In this chapter, we show how individual demand curves are “added up” to create the market demand curve for a good. Market demand curves reflect the actions of many people and show how these actions are affected by market prices.

This chapter also describes a few ways of measuring market demand. We introduce the concept of elasticity and show how we can use it to summarize how the quantity demanded of a good changes in response to changes in income and prices.

**MARKET DEMAND CURVES**

The market demand for a good is the total quantity of the good demanded by all potential buyers. The market demand curve shows the relationship between this total quantity demanded and the market price of the good, when all other things that affect demand are held constant. The market demand curve’s shape and position are determined by the shape of individuals’ demand curves for the product in question. Market demand is nothing more than the combined effect of many economic choices by consumers.

**Construction of the Market Demand Curve**

Figure 4.1 shows the construction of the market demand curve for good X when there are only two buyers. For each price, the point on the market demand curve is found by summing the quantities demanded by each person. For example, at a price of $P_X^*$, individual 1 demands $X_1^*$, and individual 2 demands $X_2^*$. The total quantity demanded at the market at $P_X^*$ is therefore the sum of these two amounts: $X^* = X_1^* + X_2^*$. Consequently the point $X^*, P_X^*$ is one point on the market.
demand curve D. The other points on the curve are plotted in the same way. The market curve is simply the horizontal sum of each person’s demand curve. At every possible price, we ask how much is demanded by each person, and then we add up these amounts to arrive at the quantity demanded by the whole market. The demand curve summarizes the *ceteris paribus* relationship between the quantity demanded of X and its price. If other things that influence demand do not change, the position of the curve will remain fixed and will reflect how people as a group respond to price changes.

**Shifts in the Market Demand Curve**

Why would a market demand curve shift? We already know why individual demand curves shift. To discover how some event might shift a market demand curve, we must first find out how this event causes individual demand curves to shift and then compute the horizontal sum of these new demand curves with the old market demand. In some cases, the direction of a shift in the market demand curve is reasonably predictable. For example, using our two-buyer case, if both of their incomes increase and both regard X as a normal good, then each person’s demand curve would shift outward. Hence, the market demand curve would also shift outward. At each price, more would be demanded in the market because each person could afford to buy more. This situation in which a general rise in income increases market demand is illustrated in Figure 4.2. Application 4.1: Why the 2001 Tax Cut Was a Dud shows how this notion can be used to study the effects of tax cuts, although, as is often the case in economics, the story is not quite as simple as it appears to be.
In some cases, the direction that a market demand curve shifts may be ambiguous. For example, suppose that one person’s income increases but a second person’s income decreases. The location of the new market demand curve now depends on the relative shifts in the individual demand curves that these income changes cause. The curve could either shift inward or shift outward.

What holds true for our simple two-person example also applies to much larger groups of demanders—perhaps even to the entire economy. In this case, the market demand summarizes the behavior of all possible consumers. If personal income in the United States as a whole were to rise, the effect on the market demand curve for pizza would depend on whether the income gains went to people who love pizza or to people who never touch it. If the gains went to pizza lovers, the U.S. market demand for pizza would shift outward significantly. It would not shift at all if the income gains went only to pizza haters.

A change in the price of some other good (Y) will also affect the market demand for X. If the price of Y rises, for example, the market demand curve for X will shift outward if most buyers regard X and Y as substitutes. On the other hand, an increase in the price of Y will cause the market demand curve for X to shift inward if most people regard the two goods as complements.

**A Simplified Notation**

Often in this book we look at only one market. In order to simplify the notation, we use the letter Q for the quantity of a good demanded (per week) in this market, and we use P for its price. When we draw a demand curve in the Q, P plane,
In May 2001, the U.S. Congress passed one of the largest cuts in personal income taxes in history. The cuts are to be implemented over a 10-year period and will (over that period) amount to more than $1.6 trillion. As a “down payment” on this sum, the law provided that most U.S. taxpayers receive an immediate check for $300 (or $600 for a married couple), and these checks rolled out of the Treasury at the rate of 9 million per week during the summer of 2001. Many politicians argued that such a large tax reduction would have an important effect on fighting the recession that was then beginning by boosting the demand for virtually every good. But such a prediction ignored both economic theory and the realities of the bizarre U.S. tax system. Ultimately, the tax cut seems to have had virtually no impact on consumer spending.

The Permanent Income Hypothesis

Our discussion of demand theory showed that changes in people’s incomes do indeed shift demand curves outward. But we were a bit careless in defining exactly what income is. Milton Friedman made one of the most important discoveries that clarify this question in the 1950s. He argued that spending decisions are based on a person’s long-term view of his or her economic circumstances. Short-term increases or decreases in income have little effect on spending patterns. Friedman’s view that spending decisions are based on a person’s “permanent” income is now widely accepted by economists. Virtually all studies of actual spending behavior rely on this insight.

Tax Cuts and Permanent Income

According to Friedman’s theory, a tax reduction will affect a person’s spending only to the extent that it affects his or her permanent income. This insight suggests that the 2001 tax act had little impact for two reasons. First, consider the $300 checks. These came to people “out of the blue,” and everyone knew that such largess would not continue. The checks were too small to stimulate spending on any major goods, so they were largely saved. People made no changes in what they were already intending to buy. In this, they were exhibiting exactly the same sort of nonresponse that they had shown in many previous episodes including temporary tax increases in the late 1960s and temporary reductions in the 1970s.

Now consider the effect of the overall tax act, a plan that was intended to be implemented over a 10-year period. Because of wrangling in Congress, the actual schedule of tax cuts is “back-loaded.” That is, most of the cuts do not begin until 2006, and the largest cuts are reserved until 2009–10. Such distant tax cuts probably have little impact on people’s perceptions of their economic situations. In purely dollar terms, the present value2 of such distant tax savings is much smaller than their actual stated amounts. Perhaps more

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1 Milton Friedman, A Theory of the Consumption Function (Princeton, NJ: Princeton University Press, 1957). Recent amendments to Friedman’s theory stress the “life-cycle” nature of income and spending decisions—that is, people are assumed to plan their spending over their entire life.

2 The present value of a sum payable in the future is less than the actual amount because of forgone interest. For a discussion of this concept, see Chapter 14 and its Appendix.
important, taxpayers have become very familiar with constantly changing tax laws and probably have little faith that tax cuts projected for many years in the future will actually occur. That is, many of the tax reductions promised under the 2001 act were simply not “credible.”

Complexities in the Income Tax
Another set of reasons that led to the ineffectiveness of the 2001 tax cuts relate to the complexities in the U.S. income tax itself. First, all of the rate changes in the bill were subject to “sunset” provisions—in 2011, tax rates are supposed to return to 2001 levels. In effect, the entire tax bill is a temporary one. What happens after 2011 is anyone’s guess. Second, the bill did not deal with the alternative minimum tax (AMT)—a provision of the U.S. income tax originally intended to catch fat cats who pay little taxes, but one that has increasingly affected middle-income taxpayers. Under this arcane provision, much of the effect of the tax reductions promised under the 2001 act will be neutralized by increased taxes collected under the AMT. Finally, many of the tax reductions in the 2001 bill came about through special credits for all sorts of items such as college tuitions and energy conservation. How these actually affect the purchasing power of the average citizen obviously depends on whether they wish to spend their incomes on the especially favored items. Certainly the effect is not just a simple shift outward in people’s budget constraints.

To Think About
1. If a person makes economic decisions based on his or her permanent income, how much might be spent currently out of an unexpected $300 check from the government?
2. How might people differ in the ways in which they respond to getting a tax rebate check from the government?

we assume that all other factors affecting demand are held constant. That is, income, the price of other goods, and preferences are assumed not to change. If one of these factors should change, the demand curve would probably shift. As was the case for individual demand curves, the term “change in quantity demanded” is used for a movement along a given market demand curve, and the term “change in demand” is used for a shift in the entire curve.

