Costs of Production

LEARNING OBJECTIVES

After reading this chapter, you should be able to:

1. Define and explain the differences between accounting profit and economic profit.

2. Understand the law of diminishing returns.

3. Discuss the various production costs that firms face.

4. Determine a firm's profit-maximizing decision in the short run.

5. Describe a firm's shutdown decision.

6. Understand production and costs in the long run.

Cars that took more than 50 hours to assemble in the 1970s are now built in less than 8 hours. Similar productivity growth has occurred in many other manufacturing industries. Yet, in many service industries, productivity has grown only slowly, if at all. For example, the London Philharmonic Orchestra performs Beethoven's Fifth Symphony with no fewer musicians today than it did in 1850. And it still takes a barber about half an hour to cut someone's hair, just as it always has.

Given the spectacular growth in manufacturing workers' productivity, it is no surprise that their real wages have risen more than fivefold during the last century. But why have real wages for service workers risen just as much? If barbers and musicians are no more productive than they were at the turn of the century, why are they now paid five times as much?

An answer is suggested by the observation that the opportunity cost of pursuing any given occupation is the most one could have earned in some other occupation. Most people who become barbers or musicians could instead have chosen jobs in manufacturing. If workers in service industries were not paid roughly as much as they could have earned in other occupations, many of them would not have been willing to work in service industries in the first place.

Rare indeed is the marketplace in which businesses remain static for extended periods. New businesses enter, established ones leave. Driving these changes is the business owner's quest for profit. Businesses migrate to industries and locations in which profit opportunities abound and desert those whose prospects appear bleak. In perhaps the most widely-quoted passage from his landmark treatise, *The Wealth of Nations*, Adam Smith wrote,

> It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard of their own interest. We address ourselves not to their humanity, but to their self-love, and never talk to them of our necessities, but of their advantage.

Smith went on to argue that, although the entrepreneur "intends only his own gain," he is "led by an invisible hand to promote an end which was no part of his intention." As Smith saw it, even though self-interest is the prime mover of economic activity, the end result is an allocation of goods and services that serves society's collective interests remarkably well. If producers are offering "too much" of one product and "not enough" of another, profit opportunities alert entrepreneurs to that fact and provide incentives for them to take remedial action. All the while, the system exerts relentless pressure on producers to hold the price of each good close to its cost of production, and indeed to reduce that cost in any ways possible. The invisible hand, in short, is about all the good things that can happen because of the Incentive Principle.

Our task in this chapter is to gain deeper insight into production and the various costs that firms face, in both the short and the long run, in their quest for profits. This will set up the groundwork for the understanding of a firm's shutdown and profit-maximization decisions.

6.1 THE CENTRAL ROLE OF ECONOMIC PROFIT

The economic theory of business behavior is built on the assumption that the firm's goal is to maximize its profit. So we must be clear at the outset about what, exactly, profit means.

6.1.1 THREE TYPES OF PROFIT

The economist's understanding of profit is different from the accountant's, and the distinction between the two is important to understanding how the invisible hand works. Accountants define the annual profit of a business as the difference between the revenue it takes in and its **explicit costs** for the year, which are the actual payments the firm makes to its factors of production and other suppliers. Profit thus defined is called **accounting profit**.

explicit costs the actual payments a firm makes to its factors of production and other suppliers

Accounting profit = Total revenue – Explicit costs.

accounting profit the difference between a firm's total revenue and its explicit costs

Accounting profit is the most familiar profit concept in everyday discourse. It is the one that companies use, for example, when they provide statements about their profits in press releases or annual reports.[1]

Economists, by contrast, define profit as the difference between the firm's total revenue and not just its explicit costs, but also its **implicit costs**, which are the opportunity costs of all the resources supplied by the firm's owners. Profit thus defined is called **economic profit**, or **excess profit**.

implicit costs the opportunity costs of the resources supplied by the firm's owners

Economic profit = Total revenue – Explicit costs – Implicit costs.

economic profit (or excess profit) the difference between a firm's total revenue and the sum of its explicit and implicit costs

To illustrate the difference between accounting profit and economic profit, consider a firm with $400,000 in total annual revenue whose only explicit costs are workers' salaries, totaling $250,000 per year. The owners of this firm have supplied machines and other capital equipment with a total resale value of $1 million. This firm's accounting profit, then, is $150,000, or the difference between its total revenue of $400,000 per year and its explicit costs of $250,000 per year.

To calculate the firm's economic profit, we must first calculate the opportunity cost of the resources supplied by the firm's owners. Suppose the current annual

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[1] For simplicity, this discussion ignores any costs associated with depreciation of the firm's capital equipment. Because the buildings and machines owned by a firm tend to wear out over time, the government allows the firm to consider a fraction of their value each year as a current cost of doing business. For example, a firm that employs a $1,000 machine with a 10-year lifespan might be allowed to record $100 as a current cost of doing business each year.

interest rate on savings accounts is 10 percent. Had the owners not invested in capital equipment, they could have earned an additional $100,000 per year interest by depositing their $1 million in a savings account. So the firm's economic profit is $400,000 per year – $250,000 per year – $100,000 per year = $50,000 per year.

Note that this economic profit is smaller than the accounting profit by exactly the amount of the firm's implicit costs—the $100,000 per year opportunity cost of the resources supplied by the firm's owners. This difference between a business's accounting profit and its economic profit is called its **normal profit**. Normal profit is simply the opportunity cost of the resources supplied to a business by its owners.

Figure 6.1 illustrates the difference between accounting and economic profit. Figure 6.1(a) represents a firm's total revenues, while (b) and (c) show how these revenues are apportioned among the various cost and profit categories.

The following examples illustrate why the distinction between accounting and economic profit is so important.

