upward along the supply curve until the equilibrium price of $2.00 is reached at point *E*. The result is that the entire red triangular area between the horizontal line at the equilibrium price and the supply curve represents total producer surplus.

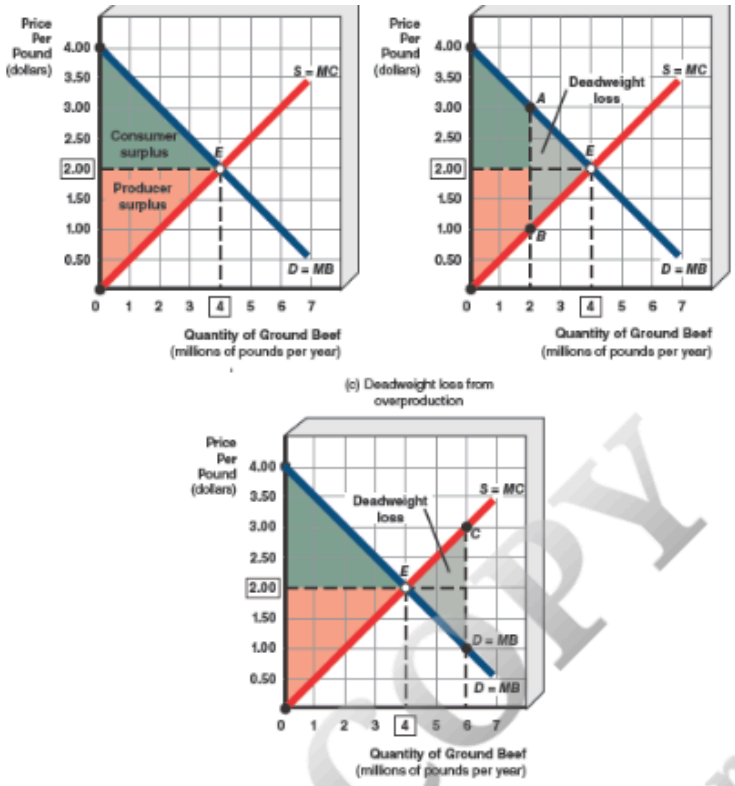
Take Note

Producer surplus is the value of the difference between the actual selling price of a product and the price producers are willing to sell it for. Total producer surplus is represented by the total area above the supply curve and below the equilibrium price.

4A-3. Market Efficiency

We learned earlier that the equilibrium price and quantity that result in a competitive market achieve market efficiency because the marginal benefit of the last unit sold (read off the demand curve) equals the marginal cost of the last unit sold (read off the supply curve). In this section, the equilibrium price and quantity will be shown to achieve market efficiency because at any other market price, the total net benefits to consumers and producers will be less. In other words, competitive markets are efficient when they maximize the sum of consumer and producer surplus. The analysis continues in Exhibit A-3(a), which combines parts (b) from each of the two previous exhibits. The green triangle represents consumer surplus earned in excess of the $2.00 equilibrium price consumers pay for ground beef. The red triangle represents producer surplus producers receive by selling ground beef at $2.00 per pound in excess of the minimum price at which they are willing to supply it. The total net benefit (total surplus) is, therefore, the entire triangular area consisting of both the green consumer surplus and red producer surplus triangles.

Exhibit A-3 Comparison of Market Efficiency and Deadweight Loss



▸ Details

In part (a), the green triangle represents consumer surplus, and the red triangle represents producer surplus. The total net benefit, or total surplus, is the entire triangle consisting of the consumer and producer surplus triangles.
In part (b), too few resources are used to produce 2 million pounds of ground beef compared to 4 million pounds at equilibrium point *E*. The market is inefficient because the deadweight loss gray triangle *ABE* is no longer earned by either consumers or producers. As shown in part (c), overproduction at the equilibrium price of $2.00 can also be inefficient. If 6 million pounds of ground beef are offered for sale, too many resources are devoted to this product and a deadweight loss of area *EDC* occurs.

Now consider in Exhibit A-3(b) the consequences to market efficiency of producers devoting fewer resources to ground beef production. If only 2 million pounds of ground beef are being bought and sold per year, the marginal benefit (point A) exceeds the marginal cost (point B), and efficiency would require devoting more resources to the production of ground beef. We can also use the analysis described in this appendix to show this inefficiency. When too few resources are devoted to ground beef production, the result is a deadweight loss.

Deadweight loss is the net loss of consumer and producer surplus from underproduction or overproduction of a product. In Exhibit A-3 (b), the deadweight loss is equal to the gray triangle *ABE*, which represents the total surplus of green and red triangles in part (a) that is not obtained because the market is operating below equilibrium point *E*.

Exhibit A-3(c) illustrates that a deadweight loss of consumer and producer surplus can also result from overproduction. Now suppose more resources are devoted to production, and 6 million pounds of ground beef are bought and sold at the equilibrium price. However, from the producers' side of the market, the equilibrium selling price is only $2.00 and is below any possible selling price on the supply curve between points *E* and *C*. Therefore, firms have a net loss for each pound sold beyond 4 million pounds, represented by the area under the supply curve and bounded below by the horizontal equilibrium price line. Similarly, consumers pay the equilibrium price of $2.00, but this price exceeds any price consumers are willing to pay between points *E* and *D* on the demand curve. This means consumers experience a total net benefit loss for each pound purchased, represented by the portion of the gray area above the demand curve but below the horizontal equilibrium price line. The total net loss of consumer and producer surplus (deadweight loss) is equal to the gray-shaded area *EDC*. This inefficiency is confirmed by noting that at 6 million pounds of ground beef exchanged per year, the marginal cost of production (point C) exceeds the marginal benefit (point D), and fewer resources should be devoted to the production of ground beef.

102

Take Note

The total dollar value of potential benefits not achieved is the deadweight loss resulting from too few or too many resources used in a given market.

103

Key Terms

Consumer surplus

Consumer Surplus

Producer Surplus

Deadweight loss

Summary

- Consumer surplus measures the value between the price consumers are willing to pay for a product along the demand curve and the price they actually pay.
- Producer surplus measures the value between the actual selling price of a product and the price along the supply curve at which sellers are willing to sell the product. Total surplus is the sum of consumer surplus and producer surplus.
- Deadweight loss is the net loss of both consumer and producer surplus resulting from underproduction or overproduction of a product.

Study Questions and Problems

Please see Appendix A for answers to the odd-numbered questions. Your instructor has access to the answers to even-numbered questions.

1. Consider the market for used textbooks. Use Exhibit A-4 to calculate the total consumer surplus.

Exhibit A-4 Used Textbook Market

Potential Seller	Willingness to Pay	Market Price
Brad	$60	$30

Juan	45	30
Sue	35	30
Jamie	25	30
Frank	10	30

2. Consider the market for used textbooks. Use Exhibit A-5 to calculate the total producer surplus.

Exhibit A-5 Used Textbook Market

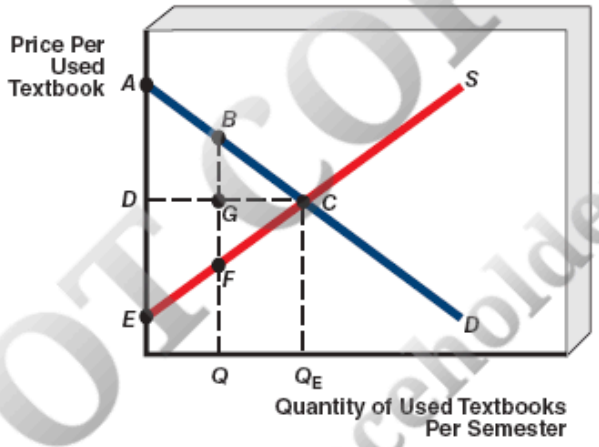
Potential Seller	Willingness to Pay	Market Price
Forest	$60	$30
Betty	45	30
Alan	35	30
Paul	25	30
Alice	10	30

3. Using Exhibits A-4 and A-5, calculate the total surplus. Then, calculate

the effect on consumer surplus, producer surplus, and total surplus of a fall in the equilibrium price of textbooks from $30 to $15 each. Explain the meaning of your calculations.

4. Using Exhibit A-6, and assuming the market is in equilibrium at Q_E, identify areas *ACD*, *DCE*, and *ACE*. Now, explain the result of underproduction at *Q* in terms of areas *BCG*, *GCF*, and *BCF*.

Exhibit A-6 Used Textbook Market



Details

Sample Quiz

Please see Appendix B for answers to Sample Quiz questions.

1. Consumer surplus measures the value between the price consumers are willing to pay and the

SHOW ANSWER

SHOW ANSWER

a. producer surplus price

a. producer surplus price.

b. deadweight gain price.

c. actual price paid.

d. preference price.

2. If Sam is willing to pay $50 for one good *X*, $30 for a second, $20 for a third, $8 for a fourth, and the market price is $10. What is Sam's consumer surplus?

SHOW ANSWER

SHOW ANSWER

a. $10

b. $40

c. $70

d. $100

3. Suppose Tucker Inc. is willing to sell one gizmo for $10, a second gizmo for $15, a third for $20, and the market price is $25. What is Tucker Inc.'s producer surplus?

SHOW ANSWER

SHOW ANSWER

a. $10

b. $15

c. $30

d. $50

4. In an efficient market, deadweight loss is

SHOW ANSWER

SHOW ANSWER

a. maximum.

b. minimum.

c. constant.

d. zero.

5. Deadweight loss results from

SHOW ANSWER

SHOW ANSWER

a. equilibrium.

b. underproduction.

c. overproduction.

d. none of the above.

e. either b or c.

6. Deadweight loss is the net loss of

SHOW ANSWER

SHOW ANSWER

a. consumer surplus.

b. producer surplus.

c. disequilibrium surplus.

d. both a and b.

7. If the quantity supplied exceeds the quantity demanded in a market, what is the result?

SHOW ANSWER

SHOW ANSWER

a. Deadweight loss

b. Inefficiency

c. Overproduction

d. All of the above answers are correct

8. Suppose a consumer is willing to pay $20 for one good *X*, $10 for a second, and $5 for a third, and the market price is $4. What is the consumer surplus?

SHOW ANSWER

SHOW ANSWER

a. $16

b. $6

c. $1

d. $23

9. Producer surplus measures the value between the actual selling price

and the

SHOW ANSWER

SHOW ANSWER

a. price sellers are willing to sell the product.

b. deadweight loss price.

c. lowest price sellers are willing to sell the product.

d. profit-maximization price.

10. Suppose seller *X* is willing to sell one good *X* for $5, a second good *X* for $10, a third for $16, a fourth for $25, and the market price is $20. What is seller *X*'s producer surplus?

SHOW ANSWER

SHOW ANSWER

a. $15

b. $20

c. $22

d. $29

11. Deadweight loss is the result of

SHOW ANSWER

SHOW ANSWER

a. disequilibrium.

b. underproduction.

c. overproduction.

d. all of the above.

12. If, at a given level of production, a deadweight loss exists, then

SHOW ANSWER

SHOW ANSWER

a. marginal benefit equals marginal cost.

b. marginal benefit is greater than marginal cost.

c. marginal benefit is less than marginal cost.

d. either b or c.

13. Deadweight loss is *not* the result of

SHOW ANSWER

SHOW ANSWER

a. an efficient market.

b. an inefficient market.

c. zero consumer surplus.

d. zero producer surplus.

14. At the equilibrium price, deadweight loss is

SHOW ANSWER

SHOW ANSWER

a. minimized.

b. zero.

c. maximized.

d. equal to the equilibrium price multiplied by the quantity exchanged.

15. If the quantity demanded exceeds the quantity supplied in a market, what is the result?

what is the result?

SHOW ANSWER

SHOW ANSWER

a. Deadweight loss

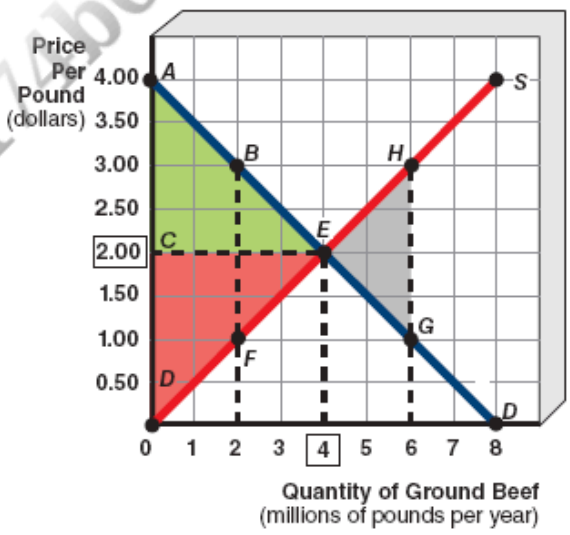
b. Inefficiency

c. Underproduction

d. All of the above answers are correct.

16. As shown in Exhibit A-7, if the market is in equilibrium, _____ represents consumer surplus.

Exhibit A-7 Comparison of Market Efficiency and Deadweight Loss



Details

SHOW ANSWER

SHOW ANSWER

a. *ABEC*

b. *AED*

c. *EGH*

d. *BEF*

17. As shown in Exhibit A-7, if the market is in equilibrium, _____ represents producer surplus.

SHOW ANSWER

SHOW ANSWER

a. *ADFB*

b. *CEFD*

c. *EGH*

d. *BEF*

18. As shown in Exhibit A-7, if the quantity supplied is 2 million pounds of ground beef per year, what is the result?

SHOW ANSWER

SHOW ANSWER

a. Deadweight loss

b. Inefficiency

c. Underproduction

d. All of the above

e. None of the above

19. As shown in Exhibit A-7, if the quantity supplied is 6 million pounds of ground beef per year, what is the result?

SHOW ANSWER

SHOW ANSWER

a. Deadweight loss

b. Inefficiency

c. Overproduction

d. All of the above

e. None of the above

20. As shown in Exhibit A-7, if the quantity supplied is 2 million pounds of ground beef per year, the result is a deadweight loss represented by area

SHOW ANSWER

SHOW ANSWER

a. *ABEC.*

b. *CEFD.*

c. *EGH.*

d. *BEF.*

Chapter 5. Elasticity

Chapter Objectives

1. Use price elasticity of demand to analyze the effects of a change in price on quantity demanded.
2. Identify factors that influence the price elasticity of demand.
3. Explain the relationship between elasticity, the demand curve, and total revenue.
4. Use other elasticity measures to classify goods (or pairs of goods) as normal, inferior, substitutes, or complements.
5. Use price elasticity of supply to analyze the effects of a change in price on quantity supplied.
6. Explain how the price elasticities of demand and supply impact tax incidence.

Introduction

Elasticity concerns how *sensitive* changes in one variable are to changes in another variable. The price elasticity of demand, for example, measures how

sensitive changes in the quantity demanded are to changes in price. That is, what happens to sales if a company raises the price of its product? We know from the law of demand that quantity will decrease, but the price elasticity of demand measures *by how much* quantity will decrease. If sales only fall a little, then the overall total revenue the firm receives from selling the product will rise. However, if sales fall a lot, then the overall total revenue the firm receives from selling the product will fall.

This chapter first teaches you how to calculate the percentage change in the quantity demanded that results when the price changes by a given percentage. Then, you will see how this relates to total revenue. You will also see how changes in price impact the quantity supplied. Finally, you will see how changes in consumer income and the prices of related goods affect percentage changes in the quantity demanded.

5-1. Price Elasticity of Demand

In Chapter 3, when you studied the demand curve, the focus was on the law of demand, which states that there is an inverse relationship between the price and the quantity demanded of a good or service. In this chapter, the emphasis is on measuring *by how much* the quantity demanded changes when the price changes. Price elasticity of demand explains how strongly consumers react to a change in price. If you think of the quantity demanded as a rubber band, then price elasticity of demand measures how "stretchy" the rubber band is when the price changes.

where Q_1 represents the first quantity demanded, Q_2 represents the second quantity demanded, and P_1 and P_2 are the first and second prices. Note that because we are finding averages, it does not matter which is the first or second number.

Now, suppose you are the manager of the Steel Porcupines rock group. At $25 per ticket, you would sell 20,000 tickets. If you raise the price to $30 per ticket, only 10,000 tickets will be sold. We can use the midpoints formula to calculate the price elasticity of demand as follows:

$$E_d = \frac{(Q_2 - Q_1)/(Q_1 + Q_2)}{(P_2 - P_1)/(P_1 + P_2)}$$

$$E_d = \frac{(10{,}000 - 20{,}000)/(20{,}000 + 10{,}000)}{(30 - 25)/(25 + 30)} = \frac{33\%}{9\%} = 3.7$$

The value of 3.7 tells us that for every 1 percent change in the price of the Steel Porcupines tickets, the quantity demanded will change in the opposite direction by 3.7 percent.

Take Note

The price elasticity of demand is the percentage change in the quantity demanded divided by the percentage change in price. The midpoints formula for calculating the price elasticity of demand is:

$$E_d = \frac{\%\Delta Q_d}{\%\Delta P} = \frac{(Q_2 - Q_1)/(Q_1 + Q_2)}{(P_2 - P_1)/(P_1 + P_2)}$$

Am I on Track?

1. Suzie's Sandwiches raises the price of a sandwich from $5 to $6

and notices sales fall from 220 sandwiches sold each week to 180 sandwiches sold each week. The price elasticity of demand for the sandwiches is:

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. 0.5

b. 0.9

c. 1.1

d. 4

5-1b. Classifying the Price Elasticity of Demand Using the Total Revenue Test

As reflected in the midpoints formula, the *responsiveness* of the quantity demanded to a change in price determines the value of the elasticity coefficient. There are three possibilities:

1. the numerator is greater than the denominator,
2. the numerator is less than the denominator, and
3. the numerator equals the denominator.

Exhibit 1 presents three cases that the Steel Porcupines rock band may confront.

Exhibit 3 Price Elasticity of Demand Terminology

Elasticity coefficient	Definition	Demand	Graph
$E_d > 1$	Percentage change in quantity demanded is greater than the percentage change in price	Elastic	
$E_d < 1$	Percentage change in quantity demanded is less than the percentage change in price	Inelastic	
$E_d = 1$	Percentage change in quantity demanded is equal to the percentage change in price	Unitary elastic	
$E_d = \infty$	Percentage change in quantity demanded is infinite in relation to the percentage change in price	Perfectly elastic	
$E_d = 0$	Quantity demanded	Perfectly	

	does not change as the price changes	inelastic	

Am I on Track?

2. Tianyi notices that each time she raises the price of her lawn mowing services, total revenue falls. We can conclude that the price elasticity of demand for lawn mowing services is:

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. elastic.

b. inelastic.

c. unit elastic.

d. perfectly elastic.

5-1c. Determinants of Price Elasticity of Demand

Economists have estimated price elasticity of demand for various goods and services. Exhibit 4 presents some of these estimates, and, as you can see, the elasticity coefficients vary a great deal. Why do the price elasticities of demand

for these products vary so much? The following factors cause these differences:

1. Availability of substitutes
2. Share of budget spent on the product
3. Adjustment to a price change over time

Exhibit 4 Estimated Price Elasticities of Demand

Item	Elasticity Coefficient	
	Short Run	Long Run
Automobiles	1.87	2.24
Chinaware	1.54	2.55
Movies	0.87	3.67
Tires	0.86	1.19
Commuter rail fares	0.62	1.59
Jewelry and watches	0.41	0.67
Medical care	0.31	0.92
Housing	0.30	1.88
Gasoline	0.34	0.84

Theater and opera tickets	0.18	0.31
Foreign travel	0.14	1.77
Air travel	0.10	2.40

Source: Martijn Brons, PeterNijkamp, Eric Pels, and Piet Rietveld, "A Meta-Analysis of the Price Elasticity of Gasoline Demand. a SUR Approach," *Energy Economics*, Volume 30, Issue 5, September 2008, pp. 2105–2122; Robert Archibald and Robert Gillingham, "An Analysis of the Short-Run Consumer Demand for Gasoline Using Household Survey Data," *Review of Economics and Statistics* 62 (November 1980), pp. 622–628; Hendrik S. Houthakker and Lester D. Taylor, *Consumer Demand in the United States: Analyses and Projections* (Cambridge, MA: Harvard University Press, 1970, pp. 56–149; Richard Voith, "The Long-Run Elasticity of Demand for Commuter Rail Transportation," *Journal of Urban Economics* 30 (November 1991), pp. 360–372.

Availability of Substitutes

By far, the most important influence on price elasticity of demand is the availability of substitutes. Demand becomes more elastic for a good or service when the number of close substitutes increases. If the price of cars rises, consumers can switch to buses, trains, bicycles, and walking. The more public transportation is available, the more responsive quantity demanded is to a change in the price of cars. When consumers have limited alternatives, the demand for a good or service is more price inelastic.

If the price of tobacco rises, people who are addicted to it have few substitutes because not smoking is unappealing to most users. Price elasticity also depends on how narrowly the market is defined—the price elasticity of Toyota Camrys is greater than the price elasticity of automobiles in general because there are more close substitutes for Camrys (other makes and models of cars as well as other forms of transportation) than there are for all cars (with only other forms of transportation as substitutes).

Share of Budget Spent on the Product

When the price of salt changes, consumers pay little attention. Why should they notice? The price of salt or toothpicks can double, and this purchase will remain a small percentage of one's budget. If, however, college tuition or housing prices double, people will look for alternatives. These goods and services account for a large part of people's budgets, so they have a more elastic demand.

Adjustment to a Price Change Over Time

As time passes, buyers can respond fully to a change in the price of a product by finding more substitutes. Consider the demand for gasoline. In the short run, people find it hard to cut back the amount they buy when the price rises sharply. They are accustomed to driving back and forth to work alone in their cars. The typical short-run response is to cut luxury travel and reduce speed on trips. If high prices persist over time, car buyers will find ways to cut back. They can buy cars with better fuel economy, form carpools, and ride buses or commuter trains. This explains why the short-run elasticity coefficient of gasoline in Exhibit 4 is more inelastic at 0.34 than the long-run elasticity coefficient of 0.84.

Take Note

Demand is more elastic when there are more close substitutes available, when a larger share of one's budget is spent on the product, or when there is more time available to adjust to a price change.

