

# 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?

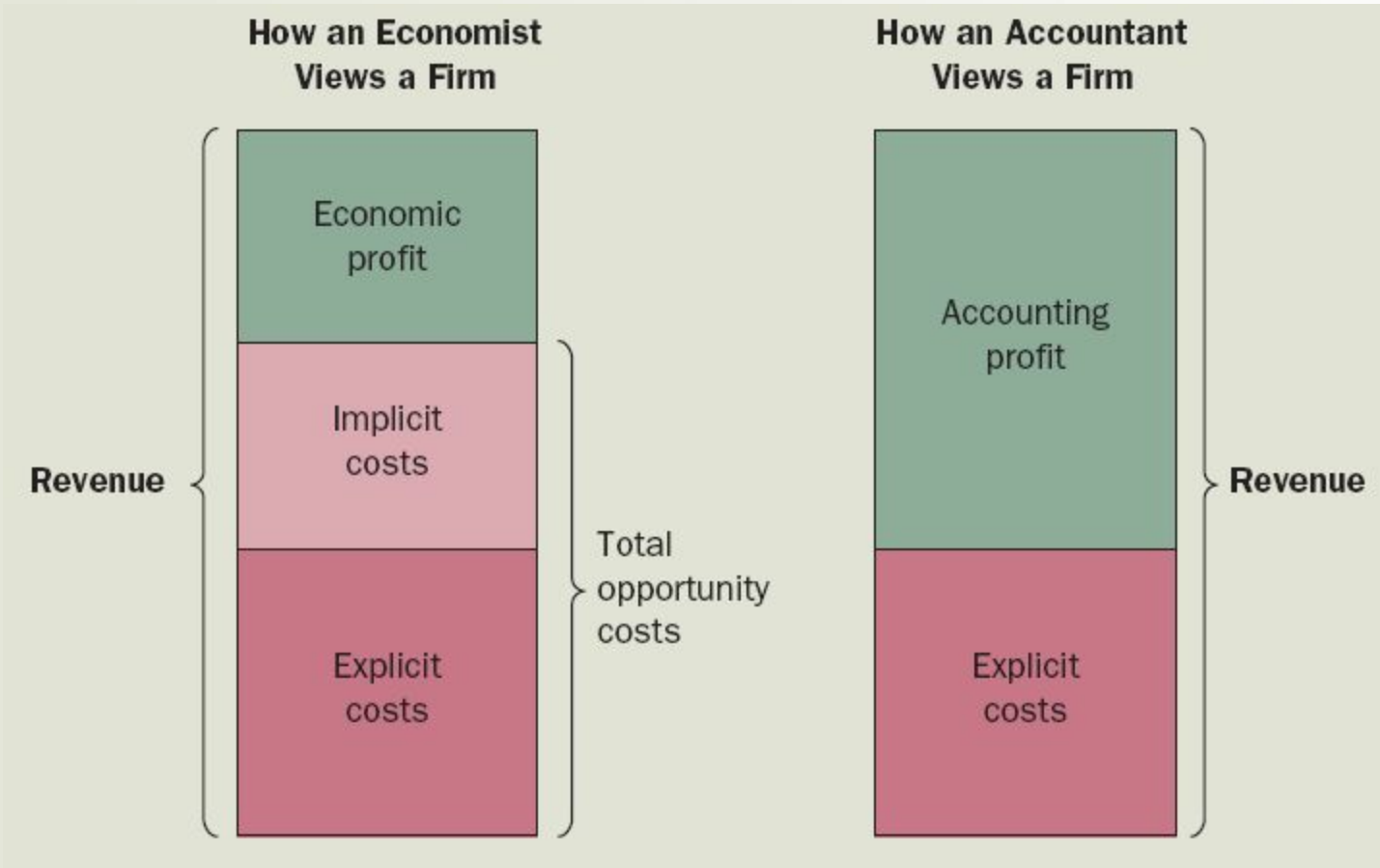
- The cost of capital as an opportunity cost
  - Implicit cost
  - Interest income not earned
    - On financial capital
      - Owned as saving
      - Invested in business
    - Not shown as cost by an accountant