normal profit the opportunity cost of the resources supplied by a firm's owners, equal to accounting profit minus economic profit
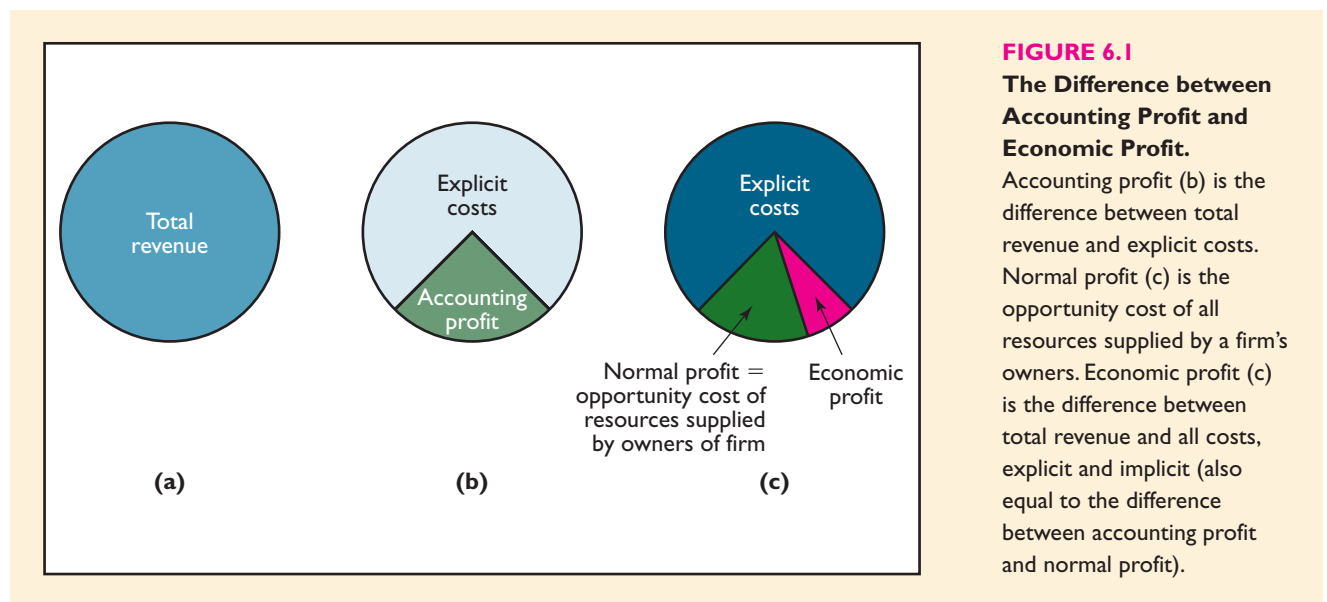

FIGURE 6.1
The Difference between Accounting Profit and Economic Profit.
Accounting profit (b) is the difference between total revenue and explicit costs. Normal profit (c) is the opportunity cost of all resources supplied by a firm's owners. Economic profit (c) is the difference between total revenue and all costs, explicit and implicit (also equal to the difference between accounting profit and normal profit).

Should Kamal Mustakil stay in the farming business?

Kamal Mustakil is a corn farmer who lives in Central Anatolia, Turkey. His payments for land and equipment rental and for other supplies come to $10,000 per year. The only input he supplies is his own labor, and he considers farming just as attractive as his only other employment opportunity, managing a retail store at a salary of $11,000 per year. Apart from the matter of pay, Kamal is indifferent between farming and being a manager. Corn sells for a constant price per bushel in an international market too large to be affected by changes in one farmer's corn production. Kamal's revenue from corn sales is $22,000 per year. What is his accounting profit? His economic profit? His normal profit? Should he remain a corn farmer?

As shown in Table 6.1, Kamal's accounting profit is $12,000 per year, the difference between his $22,000 annual revenue and his $10,000 yearly payment for land, equipment, and supplies. His economic profit is that amount less the opportunity cost of his labor. Since the latter is the $11,000 per year he could have earned as a store manager, he is making an economic profit of $1,000 per year. Finally, his normal profit is the $11,000 opportunity cost of the only resource he supplies, namely, his labor. Since Kamal likes the two jobs equally well, he will be better off by $1,000 per year if he remains in farming. ◆

TABLE 6.1

Revenue, Cost, and Profit Summary

Total revenue ($/year)	Explicit costs ($/year)	Implicit costs ($/year)	Accounting profit (= total revenue − explicit costs) ($/year)	Economic profit (= total revenue − explicit costs − implicit costs) ($/year)	Normal profit (= implicit cost) ($/year)
22,000	10,000	11,000	12,000	1,000	11,000

EXERCISE 6.1

In the example above, how will Kamal's economic profit change if his annual revenue from corn production is not $22,000, but $20,000? Should he continue to farm?

When revenue falls from $22,000 to $20,000, Kamal has an economic profit of −$1,000 per year. A negative economic profit is also called an **economic loss**. If Kamal expects to sustain an economic loss indefinitely, his best bet would be to abandon farming in favor of managing a retail store.

economic loss an economic profit that is less than zero

You might think that, if Kamal could just save enough money to buy his own land and equipment, his best option would be to remain a farmer. But as the following example illustrates, that impression is based on a failure to perceive the difference between accounting profit and economic profit.

Does owning one's own land make a difference?

Let's build on the previous example. Suppose Kamal's Uncle Jamal, who owns the farmland Kamal has been renting, dies and leaves Kamal that parcel of land. If the land could be rented to some other farmer for $6,000 per year, should Kamal remain in farming?

As shown in Table 6.2, if Kamal continues to farm his own land, his accounting profit will be $16,000 per year, or $6,000 more than in Exercise 6.1. But his economic profit will still be the same as before—that is, −$1,000 per year—because Kamal must deduct the $6,000 per year opportunity cost of farming his own land, even though he no longer must make an explicit payment to his uncle for it. The normal profit from owning and operating his farm will be $17,000 per year—the opportunity cost of the land and labor he provides. But since Kamal earns an

TABLE 6.2

Revenue, Cost, and Profit Summary

Total revenue ($/year)	Explicit costs ($/year)	Implicit costs ($/year)	Accounting profit (= total revenue − explicit costs) ($/year)	Economic profit (= total revenue − explicit costs − implicit costs) ($/year)	Normal profit (= implicit costs) ($/year)
20,000	4,000	17,000	16,000	−1,000	17,000

accounting profit of only $16,000, he will again do better to abandon farming for the managerial job. ◆

Kamal obviously would be wealthier as an owner than he was as a renter. But the question of whether to remain a farmer is answered the same way whether Kamal rents his farmland or owns it. He should stay in farming only if that is the option that yields the highest economic profit.

RECAP	**THE CENTRAL ROLE OF ECONOMIC PROFIT**

A firm's accounting profit is the difference between its revenue and the sum of all explicit costs it incurs. Economic profit is the difference between the firm's revenue and *all* costs it incurs—both explicit and implicit. Normal profit is the opportunity cost of the resources supplied by the owners of the firm. When a firm's accounting profit is exactly equal to the opportunity cost of the inputs supplied by the firm's owners, the firm's economic profit is zero. For a firm to remain in business in the long run, it must earn an economic profit greater than or equal to zero.

6.2 PRODUCTION IN THE SHORT RUN

To gain a deeper understanding of the costs that firms face, it is helpful to consider a firm confronting the decision of how much to produce. The firm in question is a small company that makes Fanoos Ramadan lanterns. To keep things simple, suppose that the silica required for making lanterns is available free of charge from a nearby desert and that the only costs incurred by the firm are the wages it pays its employees and the lease payment on its lantern-making machine. The employees and the machine are the firm's only two **factors of production**—inputs used to produce goods and services. In more complex examples, factors of production also might include land, structures, entrepreneurship, and possibly others, but for the moment we consider only labor and capital.

