This chapter studies how people change their choices when conditions change. In particular, we study how changes in income or changes in the price of a good affect the amount that people choose to consume. We compare the new choices with those that were made before conditions changed. The main result of this approach is to construct an individual’s demand curve for a good. This curve shows the amounts of a good that a person chooses to buy at different prices.

**DEMAND FUNCTIONS**

Chapter 2 concluded that the quantities of X and Y that a person chooses depend on that person’s preferences and on the shape of his or her budget constraint. If we knew a person’s preferences and all the economic forces that affect his or her choices, we could predict how much of each good would be chosen. We can summarize this conclusion using the demand function for some particular good, say, X:

\[
\text{Quantity of } X \text{ demanded} = d_X(P_X, P_Y, I; \text{preferences}) \quad (3.1)
\]

This function contains the three elements that determine what the person can buy—the prices of X and Y and the person’s income (I)—as well as a reminder that choices are also affected by preferences for the goods. These preferences appear to the right of the semicolon in Equation 3.1 because for most of our analysis we assume that preferences do not change. People’s basic likes and dislikes are assumed to be developed through a lifetime of experience. They are unlikely to change as we examine their reactions to relatively short-term changes in their economic circumstances caused by changes in commodity prices or incomes.
The quantity demanded of good Y depends on these same general influences and can be summarized by

\[
\text{Quantity of Y demanded} = d_Y(P_X, P_Y, I; \text{preferences}) \tag{3.2}
\]

Preferences again appear to the right of the semicolon in Equation 3.2 because we assume that the person’s taste for good Y will not change during our analysis.

**Homogeneity**

One important result that follows directly from Chapter 2 is that if the prices of X and Y and income (I) were all to double (or to change by any identical percentage), the amounts of X and Y demanded would not change. The budget constraint

\[
P_X X + P_Y Y = 1 \tag{3.3}
\]

is the same as the budget constraint

\[
2P_X X + 2P_Y Y = 2I \tag{3.4}
\]

Graphically, these are exactly the same lines. Consequently, both budget constraints are tangent to a person’s indifference curve map at precisely the same point. The quantities of X and Y the individual chooses when faced by the constraint in Equation 3.3 are exactly the same as when the individual is faced by the constraint in Equation 3.4.

This is an important result: The amounts a person demands depend only on the relative prices of goods X and Y and on the “real” value of income. Proportional changes in both the prices of X and Y and in income change only the units we count in (such as dollars instead of cents). They do not affect the quantities demanded. Individual demand is said to be **homogeneous** for proportional changes in all prices and income. People are not hurt by general inflation of prices if their incomes increase in the same proportion. They will be on exactly the same indifference curve both before and after the inflation. Only if inflation increases some incomes faster or slower than prices change does it then have an effect on budget constraints, on the quantities of goods demanded, and on people’s well-being.

**CHANGES IN INCOME**

As a person’s total income rises, assuming prices do not change, we might expect the quantity purchased of each good also to increase. This situation is illustrated in Figure 3.1. As income increases from $I_1$ to $I_2$ to $I_3$, the quantity of X demanded increases from $X_1$ to $X_2$ to $X_3$ and the quantity of Y demanded increases from $Y_1$
to Y₂ to Y₃. Budget lines I₁, I₂, and I₃ are all parallel because we are changing only income, not the relative prices of X and Y. Remember, the slope of the budget constraint is given by the ratio of the goods’ prices, and these prices are not changing in this figure. Increases in income do, however, make it possible for this person to consume more; this increased purchasing power is reflected by the outward shift in the budget constraint and an increase in overall utility.

**Normal Goods**

In Figure 3.1, both good X and good Y increase as income increases. Goods that follow this tendency are called normal goods. Most goods seem to be normal goods—as their incomes increase, people tend to buy more of practically everything. Of course, as Figure 3.1 shows, the demand for some “luxury” goods (such as Y) may increase rapidly when income rises, but the demand for “necessities” (such as X) may grow less rapidly. The relationship between income and the amounts of various goods purchased has been extensively examined by economists, as Application 3.1: Engel’s Law shows.
One of the most important generalizations about consumer behavior is that the fraction of income spent on food tends to decline as income increases. This finding was first discovered by the Prussian economist, Ernst Engel (1821–1896), in the nineteenth century and has come to be known as Engel’s Law. Table 1 illustrates the data that Engel used. They clearly show that richer families spent a smaller fraction of their income on food.

Recent Data
Recent data for U.S. consumers (see Table 2) tend to confirm Engel’s observations. Affluent families devote a smaller proportion of their purchasing power to food than do poor families. Comparisons of the data from Table 1 and Table 2 also confirm Engel’s Law—even current low-income U.S. consumers are much more affluent than nineteenth-century Belgians and, as might be expected, spend a much smaller fraction of their income on food.

TABLE 1 Percentage of Total Expenditures on Various Items in Belgian Families in 1853

<table>
<thead>
<tr>
<th>Expenditure Item</th>
<th>Annual Income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$225–$300</td>
</tr>
<tr>
<td>Food</td>
<td>62.0%</td>
</tr>
<tr>
<td>Clothing</td>
<td>16.0</td>
</tr>
<tr>
<td>Lodging, light, and fuel</td>
<td>17.0</td>
</tr>
<tr>
<td>Services (education, legal, health)</td>
<td>4.0</td>
</tr>
<tr>
<td>Comfort and recreation</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>


TABLE 2 Percentage of Total Expenditures by U.S. Consumers on Various Items, 2000

<table>
<thead>
<tr>
<th>Item</th>
<th>Annual Income (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$15–20</td>
</tr>
<tr>
<td>Food</td>
<td>15.4%</td>
</tr>
<tr>
<td>Clothing</td>
<td>4.8</td>
</tr>
<tr>
<td>Housing</td>
<td>32.9</td>
</tr>
<tr>
<td>Other items</td>
<td>46.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Other Laws?**  
Whether other Engel-like laws apply to the relationship between income and consumption is open to question. For example, Table 2 shows a weak tendency for the fraction of spending on housing to decline with income, but the pattern is not overwhelming.

**To Think About**  
1. The data in Table 2 includes food both eaten at home and in restaurants. Do you think eating at restaurants follows Engel's law?  
2. Property taxes are based on housing values. Are these taxes regressive?

---

** Inferior Goods**  
The demand for a few unusual goods may decrease as a person’s income increases. Some proposed examples of such goods are “rotgut” whiskey, potatoes, and secondhand clothing. This kind of good is called an **inferior good**. How the demand for an inferior good responds to rising income is shown in Figure 3.2.

---

**Figure 3.2 Indifference Curve Map Showing Inferiority**  
Good Z is inferior because the quantity purchased declines as income increases. Y is a normal good (as it must be if only two goods are available) and purchases of it increase as total expenditures increase.
The good Z is inferior because the individual chooses less of it as his or her income increases. Although the curves in Figure 3.2 continue to obey the assumption of a diminishing MRS, they exhibit inferiority. Good Z is inferior only because of the way it relates to the other goods available (good Y here), not because of its own qualities. Purchases of rotgut whiskey decline as income increases, for example, because an individual is able to afford more expensive beverages (such as French champagne). Although, as our examples suggest, inferior goods are relatively rare, the study of them does help to illustrate a few important aspects of demand theory.

**Changes in a Good’s Price**

Examining how a price change affects the quantity demanded of a good is more complex than looking at the effect of a change in income. Changing the price geometrically involves not only changing the intercept of the budget constraint but also changing its slope. Moving to a new utility-maximizing choice means moving to another indifference curve and to a point on that curve with a different MRS.

When a price changes, it has two different effects on people’s choices. There is a substitution effect that occurs even if the individual stays on the same indifference curve because consumption has to be changed to equate MRS to the new price ratio of the two goods. There is also an income effect because the price change also changes “real” purchasing power. People will have to move to a new indifference curve that is consistent with their new purchasing power. We now look at these two effects in several different situations.