# 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

# 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

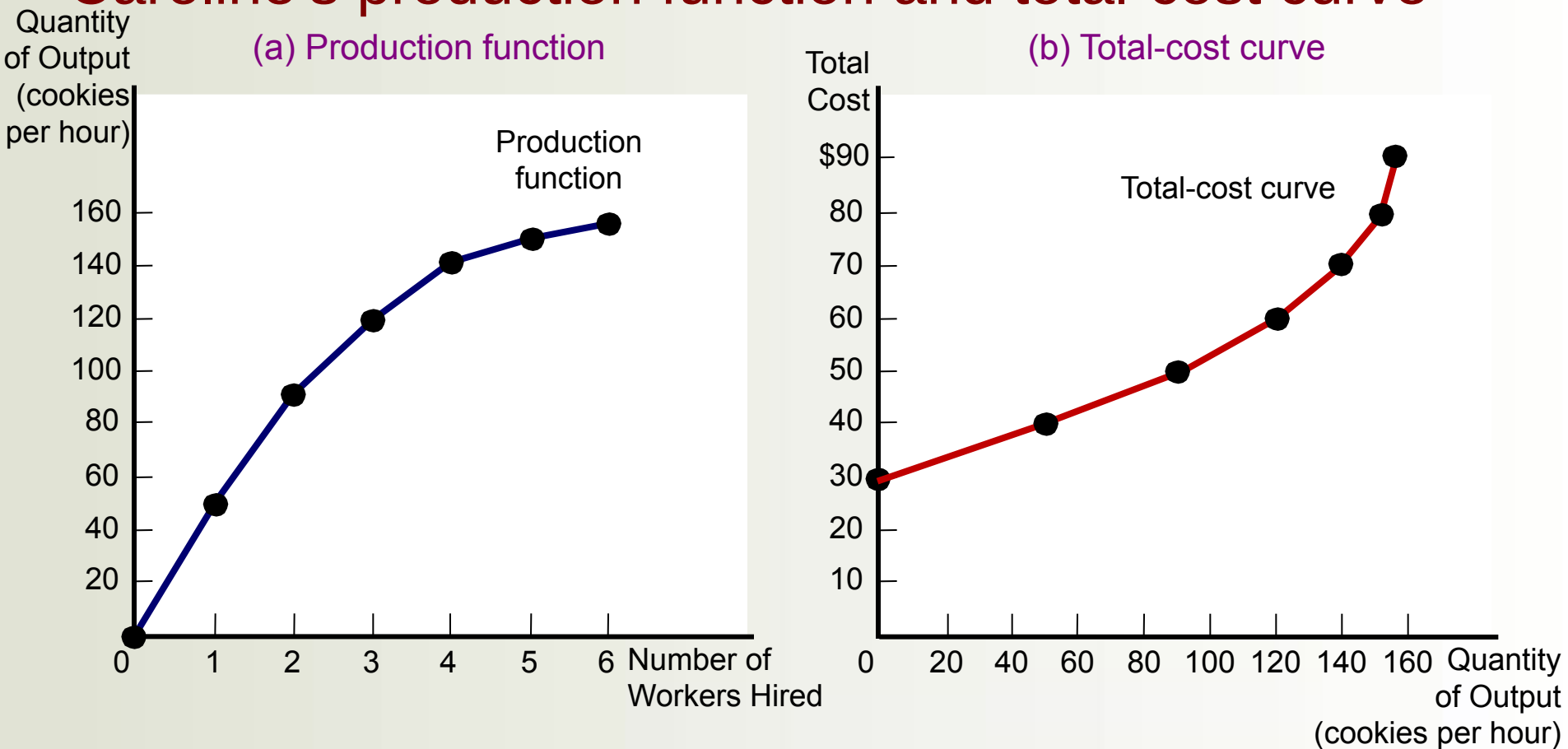
- Diminishing marginal product
  - Marginal product of an input declines as the quantity of the input increases
- **Total-cost curve**
  - Relationship between quantity produced and total costs
  - Gets steeper as the amount produced rises

## 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
1	50	50	30	10	40
2	90	40	30	20	50
3	120	30	30	30	60
4	140	20	30	40	70
5	150	10	30	50	80
6	155	5	30	60	90

