University of Zurich[UZH]

Leseaufträge «Mikroökonomik I»

Modul 2: Konsument und Nachfrage

Unit 4:

- Einkommens- und Substitutionseffekt

Quellen:

- **Chapter 5 – Individual and Market Demand**
  Frank, Robert H, & Cartwright, Edward. (2016). *Microeconomics and Behaviour (2nd European ed.)*. London: McGraw-Hill Education.
- **A tale of two cities**
  The Economists, August 15th 2015

CHAPTER

5

INDIVIDUAL AND MARKET DEMAND

A kilogram of salt costs about 30 pence in the UK. Would the average UK consumer buy more salt if the price was only 5 pence/kg? Would they buy less if it was 60 pence/kg? Would she buy more if she got a new job that doubled her income? The answer to all three questions is: probably not.

Salt is an unusual case. The amounts we buy of many other goods are much more sensitive to prices and incomes. For instance, the average rent on a two-bedroom property in London is more than £2,000 a week. Two hundred kilometres north, in Birmingham, the average rent on a four-bedroom property is less than £1,000 a week. It would be a real surprise if someone moving from London to Birmingham did not upsize and rent a bigger property.

CHAPTER PREVIEW

Viewed within the framework of the rational choice model, the differences between salt and housing are perfectly intelligible. Our focus in this chapter is to use the tools from Chapter 4 to shed additional light on why, exactly, the responses of various purchase decisions to changes in income and price differ so widely. In Chapter 4, we saw how changes in prices and incomes affect the budget constraint. Here, we will see how changes in the budget constraint affect actual purchase decisions. More specifically, we will use the rational choice model to generate an individual consumer's demand curve for a product and employ our model to construct a relationship that summarizes how individual demands vary with income.

We will see how the total effect of a price change can be decomposed into two separate effects: (1) the substitution effect, which denotes the change in the quantity demanded that results because the price change alters the attractiveness of substitute goods, and (2) the income effect, which denotes the change in quantity demanded that results from the change in purchasing power caused by the price change.

Next, we will show how individual demand curves can be added to yield the demand curve for the market as a whole. A central analytical concept we will develop in this chapter is the price elasticity of demand, a measure of the responsiveness of purchase decisions to small changes in price. We will also consider the income elasticity of demand, a measure of the responsiveness of purchase decisions to small changes in income. And we will see that, for some goods, the distribution of income, not just its average value, is an important determinant of market demand.

A final elasticity concept in this chapter is the cross-price elasticity of demand, which is a measure of the responsiveness of the quantity demanded of one good to small changes in the prices of another good. Cross-price elasticity is the criterion by which pairs of goods are classified as being either substitutes or complements.

These analytical constructs provide a deeper understanding of a variety of market behaviours as well as a stronger foundation for intelligent decision and policy analysis.

THE EFFECTS OF CHANGES IN PRICE

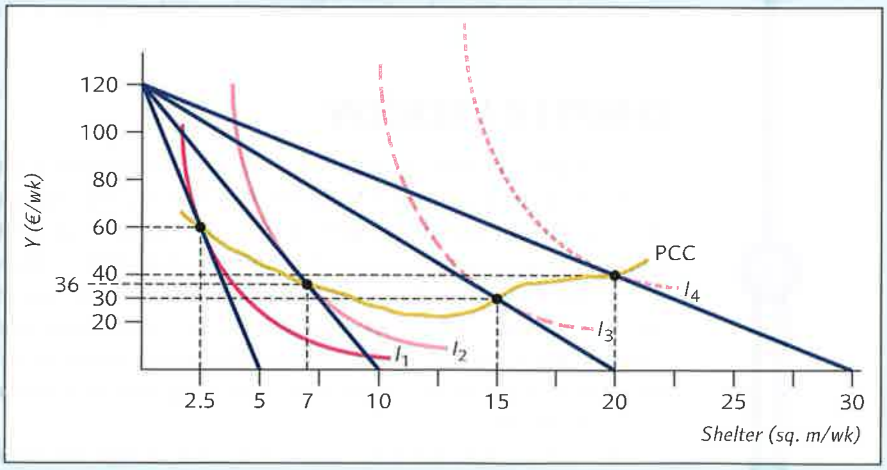
The Price–Consumption Curve

Recall from Chapter 2 that a market demand curve tells how much of a good the market as a whole wants to purchase at various prices. Suppose we want to generate a demand schedule for a good—say, shelter—not for the market as a whole but for only a single consumer. Holding income, preferences and the prices of all other goods constant, how will a change in the price of shelter affect the amount of shelter the consumer buys? To answer this question, we begin with this consumer's indifference map, plotting shelter on the horizontal axis and the composite good Y on the vertical axis. Suppose the consumer's income is €120/wk, and the price of the composite good is again €1 per unit. The vertical intercept of her budget constraint will then be 120. The horizontal intercept will be $120/P_S$, where P_S denotes the price of shelter. Figure 5.1 shows four budget constraints that correspond to four different prices of shelter, namely, €24/sq. m, €12/sq. m, €6/sq. m and €4/sq. m. The corresponding best affordable bundles contain 2.5, 7, 15 and 20 sq. m/wk of shelter, respectively. If we were to repeat this procedure for indefinitely many prices, the resulting points of tangency would trace out the line labelled PCC in Figure 5.1. This line is called the **price–consumption curve**, or **PCC**.

price–consumption curve (PCC) holding income and the price of Y constant, the PCC for a good X is the set of optimal bundles traced on an indifference map as the price of X varies.

