CHAPTER

21

The Theory of Consumer Choice

When you walk into a store, you are confronted with thousands of goods that you might buy. Because your financial resources are limited, however, you cannot buy everything that you want. You therefore consider the prices of the various goods offered for sale and buy a bundle of goods that, given your resources, best suits your needs and desires.

In this chapter, we develop a theory that describes how consumers make decisions about what to buy. Thus far in this book, we have summarized consumers' decisions with the demand curve. As we have seen, the demand curve for a good reflects consumers' willingness to pay for it. When the price of a good rises, consumers are willing to pay for fewer units, so the quantity demanded falls. We now look more deeply at the decisions that lie behind the demand curve. The theory of consumer choice presented in this chapter provides a more complete understanding of demand, just as the theory of the competitive firm in Chapter 14 provides a more complete understanding of supply.

One of the *Ten Principles of Economics* discussed in Chapter 1 is that people face trade-offs. The theory of consumer choice examines the trade-offs that people face in their role as consumers. When a consumer buys more of one good, he can afford less of other goods. When he spends more time enjoying leisure and less time working, he has lower income and can afford less consumption. When he

spends more of his income in the present and saves less of it, he must accept a lower level of consumption in the future. The theory of consumer choice examines how consumers facing these trade-offs make decisions and how they respond to changes in their environment.

After developing the basic theory of consumer choice, we apply it to three questions about household decisions. In particular, we ask:

- Do all demand curves slope downward?
- How do wages affect labor supply?
- How do interest rates affect household saving?

At first, these questions might seem unrelated. But as we will see, we can use the theory of consumer choice to address each of them.

THE BUDGET CONSTRAINT: WHAT THE CONSUMER CAN AFFORD

Most people would like to increase the quantity or quality of the goods they consume—to take longer vacations, drive fancier cars, or eat at better restaurants. People consume less than they desire because their spending is *constrained*, or limited, by their income. We begin our study of consumer choice by examining this link between income and spending.

To keep things simple, we examine the decision facing a consumer who buys only two goods: pizza and Pepsi. Of course, real people buy thousands of different kinds of goods. Assuming there are only two goods greatly simplifies the problem without altering the basic insights about consumer choice.

We first consider how the consumer's income constrains the amount he spends on pizza and Pepsi. Suppose the consumer has an income of $1,000 per month and he spends his entire income on pizza and Pepsi. The price of a pizza is $10, and the price of a pint of Pepsi is $2.

The table in Figure 1 shows some of the many combinations of pizza and Pepsi that the consumer can buy. The first row in the table shows that if the consumer spends all his income on pizza, he can eat 100 pizzas during the month, but he would not be able to buy any Pepsi at all. The second row shows another possible consumption bundle: 90 pizzas and 50 pints of Pepsi. And so on. Each consumption bundle in the table costs exactly $1,000.

The graph in Figure 1 illustrates the consumption bundles that the consumer can choose. The vertical axis measures the number of pints of Pepsi, and the horizontal axis measures the number of pizzas. Three points are marked on this figure. At point A, the consumer buys no Pepsi and consumes 100 pizzas. At point B, the consumer buys no pizza and consumes 500 pints of Pepsi. At point C, the consumer buys 50 pizzas and 250 pints of Pepsi. Point C, which is exactly at the middle of the line from A to B, is the point at which the consumer spends an equal amount ($500) on pizza and Pepsi. These are only three of the many combinations of pizza and Pepsi that the consumer can choose. All the points on the line from A to B are possible. This line, called the **budget constraint**, shows the consumption bundles that the consumer can afford. In this case, it shows the trade-off between pizza and Pepsi that the consumer faces.

budget constraint the limit on the consumption bundles that a consumer can afford

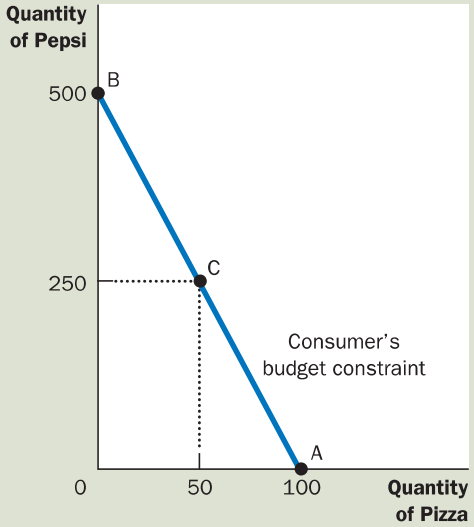
The slope of the budget constraint measures the rate at which the consumer can trade one good for the other. Recall that the slope between two points is calculated

FIGURE 1

The Consumer's Budget Constraint

The budget constraint shows the various bundles of goods that the consumer can buy for a given income. Here the consumer buys bundles of pizza and Pepsi. The table and graph show what the consumer can afford if his income is $1,000, the price of pizza is $10, and the price of Pepsi is $2.

Number of Pizzas	Pints of Pepsi	Spending on Pizza	Spending on Pepsi	Total Spending
100	0	$1,000	$ 0	$1,000
90	50	900	100	1,000
80	100	800	200	1,000
70	150	700	300	1,000
60	200	600	400	1,000
50	250	500	500	1,000
40	300	400	600	1,000
30	350	300	700	1,000
20	400	200	800	1,000
10	450	100	900	1,000
0	500	0	1,000	1,000



as the change in the vertical distance divided by the change in the horizontal distance ("rise over run"). From point A to point B, the vertical distance is 500 pints, and the horizontal distance is 100 pizzas. Thus, the slope is 5 pints per pizza. (Actually, because the budget constraint slopes downward, the slope is a negative number. But for our purposes, we can ignore the minus sign.)

Notice that the slope of the budget constraint equals the *relative price* of the two goods—the price of one good compared to the price of the other. A pizza costs 5 times as much as a pint of Pepsi, so the opportunity cost of a pizza is 5 pints of Pepsi. The budget constraint's slope of 5 reflects the trade-off the market is offering the consumer: 1 pizza for 5 pints of Pepsi.

QUICK QUIZ Draw the budget constraint for a person with income of $1,000 if the price of Pepsi is $5 and the price of pizza is $10. What is the slope of this budget constraint?

PREFERENCES: WHAT THE CONSUMER WANTS

Our goal in this chapter is to see how consumers make choices. The budget constraint is one piece of the analysis: It shows the combinations of goods the consumer can afford given his income and the prices of the goods. The consumer's choices, however, depend not only on his budget constraint but also on his preferences regarding the two goods. Therefore, the consumer's preferences are the next piece of our analysis.

Representing Preferences with Indifference Curves

The consumer's preferences allow him to choose among different bundles of pizza and Pepsi. If you offer the consumer two different bundles, he chooses the bundle that best suits his tastes. If the two bundles suit his tastes equally well, we say that the consumer is *indifferent* between the two bundles.

indifference curve
a curve that shows consumption bundles that give the consumer the same level of satisfaction

Just as we have represented the consumer's budget constraint graphically, we can also represent his preferences graphically. We do this with indifference curves. An **indifference curve** shows the bundles of consumption that make the consumer equally happy. In this case, the indifference curves show the combinations of pizza and Pepsi with which the consumer is equally satisfied.

Figure 2 shows two of the consumer's many indifference curves. The consumer is indifferent among combinations A, B, and C because they are all on the same curve. Not surprisingly, if the consumer's consumption of pizza is reduced, say, from point A to point B, consumption of Pepsi must increase to keep him equally happy. If consumption of pizza is reduced again, from point B to point C, the amount of Pepsi consumed must increase yet again.

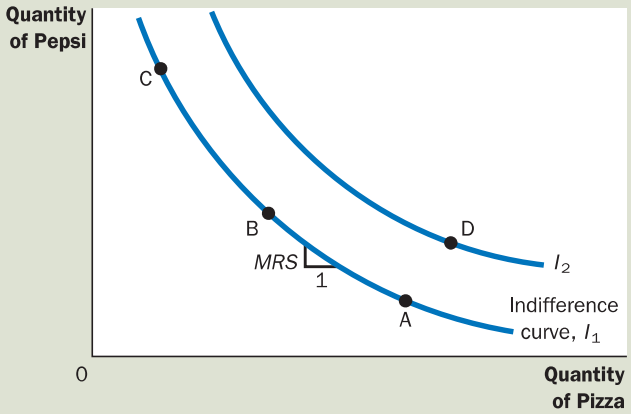
marginal rate of substitution
the rate at which a consumer is willing to trade one good for another

The slope at any point on an indifference curve equals the rate at which the consumer is willing to substitute one good for the other. This rate is called the **marginal rate of substitution** (*MRS*). In this case, the marginal rate of substitution measures how much Pepsi the consumer requires to be compensated for a one-unit reduction in pizza consumption. Notice that because the indifference curves are not straight lines, the marginal rate of substitution is not the same at all points on a given indifference curve. The rate at which a consumer is willing to trade one good for the other depends on the amounts of the goods he is already consuming. That is, the rate at which a consumer is willing to trade pizza for Pepsi depends on whether he is hungrier or thirstier, which in turn depends on how much pizza and Pepsi he is consuming.

The consumer is equally happy at all points on any given indifference curve, but he prefers some indifference curves to others. Because he prefers more consumption to less, higher indifference curves are preferred to lower ones. In Figure 2, any point on curve I_2 is preferred to any point on curve I_1.

2 FIGURE

The Consumer's Preferences
The consumer's preferences are represented with indifference curves, which show the combinations of pizza and Pepsi that make the consumer equally satisfied. Because the consumer prefers more of a good, points on a higher indifference curve (I_2 here) are preferred to points on a lower indifference curve (I_1). The marginal rate of substitution (*MRS*) shows the rate at which the consumer is willing to trade Pepsi for pizza. It measures the quantity of Pepsi the consumer must be given in exchange for 1 pizza.



