Arab World Edition

Economics

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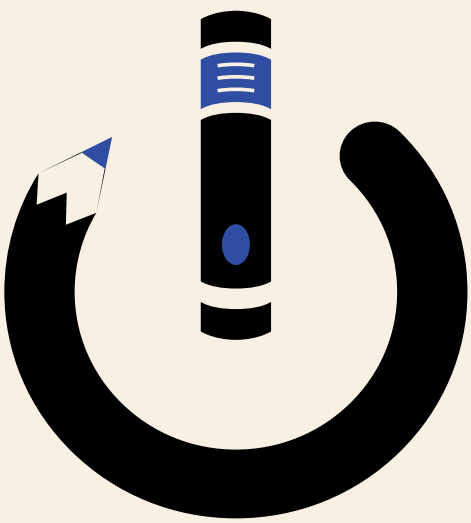

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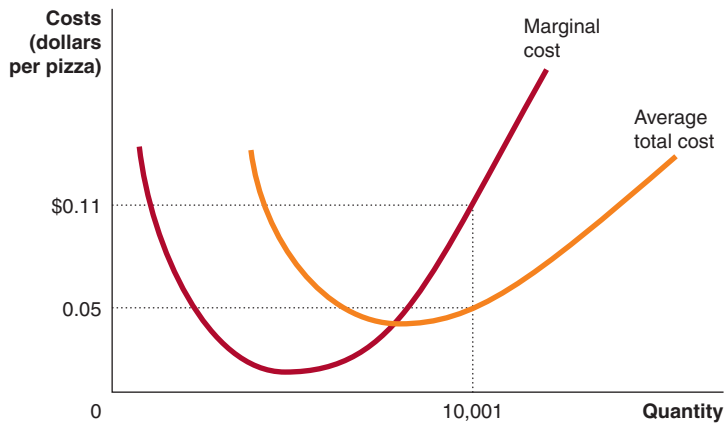
SOLVING THE PROBLEM:

Step 1: **Review the chapter material.** This problem requires understanding the relationship between marginal and average cost, so you may want to review the section "Why Are the Marginal and Average Cost Curves U-Shaped?" which begins on page 232.

Step 2: **Calculate average total cost and marginal cost.** Average total cost is total cost divided by total output. In this case, average total cost is US$500.11/10,001 = US$0.05. Marginal cost is the change in total cost divided by the change in output. In this case, marginal cost is US$0.11/1 = US$0.11.

Step 3: **Use the relationship between marginal cost and average total cost to answer the question.** When marginal cost is greater than average total cost, marginal cost must be increasing. You have shown in Step 2 that marginal cost is greater than average total cost. Therefore, Salma is right: Her marginal cost of producing pizzas must be increasing.

Step 4: **Draw the graph.**



YOUR TURN: For more practice, do related problems 4.5 and 4.6 on page 247 at the end of this chapter.

» End Solved Problem 7-4

7.5 LEARNING OBJECTIVE

7.5 | Graph average total cost, average variable cost, average fixed cost, and marginal cost.

Graphing Cost Curves

Average fixed cost Fixed cost divided by the quantity of output produced.

Average variable cost Variable cost divided by the quantity of output produced.

We have seen that we calculate average total cost by dividing total cost by the quantity of output produced. Similarly, we can calculate **average fixed cost** by dividing fixed cost by the quantity of output produced. And we can calculate **average variable cost** by dividing variable cost by the quantity of output produced. Or, mathematically, with Q being the level of output, we have:

$$\text{Average total cost} = ATC = \frac{TC}{Q}$$

$$\text{Average fixed cost} = AFC = \frac{FC}{Q}$$

$$\text{Average variable cost} = AVC = \frac{VC}{Q}$$

Finally, notice that average total cost is the sum of average fixed cost plus average variable cost:

$$ATC = AFC + AVC$$

Quantity of Workers	Quantity of Ovens	Quantity of Pizzas	Cost of Ovens (Fixed Cost)	Cost of Workers (Variable Cost)	Total Cost of Pizzas	*ATC*	*AFC*	*AVC*	*MC*
0	2	0	$800	$0	$800	—	—	—	—
1	2	200	800	650	1,450	$7.25	$4.00	$3.25	$3.25
2	2	450	800	1,300	2,100	4.67	1.78	2.89	2.60
3	2	550	800	1,950	2,750	5.00	1.45	3.55	6.50
4	2	600	800	2,600	3,400	5.67	1.33	4.33	13.00
5	2	625	800	3,250	4,050	6.48	1.28	5.2	26.00
6	2	640	800	3,900	4,700	7.34	1.25	6.09	43.33

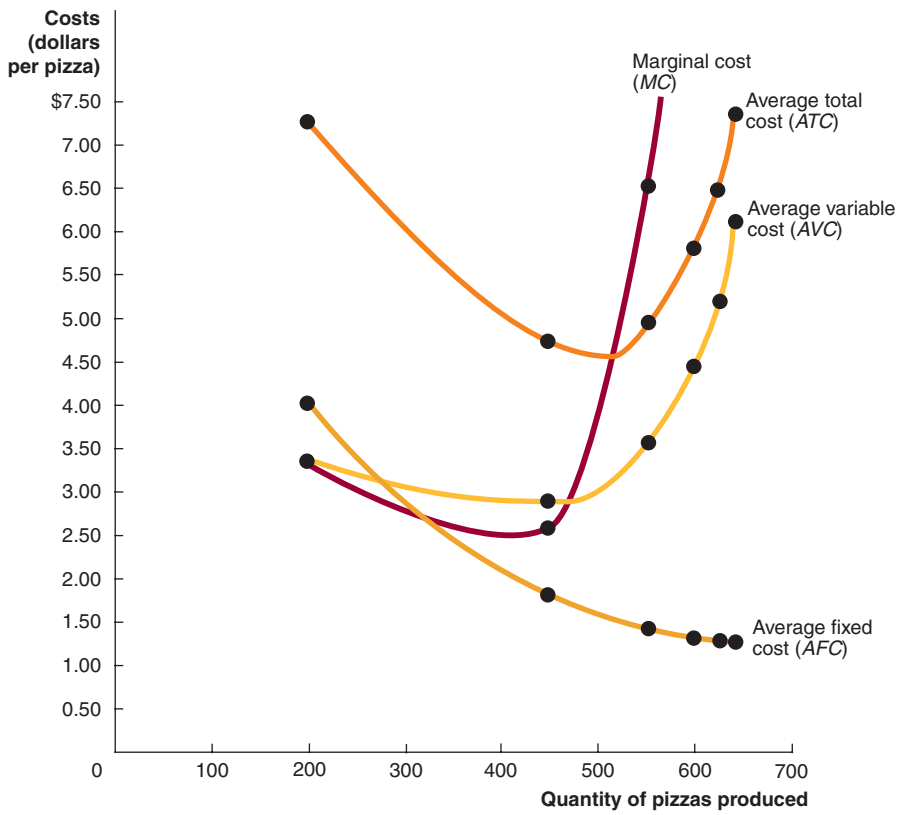


Figure 7-5

Costs at Salma's Restaurant

Salma's costs of making pizzas are shown in the table and plotted in the graph. Notice three important facts about the graph: (1) The marginal cost (*MC*), average total cost (*ATC*), and average variable cost (*AVC*) curves are all U-shaped, and the marginal cost curve intersects both the average variable cost curve and average total cost curve at their minimum points. (2) As output increases, average fixed cost (*AFC*) gets smaller and smaller. (3) As output increases, the difference between average total cost and average variable cost decreases. Make sure you can explain why each of these three facts is true. You should spend time becoming familiar with this graph because it is one of the most important graphs in microeconomics.

The only fixed cost Salma incurs in operating her restaurant is the US$800 per week she pays on the bank loan for her pizza ovens. Her variable costs are the wages she pays her workers. The table and graph in Figure 7-5 show Salma's costs.