For the particular consumer whose indifference map is shown in Figure 5.1, note that each time the price of shelter falls, the budget constraint rotates

FIGURE 5.1
The Price–Consumption Curve
Holding income and the price of Y fixed, we vary the price of shelter. The set of optimal bundles traced out by the various budget lines is called the price–consumption curve, or PCC.



outward, enabling the consumer to purchase not only more shelter but more of the composite good as well. And each time the price of shelter falls, this consumer chooses a bundle that contains more shelter than in the bundle chosen previously. Note, however, that the amount of money spent on the composite good may either rise or fall when the price of shelter falls. Thus, the amount spent on other goods falls when the price of shelter falls from €24/sq. m to €12/sq. m but rises when the price of shelter falls from €6/sq. m to €4/sq. m. Below, we will see why this is a relatively common purchase pattern.

The Individual Consumer's Demand Curve

An individual consumer's demand curve is like the market demand curve in that it tells the quantities the consumer will buy at various prices. All the information we need to construct the individual demand curve is contained in the price–consumption curve. The first step in going from the PCC to the individual demand curve is to record the relevant price–quantity combinations from the PCC in Figure 5.1, as in Table 5.1. (Recall from Chapter 4 that the price of shelter along any budget constraint is given by income divided by the horizontal intercept of that budget constraint.)

TABLE 5.1
A Demand Schedule

Price of shelter (€/sq. m)	Quantity of shelter demanded (sq. m/wk)
24	2.5
12	7
6	15
4	20

To derive the individual's demand curve for shelter from the PCC in Figure 5.1, begin by recording the quantities of shelter that correspond to the shelter prices on each budget constraint.

The next step is to plot the price–quantity pairs from Table 5.1, with the price of shelter on the vertical axis and the quantity of shelter on the horizontal. With sufficiently many price–quantity pairs, we generate the individual's demand curve, shown as *DD* in Figure 5.2.

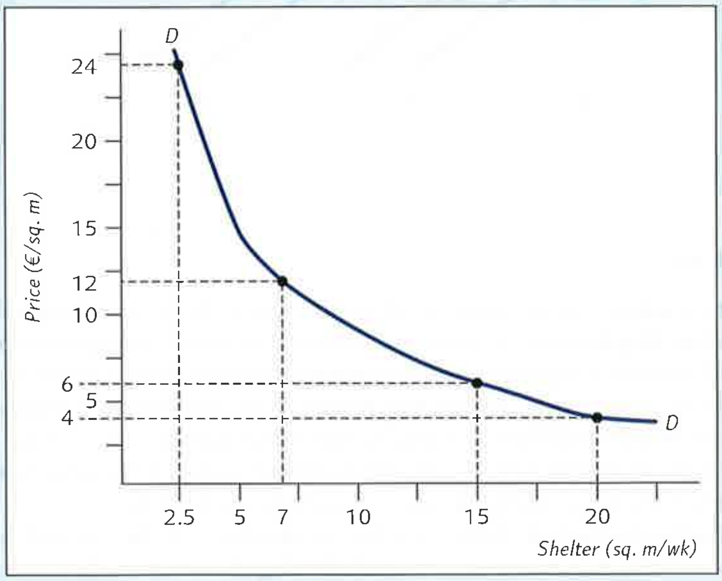


FIGURE 5.2
An Individual Consumer's Demand Curve
Like the market demand curve, the individual demand curve is a relationship that tells how much the consumer wants to purchase at different prices.

Note carefully that in moving from the PCC to the individual demand curve, we are moving from a graph in which both axes measure quantities to one in which price is plotted against quantity.

