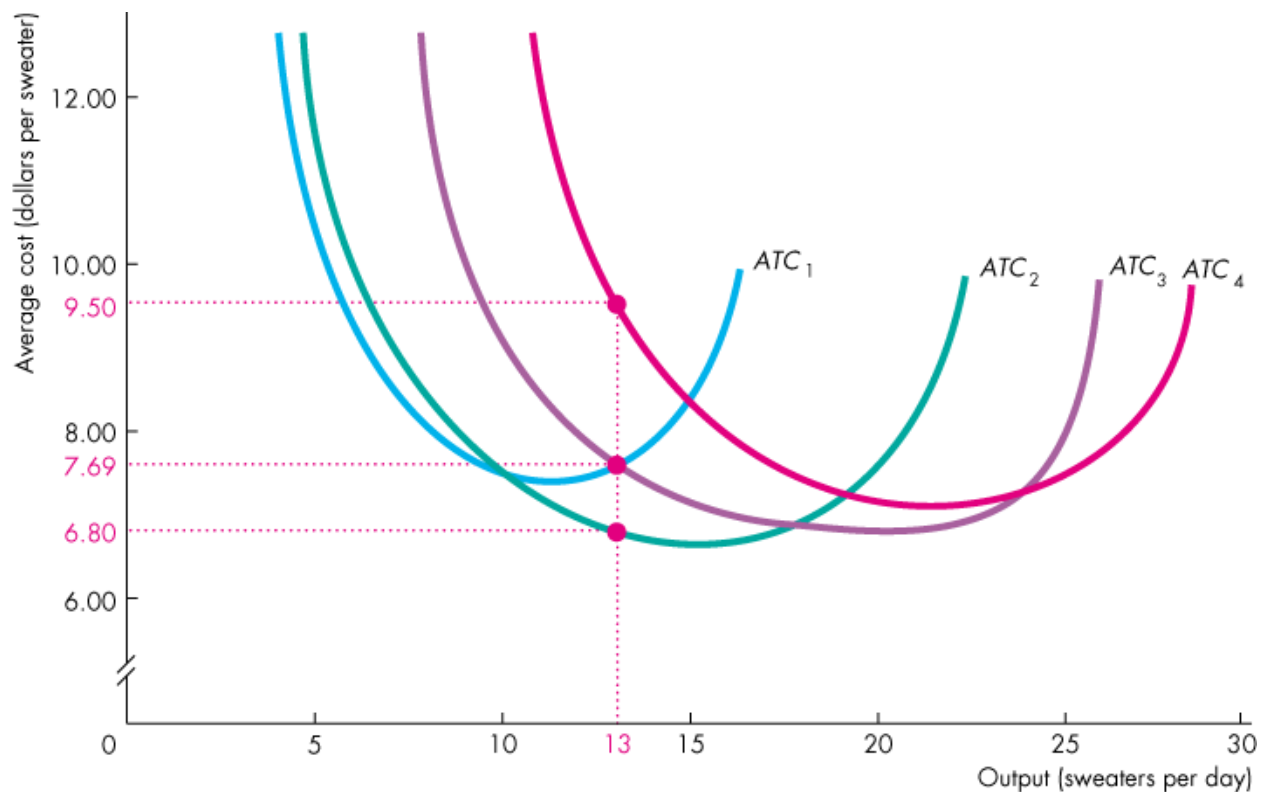
Long-Run Cost

13 sweaters a day cost \$7.69 each on ATC_3 .