When we refer to the **short run**, we mean a period of time during which at least some of the firm's factors of production cannot be varied. For our lantern maker, we will assume that the number of employees can be varied on short notice but that the capacity of its lantern-making machine can be altered only with significant delay. For this firm, then, the short run is simply that period of time during which the firm cannot alter the capacity of its lantern-making machine. By contrast, when we speak of the **long run**, we refer to a time period of sufficient length that all the firm's factors of production are variable.

Table 6.3 shows how the company's lantern production depends on the number of hours its employees spend on the job each day. The output–employment relationship described in Table 6.3 exhibits a pattern that is common to many such relationships. Each time we add an additional unit of labor, output grows, but beyond some point the additional output that results from each additional unit of labor begins to diminish. Note in the middle column, for example, that output gains begin to diminish with the third employee. This can be seen more clearly in the right column that represents the **marginal product of labor** (**MP**), which is expressed as:

$$MP = \frac{\Delta Q}{\Delta L} = \frac{\text{Change in output}}{\text{Change in labor input}}.$$

The *MP* measures the contribution of additional labor input to total output. For instance, the *MP* for the second employee is 120 units (from the difference

factor of production an input used in the production of a good or service

short run a period of time sufficiently short that at least some of the firm's factors of production are fixed

long run a period of time of sufficient length that all the firm's factors of production are variable

marginal product of labor (MP) the additional output a firm gets by employing one additional unit of labor

iStock

TABLE 6.3
Employment and Output for a Fanoos Ramadan Lantern Maker

Total number of employees per day	Total output per day	Marginal product of labor
0	0	
		80
1	80	
		120
2	200	
		60
3	260	
		40
4	300	
		30
5	330	
		20
6	350	
		12
7	362	

between 200 and 80), which means that adding that second worker contributes 120 additional units to total output, more than the 80 units that the first employee has contributed to total output. Economists describe this pattern as ***increasing returns***. This however does not imply that the second employee is more productive than the first one, but rather that *they* are more productive when they work together. The *MP* for the third employee, on the other hand, is equal to 60 units (from the difference between 260 and 200), which describes the pattern that economists refer to as the **law of diminishing returns**. This always refers to situations in which at least some factors of production are fixed. Here, the **fixed factor** is the lantern-making machine, and the **variable factor** is labor. In the context of this example, the law of diminishing returns says simply that successive increases in the labor input eventually yield smaller and smaller increments in lantern output. (Strictly speaking, the law ought to be called the law of *eventually* diminishing returns because output may initially grow at an increasing rate with additional units of the variable factor.) To emphasize that *MP* refers to the change in total output when labor input changes, we place *MP* entries between the corresponding labor input rows of the table.

Typically, returns from additional units of the variable input eventually diminish because of some form of congestion. For instance, in an office with three secretaries and only a single desktop computer, we would not expect to get three times as many letters typed per hour as in an office with only one secretary because only one person at a time can use a computer.

The total product curve, shown in Figure 6.2, initially increases at an increasing rate (or gets steeper), illustrating increasing returns. The *MP* curve, which captures the slope of the total product curve increases over the same labor input range. With three employees and more, the total product curve increases at a decreasing rate (or gets flatter), consistent with the law of diminishing returns. In fact, *MP* decreases with the addition of the third employee, thereby illustrating the decreasing contributions of additional labor input to total output.

law of diminishing returns
a property of the relationship between the amount of a good or service produced and the amount of a variable factor required to produce it; it says that, when some factors of production are fixed, increased production of the good eventually requires ever-larger increases in the variable factor

***fixed factor of production*** an input whose quantity cannot be altered in the short run

variable factor of production an input whose quantity can be altered in the short run

RECAP	PRODUCTION IN THE SHORT RUN

Production in the short run refers to a period during which at least some of the firm's factors of production cannot be varied. In contrast, in the long run, all factors of production are variable. The law of diminishing returns describes a situation where successive increases in labor input eventually yield smaller and smaller increments in output.
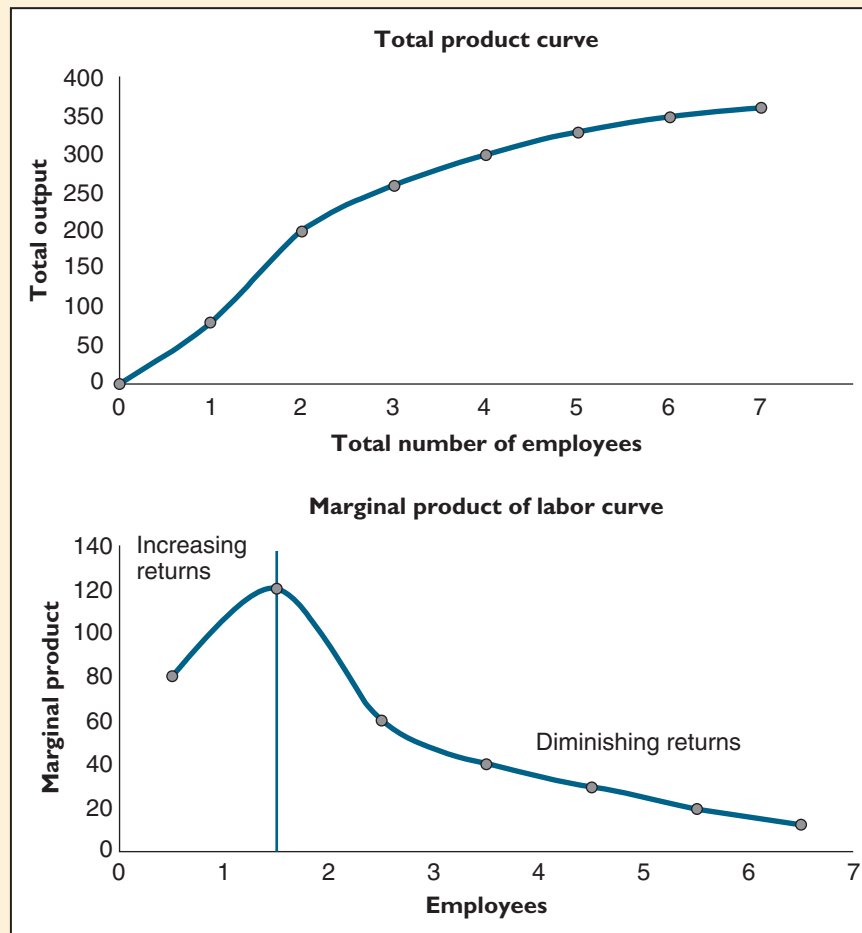
FIGURE 6.2
The Total and Marginal Product Curves.
The total product curve initially increases at an increasing rate (increasing returns) then increases at a decreasing rate (diminishing returns).

6.2.1 PRODUCTION COSTS

For the lantern-making firm described in Table 6.3, suppose the lease payment for the company's lantern-making machine is $40 per day, which must be paid whether the company makes any lanterns or not. This payment is both a **fixed cost** (*FC*) (since it does not depend on the number of lanterns per day the firm makes) and, for the duration of the lease, a **sunk cost**. The first two columns of Table 6.4 reproduce the employment and output entries from Table 6.3, and the firm's fixed cost appears in column 3.

