

Chapter 4

Supply

CHAPTER SUMMARY

A small seller, which cannot affect the market price, maximizes profit by producing at a rate where its marginal cost equals the price. (For a small seller, the price equals marginal revenue.) In the short run, at least one input is fixed and therefore cannot be adjusted. The business breaks even when total revenue covers variable cost. In the long run, the business can adjust all inputs and leave or enter the industry. It breaks even when total revenue covers total cost.

The supply curve shows the quantity supplied as a function of price, other things equal. The effect of a change in price is represented by a movement along the supply curve to a new quantity. Changes in other factors such as wages and the prices of other inputs are represented by shifts of the entire supply curve.

Seller surplus is the difference between revenue from some production rate and the minimum amount necessary to induce the seller to produce that quantity. Elasticities of supply measure the responsiveness of supply to changes in underlying factors that affect supply.

The Math Supplement to this chapter illustrates two things mathematically. First, it shows that the profit-maximizing (loss minimizing) production rate exists where marginal revenue equals marginal cost. Second, it shows that a change in any factor of supply other than the price of the item is represented by a shift of the entire market supply curve.

KEY CONCEPTS

short run	average (unit) cost	market supply curve
long run	marginal product	seller surplus
fixed cost	marginal revenue	elasticity of supply
variable cost	total revenue	price elasticity of supply
total cost	sunk cost	
marginal cost	individual supply curve	

GENERAL CHAPTER OBJECTIVES

1. Explain why short run costs vary with the production rate and what could cause a shift in short run cost curves.
2. Determine the profit-maximizing (loss-minimizing) production level in the short run.
3. Explain under what short-run conditions a business will remain in operation and when it is best to shut down.
4. Explain why the individual seller's supply curve is that portion of its marginal cost curve above minimum average variable cost.
5. Explain why the demand for inputs is derived from the level of production.
6. Explain why costs vary with the production rate and what could cause a shift in cost curves.
7. Determine the profit-maximizing (loss-minimizing) production level in the long run and explain the breakeven condition in the long run.
8. Describe how the market supply curve is derived in the short run and the long run and their properties.
9. Describe seller surplus in words and determine it graphically.
10. Explain why labor supply curves generally slope upward in terms of the work-leisure tradeoff and the income effect.
11. Describe the elasticity of supply concept, calculate price elasticity of supply coefficients and interpret them.

NOTES

1. Individual supply: short run and long run.
 - (a) Whether to continue in production and how much to produce depends on costs and revenues.
 - (b) Time horizon.
 - i. Short run – time horizon in which a seller cannot adjust at least one input. In the short run, the business must work within the constraints of past commitments such as employment contracts and investment in facilities and equipment.
 - ii. Long run - time horizon long enough for a seller to adjust all inputs (including the size of its facility) and production.
2. Costs and production rate: short run.
 - (a) Costs.
 - i. Based on estimates of expenses on rent, wages, and other supplies needed at various production rates.

- ii. Fixed cost = cost of inputs that do not change with the production rate. The entire fixed cost is a sunk cost, i.e., a cost that has been committed and cannot be avoided.
 - iii. Variable cost = cost of inputs that change with the production rate. Hence, variable cost varies with the scale of operations. It is an avoidable cost.
 - iv. Total cost = sum of fixed cost and variable cost ($C = F + V$). (Note: Some expenses may have both a fixed and a variable component.)
 - v. Average fixed cost = fixed cost divided by the output level.
 - vi. Average variable cost = variable cost divided by the output level.
 - vii. Average (total) cost/unit cost = the sum of average variable and average fixed cost; also equals total cost divided by the production rate;
 - viii. Marginal cost = the change in total cost (i.e., variable cost) associated with each additional unit produced; represented graphically as the slope of the total cost curve.
- (b) Marginal product.
- i. Definition. The increase in output arising from an additional unit of the input.
 - ii. Diminishing marginal product from the variable inputs: the marginal product becomes smaller with each increase in the quantity of the variable input.
- (c) Average total cost (average cost) generally first drops with increase in the production rate and then rises.
- i. When the production rate is higher, the fixed costs will be spread over more units, the average fixed cost will be declining.
 - ii. When the production rate is higher:
 - (1). At first, the average variable cost falls (as the variable inputs match the fixed input relatively better);
 - (2). Then, the average variable cost rises (as more of the variable inputs are added in combination with the fixed input, there will be a mismatch, leading to a diminishing marginal product from the variable inputs).
 - (3). Accordingly, the average variable, average (total), and marginal cost curves are U-shaped. The curves will change with the technology being used.
3. Revenue and production rate: short run.
- (a) Total revenue = price x sales.
 - (b) Marginal revenue = the change in total revenue arising from selling an additional unit; represented graphically as the slope of the total revenue line.