# Figure 2

## Caroline's production function and 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.

# The Various Measures of Cost

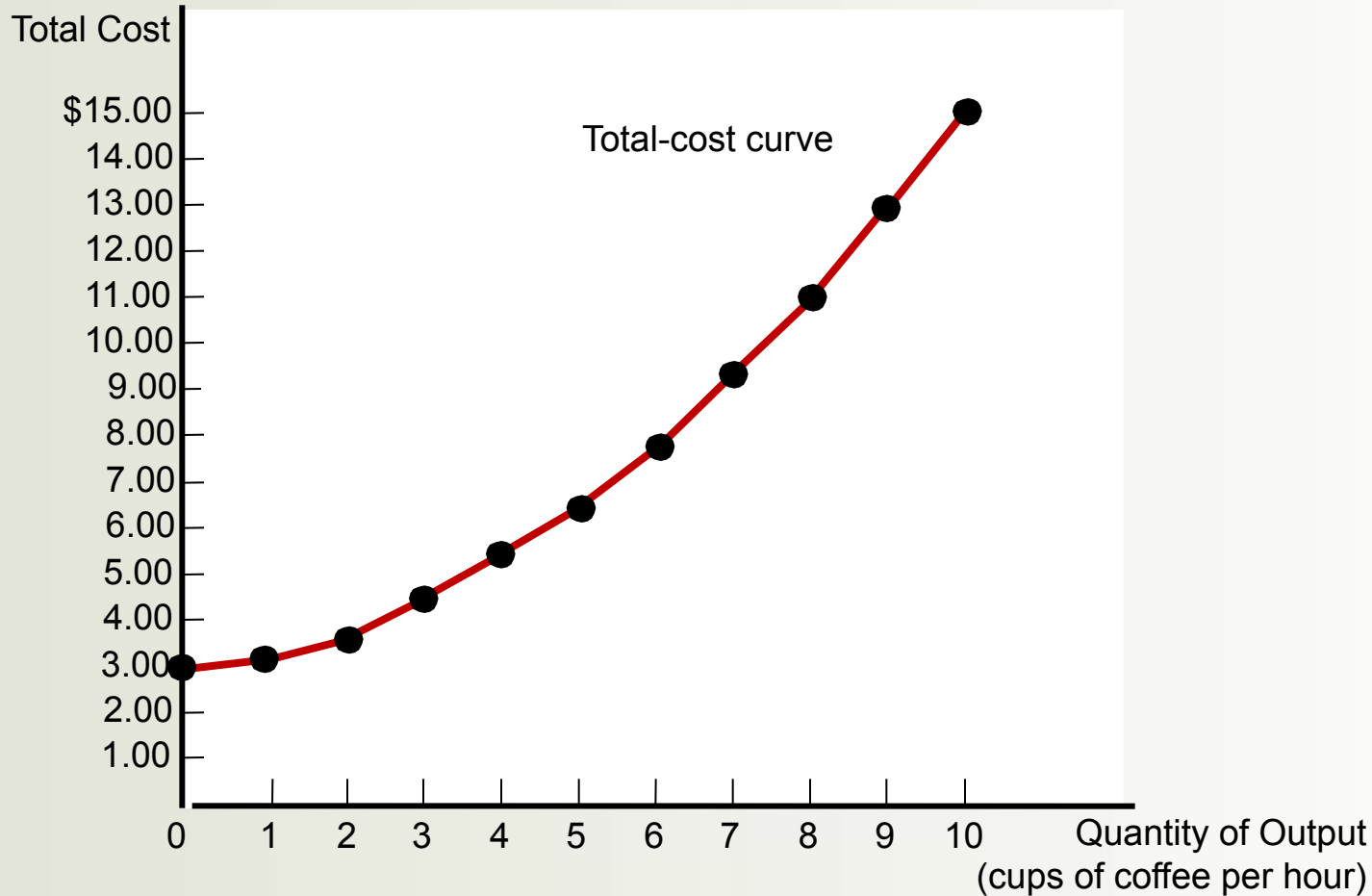
- **Fixed costs**
  - Do not vary with the quantity of output produced
- **Variable costs**
  - Vary with the quantity of output produced
- **Average fixed cost (AFC)**
  - Fixed cost divided by the quantity of output
- **Average variable cost (AVC)**
  - Variable cost divided by the quantity of output