The company's payment to its employees is called **variable cost** (*VC*) because, unlike fixed cost, it varies with the number of lanterns the company produces. The variable cost of producing 200 lanterns per day, for example, is shown in column 4 of Table 6.4 as $24 per day. Column 5 shows the firm's **total cost** (*TC*), which is the sum of its fixed and variable costs, expressed as follows:

$$TC = FC + VC.$$

Column 6, finally, shows the firm's **marginal cost**, representing the slope of the total cost, which measures how its total cost changes when its output changes. Specifically, marginal cost is expressed as:

$$MC = \frac{\Delta TC}{\Delta Q} = \frac{\text{Change in total cost}}{\text{Change in output}}.$$

fixed cost the sum of all payments made to the firm's fixed factors of production

sunk cost a cost that is beyond recovery at the moment a decision must be made

variable cost the sum of all payments made to the firm's variable factors of production

total cost the sum of all payments made to the firm's fixed and variable factors of production

marginal cost as output changes from one level to another, the change in total cost divided by the corresponding change in output

TABLE 6.4
Fixed, Variable, and Total Costs of Fanoos Ramadan Lantern Production

Employees per day	Lanterns per day	Fixed cost ($/day)	Variable cost ($/day)	Total cost ($/day)	Marginal cost ($/lantern)
0	0	40	0	40	
					0.15
1	80	40	12	52	
					0.10
2	200	40	24	64	
					0.20
3	260	40	36	76	
					0.30
4	300	40	48	88	
					0.40
5	330	40	60	100	
					0.60
6	350	40	72	112	
					1.00
7	362	40	84	124	

Note, for example, that when the firm expands production from 80 to 200 lanterns per day, its total cost goes up by $12, which gives rise to the marginal cost entry of ($12/day)/(120 lanterns/day) = $0.10 per lantern.

The law of diminishing returns explains the shape of the total cost curve. As Figure 6.3 shows, the total cost curve initially increases at a decreasing rate (or gets flatter), illustrating increasing returns. Beyond 200 units of output (which require two employees), total cost increases at an increasing rate (or gets steeper), consistent with diminishing returns. Further insight about the relationship between production and costs can be gained by superposing the *MP* and *MC* curves above. In fact, the two curves are mirror reflections of one another. That is, increasing returns are reflected by an increasing *MP* curve or decreasing *MC* curve, whereas diminishing returns are reflected by a decreasing *MP* curve or increasing *MC* curve.

RECAP	**PRODUCTION COSTS**

Firms incur fixed and variable costs in their production of goods and services. The fixed cost is independent of output, whereas the variable cost varies with output. The total cost is the sum of these two costs. Marginal cost measures the change in the total cost resulting from a change in output. The shape of the marginal cost curve is explained by the law of diminishing returns.
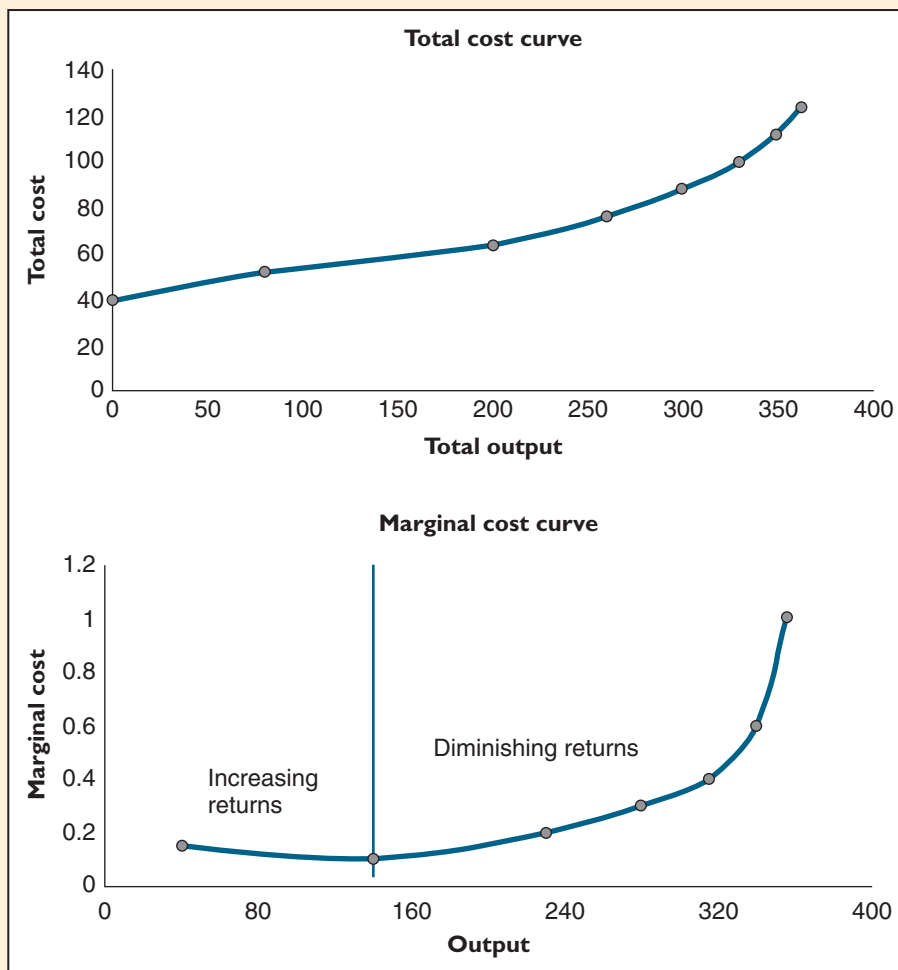
6.2.2 PROFIT MAXIMIZATION

In the following examples and exercises, we'll explore how the company's decision about how many lanterns to produce depends on the price of lanterns, the wage, and the cost of capital. Again, our starting assumption is that the firm's basic goal is to maximize the amount of **profit** it earns from the production and sale of lanterns, where profit is the difference between its total revenue and its total cost.

profit the total revenue a firm receives from the sale of its product minus all costs—explicit and implicit—incurred in producing it

$$\text{Profit} = \text{Total revenue} - \text{Total cost}$$
$$= \text{Total revenue} - \text{Variable cost} - \text{Fixed cost}.$$

(6.1)

For simplicity, profits can be expressed using the following notation:

$$\Pi = TR - TC = TR - VC - FC.$$

FIGURE 6.3
The Total and Marginal Cost Curves.
The law of diminishing returns explains the shape of the total and marginal cost curves.

It is important to note that profit maximization is "conventionally" introduced within discussions of a specific market structure, typically perfect competition. The rationale of including it in this chapter is the fact that profit maximization is independent of market structures. In other words, the profit-maximizing level of output, as described below, is determined the same way across all market structures.