THE EFFECTS OF CHANGES IN INCOME

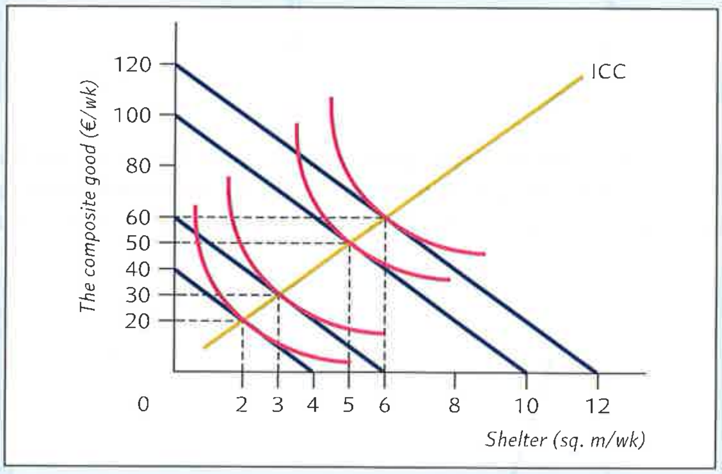
The Income–Consumption Curve

The PCC and the individual demand schedule are two different ways of summarizing how a consumer's purchase decisions respond to variations in prices. Analogous devices exist to summarize responses to variations in income. The income analogue to the PCC is the **income–consumption curve**, or **ICC**. To generate the PCC for shelter, we held preferences, income and the price of the composite good constant while tracing out the effects of a change in the price of shelter. In the case of the ICC, we hold preferences and relative prices constant and trace out the effects of changes in income.

income–consumption curve (ICC) holding the prices of *X* and *Y* constant, the ICC for a good *X* is the set of optimal bundles traced on an indifference map as income varies.

In Figure 5.3, for example, we hold the price of the composite good constant at €1 per unit and the price of shelter constant at €10/sq. m and examine what happens when income takes the values €40/wk, €60/wk, €100/wk and €120/wk. Recall from Chapter 4 that a change in income shifts the budget constraint parallel to itself. As before, to each budget there corresponds a best affordable bundle. The set of best affordable bundles is denoted as ICC in Figure 5.3. For the consumer whose indifference map is shown, the ICC happens to be a straight line, but this need not always be the case.

FIGURE 5.3
An Income–Consumption Curve
As income increases, the budget constraint moves outward. Holding preferences and relative prices constant, the ICC traces out how these changes in income affect consumption. It is the set of all tangencies as the budget line moves outward.



The Engel Curve

Engel curve a curve that plots the relationship between the quantity of *X* consumed and income.

The analogue to the individual demand curve in the income domain is the individual **Engel curve**. It takes the quantities of shelter demanded from the ICC and plots them against the corresponding values of income. Table 5.2 shows the income–shelter pairs for the four budget constraints shown in Figure 5.3. If we were to plot indefinitely many income–consumption pairs for the consumer shown in Figure 5.3, we would trace out the line *EE* shown in Figure 5.4. The Engel curve shown in Figure 5.4 happens to be linear, but Engel curves in general need not be.

Note carefully the distinction between what we measure on the vertical axis of the ICC and what we measure on the vertical axis of the Engel curve. On the vertical axis of

TABLE 5.2
Income and Quantity of Shelter Demanded

Income (€/wk)	Quantity of shelter demanded (sq. m/wk)
40	2
60	3
100	5
120	6

the ICC, we measure the amount the consumer spends each week on all goods other than shelter. On the vertical axis of the Engel curve, by contrast, we measure the consumer's total weekly income.

Note also that, as was true with the PCC and individual demand curves, the ICC and Engel curves contain essentially the same information. The advantage of the Engel curve is that it allows us to see at a glance how the quantity demanded varies with income.

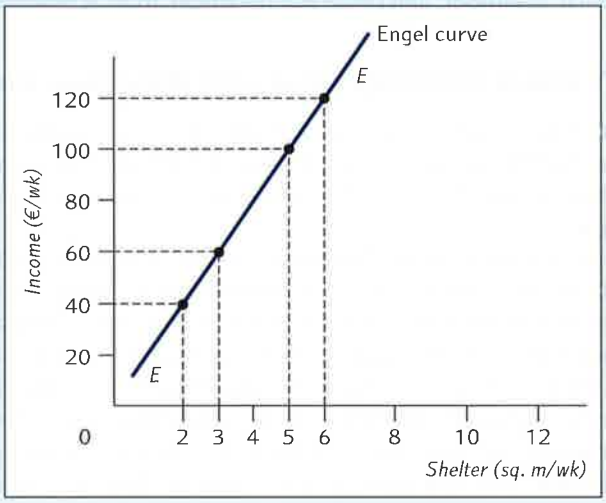


FIGURE 5.4
An Individual Consumer's Engel Curve
Holding preferences and relative prices constant, the Engel curve tells how much shelter the consumer will purchase at various levels of income.

Normal and Inferior Goods

Note that the Engel curve in Figure 5.5(a) is upward sloping, implying that the more income a consumer has, the more tenderloin steak he will buy each week. Most things we buy have this property, which is the defining characteristic of a **normal good.** Goods that do not have this property are called **inferior goods.** For such goods, an increase in income leads to a reduction in the quantity demanded. Figure 5.5(b) is an example of an Engel curve for an inferior good. The more income a person has, the fewer hamburgers he will buy each week.

normal good one whose quantity demanded rises as income rises.

inferior good one whose quantity demanded falls as income rises.