**Substitution and Income Effects from a Fall in Price**

Let’s look first at how the quantity consumed of good X changes in response to a fall in its price. This situation is illustrated in Figure 3.3. Initially, the person maximizes utility by choosing the combination $X^*$, $Y$ at point A. When the price of X falls, the budget line shifts outward to the new budget constraint as shown in the figure. Remember that the budget constraint meets the Y-axis at the point where all available income is spent on good Y. Because neither the person’s income nor the price of good Y has changed here, this Y-intercept is the same for both constraints. The new X-intercept is to the right of the old one because the lower price of X means that, with the lower price, this person could buy more X if he or she...
devoted all income to that purpose. The flatter slope of the budget constraint shows us that the relative price of X to Y (that is, $P_X/P_Y$) has fallen.

**Substitution Effect**

With this change in the budget constraint, the new position of maximum utility is at $X^{**}$, $Y^{**}$ (point C). There, the new budget line is tangent to the indifference curve $U_2$. The movement to this new set of choices is the result of two different effects. First, the change in the slope of the budget constraint would have motivated this person to move to point B even if the person had stayed on the original indifference curve $U_1$, the dashed line in Figure 3.3 has the same slope as the new budget constraint, but it is tangent to $U_1$ because we are holding “real” income

![Image](image_url)

**FIGURE 3.3 Income and Substitution Effects of a Fall in Price** When the price of X falls, the utility-maximizing choice shifts from A to C. This movement can be broken down into two effects: first, a movement along the initial indifference curve to point B where the MRS is equal to the new price ratio (the substitution effect); second, a movement to a higher level of utility, since real income has increased (the income effect). Both the substitution and income effects cause more X to be bought when its price declines.
(that is, utility) constant. A relatively lower price for X causes a move from A to B if this person does not become better off as a result of the lower price. This movement is a graphic demonstration of the substitution effect. Even though the individual is no better off, the change in price still causes a change in consumption choices.

**Income Effect**

The further move from B to the final consumption choice, C, is identical to the kind of movement we described in Figure 3.1 for changes in income. Because the price of X has fallen but nominal income (I) has stayed the same, this person has a greater “real” income and can afford a higher utility level (U2). If X is a normal good, he or she will now demand more of it. This is the income effect. As is clear from the figure, both the substitution effect and the income effect cause this person to choose more X when the price of X declines.

**The Effects Combined**

People do not actually move from A to B to C when the price of good X falls. We never observe the point B; only the two actual choices of A and C are reflected in this person’s behavior. But the analysis of income and substitution effects is still valuable because it shows that a price change affects the quantity demanded of a good in two conceptually different ways.

We can use the hamburger–soft drink example from Chapter 2 to show these effects at work. Suppose that the price of soft drinks falls to $.50 from the earlier price of $1.00. This price change will increase this person’s purchasing power. Whereas earlier 20 soft drinks could be bought with an income of $20.00, now 40 of them can be bought. The price decrease shifts the budget constraint outward and increases utility. This person now will choose some different combination of hamburgers and soft drinks than before, if only because the previous choice of five hamburgers and ten soft drinks (under the old budget constraint) now costs only $15—there is $5 left unspent, and this person will choose to do something with it.

In making the new choices, the individual is influenced by two different effects. First, even if we hold utility constant by somehow compensating for the beneficial effect that the fall in price has, this person will still act so that the MRS is brought into line with the new price ratio (now one hamburger to four soft drinks). This compensated response is the substitution effect. Even with a constant real income, this person will still choose more soft drinks and fewer hamburgers because the opportunity cost of eating a burger in terms of soft drinks forgone is now higher than before.

In actuality, real income has also increased; in order to assess the total effect of the price change on the demand for soft drinks, we must also investigate the effect of the change in purchasing power. The increase in real income would (assuming soft drinks are normal goods) be another reason to expect soft drink purchases to increase.
Substitution and Income Effects from an Increase in Price

We can use a similar analysis to see what happens if the price of good X increases. The budget line in Figure 3.4 shifts inward because of an increase in the price of X. The Y-intercept for the budget constraint again does not change since neither income nor $P_Y$ has changed. The slope of the budget constraint is now steeper, however, because X costs more than it did before.

**FIGURE 3.4 Income and Substitution Effects of an Increase in Price** When the price of good X increases, the budget constraint shifts inward. The movement from the initial utility-maximizing point (A) to the new point (C) can again be analyzed as two separate effects. The substitution effect causes a movement to point B on the initial indifference curve ($U_2$). The price increase also creates a loss of purchasing power. This income effect causes a consequent movement to a lower indifference curve. The income and substitution effects together cause the quantity demanded of X to fall as a result of the increase in its price.
The movement from the initial point of utility maximization (A) to the new point C is again caused by two forces. First, even if this person stayed on the initial indifference curve \(U_2\), he or she would substitute \(Y\) for \(X\) and move along \(U_2\) to point B. At this point, the dashed line (with the same slope as the new budget constraint) is just tangent to the indifference curve \(U_2\). The movement from A to B along \(U_2\) is the substitution effect. However, because purchasing power is reduced by the increase in the price of \(X\) (the amount of income remains constant, but now \(X\) costs more), the person must move to a lower level of utility, which is the income effect of the higher price. In Figure 3.4, both the income and substitution effects work in the same direction and cause the quantity demanded of \(X\) to fall in response to an increase in its price.

**Substitution and Income Effects for a Normal Good: Summary**

Figure 3.3 and Figure 3.4 show that, for a normal good, substitution and income effects work in the same direction to yield the expected result: People choose to consume more of a good whose price has fallen and less of a good whose price has risen. As we illustrate later, this provides the rationale for drawing downward-sloping demand curves. If other things do not change, price and quantity move in opposite directions along such a curve. Recognizing that price changes lead to both substitution and income effects also helps to analyze whether such moves will be large or small. In general, price changes that induce big substitution effects or that have big effects on purchasing power (because the good is an important component of people’s budgets) will have large effects on quantity demanded. Price changes that cause only modest substitutions among goods or that have trivial effects on purchasing power will have correspondingly small effects on quantity demanded. This kind of analysis also offers a number of insights about some commonly used economic statistics, as Application 3.2: The Consumer Price Index and Its Biases illustrates.

**Substitution and Income Effects for Inferior Goods**

For the rare case of inferior goods, we cannot make such blanket statements about the effects of price changes. In this case, substitution and income effects work in opposite directions. The net effect of a price change on quantity demanded will be ambiguous. Here we show that ambiguity for the case of an increase in price, leaving it to you to explain the case of a fall in price.

Figure 3.5 shows the income and substitution effects from an increase in price when \(X\) is an inferior good. As the price of \(X\) rises, the substitution effect causes this person to choose less \(X\). This substitution effect is represented by a movement from A to B in the initial indifference curve, \(U_2\). This movement is exactly the same as in Figure 3.4 for a normal good. Because price has increased, however, this person now has a lower real income and must move to a lower indifference curve, \(U_1\). The individual will choose combination C. At C, more \(X\) is chosen than at point B.
This happens because good X is an inferior good: As real income falls, the quantity demanded of X increases rather than declines as it would for a normal good. In Figure 3.5, however, X** is less than X*; less X is ultimately demanded in response to the rise in its price. In our example here, the substitution effect is strong enough to outweigh the “perverse” income effect from the price change.

**Giffen’s Paradox**

If the income effect of a price change for an inferior good and is strong enough, the change in price and the resulting change in the quantity demanded could move in the same direction. Legend has it that the English economist Robert Giffen observed this paradox in nineteenth-century Ireland—when the price of potatoes rose, people consumed more of them. This peculiar result can be explained by looking at the size of the income effect of a change in the price of potatoes. Potatoes were not only inferior goods but also used up a large portion of the Irish
One of the principal measures of inflation in the United States is provided by the Consumer Price Index (CPI), which is published monthly by the U.S. Department of Labor. To construct the CPI, the Bureau of Labor Statistics first defines a typical market basket of commodities purchased by consumers in a base year (1982 is the year currently used). Then data are collected every month about how much this market basket of commodities currently costs the consumer. The ratio of the current cost to the bundle’s original cost (in 1982) is then published as the current value of the CPI. The rate of change in this index between two periods is reported to be the rate of inflation.