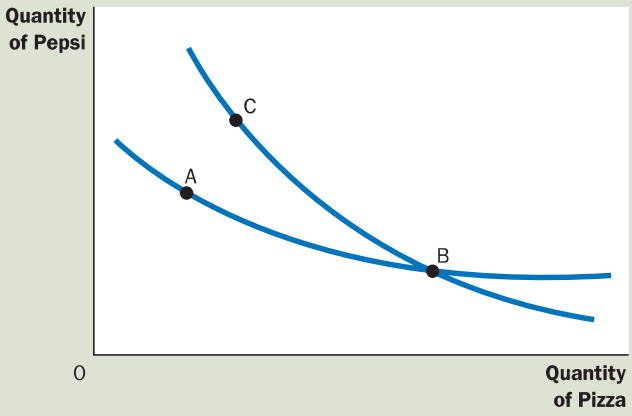
A consumer's set of indifference curves gives a complete ranking of the consumer's preferences. That is, we can use the indifference curves to rank any two bundles of goods. For example, the indifference curves tell us that point D is preferred to point A because point D is on a higher indifference curve than point A. (That conclusion may be obvious, however, because point D offers the consumer both more pizza and more Pepsi.) The indifference curves also tell us that point D is preferred to point C because point D is on a higher indifference curve. Even though point D has less Pepsi than point C, it has more than enough extra pizza to make the consumer prefer it. By seeing which point is on the higher indifference curve, we can use the set of indifference curves to rank any combination of pizza and Pepsi.

Four Properties of Indifference Curves

Because indifference curves represent a consumer's preferences, they have certain properties that reflect those preferences. Here we consider four properties that describe most indifference curves:

- *Property 1: Higher indifference curves are preferred to lower ones.* People usually prefer to consume more goods rather than less. This preference for greater quantities is reflected in the indifference curves. As Figure 2 shows, higher indifference curves represent larger quantities of goods than lower indifference curves. Thus, the consumer prefers being on higher indifference curves.
- *Property 2: Indifference curves are downward sloping.* The slope of an indifference curve reflects the rate at which the consumer is willing to substitute one good for the other. In most cases, the consumer likes both goods. Therefore, if the quantity of one good is reduced, the quantity of the other good must increase for the consumer to be equally happy. For this reason, most indifference curves slope downward.
- *Property 3: Indifference curves do not cross.* To see why this is true, suppose that two indifference curves did cross, as in Figure 3. Then, because point A is on the same indifference curve as point B, the two points would make the consumer equally happy. In addition, because point B is on the same indifference curve as point C, these two points would make the consumer equally

FIGURE 3



The Impossibility of Intersecting Indifference Curves
A situation like this can never happen. According to these indifference curves, the consumer would be equally satisfied at points A, B, and C, even though point C has more of both goods than point A.

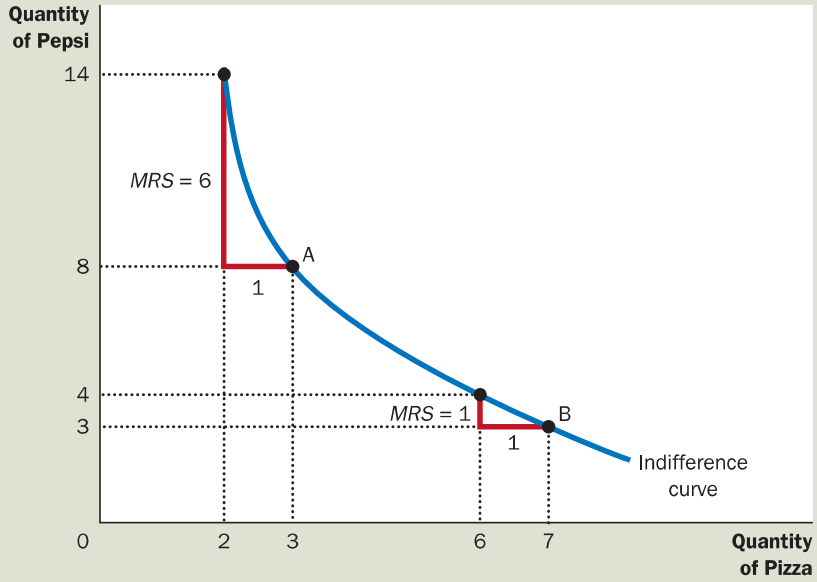
happy. But these conclusions imply that points A and C would also make the consumer equally happy, even though point C has more of both goods. This contradicts our assumption that the consumer always prefers more of both goods to less. Thus, indifference curves cannot cross.

Property 4: Indifference curves are bowed inward. The slope of an indifference curve is the marginal rate of substitution—the rate at which the consumer is willing to trade off one good for the other. The marginal rate of substitution (*MRS*) usually depends on the amount of each good the consumer is currently consuming. In particular, because people are more willing to trade away goods that they have in abundance and less willing to trade away goods of which they have little, the indifference curves are bowed inward. As an example, consider Figure 4. At point A, because the consumer has a lot of Pepsi and only a little pizza, he is very hungry but not very thirsty. To induce the consumer to give up 1 pizza, he has to be given 6 pints of Pepsi: The marginal rate of substitution is 6 pints per pizza. By contrast, at point B, the consumer has little Pepsi and a lot of pizza, so he is very thirsty but not very hungry. At this point, he would be willing to give up 1 pizza to get 1 pint of Pepsi: The marginal rate of substitution is 1 pint per pizza. Thus, the bowed shape of the indifference curve reflects the consumer's greater willingness to give up a good that he already has in large quantity.

Two Extreme Examples of Indifference Curves

The shape of an indifference curve tells us about the consumer's willingness to trade one good for the other. When the goods are easy to substitute for each other, the indifference curves are less bowed; when the goods are hard to substitute,

4 FIGURE



Bowed Indifference Curves
Indifference curves are usually bowed inward. This shape implies that the marginal rate of substitution (*MRS*) depends on the quantity of the two goods the consumer is consuming. At point A, the consumer has little pizza and much Pepsi, so he requires a lot of extra Pepsi to induce him to give up one of the pizzas: The marginal rate of substitution is 6 pints of Pepsi per pizza. At point B, the consumer has much pizza and little Pepsi, so he requires only a little extra Pepsi to induce him to give up one of the pizzas: The marginal rate of substitution is 1 pint of Pepsi per pizza.

the indifference curves are very bowed. To see why this is true, let's consider the extreme cases.

Perfect Substitutes Suppose that someone offered you bundles of nickels and dimes. How would you rank the different bundles?

Most likely, you would care only about the total monetary value of each bundle. If so, you would always be willing to trade 2 nickels for 1 dime, regardless of the number of nickels and dimes in the bundle. Your marginal rate of substitution between nickels and dimes would be a fixed number—2.

We can represent your preferences over nickels and dimes with the indifference curves in panel (a) of Figure 5. Because the marginal rate of substitution is constant, the indifference curves are straight lines. In this extreme case of straight indifference curves, we say that the two goods are **perfect substitutes**.

perfect substitutes two goods with straight-line indifference curves

Perfect Complements Suppose now that someone offered you bundles of shoes. Some of the shoes fit your left foot, others your right foot. How would you rank these different bundles?

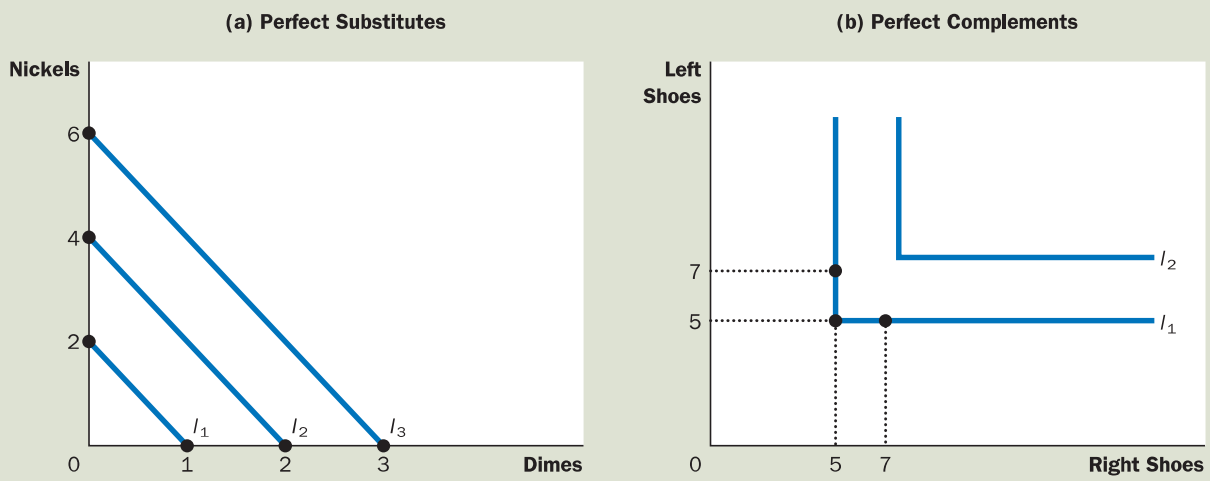
In this case, you might care only about the number of pairs of shoes. In other words, you would judge a bundle based on the number of pairs you could assemble from it. A bundle of 5 left shoes and 7 right shoes yields only 5 pairs. Getting 1 more right shoe has no value if there is no left shoe to go with it.

We can represent your preferences for right and left shoes with the indifference curves in panel (b) of Figure 5. In this case, a bundle with 5 left shoes and 5 right shoes is just as good as a bundle with 5 left shoes and 7 right shoes. It is also just as good as a bundle with 7 left shoes and 5 right shoes. The indifference curves,

FIGURE 5

Perfect Substitutes and Perfect Complements

When two goods are easily substitutable, such as nickels and dimes, the indifference curves are straight lines, as shown in panel (a). When two goods are strongly complementary, such as left shoes and right shoes, the indifference curves are right angles, as shown in panel (b).



perfect complements
two goods with right-angle indifference curves

therefore, are right angles. In this extreme case of right-angle indifference curves, we say that the two goods are **perfect complements**.