If lanterns sell for 35 cents each, how many lanterns should the company described in Table 6.4 produce each day?

To answer this question, we need simply apply the Cost–Benefit Principle to the question "Should the firm expand its level of output?" If its goal is to maximize its profit, the answer to this question will be to expand as long as the marginal benefit from expanding is at least as great as the marginal cost. Since the perfectly competitive firm can sell as many lanterns as it wishes at the market price of $0.35 per lantern, its marginal benefit from selling an additional lantern is $0.35. If we compare this marginal benefit with the marginal cost entries shown in column 6 of Table 6.4, we see that the firm should keep expanding until it reaches 300 lanterns per day (four employees per day). To expand beyond that level, it would have to hire a fifth employee, and the resulting marginal cost ($0.40 per lantern) would exceed the marginal benefit. ◆

Cost–Benefit

To confirm that the Cost–Benefit Principle thus applied identifies the profit-maximizing number of lanterns to produce, we can calculate profit levels directly,

as in Table 6.5. Column 3 of this table reports the firm's revenue from the sale of lanterns, which is calculated as the product of the number of lanterns produced per day and the price of $0.35 per lantern. Note, for example, that in the third row of that column, total revenue is (200 lanterns/day)($0.35/lantern) = $70 per day. Column 7 reports the firm's total daily profit, which is just the difference between its total revenue (column 3) and its total cost (column 5). Note that the largest profit entry in column 7, $17 per day, occurs at an output of 300 lanterns per day, just as suggested by our earlier application of the Cost–Benefit Principle.

TABLE 6.5
Output, Revenue, Costs, and Profit

| Employees per day	Output (lanterns/ day)	Total revenue ($/day)	Marginal revenue ($/lantern)	Total cost ($/day)	Marginal cost ($/lantern)	Profit ($/day)
0	0	0		40		−40
			0.35		0.15	
1	80	28		52		−24
			0.35		0.10	
2	200	70		64		6
			0.35		0.20	
3	260	91		76		15
			0.35		0.30	
4	300	105		88		17
			0.35		0.40	
5	330	115.50		100		15.50
			0.35		0.6	
6	350	122.50		112		10.50
			0.35		1.00	
7	362	126.70		124		2.70

Columns 4 and 6 report the firm's marginal revenue and marginal cost (*MC*), respectively. The **marginal revenue** (*MR*) represents the change in total revenue resulting from a change in output and is expressed as:

marginal revenue the change in a firm's total revenue that results from a one-unit change in output

$$MR = \frac{\Delta TR}{\Delta Q} = \frac{\text{Change in total revenue}}{\text{Change in output}}.$$

Note that, for simplicity, we have assumed a constant *MR*, which implies equality between price and *MR*. This is consistent with perfectly competitive firms (to be discussed in the next chapter).

The firm maximizes profits when it produces 300 lanterns per day. It can be seen at this level that the firm earns incremental profits since *MR* > *MC*. That is, producing the 300th lantern results in a $0.05 incremental profit (from the difference between *MR* and *MC*). Hence, producing more than 300 lanterns would result in incremental losses and producing fewer than 300 lanterns would result in forgone profits (or would not maximize profits). For example, producing 330 lanterns would result in a $1.50 incremental loss (from the difference between $15.50 and $17.00) since *MC* exceeds *MR*, whereas producing 260 lanterns would result in a $2.00 forgone profit (from the difference between $17.00 and $15.00) since *MR* exceeds *MC*. This line of reasoning is discussed further below.

Figure 6.4 shows that profits are maximized when producing 300 lanterns. This is clearly reflected by the highest point of the profit curve as well as by the
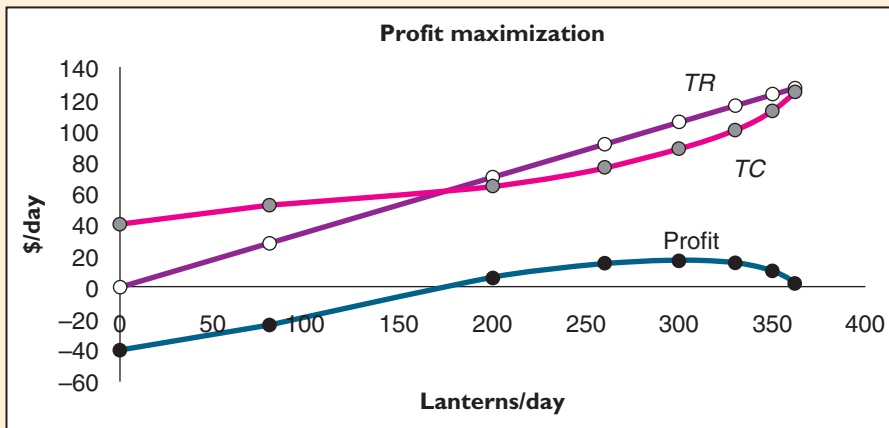
FIGURE 6.4
Profit maximization.
The profit-maximizing level of output occurs at the highest point on the profit curve, which is also represented by the largest distance between *TR* and *TC*.

area with the largest difference between the total revenue (*TR*) and total cost (*TC*) curves. In other words, profits are maximized at the point where the slope of the profit function is equal to zero, that is, when

$$\frac{\text{Change in profit}}{\text{Change in output}} = \frac{\Delta\Pi}{\Delta Q} = 0$$

$$\frac{\Delta(TR - TC)}{\Delta Q} = 0$$

$$\frac{\Delta TR}{\Delta Q} - \frac{\Delta TC}{\Delta Q} = 0$$

$$MR = MC$$

Profits are therefore maximized when no additional profits can be extracted from the production of an additional unit, that is, when the revenue generated by the last unit (*MR*) is equal to the cost of producing that unit (*MC*).

As the following exercise demonstrates, an increase in the price of the product gives rise to an increase in the profit-maximizing level of output.

EXERCISE 6.2

How would the profit-maximizing level of lantern production change in the example above if lanterns sell for 62 cents each?

The following exercise illustrates that a fall in the wage rate leads to a decline in marginal cost, which also causes an increase in the profit-maximizing level of output.

EXERCISE 6.3

How would the profit-maximizing level of lantern production change in the example above if lanterns sell for 35 cents each, but wages fall to $6 per day?

Suppose that in the example the firm's fixed cost had been not $40 per day but $45 per day. How, if at all, would that have affected the firm's profit-maximizing

level of output? The answer is "not at all." Each entry in the profit column of Table 6.3 would have been $5 per day smaller than before, but the maximum profit entry still would have been 300 lanterns per day.