**An Algebraic Example**

This construction can be clarified with a simple two-good example. Suppose that in 1982 the typical market basket contained $X_{1982}$ of good X and $Y_{1982}$ of good Y. The prices of these goods are given by $P_{X_{1982}}$ and $P_{Y_{1982}}$. The cost of this bundle in the 1982 base year would be written as

\[
\text{Cost of bundle in 1982} = B_{1982} = P_{X_{1982}} \cdot X_{1982} + P_{Y_{1982}} \cdot Y_{1982}
\]  

To compute the cost of the same bundle of goods in, say, 2002, we must first collect information on the goods’ prices in that year ($P_{X_{2002}}$, $P_{Y_{2002}}$) and then compute

\[
\text{Cost of bundle in 2002} = B_{2002} = P_{X_{2002}} \cdot X_{1982} + P_{Y_{2002}} \cdot Y_{1982}
\]  

Notice that the quantities purchased in 1982 are being valued at 2002 prices. The CPI is defined as the ratio of the costs of these two market baskets:

\[
\text{CPI (for 2002)} = \frac{B_{2002}}{B_{1982}}
\]  

The rate of inflation can be computed from this index. For example, if a market basket of items that cost $100 in 1982 costs $180 in 2002, the value of the CPI would be 1.80 and we would say there had been an 80 percent increase in prices over this 20-year period. It might (possibly incorrectly) be said that people would need an 80 percent increase in nominal 1982 income to enjoy the same standard of living in 2002 that they had in 1982. Cost-of-living adjustments (COLAs) in Social Security benefits and in many job agreements are calculated in precisely this way. Unfortunately, this approach poses a number of problems.

**Substitution Bias in the CPI**

One problem with the preceding calculation is that it assumes that people who are faced with year 2002 prices will continue to demand the same basket of commodities that they consumed in 1982. This treatment makes no allowance for substitutions among
commodities in response to changing prices. The calculation may overstate the decline in purchasing power that inflation has caused because it takes no account of how people will seek to get the most utility for their dollars when prices change.

In Figure 1, for example, a typical individual initially is consuming $X^{82}, Y^{82}$. Presumably this choice provides maximum utility ($U_1$), given his or her budget constraint in 1982 (which we call $I$). Suppose that by 2002 relative prices have changed in such a way that $P_X/P_Y$ falls—that is, assume that good $Y$ becomes relatively more expensive. Using these new prices, the CPI calculates what $X^{82}, Y^{82}$ would cost. This cost would be reflected by the budget constraint $I'$, which is flatter than $I$ (to reflect the changed prices) and passes through the 1982 consumption point. As the figure makes clear, the erosion in purchasing power that has occurred is overstated. With $I'$, our typical individual could now reach a higher utility level than could have been attained in 1982. The CPI overstates the decline in purchasing power that has occurred.

A true measure of inflation would be provided by evaluating an income level, say, $I''$, which reflects the new prices but just permits the individual to remain on $U_1$. This would take account of the substitutions in consumption that people might make in response to changing relative prices (they consume more $X$ and less $Y$ in moving along $U_1$). Unfortunately, adjusting the CPI to take such substitutions into account is a difficult task—primarily because the typical consumer’s utility function cannot be measured perfectly.

**New Product Bias**

The introduction of new or improved products produces a similar bias in the CPI. New products usually experience sharp declines in prices and rapidly growing rates of acceptance by consumers (consider notebook computers or DVDs, for example). If these goods are not included in the CPI market basket, a major source of welfare gain for consumers will have been omitted. Of course, the CPI market basket is updated every few years to permit new goods to be included. But that rate of revision is often insufficient for rapidly changing consumer markets.

(continued)
Outlet Bias
Finally, the fact that the Bureau of Labor Statistics sends buyers to the same retail outlets each month may overstate inflation. Actual consumers tend to seek out temporary sales or other bargains. They shop where they can make their money go the farthest. In recent years this has meant shopping at giant discount stores such as Wal-Mart or Costco rather than at traditional outlets. The CPI as currently constructed does not take such price-reducing strategies into account.

Consequences of the Biases
Measuring all these biases and devising a better CPI to take them into account is no easy task. Indeed, because the CPI is so widely used as “the” measure of inflation, any change can become a very hot political controversy. Still, there is general agreement that the current CPI may overstate actual increases in the cost of living by as much as 0.75 percent to 1.0 percent per year.² By some estimates, correction of the index could reduce projected federal spending by as much as a half trillion dollars over a 10-year period. Hence, some politicians have proposed caps on COLAs in government programs. Such suggestions have been very controversial, and none has so far been enacted. In private contracts, however, the upward biases in the CPI are frequently recognized. Few private COLAs provide full offsets to inflation as measured by the CPI.

To Think About
1. Would more frequent revision of the market basket used for the CPI ameliorate the various biases outlined here? What problems would arise from using a frequently changing market basket?
2. How should quality improvements be reflected in the CPI? Is a 2003 television the same good as a 1976 television? If not, how will inclusion of “one television” in the CPI market basket affect whether it measures true inflation?

² For a detailed discussion, see the compendium of articles in the Winter 1998 issue of The Journal of Economic Perspectives.

Giffen’s paradox
A situation in which an increase in the price of a good leads people to consume more of that good. An increase in the price of potatoes therefore reduced real income substantially. The Irish were forced to cut back on other food consumption in order to buy more potatoes. Even though this rendering of events is economically implausible, the possibility of an increase in the quantity demanded in response to the price increase of a good has come to be known as Giffen’s paradox.¹

¹ A major problem with this explanation is that it disregards Marshall’s observations that both supply and demand factors must be taken into account when analyzing price changes. If potato prices increased because of a decline in supply due to the potato blight, how could more potatoes possibly have been consumed? Also, since many Irish people were potato farmers, the potato price increase should have increased real income for them. For a detailed discussion of these and other fascinating bits of potato lore, see G. P. Dwyer and C. M. Lindsey, “Robert Giffen and the Irish Potato,” American Economic Review (March 1984): 188–192.
THE LUMP-SUM PRINCIPLE

Economists have had a long-standing interest in studying taxes. We look at such analyses at many places in this book. Here we use our model of individual choice to show how taxes affect utility. Of course, it seems obvious (if we don’t consider the government services that taxes provide) that paying taxes must reduce a person’s utility because purchasing power is reduced. But, through the use of income and substitution effects, we can show that the size of his or her welfare loss will depend on how a tax is structured. Specifically, taxes that are imposed on general purchasing power will have smaller welfare costs than will taxes imposed on a narrow selection of commodities. This “lump-sum principle” lies at the heart of the study of the economics of taxation.

A Graphical Approach

A graphical proof of the lump-sum principle is presented in Figure 3.6. Initially, this person has I dollars to spend and chooses to consume X* and Y*. This combination yields utility level U3. A tax on good X alone would raise its price, and the budget constraint would become steeper. With that budget constraint (shown as line I’ in the figure), a person would be forced to accept a lower utility level (U1) and would choose to consume the combination X1, Y1.

Suppose now that the government decided to institute a general income tax that raised the same revenue as this single-good excise tax. This would shift the individual’s budget constraint to I”. The fact that I” passes through X1, Y1 shows that both taxes raise the same amount of revenue. However, with the income tax budget constraint I”, this person will choose to consume X2, Y2 (rather than X1, Y1). Even though the individual pays the same tax bill in both instances, the combination chosen under the income tax yields a higher utility (U2) than does the tax on a single commodity.

Substitution effects take particularly simple forms in some cases. Describe these effects for:

1. Left shoes and right shoes (as shown in Figure 2.5d).
2. Exxon and Mobil gasoline (as shown in Figure 2.5c).

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MicroQuiz 3.2

Substitution effects take particularly simple forms in some cases. Describe these effects for:

1. Left shoes and right shoes (as shown in Figure 2.5d).
2. Exxon and Mobil gasoline (as shown in Figure 2.5c).

Algebra shows why this is true. With the sales tax (where the tax rate is given by t) the individual’s budget constraint is

\[ I = I’ = (P_X + t) X_1 + P_Y Y_1 \]

Total tax revenues are given by

\[ T = tX_1 \]

With an income tax that collected the same revenue, after-tax income is

\[ I” = I – T = P_X X_1 + P_Y Y_1 \]

which shows that I” passes through the point X1, Y1 also.
An intuitive explanation of this result is that a single-commodity tax affects people’s well-being in two ways: It reduces general purchasing power (an income effect), and it directs consumption away from the taxed commodity (a substitution effect). An income tax incorporates only the first effect, and, with equal tax revenues raised, individuals are better off under it than under a tax that also distorts consumption choices.