ELASTICITY

Economists frequently need to show how changes in one variable affect some other variable. They ask, for example, how much does a change in the price of electricity affect the quantity of it demanded, or how does a change in income affect total expenditures on automobiles? One problem in summarizing these kinds of effects is that goods are measured in different ways. For example, steak is typically sold per pound, whereas oranges are generally sold per dozen. A $.10 per pound rise in the price of steak might cause consumption of it to fall by
2 pounds per week, and a $0.10 per dozen rise in the price of oranges might cause orange purchases to fall by one-half dozen per week. But there is no way to compare the change in steak sales to the change in orange sales. When two goods are measured in different units, we cannot make a simple comparison between them to determine which item is more responsive to changes in its price.

In order to make these comparisons, economists use the concept of elasticity. In general, the elasticity of variable B with respect to changes in variable A is defined as the percentage change in B brought about by a 1 percent change in A. Elasticity is unit-free—it compares one percentage to another, and the units disappear. In our oranges and steak example, a 1 percent rise in the price of steak might lead to a 2 percent decline in the quantity bought, whereas a 1 percent rise in the price of oranges might lead to only a 1 percent decline in the quantity bought. Steak purchases in this example are more responsive to price than orange purchases are. The fact that steak and oranges are measured in different ways is no longer a problem.

### PRICE ELASTICITY OF DEMAND

Although there are many different applications of elasticity in this book, probably the most important is the price elasticity of demand. Changes in P (the price of a good) will lead to changes in Q (the quantity of it purchased), and the price elasticity of demand measures this relationship. Specifically, the price elasticity of demand \( e_{Q,P} \) is defined as the percentage change in quantity in response to a 1 percent change in price. In mathematical terms,

\[
e_{Q,P} = \frac{\text{Percentage change in } Q}{\text{Percentage change in } P}
\]

This elasticity records how Q changes in percentage terms in response to a percentage change in P. Because P and Q move in opposite directions (except in the rare case of Giffen’s paradox), \( e_{Q,P} \) will be negative.\(^1\) For example, a value of \( e_{Q,P} \) of \(-1\) means that a 1 percent rise in price leads to a 1 percent decline in quantity.

\(^1\) Sometimes the price elasticity of demand is defined as the absolute value of the definition in Equation 4.1. Using this definition, elasticity is never negative; curves are classified as elastic, unit elastic, or inelastic depending on whether \( e_{Q,P} \) is greater than, equal to, or less than 1. You need to recognize this distinction as there is no consistent use in economic literature.

### MicroQuiz 4.1

A shift outward in a demand curve can be described either by the extent of its shift in the horizontal direction or by its shift in the vertical direction. How would the following shifts be shown graphically?

1. News that nutmeg cures the common cold causes people to demand 2 million pounds more nutmeg at each price.

2. News that nutmeg cures the common cold causes people to be willing to pay $1 more per pound of nutmeg for each possible quantity.

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### Elasticity

The measure of the percentage change in one variable brought about by a 1 percent change in some other variable.
whereas a value of $e_{Q,P}$ of –2 means that a 1 percent rise in price causes quantity to decline by 2 percent.

### Values of the Price Elasticity of Demand

A distinction is often made among values of $e_{Q,P}$ that are less than, equal to, or greater than −1. Table 4.1 lists the terms used for each value. For an elastic curve ($e_{Q,P}$ is less than −1), a price increase causes a more than proportional quantity decrease. If $e_{Q,P} = -3$, for example, each 1 percent rise in price causes quantity to fall by 3 percent. For a unit elastic curve ($e_{Q,P}$ is equal to –1), a price increase causes a decrease in quantity of the same proportion. For an inelastic curve ($e_{Q,P}$ is greater than –1), price increases proportionately more than quantity decreases. If $e_{Q,P} = -1/2$, a 1 percent rise in price causes quantity to fall by only 1⁄2 of 1 percent.

In general then, if a demand curve is elastic, changes in price along the curve affect quantity significantly; if the curve is inelastic, price has little effect on quantity demanded.

### Price Elasticity and the Shape of the Demand Curve

We often classify the market demand for goods by their price elasticities of demand. For example, the demand for most medical services is very inelastic. The market demand curve here may be almost vertical, showing that the quantity demanded is not responsive to price changes. On the other hand, price changes will have a major effect on the quantity demanded of a particular kind of candy bar (the demand is elastic). Here the market demand curve would be relatively flat. If market price were to change even slightly, the quantity demanded would change significantly because people would buy other kinds of candy bars.

### Price Elasticity and the Substitution Effect

The discussion of income and substitution effects in Chapter 3 provides a theoretical basis for judging what the size of the price elasticity for particular goods might be. Goods with many close substitutes (brands of breakfast cereal, small cars, brands of electronic calculators, and so on) are subject to large substitution effects from a price change. For these kinds of goods, we can presume that demand will be elastic ($e_{Q,P} < -1$). On the other hand, goods with few close substitutes (water, insulin, and salt, for example) have small substitution effects.

---

2 Remember, numbers like −3 are less than −1 whereas −1⁄2 is greater than −1. Because we are accustomed to thinking only of positive numbers, comparisons among price elasticities can sometimes be confusing.
when their prices change. Demand for such goods will probably be inelastic with respect to price changes \((e_{Q,P} > -1);\) that is, \(e_{Q,P}\) is between 0 and –1). Of course, as we mentioned previously, price changes also create income effects on the quantity demanded of a good, which we must consider to completely assess the likely size of overall price elasticities. Still, because the price changes for most goods have only a small effect on people’s real incomes, the existence (or nonexistence) of substitutes is probably the principal determinant of price elasticity.

**Price Elasticity and Time**

Making substitutions in consumption choices may take time. To change from one brand of cereal to another may only take a week (to finish eating the first box), but to change from heating your house with oil to heating it with electricity may take years because a new heating system must be installed. We already have seen in Application 3.4: Why Are So Many “Trucks” on the Road? that trends in gasoline prices may have little short-term impact because people already own their cars and have relatively fixed travel needs. Over a longer term, however, there is clear evidence that people will change the kinds of cars they drive in response to falling real gasoline prices. In general then, it might be expected that substitution effects and the related price elasticities would be larger the longer the time period that people have to change their behavior. In some situations it is important to make a distinction between short-term and long-term price elasticities of demand, since the long-term concept may show much greater responses to price change. In Application 4.2: Brand Loyalty, we look at a few cases where this distinction can be quite important.

**Price Elasticity and Total Expenditures**

The price elasticity of demand is useful for studying how total expenditures on a good change in response to a price change. Total expenditures on a good are found by multiplying the good’s price \(P\) times the quantity purchased \(Q\). If demand is elastic, a price increase will cause total expenditures to fall. When demand is elastic, a given percentage increase in price is more than counterbalanced in its effect on total spending by the resulting large decrease in quantity demanded. For example, suppose people are currently buying 1 million automobiles at $10,000 each. Total expenditures on automobiles amount to $10 billion. Suppose also that the price elasticity of demand for automobiles is –2. Now, if the price increases to $11,000 (a 10 percent increase), the quantity purchased would fall to 800,000 cars (a 20 percent fall). Total expenditures are now $8.8 billion. Because demand is elastic, the price increase causes total expenditures to fall. This example can be easily reversed to show that, if demand is elastic, a fall in price will cause total expenditures to increase. The extra sales generated by a fall in price more than compensate for the reduced price in this case. For example, a number of computer software producers have discovered that they can increase
One reason that substitution effects are larger over longer periods than over shorter ones is that people develop spending habits that do not change easily. For example, when faced with a variety of brands consisting of the same basic product, they may develop loyalty to a particular brand, purchasing it on a regular basis. This behavior makes sense because a person does not need to reevaluate products continually. Thus, decision-making costs are reduced. Brand loyalty also reduces the likelihood of brand substitutions even when there are short-term price differentials. Over the long term, however, price differences can tempt buyers into trying other brands and thereby switch their loyalties.