## 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	-	-	-	\$0.30
1	3.30	3.00	0.30	\$3.00	\$0.30	\$3.30	0.50
2	3.80	3.00	0.80	1.50	0.40	1.90	0.70
3	4.50	3.00	1.50	1.00	0.50	1.50	0.90
4	5.40	3.00	2.40	0.75	0.60	1.35	1.10
5	6.50	3.00	3.50	0.60	0.70	1.30	1.30
6	7.80	3.00	4.80	0.50	0.80	1.30	1.50
7	9.30	3.00	6.30	0.43	0.90	1.33	1.70
8	11.00	3.00	8.00	0.38	1.00	1.38	1.90
9	12.90	3.00	9.90	0.33	1.10	1.43	2.10
10	15.00	3.00	12.00	0.30	1.20	1.50	

# 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

$$MC = \Delta TC / \Delta Q$$

# 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



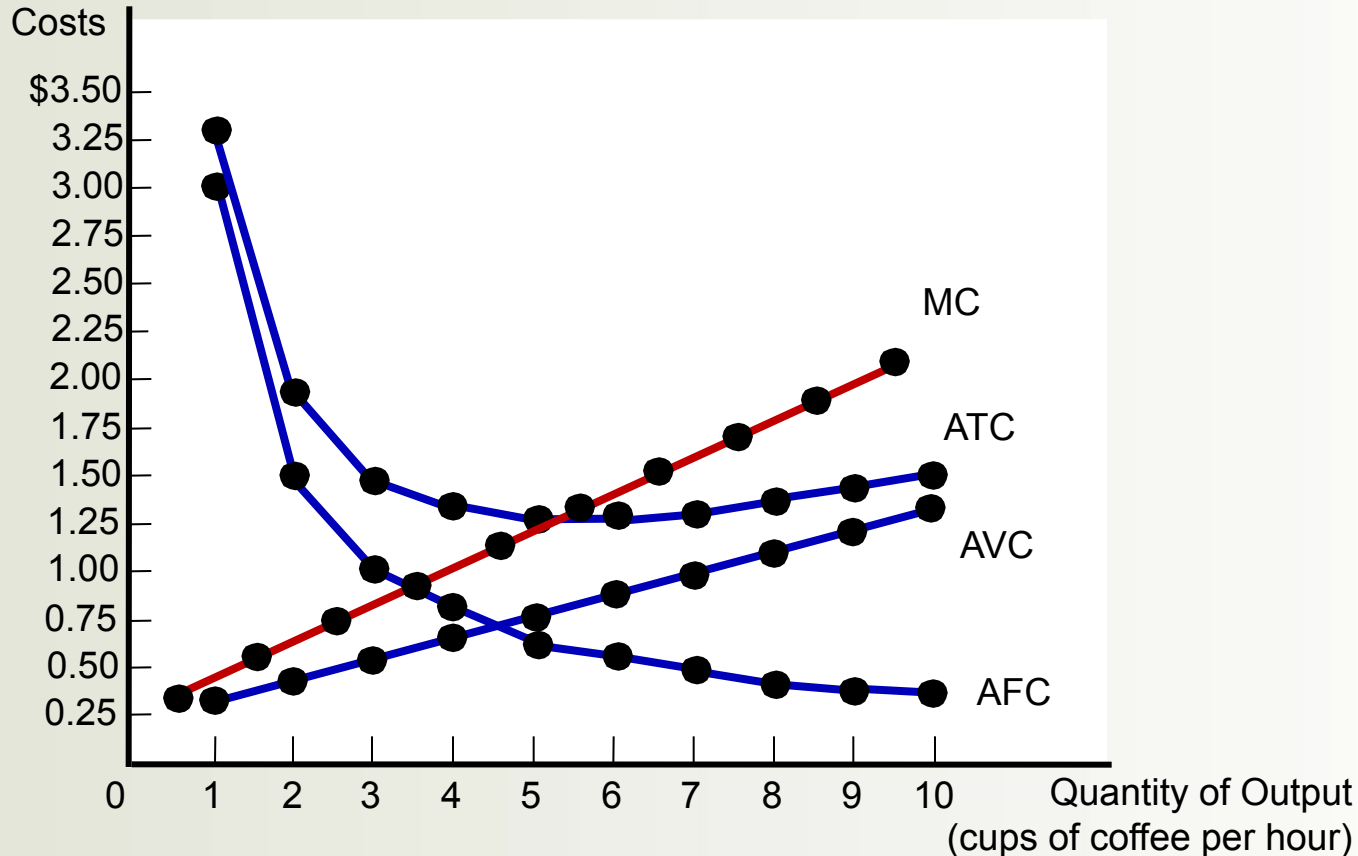
