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The Costs of Production

Competition

- In this part of the course, we will look at how the functioning of an economy depends on the degree to which businesses can exert control over the prices they set
- How much freedom a firm has to set prices depends on the intensity of the competition it faces from other firms
- This is why the analysis of prices depends on the intensity of competition

A Firm's Costs

- In Chapter 4 we saw the theory of supply and demand, which assumes perfect competition
- In Chapter 7 we saw that Chapter 4's supply curve is constructed from data on production costs
 - Recall the example of the house painters Mary, Frieda, Georgia and Grandma
- In this chapter, we take a closer look at costs

A Firm's Costs

- Another reason to study costs is that the intensity of competition between firms can depend on the relationship between a firm's costs and its level of production
- In crude terms, if firms' costs per unit produced tend to be lower when production levels are higher, existing mega-firms are likely to crush any competition from firms that are new and small

Profit, the firm's objective

- The economic goal of a firm is to maximize its *profit*.

Profit = Total revenue - Total cost

Total Revenue, Total Cost, and Profit

- Profit = Total Revenue – Total Cost
- *Total Revenue*
 - The money a firm receives from the sale of its output.
 - $TR = P \times Q$
 - We saw this in chapter 5
- *Total Cost*
 - The market value of all the inputs (resources) a firm uses in production.

Explicit and Implicit Costs

- Total Cost = Explicit Cost + Implicit Cost.
 - *Explicit* costs are costs that require a direct outlay of money by the firm's owner(s).
 - *Implicit* costs are costs that do not require an outlay of money by the firm
 - If some of the resources used in production are provided by the owner(s) of the firm, the firm may not have to pay for them.
 - The market value of such resources is the implicit cost.
 - Implicit costs are included in total cost.

Implicit Costs: Examples

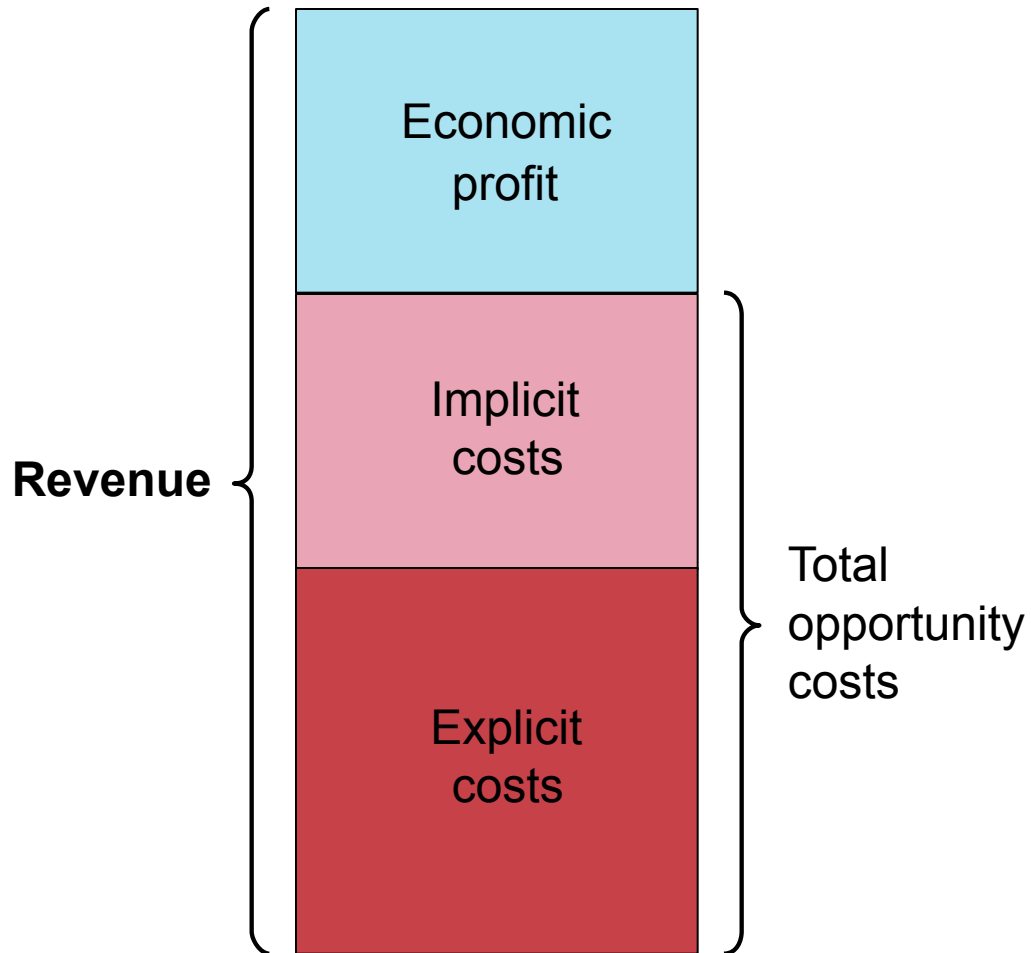
- You own a restaurant and you work eighteen hours a day in it
 - You could have worked elsewhere and earned a wage. This lost income is an implicit cost
- You have invested \$20,000 of your own savings in your restaurant
 - You could have earned interest had you put that money in a bank instead. This lost interest income is an implicit cost

Economic Profit versus Accounting Profit

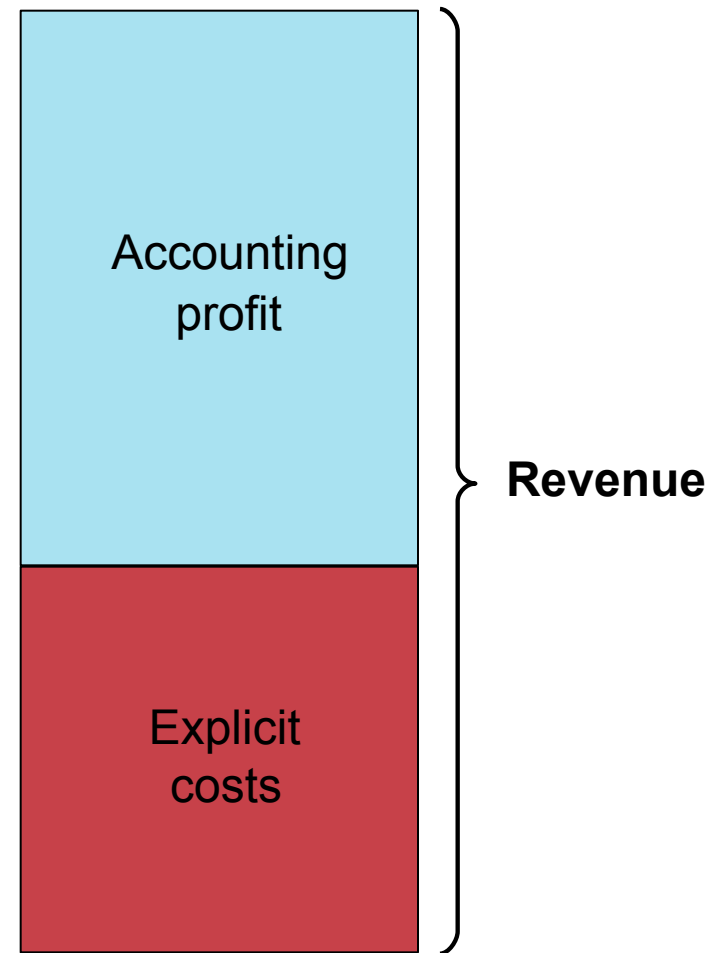
- *Economic profit* =
total revenue – total cost =
total revenue – (explicit costs + implicit costs)
- *Accounting profit* =
total revenue – explicit costs
- As a result, accounting profit > economic profit

Figure 1 Economists versus Accountants

How an Economist Views a Firm



How an Accountant Views a Firm



Economic Profit and Firm Sustainability

- Non-negative economic profit is essential for the long-run viability of a firm
- Caroline's Cookie Factory
 - total revenue = \$700 per hour
 - total explicit costs = \$650 per hour
 - for labor and raw materials
 - total implicit costs = \$110 per hour
 - in wages Caroline could have earned as a computer programmer
 - Accounting profit = \$50 per hour.
 - This indicates short-run financial viability
 - Economic profit = - \$60 per hour.
 - This indicates a dire long-run future.
 - Dissatisfied with the \$50 per hour profit, Caroline will eventually shut down the firm and take a programming job

PRODUCTION

PRODUCTION FUNCTION

- The *production function* shows how the quantity of output of a good depends on the quantity of inputs used to make that good.

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

Marginal Product

- The *marginal product* of any resource is the increase in output that arises from one additional unit of that resource, provided the technology and the amounts of all other resources are unchanged.

