CHAPTER 3

Consumer Preferences and Choice

Chapter Outline

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After Studying This Chapter, You Should Be Able to:

- Know how consumer tastes are measured or represented
- Describe the relationship between money and happiness
- Know how the consumer's constraints are represented
- Understand how the consumer maximizes satisfaction or reaches equilibrium
- Describe how consumer tastes or preferences can be inferred without asking the consumer

In this chapter, we begin the formal study of microeconomics by examining the economic behavior of the consumer. A consumer is an individual or a household composed of one or more individuals. The consumer is the basic economic unit that determines which commodities are purchased and in what quantities. Millions of such decisions are made each day on the more than $13 trillion worth of goods and services produced by the American economy each year.

What guides these individual consumer decisions? Why do consumers purchase some commodities and not others? How do they decide how much to purchase of each commodity? What is the aim of a rational consumer in spending income? These are some of the important questions to which we seek answers in this chapter. The theory of consumer behavior and choice is the first step in the derivation of the market demand curve, the importance of which was clearly demonstrated in Chapter 2.

We begin the study of the economic behavior of the consumer by examining tastes. Consumers' tastes can be related to utility concepts or indifference curves. These are

discussed in the first two sections of the chapter. In Section 3.3, we examine the convergence of tastes internationally. We then introduce the budget line, which gives the constraints or limitations consumer's face in purchasing goods and services. Constraints arise because the commodities that the consumer wants command a price in the marketplace (i.e., they are not free) and the consumer has limited income. Thus, the budget line reflects the familiar and pervasive economic fact of scarcity as it pertains to the individual consumer.

Because the consumer's wants are unlimited or, in any event, exceed his or her ability to satisfy them all, it is important that the consumer spend income so as to maximize satisfaction. Thus, a model is provided to illustrate and predict how a rational consumer maximizes satisfaction, given his or her tastes (indifference curves) and the constraints that the consumer faces (the budget line). The "At the Frontier" section presents a different way to examine consumer tastes and derive a consumer's indifference curves.

The several real-world examples and important applications presented in the chapter demonstrate the relevance and usefulness of the theory of consumer behavior and choice.

3.1 UTILITY ANALYSIS

In this section, we discuss the meaning of utility, distinguish between total utility and marginal utility, and examine the important difference between cardinal and ordinal utility. The concept of utility is used here to introduce the consumer's tastes. The analysis of consumer tastes is a crucial step in determining how a consumer maximizes satisfaction in spending income.

Total and Marginal Utility

Utility The ability of a good to satisfy a want.

Total utility (*TU*) The total satisfaction received from consuming a good or service.

Marginal utility (*MU*) The extra utility received from consuming one additional unit of a good.

Util The arbitrary unit of measure of utility.

Goods are desired because of their ability to satisfy human wants. The property of a good that enables it to satisfy human wants is called **utility.** As individuals consume more of a good per time period, their **total utility (*TU*)** or satisfaction increases, but their marginal utility diminishes. **Marginal utility (*MU*)** is the extra utility received from consuming one additional unit of the good per unit of time while holding constant the quantity consumed of all other commodities.

For example, Table 3.1 indicates that one hamburger per day (or, more generally, one unit of good *X* per period of time) gives the consumer a total utility (*TU*) of 10 utils, where a **util** is an arbitrary unit of utility. Total utility increases with each additional hamburger consumed until the fifth one, which leaves total utility unchanged. This is the *saturation point.* Consuming the sixth hamburger then leads to a decline in total utility because of storage or disposal problems.[1] The third column of Table 3.1 gives the extra or marginal utility resulting from the consumption of each *additional* hamburger. Marginal utility is positive but declines until the fifth hamburger, for which it is zero, and becomes negative for the sixth hamburger.

[1] That is, some effort (disutility), no matter how small, is required to get rid of the sixth hamburger. Assuming that the individual cannot sell the sixth hamburger, he or she would not want it even for free.

TABLE 3.1 Total and Marginal Utility

Q_X	TU_X	MU_X
0	0	. . .
1	10	10
2	16	6
3	20	4
4	22	2
5	22	0
6	20	−2

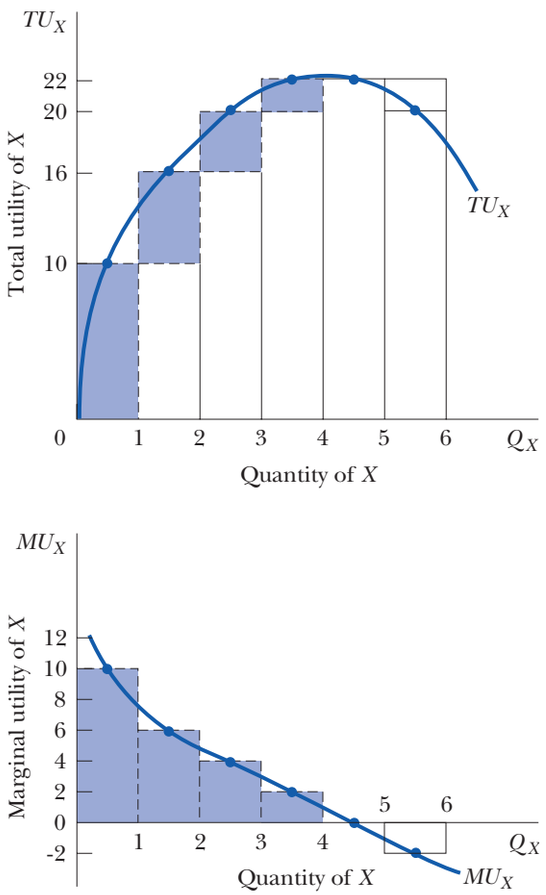

FIGURE 3.1 Total and Marginal Utility In the top panel, total utility (*TU*) increases by smaller and smaller amounts (the shaded areas) and so the marginal utility (*MU*) in the bottom panel declines. *TU* remains unchanged with the consumption of the fifth hamburger, and so *MU* is zero. After the fifth hamburger per day, *TU* declines and *MU* is negative.

Plotting the values given in Table 3.1, we obtain Figure 3.1, with the top panel showing total utility and the bottom panel showing marginal utility. The total and marginal utility curves are obtained by joining the midpoints of the bars measuring *TU* and *MU* at each level of consumption. Note that the *TU* rises by smaller and smaller amounts (the shaded areas) and so the *MU* declines. The consumer reaches saturation after consuming

the fourth hamburger. Thus, *TU* remains unchanged with the consumption of the fifth hamburger and *MU* is zero. After the fifth hamburger, *TU* declines and so *MU* is negative. The negative slope or downward-to-the-right inclination of the *MU* curve reflects the **law of diminishing marginal utility.**

Law of diminishing marginal utility Each additional unit of a good eventually gives less and less extra utility.

Utility schedules reflect tastes of a particular individual; that is, they are unique to the individual and reflect his or her own particular subjective preferences and perceptions. Different individuals may have different tastes and different utility schedules. Utility schedules remain unchanged so long as the individual's tastes remain the same.

Concept Check

What is the relationship between diminishing marginal utility and the law of demand?

Cardinal or Ordinal Utility?

The concept of utility discussed in the previous section was introduced at about the same time, in the early 1870s, by William Stanley Jevons of Great Britain, Carl Menger of Austria, and Léon Walras of France. They believed that the utility an individual receives from consuming each quantity of a good or basket of goods could be measured cardinally just like weight, height, or temperature.[2]

Cardinal utility An actual measure of utility, in util.

Cardinal utility means that an individual can attach specific values or numbers of utils from consuming each quantity of a good or basket of goods. In Table 3.1 we saw that the individual received 10 utils from consuming one hamburger. He received 16 utils, or 6 additional utils, from consuming two hamburgers. The consumption of the third hamburger gave this individual 4 extra utils, or two-thirds as many extra utils, as the second hamburger. Thus, Table 3.1 and Figure 3.1 reflect cardinal utility. They actually provide an index of satisfaction for the individual.

Ordinal utility The rankings of the utility received from consuming various amounts of a good.

In contrast, **ordinal utility** only *ranks* the utility received from consuming various amounts of a good or baskets of goods. Ordinal utility specifies that consuming two hamburgers gives the individual more utility than when consuming one hamburger, but it does not specify exactly how much additional utility the second hamburger provides. Similarly, ordinal utility would say only that three hamburgers give this individual more utility than two hamburgers, but *not* how many more utils.[3]

Ordinal utility is a much weaker notion than cardinal utility because it only requires that the consumer be able to rank baskets of goods in the order of his or her preference. That is, when presented with a choice between any two baskets of goods, ordinal utility requires only that the individual indicate if he or she prefers the first basket, the second basket, or is indifferent between the two. It does not require that the individual specify how many more utils he or she receives from the preferred basket. *In short, ordinal utility only ranks various consumption bundles, whereas cardinal utility provides an actual index or measure of satisfaction.*

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[2] A market basket of goods can be defined as containing specific quantities of various goods and services. For example, one basket may contain one hamburger, one soft drink, and a ticket to a ball game, while another basket may contain two soft drinks and two movie tickets.

[3] To be sure, numerical values could be attached to the utility received by the individual from consuming various hamburgers, even with ordinal utility. However, with ordinal utility, higher utility values only indicate higher rankings of utility, and no importance can be attached to actual numerical differences in utility. For example, 20 utils can only be interpreted as giving more utility than 10 utils, but not twice as much. Thus, to indicate rising utility rankings, numbers such as 5, 10, 20; 8, 15, 17; or I (lowest), II, and III are equivalent.

Concept Check
What is the distinction between cardinal and ordinal utility?

The distinction between cardinal and ordinal utility is important because a theory of consumer behavior can be developed on the weaker assumption of ordinal utility without the need for a cardinal measure. And a theory that reaches the same conclusion as another on weaker assumptions is a superior theory.[4] Utility theory provides a convenient introduction to the analysis of consumer tastes and to the more rigorous indifference curve approach. It is also useful for the analysis of consumer choices in the face of uncertainty, which is presented in Chapter 6. Example 3–1 examines the relationship between money income and happiness.

EXAMPLE 3–1

Does Money Buy Happiness?

Does money buy happiness? Philosophers have long pondered this question. Economists have now gotten involved in trying to answer this age-old question. They calculated the "mean happiness rating" (based on a score of "very happy" = 4, "pretty happy" = 2, and "not too happy" = 0) for individuals at different levels of personal income at a given point in time and for different nations over time. What they found was that up to an income per capita of about $20,000, higher incomes in the United States were positively correlated with happiness responses, but that after that, higher incomes had little, if any, effect on observed happiness. Furthermore, average individual happiness in the United States remained remarkably flat since the 1950s in the face of a considerable increase in average income. Similar results were found for other advanced nations, such as the United Kingdom, France, Germany, and Japan. These results seem to go counter to the basic economic assumption that higher personal income leads to higher utility.

