# Chapter 4 PRODUCTION AND THE COSTS OF PRODUCTION



## Chapter in a Nutshell

1. In general, a firm’s production may take place in the short-run or the long-run period. The short run is a period in which the quantity of at least one input is fixed and we can vary the quantities of the other inputs. The long run is a time in which all inputs are considered to be variable in amount.
2. The relationship between physical output and the quantity of resources used in the production process is called a production function. A production function shows the maximum amount of output that we can produce with a given amount of resources.
3. According to the law of diminishing marginal returns, as a firm adds more of a variable input to a fixed input beyond some point the marginal productivity of the variable input diminishes.
4. A firm producing goods in the short run employs fixed inputs and variable inputs. Fixed costs are payments to fixed inputs, and they do not vary with output. Variable costs are payments to variable inputs, and they increase as output expands.
5. We can describe a firm’s costs in terms of a total approach: total fixed cost, total variable cost, and total cost. We can also describe them in terms of a per-unit approach: average fixed cost, average variable cost, and average total cost.
6. Marginal cost refers to the change in total cost when we produce another unit of output. The short-run marginal cost curve is generally U-shaped, reflecting the law of diminishing marginal returns. Also, the marginal cost curve intersects both the average total cost and average variable cost curves at their lowest points.
7. The long-run average total cost curve shows the minimum cost per unit of producing each output level when we can construct any desired size of a factory. Economies of scale and diseconomies of scale account for the U-shaped appearance of this cost curve.
8. In discussing the general shapes of a firm’s cost curves in the short run and long run, we assume that technology, resource prices, and taxes remain constant as the firm changes its level of output. Changes in any of these factors will cause a firm’s cost curves to shift upward or downward.
9. Economists define the total costs of production as the sum of explicit costs plus implicit costs.
10. According to accounting principles, profit equals total revenue minus explicit costs. Besides caring about explicit costs, economists are interested in a firm’s implicit costs. Economic profit thus equals total revenue minus the sum of explicit costs and implicit costs.
11. A firm that makes zero economic profit is said to earn a normal profit. It represents the minimum profit necessary to keep a firm in operation. In other words, the firm earns just enough revenue to cover its explicit costs and implicit costs.

### Chapter Objectives

After reading this chapter, you should be able to:

1. Distinguish between the short run and the long run and between a fixed input and a variable input.
2. Describe how the law of diminishing returns relates to the productivity of a variable input in the short run.
3. Identify the costs of production that a firm realizes in the short run.
4. Explain how economies of scale and diseconomies of scale affect the long-run average total cost curve of a firm.
5. Distinguish between accounting profit and economic profit.



## Knowledge Check

### Key Concept Quiz

|  |  |
| --- | --- |
| 1. short run 2. long run 3. production function 4. marginal product 5. law of diminishing marginal returns 6. increasing marginal returns 7. variable cost 8. average fixed cost 9. marginal cost 10. long-run average total cost curve 11. economics of scale 12. constant returns to scale 13. implicit cost 14. economic profit 15. normal profit | \_\_\_\_\_ a. all inputs are considered variable in amounts  \_\_\_\_\_ b. the relationship between physical output and the quantity of resources used  \_\_\_\_\_ c. a period in which the quantity of at least one input is fixed  \_\_\_\_\_ d. total revenue – (explicit costs + implicit costs)  \_\_\_\_\_ e. costs that represent the value of resources for which no monetary payment is made  \_\_\_\_\_ f. what a firm makes when its earning zero economic profit  \_\_\_\_\_ g. the falling portion of the marginal product curve  \_\_\_\_\_ h. the change in output that results from changing labor by one unit  \_\_\_\_\_ i. costs that change as the rate of output changes  \_\_\_\_\_ j. change in total cost when one more unit of output is produced  \_\_\_\_\_ k. total fixed cost per unit of output  \_\_\_\_\_ l. when the firm’s output changes by the same percentage as the change in all inputs  \_\_\_\_\_ m. shows the minimum cost per unit of producing each output level when any desired size of factory can be constructed  \_\_\_\_\_ n. an increase in the scale of production results in a fall in cost per unit  \_\_\_\_\_ o. the rising portion of the marginal product curve |