# The Various Measures of Cost

- 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

## Conrad's average-cost and marginal-cost curves

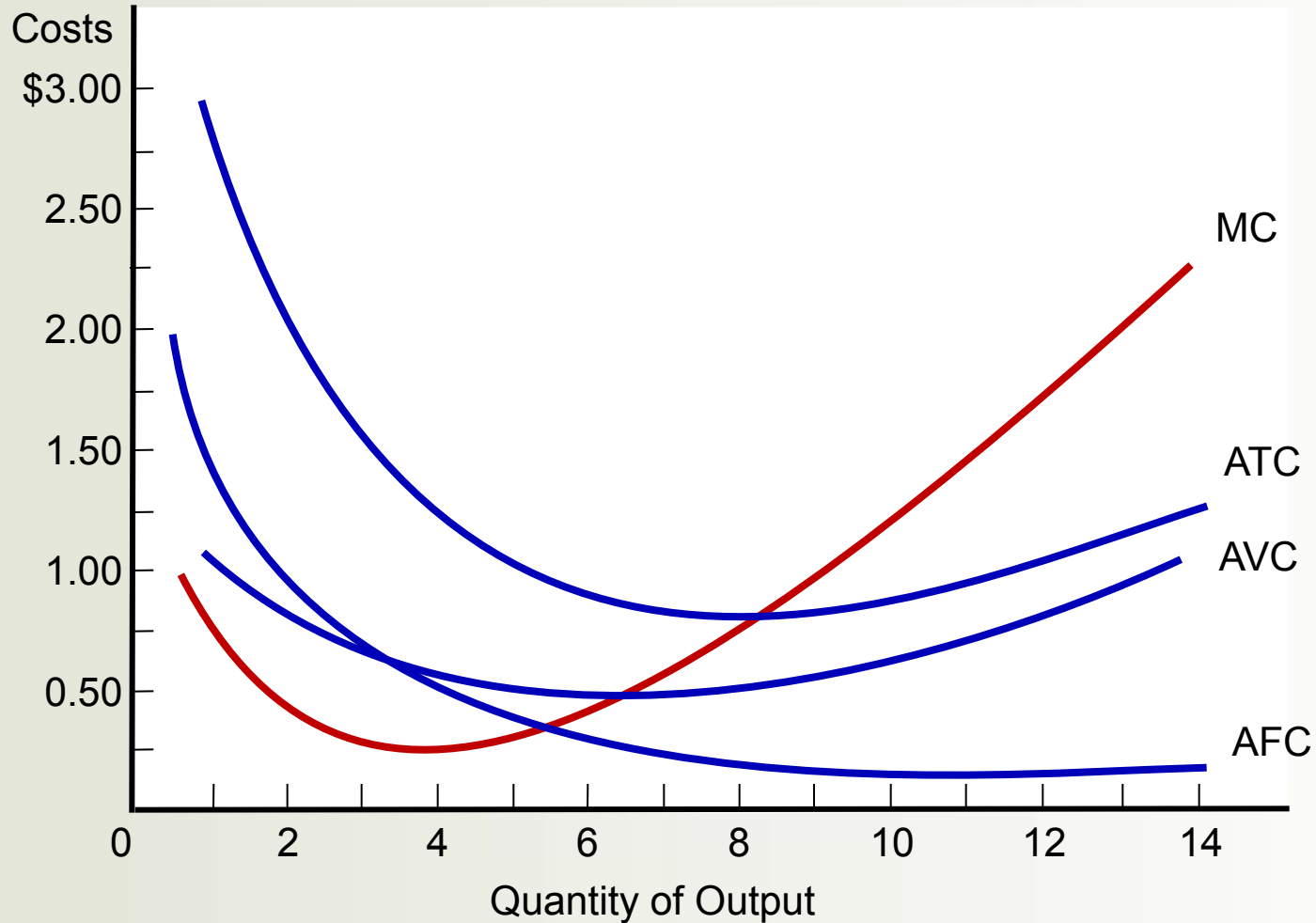


This figure shows the average total cost (ATC), average fixed cost (AFC), average variable cost (AVC), and marginal cost (MC) for Conrad's Coffee Shop. All of these curves are obtained by graphing the data in Table 2. These cost curves show three features that are typical of many firms: (1) Marginal 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