Why would someone buy less of a good following an increase in his income? The prototypical inferior good is one with several strongly preferred, but more expensive, substitutes. Supermarkets, for example, generally carry several different types of beef, ranging from cheap hamburgers to sirloin steak. A consumer trying to maximize taste

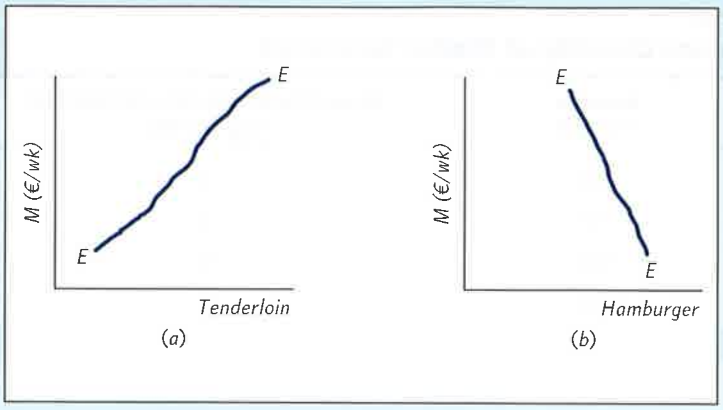


FIGURE 5.5
The Engel Curves for Normal and Inferior Goods
(*a*) This Engel curve is for a normal good. The quantity demanded increases with income. (*b*) This Engel curve for hamburger has the negative slope characteristic of inferior goods. As the consumer's income grows, he switches from hamburger to more desirable cuts of meat.

will switch to a higher quality of meat as soon as he can afford it. For such a consumer, hamburger is an inferior good.

For any consumer who spends all her income, it is a matter of simple arithmetic that not all goods can be inferior. After all, when income rises, it is mathematically impossible to spend less on all goods at once. It follows that the more broadly a good is defined, the less likely it is to be inferior. Thus, while hamburger is an inferior good for many consumers, there are probably very few people for whom 'meat' is inferior, and fewer still for whom 'food' is inferior.

ECONOMIC NATURALIST 5.1

Why does a family's choice of holiday tell us a lot about their income?

For the family on a very low income, holidays are a luxury they can do without. Indeed, before the 1950s few in Europe had the means for a week-long vacation anywhere remotely exotic. A growth in income changed all that. Now most Europeans are fortunate enough to have at least one foreign holiday a year.

Holidays are clearly a normal good. They come, however, in many different guises. A week in a cramped villa on the Costa del Sol is very different to living the life of opulence in a 5* hotel in the Maldives. As a family's income increases it is natural that they will substitute to better accommodation and more exotic locations. Consequently, if we focus on any particular type of holiday we are likely to observe backward-bending Engel curves like those depicted in Figure 5.6. In this case the consumer switches from spending money on 2* hotels to spending on 3* and 4* hotels as her income increases. A consumer's choice of holiday can, therefore, reveal a lot about her income. Not many poor people stay in the Ritz and few millionaires stay in a youth hostel.

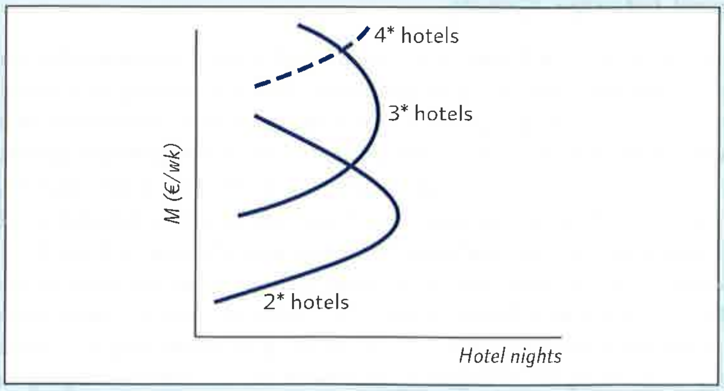


FIGURE 5.6
The Engel curves for 2*, 3* and 4* hotels
As the consumer's income increases she substitutes to higher quality hotels. This results in backward-bending Engel curves.

Figure 5.6 also illustrates the caution needed when saying that a good is a normal or inferior good. If the consumer were poor then 2* star hotels would have the characteristics of a normal good. But, if that same consumer were rich, 2* hotels would have the characteristics of an inferior good. Thus, whether a good is normal or inferior is almost always judged relative to some current or expected level of income. ■

THE INCOME AND SUBSTITUTION EFFECTS OF A PRICE CHANGE

substitution effect that component of the total effect of a price change that results from the associated change in the relative attractiveness of other goods.

income effect that component of the total effect of a price change that results from the associated change in real purchasing power.

In Chapter 2 we saw that a change in the price of a good affects purchase decisions for two reasons. Consider the effects of a price increase. (The effects of a price reduction will be in the opposite direction.) When the price of a good rises, close substitutes become more attractive than before. For example, when the price of rice increases, wheat becomes more attractive. This is the so-called **substitution effect** of a price increase.

The second effect of a price increase is to reduce the consumer's purchasing power. For a normal good, this will further reduce the amount purchased. But for an inferior good, the effect is just the opposite. The loss in purchasing power, taken by itself, increases the quantity purchased of an inferior good. The change in the quantity purchased attributable to the change in purchasing power is called the **income effect** of the price change.

