CHAPTER 4

Consumer Behavior and Individual Demand

Chapter Outline

List of Examples

After Studying This Chapter, You Should Be Able to:

- Know how to derive an individual consumer's demand curve for a commodity
- Know what a Giffen good is, how it can arise theoretically, and where it has been found
- Understand why a cash subsidy is better than food stamps
- Know the meaning and importance of consumer surplus
- Describe how to measure the benefits of exchange

In Chapter 3 we saw how a consumer maximized utility by reaching the highest possible indifference curve with the given budget line. In this chapter, we examine how the consumer responds to changes in income and prices while holding tastes constant. Incomes and prices change frequently in the real world, so it is important to examine their individual effects on consumer behavior.

We begin by examining how the consumer responds to changes in his or her income when prices and tastes remain constant. This will allow us to derive a so-called Engel curve and to distinguish between normal and inferior goods. Then we examine the consumer's response to a change in the price of the good and derive the individual's demand curve for the good. This is the basic building block for the market demand curve of the good (to be derived in Chapter 5), the importance of which was outlined in Chapter 2.

After deriving an individual's demand curve, we discuss how to separate the substitution from the income effect of a price change for normal and inferior goods. The ability to separate graphically the income from the substitution effect of a price change is one of the most powerful tools of analysis of microeconomic theory, with many important applications. Subsequently, we examine the degree by which domestic and foreign goods and services are substitutable and the great relevance of this substitution in the study of microeconomics. We then consider some important applications of the theory presented in this chapter. These applications, together with the real-world examples included in the theory sections, highlight the importance of the theory of consumer behavior and demand. Finally, the "At the Frontier" section presents the characteristics approach to consumer theory, which provides some additional insights and uses of consumer theory. The optional appendix to this chapter deals with index numbers and how they are used to measure changes in consumer welfare.

4.1 Changes in Income and the Engel Curve

A change in the consumer's income shifts his or her budget line, and this shift affects consumer purchases. In this section we examine how a consumer reaches a new optimum position when income changes but prices and tastes do not.

Income–Consumption Curve and Engel Curve

By changing the consumer's money income while holding prices and tastes constant, we can derive the consumer's income–consumption curve. The **income–consumption curve** is the locus of (i.e., joins) consumer optimum points resulting when only the consumer's income varies. From the income–consumption curve we can then derive the consumer's Engel curve (discussed below).

For example, the top panel of Figure 4.1 shows that with budget line JK the consumer maximizes utility or is at an optimum at point B, where indifference curve U_1 is tangent to budget line JK and the consumer purchases $2X$ and $6Y$ (the same as in Figure 3.8). That is (continuing with the example from Chapter 3), the best way for the student to spend a daily income allowance of \$10 on snacks of hamburgers (good X) and soft drinks (good Y) is to purchase two hamburgers and six soft drinks per day. If the prices of hamburgers and soft drinks remain unchanged at $P_X = \$2$ and $P_Y = \$1$ but the daily income allowance rises from \$10 to \$15 and then to \$20, budget line JK shifts up to $J'K'$ and then to $J''K''$ (the same as in the left panel of Figure 3.7). The three budget lines are parallel because the prices of X and Y do not change.

With an income of \$15 and budget line $J'K'$, the consumer maximizes utility at point R, where indifference curve U_2 is tangent to budget line $J'K'$ and the consumer purchases $4X$ and $7Y$ (see the top panel of Figure 4.1). Indifference curve U_2 is the same as in the right panel of Figure 3.2 because tastes have not changed. Finally, with an income of \$20 and budget line $J''K''$, the consumer maximizes utility or is at an optimum at point S on

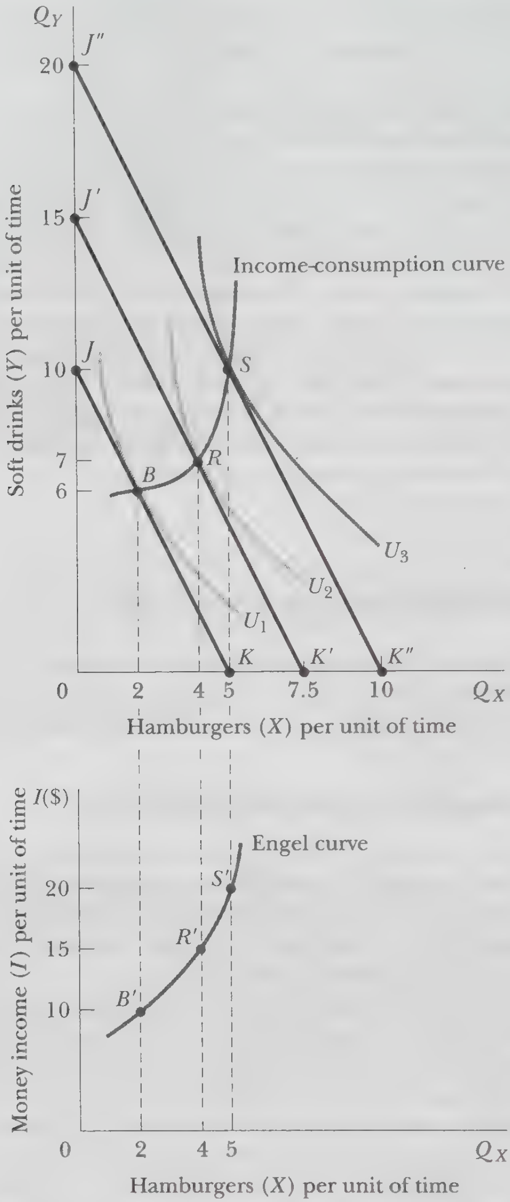

FIGURE 4.1 Income–Consumption Curve and Engel Curve With budget lines JK, $J'K'$, $J''K''$ and indifference curves U_1, U_2, and U_3 in the top panel, the individual maximizes utility at points B, R, and S, respectively. By joining optimum points B, R, and S we get the income–consumption curve (top panel). By then plotting income on the vertical axis and the various optimum quantities purchased of good X along the horizontal axis, we can derive the corresponding Engel curve $B'R'S'$ in the bottom panel.

U_3 by purchasing $5X$ and $10Y$ per unit of time (per day). By joining optimum points B, R, and S we get (a portion of) the income–consumption curve for this consumer (student). Thus, the income–consumption curve is the locus of consumer optimum points resulting when only the consumer's income varies.[1]

From the income–consumption curve in the top panel of Figure 4.1, we can derive the Engel curve in the bottom panel. The **Engel curve** shows the amount of a good that the consumer would purchase per unit of time at various income levels. To derive the Engel curve we keep the same horizontal scale as in the top panel but measure money income on the vertical axis.

The derivation of the Engel curve proceeds as follows. With a daily income allowance of $10, the student maximizes utility by purchasing two hamburgers per day (point B) in the top panel. This gives point B' (directly below point B) in the bottom panel. With an income allowance of $15, the student is at an optimum by purchasing four hamburgers (point R) in the top panel. This gives point R' in the bottom panel. Finally, with a daily income allowance of $20, the student maximizes utility by purchasing five hamburgers (point S in the top panel and S' in the bottom panel). By joining points B', R', and S' we get (a portion of) the Engel curve in the bottom panel. Thus, the Engel curve is derived from the income–consumption curve and shows the quantity of hamburgers per day (Q_X) that the student would purchase at various income levels (i.e., with various income allowances). Since the Engel curve is derived from points of consumer (student) utility maximization, $MRS_{XY} = P_X/P_Y$ at every point on the curve.

Engel curves are named after Ernst Engel, the German statistician of the second half of the nineteenth century who pioneered studies of family budgets and expenditure patterns. Sometimes Engel curves show the relationship between income and *expenditures* on various goods rather than the *quantity* purchased of various goods. However, because prices are held constant, we get the same result (i.e., the same Engel curve).

For some goods, the Engel curve may rise only gently. This indicates that a given increase in income leads to a proportionately larger increase in the quantity purchased of the good. These goods are sometimes referred to as "luxuries." Examples of luxuries may be education, recreation, and steaks and lobsters (for some people). On the other hand, the Engel curve for other goods may rise rather rapidly, indicating that a given increase in income leads to a proportionately smaller increase in the quantity purchased of these goods. These goods are called "necessities." Basic foodstuffs are usually regarded as necessities. A more precise definition of luxuries and necessities is given in Chapter 5.

EXAMPLE 4–1

Engel's Law After a Century

Table 4.1 gives the percentages of total consumption expenditures on various items for U.S. families in selected income classes in 2005. The table shows that higher-income families generally spend a smaller percentage of their income than lower-income families on food but spend a larger percentage on personal insurance and

[1] At each point along the income–consumption curve the value of the MRS_{XY} is the same. This is because $-P_X/P_Y$ is the same for each of the budget lines (i.e., parallel lines have identical slopes).

TABLE 4.1 Percentage of Total Consumption by Income Class for U.S. Families in 2005

	Annual Income						
Consumption Item	0– $9,999	$10,000– $19,999	$20,000– $29,999	$30,000– $39,999	$40,000– 49,000	$50,000– $69,000	$70,000 and over
Food	16.3%	15.2%	13.9%	13.3%	13.0%	13.4%	11.4
Housing	39.7	38.9	35.1	34.8	33.6	31.5	31.0
Apparel and services	5.0	4.1	3.9	4.3	3.6	4.0	4.0
Transportation	14.2	14.5	19.9	18.1	19.4	20.1	17.6
Health care	6.2	6.5	7.9	6.9	6.9	5.6	4.7
Entertainment	4.6	3.9	4.2	4.9	4.8	4.9	5.6
Education	4.6	2.0	1.1	1.1	1.2	1.3	2.6
Insurance and pensions	1.8	3.3	5.4	7.8	9.3	11.1	14.8
Other	7.6	11.6	8.6	8.8	8.2	8.1	8.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Consumer Expenditures in 2005*, Report 998 (Washington, D.C.: May 2001), Table 2.

pensions. Less regularity is found in the proportion of expenditures on other goods and services.