In the real world, of course, most goods are neither perfect substitutes (like nickels and dimes) nor perfect complements (like right shoes and left shoes). More typically, the indifference curves are bowed inward, but not so bowed as to become right angles.

QUICK QUIZ Draw some indifference curves for pizza and Pepsi. Explain the four properties of these indifference curves.

OPTIMIZATION: WHAT THE CONSUMER CHOOSES

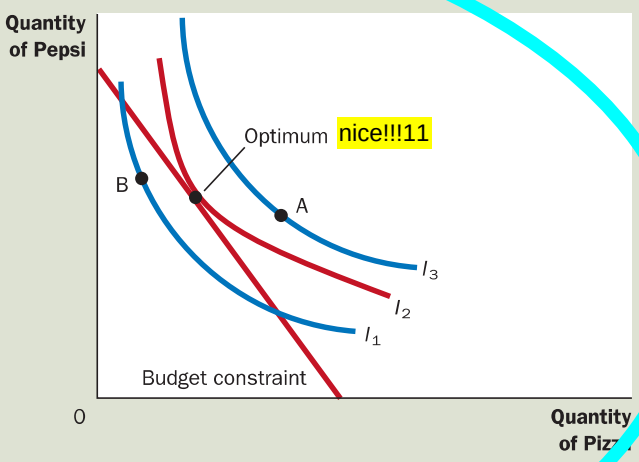
The goal of this chapter is to understand how a consumer makes choices. We have the two pieces necessary for this analysis: the consumer's budget constraint (how much he can afford to spend) and the consumer's preferences (what he wants to spend it on). Now we put these two pieces together and consider the consumer's decision about what to buy.

THE CONSUMER'S OPTIMAL CHOICES

Consider once again our pizza and Pepsi example. The consumer would like to end up with the best possible combination of pizza and Pepsi for him—that is, the combination on his highest possible indifference curve. But the consumer must also end up on or below his budget constraint, which measures the total resources available to him.

Figure 6 shows the consumer's budget constraint and three of his many indifference curves. The highest indifference curve that the consumer can reach (I_2 in the figure) is the one that just barely touches his budget constraint. The point at

FIGURE 6



The Consumer's Optimum
The consumer chooses the point on his budget constraint that lies on the highest indifference curve. At this point, called the optimum, the marginal rate of substitution equals the relative price of the two goods. Here the highest indifference curve the consumer can reach is I_2. The consumer prefers point A, which lies on indifference curve I_3, but the consumer cannot afford this bundle of pizza and Pepsi. By contrast, point B is affordable, but because it lies on a lower indifference curve, the consumer does not prefer it.

FYI

Utility: An Alternative Way to Describe Preferences and Optimization

We have used indifference curves to represent the consumer's preferences. Another common way to represent preferences is with the concept of *utility*. Utility is an abstract measure of the satisfaction or happiness that a consumer receives from a bundle of goods. Economists say that a consumer prefers one bundle of goods to another if one provides more utility than the other.

Indifference curves and utility are closely related. Because the consumer prefers points on higher indifference curves, bundles of goods on higher indifference curves provide higher utility. Because the consumer is equally happy with all points on the same indifference curve, all these bundles provide the same utility. You can think of an indifference curve as an "equal-utility" curve.

The *marginal utility* of any good is the increase in utility that the consumer gets from an additional unit of that good. Most goods are assumed to exhibit *diminishing marginal utility:* The more of the good the consumer already has, the lower the marginal utility provided by an extra unit of that good.

The marginal rate of substitution between two goods depends on their marginal utilities. For example, if the marginal utility of good X is twice the marginal utility of good Y, then a person would need 2 units of good Y to compensate for losing 1 unit of good X, and the marginal rate of substitution equals 2. More generally, the marginal rate of substitution (and thus the slope of the indifference curve) equals the marginal utility of one good divided by the marginal utility of the other good.

Utility analysis provides another way to describe consumer optimization. Recall that at the consumer's optimum, the marginal rate of substitution equals the ratio of prices. That is,

$$MRS = P_X / P_Y.$$

Because the marginal rate of substitution equals the ratio of marginal utilities, we can write this condition for optimization as

$$MU_X / MU_Y = P_X / P_Y.$$

Now rearrange this expression to become

$$MU_X / P_X = MU_Y / P_Y.$$

This equation has a simple interpretation: At the optimum, the marginal utility per dollar spent on good X equals the marginal utility per dollar spent on good Y. (Why? If this equality did not hold, the consumer could increase utility by spending less on the good that provided lower marginal utility per dollar and more on the good that provided higher marginal utility per dollar.)

When economists discuss the theory of consumer choice, they might express the theory using different words. One economist might say that the goal of the consumer is to maximize utility. Another economist might say that the goal of the consumer is to end up on the highest possible indifference curve. The first economist would conclude that at the consumer's optimum, the marginal utility per dollar is the same for all goods, whereas the second would conclude that the indifference curve is tangent to the budget constraint. In essence, these are two ways of saying the same thing.

which this indifference curve and the budget constraint touch is called the *optimum*. The consumer would prefer point A, but he cannot afford that point because it lies above his budget constraint. The consumer can afford point B, but that point is on a lower indifference curve and, therefore, provides the consumer less satisfaction. The optimum represents the best combination of pizza and Pepsi available to the consumer.

Notice that, at the optimum, the slope of the indifference curve equals the slope of the budget constraint. We say that the indifference curve is tangent to the budget constraint. The slope of the indifference curve is the marginal rate of

substitution between pizza and Pepsi, and the slope of the budget constraint is the relative price of pizza and Pepsi. Thus, *the consumer chooses consumption of the two goods so that the marginal rate of substitution equals the relative price.*

DEEEEEEP

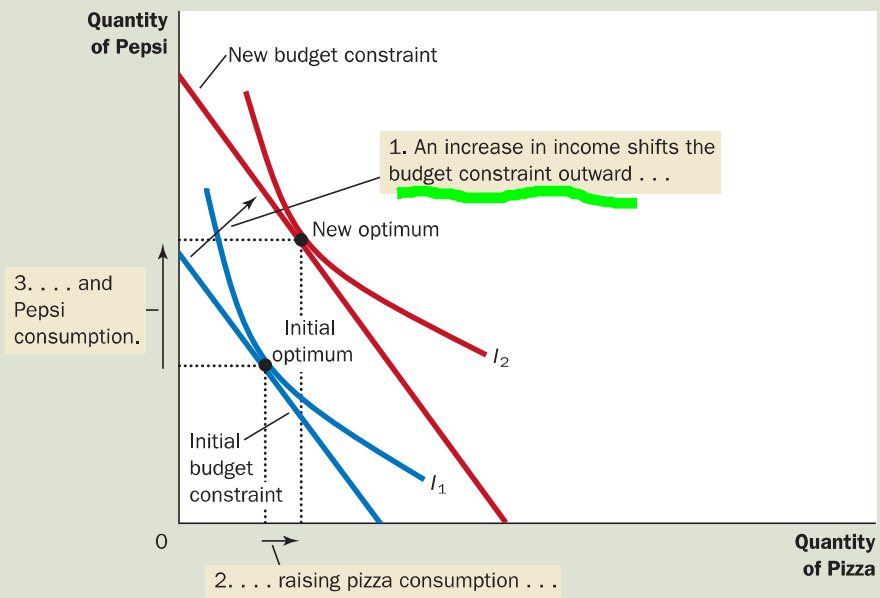
In Chapter 7, we saw how market prices reflect the marginal value that consumers place on goods. This analysis of consumer choice shows the same result in another way. In making his consumption choices, the consumer takes as given the relative price of the two goods and then chooses an optimum at which his marginal rate of substitution equals this relative price. The relative price is the rate at which the *market* is willing to trade one good for the other, whereas the marginal rate of substitution is the rate at which the *consumer* is willing to trade one good for the other. At the consumer's optimum, the consumer's valuation of the two goods (as measured by the marginal rate of substitution) equals the market's valuation (as measured by the relative price). As a result of this consumer optimization, market prices of different goods reflect the value that consumers place on those goods.

How Changes in Income Affect the Consumer's Choices

Now that we have seen how the consumer makes a consumption decision, let's examine how this decision responds to changes in the consumer's income. To be specific, suppose that income increases. With higher income, the consumer can afford more of both goods. The increase in income, therefore, shifts the budget constraint outward, as in Figure 7. Because the relative price of the two goods has not changed, the slope of the new budget constraint is the same as the slope of the initial budget constraint. That is, an increase in income leads to a parallel shift in the budget constraint.

7 FIGURE

An Increase in Income
When the consumer's income rises, the budget constraint shifts out. If both goods are normal goods, the consumer responds to the increase in income by buying more of both of them. Here the consumer buys more pizza and more Pepsi.



The expanded budget constraint allows the consumer to choose a better combination of pizza and Pepsi, one that is on a higher indifference curve. Given the shift in the budget constraint and the consumer's preferences as represented by his indifference curves, the consumer's optimum moves from the point labeled "initial optimum" to the point labeled "new optimum."

Notice that, in Figure 7, the consumer chooses to consume more Pepsi and more pizza. Although the logic of the model does not require increased consumption of both goods in response to increased income, this situation is the most common one. As you may recall from Chapter 4, if a consumer wants more of a good when his income rises, economists call it a **normal good**. The indifference curves in Figure 7 are drawn under the assumption that both pizza and Pepsi are normal goods.

Figure 8 shows an example in which an increase in income induces the consumer to buy more pizza but less Pepsi. If a consumer buys less of a good when his income rises, economists call it an **inferior good**. Figure 8 is drawn under the assumption that pizza is a normal good and Pepsi is an inferior good.

