The Costs of Production

What are Costs?

- **Total revenue**
  - Amount a firm receives for the sale of its output
- **Total cost**
  - Market value of the inputs a firm uses in production
- **Profit**
  - Total revenue minus total cost

What are Costs?

- Costs as opportunity costs
  - The cost of something is what you give up to get it
- Firm's cost of production
  - Include all the opportunity costs
    - Making its output of goods and services

What are Costs?

- Costs as opportunity costs

- Explicit costs
  - Input costs that require an outlay of money by the firm

- Implicit costs
  - Input costs that do not require an outlay of money by the firm

What are Costs?

- The cost of capital as an opportunity cost
  - Implicit cost
  - Interest income not earned
    - On financial capital
      - Owned as saving
      - Invested in business
    - Not shown as cost by an accountant

What are Costs?

- **Economic profit**
  - Total revenue minus total cost
    - Including both explicit and implicit costs
- **Accounting profit**
  - Total revenue minus total explicit cost

Figure | 1

Economists versus accountants
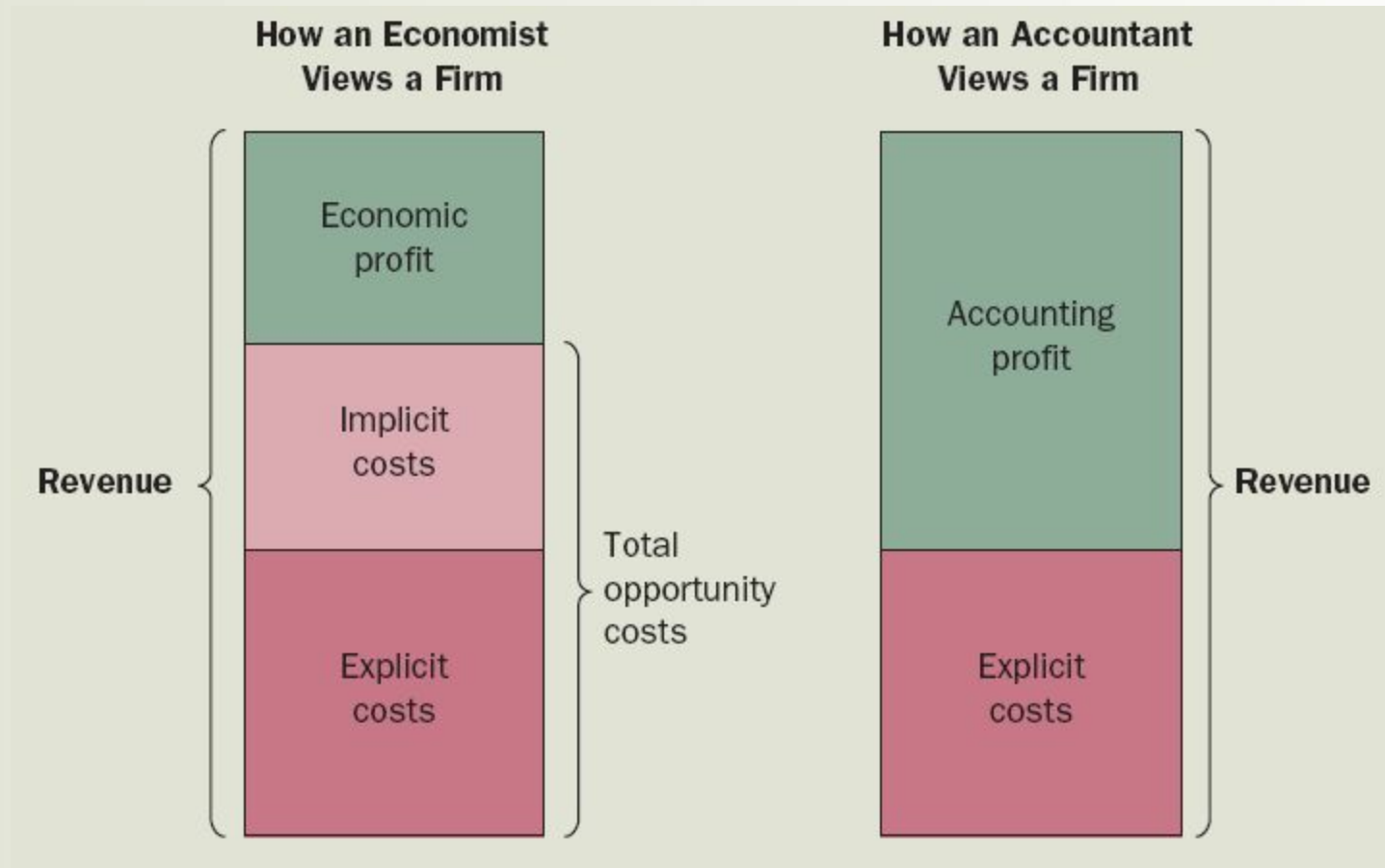
Economists include all opportunity costs when analyzing a firm, whereas accountants measure only explicit costs. Therefore, economic profit is smaller than accounting profit