The observation that the profit-maximizing quantity does not depend on fixed costs is not an idiosyncrasy of this example. That it holds true in general is an immediate consequence of the Cost–Benefit Principle, which says that a firm should increase its output if, and only if, the *marginal* benefit exceeds the *marginal* cost. Neither the marginal benefit of expanding (which is the marginal revenue or market price of lanterns) nor the marginal cost of expanding is affected by a change in the firm's fixed cost.

When the law of diminishing returns applies (that is, when some factors of production are fixed), marginal cost goes up as the firm expands production beyond some point. Under these circumstances, the firm's best option is to keep expanding output as long as marginal cost is less than price.

Note that, if the lantern company's fixed cost had been any more than $57 per day, it would have made a loss at *every* possible level of output. As long as it still had to pay its fixed cost, however, its best bet would have been to continue producing 300 lanterns per day. It is better, after all, to experience a smaller loss than a larger one. If a firm in that situation expected conditions to remain the same, though, it would want to get out of the lantern business as soon as its equipment lease expired.

Cost–Benefit ○

6.2.3 THE FIRM'S SHUTDOWN CONDITION

It might seem that a firm that can sell as much output as it wishes at a constant market price would *always* do best in the short run by producing and selling the output level for which price equals marginal cost. But there are exceptions to this rule. Suppose, for example, that the market price of the firm's product falls so low that its revenue from sales is smaller than its variable cost at all possible levels of output. The firm should then cease production for the time being. By shutting down, it will suffer a loss equal to its fixed costs. But by remaining open, it would suffer an even larger loss.

More formally, if P denotes the market price of the product and Q denotes the number of units produced and sold, then $P \times Q$ is the firm's total revenue from sales, and if we use VC to denote the firm's variable cost, the rule is that the firm should shut down in the short run if $P \times Q$ is less than VC for every level of Q:

$$\text{Short-run Shutdown Condition:} \quad P \times Q \times VC \quad \text{for all levels of } Q. \quad (6.2)$$

EXERCISE 6.4

Using the Fanoos Ramadan company example, suppose lanterns sold not for $0.35 but only $0.10. Calculate the profit corresponding to each level of output, as in Table 6.5, and verify that the firm's best option is to cease operations in the short run.

6.2.4 AVERAGE VARIABLE COST AND AVERAGE
TOTAL COST

average variable cost (AVC) variable cost divided by total output

Suppose that the firm is unable to cover its variable cost at any level of output—that is, suppose that $P \times Q < VC$ for all levels of Q. It must, then, also be true that $P < VC/Q$ for all levels of Q, since we obtain the second inequality by simply dividing both sides of the first one by Q. VC/Q is the firm's **average variable cost**—its variable cost divided by its output. The firm's short-run shutdown condition may

thus be restated a second way: Discontinue operations in the short run if the product price is less than the minimum value of its average variable cost (*AVC*). Thus

> **Short-run Shutdown Condition (alternate version):**
> $P <$ minimum value of AVC.   (6.3)

As we'll see in the next section, this version of the shutdown condition often enables us to tell at a glance whether the firm should continue operations.

A related cost concept that facilitates assessment of the firm's profitability is **average total cost (*ATC*)**, which is total cost (*TC*) divided by output (*Q*): $ATC = TC/Q$. The firm's profit, again, is the difference between its total revenue ($P \times Q$) and its total cost. And since total cost is equal to average total cost times quantity, the firm's profit is also equal to $(P \times Q) - (ATC \times Q)$. A firm is said to be **profitable** if its revenue ($P \times Q$) exceeds its total cost ($ATC \times Q$). A firm can thus be profitable only if the price of its product price (*P*) exceeds its *ATC* for some level of output.

Keeping track of all these cost concepts may seem tedious. In the next section, however, we will see that the payoff from doing so is that they enable us to recast the profit-maximization decision in a simple graphical framework.

average total cost (ATC) total cost divided by total output

profitable firm a firm whose total revenue exceeds its total cost

6.2.5 A GRAPHICAL APPROACH TO PROFIT MAXIMIZATION

For the lantern-making firm we have been discussing, average variable cost and average total cost values are shown in columns 4 and 6 of Table 6.6. Using the entries in this table, we plot the firm's average total cost, average variable cost, and marginal cost curves in Figure 6.5. (Because marginal cost corresponds to the change in total cost as we move between two output levels, each marginal cost value in Table 6.6 is plotted at an output level midway between those in the adjacent rows.)

TABLE 6.6
Average Variable Cost and Average Total Cost of Fanoos Ramadan Lantern Production

Employees per day	Lanterns per day	Variable cost ($/day)	Average variable cost ($/unit of output)	Total cost ($/day)	Average total cost ($/unit of output)	Marginal cost ($/lantern)
0	0	0		40		
						0.15
1	80	12	0.15	52	0.65	
						0.10
2	200	24	0.12	64	0.32	
						0.20
3	260	36	0.138	76	0.292	
						0.30
4	300	48	0.16	88	0.293	
						0.40
5	330	60	0.182	100	0.303	
						0.60
6	350	72	0.206	112	0.32	
						1.00
7	362	84	0.232	124	0.343	

We call your attention to several features of the cost curves in Figure 6.5. Note, for example, that the upward-sloping portion of the marginal cost curve (*MC*) corresponds to the region of diminishing returns discussed earlier. Thus, as

FIGURE 6.5

The Marginal, Average Variable, and Average Total Cost Curves for a Lantern Manufacturer.
The *MC* curve cuts both the *AVC* and *ATC* curves at their minimum points. The upward-sloping portions of the marginal cost and average variable cost curves correspond to the region of diminishing returns.
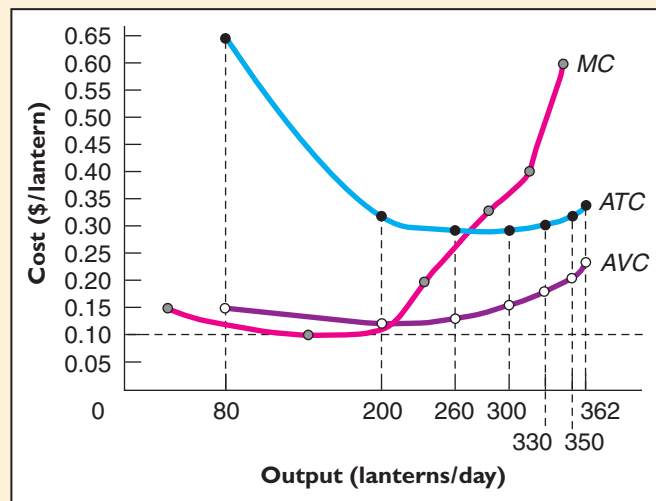
the firm moves beyond two employees per day (200 lanterns per day), the increments to total output become smaller with each additional employee, which means that the cost of producing additional lanterns (*MC*) must be increasing in this region.