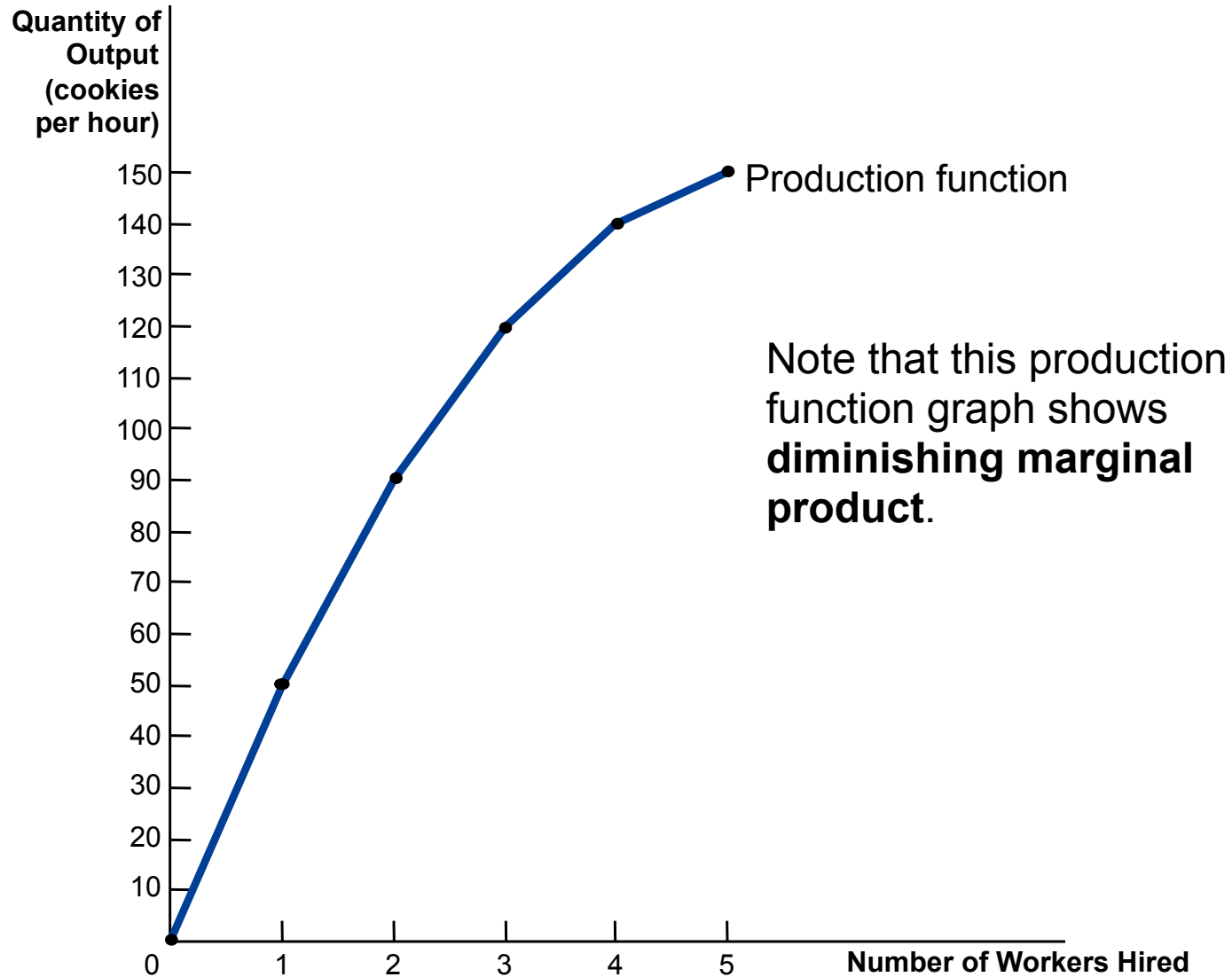
Number of Workers	Output (quantity of cookies produced per hour)	Marginal Product of Labor	Cost of Factory	Cost of Workers	Total Cost of Inputs (cost of factory + cost of workers)
0	0		\$30	\$ 0	\$30
1	50	50	30		
2	90	40	30		
3	120	30	30		
4	140	20	30		
5	150	10	30	50	80

Note that the marginal product *diminishes* as more of the resource is used. This is a common assumption in economics.

Diminishing Returns in Production

- *Diminishing marginal product* is the property whereby the marginal product of an input decreases as the quantity of the input increases.
 - Example: As more and more workers are hired at a firm, the output produced would increase by less and less because the firm has a limited amount of equipment that all workers must share.

Figure 2 Caroline's Production Function



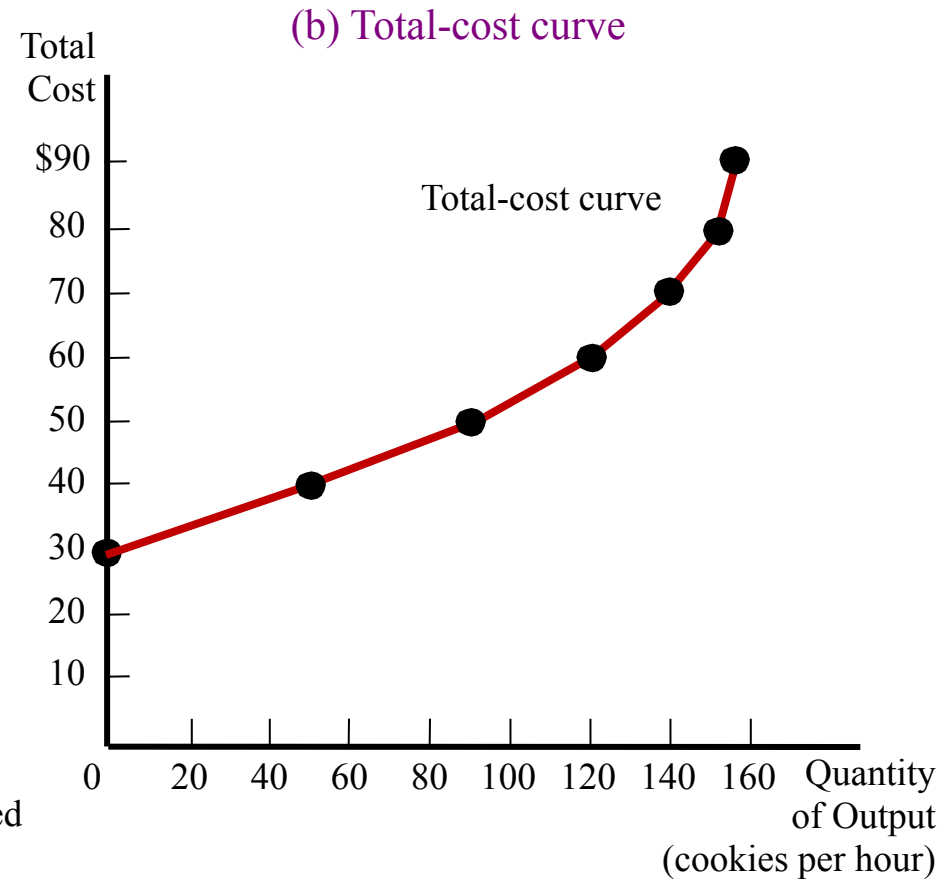
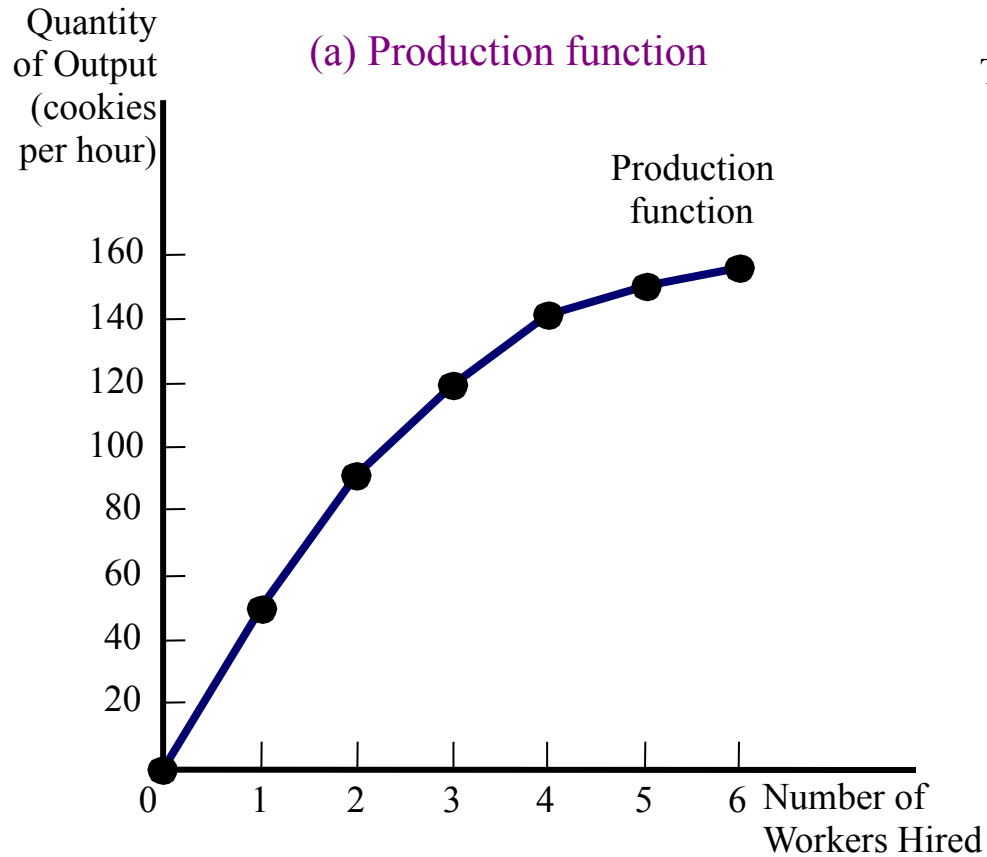
PRODUCTION AFFECTS COSTS