The decline in the proportion of total expenditures on food as income rises has been found to be true not only for the United States in the period of the survey. but also at other times and in other nations. Thus, food in general is a necessity rather than a luxury. This regularity is sometimes referred to as *Engel's law*. Indeed, the higher the proportion of income spent on food in a nation, the poorer the nation is taken to be. For example, in India almost 50% of income is spent on food on the average.

Normal and Inferior Goods

A **normal good** is one of which the consumer purchases more with an increase in income. An **inferior good** is one of which the consumer purchases less with an increase in income. Good X in Figure 4.1 is a normal good because the consumer purchases more of it with an increase in income. For example, an increase in the student's income allowance from \$10 to \$15 leads to an increase in the purchase of hamburgers from two to four per day. Thus, for a normal good, the income–consumption curve and the Engel curve are both positively sloped, as in Figure 4.1.

Figure 4.2 shows the income–consumption curve and the Engel curve for an inferior good. This results from supposing that the student, instead of spending the daily

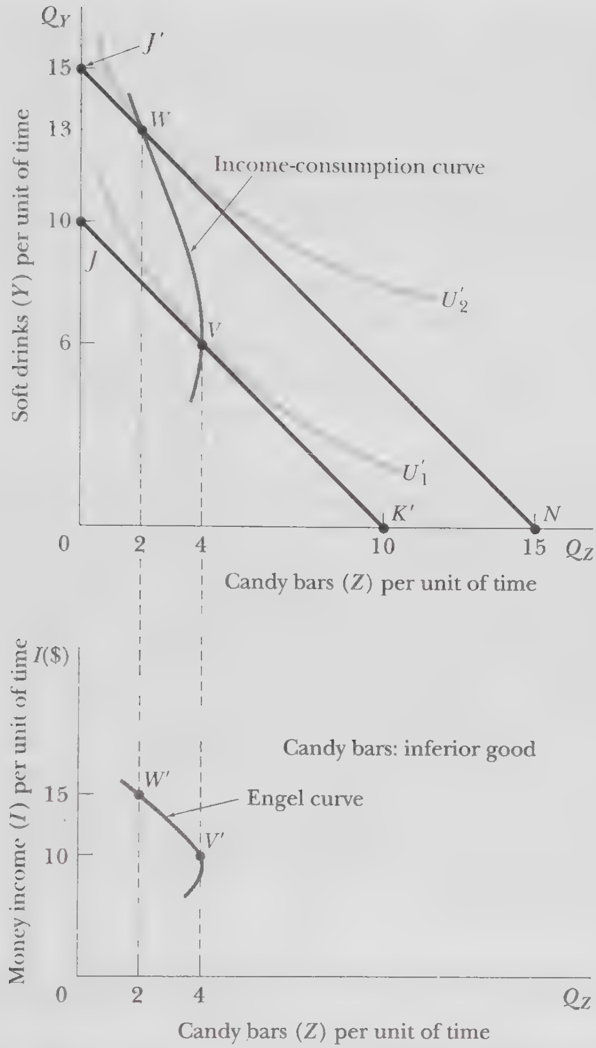

FIGURE 4.2 Income–Consumption Curve and Engel Curve for an Inferior Good With budget lines JK' and $J'N$ and indifference curves U_1' and U_2' in the top panel, the individual maximizes utility at points V and W, respectively. By joining points V and W we get the income–consumption curve (top panel). By then plotting income on the vertical axis and the optimum quantities purchased of good Z along the horizontal axis, we derive corresponding Engel curve $V'W'$ in the bottom panel. Since the income–consumption curve and Engel curve are negatively sloped, good Z is an inferior good.

income allowance on soft drinks (good Y) and hamburgers (good X), spends it on soft drinks and candy bars (good Z), and supposing the student views candy bars as an inferior good.[2] With the price of soft drinks at \$1 and the price of candy bars also at \$1, the budget line of the student is JK' with a daily income allowance of \$10 and $J'N$ with an income of \$15 (see the top panel of Figure 4.2).

If indifference curves between soft drinks and candy bars are U_1' and U_2' the student maximizes satisfaction at point V, where indifference curve U_1' is tangent to budget line JK' with a daily income allowance of \$10. The student maximizes utility at point W, where indifference curve U_2' is tangent to budget line $J'N$ with an income of \$15 (see the top panel of Figure 4.2). Thus, the consumer purchases four candy bars with an income of \$10 and only two candy bars with an income of \$15. Candy bars are, therefore, inferior goods for this student. The income–consumption curve for candy bars (VW in the top panel of Figure 4.2) and the corresponding Engel curve ($V'W'$ in the bottom panel) are both negatively sloped, indicating that the student purchases fewer candy bars as his or her income allowance increases.

The classification of a good as normal or inferior depends only on how a specific consumer views the particular good. Thus, the same candy bar can be regarded as a normal good by another student. Furthermore, a good can be regarded as a normal good by a consumer at a particular level of income and as an inferior good by the same consumer at a higher level of income. For example, with an allowance of \$40 dollars per day, the student in the previous section may begin to regard hamburgers as an inferior good, because he or she now can afford steaks and lobsters. Also note that an inferior good is not a "bad" because more is preferred to less, and indifference curves remain negatively sloped (refer back to Section 3.2).

In the real world, most broadly defined goods such as food, clothing, housing, health care, education, and recreation are normal goods. Inferior goods are usually narrowly defined cheap goods, such as bologna, for which good substitutes are available. As pointed out earlier, a normal good can be further classified as a luxury or a necessity, depending on whether the quantity purchased increases proportionately more or less than the increase in income.

4.2 CHANGES IN PRICE AND THE INDIVIDUAL DEMAND CURVE

Commodity prices frequently change in the real world, and it is important to examine their effect on consumer behavior. A change in commodity prices changes the consumer budget line, and this affects consumer purchases. In this section we examine how the consumer reaches a new optimum position when the price of a good changes but the price of the other good, income, and tastes remain unchanged.

By changing the price of good X while holding constant the price of good Y, income, and tastes, we can derive the consumer's price–consumption curve for good X. The **price–consumption curve** for good X is the locus of (i.e., joins) consumer optimum points resulting when only the price of good X varies. From the price–consumption curve we can then derive the consumer's demand curve for good X.

[2] Other commodities that are, perhaps, even more readily recognized as inferior goods in the United States today might be bologna and cheaper cuts of meats.

For example, the top panel of Figure 4.3 shows once again that with budget line *JK*, the consumer maximizes utility or is at an optimum at point *B*, where indifference curve U_1 is tangent to budget line *JK* and the consumer purchases 2*X* and 6*Y* (the same as in Figure 3.8). Suppose that the consumer's income (i.e., the student allowance) remains unchanged at $I = \$10$ per day and the price of good *Y* (soft drinks) also remains constant at $P_Y = \$1$. A reduction in the price of good *X* (hamburgers) from $P_X = \$2$ to $P_X = \$1$ and then to $P_X = \$0.50$ would cause the consumer's budget line to become flatter or

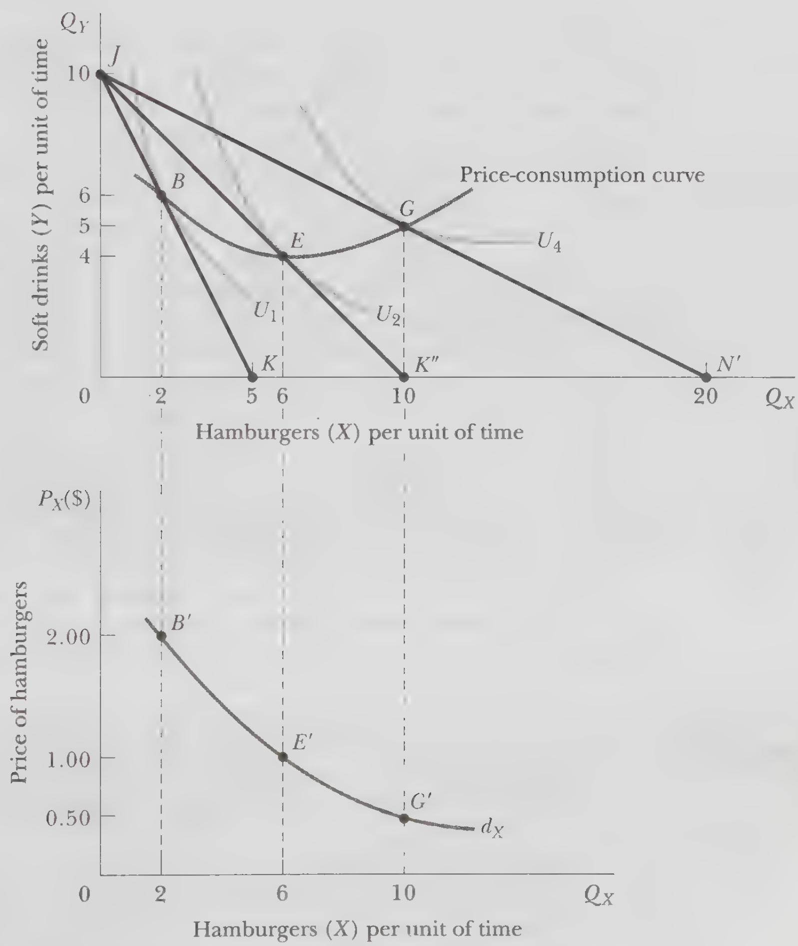

FIGURE 4.3 Price–Consumption Curve and the Individual's Demand Curve
The top panel shows that with $I = \$10$ and $P_Y = \$1$, the consumer is at an optimum at point *B* by purchasing 2*X* with $P_X = \$2$, at point *E* by purchasing 6*X* with $P_X = \$1$, and at point *G* by purchasing 10*X* with $P_X = \$0.50$. By joining points *BEG*, we get the price-consumption curve for good *X*. In the bottom panel, by plotting the optimum quantities of good *X* on the horizontal axis and the corresponding prices of good *X* on the vertical axis, we derive the individual's negatively sloped demand curve for good *X*, d_X.