# Cost curves for a typical firm



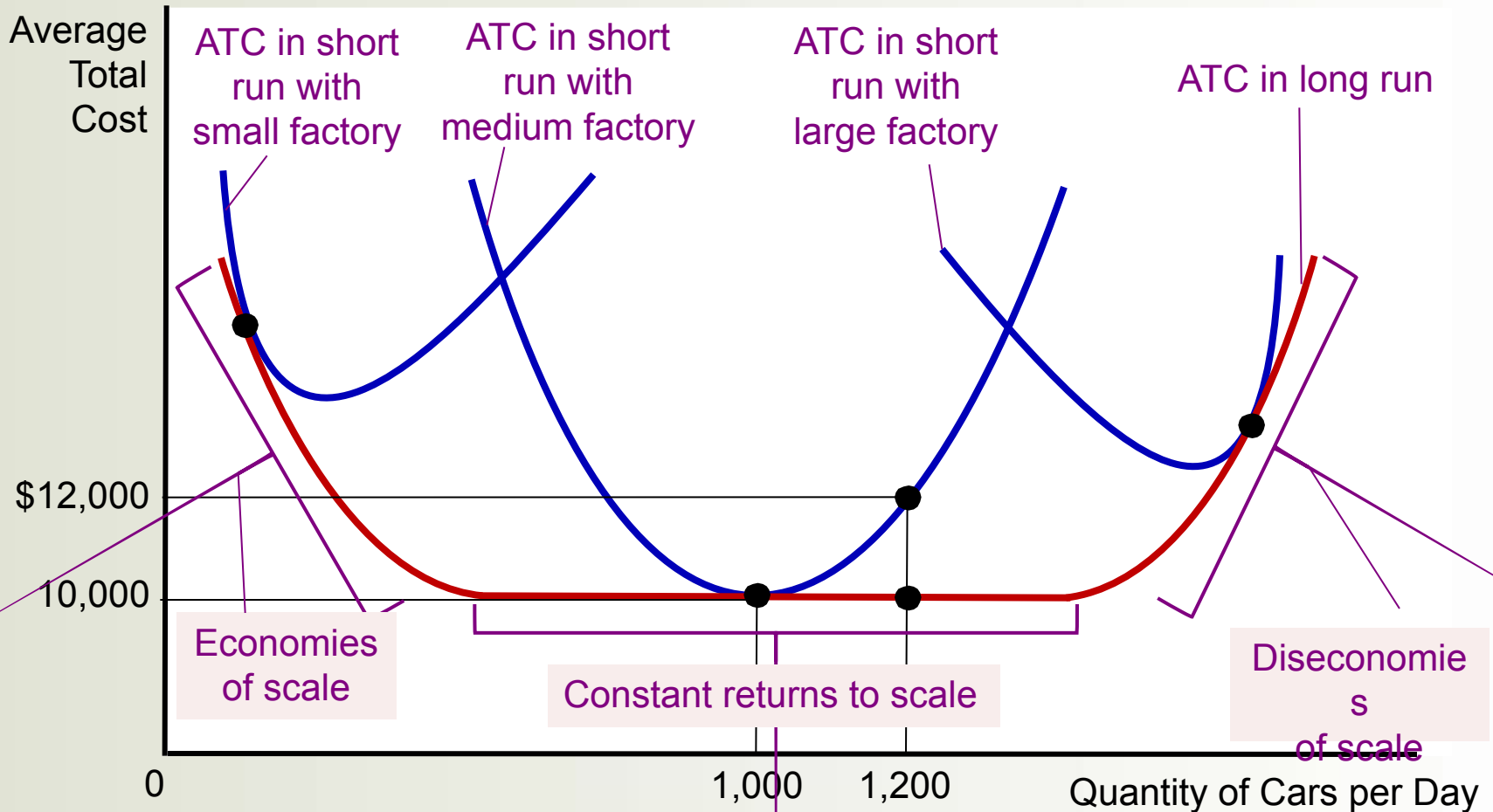
Many firms experience increasing marginal product before diminishing marginal product. As a result, they have cost curves shaped like those in this figure. Notice that marginal cost and average variable cost fall for a while before starting to rise.

# 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



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.

# 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

## 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	$MC = \Delta TC / \Delta Q$