Two explanations are given for these remarkable and puzzling results: (1) that happiness is based on relative rather than absolute income and (2) that happiness quickly adapts to changes in the level of income. Specifically, higher incomes make individuals happier for a while, but their effect fades very quickly as individuals adjust to the higher income and soon take it for granted. For example, a generation ago, central heating was regarded as a luxury, while today it is viewed as essential. Furthermore, as individuals become richer, they become happier, but when society as a whole grows richer, nobody seems happier. In other words, people are often more concerned about their income relative to others' than about their absolute income. Pleasure at your own pay rise can vanish when you learn that a colleague has been given a similar pay increase.

Concept Check
How much money do you need to be happy?

The implication of all of this is that people's effort to work more in order to earn and spend more in advanced (rich) societies does not make people any happier because others do the same. (In poor countries, higher incomes do make people happier). Lower taxes in the United States encourage people to work more and the nation to grow faster than in Europe, but this does not necessarily make Americans happier than

[4] This is like producing a given output with fewer or cheaper inputs, or achieving the same medical result (such as control of high blood pressure) with less or weaker medication.

Europeans. The consensus among happiness researchers is that after earning enough to satisfy basic wants (a per capita income of about $20,000), family, friends, and community tend to be the most important things in life.

Sources: R. A. Easterlin, "Income and Happiness," *Economic Journal,* July 2000; B. S. Frey and A. Stutzer, "What Can Economists Learn from Happiness Research?," *Journal of Economic Literature,* June 2002; R. Layard, *Happiness: Lessons from a New Science* (London: Penguin, 2005); R. Di Tella and R. MacCulloch, "Some Uses of Happiness Data, *Journal of Economic Perspectives*, Winter 2006, pp. 25–46; and A. E. Clark, P. Frijters, and M. A. Shields, "Relative Income, Happiness, and Utility: An Explanation for the Easterlin Paradox and Other Puzzles," **Journal of Economic Literature**, March 2008, pp. 95–144.

3.2 CONSUMER'S TASTES: INDIFFERENCE CURVES

In this section, we define indifference curves and examine their characteristics. Indifference curves were first introduced by the English economist F. Y. Edgeworth in the 1880s. The concept was refined and used extensively by the Italian economist Vilfredo Pareto in the early 1900s. Indifference curves were popularized and greatly extended in application in the 1930s by two other English economists: R. G. D. Allen and John R. Hicks. Indifference curves are a crucial tool of analysis because they are used to represent an ordinal measure of the tastes and preferences of the consumer and to show how the consumer maximizes utility in spending income.

Indifference Curves—What Do They Show?[5]

Consumers' tastes can be examined with ordinal utility. An ordinal measure of utility is based on three assumptions. First, we assume that when faced with any two baskets of goods, the consumer can determine whether he or she prefers basket *A* to basket *B*, *B* to *A*, or whether he or she is indifferent between the two. Second, we assume that the tastes of the consumer are *consistent* or *transitive.* That is, if the consumer states that he or she prefers basket *A* to basket *B* and also that he or she prefers basket *B* to basket *C*, then that consumer will prefer *A* to *C*. Third, we assume that more of a commodity is preferred to less; that is, we assume that the commodity is a **good** rather than a **bad,** and the consumer is never satiated with the commodity.[6] The three assumptions can be used to represent an individual's tastes with indifference curves. In order to conduct the analysis by plane geometry, we will assume throughout that there are only two goods, *X* and *Y*.

Good A commodity of which more is preferred to less.

Bad An item of which less is preferred to more.

Indifference curve The curve showing the various combinations of two commodities that give the consumer equal satisfaction.

An **indifference curve** shows the various combinations of two goods that give the consumer equal utility or satisfaction. A higher indifference curve refers to a higher level of satisfaction, and a lower indifference curve refers to less satisfaction. However, we have no indication as to how much additional satisfaction or utility a higher indifference curve indicates. That is, different indifference curves simply provide an ordering or ranking of the individual's preference.

[5] For a mathematical presentation of indifference curves and their characteristics using rudimentary calculus, see Section A.1 of the Mathematical Appendix at the end of the book.

[6] Examples of bads are pollution, garbage, and disease, of which less is preferred to more.

For example, Table 3.2 gives an indifference schedule showing the various combinations of hamburgers (good X) and soft drinks (good Y) that give the consumer equal satisfaction. This information is plotted as indifference curve U_1 in the left panel of Figure 3.2. The right panel repeats indifference curve U_1 along with a higher indifference curve (U_2) and a lower one (U_0).

Concept Check
Are the indifference curves of various individuals the same?

Indifference curve U_1 shows that one hamburger and ten soft drinks per unit of time (combination A) give the consumer the same level of satisfaction as two hamburgers and six soft drinks (combination B), four hamburgers and three soft drinks (combination C), or seven hamburgers and one soft drink (combination F). On the other hand, combination R (four hamburgers and seven soft drinks) has both more hamburgers and more soft drinks than combination B (see the right panel of Figure 3.2), and so it refers to a higher level of satisfaction. Thus, combination R and all the other combinations that give the same level of satisfaction as combination R define higher indifference curve U_2. Finally, all combinations

TABLE 3.2 Indifference Schedule

Hamburgers (X)	Soft Drinks (Y)	Combinations
1	10	A
2	6	B
4	3	C
7	1	F

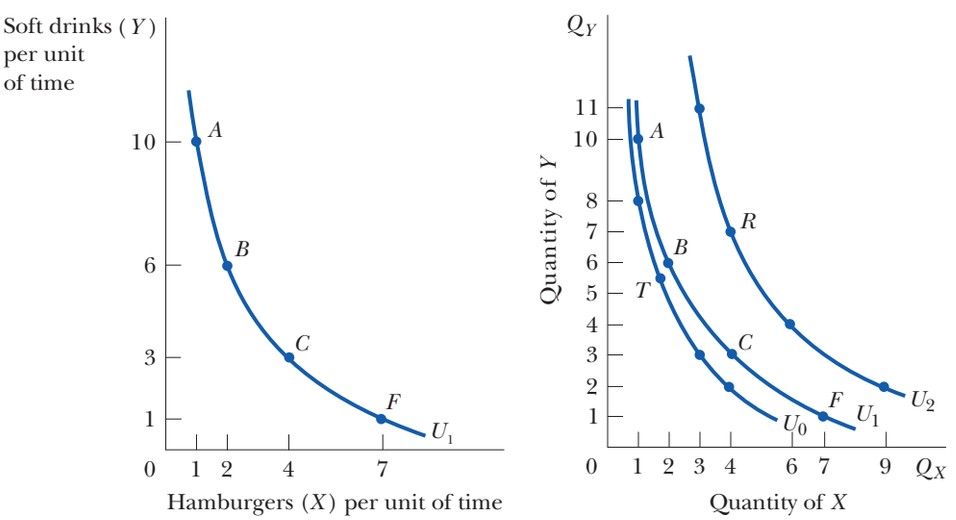

FIGURE 3.2 Indifference Curves The individual is indifferent among combinations A, B, C, and F since they all lie on indifference curve U_1. U_1 refers to a higher level of satisfaction than U_0, but to a lower level than U_2.

on U_0 give the same satisfaction as combination T, and combination T refers to both fewer hamburgers and fewer soft drinks than (and therefore is inferior to) combination B on U_1.

Although in Figure 3.2 we have drawn only three indifference curves, there is an indifference curve going through each point in the XY plane (i.e., referring to each possible combination of good X and good Y). That is, between any two indifference curves, an additional curve can always be drawn. The entire set of indifference curves is called an **indifference map** and reflects the entire set of tastes and preferences of the consumer.

Indifference map The entire set of indifference curves reflecting the consumer's tastes and preferences.

Characteristics of Indifference Curves

Indifference curves are usually negatively sloped, cannot intersect, and are convex to the origin (see Figure 3.2). Indifference curves are negatively sloped because if one basket of goods X and Y contains more of X, it will have to contain less of Y than another basket in order for the two baskets to give the same level of satisfaction and be on the same indifference curve. For example, since basket B on indifference curve U_1 in Figure 3.2 contains more hamburgers (good X) than basket A, basket B must contain fewer soft drinks (good Y) for the consumer to be on indifference curve U_1.

A positively sloped curve would indicate that one basket containing more of both commodities gives the same utility or satisfaction to the consumer as another basket containing less of both commodities (and no other commodity). Because we are dealing with goods rather than bads, such a curve could not possibly be an indifference curve. For example, in the left panel of Figure 3.3, combination B' contains more of X and more of Y than combination A', and so the positively sloped curve on which B' and A' lie cannot be an indifference curve. That is, B' must be on a higher indifference curve than A' if X and Y are both goods.[7]

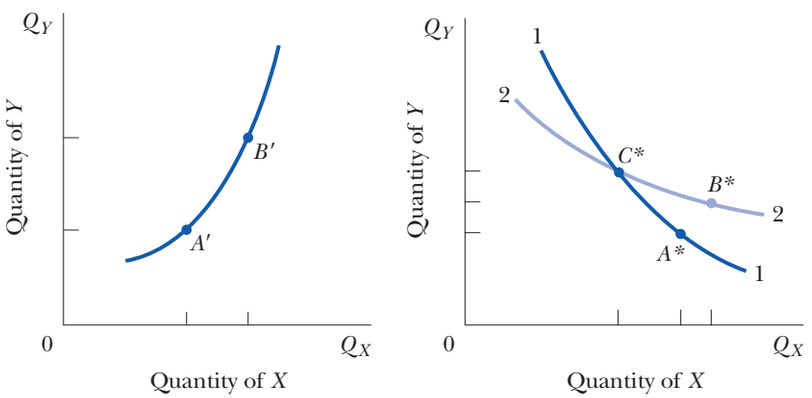

FIGURE 3.3 Indifference Curves Cannot Be Positively Sloped or Intersect
In the left panel, the positively sloped curve cannot be an indifference curve because it shows that combination B'', which contains more of X and Y than combination A', gives equal satisfaction to the consumer as A'. In the right panel, since C^* is on curves 1 and 2, it should give the same satisfaction as A^* and B^*, but this is impossible because B^* has more of X and Y than A^*. Thus, indifference curves cannot intersect.

Concept Check
Why are indifference curves negatively sloped?

[7] Only if either X or Y were a bad would the indifference curve be positively sloped as in the left panel of Figure 3.3.

Indifference curves also cannot intersect. Intersecting curves are inconsistent with the definition of indifference curves. For example, if curve 1 and curve 2 in the right panel of Figure 3.3 were indifference curves, they would indicate that basket A^* is equivalent to basket C^* since both A^* and C^* are on curve 1, and also that basket B^* is equivalent to basket C^* since both B^* and C^* are on curve 2. By transitivity, B^* should then be equivalent to A^*. However, this is impossible because basket B^* contains more of both good X and good Y than basket A^*. Thus, indifference curves cannot intersect.

Indifference curves are usually convex to the origin; that is, they lie above any tangent to the curve. Convexity results from or is a reflection of a decreasing marginal rate of substitution, which is discussed next.

The Marginal Rate of Substitution

Marginal rate of substitution (*MRS*) The amount of a good that a consumer is willing to give up for an additional unit of another good while remaining on the same indifference curve.

