Finally, observe that the marginal cost curve in the generic picture of Figure 8-5 has a region of declining marginal cost at low production levels. The graph allows for the possibility that at low production levels, the marginal product of labor increases and, therefore, marginal cost declines. This was true for Melodic Movements, which had increasing marginal product of labor initially, and we allow for it in the generic case.

For the cost curves for Melodic Movements in Figure 8-4, the marginal cost curve and the average variable cost curve touch at one unit of output. This occurs because the marginal cost of producing one rather than zero units of output must equal the variable cost of producing one unit, and hence the average variable cost of producing one unit, as shown in Table 8-1. Thus, if the generic cost curve were drawn all the way over to one unit of output on the left of Figure 8-5, then the marginal cost curve and the average variable cost curve would start at the same point. Because we usually do not draw generic cost curves that go all the way over to the vertical axis, we do not show them starting at the same point.

**REVIEW**

- The marginal cost curve, the average total cost curve, and the average variable cost curve are closely related. In the region in which the marginal cost is higher than the average total (or variable) cost, average total (or variable) cost is increasing, and vice versa.
- We can apply the lessons learned in the example of Melodic Movements to derive the generic shapes of a firm’s cost curves. These curves should have the following attributes:
  - The marginal cost (MC) curve should cut through both the average total cost (ATC) curve and the average variable cost (AVC) curve at their lowest points.
  - The average fixed cost becomes very small as output increases. Therefore, the gap between average total cost and average variable cost gets smaller as more is produced.
  - The marginal cost curve typically slopes downward at very low levels of output before sloping upward. The marginal cost and the average variable cost are also identical at one unit of output.

**The Production Decision in the Short Run**

As we saw in Chapter 6, a competitive firm takes the market price as given. If it is maximizing profits, it will choose a quantity to produce in the short run such that its marginal cost equals the market price \( P = MC \). But when the firm produces this quantity, are its profits positive? Or is the firm running a loss? If it is running a loss, should it shut down in the short run? To answer these questions, we need to use the cost curves to find the firm’s profits.

**The Profit or Loss Rectangle**

The level of production for a competitive firm with the cost curves in Figure 8-5 is shown in Figure 8-6. The quantity produced is determined by the intersection of the marginal cost \( (MC) \) curve and the market price line \( (P) \). We draw a dashed vertical line to mark the quantity \( (Q) \) produced. Because profits equal total revenue minus total costs, we need to represent total revenue and total costs on the average cost diagram.
Price Equals Marginal Cost

If a firm is maximizing profits, then it chooses a quantity \( Q \) such that price equals marginal cost. Thus, the quantity is determined by the intersection of the market price line and the marginal cost curve, as shown on the diagram. In this picture, the \( ATC \) and \( AVC \) curves are a sideshow, but they enter the main act in Figure 8-7, when we look at the firm's level of profits.

The Total Revenue Area

Figure 8-6 shows a particular market price \( P \) and the corresponding level of production \( Q \) chosen by the firm. The total revenue that the firm gets is price \( P \) times quantity \( Q \). Figure 8-7 shows that this total revenue can be represented by the area of a rectangle with width \( Q \) and height \( P \). The shaded area in Figure 8-7 illustrates this rectangle. The area of this rectangle, \( P \times Q \), is total revenue.

The Total Costs Area

Total costs also can be represented in Figure 8-7. First, observe the dashed vertical line in Figure 8-7 marking the profit-maximizing quantity produced. Next, observe the point at which the average total cost curve intersects this dashed vertical line. This point tells us what the firm's average total cost is when it produces the profit-maximizing quantity. The area of the rectangle with the hash marks shows the firm's total costs. Why? Remember that average total cost is defined as total costs divided by quantity. If we take average total cost and multiply by quantity, we get total costs: \( ATC \times Q = TC \). The quantity produced \( Q \) is the width of the rectangle, and average total cost \( ATC \) is the height of the rectangle. Hence, total costs are given by the area of the rectangle with the hash marks.

Profits or Losses

Because profits are total revenue less total costs, we compute profits by looking at the difference between the two rectangles. The difference is a rectangle, shown by the part of the revenue rectangle that rises above the total costs rectangle. Profits are positive in Figure 8-7 because total revenue is greater than total costs. But profits can also be negative, as shown in Figure 8-8.

Suppose that the market price is at a point at which the intersection of the marginal cost curve and the market price line gives a quantity of production for which average total cost is above the price. This situation is shown in Figure 8-8. At this lower price, we still have the necessary condition for profit maximization. The firm will produce the quantity that equates to price and marginal cost, as shown by the intersection of the price line and the marginal cost curve.
The amount of total revenue at this price is again price times quantity \((P \times Q)\), or the shaded rectangle. Total costs are average total cost times the quantity produced, that is, \(ATC \times Q\), or the area of the rectangle with the hash marks.

**Figure 8-7**

**Showing Profits on the Cost Curve Diagram**

The price and quantity produced are the same as those in Figure 8-6. The area of the shaded rectangle is total revenue. We use the \(ATC\) curve to find total costs to compute profits. First, we mark where the \(ATC\) curve intersects the dashed vertical line showing the quantity produced. The area of the rectangle with the hash marks is total costs because the total costs \((TC)\) equal average total cost \((ATC)\) times quantity produced, \(TC = ATC \times Q\). The part of the shaded rectangle rising above the hash-marked area is profits.

