Costs of Production

Objectives

After studying this section you will be able to:

1. **Explain** how firms decide how much labor to hire to produce a certain level of output.
2. **Analyze** the production costs of a firm.
3. **Understand** how a firm chooses to set output.
4. **Explain** how a firm decides to shut down an unprofitable business.

Section Focus

Entrepreneurs consider marginal benefits and costs when deciding how much output to produce. Ordinarily, firms earn their highest profits when the cost of making one more unit is the same as the market price of the good.

Key Terms

marginal product of labor
increasing marginal returns
diminishing marginal returns
fixed cost
variable cost
total cost
marginal cost
marginal revenue
operating cost

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marginal product of labor *the change in output from hiring one additional unit of labor*

In Section 1, we identified how producers respond to a change in price. The law of supply states that producers will offer more goods as the price goes up and fewer as the price falls. In this section, we will explain how a supplier decides *how much* to produce.

Consider a firm that produces beanbags. The firm's factory has one sewing machine and one pair of scissors. The firm's inputs are workers and materials, including cloth, thread, and beans. Assume that each beanbag requires the same amount of materials. As the number of workers increases, what happens to the quantity of beanbags produced?

The supply of beanbag chairs in the market depends on several factors, including the cost of labor and capital. ▼

Labor and Output

One of the basic questions any business owner has to answer is how many workers to hire. To answer this question, owners have to consider how the number of workers they hire will affect their total production. For example, at the beanbag factory, one worker can produce four beanbags per hour. Two workers can make a total of ten bags per hour, and three can make a total of seventeen beanbags an hour. As new workers join the company, total output increases. After the seventh worker is hired, production peaks at 32 beanbags per hour. When the firm hires the eighth worker, however, total output drops to 31 bags per hour.

Figure 5.6 shows the relationship between labor, measured by the number of workers in the factory, and the number of beanbags produced.

Marginal Product of Labor

The third column of Figure 5.6 shows the **marginal product of labor**, or the change in output from hiring one more worker. This is called the marginal product because it measures the change in output at the margin, where the last worker has been hired or fired.

The first worker to be hired produces four bags an hour, so her marginal product is four bags. The second worker raises total output from four bags an hour to ten, so her marginal product of labor is six. Looking at this column, we see that the marginal product of labor increases for the first three workers, rising from four to seven.

Increasing Marginal Returns

The marginal product of labor increases for the first three workers because there are three tasks involved in making a beanbag. Workers cut and sew cloth into the correct shape, stuff it with beans, and sew the bag closed. In our example, a single worker performing all these tasks would only produce four bags per hour. Adding a second worker would allow each worker to specialize in one or two tasks. If each worker focuses on only one part of the process, she will waste less time switching between tasks and will become more skillful at her assigned tasks. In other words, specialization increases output per worker, so the second worker adds more to output than the first. The firm enjoys **increasing marginal returns**.

In our example, there are benefits from specialization for the first three workers. The firm enjoys a rising marginal product of labor for the first three workers.

Diminishing Marginal Returns

When the fourth through the seventh workers are hired, the marginal product of labor is still positive. Each new worker still adds to total output. However, the marginal product of labor shrinks as each worker joins the company. The fourth worker increases output by six bags, while the seventh increases output by only one bag. Why?

After the beanbag firm hires its first three workers, one for each task, the benefits of specialization end. At that point, adding more workers increases total output, but at a decreasing rate. This situation is known as **diminishing marginal returns**. A firm with diminishing marginal returns of labor will

produce less and less output from each additional unit of labor added to the mix.

The firm suffers from diminishing marginal returns from labor because its workers must work with a limited amount of capital. Remember that capital is any human-made resource that is used to produce other goods. In this example, capital is represented by the factory's single sewing machine and pair of scissors. When there are three workers, but only one needs to use the sewing machine, this worker will never have to wait to get to
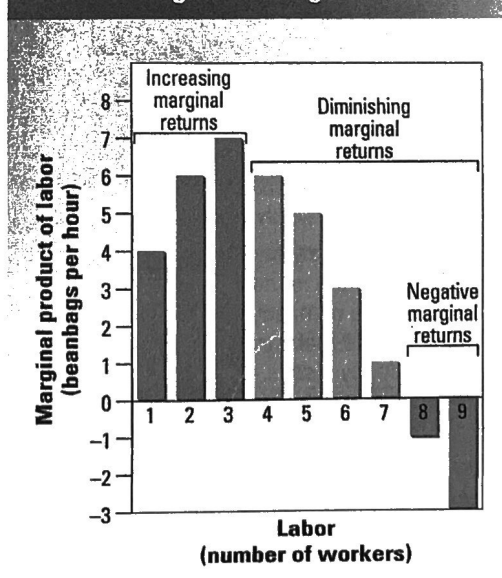
Figure 5.6 Marginal Product of Labor