We will use graphs like the one in Figure 7-5 in the next several chapters to analyze how firms decide the level of output to produce and the price to charge. Before going further, be sure you understand the following three key facts about Figure 7-5:

1 The marginal cost (*MC*), average total cost (*ATC*), and average variable cost (*AVC*) curves are all U-shaped, and the marginal cost curve intersects the average variable cost and average total cost curves at their minimum points. When marginal cost is less than either average variable cost or average total cost, it causes them to decrease. When marginal cost is above average variable cost or average total cost, it causes them to increase. Therefore, when marginal cost equals average variable cost or average total cost, they must be at their minimum points.

2 As output increases, average fixed cost gets smaller and smaller. This happens because in calculating average fixed cost, we are dividing something that gets larger and larger—output—into something that remains constant—fixed cost. Firms

often refer to this process of lowering average fixed cost by selling more output as 'spreading the overhead.' By 'overhead' they mean fixed costs.

3 As output increases, the difference between average total cost and average variable cost decreases. This happens because the difference between average total cost and average variable cost is average fixed cost, which gets smaller as output increases.

7.6 LEARNING OBJECTIVE

7.6 | Understand how firms use the long-run average cost curve in their planning.

Costs in the Long Run

The distinction between fixed cost and variable cost that we just discussed applies to the short run but *not* to the long run. For example, in the short run, Salma has fixed costs of US$800 per week because she signed a loan agreement with a bank when she bought her pizza ovens. In the long run, the cost of purchasing more pizza ovens becomes variable because Salma can choose whether to expand her business by buying more ovens. The same would be true of any other fixed costs a company like Salma's might have. Once a company has purchased a fire insurance policy, the cost of the policy is fixed. But when the policy expires, the company must decide whether to renew it, and the cost becomes variable. The important point here is this: *In the long run, all costs are variable. There are no fixed costs in the long run.* In other words, in the long run, total cost equals variable cost, and average total cost equals average variable cost.

Managers of successful firms simultaneously consider how they can most profitably run their current store, factory, or office and also whether in the long run they would be more profitable if they became larger or, possibly, smaller. Salma must consider how to run her current restaurant, which has only two pizza ovens, and she must also plan what to do when her current bank loan is paid off and the lease on her store ends. Should she buy more pizza ovens? Should she lease a larger restaurant?

Economies of Scale

Long-run average cost curve A curve showing the lowest cost at which a firm is able to produce a given quantity of output in the long run, when no inputs are fixed.

Economies of scale The situation when a firm's long-run average costs fall as it increases output.

Short-run average cost curves represent the costs a firm faces when some input, such as the quantity of machines it uses, is fixed. The **long-run average cost curve** shows the lowest cost at which a firm is able to produce a given level of output in the long run, when no inputs are fixed. Many firms experience **economies of scale**, which means the firm's long-run average costs fall as it increases the quantity of output it produces. We can see the effects of economies of scale in Figure 7-6, which shows the relationship between short-run and long-run average cost curves. Managers can use long-run average cost curves for planning because they show the effect on cost of expanding output by, for example, building a larger factory or store.

Long-Run Average Total Cost Curves for Bookstores

Figure 7-6 shows long-run average cost in the retail bookstore industry. If a small bookstore expects to sell only 1,000 books per month, then it will be able to sell that quantity of books at the lowest average cost of US$22 per book if it builds the small store represented by the *ATC* curve on the left of the figure. A much larger bookstore, such as a national chain like Jarir Bookstore, will be able to sell 20,000 books per month at a lower average cost of US$18 per book. This decline in average cost from US$22 to US$18 represents the economies of scale that exist in bookselling. Why would the larger bookstore have lower average costs? One important reason is that Jarir is selling 20 times as many books per month as the small store but might need only six times as many workers. This saving in labor cost would reduce Jarir's average cost of selling books.

