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## Objectives

- Distinction between the short run and the long run
- The relationship between a firm's output and labor employed in the short run
- The relationship between a firm's output and costs in the short run
- A firm's short-run cost curves
- Relationship between a firm's output and costs in the long run

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## 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.

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## 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.

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.

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## 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

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## Short-Run Technology Constraint

### Product Schedules

#### Total product

total output produced in a given period.

#### Marginal product of labor

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

#### Average product of labor

total product divided by the quantity of labor

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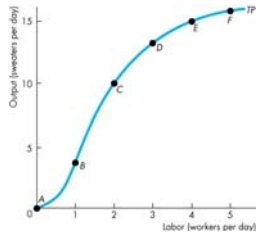
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## Short-Run Technology Constraint

### The Total Product Curve

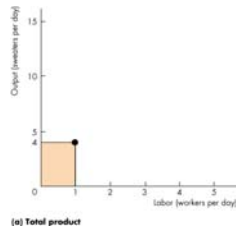


## Short-Run Technology Constraint

### The Marginal Product Curve

The marginal product of labor curve and how the marginal product curve relates to the total product curve.

The first worker hired produces 4 units of output.

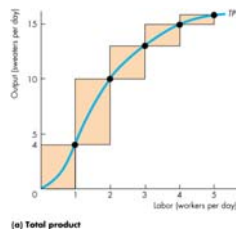


## Short-Run Technology Constraint

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.

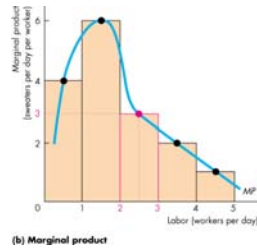
And so on.



## Short-Run Technology Constraint

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

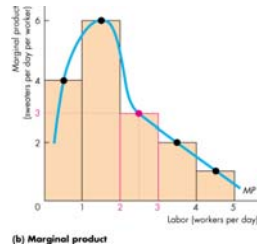
The marginal product of labor curve passes through the mid-points of these bars.



## Short-Run Technology Constraint

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

- Initially increasing marginal returns
- Eventually 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.

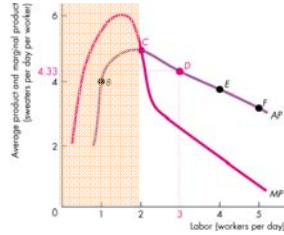
The **law of diminishing returns** states that as a firm uses more of a variable input with a given quantity of fixed inputs, the marginal product of the variable input *eventually diminishes*.

## Short-Run Technology Constraint

### Average Product Curve

The average product curve and its relationship with the marginal product curve.

When marginal product exceeds average product, average product increases.



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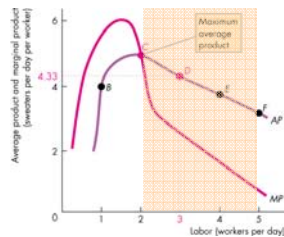
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## Short-Run Technology Constraint

When marginal product is *below* average product, average product decreases.

When marginal product equals average product, average product is at its maximum.



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## 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

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## 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:

$$TC = TFC + TVC$$

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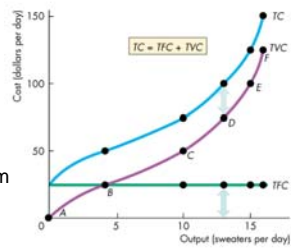
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## Short-Run Cost

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.



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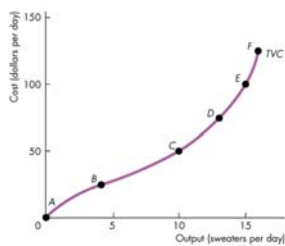
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## Short-Run Cost

The total variable cost curve gets its shape from the Law of Diminishing Marginal Returns.

Initially, TVC rises at a decreasing rate (increasing marginal returns)

Eventually, TVC rises at an increasing rate (diminishing marginal returns)



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## Short-Run Cost

### Marginal Cost

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

If labor is the only variable input,  $MC = W / (MP \text{ of labor})$

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.