The *total effect* of the price increase is the sum of the substitution and income effects. The substitution effect always causes the quantity purchased to move in the opposite direction from the change in price—when price goes up, the quantity demanded goes down, and vice versa. The direction of the income effect depends on whether the good is normal or inferior. For normal goods, the income effect works in the same direction as the substitution effect—when price goes up (down), the fall (rise) in purchasing power causes the quantity demanded to fall (rise). For inferior goods, by contrast, the income and substitution effects work against one another.

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When incomes rise, many consumers switch from low-priced beef . . .

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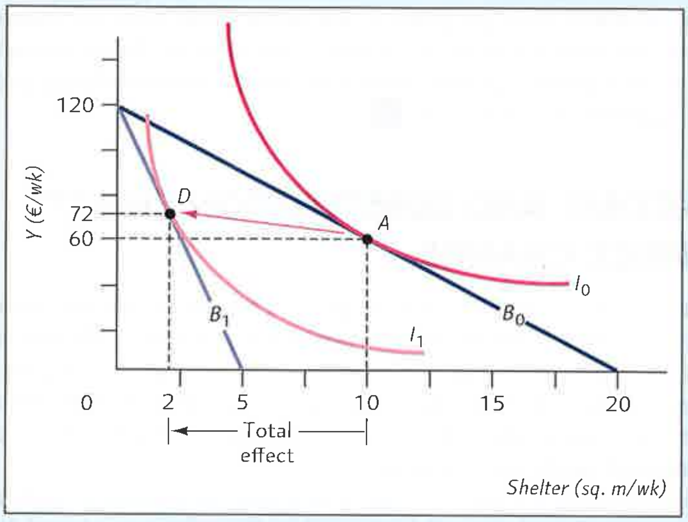
. . . to more expensive cuts of meat.

The substitution, income and total effects of a price increase can be seen most clearly when displayed graphically. Let us begin by depicting the total effect. In Figure 5.7, the consumer has an initial income of €120/wk and the initial price of shelter is €6/sq. m. This gives rise to the budget constraint labelled B_0, along which the optimal bundle is A, which contains 10 sq. m/wk of shelter. Now let the price of shelter increase from €6/sq. m to €24/sq. m, resulting in the budget labelled B_1. The new optimal bundle is D, which contains 2 sq. m/wk of shelter. The movement from A to D is called the total effect of the price increase. Naturally, the price increase causes the consumer to end up on a lower indifference curve (I_1) than the one he was able to attain on his original budget (I_0).

To decompose the total effect into the income and substitution effects, we begin by asking the following question: How much income would the consumer need to reach his original indifference curve (I_0) after the increase in the price of shelter? We can see in Figure 5.8 that the answer is €240/wk. If the consumer were given a total income of that amount, it would undo the injury caused by the loss in purchasing power resulting from the increase in the price of shelter. The budget constraint labelled B' is purely hypothetical, a device constructed for the purpose at hand. It has the same slope as the new budget constraint (B_1)—namely, −24—and is just far enough out to be tangent to

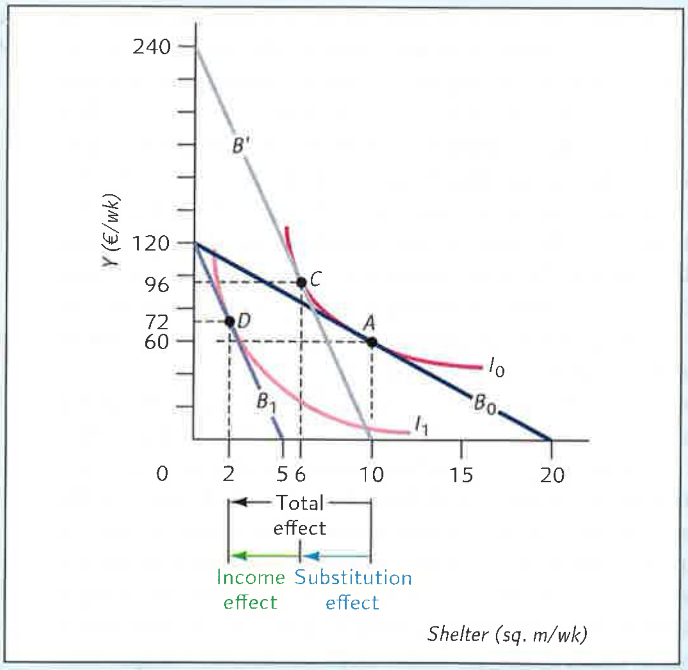
FIGURE 5.7
The Total Effect of a Price Increase
With an income of €120/wk and a price of shelter of €6/sq. m, the consumer chooses bundle A on the budget constraint B_0. When the price of shelter rises to €24/sq. m, with income held constant at €120/wk, the best affordable bundle becomes D. The movement from 10 to 2 sq. m/wk of shelter is called the total effect of the price increase.



the original indifference curve, I_0. With the budget constraint B', the optimal bundle is C, which contains 6 sq. m/wk of shelter. The movement from A to C gives rise to the substitution effect of the price change—here, a reduction of 4 sq. m/wk of shelter and an increase of 36 units/wk of the composite good.