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	Fixed Cost Cost of factory	Variable Cost 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

Turning the two bordered columns into a graph yields the cost curve. See next slide.

Figure 2 Caroline's production function and total-cost curve



THE VARIOUS MEASURES OF COST

- Total Cost = *fixed cost* + *variable cost*.
- **Fixed costs** are those costs that do *not* vary with the quantity produced.
- **Variable costs** are those costs that vary with the quantity produced.
- $TC = FC + VC$

Fixed Costs

- Fixed costs are those costs that do *not* vary with the quantity produced
 - Factory rent
 - Security costs
 - Marketing costs
 - Research and development costs

Variable Costs

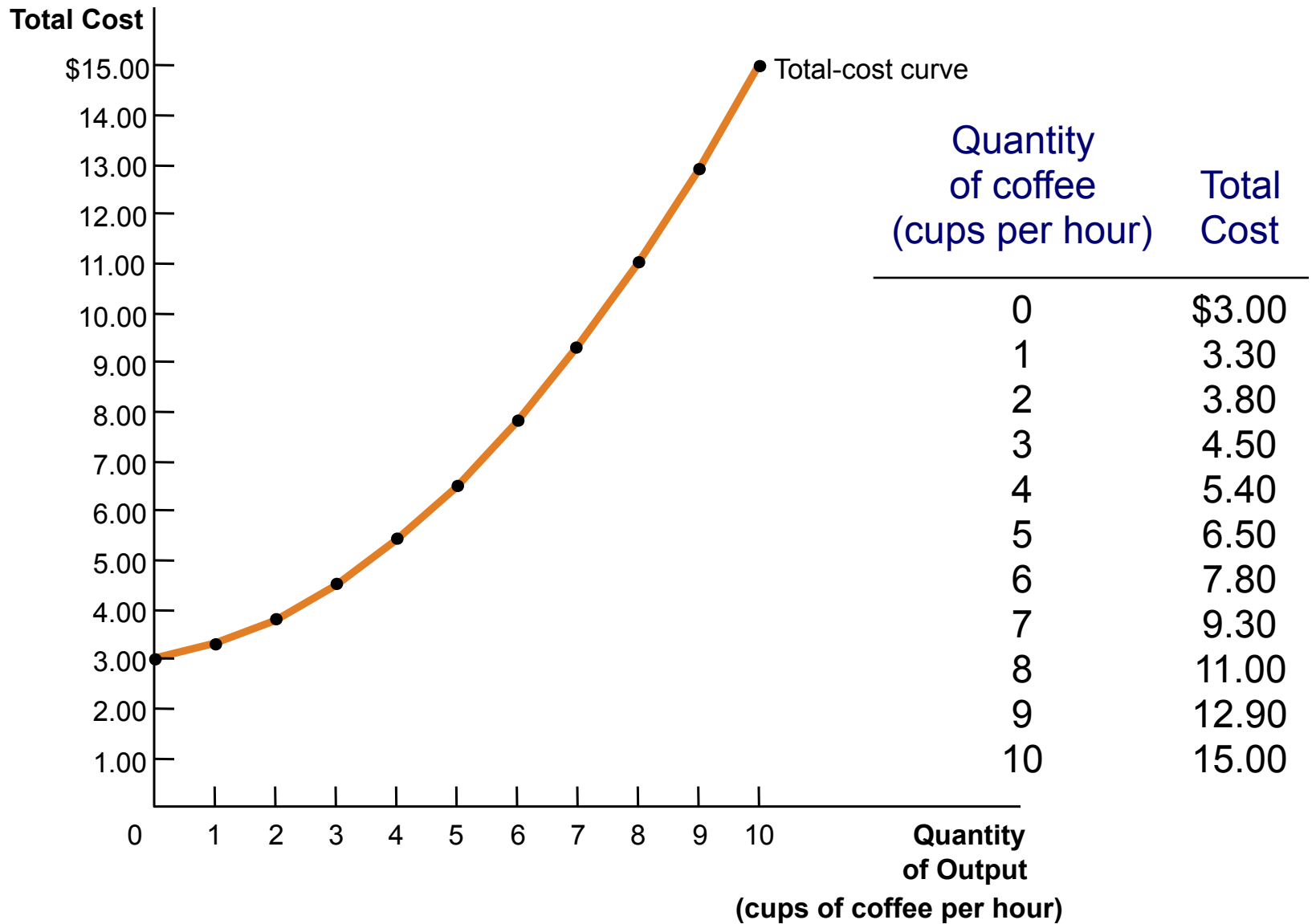
- Variable costs are those costs that vary with the quantity produced
 - Cost of raw materials
 - Labor costs

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	

Check that $TC = FC + VC$

Figure 3 Conrad's Coffee Shop Total-Cost Curve



Average Costs

$$AFC = \frac{\text{Fixed cost}}{\text{Quantity}} = \frac{FC}{Q}$$

$$AVC = \frac{\text{Variable cost}}{\text{Quantity}} = \frac{VC}{Q}$$

$$ATC = \frac{\text{Total cost}}{\text{Quantity}} = \frac{TC}{Q}$$

Average Fixed and Variable Costs

- We know that $TC = FC + VC$
- Therefore, $TC/Q = FC/Q + VC/Q$
- Therefore, $ATC = AFC + AVC$