Automobiles
The competition between American and Japanese automakers provides a good example of changing loyalties. Prior to the 1980s, Americans exhibited considerable loyalty to U.S. automobiles. Repeat purchases of the same brand were a common pattern. In the early 1970s, Japanese automobiles began making inroads into the American market on a price basis. The lower prices of Japanese cars eventually convinced Americans to buy them. Satisfied with their experiences, by the 1980s many Americans developed loyalty to Japanese brands. This loyalty was encouraged, in part, by large differences in quality between Japanese and U.S. cars that became especially wide in the mid-1980s. Although U.S. automakers seem to have closed some of the quality gap in the 1990s, lingering loyalty to Japanese autos has made it difficult to regain market share. By one estimate, U.S. cars would have to sell for approximately $1,600 less than their Japanese counterparts in order to encourage buyers of Japanese cars to switch.1

Licensing of Brand Names
The advantages of brand loyalty have not been lost on innovative marketers. Famous trademarks such as Coca-Cola, Harley-Davidson, or even Disney’s Mickey Mouse have been applied to products rather different from the originals. For example, Coca-Cola for a period licensed its famous name and symbol to makers of sweatshirts and blue jeans in the hope that this would differentiate the products from their generic competitors. Similarly, Mickey Mouse is one of the most popular trademarks in Japan, appearing on products both conventional (watches and lunchboxes) and unconventional (fashionable handbags and neckties).

The economics behind these moves are straightforward. Prior to licensing, products are virtually perfect substitutes and consumers shift readily among various makers. Licensing creates somewhat lower price responsiveness for the branded product, so producers can charge more for it without losing all their sales. The large fees paid to Coca-Cola, Disney, Michael Jordan, or major league baseball provide strong evidence of the strategy’s profitability.

To Think About

1. Does the speed with which price differences erode brand loyalties depend on the frequency with which products are bought? Why might differences between short-term and long-term price elasticities be much greater for brands of automobiles than for brands of toothpaste?

2. Why do people buy licensed products when they could probably buy generic brands at much lower prices? Does the observation that people pay 50 percent more for Nike shoes endorsed by basketball star Michael Jordan than for identical no-name competitors violate the assumptions of utility maximization?

their total revenues by selling at low, cut-rate prices. The extra users attracted by low prices more than compensates for those low prices.3

If demand is unit elastic (\(e_{Q,P} = -1\)), total expenditures stay the same when prices change. A movement of \(P\) in one direction causes an exactly opposite proportional movement in \(Q\), and the total price-times-quantity stays fixed. Even if prices fluctuate substantially, total spending on a good with unit elastic demand never changes.

Finally, when demand is inelastic, a price rise will cause total expenditures to rise. A price rise in an inelastic situation does not cause a very large reduction in quantity demanded, and total expenditures will increase. For example, suppose people buy 100 million bushels of wheat per year at a price of $3 per bushel. Total expenditures on wheat are $300 million. Suppose also that the price elasticity of demand for wheat is \(-0.5\) (demand is inelastic). If the price of wheat rises to $3.60 per bushel (a 20 percent increase), quantity demanded will fall by 10 percent (to 90 million bushels). The net result of these actions is to increase total expenditures on wheat to $324 million. Because the quantity of wheat demanded is not very responsive to changes in price, total revenues are increased by a price rise. This same example could also be reversed to show that, in the inelastic case, total revenues are reduced by a fall in price. Application 4.3: Volatile Farm Prices illustrates how inelastic demand can result in highly unstable prices when supply conditions change.

The relationship between price elasticity and total expenditures is summarized in Table 4.2. You should think through the logic of each entry in the table to obtain a working knowledge of the elasticity concept. These relationships are used many times in later chapters.

3 Of course, costs are also important to software producers; but the extra cost of producing more copies of a software program is very low.
The demand for agricultural products is relatively inelastic. That is especially true for such basic crops as wheat, corn, or soybeans. An important implication of this inelasticity is that even modest changes in supply, often brought about by weather patterns, can have large effects on the prices of these crops. This volatility in crop prices has been a feature of farming throughout all of history.

**The Paradox of Agriculture**

Recognition of the fundamental economics of farm crops yields paradoxical insights about the influence of the weather on farmers' well-being. “Good” weather can produce bountiful crops and abysmally low prices, whereas “bad” weather (in moderation) can result in attractively high prices. For example, relatively modest supply disruptions in the U.S. grain belt during the early 1970s caused an explosion in farm prices. Farmers’ incomes increased more than 40 percent over a short, 2-year period. These incomes quickly fell back again when more normal weather patterns returned.

This paradoxical situation also results in somewhat misleading news coverage of localized droughts. Television news reporters will usually cover such droughts by showing the viewer a shriveled ear of corn, leaving the impression that all farmers are being devastated. That is undoubtedly true for the farmer whose parched field is being shown (though he or she may also have irrigated fields next door). But the larger story of local droughts is that the price increases they bring benefit most farmers outside the immediate area—a story that is seldom told.

**Volatile Prices and Government Programs**

Ever since the New Deal of the 1930s, the volatility of U.S. crop prices was moderated through a variety of federal price-support schemes. These schemes operated in two ways. First, through various acreage restrictions, the laws constrained the extent to which farmers could increase their plantings. In many cases, farmers were paid to keep their land fallow. A second way in which prices were supported was through direct purchases of crops by the government. By manipulating purchases and sales from grain reserves, the government was able to moderate any severe swings in price that may have otherwise occurred. All of that seemed to have ended in 1996 with the passage of the Federal Agricultural Improvement and Reform (FAIR) Act. That act sharply reduced government intervention in farm markets.

Initially, farm prices held up quite well following the passage of the FAIR Act. Throughout 1996 and 1997, they remained significantly above their levels of the early 1990s. But the increased plantings encouraged by the act in combination with downturns in some Asian economies caused a decline in crop prices of nearly 20 percent between 1998 and 2000. Though prices staged a bit of a rebound in early 2001, by the end of the year they had again fallen back. Faced with elections in November 2002, this created considerable pressure on politicians to do something. Such pressures culminated in the passage of a 10-year, $83 billion farm subsidy bill in May of 2002. That bill largely reversed many of the provisions of the FAIR Act. It increased assistance to wheat and corn farmers and expanded subsidies to such essential farm products as peanuts, honey, and mohair. The bill also brought threats of retaliation from many U.S. trading partners as its subsidies were per-
ceived to give unfair advantages to American farmers in international markets. Clearly, the volatility of farm prices will continue to exert political influences so long as farmers vote in close elections.

**To Think About**

1. The volatility of farm prices is both good and bad news for farmers. Since periods of low prices are often followed by periods of high prices, the long-term welfare of farmers is hard to determine. Would farmers be better off if their prices had smaller fluctuations around the same trend levels?

2. How should fluctuations in foreign demand for U.S. crops be included in a supply-demand model? Do such fluctuations make crop prices even more volatile?