Although most goods are normal goods, there are some inferior goods in the world. One example is bus rides. As income increases, consumers are more likely to own cars or take a taxi and less likely to ride a bus. Bus rides, therefore, are an inferior good.

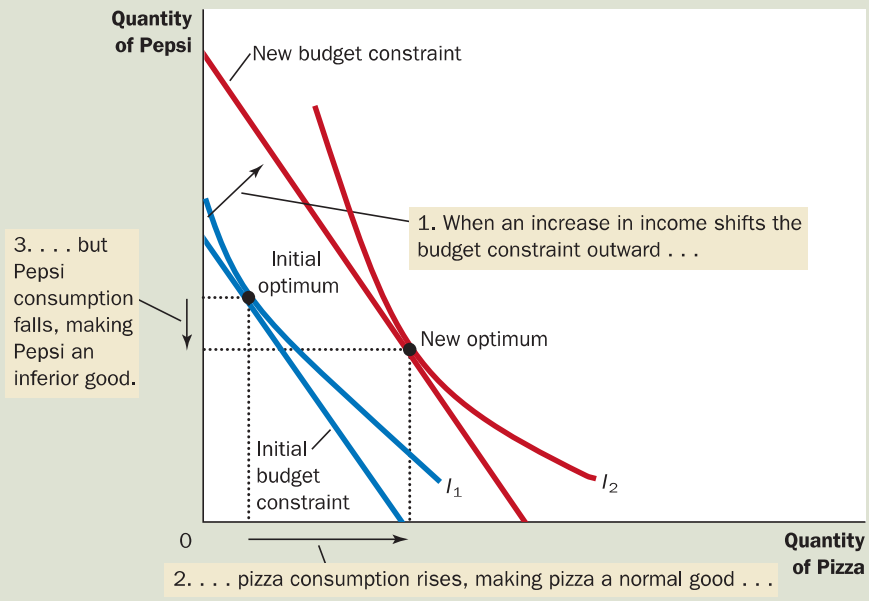
normal good
a good for which an increase in income raises the quantity demanded

inferior good
a good for which an increase in income reduces the quantity demanded

How Changes in Prices Affect the Consumer's Choices

Let's now use this model of consumer choice to consider how a change in the price of one of the goods alters the consumer's choices. Suppose, in particular, that the

FIGURE 8



An Inferior Good
A good is an inferior good if the consumer buys less of it when his income rises. Here Pepsi is an inferior good: When the consumer's income increases and the budget constraint shifts outward, the consumer buys more pizza but less Pepsi.

price of Pepsi falls from $2 to $1 per pint. It is no surprise that the lower price expands the consumer's set of buying opportunities. In other words, a fall in the price of any good shifts the budget constraint outward.

Figure 9 considers more specifically how the fall in price affects the budget constraint. If the consumer spends his entire $1,000 income on pizza, then the price of Pepsi is irrelevant. Thus, point A in the figure stays the same. Yet if the consumer spends his entire income of $1,000 on Pepsi, he can now buy 1,000 rather than only 500 pints. Thus, the end point of the budget constraint moves from point B to point D.

Notice that in this case the outward shift in the budget constraint changes its slope. (This differs from what happened previously when prices stayed the same but the consumer's income changed.) As we have discussed, the slope of the budget constraint reflects the relative price of pizza and Pepsi. Because the price of Pepsi has fallen to $1 from $2, while the price of pizza has remained $10, the consumer can now trade a pizza for 10 rather than 5 pints of Pepsi. As a result, the new budget constraint has a steeper slope.

How such a change in the budget constraint alters the consumption of both goods depends on the consumer's preferences. For the indifference curves drawn in this figure, the consumer buys more Pepsi and less pizza.

income effect
the change in consumption that results when a price change moves the consumer to a higher or lower indifference curve

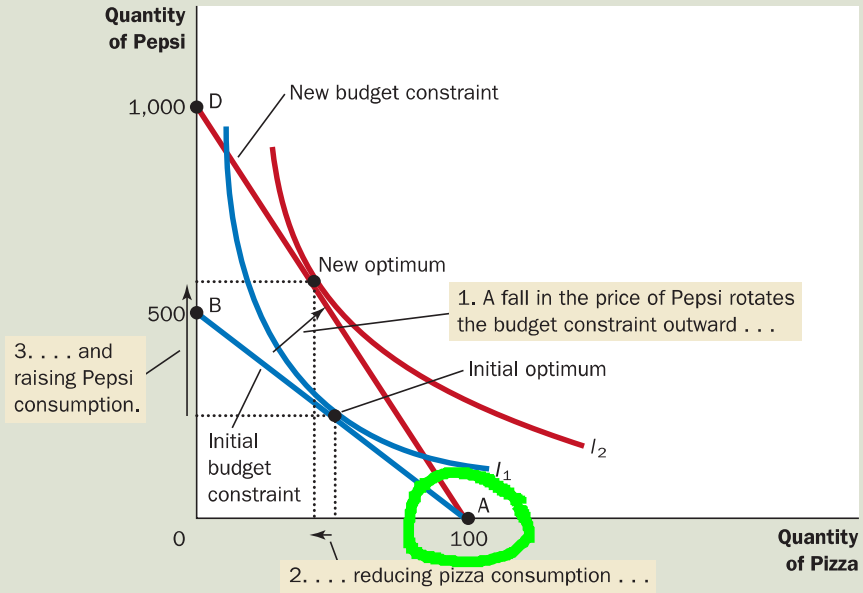
substitution effect
the change in consumption that results when a price change moves the consumer along a given indifference curve to a point with a new marginal rate of substitution

Income and Substitution Effects

The impact of a change in the price of a good on consumption can be decomposed into two effects: an **income effect** and a **substitution effect**. To see what these two effects are, consider how our consumer might respond when he learns that the price of Pepsi has fallen. He might reason in the following ways:

9 FIGURE

A Change in Price
When the price of Pepsi falls, the consumer's budget constraint shifts outward and changes slope. The consumer moves from the initial optimum to the new optimum, which changes his purchases of both pizza and Pepsi. In this case, the quantity of Pepsi consumed rises, and the quantity of pizza consumed falls.



- "Great news! Now that Pepsi is cheaper, my income has greater purchasing power. I am, in effect, richer than I was. Because I am richer, I can buy both more pizza and more Pepsi." (This is the income effect.)
- "Now that the price of Pepsi has fallen, I get more pints of Pepsi for every pizza that I give up. Because pizza is now relatively more expensive, I should buy less pizza and more Pepsi." (This is the substitution effect.)

Which statement do you find more compelling?

In fact, both of these statements make sense. The decrease in the price of Pepsi makes the consumer better off. If pizza and Pepsi are both normal goods, the consumer will want to spread this improvement in his purchasing power over both goods. This income effect tends to make the consumer buy more pizza and more Pepsi. Yet at the same time, consumption of Pepsi has become less expensive relative to consumption of pizza. This substitution effect tends to make the consumer choose less pizza and more Pepsi.

Now consider the result of these two effects working at the same time. The consumer certainly buys more Pepsi because the income and substitution effects both act to raise purchases of Pepsi. But it is ambiguous whether the consumer buys more pizza because the income and substitution effects work in opposite directions. This conclusion is summarized in Table 1.

We can interpret the income and substitution effects using indifference curves. *The income effect is the change in consumption that results from the movement to a higher indifference curve. The substitution effect is the change in consumption that results from being at a point on an indifference curve with a different marginal rate of substitution.*

Figure 10 shows graphically how to decompose the change in the consumer's decision into the income effect and the substitution effect. When the price of Pepsi falls, the consumer moves from the initial optimum, point A, to the new optimum, point C. We can view this change as occurring in two steps. First, the consumer moves *along* the initial indifference curve, I_1, from point A to point B. The consumer is equally happy at these two points, but at point B, the marginal rate of substitution reflects the new relative price. (The dashed line through point B reflects the new relative price by being parallel to the new budget constraint.) Next, the

TABLE 1

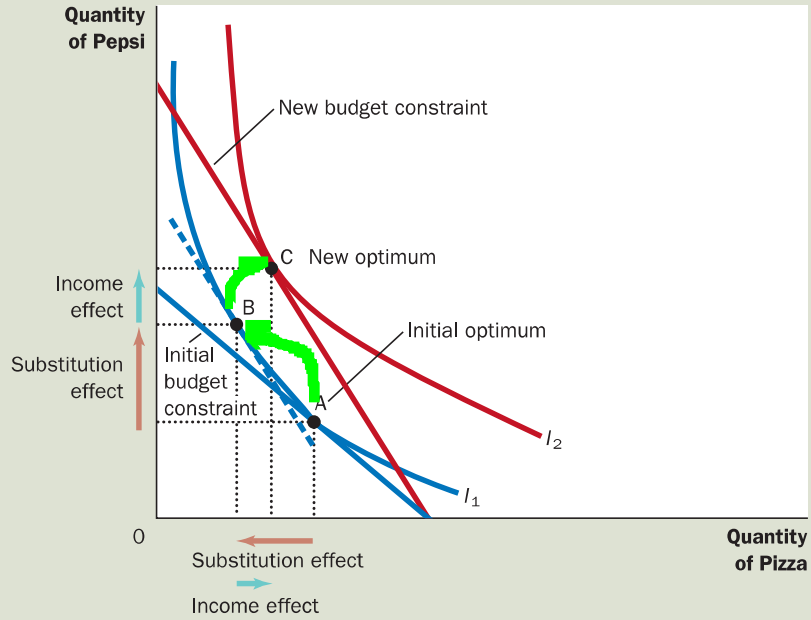
Income and Substitution Effects When the Price of Pepsi Falls

Good	Income Effect	Substitution Effect	Total Effect
Pepsi	Consumer is richer, so he buys more Pepsi.	Pepsi is relatively cheaper, so consumer buys more Pepsi.	Income and substitution effects act in same direction, so consumer buys more Pepsi.
Pizza	Consumer is richer, so he buys more pizza.	Pizza is relatively more expensive, so consumer buys less pizza.	Income and substitution effects act in opposite directions, so the total effect on pizza consumption is ambiguous.