4. Individual supply: short run.
 - (a) Assumptions.
 - i. Business aims to maximize profit.
 - ii. The business is so small relative to the market that it can sell as much as it would like at the going market price.
 - (b) Profit-maximizing (loss-minimizing) quantity to produce.
 - i. If continuing in production, profit = total revenue – total cost; Profit = $R - F - V$.
 - ii. The profit-maximizing production rate is where marginal revenue equals marginal cost (where the total revenue line and the total cost curve climb at exactly the same rate).
 - (1). Whenever the marginal revenue exceeds the marginal cost, profit will be raised by increasing production.
 - (2). Whenever the marginal revenue is less than the marginal cost, profit will be raised by reducing production.
 - iii. When a business can sell as much as it would like at the market price, marginal revenue equals price (it does not have to reduce price to sell more units); and therefore, the profit-maximizing rule for such a business becomes that production rate at which price equals marginal cost.
 - (c) To decide whether to continue production at all.
 - i. If the business shuts down, it must pay the fixed cost, though not the variable cost; profit = $-F$.
 - ii. A business should continue in production:
 - (1). If the maximum profit from continuing in production is at least as large as the profit from shutting down; i.e., if the business breaks even.
 - (2). Break even condition: so long as total revenue covers variable cost; or equivalently, so long as average revenue (price) covers average variable cost.
 - (3). Sunk costs should be ignored in making a current decision.
 - (d) Individual supply curve – short run.
 - i. A graph showing the quantity that one seller will supply at every possible price. It shows the minimum price that the seller will accept for each unit of production.
 - ii. It is identical to that part of the marginal cost curve above the minimum point of the average variable cost curve.
 - iii. For every possible price of its output, a business should produce at the rate that balances its marginal cost with the price, provided that the price covers average variable cost.

- iv. As marginal cost rises when production is expanded, a seller should expand production only if it receives a higher price.
 - v. A change in the price of the output generally causes movement along a supply curve.
- (e) Demand for inputs.
- i. As the costs of inputs change, the marginal cost curve shifts up or down, the profit-maximizing scale of production changes, the demand of input also changes.
 - ii. By varying the cost of a particular input, we can determine the quantity demanded of that input at every possible cost and construct the seller's demand for that input.
 - iii. As the quantity demanded of the input will be higher at a lower input price, the demand curve will slope downward.
5. Individual supply: long run.
- (a) Costs.
- i. Based on estimates of expenses on rent, wages, and other supplies needed at various production rates when all inputs are avoidable.
 - ii. The business may incur some costs even at production level of zero, e.g., maintenance of minimum size facility.
 - iii. Long run average cost curve is lower and has a gentler slope than that of the short run. In the long run, the seller has more flexibility in adjusting inputs to changes in the production rate, and can thus produce at a lower cost. In the short run, it may not be able to change one or more inputs.
- (b) Profit-maximizing quantity to produce. The profit-maximizing rule is to produce where price equals long run marginal cost (essentially the same in the long run as for the short run).
- (c) To decide whether to continue production at all.
- i. If the business shuts down, it will incur no costs (as all costs are avoidable in the long run); profit = 0.
 - ii. A business should continue in production:
 - (1). If the maximum profit from continuing in production is at least as large as the profit from shutting down; i.e., if the business breaks even.
 - (2). Break even condition: so long as its total revenue covers total cost; or equivalently, so long as average revenue (price) covers average total cost.
- (d) Individual supply curve: long run.
- i. The long run individual supply curve is identical to that part of the long run marginal cost curve above the minimum point of the long run average total cost.

6. Market supply: short run.
 - (a) The market supply curve.
 - i. It is a graph showing the quantity that the market will supply at every possible price of the output.
 - ii. The effect of a change in the price of an output is represented by a movement along the supply curve.
 - (b) The market supply curve is the horizontal summation of the various individual sellers' supply curves. The market supply curve begins with the seller that has the lowest average variable cost, then blends in sellers with higher average variable cost.
 - (c) The market supply curve slopes upward. The higher the price of the output, each individual seller will wish to produce more, the market as a whole will also produce more.
 - (d) A change in the price of an input will affect an individual seller's marginal cost at all production levels and shift the entire marginal cost curve. Such changes will also shift the market supply curve.