to rotate counterclockwise from JK to JK'' and then to JN' (the same as in the right ~~panel~~ of Figure 3.7).[3]

With $P_X = \$1$ and budget line JK'', the consumer maximizes utility at point E, where indifference curve U_2 is tangent to budget line JK'' and the consumer purchases $6X$ and $4Y$ (see the top panel of Figure 4.3). Indifference curve U_2 is the same as in the right panel of Figure 3.2 because tastes have not changed. Finally, with $P_X = \$0.50$ and budget line JN', the consumer maximizes ~~utility~~ or is at an optimum at point G on U_4 by purchasing $10X$ and $5Y$ per unit of time (per day). By joining optimum points B, E, and G we get (a portion of) the price–consumption curve for this consumer (student). Thus, the price–consumption curve for good X is the locus of consumer optimum points resulting when only the price of X changes.[4]

From the price–consumption curve in the top panel of Figure 4.3, we can derive the individual consumer's (student's) demand curve for good X in the bottom panel. The **individual's demand curve** for good X shows the amount of good X that the consumer would purchase per unit of time at various alternative prices of good X while holding everything else constant. It is derived by keeping the same horizontal scale as in the top panel but measuring the price of good X on the vertical axis.

The derivation of the individual's demand curve proceeds as follows. With $I = \$10$, $P_Y = \$1$, and $P_X = \$2$, the student maximizes utility by purchasing $2X$ (two hamburgers) per day (point B) in the top panel. This gives point B' (directly below point B) in the bottom panel. With $P_X = \$1$, the consumer is at optimum by purchasing $6X$ (point E) in the top panel. This gives point E' in the bottom panel. Finally, with $P_X = \$0.50$, the consumer maximizes utility by purchasing $10X$ (point G in the top panel and G' in the bottom panel). Other points could be similarly obtained. By joining points B', E', and G' we get the individual consumer's demand curve for good X, d_X, in the bottom panel. Thus, the demand curve is derived from the price–consumption curve and shows the quantity of the good that the consumer would purchase per unit of time at various alternative prices of the good while holding everything else constant (the *ceteris paribus* assumption).

We will see in Chapter 5 that the market demand curve for a good (our ultimate aim in Part Two of the text) is obtained from the addition or the horizontal summation of all individual consumers' demand curves for the good. Note that the individual consumer's demand curve for a good (d_x in the bottom panel of Figure 4.3) is negatively sloped. This

EXAMPLE 4–2

Higher Alcohol Prices Would Sharply Reduce Youth Alcohol Use and Traffic Deaths

Road accidents are the single largest cause of deaths among young people in America, and about half of the road fatalities are caused by young people driving while intoxicated. Efforts to reduce alcohol use by youths have centered on increasing the minimum legal age for purchasing and drinking alcohol, which is now 21 in

[3] Remember that the X-intercepts of the budget lines are obtained by I/P_X. Thus, with $I = \$10$ and $P_X = \$2$, we get endpoint K and budget line JK. With $P_X = \$1$, we get endpoint K'' and budget line JK'', and with $P_X = \$0.50$, we get endpoint N' and budget line JN'.

[4] At each point along the price–consumption curve, $MRS_{XY} = P_X/P_Y$. However, unlike the case of the income–consumption curve, these ratios will vary because the budget lines are no longer parallel.

all 50 states. The hope is that this will shift the demand curve for alcohol use by young people to the left (despite the fact that some forge identity cards to get around the rule). Surprisingly, little use has been made in the United States of an even more powerful deterrent to youth alcohol use—higher alcohol prices through higher federal alcohol taxes. In fact, the real price (i.e., the nominal price divided by the price index to adjust for inflation) of alcoholic beverages has declined by about 40% for beer and wine and 70% for hard liquor in the United States since 1951. Taxes are currently only about $2 per quart for beer and $3.60 for hard liquor in the United States, compared with $18.20 and $34.50 in England.

Using simulations for a sample of high school students, Douglas Coate and Michael Grossman found that by indexing the tax on beer to the rate of inflation (so as to keep the real price of beer constant at the 1951 level) would have cut the number of frequent young beer drinkers by about 20% and that this would have saved 1,660 lives from traffic accidents per year (twice as many as resulting from increasing the minimum legal drinking age from 18 to 21). Of course, raising taxes even higher so as to increase the real price of alcoholic beverages would have reduced drinking and road fatalities even more. This is not surprising, since most teenagers have much less disposable income than adults. Thus, increasing the price of alcoholic beverages would have a more powerful deterring effect on them than on older drinkers. What is surprising is that despite the predictions of economic theory and the confirmation of empirical studies, the government has chosen thus far not to use price as a powerful deterrent to youth alcohol use.

Sources: "Efforts to Reduce Teen Drinking May Provide Lessons," *Wall Street Journal,* August 10, 1995, p. B1; "Beer, Taxes and Death," *The Economist,* September 18, 1993, p. 33; Douglas Coate and Michael Grossman, "Effects of Alcoholic Beverage Prices and Legal Drinking Ages on Youth Alcohol Use," *Journal of Law and Economics,* April 1988, pp. 145–172; "Traffic Death Rose in 2001, But Rates for Miles Fell," *New York Times*, August 8, 2002, p. 21; and Center for Disease Control and Prevention, "Teen Drivers: Fact Sheets," April 20, 2007, http://www.cdc.gov/ncipc/factsheets/teenmvh.htm.

reflects the *law of demand,* which postulates that the quantity purchased of a good per unit of time is inversely related to its price. Thus, the individual purchases more hamburgers per unit of time when their price falls and less of them when their price rises. Also note that an individual consumer's demand curve for a good is derived by holding constant the individual's tastes, his or her income, and the prices of other goods. If any of these change, the entire demand curve will shift. This is referred to as a change in demand as opposed to a change in the quantity demanded, which is a movement along a given demand curve as a result of a change in the price of the good while holding everything else constant (refer back to Section 2.2).

4.3 Substitution Effect and Income Effect

In this section, we separate the substitution effect from the income effect of a price change for both normal and inferior goods. This separation will give us an important analytical tool with wide applicability and will also allow us to examine the exception to the law of downward sloping demand.

How Are the Substitution Effect and the Income Effect Separated?[5]

We have seen in the previous section that when the price of a good falls the consumer buys more of it. This is the combined result of two separate forces at work called the substitution effect and the income effect. We now want to separate the total effect of a price change into these two components. We begin by first reviewing how the total effect of a price change (discussed in Section 4.2) operates.

In Figure 4.4, $I = \$10$ and $P_Y = \$1$, and these remain constant. With $P_X = \$2$, we have budget line JK and the consumer maximizes utility at point B on indifference curve

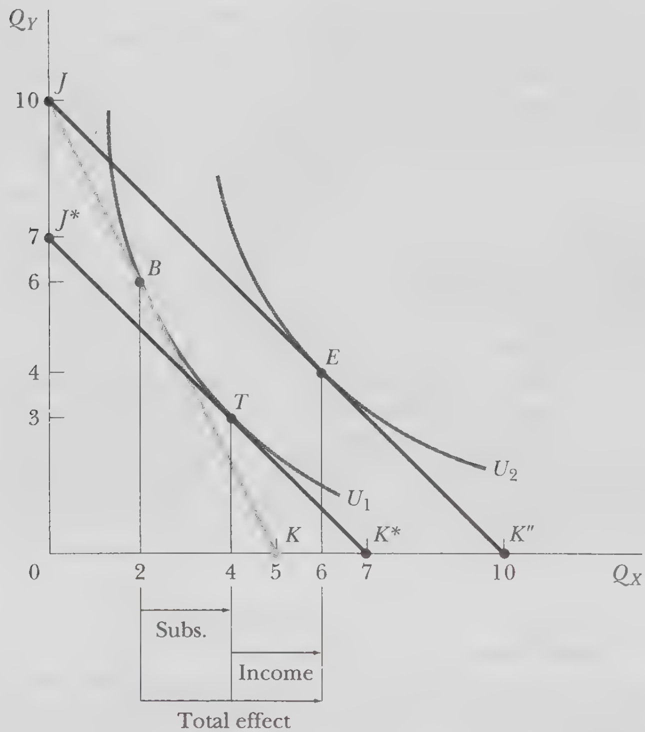

FIGURE 4.4 Income and Substitution Effects for a Normal Good
Starting from optimum point B (as in the top panel of Figure 4.3), we can isolate the substitution effect by drawing imaginary budget line J^*K^* tangent to U_1 at T. The movement along U_1 from point B to point T is the substitution effect and results from the relative reduction in P_X only (with real income constant). The shift from point T on U_1 to point E on U_2 is then the income effect. The total effect ($BE = 4X$) equals the substitution effect ($BT = 2X$) plus the income effect ($TE = 2X$).