10 FIGURE

Income and Substitution Effects

The effect of a change in price can be broken down into an income effect and a substitution effect. The substitution effect—the movement along an indifference curve to a point with a different marginal rate of substitution—is shown here as the change from point A to point B along indifference curve I_1. The income effect—the shift to a higher indifference curve—is shown here as the change from point B on indifference curve I_1 to point C on indifference curve I_2.



consumer *shifts* to the higher indifference curve, I_2, by moving from point B to point C. Even though point B and point C are on different indifference curves, they have the same marginal rate of substitution. That is, the slope of the indifference curve I_1 at point B equals the slope of the indifference curve I_2 at point C.

Although the consumer never actually chooses point B, this hypothetical point is useful to clarify the two effects that determine the consumer's decision. Notice that the change from point A to point B represents a pure change in the marginal rate of substitution without any change in the consumer's welfare. Similarly, the change from point B to point C represents a pure change in welfare without any change in the marginal rate of substitution. Thus, the movement from A to B shows the substitution effect, and the movement from B to C shows the income effect.

Deriving the Demand Curve

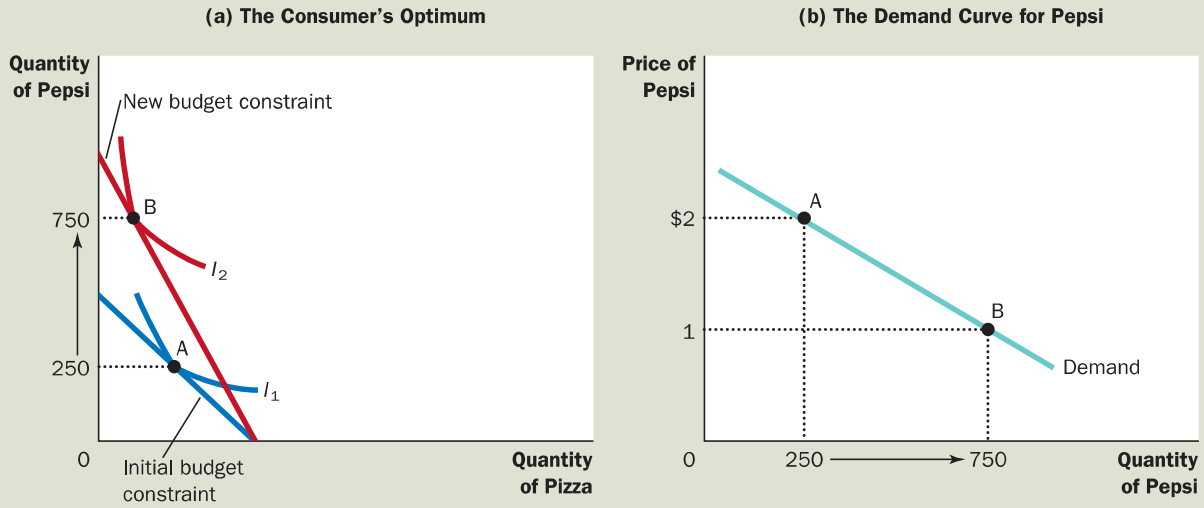
We have just seen how changes in the price of a good alter the consumer's budget constraint and, therefore, the quantities of the two goods that he chooses to buy. The demand curve for any good reflects these consumption decisions. Recall that a demand curve shows the quantity demanded of a good for any given price. We can view a consumer's demand curve as a summary of the optimal decisions that arise from his budget constraint and indifference curves.

For example, Figure 11 considers the demand for Pepsi. Panel (a) shows that when the price of a pint falls from $2 to $1, the consumer's budget constraint shifts outward. Because of both income and substitution effects, the consumer increases

FIGURE 11

Deriving the Demand Curve

Panel (a) shows that when the price of Pepsi falls from $2 to $1, the consumer's optimum moves from point A to point B, and the quantity of Pepsi consumed rises from 250 to 750 pints. The demand curve in panel (b) reflects this relationship between the price and the quantity demanded.



his purchases of Pepsi from 250 to 750 pints. Panel (b) shows the demand curve that results from this consumer's decisions. In this way, the theory of consumer choice provides the theoretical foundation for the consumer's demand curve.

It may be comforting to know that the demand curve arises naturally from the theory of consumer choice, but this exercise by itself does not justify developing the theory. There is no need for a rigorous, analytic framework just to establish that people respond to changes in prices. The theory of consumer choice is, however, useful in studying various decisions that people make as they go about their lives, as we see in the next section.

QUICK QUIZ Draw a budget constraint and indifference curves for pizza and Pepsi. Show what happens to the budget constraint and the consumer's optimum when the price of pizza rises. In your diagram, decompose the change into an income effect and a substitution effect.

THREE APPLICATIONS

Now that we have developed the basic theory of consumer choice, let's use it to shed light on three questions about how the economy works. These three questions might at first seem unrelated. But because each question involves household decision making, we can address it with the model of consumer behavior we have just developed.

Do All Demand Curves Slope Downward?

Normally, when the price of a good rises, people buy less of it. This usual behavior, called the *law of demand*, is reflected in the downward slope of the demand curve.

As a matter of economic theory, however, demand curves can sometimes slope upward. In other words, consumers can sometimes violate the law of demand and buy *more* of a good when the price rises. To see how this can happen, consider Figure 12. In this example, the consumer buys two goods—meat and potatoes. Initially, the consumer's budget constraint is the line from point A to point B. The optimum is point C. When the price of potatoes rises, the budget constraint shifts inward and is now the line from point A to point D. The optimum is now point E. Notice that a rise in the price of potatoes has led the consumer to buy a larger quantity of potatoes.

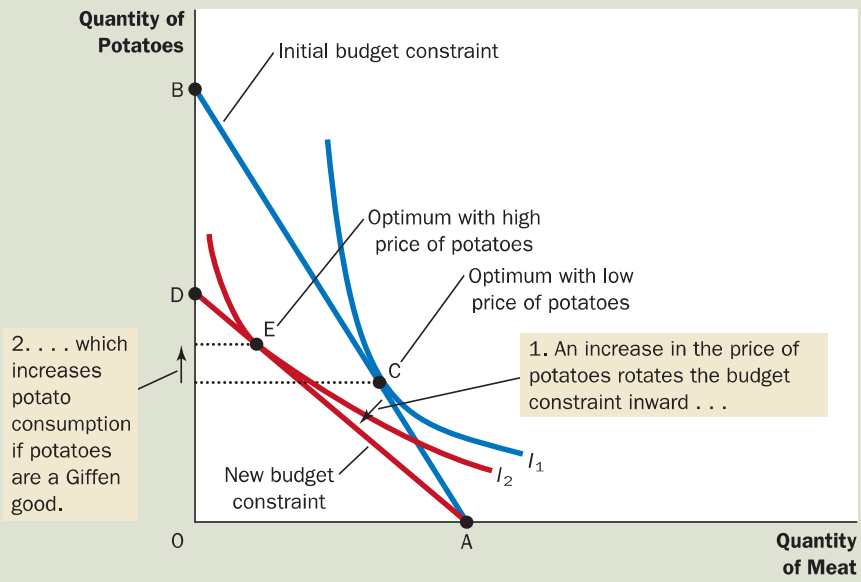
Why is the consumer responding in a seemingly perverse way? In this example, potatoes are a strongly inferior good. When the price of potatoes rises, the consumer is poorer. The income effect makes the consumer want to buy less meat and more potatoes. At the same time, because the potatoes have become more expensive relative to meat, the substitution effect makes the consumer want to buy more meat and less potatoes. In this particular case, however, the income effect is so strong that it exceeds the substitution effect. In the end, the consumer responds to the higher price of potatoes by buying less meat and more potatoes.

Giffen good
a good for which an increase in the price raises the quantity demanded

Economists use the term **Giffen good** to describe a good that violates the law of demand. (The term is named for economist Robert Giffen, who first noted this possibility.) In this example, potatoes are a Giffen good. Giffen goods are inferior goods for which the income effect dominates the substitution effect. Therefore, they have demand curves that slope upward.

12 FIGURE

A Giffen Good
In this example, when the price of potatoes rises, the consumer's optimum shifts from point C to point E. In this case, the consumer responds to a higher price of potatoes by buying less meat and more potatoes.



CASE STUDY THE SEARCH FOR GIFFEN GOODS

Have any actual Giffen goods ever been observed? Some historians suggest that potatoes were a Giffen good during the Irish potato famine of the 19th century. Potatoes were such a large part of people's diet that when the price of potatoes rose, it had a large income effect. People responded to their reduced living standard by cutting back on the luxury of meat and buying more of the staple food of potatoes. Thus, it is argued that a higher price of potatoes actually raised the quantity of potatoes demanded.

A recent study by Robert Jensen and Nolan Miller has produced similar but more concrete evidence for the existence of Giffen goods. These two economists conducted a field experiment for 5 months in the Chinese province of Hunan. They gave randomly selected households vouchers that subsidized the purchase of rice, a staple in local diets, and used surveys to measure how consumption of rice responded to changes in the price. They found strong evidence that poor households exhibited Giffen behavior. Lowering the price of rice with the subsidy voucher caused households to reduce their consumption of rice, and removing the subsidy had the opposite effect. Jensen and Miller wrote, "To the best of our knowledge, this is the first rigorous empirical evidence of Giffen behavior."

Thus, the theory of consumer choice allows demand curves to slope upward, and sometimes that strange phenomenon actually occurs. As a result, the law of demand we first saw in Chapter 4 is not completely reliable. It is safe to say, however, that Giffen goods are very rare. ●

How Do Wages Affect Labor Supply?