7. Market supply: long run.
 - (a) The market supply curve.
 - i. It is a graph showing the quantity that the market will supply at every possible price of the output.
 - ii. The effect of a change in the price of an output is represented by a movement along the supply curve.
 - (b) The long-run market supply curve may be flat. Quantity supplied can expand through replication of existing businesses. Cost of production supplied by the new entrants should be the same as that of the existing businesses.
 - (c) The long-run market supply curve may slope upward. The resources available to various suppliers may vary in quality. New entrants may not be able to replicate the resources (especially in resource-based industries and where location is important) of existing suppliers and will incur higher costs.
 - (d) The long-run market supply curve slopes more gently upward (i.e., is more elastic) than the short-run market supply curve.
 - i. The freedom of entry and exit is a key difference between the short run and the long run: In the long run, every business has complete flexibility in deciding on inputs and production.
 - ii. In the long run, when there is a change in market price, the quantity supplied will adjust in two ways:
 - (1). All existing sellers will adjust their quantities supplied along their individual supply curves; and
 - (2). Some sellers may enter or leave the market.
 - iii. Sellers whose total revenue cannot cover total costs will leave the industry until all remaining sellers break even.

- iv. An industry where businesses are profitable (i.e., total revenue exceeds total costs) will attract new entrants. This will increase market supply, reduce market price (push down the profit of all sellers):
 - (1). Existing sellers will adjust the quantities supplied along their individual supply curves;
 - (2). Some sellers may leave or enter the market until all sellers just break even.
 - (e) A change in the price of an input and other factors than the price of output will cause a shift in the entire market supply curve.
8. Individual seller surplus.
- (a) A seller's profit varies with the price of its output.
 - (b) Seller's surplus = difference between a seller's revenue from some production rate and the minimum amount necessary to induce the seller to produce that quantity.
 - i. It is equal to the difference between price and marginal cost, for all quantities from zero up to the production level.
 - ii. In the short run, it is equal to the difference between total revenue from some production rate and the variable cost, or $R - V$.
 - iii. In the long run, it is equal to the difference between total revenue from some production rate and the total cost.
 - (c) A buyer can extract the seller's surplus. The buyer should design a bulk order and pay the seller the minimum amount to induce production at the desired level, i.e., the buyer should purchase up the seller's marginal cost curve.
 - (d) A seller's profit varies relatively more than the price of its output.
 - i. A change in price affects the revenue at the original production rate; and
 - ii. induces the seller to adjust its production level.
9. Market seller surplus.
- (a) Market seller surplus = difference between a seller's revenue from some production rate and the minimum amount necessary to induce the seller to produce that quantity.
 - i. It is equal to the sum of the individual seller surpluses; and
 - ii. It is represented graphically by the area between the price line and the market supply curve (in both the short run and the long run).
 - (b) In the long run:
 - i. If the market supply curve is flat, there will be no market seller surplus;

- ii. If the market supply curve slopes upward, there will be some market seller surplus. Seller surplus accrues to those who own the superior resources.
10. Supply of labor (as an output, as opposed to being an input).
- (a) Sellers are the individual persons.
 - (b) Individual labor supply curve.
 - i. It shows the quantity of labor that the person will supply at every possible wage.
 - ii. Slope of the individual labor supply curve: work-leisure tradeoff.
 - (1). Leisure is a consumer good.
 - a. A person's time is limited to 168 hours per day.
 - b. Increasing marginal cost of labor: the marginal cost of labor begins from a low level for 0 hours to labor and rises with increasing hours of labor.
 - c. Diminishing marginal benefit of leisure time: owing to diminishing marginal benefit, the marginal benefit of leisure starts high and declines with increasing leisure time.
 - (2). Increasing marginal cost of labor: causes the labor supply curve to slope upward. To maximize net benefit, a person chooses the quantity of labor where the marginal cost of labor equals the wage. As the marginal cost of labor increases with the quantity labor, if the wage is higher, a larger quantity of labor will be supplied.
 - (3). The income effect: causes the labor supply curve to slope downward. For any given quantity of labor, income will be higher with a higher wage. The higher income will raise the marginal benefit from leisure and the marginal cost of work, reducing the quantity of labor supplied.
 - (4). The net effect on the supply curve depends on the balance of the two effects.
 - (c) Market supply curve of labor: it is the horizontal summation of all individual supply curves of labor.
11. Price elasticity of supply.
- (a) Elasticity of supply: the responsiveness of supply to changes in an underlying factor (such as the price of the item and inputs). There is an elasticity corresponding to every factor that affects supply.
 - (b) Price elasticity of supply.
 - i. It is the percentage by which the quantity supplied will change if the price of the item rises by 1%, other things equal.