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Take Note

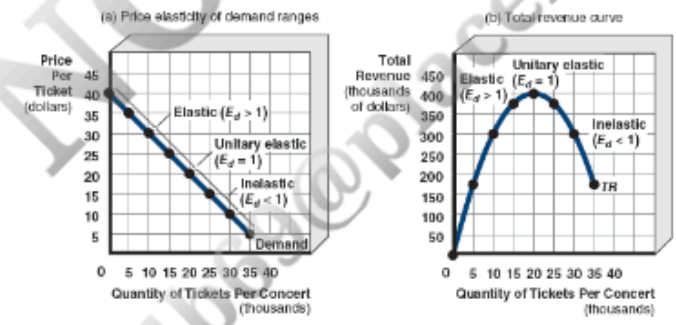
Demand is more elastic when there are more close substitutes available, when a larger share of one's budget is spent on the product, or when there is more time available to adjust to a price change.

5-2. Price Elasticity of Demand along a Demand Curve

The price elasticity of demand for a downward-sloping straight-line demand

curve varies as we move along the curve. Look at Exhibit 5, which shows a linear demand curve in part (a) and the corresponding total revenue curve in part (b). Begin at $40 on the demand curve and move down to $35, to $30, to $25, and so on. The table in Exhibit 5 lists variations in the total revenue and the elasticity coefficient, E_d, at different ticket prices. As we move down the upper segment of the demand curve where $E_d > 1$ and demand is elastic, price falls, and total revenue rises. Recall that when the demand is elastic, the percentage change in the quantity demanded is larger than the percentage change in price. So, a price decrease corresponds to a large increase in sales, and overall revenues increase. At $20, price elasticity is unitary elastic, $E_d = 1$, and total revenue is maximized at $400,000. As we move down the lower segment of the demand curve, price elasticity of demand falls below a value of 1.0, so now, price decreases correspond to small increases in sales and total revenue falls.

Exhibit 5 The Variation in Elasticity and Total Revenue along a Hypothetical Demand Curve



Calculation of Total Revenue and Elasticity along a Hypothetical Demand Curve

Price	Quantity (thousands of tickets)	Total Revenue (thousands of dollars)	Elasticity Coefficient (E_d)	Price Elasticity of Demand
$40	0	$0		
			15.00	Elastic
35	5	175		
			4.33	Elastic
30	10	300		
			2.20	Elastic
25	15	375		
			1.29	Elastic
20	20	400	1.00	Unitary elastic
			0.78	Inelastic
15	25	375		
			0.45	Inelastic
10	30	300		
			0.23	Inelastic
5	35	175		

▸ Details

Part (a) shows a straight-line demand curve and its three elasticity ranges. In the $40–$20 price range, demand is elastic. As price decreases in this range, there is a large quantity response, and total revenue increases. At $20, demand is unitary elastic, and total revenue is at its maximum. Below $20, demand is inelastic. As price decreases in this range, there is a relatively small quantity response, and total revenue decreases. The total revenue (TR) curve is plotted in part (b) to trace its relationship to price elasticity.

A Closer Look Applicable Concept: Price Elasticity of Demand

Cigarette Smoking Price Elasticity of Demand

Tobacco use is one of the chief preventable causes of death in the world. Since 1964, health warnings have been mandated in the United States on tobacco advertising, including billboards and printed advertising. In 1971, television advertising was prohibited. Most states have banned smoking in state buildings, and the federal government has restricted smoking in federal offices and military facilities.

One way to curb smoking is to raise cigarette taxes. This can be especially effective in preventing teenagers from picking up the habit. Studies by Alexander Ding estimate the price elasticity of demand for cigarettes for youth to be elastic at 1.4 and for adults to be inelastic at 0.2 , . This means that if prices rise by 10 percent, cigarette consumption will fall by about 14 percent among the young but by only 2 percent among adults.

The passage of the Children's Health Insurance Program Reauthorization Act of 2009 more than doubled the cigarette tax per pack from $0.39 to $1.01 per pack. Critics argue that this price increase would be a massive tax on low-income Americans that would generate huge revenues to finance additional government programs and spending. In fact, proponents, in part, raised the cigarette tax to fund the increased costs of expanding the State Children Health Insurance Program (SCHIP). In addition, proponents argued that it is not about taxes. Instead, the legislation is an attack on the death march of Americans who die early from tobacco-related diseases.

Estimates of the price elasticity of demand vary significantly across states from 2.00 (Kentucky) to 0.09 (Mississippi). The price elasticity of demand for cigarettes also appears to vary by education.

PhotoVectorStudio/Shutterstock.com

Less-educated adults are more responsive to price changes than better-educated adults. This finding supports the theory that less-educated people are more present-oriented, or "myopic," than people with more education. Thus, less-educated individuals tend to be more influenced by current changes in the price of a pack of cigarettes. * Another study in 2000 confirmed that education has strong negative effects on the quantity of cigarettes smoked, especially for high-income individuals. The presence of young children reduces smoking, with the effect most pronounced for women. *

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5-3. Other Elasticity Measures

The elasticity concept has other applications beyond calculating the price elasticity of demand. Broadly defined, elasticity is a technique for measuring the response of one variable to changes in some other variable.

5-3a. Income Elasticity of Demand

Recall from Chapter 3 that an increase in income can increase demand for a normal good or service and decrease demand for an inferior good or service. To measure exactly how consumption responds to changes in income, economists calculate the income elasticity of demand. **Income elasticity of demand** is the ratio of the percentage change in the quantity demanded of a good or service to a given percentage change in income. We use a midpoints formula similar to the one we used for calculating price elasticity of demand:

$$E_I = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$$

$$E_I = \frac{\%\Delta Q}{\%\Delta I} = \frac{\dfrac{Q_2 - Q_1}{Q_1 + Q_2}}{\dfrac{I_2 - I_1}{I_1 + I_2}}$$

where E_I is the income elasticity of demand coefficient, Q_1 and Q_2 represent

where E_I is the income elasticity of demand coefficient, q_1 and q_2 represent quantities demanded before and after the income change, and I_1 and I_2 represent income before and after the income change.

For a *normal* good or service, the income elasticity of demand is *positive*, $E_I > 0$. Recall that for this type of good, demand and income move in the same direction. Thus, the variables in the numerator and denominator change in the same direction. For an *inferior* good or service, the reverse is true, and the income elasticity of demand is *negative*, $E_I < 0$.

Why is the income elasticity coefficient important? Returning to our rock group example, the Steel Porcupines band needs to know the impact of a recession on ticket sales. During a downturn, when consumers' incomes fall, if a rock concert is a *normal good*, the quantity of ticket sales falls. Conversely, if a rock concert is an *inferior good*, the quantity of ticket sales rises.

income elasticity of demand. **Income elasticity of demand** is the ratio of the percentage change in the quantity demanded of a good or service to a given percentage change in income. We use a midpoints formula similar to the one we used for calculating price elasticity of demand:

$$E_I = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$$

$$E_I = \frac{\%\Delta Q}{\%\Delta I} = \frac{\frac{Q_2 - Q_1}{Q_1 + Q_2}}{\frac{I_2 - I_1}{I_1 + I_2}}$$

where E_I is the income elasticity of demand coefficient, Q_1 and Q_2 represent quantities demanded before and after the income change, and I_1 and I_2 represent income before and after the income change.

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5-3b. Cross-Elasticity of Demand

In Chapter 3, we learned that a change in the price of one good, *Y*, can cause the consumption of another good, *X*, to change. This responsiveness of the quantity demanded to a change in the price of some other good is estimated by the cross-elasticity of demand. **Cross-elasticity of demand** is the ratio of the percentage change in the quantity demanded of a good or service to a given percentage change in the price of another good or service. Again, we use the midpoints formula as follows to compute the cross-elasticity coefficient of demand:

$$E_c = \frac{\text{percentage change in quantity demanded of one good}}{\text{percentage change in price of another good}}$$

$$E_c = \frac{\%\Delta Q_x}{\%\Delta P_Y} = \frac{\dfrac{Q_{x_2} - Q_{x_1}}{Q_{x_1} + Q_{x_2}}}{\dfrac{P_{Y_2} - P_{Y_1}}{P_{Y_1} + P_{Y_2}}}$$

where E_c is the cross-elasticity coefficient, Q_{x_1} and Q_{x_2} represent quantities before and after the price of another good or service changes, and P_{Y_1} and P_{Y_2} represent the price of another good or service before and after the price change.

The cross-elasticity coefficient reveals whether a good or service is a *substitute* or a *complement*. For example, suppose Coke increases its price 10 percent, which causes consumers to buy 5 percent more Pepsi. The cross-elasticity of demand for Pepsi is

positive 0.50 $(+5 \text{ percent}/+10 \text{ percent})$. Since $E_c > 0$, Coke and Pepsi are *substitutes* because the numerator and denominator variables change in the same direction. The larger the positive coefficient, the greater the substitutability between the two goods.

Now suppose there is a 50 percent increase in the price of motor oil, and the quantity demanded of gasoline decreases by 10 percent. The cross-elasticity of demand for gasoline is *negative* 0.20 $(-10 \text{ percent}/+50 \text{ percent})$. The variables in the numerator and denominator change in opposite directions. Since $E_c < 0$, these two goods are *complements*. The larger the negative coefficient, the greater the complementary relationship between the two goods.

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Now suppose there is a 50 percent increase in the price of motor oil, and the quantity demanded of gasoline decreases by 10 percent. The cross-elasticity of demand for gasoline is *negative* 0.20 . The variables in the numerator and denominator change in opposite directions. Since , these two goods are *complements*. The larger the negative coefficient, the greater the complementary relationship between the two goods.

5-3c. Price Elasticity of Supply

The price elasticity of supply closely follows the price elasticity of demand concept. **Price elasticity of supply** is the ratio of the percentage change in the quantity supplied of a product to the percentage change in its price. This elasticity coefficient is calculated using the following formula:

---

where is the price elasticity of supply coefficient. Since price and quantity supplied change in the same direction, the elasticity coefficient is a positive value. Economists use terminology corresponding to that for the price elasticity of demand. Supply is *elastic* when , *unit elastic* when , *inelastic* when , *perfectly elastic (expressed graphically as a horizontal supply curve)* when , and *perfectly inelastic (expressed graphically as a vertical supply curve)* when .

In Chapter 8, we will explain why the time period of analysis is a primary determinant of the shape of the supply curve. More specifically, it will show that price elasticity of supply is greater in the long run than in the short run. Thus, the long-run supply curve will be flatter (more elastic).

Exhibit 7 gives a summary of the three elasticity concepts presented in this

section.

Exhibit 7 Summary of Other Elasticity Concepts

Type	Definition
Income elasticity of demand	$\frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in income}}$
Cross-elasticity of demand	$\frac{\text{Percentage change in quantity demanded of one good}}{\text{Percentage change in price of another good}}$
Price elasticity of supply	$\frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}}$

Summary

- Price elasticity of demand is a measure of the responsiveness of the quantity demanded to a change in price. Specifically, price elasticity of demand is the ratio of the percentage change in quantity demanded to the percentage change in price.

$$E_{\mathrm{d}} = \frac{\%\Delta Q}{\%\Delta P} = \frac{\frac{Q_2 - Q_1}{Q_1 + Q_2}}{\frac{P_2 - P_1}{P_1 + P_2}}$$

- Elastic demand occurs where there is a change of more than 1 percent in quantity demanded in response to a 1 percent change in price. Demand is elastic when the elasticity coefficient is greater than 1 and *total revenue* (price times quantity) varies inversely with the direction of the price change.

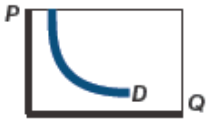
▸ Details

- Inelastic demand occurs where there is a change of less than 1 percent in quantity demanded in response to a 1 percent change in price. Demand is inelastic when the elasticity coefficient is less than 1, and total revenue varies directly with the direction of the price change.

▸ Details

- Unitary elastic demand occurs where there is a 1 percent change in quantity demanded in response to a 1 percent change in price. Demand is

quantity demanded in response to a 1 percent change in price. Demand is unitary elastic when the elasticity coefficient equals 1, and total revenue remains constant as the price changes.

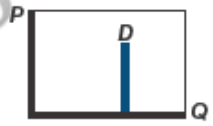


▸ Details

- Perfectly elastic demand occurs when the quantity demanded declines to zero for even the slightest rise or fall in price. This is an extreme case in which the demand curve is horizontal, and the elasticity coefficient equals infinity.

▸ Details

- Perfectly inelastic demand occurs when the quantity demanded does not change in response to price changes. This is an extreme case in which the demand curve is vertical, and the elasticity coefficient equals zero.



▸ Details

- Determinants of price elasticity of demand include:

  the availability of substitutes,

  the percentage of one's budget spent on the product, and

  the length of time allowed for adjustment.

  Each of these factors is directly related to the elasticity

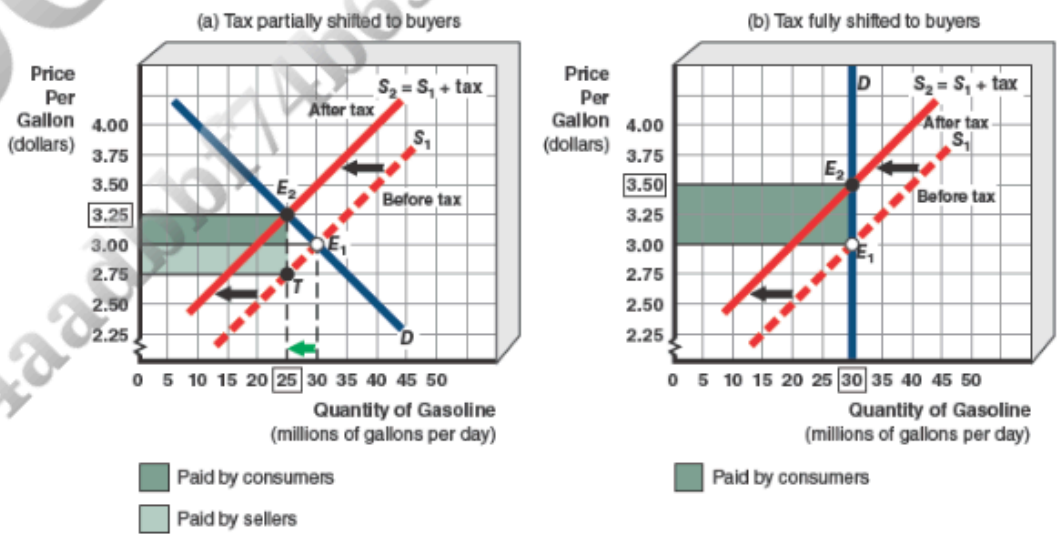
coefficient.

- Income elasticity of demand is the percentage change in the quantity demanded divided by the percentage change in income. For a *normal* good or service, income elasticity of demand is positive. For an *inferior* good or service, income elasticity of demand is negative.

- Cross-elasticity of demand is the percentage change in the quantity demanded of one product caused by a change in the price of another product. When the cross-elasticity of demand is positive, the two products are substitutes. When the cross-elasticity of demand is negative, the two products are complements.

- Price elasticity of supply is a measure of the responsiveness of the quantity supplied to a change in price. Price elasticity of supply is the ratio of the percentage change in the quantity supplied to the percentage change in price.

- Tax incidence is the share of a tax ultimately paid by buyers and sellers. Facing a downward-sloping demand curve and an upward-sloping supply curve, sellers cannot raise the price by the full amount of the tax. If the demand curve is vertical, sellers will raise the price by the full amount of the tax.



▸ Details

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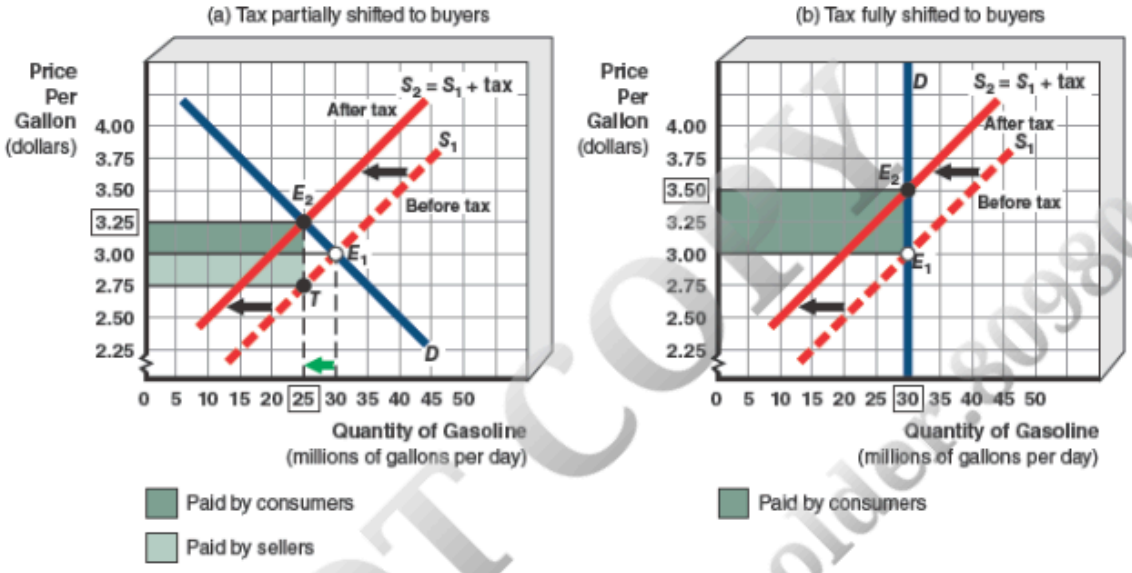

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Take Note Revisited

- The price elasticity of demand is the percentage change in the quantity demanded divided by the percentage change in price. The midpoints formula for calculating the price elasticity of demand is:

$$E_{\mathrm{d}} = \frac{\%\Delta Q}{\%\Delta P} = \frac{(Q_2 - Q_1)/(Q_1 + Q_2)}{(P_2 - P_1)/(P_1 + P_2)}$$

- Demand is more elastic when there are more close substitutes available, when a larger share of one's budget is spent on the product, or when there is more time available to adjust to a price change.

- When demand is elastic, a decrease in price results in a relatively larger increase in the quantity sold, and total revenue increases. When demand

increase in the quantity sold, and total revenue increases. When demand is inelastic, a decrease in price results in a relatively small increase in the quantity sold, and total revenue falls.

- The tax incidence, or the share of a tax ultimately paid for by consumers or producers, is determined by the price elasticity of demand and supply.

Study Questions and Problems

Please see Appendix A for answers to the odd-numbered questions. Your instructor has access to the answers to even-numbered questions.

1. If the price of a good or service increases, and the total revenue received by the seller declines, is the demand for this good over this segment of the demand curve elastic or inelastic? Explain.

SHOW ANSWER

2. Suppose the price elasticity of demand for farm products is inelastic. If the federal government wants to follow a policy of increasing income for farmers, what type of programs will the government enact?

3. Suppose the price elasticity of demand for used cars is estimated to be 3. What does this mean? What will be the effect on the quantity demanded for used cars if the price rises by 10 percent?

SHOW ANSWER

4. Consider the following demand schedule:

Price	Quantity Demanded	Elasticity Coefficient
$25	20	
20	40	_____
15	60	_____

15	60	_____
10	80	_____
5	100	_____

What is the price elasticity of demand between

a. $P = \$25$ and $P = \$20$?

b. $P = \$20$ and $P = \$15$?

c. $P = \$15$ and $P = \$10$?

d. $P = \$10$ and $P = \$5$?

5. Suppose a university raises its tuition from $30,000 to $35,000. As a result, student enrollment falls from 5,000 to 4,500. Calculate the price elasticity of demand. Is demand elastic, unitary elastic, or inelastic?

SHOW ANSWER

6. Will each of the following changes in price cause total revenue to increase, decrease, or remain unchanged?

a. The price falls, and demand is elastic.

b. The price rises, and demand is elastic.

c. The price falls, and demand is unitary elastic.

d. The price rises, and demand is unitary elastic.

e. The price falls, and demand is inelastic.

e. The price falls, and demand is inelastic.

f. The price rises, and demand is inelastic.

7. Suppose a movie theater raises the price of popcorn by 10 percent, but customers do not buy any less popcorn. What does this tell you about the price elasticity of demand? What will happen to total revenue as a result of the price increase?

SHOW ANSWER

8. Charles loves Mello Yello and will spend $10 per week on the product no matter what the price. What is his price elasticity of demand for Mello Yello?

9. Which of the following pairs of goods has the higher price elasticity of demand?

a. Oranges or Sunkist oranges

b. Cars or salt

c. Foreign travel in the short run or foreign travel in the long run

SHOW ANSWER

10. The Energizer Bunny that "keeps going and going" has been a very successful ad campaign for batteries. Explain the relationship between this slogan and the firm's price elasticity of demand and total revenue.

11. Suppose the income elasticity of demand for furniture is 3.0 and the income elasticity of demand for physician services is 0.3. Compare the impact on furniture and physician services of a recession that reduces consumers' incomes by 10 percent.

SHOW ANSWER

12. How could you determine whether Nike and Reebok are in competition with each other?

13. Assume the cross-elasticity of demand for car tires with respect to the price of cars is -2 . What does this tell you about the relationship between car tires and cars when the price of cars rises by 10 percent?

SHOW ANSWER

14. Consider the following supply schedule:

Price	Quantity Supplied	Elasticity Coefficient
$10	50	
8	40	_____
6	30	_____
4	20	_____
2	10	_____
0	0	_____

What is the price elasticity of supply between

- **a.** $P = \$10$ and $P = \$8$?
- **b.** $P = \$8$ and $P = \$6$?
- **c.** $P = \$6$ and $P = \$4$?
- **d.** $P = \$4$ and $P = \$2$?
- **e.** $P = \$2$ and $P = \$0$?

- Why would consumers prefer that the government tax products with elastic rather than inelastic demand?

  As the demand for a product becomes more inelastic, the greater the amount of a tax on this product that sellers can pass on to consumers by raising the product's price.

- Opponents of increasing the tax on gasoline argue that the big oil companies just pass the tax along to the consumers. Do you agree or disagree? Explain your answer.

- The marketing staff at American Airlines is concerned about low sales revenues and announces special cuts in its fares this summer. The New York to Los Angeles fare, for example, is reduced from $500 to $420. Does the American Airlines staff think demand is elastic, unitary elastic, or inelastic?

  American Airlines must believe the quantity of airline tickets demanded during the summer is quite responsive to a price cut. For total revenue to rise with a price cut, the quantity demanded must increase by a larger percentage than the percentage decrease in the price. For this to occur, the price elasticity of demand must exceed 1.