[5] The separation of the substitution effect from the income effect of a price change using rudimentary calculus is shown in section A.4 of the Mathematical Appendix at the end of the book.

U_1 by purchasing $2X$. When the price of good X falls to $P_X = \$1$, the budget line becomes JK'' and the consumer maximizes utility at point E on indifference curve U_2 by purchasing $6X$ (so far this is the same as in Figure 4.3). The increase in the quantity purchased from $2X$ to $6X$ is the total effect or the sum of the substitution and income effects. We are now ready to separate this total effect into its two components: the substitution effect and the income effect. *The substitution effect measures the increase in the quantity demanded of a good when its price falls resulting only from the relative price decline and independent of the change in real income.* On the other hand, *the income effect measures the increase in the quantity purchased of a good resulting only from the increase in real income that accompanies a price decline.*

First, consider the **substitution effect.** In Figure 4.4, we see that when the price of X falls from $P_X = \$2$ to $P_X = \$1$, the individual moves from point B on U_1 to point E on U_2 so that his or her level of satisfaction increases. Suppose that as P_X falls we could reduce the individual's money income sufficiently to keep him or her on original indifference curve U_1. We can show this by drawing hypothetical or imaginary budget line J^*K^* in Figure 4.4. Imaginary budget line J^*K^* is parallel to budget line JK'' so as to reflect the *new* set of relative prices (i.e., $P_X/P_Y = \$1/\$1 = 1$) and is below budget line JK'' in order to keep the individual at the original level of satisfaction (i.e., on indifference curve U_1).[6] The individual would then maximize satisfaction at point T, where indifference curve U_1 is tangent to imaginary budget line J^*K^* (so that $MRS_{XY} = P_X/P_Y = \$1/\$1 = 1$).

The movement along indifference curve U_1 from original point B to imaginary point T measures the substitution effect only (since the individual remains on the same indifference curve or level of satisfaction). From Figure 4.4, we see that the substitution effect, by itself, leads the individual to increase the quantity purchased of good X from two to four units when P_X falls from \$2 to \$1. That is, the individual substitutes hamburgers for, say, hot dogs and purchases two additional hamburgers and fewer hot dogs per unit of time. The substitution effect results exclusively from the reduction in the **relative price** of X (from $P_X/P_Y = \$2/\$1 = 2$ to $P_X/P_Y = \$1/\$1 = 1$) with the level of satisfaction held constant. Because indifference curves are convex, the substitution effect always involves an increase in the quantity demanded of a good when its price falls.

Next, consider the **income effect.** The shift from the imaginary point T on U_1 to the actual new point E on U_2 can be taken as a measure of the income effect. The shift from point T to point E does not involve any price change. That is, since the imaginary budget line J^*K^* and the actual new budget line JK'' are parallel, relative prices are the same (i.e., $P_X/P_Y = 1$ in both). The shift from indifference curve U_1 to U_2 can thus be taken as a measure of the increase in the individual's real income or purchasing power.[7] Because good X is a normal good, an increase in the consumer's purchasing power or real income leads him or her to purchase more of X (and other normal goods). In Figure 4.4, the income effect, by itself, leads the consumer to purchase two additional hamburgers (i.e., to go from $4X$ to $6X$).[8]

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[6] Budget line J^*K^* is imaginary in the sense that we do not actually observe it, unless the reduction in P_X is in fact accompanied by a lump-sum tax that removes \$3 ($JJ^* = K''K^*$) from the money income of the individual.

[7] The shift from point T to point E could be observed by giving back to the consumer the hypothetical lump-sum tax of \$3 collected earlier. Only with such an increase in real income or purchasing power can the consumer move from point T on U_1 to point E on U_2.

[8] It also leads the individual to purchase one additional soft drink (i.e., to go from $3Y$ to $4Y$). See Figure 4.4.

Thus, the total effect of the reduction in P_X ($BE = 4X$) equals the substitution effect ($BT = 2X$) plus the income effect ($TE = 2X$). The substitution effect reflects the increase in Q_X resulting only from the reduction in P_X and is independent of any change in the consumer's level of satisfaction or real income. On the other hand, the income effect reflects the increase in Q_X resulting only from the increase in satisfaction or real income. Only the total effect of the price change is actually observable in the real world, but we have been able, at least conceptually or experimentally, to separate this total effect into a substitution effect and an income effect.

In Figure 4.4, the substitution effect and the income effect are of equal size. In the real world, the substitution effect is likely to be much larger than the income effect. The reason is that most goods have suitable substitutes, and when the price of a good falls, the quantity of the good purchased is likely to increase very much as consumers substitute the now-cheaper good for others. On the other hand, with the consumer purchasing many goods and spending only a small fraction of his or her income on any one good, the income effect of a price decline of any one good is likely to be small. There are, however, exceptional cases in which the income effect exceeds the substitution effect. Also note that although the substitution effect of a price reduction is always positive (i.e., it always leads to an increase in the quantity demanded of a good), the income effect can be positive if the good is normal or negative if the good is inferior.[9]

EXAMPLE 4–3

Substitution Effect and Income Effect of a Gasoline Tax

One of the biggest political battles being fought in Congress centers on energy policy in general and the size of the federal gasoline tax in particular. This is not a new battle. It is a battle that has been fought periodically every five years or so during the past three decades, every time the price of petroleum and American dependence on imported petroleum increased. It is surely a battle that will be fought again before the end of this decade because of the need for an energy policy in the United States.

Overall, gasoline taxes are now about 47 cents per gallon in the United States, as compared with more than \$2 per gallon in Europe and Japan. Ever since the first petroleum crisis in 1973–1974, many in Congress have sought a gasoline tax of 50 cents per gallon. The tax would increase gasoline prices for American motorists and lead to a reduction in gasoline consumption and American dependence on foreign oil (which now stands at more than 60%, up from 35% in 1973). To avoid the deflationary impact (i.e., the reduction in purchasing power) of the tax on the economy, it has been proposed to either (a) return to consumers the amount of the tax collected on gasoline in the form of a *general* tax rebate unrelated to gasoline consumption or (b) reduce other taxes.

[9] We could derive a demand curve along which real, rather than nominal, income is kept constant (i.e., showing or reflecting only the substitution effect). Such a demand curve would be steeper than the usual demand curve (which shows both the substitution and the income effects) if the good is normal (because in that case the income effect reinforces the substitution) and flatter than the usual demand curve if the good is inferior (because in that case part of the substitution effect would be neutralized by the opposite income effect).

The gasoline tax, coupled with a general tax rebate to avoid the deflationary impact of a gasoline tax, relies on the distinction between the substitution effect and the income effect of an increase in gasoline prices. The substitution effect would result as people switch to cheaper means of transportation (trains, buses, subways), car pools, and more fuel-efficient cars and economize on the use of automobiles in general. The general income subsidy would then neutralize the reduction in real income associated with the increase in the price of gasoline. Thus, while the reduction in purchasing power would be neutralized by the general income subsidy, the increase in the gasoline price would reduce its consumption. Despite strong opposition to a large increase in the gasoline tax from road builders, tourist interests, farm groups, the oil industry, and truckers, a large increase in the gasoline tax seems likely. It has been estimated that the optimal gasoline tax in the United States is $1.00 per gallon. Americans strongly prefer (and have relied on) tougher fuel-efficiency rules on automakers to reduce the growth of gasoline consumption. The sharp increase in gasoline prices since 2007 is leading Americans to drive less and reduce gasoline consumption.

Sources: A. A. Taheri, "Oil Shocks and the Dynamics of Substitution Adjustments in Industrial Fuels in the U.S.," *Applied Economics,* August 1994, pp. 751–756; "Oil Prices Generate Political Heat," *Wall Street Journal,* August 30, 2000, p. A18; "Looking for Ways to Save Gasoline," *Wall Street Journal,* July 12, 2001, p. A1; "Want to Cut Gasoline Use? Raise Taxes," *Business Week*, May 27, 2002, p. 26; "The Gasoline Tax: Should It Rise?" *Wall Street Journal*, August 18, 2007, p. A4; and "Drinking Less, Americans Finally React to Sting of Gas Prices," *New York Times*, June 19, 2008, p. C3.

Substitution Effect and Income Effect for Inferior Goods

For a normal good, the substitution effect and the income effect of a price decline are both positive and reinforce each other in leading to a greater quantity purchased of the good. On the other hand, when the good is inferior, the income effect moves in the opposite direction from the substitution effect. That is, when the price of an inferior good falls, the substitution effect continues to operate as before to *increase* the quantity purchased of the good. This results from the convex shape of indifference curves. However, the increase in purchasing power or real income resulting from the price decline leads the consumer to purchase *less* of an inferior good. But, because the substitution effect is usually larger than the income effect, the quantity demanded of the inferior good increases when its price falls and the demand curve is still negatively sloped.

We can separate the substitution effect from the income effect of a price decline for an inferior good by returning to the candy bar (inferior good Z) example of the previous section. In the top panel of Figure 4.5, the consumer is originally at optimum at point V, where indifference curve U'_1 is tangent to budget line JK' and the consumer purchases four candy bars (as in the top panel of Figure 4.2). If the price of candy bars declines from $P_Z = \$1$ to $P_Z = \$0.50$, the consumer moves to optimum point S, where indifference curve U'_2 is tangent to budget line JN' and the consumer purchases $6Z$. The movement from point V to point S $(+2Z)$ is the sum or net effect of the substitution and income effects.