**Figure 8-8**

**Showing a Loss on the Cost Curve Diagram**

In this figure, the market price is lower than in Figure 8-7. The market price line intersects the marginal cost curve at a point below the average total cost curve. Thus, the area of the total costs rectangle is larger than the area of the total revenue rectangle. Profits are less than zero, and the loss is shown in the diagram.
The difference between total revenue and total costs is profit, but in this case profits are negative, that is, at a loss. Total revenue is less than total costs, as shown by the cost rectangle’s extending above the revenue rectangle. The extent of cost overhang is the loss.

**The Breakeven Point**

If the intersection of price and marginal cost is at a quantity at which price exceeds average total cost, the firm makes profits. If, on the other hand, the intersection of price and marginal cost is at a quantity at which price is less than the average total cost, the firm loses money. Therefore, if the intersection of price and marginal cost is at a quantity at which price is equal to average total cost, the firm is breaking even, neither making nor losing money.

Breaking even is shown in the middle panel of Figure 8-9. The market price is drawn through the point at which the marginal cost curve intersects the average total cost curve, which is the minimum point on the average total cost curve. At that price, average total cost equals the price, so that the total revenue rectangle and the total cost rectangle are exactly the same. Thus, the difference between their areas is zero. At \( P = \text{minimum } ATC \), the firm is at a breakeven point and economic profits are zero. The firm earns positive profits if the price is greater than the breakeven point (\( P > \text{minimum } ATC \)), as shown in the left panel. The firm has negative profits (a loss) if the price is lower than the breakeven point (\( P < \text{minimum } ATC \)), as shown in the right panel of Figure 8-9.

**Figure 8-9**

When profits are zero, we are at the breakeven point, as shown in the middle panel. In this case, the market price line intersects the marginal cost curve exactly where it crosses the average total cost curve. The left panel shows a higher market price, and profits are greater than zero. The right panel shows a lower market price, and profits are less than zero—there is a loss. The cost curves are exactly the same in each diagram.
The Shutdown Point

The situation illustrated in the right panel of Figure 8-9 is not uncommon; every day we hear of businesses losing money. But many of these money-losing firms continue to stay in business. In 1993, Adidas, the running shoe company, lost $100 million. In 2001, Amazon.com lost more than $1 billion, but the money-losing firm did not shut down in either case. Why does a firm with negative profits stay in business? At what point does it decide to shut down? Let’s examine this more carefully.

The key concept is that, in the short run, the fixed costs have to be paid even if the firm is shut down. So the firm should keep operating if it can minimize its losses by doing so, in other words, if the losses from shutting down exceed the losses from continuing to operate. Using our example of the piano-moving firm, Melodic Movements should keep producing as long as its revenue from moving pianos exceeds the cost of paying its workers to move the pianos, even if its revenue is insufficient to cover total costs, which include paying for the trucks and terminals in addition to paying the workers. If the firm shuts down, it will end up losing more because it will lose the entire fixed costs, whereas if it keeps operating, it will earn enough to cover at least part of the fixed costs. Conversely, if the price of moving pianos is so low that the revenue from moving the pianos is less than the workers are paid to move the pianos, it is best to shut down production and not move any pianos. The firm will lose the fixed costs for the trucks and the garage, but at least it will not lose any additional money.

We can make this analysis more formal by presenting it in terms of the cost curves shown in Figure 8-10. If the price is above minimum average variable cost \( (P > \text{minimum } AVC) \),

![Figure 8-10](image-url)
You can use some algebra to check the result that a firm should stop producing when the price is less than average variable cost:

\[ P < AVC. \]

Note that

\[ \text{Profits} = \text{total revenue} - \text{total costs} \]

Because total costs equal variable costs plus fixed costs, we can replace total costs to get

\[ \text{Profits} = P \times Q - (VC + FC) \]

Now, since

\[ VC = AVC \times Q, \]

we have

\[ \text{Profits} = P \times Q - AVC \times Q - FC \]

Rearranging this gives

\[ \text{Profits} = (P - AVC) \times Q - FC \]

If \( P < AVC \), the first term in this expression is negative unless \( Q = 0 \). Thus, if \( P < AVC \), the best your firm can do is set \( Q = 0 \). This eliminates the negative drain on profits in the first term in the last expression. You minimize your loss by setting \( Q = 0 \).

**Shutdown point**

the point at which price equals the minimum of average variable cost.

as shown in the left panel of Figure 8-10, the firm should not shut down, even if the price is below average total cost and profits are negative. Because total revenue is greater than variable costs, shutting down would eliminate this extra revenue. By continuing operations, the firm can minimize its losses, so it is better to keep producing in the short run. For example, Adidas did not shut down in 1993 because it had to pay fixed costs in the short run; with the price of running shoes greater than the average variable cost of producing them, the losses were less than if it had shut down.