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	

Check that $ATC = TC/Q$, $AFC = FC/Q$, and $AVC = VC/Q$

Check that $ATC = AFC + AVC$

Figure 4 Conrad's Coffee Shop Average-Cost and Marginal-Cost Curves

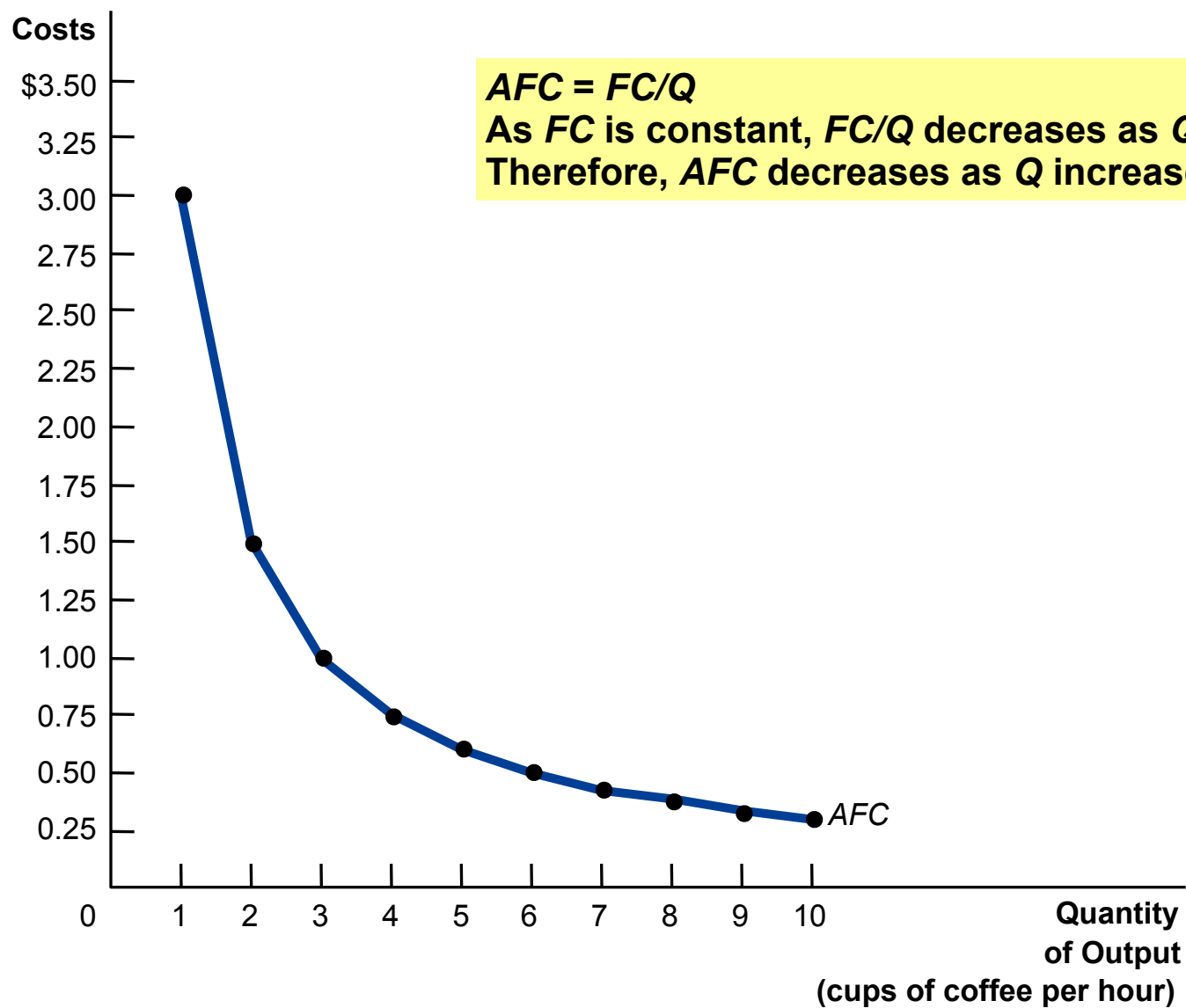
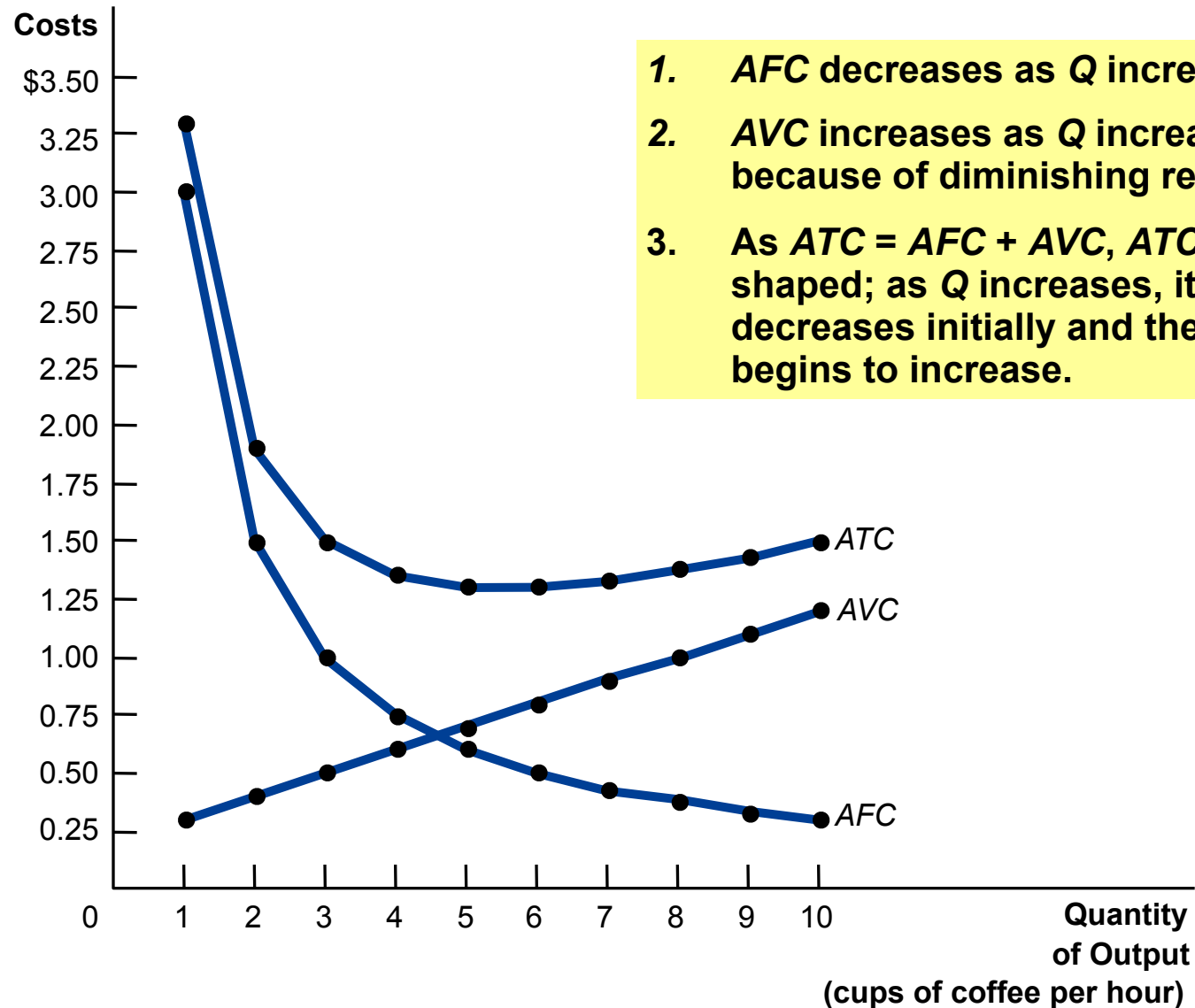
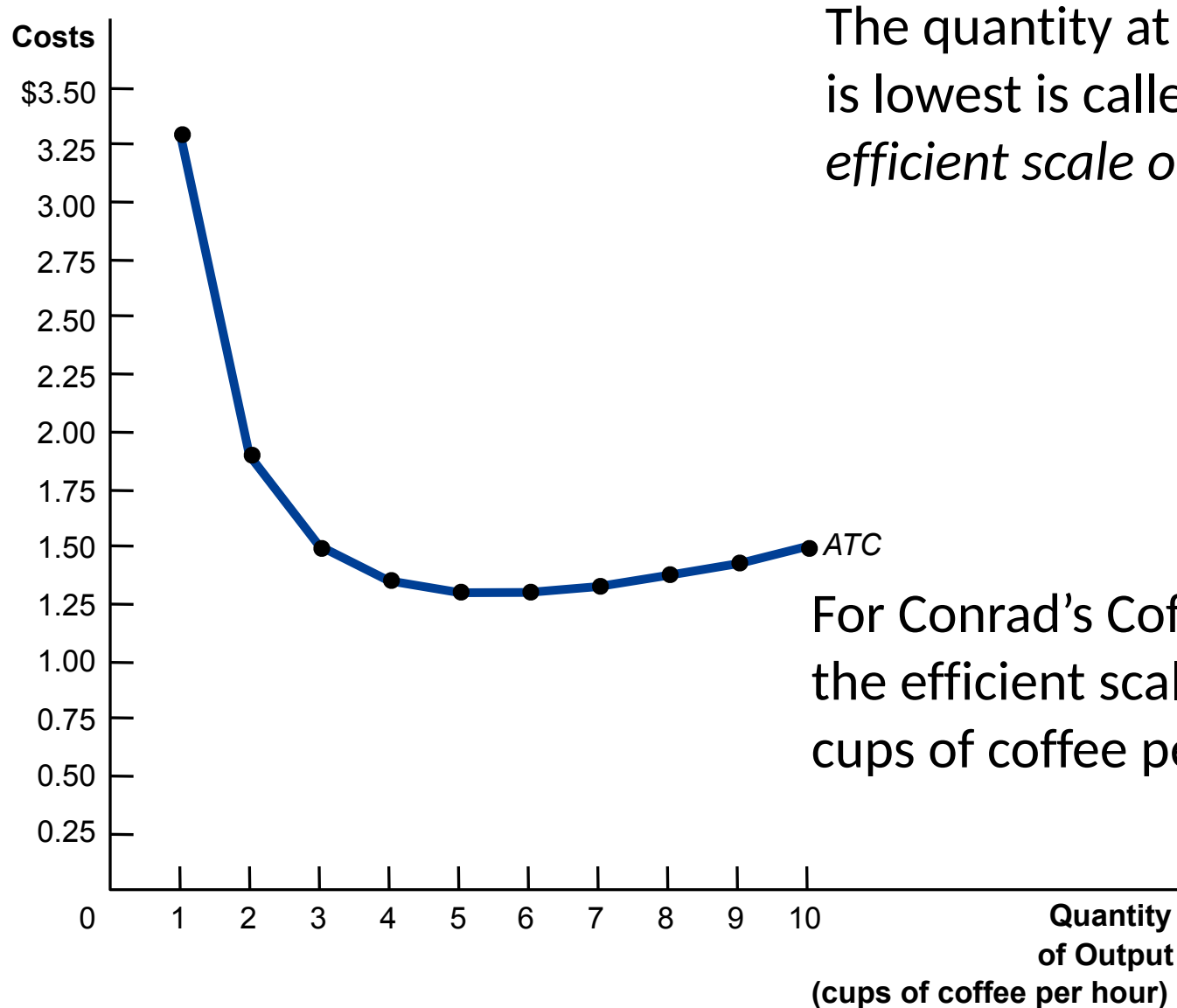