The **marginal rate of substitution (*MRS*)** refers to the amount of one good that an individual is willing to give up for an additional unit of another good while maintaining the same level of satisfaction or remaining on the same indifference curve. For example, the marginal rate of substitution of good X for good Y (MRS_{XY}) refers to the amount of Y that the individual is willing to exchange per unit of X and maintain the same level of satisfaction. Note that MRS_{XY} measures the downward vertical distance (the amount of Y that the individual is willing to give up) per unit of horizontal distance (i.e., per additional unit of X required) to remain on the same indifference curve. That is, $MRS_{XY} = -\Delta Y/\Delta X$. Because of the reduction in Y, MRS_{XY} is negative. However, we multiply by -1 and express MRS_{XY} as a positive value.

For example, starting at point A on U_1 in Figure 3.4, the individual is willing to give up four units of Y for one additional unit of X and reach point B on U_1. Thus, $MRS_{XY} = -(-4/1) = 4$. This is the absolute (or positive value of the) slope of the chord from point A to point B on U_1. Between point B and point C on U_1, $MRS_{XY} = 3/2 = 1.5$ (the absolute slope of chord BC). Between points C and F, $MRS_{XY} = 2/3 = 0.67$. At a particular point on the indifference curve, MRS_{XY} is given by the absolute slope of the tangent to the indifference curve at that point. Different individuals usually have different indifference curves and different MRS_{XY} (at points where their indifference curves have different slopes).

We can relate indifference curves to the preceding utility analysis by pointing out that all combinations of goods X and Y on a given indifference curve refer to the same level of total utility for the individual. Thus, for a movement down a given indifference curve, the gain in utility in consuming more of good X must be equal to the loss in utility in consuming less of good Y. Specifically, the increase in consumption of good X (ΔX) times the marginal utility that the individual receives from consuming each additional unit of X (MU_X) must be equal to the reduction in Y ($-\Delta Y$) times the marginal utility of Y (MU_Y). That is,

$$(\Delta X)(MU_X) = -(\Delta Y)(MU_Y) \qquad [3.1]$$

so that

$$MU_X/MU_Y = -\Delta Y/\Delta X = MRS_{XY} \qquad [3.2]$$

Thus, MRS_{XY} is equal to the absolute slope of the indifference curve and to the ratio of the marginal utilities.

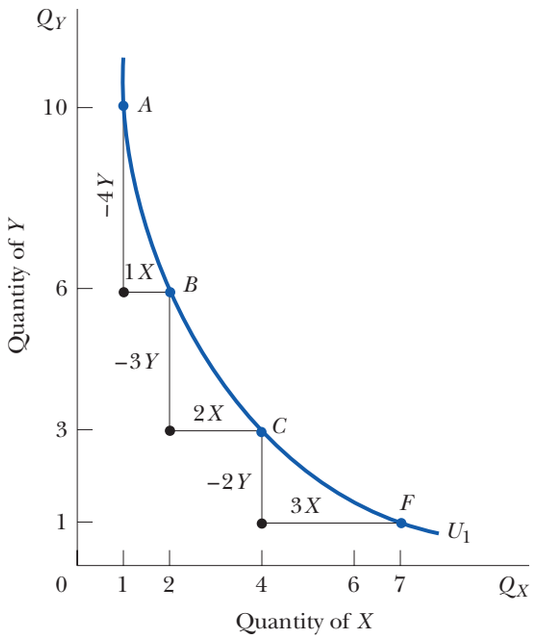

FIGURE 3.4 Marginal Rate of Substitution (*MRS*) Starting at point *A*, the individual is willing to give up 4 units of *Y* for one additional unit of *X* and reach point *B* on U_1. Thus, $MRS_{XY} = 4$ (the absolute slope of chord *AB*). Between points *B* and *C*, $MRS_{XY} = 3/2$. Between *C* and *F*, $MRS_{XY} = 2/3$. MRS_{XY} declines as the individual moves down the indifference curve.

Note that MRS_{XY} (i.e., the absolute slope of the indifference curve) declines as we move down the indifference curve. This follows from, or is a reflection of, the convexity of the indifference curve. That is, as the individual moves down an indifference curve and is left with less and less *Y* (say, soft drinks) and more and more *X* (say, hamburgers), each remaining unit of *Y* becomes more valuable to the individual and each additional unit of *X* becomes less valuable. Thus, the individual is willing to give up less and less of *Y* to obtain each additional unit of *X*. It is this property that makes MRS_{XY} diminish and indifference curves convex to the origin. We will see in Section 3.5 the crucial role that convexity plays in consumer utility maximization.[8]

Some Special Types of Indifference Curves

Although indifference curves are usually negatively sloped and convex to the origin, they may sometimes assume other shapes, as shown in Figure 3.5. Horizontal indifference curves, as in the top left panel of Figure 3.5, would indicate that commodity *X* is a **neuter;** that is, the consumer is indifferent between having more or less of the commodity. Vertical indifference curves, as in the top right panel of Figure 3.5, would indicate instead that commodity *Y* is a neuter.

The bottom left panel of figure 3.5 shows indifference curves that are negatively sloped straight lines. Here, MRS_{XY} or the absolute slope of the indifference curves is constant. This means that an individual is always willing to give up the same amount of good *Y* (say, two cups of tea) for each additional unit of good *X* (one cup of coffee). Therefore, good *X* and two units of good *Y* are *perfect substitutes* for this individual.

[8] A movement along an indifference curve in the upward direction measures MRS_{YX}, which also diminishes.

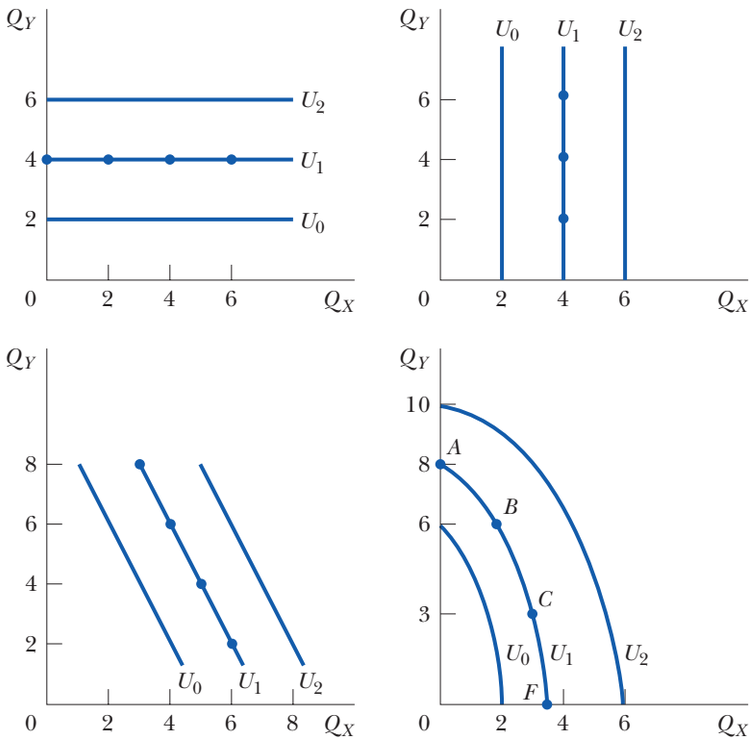

FIGURE 3.5 Some Unusual Indifference Curves Horizontal indifference curves, as in the top left panel, indicate that X is a neuter; that is, the consumer is indifferent between having more or less of it. Vertical indifference curves, as in the top right panel, would indicate instead that commodity Y is a neuter. Indifference curves that are negatively sloped straight lines, as in the bottom left panel, indicate that MRS_{XY} is constant, and so X and Y are perfect substitutes for the individual. The bottom right panel shows indifference curves that are concave to the origin (i.e., MRS_{XY} increases).

Finally, the bottom right panel shows indifference curves that are concave rather than convex to the origin. This means that the individual is willing to give up more and more units of good Y for each additional unit of X (i.e., MRS_{XY} increases). For example, between points A and B on U_1, $MRS_{XY} = 2/2 = 1$; between B and C, $MRS_{XY} = 3/1 = 3$; and between C and F, $MRS_{XY} = 3/0.5 = 6$. In Section 3.5, we will see that in this unusual case, the individual would end up consuming only good X or only good Y.

Even though indifference curves can assume any of the shapes shown in Figure 3.5, they are usually negatively sloped, nonintersecting, and convex to the origin. These characteristics have been confirmed experimentally.[9] Because it is difficult to derive indifference curves experimentally, however, firms try to determine consumers' preferences by marketing studies, as explained in Example 3–2.

[9] See, for example, K. R. MacCrimmon and M. Toda, "The Experimental Determination of Indifference Curves," *Review of Economic Studies,* October 1969.

EXAMPLE 3–2

How Ford Decided on the Characteristics of Its Taurus

Firms can learn about consumers' preferences by conducting or commissioning marketing studies to identify the most important characteristics of a product, say, styling and performance for automobiles, and to determine how much more consumers would be willing to pay to have more of each attribute, or how they would trade off more of one attribute for less of another. This approach to consumer demand theory, which focuses on the characteristics or attributes of goods and on their worth or *hedonic prices* rather than on the goods themselves, was pioneered by Kelvin Lancaster (see "At the Frontier" in Chapter 4). This is in fact how the Ford Motor Company decided on the characteristics of its 1986 Taurus.

Specifically, Ford determined by marketing research that the two most important characteristics of an automobile for the majority of consumers were styling (i.e., design and interior features) and performance (i.e., acceleration and handling) and then produced its Taurus in 1986 that incorporated those characteristics. The rest is history (the Taurus regained in 1992 its status of the best-selling car in America—a position that it had lost to the Honda Accord in 1989). Ford also used this approach to decide on the characteristics of the all-new 1996 Taurus, the first major overhaul since its 1986 launch, at a cost of $2.8 billion, as well as in deciding the characteristics of its world cars, Focus, launched in 1998, the Mondeo introduced in 2000, and the new Fiesta in Europe in 2008 and in the United States in 2010. Other automakers, such as General Motors, followed similar procedures in determining the characteristics of their automobiles. Since then U.S. automakers have shifted somewhat toward producing "sports wagons," which are a cross between sedans and sport-utility vehicles (SUVs) to reflect recent changes in consumer tastes, and toward more fuel-efficient and "green" automobiles as a result of the sharp increase in gasoline prices and heightened environmental concerns.

Market studies can also be used to determine how consumers' tastes have changed over time. In terms of indifference curves, a reduction in the consumer's taste for commodity X (hamburgers) in relation to commodity Y (soft drinks) would be reflected in a flattening of the indifference curve of Figure 3.4, indicating that the consumer would now be willing to give up less of Y for each additional unit of X. The different tastes of different consumers are also reflected in the shapes of their indifference curves. The consumer who prefers soft drinks to hamburgers will have a flatter indifferences curve than a consumer who does not.