**Generalizations**

More generally, the demonstration of the lump-sum principle in Figure 3.6 suggests that the utility loss associated with the need to collect a certain amount of tax revenue can be kept to a minimum by taxing goods for which substitution effects are small. By doing so, taxes will have relatively little welfare effect beyond their direct effect on purchasing power. On the other hand, taxes on goods for which there are many substitutes will cause individuals to alter their consumption plans in major ways. This additional distortionary effect raises the overall utility cost of such taxes to consumers. In Application 3.3: Wouldn’t Cash Be a Better Way to Help Poor People, we look at a few implications of these observations for welfare policy.

**FIGURE 3.6 The Lump-Sum Principle** An excise tax on good X shifts the budget constraints to \( I' \). The individual chooses \( X_1, Y_1 \) and receives utility of \( U_1 \). A lump-sum tax that collects the same amount shifts the budget constraint to \( I'' \). The individual chooses \( X_2, Y_2 \) and receives more utility (\( U_2 \)).
Most countries provide a wide variety of programs to help poor people. In the United States, there is a general program for cash assistance to low-income families, but most anti-poverty spending is done through a variety of “in-kind” programs such as Food Stamps, Medicaid, and low-income housing assistance. Such programs have expanded very rapidly during the past 30 years, whereas the cash program has tended to shrink (especially following the 1996 welfare reform initiative).

Inefficiency of In-Kind Programs
The lump-sum principle suggests that these trends may be unfortunate because the in-kind programs do not generate as much welfare for poor people as would the spending of the same funds in a cash program. The argument is illustrated in Figure 1. The typical low-income person’s budget constraint is given by \( I \) prior to any assistance. This yields a utility of \( U_1 \). An anti-poverty program that provided, say, good \( X \) at a highly subsidized price would shift this budget constraint to \( I' \) and raise this person’s utility to \( U_2 \). If the government were instead to spend the same funds\(^1\) on a pure income grant to this person, his or her budget constraint would be \( I'' \) and this would permit a higher utility to be reached (\( U_3 \)). Hence, the in-kind program is inefficient in terms of raising the utility of this low-income person.

There is empirical evidence supporting this conclusion. Careful studies of spending patterns of poor people suggest that a dollar spent on food subsidy programs is “worth” only about $.90 to the recipients. A dollar in medical care subsidies may be worth only about $.70, and housing assistance may be worth less than $.60. Spending on these kinds of in-kind programs therefore may not be an especially effective way of raising the utility of poor people.

---

\(^1\) Budget constraints \( I' \) and \( I'' \) represent the same government spending because both permit this person to consume point B.

(continued)
Paternalism and Donor Preferences
Why have most countries favored in-kind programs over cash assistance? Undoubtedly, some of this focus stems from paternalism—policymakers in the government may feel that they have a better idea of how poor people should spend their incomes than do poor people themselves. In Figure 1, for example, X purchases are indeed greater under the in-kind program than under the cash grant though utility is lower. A related possibility is that “donors” (usually taxpayers) have strong preferences for how aid to poor people should be provided. Donors may care more about providing food or medical care to poor people than about increasing their overall welfare. Political support for (seemingly more efficient) cash grants is simply nonexistent.

To Think About
1. How should the welfare of children be factored into Figure 1 (which may only reflect the decision making of the head-of-household)?
2. Some people fear that cash grants may affect the work incentives of poor people. Would similar concerns apply to in-kind programs?

CHANGES IN THE PRICE OF ANOTHER GOOD
A careful examination of our analysis so far would reveal that a change in the price of X will also have an effect on the quantity demanded of the other good (Y). In Figure 3.3, for example, a decrease in the price of X causes not only the quantity demanded of X to increase but the quantity demanded of Y to increase as well. We can explain this result by looking at the substitution and income effects on the demand for Y associated with the decrease in the price of X.

First, as we see in Figure 3.3, the substitution effect caused less Y to be demanded. In moving along the indifference curve \( U_1 \) from A to B, X is substituted for Y because the lower ratio of \( P_X/P_Y \) required an adjustment in the MRS. In this figure, the income effect of the decline in the price of good X is strong enough to reverse this result. Because Y is a normal good and real income has increased, more Y is demanded: The individual moves from B to C. Here \( Y^{**} \) exceeds \( Y^* \), and the total effect of the price change is to increase the demand for Y.

A slightly different set of indifference curves (that is, different preferences) could have shown different results. Figure 3.7 shows a relatively flat set of indifference curves where the substitution effect from a decline in the price of X is very large. In moving from A to B, a large amount of X is substituted for Y. The income effect on Y is not strong enough to reverse this large substitution effect. In this case, the quantity of Y finally chosen (\( Y^{**} \)) is smaller than the original amount. The effect of a decline in the price of one good on the quantity demanded of some other good is ambiguous; it all depends on what the person’s preferences, as reflected by his or her indifference curve map, look like. We have
to examine carefully income and substitution effects that (at least in the case of only two goods) work in opposite directions.

**Substitutes and Complements**

Economists use the terms *substitutes* and *complements* to describe the way people look at the relationships between goods. Complements are goods that go together in the sense that people will increase their use of both goods simultaneously. Examples of complements might be coffee and cream, fish and chips, peanut butter and jelly, or gasoline and automobiles. Substitutes, on the other hand, are goods that can replace one another. Tea and coffee, Hondas and Pontiacs, or owned versus rented housing are some goods that are substitutes for each other.

Whether two goods are substitutes or complements of each other is primarily a question of the shape of people’s indifference curves. The market behavior of

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**FIGURE 3.7 Effect on the Demand for Good Y of a Decrease in the Price of Good X**

In contrast to Figure 3.3, the quantity demanded of Y now declines (from $Y^*$ to $Y^{**}$) in response to a decrease in the price of X. The relatively flat indifference curves cause the substitution effect to be very large. Moving from A to B means giving up a substantial quantity of Y for additional X. This effect more than outweighs the positive income effect (from B to C), and the quantity demanded of Y declines. So, purchases of Y may either rise or fall when the price of X falls.
individuals in their purchases of goods can help economists to discover these relationships. Two goods are **complements** if an increase in the price of one causes a decrease in the quantity consumed of the other. For example, an increase in the price of coffee might cause not only the quantity demanded of coffee to decline but also the demand for cream to decrease because of the complementary relationship between cream and coffee. Similarly, coffee and tea are **substitutes** because an increase in the price of coffee might cause the quantity demanded of tea to increase as tea replaces coffee in use.

How the demand for one good relates to the price increase of another good is determined by both income and substitution effects. It is only the combined gross result of these two effects that we can observe. Including both income and substitution effects of price changes in our definitions of substitutes and complements can sometimes lead to problems. For example, it is theoretically possible for X to be a complement for Y and at the same time for Y to be a substitute for X. This perplexing state of affairs has led some economists to favor a definition of substitutes and complements that looks only at the direction of substitution effects.3 We do not make that distinction in this book.

In Application 3.4: Why Are So Many “Trucks” on the Road?, we take a brief look at some of the complex relationships between gas prices and what people drive.

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**MicroQuiz 3.3**

Changes in the price of another good create both income and substitution effects in a person’s demand for, say, coffee. Describe those effects in the following cases and state whether they work in the same direction or in opposite directions in their total impact on coffee purchases.

1. A decrease in the price of tea
2. A decrease in the price of cream

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**CONSTRUCTION OF INDIVIDUAL DEMAND CURVES**

We have now completed our discussion of how the individual’s demand for good X is affected by various changes in economic circumstances. We started by writing the demand function for good X as

\[
\text{Quantity of } X \text{ demanded} = d_x(P_X, P_Y, I; \text{preferences})
\]

Then we examined how changes in each of the economic factors \( P_X, P_Y, \) and \( I \) might affect an individual’s decision to purchase good X. The principle purpose

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1 For a slightly more extended treatment for this subject, see Walter Nicholson, *Microeconomic Theory: Basic Principles and Extensions*, 8th ed. (Mason, OH: South-Western/Thomson Learning), 154–158. For a complete treatment, see J. R. Hicks, *Value and Capital* (London: Cambridge University Press, 1939), Chapter 3 and the mathematical appendix.
Motor vehicle registrations in the United States have shown a remarkable change over the past 10 years. In 1990, fewer than 30 percent of the vehicles on U.S. roads were “trucks” whereas by 2000 that figure had increased to over 40 percent. Virtually all of the new vehicle registrations during the 1990s were trucks. How is it that people in the United States have such a great need to transport things?