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## Short-Run Cost

### Average Cost

Average cost measures can be derived from each of the total cost measures:

**Average fixed cost (AFC)** =  $TFC / TP$

**Average variable cost (AVC)** =  $TVC / TP$

If labor is the only variable input,  $AVC = W / (AP \text{ of labor})$

**Average total cost (ATC)** is total cost per unit of output.

$$ATC = TC / TP = AFC + AVC.$$

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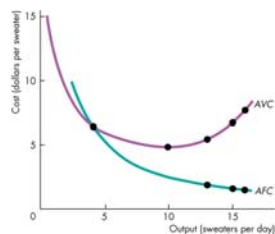
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## Short-Run Cost

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.



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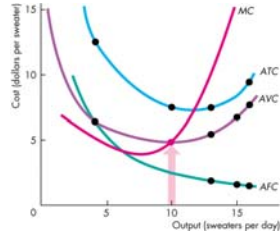
## Short-Run Cost

The ATC curve is also U-shaped.

If  $MC < AVC$ ,  $AVC$  is falling.

If  $MC > AVC$ ,  $AVC$  is rising.

$MC$  always intersects  $AVC$  at the minimum of  $AVC$ .

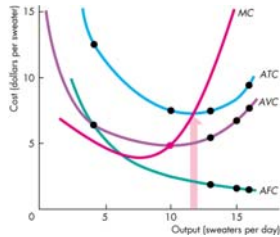


## Short-Run Cost

If  $MC < ATC$ ,  $ATC$  is falling

If  $MC > ATC$ ,  $ATC$  is rising.

$MC$  always intersects  $ATC$  at the minimum of  $ATC$ .



## Short-Run Cost

### Cost Curves and Product Curves

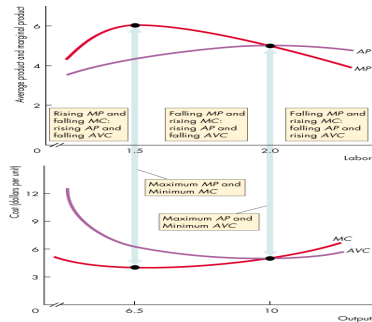
If labor is the only variable input,

$MC = W/MP$  of labor

$AVC = W/AP$  of labor



## Short-Run Cost



## 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
- shifts 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
- 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.

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### 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*, which is the relationship between the maximum output attainable and the quantities of both capital and labor.

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### Long-Run Cost

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 labor employed.

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

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

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## 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 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.

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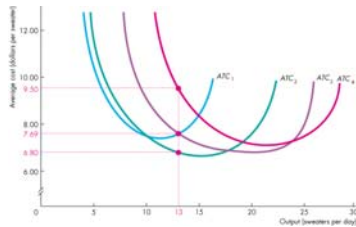
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## Long-Run Cost

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.



What's the low cost method for producing 5 sweaters? 13 sweaters? 25 sweaters?

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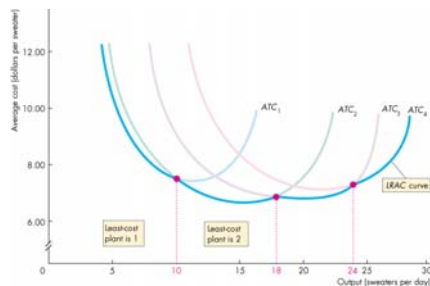
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## Long-Run Cost

The long-run average cost ( $LRAC$ ) curve.




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## 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.

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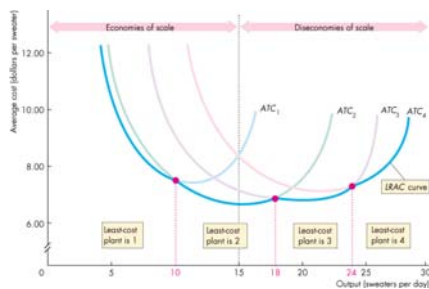
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## Long-Run Cost



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## 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.

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### Market Structure and Minimum Efficient Scale

•As MES rises relative to consumer demand, the number of firms in the industry will fall.

•Cases to consider:

- Microsoft
- Steel industry
- Printing industry
- Farming

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