PRINCIPLES OF
MICROECONOMICS
ELEVENTH EDITION

CASE · FAIR · OSTER

PEARSON

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Short-Run Costs and Output Decisions

8

CHAPTER OUTLINE

In their quest for profits, firms make three specific decisions involving their production.

DECISIONS	are based on	INFORMATION
1. The quantity of output to *supply*		1. The price of output
2. How to produce that output (which technique to use)		2. Techniques of production available*
3. The quantity of each input to *demand*		3. The price of inputs*

*Determines production costs

▲ FIGURE 8.1 **Decisions Facing Firms**

Costs in the Short Run

fixed cost Any cost that does not depend on the firms' level of output. These costs are incurred even if the firm is producing nothing. There are no fixed costs in the long run.

variable cost A cost that depends on the level of production chosen.

total cost (*TC*) Total fixed costs plus total variable costs.

$$TC = TFC + TVC$$

Fixed Costs

Total Fixed Cost (*TFC*)

total fixed costs (*TFC*) *or* overhead The total of all costs that do not change with output even if output is zero.

TABLE 8.1 Short-Run Fixed Cost (Total and Average) of a Hypothetical Firm

(1) *q*	(2) *TFC*	(3) *AFC (TFC/q)*
0	$100	$ –
1	100	100
2	100	50
3	100	33
4	100	25
5	100	20

If fixed cost at Q = 100 is $170, then:
a. fixed cost at Q = 0 is zero.
b. fixed cost at Q = 0 is less than $170.
c. fixed cost at Q = 200 is $340.
d. fixed cost at Q = 200 is $170.
e. There is insufficient information given to calculate any amount of cost.

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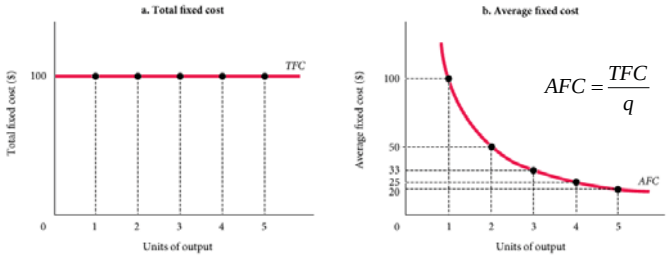
b. fixed cost at Q = 0 is less than $170.
c. fixed cost at Q = 200 is $340.
d. fixed cost at Q = 200 is $170.
e. There is insufficient information given to calculate any amount of cost.

Average Fixed Cost (*AFC*)

average fixed cost (*AFC*) Total fixed cost divided by the number of units of output; a per-unit measure of fixed costs.



▲ **FIGURE 8.2 Short-Run Fixed Cost (Total and Average) of a Hypothetical Firm**

Average fixed cost is simply total fixed cost divided by the quantity of output. As output increases, average fixed cost declines because we are dividing a fixed number ($1,000) by a larger and larger quantity.

spreading overhead The process of dividing total fixed costs by more units of output. Average fixed cost declines as quantity rises.

Average fixed cost:
a. Increases as output increases.
b. Decreases as output increases.
c. Remains constant as output increases.
d. First decreases then, beyond some point, it begins to increase.

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Variable Costs

Total Variable Cost (*TVC*)

total variable cost (*TVC*) The total of all costs that vary with output in the short run.

TABLE 8.2 Derivation of Total Variable Cost Schedule from Technology and Factor Prices

Produce	Using Technique	Units of Input Required (Production Function) *K*	*L*	Total Variable Cost Assuming P_K = $2, P_L = $1 $TVC = (K \times P_K) + (L \times P_L)$
1 unit of output	*A*	10	7	(10 x $2) + (7 x $1) = $27
	B	6	8	(6 x $2) + (8 x $1) = $20
2 units of output	*A*	16	8	(16 x $2) + (8 x $1) = $40
	B	11	16	(11 x $2) + (16 x $1) = $38
3 units of output	*A*	19	15	(19 x $2) + (15 x $1) = $38
	B	18	22	(18 x $2) + (22 x $1) = $58

Which of the following curves embodies information about both input prices and technology?

a. The total fixed cost curve.
b. The average fixed cost curve.
c. The total variable cost curve.
d. All of the above.