Long-Run Cost

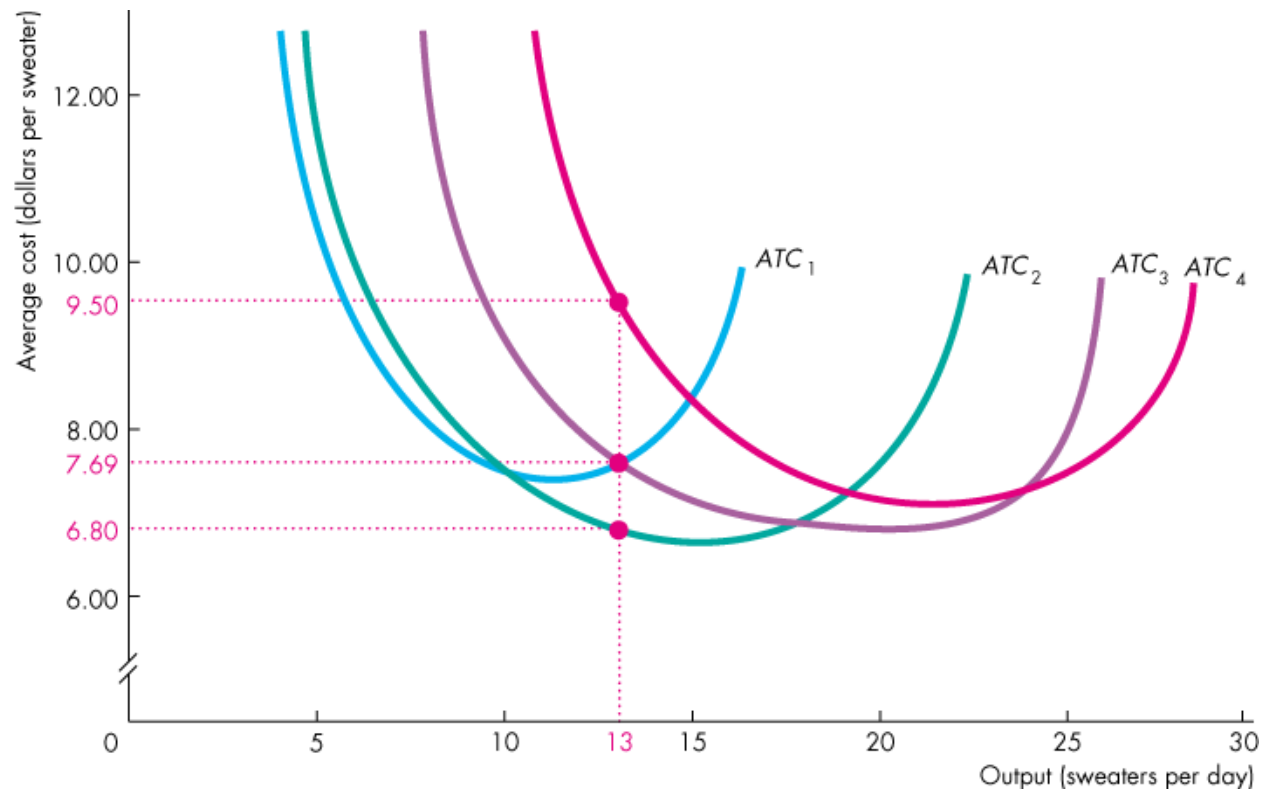
13 sweaters a day cost \$9.50 each on ATC_4 .



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

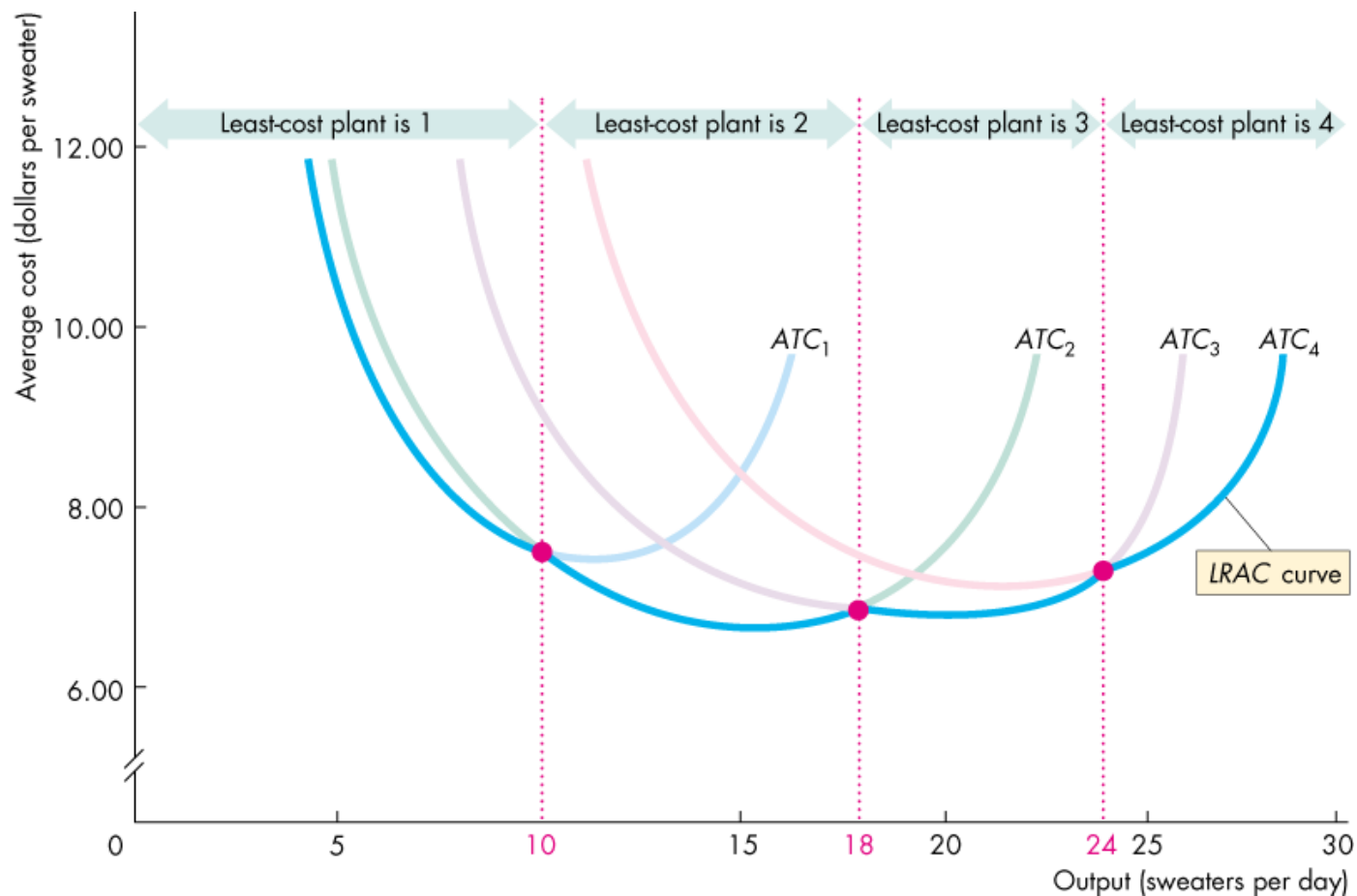
The **long-run average cost curve** is the relationship between the lowest attainable average total cost and output when both the plant and labour are varied.

