CHAPTER 8

# Competitive Firms and Markets

*The love of money is the root of all virtue.* —George Bernard Shaw

One of the major questions firms face is "How much should we produce?" To pick a level of output that maximizes its profit, a firm must consider its cost function and how much it can sell at a given price. The amount the firm thinks it can sell depends in turn on the market demand of consumers and its beliefs about how other firms in the market will behave. The behavior of firms depends on the market structure: the number of firms in the market, the ease with which firms can enter and leave the market, and the ability of firms to differentiate their products from those of their rivals.

In this chapter, we look at a competitive market structure, one in which many firms produce identical products and firms can easily enter and exit the market. Because each firm produces a small share of the total market output and its output is identical to that of other firms, each firm is a *price taker* that cannot raise its price above the market price. If it were to try to do so, this firm would be unable to sell any of its output because consumers would buy the good at a lower price from the other firms in the market. The market price summarizes all a firm needs to know about the demand of consumers *and* the behavior of its rivals. Thus a competitive firm can ignore the specific behavior of individual rivals in deciding how much to produce.[1]

*In this chapter, we examine five main topics*

1. **Competition:** A competitive firm is a price taker, and as such, it faces a horizontal demand curve.
2. **Profit maximization:** To maximize profit, any firm must make two decisions: how much to produce and whether to produce at all.
3. **Competition in the short run:** Variable costs determine a profit-maximizing, competitive firm's supply curve, the market supply curve, and with the market demand curve, the competitive equilibrium in the short run.
4. **Competition in the long run:** Firm supply, market supply, and competitive equilibrium are different in the long run than in the short run because firms can vary inputs that were fixed in the short run.
5. **Zero profit for competitive firms in the long run:** In the long-run competitive market equilibrium, profit-maximizing firms break even, so firms that do not try to maximize profits lose money and leave the market.

[1]In contrast, each oligopolistic firm must consider the behavior of each of its small number of rivals, as we discuss in Chapter 13.

## 8.1 COMPETITION

Competition is a common market structure that has very desirable properties, so it is useful to compare other market structures to competition. In this section, we describe the properties of competitive firms and markets. Next, we examine how competitive firms maximize profit to derive the short-run and long-run supply curves of competitive firms and competitive markets. Then we reexamine the competitive equilibrium.

### Price Taking

When most people talk about "competitive firms," they mean firms that are rivals for the same customers. By this interpretation, any market that has more than one firm is competitive. However, to an economist, only some of these multifirm markets are competitive.

Economists say that a market is *competitive* if each firm in the market is a *price taker*: a firm that cannot significantly affect the market price for its output or the prices at which it buys its inputs. If any one of the more than 40,000 apple farms in the United States were to stop producing apples or to double its production, the market price of apples would not change appreciably. Similarly, by stopping production or doubling its production, an apple farm would have little or no effect on the price for apple seeds, fertilizer, and other inputs.

Why would a competitive firm be a price taker? It has no choice. The firm *has* to be a price taker if it faces a demand curve that is horizontal at the market price. If the demand curve is horizontal at the market price, the firm can sell as much as it wants at the market price, so it has no incentive to lower its price. Similarly, the firm cannot increase the price at which it sells by restricting its output because it faces an infinitely elastic demand (see Chapter 3): A small increase in price results in its demand falling to zero.

### Why the Firm's Demand Curve Is Horizontal

Firms are likely to be price takers in markets that have some or all of four properties:

- Consumers believe that all firms in the market sell *identical products*.
- Firms *freely enter and exit* the market.
- *Buyers and sellers know the prices* charged by firms.
- *Transaction costs*—the expenses of finding a trading partner and making a trade for a good or service other than the price paid for that good or service—*are low*.

When the products of all firms are seen as perfect substitutes, no firm can sell its product if it charges more than others because no consumer is willing to pay a premium for that product. Consumers don't ask which farm grew an apple because they view apples as *homogeneous* or *undifferentiated* products. In contrast, consumers who know that the characteristics of a Jaguar and a Civic differ substantially view automobiles as *heterogeneous* or *differentiated* products. If some customers prefer one firm's product to those of other firms, the firm's demand curve has a downward slope. One firm can charge more than other firms without losing all its customers.

No firm can raise its price above the market price if other firms are able and eager to undercut another firm's high price to attract more customers. Even in markets with only a few firms, if other firms can quickly and easily enter, a firm cannot raise its price without other firms entering the market and undercutting its price. Moreover, ease of entry may cause the number of firms in a market to be large. The more firms there are in a market, the less the effect of a change in one firm's output on total market output and hence on the market price. If one of the 40,000 apple growers drops out of the market, market supply falls by only 0.0025% (assuming that the firms are of equal size), so the market price is unaffected.

If buyers know the prices other firms charge—the market price—a firm cannot raise its price without losing its customers. In contrast, if consumers do not know the prices other firms charge, a firm can charge more than other firms without losing all its customers, so its demand curve is downward sloping.

If transaction costs are low, it is easy for a customer to buy from a rival firm if the customer's usual supplier raises its price. Transaction costs are low if buyers and sellers do not have to spend time and money finding each other or hiring lawyers to write contracts in order to make a trade. The higher the transaction costs, the more likely it is that a firm's demand curve is downward sloping. Because finding a new, competent auto mechanic is very time consuming or involves traveling a great distance, some consumers continue to use their current auto repair shop even if it charges more than other firms. In some markets, buyers and sellers are brought together in a single room, so transaction costs are virtually zero. For example, transaction costs are very low at the auction in Amsterdam that the Bloemenveilingen Aalsmeer cooperative holds daily for the 7,000 sellers who ship 19 million flowers and 2 million plants from Zimbabwe, Colombia, Israel, Thailand, and Europe to 1,300 buyers around the world.

We call a market in which all these conditions hold a *perfectly competitive market*. In such a market, if a firm raised its price above the market price, the firm would be unable to make any sales. Its former customers would know that other firms sell an identical product at a lower price. These customers can easily find those other firms and buy from them without incurring extra transaction costs. If firms that are currently in the market cannot meet the demand of this firm's former customers, new firms can quickly and easily enter the market. Thus firms in such a market must be price takers.

The market for wheat is an example of an almost perfectly competitive market. Many farmers produce identical products, and transaction costs are negligible. Wheat is sold in a formal exchange or market such as the Chicago Commodity Exchange. Using a formal exchange, buyers and sellers can easily place buy or sell orders in person, over the telephone, or electronically, so transaction costs are negligible. No time is wasted in finding someone who wants to trade, and the transactions are made virtually instantaneously without much paperwork. Moreover, every buyer and seller in the market knows the market prices, quantities, and qualities of wheat available at any moment.

Even if some of these conditions are violated, firms and consumers may still be price takers. For example, even if entry of new firms is limited but the market has a very large number of firms and each can produce much more than its current output at about the same cost, firms are price takers. If one of these firms tries to raise its price, it will be unable to sell to consumers because other firms will expand their output if necessary to meet demand. A firm's demand curve is nearly horizontal as long as there are many firms in the market.

### ★Derivation of a Competitive Firm's Demand Curve

As a practical matter, are the demand curves faced by individual competitive firms flat? To answer this question, we use a modified supply-and-demand diagram to derive the demand curve an individual firm faces.

The demand curve that an individual firm faces is called the *residual demand curve*: the market demand that is not met by other sellers at any given price. The firm's residual demand function, $D^r(p)$, shows the quantity demanded from the firm at price $p$. A firm sells only to people who have not already purchased the good from another seller. We can determine how much demand is left for a particular firm at each possible price using the market demand curve and the supply curve for all *other* firms in the market. The quantity the market demands is a function of the price: $Q = D(p)$. The supply curve of other firms is $S^o(p)$. The residual demand function equals the market demand function, $D(p)$, minus the supply of all other firms:

$$D^r(p) = D(p) - S^o(p). \tag{8.1}$$

At prices so high that $S^o(p)$ is greater than $D(p)$, the residual demand, $D^r(p)$, is zero.

In Figure 8.1, we derive the residual demand for a Canadian manufacturing firm that produces metal chairs. Panel b shows the market demand curve, $D$, and the supply of all but one manufacturing firm, $S^o$.[2] At $p = \$66$ per chair, the supply of other firms, 500 units (one unit being 1,000 metal chairs) per year, exactly equals the market demand (panel b), so the residual quantity demanded of the remaining firm (panel a) is zero.

At prices below \$66, the other chair firms are not willing to supply as much as the market demands. At $p = \$63$, for example, the market demand is 527 units, but other firms want to supply only 434 units. As a result, the residual quantity demanded from the individual firm at $p = \$63$ is 93 (= 527 – 434) units. Thus the residual demand curve at any given price is the horizontal difference between the market demand curve and the supply of the other firms.

The residual demand curve the firm faces, panel a, is much flatter than the market demand curve, panel b. As a result, the elasticity of the residual demand curve is much higher than the market elasticity.

If there are $n$ identical firms in the market, the elasticity of demand, $\varepsilon_i$, facing Firm $i$ is

$$\varepsilon_i = n\varepsilon - (n - 1)\eta_o, \tag{8.2}$$

where $\varepsilon$ is the market elasticity of demand (a negative number), $\eta_o$ is the elasticity

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[2]The figure uses constant elasticity demand and supply curves. The elasticity of supply, 3.1, is based on the estimated cost function from Robidoux and Lester (1988) for Canadian office furniture manufacturers. I estimate that the elasticity of demand is –1.1, using data from Statistics Canada, *Office Furniture Manufacturers*.

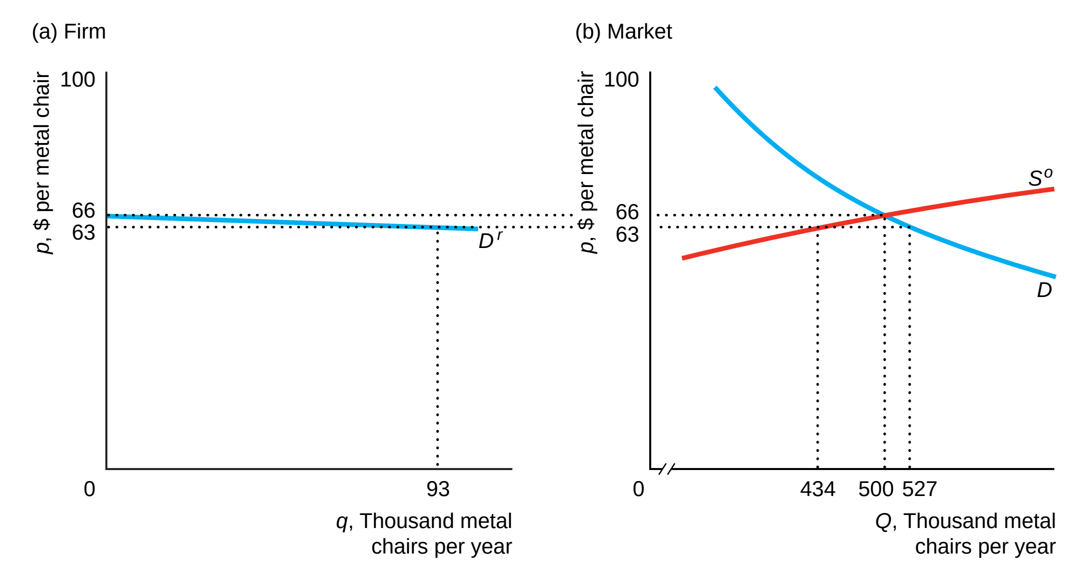


**Figure 8.1 Residual Demand Curve.** The residual demand curve, $D^r(p)$, a single office furniture manufacturing firm faces is the market demand, $D(p)$, minus the supply of the other firms in the market, $S^o(p)$. The residual demand curve is much flatter than the market demand curve.

of supply of the other firms (typically a positive number), and $n - 1$ is the number of other firms (see Appendix 8A for a derivation).

There are $n = 78$ firms manufacturing metal chairs in Canada. If they are identical, the elasticity of demand facing a single firm is

$$\begin{aligned} \varepsilon_i &= n\varepsilon - (n-1)\eta_o = [78 \times (-1.1)] - (77 \times 3.1) \\ &= -85.8 - 238.7 = -324.5. \end{aligned}$$

So even though the market demand elasticity is only −1.1, a typical firm faces a residual demand elasticity of −324.5. If a firm raises its price by one-tenth of a percent, the quantity it could sell would fall by nearly one-third. Therefore, the competitive model assumption that this firm faces a horizontal demand curve with an infinite price elasticity is not much of an exaggeration.

As Equation 8.2 shows, the residual demand curve a single firm faces is more elastic the more firms, $n$, in the market, the more elastic the market demand, $\varepsilon$, and the larger the elasticity of supply of the other firms, $\eta_o$.

## Why We Study Perfect Competition

Economists spend a great deal of time discussing perfect competition, which takes place in markets in which firms are price takers because products are homogeneous, firms enter and exit the market freely, buyers and sellers know the prices charged by firms, and transaction costs are low.[3]

[3]In addition, a perfectly competitive market has no externalities such as pollution (see Chapter 18).

Perfectly competitive markets are important for two reasons. First, many markets can be reasonably described as competitive. Many agricultural and other commodity markets, stock exchanges, retail and wholesale markets, building construction markets, and others have many or all of the properties of a perfectly competitive market. The competitive supply-and-demand model works well enough in these markets that it accurately predicts the effects of changes in taxes, costs, incomes, and other factors on market equilibrium.

Second, a perfectly competitive market has many desirable properties. Economists use this model as the ideal against which real-world markets are compared. Throughout the rest of this book, we show that society as a whole is worse off if the properties of the perfectly competitive market fail to hold. From this point on, for brevity, we use the phrase *competitive market* to mean a *perfectly competitive market* unless we explicitly note an imperfection.

## 8.2 PROFIT MAXIMIZATION

*"Too caustic?" To hell with the cost. If it's a good picture, we'll make it.*

—Samuel Goldwyn

Economists usually assume that *all* firms—not just competitive firms—want to maximize their profits. One reason is that many businesspeople say that their objective is to maximize profits. A second reason is that firms—especially competitive firms—that do not maximize profit are likely to lose money and be driven out of business.

In this section, we discuss how any type of firm—not just a competitive firm—maximizes its profit. We then examine how a competitive firm in particular maximizes profit.

### Profit

A firm's *profit*, $\pi$, is the difference between a firm's revenues, $R$, and its cost, $C$:

$$\pi = R - C.$$

If profit is negative, $\pi < 0$, the firm makes a *loss*.

Economists and businesspeople often measure profit differently. Because both economists and businesspeople measure revenue the same way—revenue is price times quantity—the difference in their profit measures is due to the way they measure costs (see Chapter 7). Some businesses use only explicit costs: a firm's out-of-pocket expenditures on inputs such as workers' wage payments, payments for materials, and payments for energy. *Economic cost* includes both explicit and implicit costs. Economic cost is the *opportunity cost*: the value of the best alternative use of any asset the firm employs.

**Economic profit** is revenue minus economic cost. Because explicit cost is less than economic cost, *business profit*—based on only explicit cost—is often larger than economic profit. The reason that this distinction is important is that a firm may make a costly mistake if it mismeasures profit by ignoring relevant opportunity costs.

A couple of examples illustrate the difference in the two profit measures and the importance of this distinction. First, let's return to the scenario in Chapter 7 in which you start your own firm.[4] You have to pay explicit costs such as workers' wages and the price of materials. Like many owners, you do not pay yourself a salary. Instead, you take home a business profit of $20,000 per year.

Economists (well-known spoilsports) argue that your profit is less than $20,000. Economic profit is business profit minus any additional opportunity cost. Suppose that you could have earned $25,000 a year working for someone else instead of running your business. The opportunity cost of your time working in your business is $25,000—your forgone salary. So even though your firm made a business profit of $20,000, you had an economic loss (negative economic profit) of $5,000. Put another way, the price of being your own boss is $5,000.