So far, we have used the theory of consumer choice to analyze how a person allocates income between two goods. We can use the same theory to analyze how a person allocates time. People spend some of their time enjoying leisure and some of it working so they can afford to buy consumption goods. The essence of the time-allocation problem is the trade-off between leisure and consumption.

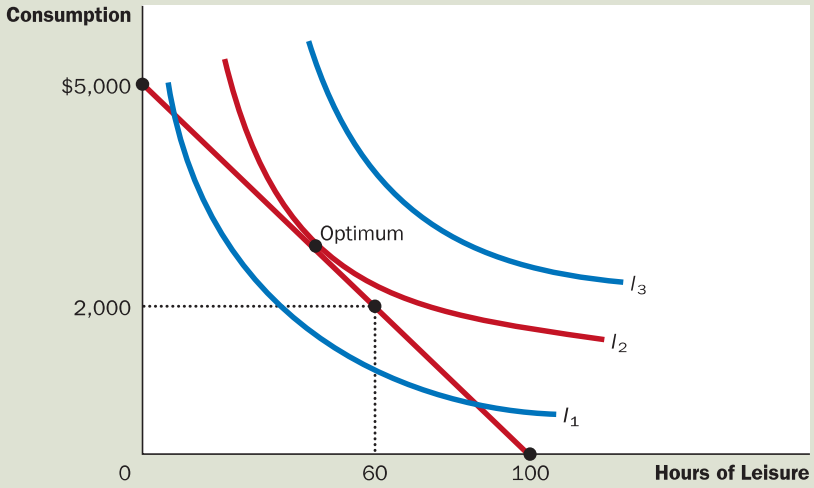
Consider the decision facing Sally, a freelance software designer. Sally is awake for 100 hours per week. She spends some of this time enjoying leisure—riding her bike, watching television, and studying economics. She spends the rest of this time developing software at her computer. For every hour she works developing software, she earns $50, which she spends on consumption goods—food, clothing, and music downloads. Her wage ($50) reflects the trade-off Sally faces between leisure and consumption. For every hour of leisure she gives up, she works one more hour and gets $50 of consumption.

Figure 13 shows Sally's budget constraint. If she spends all 100 hours enjoying leisure, she has no consumption. If she spends all 100 hours working, she earns a weekly consumption of $5,000 but has no time for leisure. If she works a normal 40-hour week, she enjoys 60 hours of leisure and has weekly consumption of $2,000.

Figure 13 uses indifference curves to represent Sally's preferences for consumption and leisure. Here consumption and leisure are the two "goods" between which Sally is choosing. Because Sally always prefers more leisure and more consumption, she prefers points on higher indifference curves to points on lower ones. At a wage of $50 per hour, Sally chooses a combination of consumption and leisure represented by the point labeled "optimum." This is the point on the budget constraint that is on the highest possible indifference curve, I_2.

13 FIGURE

The Work-Leisure Decision
This figure shows Sally's budget constraint for deciding how much to work, her indifference curves for consumption and leisure, and her optimum.



Now consider what happens when Sally's wage increases from $50 to $60 per hour. Figure 14 shows two possible outcomes. In each case, the budget constraint, shown in the left graphs, shifts outward from BC_1 to BC_2. In the process, the budget constraint becomes steeper, reflecting the change in relative price: At the higher wage, Sally earns more consumption for every hour of leisure that she gives up.

Sally's preferences, as represented by her indifference curves, determine how her choice regarding consumption and leisure responds to the higher wage. In both panels, consumption rises. Yet the response of leisure to the change in the wage is different in the two cases. In panel (a), Sally responds to the higher wage by enjoying less leisure. In panel (b), Sally responds by enjoying more leisure.

Sally's decision between leisure and consumption determines her supply of labor because the more leisure she enjoys, the less time she has left to work. In each panel of Figure 14, the right graph shows the labor-supply curve implied by Sally's decision. In panel (a), a higher wage induces Sally to enjoy less leisure and work more, so the labor-supply curve slopes upward. In panel (b), a higher wage induces Sally to enjoy more leisure and work less, so the labor-supply curve slopes "backward."

At first, the backward-sloping labor-supply curve is puzzling. Why would a person respond to a higher wage by working less? The answer comes from considering the income and substitution effects of a higher wage.

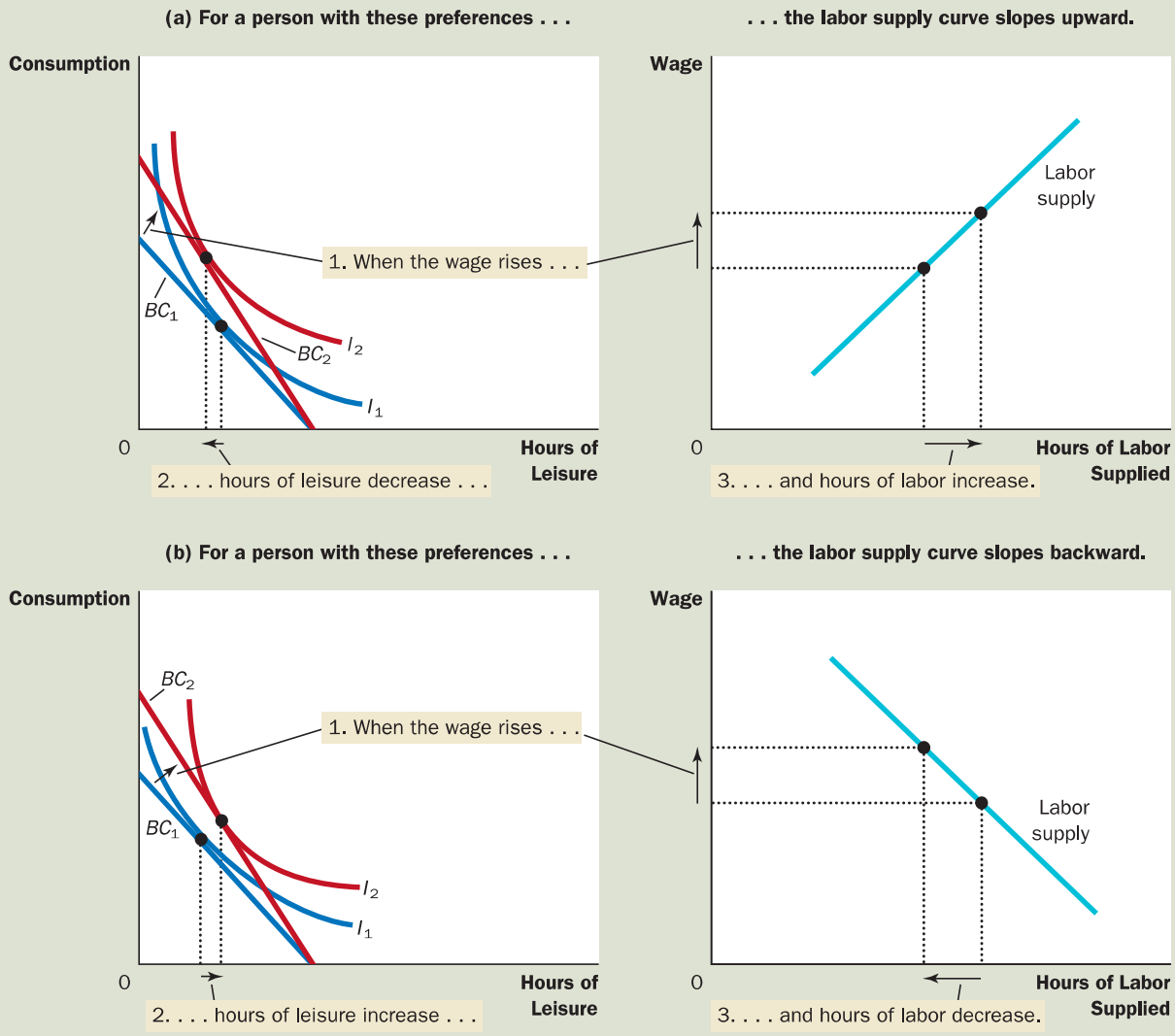
Consider first the substitution effect. When Sally's wage rises, leisure becomes more costly relative to consumption, and this encourages Sally to substitute away from leisure and toward consumption. In other words, the substitution effect induces Sally to work harder in response to higher wages, which tends to make the labor-supply curve slope upward.

Now consider the income effect. When Sally's wage rises, she moves to a higher indifference curve. She is now better off than she was. As long as consumption and leisure are both normal goods, she tends to want to use this increase in well-being to enjoy both higher consumption and greater leisure. In other words, the

FIGURE 14

An Increase in the Wage

The two panels of this figure show how a person might respond to an increase in the wage. The graphs on the left show the consumer's initial budget constraint, BC_1, and new budget constraint, BC_2, as well as the consumer's optimal choices over consumption and leisure. The graphs on the right show the resulting labor-supply curve. Because hours worked equal total hours available minus hours of leisure, any change in leisure implies an opposite change in the quantity of labor supplied. In panel (a), when the wage rises, consumption rises and leisure falls, resulting in a labor-supply curve that slopes upward. In panel (b), when the wage rises, both consumption and leisure rise, resulting in a labor-supply curve that slopes backward.



income effect induces her to work less, which tends to make the labor-supply curve slope backward.

In the end, economic theory does not give a clear prediction about whether an increase in the wage induces Sally to work more or less. If the substitution effect is greater than the income effect for Sally, she works more. If the income effect is greater than the substitution effect, she works less. The labor-supply curve, therefore, could be either upward or backward sloping.