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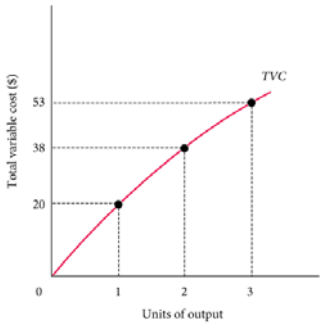
total variable cost curve A graph that shows the relationship between total variable cost and the level of a firm's output.

▶ **FIGURE 8.3 Total Variable Cost Curve**

In Table 8.2, total variable cost is derived from production requirements and input prices.
A total variable cost curve expresses the relationship between *TVC* and total output.



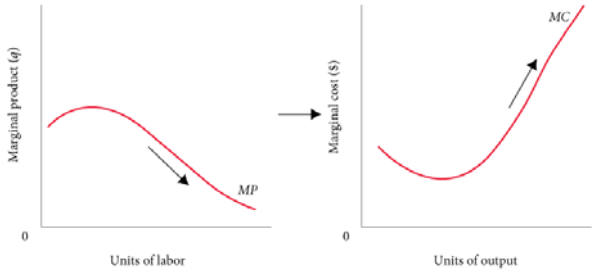
Marginal Cost (*MC*)

marginal cost (*MC*) The increase in total cost that results from producing 1 more unit of output. Marginal costs reflect changes in variable costs.

TABLE 8.3 Derivation of Marginal Cost from Total Variable Cost

Units of Output	Total Variable Costs ($)	Marginal Costs ($)
0	0	
1	20	20
2	38	18
3	53	15

The Shape of the Marginal Cost Curve in the Short Run



▲ **FIGURE 8.4 Declining Marginal Product Implies That Marginal Cost Will Eventually Rise with Output**

In the short run, every firm is constrained by some fixed factor of production.
A fixed factor implies diminishing returns (declining marginal product) and a limited capacity to produce. As that limit is approached, marginal costs rise.

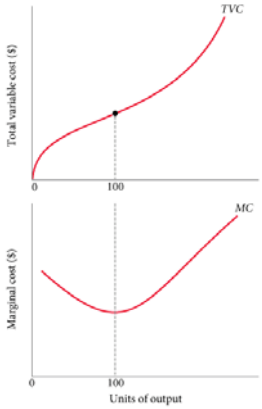
In the short run, every firm is constrained by some fixed input that (1) leads to diminishing returns to variable inputs and (2) limits its capacity to produce. As a firm approaches that capacity, it becomes increasingly costly to produce successively higher levels of output. Marginal costs ultimately increase with output in the short run.

Graphing Total Variable Costs and Marginal Costs

▶ **FIGURE 8.5 Total Variable Cost and Marginal Cost for a Typical Firm**

Total variable costs always increase with output.
Marginal cost is the cost of producing each additional unit.
Thus, the marginal cost curve shows how total variable cost changes with single-unit increases in total output.

$$\text{slope of } TVC = \frac{\Delta TVC}{\Delta q} = \frac{\Delta TVC}{1} = \Delta TVC = MC$$



Which of the following is *marginal cost*?

a. The slope of the total variable cost curve.
b. Total variable cost divided by the number of units of output.
c. The wage rate times the units of labor employed.
d. All of the above.

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d. All of the above.

Average Variable Cost (*AVC*)

average variable cost (*AVC*) Total variable cost divided by the number of units of output.

$$AVC = \frac{TVC}{q}$$

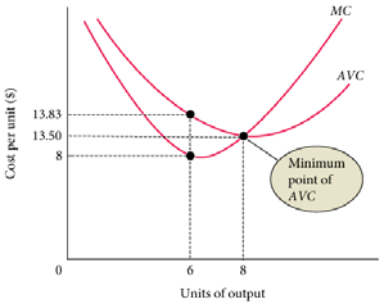
TABLE 8.4 Short-Run Costs of a Hypothetical Firm