Note also that the definition of marginal cost implies that the marginal cost curve must intersect both the average variable cost curve (*AVC*) and the average total cost curve (*ATC*) at their respective minimum points. To see why, consider the logic that explains what happens to the average weight of children in a third-grade class when a new student joins the class. If the new (marginal) student is lighter than the previous average weight for the class, average weight will fall, but if the new student is heavier than the previous average, average weight will rise. By the same token, when marginal cost is below average total cost or average variable cost, the corresponding average cost must be falling, and vice versa. And this ensures that the marginal cost curve must pass through the minimum points of both average cost curves.

It is important to note that, unlike *MC* and *AVC*, the shape of the *ATC* does not correspond to the law of diminishing returns. The *ATC* curve is generally U-shaped because fixed costs dominate at low levels of output. As production increases, average fixed cost (*AFC*) decreases and *AVC* increases (due to diminishing returns), eventually causing *ATC* to rise.

Seeing the lantern maker's *AVC* curve displayed graphically makes the question posed in Exercise 6.4 much easier to answer. The question, recall, was whether the firm should shut down in the short run if the price per lantern was only $0.10. A glance at Figure 6.5 reveals that the firm should indeed shut down because this

RECAP	**PROFIT MAXIMIZATION AND SHUTDOWN CONDITION**

Firms determine their profit-maximizing level of output by producing until the revenue generated by the last unit is equal to the cost of producing that unit. Firms will shut down if their revenues from sales are smaller than their variable cost at all possible levels of output.

price lies below the minimum value of its *AVC* curve, making it impossible for the firm to cover its variable costs at any output level.

6.3 PRODUCTION AND COSTS IN THE LONG RUN

We described earlier the long run as a time period of sufficient length that all the firm's factors of production are variable. This means for the lantern maker that it is possible, over time, to vary not only the number of employees but also the capacity of the lantern-making machine or the number of lantern-making machines. Hence, all production costs are variable in the long run.

Figure 6.6 shows that the *ATC* curve is U-shaped in the long run. The rationale behind this shape is that the lantern producer can avert diminishing returns simply by adding another lantern-making machine and expanding its scale of operations. For instance, the third and fourth employees can be assigned to another lantern-making machine rather than work on the first machine and generate increasing returns for the firm. In other words, increasing returns can be extended over time by getting more output out of every additional employee, thus resulting in a decreasing average total cost. This is represented by the decreasing portion of the long-run *ATC*, which economists describe as **economies of scale**. However, as a firm expands its scale of operations, it eventually experiences increasing *ATC*, which economists describe as **diseconomies of scale**. This is represented by the rising portion of the long-run *ATC* in Figure 6.6. The area separating the decreasing and the rising portion of the long-run *ATC* is described as **constant returns to scale**. Along this portion, *ATC* remains constant as the firm expands its scale of operation.

Examples of potential sources of economies of scale include *division of labor and specialization*, *increased capital efficiency*, and *mass production*. Division of labor can result in greater efficiency by making workers specialize on single subtasks rather than being jack-of-all-trades. This practice has been widely adopted in various industries. For example, more sandwiches can be made within a particular timeframe if the making of a sandwich can be broken down into subtasks allocated to separate individuals. Employee 1 could take the bread out of the oven, cut it open, and place the customer's choice of meat and cheese. Employee 2 would then add toppings and sauces and pass the sandwich on to employee 3, who wraps it up and places it in a bag. Employee 4 could offer to sell to the customer additional snacks and receive payment.

Increased capital efficiency arises from technological progress. When firms choose to expand their scale of operations by increasing their capital input, they

economies of scale a production process is said to have economies of scale if, when all inputs are changed by a given proportion, output changes by more than that proportion; also called increasing returns to scale

diseconomies of scale a production process is said to have diseconomies of scale if, when all inputs are changed by a given proportion, output changes by less than that proportion

constant returns to scale a production process is said to have constant returns to scale if, when all inputs are changed by a given proportion, output changes by the same proportion
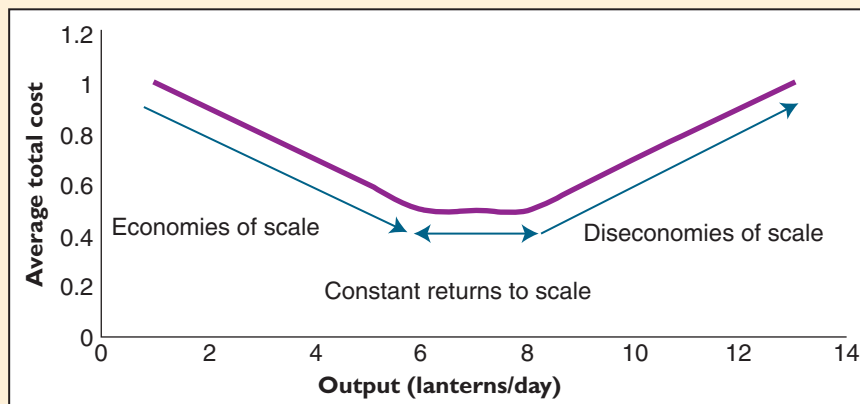

FIGURE 6.6
Average Total Cost in the Long Run.
The long-run average total cost curve is U-shaped.

may do so by acquiring better technology, which would result in higher productivity of their labor input. Using the new technology, one employee may be able to produce more than 80 lanterns and two employees may be able to produce more than 200 lanterns, thus resulting in a lower *ATC*.

Firms may experience decreasing *ATC* when undertaking large-scale production. A common example of mass production goes back to 1905, when Henry Ford introduced the N-model car, which was produced inexpensively thanks to increased capital intensity and division of labor. Henry Ford used the assembly line to increase the productivity of workers and to realize a high production rate, a necessary condition for maintaining low production costs. Such a process, however, required substantial capital commitment, which could only be achieved by relatively large firms.

Diseconomies of scale can result from the complexities that arise from an overly-expanded firm. A larger firm tends to add layers of management to its structure, thus lengthening the corporate hierarchy and hindering communication and coordination. Such a phenomenon increases (unproductive) costs and results in increasing *ATC*.

RECAP	PRODUCTION AND COSTS IN THE LONG RUN

As a firm expands its scale of operations, it may experience economies of scale resulting from division of labor and specialization, increased capital efficiency, and mass production. An overly-expanded firm may eventually experience diseconomies of scale arising from a breakdown in communication, coordination, and management.