Figure 4 Conrad's Coffee Shop Average-Cost and Marginal-Cost Curves



1. **AFC decreases as Q increases,**
2. **AVC increases as Q increases, because of diminishing returns.**
3. **As $ATC = AFC + AVC$, ATC is U-shaped; as Q increases, it decreases initially and then begins to increase.**

Figure 4 Conrad's Coffee Shop Average-Cost and Marginal-Cost Curves



The quantity at which ATC is lowest is called the *efficient scale output*.

For Conrad's Coffee Shop, the efficient scale is 5 or 6 cups of coffee per hour

Cost Curves and Their Shapes

- The average total-cost curve is *U-shaped*.
 - At very low levels of output average total cost is high because the fixed cost is spread over only the few units that are produced.
 - Average fixed cost declines as output increases.
 - Average variable cost rises as output increases.
 - These features of a firm's costs explains the U-shape of the *ATC* curve
 - Recall that $ATC = AFC + AVC$

Marginal Cost

- *Marginal cost* (MC) is the increase in total cost (TC) that arises from an additional unit of production.
- The increase in cost that arises from an extra unit of production is entirely due to the use of additional raw materials and labor
- Therefore, marginal cost can also be defined as the increase in total variable cost (VC) that arises from an additional unit of production.

Marginal Cost

$$MC = \frac{\text{(change in total cost)}}{\text{(change in quantity)}} = \frac{\Delta TC}{\Delta Q}$$

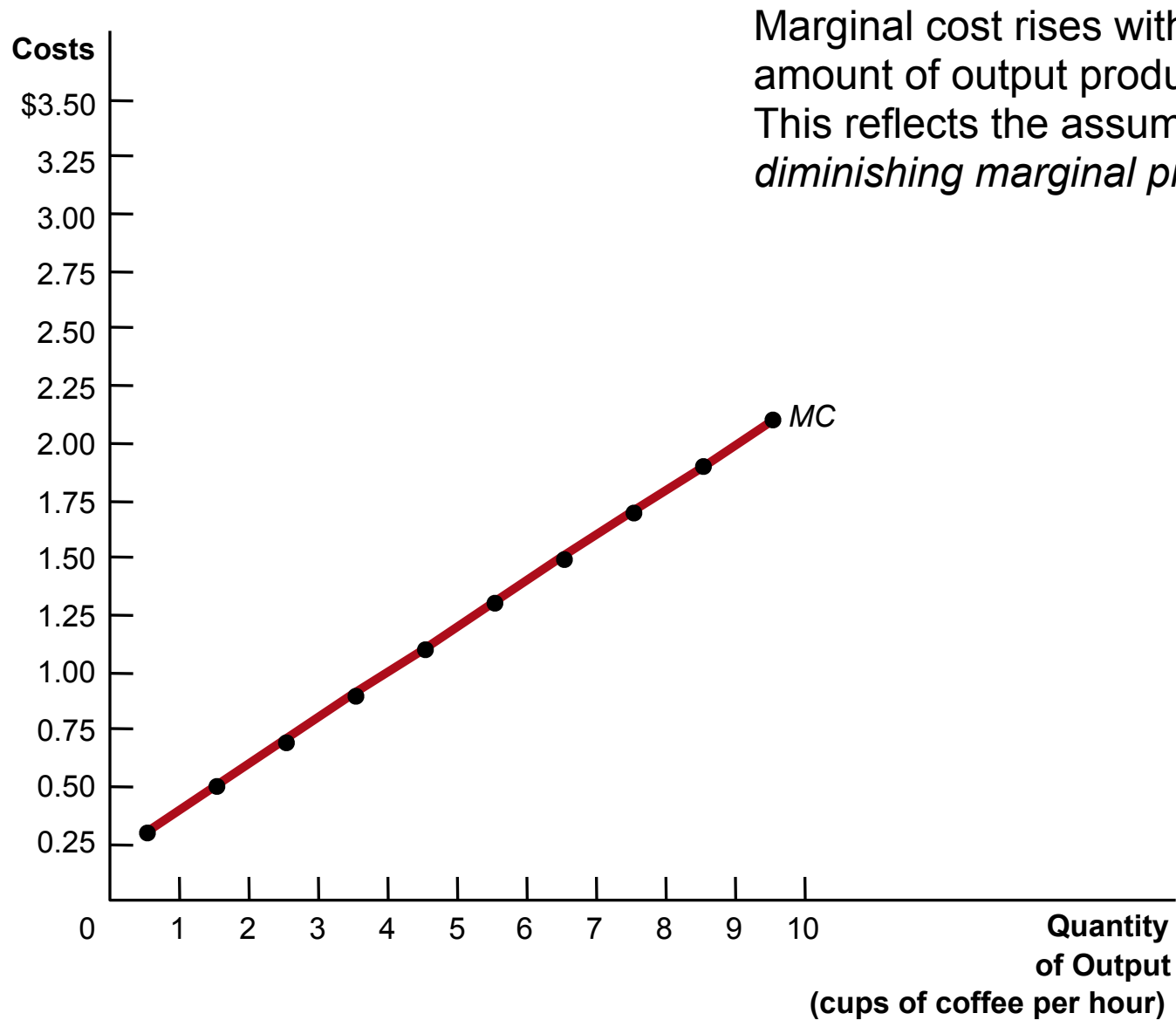
$$MC = \frac{\text{increase in total variable cost}}{\text{increase in production}} = \frac{\Delta VC}{\Delta Q}$$

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

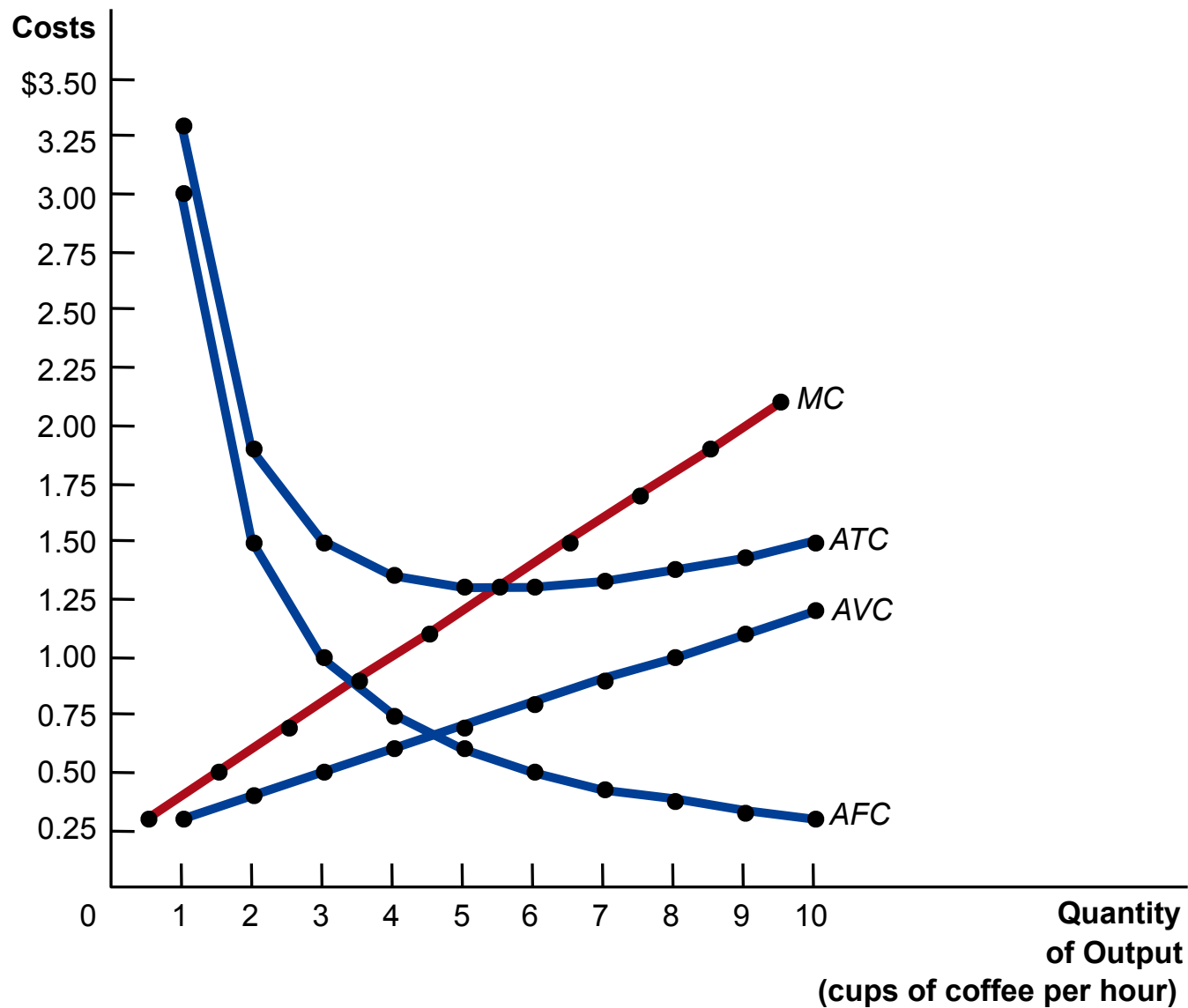
Check that $MC = \Delta TC / \Delta Q = \Delta VC / \Delta Q$