Labor (number of workers)	Output (beanbags per hour)	Marginal product of labor
0	0	—
1	4	4
2	10	6
3	17	7
4	23	6
5	28	5
6	31	3
7	32	1
8	31	-1

increasing marginal returns *a level of production in which the marginal product of labor increases as the number of workers increases*

diminishing marginal returns *a level of production in which the marginal product of labor decreases as the number of workers increases*

Figure 5.7 Increasing, Diminishing, and Negative Marginal Returns

work. When there are more than three workers, the factory will assign more than one to work at the sewing machine. While one is working, the other will have to wait. She may be able to help cut fabric or stuff bags in the meantime, but every bag must be sewn up at some point, so she cannot greatly increase the speed of the production process.

The problem gets worse as more workers are hired and the amount of capital remains constant. Wasted time waiting for the sewing machine or scissors means that additional workers will add less and less to tota output at the factory.
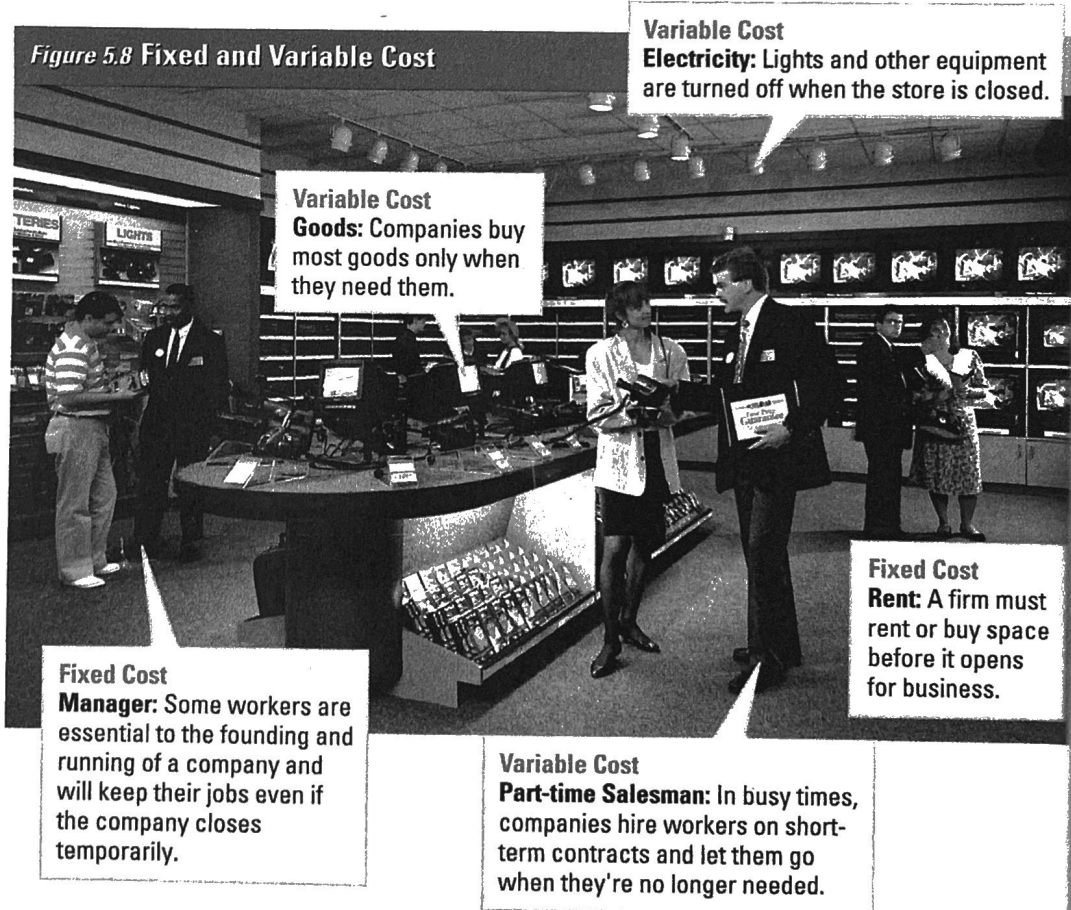
Negative Marginal Returns

As the table in Figure 5.6 shows, adding the eighth worker at the beanbag factory can actually decrease output by one bag. At this stage, workers get in each other's way and disrupt the production process, so overall output decreases. Of course, few companies ever hire so many workers that their marginal product of labor becomes negative.