The hypothetical budget constraint B' tells us that even if the consumer had enough income to reach the same indifference curve as before, the increase in the price of shelter would cause him to reduce his consumption of it in favour of other goods and services. *For consumers whose indifference curves have the conventional convex shape, the substitution effect of a price increase will always reduce consumption of the good whose price increased.*

FIGURE 5.8
The Substitution and Income Effects of a Price Change
To get the substitution effect, slide the new budget B_1 outward parallel to itself until it becomes tangent to the original indifference curve, I_0. The movement from A to C gives rise to the substitution effect, the reduction in shelter due solely to the fact that shelter is now more expensive relative to other goods. The movement from C to D gives rise to the income effect. It is the reduction in shelter that results from the loss in purchasing power implicit in the price increase.



The income effect stems from the movement from C to D. The particular good shown in Figure 5.8 happens to be a normal good. The hypothetical movement of the consumer's income from €240/wk to €120/wk accentuates the reduction of his consumption of shelter, causing it to fall from 6 sq. m/wk to 2 sq. m/wk.

Whereas the income effect reinforces the substitution effect for normal goods, the two effects tend to offset one another for inferior goods. In Figure 5.9, B_0 depicts the budget constraint for a consumer with an income of €24/wk who faces a price of hamburger of €1/kg. On B_0 the best affordable bundle is A, which contains 12 kg/wk of hamburger. When the price of hamburger rises to €2/kg, the resulting budget constraint is B_1 and the best affordable bundle is now D, which contains 9 kg/wk of hamburger. The total effect of the price increase is thus to reduce hamburger consumption by 3 kg/wk. Budget constraint B' once again is the hypothetical budget constraint that enables the consumer to reach the original indifference curve at the new price ratio. Note that the substitution effect (the change in hamburger consumption associated with movement from A to C in Figure 5.9) is to reduce the quantity of hamburger consumed by 4 kg/wk—that is, to reduce it by more than the value of the total effect. The income effect by itself (the change in hamburger consumption associated with the movement from C to D) actually increases hamburger consumption by 1 kg/wk. The income effect thus works in the opposite direction from the substitution effect for an inferior good such as hamburger.

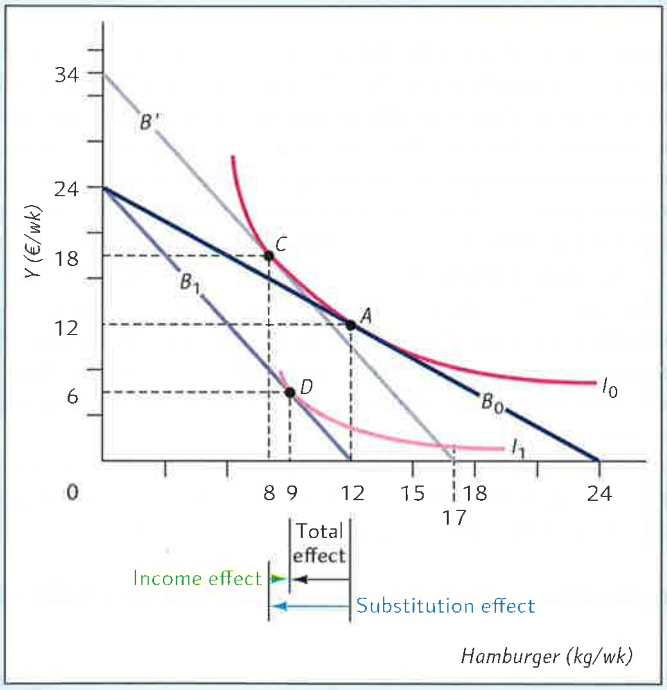


FIGURE 5.9
Income and Substitution Effects for an Inferior Good
By contrast to the case of a normal good, the income effect acts to offset the substitution effect for an inferior good.

Giffen Goods

Recall that the *law of demand* (see Chapter 2) states that the demand for a good should fall if the price of that good increases. So, the total effect of a price rise is to reduce the quantity purchased. The scenarios depicted in Figures 5.8 and 5.9 both satisfy this property. By contrast, a **Giffen good** is one for which the total effect of a price increase is to increase, not reduce, the quantity purchased. Since the substitution effect of a price increase is always to reduce the quantity purchased, the Giffen good must be one whose income effect offsets the substitution effect. That is, the Giffen good must be an inferior good—so strongly inferior, in fact, that the income effect is actually larger than the substitution effect.

Giffen good one for which the quantity demanded rises as its price rises.