<table>
<thead>
<tr>
<th>Elasticity</th>
<th>If demand is elastic</th>
<th>In response to an increase in price, expenditures will</th>
<th>In response to a decrease in price, expenditures will</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit elastic</td>
<td>Not change</td>
<td>Rise</td>
<td>Not change</td>
</tr>
<tr>
<td>Inelastic</td>
<td>Rise</td>
<td>Fall</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 4.2 Relationship between Price Changes and Changes in Total Expenditure

**DEMAND CURVES AND PRICE ELASTICITY**

The relationship between a particular demand curve and the price elasticity it exhibits is relatively complicated. Although it is common to talk about the price elasticity of demand for a good, this usage conveys the false impression that price elasticity necessarily has the same value at every point on a market demand curve. A more accurate way of speaking is to say that “at current prices, the price elasticity of demand is ...” and, thereby, leave open the possibility that the elasticity may take on some other value at a different point on the demand curve. In some cases, this distinction may be unimportant because the price elasticity of demand has the same value over the range of demand being examined. In other cases, the distinction may be important, especially when large movements along a demand curve are being considered.

**Linear Demand Curves and Price Elasticity**

Probably the most important illustration of this warning about elasticities occurs in the case of a linear (straight-line) demand curve. As one moves along such a curve, the price elasticity of demand is always changing value. At high price...
Part 2: Demand

levels, demand is elastic; that is, a fall in price increases quantity purchased more than proportionally. At low prices, on the other hand, demand is inelastic; a further decline in price has relatively little proportional effect on quantity.

This result can be most easily shown with a numerical example. Figure 4.3 illustrates a straight-line (linear) demand curve for, say, portable cassette tape players. In looking at the changing elasticity of demand along this curve, we will assume it has the specific algebraic form

\[ Q = 100 - 2P \]  

(4.2)

where \( Q \) is the quantity of players demanded per week and \( P \) is their price. The demonstration would be the same for any other linear equation we might choose. Table 4.3 shows a few price-quantity combinations that lie on the demand curve, and these points are also reflected in Figure 4.3. Notice, in particular, that the quantity demanded is zero for prices of $50 or greater.

Table 4.3 also records total expenditures on tape players (\( P \cdot Q \)) represented by each of the points on the demand curve. These expenditures are also repre-
presented by the areas of the various rectangles in Figure 4.3. For prices of $50 or above, total expenditures are $0. No matter how high the price, if nothing is bought, expenditures are $0. As price falls below $50, total expenditures increase. At $P = 40$, total expenditures are $800 ($40 \times 20$), and for $P = 30$, the figure rises to $1,200 ($30 \times 40$).

For high prices, the demand curve in Figure 4.3 is elastic; a fall in price causes enough additional sales to increase total expenditures. This increase in total expenditures begins to slow as price drops still further. In fact, total spending reaches a maximum at a price of $25$. When $P = 25$, $Q = 50$ and total expenditures on tape players are $1,250$. For prices below $25$, reductions in price cause total expenditures to fall. At $P = 20$, expenditures are $1,200 ($20 \times 60$), whereas at $P = 10$, they are only $800 ($10 \times 80$). At these lower prices, the increase in quantity demanded brought about by a further fall in price is simply not large enough to compensate for the price decline itself, and total expenditures fall.

This relationship is quite general. At high prices on a linear demand curve, demand is elastic ($e_{Q,P} < -1$). Demand is unit elastic ($e_{Q,P} = -1$) at a price halfway between $0$ and the price at which demand drops to nothing (given by $P = 50$ in the prior example). Hence, demand is unit elastic at a price of $P = 25$. Below that price, demand is inelastic. Further reductions in price actually reduce total revenues.

Because of this property of linear demand curves, it is particularly important when using them to note clearly the point at which price elasticity is to be

### MicroQuiz 4.2

How would knowledge of the price elasticity of demand for its product help to guide these producers?

**Producer 1 (movie theater owner).** My seats are mainly empty—would a lower price for tickets help my profits?

**Producer 2 (gas station owner).** The state just raised gasoline taxes by $.10—how should I adjust my pump prices?

<table>
<thead>
<tr>
<th>Price (P)</th>
<th>Quantity (Q)</th>
<th>Total expenditures (P × Q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$50</td>
<td>0</td>
<td>$0</td>
</tr>
<tr>
<td>40</td>
<td>20</td>
<td>800</td>
</tr>
<tr>
<td>30</td>
<td>40</td>
<td>1,200</td>
</tr>
<tr>
<td>25</td>
<td>50</td>
<td>1,250</td>
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<tr>
<td>20</td>
<td>60</td>
<td>1,200</td>
</tr>
<tr>
<td>10</td>
<td>80</td>
<td>800</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

**TABLE 4.3 Price, Quantity, and Total Expenditures of Tape Players for the Demand Function**
measured. When looking at economic data from such a demand curve, if the price being examined has not changed very much over the period being analyzed, the distinction may be relatively unimportant. But, if the analysis is being conducted over a period of substantial price change, the possibility that elasticity may have changed should be considered.

A Unitary Elastic Curve

Suppose that instead of being characterized by Equation 4.2, the demand for tape players took the form

$$Q = \frac{1,200}{P}$$  \hspace{1cm} (4.3)

As shown in Figure 4.4, the graph of this equation is a hyperbola—it is not a straight line. In this case, $P \cdot Q = 1,200$ regardless of the price. This can be verified by examining any of the points identified in Figure 4.4. Because total expenditures are constant everywhere along this hyperbolic demand curve, the price elasticity of demand is always $-1$. Therefore, this is one simple example of a demand curve that has the same price elasticity along its entire length.  

\[\text{4 The changing price elasticity along a linear demand curve can be shown algebraically as follows: Assume a demand curve of the form}
\]

$$Q = a - bP$$  \hspace{1cm} (i)

\[\text{Because}
\]

$$e_{Q,P} = \frac{\Delta Q}{Q} \cdot \frac{P}{\Delta P} = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

\[\text{for the case of the demand curve in equation i,}
\]

$$e_{Q,P} = -b \cdot \frac{P}{Q}$$  \hspace{1cm} (ii)

\[\text{For large P, P/Q is large and } e_{Q,P} \text{ is a large negative number. For small P, P/Q is small and } e_{Q,P} \text{ is a small positive number. Equation ii provides a convenient way to compute } e_{Q,P}; \text{ use two points on the demand curve to derive the curve’s slope, b, then multiply by P/Q for the point being examined. Alternatively, equation ii can be used to derive } -b \text{ (the slope of the demand curve) if } e_{Q,P}, P, \text{ and Q are known.}
\]

\[\text{5 More generally, if demand takes the form}
\]

$$Q = aP^b \ (b < 0)$$  \hspace{1cm} (i)

\[\text{the price elasticity of demand is given by } b. \text{ This elasticity is the same everywhere along such a demand curve. Equation 4.3 is a special case of equation i for which}
\]

$$e_{Q,P} = b = -1$$  \hspace{1cm} (ii)

\[\text{Taking logarithms of equations i yields}
\]

$$\ln Q = \ln a + b \ln P$$  \hspace{1cm} (iii)

\[\text{which shows that the price elasticity of demand can be found by studying the relationship between } \ln Q \text{ and } \ln P.
\]
linear case, for this curve, there is no need to worry about being specific about the point at which elasticity is to be measured. Application 4.4: An Experiment in Health Insurance illustrates how this approach can yield very useful results.

### INCOME ELASTICITY OF DEMAND

Another type of elasticity is the **income elasticity of demand** \((e_{Q,I})\). This concept records the relationship between income changes and change in quantity demanded:

\[
e_{Q,I} = \frac{\text{Percentage change in } Q}{\text{Percentage change in } I} \tag{4.4}
\]

For a normal good, \(e_{Q,I}\) is positive because increases in income lead to increases in purchases of the good. For the unlikely case of an inferior good, on the other hand, \(e_{Q,I}\) would be negative, implying that increases in income lead to decreases in quantity purchased.