The firm should shut down if the price falls below minimum average variable cost (\( P < \text{minimum } AVC \)) and is not expected to rise again, as shown in the right panel of Figure 8-10. Because total revenue is less than variable costs, shutting down would eliminate the extra costs. By shutting down, the firm will have to pay its fixed costs in the short run but will not have the burden of additional losses. Economists have developed the concept of sunk cost, which may help you understand and remember why a firm like Adidas would continue to operate in the short run even though it was reporting losses. A sunk cost is a cost that you have committed to pay and that you cannot recover. For example, if a firm signs a year’s lease for factory space, it must make rental payments until the lease is up, whether the space is used or not. The important thing about a sunk cost is that once you commit to it, you cannot do anything about it, so you might as well ignore it in your decisions. The firm cannot recover these costs by shutting down. All Adidas could do in the short run was reduce its losses, and it did so by continuing to produce shoes (assuming that the revenue from each pair of shoes was greater than the variable cost of producing them).

Now, observe that the middle panel of Figure 8-10 shows the case in which price exactly equals the minimum point of the average variable cost curve (\( P = \text{minimum } AVC \)). This is called the **shutdown point**: It is the price at which total revenue exactly equals the firm’s variable costs. If the price falls below the shutdown point, the firm should shut down. If the price is above the shutdown point, the firm should continue producing.

In thinking about the shutdown point, the time period is important. We are looking at the firm during the short run, when it is obligated to pay its fixed costs and cannot alter its capital. The question for Melodic Movements is what to do when it already has committed to paying for the trucks and terminals, but the price of moving pianos falls to such a low level that it does not cover variable costs. The shutdown rule says to stop producing in that situation. However, if profits are negative, but the price is greater than average variable cost, then it is best to keep producing.

The shutdown point can be incorporated into the firm’s supply curve. Recall that the supply curve of a single firm tells us the quantity of a good that the firm will produce at different prices. As long as the price is above minimum average variable cost, the firm will produce a quantity such that marginal cost equals the price. Thus, for prices above minimum average variable cost, the marginal cost curve is the firm’s supply curve, as shown in the marginal figure. If the price falls below minimum average variable cost, however, then the firm will shut down; in other words, the quantity produced will equal zero (\( Q = 0 \)). Thus, for prices below minimum average variable cost, the supply curve jumps over to the vertical axis, where \( Q = 0 \), as shown in the marginal figure.

Ensure that you understand the difference between the shutdown point and the breakeven point. The shutdown point is the point at which price equals the minimum average variable cost (Figure 8-10). The breakeven point is the point at which price equals the minimum average total cost (Figure 8-9). If the price is between the
minimum average total cost and the minimum average variable cost, then the firm is not breaking even; it is losing money. It does not make sense to shut down in the short run, however, unless the price falls below the shutdown point.

**REVIEW**

- Total revenue for a firm for a given price is represented by the area of the rectangle whose height is the price and whose width is the profit-maximizing quantity corresponding to that price. Total costs for a firm producing that quantity are represented by the area of the rectangle whose width is the quantity and whose height is the average total cost corresponding to that quantity.
- Profits also can be represented as a rectangle on the cost curve diagram. The profit or loss rectangle is the difference between the revenue rectangle and the loss rectangle.
- When \( P > \) minimum ATC, total revenue exceeds total costs, so the firm is making profits. When \( P < \) minimum ATC, total costs exceed total revenue, so the firm is losing money. When \( P = \) minimum ATC, the firm is making zero profits; this is called the breakeven point.
- A firm that is losing money may continue to operate, or it may choose to shut down. That decision depends on the relationship between price and average variable cost, keeping in mind that fixed costs already have been incurred in the short run.
- If \( P > \) minimum AVC, then the firm will continue to operate in the short run because it is earning enough to cover its variable costs and some, but not all, of its fixed costs. When \( P < \) minimum AVC, profits are maximized by shutting down because continuing to operate will result in the firm losing even more than its fixed costs.
- The point at which \( P = \) minimum AVC is called the shutdown point. When price is in between the breakeven point and the shutdown point, the firm is losing money, but it is minimizing its losses in the short run by continuing to operate.
- The shutdown point can be incorporated into the supply curve. Because the firm will choose to stay in business only when \( P > \) minimum AVC, the supply curve will be zero for prices below minimum AVC. Above minimum AVC, the marginal cost curve will be the supply curve.

Costs and Production: The Long Run

Thus far, we have focused our analysis on the short run. By definition, the short run is the period of time during which it is not possible for firms to adjust certain inputs to production. But what happens in the long run, when it *is* possible for firms to make such adjustments? For example, what happens to Melodic Movements when it opens new terminals or takes out a lease on a fleet of new trucks? To answer this question, we need to show how the firm can adjust its costs in the long run. All costs, fixed costs as well as variable costs, can be adjusted in the long run.

The Effect of Capital Expansion on Costs

First, consider what happens to fixed costs when the firm increases its capital. Suppose Melodic Movements increases the size of its fleet from four trucks to eight trucks and raises the number of terminals from two to four. Then its fixed costs would increase because more rent would have to be paid for four terminals and eight trucks than for