### Multiple Choice Questions

1. In the short run
2. all inputs are variable
3. all inputs must remain fixed
4. at least one input is fixed
5. at least two inputs are fixed.
6. When a firm operating with two inputs, labor and capital, succeeds in increasing the total product by increasing the units of labor employed, the
7. marginal product of labor is positive
8. units of capital employed must also be increasing
9. the firm is experiencing economies of scale
10. marginal product of capital is zero.
11. If the marginal product of the fourth worker is more than the marginal product of the third worker, the firm is experiencing
12. increasing marginal returns
13. diminishing marginal returns
14. supernormal profits
15. a technological improvement
16. A technological improvement
17. shifts the marginal and total product curve outward
18. can reverse the effects of falling marginal productivity
19. changes the production function
20. all of the above
21. Average fixed costs
22. behave like marginal costs
23. behave like variable costs
24. behave like average variable costs
25. decline as output increases
26. Average variable costs rise whenever
27. marginal costs exceed fixed costs
28. marginal costs exceed average variable costs
29. marginal costs exceed average total costs
30. marginal costs are rising.
31. The marginal cost curve intersects the average variable cost curve and the average total cost curve
32. at their minimum points
33. at their maximum points
34. at the point where average total cost and average variable cost are identical
35. at the point where the average fixed cost is at its minimum
36. When a firm experiences economies of scale
37. the LRATC slopes downward
38. the LRATC is vertical
39. the LRATC slopes upward
40. the LRATC is horizontal
41. All of the following shift cost curves *except* for
42. technology
43. resource prices
44. taxes
45. the political majority in the United States Congress
46. Implicit costs are
47. always more than explicit costs
48. not relevant for decision-making
49. measured by accountants
50. opportunity costs
51. Normal profit
52. is always positive
53. equals zero economic profit
54. is calculated by ignoring implicit costs
55. is higher than economic profit
56. A firm earning normal profit
57. should not remain in business
58. is covering all its costs
59. is not being efficient
60. is ignoring the opportunity costs of the entrepreneur
61. Accounting practices typically
62. overestimate economic costs
63. underestimate economic costs
64. estimate economic costs accurately
65. bear no relationship to economic costs
66. The average fixed costs of an operation may be represented by a
67. horizontal line
68. downward-sloping curve
69. upward-sloping curve
70. vertical line
71. When overhead costs are absent
72. total cost equals total variable cost
73. average total cost = average variable cost
74. the average total variable cost curve is U-shaped
75. all of the above
76. An economist would argue that accountants tend to
77. understate costs and overstate profits
78. understate costs and understate profits
79. overstate costs and understate profits
80. overstate costs and overstate profits
81. A long-run adjustment would be represented by
82. owner of a Pizza Hut franchise hires additional waiters and cooks
83. General Motors reduces its purchases of glass, steel, and paint
84. Darigold Farms purchases additional hay to feed its cows
85. South-Western College Publishing replaces its old headquarters with a new one
86. For Ford Motor Co., all of the following are sources of economies of scale *except*
87. mass production techniques used in the manufacturing of autos
88. bureaucracy and red tape encountered as the firm becomes larger
89. learning by doing which allows workers to become more productive
90. additional specialization made possible by large-scale production
91. An implicit cost is best represented by
92. wages paid by General Electric to its employees
93. interest payments on outstanding loans by Sears
94. salaries paid to the managers of Microsoft
95. rental income forgone on property owned by K-Mart
96. Assume that, when producing 100 units of output, Johnson Machinery’s average variable cost is $240, its average fixed cost is $60, and its marginal cost is $80. On the basis of this information, we can conclude that the firm’s
97. total variable cost is $18,000
98. total cost is $30,000
99. average total cost is $180
100. average total cost is $380
101. Technological improvements tend to offset or neutralize
102. the law of diminishing marginal returns
103. the law of increasing marginal returns
104. economies of large-scale production
105. none of the above
106. If a Wendy’s franchise replaces its older equipment with more efficient equipment, the total product curve and marginal product curve of its fast food tend to