By looking at only the business profit and ignoring opportunity cost, you conclude that running your business is profitable. However, if you consider economic profit, you realize that working for others maximizes your income.

Similarly, when a firm decides whether to invest in a new venture, it must consider its next best alternative use of its funds. A firm that is considering setting up a new branch in Tucson must consider all the alternatives—placing the branch in Santa Fe, putting the money that the branch would cost in the bank and earning interest, and so on. If the best alternative use of the money is to put it in the bank and earn $10,000 per year in interest, the firm should build the new branch in Tucson only if it expects to make $10,000 or more per year in business profits. That is, the firm should create a Tucson branch only if its economic profit from the new branch is zero or positive. If its economic profit is zero, then it is earning the same return on its investment as it would from putting the money in its next best alternative, the bank. From this point on, when we use the term *profit*, we mean *economic profit* unless we specifically refer to business profit.

## BREAKING EVEN ON CHRISTMAS TREES

On the day after Thanksgiving each year, Tom Ruffino begins selling Christmas trees in Lake Grove, New York. The table summarizes his seasonal explicit costs.

| | |
|---|---|
| *Fixed Costs* | |
| Permit | $ 300 |
| Security (guard patrol when the lot is closed to prevent theft) | 360 |
| Insurance | 700 |
| Electricity | 1,000 |
| Lot rental (undeveloped land across from a major shopping mall) | 2,500 |
| Miscellaneous (fences, lot cleanup, snow removal) | 2,000 |
| Total fixed costs: | $6,860 |

[4]Michael Dell started a mail-order computer company while he was in college. Today, it is the world's largest personal computer company. By 2002, his wealth reached $16.5 billion.

| | |
|---|---|
| *Variable Costs* | |
| Labor (two full-time employees at $12 an hour for 50 hours a week, plus some part-time workers) | $ 5,500 |
| Trees (1,500 trees bought from a Canadian tree farm at $11.50 each) | 17,250 |
| Shipping (1,500 trees at $2 each) | 3,000 |
| Total variable costs: | $25,750 |
| Total accounting costs: | $32,610 |

Mr. Ruffino sells trees for 29 days at the market price of $25 each. To break even, he has to sell an average of 45 trees per day, so his average cost is $25. If he can sell an average of 52 trees per day (1,508 trees total), he makes an accounting profit of $5,090 for the season.

To calculate his economic profit, he has to subtract his forgone earnings at another job and the interest he would have earned on the money he paid at the beginning of the month (on his fixed costs and the price of the trees, $27,110) if he had invested that money elsewhere, such as in a bank, for a month. Although the forgone interest is small, his alternative earnings could be a large proportion of his business profit.

## Two Steps to Maximizing Profit

A firm's profit varies with its output level. The firm's profit function is

$$\pi(q) = R(q) - C(q).$$

A firm decides how much output to sell to maximize its profit. To maximize its profit, any firm (not just competitive, price-taking firms) must answer two questions:

- **Output decision:** If the firm produces, what output level, $q^*$, maximizes its profit or minimizes its loss?
- **Shutdown decision:** Is it more profitable to produce $q^*$ or to shut down and produce no output?

The profit curve in Figure 8.2 illustrates these two basic decisions. This firm makes losses at very low and very high output levels and positive profits at moderate output levels. The profit curve first rises and then falls, reaching a maximum profit of $\pi^*$ when its output is $q^*$. Because the firm makes a positive profit at that output, it chooses to produce $q^*$ units of output.

**Output Rules.** A firm can use one of three equivalent rules to choose how much output to produce. All types of firms maximize profit using the same rules.

The most straightforward rule is

*Output Rule 1:* The firm sets its output where its profit is maximized.

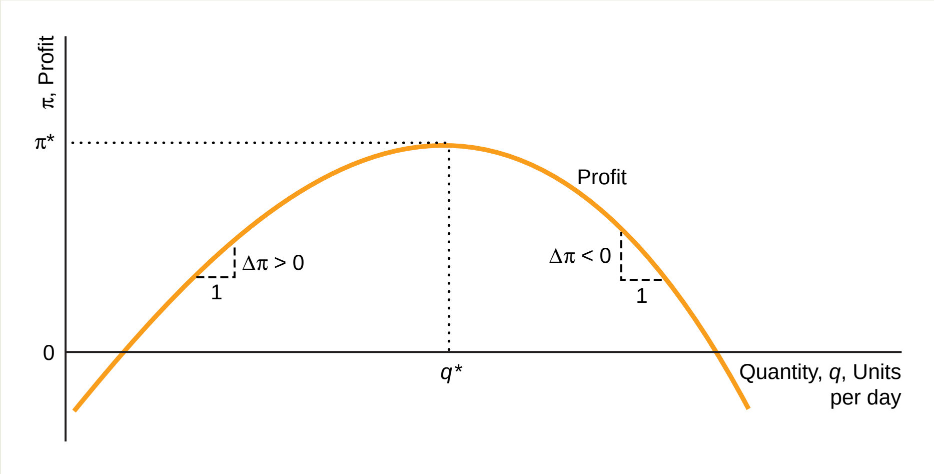


**Figure 8.2 Maximizing Profit.** By setting its output at $q^*$, the firm maximizes its profit at $\pi^*$.

The profit curve in Figure 8.2 is maximized at $\pi^*$ when output is $q^*$. If the firm knows its entire profit curve, it can immediately set its output to maximize its profit.

Even if the firm does not know the exact shape of its profit curve, it may be able to find the maximum by experimenting. The firm slightly increases its output. If profit increases, the firm increases the output more. The firm keeps increasing output until profit does not change. At that output, the firm is at the peak of the profit curve. If profit falls when the firm first increases its output, the firm tries decreasing its output. It keeps decreasing its output until it reaches the peak of the profit curve.

What the firm is doing is experimentally determining the slope of the profit curve. The slope of the profit curve is the firm's **marginal profit**: the change in the profit the firm gets from selling one more unit of output, $\Delta\pi/\Delta q$.[5] In the figure, the marginal profit or slope is positive when output is less than $q^*$, zero when output is $q^*$, and negative when output is greater than $q^*$. Thus,

*Output Rule 2:* A firm sets its output where its marginal profit is zero.

A third way to express this profit-maximizing output rule is in terms of cost and revenue. The marginal profit depends on a firm's *marginal cost* and *marginal revenue*. A firm's *marginal cost* ($MC$) is the amount by which a firm's cost changes if it produces one more unit of output (Chapter 7): $MC = \Delta C/\Delta q$, where $\Delta C$ is the change in cost when output changes by $\Delta q$. Similarly, a firm's **marginal revenue**, $MR$, is the change in revenue it gets from selling one more unit of output: $\Delta R/\Delta q$, where $\Delta R$ is the change in revenue.[6] If a firm that was selling $q$ units of output sells one more

[5]The marginal profit is the derivative of the profit function, $\pi(q)$, with respect to quantity, $d\pi(q)/dq$.

[6]The marginal revenue is the derivative of the revenue function with respect to quantity: $MR(q) = dR(q)/dq$.

unit of output, the extra revenue, $MR(q)$, raises its profit, but the extra cost, $MC(q)$, lowers its profit. The change in the firm's profit is[7]

$$\text{Marginal profit}(q) = MR(q) - MC(q).$$

Does it pay for a firm to produce one more unit of output? If the marginal revenue from this last unit of output exceeds its marginal cost, $MR(q) > MC(q)$, the firm's marginal profit is positive, $MR(q) - MC(q) > 0$, so it pays to increase output. The firm keeps increasing its output until its marginal profit = $MR(q) - MC(q) = 0$. There, its marginal revenue equals its marginal cost: $MR(q) = MC(q)$. If the firm produces more output where its marginal cost exceeds its marginal revenue, $MR(q) < MC(q)$, the extra output reduces the firm's profit. Thus a third, equivalent rule is (Appendix 8A):

> *Output Rule 3:* A firm sets its output where its marginal revenue equals its marginal cost
>
> $$MR(q) = MC(q).$$

**Shutdown Rule.** The firm chooses to produce if it can make a profit. If the firm is making a loss, however, does it shut down? The answer, surprisingly, is "It depends." The general rule, which holds for all types of firms in both the short run and in the long run, is

> *Shutdown Rule 1:* The firm shuts down only if it can reduce its loss by doing so.

In the short run, the firm has variable and sunk fixed costs (Chapter 7). By shutting down, it can eliminate the variable cost, such as labor and materials, but usually not the fixed cost, the amount it paid for its factory and equipment. By shutting down, the firm stops receiving revenue and stops paying the avoidable costs, but it is still stuck with its fixed cost. Thus it pays the firm to shut down only if its revenue is less than its avoidable cost.

Suppose that the firm's revenue is $R$ = \$2,000, its variable cost is $VC$ = \$1,000, and its fixed cost is $F$ = \$3,000, which is the price it paid for a machine that it cannot resell or use for any other purpose. This firm is making a short-run loss:

$$\pi = R - VC - F = \$2{,}000 - \$1{,}000 - \$3{,}000 = -\$2{,}000.$$

If the firm shuts down, it loses its fixed cost, \$3,000, so it is better off operating. Its revenue more than covers its avoidable, variable cost and offsets some of the fixed cost.

However, if its revenue is only \$500, its loss is \$3,500, which is greater than the loss from the fixed cost alone of \$3,000. Because its revenue is less than its avoidable, variable cost, the firm reduces its loss by shutting down.

In conclusion, the firm compares its revenue to its variable cost only when deciding whether to stop operating. Because the fixed cost is *sunk*—the expense

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[7]Because profit is $\pi(q) = R(q) - C(q)$, marginal profit is the difference between marginal revenue and marginal cost:

$$\frac{d\pi(q)}{dq} = \frac{dR(q)}{dq} - \frac{dC(q)}{dq} = MR - MC.$$

cannot be avoided by stopping operations (Chapter 7)—the firm pays this cost whether it shuts down or not. Thus the sunk fixed cost is irrelevant to the shut-down decision.[8]

In the long run, all costs are avoidable because the firm can eliminate them all by shutting down. Thus in the long run, where the firm can avoid all losses by not operating, it pays to shut down if the firm faces any loss at all. As a result, we can restate the shut-down rule as:

> *Shutdown Rule 2:* The firm shuts down only if its revenue is less than its avoidable cost.

This rule holds for all types of firms in both the short run and the long run.

## 8.3 COMPETITION IN THE SHORT RUN

Having considered how firms maximize profit in general, we now examine the profit-maximizing behavior of competitive firms, first in the short run and then in the long run. In doing so, we pay careful attention to the firm's shutdown decision.

### Short-Run Competitive Profit Maximization

A competitive firm, like other firms, first determines the output at which it maximizes its profit (or minimizes its loss). Second, it decides whether to produce or to shut down.

**Short-Run Output Decision.** We've already seen that *any* firm maximizes its profit at the output where its marginal profit is zero or, equivalently, where its marginal cost equals its marginal revenue. Because it faces a horizontal demand curve, a competitive firm can sell as many units of output as it wants at the market price, $p$. Thus a competitive firm's revenue, $R = pq$, increases by $p$ if it sells one more unit of output, so its marginal revenue is $p$.[9] For example, if the firm faces a market price of \$2 per unit, its revenue is \$10 if it sells 5 units and \$12 if it sells 6 units, so its marginal revenue for the sixth unit is \$2 = \$12 – \$10 (the market price). Because a competitive firm's marginal revenue equals the market price, *a profit-maximizing competitive firm produces the amount of output at which its marginal cost equals the market price:*

$$MC(q) = p. \tag{8.3}$$

To illustrate how a competitive firm maximizes its profit, we examine a typical Canadian lime manufacturing firm, which we assume is a price taker. Lime is a

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[8] We usually assume that fixed cost is sunk. However, if a firm can sell its capital for as much as it paid, its fixed cost is avoidable and should be taken into account when the firm is considering whether to shut down. A firm with a fully avoidable fixed cost always shuts down if it makes a short-run loss. If a firm buys a specialized piece of machinery for \$1,000 that can be used only in its business but can be sold for scrap metal for \$100, then \$100 of the fixed cost is avoidable and \$900 is sunk. Only the avoidable portion of fixed cost is relevant for the shutdown decision.

[9] Because $R(q) = pq$, $MR = \mathrm{d}R(q)/\mathrm{d}q = \mathrm{d}(pq)/\mathrm{d}q = p$.

nonmetallic mineral used in mortars, plasters, cements, bleaching powders, steel, paper, glass, and other products. The lime plant's estimated cost curve, $C$, in panel a of Figure 8.3 rises less rapidly with output at low quantities than at higher quantities.[10] If the market price of lime is $p = \$8$, the competitive firm faces a horizontal demand curve at \$8 (panel b), so the revenue curve, $R = pq = \$8q$, in panel a is an upward-sloping straight line with a slope of 8.

By producing 284 units (one unit being 1,000 metric tons), the firm maximizes its profit at $\pi^* = \$426{,}000$, which is the height of the profit curve and the difference between the revenue and cost curves at that quantity in panel a. At the competitive firm's profit-maximizing output, its marginal cost equals the market price of \$8 (Equation 8.3) at point $e$ in panel b.

Point $e$ is the competitive firm's equilibrium. Were the firm to produce less than the equilibrium quantity, 284 units, the market price would be above its marginal cost. As a result, the firm could increase its profit by expanding output because the firm earns more on the next ton, $p = \$8$, than it costs to produce it, $MC < \$8$. If the firm were to produce more than 284 units, so market price was below its marginal cost, $MC > \$8$, the firm could increase its profit by reducing its output. Thus the firm does not want to change its quantity only at output when its marginal cost equals the market price.

The firm's maximum profit, $\pi^* = \$426{,}000$, is the shaded rectangle in panel b. The length of the rectangle is the number of units sold, $q = 284$ units. The height of the rectangle is the firm's average profit, which is the difference between the market price, or average revenue, and its average cost:

$$\frac{\pi}{q} = \frac{R - C}{q} = \frac{pq}{q} - \frac{C}{q} = p - AC. \tag{8.4}$$

Here the average profit per unit is $\$1.50 = p - AC(284) = \$8 - \$6.50$.

As panel b illustrates, the firm chooses its output level to maximize its total profit rather than its profit per ton. By producing 140 units, where its average cost is minimized at \$6, the firm could maximize its average profit at \$2. Although the firm gives up 50¢ in profit per ton when it produces 284 units instead of 140 units, it more than makes up for that by selling an extra 144 units. The firm's profit is \$146,000 higher at 284 units than at 140 units.

Using the $MC = p$ rule, a firm can decide how much to alter its output in response to a change in its cost due to a new tax. For example, one of the many lime plants in Canada is in the province of Manitoba. If that province taxes that lime firm, the Manitoba firm is the only one in the lime market affected by the tax, so the tax will not affect market price. Solved Problem 8.1 shows how a profit-maximizing competitive firm would react to a tax that affected only it.

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[10]Robidoux and Lester (1988) estimate the variable cost function. In the figure, we assume that the minimum of the average variable cost curve is \$5 at 50,000 metric tons of output. Based on information from Statistics Canada, we set the fixed cost so that the average cost is \$6 at 140,000 tons.