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Production and Costs

- Production function
  - Relationship between
    - Quantity of inputs used to make a good
    - And the quantity of output of that good
  - Gets flatter as production rises
- Rational people think at the margin
- Marginal product
  - Increase in output
    - Arising from an additional unit of input

Production and Costs

- Diminishing marginal product
  - Marginal product of an input declines as the quantity of the input increases
- Total-cost curve
  - Relationship between quantity produced and total costs
  - Gets steeper as the amount produced rises

Table 1

A production function and total cost: Caroline's cookie factory

Number of workers	Output (quantity of cookies produced per hour)	Marginal product of labor	Cost of factory	Cost of workers	Total cost of inputs (cost of factory + cost of workers)
0	0		$30	$0	$30
		50			
1	50		30	10	40
		40			
2	90		30	20	50
		30			
3	120		30	30	60
		20			
4	140		30	40	70
		10			
5	150		30	50	80
		5			
6	155		30	60	90

Figure 2

Caroline's production function and total-cost curve

(a) Production function

(b) Total-cost curve
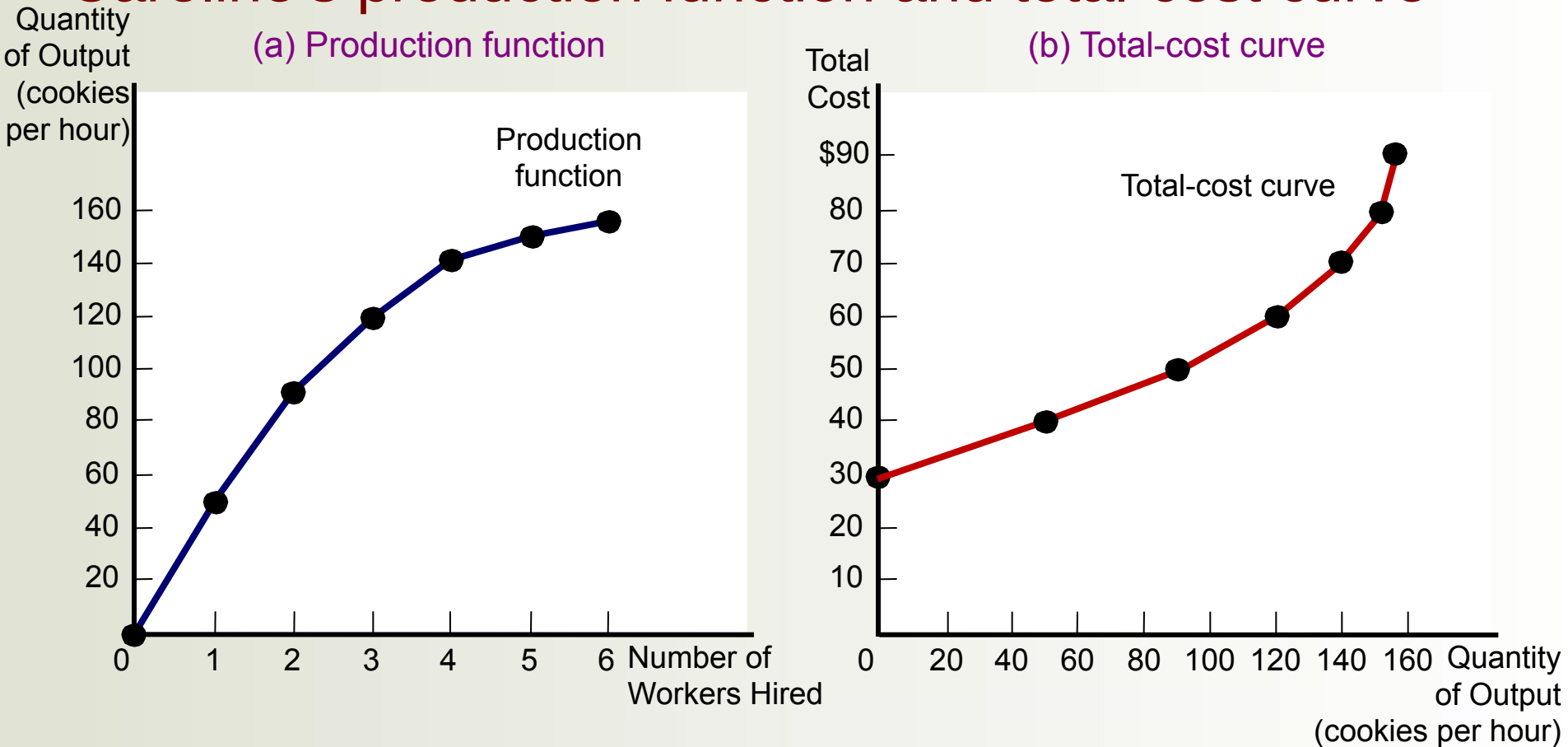
The production function in panel (a) shows the relationship between the number of workers hired and the quantity of output produced. Here the number of workers hired (on the horizontal axis) is from the first column in Table 1, and the quantity of output produced (on the vertical axis) is from the second column. The