a. shift downward

b. shift upward

c. become flatter

d. become horizontal

1. Your variable costs of driving would include
2. insurance
3. maintenance
4. depreciation
5. license
6. Dell’s marginal cost curve and average total cost curve of producing a computer would shift upward if

a. the firm realizes technological improvements

b. workers become less productive

c. materials prices decline for the firm

d. business taxes decrease for the firm

1. The minimum profit necessary to keep a firm in operation is called

a. economic profit

b. normal profit

c. accounting profit

d. explicit profit

1. Suppose that as a producer gets larger, its economies of scale more than offset its diseconomies of scale. The long run average total cost curve of the producer would be

a. downward sloping

b. upward sloping

c. horizontal

d. vertical

### True-False Questions

1. T F In the short run there are no variable inputs.

2. T F In the long run at least one input is fixed.

3. T F The total product increases when marginal product is declining.

4. T F When the marginal product of an input begins to decline, the firm experiences diminishing marginal returns.

5. T F Total fixed costs are represented by a horizontal line.

6. T F Average fixed cost curves and average variable cost curves always have identical shapes.

7. T F As output increases, the difference between ATC and AVC declines.

8. T F The marginal cost curve is U-shaped.

9. T F When marginal productivity declines, marginal cost increases.

10. T F The MC, ATC, and AVC curves are all U-shaped curves.

11. T F Diminishing marginal productivity is unrelated to the shape of the ATC curve.

1. T F When diseconomies of scale set in, the LRATC slopes upward.
2. T F An improvement in technology shifts the marginal product curve upward.
3. T F A shift in the marginal product curve does not have any effect on production costs.
4. T F Explicit costs are always more than implicit costs.
5. T F Accountants typically ignore implicit costs.
6. T F Normal profits exceed economic profits.
7. T F Normal profits are profits that are necessary to keep the firm in operation.
8. T F A production function describes the maximum amount of output that can be produced with a given amount of input.
9. T F The long-run production function and short-run production function are identical to each other.

21. T F Suppose that ABC Electric Co. enlarges its manufacturing plant and finds that diseconomies of scale more than offset economies of scale. The firm=s long run average total cost curve would slope downward.

22. T F When preparing financial reports, cost accountants are concerned with only the explicit costs that are payable to others, such as wages, materials, and interest.

23. T F Suppose that U.S. Steel Co. pays wages to its workers that are double the wages paid by a steel company in Japan. Also suppose that the productivity of U.S. Steel Co.=s workers is three times that of the Japanese. U.S. Steel Co.=s unit labor costs would be lower than the Japanese company.

24. T F The production of prescription drugs provides an example of a product that benefits from the principle of decreasing long-run average cost.

25. T F Your fixed costs of driving include insurance, license, depreciation, and finance charges on your automobile loan.

26. T F Advances in technology will cause the total product curve and marginal product curve to shift upward, thus helping offset the law of diminishing marginal returns.

27. T F In the long run, all costs are considered to be fixed costs.

### Application Questions

1. The following table shows the total amount of ice cream produced by the Jen and Berry’s ice cream company. The company maintains a fixed amount of capital equipment.

|  |  |  |
| --- | --- | --- |
| **Workers** | **Output  (Total Product)** | **Marginal Product** |
| 0 | 0 |  |
| 1 | 8 |  |
| 2 | 20 |  |
| 3 | 34 |  |
| 4 | 50 |  |
| 5 | 64 |  |
| 6 | 74 |  |
| 7 | 80 |  |
| 8 | 85 |  |

a. Complete the table above.

b. Graph the marginal product curve.

c. Does the marginal product always increase as the number of workers increases?

1. Can you explain the behavior of the marginal product curve?
2. Every fourth of July, A Stitch in Time prints T-shirts for visitors to the small town of Liberty. This production process involves both fixed and variable costs. The fixed cost of printing these shirts is $10. The following table describes some of these costs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Output** | **Total Variable Cost** | **Total  Cost** | **Average Variable  Cost** | **Average  Total Cost** | **Marginal  Cost** |
| 0 | 0 | 10.00 |  |  |  |
| 1 | 8.00 |  |  |  |  |
| 2 |  |  |  | 12.00 |  |
| 3 |  | 28.00 |  |  |  |
| 4 |  |  |  |  | 4.00 |
| 5 | 0 |  | 6.40 |  |  |
| 6 |  |  |  |  | 10.00 |
| 7 | 54.00 |  |  |  |  |

1. Complete the table above.

b. Graph the total variable cost and total cost curves.

c. How are the total variable cost and total cost curves positioned relative to one

another? What accounts for their positions?

d. Now, graph the average total cost, average variable cost, and marginal cost curves.

e. What are the output levels at which the average total cost and average variable cost curves intersect the marginal cost curve?

f. Are these costs short or long run? Why?