- If Congress prohibited the sale of Japanese luxury cars, such as Lexus, Acura, and Infiniti, in the United States, how would this affect the price elasticity of demand for Mercedes, BMWs, and Jaguars in the United States?

- When Honda introduced the Acura to compete with European luxury cars, there was a danger that the new line would take sales away from Honda's Accord. To make Acura more competitive with other luxury cars, suppose Honda cuts the price of the Acura while keeping the price of the Accord unchanged. If Honda's fear comes true, will it find a negative cross-elasticity of demand or a positive cross-elasticity of demand?

  The cross-elasticity of demand would be positive if Acuras and Accords are substitutes for one another (Acuras would take sales away from Accords). Decreasing the price of Acuras results in fewer Accords being sold and a positive cross-elasticity.

Sample Quiz

Please see Appendix B for the answers to the Sample Quiz questions.

1. A perfectly elastic demand curve has an elasticity coefficient of

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. 0.

b. 1.

c. less than 1.

d. infinity.

2. If the percentage change in the quantity demanded of a good is less than the percentage change in price, price elasticity of demand is

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. elastic.

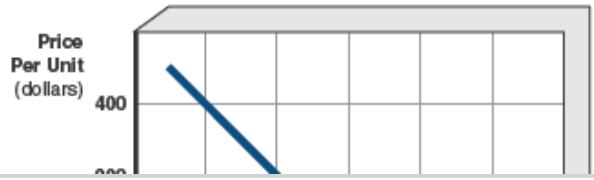
b. inelastic.

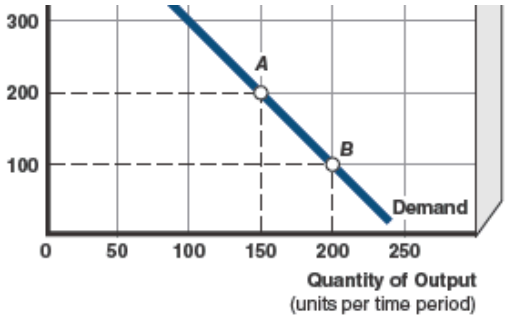
c. perfectly inelastic.

d. unitary elastic.

3. As shown in Exhibit 9, the price elasticity of demand for good *X* between points *A* and *B* is

Exhibit 9 Demand Curve for Good *X*





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SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. $3/7 = 0.43$.

b. $7/3 = 2.33$.

c. $\frac{1}{2} = 0.50$.

d. 1.

Chapter 6. Consumer Choice Theory

Chapter Objectives

1. Define utility.
2. Describe the law of diminishing marginal utility.
3. Explain how consumers maximize utility using the concept of marginal utility per dollar spent.
4. Explain how the law of demand can be derived using the law of diminishing marginal utility and consumer equilibrium.
5. Describe how the income and substitution effects can explain the law of demand.

Introduction

This chapter expands our understanding of demand by investigating more deeply *why* people buy goods and services. In Chapter 3, the law of demand rested on a foundation of common sense and everyday observation. When the price of a Big Mac falls, people *do* buy more, and a price rise causes people to

price of a Big Mac falls, people *do* buy more, and a price rise causes people to buy less. But there is more to the story.

The focus of this chapter is the logic of consumer behavior. Why does a consumer buy one bundle of goods rather than another? Suppose someone asked why you bought a milkshake and french fries, rather than a Coke and a hot dog. You would probably answer that given the money you had to spend, the Coke and hot dog would have given you less satisfaction. In this chapter, you will transform this simple explanation into consumer choice theory and then connect this theory to the law of demand.

6-1. From Utility to the Law of Demand

The basis of the law of demand is self-interested behavior. Consumers spend their limited budget to satisfy some want, such as eating a Big Mac or driving a new car. The motivation to consume goods and services is to gain utility. **Utility** is the satisfaction, or pleasure, that people receive from consuming a good or service. Utility is want-satisfying power "in the eye of the beholder." Just as
130 wants differ among people, utility received from consumption varies from person to person. Fred's utility from consuming a BMW will probably differ from Maria's utility. In spite of the subjective nature of utility, this section develops in steps the derivation of a demand curve based on the utility concept.

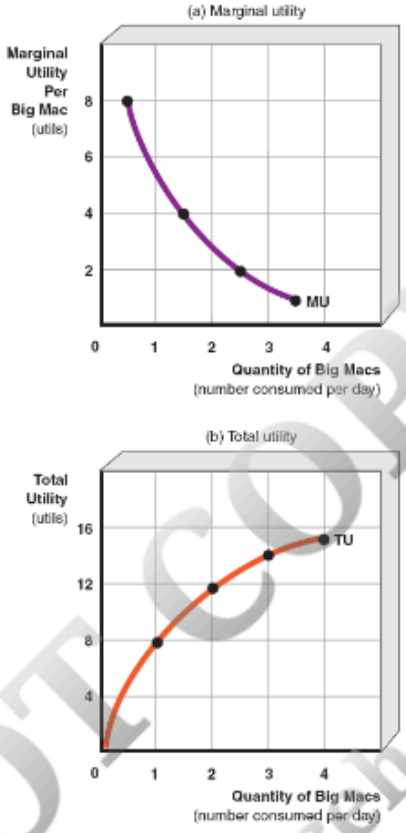
want-satisfying power "in the eye of the beholder." Just as wants differ among people, utility received from consumption varies from person to person. Fred's utility from consuming a BMW will probably differ from Maria's utility. In spite of the subjective nature of utility, this section develops in steps the derivation of a demand curve based on the utility concept.

6-1a. Total Utility and Marginal Utility

Actual measurement of utility is impossible because only you know the satisfaction from consuming, say, four Big Macs in one day. But suppose we could gauge your total utility of consuming four Big Macs in a day. **Total utility** is the amount of satisfaction received from all the units of a good or service consumed. That is, the utility of the first unit consumed added to that of the second unit, and so on. What units can be used to measure total utility? Economists use a mythical unit called a *util*, which allows us to quantify our thinking about consumer behavior.

No one has invented a "utility meter," but assume we could connect such a meter to your brain. Like taking your temperature, we could read the marginal utility each time you eat a Big Mac. **Marginal utility** is the change in total utility from one additional unit of a good or service. Instead of the total pleasure from eating X number of Big Macs, the question is how much *extra* satisfaction the first, second, or third Big Mac gives you. For example, Exhibit 1(a) shows your marginal utility data for eating four Big Macs in a day. You munch down the first Big Mac. Ah, the util meter hits an 8. You grab another Big Mac and eat it a little more slowly. The util meter hits 4 this time. You're starting to feel full, but you eat a third Big Mac. This one gets a 2. Even though you are pretty full, there is room for one more. You eat the fourth Big Mac very slowly, and it gives you less satisfaction than any of the previous burgers. Your utility meter reads 1. This trend conforms to the law of diminishing marginal utility. The **law of diminishing marginal utility** is the principle that the extra satisfaction provided by a good or service declines as people consume more in a given period. Economists have found that this is a universal principle of human consumption behavior.

Exhibit 1 Marginal Utility and Total Utility Curves for Consuming Big Macs



▸ Details

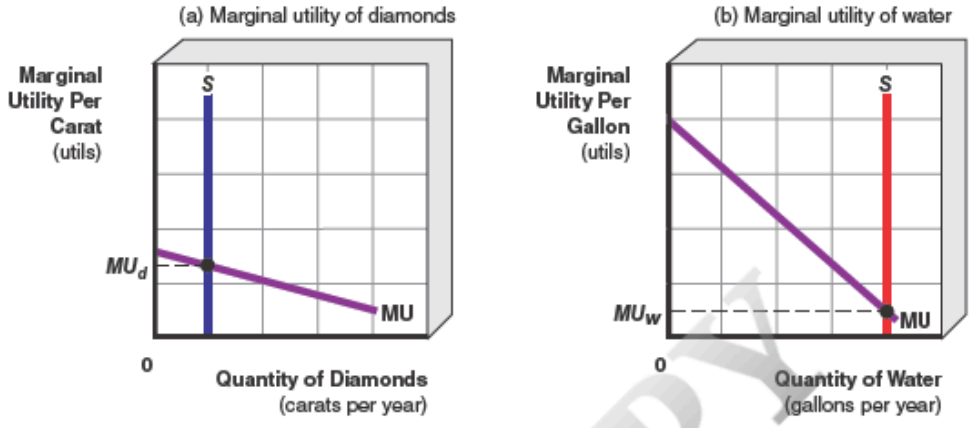
Part (a) shows that as more Big Macs are consumed per day, the utility from each additional Big Mac declines*. The utils are only imaginary because utility cannot be measured. When the marginal utility of each Big Mac consumed is summed, we obtain the total utility curve shown in part (b). *Graphically, marginal utility is plotted at the midpoints to represent that the change in total utility occurs between each additional unit of Big Macs consumed.

Exhibit 1(a) is a marginal utility (MU) graph. Consistent with the law of diminishing marginal utility, the MU curve slopes downward as you consume more Big Macs. This reflects a steady decline in the utility of each additional Big Mac consumed. If you continue to eat Big Macs, a quantity of Big Macs is eventually reached at which the marginal utility is zero. Here you say to yourself, "If I eat another bite, I'll be sick." Then if you did eat another bite after

all, marginal utility would be negative. A rational person never consumes goods when the marginal utility is negative (disutility) unless they are paid enough to do so. In our example, we assume you are rational and will not eat a Big Mac that gives you a negative marginal utility and a stomach ache. Also keep in mind that the MU curve for a good is different for different circumstances and individuals. Your MU curve would be much higher if you had not eaten in days. On the other hand, a vegetarian would receive no positive marginal utility from consuming a Big Mac.

Exhibit 1(b) shows how the shape of the total utility (TU) curve varies with marginal utility as you consume more Big Macs each day. The total utility of Big Macs increases steadily because each hamburger provides *additional* satisfaction to the sum of all the Big Macs already consumed. However, the TU curve becomes flatter as the marginal utility diminishes. This is because, as you consume more, the positive pleasure per Big Mac declines, and, in turn, each Big Mac adds less to total utility.

Exhibit 2 The Diamond–Water Paradox



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6-1 b. Consumer Equilibrium

We will now make our example of consumer choice more realistic. Let's examine how Bob Moore, a sophomore at Seaview College, might behave, given a limited budget and the choice between two goods. Suppose Bob goes to McDonald's for lunch with $8 in his pocket to spend for Big Macs and milkshakes. The price of a Big Mac is $2, and the price of a milkshake is also $2. How can Bob enjoy the maximum total utility with his limited money?

Recall from Chapter 2 the concept of *marginal analysis*. This is the method Bob uses to decide how many Big Macs and milkshakes to order. Exhibit 3 shows Bob's marginal utility for each Big Mac and milkshake consumed. The *marginal utility per dollar* (MU/P) is the ratio of the marginal utility of each good to its price. In making purchases, the key consideration is how additional satisfaction relates to price. Using marginal decision-making before ordering his lunch, Bob compares the marginal utility of one Big Mac to the marginal utility of one milkshake. Being a rational consumer, Bob sees that spending his first $2 on a Big Mac gives more "bang for the buck." The first Big Mac gives him 4 utils per dollar, but the same $2 spent on a milkshake gives him 3 utils per dollar. Next, Bob ponders how to spend his next $2. The best buy now is a milkshake because

it gives 3 utils per dollar compared to 2 utils per dollar for a second Big Mac.

Exhibit 3 Marginal Utility for Big Macs and Milkshakes (Utils per Day)

Quantity	Big Macs		Milkshakes	
	MU	MU/P	MU	MU/P
1	8	4	6	3
2	4	2	4	2
3	2	1	1	1/2
4	1	1/2	0	0

Note: The price per Big Mac and per milkshake is $2.

Spending Bob's last $4 is a toss-up. Both the second Big Mac and the second milkshake give the same 2 utils per dollar. So Bob can spend $2 for a second Big Mac and his last $2 for a second milkshake. Or he can spend $2 for a second milkshake and his last $2 for a second Big Mac. The order does not matter. Now that Bob has spent all his income, the marginal utility per dollar of the last Big Mac is equal to the marginal utility per dollar of the last milkshake.

To convince yourself that two Big Macs and two milkshakes do indeed maximize total utility, consider any other combination Bob could buy with $8. All others yield lower total utility. Suppose Bob were to buy three Big Macs and one milkshake. The third Big Mac adds 2 utils, but giving up the second milkshake

milkshake. The third Big Mac adds 2 utils, but giving up the second milkshake subtracts 4 utils. As a result, total utility falls by 2 utils. Or can Bob maximize utility if he were to eat only one Big Mac and drink three milkshakes? The extra utility of the third milkshake is 1 util, but this is less than the 4 utils he would lose by saying no to the second Big Mac. In this case, total utility would fall by 3 utils.

This example demonstrates the utility-maximizing concept of consumer equilibrium. **Consumer equilibrium** is a condition in which total utility cannot increase by spending more of a given budget on one good and spending less on another good. Suppose Bob knows not only the exact marginal utility of consuming Big Macs and milk-shakes, but also the marginal utility of french
134 fries, pizza, and other goods. To obtain the highest possible satisfaction, Bob allocates his budget so that the last dollar spent on good *A*, the last on good *B*, and so on, yield equal MU/P ratios. Consumer equilibrium can be restated algebraically as follows:

$$\frac{\text{MU of good } A}{\text{Price of good } A} = \frac{\text{MU of good } B}{\text{Price of good } B} = \frac{\text{MU of good } Z}{\text{Price of good } Z}$$

The letters *A*, *B*, ... *Z* indicate all the various goods and services purchased by the consumer with a given budget.

Take Note

If the marginal utility per last dollar spent on each good is equal and the entire budget is spent, total utility is maximized.

Am I on Track?

1. Return to the example in Exhibit 3, in which Bob has $8 to spend on Big Macs, which cost $2, and milkshakes, which also cost $2.

Now suppose instead, the price of a Big Mac is $4 (and Bob still has $8 to spend and milkshakes still cost $2 each). Which of the following combinations of Big Macs and milkshakes maximizes Bob's total utility given the $8 he has to spend?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. 2 Big Macs and 2 milkshakes

b. 1 Big Mac and 2 milkshakes

c. 1 Big Mac and 3 milkshakes

d. 0 Big Macs and 4 milkshakes

milk-shakes, but also the marginal utility of french fries, pizza, and other goods. To obtain the highest possible satisfaction, Bob allocates his budget so that the last dollar spent on good *A*, the last on good *B*, and so on, yield equal MU/P ratios. Consumer equilibrium can be restated algebraically as follows:

$$\frac{\text{MU of good } A}{\text{Price of good } A} = \frac{\text{MU of good } B}{\text{Price of good } B} = \frac{\text{MU of good } Z}{\text{Price of good } Z}$$

The letters *A*, *B*, ... *Z* indicate all the various goods and services purchased by the consumer with a given budget.

Take Note

If the marginal utility per last dollar spent on each good is equal and the entire budget is spent, total utility is maximized.

Am I on Track?

1. Return to the example in Exhibit 3, in which Bob has $8 to spend on Big Macs, which cost $2, and milkshakes, which also cost $2. Now suppose instead, the price of a Big Mac is $4 (and Bob still has $8 to spend and milkshakes still cost $2 each). Which of the following combinations of Big Macs and milkshakes maximizes Bob's total utility given the $8 he has to spend?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. 2 Big Macs and 2 milkshakes

b. 1 Big Mac and 2 milkshakes

c. 1 Big Mac and 3 milkshakes

d. 0 Big Macs and 4 milkshakes

6-1c. From Consumer Equilibrium to the Law of Demand

Understanding the law of diminishing marginal utility and consumer equilibrium provides you with a new set of tools to explore the law of demand. Let's begin with a straightforward link between the law of diminishing marginal utility and the demand curve. Declining marginal utility from consuming more Big Macs and milkshakes means each extra quantity consumed is less important or valuable to the consumer. Therefore, as the quantity consumed increases and the marginal utility falls, Bob is willing to pay less per Big Mac and milkshake. Thus, Bob's individual demand curve conforms to the law of demand and is downward sloping.

A more complete explanation of the law of demand combines diminishing marginal utility and consumer equilibrium. Suppose Bob reaches consumer equilibrium as follows:

$$\frac{\text{MU of Big Mac}}{\text{Price of Big Mac}} = \frac{\text{MU of milkshake}}{\text{Price of milkshake}}$$

$$\frac{4 \text{ utils}}{\$2} = \frac{4 \text{ utils}}{2}$$

Now suppose the price of a Big Mac falls to $1 and upsets the above equality. This changes the formula to the following:

$$\frac{\text{MU of Big Mac}}{\text{Price of Big Mac}} > \frac{\text{MU of milkshake}}{\text{Price of milkshake}}$$

$$\frac{4 \text{ utils}}{1} > \frac{4 \text{ utils}}{2}$$

Now Bob gains more utility per dollar by buying a Big Mac rather than a milkshake. To restore maximum total utility, he spends more on Big Macs. The marginal utility of a Big Mac falls as he buys more. At the same time, the marginal utility of a milkshake rises as Bob buys fewer milkshakes. A fall in the price of Big Macs therefore causes Bob to buy more Big Macs. Voila! The law of demand.

Am I on Track?

2. The table list menu items and prices for Jose's Hacienda as well as the total utility you would receive from consuming each. If you have $15 to spend, which combination of menu items will you order to achieve consumer equilibrium (to maximize your total utility given prices and your limited budget)? Hint: Fill in the tables first.

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. 2 tacos, 3 flans, and 3cokes

b. 2 tacos, 2 flans, and 2 cokes

c. 3 tacos, 2 flans, and 2 cokes

d. 3 tacos, 3 flans, and 3 cokes

Tacos—$3 each	Total Utility	Marginal Utility (MU)	(Marginal Utility)/ Price (MU/P)
1 taco	99 utils		
2 tacos	162 utils		
3 tacos	174 utils		

Flan * —$2 each	Total Utility	Marginal Utility (MU)	(Marginal Utility)/ Price (MU/P)
1 flan	40 utils		
2 flans	48 utils		
3 flans	50 utils		

Coke—$1 each	Total Utility	Marginal Utility (MU)	(Marginal Utility)/ Price (MU/P)
1 Coke	25 utils		
2 Cokes	29 utils		
3 Cokes	32 utils		

6-2. Income and Substitution Effects and the Law of Demand

Since utility is not measurable, it is desirable to have an alternative explanation of demand. Economists offer two complementary explanations for the law of demand, which do not rely on utility: the income effect and the substitution effect.

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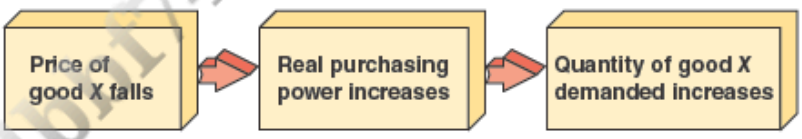
6-2a. Income Effect

One reason people buy more of a good when the price falls is the effect of a price change on real income. The *nominal*, or *money*, amount of your paycheck is simply the number of dollars you earn. On the other hand, price changes alter your *real* income. A rise in prices decreases purchasing power, and a fall in prices increases purchasing power, ceteris paribus. Suppose your weekly nominal income is $100, and you decide to stock up on Pepsi-Cola (a normal good). If the price per quart is $1, you can afford to buy 100 quarts this week. If the price is instead $0.50 per quart and the prices of other goods remain constant, you can now afford to buy 200 quarts of Pepsi-Cola without giving up any other goods, and as a result you feel richer because of the rise in purchasing power. As predicted by the law of demand, the lower price for Pepsi-Cola causes real income to rise and, in turn, causes the quantity demanded to rise. This relationship between changes in real income and your ability to buy goods and services is the income effect. The **income effect** is the change in quantity demanded of a good or service caused by a change in real income (purchasing power).



▸ Details

A Closer Look Applicable Concept: Substitution Effect

Testing the Law of Demand with White Rats

Economists often envy the controlled laboratory experiments of biologists and other scientists. In the real world, the economist is unable to observe consumer behavior without the prices of other goods, expectations, and other factors changing. So it is no wonder that the idea of studying the behavior of white rats to test the law of demand was intriguing. The question was whether the consumer choice of a white rat supports the downward-sloping demand curve.

Standard laboratory rats were placed in experimental cages with two levers. If a rat pressed one lever, nonalcoholic Collins mix was the reward. Pressing the second lever rewarded the rat with root beer. It seems rats are fond of these two beverages. Each rat was given a limited "income" of lever presses per day. After, say, 300 presses, a light above the lever went out, signaling the daily budget was gone. The next day the light was turned on, and the rat was given a new income of lever presses. The "price" of each good corresponded to the number of lever pushes required to obtain 1 milliliter of liquid. For example, if the number of pushes per milliliter for Collins mix released increased by 10 percent, this equaled a 10 percent increase in the price of Collins mix.

The crucial test was to measure the substitution effect resulting from a change in price. As explained in the text, a change in price sets in motion both an income effect and a substitution effect. In the experiment, the price of Collins mix was lowered by decreasing the number of pushes required per milliliter. At the same time, the price of root beer was raised by increasing the number of pushes required per milliliter. To eliminate the income effect, the number of lever presses was raised to compensate for loss of purchasing power. For example, if a rat purchased 4 milliliters of Collins mix per day and 11 milliliters of root beer before the price change, it

would be given enough extra pushes after the price change to still purchase these quantities.

In one experiment, a male albino rat was given 300 pushes per day for two weeks, and both liquids were priced at 20 pushes per milliliter. The rat soon settled into a consistent consumption pattern of 4 milliliters of Collins mix and 11 milliliters of root beer per day. Then the experimenters made changes in prices and income. The price (pushes per milliliter) of Collins mix was cut in half, and the price of root beer was doubled. At the same time, the total income of pushes was increased just enough to allow the rat to afford its initial consumption pattern. Stated differently, the income effect was eliminated in order to focus on the substitution effect. After two weeks of decisions under the new conditions, the rat changed its consumption pattern to 17 milliliters of Collins mix and 8 milliliters of root beer per day.

Source: John H. Kagel, Raymond C. Battalio, Howard Rachlin, and Leonard Green, "Demand Curves for Animal Consumers," *Quarterly Journal of Economics* 96 (February 1981), pp. 1–16.