To separate the substitution effect from the income effect, we now draw the imaginary budget line J^*N^*, which is lower than, but parallel to, budget line JN' and tangent to U'_1 at point T. The movement along U'_1 from the original point V to imaginary point T is the *substitution effect.* It results exclusively from the reduction in P_Z relative to P_Y

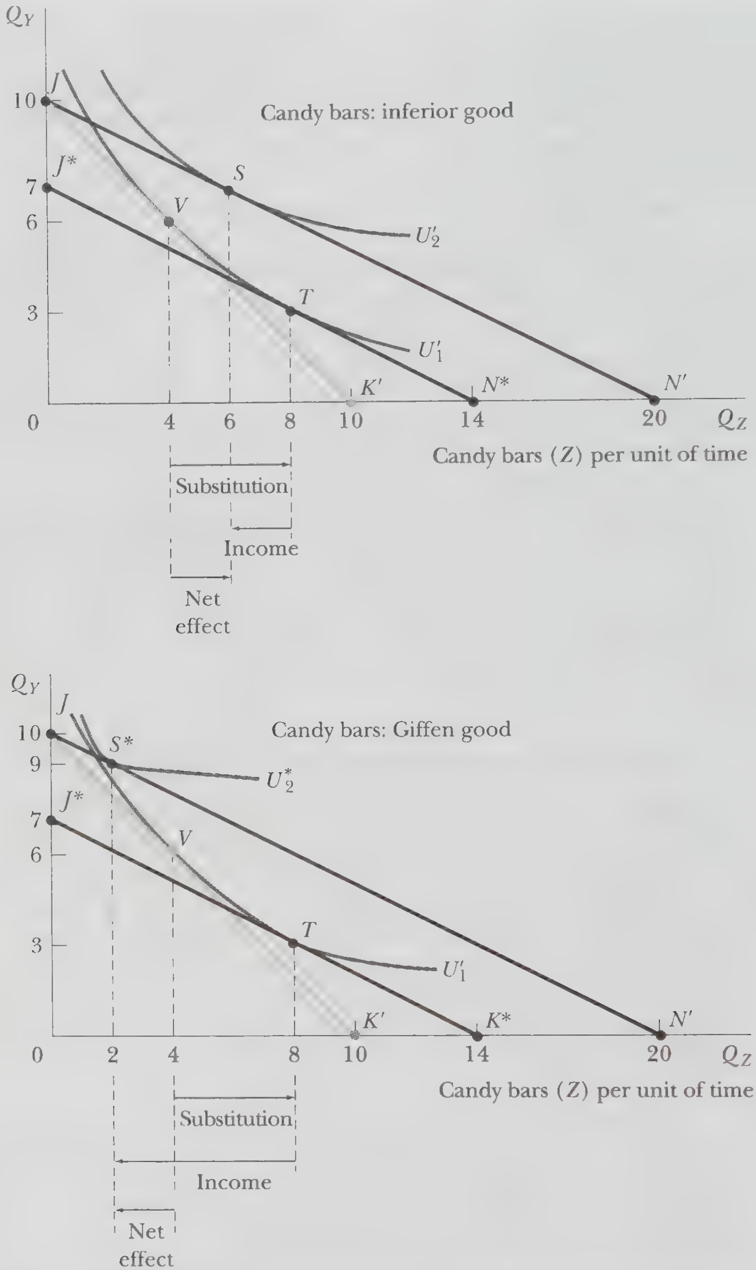

FIGURE 4.5 Income and Substitution Effects for Inferior Goods Starting from optimum point V in the top panel, we can isolate the substitution effect by drawing J^*N^* parallel to JN' and tangent to U_1' at point T. The movement along U_1' from point V to point T is the substitution effect. The movement from point T on U_1' to point S on U_2' is the income effect. Since the income effect is negative, good Z is inferior. However, since the positive substitution effect exceeds the negative income effect, Q_Z increases when P_Z falls. In the bottom panel, the positive substitution effect ($VT = 4Z$) is smaller than the negative income effect ($TS^* = -6Z$), so that Q_Z declines by $2Z$ when P_Z falls. Good Z is then a Giffen good.

and is independent of any increase in real income. Thus, the substitution effect, by itself, leads the individual to purchase four additional units of good Z per unit of time (from $4Z$ to $8Z$).

On the other hand, the movement from imaginary point T on U'_1 to the new point S on U'_2 can be taken as a measure of the *income effect*. It results exclusively from the increase in the level of satisfaction of the consumer with relative prices constant ($P_Z/P_Y = \$0.50/\$1 = 1/2$ for imaginary budget line J^*N^* and for new budget line JN'). The income effect, by itself, leads the consumer to purchase two *fewer* units of good Z per unit of time (from $8Z$ to $6Z$) because good Z is an inferior good.

Thus, the total effect ($VS = 2Z$ given by the movement from point V on U'_1 to point S on U'_2) equals the positive substitution effect ($VT = 4Z$ given by the movement from point V to T on U'_1) plus the negative income effect ($TS = -2Z$ given by the movement from point T on U'_1 to point S on U'_2). However, since the positive substitution effect exceeds the negative income effect, the consumer purchases two additional units of good Z when its price declines. Thus, the demand curve for good Z is negatively sloped, even though good Z is an inferior good. That is, the consumer purchases $4Z$ at $P_Z = \$1$ and $6Z$ at $P_Z = \$0.50$.

On the other hand, if the positive substitution effect is smaller than the negative income effect when the price of an inferior good falls, then the demand curve for the inferior good is positively sloped. This very rarely, if ever, occurs in the real world, and is referred to as the **Giffen good,** after the nineteenth-century British economist, Robert Giffen, who supposedly first discussed it. Note that a Giffen good is an inferior good, but not all inferior goods are Giffen goods. If it existed, a Giffen good would lead to a positively sloped demand curve for the individual and would represent an exception to the law of negatively sloped demand.[10]

The bottom panel of Figure 4.5 is drawn on the assumption that good Z is now a Giffen good. In this panel, the consumer is originally at optimum point V and hypothetically moves to point T because of the substitution effect (as in the top panel). However, with *alternative* indifference curve U_2^* in the bottom panel (as opposed to U'_2 in the top panel), the income effect is given by the movement from point T to point S^*. Point S^* is to the left of point T because good Z is an inferior good, so that an increase in real income leads to less of it being purchased. The total effect is now $VS^*(-2Z)$ and is equal to substitution effect VT $(4Z)$ plus income effect $TS^*(-6Z)$. Because the positive substitution effect is smaller than the negative income effect, the quantity demanded of good Z *declines* when its price falls, and d_Z would be positively sloped over this range. That is, the individual would purchase $4Z$ at $P_Z = \$1$ but only $2Z$ at $P_Z = \$0.50$.

Although theoretically interesting, the Giffen paradox rarely, if ever, occurs in the real world. The reason is that inferior goods are usually narrowly defined goods for which suitable substitutes are available (so that the substitution effect usually exceeds the opposite income effect). Giffen thought that potatoes in nineteenth-century Ireland provided an example of the paradox, but subsequent research did not support his belief.[11] Example 4–4 presents the first, rigorous empirical evidence of Giffen behavior.

The separation of the substitution effect from the income effect (and all of the analysis in this chapter) could easily be shown for a price increase rather than for a price decline. These alternatives are assigned as end-of-chapter problems.

[10] If we kept real rather than nominal income constant in deriving the demand curve (i.e., if the demand curve showed or reflected only the substitution effect), there would be no Giffen exception to the law of negatively sloped demand.

[11] See S. Rosen, "Potatoes Paradoxes," *Journal of Political Economy*, December 1999.

EXAMPLE 4–4

Giffen Behavior Found!

Jensen and Miller (2007) provided the first, rigorous empirical evidence of the existence of Giffen behavior among extremely poor households in two provinces of China in 2006. The authors conducted a field experiment in which they provided randomly selected poor households with price subsidies for the primary dietary staple food (rice in Hunan province in southern China and wheat flour in Gansu province in northern China).

The sample consisted of 100–150 households in each of 11 county seats in Hunan and Gansu provinces, for a total of 1,300 households (650 in each province) with 3,661 individuals. Within each county, households were chosen at random from the list of the urban poor obtained from the office of the Ministry of Civil Affairs. Households on the list typically had incomes of between 100 and 200 yuan per person per month, or $0.41 to $0.82 per person per day (which is below even the World Bank's "extreme" poverty line of $1 per person per day). Data were gathered at three different times: April, September, and December 2006. After completing the first (April) survey to choose the sample, the sample households were informed that they would receive subsidies from June through October to purchase their staple food; the change in the quantity purchased of the staple food was recorded.

The authors found strong and clear evidence of the Giffen behavior with respect to rice in Hunan province. The evidence with respect to wheat flour in Gansu province was less robust, because some of the theoretical conditions necessary for the Giffen behavior were not met. By restricting the Gansu sample to households that met those conditions, the authors were able to find strong evidence of the Giffen behavior in Gansu province also. Note that Giffen behavior was found precisely where theory would predict: among very poor consumers, heavily dependent on a staple food, with limited substitution possibilities.

Source: Robert T. Jensen and Nola H. Miller, "Giffen Behavior: Theory and Evidence," ***NBER Working Paper No. 13243***, July 2007.