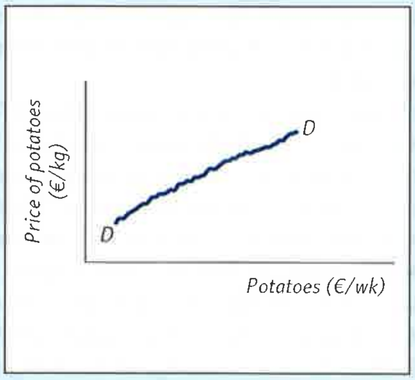


FIGURE 5.10
The Demand Curve for a Giffen Good
If a good is so strongly inferior that the income effect of a price increase dominates the substitution effect, the demand curve for that good will be upward sloping. Giffen goods are a theoretical possibility, but are seldom, if ever, observed in practice.

A much-cited example of a Giffen good was the potato during the Irish potato famine of the nineteenth century. The idea was that potatoes were such a large part of poor people's diets to begin with that an increase in their price had a severe adverse effect on the real value of purchasing power. Having less real income, many families responded by cutting back on meat and other more expensive foods, and buying even more potatoes. (See Figure 5.10.) Or so the story goes.

Modern historians dispute whether the potato was ever really a Giffen good. Whatever the resolution of this dispute, the potato story does illustrate the characteristics that a Giffen good would logically have to possess. First, it would not only have to be inferior, but also have to occupy a large share of the consumer's budget. Otherwise, an increase in its price would not create a significant reduction in real purchasing power. (Doubling the price of keyrings, for example, does not make anyone appreciably poorer.) The second characteristic required of a Giffen good is that it has a relatively small substitution effect, one small enough to be overwhelmed by the income effect.

In practice, it is extremely unlikely that a good will satisfy both requirements. Most goods, after all, account for only a tiny share of the consumer's total expenditures. Moreover, as noted, the more broadly a good is defined, the less likely it is to be inferior. Finally, inferior goods by their very nature tend to be ones for which there are close substitutes. The consumer's tendency to substitute sirloin for hamburger, for example, is precisely what makes hamburger an inferior good.

The Giffen good is an intriguing anomaly, chiefly useful for testing students' understanding of the subtleties of income and substitution effects. Unless otherwise stated, all demand curves used in the remainder of this text will be assumed to have the conventional downward slope.

ECONOMIC NATURALIST 5.2

Why does a standard haircut cost anything from €20 to €2,000 depending on the stylist?

There are lots of reasons why the demand for a product can increase the higher the price. It is important to recognize that these do not imply the product in question is a Giffen good. One particularly relevant issue is that of uncertainty, either about the quality of a product or the characteristics of the consumer.

To illustrate the point, consider a hairdressing salon that charges €2,000 for a haircut. The expectation must surely be that this salon cuts hair really, really well. How else could it justify such a price? A high price serves, therefore, as a signal of quality. We shall see in Chapter 7 that signals can be misleading—a €20 haircut may be equally as good as a €2,000 haircut. Even so, on average, we would expect price and quality to be positively related. In that case a high price can increase demand if sufficiently many consumers want a high quality product.

Another reason someone might be willing to splash out €2,000 on a haircut is to signal to others that she has money to spare (see also Chapter 7). At the end of the nineteenth century the American economist Thorstein Veblen introduced the concept of *conspicuous consumption*, the idea that a consumer might buy an expensive good purely to show that she had wealth. The return for conspicuous consumption is social status. Who, for instance, would not be impressed if you were to use the same hairstylist as David Beckham? A *Veblen good* is a good that appeals precisely because it is expensive enough that only the rich can afford it. ■

Perfect Substitutes and Complements

To further your understanding of income and substitution effects it is instructive to consider what happens in the special case of two goods that are perfect complements, or perfect substitutes.

EXAMPLE 5.1 Suppose skis and bindings are perfect, one-for-one complements and Paula spends all her equipment budget of €1,200/yr on these two goods. Skis and bindings each cost €200. What will be the income and substitution effects of an increase in the price of bindings to €400 per pair?

Since our goal here is to examine the effect on two specific goods (skis and bindings), we proceed by devoting one axis to each good and dispense with the composite good. On the original budget constraint, B_0, the optimal bundle is denoted A in Figure 5.11. Paula buys three pairs of skis per year and three pairs of bindings. When the price of bindings rises from €200 per pair to €400 per pair, we get the new budget constraint, B_1, and the resulting optimal bundle D, which contains two pairs of skis per year and two pairs of bindings.