A Closer Look Applicable Concept: Substitution Effect

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Key Terms

Utility

Total utility

Marginal utility

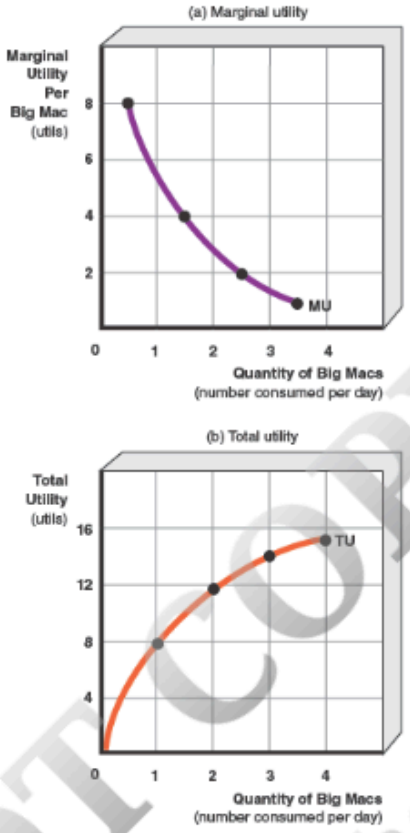
Law of diminishing marginal utility

Consumer equilibrium

Income effect

Substitution effect

Marginal utility is the change in total utility from a 1-unit change in the quantity of a good or service consumed.



▸ Details

- The law of diminishing marginal utility states that the marginal utility of a good or service eventually declines as consumption increases.

- Consumer equilibrium is the condition of reaching the maximum level of satisfaction, given a budget, when the marginal utility per dollar spent on each good purchased is equal. Consumer equilibrium and the law of diminishing marginal utility can be used to derive a downward-sloping demand curve. When the price of a good falls, consumer equilibrium no longer holds because the marginal utility per dollar for the good rises. To restore equilibrium, the consumer will increase consumption of the good. As the quantity demanded increases, the marginal utility falls until equilibrium is once again achieved. Thus, as predicted by the law of demand, when the price falls, the quantity demanded rises.

$$\frac{\text{MU of good } A}{\text{Price of good } A} = \frac{\text{MU of good } B}{\text{Price of good } B} = \frac{\text{MU of good } Z}{\text{Price of good } Z}$$

- The income effect and substitution effect are complementary explanations for the law of demand. As the price falls, real purchasing power increases, causing an increase in the consumer's willingness and ability to purchase a normal good or service. This is the *income effect*. Also, as the price falls, the consumer substitutes the now cheaper good for other goods that are now relatively more expensive. This is the *substitution effect*.

Take Note Revisited

- If the marginal utility per last dollar spent on each good is equal and the entire budget is spent, total utility is maximized.
- When the price of a normal good falls, the income effect and the substitution effect combine to cause the quantity demanded to increase.

Study Questions and Problems

Please see Appendix A for answers to the odd-numbered questions. Your instructor has access to the answers for even-numbered questions.

1. Does a dollar given to a rich person raise the rich person's total utility more than a dollar given to a poor person raises the poor person's total utility?

   SHOW ANSWER

2. Do you agree with the following statement? "If you like tacos, you should consume as many as you can."

3. This week you have gone to two parties. Assume the total utility you gained from these parties is 100 utils. Then you go to a third party, and your total utility rises to 110 utils. What is the marginal utility of the third party attended per week? Given the law of diminishing marginal utility, what will happen to total utility and marginal utility when you go to a fourth party this week?

   SHOW ANSWER

4. Suppose your marginal utility for meals at the campus cafeteria this week has fallen to zero. Explain what has happened to your total utility curve derived from consuming these meals. Now explain what will happen to total utility if you eat more meals at the cafeteria this week.

5. Suppose you consume 3 pounds of beef and 5 pounds of pork per month. The price of beef is $1.50 per pound, and pork is $2.00 per pound. Assuming you have studied economics and achieved consumer equilibrium, what is the ratio of the marginal utility of beef to the

equilibrium, what is the ratio of the marginal utility of beef to the marginal utility of pork?

SHOW ANSWER

6. Suppose the marginal utility of a Coke is 15 utils and its price is $1. The marginal utility of a pizza is 20 utils, and its price is $2. If you buy 1 unit of each good, will you achieve consumer equilibrium? If not, how can greater total utility be obtained?

7. Explain the relationship between the law of diminishing marginal utility and the law of demand.

SHOW ANSWER

8. Consider the following table, which lists James's marginal utility schedule for steak and hamburger meals:

Steak Meals per Month	Marginal Utility of Steak Meals	Price per Steak Meal	Hamburger Meals per Month	Marginal Utility of Hamburger Meals
1	20	$10	1	15
2	15	10	2	8
3	12	10	3	6
4	10	10	4	4
5	8	10	5	2

Given a budget of $45, how many steak and hamburger meals will James buy per month to maximize his total utility? What is the total utility realized?

9. Using the marginal utility schedule in question 8, begin in consumer equilibrium and assume the price per hamburger meal falls from $5 to $2, all other factors held constant. How will James alter his consumption of steak and hamburger meals?

SHOW ANSWER

10. Suppose the price of a BMW falls. Explain the law of demand based on the income and substitution effects.

11. Jenny Tanaka wants to buy a new car, and the annual gasoline expense is a major consideration. Her present car gets 25 miles per gallon (mpg), and she is considering purchasing a new car that gets 40 mpg. Jenny now drives about 12,000 miles per year and pays $3.25 per gallon of gasoline. She therefore calculates an annual gasoline consumption of 480 gallons for her 25 mpg car (12,000 miles/25 mpg) compared to 300 gallons consumed per year for the 40 mpg car (12,000 miles/40 mpg). Since driving the higher-mileage car would use 180 gallons less per year, Jenny estimates the new car will save her $585 in gasoline expense per year ($180 \text{ gallons} \times \$3.25 \text{ per gallon}$). Suppose Jenny buys the 40 mpg car. Why might her actual savings be LESS than the $585 she calculated?

Buying a higher mpg car will reduce the cost per mile of driving relative to substitutes, such as riding a bus, a train, or an airplane. As the cost of driving falls, the *substitution effect* predicts Jenny will drive more in the 40-mpg car than the 12,000 miles she now drives per year in the 25 mpg car. The extra cost of gasoline for driving these extra miles must be subtracted from the $585 savings that Jenny predicted.

Sample Quiz

Please see Appendix B for answers to Sample Quiz questions.

1. The term *utility* refers to the

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. usefulness of a good in relation to its scarcity.

b. necessity of a good.

c. price of a good.

d. number of goods a consumer has.

e. pleasure, or satisfaction, a consumer receives upon consuming a good.

2. When total utility is at a maximum, marginal utility is

2. When total utility is at a maximum, marginal utility is

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. zero.

b. positive.

c. negative.

d. one.

3. The *marginal* utilities associated with the first 4 units of consumption of good *Y* are 12, 10, 9, and 7. What is the *total* utility associated with the third unit?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. 3

b. 9

c. 25

d. 31

e. The amount cannot be determined from the marginal utilities.

4. Generally speaking, as more of a particular good is purchased, a consumer's marginal utility _____ and total utility _____ .

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. increases; decreases

b. decreases; increases

c. increases; increases

d. decreases; decreases

e. Generalizations cannot be made.

5. Marginal utility is defined as the

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. extra satisfaction the consumer receives from an extra $1 of income.

b. total level of satisfaction a consumer receives upon the consumption of a certain number of goods.

c. number of hours a consumer would be willing to work to receive a certain product.

d. extra satisfaction a person derives from consuming an additional unit of a good.

6. The statement "As more of a good is consumed, the utility a person derives from each additional unit diminishes" is known as the

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. water and diamond paradox.

b. law of diminishing marginal utility.

c. law of total utility.

d. marginal-utility-to-price ratio equalization rule.

7. The law of diminishing marginal utility indicates that the marginal utility curve is

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. downward sloping.

b. upward sloping.

c. U-shaped.

d. flat.

8. Refer to Exhibit 4. Clothes and entertainment are priced at $10 each. The marginal utility per dollar for the first unit of entertainment is:

Exhibit 4 Marginal Utility for Data for Clothes and Entertainment

Quantity	Clothes	Entertainment

1	15	20
2	13	18
3	10	13
4	8	12
5	6	10

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. 0.5.

b. 1.5.

c. 2.0.

d. 5.0.

9. Refer to Exhibit 4. Your budget is $50. The price of entertainment is $10. If the price of clothes falls to $4, which of the following statements is true?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. The marginal-utility-to-price ratio for clothes will decrease.

b. The marginal-utility-to-price ratio for clothes will increase.

c. The quantity demanded of clothes will decrease.

d. Both b and c are true.

Appendix to Chapter 6. Indifference Curve Analysis

This appendix explains another version of consumer choice theory based on indifference curves and budget lines.

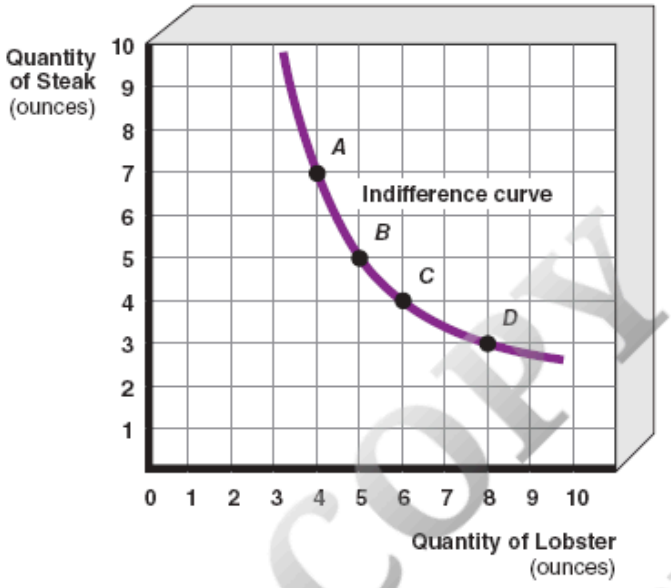
6A-1. Constructing an Indifference Curve

Let's begin with an experiment to find out a consumer's consumption preferences for the quantities of two goods. Suppose the consumer samples a number of combinations of lobster tail and steak (surf and turf). Each time the same question is asked, "Would you prefer combination *A* or combination *B*?" After numerous trials, the consumer states indifference between eating choices *A, B, C, and D* shown in Exhibit A-1. This means the consumer is just as satisfied having either 7 ounces of steak and 4 ounces of lobster (*A*), or 3 ounces of steak and 8 ounces of lobster (*D*), or either of the other two combinations, *B* or *C*. Interpretation of the curve connecting these points is that each of these points represents the choice of a combination of goods that yields the same total utility because no one choice is preferred to any other choice. Since, as explained in the chapter, there is no such thing as a utility meter, this approach is actually a method for determining equal levels of satisfaction or total utility for different bundles of goods without an exact measure of utils. The curve derived from this experimental data is called an indifference curve. An **indifference curve** is a curve showing the different combinations of two products that yield the same satisfaction or total utility to a consumer. Note that not only points *A*, *B*, *C*, and *D*, but also all other points on the smooth curve connecting them are equally satisfactory combinations to the consumer.

Exhibit A-1. A Consumer's Indifference Curve

Points *A*, *B*, *C*, *D*, and each point along the curve represent a combination of steak and lobster that yields equal total utility for a given consumer. Stated

steak and lobster that yields equal total utility for a given consumer. Stated differently, the consumer is indifferent between consuming servings having quantities represented by all points composing the indifference curve.



▸ Details

An Indifference Schedule for a Consumer

Choice	Steak (ounces)	Lobster (ounces)
A	7	4
B	5	5
C	4	6
D	3	8

6A-1a. Why Indifference Curves Are Downward Sloping and

Convex

If total utility is the same at all points along the indifference curve, then consuming more of one good must mean consuming less of the other good. Given this condition, movement along the indifference curve generates a curve with a negative slope. Suppose a consumer moves in marginal increments between any two combination points in Exhibit A-1. For instance, say the consumer decides to move from point *A* to point *B* and consume an extra ounce of lobster. To do so, the consumer increases total utility (+MU) by consuming an extra quantity of lobster. However, since by definition total utility is constant everywhere along the curve, the consumer must give up a quantity of steak (2 ounces) in order to reduce total utility (−MU) by precisely enough to offset the gain in total utility from the extra lobster.

144

The inverse relationship between goods along the downward-sloping indifference curve means that the absolute value of the slope of an indifference curve equals what is called the marginal rate of substitution. The **marginal rate of substitution (MRS)** is the rate at which a consumer is willing to substitute one good for another with no change in total utility. If we begin at *A* and move to *B* along the curve, the slope of the curve is −2/1, so the MRS is 2 (the minus sign is removed to give the absolute value). This is the consumer's subjective willingness to substitute lobster for steak. At point *A*, the consumer has a substantial amount of steak and relatively little lobster. Therefore, the consumer is willing to forgo or "substitute" 2 ounces of steak to get 1 more ounce of lobster. In other words, the marginal utility of losing each ounce of steak between *A* and *B* is low compared to the marginal utility of gaining each ounce of lobster. In fact, the MRS is really the ratio of the marginal utility of good X (placed on the X axis—in this case, X is lobster) in relation to the marginal utility of good Y (placed on the Y axis—in this case, Y is steak). This can be written:

145 MUx/MUy. So, moving from point *A* to *B*, the MU of lobster is twice that for steak because the consumer was willing to give up 2 ounces of steak to get an additional ounce of lobster.

Take Note

The marginal rate of substitution, which represents a consumer's willingness to substitute good X for good Y, is the absolute value of the slope of the indifference curve and can be calculated as MUx/MUy.

Now suppose the consumer moves from *B* to *C*, and the slope changes to −1/1 ($\text{MRS} = 1$). Between these two points, the consumer is willing to substitute 1 ounce of steak for an equal quantity of lobster. This means that between *B* and *C* the marginal utility lost per ounce of steak equals the marginal utility gained from an ounce of lobster, while total utility remains constant. The ratio of MUx in relation to MUy (MUx/MUy) equals one.

Finally, assume the consumer moves from *C* to *D*. Here the ratio of MUx/MUy which equals the MRS of $^1/_2$ is smaller because the consumer at point *C* has a substantial amount of lobster and relatively little steak. Consequently, the marginal utility lost from giving up 1 ounce of steak equals twice the marginal utility gained from an additional ounce of lobster.

As we see in this example, as the quantity of lobster increases along the horizontal axis, the marginal utility of additional ounces of lobster decreases. Correspondingly, as the quantity of steak decreases along the vertical axis, its marginal utility increases. So moving down the curve means the consumer is willing to give up smaller and smaller quantities of steak on the vertical axis to obtain each additional ounce of lobster on the horizontal axis.

Take Note

The marginal rate of substitution (MRS) declines as one moves downward along an indifference curve resulting in a curve with a diminishing slope that is convex (bowed inward) to the origin.

Am I on Track?

A1. The typical shape of the indifference curve shown in Exhibit A-1 reflects the fact that for each additional ounce of lobster consumed,

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. more and more steak must be given up to remain on the indifference curve.

b. a consistent amount of steak must be given to remain on the indifference curve.

c. less and less steak must be given up to remain on the indifference curve.

d. no steak must be given up to remain on the indifference curve.

Sample Quiz

Please see Appendix B for answers to Sample Quiz questions.

1. The slope of an indifference curve is _____ , and a movement along the curve causes the loss in marginal utility (MU) of one good to _____ the marginal utility (MU) gained from another good.

SHOW ANSWER

SHOW ANSWER

zero; maximize

positive; exceed

concave; reduce

negative; equal

2. The _____ is the absolute value of the slope of the indifference curve.

SHOW ANSWER

SHOW ANSWER

marginal rate of substitution

marginal rate of substitution

average rate of transitivity

relative rate of utility

marginal rate of transposition

3. Consumers always _____ indifference curves that are farther from the origin.

SHOW ANSWER

SHOW ANSWER

reject

cross

prefer

maximize

4. Given the prices of two goods, all quantity combinations inside the budget line are

SHOW ANSWER

SHOW ANSWER

indifferent.

efficient.

unattainable.

attainable.

5. Consumer equilibrium occurs where the budget line is _____ to the _____ possible indifference curve.

SHOW ANSWER

SHOW ANSWER

tangent; highest

equal; lowest

marginal; maximum

differential; highest

6. An indifference curve consists of quantity combinations of two goods that yield

SHOW ANSWER

SHOW ANSWER

equal marginal utilities.

negative marginal utilities.

the same price ratios.

the same total satisfaction.

7. The slope of an indifference curve is equal to the ratio of

the _____ of the good on the horizontal axis to

the _____ of the good on the vertical axis.

SHOW ANSWER

SHOW ANSWER

marginal utility (MU); marginal utility (MU)

total utility (TU); total utility (TU)

marginal product (MP); marginal product (MP)

price (P); total utility (TU)

8. The equation for a budget line for goods *X* and *Y*, with P_x being the

price of X, P_y being the price of Y, and B being the budget, can be written as

SHOW ANSWER

SHOW ANSWER

$P_xX + P_yY = B$.

$P_xX + P_yY = 1/B$.

$P_xX = B + P_yY$.

$P_xX/P_yY = 1 - B$.

9. Given the budget line and indifference curves shown in Exhibit A-6, consumer equilibrium occurs at point

SHOW ANSWER

SHOW ANSWER

A.

B.

C.

D.

E.

10. Given the budget line and indifference curves shown in Exhibit A-6, assume the consumer is initially at point *C*. To maximize total utility, the consumer should

SHOW ANSWER

SHOW ANSWER

purchase more of good *X* and less of good *Y*.

remain at point *C*.

move to point *B* and then to point *A*.

purchase more of good *Y* and less of good *X*.

11. An indifference curve has a negative slope because movement along the curve requires the consumer to give up the

SHOW ANSWER

SHOW ANSWER

marginal utility of one good.

total utility of one good.

marginal substitution value (MSV).

marginal transitivity of one good.

12. The marginal rate of substitution _____ as one moves downward along the indifference curve.

SHOW ANSWER

SHOW ANSWER

increases

remains constant

decreases

increases and then decreases

13. Assume P_x is the price of good X on the horizontal axis and P_y is the price of good Y on the vertical axis. The absolute value of the slope of the budget line equals

SHOW ANSWER

SHOW ANSWER

P_y / P_xY .

P_yQ_y/P_xQ_x .

$(1 - P_y/P_x)$.

P_x/P_y .

14. As shown in Exhibit A-7, the marginal rate of substitution (MRS) at point *B* is equal to

SHOW ANSWER

SHOW ANSWER

0.33.

2.0.

0.5.

3.0.

15. As shown in Exhibit A-7, movement from consumer equilibrium at point *A* to point *B* is caused by a(an)

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SHOW ANSWER

increase in the price of good *X*.

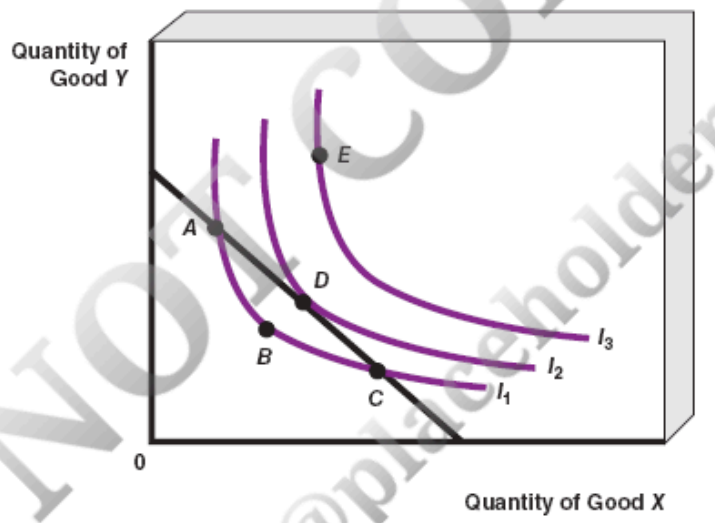
decrease in the price of good *X*.

increase in the price of good *Y*.

decrease in the price of good *Y*.