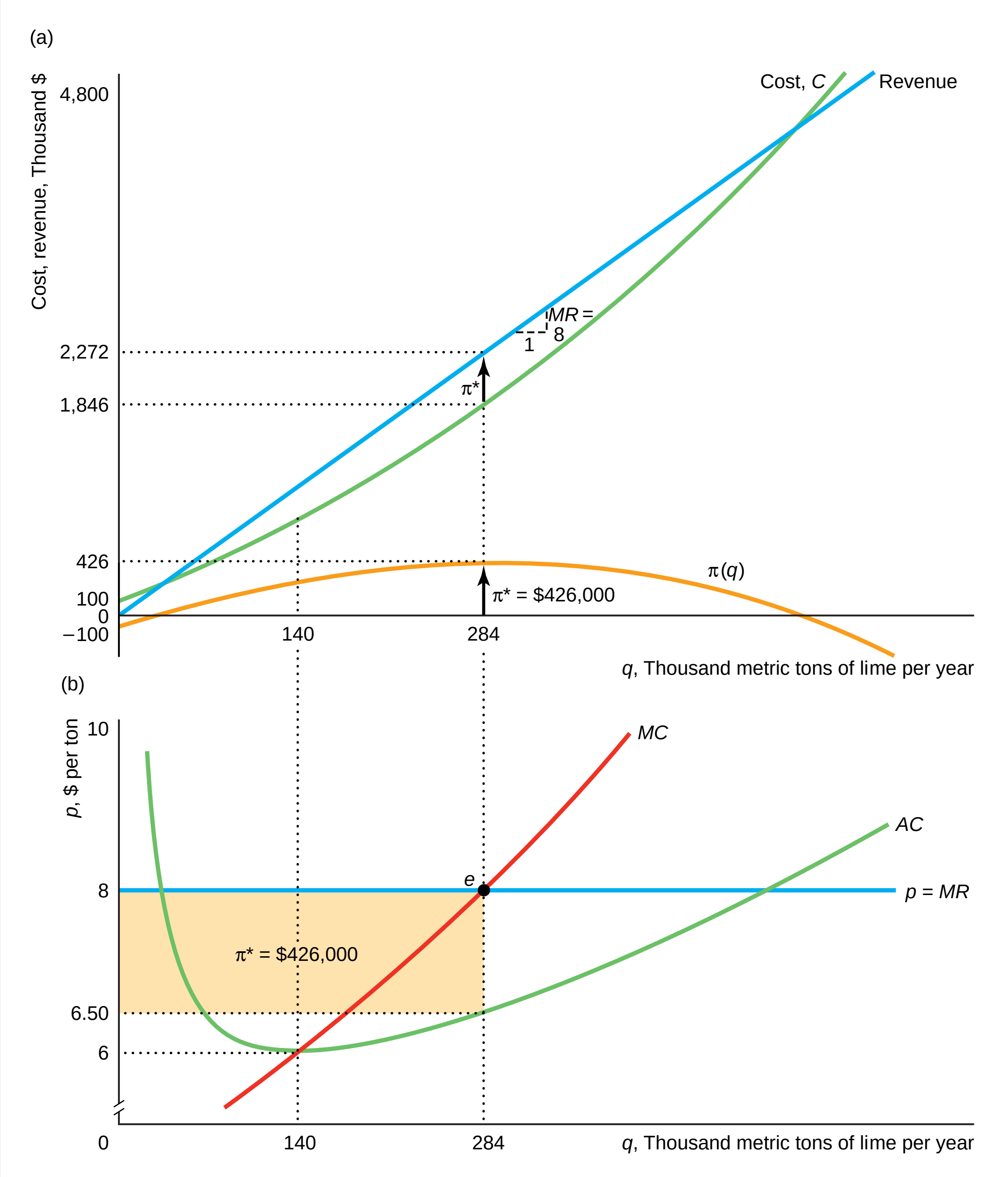


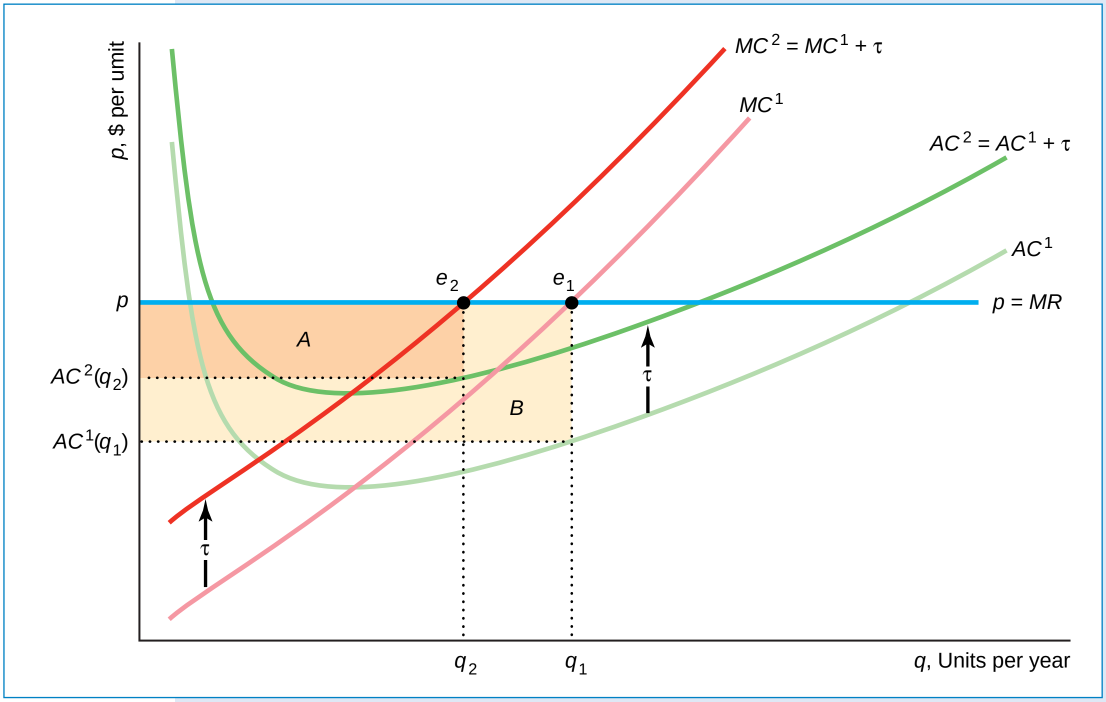

**Figure 8.3 How a Competitive Firm Maximizes Profit.** (a) A competitive lime manufacturing firm produces 284 units of lime so as to maximize its profit at $\pi^*$ = \$426,000 (Robidoux and Lester, 1988). (b) The firm's profit is maximized where its marginal revenue, *MR*, which is the market price, $p$ = \$8, equals its marginal cost, *MC*.

## Solved Problem 8.1

**If a specific tax of $\tau$ is collected from only one competitive firm, how should that firm change its output level to maximize its profit, and how does its maximum profit change?**

### Answer

1. *Show how the tax shifts the marginal cost and average cost curves*: The firm's before-tax marginal cost curve is $MC^1$ and its before-tax average cost curve is $AC^1$. Because the specific tax adds $\tau$ to the per-unit cost, it shifts the after-tax marginal cost curve up to $MC^2 = MC^1 + \tau$ and the after-tax average cost curve to $AC^2 = AC^1 + \tau$ (see Chapter 7).




2. *Determine the before-tax and after-tax equilibria and the amount by which the firm adjusts its output*: Where the before-tax marginal cost curve, $MC^1$, hits the horizontal demand curve, $p$, at $e_1$, the profit-maximizing quantity is $q_1$. The after-tax marginal cost curve, $MC^2$, intersects the demand curve, $p$, at $e_2$ where the profit-maximizing quantity is $q_2$. Thus in response to the tax, the firm produces $q_1 - q_2$ fewer units of output.

3. *Show how the profit changes after the tax*: Because the market price is constant but the firm's average cost curve shifts upward, the firm's profit at every output level falls. The firm sells fewer units (because of the

increase in $MC$) and makes less profit per unit (because of the increase in $AC$). The after-tax profit is area $A = \pi_2 = [p - AC^2(q_2)]q_2$, and the before-tax profit is area $A + B = \pi_1 = [p - AC^1(q_1)]q_1$, so profit falls by area $B$ due to the tax.

**Short-Run Shutdown Decision.** Does the competitive lime firm operate or shut down? At the market price of \$8 in Figure 8.3, the lime firm is making an economic profit, so it chooses to operate.

If the market price falls below \$6, which is the minimum of the average cost curve, the price does not cover average cost, so average profit is negative (using Equation 8.4), and the firm makes a loss. (A firm cannot "lose a little on every sale but make it up on volume.") The firm shuts down only if doing so reduces or eliminates its loss.

The firm can gain by shutting down only if its revenue is less than its short-run variable cost:

$$pq < VC. \tag{8.5}$$

By dividing both sides of Equation 8.5 by output, we can write this condition as

$$p < AVC(q).$$

*A competitive firm shuts down if the market price is less than the minimum of its short-run average variable cost curve.*

We illustrate this rule in Figure 8.4 using the lime firm's cost curves. The minimum of the average variable cost, point *a*, is \$5 at 50 units (one unit again being 1,000 metric tons). If the market price is less than \$5 per ton, the firm shuts down. The firm stops hiring labor, buying materials, and paying for energy, thereby avoiding these variable costs. If the market price rises above \$5, the firm starts operating again.

In this figure, the market price is \$5.50 per ton. Because the minimum of the firm's average cost, \$6 (point *b*), is more than \$5.50, the firm loses money if it produces.

If the firm produces, it sells 100 units at *e*, where its marginal cost curve intersects its demand curve, which is horizontal at \$5.50. By operating, the firm loses area *A*, or \$62,000. The length of *A* is 100 units, and the height is the average loss per ton, or 62¢, which equals the price of \$5.50 minus the average cost at 100 units of \$6.12.

The firm is better off producing than shutting down. If the firm shuts down, it has no revenue or variable cost, so its loss is the fixed cost, \$98,000, which equals area $A + B$. The length of this box is 100 units, and its height is the lost average fixed cost of 98¢, which is the difference between the average variable cost and the average cost at 100 units.

The firm saves area $B$ = \$36,000 by producing rather than shutting down. This amount is the money left over from the revenue after paying for the variable cost, which helps cover part of the fixed cost.

In summary, a competitive firm uses a two-step decision-making process to maximize its profit. First, the competitive firm determines the output that maximizes its

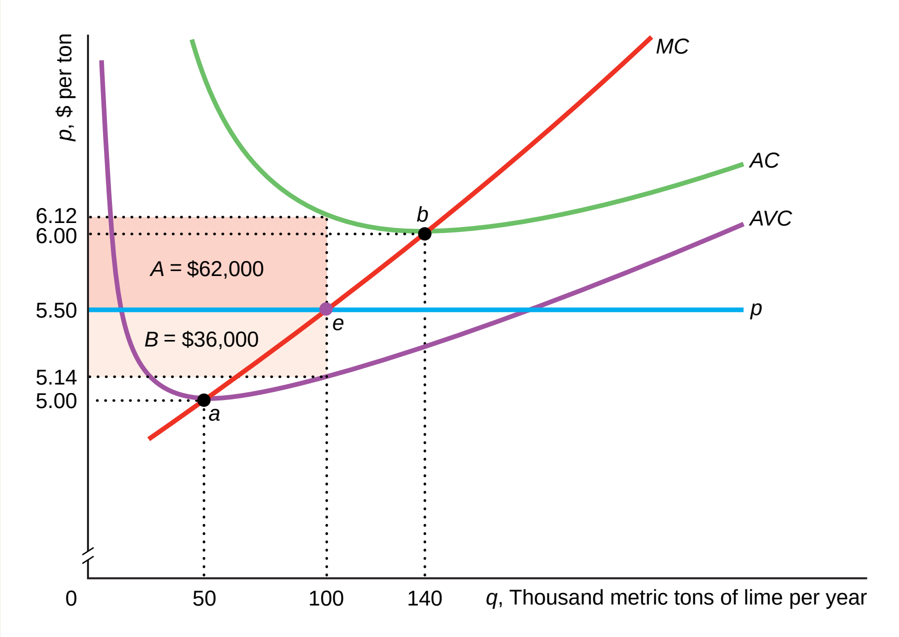



**Figure 8.4 The Short-Run Shutdown Decision.** The competitive lime manufacturing plant operates if price is above the minimum of the average variable cost curve, point *a*, at $5. With a market price of $5.50, the firm produces 100 units because that price is above $AVC(100) = \$5.14$, so the firm more than covers its out-of-pocket, variable costs. At that price, the firm makes a loss of area $A = \$62,000$ because the price is less than the average cost of $6.12. If it shuts down, its loss is its fixed cost, area $A + B = \$98,000$. Thus the firm does not shut down.

profit or minimizes its loss when its marginal cost equals the market price (which is its marginal revenue): $MC = p$. Second, the firm chooses to produce that quantity unless it would lose more by operating than by shutting down. The firm shuts down only if the market price is less than the minimum of its average variable cost, $p < AVC$.

**8.2** A competitive firm's bookkeeper, upon reviewing the firm's books, finds that the firm spent twice as much on its plant, a fixed cost, as the firm's manager had previously thought. Should the manager change the output level because of this new information? How does this new information affect profit?

**Answer**

1. *Show that a change in fixed costs does not affect the firm's decisions*: How much the firm produces and whether it shuts down in the short run

depend only on the firm's variable costs. (The firm picks its output level so that its marginal cost—which depends only on variable costs—equals the market price, and it shuts down only if market price is less than its minimum average variable cost.) Learning that the amount spent on the plant was greater than previously believed should not change the output level that the manager chooses.

2. *Show that the change in how the bookkeeper measures fixed costs does not affect economic profit*: The change in the bookkeeper's valuation of the historical amount spent on the plant may affect the firm's short-run business profit but does not affect the firm's true economic profit. The economic profit is based on opportunity costs—the amount for which the firm could rent the plant to someone else—and not on historical payments.

## Short-Run Firm Supply Curve

We just demonstrated how a competitive firm chooses its output for a given market price so as to maximize its profit. By repeating this analysis at different possible market prices, we learn how the amount the competitive firm supplies varies with the market price.

**Tracing Out the Short-Run Supply Curve.** As the market price increases from $p_1$ = \$5 to $p_2$ = \$6 to $p_3$ = \$7 to $p_4$ = \$8, the lime firm increases its output from 50 to 140 to 215 to 285 units per year in Figure 8.5. The equilibrium at each market price, $e_1$ through $e_4$, is determined by the intersection of the relevant demand curve—market price line—and the firm's marginal cost curve. That is, as the market price increases, the equilibria trace out the marginal cost curve.

If the price falls below the firm's minimum average variable cost at \$5, the firm shuts down. Thus *the competitive firm's short-run supply curve is its marginal cost curve above its minimum average variable cost*.

The firm's short-run supply curve, *S*, is a thick line in the figure. At prices above \$5, the short-run supply curve is the same as the marginal cost curve. The supply is zero when price is less than the minimum of the *AVC* curve of \$5. (From now on, we will not show the supply curve at prices below minimum *AVC*, to keep the graph as simple as possible.)

### APPLE CRUNCH

For Red Delicious apple farmers in Washington, 2001 was a terrible year. The average price for Red Delicious—the top-selling Washington apple—was \$10.61 per box, well below the shutdown level of \$13.23. Consequently, many farmers avoided the variable costs of harvesting by not picking apples off their

trees. Indeed, some other farmers, fearing that the price would not rise anytime soon, bulldozed their trees, getting out of the Red Delicious business for good. In 2001, farmers pulled 25,000 acres out of production.

Larry Olsen, the head of the Washington Apple Commission, pulled out every Red and Golden Delicious apple tree he owned on 200 acres. He replanted half of these acres with more popular varieties, including Granny Smith and Gala. Other orchard owners went with the relatively new Fuji apples, which were selling for $18.10 a box, which was above the break-even price of $16.68.

**Factor Prices and the Short-Run Firm Supply Curve.** An increase in factor prices causes the production costs of a firm to rise, shifting the firm's supply curve to the left. If all factor prices double, it costs the firm twice as much as before to produce a given level of output. If only one factor price rises, costs rise less than in proportion.