- ii. Calculated by using the arc or point approach and interpreting the resulting number.
 - iii. A pure number that does not depend on any units of measure.
 - (1). Generally the supply curves of businesses selling goods and services slope upward, so the price elasticity of supply is a positive number ranging from 0 to infinity.
 - (2). If the price elasticity is less than 1, supply is inelastic.
 - (3). If the price elasticity is more than 1, supply is elastic.
 - iv. It may vary along a supply curve.
 - v. A change in any of the factors of that affect supply may affect the price elasticity.
- (c) Intuitive factors.
- i. Capacity utilization affects both individual and market supply elasticities, e.g., if capacity is tight, the seller may not increase production much even if the price rises substantially, and supply will be relatively inelastic.
 - ii. Time under consideration. In the short run, some inputs may be costly or impossible to change, the marginal cost of production will be steep and supply inelastic. In the long run, the marginal cost of production will slope more gently, and an individual and market supply curve will be more elastic.

12. Forecasting quantity supplied. A change in price will affect revenue:

- (a) Directly; and
- (b) Through changing the sales or quantity supplied (using the price elasticity).

ANSWERS TO PROGRESS CHECKS

- 4A. The total cost curve would be higher but the variable cost curve would not change.
- 4B. The marginal and average variable cost curves would not change, but the average cost curve would be lower.
- 4C. To maximize profit, Luna must produce at the rate where marginal cost equals 75 cents. See Figure 4C on page 529 of the textbook.
- 4D. If the market price of eggs is \$1.31, Luna should produce 8000 dozen eggs a week and its revenue would be $\$1.31 \times 8,000 = \$10,840$, hence its profit would be $\$10,840 - \$7,232 = \$3,248$.

- 4E. See Figure 4E on page 530 of the textbook.
- 4F. See Figure 4F on page 530 of the textbook.
- 4G. Proportionate change in quantity = $(6500 - 5800)/6150 = 11\%$.
Proportionate change in price = $(90 - 80)/85 = 12\%$. Hence, the price elasticity = $11/12 = 0.9$.

ANSWERS TO REVIEW QUESTIONS

1. The short run is a time horizon within which a seller cannot adjust at least one input. By contrast, the long run is a time horizon long enough that the seller can adjust all inputs. Assuming that all fixed costs are also sunk, while all variable cost are not sunk, then there are fixed costs only in the short run, while all costs are variable in the long run.
2. This statement confuses average with marginal cost. The average cost is \$2. The marginal cost may be greater than, equal to, or less than \$2, depending on the production technology.
3. Nothing. Marginal costs are not necessarily related to fixed costs.
4. The marginal revenue is the change in total revenue arising from the sale of an additional unit. If the business can sell as much as it wants at the market price, then the additional unit can be sold at the market price without affecting the price at which the original units are sold. Hence, the marginal revenue equals the price.
5. Since the price of Mercury's output is less than the marginal cost, Mercury can raise profit by reducing production.
6. The analysis underestimates the increase in profit: It considers only the increase in profit on the existing production, and ignores the increase in profit resulting from an increase in production.
7. (a) Increases both average and marginal cost curves; (b) No effect; (c) Reduces both average and marginal cost curves.
8. Like any other input, advertising is subject to diminishing marginal product. Each additional dollar of advertising yields a smaller increment in sales and profit.

9. Not necessarily. In the short run, a business that is covering its variable cost should continue in production.
10. The bus operator that suspended operations may have realized that the price fell below its average variable cost, while the other that continued in business may have had an average variable cost that was below the price.
11. (a) Movement along; (b) Shift of the entire curve to the left; and (c) Shift of the entire curve to the right.
12. The buyer should design its order to leave the seller with zero seller surplus.
13. (a) False; (b) True.
14. Omitted.
15. The supply will be relatively more elastic in the long run.

WORKED ANSWER TO DISCUSSION QUESTION

Venus Ltd was finalizing plans for a brick factory. The variable and fixed costs would have been identical to those of Sol Inc.'s existing brick factory. The only difference between the two companies was that Sol had already sunk the fixed cost of its plant, while Venus had not. Then, an industry analyst forecast that, due to expansion of supply, the long-run price of bricks would fall by 20%. Venus suspended all investment plans. By contrast, Sol announced that it would continue production. Venus and Sol are so small relative to the market that each can sell as much as it would like at the market price

- a. Explain the short run break-even condition.
- b. Explain the long run break-even condition.
- c. Suppose that the new long-run price is less than Venus' average cost but higher than Sol's average variable cost. Explain why the two companies came to different decisions.

Answer:

- (a) In the short run, the business should continue production so long as its revenue covers variable costs. Or, alternatively, so long as price covers average variable cost.
- (b) In the long run, the business should continue in production so long as its total revenue covers total cost. Or, alternatively, so long as price covers average cost.

- (c) Venus was still operating in the long run---it did not yet have any fixed (sunk) costs. Because the new price was not sufficient to cover Venus's average (total) cost, it was correct to suspend investment. On the other hand, Sol was operating in the short run where some costs are fixed (sunk). Because the price is greater than Sol's average variable cost, it should continue producing.