## Answers to Knowledge Check Questions

### Key Concept Answers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1. c | 4. h | 7. i | 10. m | 13. e |
| 2. a | 5. g | 8. k | 11. n | 14. d |
| 3. b | 6. o | 9. j | 12. l | 15. f |

### Multiple Choice Answers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1. c | 6. b | 11. b | 16. a | 21. a | 26. a |
| 2. a | 7. a | 12. b | 17. d | 22. b |  |
| 3. a | 8. a | 13. b | 18. b | 23. b |  |
| 4. d | 9. d | 14. b | 19. d | 24. b |  |
| 5. d | 10. d | 15. d | 20. b | 25. b |  |

### True-False Answers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1. F | 6. F | 11. F | 16. T | 21. F | 26. T |
| 2. F | 7. T | 12. T | 17. F | 22. T | 27. F |
| 3. F | 8. T | 13. T | 18. T | 23. T |  |
| 4. T | 9. T | 14. F | 19. T | 24. T |  |
| 5. T | 10. T | 15. F | 20. F | 25. T |  |

### Application Question Answers

1. a. Below is the completed production table for Jen and Berry’s ice cream company.

|  |  |  |
| --- | --- | --- |
| **Workers** | **Output  (Total Product)** | **Marginal Product** |
| 0 | 0 | — |
| 1 | 8 | 8 |
| 2 | 20 | 12 |
| 3 | 34 | 14 |
| 4 | 50 | 16 |
| 5 | 64 | 14 |
| 6 | 74 | 10 |
| 7 | 80 | 6 |
| 8 | 85 | 5 |

b. Below is the marginal product curve for Jen and Berry’s ice cream.

c. The marginal product initially increases as the number of workers is increased from 0 to 3. It reaches a peak when four workers are employed and declines when more employees are added.

d. The company maintains a fixed amount of capital. As more and more workers are used in combination with this fixed amount of capital, diminishing marginal returns to the variable factor sets in on employing more than four workers.

3. a. Below is the completed production cost table for A Stitch in Time T-shirt company.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Output** | **Total Variable Cost (Dollars)** | **Total  Cost (Dollars)** | **Average Variable  Cost (Dollars)** | **Average  Total Cost (Dollars)** | **Marginal  Cost (Dollars)** |
| 0 | 0 | 10.00 | — | — | — |
| 1 | 8.00 | 18.00 | 8.00 | 18.00 | 8.00 |
| 2 | 14.00 | 24.00 | 7.00 | 12.00 | 6.00 |
| 3 | 18.00 | 28.00 | 6.00 | 9.33 | 4.00 |
| 4 | 24.00 | 34.00 | 6.00 | 8.50 | 6.00 |
| 5 | 32.00 | 42.00 | 6.40 | 8.40 | 8.00 |
| 6 | 42.00 | 52.00 | 7.00 | 8.66 | 10.00 |
| 7 | 54.00 | 64.00 | 7.72 | 9.14 | 12.00 |

b. Below is the graph showing total variable cost and total cost for A Stitch in Time’s T‑shirt production.

#### Total Cost

#### Variable Cost

c. The marginal cost curve intersects the average variable cost at an output level of 4 units.

The marginal cost curve intersects the average total cost at an output level of 5.2 units (approximately 5 units).

d. Below is a graph showing A Stitch in Time’s average total cost (ATC), average variable cost (AVC), and marginal cost (MC).

#### AVC

#### MC

#### ATC

1. These costs are short-run costs because at least one input, capital equipment, remains fixed in this production process.
2. These costs are short-run costs because at least one input, capital equipment, remains fixed in this production process.