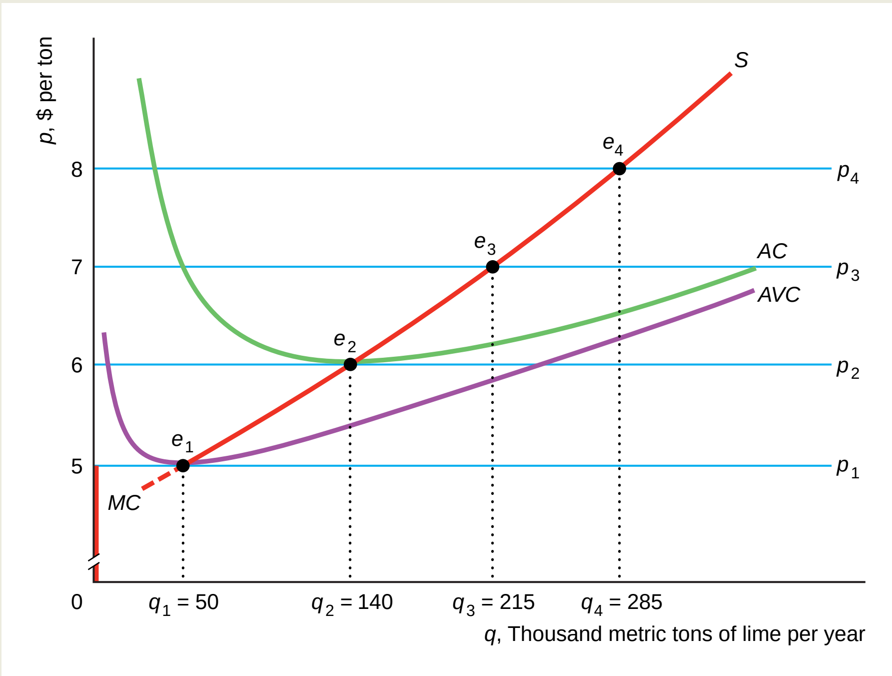



Figure 8.5 **How the Profit-Maximizing Quantity Varies with Price.** As the market price increases, the lime manufacturing firm produces more output. The change in the price traces out the marginal cost curve of the firm.

To illustrate the effect of an increase in a single factor price on supply, we examine a vegetable oil mill. This firm uses vegetable oil seed to produce canola and soybean oils, which customers use in commercial baking and soap making, as lubricants, and for other purposes. At the initial factor prices, a Canadian oil mill's average variable cost curve, $AVC^1$, reaches its minimum of \$7 at 100 units (where one unit is 100 metric tons) of vegetable oil, as in Figure 8.6 (based on the estimates of the variable cost function for vegetable oil mills by Robidoux and Lester, 1988). As a result, the firm's initial short-run supply curve, $S^1$, is the initial marginal cost curve, $MC^1$, above \$7.

If the wage, the price of energy, or the price of oil seeds increases, the cost of production rises for a vegetable oil mill. The vegetable oil mill cannot substitute between oil seeds and other factors of production. The cost of oil seeds is 95% of the variable cost. Thus if the price of raw materials increases by 25%, variable cost rises by 95% × 25%, or 23.75%. This increase in the price of oil seeds causes the marginal cost curve to shift from $MC^1$ to $MC^2$ and the average variable cost curve to go from $AVC^1$ to $AVC^2$ in the figure. As a result, the firm's short-run supply curve shifts upward from $S^1$ to $S^2$. The price increase causes the shutdown price to rise

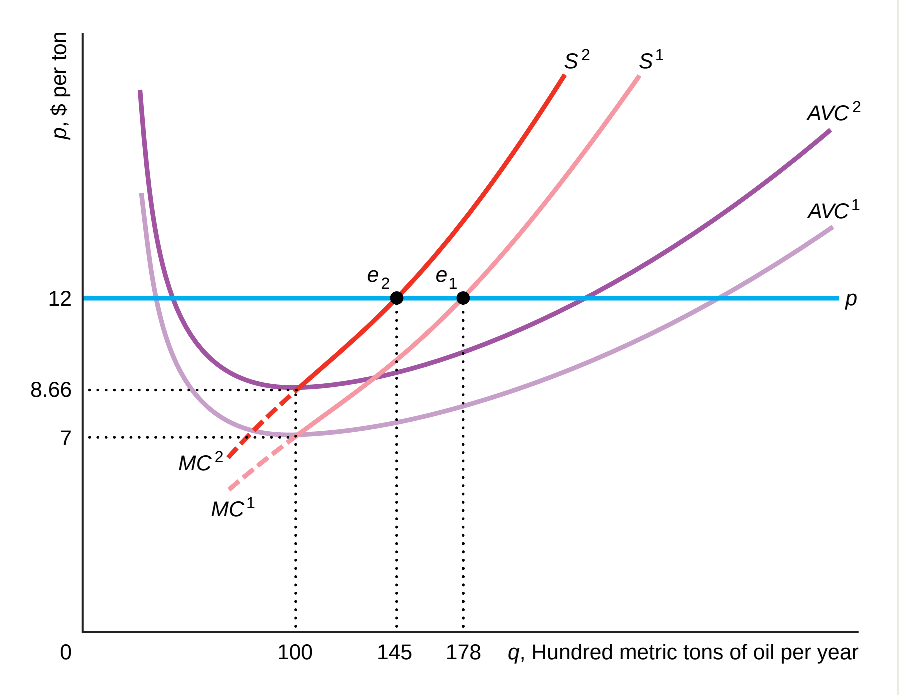



**Figure 8.6 Effect of an Increase in the Cost of Materials on the Vegetable Oil Supply Curve.** Materials are 95% of variable costs, so when the price of materials rises by 25%, variable costs rise by 23.75% (95% of 25%). As a result, the supply curve of a vegetable oil mill shifts up from $S^1$ to $S^2$. If the market price is \$12, the quantity supplied falls from 178 to 145 units.

from \$7 per unit to \$8.66. At a market price of \$12 per unit, at the original factor prices, the firm produces 178 units. After the increase in the price of vegetable oil seeds, the firm produces only 145 units if the market price remains constant.

## Short-Run Market Supply Curve

The market supply curve is the horizontal sum of the supply curves of all the individual firms in the market (see Chapter 2). In the short run, the maximum number of firms in a market, $n$, is fixed because new firms need time to enter the market. If all the firms in a competitive market are identical, each firm's supply curve is identical, so the market supply at any price is $n$ times the supply of an individual firm. Where firms have different shutdown prices, the market supply reflects a different number of firms at various prices even in the short run. We examine competitive markets first with firms that have identical costs and then with firms that have different costs.

**Short-Run Market Supply with Identical Firms.** To illustrate how to construct a short-run market supply curve, we suppose that the lime manufacturing market has $n = 5$ competitive firms with identical cost curves. Panel a of Figure 8.7 plots the short-run supply curve, $S^1$, of a typical firm—the *MC* curve above the minimum *AVC*—where the horizontal axis shows the firm's output, $q$, per year. Panel b illustrates the competitive market supply curve, the dark line $S^5$, where the horizontal axis is market output, $Q$, per year. The price axis is the same in the two panels.

If the market price is less than \$5 per ton, no firm supplies any output, so the market supply is zero. At \$5, each firm is willing to supply $q = 50$ units, as in panel

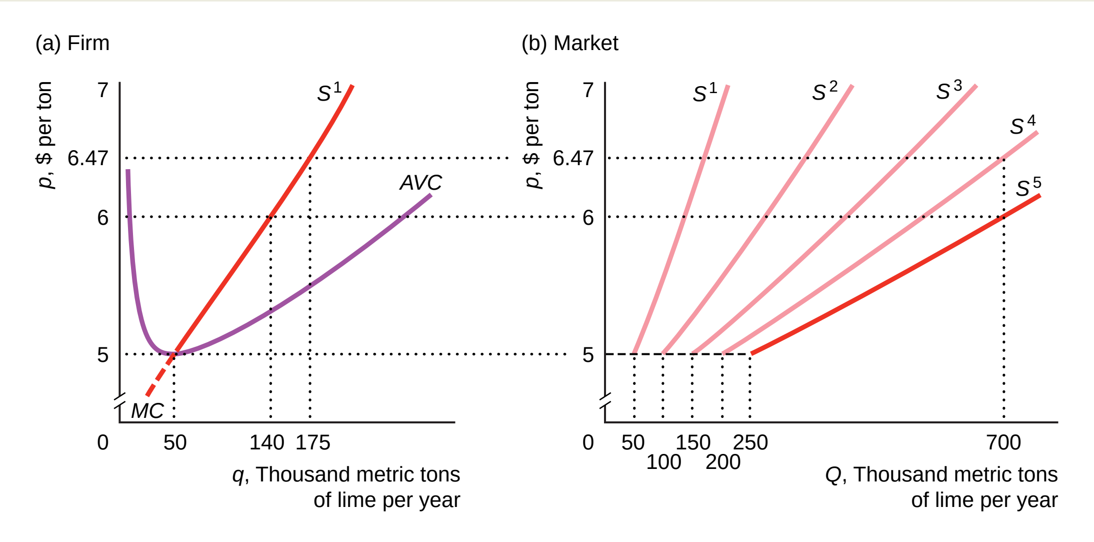



**Figure 8.7 Short-Run Market Supply with Five Identical Lime Firms.** (a) The short-run supply curve, $S^1$, for a typical lime manufacturing firm is its *MC* above the minimum of its *AVC*. (b) The market supply curve, $S^5$, is the horizontal sum of the supply curves of each of the five identical firms. The curve $S^4$ shows what the market supply curve would be if there were only four firms in the market.

a. Consequently, the market supply is $Q = 5q = 250$ units in panel b. At \$6 per ton, each firm supplies 140 units, so the market supply is 700 (= $5 \times 140$) units.

Suppose, however, that there were fewer than five firms in the short run. The light-color lines in panel b show the market supply curves for various other numbers of firms. The market supply curve is $S^1$ if there is one price-taking firm, $S^2$ with two firms, $S^3$ with three firms, and $S^4$ with four firms. The market supply curve flattens as the number of firms in the market increases because the market supply curve is the horizontal sum of more and more upward-sloping firm supply curves. As the number of firms grows very large, the market supply curve approaches a horizontal line at \$5. Thus *the more identical firms producing at a given price, the flatter (more elastic) the short-run market supply curve at that price*. As a result, the more firms in the market, the less the price has to increase for the short-run market supply to increase substantially. Consumers pay \$6 per ton to obtain 700 units of lime if there are five firms but must pay \$6.47 per ton to obtain that much with only four firms.

**Short-Run Market Supply with Firms That Differ.** If the firms in a competitive market have different minimum average variable costs, not all firms produce at every price, a situation that affects the shape of the short-run market supply curve. Suppose that the only two firms in the lime market are our typical lime firm with a supply curve of $S^1$ and another firm with a higher marginal and minimum average cost with the supply curve of $S^2$ in Figure 8.8. The first firm produces at a market price of \$5 or above, whereas the second firm does not produce unless the price is \$6 or more. At \$5, the first firm produces 50 units, so the quantity on the market supply curve, $S$, is 50 units. Between \$5 and \$6, only the first firm produces, so the market supply, $S$, is the same as the first firm's supply, $S^1$. At and above \$6, both firms produce, so the market supply curve is the horizontal summation of their two individual supply curves. For example, at \$7, the first firm produces 215 units, and the second firm supplies 100 units, so the market supply is 315 units.

As with the identical firms, where both firms are producing, the market supply curve is flatter than that of either firm. Because the second firm does not produce at as low a price as the first firm, the short-run market supply curve has a steeper slope (less elastic supply) at relatively low prices than it would if the firms were identical.

Where firms differ, only the low-cost firm supplies goods at relatively low prices. As the price rises, the other, higher-cost firm starts supplying, creating a stairlike market supply curve. The more suppliers there are with differing costs, the more steps there are in the market supply curve. As price rises and more firms are supplying goods, the market supply curve flattens, so it takes a smaller increase in price to increase supply by a given amount. Stated the other way, the more firms differ in costs, the steeper the market supply curve at low prices. Differences in costs are one explanation for why some market supply curves are upward sloping.

## Short-Run Competitive Equilibrium

By combining the short-run market supply curve and the market demand curve, we can determine the short-run competitive equilibrium. We first show how to determine the equilibrium in the lime market, and we then examine how the equilibrium changes when firms are taxed.

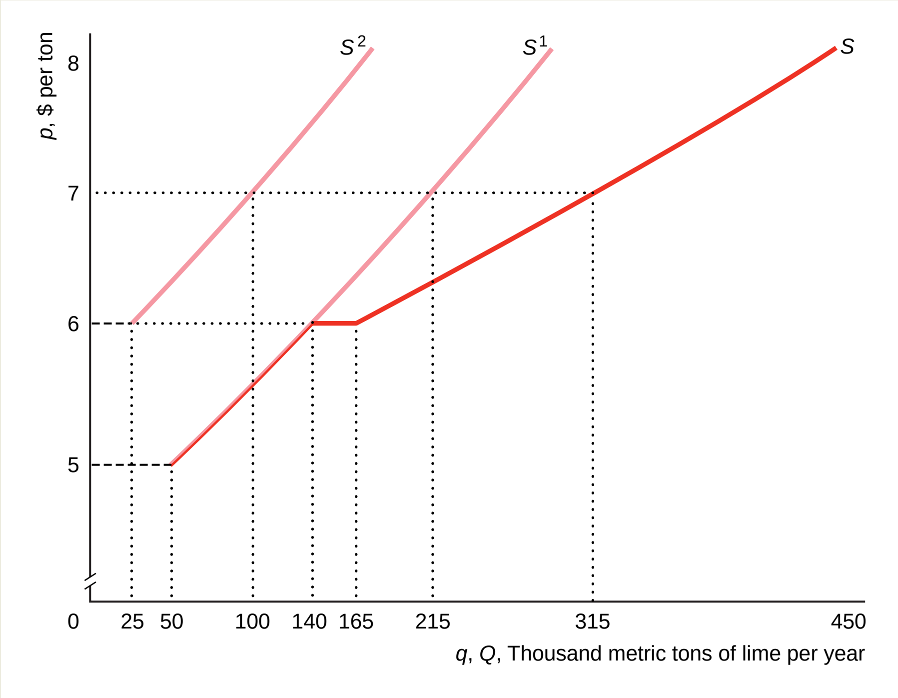



**Figure 8.8 Short-Run Market Supply with Two Different Lime Firms.** The supply curve $S^1$ is the same as for the typical lime firm in Figure 8.7. A second firm has a *MC* that lies to the left of the original firm's cost curve and a higher minimum of its *AVC*. Thus its supply curve, $S^2$, lies above and to the left of the original firm's supply curve, $S^1$. The market supply curve, *S*, is the horizontal sum of the two supply curves. When prices are high enough for both firms to produce, $6 and above, the market supply curve is flatter than the supply curve of either individual firm.

**Short-Run Equilibrium in the Lime Market.** Suppose that there are five identical firms in the short-run equilibrium in the lime manufacturing industry. Panel a of Figure 8.9 shows the short-run cost curves and the supply curve, $S^1$, for a typical firm, and panel b shows the corresponding short-run competitive market supply curve, *S*.

In panel b, the initial demand curve $D^1$ intersects the market supply curve at $E_1$, the market equilibrium. The equilibrium quantity is $Q_1$ = 1,075 units of lime per year, and the equilibrium market price is $7.

In panel a, each competitive firm faces a horizontal demand curve at the equilibrium price of $7. Each price-taking firm chooses its output where its marginal cost curve intersects the horizontal demand curve at $e_1$. Because each firm is maximizing its profit at $e_1$, no firm wants to change its behavior, so $e_1$ is the firm's equilibrium. In panel a, each firm makes a short-run profit of area $A + B$ = $172,000, which is the average profit per ton, $p - AC = \$7 - \$6.20 = 80¢$, times the firm's output, $q_1$ = 215 units. The equilibrium market output, $Q_1$, is the number of firms, *n*, times the equilibrium output of each firm: $Q_1 = nq_1 = 5 \times 215$ units = 1,075 units (panel b).