Figure 4 Conrad's Coffee Shop Average-Cost and Marginal-Cost Curves



Marginal cost rises with the amount of output produced. This reflects the assumption of *diminishing marginal product*

Figure 4 Conrad's Coffee Shop Average-Cost and Marginal-Cost Curves



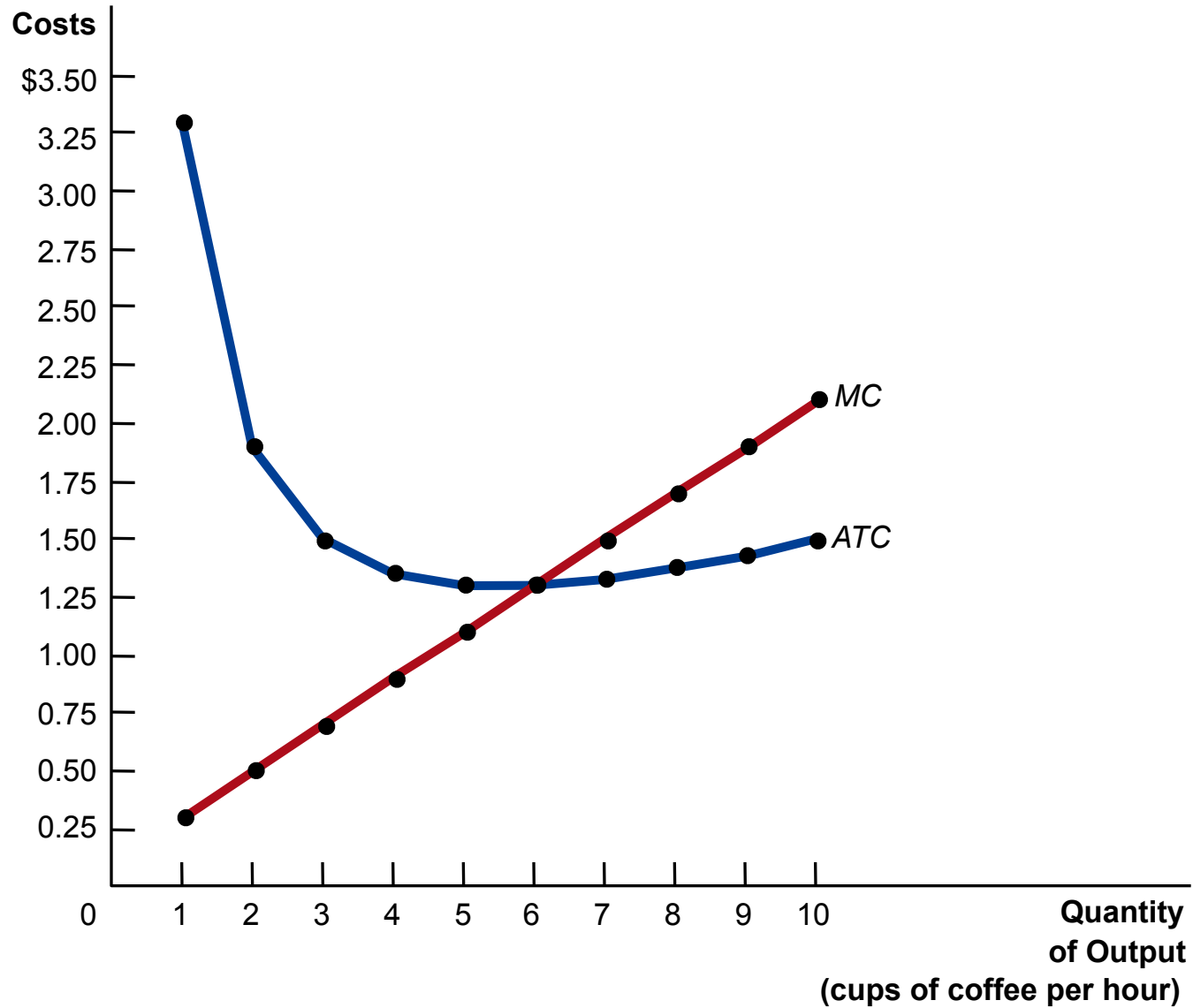
Cost Curves and Their Shapes

- Whenever marginal cost is less *than* average total cost, average total cost must be *decreasing* (negatively sloped).
- Whenever marginal cost is *more* than average total cost, average total cost must be *increasing* (positively sloped).
- Whenever marginal cost is *equal* to average total cost, average total cost must be *constant* (horizontal).

Cost Curves and Their Shapes

- The marginal-cost curve crosses the average-total-cost curve at the efficient scale output.
 - Efficient scale output is the quantity that minimizes average total cost.

Figure 4 Conrad's Coffee Shop Average-Cost and Marginal-Cost Curves



Typical cost curves are assumed to be slightly different from the ones we have just seen

TYPICAL COST CURVES

A Typical Firm's Costs

Quantity of Bagels (per hour)	Total Cost	Fixed Cost	Variable Cost	Average Fixed Cost	Average Variable Cost	Average Total Cost	Marginal Cost
Q	$TC = FC + VC$	FC	VC	$AFC = FC/Q$	$AVC = VC/Q$	$ATC = TC/Q$	$MC = \Delta TC/\Delta Q$
0	\$ 2.00	\$2.00	\$ 0.00	—	—	—	\$1.00
1	3.00	2.00	1.00	2.00	\$1.00	\$3.00	0.80
2	3.80	2.00	1.80	1.00	0.90	1.90	0.60
3	4.40	2.00	2.40	0.67	0.80	1.47	0.40
4	4.80	2.00	2.80	0.50	0.70	1.20	0.40
5	5.20	2.00	3.20	0.40	0.64	1.04	0.60
6	5.80	2.00	3.80	0.33	0.63	0.96	0.80
7	6.60	2.00	4.50	0.29	0.66	0.95	1.00
8	7.60	2.00	5.50	0.25	0.70	0.95	1.20
9	8.80	2.00	6.80	0.22	0.76	0.98	1.40
10	10.20	2.00	8.20	0.20	0.82	1.02	1.60
11	11.80	2.00	9.80	0.18	0.89	1.07	1.80
12	13.60	2.00	11.50	0.17	0.97	1.14	2.00
13	15.60	2.00	13.50	0.15	1.05	1.20	2.20
14	17.80	2.00	15.80	0.14	1.13	1.27	