production function gets flatter as the number of workers increases, which reflects diminishing marginal product. The total-cost curve in panel (b) shows the relationship between the quantity of output produced and total cost of production. Here the quantity of output produced (on the horizontal axis) is from the second column in Table 1, and the total cost (on the vertical axis) is from the sixth column. The total-cost curve gets steeper as the quantity of output increases because of diminishing marginal product.

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The Various Measures of Cost

- **Fixed costs**
  - Do not vary with the quantity of output produced
- **Variable costs**
  - Vary with the quantity of output produced
- **Average fixed cost (AFC)**
  - Fixed cost divided by the quantity of output
- **Average variable cost (AVC)**
  - Variable cost divided by the quantity of output

Table 2

The various measures of cost: Conrad's coffee shop

Quantity of coffee (cups per hour)	Total Cost	Fixed Cost	Variable Cost	Average Fixed Cost	Average Variable Cost	Average Total Cost	Marginal Cost
0	$3.00	$3.00	$0.00	-	-	-	
1	3.30	3.00	0.30	$3.00	$0.30	$3.30	$0.30
2	3.80	3.00	0.80	1.50	0.40	1.90	0.50
3	4.50	3.00	1.50	1.00	0.50	1.50	0.70
4	5.40	3.00	2.40	0.75	0.60	1.35	0.90
5	6.50	3.00	3.50	0.60	0.70	1.30	1.10
6	7.80	3.00	4.80	0.50	0.80	1.30	1.30
7	9.30	3.00	6.30	0.43	0.90	1.33	1.50
8	11.00	3.00	8.00	0.38	1.00	1.38	1.70
9	12.90	3.00	9.90	0.33	1.10	1.43	1.90
10	15.00	3.00	12.00	0.30	1.20	1.50	2.10