The long-run average cost curve is a planning curve that tells the firm the plant that minimizes the cost of producing a given output range.

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

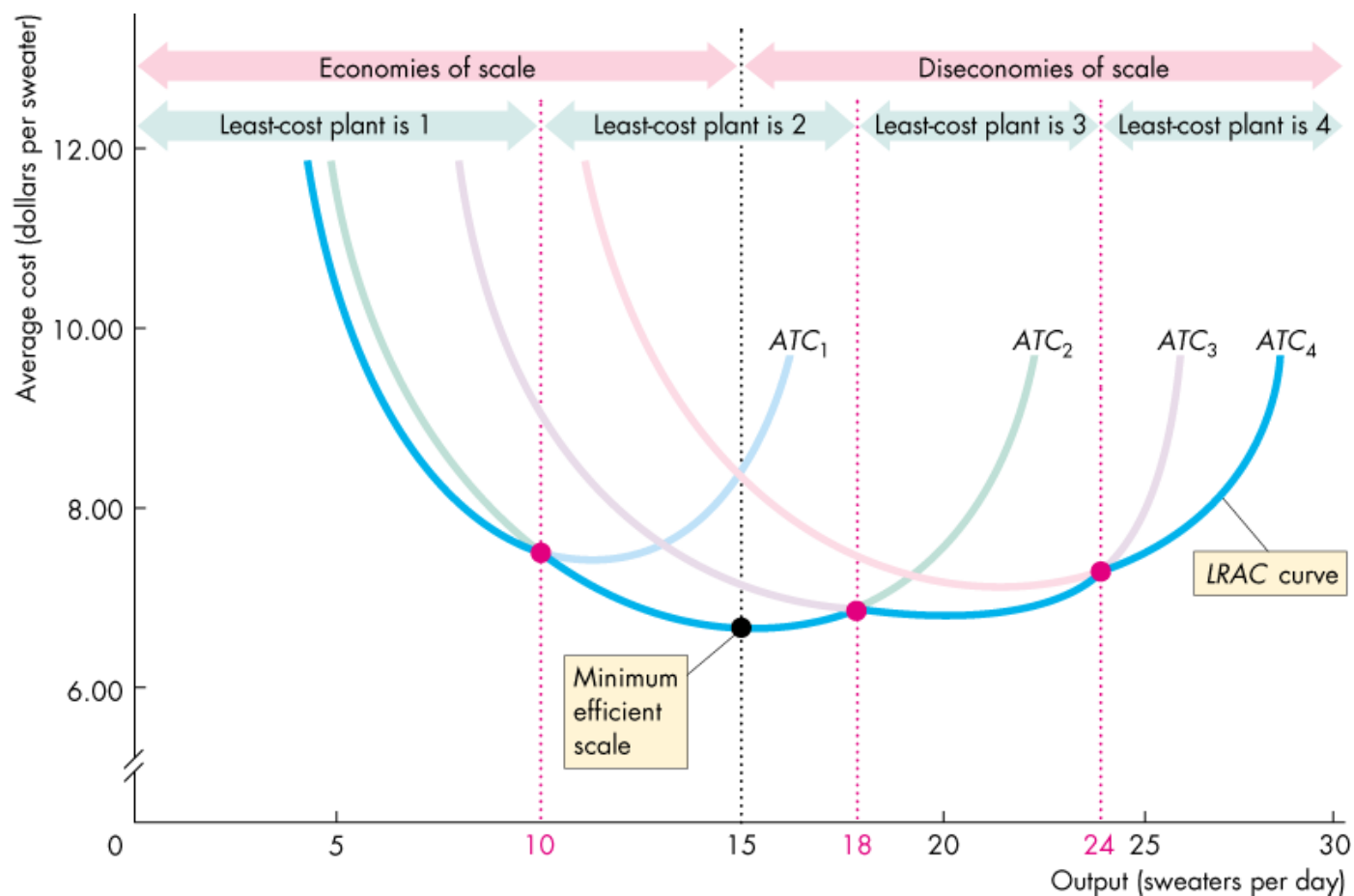
Economies of scale are features of a firm's technology that lead to falling long-run average cost as output increases.

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

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.