CASE STUDY: INCOME EFFECTS ON LABOR SUPPLY: HISTORICAL TRENDS, LOTTERY WINNERS, AND THE CARNEGIE CONJECTURE

The idea of a backward-sloping labor-supply curve might at first seem like a mere theoretical curiosity, but in fact, it is not. Evidence indicates that the labor-supply curve, considered over long periods, does in fact slope backward. A hundred years ago, many people worked six days a week. Today, five-day workweeks are the norm. At the same time that the length of the workweek has been falling, the wage of the typical worker (adjusted for inflation) has been rising.

Here is how economists explain this historical pattern: Over time, advances in technology raise workers' productivity and, thereby, the demand for labor. The increase in labor demand raises equilibrium wages. As wages rise, so does the reward for working. Yet rather than responding to this increased incentive by working more, most workers choose to take part of their greater prosperity in the form of more leisure. In other words, the income effect of higher wages dominates the substitution effect.

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"No more 9 to 5 for me."

Further evidence that the income effect on labor supply is strong comes from a very different kind of data: winners of lotteries. Winners of large prizes in the lottery see large increases in their incomes and, as a result, large outward shifts in their budget constraints. Because the winners' wages have not changed, however, the *slopes* of their budget constraints remain the same. There is, therefore, no substitution effect. By examining the behavior of lottery winners, we can isolate the income effect on labor supply.

The results from studies of lottery winners are striking. Of those winners who win more than $50,000, almost 25 percent quit working within a year, and another 9 percent reduce the number of hours they work. Of those winners who win more than $1 million, almost 40 percent stop working. The income effect on labor supply of winning such a large prize is substantial.

Similar results were found in a 1993 study, published in the *Quarterly Journal of Economics*, of how receiving a bequest affects a person's labor supply. The study found that a single person who inherits more than $150,000 is four times as likely to stop working as a single person who inherits less than $25,000. This finding would not have surprised the 19th-century industrialist Andrew Carnegie. Carnegie warned that "the parent who leaves his son enormous wealth generally deadens the talents and energies of the son, and tempts him to lead a less useful and less worthy life than he otherwise would." That is, Carnegie viewed the income effect on labor supply to be substantial and, from his paternalistic perspective, regrettable. During his life and at his death, Carnegie gave much of his vast fortune to charity.

How Do Interest Rates Affect Household Saving?

An important decision that every person faces is how much income to consume today and how much to save for the future. We can use the theory of consumer choice to analyze how people make this decision and how the amount they save depends on the interest rate their savings will earn.

Consider the decision facing Sam, a worker planning for retirement. To keep things simple, let's divide Sam's life into two periods. In the first period, Sam is young and working. In the second period, he is old and retired. When young, Sam earns $100,000. He divides this income between current consumption and saving. When he is old, Sam will consume what he has saved, including the interest that his savings have earned.

Suppose the interest rate is 10 percent. Then for every dollar that Sam saves when young, he can consume $1.10 when old. We can view "consumption when young" and "consumption when old" as the two goods that Sam must choose between. The interest rate determines the relative price of these two goods.

Figure 15 shows Sam's budget constraint. If he saves nothing, he consumes $100,000 when young and nothing when old. If he saves everything, he consumes nothing when young and $110,000 when old. The budget constraint shows these and all the intermediate possibilities.

Figure 15 uses indifference curves to represent Sam's preferences for consumption in the two periods. Because Sam prefers more consumption in both periods, he prefers points on higher indifference curves to points on lower ones. Given his preferences, Sam chooses the optimal combination of consumption in both periods of life, which is the point on the budget constraint that is on the highest possible indifference curve. At this optimum, Sam consumes $50,000 when young and $55,000 when old.

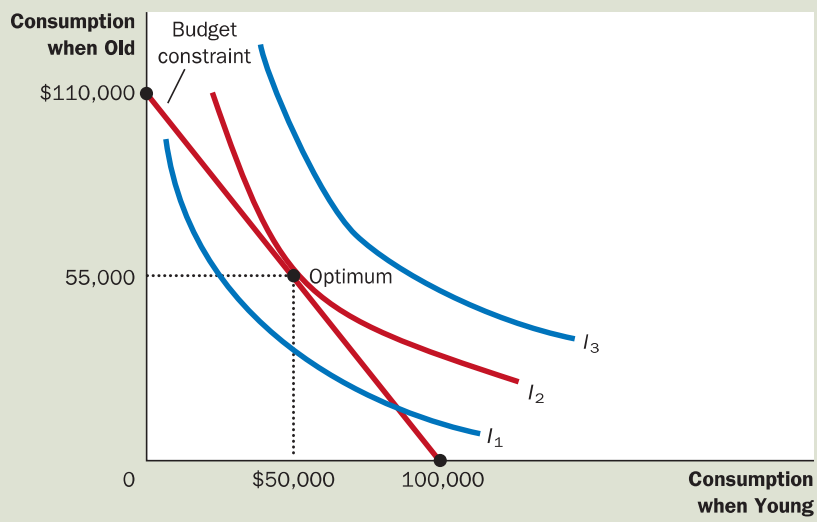


FIGURE 15

The Consumption-Saving Decision

This figure shows the budget constraint for a person deciding how much to consume in the two periods of his life, the indifference curves representing his preferences, and the optimum.

Now consider what happens when the interest rate increases from 10 percent to 20 percent. Figure 16 shows two possible outcomes. In both cases, the budget constraint shifts outward and becomes steeper. At the new higher interest rate, Sam gets more consumption when old for every dollar of consumption that he gives up when young.

The two panels show the results given different preferences by Sam. In both cases, consumption when old rises. Yet the response of consumption when young to the change in the interest rate is different in the two cases. In panel (a), Sam responds to the higher interest rate by consuming less when young. In panel (b), Sam responds by consuming more when young.

Sam's saving is his income when young minus the amount he consumes when young. In panel (a), consumption when young falls when the interest rate rises, so saving must rise. In panel (b), Sam consumes more when young, so saving must fall.

The case shown in panel (b) might at first seem odd: Sam responds to an increase in the return to saving by saving less. Yet this behavior is not as peculiar as it might seem. We can understand it by considering the income and substitution effects of a higher interest rate.

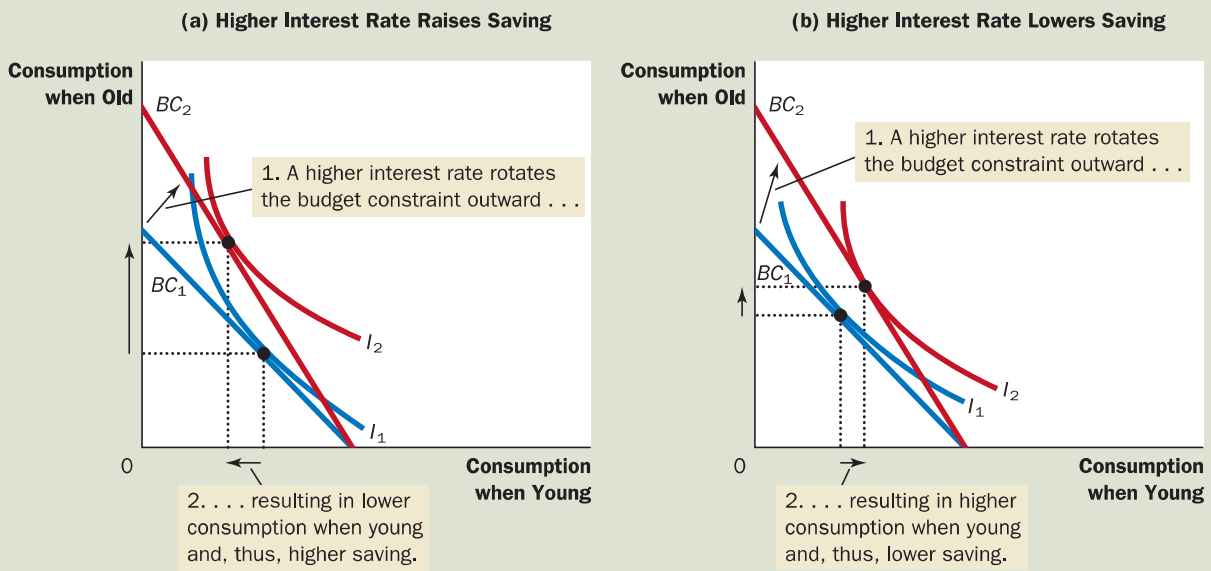
Consider first the substitution effect. When the interest rate rises, consumption when old becomes less costly relative to consumption when young. Therefore, the substitution effect induces Sam to consume more when old and less when young. In other words, the substitution effect induces Sam to save more.

Now consider the income effect. When the interest rate rises, Sam moves to a higher indifference curve. He is now better off than he was. As long as consump-

16 FIGURE

An Increase in the Interest Rate

In both panels, an increase in the interest rate shifts the budget constraint outward. In panel (a), consumption when young falls, and consumption when old rises. The result is an increase in saving when young. In panel (b), consumption in both periods rises. The result is a decrease in saving when young.



tion in both periods consists of normal goods, he tends to want to use this increase in well-being to enjoy higher consumption in both periods. In other words, the income effect induces him to save less.

The result depends on both the income and substitution effects. If the substitution effect of a higher interest rate is greater than the income effect, Sam saves more. If the income effect is greater than the substitution effect, Sam saves less. Thus, the theory of consumer choice says that an increase in the interest rate could either encourage or discourage saving.

Although this ambiguous result is interesting from the standpoint of economic theory, it is disappointing from the standpoint of economic policy. It turns out that an important issue in tax policy hinges in part on how saving responds to interest rates. Some economists have advocated reducing the taxation of interest and other capital income, arguing that such a policy change would raise the after-tax interest rate that savers can earn and would thereby encourage people to save more. Other economists have argued that because of offsetting income and substitution effects, such a tax change might not increase saving and could even reduce it. Unfortunately, research has not led to a consensus about how interest rates affect saving. As a result, there remains disagreement among economists about whether changes in tax policy aimed to encourage saving would, in fact, have the intended effect.