Among normal goods, whether \(e_{Q,I}\) is greater than or less than 1 is a matter of considerable interest. Goods for which \(e_{Q,I} > 1\) might be called luxury goods, in that purchases of these goods increase more rapidly than income. For example, if the income elasticity of demand for automobiles is 2, then a 10 percent increase in income will lead to a 20 percent increase in automobile purchases. On the other hand, \(e_{Q,I} < 1\) implies that increases in income lead to decreases in purchases of inferior goods.
The provision of health insurance is one of the most universal and controversial social policies throughout the world. Although many nations have comprehensive insurance schemes that cover most of their populations, policymakers in the United States have resisted such an all-inclusive approach. Instead, U.S. policies have evolved as a patchwork, stressing employer-provided insurance for workers together with special programs for the aged (Medicare) and the poor (Medicaid).

Regardless of how health insurance policies are designed, however, all face a similar set of problems.

Moral Hazard
One of the most important such problems is that insurance coverage of health care needs tends to increase the demand for services. Because insured patients pay only a small fraction of the costs of the services they receive, they will demand more than they would have if they had to pay market prices. This tendency of insurance coverage to increase demand is (perhaps unfortunately) called “moral hazard,” though there is nothing especially immoral about such behavior. Taking the effect into account in planning for the potential costs of health insurance schemes is crucial to getting a realistic picture.

The Rand Experiment
The Medicare program was introduced in the United States in 1965, and the increase in demand for medical services by the elderly was immediately apparent. In order to understand better the factors that were leading to this increase in demand, the government funded a large-scale experiment in four cities. In that experiment, which was conducted by the Rand Corporation, people were assigned to different insurance plans that varied in the generosity of coverage they offered. Specifically, the plans varied the fraction of medical costs that people would have to pay out of their own pockets for medical care. In insurance terms, the experiment varied the “coinsurance” rate from zero (free care) to nearly 100 percent (patients pay everything). By studying the reactions to these variations in price, the researchers were able to estimate the price elasticity of demand for medical services.

Results of the Experiment
Table 1 shows the results from the experiment. People who faced lower out-of-pocket costs for medical care tended to demand more of it. A rough estimate of the elasticity of demand can be obtained by averaging the percentage changes across the various plans in the table. That is,

\[
e = \frac{\% \text{ change in } Q}{\% \text{ change in } P} = \frac{-12}{-66} = 0.18
\]

So, as might have been expected, the demand for medical care is inelastic, but it clearly is not zero. In fact, the Rand study found much larger price effects for some specific

---

medical services such as mental health care and dental care. It is these kinds of services for which new insurance coverage would be expected to have the greatest impact on market demand. This fact is recognized in the design of medical plans throughout the world that often have stricter limits on the coverage of mental and dental care than on services with smaller price elasticities (such as surgery).

To Think About
1. The data in Table 1 show average spending for families who faced differing out-of-pocket prices for medical care. Why do these data accurately reflect the changes in quantity that are required in the elasticity formula?

2. In recent years, prepaid health plans (i.e., HMOs) have come to be the dominant form of employer-provided health plans. How do prepaid plans seek to control the moral hazard problem? Why are they so controversial? (See also Application 15.2)

Chapter 4: Market Demand and Elasticity

other hand, as Engel's Law suggests, food has an income elasticity of much less than 1. If the income elasticity of demand for food were 0.5, for example, then a 10 percent rise in income would result in only a 5 percent increase in food purchases. Considerable research has been done to determine the actual values of income elasticities for various items, and we discuss the results of some of these studies in the final section of this chapter.

<table>
<thead>
<tr>
<th>Coinsurance rate</th>
<th>Percent change in price</th>
<th>Average total spending</th>
<th>Percent change in quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.95</td>
<td>-47%</td>
<td>$540</td>
<td>+6.1%</td>
</tr>
<tr>
<td>0.50</td>
<td>-50</td>
<td>573</td>
<td>+7.7</td>
</tr>
<tr>
<td>0.25</td>
<td>-100</td>
<td>617</td>
<td>+21.6</td>
</tr>
<tr>
<td>0.00</td>
<td>-66</td>
<td>750</td>
<td>+12.0</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Manning et al. Table 2.

TABLE 1 Results of the Rand Health Insurance Experiment

MicroQuiz 4.3

Values for the income elasticity of demand are restricted by the fact that consumers are bound by budget constraints. Use this fact to explain:

1. Why is it that not every good can have an income elasticity of demand greater than one? Can every good have an income elasticity of demand less than 1?

2. If a set of consumers spend 95 percent of their incomes on housing, why can’t the income elasticity of demand for housing be much greater than 1?
CROSS-PRICE ELASTICITY OF DEMAND

In Chapter 3 we showed that a change in the price of one good will affect the quantity demanded of most other goods. To measure such effects, economists use the cross-price elasticity of demand. This concept records the percentage change in quantity demanded (Q) that results from a 1 percentage point change in the price of some other good (call this other price P'). That is,

\[
\text{Cross-price elasticity of demand} = e_{q,p} = \frac{\text{Percentage change in } Q}{\text{Percentage change in } P'}
\]  

If these goods are substitutes, the cross-price elasticity of demand will be positive because the price of one good and the quantity demanded of the other good will move in the same direction. For example, the cross-price elasticity for changes in the price of tea on coffee demand might be 0.2. Each 1 percentage point increase in the price of tea results in a 0.2 percentage point increase in the demand for coffee because coffee and tea are substitutes in people’s consumption choices. A fall in the price of tea would cause the demand for coffee to fall also, since people would choose to drink tea rather than coffee.

If two goods are complements, the cross-price elasticity will be negative showing that the price of one good and the quantity of the other good move in opposite directions. The cross-price elasticity of doughnut prices on coffee demand might be, say, –1.5. This would imply that a 1 percent increase in the price of doughnuts would cause the demand for coffee to fall by 1.5 percent. When doughnuts are more expensive, it becomes less attractive to drink coffee because many people like to have a doughnut with their morning coffee. A fall in the price of doughnuts would increase coffee demand because, in that case, people will choose to consume more of both complementary products. As for the other elasticities we have examined, considerable empirical research has been conducted to try to measure actual cross-price elasticities of demand.

Suppose that a set of consumers spend their incomes only on beer and pizza.

1. Explain why a fall in the price of beer will have an ambiguous effect on pizza purchases.

2. What does the fact that the demand for pizza must be homogeneous imply about the relationship between the price elasticity of demand for pizza, the income elasticity of demand for pizza, and the cross-price elasticity of the demand for pizza with respect to beer prices?

EMPIRICAL STUDIES OF DEMAND

Economists have for many years studied the demand for all sorts of goods. Some of the earliest studies generalized from the expenditure patterns of a small sample of families. More recent studies have examined a wide variety of goods to estimate both income and price elasticities.
Although it is not possible for us to discuss in detail here the statistical techniques used in these studies, we can show in a general way how these economists proceeded.

**Estimating Demand Curves**

Estimating the demand curve for a product is one of the more difficult and important problems in econometrics. The importance of the question is obvious. Without some idea of what the demand curve for a product looks like, economists could not describe with any precision how the market for a good might be affected by various events. Usually the notion that a rise in price will cause quantity demanded to fall will not be precise enough—we want some way to estimate the size of the effect.

Problems in deriving such an estimate are of two general types. First are those related to the need to implement the *ceteris paribus* assumption. One must find some way to hold constant all of the other factors that affect quantity demanded so that the direct relationship between price and quantity can be observed. Otherwise, we will be looking at points on several demand curves rather than on only one. We have already discussed this problem in Appendix to Chapter 1, which shows how it can often be solved through the use of relatively simple statistical procedures.