Production Costs

Paying workers and purchasing capital are all costs of producing goods. Economists

Figure 5.8 **Fixed and Variable Cost**

Variable Cost
Electricity: Lights and other equipment are turned off when the store is closed.

Variable Cost
Goods: Companies buy most goods only when they need them.

Fixed Cost
Rent: A firm must rent or buy space before it opens for business.

Fixed Cost
Manager: Some workers are essential to the founding and running of a company and will keep their jobs even if the company closes temporarily.

Variable Cost
Part-time Salesman: In busy times, companies hire workers on short-term contracts and let them go when they're no longer needed.

BUILDING KEY CONCEPTS

Firms must separate fixed costs from variable costs to determine whether or not to produce at a given market price.
Entrepreneurs Why are some employees considered variable costs?

Figure 5.9 Production Costs

Beanbags (per hour)	Fixed cost	Variable cost	Total cost (fixed cost + variable cost)	Marginal cost	Marginal revenue (market price)	Total revenue	Profit (total revenue − total cost)
0	$36	$0	$36	—	$24	$0	$–36
1	36	8	44	$8	24	24	–20
2	36	12	48	4	24	48	0
3	36	15	51	3	24	72	21
4	36	20	56	5	24	96	40
5	36	27	63	7	24	120	57
6	36	36	72	9	24	144	72
7	36	48	84	12	24	168	84
8	36	63	99	15	24	192	93
9	36	82	118	19	24	216	98
10	36	106	142	24	24	240	98
11	36	136	172	30	24	264	92
12	36	173	209	37	24	288	79

divide a producer's costs into two categories: fixed costs and variable costs.

Fixed Costs

A **fixed cost** is a cost that does not change, no matter how much of a good is produced. Most fixed costs involve the production facility, the cost of building and equipping a factory, office, store, or restaurant. Examples of fixed costs include rent, machinery repairs, property taxes on a factory, and the salaries of workers who keep the business running even when production temporarily stops.

Variable Costs

Variable costs are costs that rise or fall depending on the quantity produced. They include the costs of raw materials and some labor. For example, to produce more beanbags, the firm must purchase more beans and hire more workers to stuff the beanbags. If the company wants to produce less and cut costs, it can stop buying beans or have some workers work fewer hours a week. The cost of labor is a variable cost because it changes with the number of workers, which changes with the quantity produced. Electricity and heating bills are also variable costs, because the company can cut off heat and

electricity for the factory and its machines when they are not in use.

Total Cost

Figure 5.9 shows some cost data for the firm that produces beanbags. The firm has a factory that is fully equipped to produce beanbags. How does the cost of producing beanbags change as the output increases?

In our example, the fixed costs are the costs of the factory building and all the machinery and equipment inside. As shown in the second column in Figure 5.9, the fixed costs are $36.00 per hour.

Variable costs include the cost of beans, fabric, and most of the workers hired to produce the beanbags. As shown in the third column, variable costs rise with the number of beanbags produced. Fixed costs and variable costs are added together to find **total cost**. Total cost is shown in the fourth column.

Marginal Cost

If we know the total cost at several levels of output, we can determine the **marginal cost** of production at each level. Marginal cost is the additional cost of producing one more unit.

As shown in Figure 5.9, even if the firm is not producing a single beanbag, it still

fixed cost *a cost that does not change, no matter how much of a good is produced*

variable cost *a cost that rises or falls depending on how much is produced*

total cost *fixed costs plus variable costs*

marginal cost *the cost of producing one more unit of a good*

marginal cost of the first beanbag is $8.00.

For the first three beanbags, the marginal cost falls as output increases. The marginal cost of the second beanbag is $4.00, and the marginal cost of the third beanbag is $3.00. Each additional beanbag is cheaper to make because of increasing marginal returns resulting from specialization.