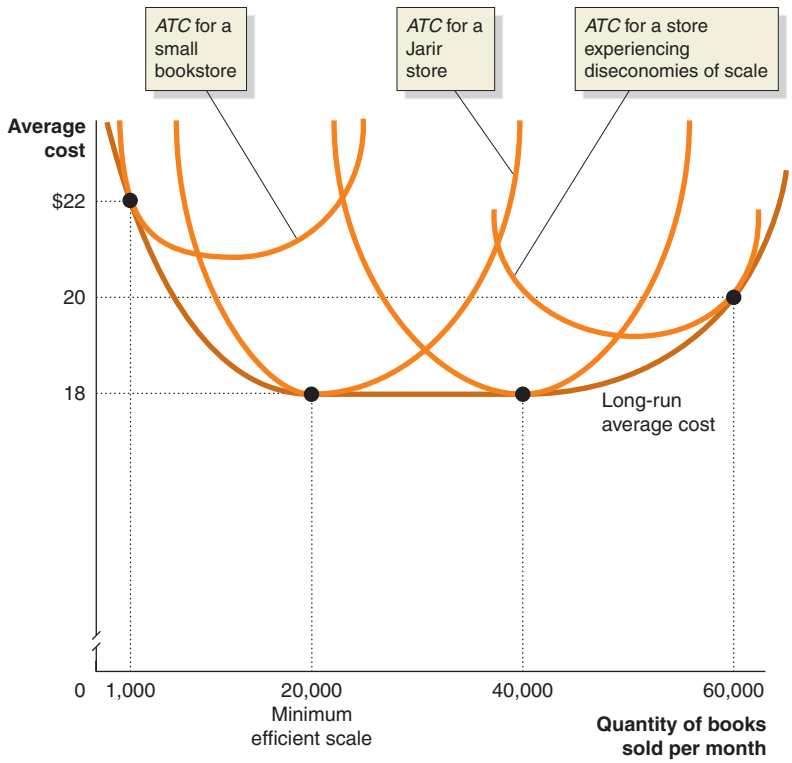


Figure 7-6

The Relationship between Short-Run Average Cost and Long-Run Average Cost

If a small bookstore expects to sell only 1,000 books per month, then it will be able to sell that quantity of books at the lowest average cost of US$22 per book if it builds the small store represented by the *ATC* curve on the left of the figure. A larger bookstore will be able to sell 20,000 books per month at a lower cost of US$18 per book. A bookstore selling 20,000 books per month and a bookstore selling 40,000 books per month will experience constant returns to scale and have the same average cost. A bookstore selling 20,000 books per month will have reached minimum efficient scale. Very large bookstores will experience diseconomies of scale, and their average costs will rise as sales increase beyond 40,000 books per month.

Firms may experience economies of scale for several reasons. First, as in the case of Jarir, the firm's technology may make it possible to increase production with a smaller proportional increase in at least one input. Second, both workers and managers can become more specialized, enabling them to become more productive, as output expands. Third, large firms, like Jarir, Carrefour, and Aramco (the largest oil company in the world), may be able to purchase inputs at lower costs than smaller competitors. In fact, as Carrefour expanded, its bargaining power with its suppliers increased, and its average costs fell. Finally, as a firm expands, it may be able to borrow money more inexpensively, thereby lowering its costs.

Economies of scale do not continue forever. The long-run average cost curve in most industries has a flat segment that often stretches over a substantial range of output. As Figure 7-6 shows, a bookstore selling 20,000 books per month and a bookstore selling 40,000 books per month have the same average cost. Over this range of output, firms in the industry experience **constant returns to scale**. As these firms increase their output, they have to increase their inputs, such as the size of the store and the quantity of workers, proportionally. The level of output at which all economies of scale are exhausted is known as **minimum efficient scale**. A bookstore selling 20,000 books per month has reached minimum efficient scale.