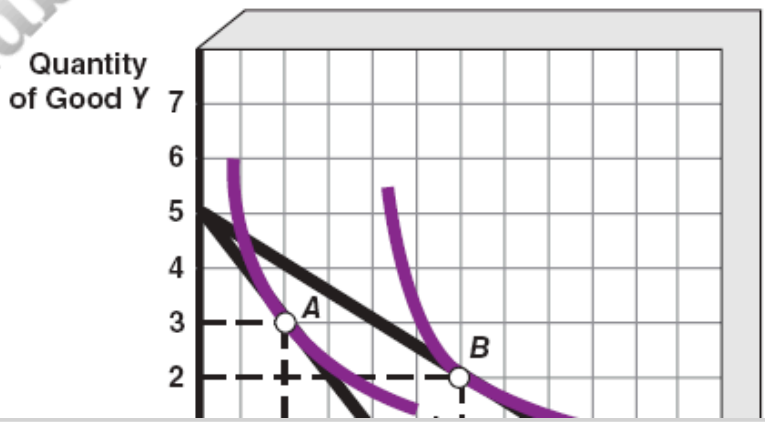
155

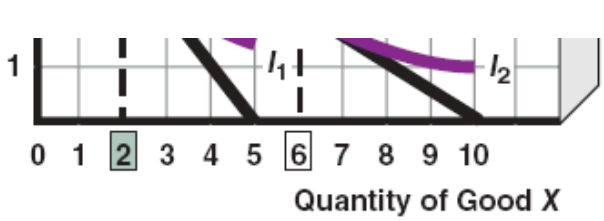
Exhibit A-6 Consumer Equilibrium



Details

Exhibit A-7 Consumer Equilibrium





▸ Details

Exhibit A-6 Consumer Equilibrium

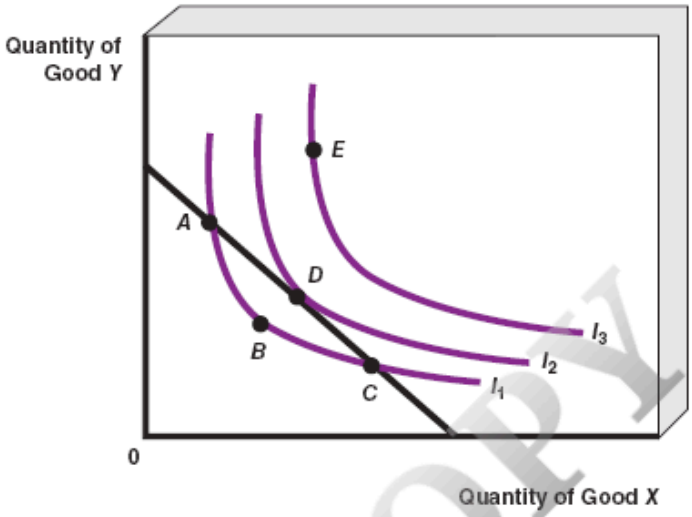


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Exhibit A-7 Consumer Equilibrium

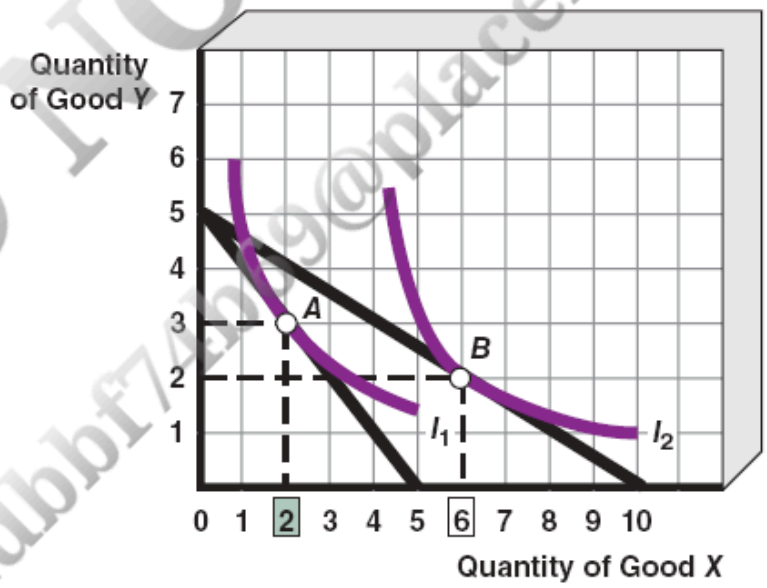

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Exhibit A-6 Consumer Equilibrium

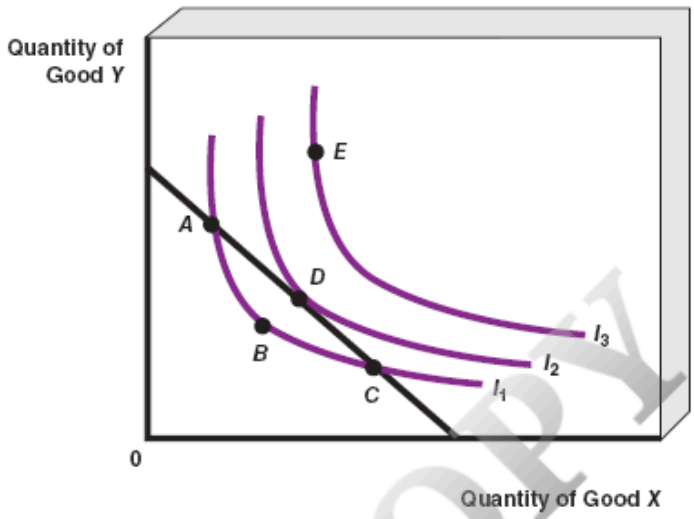

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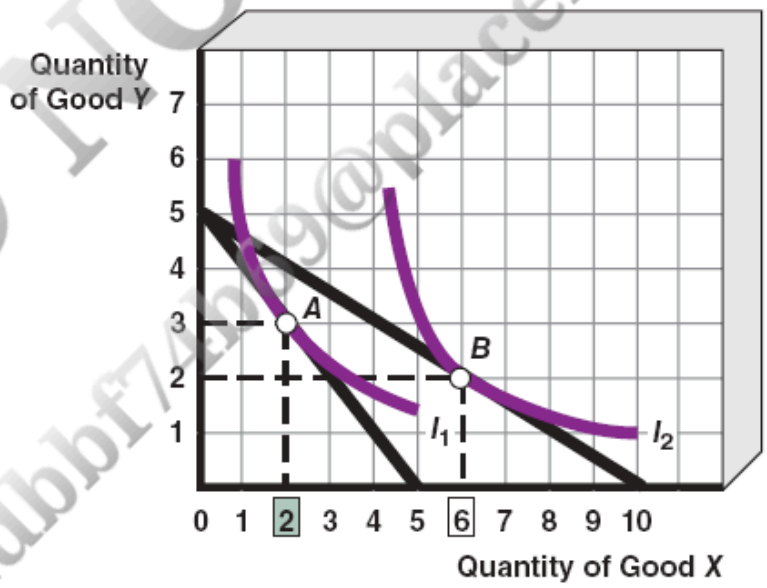
Exhibit A-7 Consumer Equilibrium



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Chapter 7. Production Costs

Chapter Objectives

1. Explain the difference between economic profit and accounting profit.
2. Analyze the relationship between inputs and the resulting outputs for a firm, including the law of diminishing returns.
3. Analyze the relationship between output and both total and average costs.
4. Explain the relationship between marginal product and marginal costs.
5. Discuss how the long-run average cost curve is constructed as well as how the shape identifies the scale of production.

Introduction

Understanding costs is essential for any company's success. The purpose of this chapter is to study production and its relationship to costs. Suppose you are an electrical engineer who is an expert at designing electronic components for cell phones and other applications. You dream of owning your own company, so, you quit your job and invest your savings in starting Computech (a mythical company). You lease factory space, hire employees, and purchase raw materials.

In this chapter and the next two chapters, you will follow Computech and learn the basic principles of both production and cost.

7-1. Costs and Profit

A basic assumption in economics is that the motivation for business decisions is profit maximization. Economists realize that managers of firms sometimes pursue other goals, such as contributing to the United Way or building an empire for the purpose of ego satisfaction. Nevertheless, the profit maximization goal has proved to be the best theory to explain why managers of firms choose a particular level of output or price. To understand profit as a driving force for business firms, we must distinguish between the way economists measure costs and the way accountants measure costs.

7-1a. Explicit and Implicit Costs

Economists define the total opportunity cost of a business as the sum of *explicit costs* and *implicit costs*. **Explicit costs** are payments to nonowners of a firm for their resources. In our Computech example, explicit costs include the wages paid to labor, the rental charges for a plant, the cost of electricity, the cost of materials, and the cost of medical insurance. These resources are owned outside the firm and must be purchased with actual payments to these "outsiders."

Implicit costs are the opportunity costs of using resources owned by a firm. These are opportunity costs of resources because the firm makes no actual payments to outsiders. When you started Computech, you gave up the opportunity to earn a salary as an electrical engineer for someone else's firm. When you invested your savings in your own enterprise, you gave up the opportunity to earn interest. You also used a building you own to warehouse Computech products. Although you made no payment to anyone, you gave up the opportunity to earn rental payments.

7-2. Short-Run Production

Having presented the basic definitions of total cost, the next step is to study cost theory in more detail. We begin by looking at production, that is, the process by which firms turn resources (or inputs) into products (output).

7-2a. Short Run versus Long Run

Suppose I asked you, "What is the difference between the short run and the long run?" Your answer might be that the short run is less than a year and the long run is over a year. Good guess, but wrong! Economists do not partition production decisions based on any specific number of days, months, or years. Instead, the distinction depends on the ability to vary the quantity of inputs or resources used in production. There are two types of inputs—*fixed inputs* and *variable inputs*. A **fixed input** is any resource for which the quantity cannot change during the period of time under consideration. For example, the physical size of a firm's plant and the production capacity of heavy machines cannot easily change within a short period of time. They must remain as fixed amounts while managers decide to vary output. In addition to fixed inputs, the firm uses *variable inputs* in the production process. A **variable input** is any resource for which the quantity can change during the period of time under consideration. For example, managers can hire fewer or more workers during a given year. They can also change the amount of raw materials and electricity used in production.

Now we can link the concepts of fixed and variable inputs to the *short run* and the *long run*. The **short run** is a period of time so short that there is at least one fixed input. For example, the short run is a period of time during which a firm can increase output by hiring more workers (variable input), while the size of the firm's plant (fixed input) remains unchanged. The firm's plant is the most difficult input to change quickly. The **long run** is a period of time so long that all inputs are variable. In the long run, the firm can build new factories or purchase

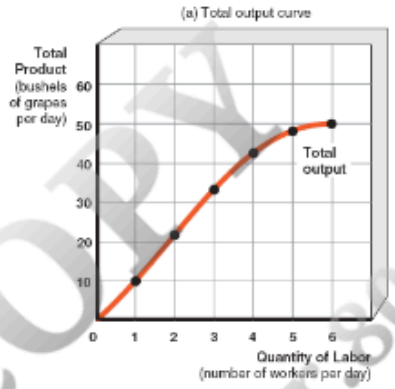
new machinery. New firms can enter the industry, and existing firms may leave the industry.

Take Note

The short run is a period of time so short that there is at least one fixed input while the long run is a period of time so long that all inputs are variable.

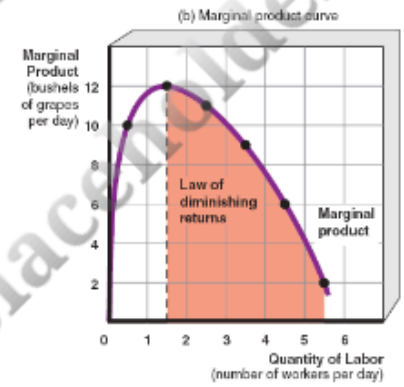
loads containers, and transports the grapes to the winery. Adding a second worker raises output to 22 bushels per day because the workers divide the tasks and *specialize*, allowing the vineyard to more than double the output produced by just one worker. Adding four more workers raises total production to 50 bushels per day.

Exhibit 2 A Production Function and the Law of Diminishing Returns



Short-Run Production Function of Eaglecrest Vineyard

(1) Labor Input (number of workers per day)	(2) Total Output (bushels of grapes per day)	(3) Marginal Product (bushels of grapes per day) [D(2)/D(1)]
0	0	
		10
1	10	
		12
2	22	
		11
3	33	
		9
4	42	
		6
5	48	
		2
6	50	



▸ Details

Part (a) shows how the total output of bushels of grapes per day increases and the number of workers increases while all other inputs remain constant. This figure is a short-run production function, which relates outputs to a single input while all other inputs are fixed.
Part (b) illustrates the law of diminishing returns. The first worker adds 10 bushels of grapes per day, and marginal product is 10 bushels per day. Adding a second worker adds another 12 bushels of grapes per day to total output. This is the range of increasing marginal returns. After two workers, diminishing marginal returns set in, and marginal product declines continuously.

7-2c. Marginal Product and the Law of Diminishing Returns

The relationship between changes in total output and changes in labor is called the marginal product of labor. **Marginal product** is the change in total output produced by adding one unit of a variable input, with all other inputs used being held constant. When Eaglecrest increases labor from zero to one worker, output rises from 0 to 10 bushels produced per day. This increase is the result of the addition of one

7-3. Short-Run Cost of Production

To make production decisions in either the short run or the long run, a business must determine the costs associated with producing various levels of output. Using Computech, you will study the relationship between two "families" of short-run costs and output:

(1) the total cost curves and

(2) the average cost curves.

7-3a. Total Cost

Total Fixed Cost

As production expands in the short run, costs are divided into two basic categories—*total fixed cost* and *total variable cost*. **Total fixed cost (TFC)** consists of costs associated with paying for fixed inputs that do not vary as output varies and that must be paid even if output is zero. These are payments that the firm must make in the short run, regardless of the level of output. Even if a firm, such as Computech, produces nothing, it must still pay for fixed inputs such as rent, interest on loans, property taxes, and fire insurance. Fixed costs are therefore beyond management's control in the short run. Fixed costs are sometimes referred to as "overhead costs." The total fixed cost for Computech is $100, as shown in column (2) of Exhibit 3.

Exhibit 3 Short-Run Cost Schedule for Computech

(1) Total Product (Q)	(2) Total Fixed Cost (TFC)	(3) Total Variable Cost (TVC)	(4) Total Cost (TC)	(5) Marginal Cost (MC)	(6) Average Fixed Cost (AFC)	(7) Average Variable Cost (AVC)	(8) Average Total Cost (ATC)
0	$100	$ 0	$100		–	–	–
				$50			
1	100	50	150		$100	$50	$150
				34			
2	100	84	184		50	42	92
				24			

3	100	108	208	33	36	69
4	100	127	227	25	32	57
5	100	150	250	20	30	50
6	100	180	280	17	30	47
7	100	218	318	14	31	45
8	100	266	366	13	33	46
9	100	325	425	11	36	47
10	100	400	500	10	40	50
11	100	495	595	9	45	54
12	100	612	712	8	51	59

Total Variable Cost

As the firm expands from zero output, total variable cost is added to total fixed cost. **Total variable cost (TVC)** consists of costs associated with paying for variable inputs that are zero when output is zero and vary as output varies. Examples include wages for hourly workers, electricity, fuel, and raw materials. As a firm uses more input to produce output, its variable costs will increase. Management can influence variable costs in the short run by changing the level of output. Exhibit 3 lists the total variable cost for Computech in column (3).

Total Cost

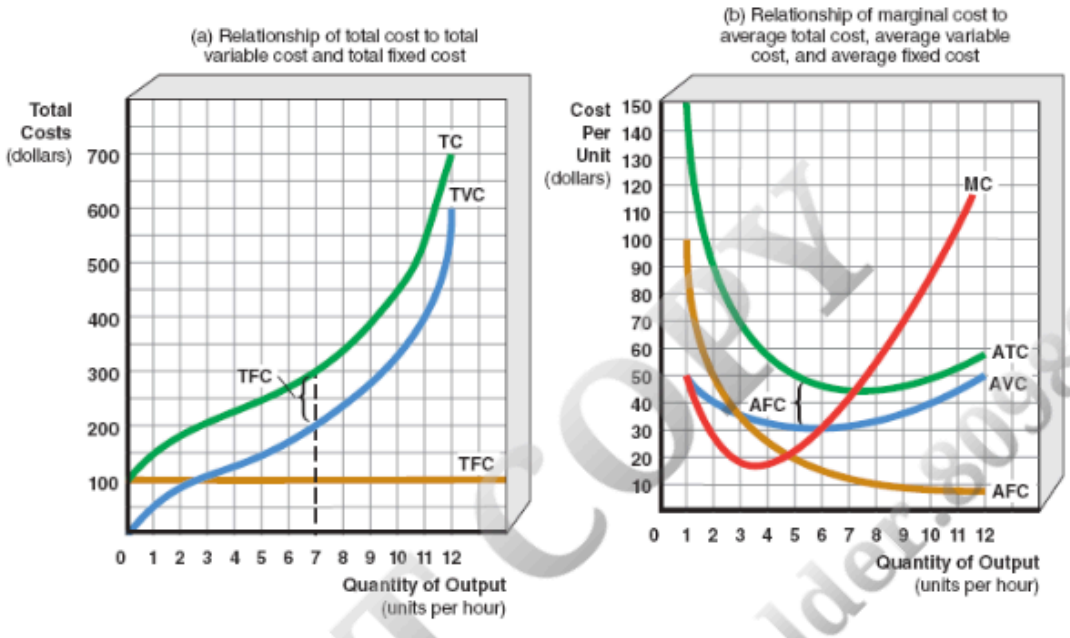
Given total fixed cost and total variable cost, the firm can calculate total cost. **Total cost (TC)** is the sum of total fixed cost and total variable cost at each level of output. As a formula:

$$TC = TFC + TVC$$

Total cost for Computech is shown in column (4) of Exhibit 3. Exhibit 4(a) uses the data in Exhibit 3 to construct graphically the relationships between total cost, total fixed cost, and total variable cost. Note that the TVC curve varies with the level of output and the horizontal TFC curve does not. The TC curve is simply the TVC curve plus TFC curve, so the vertical distance between the TC and TVC

curves equals TFC.

Exhibit 4 Short-Run Cost Curves



▸ Details

The curves in this exhibit are derived by plotting data from Exhibit 3. Part (a) shows that the total cost (TC) at each level of output is the sum of total variable cost (TVC) and total fixed cost (TFC). Because the TFC curve does not vary with output, the shape of the TC curve is determined by the shape of the TVC curve. The vertical distance between the TC and the TVC curves is TFC.

In part (b), the marginal cost (MC) curve decreases at first, then reaches a minimum, and then increases as output increases. The MC curve intersects both the average variable cost (AVC) curve and the average total cost (ATC) curve at the minimum point on each of these cost curves. The average fixed cost (AFC) curve declines continuously as output expands. AFC is also the difference between the ATC and the AVC curves at any quantity of output.

Average Total Cost

Average total cost is sometimes referred to as *per-unit cost*.

Average total cost (ATC) is total cost divided by the quantity of output produced. Written as a formula:

$$\text{ATC} = \frac{\text{TC}}{\text{Q}}$$

or

$$\text{ATC} = \text{AFC} + \text{AVC}$$

Like the AVC curve, the ATC curve is U-shaped, as shown in Exhibit 4(b). At first, the ATC curve falls because its component parts—AVC and AFC—are falling. As output continues to rise, the AVC curve begins to rise, while the AFC curve falls continuously. Beyond the output of 7 units per hour, the rise in the AVC curve is greater than the fall in the AFC curve, which causes the ATC curve to rise in a U-shaped pattern.

Marginal Cost

Marginal cost asks how much it costs to produce an *additional* unit of output. Column (5) in Exhibit 3 is marginal cost. **Marginal cost (MC)** is the change in total cost when one additional unit of output is produced. Stated differently, marginal cost is the ratio of the change in total cost to a 1-unit change in output. Written as a formula:

$$\text{MC} = \frac{\text{change in TC}}{\text{change in Q}}$$

Changing output by one unit at a time simplifies the marginal cost calculations in our Computech example. The marginal cost data are listed between output levels to show that marginal cost is the change in total cost as the output level changes. Exhibit 4(b) shows this marginal cost schedule graphically. Note that

changes. Exhibit 4(b) shows this marginal cost schedule graphically. Note that marginal cost is plotted at the midpoints because the change in cost actually occurs between each additional unit of output. In the short run, a firm's marginal cost initially falls as output expands, eventually reaches a minimum, and then rises, forming a J-shaped curve. The explanation for the shape of the MC curve is given in the next section.

Exhibit 5 summarizes a firm's short-run cost relationships.

Exhibit 5 Short-Run Cost Formulas

Cost Concept	Formula	Graph
Total cost (TC)	$TC = TFC + TVC$	
Marginal cost (MC)	$\frac{\text{change in TC}}{\text{cgange in Q}}$	
Average fixed cost (AFC)	$AFC = \frac{TFC}{Q}$	
Average variable cost (AVC)	$AVC = \frac{TVC}{Q}$	
Average total cost (ATC)	$ATC = \frac{TC}{Q}$	

Average Total Cost

Average total cost is sometimes referred to as *per-unit cost*.

Average total cost (ATC) is total cost divided by the quantity of output produced. Written as a formula:

$$\text{ATC} = \frac{\text{TC}}{\text{Q}}$$

or

$$\text{ATC} = \text{AFC} + \text{AVC}$$

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Cost Concept	Formula	Graph
Total cost (TC)	$TC = TFC + TVC$	
Marginal cost (MC)	$\frac{\text{change in TC}}{\text{cgange in Q}}$	
Average fixed cost (AFC)	$AFC = \frac{TFC}{Q}$	
Average variable cost (AVC)	$AVC = \frac{TVC}{Q}$	
Average total cost (ATC)	$ATC = \frac{TC}{Q}$	

7-4. Marginal Cost Relationships

Part (b) of Exhibit 4 presents two important relationships that require

explanation. First, we will explain the rule that links the marginal cost curve to the average cost curves. Second, we will return to the marginal product curve in Exhibit 2(b) and explain its connection to the marginal cost curve.

7-4a. The Marginal-Average Rule

Observe that the MC curve in Exhibit 4(b) intersects both the AVC curve and the ATC curve at their minimum points. This is not accidental. It is a result of a relationship called the marginal-average rule. The **marginal-average rule** states that when marginal cost is below average cost, average cost falls. When marginal cost is above average cost, average cost rises. When marginal cost equals average cost, average cost is at its minimum point. The marginal-average rule applies to grades, weights, and any average figure.

Perhaps the best way to understand this rule is to apply it to a noneconomic example. Suppose there are 20 students in your class and each student has a grade point average (GPA) of 4.0. The average GPA of the class is, therefore, 4.0.
165 Now assume another student who has a GPA of 2.0 joins the class. The new average GPA of 21 students in the class falls to 3.9. The average GPA was pulled down because the *marginal* GPA of the additional student was lower than the *average* GPA of the other students. Now suppose we start with a class of 20 students with a 2.0 GPA and add a student who has a 4.0 GPA. In this case, the new average GPA of the 21 students rises from 2.0 to 2.1. Thus, the *marginal* GPA of the last student must have been higher than the *average* GPA of all students in class before the addition of the new student.

Now consider the MC curve in part (b) of Exhibit 4. In the range of output from 0 to 6 units per hour, the MC curve is below the AVC curve, and AVC is falling. Beyond 6 units per hour, the MC curve is above AVC, and AVC is rising. Hence, the relationship between AVC and MC conforms to the marginal-average rule. It follows that the MC curve intersects the AVC curve at its lowest point. This analysis also applies to the relationship between the MC and ATC curves. Initially, the MC curve is lower than the ATC curve causing the ATC curve to fall until it reaches its minimum. Beginning with 8 units of output, the MC curve

until it reaches its minimum. Beginning with 8 units of output, the MC curve exceeds the ATC curve, causing the ATC curve to rise.

point average (GPA) of 4.0. The average GPA of the class is, therefore, 4.0. Now assume another student who has a GPA of 2.0 joins the class. The new average GPA of 21 students in the class falls to 3.9. The average GPA was pulled down because the *marginal* GPA of the additional student was lower than the *average* GPA of the other students. Now suppose we start with a class of 20 students with a 2.0 GPA and add a student who has a 4.0 GPA. In this case, the new average GPA of the 21 students rises from 2.0 to 2.1. Thus, the *marginal* GPA of the last student must have been higher than the *average* GPA of all students in class before the addition of the new student.