What Is a “Truck”?
Of course, the huge gain in truck registrations does not mean that most people in the United States are driving 18-wheelers. Rather, the issue is one of definition. The U.S. Department of Transportation regards a wide variety of automobile-like vehicles as “trucks” for purposes of data collection. These include vans, minivans, mobile homes, and (most important) sport-utility vehicles (SUVs). The data reflect a huge increase in the popularity of these autolike vehicles during the 1990s. People in the United States have proven more than willing to make substitutions in the types of vehicles they buy.

Relative Price Effects
One of the most important reasons for the trend toward SUVs and their ilk has been a sharp decline in real gasoline prices. In the late 1980s, gasoline sold for about $1.50 per gallon with that price falling to about $1.10 by 1999. In inflation-adjusted terms, the real price of gasoline declined by over 40 percent. This had the effect of significantly reducing the relative costs of operating trucklike vehicles. Suppose that the typical SUV averages about 15 miles per gallon of gasoline and is driven 15,000 miles per year. The savings from lower fuel prices on the 1,000 gallons of gasoline used during the year would amount to perhaps $800. This might be as much as 15 to 20 percent of the overall operating cost of an SUV during the year. For a similarly priced but higher-mileage automobile, the percent reduction might only be in the 5 to 10 percent range. Hence, the relative price (remember, *relative prices* are what matter in consumers’ choices) of SUVs fell rather significantly. Clearly, the decline in relative operating costs had a major impact in causing people to substitute away from more traditional automobiles.

The Unintended Effects of Regulations
Part of the increased buying of trucklike vehicles can also be explained as unintended side effects of various governmental regulations that were (perhaps paradoxically) intended to reduce gasoline usage. One set of regulations was the Corporate Average Fuel Economy (CAFE) standards that required automakers to achieve certain average miles-per-gallon goals on their annual car sales. “Trucks” were generally exempt from the CAFE standards, so firms could freely market all types of SUVs but had to be more careful about the numbers of large cars they sold. A 1991 tax on “gas guzzlers” put large automobiles at a further disadvantage relative to trucks by imposing taxes of as much as $5,000 on cars with especially low mileage ratings.

(continued)
The End of the Large SUV Era?
Several factors suggest that U.S. consumers’ infatuation with “trucks” may be coming to an end. After 2000, gas prices have tended to move upward, reaching perhaps $1.45 by mid-2002 (still well below the real prices of the 1980s). Congress, perhaps embarrassed by the emergence of super-large SUVs such as the Ford Excursion, the GMC Yukon, or the Toyota Sequoia, has belatedly moved to start the inclusion of SUVs under the CAFE standards. Perhaps most important, several automakers have introduced smaller, more fuel-efficient SUVs that are built on automobile bodies (the Honda CRV, for example, is built on the Civic frame). For many buyers, these may provide a better match to the characteristics they are seeking than do the large SUVs.

To Think About
1. Why does the government have fuel economy standards? Doesn’t the attempt to regulate how much gasoline people buy conflict with our more general presumptions that consumers should, within the limits of the law, be able to make up their own minds about what they wish to consume?
2. Passengers in large SUVs are much less likely to suffer injuries in crashes—especially when an SUV collides with a small car. Is this an additional area where the government should seek to limit consumer choices by prescribing size limits for cars? Or should people be able to buy as much “safety” as they would like?

Individual demand curve
A graphic representation of the relationship between the price of a good and the quantity of it demanded by a person, holding all other factors constant.
The information in panel a in Figure 3.8 can be used to construct the demand curve shown in panel b. The price of X is shown on the vertical axis, and the quantity chosen continues to be shown on the horizontal axis. The demand curve \(d_X\) is downward sloping, showing that when the price of X falls, the quantity demanded of X increases. As we have shown, this increase represents both the substitution and income effects of the price decline.

**FIGURE 3.8 Construction of an Individual’s Demand Curve** In panel a, the individual’s utility-maximizing choices of X and Y are shown for three successively lower prices of X. In panel b, this relationship between \(P_X\) and X is used to construct the demand curve for X. The demand curve is drawn on the assumption that the price of Y and money income remain constant as the price of X varies.
Shape of the Demand Curve

The precise shape of the demand curve is determined by the income and substitution effects that occur when the price of $X$ changes. A person’s demand curve may be either rather flat or quite steeply sloped, depending on the nature of his or her indifference curve map. If $X$ has many close substitutes, the indifference curves will be nearly straight lines (such as those shown in Figure 3.7), and the substitution effect from a price change will be very large. The quantity of $X$ chosen may fall substantially in response to a rise in its price; consequently, the demand curve will be relatively flat. For example, consider a person’s demand for one particular brand of cereal (say, the famous Brand X). Because any one brand has many close substitutes, the demand curve for Brand X will be relatively flat. A rise in the price of Brand X will cause people to shift easily to other kinds of cereal, and the quantity demanded of Brand X will be reduced significantly.

On the other hand, a person’s demand curve for some goods may be steeply sloped. That is, price changes will not affect consumption very much. This might be the case if the good has no close substitute. For example, consider a person’s demand for water. Because water satisfies many unique needs, it is unlikely that it would have any substitutes when the price of water rose, and the substitution effect would be very small. However, since water does not use up a large portion of a person’s total income, the income effect of the increase in the price of water would also not be large. The quantity demanded of water probably would not respond greatly to changes in its price; that is, the demand curve would be nearly vertical.

As a third possibility, consider the case of food. Because food as a whole has no substitutes (although individual food items obviously do), an increase in the price of food will not induce important substitution effects. In this sense, food is similar to our water example. However, food is a major item in a person’s total expenditures, and an increase in its price will have a significant effect on purchasing power. It is possible, therefore, that the quantity demanded of food may be reduced substantially in response to a rise in food prices because of this income effect. The demand curve for food might be flatter (that is, demand reacts more to price) than we might expect if we thought of food only as a “necessity” with few, if any, substitutes.\footnote{For this reason, sometimes it is convenient to talk about demand curves that reflect only substitution effects. We do not study such “compensated” demand curves in this book, however.}

SHIFTS IN AN INDIVIDUAL’S DEMAND CURVE

An individual’s demand curve summarizes the relationship between the price of $X$ and the quantity demanded of $X$ when all the other things that might affect demand are held constant. The income and substitution effects of changes in that
price cause the person to move along his or her demand curve. If one of the factors (the price of Y, income, or preferences) that we have so far been holding constant were to change, the entire curve would shift. The demand curve remains fixed only while the *ceteris paribus* assumption is in effect. Figure 3.9 shows the kinds of shifts that might take place. In panel a, the effect on good X of an increase in income is shown. Assuming that good X is a normal good, an increase in income causes more X to be demanded at each price. At $P_1$, for example, the quantity of X demanded rises from $X_1$ to $X_2$. This is the kind of effect we described early in this chapter (Figure 3.1). When income increases, people buy more X even if its price has not changed, and the demand curve shifts outward.

Panels b and c in Figure 3.9 record two possible effects that an increase in the price of Y might have on the demand curve for good X. In panel b, X and Y are assumed to be substitutes—for example, coffee (X) and tea (Y). An increase in the price of tea causes the individual to substitute coffee for tea. More coffee (that is, good X) is demanded at each price than was previously the case. At $P_1$, for example, coffee demand increases from $X_1$ to $X_2$.

On the other hand, suppose X and Y are complements—for example, coffee (X) and cream (Y). An increase in the price of cream causes the demand curve for coffee to shift inward. Because coffee and cream go together, less coffee (that is, good X) will now be demanded at each price. This shift in the demand curve is shown in panel c—at $P_1$, coffee demand falls from $X_1$ to $X_2$.