With the fourth beanbag, the marginal cost starts to rise. The marginal cost of the fifth per hour is $7.00, the sixth costs $9.00, and the seventh costs $12.00. The rising marginal cost reflects diminishing returns to labor. The benefits of specialization are exhausted when the firm reaches three beanbags, and diminishing returns set in as more and more workers share a fixed production facility.

Setting Output

Behind all of the decisions about how many workers to hire is the firm's basic goal: to maximize profits. Profit is defined as total revenue minus total cost. As you

of each good multiplied by the numb goods sold. Figure 5.9 shows total rev when the price of a beanbag is $24.0 find the level of output with the hig profit, we look for the biggest gap bet total revenue and total cost. The g biggest and profit is highest when the makes 9 or 10 beanbags per hour. At rate, the firm can expect to make a prof $98.00 an hour.

Marginal Revenue and Marginal Cos

Another way to find the best level of ou is to find the output level where marg **revenue** is equal to marginal cost. Marg revenue is the additional income f selling one more unit of a good. If the T has no control over the market pr marginal revenue equals the market p Each beanbag sold at $24.00 increases firm's total revenue by $24.00, so marg revenue is $24.00. According to the ta price equals marginal cost with beanbags, so that's the quantity that ma mizes profit at $98 an hour.

To understand how an output of beanbags maximizes the firm's prof suppose that the firm picked a differ level of output. If the firm made only beanbags per hour, is it making as m money as it can?

From Figure 5.9, we know that marginal cost of the fifth beanbag is $7.0 The market price for a beanbag is $24.0 so the marginal revenue from that beanb is $24.00. The $17.00 difference betwe the marginal revenue and marginal c represents pure profit for the compan from making and selling the fifth beanba The company should increase its produ tion to five beanbags an hour to captur that profit on the fifth beanbag.

If we do the same calculations for a six beanbag, we find that the company ca capture a profit of $15.00 by producin the sixth beanbag per hour. The price the seventh beanbag is $12.00 higher tha its marginal cost, so that beanbag earns a

Figure 5.10 Marginal Cost Curve

Marginal cost (in dollars) vs *Output (beanbags per hour)* — Marginal cost
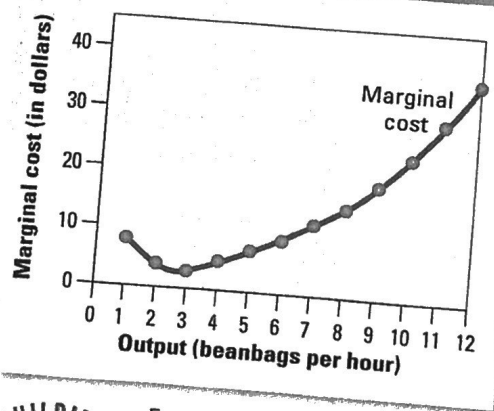
For most firms, the marginal cost of production falls as output rises from zero, but eventually begins to rise.

Markets and Prices How many beanbags an hour should this firm make to produce at the lowest possible marginal cost?

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additional $12.00 in profit for the company. The profit is available any time the company receives more for the last beanbag than it cost to produce. Any rational entrepreneur would take this opportunity to increase profit.

Now suppose that the firm is producing so many beanbags an hour that marginal cost is *higher* than price. If the firm produces eleven beanbags an hour, it receives $24.00 for that eleventh beanbag, but the $30.00 cost of that beanbag wipes out the profit. The firm actually loses $6.00 on the sale of the eleventh beanbag. Because marginal cost is increasing, and price is constant in this example, the losses would get worse at higher levels of output. The company would be better off producing less and keeping costs down.

The ideal level of output is where marginal revenue (price) is equal to marginal cost. Any other quantity of output would generate less profit.

Responding to Price Changes

What would happen if the price of a beanbag suddenly rose from $24.00 to $37.00? Thinking at the margin, we would predict that the firm would increase production to twelve beanbags per hour. That's the quantity at which the marginal cost is equal to the new, higher price. At the original price of $24.00, the firm would not produce more than ten beanbags, according to the graph in Figure 5.11. When the price rises to $37.00, marginal revenue soars above marginal cost at that level of output. Raising production to twelve beanbags an hour would allow the firm to capture profits on the eleventh and twelfth beanbags.

This example shows the law of supply in action. An increase in price from $24.00 to $37.00 causes the firm to increase the quantity supplied from ten to twelve beanbags an hour.