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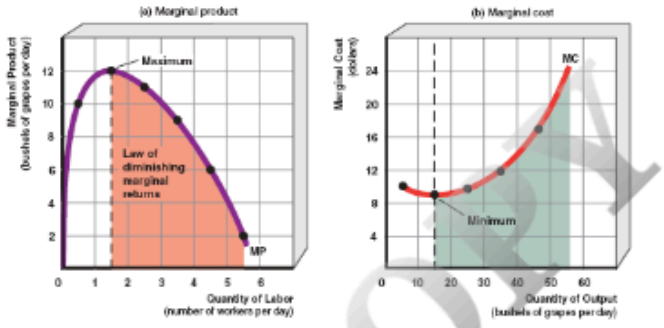
7-4b. Marginal Cost's Mirror Image

Since the MC curve determines the U-shape of the AVC and ATC curves, we must explain the J-shape of the MC curve. Exhibit 6 illustrates that the shape of the MC curve is the mirror reflection of the shape of the marginal product (MP) curve. Comparing

parts (a) and (b) of Exhibit 6, we see that as the marginal product rises, indicating workers are more productive, the marginal cost of production falls. Similarly, when marginal product falls, and workers are less productive, the marginal cost of production rises.

Exhibit 6 The Inverse Relationship between Marginal Product and Marginal Cost



(1) Labor Input (number of workers per day)	(2) Total Output (bushels of grapes per day)	(3) Marginal Product (bushels of grapes per day) [Δ(2)/Δ(1)]	(4) Total Cost per Day [$100 × (1)]	(5) Marginal Cost [Δ(4)/(3)]
0	0		$ 0	
		10		$10.00
1	10		100	
		12		8.33
2	22		200	
		11		9.09
3	33		300	
		9		11.11
4	42		400	
		6		16.67
5	48		500	
		2		50.00
6	50		600	

▸ Details

Part (a) represents the marginal product (MP) of labor curve. At first each additional worker hired adds more to output than does the previously hired worker as workers are able to specialize and the MP curve rises until a maximum is reached when the second worker is hired. When the third worker hired, the law of diminishing returns sets in and each additional worker hired adds less output than previously hired workers.
Part (b) shows the marginal cost (MC) curve is a J-shaped curve that is inversely related to the MP curve. Assuming the wage rate remains constant, as the MP curve rises, the MC curve falls. When the MP curve reaches a maximum at two workers, the MC curve is at a minimum. As diminishing returns set in and the MP curve falls, the MC curve rises.

As explained earlier in this chapter, the law of diminishing returns is the declining portion of the MP curve, and this range of production corresponds to the rising portion of the MC curve. To understand why this relationship exists, we return to the case of Eaglecrest Vineyard presented earlier in Exhibit 2. Now we again assume that labor is the only variable input and add the new important assumption that the wage rate is constant at $100 per day. When Eaglecrest hires the first worker, its total output rises from 0 to 10 bushels of grapes per day. As explained earlier, the marginal product is also 10 bushels, and the marginal cost is $\$100/10 = \$10(\Delta TC/\Delta Q)$. When Eaglecrest hires the second worker, total output rises by 12 bushels per day (ΔQ). Hiring this worker increases the firm's total cost by $100, while the marginal product rises to 12 bushels. The marginal cost of the second worker therefore falls to $8.33 ($100/12). This is the minimum point on the MC curve, which corresponds to the maximum point on the MP curve. The third worker hired yields only 11 additional bushels of grapes per day (ΔQ), so marginal cost rises to $9.09 ($100/11). Thus, diminishing returns begin with the third worker, and the marginal cost continues to rise as more workers are hired.

Take Note

As marginal product increases and workers are more productive, the marginal cost of production falls. As diminishing returns occur and marginal product decreases, the marginal cost of production rises.

Am I on Track?

3. Suppose your quiz average this semester is 80 after taking 5 quizzes. You have just taken the sixth quiz and received a 90. Which of the following statements bests represents the marginal-average rule?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. My quiz average will decrease because my marginal quiz grade is less than my average.

b. My quiz average will decrease because my marginal quiz grade is greater than my average.

c. My quiz average will increase because my marginal quiz grade is less than my average.

d. My quiz average will increase because my marginal quiz grade is greater than my average.

7-5. Long-Run Production Costs

As mentioned earlier in this chapter, the long run is a time period long enough to change the quantity of all fixed inputs. A firm can, for example, build a larger or smaller factory or vary the capacity of its machinery. In this section, we will discuss how varying factory size and *all* other inputs in the long run affects the relationship between production and costs.

7-5a. Long-Run Average Cost Curves

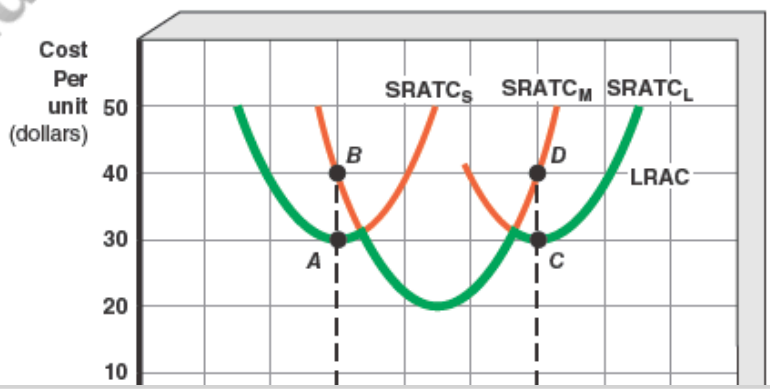
Suppose Computech is making its production plans for the future. Taking a long-run view of production means the firm is not locked into a small, medium-sized, or large factory. However, once a factory of any particular size is built, the firm operates in the short run because the plant becomes a fixed input.

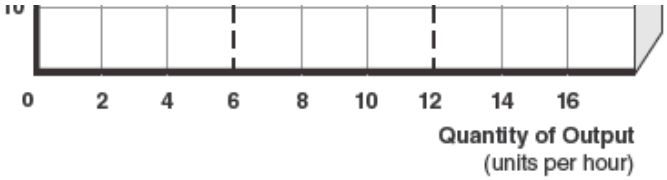
Take Note

A firm *operates* in the short run when there is insufficient time to alter some fixed input. The firm *plans* in the long run when all inputs are variable.

Exhibit 7 illustrates a situation in which there are only three possible factory sizes Computech might select. Short-run cost curves representing these three possible plant sizes are labeled SRATC_S , SRATC_M , and SRATC_L . SR is the abbreviation for short run, and ATC stands for average total cost. The subscripts S, M, and L represent small, medium, and large plant sizes, respectively. In the previous sections, there was no need to use SR for short run because we were discussing only short-run cost curves and not long-run cost curves.

Exhibit 7 The Relationship between Three Factory Sizes and the Long-Run Average Cost Curve





▸ Details

Each of the three short-run ATC curves in the exhibit corresponds to a different plant size. Assuming these are the only three plant-size choices, a firm can choose any one of these plant sizes in the long run. For example, a young firm may operate a small plant represented by the U-shaped short-run average total cost curve $\mathbf{SRATC_S}$. As a firm matures and demand for its product expands, it can decide to build a larger factory, corresponding to either $\mathbf{SRATC_M}$ or $\mathbf{SRATC_L}$. The long-run average cost curve, LRAC, is the green shaded scalloped curve joining the short-run curves below their `intersections`.

Suppose Computech estimates that it will be producing an output level of 6 units per hour for the foreseeable future. Which plant size should the company choose? It will build the plant size represented by $\mathrm{SRATC_S}$ because this affords a lower cost

of $30 per unit (point *A*) than the factory size represented by $SRATC_M$, which has a cost of $40 per unit (point *B*).

What if production is expected to be 12 units per hour? In this case, the firm will choose the plant size represented by $SRATC_L$. At this plant size, the cost is $30 per unit (point *C*), which is lower than $40 per unit (point *D*).

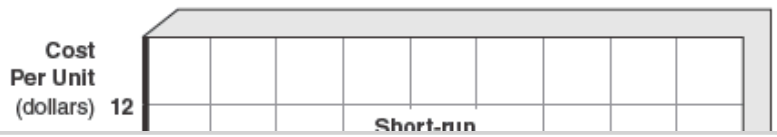
Take Note

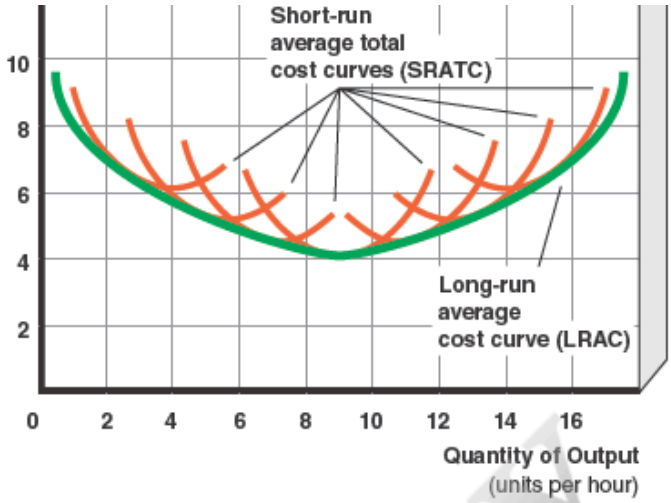
The plant size selected by a firm in the long run depends on the expected level of production.

Using the three short-run average cost curves shown in Exhibit 7, we can construct the firm's long-run average cost curve. The **long-run average cost curve (LRAC)** curve traces the lowest cost per unit at which a firm can produce any level of output after the firm can build any desired plant size. The LRAC curve is sometimes called the firm's planning curve. In Exhibit 7, the green curve represents the LRAC curve.

Exhibit 8 shows there are actually an infinite number of possible plant sizes from which managers can choose in the long run. As the intersection points of the short-run ATC curves move closer and closer together, the lumps in the LRAC curve in Exhibit 7 disappear. With a great variety of plant sizes, the corresponding short-run ATC curves trace a smooth LRAC curve in Exhibit 8. Over the range of output when the LRAC curve falls, the tangency points are to the left of the minimum points on the short-run ATC curves. As output expands and the LRAC curve rises, the tangency points are to the right of the minimum points on the short-run ATC curves.

Exhibit 8 The Long-Run Average Cost Curve When the Number of Factory Sizes Is Unlimited





▸ Details

There are an infinite number of possible short-run ATC curves that correspond to different plant sizes. The long-run average cost curve (LRAC) is the green curve tangent to each of the possible red short-run ATC curves.

7-5b. Scales of Production

As a firm becomes large and expands output beyond some level, such as Q_2 in Exhibit 9, it encounters diseconomies of scale. **Diseconomies of scale** exists when the long-run average cost curve rises as the firm increases output. A very large-scale firm becomes harder to manage. As the firm grows, the chain of command lengthens, and communication becomes more complex. People communicate through forms instead of direct conversation. The firm becomes too bureaucratic, and operations bog down, causing the average cost of production to rise.

Steven Jobs, founder of Apple Computer Company, stated:

> When you are growing [too big], you start adding middle management like crazy... People in the middle have no understanding of the business, and because of that, they screw up communications. To them, it's just a job. The corporation ends up with mediocre people that form a layer of concrete.

Ideally, firms want to operate at a scale that minimizes their LRAC. Operating in the diseconomies of scale region can motivate firms to downsize, to reduce their costs in order to remain price competitive. On the other hand, if economies of scale can be experienced, firms are motivated to expand output, moving down their LRAC curve.

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Key Terms

Explicit costs

Implicit costs

Economic profit

Normal profit

Normal profit

Fixed input

Variable input

Short run

Long run

Production function

Marginal product

Law of diminishing returns

Total fixed cost (TFC)

Total variable cost (TVC)

Total cost (TC)

Average fixed cost (AFC)

Average variable cost (AVC)

Average total cost (ATC)

Marginal cost (MC)

Marginal-average rule

Long-run average cost curve (LRAC)

Economies of scale

Constant returns to scale

Diseconomies of scale

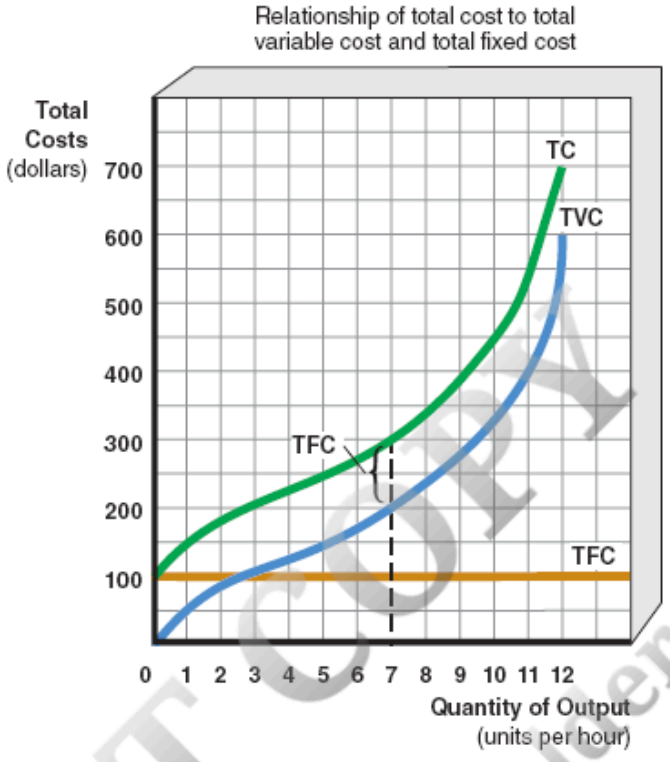
Summary

- Economic profit is equal to total revenue minus both *explicit* and *implicit* costs. Explicit costs are payments to nonowners of a firm for their resources. Implicit costs are the opportunity costs of forgone returns to

resources. Implicit costs are the opportunity costs of forgone returns to resources owned by a firm. Economic profit can be positive, zero, or negative (an economic loss). Economic profit is important for decision-making purposes because it includes implicit costs and accounting profit does not. Accounting profit equals total revenue minus explicit costs.

- Normal profit is the minimum profit necessary to keep a firm in operation. A normal profit is a zero economic profit, and it signifies there is just enough total revenue to pay the owners for all explicit and implicit costs.
- A fixed input is any resource for which the quantity cannot change during the period of time under consideration. A variable input is any resource for which the quantity can change during the period of time under consideration.
- The short run is a time period during which a firm has at least one fixed input, such as its factory size. The long run for a firm is defined as a period during which all inputs are variable.
- A production function is the relationship between output and inputs. Holding all other factors of production constant, the production function shows the total output as the amount of one input, such as labor, varies.
- Marginal product is the change in total output caused by a one-unit change in a variable input, such as the number of workers hired. The law of diminishing returns states that after some level of output in the short run, each additional unit of the variable input yields smaller and smaller marginal product. This range of declining marginal product is the region of diminishing returns.
- Total fixed cost (TFC) consists of costs that do not vary with the level of output, such as rent for office space. Total fixed cost is the cost of inputs that do not change as a firm changes output in the short run. Total variable cost (TVC) consists of costs that vary with the level of output, such as wages. Total variable cost is the cost of variable inputs used in production. Total cost (TC) is the sum of total fixed cost (TFC) and total

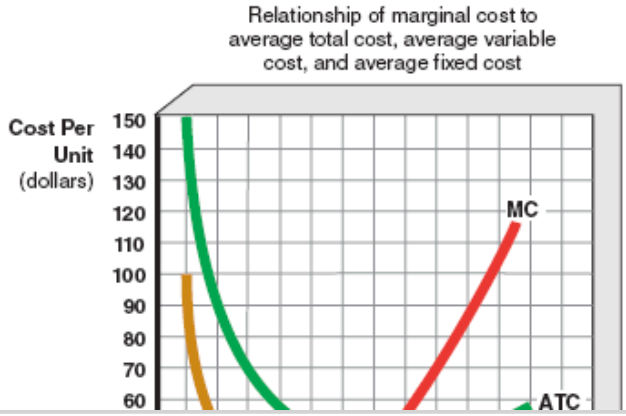
production. Total cost (TC) is the sum of total fixed cost (TFC) and total variable cost (TVC).

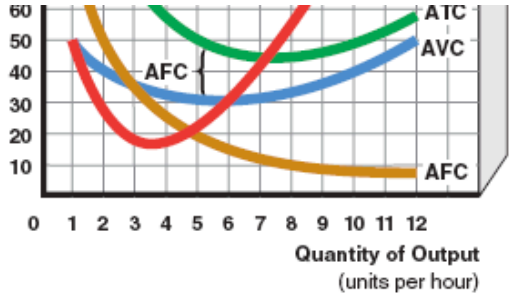


▸ Details

Total Cost Curves

- Marginal cost (MC) is the change in total cost associated with one additional unit of output. Average fixed cost (AFC) is the total fixed cost divided by total output. Average variable cost (AVC) is the total variable cost divided by total output. Average total cost (ATC) is the total cost divided by output, or the sum of average fixed cost and average variable cost.

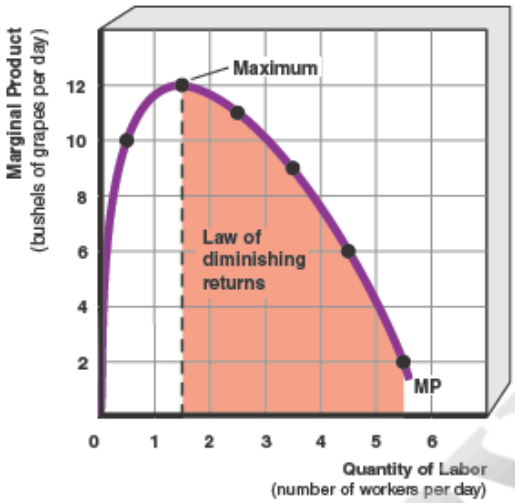




▸ Details

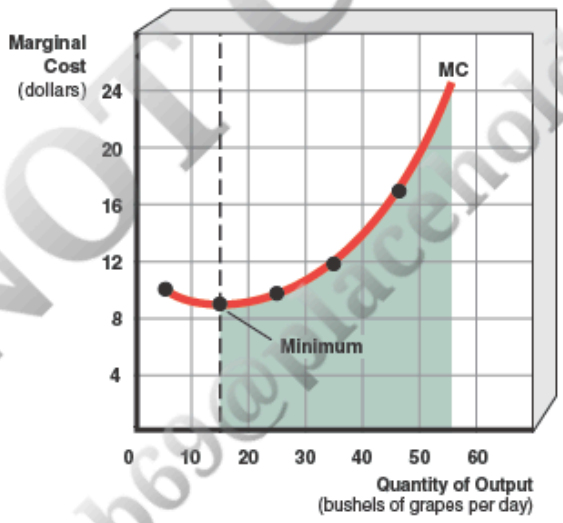
Average and Marginal Cost Curves

- The marginal-average rule explains the relationship between marginal cost and average cost. When marginal cost is less than average cost, average cost falls. When marginal cost is greater than average cost, average cost rises. Following this rule, the marginal cost curve intersects the average variable cost curve and the average total cost curve at their minimum points.
- Marginal cost (MC) and marginal product (MP) are mirror images of each other. Assuming a constant wage rate, marginal cost equals the wage rate divided by the marginal product. Increasing returns cause marginal cost to fall, and diminishing returns cause marginal cost to rise. This explains the J-shaped marginal cost curve.



▸ Details

Marginal Product Curve

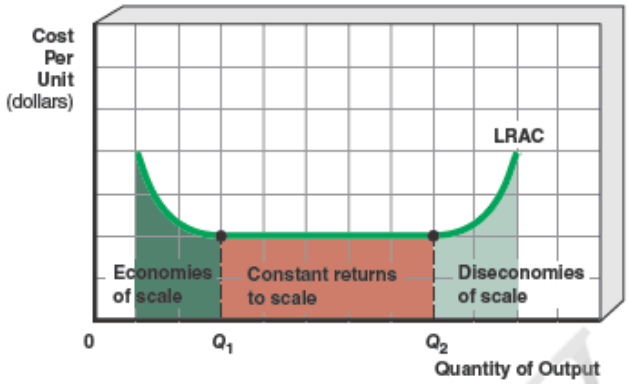


▸ Details

Marginal Cost Curve

- The long-run average cost curve (LRAC) is a curve drawn tangent to all possible short-run average total cost curves. When the LRAC curve decreases as output increases, a firm experiences economies of scale. If the LRAC curve remains unchanged as output increases, a firm experiences constant returns to scale. If the LRAC curve increases as output increases, a firm experiences diseconomies of scale.

of scale.



▸ Details

Long-Run Average Cost Curve

Take Note Revisited

- Since business decision making is based on economic profit, rather than accounting profit, the word *profit* in this text always means economic profit.
- The short run is a period of time so short that there is at least one fixed input while the long run is a period of time so long that all inputs are variable.
- Marginal product (MP) measures the change to total output that results from hiring an additional worker. Marginal product may increase initially as workers specialize, but diminishing returns will always eventually occur in the short run as workers must share limited fixed inputs.
- As marginal product increases and workers are more productive, the marginal cost of production falls. As diminishing returns occur and marginal product decreases, the marginal cost of production rises.
- A firm *operates* in the short run when there is insufficient time to alter some fixed input. The firm *plans* in the long run when all inputs are variable.

variable.

- The plant size selected by a firm in the long run depends on the expected level of production.

Study Questions and Problems

Please see Appendix A for answers to the odd-numbered questions. Your instructor has access to the answers for even-numbered questions.

1. Indicate whether each of the following is an explicit cost or an implicit cost.

a. A manager's salary

SHOW ANSWER

b. Payments to Dell for computers

SHOW ANSWER

c. A salary forgone by the owner of a firm by operating their own company

SHOW ANSWER

d. Interest forgone on a loan an owner makes to their own company

SHOW ANSWER

e. Medical insurance payments a company makes for its employees

SHOW ANSWER

f. Income forgone while going to college

SHOW ANSWER

SHOW ANSWER

2. Suppose you own a bakery. List some of the fixed inputs and variable inputs you would use.

3.

a. Construct the marginal product schedule for the production function data in the table in Exhibit 10.

Exhibit 10 Total Output and Marginal Product

Labor	Total Output	Marginal Product
0	0	
1	8	
2	18	
3	30	
4	43	
5	55	
6	65	
7	73	
8	79	
9	82	
10	80	

SHOW ANSWER

b. Graph the total output and marginal product curves, and identify increasing and diminishing marginal returns.