Very large bookstores experience increasing average costs as managers begin to have difficulty coordinating the operation of the store. Figure 7-6 shows that for sales above 40,000 books per month, firms in the industry experience **diseconomies of scale**. Toyota ran into diseconomies of scale in assembling automobiles. The firm found that as it expanded production at its Georgetown, Kentucky, plant and its plants in China, its managers had difficulty keeping costs from rising. The president of Toyota's Georgetown plant was quoted as saying, "Demand for…high volumes saps your energy. Over a period of time, it eroded our focus…[and] thinned out the expertise and knowledge we painstakingly built up over the years." One analysis of the problems Toyota faced in expanding production concluded: "It is the kind of paradox many highly successful companies face: getting bigger doesn't always mean getting better."

Constant returns to scale The situation when a firm's long-run average costs remain unchanged as it increases output.

Minimum efficient scale The level of output at which all economies of scale are exhausted.

Diseconomies of scale The situation when a firm's long-run average costs rise as the firm increases output.

Solved Problem 7-6

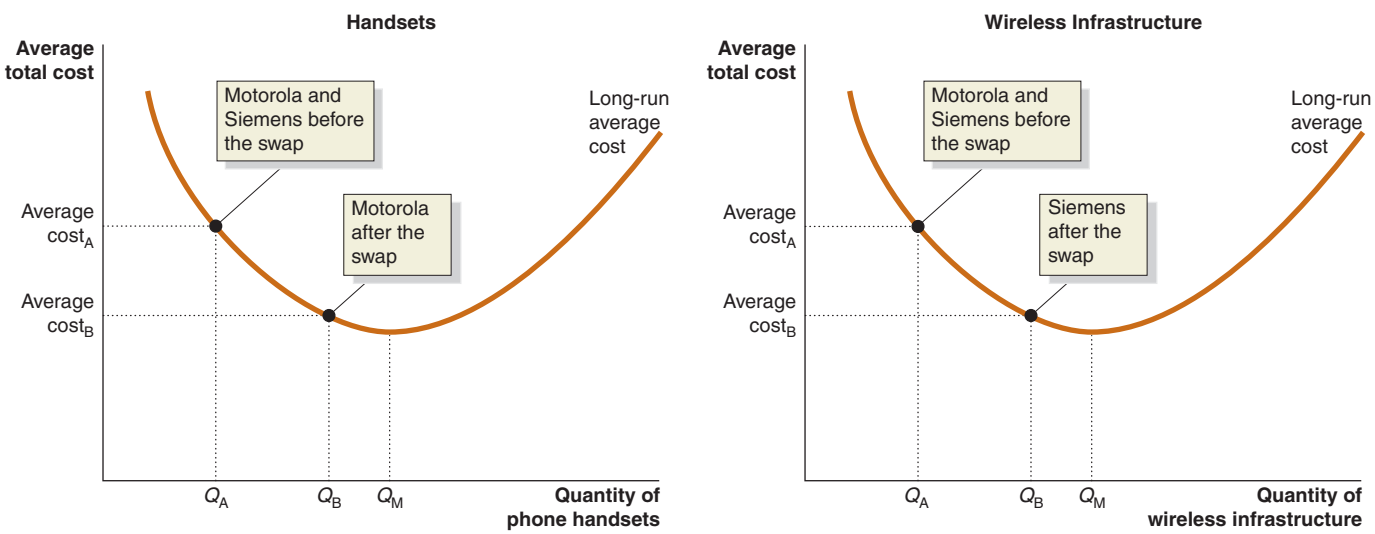
Using Long-Run Average Cost Curves to Understand Business Strategy

In fall 2002, Motorola and Siemens were each manufacturing both mobile phone handsets and wireless infrastructure—the base stations needed to operate a wireless communications network. The firms discussed the following arrangement: Motorola would give Siemens its wireless infrastructure business in exchange for Siemens giving Motorola its mobile phone handsets business. The main factor motivating the trade was the hope of taking advantage of economies of scale in each business. Use long-run average total cost curves to explain why this trade might make sense for Motorola and Siemens.

SOLVING THE PROBLEM:

Step 1: **Review the chapter material.** This problem is about the long-run average cost curve, so you may want to review the material in the section "Costs in the Long Run," which begins on page 236.