Sources: "Ford Puts Its Future on the Line," *New York Times Magazine,* December 4, 1985, pp. 94–110; V. Bajic, "Automobiles and Implicit Markets: An Estimate of a Structural Demand Model for Automobile Characteristics," *Applied Economics,* April 1993, pp. 541–551; "Ford Hopes Its New Focus Will Be a Global Best Seller," *Wall Street Journal,* October 8, 1998, p. B10; S. Berry, J. Levinsohn, and A. Pakes, "Differentiated Products Demand Systems from a Combination of Macro and Micro Data: The New Car Market," National Bureau of Economic Research, *Working Paper 6481,* March 1998; and "Ford's Taurus Loses Favor to New-Age Sport Wagon," *New York Times*, February 7, 2002, p. B1; "Once Frumpy, Green Cars Start Showing Some Flash," *New York Times*, July 15, 2007, p. 13; "Ford Eyes More Cuts, as Recovery Advances," *Wall Street Journal*, April 23, 2008, p. A1; and "One World, One Car, One Name," *Business Week*, March 24, 2008, p. 63.

3.3 INTERNATIONAL CONVERGENCE OF TASTES

A rapid convergence of tastes is taking place in the world today. Tastes in the United States affect tastes around the world and tastes abroad strongly influence tastes in the United States. Coca-Cola and jeans are only two of the most obvious U.S. products that have become household items around the world. One can see Adidas sneakers and Walkman personal stereos on joggers from Central Park in New York City to Tivoli Gardens in Copenhagen. You can eat Big Macs in Piazza di Spagna in Rome or Pushkin Square in Moscow. We find Japanese cars and VCRs in New York and in New Delhi, French perfumes in Paris and in Cairo, and Perrier in practically every major (and not so major) city around the world. Texas Instruments and Canon calculators, Dell and Hitachi portable PCs, and Xerox and Minolta copiers are found in offices and homes more or less everywhere. With more rapid communications and more frequent travel, the worldwide convergence of tastes has even accelerated. This has greatly expanded our range of consumer choices and forced producers to think in terms of global production and marketing to remain competitive in today's rapidly shrinking world.

In his 1983 article "The Globalization of Markets" in the *Harvard Business Review,* Theodore Levitt asserted that consumers from New York to Frankfurt to Tokyo want similar products and that success for producers in the future would require more and more standardized products and pricing around the world. In fact, in country after country, we are seeing the emergence of a middle-class consumer lifestyle based on a taste for comfort, convenience, and speed. In the food business, this means packaged, fast-to-prepare, and ready-to-eat products. Market researchers have discovered that similarities in living styles among middle-class people all over the world are much greater than we once thought and are growing with rising incomes and education levels. Of course, some differences in tastes will always remain among people of different nations, but with the tremendous improvement in telecommunications, transportation, and travel, the cross-fertilization of cultures and convergence of tastes can only be expected to accelerate. This trend has important implications for consumers, producers, and sellers of an increasing number and types of products and services.

EXAMPLE 3–3

Gillette Introduces the Sensor and Mach3 Razors—Two Truly Global Products

As tastes become global, firms are responding more and more with truly global products. These are introduced more or less simultaneously in most countries of the world with little or no local variation. This is leading to what has been aptly called the "global supermarket." For example, in 1990, Gillette introduced its new Sensor Razor at the same time in most nations of the world and advertised it with virtually the same TV spots (ad campaign) in 19 countries in Europe and North America. In 1994, Gillette introduced an upgrade of the Sensor Razor called SensorExcell

with a high-tech edge. By 1998, Gillette had sold over 400 million of Sensor and SensorExcell razors and more than 8 billion twin-blade cartridges, and it had captured an incredible 71% of the global blade market. Then in April 1998, Gillette unveiled the Mach3, the company's most important new product since the Sensor. It has three blades with a new revolutionary edge produced with chipmaking technology that took five years to develop. Gillette developed its new razor in stealth secrecy at the astounding cost of over $750 million, and spent another $300 million to advertise it. Since it went on sale in July 1998, the Mach3 has proven to be an even greater success than the Sensor Razor. Gillette introduced the Mach3 Turbo Razor worldwide in April 2002, in June 2004 its M3Power Razor, as an evolution of its Mach 3, and its five-blade Fusion in early 2006. With the merger of Gillette and Procter & Gamble, the global reach of the M3Power and Fusion are likely to be even greater than for its predecessors.

Concept Check

Why are tastes converging internationally?

The trend toward the global supermarket is rapidly spreading in Europe as borders fade and as Europe's single currency (the euro) brings prices closer across the continent. A growing number of companies are creating "Euro-brands"—a single product for most countries of Europe—and advertising them with "Euro-ads," which are identical or nearly identical across countries, except for language. Many national differences in taste will, of course, remain; for example, Nestlé markets more than 200 blends of Nescafé to cater to differences in tastes in different markets. But the converging trend in tastes around the world is unmistakable and is likely to lead to more and more global products. This is true not only in foods and inexpensive consumer products but also in automobiles, tires, portable computers, phones, and many other durable products.

Sources: "Building the Global Supermarket," *New York Times,* November 18, 1988, p. D1; "Gillette's World View: One Blade Fits All," *Wall Street Journal,* January 3, 1994, p. C3; "Gillette Finally Reveals Its Vision of the Future, and it Has 3 Blades," *Wall Street Journal,* April 4, 1998, p. A1; "Gillette, Defying Economy, Introduces a $9 Razor Set," *New York Times,* October 31, 2001, p. C4; "Selling in Europe: Borders Fade," *New York Times,* May 31, 1990, p. D1; "Converging Prices Mean Trouble for European Retailers," *Financial Times,* June 18, 1999, p. 27; "Can Nestlé Be the Very Best?," *Fortune,* November 13, 2001, pp. 353–360; "For Cutting-Edge Dads," *US News & World Report,* June 14, 2004, pp. 80–81; "P&G's $57 Billion Bargain," *BusinessWeek*, July 25, 2005, p. 26; and "How Many Blades Is Enough?" *Fortune*, October 31, 2005, p. 40; and "Gillette New Edge," *Business Week*, February 6, 2006, p. 44.

3.4 The Consumer's Income and Price Constraints: The Budget Line

In this section, we introduce the constraints or limitations faced by a consumer in satisfying his or her wants. In order to conduct the analysis by plane geometry, we assume that the consumer spends all of his or her income on only two goods, X and Y. We will see that the constraints of the consumer can then be represented by a line called the budget line. The position of the budget line and changes in it can best be understood by looking at its endpoints.

Definition of the Budget Line

In Section 3.2, we saw that we can represent a consumer's tastes with an indifference map. We now introduce the constraints or limitations that a consumer faces in attempting to satisfy his or her wants. The amount of goods that a consumer can purchase over a given period of time is limited by the consumer's income and by the prices of the goods that he or she must pay. In what follows we assume (realistically) that the consumer cannot affect the price of the goods he or she purchases. In economics jargon, we say that the consumer faces a **budget constraint** due to his or her limited income and the given prices of goods.

Budget constraint The limitation on the amount of goods that a consumer can purchase imposed by his or her limited income and the prices of the goods.

By assuming that a consumer spends all of his or her income on good X (hamburgers) and on good Y (soft drinks), we can express the budget constraint as

$$P_X Q_X + P_Y Q_Y = I \qquad [3.3]$$

where P_X is the price of good X, Q_X is the quantity of good X, P_Y is the price of good Y, Q_Y is the quantity of good Y, and I is the consumer's money income. Equation [3.3] postulates that the price of X times the quantity of X plus the price of Y times the quantity of Y equals the consumer's money income. That is, the amount of money spent on X plus the amount spent on Y equals the consumer's income.[10]

Suppose that $P_X = \$2$, $P_Y = \$1$, and $I = \$10$ per unit of time. This could, for example, be the situation of a student who has \$10 per day to spend on snacks of hamburgers (good X) priced at \$2 each and on soft drinks (good Y) priced at \$1 each. By spending all income on Y, the consumer could purchase $10Y$ and $0X$. This defines endpoint J on the vertical axis of Figure 3.6. Alternatively, by spending all income on X, the consumer could purchase $5X$ and $0Y$. This defines endpoint K on the horizontal axis. By joining endpoints J and K with a straight line we get the consumer's **budget line.** This line shows the various combinations of X and Y that the consumer can purchase by spending all income at the given prices of the two goods. For example, starting at endpoint J, the consumer could give up two units of Y and use the \$2 not spent on Y to purchase the first unit of X and reach point L. By giving up another $2Y$, he or she could purchase the second unit of X. The slope of -2 of budget line JK shows that for each $2Y$ the consumer gives up, he or she can purchase $1X$ more.

Budget line A line showing the various combinations of two goods that a consumer can purchase by spending all income.

By rearranging equation [3.3], we can express the consumer's budget constraint in a different and more useful form, as follows. By subtracting the term $P_X Q_X$ from both sides of equation [3.3] we get

$$P_Y Q_Y = I - P_X Q_X \qquad [3.3A]$$

By then dividing both sides of equation [3.3A] by P_Y, we isolate Q_Y on the left-hand side and define equation [3.4]:

$$Q_Y = I/P_Y - (P_X/P_Y)Q_X \qquad [3.4]$$

[10] Equation [3.3] could be generalized to deal with any number of goods. However, as pointed out, we deal with only two goods for purposes of diagrammatic analysis.

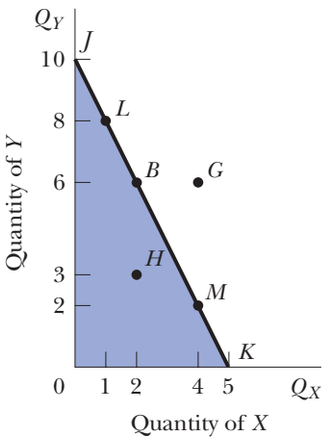

FIGURE 3.6 The Budget Line With an income of $I = \$10$, and $P_Y = \$1$ and $P_X = \$2$, we get budget line *JK*. This shows that the consumer can purchase 10*Y* and 0*X* (endpoint *J*), 8*Y* and 1*X* (point *L*), 6*Y* and 2*X* (point *B*), or . . . 0*Y* and 5*X* (endpoint *K*). $I/P_Y = \$10/\$1 = 10$ is the vertical or *Y*-intercept of the budget line and $-P_X/P_Y = -\$2/\$1 = -2$ is the slope.

The first term on the right-hand side of equation [3.4] is the vertical or *Y*-intercept of the budget line and $-P_X/P_Y$ is the slope of the budget line. For example, continuing to use $P_X = \$2$, $P_Y = \$1$, and $I = \$10$, we get $I/P_Y = 10$ for the *Y*-intercept (endpoint *J* in Figure 3.6) and $-P_X/P_Y = -2$ for the slope of the budget line. The slope of the budget line refers to the rate at which the two goods can be exchanged for one another in the market (i.e., 2*Y* for 1*X*).