SHOW ANSWER

4. Explain this statement: "Total output starts falling when diminishing returns occur."

5. What effect might a decrease in the demand for high-definition televisions have on the short-run average total cost curve for this product?

SHOW ANSWER

6.

a. Construct the cost schedule using the data in Exhibit 11 for a firm operating in the short run.

Exhibit 11 Short-run Costs

Total Output (Q)	Total Fixed Cost (TFC)	Total Variable Cost (TVC)	Total Cost (TC)	Marginal Cost (MC)	Average Fixed Cost (AFC)	Average Variable Cost (AVC)	Average Total Cost (ATC)
0	$50	$____	$50	$	$____	$____	$____
1	____	____	$70	____	____	____	____
2	____	____	$85	____	____	____	____
3	____	____	$95	____	____	____	____
4	____	____	$100	____	____	____	____
5	____	____	$110	____	____	____	____
6	____	____	$130	____	____	____	____
7	____	____	$165	____	____	____	____
8	____	____	$215	____	____	____	____
9	____	____	$275	____	____	____	____

Details

b. Graph the average variable cost, average total cost, and marginal cost curves.

7. Explain why the average total cost curve and the average variable cost curve move closer together as output expands.

SHOW ANSWER

8. Ace Manufacturing produces 1,000 hammers per day. The total fixed cost for the plant is $5,000 per day, and the total variable cost is $15,000 per day. Calculate the average fixed cost, average variable cost, average total cost, and total cost at the current output level.

9. An owner of a firm estimates that the average total cost is $6.71 and the marginal cost is $6.71 at the current level of output. Explain the relationship between these marginal cost and average total cost figures.

SHOW ANSWER

10. What short-run effect might a decline in the demand for electronic components for cell phones have on Computech's average total cost curve?

Sample Quiz

Please see Appendix B for answers to Sample Quiz questions.

1. A firm has $200 million in total revenue and explicit costs of $190 million. Suppose its owners have invested $100 million in the company at an opportunity cost of 10 percent interest per year. What is the firm's economic profit?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. $400 million

b. $100 million

c. $80 million

d. zero

2. The units of labor in a production process are 1, 2, 3, 4, and 5, and the corresponding total output is 30, 34, 37, 39, and 40, respectively. What is the marginal product of the fourth unit?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. 2

b. 1

c. 37

d. 39

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Road Map for Chapters 3, 4, 5, 6, and 7

Microeconomics Fundamentals

This road map feature helps you tie together material in the part as you travel the Economic Way of Thinking Highway. The following are review questions listed by chapter from the previous part. The correct answers to the multiple-choice questions are given in Appendix C.

Chapter 3: Market Demand and Supply

1. Key Concept: Movement along versus shift in demand

Which of the following would shift the demand curve for autos to the right?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. A fall in the price of autos

b. A fall in the price of auto insurance

c. A fall in consumers' incomes

d. A fall in the price of steel

2. Key Concept: Movement along versus shift in supply

Assuming that both soybeans and tobacco can be grown on the same land, a decrease in the price of tobacco, other things being equal, causes a(an)

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. rightward shift of the supply curve for tobacco.

b. upward movement along the supply curve for soybeans.

c. rightward shift in the supply curve for soybeans.

d. leftward shift in the supply curve for soybeans.

3. Key Concept: Shortage

Which of the following situations results from a ticket price to a concert set below the equilibrium price?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. A long line of people wanting to purchase tickets to the concert.

b. No line of people wanting to buy tickets to the concert.

c. Tickets available at the box office, but no line of people wanting to buy them.

d. None of the above.

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4. Key Concept: Change in demand

A decrease in consumer income decreases the demand for compact discs. As a result of the change to a new equilibrium, there is a(an)

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. leftward shift of the supply curve.

b. rightward shift of the supply curve.

c. upward movement along the supply curve.

d. downward movement along the supply curve.

5. Key Concept: Change in supply

Consider the market for grapes. An increase in the wage paid to grape pickers will cause the

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. demand curve for grapes to shift to the right, resulting in a higher equilibrium price for grapes and a reduction in the quantity consumed.

b. demand curve for grapes to shift to the left, resulting in a lower equilibrium price for grapes and an increase in the quantity consumed.

c. supply curve for grapes to shift to the left, resulting in a

lower equilibrium price for grapes and a decrease in the quantity consumed.

d. supply curve for grapes to shift to the left, resulting in a higher equilibrium price for grapes and a decrease in the quantity consumed.

6. Key Concept: Change in both demand and supply

Consider the market for new cars. What will happen to the equilibrium price for new cars if there is a simultaneous increase in the demand and decrease in the supply for new cars?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. Price will increase.

b. Price will decrease.

c. Price will stay the same.

d. Price might increase, decrease, or stay the same.

Chapter 4: Markets in Action

7. **Key Concept: Efficiency**

Market efficiency is achieved when the marginal benefit is

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

greater than the marginal cost.

equal to the total cost.

equal to the marginal cost.

less than the total cost.

8. **Key Concept: Rent control**

Rent controls create distortions in the housing market by

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

increasing rents received by landlords.

raising property values.

encouraging landlords to overspend for maintenance.

discouraging new housing construction.

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9. Key Concept: Minimum wage

Which of the following is an example of a price floor?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

Rent controls on apartments in major cities

General admission tickets to concerts

The minimum wage law

Food stamp regulations

Chapter 5: Elasticity

10. Key Concept: Price elasticity of demand

Suppose Good Food's supermarket raises the price of its steak and finds that its total revenue from steak sales does *not* change. This is evidence that price elasticity of demand for steak is

price elasticity of demand for steak is

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

perfectly elastic.

perfectly inelastic.

unitary elastic.

inelastic.

elastic.

11. Key Concept: Tax incidence

Which of the following statements is *true* about a per unit tax placed in a market?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

The full tax is always passed on to the consumer no matter how elastic (flat) the demand curve is.

The full tax is always passed on to the seller no matter how elastic (flat) the demand curve is.

The more elastic (flat) the demand curve, the more the tax is passed on to the consumer.

The more inelastic (steep) the demand curve, the more the tax is passed on to the consumer.

Chapter 6: Consumer Choice Theory

12. Key Concept: Consumer equilibrium

Total utility is maximized when the entire budget is spent and

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

the total utility of each good is equal.

the marginal utility of each good is equal.

the total utility per dollar spent on each good is equal.

the marginal utility per dollar spent on each good is equal.

13. Key Concept: Substitution effect

Which of the following is the *best* example of the substitution effect?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

Joe buys fewer apples and more oranges as the result of an increase in the price of apples.

Joe buys more apples when his income increases.

Joe buys an apple slicer when the price of apples decreases.

Joe buys less sugar as the result of an increase in the price of apples.

Chapter 7: Production Costs

14. Key Concept: Marginal product and marginal cost

Which of the following is *true* at the point where diminishing returns set in?

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

Both marginal product and marginal cost are at a maximum.

Both marginal product and marginal cost are at a minimum.

Marginal product is at a maximum, and marginal cost is at a minimum.

Marginal product is at a minimum, and marginal cost is at a maximum.

Chapter 8. Perfect Competition

Chapter Objectives

1. Describe the characteristics of a perfectly competitive market.
2. Explain how a profit maximizing perfectly competitive firm determines how much output to produce.
3. Analyze how a perfectly competitive firm decides whether to shut down or stay in business.
4. Describe how both an individual firm's supply and the market supply are determined for a perfectly competitive market in the short run.
5. Describe how the long run supply curve is derived for a perfectly competitive firm.

Introduction

This chapter combines the demand and supply, cost of production, and marginal analysis concepts from previous chapters to explain how competitive markets determine prices, output, and profits. Here firms are small, like a bakery or an

ostrich farm, rather than huge, like Wal-Mart or Microsoft. In the short run, when there are profits, additional firms enter the market and start producing output. In contrast, when there are losses, some firms leave the market, halting their production. The entry and exit of firms drives economic profit to zero, which is a long-run equilibrium. Without economic profits or losses, firms no longer have an incentive to enter or leave the competitive market, and the number of firms remains stable. Other types of markets in which large and powerful firms operate are discussed in the next two chapters.

8-1. Perfect Competition

Firms sell goods and services under different market conditions, which economists call market structures. A **market structure** describes the key traits of a market, including the number of firms, the similarity of the products they sell, and the ease of entry into and exit from the market. Examination of the business sector of our economy reveals firms operating in different market structures. In this chapter and the two chapters that follow, we will study four market structures. The first is perfect competition, to which this entire chapter is devoted.

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8-1a. Characteristics of Perfect Competition

Perfect, or pure, competition is a market structure characterized by:

1. a large number of small firms,
2. a homogeneous product, and
3. very easy entry into or exit from the market.

Let's discuss each of these characteristics.

Large Number of Small Firms

How many sellers comprise a large number? And how small is a small firm? Certainly, one, two, or three firms in a market would not be a large number. In fact, the exact number cannot be stated. This condition is fulfilled when each firm in a market has no significant share of total output and, therefore, no ability to affect the product's price. Each firm acts independently, rather than coordinating decisions collectively. For example, there are thousands of independent egg farmers in the United States. If any single egg farmer decides to alter the number of eggs produced, the change in egg output will be so small that it will have no measurable impact on the market supply; therefore, the famer's decision will not influence the market price.

Homogeneous Product

In a perfectly competitive market, all firms produce a standardized or **homogeneous product**. This means the good or service of each firm is identical. Farmer Julie's wheat is identical to Farmer Gustavo's wheat. Buyers may believe the transportation services of one independent trucker are about the same as another's services. This assumption rules out rivalry among firms in advertising and quality differences.

Very Easy Entry and Exit

Very easy entry into a market means that a new firm faces no barrier to entry. A **barrier to entry** is any obstacle that makes it difficult for a new firm to enter a market. Barriers can be financial, technical, or government-imposed, such as licenses, permits, and patents. Such barriers do not exist for ostrich farming. Anyone who wants to try their hand at raising ostriches needs only a plot of land and feed.

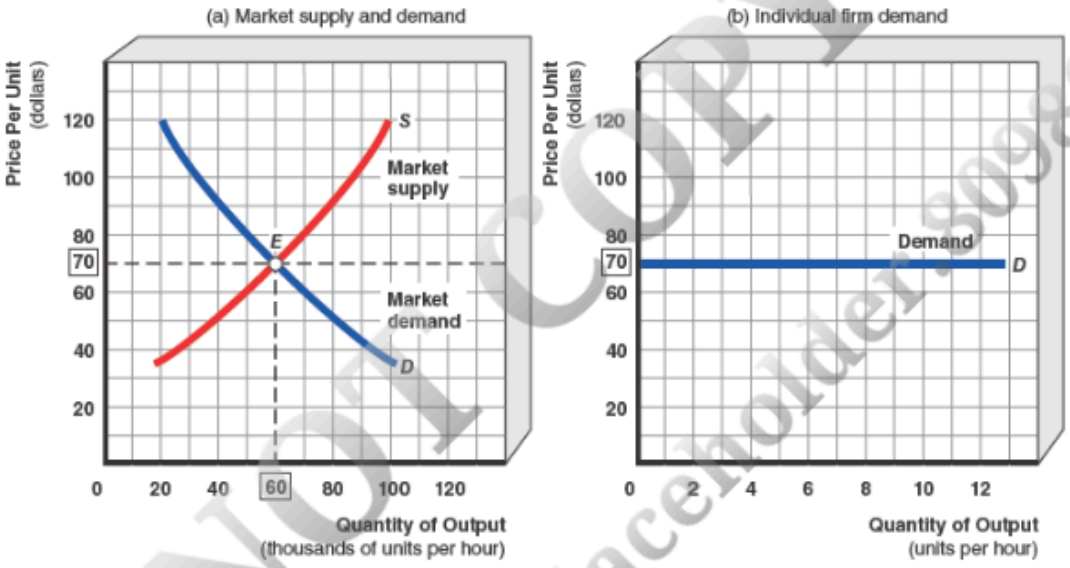
Take Note

Perfect competition is characterized by a large number of small firms each producing a homogeneous product in a market with very easy entry and exit of firms.

No real-world market exactly fits the three assumptions of perfect competition. The perfectly competitive market structure is a theoretical or ideal model, but some actual markets do approximate the model fairly closely. Examples include agricultural markets, the stock market, and the foreign exchange market.

industry's thousands of units per hour.) Recall from Chapter 5 that when a firm facing a perfectly elastic demand curve tries to raise its price one penny higher than $70, no buyer will purchase its product [Exhibit 2(a) in Chapter 5]. The reason is that many other firms are selling the same product at $70 per unit. Hence, the perfectly competitive firm will not set the price above the prevailing market price and risk selling zero output. Nor will the firm set the price below the market price because a lower price would reduce the firm's revenue, and the firm can sell all it wants to at the going price.

Exhibit 1 The Market Price and Demand for the Perfectly Competitive Firm



▸ Details

In part (a), the market equilibrium price of $70 per unit is determined by the intersection of the market demand and market supply curves (point *E*). The perfectly competitive firm in part (b) is a price taker because it is so small relative to the market that it has no market power to affect the price. At $70, the individual firm faces a horizontal demand curve, *D*. This means that the firm's demand curve is perfectly elastic. If the firm raises its price even one penny, it will sell zero output.

Take Note

A perfectly competitive firm has no control over the price of the product it sells, so it "takes" the market equilibrium price. As a result, the individual firm's demand curve is perfectly elastic (horizontal) at this price.

firm's demand curve is perfectly elastic (horizontal) at this price.

Am I on Track?

1. Which of the following is NOT true for a perfectly competitive market?

SHOW ANSWER

SHOW ANSWER

a. There are many small firms, each producing a homogeneous product.

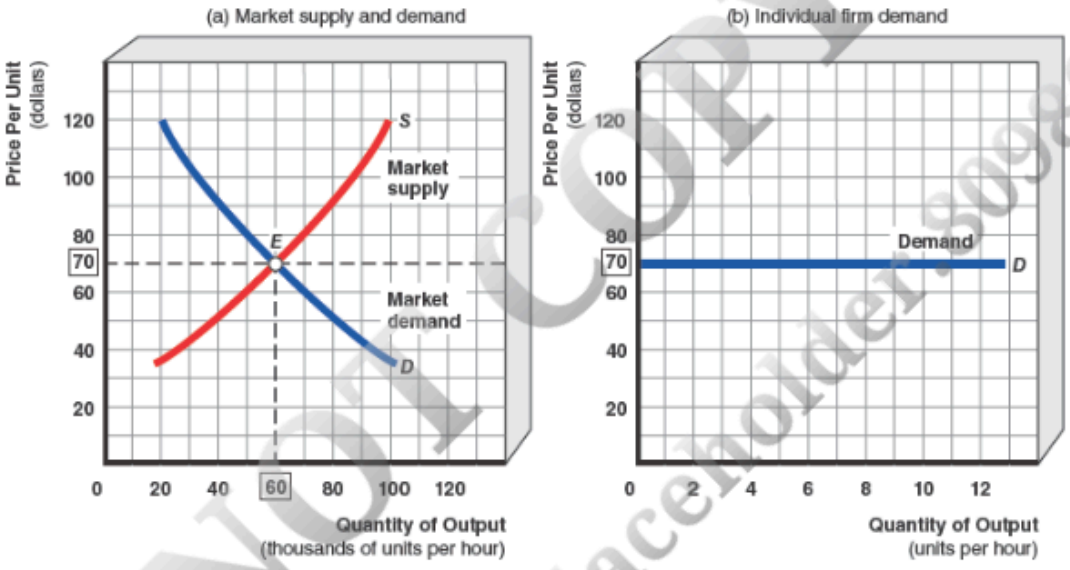
b. There are no barriers to entry.

c. An individual firm's demand curve is the same as the market demand curve.

d. Individual firms have no ability to set price so must "take" the market price.

industry's thousands of units per hour.) Recall from Chapter 5 that when a firm facing a perfectly elastic demand curve tries to raise its price one penny higher than $70, no buyer will purchase its product [Exhibit 2(a) in Chapter 5]. The reason is that many other firms are selling the same product at $70 per unit. Hence, the perfectly competitive firm will not set the price above the prevailing market price and risk selling zero output. Nor will the firm set the price below the market price because a lower price would reduce the firm's revenue, and the firm can sell all it wants to at the going price.

Exhibit 1 The Market Price and Demand for the Perfectly Competitive Firm



▸ Details

In part (a), the market equilibrium price of $70 per unit is determined by the intersection of the market demand and market supply curves (point *E*). The perfectly competitive firm in part (b) is a price taker because it is so small relative to the market that it has no market power to affect the price. At $70, the individual firm faces a horizontal demand curve, *D*. This means that the firm's demand curve is perfectly elastic. If the firm raises its price even one penny, it will sell zero output.

Take Note

A perfectly competitive firm has no control over the price of the product it sells, so it "takes" the market equilibrium price. As a result, the individual firm's demand curve is perfectly elastic (horizontal) at this price.

firm's demand curve is perfectly elastic (horizontal) at this price.

Am I on Track?

1. Which of the following is NOT true for a perfectly competitive market?

SHOW ANSWER

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SHOW ANSWER

a. There are many small firms, each producing a homogeneous product.

b. There are no barriers to entry.

c. An individual firm's demand curve is the same as the market demand curve.

d. Individual firms have no ability to set price so must "take" the market price.

8-2. Short-Run Profit Maximization for a Perfectly Competitive Firm

Since the perfectly competitive firm has no control over price, what does the firm control? The firm makes only one decision—what quantity of output to produce that maximizes profit. This section develops two profit maximization methods that determine the output level for a competitive firm in the short run when some input, such as factory size, is fixed. We begin by examining the total revenue–total cost approach for finding the profit-maximizing level of output, then marginal analysis is used to show the same.

8-2a. The Total Revenue–Total Cost Method

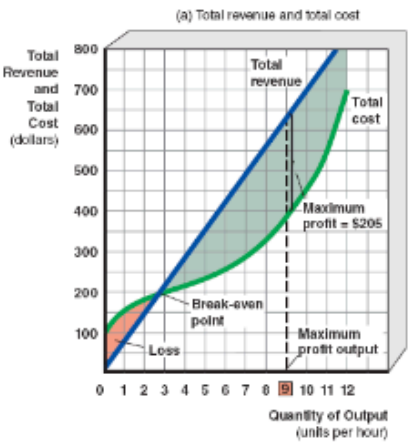
Exhibit 2 provides hypothetical data on output, total revenue, total cost, and profit for our typical electronic components producer—Computech. Using Computech as our example allows us to extend the data and analysis presented in previous chapters. The cost figures are taken from Exhibit 3 in Chapter 7. Total fixed cost at zero output is $100. Total revenue is reported in column (3) of Exhibit 2 and is computed as

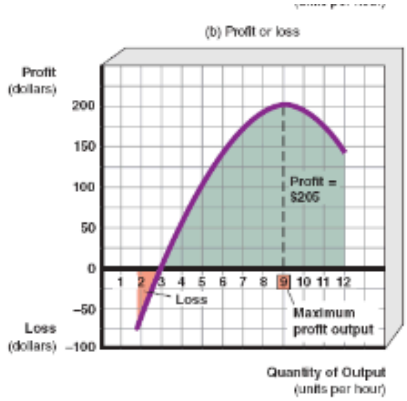
$205 per hour. As output expands between 9 and 12 units of output, the firm's profit diminishes. Exhibit 3 illustrates graphically that the maximum profit occurs where the vertical distance between the total revenue and the total cost curves is at a maximum.

Exhibit 2 Short-Run Profit Maximization Schedule for Computech as a Perfectly Competitive Firm

(1) Output (Units Per Hour) (Q)	(2) Price Per Unit (P)	(3) Total Revenue (TR)	(4) Marginal Revenue (MR)	(5) Marginal Cost (MC)	(6) Total Cost (TC)	(7) Average Variable Cost (AVC)	(8) Average Total Cost (ATC)	(9) Profit (+) or Loss (–) [(3) – (6)]
0	$70	$0			$100	–	–	–$100
			$70	$50				
1	70	70			150	$50	$150	–80
			70	34				
2	70	140			184	42	92	–44
			70	24				
3	70	210			208	36	69	2
			70	19				
4	70	280			227	32	57	53
			70	23				
5	70	350			250	30	50	100
			70	30				
6	70	420			280	30	47	140
			70	38				
7	70	490			318	31	45	172
			70	48				
8	70	560			366	33	46	194
			70	59				
9	70	630	70	70	425	36	47	205
			70	75				
10	70	700			500	40	50	200
			70	95				
11	70	770			595	45	54	175
			70	117				
12	70	840			712	51	59	128

Exhibit 3 Short-Run Profit Maximization Using the Total Revenue–Total Cost Method for a Perfectly Competitive Firm





▸ Details

This exhibit shows the profit-maximizing level of output chosen by a perfectly competitive firm, Computech. Part (a) shows the relationships between total revenue, total cost, and output, given a market price of $70 per unit. The maximum profit is earned by producing 9 units per hour. At this level of output, the vertical distance between the total revenue and the total cost curves is the greatest. At an output level below 3 units per hour, the firm incurs losses.
Profit maximization is also shown in part (b). The maximum profit of $205 per hour corresponds to the profit-maximizing output of 9 units per hour, represented in part (a).

8-2b. The Marginal Revenue Equals Marginal Cost Method

A second approach uses *marginal analysis* to determine the profit-maximizing level of output by comparing marginal revenue (marginal benefit) and marginal cost. Recall from the previous chapter that a synonym for marginal is “extra” and that marginal cost is the change in total cost as the output level increases by one unit. Also recall that these marginal cost data are listed between the quantity of output line entries because the change in total cost occurs between each additional whole unit of output rather than exactly at each listed output level.

Now we introduce marginal revenue (MR), a concept similar to marginal cost. **Marginal revenue** is the “extra” revenue or the change in total revenue from the sale of one additional unit of output. Stated another way, marginal revenue

the sale of one additional unit of output. Stated another way, marginal revenue is the ratio of the change in total revenue to a change in output.