Changes in preferences might also cause the demand curve to shift. For example, a sudden warm spell would undoubtedly shift the entire demand curve for cold drinks outward. More drinks would be demanded at each price because now

**FIGURE 3.9 Shifts in an Individual’s Demand Curve** In panel a, the demand curve shifts outward because the individual’s income has increased. More X is now demanded at each price. In panel b, the demand curve shifts outward because the price of Y has increased, and X and Y are substitutes for the individual. In panel c, the demand curve shifts inward because of the increase in the price Y; that is, X and Y are complements.
each person’s desire for them has increased. Similarly, increased environmental consciousness during the 1980s and 1990s vastly increased the demand for such items as recycling containers and organically grown food. Application 3.5: Fads, Seasons, and Health Scares explores a few other reasons why demand curves might shift.

**MicroQuiz 3.4**

The following statements were made by two reporters describing the same event. Which reporter (if either) gets the distinction between shifting a demand curve and moving along it correct?

*Reporter 1.* The freezing weather in Florida will raise the price of oranges and people will reduce their demand for oranges. Because of this reduced demand, producers will get lower prices for their oranges than they might have and these lower prices will help restore orange purchases to their original level.

*Reporter 2.* The freezing weather in Florida raises orange prices and reduces the demand for oranges. Orange growers should therefore accustom themselves to lower sales even when the weather returns to normal.

**Increase or decrease in quantity demanded**
The increase or decrease in quantity demanded caused by a change in the good’s price. Graphically represented by the movement along a demand curve.

**Increase or decrease in demand**
The change in demand for a good caused by changes in the price of another good, in income, or in preferences. Graphically represented by a shift of the entire demand curve.

**Be Careful in Using Terminology**

It is important to be careful in making the distinction between shifting a demand curve and moving along a stationary demand curve. Changes in the price of X lead to movements along the demand curve for good X. Changes in other economic factors (such as a change in income, a change in another good’s price, or a change in preferences) cause the entire demand curve for X to shift. If we wished to see how a change in the price of steak would affect a person’s steak purchases, we would use a single demand curve and study movements along it. On the other hand, if we wanted to know how a change in income would affect the quantity of steak purchased, we would have to study the shift in the position of the entire demand curve.

To keep these matters straight, economists must speak carefully. The movement downward along a stationary demand curve in response to a fall in price is called an increase in quantity demanded. A shift outward in the entire curve is an increase in demand. A rise in the price of a good causes a decrease in quantity demanded (a move along the demand curve), whereas a change in some other factor may cause a decrease in demand (a shift of the entire curve to the left). It is important to be precise in using those terms; they are not interchangeable.

**CONSUMER SURPLUS**

Demand curves provide a considerable amount of information about the willingness of people to make voluntary transactions. Because demand curves are in principle measurable, they are much more useful for studying economic behavior in the real world than are utility functions. One important application uses demand curves to study the consequences of price changes for people’s overall welfare. This technique relies on the concept of consumer surplus—a concept we
The notion that changes in preferences can influence the demand for products incorporates a wide variety of possible cultural and psychological influences. Let’s look at a few.

**Fads**

Products such as Holiday Barbies, Beanie Babies, and Super Nintendo systems all experienced extremely rapid growth in demand when they were initially introduced, followed by an equally rapid loss of consumer interest. The widespread use of a product among consumers actually generates additional demand until a saturation point is reached. Then, demand falls precipitously. Such temporary bursts of demand (sometimes termed *bandwagon effects*) arise because of the interdependence among people’s preferences—everyone wants to be part of the latest craze. This recurring pattern in the product fad’s purchasing indicates a rather predictable demand for such products. Predicting exactly which products will catch on, however, is a mystery.

**Seasonality**

Season-sensitive goods are the polar opposites of fad products when it comes to predictability. Everyone knows that the demand for wedding cakes increases in June, that turkeys are mostly consumed at Thanksgiving, and that Christmas trees are bought in December. Seasonality also affects the demand for less familiar items. A famous early study of New England fishing, for example, found that the demand for scrod (New Englandese for small cod) regularly increased by about 13 percent during Lent because of the dietary restrictions imposed during this period by the Catholic Church upon its members.1 All these seasonal patterns show that preferences are formed through a variety of long-term historical and cultural influences. This is one reason why economists tend to treat them as being stable over short periods.

**Health Scares**

Some of the more rapid shifts in demand in recent years have been associated with changing perceptions by consumers about the health risks associated with various products. Concern about the risks of smoking, for example, has resulted in a long-term reduction in the number of smokers in the United States since the Surgeon General’s report of 1964. Concern about cholesterol has led to similar long-term declines in individuals’ demands for beef and dairy products.

Health concerns have also had dramatic short-term effects on demand. A 1982 incident in Chicago in which cyanide tablets were inserted into a few Tylenol bottles reduced the demand for that product by more than 50 percent. Finding two cyanide-injected grapes in 1988 caused the demand for Chilean fruits to drop dramatically. A 1993 study of the fat content of Chinese food caused a large decline in sales at Chinese restaurants.

Many times the demand for food items may react strongly to recent “scientific” studies. European demand for American beef dropped sharply in 1997 following some suggestions

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(continued)
(subsequently disproved) that growth hormones fed to cattle are unsafe. Studies purporting to show health benefits from eating tomatoes had an important effect on demand in 1998, though many were skeptical of the study’s methods.

To Think About
1. Does the unpredictability of demand affect the profits firms might earn on a product? Why might turkeys or Christmas trees yield relatively small profits, whereas fad products often are quite profitable? (See Part 4 for further analysis.)
2. Do you think people often overreact to “scientific” studies of the health effects of consuming certain foods? How should a consumer choose among food items when the science is unclear?

examine in this section. The tools developed here are widely used by economists to study the effects of public policies on the welfare of citizens.

Demand Curves and Consumer Surplus

In order to understand the consumer surplus idea, we begin by thinking about an individual’s demand curve for a good in a slightly different way. Specifically, each point on such a demand curve can be regarded as showing what a person would be willing to pay for one more unit of the good. Demand curves slope downward because this “marginal willingness to pay” declines as a person consumes more of a given good. On the demand curve for T-shirts in Figure 3.10, for example, this person chooses to consume ten T-shirts when the price is $11. In other words, this person is willing to pay $11 for the tenth T-shirt he or she buys. With a price of $9, on the other hand, this person chooses fifteen T-shirts, so, implicitly, he or she values the fifteenth shirt at only $9. Viewed from this perspective then, a person’s demand curve tells us quite a bit about his or her willingness to pay for different quantities of a good.

Because a good is usually sold at a single market price, people choose to buy additional units of the good up to the point at which their marginal valuation is equal to that price. In Figure 3.10, for example, if T-shirts sell for $7, this person will buy twenty T-shirts because the twentieth T-shirt is worth precisely $7. He or she will not buy the twenty-first T-shirt because it is worth less than $7 (once this person already has twenty T-shirts). Because this person would be willing to pay more than $7 for the tenth or the fifteenth T-shirt, it is clear that this person gets a “surplus” on those shirts because he or she is actually paying less than the maximal amount that would willingly be paid. Hence, we have a formal definition of consumer surplus as the difference between the maximal amounts a person would pay for a good and what he or she actually pays. In graphical terms, consumer surplus is given by the area below the demand curve and above the market price. The concept is measured in dollars.
Because the demand curve in Figure 3.10 is a straight line, the computation of consumer surplus is especially simple. It is just the area of triangle AEB. When the price of T-shirts is $7, the size of this area is $0.5 \cdot 20 \cdot (\$15 - \$7) = \$80$. When this person buys twenty T-shirts at $7$, he or she actually spends $\$140$ but also receives a consumer surplus of $\$80$. If we were to value each T-shirt at the maximal amount this person would pay for that shirt, we would conclude that the total value of the twenty T-shirts he or she consumes is $\$220$, but they are bought for only $\$140$.