Figure 3

Conrad's total-cost curve
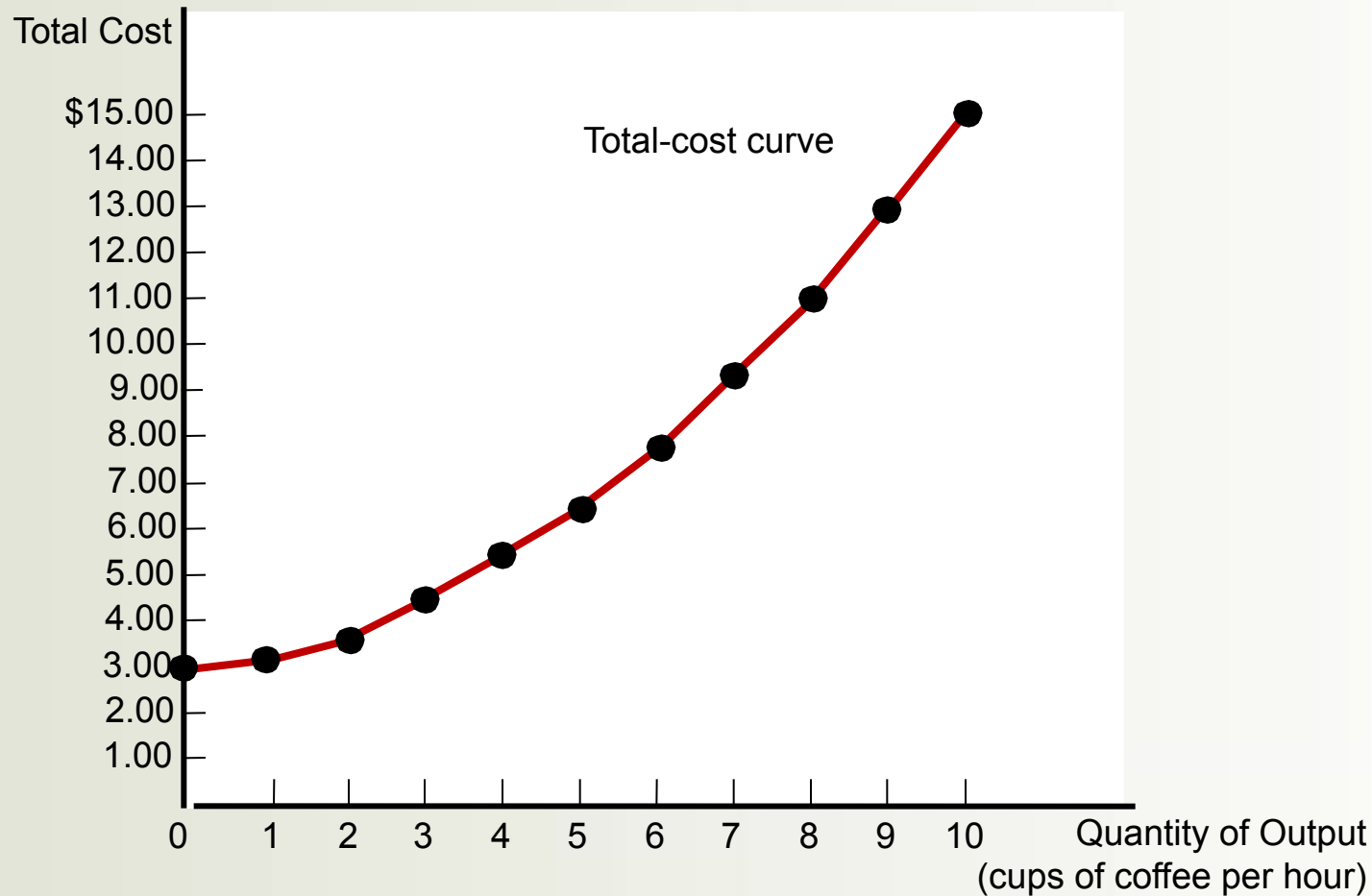
Here the quantity of output produced (on the horizontal axis) is from the first column in Table 2, and the total cost (on the vertical axis) is from the second column. As in Figure 2, the total-cost curve gets steeper as the quantity of output increases because of diminishing marginal product.