The consumer can purchase any combination of *X* and *Y* on the budget line or in the shaded area below the budget line (called *budget space*). For example, at point *B* the individual would spend \$4 to purchase 2*X* and the remaining \$6 to purchase 6*Y*. At point *M*, he or she would spend \$8 to purchase 4*X* and the remaining \$2 to purchase 2*Y*. On the other hand, at a point such as *H* in the shaded area below the budget line (i.e., in the budget space), the individual would spend \$4 to purchase 2*X* and \$3 to purchase 3*Y* and be left with \$3 of unspent income. In what follows, we assume that the consumer *does* spend all of his or her income and is on the budget line. Because of the income and price constraints, the consumer cannot reach combinations of *X* and *Y* above the budget line. For example, the individual cannot purchase combination *G* (4*X*, 6*Y*) because it requires an expenditure of \$14 (\$8 to purchase 4*X* plus \$6 to purchase 6*Y*).

Changes in Income and Prices and the Budget Line

A particular budget line refers to a specific level of the consumer's income and specific prices of the two goods. If the consumer's income and/or the price of good *X* or good *Y* change, the budget line will also change. When only the consumer's income changes, the budget line will shift up if income (*I*) rises and down if *I* falls, but the slope of the budget line remains unchanged. For example, the left panel of Figure 3.7 shows budget line *JK* (the same as in Figure 3.6 with $I = \$10$), higher budget line $J'K'$ with $I = \$15$, and still higher budget line $J''K''$ with $I = \$20$ per day. P_X and P_Y do not change, so the three budget lines are parallel and their slopes are equal. If the consumer's income falls, the budget line shifts down but remains parallel.

If only the price of good X changes, the vertical or Y-intercept remains unchanged, and the budget line rotates upward or counterclockwise if P_X falls and downward or clockwise if P_X rises. For example, the right panel of Figure 3.7 shows budget line JK (the same as in Figure 3.6 at $P_X = \$2$), budget line JK'' with $P_X = \$1$, and budget line JN' with $P_X = \$0.50$. The vertical intercept (endpoint J) remains the same because I and P_Y do not change. The slope of budget line JK'' is $-P_X/P_Y = -\$1{=}\$1 = -1$. The slope of budget line JN' is $-1/2$. With an increase in P_X, the budget line rotates clockwise and becomes steeper.

Concept Check
What happens to the budget line if the price of Y falls more than the price of X?

On the other hand, if only the price of Y changes, the horizontal or X-intercept will be the same, but the budget line will rotate upward if P_Y falls and downward if P_Y rises. For example, with $I = \$10$, $P_X = \$2$, and $P_Y = \$0.50$ (rather than $P_Y = \$1$), the new vertical or Y-intercept is $Q_Y = 20$ and the slope of the new budget line is $-P_X/P_Y = -4$. With $P_Y = \$2$, the new Y-intercept is $Q_Y = 5$ and $-P_X{=}P_Y = -1$ (you should be able to sketch these lines). Finally, with a proportionate reduction in P_X and P_Y and constant I, there will be a parallel upward shift in the budget line; with a proportionate increase in P_X and P_Y and constant I, there will be a parallel downward shift in the budget line. Example 3–4 shows that time, instead of the consumer's income, can be a constraint.

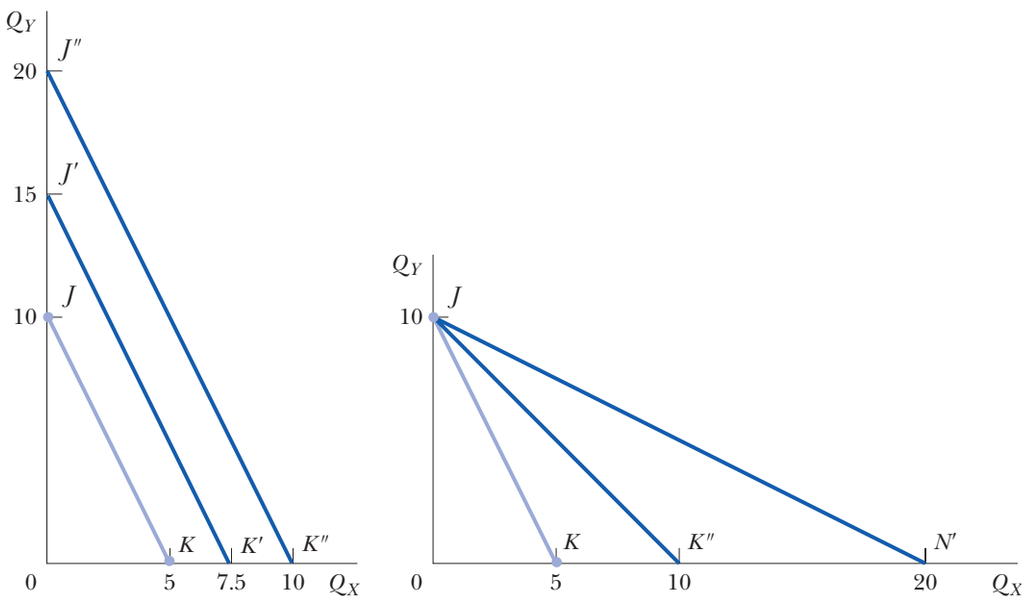

FIGURE 3.7 Changes in the Budget Line The left panel shows budget line JK (the same as in Figure 3.6 with $I = \$10$), higher budget line $J'K'$ with $I = \$15$, and still higher budget line $J''K''$ with $I = \$20$ per day. P_X and P_Y do not change, so the three budget lines are parallel and their slopes are equal. The right panel shows budget line JK with $P_X = \$2$, budget line JK'' with $P_X = \$1$, and budget line JN'' with $P_X = \$0.50$. The vertical or Y-intercept (endpoint J) remains the same because income and P_Y do not change. The slope of budget line JK'' is $-P_X/P_Y = -\$1/\$1 = -1$, while the slope of budget line JN' is $-1/2$.

EXAMPLE 3–4

Time as a Constraint

In the preceding discussion of the budget line, we assumed only two constraints: the consumers' income and the given prices of the two goods. In the real world, consumers are also likely to face a time constraint. That is, since the consumption of goods requires time, which is also limited, time often represents another constraint faced by consumers. This explains the increasing popularity of precooked or ready-to-eat foods, restaurant meals delivered at home, and the use of many other time-saving goods and services. But the cost of saving time can be very expensive—thus proving the truth of the old saying that "time is money."

For example, the food industry is introducing more and more foods that are easy and quick to prepare, but these foods carry with them a much higher price. A meal that could be prepared from scratch for a few dollars might cost instead more than $10 in its ready-to-serve variety which requires only a few minutes to heat up. More and more people are also eating out and incurring much higher costs in order to save the time it takes to prepare home meals. McDonald's, Burger King, Taco Bell, and other fast-food companies are not just selling food, but fast food, and for that customers are willing to pay more than for the same kind of food at traditional food outlets, which require more waiting time. Better still, many suburbanites are increasingly reaching for the phone, not the frying pan, at dinner time to arrange for the home delivery of restaurant meals, adding even more to the price or cost of a meal.

Time is also a factor in considering transportation costs and access to the Internet. You could travel from New York to Washington, D.C., by train or, in less time but at a higher cost, by plane. Similarly, you can access the Internet with a regular but slow telephone line or much faster, but at a higher cost, by DSL or fiber optics.

Sources: "Suburban Life in the Hectic 1990s: Dinner Delivered," *New York Times,* November 20, 1992, p. B1; "How Much Will People Pay to Save a Few Minutes of Cooking? Plenty," *Wall Street Journal,* July 25, 1985, p. B1; "Riding the Rails at What Price," *New York Times*, June 18, 2001, p. 12; and "Shining Future for Fiber Optics," *New York Times*, November 19, 1995, p. B10.

3.5 CONSUMER'S CHOICE

We will now bring together the tastes and preferences of the consumer (given by his or her indifference map) and the income and price constraints faced by the consumer (given by his or her budget line) to examine how the consumer determines which goods to purchase and in what quantities to maximize utility or satisfaction. As we will see in the next chapter, utility maximization is essential for the derivation of the consumer's demand curve for a commodity (which is a major objective of this part of the text).

Utility Maximization

Rational consumer An individual who seeks to maximize utility or satisfaction in spending his or her income.

Given the tastes of the consumer (reflected in his or her indifference map), the **rational consumer** seeks to maximize the utility or satisfaction received in spending his or her income. A rational consumer maximizes utility by trying to attain the highest indifference

curve possible, given his or her budget line. This occurs where an indifference curve is tangent to the budget line so that the slope of the indifference curve (the MRS_{XY}) is equal to the slope of the budget line (P_X/P_Y). Thus, the condition for **constrained utility maximization, consumer optimization,** or **consumer equilibrium** occurs where the consumer spends all income (i.e., he or she is on the budget line) and

Constrained utility maximization The process by which the consumer reaches the highest level of satisfaction given his or her income and the prices of goods.

$$MRS_{XY} = P_X/P_Y \qquad [3.5]$$

Figure 3.8 brings together on the same set of axes the consumer indifference curves of Figure 3.2 and the budget line of Figure 3.6 to determine the point of utility maximization. Figure 3.8 shows that the consumer maximizes utility at point B where indifference curve U_1 is tangent to budget line JK. At point B, the consumer is on the budget line and $MRS_{XY} = P_X/P_Y = 2$. Indifference curve U_1 is the highest that the consumer can reach with his or her budget line. Thus, to maximize utility the consumer should spend \$4 to purchase $2X$ and the remaining \$6 to purchase $6Y$. Any other combination of goods X and Y that the consumer could purchase (those on or below the budget line) provides less utility. For example, the consumer could spend all income to purchase combination L, but this would be on lower indifference curve U_0.

Concept Check
Why is utility not maximized if the indifference curve crosses the budget line twice?

At point L the consumer is willing to give up more of Y than he or she has to in the market to obtain one additional unit of X. That is, MRS_{XY} (the absolute slope of indifference curve U_0 at point L) exceeds the value of P_X/P_Y (the absolute slope of budget line JK). Thus, starting from point L, the consumer can increase his or her satisfaction by purchasing less of Y and more of X until he or she reaches point B on U_1, where the slopes of U_1 and the budget line are equal (i.e., $MRS_{XY} = P_X/P_Y = 2$). On the other hand, starting from point M, where $MRS_{XY} < P_X/P_Y$, the consumer can increase his or her satisfaction by purchasing less of X and more of Y until he or she reaches point B on U_1, where $MRS_{XY} = P_X/P_Y$. One tangency point such as B is assured by the fact that there is an indifference curve going through each point in the XY commodity space. The consumer

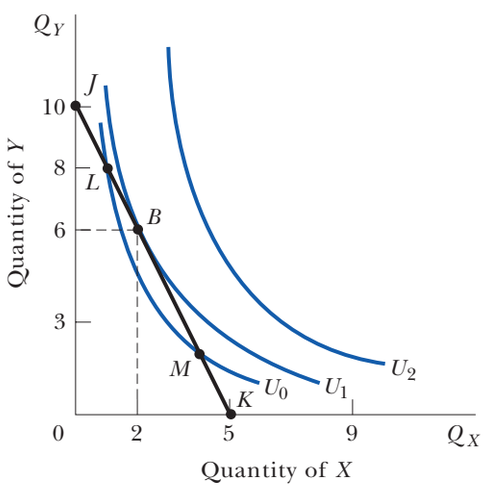

FIGURE 3.8 Constrained Utility Maximization The consumer maximizes utility at point B, where indifference curve U_1 is tangent to budget line JK. At point B, $MRS_{XY} = P_X/P_Y = 2$. Indifference curve U_1 is the highest that the consumer can reach with his or her budget line. Thus, the consumer should purchase $2X$ and $6Y$.

cannot reach indifference curve U_2 with the present income and the given prices of goods X and Y.[11]

Utility maximization is more prevalent (as a general aim of individuals) than it may at first seem. It is observed not only in consumers as they attempt to maximize utility in spending income but also in many other individuals—including criminals. For example, a study found that the rate of robberies and burglaries was positively related to the gains and inversely related to the costs of (i.e., punishment for) criminal activity.[12] Utility maximization can also be used to analyze the effect of government warnings on consumption, as Example 3–5 shows.