A second problem in estimating a demand curve goes to the heart of microeconomic theory. From the early days in your introductory economics course, you have (hopefully) learned that quantity and price are determined by the simultaneous operation of demand and supply. A simple plot of quantity versus price will be neither a demand curve nor a supply curve, but only points at which the two curves intersect. The econometric problem then is to penetrate behind this confusion and “identify” the true demand curve. There are indeed methods for doing this, though we will not pursue them here. All studies of demand, including those we look at in the next section, must address this issue, however.

**Some Elasticity Estimates**

Table 4.4 gathers a number of estimated income and price elasticities of demand. As we shall see, these estimates often provide the starting place for analyzing how activities such as changes in taxes or import policy might affect various markets. In several later chapters, we use these numbers to illustrate such applications.

---

6 The most common technique, multiple regression analysis, estimates a relationship between quantity demanded (Q), price (P), and other factors that affect quantity demanded (X) of the form $Q = a + bP + cX$. Given this relationship, X can be held constant while looking at the relationship between Q and P. Following footnote 5, it is common practice to use logarithms to provide estimates of elasticities.

Although interested readers are urged to explore the original sources of these estimates to understand more details about them, in our discussion we just take note of a few regularities they exhibit. With regard to the price elasticity figures, most are relatively inelastic (between 0 and –1). For the groupings of commodities listed, substitution effects are not especially large, although they may be large within these categories. For example, substitutions between beer and other commodities may be relatively small, though substitutions among

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Price elasticity</th>
<th>Income elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>–0.21</td>
<td>+0.28</td>
</tr>
<tr>
<td>Medical services</td>
<td>–0.18</td>
<td>+0.27</td>
</tr>
<tr>
<td>Housing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rental</td>
<td>–0.18</td>
<td>+1.00</td>
</tr>
<tr>
<td>Owner-occupied</td>
<td>–1.20</td>
<td>+1.20</td>
</tr>
<tr>
<td>Electricity</td>
<td>–1.14</td>
<td>+0.91</td>
</tr>
<tr>
<td>Automobiles</td>
<td>–1.20</td>
<td>+3.00</td>
</tr>
<tr>
<td>Beer</td>
<td>–0.26</td>
<td>–0.38</td>
</tr>
<tr>
<td>Wine</td>
<td>–0.88</td>
<td>+0.97</td>
</tr>
<tr>
<td>Marijuana</td>
<td>–1.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Cigarettes</td>
<td>–0.35</td>
<td>+0.50</td>
</tr>
<tr>
<td>Abortions</td>
<td>–0.81</td>
<td>+0.79</td>
</tr>
<tr>
<td>Transatlantic air travel</td>
<td>–1.30</td>
<td>+1.40</td>
</tr>
<tr>
<td>Imports</td>
<td>–0.50</td>
<td>+2.73</td>
</tr>
<tr>
<td>Money</td>
<td>–0.40</td>
<td>+1.00</td>
</tr>
</tbody>
</table>

brands of beer may be substantial in response to price differences. Still, all the estimates are less than zero, so there is clear evidence that people do respond to price changes for most goods. Application 4.5: Alcohol Taxes as Drunk Driving Policy shows how price elasticity estimates can inform an important policy debate.

As expected, the income elasticities in Table 4.4 are positive and are roughly centered about 1.0. Luxury goods, such as automobiles or transatlantic travel ($e_{Q1} > 1$), tend to be balanced by necessities, such as food or medical care ($e_{Q1} < 1$). Because none of the income elasticities is negative, it is clear that Giffen’s paradox is very rare.

### Some Cross-Price Elasticity Estimates

Table 4.5 shows a few cross-price elasticity estimates that economists have derived. All of the pairs of goods illustrated are probably substitutes, and the positive estimated values for the elasticities confirm that view. The figure for the relationship between butter and margarine is the largest in Table 4.5. Even in the absence of health issues, the competition between these two spreads on the basis of price is clearly very intense. Similarly, natural gas prices have an important effect on electricity sales because they help determine how people will heat their homes.

---

**TABLE 4.5 Representative Cross-Price Elasticities of Demand**

<table>
<thead>
<tr>
<th>Demand for</th>
<th>Effect of price of</th>
<th>Elasticity estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter</td>
<td>Margarine</td>
<td>1.53</td>
</tr>
<tr>
<td>Electricity</td>
<td>Natural gas</td>
<td>0.50</td>
</tr>
<tr>
<td>Coffee</td>
<td>Tea</td>
<td>0.15</td>
</tr>
</tbody>
</table>


---

Although the estimated price elasticities in Table 4.4 incorporate both substitution and income effects, they predominantly represent substitution effects. To see this, note that the price elasticity of demand ($e_{Q,P}$) can be disaggregated into substitution and income effects by

$$e_{Q,P} = e_s - s e_i$$

where $e_s$ is the “substitution” price elasticity of demand representing the effect of a price change holding utility constant, $s$ is the share of income spent on the good in question, and $e_i$ is the good’s income elasticity of demand. Because $s$ is small for most of the goods in Table 4.4, $e_{Q,P}$ and $e_s$ have values that are reasonably close.
Each year more than 40,000 Americans die in automobile accidents. Such accidents are the leading cause of death for teenagers. It is generally believed that alcohol consumption is a major contributing factor in at least half of those accidents. In recent years the government has tried to combat drunk driving by teenagers in two primary ways: by increasing legal minimum ages for drinking and by adopting stricter drunk driving laws. These efforts appear to have had significant effects in reducing teen fatalities. At the same time that these laws were coming into effect, however, real taxes on alcohol declined. Because teens may be especially sensitive to alcohol prices, these reductions may have eroded some of the impact of the more stringent laws. But the connection between teen alcohol consumption and alcohol taxes is actually more complex than it first appears.

Price Elasticity Estimates—The Importance of Beer

Most empirical studies of alcohol consumption show that it is sensitive to price. The figures in Table 4.4 suggest that these elasticities in the United States range from approximately –0.3 for beer to perhaps as large as –0.9 for wine. Studies of alcohol consumption in other countries reach essentially the same conclusion: while all alcohol consumption appears to be relatively price sensitive, price elasticities for beer are usually found to be less than half those for wine (and other spirits). Unfortunately, most teenage alcohol consumption is beer. The lower price elasticity of demand for this product therefore poses a problem for those who would use alcohol taxes as a deterrent to drunk driving.

Why beer should have a lower price elasticity of demand than other alcoholic beverages is somewhat of a puzzle. Two factors may provide a partial explanation. First, a significant portion of beer consumption is done in a group setting (tapping a keg, for example). In this case, the direct impact of higher prices may be less than when goods are purchased individually because, at the margin, drinking more costs the consumer no more in out-of-pocket costs. A second possible reason for the lower price elasticity of beer consumption relates to differences among beer consumers. Most beer is consumed by those who drink quite a lot (say, more than a six-pack at a session). This is a group of consumers for whom demand has been found to be less responsive to price than is the case for most other consumers.

Beer Consumption and Habit Formation

Another possibility, however, is that past studies of alcohol consumption have not modeled this activity correctly and thus consumption may be more price responsive than the elasticity estimates imply. Specifically, some authors have argued that “binge” drinking of beer is primarily a habit, created over several years of increasingly serious drinking. Hence, as for many products, the price elasticity of demand for beer may be much larger over the long run than the short-run estimates imply. One important econometric study\(^1\) that supports this conclusion finds that restoring the real rate of taxation on beer to that prevailing in the

1970s would reduce highway fatalities by 7 to 8 percent—a figure about in line with the declines brought on by the stricter laws. Overall, such a price increase might save about 3,500 lives.