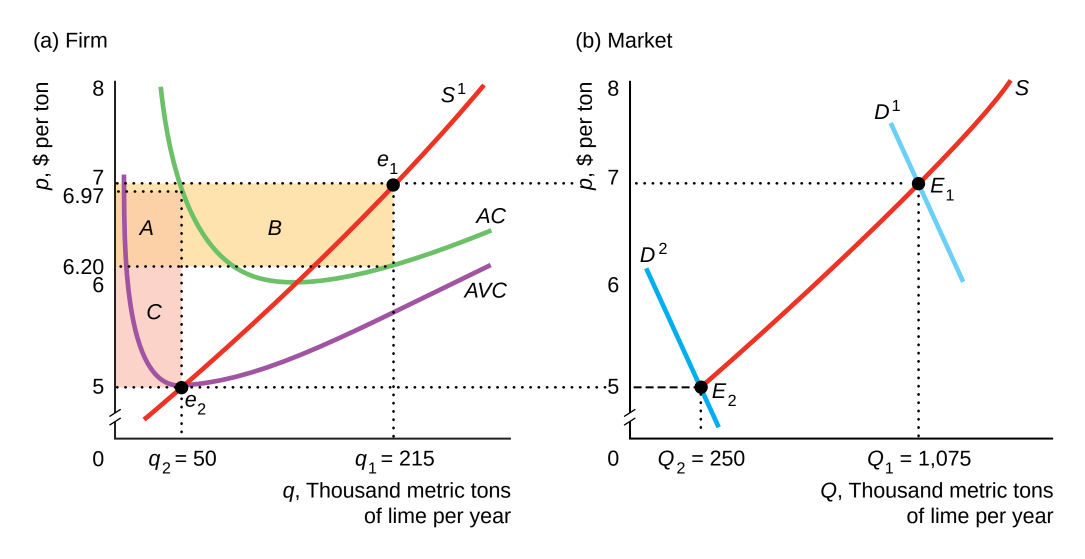



**Figure 8.9 Short-Run Competitive Equilibrium in the Lime Market.** (a) The short-run supply curve is the marginal cost above minimum average variable cost of \$5. At a price of \$5, each firm makes a short-run loss of $(p - AC)q = (\$5 - \$6.97) \times 50{,}000 = -\$98{,}500$, area $A + C$. At a price of \$7, the short-run profit of a typical lime firm is $(p - AC)q = (\$7 - \$6.20) \times 215{,}000 = \$172{,}000$, area $A + B$. (b) If there are five firms in the lime market in the short run, so the market supply is $S$, and the market demand curve is $D^1$, then the short-run equilibrium is $E_1$, the market price is \$7, and market output is $Q_1 = 1{,}075$ units. If the demand curve shifts to $D^2$, the market equilibrium is $p = \$5$ and $Q_2 = 250$ units.

Now suppose that the demand curve shifts to $D^2$. The new market equilibrium is $E_2$, where the price is only \$5. At that price, each firm produces $q = 50$ units, and market output is $Q = 250$ units. In panel a, each firm loses \$98,500, area $A + C$, because it makes an average per ton of $(p - AC) = (\$5 - \$6.97) = -\$1.97$ and it sells $q_2 = 50$ units. However, such a firm does not shut down because price equals the firm's average variable cost, so the firm is covering its out-of-pocket expenses.

**Effect of a Specific Tax on Short-Run Equilibrium.** A tax that is applied to all firms in the market shifts the market supply curve, thereby altering the short-run equilibrium. In Figure 8.10, the government collects a specific tax of $\tau$ per unit from each of the identical firms in a competitive market. The specific tax causes both the marginal and average cost curves of each firm to shift up by $\tau$ in panel a (Solved Problem 8.1), which causes the firm's supply curve to move upward by $\tau$.

As a result, the short-run market supply curve, which is the sum of all the individual firm supply curves, also shifts upward by $\tau$ from $S^1$ to $S^1 + \tau$ in panel b. If the market demand curve is $D$, the pretax market equilibrium is $E_1$ and the post-tax equilibrium is $E_2$. The corresponding firm equilibria are $e_1$ and $e_2$ in panel a. The tax causes the equilibrium market quantity to fall from $Q_1$ to $Q_2$ in panel b

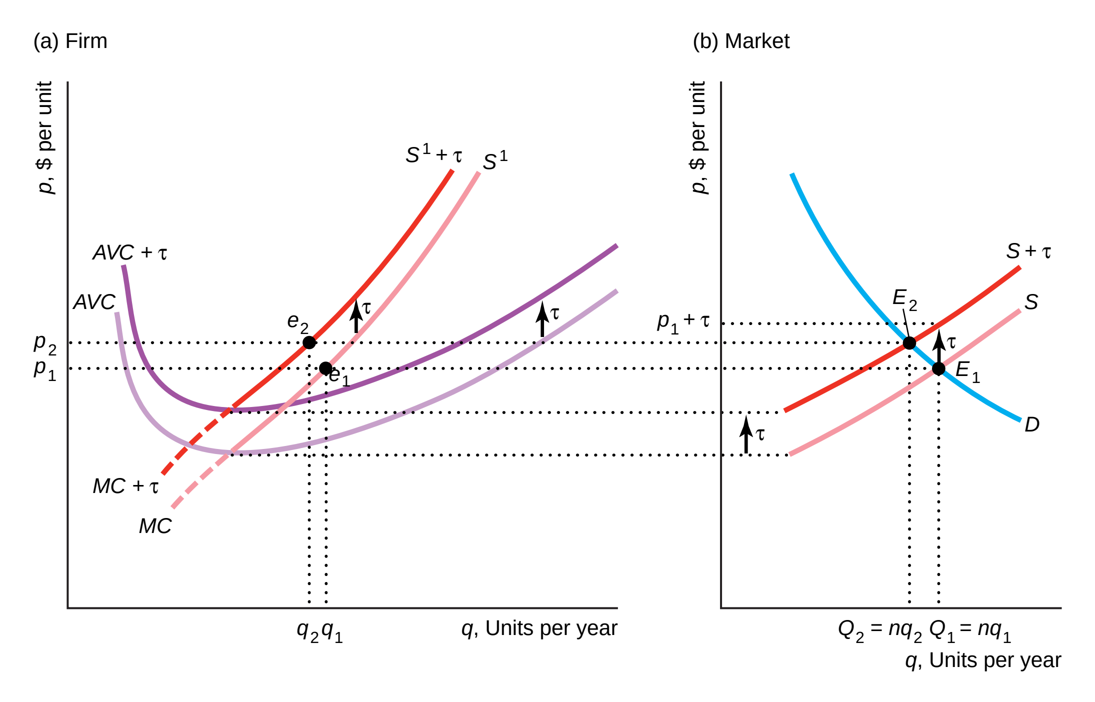



**Figure 8.10 Short-Run Effect of a Specific Tax in the Lime Market.** (a) A specific tax of $\tau$ per unit causes each identical firm's *MC* and *AC* curves to shift upward by $\tau$, so the firm's short-run supply curve shifts upward from $S^1$ to $S^1 + \tau$. (b) As a result, the short-run market supply curve shifts from $S$ to $S + \tau$. If the market demand curve is $D$, price rises by less than $\tau$, and both market quantity and each firm's output fall.

and each firm's output to fall from $q_1$ to $q_2$ in panel a. Because price is above post-tax average variable cost, $AVC + \tau$, all firms continue to produce. The after-tax price, $p_2$, rises above the before-tax price, $p_1$, by less than the full amount of the tax: $p_2 < p_1 + \tau$. The incidence of the tax is shared between consumers and producers because both the supply and the demand curve are sloped (Chapter 3).

## 8.4 COMPETITION IN THE LONG RUN

*I think there is a world market for about five computers.*

—Thomas J. Watson, IBM chairman, 1943

In the long run, competitive firms can vary inputs that were fixed in the short run, so the long-run firm and market supply curves differ from the short-run curves. After briefly looking at how a firm determines its long-run supply curve so as to maximize its profit, we examine the relationship between short-run and long-run market supply curves and competitive equilibria.

### Long-Run Competitive Profit Maximization

The firm's two profit-maximizing decisions—how much to produce and whether to produce at all—are simpler in the long run than in the short run. In the long run, typically all costs are variable, so the firm does not have to consider whether fixed costs are sunk or avoidable.

**Long-Run Output Decision.** The firm chooses the quantity that maximizes its profit using the same rules as in the short run. The firm picks the quantity that maximizes long-run profit, the difference between revenue and long-run cost. Equivalently, it operates where long-run marginal profit is zero and where marginal revenue equals long-run marginal cost.

**Long-Run Shutdown Decision.** After determining the output level, $q^*$, that maximizes its profit or minimizes its loss, the firm decides whether to produce or shut down. The firm shuts down if its revenue is less than its avoidable or variable cost. In the long run, however, all costs are variable. As a result, in the long run, the firm shuts down if it would make an economic loss by operating.

### Long-Run Firm Supply Curve

A firm's long-run supply curve is its long-run marginal cost curve above the minimum of its long-run average cost curve (because all costs are variable in the long run). The firm is free to choose its capital in the long run, so the firm's long-run supply curve may differ substantially from its short-run supply curve.

The firm chooses a plant size to maximize its long-run economic profit in light of its beliefs about the future. If its forecast is wrong, it may be stuck with a plant that is too small or too large for its level of production in the short run. The firm acts to correct this mistake in plant size in the long run.

The firm in Figure 8.11 has different short-and long-run cost curves. In the short run, the firm uses a plant that is smaller than the optimal long-run size if the price is \$35. (Having a short-run plant size that is too large is also possible.) The firm produces 50 units of output per year in the short run, where its short-run marginal cost, *SRMC*, equals the price, and makes a short-run profit equal to area *A*. The firm's short-run supply curve, $S^{SR}$, is its short-run marginal cost above the minimum, \$20, of its short-run average variable cost, *SRAVC*.

If the firm expects the price to remain at \$35, it builds a larger plant in the long run. Using the larger plant, the firm produces 110 units per year, where its long-run marginal cost, *LRMC*, equals the market price. It expects to make a long-run profit, area $A + B$, which is greater than its short-run profit by area *B* because it sells 60 more units and its equilibrium long-run average cost, $LRAC = \$25$, is lower than its short-run average cost in equilibrium, \$28.

The firm does not operate at a loss in the long run when all inputs are variable. It shuts down if the market price falls below the firm's minimum long-run average cost of \$24. Thus the competitive firm's long-run supply curve is its long-run marginal cost curve above \$24.

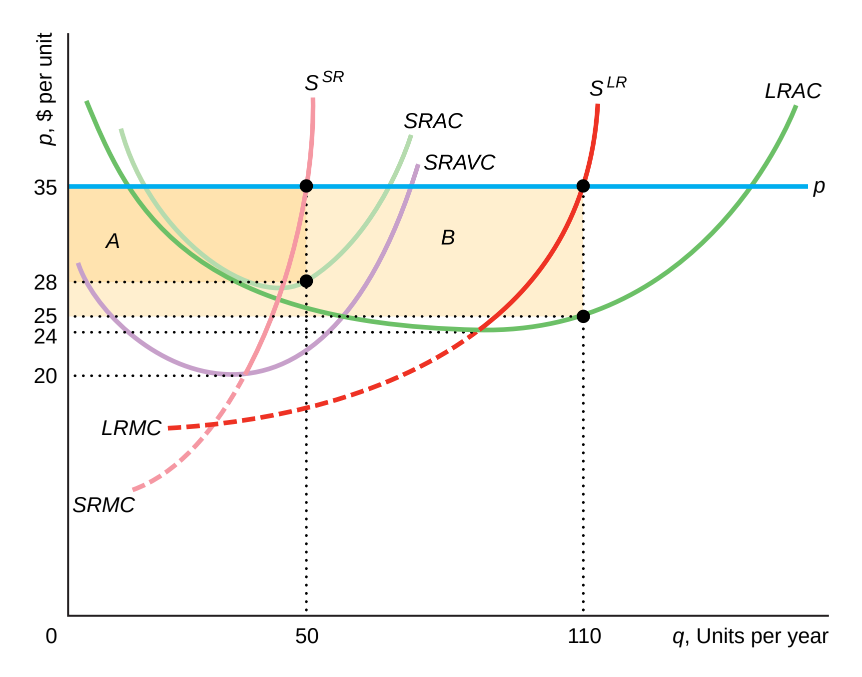



**Figure 8.11 The Short-Run and Long-Run Supply Curves.** The firm's long-run supply curve, $S^{LR}$, is zero below its minimum average cost of $24 and equals the long-run marginal cost, *LRMC*, at higher prices. The firm produces more in the long run than in the short run, 110 units instead of 50 units, and earns a higher profit, area $A + B$ instead of just area $A$.

## Long-Run Market Supply Curve

The competitive market supply curve is the horizontal sum of the supply curves of the individual firms in both the short run and the long run. Because the maximum number of firms in the market is fixed in the short run, we add the supply curves of a known number of firms to obtain the short-run market supply curve. The only way for the market to supply more output in the short run is for existing firms to produce more.

In the long run, firms can enter or leave the market. Thus before we can add all the relevant firm supply curves to obtain the long-run market supply curve, we need to determine how many firms are in the market at each possible market price.

To construct the long-run market supply curve properly, we also have to determine how input prices vary with output. As the market expands or contracts substantially, changes in factor prices may shift firms' cost and supply curves. If so, we need to determine how such shifts in factor prices affect firm supply curves so that we can properly construct the market supply curve. The effect of changes in input prices is greater in the long run than in the short run because market output can change more dramatically in the long run.

We now look in detail at how entry and changing factor prices affect long-run market supply. We first derive the long-run market supply curve, assuming that the price of inputs remains constant as market output increases, so as to isolate the role of entry. We then examine how the market supply curve is affected if the price of inputs changes as market output rises.

**Role of Entry and Exit.** The number of firms in a market in the long run is determined by the *entry* and *exit* of firms. In the long run, each firm decides whether to enter or exit, depending on whether it can make a long-run profit.

In many markets, firms face barriers to entry or must incur significant costs to enter. Many city governments limit the number of cab drivers, creating an insurmountable barrier that prevents additional firms from entering. To enter other markets, a new firm has to hire consultants to determine the profit opportunities, pay lawyers to write contracts, and incur other expenses. Typically, such costs of entry or exit are fixed costs.

Even if existing firms are making positive profits, no entry occurs in the short run if entering firms need time to find a location, build a new plant, and hire workers. In the long run, firms enter the market if they can make profits by so doing. The costs of entry are often lower, and hence the profits from entering are higher, if a firm takes its time to enter. As a result, firms may enter markets long after profit opportunities first appear. For example, in 2002, Starbucks announced it planned to enter the Puerto Rican and Spanish markets, but that it would take up to two years to build its initial 11 to 16 stores in each market.

In contrast, firms usually react faster to losses than to potential profits. We expect firms to shut down or exit the market quickly in the short run when price is below average variable cost.

In some markets, there are no barriers or fixed costs to entry, so firms can freely enter and exit. For example, many construction firms, which have no capital and provide only labor services, engage in *hit-and-run* entry and exit: They enter the market whenever they can make a profit and exit when they can't. These firms may enter and exit markets several times a year.

In such markets, a shift of the market demand curve to the right attracts firms to enter. For example, if there were no government regulations, the market for taxicabs would have free entry and exit. Car owners could enter or exit the market virtually instantaneously. If the demand curve for cab rides shifted to the right, the market price would rise, and existing cab drivers would make unusually high profits in the short run. Seeing these profits, other car owners would enter the market, causing the market supply curve to shift to the right and the market price to fall. Entry occurs until the last firm to enter—the *marginal firm*—makes zero long-run profit.

Similarly, if the demand curve shifts to the left so that the market price drops, firms suffer losses. Firms with minimum average costs above the new, lower market price exit the market. Firms continue to leave the market until the next firm considering leaving, the marginal firm, is again earning a zero long-run profit.