▪ S U M M A R Y ▪

- Accounting profit is the difference between a firm's revenue and its explicit expenses. It differs from economic profit, which is the difference between revenue and the sum of the firm's explicit and implicit costs. Normal profit is the difference between accounting profit and economic profit. It is the opportunity cost of the resources supplied to a business by its owners. **LO1**

- The law of diminishing returns describes the fact that, when some factors of production are fixed in the short run, increases in variable factors will eventually result in smaller and smaller increases in output. **LO2**

- The law of diminishing returns explains the shape of the total product curve, the marginal product curve, the total cost curve, the total variable cost curve, the marginal cost curve, and the average variable cost curve. **LO2, LO3**

- A profit-maximizing firm will sell a quantity of output in the short run for which marginal revenue equals marginal cost, provided price exceeds the minimum value of average variable cost. **LO4, LO5**

- Firms face a U-shaped average total cost curve in the long run. **LO6**

▪ K E Y   T E R M S ▪

accounting profit (194)
average total cost (*ATC*) (205)

average variable cost (*AVC*) (204)
constant returns to scale (207)

diseconomies of scale (207)
economic loss (196)

economic profit (194)
economies of scale (207)
explicit costs (194)
factor of production (197)
fixed cost (199)
fixed factor of production (198)
implicit costs (194)

law of diminishing returns (198)
long run (197)
marginal cost (199)
marginal product of labor (*MP*)
  (197)
marginal revenue (202)
normal profit (195)

profit (200)
profitable firm (205)
short run (197)
sunk cost (199)
total cost (199)
variable cost (199)
variable factor of production (198)

▪ R E V I E W   Q U E S T I O N S ▪

1. How can a business-owner who earns $10 million per year from his business credibly claim to earn zero economic profit?   **LO1**

2. Which do you think is more likely to be a fixed factor of production for an ice cream producer during the next two months: its factory building or its workers who operate the machines? Explain.   **LO2**

3. Economists often stress that congestion helps account for the law of diminishing returns. With this in mind, explain why it would be impossible to feed all the people on Earth with food grown in a single flowerpot, even if unlimited water, labor, seed, fertilizer, sunlight, and other inputs were available.   **LO2**

4. Describe the shape of the total product, marginal product, marginal cost, total cost, total variable cost, and average variable cost curves if a firm only experiences diminishing returns in the short run. **LO2, LO3**

5. What should a firm do if it realizes that, at its current level of production, its marginal revenue is less than its marginal cost?   **LO4**

6. Suppose that bank analysts have come to know that the merger between National Bank of Dubai and Emirates Bank has resulted in a higher average total cost than prior to the merger. What has likely happened and what solution can be suggested?   **LO6**

▪ P R O B L E M S ▪

1. Jawad owns and manages a café in Collegetown whose annual revenue is $5,000. Annual expenses are as follows: **LO1**

Labor	$2,000
Food and drink	500
Electricity	100
Vehicle lease	150
Rent	500
Interest on loan for equipment	1,000

a. Calculate Jawad's annual accounting profit.
b. Jawad could earn $1,000 per year as a recycler of aluminum cans. However, he prefers to run the café. In fact, he would be willing to pay up to $275 per year to run the café rather than to recycle. Is the café making an economic profit? Should Jawad stay in the café business? Explain.
c. Suppose the café's revenues and expenses remain the same, but recyclers' earnings rise to $1,100 per year. Is the café still making an economic profit? Explain.

2. The Racqueteer Company makes tennis racquets out of graphite supplied to it by Acme Sporting Goods, which pays Racqueteer $10 for each finished racquet. Racqueteer's only factors of production are lathe operators and a small building with a lathe. The number of racquets per day it produces

depends on the number of employee-hours per day, as shown in the table below. **LO3, LO4**

Number of racquets per day	Number of employee-hours per day
0	0
5	1
10	2
15	4
20	7
25	11
30	16
35	22

a. If the wage is $15 per hour and Racqueteer's daily fixed cost for the lathe and building is $60, what is the profit-maximizing quantity of racquets?
b. What would be the profit-maximizing number of racquets if the firm's fixed cost were not $60 per day but only $30?

3. In the preceding question, how would Racqueteer's profit-maximizing level of output be affected if the government imposed a tax of $10 per day on the company? (*Hint*: Think of this tax as equivalent to a $10 increase in fixed cost.) What would Racqueteer's profit-maximizing level of output be if the government imposed a tax of $2 per racquet? (*Hint*: Think of this tax as a $2-per-racquet increase in the firm's marginal cost.) Why do these two taxes have such different effects? **LO3, LO4**

4. Complete the table below based on the relationships among the various cost functions. **LO3**

Output	TC	TFC	TVC	ATC	AFC	AVC	MC
0	$200						
1							$40
2			$70				
3	$305						
4				$90			
5						$46	

5. Based on the information provided in the table below, which of the three firms experiences economies of scale, constant returns to scale, and diseconomies of scale? **LO6**

Output	TC of Firm 1	TC of Firm 2	TC of Firm 3
1	$100	$25	$50
2	$110	$60	$100
3	$120	$100	$150
4	$130	$160	$200
5	$140	$220	$250
6	$150	$280	$300

· ANSWERS TO IN-CHAPTER EXERCISES ·

6.1 As shown in the table below, Kamal's accounting profit is now $10,000, the difference between his $20,000 annual revenue and his $10,000-per-year payment for land, equipment, and supplies. His economic profit is that amount minus the opportunity cost of his labor—again, the $11,000 per year he could have earned as a store manager. So Kamal is now earning a negative economic profit, –$1,000 per year. As before, his normal profit is the $11,000-per-year opportunity cost of his labor. Although an accountant would say Kamal is making an annual profit of $10,000, that amount is less than a normal profit for his activity. An economist would therefore say that he is making an economic loss of $1,000 per year. Since Kamal likes the two jobs equally well, he will be better off by $1,000 per year if he leaves farming to become a manager.   **LOI**

Total revenue ($/year)	Explicit costs ($/year)	Implicit costs ($/year)	Accounting profit (= total revenue − explicit costs) ($/year)	Economic profit (= total revenue − explicit costs − implicit costs) ($/year)	Normal profit (= implicit costs) ($/year)
20,000	10,000	11,000	10,000	−1,000	11,000

6.2 If lanterns sell for 62 cents each, the firm should continue to expand up to and including the sixth employee (350 lanterns per day).   **L04**

6.3 The relevant costs are now as shown in the following table. With each variable and marginal cost entry half what it was in the original example, the firm should now hire six employees and produce 350 lanterns per day.   **L03, L04**

Employees per day	Lanterns per day	Fixed cost ($/day)	Variable cost ($/day)	Total cost ($/day)	Marginal cost ($/lantern)
0	0	40	0	40	
					0.075
1	80	40	6	46	
					0.05
2	200	40	12	52	
					0.10
3	260	40	18	58	
					0.167
4	300	40	24	64	
					0.20
5	330	40	30	70	
					0.30
6	350	40	36	76	
					0.50
7	362	40	42	82	

6.4 Because the firm makes its smallest loss when it hires zero employees (see table below), it should shut down in the short run.   **L05**

Employees per day	Output (lanterns/day)	Total revenue ($/day)	Total cost ($/day)	Profit ($/day)
0	0	0	40	−40
1	80	8	52	−44
2	200	20	64	−44
3	260	26	76	−50
4	300	30	88	−58
5	330	33	100	−67
6	350	35	112	−77
7	362	36.20	124	−87.80