The Various Measures of Cost

- **Average total cost (ATC)**
  - Total cost divided by the quantity of output
  - Average total cost = Total cost / Quantity

    ATC = TC / Q

- **Marginal cost (MC)**
  - Increase in total cost
    - Arising from an extra unit of production
  - Marginal cost = Change in total cost / Change in quantity

    MC = ΔTC / ΔQ

The Various Measures of Cost

- Average total cost
  - Cost of a typical unit of output
    - If total cost is divided evenly over all the units produced

- Marginal cost
  - Increase in total cost
    - From producing an additional unit of output

The Various Measures of Cost

- Cost curves and their shapes
- Rising marginal cost
  - Because of diminishing marginal product
- U-shaped average total cost: ATC = AVC + AFC
  - AFC – always declines as output rises
  - AVC – typically rises as output increases
    - Diminishing marginal product
  - The bottom of the U-shape
    - At quantity that minimizes average total cost

The Various Measures of Cost

- Cost curves and their shapes

- Efficient scale
  - Quantity of output that minimizes average total cost

- Relationship between MC and ATC
  - When MC < ATC: average total cost is falling
  - When MC > ATC: average total cost is rising
  - The marginal-cost curve crosses the average-total-cost curve at its minimum

Figure 4

Conrad's average-cost and marginal-cost curves
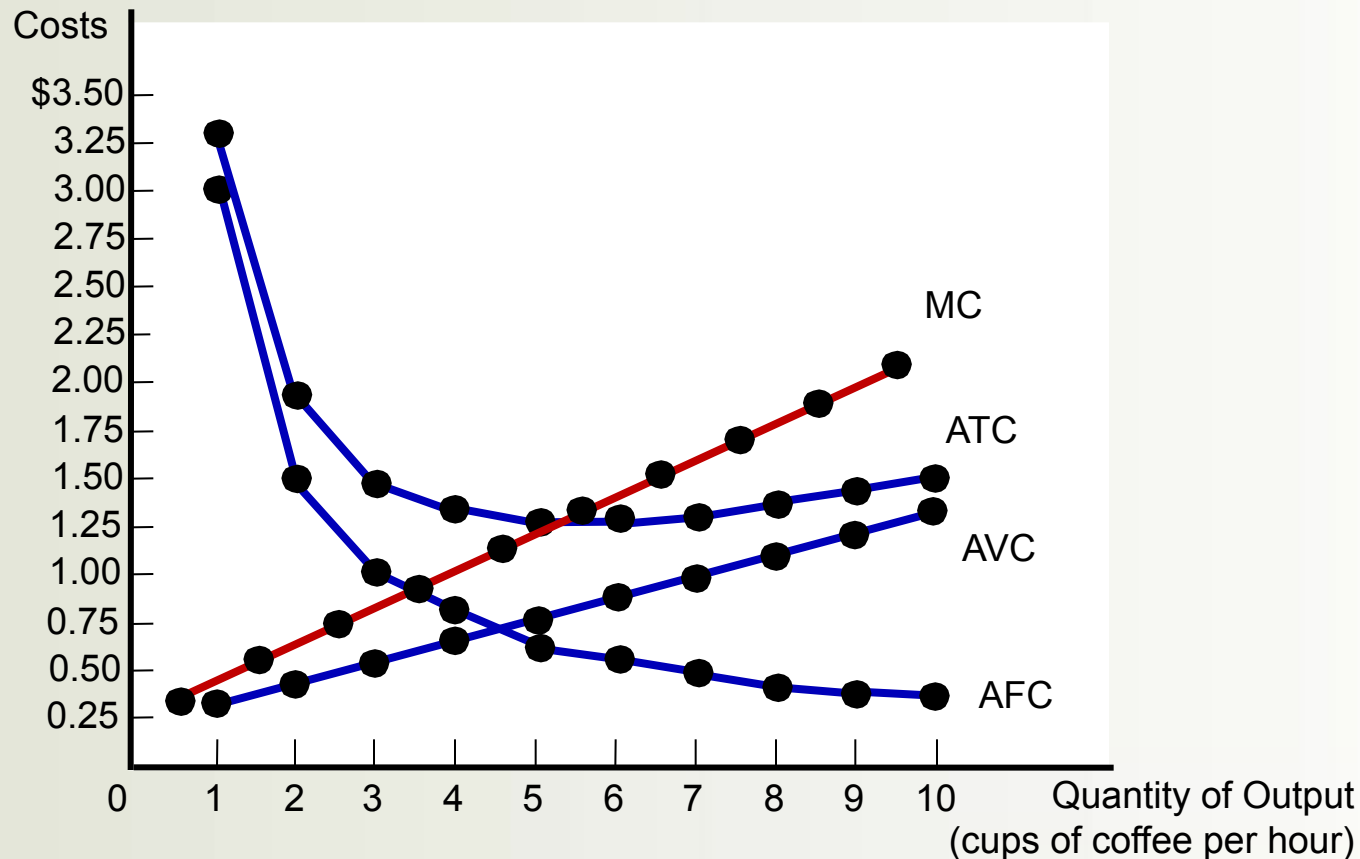
This figure shows the average total cost (ATC), average fixed cost (AFC), average variable cost (AVC), and marginal cost (MC) for Conrad's Coffee Shop. All of these curves are obtained by graphing the data in Table 2. These cost curves show three features that are typical of many firms: (1) Marginal cost rises with the quantity of output. (2) The average-total-cost curve is U-shaped. (3) The marginal-cost curve crosses the average-total-cost curve at the minimum of average total cost.
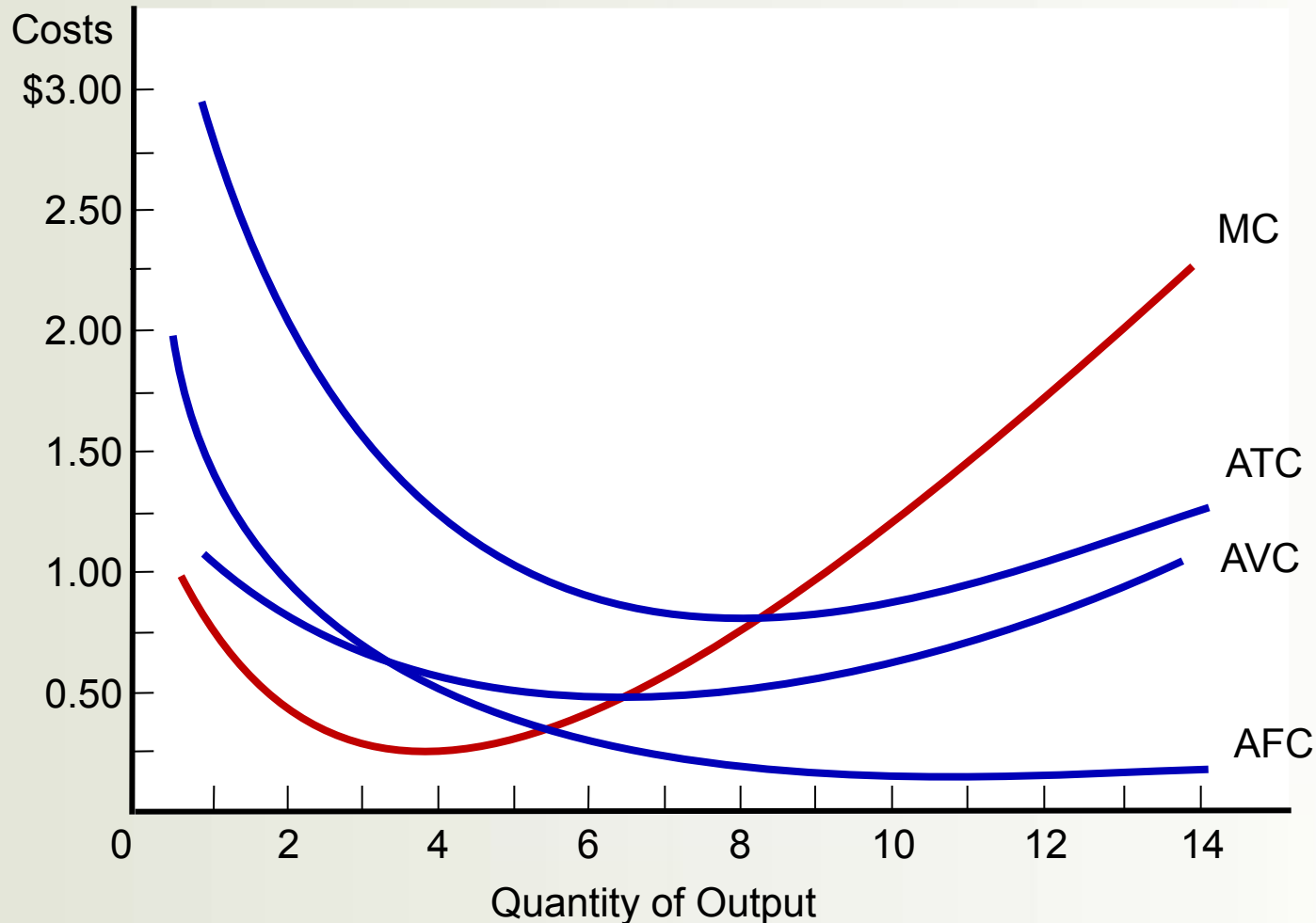
The Various Measures of Cost