Thus in a market with free entry and exit:

- A firm enters the market if it can make a long-run profit, $\pi > 0$.
- A firm exits the market to avoid a long-run loss, $\pi < 0$.

If firms in a market are making zero long-run profit, they are indifferent between staying in the market and exiting. We presume that if they are already in the market, they stay in the market when they are making zero long-run profit.

Most transportation markets are thought to have free entry and exit unless governments regulate them. Relatively few airline, trucking, or shipping firms may serve a particular route, but they face extensive potential entry. Other firms can and will quickly enter and serve a route if a profit opportunity appears. Entrants shift their highly mobile equipment from less profitable routes to more profitable ones.

**Application**

### THREAT OF ENTRY IN SHIPPING

Davies (1986) argued that in international ocean liner shipping, a market in which only a few firms serve a route, firms enter and exit frequently, so the threat of entry drives economic profits to zero. Only seven firms provide services between Canada and Japan, China, Korea, and Pacific Russia; only eight firms serve the Canada–Continental Europe route.

Existing firms can quickly shift ships from one route to another. With the increased use of internationally standardized container ships, liners can travel any route (in the past, the type of ship differed across routes). New and used vessels and equipment are sold on a world market that is accessible to all firms. As a result, potential entrants can easily rent equipment rather than have to raise large sums to buy liners. Similarly, exit is easy today. A firm exiting all markets can readily sell its used equipment.

As a result, firms engage in hit-and-run entry and exit to take advantage of fleeting profit opportunities. For example, for the nine principal trade routes to and from Canada, in a two-year period, the number of new services (152) on routes was 41% of the original number (373), while services terminated (109) were 29% of the original number. Thus even though relatively few firms serve any given route, firms can enter and exit easily and do so frequently.

**Evidence on Ease of Entry and Exit.** Entry and exit are relatively difficult in many manufacturing, mining, and government-regulated industries, such as public utilities and insurance. Firms can enter and exit easily in many agriculture, construction, wholesale and retail trade, and service industries.

Dunne, Roberts, and Samuelson (1988) reported the entry rate (percentage of firms that enter in the last year relative to total firms) and exit rate in various U.S. industries, some of which are listed in Table 8.1. Entry rates ranged from a low of 21% in tobacco (which is government regulated) to a high of 60% in instruments. Exit rates varied from a low of 22% in tobacco to a high of 47% in instruments. In general, industries with high entry rates tend to have high exit rates. That is, entry and exit barriers are likely to be related.

**Table 8.1 Entry and Exit Rates in Selected U.S. Industries, 1972–1982**

| Industry | Entry Rate, % | Exit Rate, % |
|---|---|---|
| Food processing | 24 | 31 |
| Tobacco | 21 | 22 |
| Textiles | 37 | 37 |
| Apparel | 40 | 45 |
| Lumber | 50 | 44 |
| Printing | 49 | 43 |
| Petroleum and coal | 34 | 30 |
| Rubber and plastics | 43 | 30 |
| Leather | 29 | 39 |
| Primary metals | 32 | 28 |
| Fabricated metals | 43 | 36 |
| Transportation equipment | 47 | 33 |
| Instruments | 60 | 47 |

*Source:* Dunne, Roberts, and Samuelson (1988), Table 5, p. 506.

### THE NAKED TRUTH ABOUT COSTS AND ENTRY

Cheap handheld video cameras have revolutionized the hard-core pornography market. Previously, making movies required expensive equipment and at least some technical expertise. Now, anyone with a couple of thousand dollars and a moderately steady hand can buy and use a video camera to make a movie. Consequently, many new firms have entered the market, and the supply curve of porn movies has slithered substantially to the right. Whereas only 1,000 to 2,000 video porn titles were released annually in the United States from 1986 to 1991, that number grew to nearly 10,000 by 1999.

**Long-Run Market Supply with Identical Firms and Free Entry.** The *long-run market supply curve is flat* at the minimum long-run average cost *if firms can freely enter and exit* the market, an unlimited number of *firms have identical costs*, and *input prices are constant*. This result follows from our reasoning about the short-run supply curve, in which we showed that the market supply was flatter, the more firms there were in the market. With many firms in the market in the long run, the market supply curve is effectively flat. ("Many" is 10 firms in the vegetable oil market.)

The long-run supply curve of a typical vegetable oil mill, $S^1$ in panel a of Figure 8.12, is the long-run marginal cost curve above a minimum long-run average cost of \$10. Because each firm shuts down if the market price is below \$10, the long-run market supply curve is zero at a price below \$10. If the price rises above \$10, firms are making positive profits, so new firms enter, expanding market output until profits are driven to zero, where price is again \$10. The long-run market supply

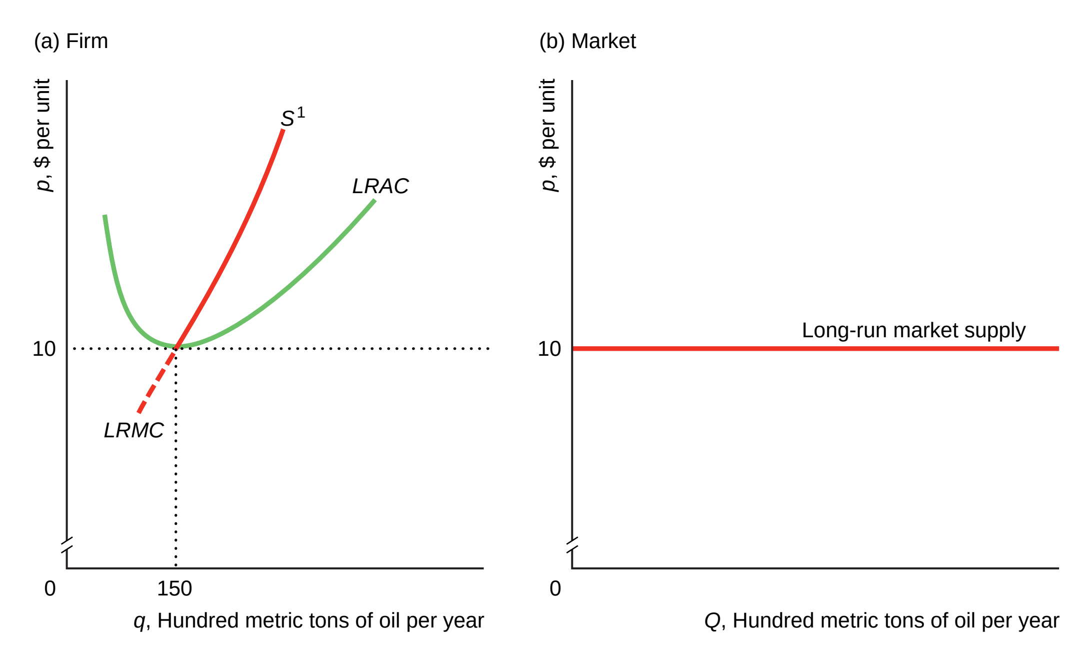



**Figure 8.12 Long-Run Firm and Market Supply with Identical Vegetable Oil Firms.** (a) The long-run supply curve of a typical vegetable oil mill, $S^1$, is the long-run marginal cost curve above the minimum average cost of \$10. (b) The long-run market supply curve is horizontal at the minimum of the long-run minimum average cost of a typical firm. Each firm produces 150 units, so market output is $150n$, where $n$ is the number of firms.

curve in panel b is a horizontal line at the minimum long-run average cost of the typical firm, \$10. At a price of \$10, each firm produces $q = 150$ units (where one unit equals 100 metric tons). Thus the total output produced by $n$ firms in the market is $Q = nq = n \times 150$ units. Extra market output is obtained by new firms entering the market.

In summary, the long-run market supply curve is horizontal if the market has free entry and exit, an unlimited number of firms have identical costs, and input prices are constant. When these strong assumptions do not hold, the long-run market supply curve has a slope, as we now show.

**Long-Run Market Supply When Entry Is Limited.** If the number of firms in a market is limited in the long run, the market supply curve slopes upward. The number of firms is limited if the government restricts that number, if firms need a scarce resource, or if entry is costly. An example of a scarce resource is the limited number of lots on which a luxury beachfront hotel can be built in Miami. High entry costs restrict the number of firms in a market because firms enter only if the long-run economic profit is greater than the cost of entering.

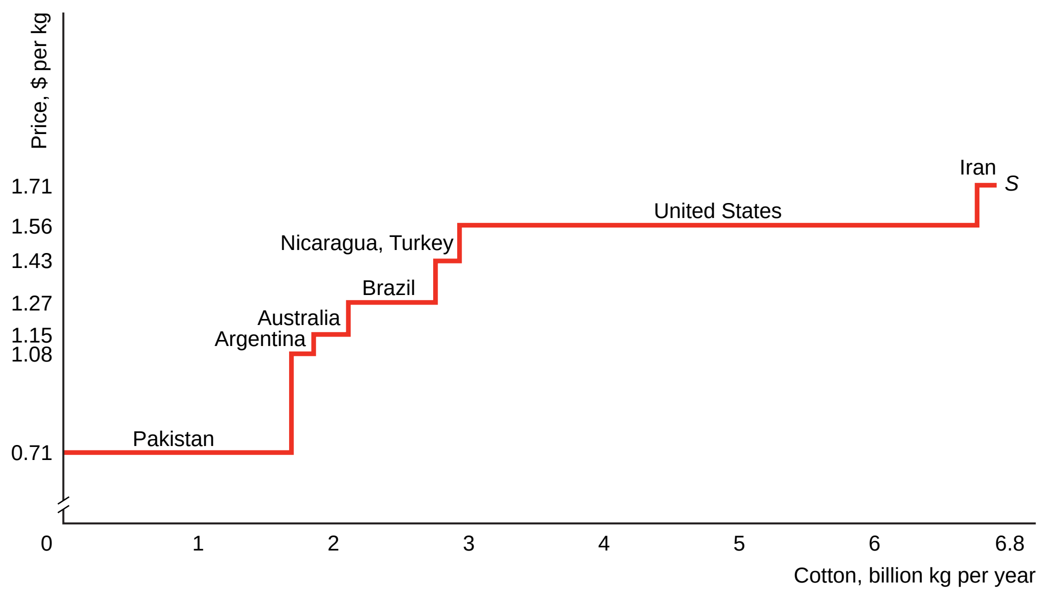
The only way to get more output if the number of firms is limited is for existing firms to produce more. Because individual firms' supply curves slope upward, the long-run market supply curve is also upward sloping. The reasoning is the same as in the short run, as panel b of Figure 8.7 illustrates, given that no more than five firms can enter. The market supply curve is the upward-sloping $S^5$ curve, which is the horizontal sum of the five firms' upward-sloping marginal cost curves above minimum average cost.

**Long-Run Market Supply When Firms Differ.** A second reason why some long-run market supply curves slope upward is that firms differ. Firms with relatively low minimum long-run average costs are willing to enter the market at lower prices than others, resulting in an upward-sloping long-run market supply curve.

The long-run supply curve is upward sloping because of differences in costs across firms *only* if the amount that lower-cost firms can produce is limited. If there were an unlimited number of the lowest-cost firms, we would never observe any higher-cost firms producing. Effectively, then, the only firms in the market would have the same low costs of production.

## UPWARD-SLOPING LONG-RUN SUPPLY CURVE FOR COTTON

Many countries produce cotton. Production costs differ among countries because of differences in the quality of land, rainfall, costs of irrigation, costs of labor, and other factors.



The length of each steplike segment of the long-run supply curve of cotton in the graph is the quantity produced by the labeled country. The amount that the low-cost countries can produce must be limited, or we would not observe production by the higher-cost countries.

The height of each segment of the supply curve is the typical minimum average cost of production in that country. The average cost of production in Pakistan is less than half that in Iran. The supply curve has a steplike appearance because we are using an average of the estimate average cost in each country, which is a single number. If we knew the individual firms' supply curves in each of these countries, the market supply curve would have a smoother shape.

As the market price rises, the number of countries producing rises. At market prices below \$1.08 per kilogram, only Pakistan produces. If the market price is below \$1.50, the United States and Iran do not produce. If the price increases to \$1.56, the United States supplies a large amount of cotton. In this range of the supply curve, supply is very elastic. For Iran to produce, the price has to rise to \$1.71. Price increases in that range result in only a relatively small increase in supply. Thus the supply curve is relatively inelastic at prices above \$1.56.

**Long-Run Market Supply When Input Prices Vary with Output.** A third reason why market supply curves may slope is nonconstant input prices. In markets in which factor prices rise or fall when output increases, the long-run supply curve slopes even if firms have identical costs and can freely enter and exit.

If the market buys a relatively small share of the total amount of a factor of production that is sold, then, as market output expands, the price of the factor is unlikely to be affected. For example, dentists do not hire enough receptionists to affect the market wage for receptionists.

In contrast, if the market buys most of the total sales of a factor, the price of that input is more likely to vary with market output. As jet plane manufacturers expand and buy more jet engines, the price of these engines rises because the jet plane manufacturers are the sole purchaser of these engines.

To produce more goods, firms must use more inputs. If the prices of some or all inputs rise when more inputs are purchased, the cost of producing the final good also rises. We call a market in which input prices rise with output an *increasing-cost market*. Few steelworkers have no fear of heights and are willing to construct tall buildings, so their supply curve is steeply upward sloping. As more skyscrapers are built at one time, the demand for these workers shifts to the right, driving up their wage.

We assume that all firms in a market have the same cost curves and that input prices rise as market output expands. We use the cost curves of a representative firm in panel a of Figure 8.13 to derive the upward-sloping market supply curve in panel b.

When input prices are relatively low, each identical firm has the same long-run marginal cost curve, $MC^1$, and average cost curve, $AC^1$, in panel a. A typical firm produces at minimum average cost, $e_1$, and sells $q_1$ units of output. The

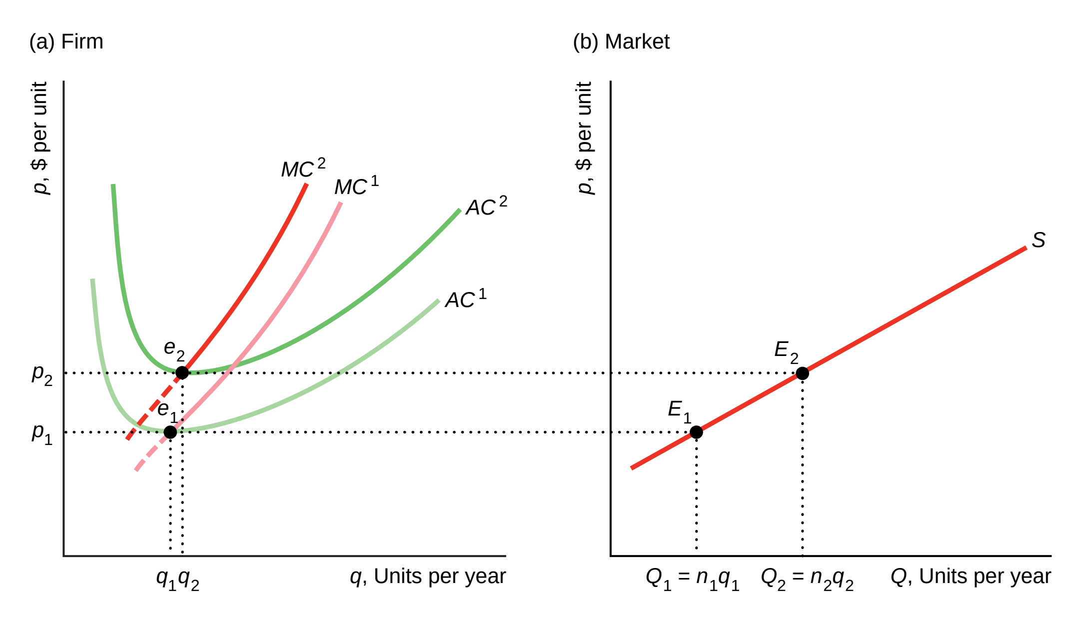



**Figure 8.13 Long-Run Market Supply in an Increasing-Cost Market.** (a) At a relatively low market output, $Q_1$, the firm's long-run marginal and average cost curves are $MC^1$ and $AC^1$. At the higher market quantity $Q_2$, the cost curves shift upward to $MC^2$ and $AC^2$ because of the higher input prices. Given identical firms, each firm produces at minimum average cost, such as points $e_1$ and $e_2$. (b) Long-run market supply, *S*, is upward sloping.

market supply is $Q_1$ in panel b when the market price is $p_1$. The $n_1$ firms collectively sell $Q_1 = n_1 q_1$ units of output, which is point $E_1$ on the market supply curve in panel b.