To Think About
1. Reducing alcohol consumption through taxation would have a number of effects in addition to those related to drunk driving. What are some of these effects? Do these also provide a rationale for higher alcohol taxes?
2. One principle of efficient taxation is that taxes should be imposed directly on the “problem.” Alcohol taxes do not do that because they tax alcohol consumers who do not drive and they do not tax nondrinkers who cause accidents. Still, why might this policy be preferred to a more direct tax on drunk drivers?

SUMMARY
In this chapter, we constructed a market demand curve by adding up the demands of many consumers. This curve shows the relationship between the market price of a good and the amount that people choose to purchase of that good, assuming all the other factors that affect demand do not change. The market demand curve is a basic building block for the theory of price determination. We use the concept frequently throughout the remainder of this book. You should therefore keep in mind the following points about this concept:

- The market demand curve represents the summation of the demands of a given number of potential consumers of a particular good. The curve shows the \textit{ceteris paribus} relationship between the market price of the good and the amount demanded by all consumers.
- Factors that shift individual demand curves also shift the market demand curve to a new position. Such factors include changes in incomes, changes in the prices of other goods, and changes in people’s preferences.
- The price elasticity of demand provides a convenient way of measuring the extent to which market demand responds to price changes. Specifically, the price elasticity of demand shows the percentage change in quantity demanded in response to a 1 percent change in market price. Demand is said to be elastic if a 1 percent change in price leads to a greater than 1 percent change in quantity demanded. Demand is inelastic if a 1 percent change in price leads to a smaller than 1 percent change in quantity.
- There is a close relationship between the price elasticity of demand and total expenditures on a good. If demand is elastic, a rise in price will reduce total expenditures. If demand is inelastic, a rise in price will increase total expenditures.
- Other elasticities of demand are defined in a way similar to that used for the price elasticity. For example, the income elasticity of demand measures the percentage change in quantity demanded in response to a 1 percent change in income.
- The price elasticity of demand is not necessarily the same at every point on a demand curve. For a linear demand curve, demand is elastic for high prices and inelastic for low prices.
- Economists have estimated elasticities of demand for many different goods using real-world data. A major problem in making such estimates is to devise ways of holding constant all other factors that affect demand so that the price–quantity points being used lie on a single demand curve.
**REVIEW QUESTIONS**

1. In the construction of the market demand curve shown in Figure 4.1, why is a horizontal line drawn at the prevailing price, $P^*_X$? What does this assume about the price facing each person? How are people assumed to react to this price?

2. Explain how the following events might affect the market demand curve for prime filet mignon:
   a. A fall in the price of filet mignon because of a decline in cattle prices
   b. A general rise in consumers’ incomes
   c. A rise in the price of lobster
   d. Increased health concerns about cholesterol
   e. An income tax increase for high-income people used to increase welfare benefits
   f. A cut in income taxes and welfare benefits

3. Why is the price elasticity of demand usually negative? If the price elasticity of demand for automobiles is less than the price elasticity of demand for medical care, which demand is more elastic? Give a numerical example.

4. “Gaining extra revenue is easy for any producer—all it has to do is raise the price of its product.” Do you agree? Explain when this would be true, and when it would not be true.

5. Suppose that the market demand curve for pasta is a straight line of the form $Q = 300 - 50P$ where $Q$ is the quantity of pasta bought in thousands of boxes per week and $P$ is the price per box (in dollars).
   a. At what price does the demand for pasta go to zero? Develop a numerical example to show that the demand for pasta is elastic at this point.
   b. How much pasta is demanded at a price of $0$? Develop a numerical example to show that demand is inelastic at this point.
   c. How much pasta is demanded at a price of $3$? Develop a numerical example that suggests that total spending on pasta is as large as possible at this price.

6. Marvin currently spends 35 percent of his $100,000 income on renting his apartment. If his income elasticity of demand for housing is 0.8, will this fraction rise or fall when he gets a raise to $120,000? Would you give a different answer to this question if Marvin’s income elasticity of demand for housing were 1.3?

7. J. Trueblue always spends one-third of his income on American flags. What is the income elasticity of his demand for such flags? What is the price elasticity of his demand for flags?

8. Table 4.4 reports an estimated price elasticity of demand for electricity of –1.14. Explain what this means with a numerical example. Does this number seem large? Do you think this is a short- or long-term elasticity estimate? How might this estimate be important for owners of electric utilities or for bodies that regulate them?

9. Table 4.5 reports that the cross-price elasticity of demand for electricity with respect to the price of natural gas is 0.50. Explain what this means with a numerical example. What does the fact that the number is positive imply about the relationship between electricity and natural gas use?

10. An economist hired by a home building firm has been asked to estimate a demand curve for homes. He gathers data on the price of new houses and on the number sold from the top 100 metropolitan areas in the United States. He plots these data, draws a line that seems to pass near the points, and labels that line “demand.” How many problems can you identify in this approach to estimating the demand for houses?
4.1 Suppose the demand curve for flyswatters is given by

\[ Q = 500 - 50P \]

where \( Q \) is the number of flyswatters demanded per week and \( P \) is the price in dollars.

a. How many flyswatters are demanded at a price of $2? How about a price of $3? $4? Suppose flyswatters were free; how many would be bought?
b. Graph the flyswatter demand curve. Remember to put \( P \) on the vertical axis and \( Q \) on the horizontal axis. To do so, you may wish to solve for \( P \) as a function of \( Q \).
c. Suppose during July the flyswatter demand curve shifts to

\[ Q = 1,000 - 50P \]

Answer part a and part b for this new demand curve.

4.2 Suppose that the demand curve for garbanzo beans is given by

\[ Q = 20 - P \]

where \( Q \) is thousands of pounds of beans bought per week and \( P \) is the price in dollars per pound.

a. How many beans will be bought at \( P = 0 \)?
b. At what price does the quantity demanded of beans become zero?
c. Calculate total expenditures (\( P \times Q \)) for beans of each whole dollar price between the prices identified in part a and part b.
d. What price for beans yields the highest total expenditures?
e. Suppose the demand for beans shifted to \( Q = 40 - 2P \). How would your answers to part a through part d change? Explain the differences intuitively and with a graph.

4.3 Consider the three demand curves

\[ Q = \frac{100}{P} \]  

(i)

\[ Q = \frac{100}{\sqrt{P}} \]  

(ii)

\[ Q = \frac{100}{P^2} \]  

(iii)

a. Use a calculator to compute the value of \( Q \) for each demand curve for \( P = 1 \) and for \( P = 1.1 \).
b. What do your calculations show about the price elasticity of demand at \( P = 1 \) for each of the three demand curves?
c. Now perform a similar set of calculations for the three demand curves at \( P = 4 \) and \( P = 4.4 \). How do the elasticities computed here compare to those from part b? Explain your results using footnote 5 of this chapter.

4.4 The market demand for potatoes is given by

\[ Q = 1,000 + 0.3I - 300P + 299P' \]

where

- \( Q \) = Annual demand in pounds
- \( I \) = Average income in dollars per year
- \( P \) = Price of potatoes in cents per pound
- \( P' \) = Price of rice in cents per pound.

a. Suppose \( I = $10,000 \) and \( P' = $0.25 \); what would be the market demand for potatoes? At what price would \( Q = 0 \)? Graph this demand curve.
b. Suppose \( I \) rose to \$20,000 with \( P' \) staying at \$0.25. Now what would the demand for potatoes be? At what price would \( Q = 0 \)? Graph this demand curve. Explain why more potatoes are demanded at every price in this case than in part a.
c. If I returns to \$10,000 but \( P' \) falls to \$0.10, what would the demand for potatoes be? At what price
would \( Q = 0 \)? Graph this demand curve. Explain why fewer potatoes are demanded at every price in this case than in part a.