A rise in price would reduce this person’s consumer surplus from T-shirt purchases. At a price of $\$11$, for example, he or she buys ten T-shirts and consumer surplus would be computed as $0.5 \cdot 10 \cdot (\$15 - \$11) = \$20$. Hence, $\$60$ of consumer surplus has been lost because of the rise in the price of T-shirts from $\$7$ to $\$11$. Some of this loss in consumer surplus went to shirt-makers because this person must pay $\$40$ more for the ten T-shirts he or she does buy than was the case when the price was $\$7$. The other $\$20$ in consumer surplus just disappears.

In later chapters, we see how computations of this type can be used to judge the consequences of a wide variety of economic situations in which prices change. Application 3.6: Valuing Clean Air shows an application of the concept to environmental policy.

**Consumer Surplus and Utility**

The concept of consumer surplus can be tied directly to the theory of utility maximization we have been studying. Specifically, consumer surplus provides a way of putting a monetary value on the effects that changes in the marketplace have on people’s utility. Consumer surplus is not really a new concept but just an alternative way of getting at the utility concepts with which we started the study of demand.
In recent years, a variety of environmental laws have been passed to clean up the nation’s air, water, and land. Many of these actions are quite expensive with costs running into the billions of dollars. In order to determine whether such costs are warranted, economists have devised some ingenious procedures for evaluating the benefits that environmental regulations provide.

**Estimating a Demand Curve**

One method economists use to evaluate improvements is to look at how environmental factors affect measurable values in related markets. For example, by looking at the *ceteris paribus* relationship between air pollution levels in various locations and the prices of houses in these locations, it is possible to infer the amount that people will pay to avoid dirty air. One study of six metropolitan areas found that home owners were willing to pay between $20 and $80 more for a house in order to avoid one extra microgram of suspended particulates per cubic meter of air. Using this information, it is possible to compute a demand curve for clean air as shown in Figure 1. The vertical axis shows the price home buyers seem willing to pay to avoid air pollution, and the horizontal axis shows the quantity of clean air purchased. Here, clean air is measured by the number of suspended particles and ranges from very dirty (100 micrograms per cubic meter) to very clean (0 micrograms per cubic meter).

**Consumer Surplus and the Value of Clean Air**

Figure 1 shows that on average people are spending $2,250 (= $50 times a reduction of 45 micrograms of particulates) extra in housing costs to avoid dirty air. But this reflects only

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part of the value of cleaner air to consumers. At point E, individuals also receive a consumer surplus represented by the shaded triangle in the figure. This represents the additional amount that consumers would be willing to pay rather than being forced to live with dirty air. The value represented by this triangle is $788 (= [85 – 50] \cdot [45] \div 2)$. This value can be multiplied by the total number of households to estimate the total consumer surplus from clean air.

**To Think About**
1. What is the total value of completely clean air for the typical person illustrated in Figure 1? How might this figure be used to evaluate environmental clean-up activities?
2. Does the use of a linear demand curve in Figure 1 seem reasonable? What does the curve imply about individuals’ willingness to tolerate extra dirty air (more than 100 mg/m³)?

Figure 3.11 illustrates the connection between consumer surplus and utility. The figure shows a person’s choices between a particular good (here again we use the T-shirt example) and “all other” goods he or she might buy. The budget constraint shows that with a $7 price and a budget constraint given by line I, this person would choose to consume twenty T-shirts along with $500 worth of other items. Including the $140 spent on T-shirts, total spending on all items would be $640. This consumption plan yields a utility level of U₁ to this person.

Now consider a situation in which T-shirts were not available—perhaps they are banned by a paternalistic government that objects to slogans written on the shirts. In this situation, this person requires some compensation if he or she is to continue to remain on the U₁ indifference curve. Specifically, an extra income given by distance AB would just permit this person to reach U₁ when there are no T-shirts available. It is possible to show that this dollar value is approximately equal to the consumer surplus figure computed in the previous section—that is, distance AB is approximately $80. Hence, consumer surplus can also be interpreted as measuring the amount one would have to compensate a person for withdrawing a product from the marketplace.

A somewhat different way to measure consumer surplus would be to ask how much income this person would be willing to pay for the right to consume T-shirts at $7 each. This amount would be given by distance BC in Figure 3.11. With a budget constraint given by \( I' \), this person can achieve that same utility level (U₀) that he or she could obtain with budget constraint I throughout this book, we see that consumer surplus areas are often triangular.

1. Explain why this area is measured in dollars. (Hint: What are the units of the height and width of the consumer surplus triangle?)
2. Suppose that the price of a product rose by 10 percent. Would you expect the size of the consumer surplus triangle to fall by more or less than 10 percent?
if no T-shirts were available. Again, it is possible to show\(^5\) that this amount also is approximately equal to the consumer surplus figure calculated in the previous section ($80). In this case, the figure represents the amount that a person would voluntarily give up in exchange for dropping a no-T-shirt law. Hence, both approaches reach the same conclusion—that consumer surplus provides a way of putting a dollar value on the utility people gain from being able to make market transactions.

Increases in the market price of T-shirts would again reduce these consumer surplus/utility measures. The correspondence between Figure 3.10 and Figure 3.11 would permit us to continue to study the welfare consequences of price changes using either graph. Because it is usually much easier to study these matters using a demand curve, however, that is the approach we take in later chapters.

\(^5\) For a theoretical treatment of these issues, see R. D. Willig, “Consumer’s Surplus without Apology,” *American Economic Review* (September 1976): 589–597. Willig shows that distance AB in Figure 3.11 (which is termed the “compensating income variation”) exceeds total consumer surplus whereas distance BC (termed the “equivalent income variation”) is smaller than consumer surplus. All three measures approach the same value if income effects in the demand for the good in question are small.
SUMMARY

This chapter uses the model of individual choice to examine how people react to changes in income or prices. We have come to several important conclusions about the demand for a good:

- Proportionate changes in all prices and income will not affect choices because such changes do not shift the budget constraint.
- When income alone increases, the demand for a good will increase unless that good is inferior.
- A change in the price of a good has substitution and income effects that together cause changes in consumption choices. Except in the unlikely case of Giffen’s paradox, a reduction in a good’s price will cause more of it to be demanded. An increase in price will cause less of the good to be demanded.
4. Ivan always buys left and right shoes in pairs. Explain why a sale on right shoes will have an income effect but no substitution effect on his left and right shoe purchases.

5. Suppose George doesn’t care what brand of toothpaste he buys. Show graphically why he will always buy the cheapest brand.

6. Is the following statement true or false? Explain. “Every Giffen good must be inferior, but not every inferior good exhibits the Giffen paradox.”

7. Suppose that Eve never changes the quantity of water she consumes when the price of water changes. How do income and substitution effects work in this case?

8. When coffee prices rise, John buys more tea but fewer coffee mugs. Explain the substitution and income effects of the price change on these two goods.

9. Does the theory of consumer choice require that an individual’s demand curve for a good be downward sloping? In what case would a demand curve be vertical? When might it be positively sloped?

10. Explain whether the following events would result in a move along an individual’s demand curve for popcorn or in a shift of the curve. If the curve would shift, in what direction?
   a. An increase in the individual’s income
   b. A decline in popcorn prices
   c. An increase in prices for pretzels
   d. A reduction in the amount of butter included in a box of popcorn
   e. The presence of long waiting lines to buy popcorn
   f. A sales tax on all popcorn purchases

### PROBLEMS

#### 3.1
Elizabeth M. Suburbs makes $200 a week at her summer job and spends her entire weekly income on new running shoes and designer jeans, since these are the only two items that provide utility to her. Furthermore, Elizabeth insists that for every pair of jeans she buys, she must also buy a pair of shoes (without the shoes, the new jeans are worthless). Therefore, she buys the same number of pairs of shoes and jeans in any given week.

a. If jeans cost $20 and shoes cost $20, how many will Elizabeth buy in each?

b. Suppose that the price of jeans rises to $30 a pair. How many shoes and jeans will she buy?

c. Show your results by graphing the budget constraints from part a and part b. Also draw Elizabeth’s indifference curves.

d. To what effect (income or substitution) do you attribute the change in utility levels between part a and part b?

#### 3.2
Consider again the clothing choices of Ms. Suburbs from problem 3.1. Assume again that she always buys running shoes and jeans in combination and that initially the price of shoes is $20 and that her income is $200.

a. How many pairs of jeans will this person choose to buy if jeans prices are $30, $20, $10, or $5?

b. Use the information from part a to graph Ms. Suburbs’s demand curve for jeans.

c. Suppose that her income rises to $300. Graph her demand curve for jeans in this new situation.

d. Suppose that the price of running shoes rises to $30 per pair. How will this affect the demand curves drawn in part b and part c?