Step 2: **Draw long-run average cost graphs for Motorola and Siemens.** The question does not provide us with the details of the quantity of each product each firm is producing before the trade or the firms' average costs of production. If economies of scale were an important reason for the trade, we can assume that Motorola and Siemens were not yet at minimum efficient scale in the wireless infrastructure and phone handset businesses. Therefore, we can draw the following graphs:



Step 3: **Explain the curves in the graphs.** Before the proposed trade, Motorola and Siemens are producing both products at less than the minimum efficient scale, which is Q_M in both graphs. After the trade, Motorola's production of handsets will increase, moving it from Q_A to Q_B in the first graph. This increase in production will allow it to take advantage of economies of scale and reduce its average cost from Average Cost$_A$ to Average Cost$_B$. Similarly, production of wireless infrastructure by Siemens will increase from Q_A to Q_B, lowering its average cost from Average Cost$_A$ to Average Cost$_B$. As drawn, the graphs show that both firms will still be short of minimum efficient scale after the trade, although their average costs will have fallen.

EXTRA CREDIT: These were new technologies at the time Motorola and Siemens discussed the trade. As a result, companies making these products were only beginning to understand how large minimum efficient scale was. To survive in the industry, the managements of both companies wanted to lower their costs by taking advantage of economies of scale. As one industry analyst put it: "Motorola and Siemens may be driven by the conviction that they have little choice. Most observers believe consolidation in both the [wireless] networking and handset areas is inevitable."

Source for quote: Ray Hegarty, *Rumored Motorola–Siemens Business Unit Swap? A Compelling M&A Story*, www.thefeature.com.

YOUR TURN: For more practice, do related problems 6.4, 6.5, 6.6, and 6.7 on pages 249–250 at the end of this chapter.

» End Solved Problem 7-6

Over time, most firms in an industry will build factories or stores that are at least as large as the minimum efficient scale but not so large that diseconomies of scale occur. In the bookstore industry, stores will sell between 20,000 and 40,000 books per month. However, firms often do not know the exact shape of their long-run average cost curves. As a result, they may mistakenly build factories or stores that are either too large or too small.

Making the Connection

Economies and Diseconomies of Scale in the Car Industry

GB Auto Ghabbour, founded in 1960, is a leading Egyptian automotive assembler, importer, and distributor in the Middle East and North Africa, with a market share of around 25 percent of Egypt's transportation market. The company assembles and distributes passenger cars under the Hyundai brand, as well as buses and trucks under the Volvo, Mitsubishi, Hyundai, and Ghabbour brands. Until 2004, the company was not able to benefit from its economies of scale for two main reasons. First, the Egyptian automotive market is considered small by international standards, which makes it difficult to establish economies of scale for manufacturing. Second, Egypt was hit by a recession in the late 1990s, which significantly affected demand for cars, from a peak of 72,000 units in 1998 to a low of 47,000 units in 2002. The year 2004 was a turning point in the automotive market in Egypt, when the Egyptian government implemented an economic reform program that led to a sharp reduction in tariffs on imported cars (up to 1600 CC) from 105 percent to 40 percent. This dramatic reduction in customs duties on both imported cars and also car parts resulted in a sharp increase in demand on passenger cars by 323 percent in only 3 years (2005–07). This helped GB Auto to increase its production and generate economies of scale. The company's revenue increased by 108.7 percent, 50.2 percent, and 57.3 percent in the three years following the economic reform.

In another trend, when Henry Ford started the Ford Motor Company in Detroit, USA, in 1903, he introduced two new ideas that allowed him to take advantage of economies of scale. First, Ford used identical—or, interchangeable—parts so that unskilled workers could assemble the cars. Second, instead of having groups of workers moving from one stationary automobile to the next, he had the workers remain stationary while the automobiles moved along an assembly line. Ford built a large factory where he used these ideas to produce the famous Model T at an average cost well below what his competitors could match using older production methods in smaller factories.

(*Continued*)

Ghabbour Auto, the Egyptian motor manufacturer, has a major strategic partnership with Hyundai.