(1) *q*	(2) *TVC*	(3) *MC* (Δ *TVC*)	(4) *AVC* (*TVC*/*q*)	(5) *TFC*	(6) *TC* (*TVC* + *TFC*)	(7) *AFC* (*TFC*/*q*)	(8) *ATC* (*TC*/*q* or *AFC* + *AVC*)
0	$ 0.00	$ -	$ -	$ 100.00	$ 100.00	$ -	$ -
1	20.00	20.00	20.00	100.00	120.00	100.00	120.00
2	38.00	18.00	19.00	100.00	138.00	50.00	69.00
3	53.00	15.00	17.66	100.00	153.00	33.33	51.00
4	65.00	12.00	16.25	100.00	165.00	25.00	41.25
5	75.00	10.00	15.00	100.00	175.00	20.00	35.00
6	83.00	8.00	13.83	100.00	183.50	16.67	30.50
7	94.50	11.50	13.50	100.00	194.50	14.28	27.78
8	108.00	13.50	13.50	100.00	208.00	12.50	26.00
9	128.50	20.50	14.28	100.00	228.50	11.11	25.39
10	168.50	40.00	16.85	100.00	268.50	10.00	26.85

Graphing Average Variable Costs and Marginal Costs

▶ **FIGURE 8.6 More Short-Run Costs**

When marginal cost is *below* average cost, average cost is declining.
When marginal cost is *above* average cost, average cost is increasing.
Rising marginal cost intersects average variable cost at the minimum point of *AVC*.



ECONOMICS IN PRACTICE

Flying Standby

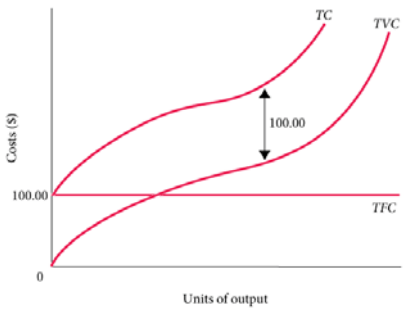
In January 2013, a one-way ticket from New York to San Diego, California cost about $500 on one of the major airlines. Alternatively, you could buy a Standby ticket for $50 and wait around JFK airport hoping for a seat to San Diego. Why would an airline offer a $50 seat for this flight? The answer has to do with marginal costs.

If there is an empty seat at takeoff time, what is the marginal cost of putting a passenger in it? The added weight of that passenger likely does little to fuel usage, and the peanut and beverage costs are also modest these days. In fact, the marginal cost of adding a passenger when you already plan to make the flight is probably close to zero if there is an empty seat. The Standby price of $50 is well above the marginal costs of the added passenger.

THINKING PRACTICALLY

1. Thinking back to the lessons on opportunity cost earlier in the book, who do you expect to see waiting in airports for a Standby seat?
2. And this harder question: Is there any business danger to the airline of having Standby tickets?

Total Costs

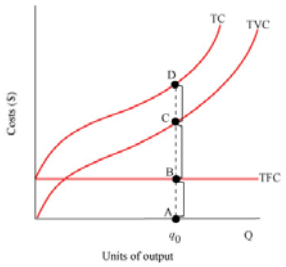


▲ **FIGURE 8.7 Total Cost = Total Fixed Cost + Total Variable Cost**

Adding *TFC* to *TVC* means adding the same amount of total fixed cost to every level of total variable cost.
Thus, the total cost curve has the same shape as the total variable cost curve; it is simply higher by an amount equal to *TFC*.

Refer to the figure below. Which distance from point D is equal to *total fixed cost*?

a. The distance from D to B.
b. The distance from D to C.
c. The distance from D to A.
d. None of the above. Fixed cost cannot be measured from point D.



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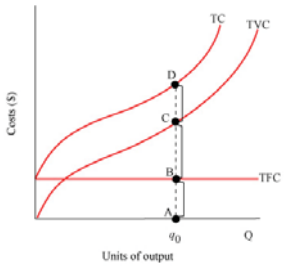


Average Total Cost (*ATC*)

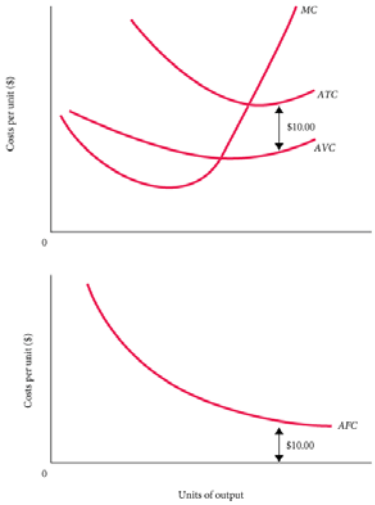
average total cost (*ATC*) Total cost divided by the number of units of output.