Figure 5 Cost Curves of a Typical Firm

(a) Total-Cost Curve

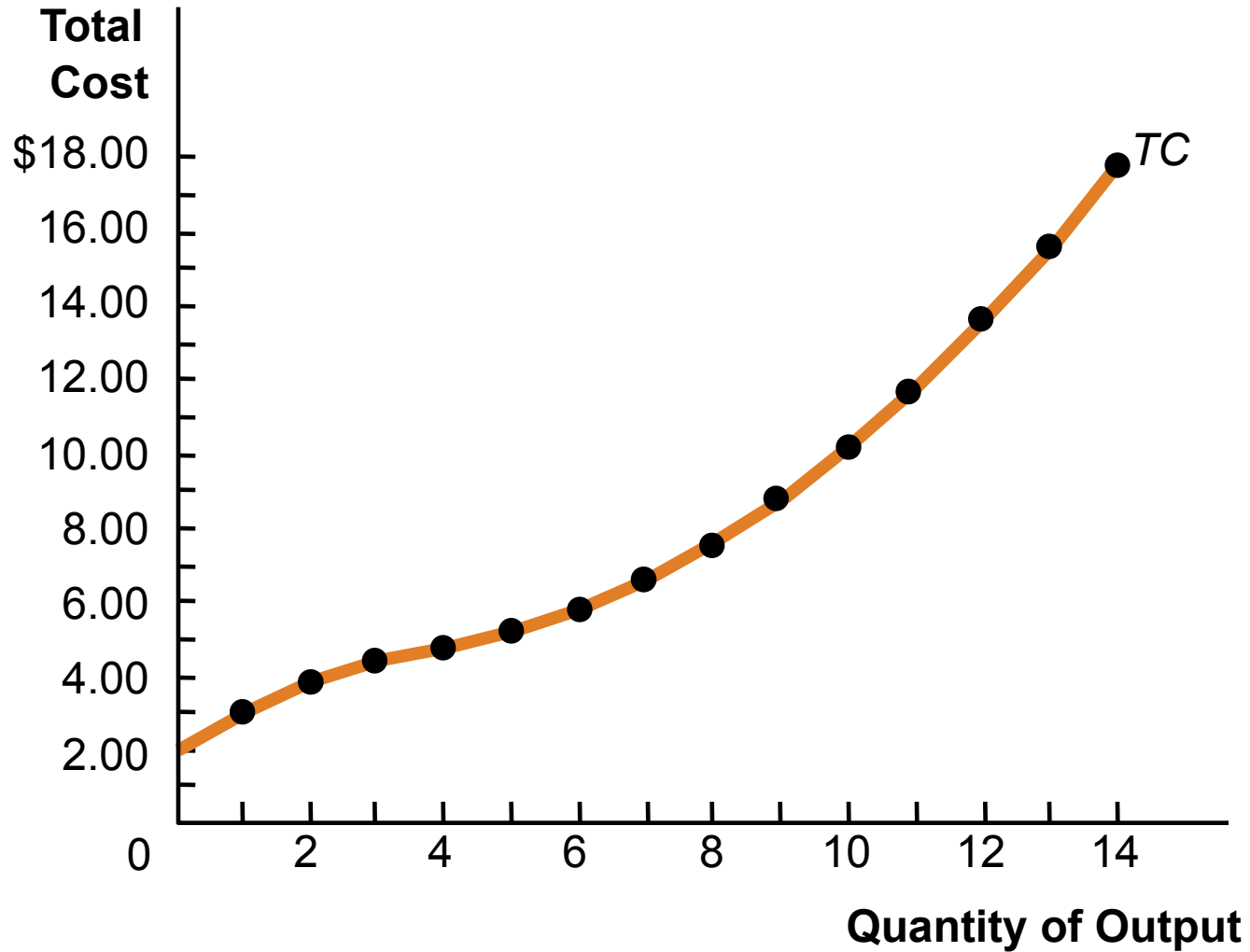
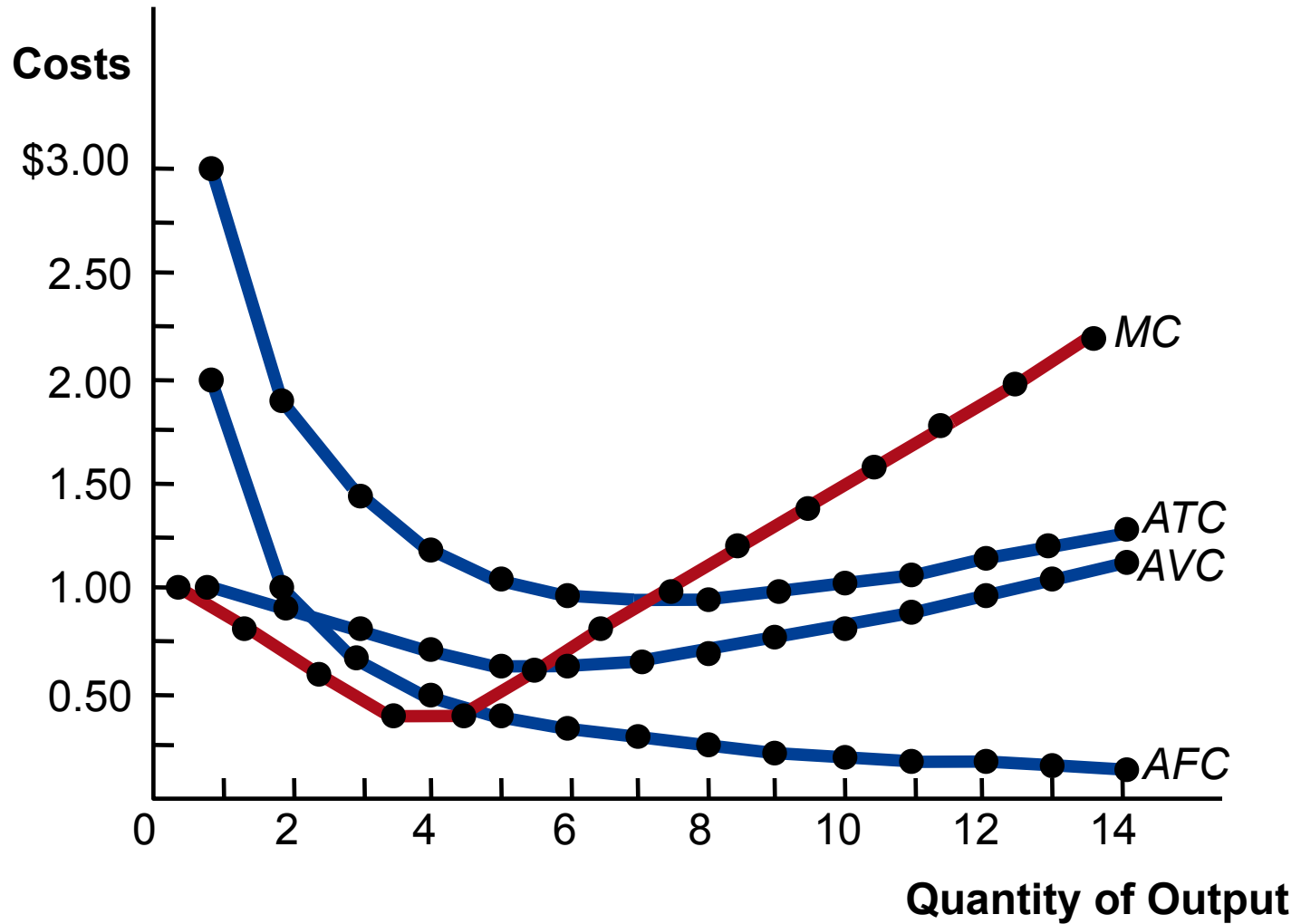


Figure 5 Cost Curves of a Typical Firm

(b) Marginal- and Average-Cost Curves



Typical Cost Curves

- Three Important Properties of Cost Curves
 - Marginal cost *eventually* rises with the quantity of output.
 - The average-total-cost curve is U-shaped.
 - The marginal-cost curve crosses the average-total-cost curve at the minimum of average total cost.