- Typical cost curves
  - Marginal cost eventually rises with the quantity of output
  - Average-total-cost curve is U-shaped
  - Marginal-cost curve crosses the average-total-cost curve at the minimum of average total cost
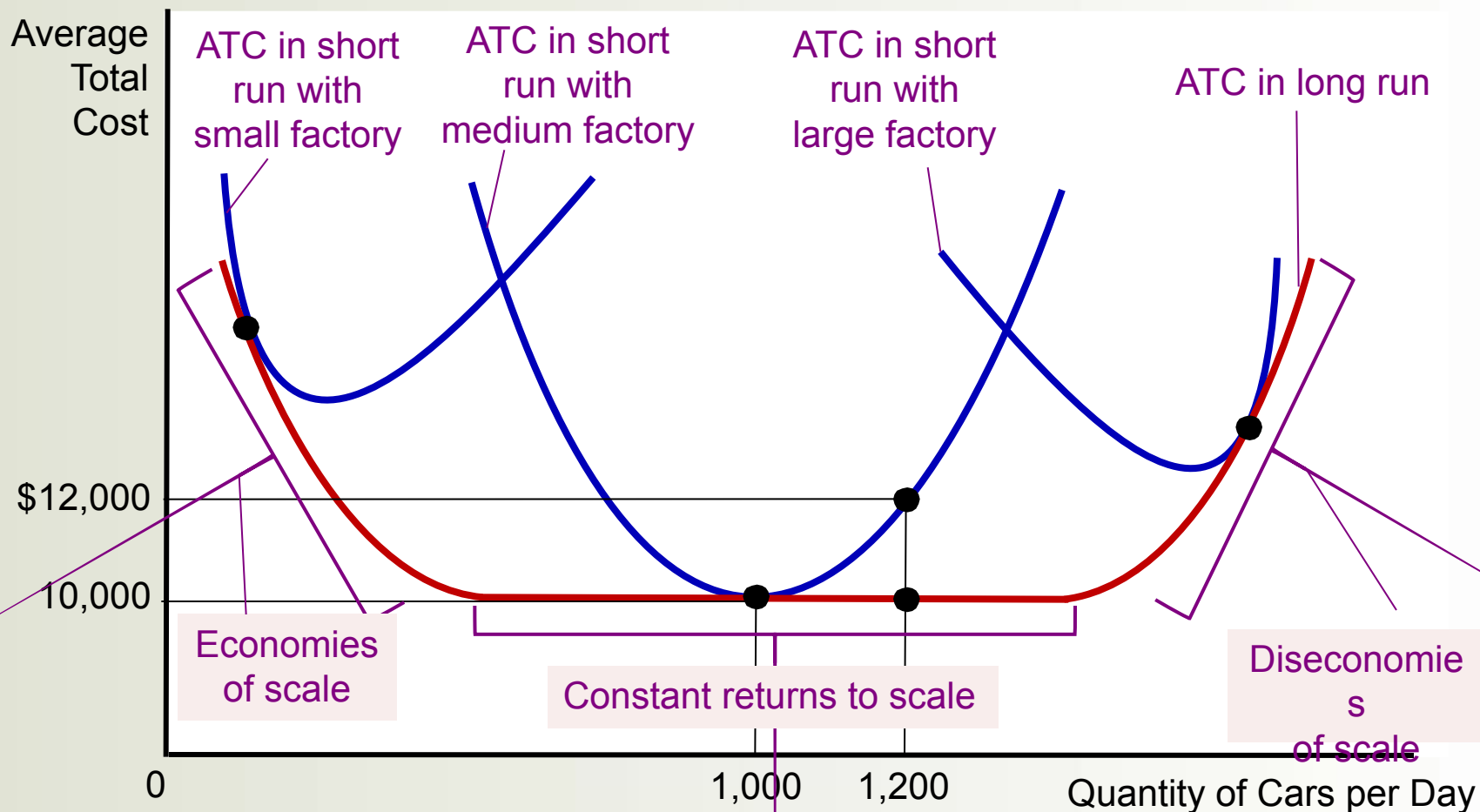
Figure | 5