$$ATC = \frac{TC}{q}$$

$$ATC = AFC + AVC$$

▶ **FIGURE 8.8 Average Total Cost = Average Variable Cost + Average Fixed Cost**

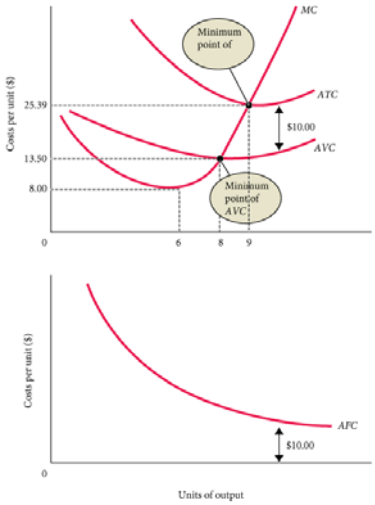
To get average total cost, we add average fixed and average variable costs at all levels of output. Because average fixed cost falls with output, an ever-declining amount is added to *AVC*. Thus, *AVC* and *ATC* get closer together as output increases, but the two lines never meet.



The Relationship Between Average Total Cost and Marginal Cost

The relationship between average *total* cost and marginal cost is exactly the same as the relationship between average *variable* cost and marginal cost.

If marginal cost is *below* average total cost, average total cost will *decline* toward marginal cost. If marginal cost is *above* average total cost, average total cost will *increase*. As a result, marginal cost intersects average *total* cost at *ATC*'s minimum point for the same reason that it intersects the average *variable* cost curve at its minimum point.



Short-Run Costs: A Review

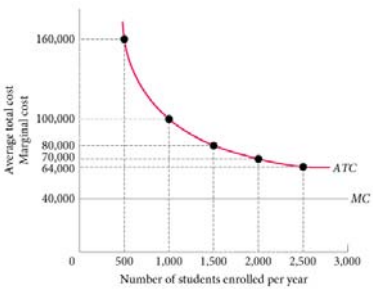
TABLE 8.5 A Summary of Cost Concepts

Term	Definition	Equation
Accounting costs	Out-of-pocket costs or costs as an accountant would define them. Sometimes referred to as *explicit costs*.	–
Economic costs	Costs that include the full opportunity costs of all inputs. These include what are often called *implicit costs*.	–
Total fixed costs (*TFC*)	Costs that do not depend on the quantity of output produced. These must be paid even if output is zero.	–
Total variable costs (*TVC*)	Costs that vary with the level of output.	–
Total cost (*TC*)	The total economic cost of all the inputs used by a firm in production.	$TC = TFC + TVC$
Average fixed costs (*AFC*)	Fixed costs per unit of output.	$AFC = TFC/q$
Average variable costs (*AVC*)	Variable costs per unit of output.	$AVC = TVC/q$
Average total costs (*ATC*)	Total costs per unit of output.	$ATC = TC/q$ $ATC = AFC + AVC$
Marginal costs (*MC*)	The increase in total cost that results from producing 1 additional unit of output.	$MC = \Delta TC/\Delta q$

ECONOMICS IN PRACTICE

Average and Marginal Costs at a College

	Costs in Dollars			
Students	Total Fixed Cost	Total Variable Cost	Total Cost	Average Total Cost
500	$60 million	$ 20 million	$ 80 million	$160,000
1,000	60 million	40 million	100 million	100,000
1,500	60 million	60 million	120 million	80.000
2,000	60 million	80 million	140 million	70,000
2,500	60 million	100 million	160 million	64,000



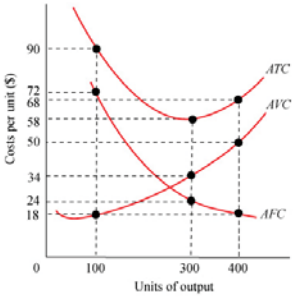
The key issue here is to recognize that for a college like Pomona—and indeed for most colleges—the average total cost of educating a student is higher than the marginal cost.

THINKING PRACTICALLY

1. How can we use this hypothetical cost curve to help explain why colleges struggle when attendance falls dramatically? What is it about the cost structure that magnifies this issue?