4.4 Substitution Between Domestic and Foreign Goods

The substitution between domestic and foreign goods and services has reached an all-time high in the world today and is expected to continue to increase sharply in the future. This increase has been the result of (1) transportation costs having fallen to very low levels for most products, (2) increased knowledge of foreign products due to an international information revolution, (3) global advertising campaigns by multinational corporations, (4) the explosion of international travel, and (5) the rapid convergence of tastes internationally. For homogeneous products such as a particular grade of wheat or steel, and for many industrial products with precise specifications such as computer chips, fiber optics, and specialized machinery, substitutability between domestic and foreign products is almost perfect. Here, a small price difference can lead quickly to large shifts in sales from domestic to foreign sources and vice versa. Indeed, so fluid is the market for such products that governments often step in to protect these industries from foreign competition.

Even for differentiated products, such as automobiles and motorcycles, computers and copiers, watches and cameras, TV films and TV programs, soft drinks and cigarettes, soaps and detergents, commercial and military aircraft, and most other products that are similar but not identical, substitutability between domestic and foreign products is very high and continues to rise. Despite the quality problems of the past, U.S.-made automobiles today are highly substitutable for Japanese and European automobiles, and so are most other products. Indeed, intraindustry trade in such differentiated products now represents over 60% of total U.S. trade and an even larger percentage of the trade of most other industrial countries.[12] With many parts and components imported from many nations, and with production facilities and sales around the world often exceeding sales at home, even the distinction between domestic and foreign products is fast becoming obsolete.

4.5 Some Applications of Indifference Curve Analysis

We now can apply the tools developed in this chapter to analyze the economics of the food stamp program, consumer surplus, and exchange. These applications deal only with the demand for goods and services, but the tools developed in this chapter have many other applications (examined in other parts of the text). For example, the distinction between the substitution and income effects is useful in analyzing the effect of overtime pay on the number of hours worked and on leisure time. Because this topic deals with the supply of labor, however, it is appropriately postponed until Chapter 14, which deals with input price and employment. Indifference curve analysis is also useful in analyzing the choice between borrowing or lending from present income, in general equilibrium and welfare economics (examined in Chapter 16), and in the analysis of time as an economic good (discussed more extensively in Chapter 18).

Is a Cash Subsidy Better Than Food Stamps?

Under the federal **food stamp program,** low-income families receive free food stamps, which they can use only to purchase food. At its peak in 1988, more than 4.8 million eligible low-income families received free food stamps at a cost of $12.4 billion to the federal government. The important question is whether it would have been better (i.e., provided more satisfaction) to have given an equal amount of subsidy in cash to these families.

We can examine this question using Figure 4.6. Suppose that, initially, a typical poor family has a weekly income of $100. If the poor family spent its entire weekly income on nonfood items, it could purchase $100 worth of nonfood items per week (point *A* on the vertical axis). On the other hand, if the poor family spent the entire $100 on food, it could purchase 100 units of food per week if the unit price of food were $1 (point *C* on the horizontal axis). The initial budget line of the family would be *AC*.

[12] D. Salvatore, *International Economics*, 9th ed. (Hoboken, N.J.: John Wiley & Sons, 2007), Section 6.4.

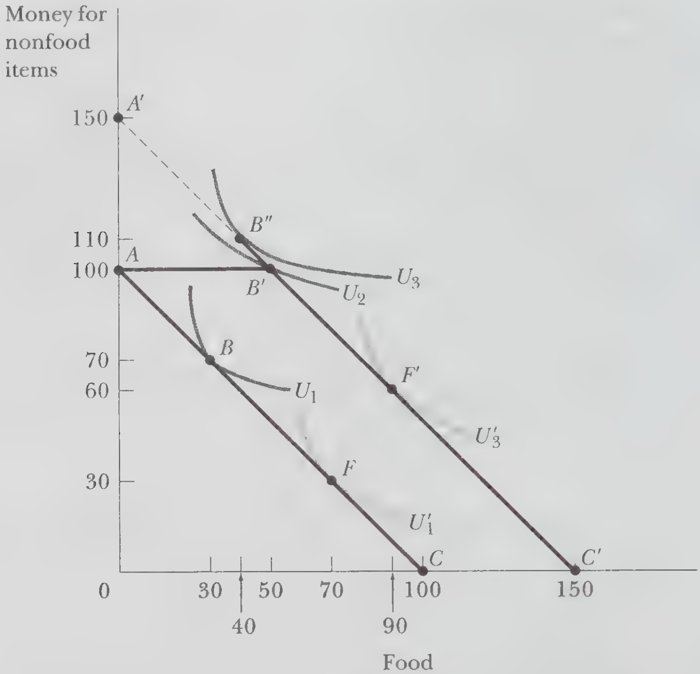

FIGURE 4.6 Food Stamps Versus Cash Aid A poor family's budget line, *AC*, becomes *AB′C′* with $50 worth of free food stamps per week, and *A′C′* with a $50 cash subsidy instead. The family maximizes utility at point *B* on U_1 without any aid, at point *B′* on U_2 with food stamps, and at point *B″* on U_3 with the cash subsidy. However, another family with the same original income and budget line *AC* but with a stronger preference for food may go instead from point *F* on U_1' to point *F′* on U_3' either with the cash subsidy or with food stamps.

With free food stamps that allow the family to purchase $50 worth of food per week, the budget line of the family becomes $AB'C'$, where $AB' = CC' = 50$. Combinations on dashed segment $A'B'$ are not available with the food stamp programbecause the family would have to spend more than its $100 money income on nonfood items and less than the $50 of food stamps on food (and this is not possible if it cannot sell its food stamps). Were the government to provide $50 in cash rather than in food stamps, the budget line would then be $A'C'$. Thus, we have three alternative budget lines for the family: budget line AC without any aid, budget line $AB'C'$ with $50 in food stamps, and budget line $A'C'$ with $50 cash aid instead.

If the family's indifference curves are U_1, U_2, and U_3, the family maximizes utility at point B where U_1 is tangent to AC before receiving any aid, at point B' on U_2 with food stamps, and at point B'' (preferred to B') on U_3 with the cash subsidy. In this case, the cash subsidy allows the family to reach a higher indifference curve than do food stamps.[13]

[13] Both cost the government $50.

However, *another family* with the same initial income of \$100 (and budget line AC) but stronger preference for food and facing indifference curves U_1' and U_3' will move instead from point F on U_1' to point F' on U_3' either with the cash subsidy or with food stamps. Thus, depending on the family's tastes, *a cash subsidy will not be worse than food stamps and may be better* (i.e., provide more satisfaction). Why then does the federal government continue to use food stamps? One reason is to improve nutrition.[14]

Consumer Surplus Measures Unpaid Benefits

Consumer surplus is the difference between what a consumer is willing to pay for a good and what he or she actually pays. It results because the consumer pays for *each* unit of the good only as much as he or she is willing to pay for the *last* unit of the good (which gives less utility than earlier units). We can see how consumer surplus arises and how it can be measured with the aid of Figure 4.7.

The figure shows that \$5 is the maximum amount that the consumer is willing to pay for the first unit of good X (say, hamburgers) rather than go without it. Thus, the area of the first rectangle (with height of \$5 and width of 1) measures the marginal value or benefit that the consumer gets from the first hamburger. After all, by being willing to purchase the first hamburger for \$5, the consumer indicates that he or she prefers paying \$5 for the first hamburger rather than keeping the \$5 in cash or spending the \$5 on other goods. The second unit of good X (hamburger) gives the consumer less utility than the first, and the consumer would be willing to pay \$4 for it rather than go without it. Thus, \$4 (the area of the second rectangle) can be taken as a measure of the marginal value or benefit of the second hamburger to the consumer. The third hamburger gives the consumer less utility than either the first or the second and so the consumer is willing to pay only \$3 for it. Thus, the marginal value or benefit of the third hamburger is \$3 and is given by the area of the third rectangle. For the fourth hamburger, the consumer would be willing

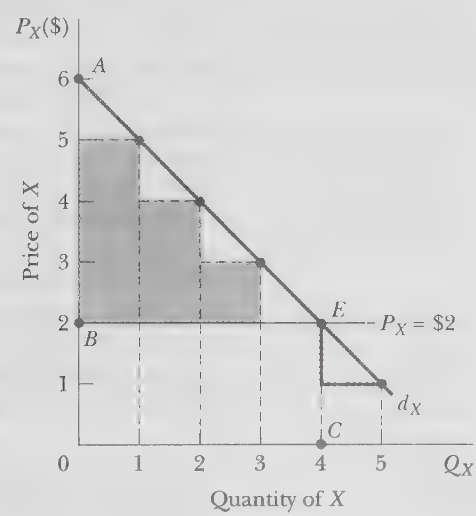

FIGURE 4.7 Consumer Surplus The difference between what the consumer is willing to pay for $4X$ (\$5 + \$4 + \$3 + \$2 = \$14) and what he or she actually pays (\$8) is the consumer surplus (the shaded area that equals \$6). If good X could be purchased in infinitesimally small units, the consumer surplus would equal the area under d_X and above P_X = \$2 (area AEB = \$8).

[14] Note that the indifference curves of the two *different* families shown in Figure 4.6 would cross if extended. It is only the individual indifference curves of each family that cannot cross.

to pay \$2 (the area of the fourth rectangle), and this is a measure of the marginal value or benefit of the fourth hamburger, and so on.

To summarize, the consumer would be willing to pay \$5 for the first hamburger, \$4 for the second, \$3 for the third, and \$2 for the fourth, for a total of \$14 for all four hamburgers. Thus, \$14 is the total benefit that the consumer receives from purchasing four hamburgers. However, if the market price is \$2 per hamburger, the consumer can purchase all four hamburgers at a total cost of (i.e., by actually spending) only \$8. Because the consumer would be willing to pay \$14 for the first four hamburgers rather than go entirely without them, but actually pays only \$8, he or she enjoys a net benefit or *consumer surplus* equal to the difference (\$6).