Cost curves for a typical firm

Many firms experience increasing marginal product before diminishing marginal product. As a result, they have cost curves shaped like those in this figure. Notice that marginal cost and average variable cost fall for a while before starting to rise.

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Costs in Short Run and in Long Run

- Many decisions
  - Fixed in the short run
  - Variable in the long run,
- Firms – greater flexibility in the long-run
  - Long-run cost curves
    - Differ from short-run cost curves
    - Much flatter than short-run cost curves
  - Short-run cost curves
    - Lie on or above the long-run cost curves

Figure 6

Average total cost in the short and long runs

Average Total Cost

ATC in short run with small factory

ATC in short run with medium factory

ATC in short run with large factory

ATC in long run

$12,000

10,000

Economies of scale

Constant returns to scale

Diseconomies of scale

0   1,000   1,200   Quantity of Cars per Day

Because fixed costs are variable in the long run, the average-total-cost curve in the short run differs from the average-total-cost curve in the long run.

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Costs in Short Run and in Long Run

- **Economies of scale**
  - Long-run average total cost falls as the quantity of output increases
  - Increasing specialization
- **Constant returns to scale**
  - Long-run average total cost stays the same as the quantity of output changes

Costs in Short Run and in Long Run

- Diseconomies of scale
  - Long-run average total cost rises as the quantity of output increases
  - Increasing coordination problems

Table 3

The many types of cost: A summary

Term	Definition	Mathematical Description
Explicit costs	Costs that require an outlay of money by the firm	
Implicit costs	Costs that do not require an outlay of money by the firm	
Fixed costs	Costs that do not vary with the quantity of output produced	FC
Variable costs	Costs that vary with the quantity of output produced	VC
Total cost	The market value of all the inputs that a firm uses in production	$TC = FC + VC$
Average fixed cost	Fixed cost divided by the quantity of output	$AFC = FC / Q$
Average variable cost	Variable cost divided by the quantity of output	$AVC = VC / Q$
Average total cost	Total cost divided by the quantity of output	$ATC = TC / Q$
Marginal cost	The increase in total cost that arises from an extra unit of production	$MC = \Delta TC / \Delta Q$