Refer to the figure below. What is the value of total variable cost when 300 units of output are produced?

a. $1,800
b. $10,200
c. $20,000
d. $7,200
e. $17,400



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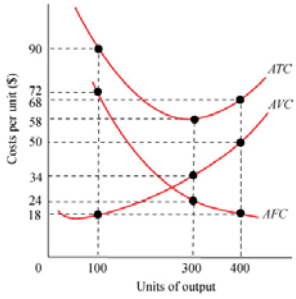
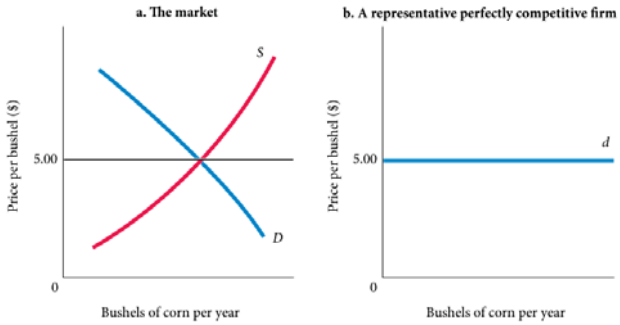


Output Decisions: Revenues, Costs, and Profit Maximization

Perfect Competition

perfect competition An industry structure in which there are many firms, each small relative to the industry, producing identical products and in which no firm is large enough to have any control over prices. In perfectly competitive industries, new competitors can freely enter and exit the market.

homogeneous products Undifferentiated products; products that are identical to, or indistinguishable from, one another.



▲ **FIGURE 8.9 Demand Facing a Single Firm in a Perfectly Competitive Market**

If a representative firm in a perfectly competitive market raises the price of its output above $5.00, the quantity demanded of *that firm's* output will drop to zero. Each firm faces a perfectly elastic demand curve, *d*.

Total Revenue and Marginal Revenue

total revenue (*TR*) The total amount that a firm takes in from the sale of its product: the price per unit times the quantity of output the firm decides to produce (*P* x *q*).

$$\text{total revenue} = \text{price} \times \text{quantity}$$

$$TR = P \times q$$

marginal revenue (*MR*) The additional revenue that a firm takes in when it increases output by one additional unit. In perfect competition, *P* = *MR*.

The *marginal revenue curve and the demand curve facing a competitive firm are identical*. The horizontal line in Figure 8.9(b) can be thought of as both the demand curve facing the firm and its marginal revenue curve:

$$P^* = d = MR$$

Marginal revenue equals the change in total revenue associated with:

a. Marginal cost.
b. Hiring an additional worker.
c. Increasing the price per unit of output sold.
d. Selling an additional unit of output.
e. Decreasing sales revenue from laying off an additional worker.

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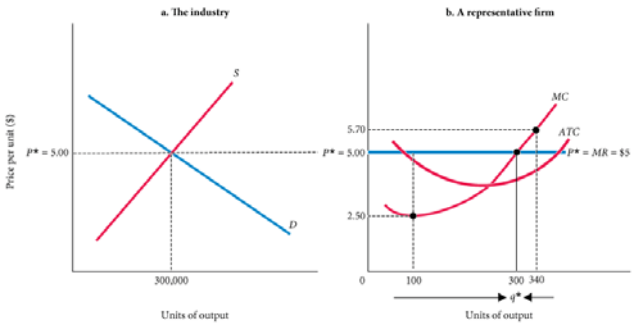
The Profit-Maximizing Level of Output

As long as marginal revenue is greater than marginal cost, even though the difference between the two is getting smaller, added output means added profit. Whenever marginal revenue exceeds marginal cost, the revenue gained by increasing output by 1 unit per period exceeds the cost incurred by doing so.

The profit-maximizing perfectly competitive firm will produce up to the point where the price of its output is just equal to short-run marginal cost—the level of output at which $P^* = MC$.

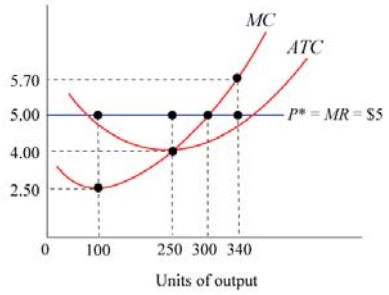
The profit-maximizing output level for *all* firms is the output level where $MR = MC$. In perfect competition, however, MR = P, as shown earlier. Hence, for perfectly competitive firms, we can rewrite our profit-maximizing condition as $P = MC$.

Important note: The key idea here is that firms will produce as long as marginal revenue exceeds marginal cost.