To put it another way, the consumer is willing to pay \$5 for the first hamburger, but since he or she can purchase it for only \$2, he or she receives a surplus of \$3 for the first hamburger. Since the consumer is willing to pay \$4 for the second hamburger but pays only \$2, there is a surplus of \$2 on the second hamburger. For the third hamburger, the consumer is willing to pay \$3, but since he or she pays only \$2, the surplus is \$1. For the fourth hamburger, the consumer is willing to pay \$2, and since he or she has to pay \$2 for it, there is no surplus on the fourth hamburger. The consumer would not purchase the fifth hamburger because he or she is not willing to pay the \$2 market price for it.

By adding the consumer surplus of \$3 on the first hamburger, \$2 on the second, \$1 on the third, and \$0 on the fourth, we get the consumer surplus of \$6 obtained earlier. This is given by the sum of the shaded areas in the figure. The same result would have been obtained if the consumer had been asked for the maximum amount of money that he or she would have been willing to pay for four hamburgers rather than do entirely without them—*all or nothing.*

If hamburgers could have been purchased in smaller and smaller fractions of a whole hamburger, then the consumer surplus would have been given by the entire area under demand curve d_X above the market price of \$2. That is, the consumer surplus would have been the area of triangle *AEB*, which is $(1/2)(4)(4) = \$8$. This exceeds the consumer surplus of \$6 that we found by adding only the shaded areas in the figure. Specifically, the consumer would have been willing to pay \$16 (the area of *OAEC*) for four hamburgers. Note that *OAEC* is composed of triangle *AEB* plus rectangle *OBEC*. Since the consumer only pays \$8 (*OBEC*), the consumer surplus is \$8 (*AEB*). If P_X fell to \$1, the consumer would purchase five hamburgers and the consumer's surplus would be \$12.50 (the area under d_X and above $P_X = \$1$ in the figure) if hamburgers could be purchased by infinitely small fractions of a whole hamburger.[15]

The concept of consumer surplus was first used by Jules Dupuit in 1844 and was subsequently refined and popularized by Alfred Marshall. The concept helped resolve the so-called **water–diamond paradox,** which plagued classical economists until 1870. Why is water, which is essential for life, so cheap, whereas diamonds, which are not essential, are so expensive? The explanation is that because water is so plentiful (relatively cheap) and we use so much of it, the utility of the last unit is very little (washing the car), and we pay as little for all units of water as we are willing to pay for the last *nonessential* unit of it. On

[15] Measuring consumer surplus by the area under the demand curve and above the prevailing market price is only an approximation (it is based on the assumption that a consumer's indifference curves are parallel), but for most purposes it is sufficiently accurate to be a useful tool of analysis. See, R. D. Willig, "Consumer Surplus without Apology," *American Economic Review,* September 1976. See, however, K. S. Lyon and Ming Yan, "Compensating Variation Consumer's Surplus Via Successive Approximations," *Applied Economics,* June 1995, pp. 547–554.

the other hand, diamonds are scarce in relation to demand, and because we use very little of them, the utility and price of the *last unit* are very great. The *total* utility and the consumer surplus from all the water used are far greater than the total utility and the consumer surplus from all the diamonds purchased. However, demand depends on marginal utility, not on total utility. In a desert, the first glass of water would be worth much more than any glassful of diamonds.

The above analysis referred to an individual's demand curve, but a similar analysis would also apply to a market demand curve. In subsequent chapters we will use the concept of consumer surplus to measure the benefits and costs of excise taxes, import tariffs, pollution control, government projects, and other microeconomic policies, as well as to measure the benefits and costs of alternative market structures.

Benefits from Exchange

Suppose that two individuals, A and B, have a given amount of good X and good Y and decide to trade some of these goods with each other. If the exchange is voluntary, the strong presumption is that both individuals gain from the exchange (otherwise, the individual who loses would simply refuse to trade). We can examine the process of voluntary exchange by indifference curve analysis.

Suppose that individual A's tastes and preferences for good X and good Y are shown by indifference curves U_1, U_2, and U_3 in the top left panel of Figure 4.8. Individual B's tastes and preferences are given by indifference curves U'_1, U'_2, and U'_3 (with origin $0'$) in the top right panel. Initially, individual A has an allocation of $3X$ and $6Y$ (point C in the top left panel) and individual B has $7X$ and $2Y$ (point C' in the top right panel).

We now rotate individual B's indifference diagram by 180 degrees (so that origin $0'$ appears in the top right corner) and superimpose it on individual A's indifference diagram in such a way that the axes of the two diagrams form the so-called **Edgeworth box diagram,** shown in the bottom panel of Figure 4.8. The length of the box ($10X$) measures the combined amount of X initially owned by individual A ($3X$) and individual B ($7X$). The height of the box ($8Y$) measures the amount of Y initially owned by individual A ($6Y$) and individual B ($2Y$). A's indifference curves are convex to origin 0 (as usual), while B's indifference curves are convex to origin $0'$.

Any point inside the box indicates how the total amount of X and Y may be distributed between the two individuals. For example, the initial distribution of X and Y given by point C indicates that individual A has $3X$ and $6Y$ (viewed from origin 0) and individual B has the remainder of $7X$ and $2Y$ (when viewed from origin $0'$) for a total of $10X$ and $8Y$ (the dimensions of the box). Individual A is on indifference curve U_1 and individual B is on indifference curve U'_1.

Since at point C (where U_1 and U'_1 intersect) the marginal rate of substitution of good X for good Y (MRS_{XY}) for individual A exceeds MRS_{XY} for individual B, there is a basis for mutually beneficial exchange between the two individuals. Starting at point C, individual A would be willing to give up $4Y$ to get one additional unit of X (and move to point D on U_1). On the other hand, individual B would be willing to give up $1X$ for about 0.2 additional units of Y (and move to point H on U'_1). Because A is willing to give up more of Y than necessary to induce B to give up $1X$, there is a basis for trade in which individual A gives up some of Y in exchange for some of X from individual B.

Whenever the MRS_{XY} for the two individuals differs at the initial distribution of X and Y, either or both may gain from exchange. For example, starting from point C, if individual A exchanges $4Y$ for $1X$ with individual B, A would move from point C to

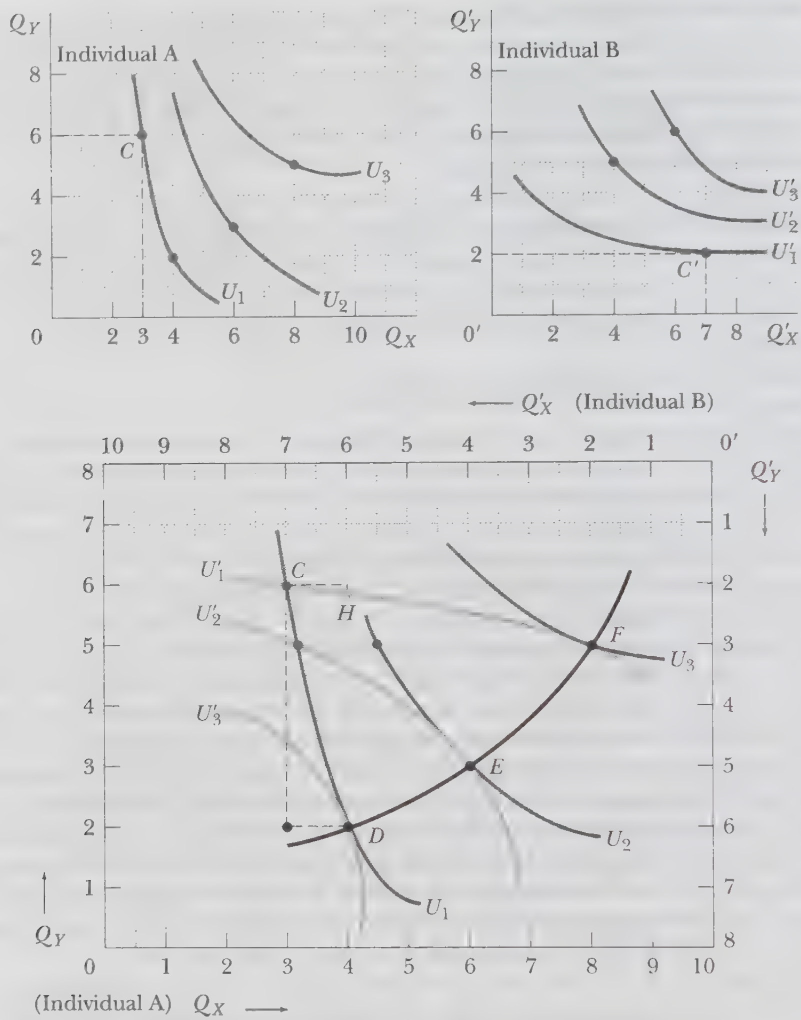

FIGURE 4.8 Edgeworth Box Diagram The top left panel shows individual A's indifference curves, and the top right panel shows B's indifference curves. The box in the bottom panel is obtained by rotating B's indifference map diagram 180 degrees and superimposing it on A's diagram in such a way that the dimensions of the box equal the initial combined amounts of goods X and Y owned by A and B. Any point in the box refers to a particular distribution of X and Y between A and B. At point C, MRS_{XY} for the two individuals differs (U_1 and U_1' cross) and there is a basis for mutually beneficial exchange until a point between D and F on curve DEF is reached (where MRS_{XY} for A and B are equal).

point D along indifference curve U_1, while B would move from point C on U'_1 to point D on U'_3. By moving from indifference curve U'_1 to indifference curve U'_3, individual B receives all of the gains from the exchange while individual A gains or loses nothing (since A remains on U_1). At point D, U_1 and U'_3 are tangent, and so their slopes (MRS_{XY}) are equal. Thus, there is no basis for further exchange (at point D, the amount of Y that A is willing to give up for 1X is exactly equal to what B requires to give up 1X). Any further exchange would make either one or both individuals worse off than they are at point D.