Mathematically,

$$\text{MR} = \frac{\text{change in total revenue}}{\text{one-unit change in output}}$$

As shown in Exhibit 1(b), the perfectly competitive firm faces a perfectly elastic demand curve. Because the competitive firm is a price taker, the sale of each additional unit adds to total revenue an amount equal to the price. In our example, Computech adds $70 to its total revenue each time it sells one unit. Therefore, $70 is the marginal revenue for each additional unit of output in column (4) of Exhibit 2. As with MC, MR is also listed between the quantity of output line entries because the change in total revenue occurs between each additional unit of output.

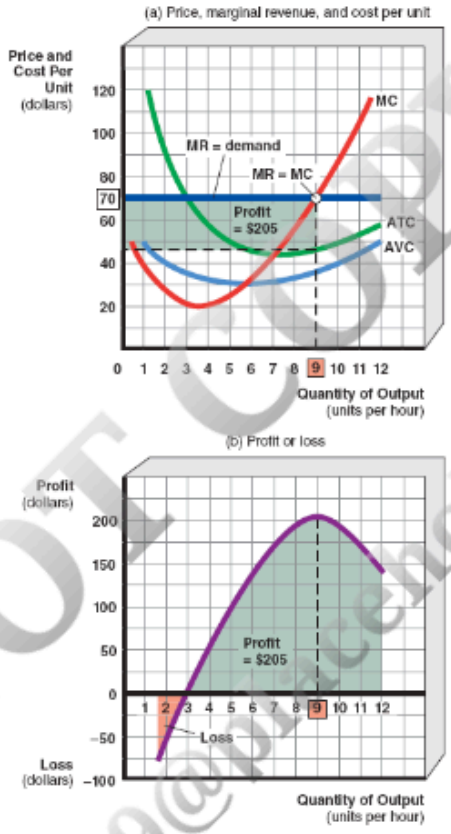
Take Note

In perfect competition, the firm's marginal revenue equals the price, which the firm views as a horizontal demand curve.

Columns (3) and (6) in Exhibit 2 show that both total revenue and total cost rise as the level of output increases. Now compare marginal revenue and marginal cost in columns (4) and (5). As explained, marginal revenue remains equal to the price, but marginal cost follows the J-shaped pattern introduced in Exhibit 4 of Chapter 7. At first, marginal revenue exceeds marginal cost, and the firm is adding more to its revenues than to its costs as output increases. Economic profit therefore increases as output expands from zero until the output level reaches 9 units per hour. Over this output range, Computech moves from a $100 loss to a $205 profit per hour. Beyond an output level of 9 units per hour, marginal cost exceeds marginal revenue, and profit falls. This is because each additional unit of output per hour raises total cost by more than it raises total revenue. In this case, profit falls from $205 to only $128 per hour as output increases from 9 to

case, profit falls from $205 to only $128 per hour as output increases from 9 to 12 units per hour.

Exhibit 4 Short-Run Profit Maximization Using the Marginal Revenue Equals Marginal Cost Method for a Perfectly Competitive Firm



Details

In addition to comparing total revenue and total cost, a firm can find the profit-maximizing level of output by comparing marginal revenue (MR) and marginal cost (MC). As shown in part (a), profit is at a maximum where marginal revenue equals marginal cost at $70 per unit. The intersection of the marginal revenue and marginal cost curves establishes the profit-maximizing output at 9 units per hour. Profit is then calculated as $(P - ATC) \times Q$.

A profit curve is depicted separately in part (b) to show that the maximum profit occurs when the firm produces at the level of output corresponding to the MR = MC point. Below 3 units per hour output, the firm incurs losses.

Our example leads to this question: How does the firm use its marginal revenue and marginal cost curves to determine the profit-maximizing level of output? The answer is that the firm follows a guideline called the MR = MC rule: *The firm*
191 *maximizes profit by producing the output where marginal revenue equals marginal cost.* Exhibit 4 relates the marginal revenue equals marginal cost condition to profit maximization. In Exhibit 4(a), the perfectly elastic demand curve is drawn at the market-determined price of $70. The average total cost (ATC) and average variable cost (AVC) curves are drawn using data from Exhibit 2. We can apply the MR = MC rule to the same profit data given in Exhibit 2. Between 8 and 9 units of output, the MR curve is above the MC curve
192 ($\$70 > \$59$), and the profit curve rises to its peak at $205. Beyond 9 units of output, the MC curve is above the MR curve, and the profit curve falls. For example, between 9 and 10 units of output, marginal cost is $75, and marginal revenue is $70. Therefore, if the firm produces at 9 units of output rather than, say, at 8 or 10 units of output, the MR curve equals the MC curve, and profit is maximized.

Take Note

Perfectly competitive firms choose the level of output that maximizes profit. This occurs when total revenue minus total cost is as large as possible, or equivalently, when marginal revenue is equal to marginal cost.

You can also calculate profit directly from Exhibit 4(a). *Profit* is calculated as:

$$\text{Profit} = \text{Total Revenue} - \text{Total Cost or}$$
$$\text{Profit} = (\text{P} \times \text{Q}) - \text{TC/Q}$$

Average profit per unit, then is calculated by dividing by quantity, which yields:

$$\text{Profit/Q} = (\text{P} \times \text{Q})/\text{Q} - \text{TC/Q or}$$
$$\text{Average profit per unit} = (\text{P} - \text{ATC})$$

At the profit-maximizing level of output of 9 units in Exhibit 4(a), the vertical distance between the demand curve (price of \$70 per unit) and the ATC curve (ATC of \$47.22 per unit) is the *average profit per unit*. Multiplying the average profit per unit times the quantity of output gives the total profit $[(\$70 - \$47.22) \times 9 = \$205.02]$. The shaded rectangle then represents the maximum profit of \$205 per hour. Note that we have arrived at the same profit maximization amount $(\$630 - \$425 = \$205)$ derived earlier by comparing the total revenue and the total cost curves.

Am I on Track?

2. A perfectly competitive firm producing at an output level where marginal revenue exceeds marginal cost could increase profit by

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. increasing output.

b. decreasing output.

c. increasing the price.

d. decreasing the price.

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SHOW ANSWER

SHOW ANSWER

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8-3. Short-Run Supply Under Perfect Competition

Because the perfectly competitive firm must take the price determined by market supply and demand forces, market conditions can change the prevailing price. When the market price drops, the firm can do nothing but adjust its output to make the best of the situation. Here we will use the marginal approach to predict output decisions of firms. In the short run, it is possible for perfectly competitive firms to earn positive profits, zero profit or negative profits (losses).

8-3a. Identifying Profit or Loss

In the previous section we showed how a firm maximizes profit by producing the output level at which marginal revenue is equal to marginal cost. We further showed that profit can be calculated as $(\mathrm{P} - \mathrm{ATC}) \times \mathrm{Q}$ at this level of output. In Exhibit 5(a), which reproduces the graph from Exhibit 4(a), we show the case where price is greater than average total cost and profit is positive. The firm maximizes profit by producing the level of output where marginal revenue equals marginal cost (point *A*), or 9 units of output. Profit, shown as the blue rectangle, is calculated as $(\mathrm{P} - \mathrm{ATC}) \times \mathrm{Q}$ or $(\$70 - \$47.22) \times 9 = \$205$. Any time price is greater than average total cost, the firm will earn positive economic profits.

Suppose a decrease in the market demand for electronic components causes the market price to fall to $45. As a result, the firm's horizontal demand curve shifts downward to the new position shown in Exhibit 5(b). Notice that marginal revenue equals marginal cost at an output of 7 units now (point *B*) and profit is $(\mathrm{P} - \mathrm{ATC}) \times \mathrm{Q} = (\$45 - \$45) \times 7 = \$0$. When the firm produces 7 units of output, price is equal to average total cost and the firm breaks even and earns a normal profit (a zero economic profit).

Finally, suppose a further decrease in the market demand for electronic components causes the market price to fall to $35. The firm's horizontal demand curve shifts downward to the new position shown in Exhibit 5(c). In this case, there is no level of output at which the firm earns a profit because any price along the demand curve is below the ATC curve. At a price of $35, MR = MC at 6 units per hour and profit is $(\mathrm{P} - \mathrm{ATC}) \times \mathrm{Q} = (\$35 - \$46.67) \times 6 = -\$70$, which is a loss.

Take Note

Profit can be calculated as $(\mathrm{P} - \mathrm{ATC}) \times \mathrm{Q}$, so when price exceeds ATC the firm earns a positive economic profit; when they are equal a normal

the firm earns a positive economic profit, when they are equal a normal profit is earned, and when price falls below ATC the firm earns a loss.

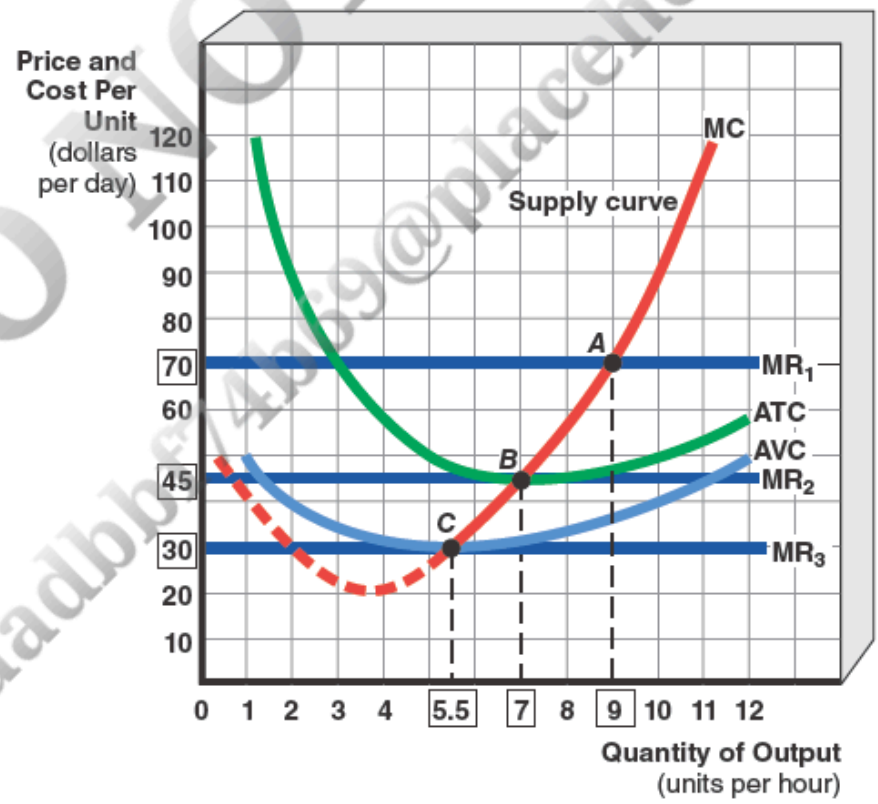
8-3c. Short-run Supply Curves

The preceding examples provide a framework for a more complete explanation of the supply curve than was given earlier in Chapter 3. We now develop the short-run supply curve for an individual firm and then derive it for an industry.

Individual Firm Supply

Exhibit 7 reproduces the cost curves from our Computech example. Also represented in the exhibit are three possible demand curves the firm might face — MR_1 , MR_2 , and MR_3 . As the marginal revenue curve moves downward along the marginal cost curve, the MR = MC point changes.

Exhibit 7 The Perfectly Competitive Firm's Short-Run Supply Curve



▸ Details

This exhibit shows how the short-run supply curve for Computech is

This exhibit shows how the short-run supply curve for Computech is derived. When the price is $70, the firm sets marginal revenue equal to marginal cost and produces 9 units per hour at point *A*. If the price falls to $45, the firm will move downward along its marginal cost (MC) curve to point *B* and produce 7 units per hour. At $30, the firm produced 5.5 units per hour, but at prices below that the firm shuts down. Thus, the firm's short-run supply curve is the MC curve above its AVC curve.

Suppose demand for electronic components begins at a market price of $70. Point *A* shows MR_1 intersects the MC curve at an output of 9 units per hour, and the firm earns an economic profit. Recall from Chapter 3 that a supply curve shows various quantities of a product that sellers are willing to produce and offer for sale at possible prices. Point *A* is therefore one point on the individual firm's short-run supply curve, indicating that at a price of $70 the firm will offer 9 units for sale. Note that if the price rose higher than $70, the firm would continue to increase the quantity supplied and doing so would increase its profit.

Am I on Track?

3. Myrtle Beach, South Carolina, is lined with virtually identical motels. Summertime rates run about $250 a night. During the winter, rooms rent for as little as $70 a night. Assume the average fixed cost of a room per night, including insurance, taxes, and depreciation, is $30. The average guest-related cost (average variable cost) for a room each night, including cleaning service and linens, is $65. The average total cost, which is the sum of the average fixed cost ($30) and the average variable cost ($65), is $95. During the winter, these hotels should

SHOW ANSWER

SHOW ANSWER

SHOW ANSWER

a. shut down until summer because they are currently operating at a loss.

b. shut down until summer because they cannot cover all of their fixed costs.

c. continue to operate because they are earning a positive economic profit.

d. continue to operate despite operating at a loss because they are covering all of their variable cost and a portion of their fixed costs.

As we saw in Section 8-3a if market conditions change and the price falls to $45, represented in the exhibit by MR_2 , the firm breaks even and earns a normal profit at point *B* with an output of 7 units per hour. Point *B* is therefore another point on the individual firm's short-run supply curve, indicating that at a price of $45 the firm will offer 7 units for sale. As the marginal revenue curve falls, the firm's supply curve is traced by moving downward along its MC curve.

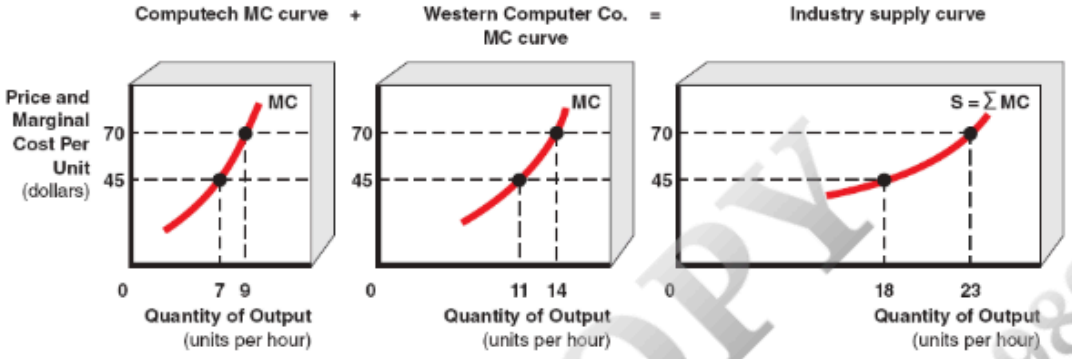
At prices below ATC, the firm earns a loss but will continue to produce as long as price is above AVC. This is because the firm is able to cover all its variable costs and a portion of its fixed costs. However, at any price below AVC, the firm minimizes its loss by shutting down. In Exhibit 7, the firm will continue to

minimizes its loss by shutting down. In Exhibit 7, the firm will continue to produce as price falls until the price falls below $30 (point *C*). At $30, MR_3 equals MC at the lowest point on the AVC curve and the firm produces 5.5 units per hour. But the firm shuts down in the short run if the price falls below this minimum point on the AVC curve.

We can now define a perfectly competitive firm's short-run supply curve. The **perfectly competitive firm's short-run supply curve** is its marginal cost curve above the minimum point on its average variable cost curve. Graphically it is represented as the solid red portion of the MC curve in Exhibit 7.

7 units, and the quantity supplied by Western Computer Co. is 11 units. Now horizontally add these two quantities and obtain one point on the industry supply curve corresponding to a price of $45 and 18 units. Following this procedure for all prices, we generate the short-run industry supply curve.

Exhibit 8 Deriving the Industry Short-Run Supply Curve



▸ Details

Assuming input prices remain constant as output expands, the short-run supply curve for an industry is derived by horizontally summing the quantities supplied at each price by all firms in the industry. In this exhibit, we assume there are only two firms in an industry. At $45, Computech supplies 7 units of output, and Western Computer Co. supplies 11 units. The quantity supplied by the industry is therefore 18 units. Other points forming the industry short-run supply curve are obtained similarly.

Note that the industry supply curve derived above is based on the assumption that input prices remain unchanged as output expands. In the next section, we will learn how changes in input prices affect the derivation of the industry supply curve.

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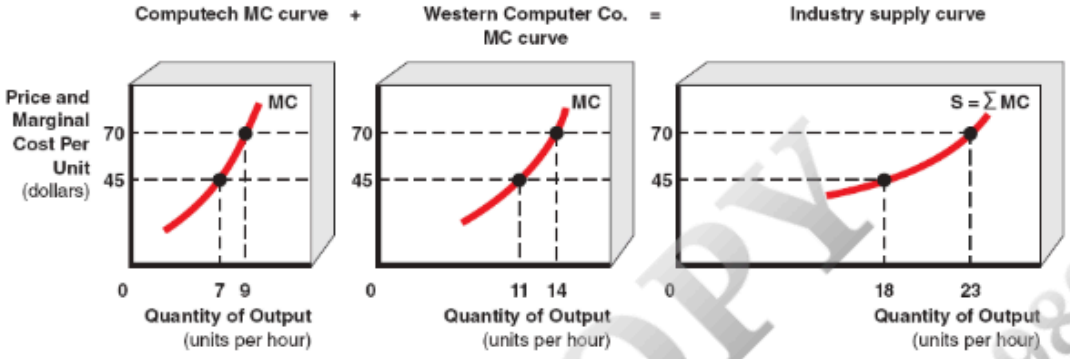

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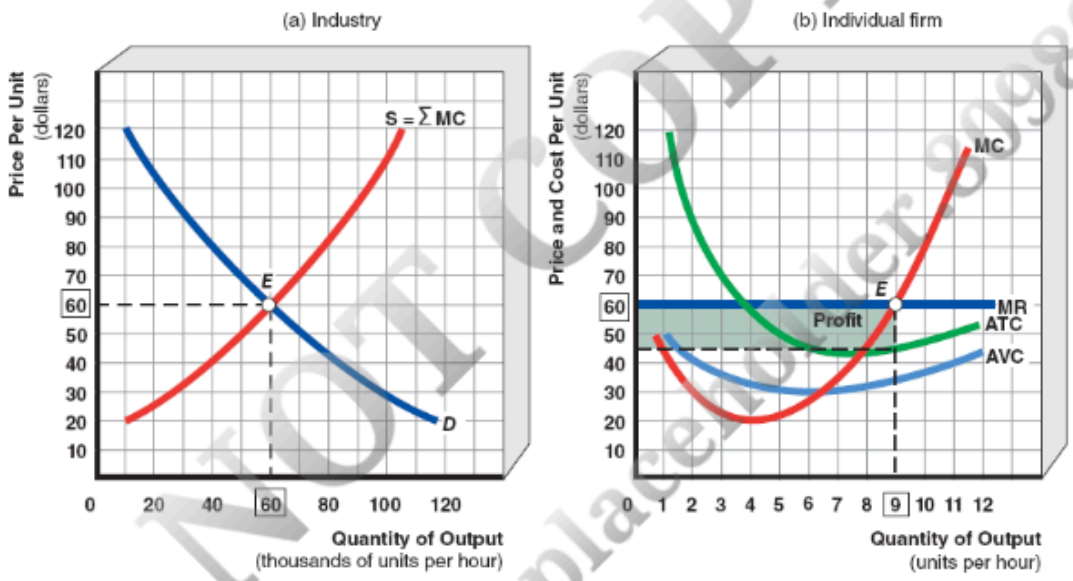
Note that the industry supply curve derived above is based on the assumption that input prices remain unchanged as output expands. In the next section, we will learn how changes in input prices affect the derivation of the industry supply curve.

8-3d. Short-Run Equilibrium for a Perfectly Competitive Firm

Exhibit 9 illustrates a condition of short-run equilibrium under perfect competition. Part(a) represents the market where the equilibrium price of $60 is established. As explained earlier, the industry supply curve is the aggregate of each firm's MC curve above the minimum point on the AVC curve. Including industry demand establishes the equilibrium price of $60 that all firms in the

industry demand establishes the equilibrium price of $60 that all firms in the industry must take. Part (b) represents the marginal revenue and cost situation for one of the many firms in an industry. As shown in the exhibit, the firm earns an economic profit in the short run by producing 9 units. Exhibit 9(a) depicts short-run equilibrium for the industry. The industry's equilibrium quantity supplied is 60,000 units. This state of short-run equilibrium will remain until some factor changes and causes a new equilibrium condition in the industry.

Exhibit 9 Short-Run Perfectly Competitive Equilibrium



Details

Short-run equilibrium occurs at point *E*. The intersection of the industry supply and demand curves shown in part (a) determines the price of $60 facing the firm shown in part (b). Given this equilibrium price, the firm represented in part (b) establishes its profit-maximizing output at 9 units per hour and earns an economic profit shown by the shaded area. Note in part (a) that the short-run industry supply curve is the horizontal summation of the marginal cost (MC) curves of all individual firms above their minimum average variable cost points.

8-4. Long-Run Supply Under Perfect Competition

Recall from Chapter 7 that *all* inputs are variable in the long run. Existing firms in an industry can react to profit opportunities by building larger or smaller plants, buying or selling land and equipment, or varying other inputs that are fixed in the short run. Profits also attract new firms to an industry, while losses
199 cause some existing firms to leave the industry. As you will now see, the free entry and exit characteristic of perfect competition is a crucial determinant of the shape of the long-run supply curve.

199 Profits also attract new firms to an industry, while losses cause some existing firms to leave the industry. As you will now see, the free entry and exit characteristic of perfect competition is a crucial determinant of the shape of the long-run supply curve.

8-4a. Long-Run Equilibrium

As discussed in Chapter 7, in the long run a firm can change its plant size or any input used to produce a product. This means that an established firm can decide to *leave* an industry if it earns below normal profits (negative economic profits) and that new firms may enter an industry in which earnings of established firms exceed normal profits (positive economic profits). This process of entry and exit of firms is the key to long-run equilibrium. If there are economic profits, new firms enter the industry and shift the short-run industry supply curve to the right. This increase in short-run supply causes the price to fall until economic profits reach zero in the long run. On the other hand, if there are economic losses in an industry, existing firms leave, causing the short-run supply curve to shift to the left, and the price rises. This adjustment continues until economic losses are eliminated and economic profits equal zero in the long run.

Part (a) of Exhibit 10 shows that supply and demand for the market as a whole set the equilibrium price of $60 and part(b) shows a typical firm in long-run

200