▶ **FIGURE 8.10 The Profit-Maximizing Level of Output for a Perfectly Competitive Firm**
If price is above marginal cost, as it is at every quantity less than 300 units of output, profits can be increased by raising output; each additional unit increases revenues by more than it costs to produce the additional output because $P > MC$. Beyond $q^* = 300$, however, added output will reduce profits.
At 340 units of output, an additional unit of output costs more to produce than it will bring in revenue when sold on the market. Profit-maximizing output is thus q^*, the point at which $P^* = MC$.

Refer to the figure below. Which level of output maximizes profit?
a. 100 units.
b. 200 units.
c. 300 units.
d. 340 units.
e. None of the above.



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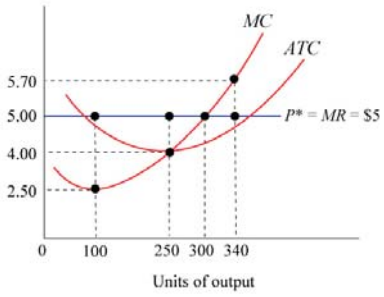
e. None of the above.



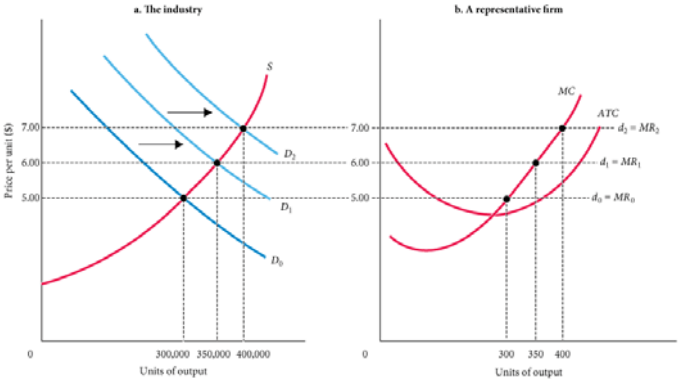
A Numerical Example

TABLE 8.6 Profit Analysis for a Simple Firm

(1) q	(2) TFC	(3) TVC	(4) MC	(5) $P = MR$	(6) TR ($P \times q$)	(7) TC ($TFC + TVC$)	(8) Profit ($TR - TC$)
0	$ 10	$ 0	$ –	$ 15	$ 0	$ 10	$ –10
1	10	10	10	15	15	20	–5
2	10	15	5	15	30	25	5
3	10	20	5	15	45	30	15
4	10	30	10	15	60	40	20
5	10	50	20	15	75	60	15
6	10	80	30	15	90	90	0

If firms can produce fractional units, it is optimal to produce between 4 and 5 units. The profit-maximizing level of output is thus between 4 and 5 units. The firm continues to increase output as long as price (marginal revenue) is greater than marginal cost.

The Short-Run Supply Curve



▲ **FIGURE 8.11 Marginal Cost Is the Supply Curve of a Perfectly Competitive Firm**

At any market price,[a] the marginal cost curve shows the output level that maximizes profit. Thus, the marginal cost curve of a perfectly competitive profit-maximizing firm is the firm's short-run supply curve.

[a]This is true except when price is so low that it pays a firm to shut down—a point that will be discussed in Chapter 9.

Looking Ahead

The *marginal cost curve* carries information about both *input prices* and *technology*.

With one important exception, the marginal cost curve *is* the perfectly competitive firm's supply curve in the short run.

In the next chapter, we turn to the long run.

REVIEW TERMS AND CONCEPTS

average fixed cost (*AFC*)
average total cost (*ATC*)
average variable cost (*AVC*)
fixed cost
homogeneous product
marginal cost (*MC*)
marginal revenue (*MR*)
perfect competition
spreading overhead
total cost (*TC*)
total fixed costs (*TFC*) *or* overhead
total revenue (*TR*)
total variable cost (*TVC*)
total variable cost curve
variable cost

1. $TC = TFC + TVC$
2. $AFC = TFC/q$
3. Slope of $TVC = MC$
4. $AVC = TVC/q$
5. $ATC = TC/q = AFC + AVC$
6. $TR = P \times q$
7. Profit-maximizing level of output for all firms: $MR = MC$
8. Profit-maximizing level of output for perfectly competitive firms: $P = MC$