QUICK QUIZ Explain how an increase in the wage can potentially decrease the amount that a person wants to work.

CONCLUSION: DO PEOPLE REALLY THINK THIS WAY?

The theory of consumer choice describes how people make decisions. As we have seen, it has broad applicability. It can explain how a person chooses between pizza and Pepsi, work and leisure, consumption and saving, and on and on.

At this point, however, you might be tempted to treat the theory of consumer choice with some skepticism. After all, you are a consumer. You decide what to buy every time you walk into a store. And you know that you do not decide by writing down budget constraints and indifference curves. Doesn't this knowledge about your own decision making provide evidence against the theory?

The answer is no. The theory of consumer choice does not try to present a literal account of how people make decisions. It is a model. And as we first discussed in Chapter 2, models are not intended to be completely realistic.

The best way to view the theory of consumer choice is as a metaphor for how consumers make decisions. No consumer (except an occasional economist) goes through the explicit optimization envisioned in the theory. Yet consumers are aware that their choices are constrained by their financial resources. And given those constraints, they do the best they can to achieve the highest level of satisfaction. The theory of consumer choice tries to describe this implicit, psychological process in a way that permits explicit, economic analysis.

Just as the proof of the pudding is in the eating, the test of a theory is in its applications. In the last section of this chapter, we applied the theory of consumer choice to three practical issues about the economy. If you take more advanced courses in economics, you will see that this theory provides the framework for much additional analysis.

SUMMARY

- A consumer's budget constraint shows the possible combinations of different goods he can buy given his income and the prices of the goods. The slope of the budget constraint equals the relative price of the goods.
- The consumer's indifference curves represent his preferences. An indifference curve shows the various bundles of goods that make the consumer equally happy. Points on higher indifference curves are preferred to points on lower indifference curves. The slope of an indifference curve at any point is the consumer's marginal rate of substitution—the rate at which the consumer is willing to trade one good for the other.
- The consumer optimizes by choosing the point on his budget constraint that lies on the highest indifference curve. At this point, the slope of the indifference curve (the marginal rate of substitution between the goods) equals the slope of the budget constraint (the relative price of the goods).
- When the price of a good falls, the impact on the consumer's choices can be broken down into an income effect and a substitution effect. The income effect is the change in consumption that arises because a lower price makes the consumer better off. The substitution effect is the change in consumption that arises because a price change encourages greater consumption of the good that has become relatively cheaper. The income effect is reflected in the movement from a lower to a higher indifference curve, whereas the substitution effect is reflected by a movement along an indifference curve to a point with a different slope.
- The theory of consumer choice can be applied in many situations. It explains why demand curves can potentially slope upward, why higher wages could either increase or decrease the quantity of labor supplied, and why higher interest rates could either increase or decrease saving.

KEY CONCEPTS

budget constraint, *p. 458*
indifference curve, *p. 460*
marginal rate of substitution, *p. 460*
perfect substitutes, *p. 463*
perfect complements, *p. 464*
normal good, *p. 467*
inferior good, *p. 467*
income effect, *p. 468*
substitution effect, *p. 468*
Giffen good, *p. 472*

QUESTIONS FOR REVIEW

1. A consumer has income of $3,000. Wine costs $3 per glass, and cheese costs $6 per pound. Draw the consumer's budget constraint. What is the slope of this budget constraint?
2. Draw a consumer's indifference curves for wine and cheese. Describe and explain four properties of these indifference curves.
3. Pick a point on an indifference curve for wine and cheese and show the marginal rate of substitution. What does the marginal rate of substitution tell us?
4. Show a consumer's budget constraint and indifference curves for wine and cheese. Show the optimal consumption choice. If the price of wine is $3 per glass and the price of cheese is $6 per pound, what is the marginal rate of substitution at this optimum?

5. A person who consumes wine and cheese gets a raise, so his income increases from $3,000 to $4,000. Show what happens if both wine and cheese are normal goods. Now show what happens if cheese is an inferior good.
6. The price of cheese rises from $6 to $10 per pound, while the price of wine remains $3 per glass. For a consumer with a constant income of $3,000, show what happens to consumption of wine and cheese. Decompose the change into income and substitution effects.
7. Can an increase in the price of cheese possibly induce a consumer to buy more cheese? Explain.

PROBLEMS AND APPLICATIONS

1. Jennifer divides her income between coffee and croissants (both of which are normal goods). An early frost in Brazil causes a large increase in the price of coffee in the United States.
   a. Show the effect of the frost on Jennifer's budget constraint.
   b. Show the effect of the frost on Jennifer's optimal consumption bundle assuming that the substitution effect outweighs the income effect for croissants.
   c. Show the effect of the frost on Jennifer's optimal consumption bundle assuming that the income effect outweighs the substitution effect for croissants.
2. Compare the following two pairs of goods:
   - Coke and Pepsi
   - Skis and ski bindings

   a. In which case are the two goods complements? In which case are they substitutes?
   b. In which case do you expect the indifference curves to be fairly straight? In which case do you expect the indifference curves to be very bowed?
   c. In which case will the consumer respond more to a change in the relative price of the two goods?
3. Mario consumes only cheese and crackers.
   a. Could cheese and crackers both be inferior goods for Mario? Explain.
   b. Suppose that cheese is a normal good for Mario while crackers are an inferior good. If the price of cheese falls, what happens to Mario's consumption of crackers? What happens to his consumption of cheese? Explain.
4. Jim buys only milk and cookies.
   a. In year 1, Jim earns $100, milk costs $2 per quart, and cookies cost $4 per dozen. Draw Jim's budget constraint.
   b. Now suppose that all prices increase by 10 percent in year 2 and that Jim's salary increases by 10 percent as well. Draw Jim's new budget constraint. How would Jim's optimal combination of milk and cookies in year 2 compare to his optimal combination in year 1?
5. A college student has two options for meals: eating at the dining hall for $6 per meal, or eating a Cup O' Soup for $1.50 per meal. His weekly food budget is $60.
   a. Draw the budget constraint showing the trade-off between dining hall meals and Cups O' Soup. Assuming that he spends equal amounts on both goods, draw an indifference curve showing the optimum choice. Label the optimum as point A.
   b. Suppose the price of a Cup O' Soup now rises to $2. Using your diagram from part (a), show the consequences of this change in price. Assume that our student now spends only 30 percent of his income on dining hall meals. Label the new optimum as point B.
   c. What happened to the quantity of Cups O' Soup consumed as a result of this price change? What does this result say about the income and substitution effects? Explain.
   d. Use points A and B to draw a demand curve for Cup O' Soup. What is this type of good called?
6. Consider your decision about how many hours to work.
   a. Draw your budget constraint assuming that you pay no taxes on your income. On the same diagram, draw another budget constraint assuming that you pay 15 percent tax.
   b. Show how the tax might lead to more hours of work, fewer hours, or the same number of hours. Explain.

7. Sarah is awake for 100 hours per week. Using one diagram, show Sarah's budget constraints if she earns $6 per hour, $8 per hour, and $10 per hour. Now draw indifference curves such that Sarah's labor-supply curve is upward sloping when the wage is between $6 and $8 per hour, and backward sloping when the wage is between $8 and $10 per hour.
8. Draw the indifference curve for someone deciding how to allocate time between work and leisure. Suppose the wage increases. Is it possible that the person's consumption would fall? Is this plausible? Discuss. (Hint: Think about income and substitution effects.)
9. Suppose you take a job that pays $30,000 and set some of this income aside in a savings account that pays an annual interest rate of 5 percent. Use a diagram with a budget constraint and indifference curves to show how your consumption changes in each of the following situations. To keep things simple, assume that you pay no taxes on your income.
   a. Your salary increases to $40,000.
   b. The interest rate on your bank account rises to 8 percent.
10. As discussed in the text, we can divide an individual's life into two hypothetical periods: "young" and "old." Suppose the individual earns income only when young and saves some of that income to consume when old. If the interest rate on savings falls, can you tell what happens to consumption when young? Can you tell what happens to consumption when old? Explain.
11. Consider a couple's decision about how many children to have. Assume that over a lifetime a couple has 200,000 hours of time to either work or raise children. The wage is $10 per hour. Raising a child takes 20,000 hours of time.
   a. Draw the budget constraint showing the trade-off between lifetime consumption and number of children. (Ignore the fact that children come only in whole numbers!) Show indifference curves and an optimum choice.
   b. Suppose the wage increases to $12 per hour. Show how the budget constraint shifts. Using income and substitution effects, discuss the impact of the change on number of children and lifetime consumption.
   c. We observe that, as societies get richer and wages rise, people typically have fewer children. Is this fact consistent with this model? Explain.
12. Economist George Stigler once wrote that, according to consumer theory, "if consumers do not buy less of a commodity when their incomes rise, they will surely buy less when the price of the commodity rises." Explain this statement using the concepts of income and substitution effects.
13. The welfare system provides income to some needy families. Typically, the maximum payment goes to families that earn no income; then, as families begin to earn income, the welfare payment declines gradually and eventually disappears. Let's consider the possible effects of this program on a family's labor supply.
   a. Draw a budget constraint for a family assuming that the welfare system did not exist. On the same diagram, draw a budget constraint that reflects the existence of the welfare system.
   b. Adding indifference curves to your diagram, show how the welfare system could reduce the number of hours worked by the family. Explain, with reference to both the income and substitution effects.
   c. Using your diagram from part (b), show the effect of the welfare system on the well-being of the family.
14. Five consumers have the following marginal utility of apples and pears:

	Marginal Utility of Apples	Marginal Utility of Pears
Jerry	12	6
George	6	6
Elaine	6	3
Kramer	3	6
Newman	12	3

The price of an apple is $2, and the price of a pear is $1. Which, if any, of these consumers are optimizing over their choice of fruit? For those who are not, how should they change their spending?