EXAMPLE 3–5

Utility Maximization and Government Warnings on Junk Food

Suppose that in Figure 3.9, good X refers to milk and good Y refers to soda, $P_X = \$1$, $P_Y = \$1$, and the consumer spends his or her entire weekly allowance of \$10 on milk and sodas. Suppose also that the consumer maximizes utility by spending \$3 to purchase three containers of milk and \$7 to purchase seven sodas (point B on indifference curve U_1) before any government warning on the danger of dental cavities and obesity from sodas. After the warning, the consumer's tastes may change away from sodas and toward milk. It may be argued that government warnings change the information available to consumers rather than tastes; that is, the warning affects consumers' perception

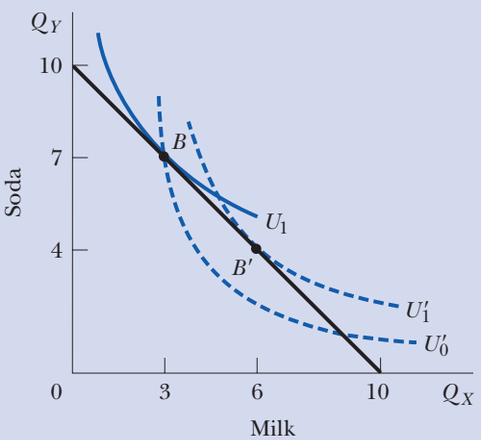

FIGURE 3.9 Effect of Government Warnings The consumer maximizes utility by purchasing 3 containers of milk and 7 sodas (point B on indifference curve U_1) before the government warning on the consumption of sodas. After the warning, the consumer's tastes change and are shown by dashed indifference curves U'_0 and U'_1. The consumer now maximizes utility by purchasing 6 containers of milk and only 4 sodas (point B', where U'_1 is tangent to the budget line).

[11] For a mathematical presentation of utility maximization using rudimentary calculus, see Section A.2 of the Mathematical Appendix.

[12] See I. Ehrlich, "Participation in Illegitimate Activities: A Theoretical and Empirical Investigation," *Journal of Political Economy,* May/June 1973; W. T. Dickens, "Crime and Punishment Again: The Economic Approach with a Psychological Twist," National Bureau of Economic Research, *Working Paper No. 1884,* April 1986; and A. Gaviria, "Increasing Returns and the Evolution of Violent Crimes: The Case of Colombia," *Journal of Development Economics,* February 2000.

as to the ability of various goods to satisfy their wants—see M. Shodell, "Risky Business," *Science,* October 1985.

The effect of the government warning can be shown with dashed indifference curves U'_0 and U'_1. Note that U'_0 is steeper than U_1 at than original optimization point B, indicating that after the warning the individual is willing to give up more sodas for an additional container of milk (i.e., MRS_{XY} is higher for U'_0 than for U_1 at point B). Now U'_0 can intersect U_1 because of the change in tastes. Note also that U'_0 involves less utility than U_1 at point B because the seven sodas (and the three containers of milk) provide less utility after the warning. After the warning, the consumer maximizes utility by consuming six containers of milk and only four sodas (point B', where U'_1 is tangent to the budget line).

The above analysis clearly shows how indifference curve analysis can be used to examine the effect of any government warning on consumption patterns, such as the 1965 law requiring manufacturers to print on each pack of cigarettes sold in the United States the warning that cigarette smoking is dangerous to health. Indeed, the World Health Organization is now stepping up efforts to promote a global treaty to curb cigarette smoking. We can analyze the effect on consumption of any new information by examining the effect it has on the consumer's indifference map. Similarly, indifference curve analysis can be used to analyze the effect on consumer purchases of any regulation such as the one requiring drivers to wear seat belts.

Sources: "Some States Fight Junk Food Sales in School," *New York Times,* September 9, 2001, p. 1; and "Companies Agree to Ban on Sale of Fizzy Drinks in Schools," *Financial Times*, May 4, 2006, p. 6.

Corner Solutions

Corner solution
Constrained utility maximization with the consumer spending all of his or her income on only one or some goods.

If indifference curves are everywhere either flatter or steeper than the budget line, or if they are concave rather than convex to the origin, then the consumer maximizes utility by spending all income on either good Y or good X. These are called **corner solutions.**

In the left panel of Figure 3.10, indifference curves U_0, U_1, and U_2 are everywhere flatter than budget line JK, and U_1 is the highest indifference curve that the consumer can reach by purchasing $10Y$ and $0X$ (endpoint J). Point J is closest to the tangency point, which cannot be achieved. The individual could purchase $2X$ and $6Y$ and reach point B, but point B is on lower indifference curve U_0. Since point J is on the Y-axis (and involves the consumer spending all his or her income on good Y), it is called a corner solution.

The middle panel shows indifference curves that are everywhere steeper than the budget line, and U_1 is the highest indifference curve that the consumer can reach by spending all income to purchase $5X$ and $0Y$ (endpoint K). The individual could purchase $1X$ and $8Y$ at point L, but this is on lower indifference curve U_0. Point K is on the horizontal axis and involves the consumer spending all his or her income on good X, so point K is also a corner solution.

In the right panel, *concave* indifference curve U_1 is tangent to the budget line at point B, but this is not optimum because the consumer can reach higher indifference curve U_2 by spending all income to purchase $10Y$ and $0X$ (endpoint J). This is also a corner solution. Thus, the condition that an indifference curve must be tangent to the budget line for

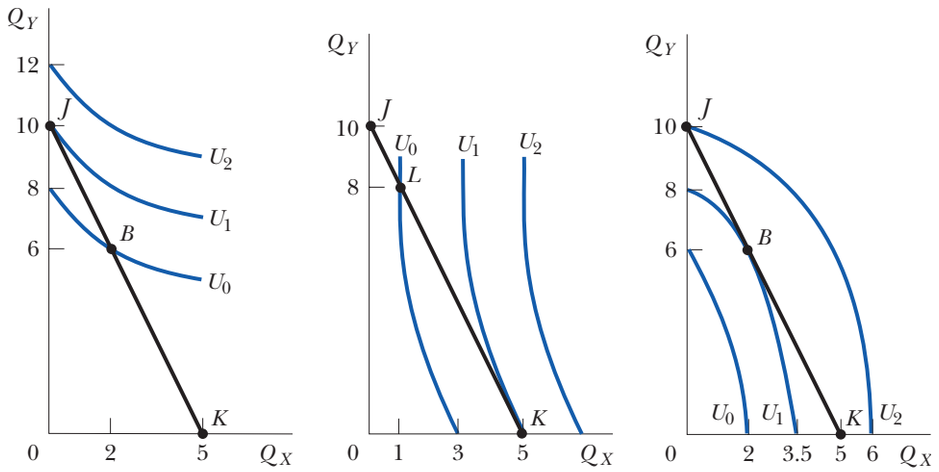

FIGURE 3.10 Corner Solutions In the left panel, indifference curves are everywhere flatter than the budget line, and U_1 is the highest indifference curve that the consumer can reach by purchasing $10Y$ only (point J). The middle panel shows indifference curves everywhere steeper than the budget line, and U_1 is the highest indifference curve that the consumer can reach by spending all income to purchase $5X$ (point K). In the right panel, concave indifference curve U_1 is tangent to the budget line at point B, but this is not the optimum point because the consumer can reach higher indifference curve U_2 by consuming only good Y (point J).

optimization is true only when indifference curves assume their usual convex shape and are neither everywhere flatter nor steeper than the budget line.

Finally, although a consumer in the real world does not spend all of his or her income on one or a few goods, there are many more goods that he or she does not purchase because they are too expensive for the utility they provide. For example, few people purchase a $2,000 watch because the utility that most people get from the watch does not justify its $2,000 price. The nonconsumption of many goods in the real world can be explained by indifference curves which, though convex to the origin, are everywhere either flatter or steeper than the budget line, yielding corner rather than interior solutions. Corner solutions can also arise with rationing, as Example 3–6 shows.

EXAMPLE 3–6

Water Rationing in the West

Rationing Quantitative restrictions.

Because goods are scarce, some method of allocating them among individuals is required. In a free-enterprise economy such as our own, the price system accomplishes this for the most part. Sometimes, however, the government rations goods, such as water in the West of the United States (as a result of recurrent droughts) and gasoline in 1974 and 1979 (at the height of the petroleum crisis). If the maximum amount of the good that the government allows is less than the individual would have purchased or used, the **rationing** will reduce the individual's level of satisfaction.

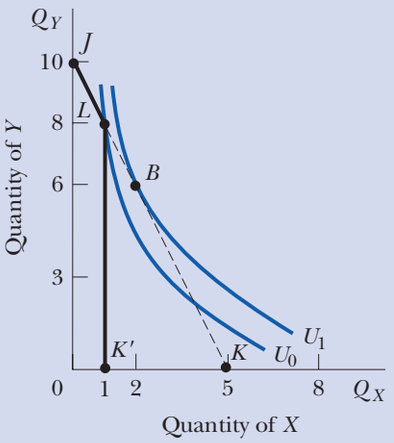

FIGURE 3.11 Rationing In the absence of rationing, the individual maximizes satisfaction at point *B*, where indifference curve U_1 is tangent to budget line *JK*, and consumes 2*X* and 6*Y* (as in Figure 3.8). If the government did not allow the individual to purchase more than 1*X* per week, the budget line becomes *JLK′*, with a kink at point *L*. The highest indifference curve that the individual can reach with budget line *JLK′*, is now U_0 at point *L*, by consuming 1*X* and 8*Y*.

The effect of rationing on utility maximization and consumption can be examined with Figure 3.11. In the absence of rationing, the individual maximizes satisfaction at point *B*, where indifference curve U_1 is tangent to budget line *JK*, by consuming 2*X* and 6*Y* (as in Figure 3.8). Good *X* could refer to hours per week of lawn watering (in absence of an automatic water sprinkler system), while good *Y* could refer to hours per week of TV viewing. If the government did not allow the individual to use more than 1*X* per week, the budget line becomes *JLK′*, with a kink at point *L*. Thus, rationing changes the constraints under which utility maximization occurs. The highest indifference curve that the individual can reach with budget line *JLK′* is now U_0 at point *L*, by consuming 1*X* and 8*Y*. In our water rationing case, this refers to one hour of lawn watering and eight hours of TV viewing per week. With water rationing, the incentive arises to illegally water lawns at night under the cover of darkness. On the other hand, gasoline rationing during 1974 and 1979 led to long lines at the gas pump and to black markets where gasoline could be purchased illegally at a higher price without waiting. Thus, rationing leads to price distortions and inefficiencies.