Alternatively, if individual A exchanged 1Y for 5X with individual B, individual A would move from point C on U_1 to point F on U_3, while individual B would move from point C to point F along U'_1. In this case, A would reap all the benefits from exchange while B would neither gain nor lose. At point F, MRS_{XY} for A equals MRS_{XY} for B and there is no further basis for exchange. Finally, starting again from point C on U_1 and U'_1, if A exchanges 3Y for 3X with B and gets to point E, both individuals gain from the exchange since point E is on U_2 and U'_2.

Starting from any point within $CDEF$ but not on curve DEF, both individuals can gain from exchange by moving to a point on curve DEF between points D and F. The closer individual A gets to point F (i.e., the more shrewd A is as a bargainer), the greater is the proportion of the total gain from the exchange accruing to A and the less is left for B. The Edgeworth box is named after the English economist F. Y. Edgeworth, who in 1881 first outlined its construction. (We will return to exchange in greater detail in Chapter 16.)

AT THE FRONTIER
The Characteristics Approach to Consumer Theory

The **characteristics approach to consumer theory,** pioneered by Kelvin Lancaster, postulates that consumers demand a good because of the characteristics, properties, and attributes of the good, and it is these characteristics that give rise to utility.[16] For example, a consumer does not demand beef, as such, but rather the characteristics of protein and calories, which are the direct source of utility. But protein and calories are also provided (though in different proportions) by pork and chicken. Thus, a good usually possesses more than one characteristic, and any given characteristic is present in more than one good.

The characteristics approach to consumer theory can be shown graphically. In the top panel of Figure 4.9, the horizontal axis measures the characteristic of protein and the vertical axis measures calories. Suppose that the consumer's income is \$10 and that \$10 worth of pork provides the combination of protein and calories given by point A, while \$10 worth of beef gives the combination at point B.[17] The budget line is then AB. Area $0AB$ is called the *feasible region* and budget line AB is the *efficiency frontier*. That is, the consumer can purchase any combination of protein and calories in area $A0B$, but he or she will maximize utility or satisfaction by choosing combinations on line AB.

If U_1 is a consumer's indifference curve in characteristics space (i.e., with characteristics protein and calories measured along the axes), the consumer maximizes utility at point C, where indifference curve U_1 is tangent to budget line AB. The consumer reaches point C by obtaining $0F$ characteristics from spending \$5 on beef and FC characteristics from spending the remaining \$5 on pork. $0F = 1/2\ 0B$ and $0G = 1/2\ 0A$. Note that FC equals $0G$, both in length and direction.[18]

[16] Kelvin Lancaster, *Consumer Demand: A New Approach* (New York: Columbia University Press, 1971).
[17] Note that the characteristics ray for pork has a slope four times larger than the characteristics ray for beef. Thus, pork provides four times as many calories per unit of protein as beef.

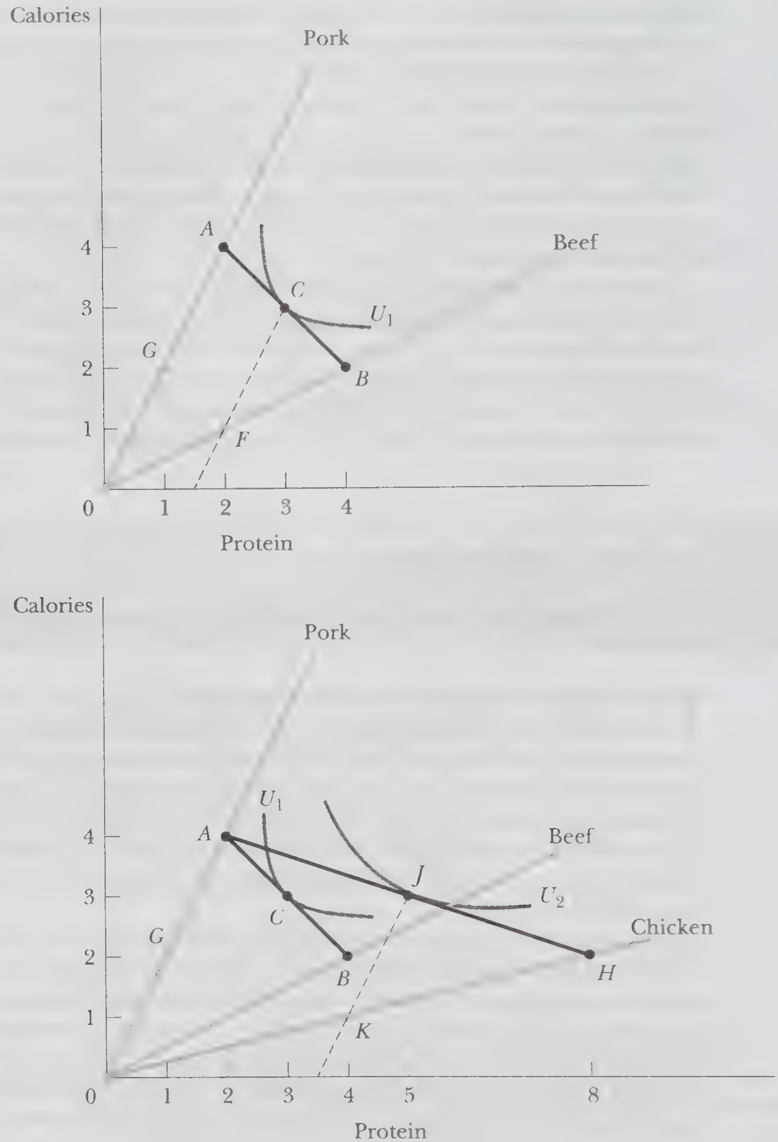

FIGURE 4.9 The Characteristics Approach to Consumer Demand Theory In the top panel, \$10 worth of pork gives the combination of protein and calories indicated by point *A* and \$10 worth of beef gives the combination at point *B*. Thus, *AB* is the budget line. The consumer maximizes utility at point *C*, where U_1 is tangent to *AB*, by spending \$5 on pork and \$5 on beef, and receiving *0F* characteristics from beef and *FC* (equals *0G*) from pork. In the bottom panel, \$10 worth of chicken gives point *H*, so that the budget line is *AH*. The consumer maximizes utility at point *J* on U_2 by spending \$5 on pork and \$5 on chicken, and obtaining *0K* characteristics from chicken and *KJ* (equals *0G*) characteristics from pork, with no beef purchased.

Continued . . .

The Characteristics Approach to Consumer Theory *Continued*

In the bottom panel, a new good is introduced, chicken, which has half as many calories per unit of protein as beef. If \$10 worth of chicken provides the combination of protein and calories given by point *H*, the budget line or efficiency frontier becomes *AH*. The consumer now maximizes utility at point *J*, where indifference curve U_2 is tangent to budget line *AH*. The consumer reaches point *J* by obtaining 0*K* characteristics from spending \$5 on chicken and *KJ* (equals 0*G*) characteristics from spending the remaining \$5 on pork. No beef is now purchased.

The reduction in the price of a good can be shown by a proportionate outward movement along the characteristics ray of the good, while an increase in income can be shown by a proportionate outward shift of the entire budget line. These shifts will allow the consumer to reach a higher indifference curve as in traditional consumer theory.

The characteristics approach to consumer theory has several important advantages over traditional demand theory. First, substitution among goods can be easily explained in terms of some common characteristics of the goods. For example, according to this theory coffee and tea are substitutes because they both have the characteristic of being stimulants.

Second, the introduction of a new good can easily be taken care of by drawing a new ray from the origin reflecting the combination of the two characteristics of the new good. This was shown by the introduction of chicken in the bottom panel of Figure 4.9. However, the new good will only be purchased if its price is sufficiently low (e.g., chicken in the bottom panel of Figure 4.9). Had \$10 worth of chicken provided only the combination of protein and calories given by point *K* on the characteristics ray for chicken, the budget line would become *ABK* and the consumer would maximize utility by remaining at point *C* and purchasing no chicken.

Third, a quality change can be shown by rotating the characteristics ray for the good. For example, the introduction of a new breed of leaner hogs resulting in pork with less calories per unit of protein can be shown by a clockwise rotation of the characteristics ray for pork. Finally, by comparing the price of two goods that are identical except for a particular characteristic, this approach permits the estimation of the implicit or *hedonic* price of the characteristic. For example, by comparing the price of houses that are otherwise identical except for some other characteristic, such as lower noise pollution, proximity to good schools, parks, and a good transportation network, we can estimate the implicit or hedonic price of each of these characteristics. Thus, if the price of a house that is near a park is \$10,000 more than the price of another identical house that is not near a park, the characteristic of being closer to a park is worth \$10,000.

One disadvantage of the theory is that some characteristics, such as taste and style, are subjective and cannot be measured explicitly. The problem is even more serious in dealing with the characteristics of services. Nevertheless, the hedonic approach is very useful because it allows at least an *implicit* measure of the various characteristics of each good.

[18] *FC* and 0*G* are called vectors. Thus, the above is an example of vector analysis, whereby vector 0*C* (not shown in the top panel of Figure 4.9) is equal to the sum of vectors 0*F* and 0*G*.