If the market demand curve shifts outward, the market price rises to $p_2$, new firms enter, and market output rises to $Q_2$, causing input prices to rise. As a result, the marginal cost curve shifts from $MC^1$ to $MC^2$, and the average cost curve rises from $AC^1$ to $AC^2$. The typical firm produces at a higher minimum average cost, $e_2$. At this higher price, there are $n_2$ firms in the market, so market output is $Q_2 = n_2 q_2$ at point $E_2$ on the market supply curve.

Thus in both an increasing-cost market and a constant-cost market—in which input prices remain constant as output increases—firms produce at minimum average cost in the long run. The difference is that the minimum average cost rises as market output increases in an increasing-cost market, whereas minimum average cost is constant in a constant-cost market. In conclusion, *the long-run supply curve is upward sloping in an increasing-cost market and flat in a constant-cost market.*

In decreasing-cost markets, as market output rises, at least some factor prices fall. As a result, *in a decreasing-cost market, the long-run market supply curve is downward sloping.*

Increasing returns to scale may cause factor prices to fall. For example, in the early 1980s, when the personal computer market was young, there was much less demand for floppy disk drives than there is today. As a result, those drives were partially assembled by hand at relatively high cost. As demand for floppy disk drives increased, it became practical to automate more of the production process so that drives could be produced at lower per-unit cost. The decrease in the price of these drives lowers the cost of personal computers.

Figure 8.14 shows a decreasing-cost market. As the market output expands from $Q_1$ to $Q_2$ in panel b, the prices of inputs fall, so a typical firm's cost curves shift downward, and the minimum average cost falls from $e_1$ to $e_2$ in panel a. On the long-run market supply curve in panel b, point $E_1$, which corresponds to $e_1$, is above $E_2$, which corresponds to $e_2$. As a consequence, *a decreasing-cost market supply curve is downward sloping*.

To summarize, theory tells us that competitive long-run market supply curves may be flat, upward sloping, or downward sloping. If all firms are identical in a market in which firms can freely enter and input prices are constant, the long-run market supply curve is flat. If entry is limited, firms differ in costs, or input prices rise with output, the long-run supply curve is upward sloping. Finally, if input prices fall with market output, the long-run supply curve is downward sloping. (See **www.aw.com/perloff**, Chapter 8, "Slope of Long-Run market Supply Curves.")

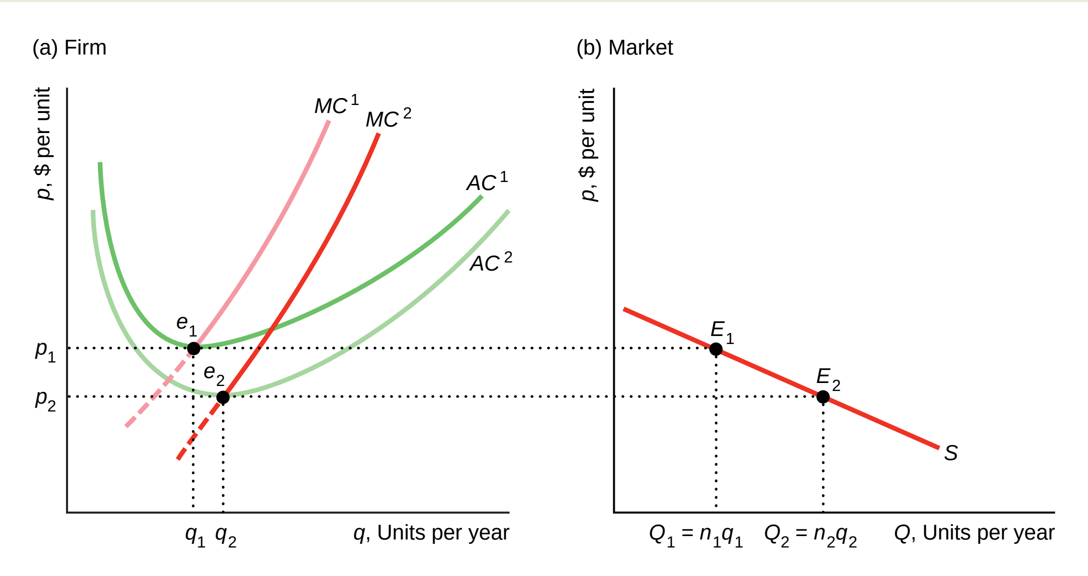



**Figure 8.14 Long-Run Market Supply in a Decreasing-Cost Market.** (a) At a relatively low market output, $Q_1$, the firm's long-run marginal and average cost curves are $MC^1$ and $AC^1$. At the higher market quantity $Q_2$, the cost curves shift downward to $MC^2$ and $AC^2$ because of lower input prices. Given identical firms, each firm produces at minimum average cost, such as points $e_1$ and $e_2$. (b) Long-run market supply, $S$, is downward sloping.

## Long-Run Competitive Equilibrium

The intersection of the long-run market supply and demand curves determines the long-run competitive equilibrium. With identical firms, constant input prices, and free entry and exit, the long-run competitive market supply is horizontal at minimum long-run average cost, so the equilibrium price equals long-run average cost. A shift in the demand curve affects only the equilibrium quantity and not the equilibrium price, which remains constant at minimum long-run average cost.

The market supply curve is different in the short run than in the long run, so the long-run competitive equilibrium differs from the short-run equilibrium. The relationship between the short- and long-run equilibria depends on where the market demand curve crosses the short- and long-run market supply curves. Figure 8.15 illustrates this point using the short- and long-run supply curves for the vegetable oil mill market.

The short-run firm supply curve for a typical firm in panel a is the marginal cost above the minimum of the average variable cost, \$7. At a price of \$7, each firm produces 100 units, so the 20 firms in the market in the short run collectively supply 2,000 (= 20 × 100) units of oil in panel b. At higher prices, the short-run market supply curve slopes upward because it is the horizontal summation of the firm's upward-sloping marginal cost curves.

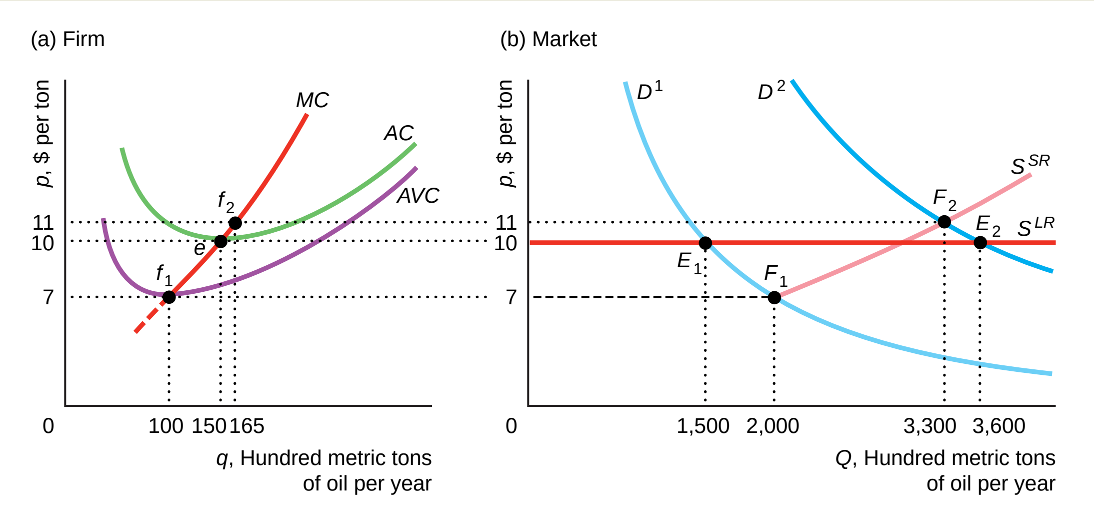



**Figure 8.15 The Short-Run and Long-Run Equilibria for Vegetable Oil.** (a) A typical vegetable oil mill is willing to produce 100 units of oil at \$7,150 units at \$10, or 165 units at \$11. (b) The short-run market supply curve, $S^{SR}$, is the horizontal sum of 20 individual firms' short-run marginal cost curves above minimum average variable cost, \$7. The long-run market supply curve, $S^{LR}$, is horizontal at the minimum average cost, \$10. If the demand curve is $D^1$, in the short-run equilibrium, $F_1$, 20 firms sell 2,000 units of oil at \$7. In the long-run equilibrium, $E_1$, 10 firms sell 1,500 units at \$10. If demand is $D^2$, the short-run equilibrium is $F_2$ (\$11, 3,300 units, 20 firms) and the long-run equilibrium is $E_2$ (\$10, 3,600 units, 24 firms).

We assume that the firms use the same size plant in the short and long run so that the minimum average cost is \$10 in both the short and long run. Because all firms have the same costs and can enter freely, the long-run market supply curve is flat at the minimum average cost, \$10, in panel b. At prices between \$7 and \$10, firms supply goods at a loss in the short run but not in the long run.

If the market demand curve is $D^1$, the short-run market equilibrium, $F_1$, is below and to the right of the long-run market equilibrium, $E_1$. This relationship is reversed if the market demand curve is $D^2$.[11]

In the short run, if the demand is as low as $D^1$, the market price in the short-run equilibrium, $F_1$, is \$7. At that price, each of the 20 firms produces 100 units, at $f_1$ in panel a. The firms lose money because the price of \$7 is below average cost at 100 units. These losses drive some of the firms out of the market in the long run, so market output falls and the market price rises. In the long-run equilibrium, $E_1$, price is \$10, and each firm produces 150 units, $e$, and breaks even. As the market demands only 1,500 units, only 10 (= 1,500/150) firms produce, so half the firms that produced in the short run exit the market.[12] Thus with the $D^1$ demand curve, price rises and output falls in the long run.

If demand expands to $D^2$, in the short run, each of the 20 firms expands its output to 165 units, $f_2$, and the price rises to \$11, where the firms make profits: The price of \$11 is above the average cost at 165 units. These profits attract entry in the long run, and the price falls. In the long-run equilibrium, each firm produces 150 units, $e$, and 3,600 units are sold by the market, $E_2$, by 24 (= 3,600/150) firms. Thus with the $D^2$ demand curve, price falls and output rises in the long run.

Because firms may enter and exit in the long run, taxes can have a counterintuitive effect on the competitive equilibrium. For example, as Solved Problem 8.3 shows, a lump-sum franchise tax causes the competitive equilibrium output of a firm to increase, although market output falls.

**8.3** **If the government starts collecting a lump-sum franchise tax of $\mathcal{L}$ each year from each identical firm in a competitive market with free entry and exit, how do the long-run market and firm equilibria change?**

**Answer**

1. *Show that the franchise tax causes the minimum long-run average cost to rise*: A typical firm's cost curves are shown in panel a and the market

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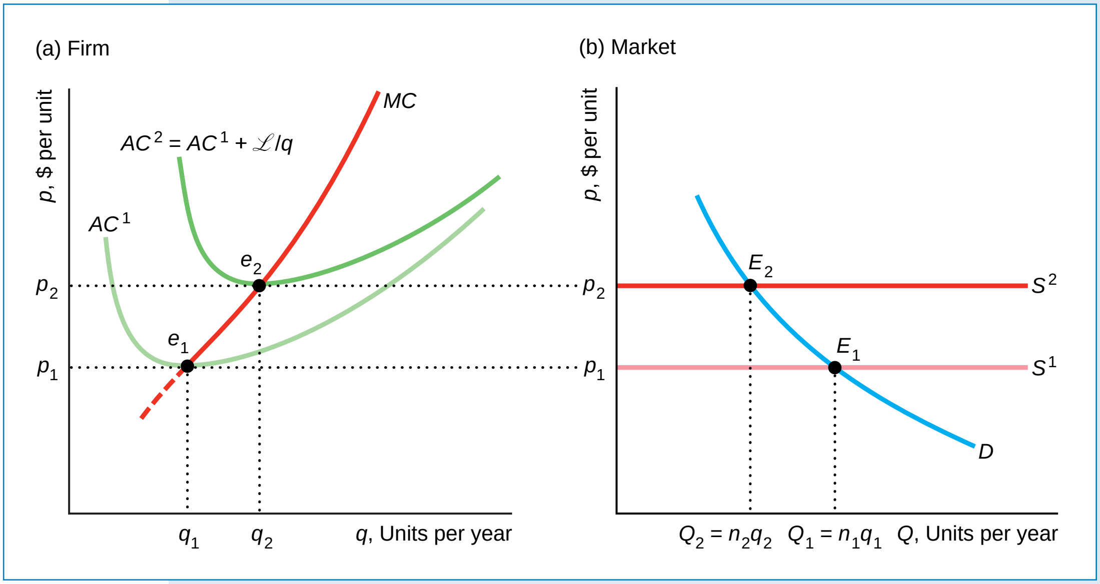
[11]Using data from *Statistics Canada*, I estimate that the elasticity of demand for vegetable oil is –0.8. Both $D^1$ and $D^2$ are constant –0.8 elasticity demand curves, but the demand at any price on $D^2$ is 2.4 times that on $D^1$.

[12]How do we know which firms leave? If the firms are identical, the theory says nothing about which ones leave and which ones stay. The firms that leave make zero economic profit, and those that stay make zero economic profit, so firms are indifferent as to whether they stay or exit.

equilibrium in panel b. In panel a, a lump-sum, franchise tax shifts the typical firm's average cost curve upward from $AC^1$ to $AC^2 = AC^1 + \mathscr{L}/q$ but does not affect the marginal cost (see the answer to Solved Problem 7.1). As a result, the minimum average cost rises from $e_1$ to $e_2$.




2. *Show that the shift in the minimum average cost causes the market supply curve to shift upward, equilibrium quantity to fall, and equilibrium price to rise*: The long-run market supply is horizontal at minimum average cost. Thus the market supply curve shifts upward by the same amount as the minimum average cost increases in panel b. With a downward-sloping market demand curve, the new equilibrium, $E_2$, has a lower quantity, $Q_2 < Q_1$, and higher price, $p_2 > p_1$, than the original equilibrium, $E_1$.

3. *Show that the increase in the equilibrium price causes output of an individual firm to rise*: Because the market price rises, the quantity that a firm produces rises from $q_1$ to $q_2$. Thus if the firm remains in the market, it will produce more.

4. *Use the market quantity and individual firm quantity to determine how the number of firms changes*: At the initial equilibrium, the number of firms was $n_1 = Q_1/q_1$. The new equilibrium number of firms, $n_2 = Q_2/q_2$, must be smaller than $n_1$ because $Q_2 < Q_1$ and $q_2 > q_1$. Thus there are fewer firms but each remaining firm produces more output at the new equilibrium.

## 8.5 ZERO PROFIT FOR COMPETITIVE FIRMS IN THE LONG RUN

Competitive firms earn zero profit in the long run whether or not entry is completely free. As a consequence, competitive firms must maximize profit.