Concept Check
Can rationing lead to a black market?

If rations were 2*X* or more per week, the rationing system would not affect this consumer since he or she maximizes utility by purchasing 2*X* and 6*Y* (point *B* in the figure). Rationing is more likely to be binding or restrictive on high-income people than on low-income people (who may not have sufficient income to purchase even the allowed quantity of the rationed commodity). Thus, our model predicts that high-income people are more likely to make black-market purchases than low-income people. Effective rationing leads not only to black markets but also to "spillover" of consumer purchases on other goods not subject to rationing (or into savings). Both occurred in the United States during the 1974 and 1979 gasoline rationing periods. As pointed out in Section 2.7, allowing the market to operate (i.e., letting the price of the commodity reach its equilibrium level) eliminates the inefficiency of price controls and leads to much better results.

Sources: "Trickle-Down Economics," *Wall Street Journal,* August 23, 1999, p. A14; "Water Rights May Become More Liquid," *Wall Street Journal,* February 15, 1996, p. A2; W. C. Lee, "The Welfare Cost of Rationing-by-Queuing Across Markets," *Quarterly Journal of Economics,* July 1987; J. Brewer, et al., "Water Markets in the West: Prices, Trading, and Contractual Forms," *NBER Working Paper No. 13002*, March 2007, and M. Greenstone, "Tradable Water Rights," *Democracy Journal*, No. 8, Spring 2008, pp. 1–2.

Marginal Utility Approach to Utility Maximization

Until now we have examined constrained utility maximization with ordinal utility (i.e., with indifference curves). If utility were cardinally measurable, the condition for constrained utility maximization would be for the consumer to spend all income on X and Y in such a way that

$$\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y} \qquad [3.6]$$

Equation [3.6] reads, the marginal utility of good X divided by the price of good X equals the marginal utility of good Y divided by the price of good Y. MU_X/P_X is the extra or marginal utility per dollar spent on X. Likewise, MU_Y/P_Y is the marginal utility per dollar spent on Y. Thus, for constrained utility maximization or optimization, the marginal utility of the last dollar spent on X and Y should be the same.[13]

For example, Table 3.3 shows a portion of the declining marginal utility schedule for good X and good Y (from Table 3.1), on the assumption that MU_X is independent of MU_Y (i.e., that MU_X is not affected by how much Y the individual consumes, and MU_Y is not affected by the amount of X consumed). If the consumer's income is $I = \$10$, $P_X = \$2$, and $P_Y = \$1$, the consumer should spend \$4 to purchase $2X$ and the remaining \$6 to purchase $6Y$ so that equation [3.6] is satisfied. That is,

$$\frac{6 \text{ utils}}{\$2} = \frac{3 \text{ utils}}{\$1} \qquad [3.6A]$$

If the consumer spent only \$2 to purchase $1X$ and the remaining \$8 to purchase $8Y$, $MU_X/P_X = 10/2 = 5$ and $MU_Y/P_Y = 1/1 = 1$. The last (second) dollar spent on X thus gives the consumer five times as much utility as the last (eighth) dollar spent on Y and the consumer would not be maximizing utility. To be at an optimum, the consumer should purchase more of X (MU_X falls) and less of Y (MU_Y rises) until he or she purchases $2X$ and $6Y$, where equation [3.6] is satisfied.[14] This is the same result obtained with the indifference curve approach in Section 3.5. Note that even when the consumer purchases $1X$ and $4Y$ equation [3.6] is satisfied ($MU_X/P_X = 10/2 = MU_Y/P_Y = 5/1$), but the consumer would not be at an optimum because he or she would be spending only \$6 of the \$10 income.

TABLE 3.3 Marginal Utility of X and Y

Q_X	MU_X	Q_Y	MU_Y
1	10	4	5
2	6	5	4
3	4	6	3
4	2	7	2
5	0	8	1

[13] We will see in footnote 14 that equation [3.6] also holds for the indifference curve approach.

[14] By giving up the eighth and the seventh units of Y, the individual loses 3 utils. By using the \$2 not spent on Y to purchase the second unit of X, the individual receives 6 utils, for a net gain of 3 utils. Once the individual consumes $6Y$ and $2X$, equation [3.6] holds and he or she maximizes utility.

The fact that the marginal utility approach gives the same result as the indifference curve approach (i.e., 2*X* and 6*Y*) should not be surprising. In fact, we can easily show why this is so. By cross multiplication in equation [3.6], we get

$$\frac{MU_X}{MU_Y} = \frac{P_X}{P_Y} \qquad [3.7]$$

But we have shown in Section 3.2 that $MRS_{XY} = MU_X/MU_Y$ (see equation [3.2]) and in Section 3.5 that $MRS_{XY} = P_X/P_Y$ when the consumer maximizes utility (see equation [3.5]). Therefore, combining equations [3.2], [3.5], and [3.7], we can express the condition for consumer utility maximization as

$$MRS_{XY} = \frac{MU_X}{MU_Y} = \frac{P_X}{P_Y} \qquad [3.8]$$

Thus, the condition for consumer utility maximization with the marginal utility approach (i.e., equation [3.6]) is equivalent to that with the indifference curve approach (equation [3.5]), except for corner solutions. With both approaches, the value of equation [3.8] is 2.

AT THE FRONTIER
The Theory of Revealed Preference

Theory of revealed preference The theory that postulates that a consumer's indifference curve can be derived from the consumer's market behavior.

Until now we have assumed that indifference curves are derived by asking the consumer to choose between various market baskets or combinations of commodities. Not only is this difficult and time consuming to do, but we also cannot be sure that consumers can or will provide trustworthy answers to direct questions about their preferences. According to the **theory of revealed preference** (developed by Paul Samuelson and John Hicks), a consumer's indifference curves can be derived from observing the actual market behavior of the consumer and without any need to inquire directly about preferences. For example, if a consumer purchases basket A rather than basket B, even though A is not cheaper than B, we can infer that the consumer prefers A to B.

The theory of revealed preference rests on the following assumptions:

1. The tastes of the consumer do not change over the period of the analysis.
2. The consumer's tastes are *consistent,* so that if the consumer purchases basket A rather than basket B, the consumer will never prefer B to A.
3. The consumer's tastes are *transitive,* so that if the consumer prefers A to B and B to C, the consumer will prefer A to C.
4. The consumer can be induced to purchase any basket of commodities if its price is lowered sufficiently.

Figure 3.12 shows how a consumer's indifference curve can be derived by revealed preference. Suppose that the consumer is observed to be at point *A* on budget line *NN* in the left panel. In this case, the consumer prefers *A* to any point on or below *NN.* On the other hand, points above and to the right of *A* are superior to *A* since they involve more of commodity *X* and commodity *Y*. Thus, the consumer's indifference curve must be tangent to budget line *NN* at point *A* and be above *NN* everywhere else.

Continued . . .

The Theory of Revealed Preference *Continued*

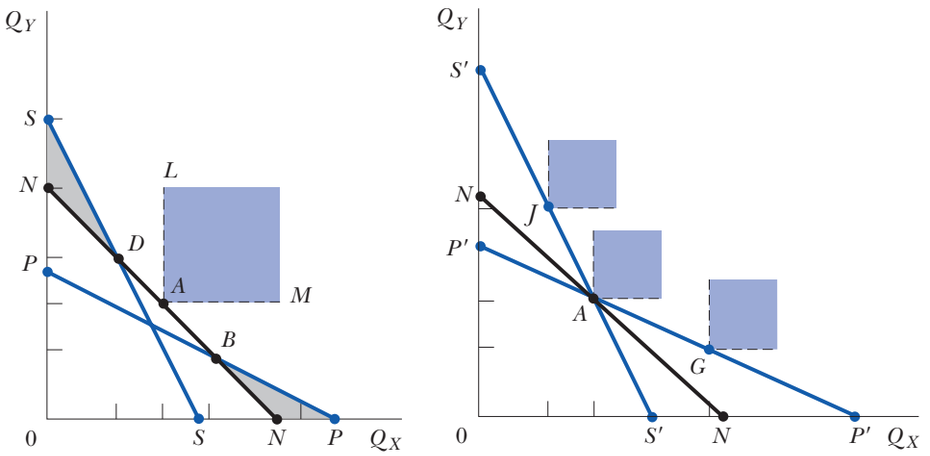

FIGURE 3.12 Derivation of an Indifference Curve by Revealed Preference In the left panel, the consumer is originally at optimum at point *A* on *NN*. Thus, the indifference curve must be tangent to *NN* at point *A* and above *NN* everywhere else. It must also be to the left and below shaded area *LAM*. If the consumer is induced to purchase combination *B* (which is inferior to *A*) with budget line *PP*, we can eliminate shaded area *BPN*. Similarly, with combination *D* on budget line *SS*, shaded area *DSN* can be eliminated. Thus, the indifference curve must be above *SDBP*. In the right panel, the consumer prefers *G* to *A* with budget line *P′P′* and prefers *J* to *A* with budget line *S′S′*. Thus, the indifference curve must be below points *G* and *J*.

The indifference curve must also be to the left and below shaded area *LAM*. Such an indifference curve would be of the usual shape (i.e., negatively sloped and convex to the origin).

To locate more precisely the indifference curve in the *zone of ignorance* (i.e., in the area between *LAM* and *NN*), consider point *B* on *NN*. Point *B* is inferior to *A* since the consumer preferred *A* to *B*. However, the consumer could be induced to purchase *B* with budget line *PP* (i.e., with P_X/P_Y sufficiently lower than with *NN*). Since *A* is preferred to *B* and *B* is preferred to any point on *BP*, the indifference curve must be above *BP*. We have thus eliminated shaded area *BPN* from the zone of ignorance. Similarly, by choosing another point, such as *D*, we can, by following the same reasoning as for *B*, eliminate shaded area *DSN*. Thus, the indifference curve must lie above *SDBP* and be tangent to *NN* at point *A*.

The right panel of Figure 3.12 shows that we can chip away from the zone of ignorance immediately to the left of *LA* and below *AM*. Suppose that with budget line *P′P′* (which goes through point *A* and thus refers to the same real income as at *A*), the consumer chooses combination *G* (with more of *X* and less of *Y* than at *A*) because P_X/P_Y is lower than on *NN*. Points in the shaded area above and to the right of *G* are preferred to *G*, which is preferred to *A*. Thus, we have eliminated some of the upper zone of ignorance. Similarly, choosing another budget line, such as *S′S′*, we can eliminate the area above and to the right of a point such as *J*, which the consumer prefers

to A at the higher P_X/P_Y given by $S'S'$. It follows that the indifference curve on which A falls must lie below points G and J. The process can be repeated any number of times to further reduce the upper and lower zones of ignorance, thereby locating the indifference curve more precisely. Note that the indifference curve derived is the one we need to show consumer equilibrium because it is the indifference curve that is tangent to the consumer's budget line.