### 4.5

Tom, Dick, and Harry constitute the entire market for scrod. Tom’s demand curve is given by

\[
Q_1 = 100 - 2P
\]

for \( P \leq 50 \). For \( P > 50 \), \( Q_1 = 0 \). Dick’s demand curve is given by

\[
Q_2 = 160 - 4P
\]

for \( P \leq 40 \). For \( P > 40 \), \( Q_2 = 0 \). Harry’s demand curve is given by

\[
Q_3 = 150 - 5P
\]

for \( P \leq 30 \). For \( P > 30 \), \( Q_3 = 0 \). Using this information, answer the following:

a. How much scrod is demanded by each person at \( P = 50 \)? At \( P = 35 \)? At \( P = 25 \)? At \( P = 10 \)? And at \( P = 0 \)?

b. What is the total market demand for scrod at each of the prices specified in part a?

c. Graph each individual’s demand curve.

d. Use the individual demand curves and the results of part b to construct the total market demand for scrod.

### 4.6

Suppose the quantity of good \( X \) demanded by individual 1 is given by

\[
X_1 = 10 - 2P_x + 0.01I_1 + 0.4P_y
\]

and the quantity of \( X \) demanded by individual 2 is

\[
X_2 = 5 - P_x + 0.02I_2 + 0.2P_y
\]

a. What is the market demand function for total \( X \) (= \( X_1 + X_2 \)) as a function of \( P_x \), \( I_1 \), \( I_2 \), and \( P_y \)?

b. Graph the two individual demand curves (with \( X \) on the horizontal axis, \( P_x \) on the vertical axis) for the case \( I_1 = 1,000 \), \( I_2 = 1,000 \), and \( P_y = 10 \).

c. Using these individual demand curves, construct the market demand curve for total \( X \). What is the algebraic equation for this curve?

d. Now suppose \( I_1 \) increases to 1,100 and \( I_2 \) decreases to 900. How would the market demand curve shift? How would the individual demand curves shift? Graph these new curves.

e. Finally, suppose \( P_y \) rises to 15. Graph the new individual and market demand curves that would result.

### 4.7

Suppose that the current market price of VCRs is $300, that average consumer disposable income is $30,000, and that the price of DVD players (a substitute for VCRs) is $500. Under these conditions, the annual U.S. demand for VCRs is 5 million per year. Statistical studies have shown that for this product \( e_{Q,P} = -1.3 \), \( e_{Q,I} = 1.7 \), and \( e_{Q,P'} = 0.8 \) where \( P' \) is the price of DVD players.

Use this information to predict the annual number of VCRs sold under the following conditions:

a. Increasing competition from Korea causes VCR prices to fall to $270 with \( I \) and \( P' \) unchanged.

b. Income tax reductions raise average disposable income to $31,500 with \( P \) and \( P' \) unchanged.

c. Technical improvements in DVD players cause their price to fall to $400 with \( P \) and \( I \) unchanged.

d. All of the events described in part a through part c occur simultaneously.

e. The market demand for cashmere socks is given by

\[
Q = 1,000 + .5I - 400P + 200P'
\]

where

- \( Q \) = Annual demand in number of pairs
- \( I \) = Average income in dollars per year
- \( P \) = Price of one pair of cashmere socks
- \( P' \) = Price of one pair of wool socks

Given that \( I = 20,000 \), \( P = 10 \), and \( P' = 5 \), determine \( e_{Q,P} \), \( e_{Q,P} \), and \( e_{Q,P} \) at this point. (Hint: Use footnote 4 of this chapter.)

### 4.9

In Problem 3.9, we introduced compensated demand curves along which utility is held constant and only the substitution effect of price changes is considered. This problem shows how the price elasticity of demand along such a curve is related to the customary measure of price elasticity.

a. Suppose consumers buy only two goods, food and shelter, and that they buy these in fixed proportions—one unit of food for each unit of shelter. In this case, what does the compensated demand curve for food look like? What is the
price elasticity of demand along this curve (call this elasticity $e_s$—the substitution elasticity). Are there any substitution effects in this demand?

b. Under the conditions of part a, what is the income elasticity of demand for food ($e_{F,I}$)?

c. Continuing as in part a, suppose one unit of food costs half what one unit of housing costs. What fraction of income will be spent on food (call this $s_F$)?

d. Using the information in part c, what is the overall price elasticity of demand (including both substitution and income effects) for food ($e_{F,P}$)? (Hint: A numerical example may help here.)

e. Use your answers to part a through part d to show that the numbers calculated in this problem obey the formula in footnote 8 of this chapter:

$$e_{F,P} = e_s - s_F e_{F,I}$$

This formula is quite general. It is sometimes called the “Slutsky Equation” after its discoverer.

f. Let us change this problem a bit now to assume that people always spend $\frac{1}{3}$ of their income on food no matter what their income or what the price of food is. What is the demand function for food in this case?

g. Under the conditions of part f, what are the values of $e_{F,P}$, $s_F$, $e_{F,P}$, and (using the formula in part e) $e_s$ for this case? Explain why the value for $e_s$ differs between this case and the value calculated in part a.

h. How would your answers to part a through part g change if we focused on shelter instead of food?

4.10 For the linear demand curve shown in the following figure, show that the price elasticity of demand at any given point (say, point E) is given by minus the ratio of distance X to distance Y in the figure. (Hint: Use footnote 4 of this chapter.) Explain how this result provides an alternative way of showing how elasticity varies along a linear demand curve.
1. **Elasticity and Bus Fares.** Suppose you are the manager of a major city transit system. You are considering increasing bus fares from $0.75 to $0.81, but you need to know the impact of such an increase on transit ridership and revenues before doing so. Consult the analysis of bus fare elasticity at [http://www.apta.com/info/online/elastic.htm](http://www.apta.com/info/online/elastic.htm), which is abstracted from an article entitled “Fare Elasticity and Its Application to Forecasting Transit Demand,” published by the American Public Transportation Association. Complete the following statement: Using the Simpson-Curtin elasticity, the fare increase from $0.75 to $0.81 will reduce ridership by ________ percent while the newer overall average elasticity estimate suggests the same fare increase will reduce ridership by ________ percent. What do you predict will happen to your total revenue as a result of the fare increase, regardless of which estimate you use? Explain. On average, is the overall peak hour demand for ridership more or less elastic than the overall off-peak demand for ridership? Explain. Is this what you would expect? Why or why not?

2. **Elasticity and Alcohol Duties.** Application 4.5 discusses how elasticities can be used to determine the effectiveness of increasing taxes on alcohol to discourage drunk driving. In a very readable study, Zoë Smith also considers alcohol taxes and elasticities, but as applied to a very different question: Will lowering the tax on alcohol increase government revenue in the United Kingdom by reducing the amount of cross-border shopping, or will the lower tax rate lead to a loss in revenue? Read her briefing note at [http://www.ifs.org.uk/consume/alcohol.pdf](http://www.ifs.org.uk/consume/alcohol.pdf). Explain why, in order to determine whether, for example, lowering the tax on beer will raise or lower total revenue to the government, the following elasticities are important: the price elasticity of demand for beer and the cross-price elasticity of demand for wine with respect to the price of beer. From the information in Table 3 on the Web site, for which good (beer, spirits, or wine) is demand most price responsive? Least price responsive? For each good (the most and least price responsive), predict the resulting percentage change in quantity demanded in response to a 5 percent decrease in price. According to the information in Table 4 on the Web site, a reduction in the wine tax will lead to an increase in total wine sales. Refer to the appropriate elasticity from Table 3 to explain why. Use the information in Table 3 to determine whether beer and wine are substitutes or complements. Explain your answer. What does this imply about how tax revenue from beer sales will change if there is a decrease in the wine tax? Explain.