### Zero Long-Run Profit with Free Entry

The long-run supply curve is horizontal if firms are free to enter the market, firms have identical cost, and input prices are constant. All firms in the market are operating at minimum long-run average cost. That is, they are indifferent between shutting down or not because they are earning zero profit.

One implication of the shutdown rule is that the firm is willing to operate in the long run even if it is making zero profit. This conclusion may seem strange unless you remember that we are talking about *economic profit*, which is revenue minus opportunity cost. Because opportunity cost includes the value of the next best investment, at a zero long-run economic profit, the firm is earning the normal business profit that the firm could earn by investing elsewhere in the economy.

For example, if a firm's owner had not built the plant the firm uses to produce, the owner could have spent that money on another business or put the money in a bank. The opportunity cost of the current plant, then, is the forgone profit from what the owner could have earned by investing the money elsewhere.

The five-year after-tax accounting return on capital across all firms was 10.5%, indicating that the typical firm earned a business profit of 10.5¢ for every dollar it invested in capital (*Forbes*). These retailers were earning roughly zero economic profit but positive business profit.

Because business cost does not include all opportunity costs, business profit is larger than economic profit. Thus *a profit-maximizing firm may stay in business if it earns zero long-run economic profit but shuts down if it earns zero long-run business profit*.

#### ABORTION MARKET

Abortion clinics operate in a nearly perfectly competitive market, close to their break-even point. Medoff (1997) estimated that the price elasticity of demand for abortions ranges from −0.70 to −0.99 and the income elasticity from 0.27 to 0.35. However in recent years, the demand curve has apparently shifted substantially to the left. The number of abortions in 2000 was down more than 17% from the peak in 1990. The abortion rate per 1,000 women of childbearing age dropped from 24 in 1994 to just 21 in 2000.

This large shift in the number of abortions performed forced smaller clinics to shut down; however, the number of clinics performing 400 or more abortions a year—clinics responsible for more than 89% of all abortions—has remained steady at 690 since 1992.

Women in rural areas and in areas with fewer than 200,000 people who want abortions generally must travel to a major metropolitan area, where virtually all large clinics are located. These in-city abortion clinics fiercely compete with respect to price. Many doctors who perform abortions refuse to train others, so as to prevent them from entering the market.

As clinics fight for the diminishing business, they are forced to operate at the shutdown point and make zero economic profit. To stay in business, the clinics keep their variable costs as low as possible. A low-paid staff does everything but the actual surgery, from drawing blood to doing lab tests. Clinics have a doctor present only on days when they can schedule a steady stream of patients. Each first-trimester procedure takes only two to three minutes of the doctor's time.

The average price of an abortion has remained relatively constant over the last 25 years, in contrast to a fivefold increase in the price of other medical services. According to the Alan Guttmacher Institute in 2002, the average price (in 1997 dollars) of an abortion at 10 weeks with local anesthesia was $322 in 1983, $325 in 1989, and $316 in 1997. That the price has remained relatively constant over time, despite major shifts in the demand curve, is consistent with a nearly horizontal supply curve for abortions.

### Zero Long-Run Profit When Entry Is Limited

In some markets, firms cannot enter in response to long-run profit opportunities. One reason for the limited number of firms is that the supply of an input is limited. Only so much land is suitable for mining uranium, and only a few people have the superior skills needed to play professional basketball.

One might think that firms could make positive long-run economic profits in such markets; however, that's not true. The reason why firms earn zero economic profits is that firms bidding for the scarce input drive its price up until the firms' profits are zero.

Suppose that the number of acres suitable for growing tomatoes is limited. Figure 8.16 shows a typical farm's average cost curve if the rental cost of land is zero (the average cost curve includes only the farm's costs of labor, capital, materials, and energy—not land). At the market price $p^*$, the firm produces $q^*$ bushels of tomatoes and makes a profit of $\pi^*$, the shaded rectangle in the figure.

Thus if the owner of the land does not charge rent, the farmer makes a profit. Unfortunately for the farmer, the landowner rents the land for $\pi^*$, so the farmer actually earns zero profit. Why does the landowner charge that much? The reason is that $\pi^*$ is the opportunity cost of the land: The land is worth $\pi^*$ to other potential farmers. These farmers will bid against each other to rent this land until the rent is driven up to $\pi^*$.

This rent is a fixed cost to the farmer because it doesn't vary with the amount of output. Thus the rent affects the farm's average cost curve but not its marginal cost curve.

As a result, if the farm produces at all, it produces $q^*$, where its marginal cost equals the market price, no matter what rent is charged. The higher average cost curve in the figure includes a rent equal to $\pi^*$. The minimum point of this average

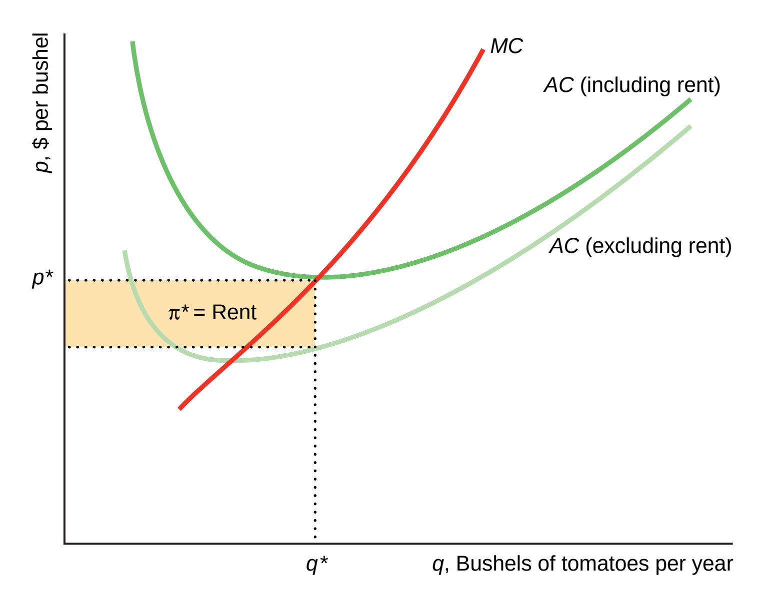



**Figure 8.16 Rent.** If it did not have to pay rent for its land, a farm with high-quality land would earn a positive long-run profit of π*. Due to competitive bidding for this land, however, the rent equals π*, so the landlord reaps all the benefits of the superior land, and the farmer earns a zero long-run economic profit.

cost curve is $p^*$ at $q^*$ bushels of tomatoes, so the farmer earns zero economic profit.

If demand falls, so the market price falls, these farmers will make short-run losses. In the long run, the rental price of the land will fall enough that, once again, each firm earns zero economic profit.

Does it make a difference whether farmers own or rent the land? Not really. The opportunity cost to a farmer who owns superior land is the amount for which that land could be rented in a competitive land market. Thus the economic profit of both owned and rented land is zero at the long-run equilibrium.

Good-quality land is not the only scarce resource. The price of any fixed factor will be bid up in the same way so that economic profit for the firm is zero in the long run.

Another example is an industry in which the government requires that a firm have a license to operate and then limits the number of licenses. As we discuss at length in Chapter 9, the price of the license gets bid up by potential entrants, driving profit to zero.

Economists refer to the extra opportunity value of a scarce input as a "rent," even if the fixed factor is a person with high ability rather than land. Indeed, to economists, a **rent** is a payment to the owner of an input beyond the minimum necessary for the factor to be supplied.

Bonnie manages a store for the salary of $30,000, which is what a typical manager is paid. Because she's a superior manager, however, the firm earns an economic profit of $50,000 a year. Other firms, seeing what a good job Bonnie is doing, offer her a higher salary. The bidding for her services drives her salary up to $80,000: her $30,000 base salary plus the $50,000 rent. After paying this rent to Bonnie, the store makes zero economic profit.

Similarly, people with unusual abilities can earn staggering rents. Though no law stops anyone from trying to become a professional entertainer, most of us do not have enough talent that others will pay to watch us perform. The Rolling Stones earned $121.2 million from their 1994 concert tour, according to *Pollstar* magazine.[13] To put this amount in perspective, the 1993 gross national product (national income of the entire country) of Grenada, a country of a 100,000 people, was $215 million; that of Kiribati, $51.1 million; and that of Bhutan, $234 million.

In short, if some firms in a market make short-run economic profits due to a scarce input, the other firms in the market bid for that input. This bidding drives the price of the factor upward until all firms earn zero long-run profits. In such a market, the supply curve is flat because all firms have the same minimum long-run average cost.

### The Need to Maximize Profit

In a competitive market with identical firms and free entry, if most firms are profit-maximizing, profits are driven to zero at the long-run equilibrium. Any firm that did not maximize profit—that is, any firm that set its output so that price did not equal its marginal cost or did not use the most cost-efficient methods of production—would lose money. Thus *to survive in a competitive market, a firm must maximize its profit*.

## Summary

1. **Competition:** Competitive firms are price takers that cannot influence market price. Markets are likely to be competitive if all firms in the market sell identical products, firms can enter and exit the market freely, buyers and sellers know the prices charged by firms, and transaction costs are low. A competitive firm faces a horizontal demand curve at the market price.
2. **Profit maximization:** Most firms maximize economic profit, which is revenue minus economic cost (explicit and implicit cost). Because business profit, which is revenue minus only explicit cost, does not include implicit cost, economic profit tends to be less than business profit. A firm earning zero economic profit is making as much as it could if its resources were devoted to their best alternative uses. To maximize profit, all firms (not just competitive firms) must make two decisions. First, the firm determines the quantity at which its profit is highest. Profit is maximized when marginal profit is zero or, equivalently, when marginal revenue equals marginal cost. Second, the firm decides whether to produce at all.
3. **Competition in the short run:** Because a competitive firm is a price taker, its marginal revenue equals the market price. As a result, a competitive firm maximizes its profit by setting its output so that its short-run marginal cost equals the market price. The firm shuts down if the market price is less than its minimum average variable cost. Thus a profit-maximizing competitive firm's short-run supply curve is its marginal cost curve above its minimum

[13] No recent tour has been nearly as successful. The top music earner in 2001 was U2 at $61.9 million.

average variable cost. The short-run market supply curve, which is the sum of the supply curves of the fixed number of firms producing in the short run, is flat at low output levels and upward sloping at larger levels. The short-run competitive equilibrium is determined by the intersection of the market demand curve and the short-run market supply curve. The effect of an increase in demand depends on whether demand intersects the market supply in the flat or upward-sloping section.

4. **Competition in the long run:** In the long run, a competitive firm sets its output where the market price equals its long-run marginal cost. It shuts down if the market price is less than the minimum of its average long-run cost because all costs are variable in the long run. Consequently, the competitive firm's supply curve is its long-run marginal cost above its minimum long-run average cost. The long-run supply curve of a firm may have a different slope than the short-run curve because it can vary its fixed factors in the long run. The long-run market supply curve is the horizontal sum of the supply curves of all the firms in the market. If all firms are identical, entry and exit are easy, and input prices are constant, the long-run market supply curve is flat at minimum average cost. If firms differ, entry is difficult or costly, or input prices vary with output, the long-run market supply curve has an upward slope. The long-run market supply curve slopes upward if input prices increase with output and slopes downward if input prices decrease with output. The long-run market equilibrium price and quantity are different from the short-run price and quantity.
5. **Zero profit for competitive firms in the long run:** Although firms may make profits or losses in the short run, they earn zero economic profit in the long run. If necessary, the prices of scarce inputs adjust to ensure that competitive firms make zero long-run profit. Because profit-maximizing firms just break even in the long run, firms that do not try to maximize profits will lose money. Competitive firms must maximize profit to survive.

QUIZ

## Questions

1. Should a competitive firm ever produce when it is losing money? Why or why not?
2. Many marginal cost curves are U-shaped. As a result, it is possible that the *MC* curve hits the demand or price line at two output levels. Which is the profit-maximizing output? Why?
3. Suppose that the government imposes an *ad valorem* tax (Chapter 3) of $\alpha$ per dollar on a competitive firm. What happens to its long-run supply curve?
4. In Solved Problem 8.3, would it make a difference to the analysis whether the franchise tax were collected annually or only once when the firm starts operation? How would each of these franchise taxes affect the firm's long-run supply curve? Explain your answer.
5. Answer Solved Problem 8.3 for the short run rather than for the long run. (*Hint*: The answer depends on where the demand curve intersects the original short-run supply curve.)
6. Competitive firms in the United States and in France produce cheese. The French government gives each cheese manufacturer an annual subsidy (a negative tax) of $s$ that is independent of the amount of cheese it produces. What happens to the long-run supply curve of cheese to the world?
7. How does the cheese subsidy in Question 6 affect the world price, the amount sold by French and American firms, and the profits of both types of firms?
8. What is the effect on firm and market equilibrium of a law requiring a firm to give its workers six months' notice before it can shut down its plant?
9. Redraw Figure 8.11 showing a situation in which the short-run plant size is too large relative to the optimal long-run plant size.
10. Is it true that the long-run supply curve for a good is horizontal only if the long-run supply curves of all factors are horizontal? Explain.
11. Navel oranges are grown in California and Arizona. If Arizona starts collecting a specific tax per orange from its firms, what happens to the long-run market supply curve? (*Hint*: You may assume that all firms initially have the same costs.

Your answer may depend on whether unlimited entry occurs.)

12. Americans used 33 million real Christmas trees and 40 million artificial trees in 1994. The number of tree producers fell by about a third over the previous 10 years, to about 2,000 in 1994, due to artificial tree sales. That year, trees sold for an average of \$26.50, about 50¢ more than the previous year. Retailers' average cost was \$20. In 1998, 33 million trees sold for an average of \$29.25. Use graphs to illustrate this information.

13. *Review* (Chapters 2, 3, and 8): To reduce pollution, the California Air Resources Board in 1996 required the reformulation of gasoline sold in California. In 1999, a series of disasters at California refineries substantially cut the supply of gasoline and contributed to large price increases. Environmentalists and California refiners (who had sunk large investments to produce the reformulated gasoline) opposed imports from other states, which would have kept prices down. To minimize fluctuations in prices in California, Severin Borenstein and Steven Stoft suggest setting a 15¢ surcharge on sellers of standard gasoline. In normal times, none of this gasoline would be sold, because it costs only 8¢ to 12¢ more to produce the California version. However, when disasters trigger a large shift in the supply curve of gasoline, firms could profitably import standard gasoline and keep the price in California from rising more than about 15¢ above prices in the rest of the United States. Use figures to evaluate Borenstein and Stoft's proposal.

14. *Review* (Chapters 7 and 8): Bribes paid by Swiss companies to foreign officials, which were tax deductible since 1946, are no longer deductible as of 1999. Use economic models from this chapter and Chapter 7 to show the likely effects of this ban on the bribing behavior of Swiss firms.

## Problems

15. If a competitive firm's cost function is $C(q) = 100 + 10q - q^2 + \frac{1}{3}q^3$, what is the firm's marginal cost function? What is the firm's profit-maximizing condition?

16. If a competitive firm's cost function is $C(q) = a + bq + cq^2 + dq^3$, where $a$, $b$, $c$, and $d$ are constants, what is the firm's marginal cost function? What is the firm's profit-maximizing condition?

17. Each firm in a competitive market has a cost function of $C = 16 + q^2$. The market demand function is $Q = 24 - p$. Determine the equilibrium price, quantity per firm, market quantity, and number of firms.

18. There are 10 identical competitive firms in a market. The linear market demand curve is $Q = 100 - p$, and the linear supply curve of each firm is $q = p$. What residual demand does a typical firm face?

19. There are $n$ identical competitive firms in a market. The linear market demand curve is $Q = a - bp$, and the linear supply curve of each firm is $q = c + dp$, where $a$, $b$, $c$, and $d$ are positive constants. What residual demand does a typical firm face?

20. At least 40,000 U.S. farms produce apples. The market demand elasticity of apples is about −0.2. At least how great must the residual demand elasticity that a single farm faces be?