Although somewhat impractical as a method for actually deriving indifference curves, the theory of revealed preference (particularly the idea that a consumer's tastes can be inferred or revealed by observing actual choices in the market place) has been very useful in many applied fields of economics such as public finance and international economics. The appendix to Chapter 4 applies the theory of revealed preference to measure changes in standards of living and consumer welfare during inflationary periods.

SUMMARY

1. The want-satisfying quality of a good is called utility. More units of a good increase total utility (TU) but the extra or marginal utility (MU) declines. The saturation point is reached when TU is maximum and MU is zero. Afterwards, TU declines and MU is negative. The decline in MU is known as the law of diminishing marginal utility. Cardinal utility actually provides an index of satisfaction for a consumer, whereas ordinal utility only ranks various consumption bundles.
2. The tastes of a consumer can be represented by indifference curves. These are based on the assumptions that the consumer can rank baskets of goods according to individual preferences, tastes are consistent and transitive, and the consumer prefers more of a good to less. An indifference curve shows the various combinations of two goods that give the consumer equal satisfaction. Higher indifference curves refer to more satisfaction and lower indifference curves to less. Indifference curves are negatively sloped, cannot intersect, and are convex to the origin. The marginal rate of substitution (MRS) measures how much of a good the consumer is willing to give up for one additional unit of the other good and remain on the same indifference curve. Indifference curves also generally exhibit diminishing MRS.
3. A rapid convergence of tastes is taking place in the world today. Tastes in the United States affect tastes around the world, and tastes abroad strongly influence tastes in the United States. With the tremendous improvement in telecommunications, transportation, and travel, the convergence of tastes can only be expected to accelerate—with important implications for us as consumers, for firms as producers, and for the study of microeconomics.
4. The budget line shows the various combinations of two goods (say, X and Y) that a consumer can purchase by spending all income (I) on the two goods at the given prices (P_X and P_Y). The vertical or Y-intercept of the budget line is given by I/P_Y and $-P_X/P_Y$ is the slope. The budget line shifts up if I increases and down if I decreases, but the slope remains unchanged. The budget line rotates upward if P_X falls and downward if P_X rises.
5. A rational consumer maximizes utility when reaching the highest indifference curve possible with the budget line. This occurs where an indifference curve is tangent to the budget line so that their slopes are equal (i.e., $MRS_{XY} = P_X/P_Y$). Government warnings or new information may change the shape and location of a consumer's indifference curves and the consumption pattern. If indifference curves are everywhere either flatter or steeper than the budget line or

if they are concave, utility maximization requires the consumer to spend all income on either good Y or good X. These are called corner solutions. Corner solutions can also arise with rationing. The marginal utility approach postulates that the consumer maximizes utility when he or she spends all income and the marginal utility of the last dollar spent on X and Y are the same. Since $MRS_{XY} = MU_X/MU_Y = P_X/P_Y$, the marginal utility and the indifference curve approaches are equivalent. Indifference curves can also be derived by the theory of revealed preference.

KEY TERMS

Utility
Total Utility (*TU*)
Marginal Utility (*MU*)
Util
Law of diminishing marginal utility
Cardinal utility
Ordinal utility
Good
Bad
Indifference curve
Indifference map
Marginal rate of substitution (*MRS*)
Neuter
Budget constraint
Budget line
Rational consumer
Constrained utility maximization
Consumer optimization
Consumer equilibrium
Corner solution
Rationing
Theory of revealed preference

REVIEW QUESTIONS

1. The utility approach to consumer demand theory is based on the assumption of cardinal utility, while the indifference curve approach is based on ordinal utility. Which approach is better? Why?
2. If Alan is indifferent between Coke and Pepsi, what would Alan's indifference curves look like?
3. The indifference curve between a good and garbage is positively sloped. True or false? Explain.
4. What is the relationship between two goods if the marginal rate of substitution between them is zero or infinite? Explain.
5. What is the marginal rate of substitution between two complementary goods?
6. Are indifference curves useless because it is difficult to derive them experimentally?
7. Why is there a convergence of tastes internationally?
8. If Jennifer's budget line has intercepts $20X$ and $30Y$ and $P_Y = \$10$, what is Jennifer's income? What is P_X? What is the slope of the budget line?
9. Must a consumer purchase some quantity of each commodity to be in equilibrium?
10. Janice spends her entire weekly food allowance of \$42 on hamburgers and soft drinks. The price of a hamburger is \$2, and the price of a soft drink is \$1. Janice purchases 12 hamburgers and 18 soft drinks, and her marginal rate of substitution between hamburgers and soft drinks is 1. Is Janice in equilibrium? Explain.
11. Why is a consumer likely to be worse off when a product that he or she consumes is rationed?
12. In what way is the theory of revealed preference related to traditional consumer theory? What is its usefulness?

PROBLEMS

1. From the following total utility schedule

Q_X	0	1	2	3	4	5	6	7
TU_X	0	4	14	20	24	26	26	24

   a. derive the marginal utility schedule.
   b. plot the total and the marginal utility schedules.
   c. determine where the law of diminishing marginal utility begins to operate.
   d. find the saturation point.

2. The following table gives four indifference schedules of an individual.
   a. Using graph paper, plot the four indifference curves on the same set of axes.
   b. Calculate the marginal rate of substitution of X for Y between the various points on U_1.
   c. What is MRS_{XY} at point C on U_1?
   d. Can we tell how much better off the individual is on U_2 than on U_1?

*3. a. Starting with a given *equal* endowment of good X and good Y by individual A and individual B, draw A's and B's indifference curves on the same set of axes, showing that individual A has a preference for good X over good Y with respect to individual B.
   b. Explain why you drew individual A's and individual B's indifference curves as you did in Problem 3(a).

4. Draw an indifference curve for an individual showing that
   a. good X and good Y are perfect complements.
   b. item X becomes a bad after 4 units.
   c. item Y becomes a bad after 3 units.
   d. *MRS* is increasing for both X and Y.

5. Suppose an individual has an income of \$15 per time period, the price of good X is \$1 and the price of good Y is also \$1. That is, $I = \$15$, $P_X = \$1$, and $P_Y = \$1$.
   a. Write the equation of the budget line of this individual in the form that indicates that the amount spent on good X plus the amount spent on good Y equals the individual's income.
   b. Write the equation of the budget line in the form that you can read off directly the vertical intercept and the slope of the line.
   c. Plot the budget line.

6. This problem involves drawing three graphs, one for each part of the problem. On the same set of axes, draw the budget line of Problem 5 (label it 2) and two other budget lines:
   a. One with $I = \$10$ (call it 1), and another with $I = \$20$ (label it 3), and with prices unchanged at $P_X = P_Y = \$1$.
   b. One with $P_X = \$0.50$, $P_Y = \$1$, and $I = \$15$ (label it 2*A*), and another with $P_X = \$2$ and the same P_Y and I (label it 2*B*).
   c. One with $P_Y = \$2$, $P_X = \$1$, and $I = \$15$ (label it 2*C*), and another with $P_X = P_Y = \$2$ and $I = \$15$ (label it 2*F*).

*7. a. On the same set of axes, draw the indifference curves of Problem 2 and the budget line of Problem 5(c).
   b. Where is the individual maximizing utility? How much of X and Y should he or she purchase to be at optimum? What is the general condition for constrained utility maximization?
   c. Why is the individual not maximizing utility at point A? At point G?
   d. Why can't the individual reach U_3 or U_4?

8. On the same set of axes (on graph paper), draw the indifference curves of problem 2 and budget lines
   a. 1, 2, and 3 from Problem 6(a); label the points at which the individual maximizes utility with the various alternative budget lines.
   b. 2 and 2*A* from Problem 6(b); label the points at which the individual maximizes utility on the various alternative budget lines: E and L.

*9. Given the following marginal utility schedule for good X and good Y for the individual, and given that the price of X

	U_1		U_2		U_3		U_4	
Combination	Q_X	Q_Y	Q_X	Q_Y	Q_X	Q_Y	Q_X	Q_Y
A	3	12	6	12	8	15	10	13
B	4	7	7	9	9	12	12	10
C	6	4	9	6	11	9	14	8
F	9	2	12	4	15	6	18	6.4
G	14	1	15	3	19	5	20	6

* = Answer provided at end of book.

and the price of Y are both \$1, and that the individual spends all income of \$7 on X and Y,

Q	1	2	3	4	5	6	7
MU_X	15	11	9	6	4	3	1
MU_Y	12	9	6	5	3	2	1

a. indicate how much of X and Y the individual should purchase to maximize utility.

b. show that the condition for constrained utility maximization is satisfied when the individual is at his or her optimum.

c. determine how much total utility the individual receives when he or she maximizes utility? How much utility would the individual get if he or she spent all income on X or Y?

10. Show on the same figure the effect of (1) an increase in cigarette prices, (2) an increase in consumers' incomes, and (3) a government warning that cigarette smoking is dangerous to health, all in such a way that the net effect of all three forces together leads to a net decline in cigarette smoking.

11. a. Draw a figure showing indifference curve U_2 tangent to the budget line at point B (8X), and a lower indifference curve (U_1) intersecting the budget line at point A (4X) and at point G (12X).

b. What happens if the government rations good X and allows the individual to purchase no more than 4X? No more than 8X? No more than 12X?

c. What would happen if the government instead mandated (as in the case of requiring auto insurance, seat belts, and so on) that the individual purchase at least 4X? 8X? 12X?

*12. Show by indifference curve analysis the choice of one couple not to have children and of another couple, with the same income and facing the same costs of having and raising children, to have one child.

INTERNET SITE ADDRESSES

The relationship between income and happiness is analyzed by David G. Blanchflower in:

http://www.dartmouth.edu/~blanchflower/papers/Wellbeingnew.pdf

http://cep.lse.ac.uk/events/lectures/layard/RL040303.pdf

http://www.princeton.edu/main/news/archive/S15/15/09S18/index.xml?section=topstories

http://ideas.repec.org/a/ecj/econjl/v111y2001i473p465-84.html

For the competition between the Ford Taurus and the Honda Accord, see:

http://www.theautochannel.com/vehicles/new/reviews/2001/heilig_ford_taurus.html

http://www.edmunds.com/insideline/do/Features/articleId=46007

http://www.epinions.com/content_81797287556

For water rationing in the U.S. West, see the website for the Political Economy Research Center at:

http://www.perc.org and
http://www.cleartheair.org/waterinthewest/chapter6.vtml

The harmful effects of junk food and the need for government regulation are examined at:

http://faculty.db.erau.edu/stratect/sf320/ARTICLE10.htm

http://www.commercialfreechildhood.org/pressreleases/iomlacksobjectivity.htm

http://llr.lls.edu/volumes/v39-issue1/docs/yosifon.pdf