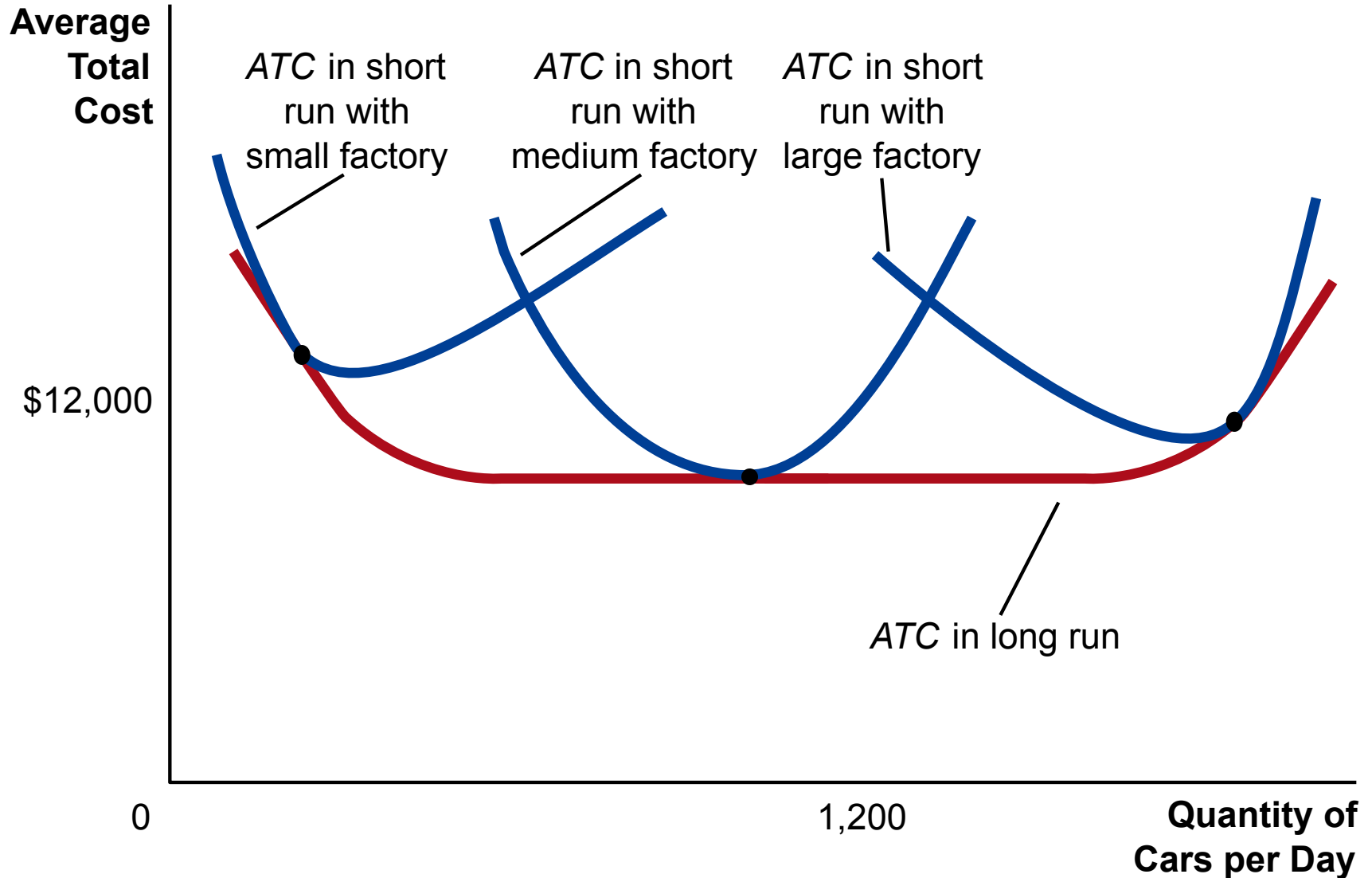
COSTS IN THE SHORT RUN AND IN THE LONG RUN

- How much of a firm's total costs are fixed costs and how much are variable costs depends on the time horizon being considered.
 - In the short run, some costs are fixed.
 - In the long run, all costs are variable.

COSTS IN THE SHORT RUN AND IN THE LONG RUN

- Because some costs are fixed in the short run and variable in the long run, a firm's long-run cost curves differ from its short-run cost curves.

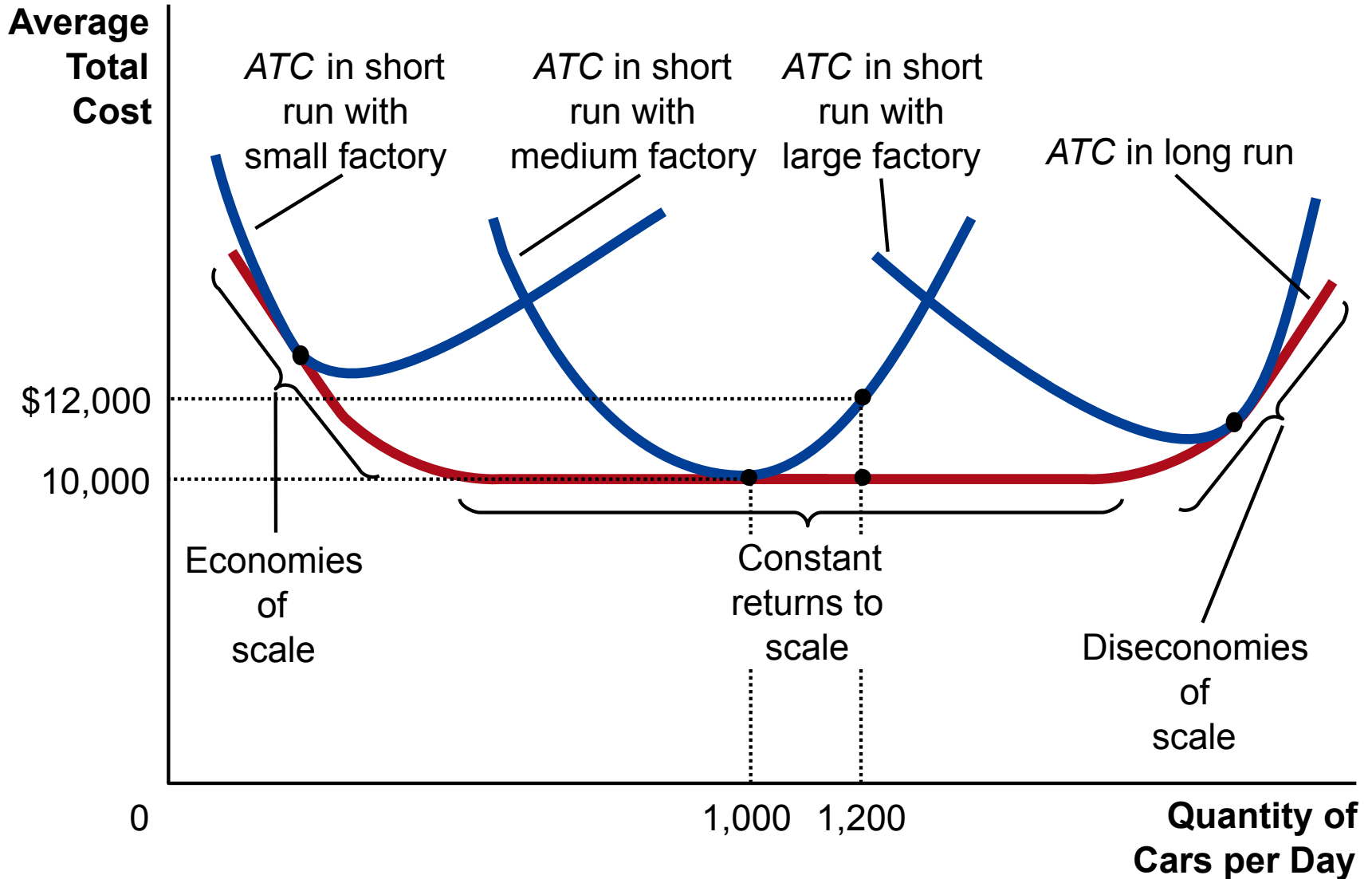
Figure 6 Average Total Cost in the Short and Long Run



Economies and Diseconomies of Scale

- *Economies of scale* exist when long-run average total cost falls as the quantity of output increases.
- *Diseconomies of scale* exist when long-run average total cost rises as the quantity of output increases.
- *Constant returns to scale* exists when long-run average total cost stays unchanged as the quantity of output increases

Figure 6 Average Total Cost in the Short and Long Run



Summary

- The goal of firms is to maximize profit, which equals total revenue minus total cost.
- When analyzing a firm's behavior, it is important to include all the opportunity costs of production.
- Some opportunity costs are explicit while other opportunity costs are implicit.

Summary

- A firm's costs reflect its production process.
- A typical firm's production function gets flatter as the quantity of input increases, displaying the property of diminishing marginal product.
- A firm's total costs are divided between fixed and variable costs. Fixed costs do not change when the firm alters the quantity of output produced; variable costs do change as the firm alters quantity of output produced.

Summary

- Average total cost is total cost divided by the quantity of output.
- Marginal cost is the amount by which total cost would rise if output were increased by one unit.
- The marginal cost always rises with the quantity of output.
- Average cost first falls as output increases and then rises.

Summary

- The average-total-cost curve is U-shaped.
- The marginal-cost curve always crosses the average-total-cost curve at the minimum of ATC.
- A firm's costs often depend on the time horizon being considered.
- In particular, many costs are fixed in the short run but variable in the long run.