The Shutdown Decision

Consider the problems faced by a factory that is losing money. The factory is

Figure 5.11 Output and a Change in Price
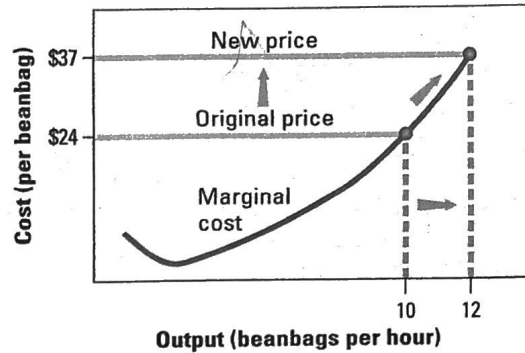
The most profitable level of output is where price (or marginal revenue) is equal to marginal cost.
Markets and Prices What would happen to output if the market price fell to $20?

producing at a level of output at which marginal revenue is equal to marginal cost. As you have read, this is the most profitable level of output. However, the market price is so low that the factory's total revenue is still less than its total cost, and the firm is losing money. Should this factory continue to produce goods and lose money, or should its owners shut the factory down?

This may seem like a silly question. In fact, there are times when keeping a money-losing factory open is the best choice. The firm should keep the factory open if the total revenue from the goods and services the factory produces is greater than the cost of keeping it open.

For example, if the price of beanbags drops to $7, and the factory produces at the profit-maximizing level of five beanbags per hour, the total revenue of the business is $35 per hour. Weigh this against the factory's **operating cost,** or the cost of operating the facility. The operating cost includes the variable costs the owners must pay to keep the factory running, but not the fixed costs, which the owners must pay whether the factory is open or closed.

According to Figure 5.9, if the factory produces five beanbags, the variable cost is $27 per hour. Therefore, the benefit of operating the facility (total revenue of $35)

operating cost *the cost of operating a facility, such as a store or factory*

▲ When a factory begins losing money, the owner must consider its operating cost and revenue when deciding what to do.

sale. Therefore, the firm would lose an amount of money equal to its fixed costs.

For this beanbag factory, the fixed costs equal $36 per hour, so the factory would lose $36 for each hour it is closed. If the factory were to keep producing five beanbags per hour, its total cost would be $63 ($36 in fixed costs plus $27 in variable costs) per hour, but it would lose only $28 ($63 in total cost minus $35 in revenue) for each hour it is open. The factory would lose less money while producing because the total revenue ($35) would exceed the variable costs ($27), leaving $8 to cover some of the fixed costs. Although the factory would lose money in either situation, it would lose less money by continuing to produce and sell beanbags.

How long will a business continue to operate a factory at a loss before it decides to replace the facility? The firm will build a new factory and stay in the market only if the market price of beanbags is high enough to cover all the costs of production, including the cost of building a new factory.

is greater than the variable cost ($27), so it makes sense to keep the facility running.

Consider the effects of the other choice. If the firm were to shut down the factory, it would still have to pay all of its fixed costs. The factory's total revenue would be zero because it would be producing nothing for

Section 2 Assessment

Key Terms and Main Ideas

1. How does the **marginal product of labor** change as more workers are hired?

2. What is the impact of **diminishing marginal returns** on labor?

3. Give an example of a **fixed cost** and a **variable cost** of a bakery.

4. How does a firm calculate **marginal cost**?

Applying Economic Concepts

5. *Critical Thinking* A firm has two factories, one twice as large as the second. As the number of workers at each factory increases, which factory will experience diminishing returns first?

6. *Decision Making* Explain whether each of these expenses of a textile mill is a fixed cost or a variable cost, and why. **(a)** repairs to a leaking roof **(b)** cotton **(c)** food for the mill's cafeteria **(d)** night security guard **(e)** electricity

7. *Math Practice* Use the table below to answer the following questions. **(a)** What is the total cost when output is 2? **(b)** What is the marginal cost of the third unit? **(c)** How much should this firm produce if the market price is $24?

Output	Fixed Cost	Variable Cost
1	$5	$10
2	$5	$27
3	$5	$55
4	$5	$91
5	$5	$145

Take It to the NET

Firms must consider their fixed and variable costs when they set their budgets and supply. Create your own virtual factory and determine three fixed and variable costs. Use the links provided in the Social Studies area at the following Web site for help in completing this activity. **www.phschool.com**