#### 3.3
The Jones family spends all its income on food and shelter. It derives maximum utility when it spends two-thirds of its income on shelter and one-third on food.

a. Use this information to calculate the demand functions for shelter and food. Show that demand is homogeneous with respect to changes in all prices and income.

b. Graph the demand curves for shelter and food for the Jones family if family income is $20,000.
c. Show how the demand curves for shelter and food would shift if income rose to $50,000.

d. Explain why a change in food prices does not affect shelter purchases in this problem.

3.4 Mr. Wright, a clothing salesman, is forced by his employer to spend at least $100 of his weekly income of $500 on clothing. Show that his utility level is lower than if he could freely allocate his income between clothing and other goods.

3.5 Pete Moss buys 100 units of fertilizer and 80 units of grass seed along with quantities of other goods. The price of fertilizer rises by $.40 per unit, and the price of grass seed drops by $.50 per unit; other prices and Pete’s income remain unchanged. Will Pete buy more, less, or the same amount of fertilizer? Explain. (Hint: How do the price changes affect Pete’s budget constraint?)

3.6 David gets $3 per month as an allowance to spend any way he pleases. Since he likes only peanut butter and jelly sandwiches, he spends the entire amount on peanut butter (at $.05 per ounce) and jelly (at $.10 per ounce). Bread is provided free of charge by a concerned neighbor. David is a picky eater and makes his sandwiches with exactly 1 ounce of jelly and 2 ounces of peanut butter. He is set in his ways and will never change these proportions.

a. How much peanut butter and jelly will David buy with his $3 allowance in a week?

b. Suppose the price of jelly were to rise to $.15 per ounce. How much of each commodity would be bought?

c. By how much should David’s allowance be increased to compensate for the rise in the price of jelly? (Hint: See part b.)

d. Graph your results of part a through part c.

e. What seem to be the problem’s single commodity—peanut butter and jelly sandwiches? Graph the demand curve for this single commodity.

f. Discuss the results of this problem in terms of the income and substitution effects involved in the demand for jelly.

3.7 Each year Sam Mellow grows 200 units of wheat and 100 units of sunflower seeds for his own consumption and for sale to the outside world. Wheat and sunflower seeds are the only two items that provide utility to Sam. They are also his only source of income. Sam cannot save his proceeds from year to year.

a. If the price of wheat is $2 per unit and sunflower seeds sell for $10 per unit, Sam chooses to sell 20 units of the sunflower seeds he produces while retaining 80 units for his own use. Show Sam’s utility-maximizing production levels and the amount of additional wheat he will buy with the proceeds from his sunflower seed sales.

b. Suppose sunflower seed prices fall to $6 per unit while wheat prices remain unchanged. Will Sam be made better or worse off by this price decline? Or is the situation ambiguous? Explain carefully using a graphic analysis. Show that if Sam is to be made better off by the price decline he must become a seller of wheat and a buyer of sunflower seeds.

c. Explain using the terms income effect and substitution effect why the analysis in part b differs from the usual case in which a price decline always increases an individual’s utility level.

(Hint: To begin this problem, show that Sam’s budget constraint always passes through the point Wheat = 200, Sunflower seeds = 100.)

3.8 Irene’s demand for pizza is given by:

\[ Q = \frac{0.3I}{P} \]

where \( Q \) is the weekly quantity of pizza bought (in slices), \( I \) is weekly income, and \( P \) is the price of pizza. Using this demand function, answer the following:

a. Is this function homogeneous in \( I \) and \( P \)?

b. Graph this function for the case \( I = 200 \).

c. One problem in using this function to study consumer surplus is that \( Q \) never reaches zero no matter how high \( P \) is. Hence, suppose that the function holds only for \( P \leq 10 \) and that \( Q = 0 \) for
10. How should your graph in part b be adjusted to fit this assumption?

d. With this demand function (and I = 200), it can be shown that the area of consumer surplus is approximately \( CS = 198 - 6P - 60 \ln(P) \) where “ln(P)” refers to the natural logarithm of P. Show that if P = 10, CS = 0.

e. Suppose P = 3. How much pizza is demanded and how much consumer surplus does Irene receive? Give an economic interpretation to this magnitude.

f. If P were to increase to 4, how much would Irene demand and what would her consumer surplus be? Give an economic interpretation to why the value of CS has fallen.

3.9 The demand curves we studied in this chapter were constructed holding a person’s nominal income constant—hence, changes in prices introduced changes in real income (that is, utility). Another way to draw a demand curve is to hold utility constant as prices change. That is, the person is “compensated” for any effects that the prices have on his or her utility. Such compensated demand curves illustrate only substitution effects, not income effects. Using this idea, show that:

a. For any initial utility-maximizing position, the regular demand curve and the compensated demand curve pass through the same price/quantity point.

b. The compensated demand curve is generally steeper than the regular demand curve.

c. Any regular demand curve intersects many different compensated demand curves.

d. If Irving consumes only pizza and chianti in fixed proportions of one slice of pizza to one glass of chianti, his regular demand curve for pizza will be downward-sloping but his compensated demand curve(s) will be vertical.

3.10 The residents of Uurp consume only pork chops (X) and Coca-Cola (Y). The utility function for the typical resident of Uurp is given by

\[ U(X, Y) = \sqrt{X \cdot Y} \]

In 2002, the price of pork chops in Uurp was $1 each; Cokes were also $1 each. The typical resident consumed 40 pork chops and 40 Cokes (saving is impossible in Uurp). In 2003, swine fever hit Uurp and pork chop prices rose to $4; the Coke price remained unchanged. At these new prices, the typical Uurp resident consumed 20 pork chops and 80 Cokes.

a. Show that utility for the typical Uurp resident was unchanged between the 2 years.

b. Show that using 2002 prices would show an increase in real income between the 2 years.

c. Show that using 2003 prices would show a decrease in real income between the years.

d. What do you conclude about the ability of these indexes to measure changes in real income?

1. The Food Stamp Program. If you were offered the choice between $100 in movie tickets and $100 in cash, which would you take? If you are like most people, you would take the cash. As Application 3.3 illustrates, individuals are generally better off with an outright cash grant than they would be under an equivalent in-kind transfer. The Food Stamp Program is one example in which individuals are subsidized with in-kind benefits. Under this program, low-income individuals are given a fixed dollar amount in food coupons that may only be applied toward the purchase of food. Information about the Food Stamp Program can be found at the USDA Food Stamp Program Web site at http://www.fns.usda.gov/fsp. Go to Program Data and then click on National Level Annual Summary. For the most recent year listed, on average, how many program recipients were there? What was the dollar value of total benefits distributed? What was the average monthly benefit per person? Go back to the Web site's main page and click on Search to per-
form a search for “participation rate trend.” For the most recent year given, what percentage of eligible individuals actually received food stamps? Why do you think this percentage is not closer to 100 percent?

2. Price indexes and cost of living. At some point in your career, you may be faced with a tempting job offer that requires you to relocate to another state. Let’s assume that you currently live in Hartford, Connecticut, and earn $40,000 per year. Suppose you are offered the opportunity to relocate to San Francisco, California, where your salary would be $55,000 per year. Should you make the move? After all, you would be earning more money, right? Well, you would probably also want to know something about the relative cost of living between the two places. Application 3.2 demonstrates how the consumer price index can be used to compare average price levels over time. Similar price indexes can also be used to compare average price levels across geographic regions. One handy cost of living calculator can be found at http://www.chelafinancial.com/studentcenter/studentcenter.cfm?referurl=overture_studctr. In the drop-down menu, select the cost of living calculator. Use the calculator to estimate what salary you would have to earn in San Francisco to maintain the same standard of living as you presently enjoy in Hartford. *Ceteris paribus*, based on this answer, should you make the move? In light of the discussion of substitution bias in Application 3.2, however, is it possible that you could actually be better off in San Francisco with a salary of $55,000 than in Hartford with a salary of $40,000? Explain.