An equipment budget of €1,800/yr is what Paula would need at the new price to attain the same indifference curve she did originally (I_0). (To get this figure, slide B_1 out until it hits I_0, then calculate the cost of buying the bundle at the vertical intercept—here, nine pairs of skis per year at €200 per pair.) Note that because perfect complements have right-angled indifference curves, the budget B' results in an optimal bundle C that is exactly the same as the original bundle A. So, the substitution effect is zero. The income and total effect of the price rise is one pair of bindings. ◆

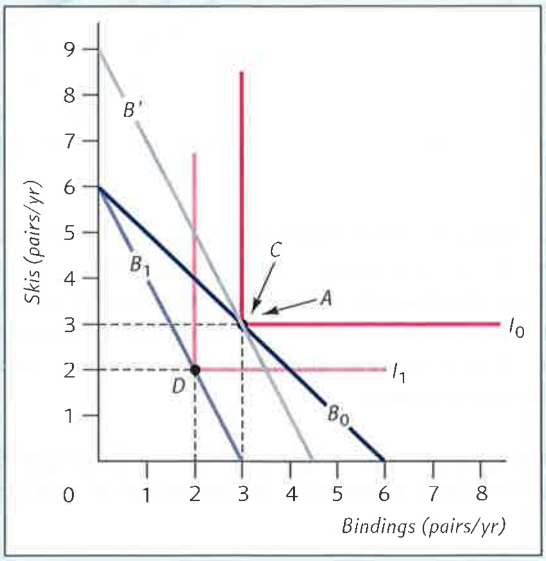


FIGURE 5.11
Income and Substitution Effects for Perfect Complements
For perfect complements, the substitution effect of an increase in the price of bindings (the movement from *A* to *C*) is equal to zero. The income effect (the movement from *A* to *D*) and the total effect are one and the same.

Example 5.1 illustrates that for perfect complements the substitution effect is zero. This property follows directly from the consumer's preference to purchase perfect complements in a fixed proportion. As the price of ski bindings, for instance, goes up relative to the price of skis, Paula will not alter the proportion of skis and bindings she purchases. There is nothing to be gained in substituting from bindings to skis. But, she will have to buy fewer units of ski equipment because she has less real purchasing power. The total effect on demand of a price increase is, thus, entirely due to the income effect.

EXERCISE 5.1 **Repeat Example 5.1 with the assumption that pairs of skis and pairs of bindings are perfect two-for-one complements. (That is, assume that Paula wears out two pairs of skis for every pair of bindings she wears out.)**

EXAMPLE 5.2 **Suppose Pam considers tea and coffee to be perfect one-for-one substitutes and spends €12/wk on these two beverages. Coffee costs €1/cup, while tea costs €1.20/cup. What will be the income and substitution effects of an increase in the price of coffee to €1.50/cup?**

Pam will initially demand 12 cups of coffee per week and no cups of tea (point A in Figure 5.12), since each good contributes equally to her utility but tea is more expensive. When the price of coffee rises, Pam switches to consuming only tea, buying 10 cups per week and no coffee (point D).

Pam would need a budget of €14.40/wk to afford 12 cups of tea (point C), which she likes as well as the 12 cups of coffee she originally consumed (points A and C both lie on I_0). The substitution effect (comparing points A and C) is 12 and the income effect (comparing points C and D) is 0. The total effect is, therefore, equal to the substitution effect. ◆

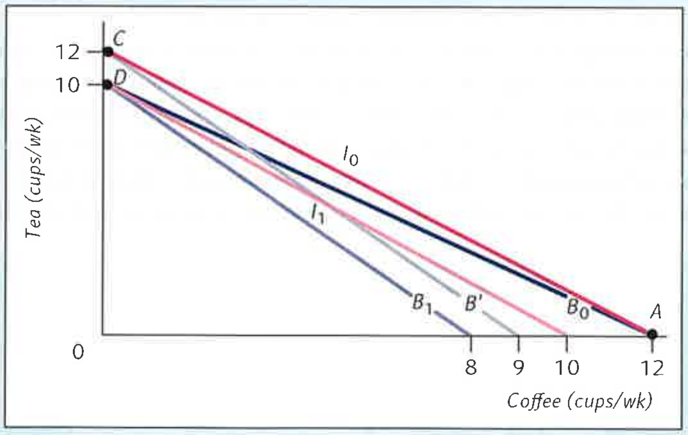


FIGURE 5.12
Income and Substitution Effects for Perfect Substitutes
For perfect substitutes, the substitution effect of an increase in the price of coffee (the movement from A to C) can be very large.

Example 5.2 illustrates that for perfect substitutes the income effect can be zero. In this case the total effect on demand of a price increase is accounted for by the substitution effect. Note, however, that this result critically depends on the way coffee went from being cheaper than tea to more expensive than tea. A switch in relative prices resulted in Pam switching consumption from coffee to tea. As the following exercise illustrates, the substitution effect is zero if the relative prices of the two goods do not switch.

EXERCISE 5.2 **Starting from the original price in Example 5.2, what will be the income and substitution effects of an increase in the price of coffee to €1.09/cup?**

CONSUMER RESPONSIVENESS TO CHANGES IN PRICE

We began this chapter with the observation that for certain goods, such as salt, consumption is highly insensitive to changes in price while for others, such as housing, it is much more sensitive. The principal reason for studying income and substitution effects is that they help us understand such differences.

Consider first the case of salt. When analysing substitution and income effects, there are two salient features to note about salt. First, for most consumers, it has no close substitutes. If someone were forbidden to shake salt onto his steak, he might respond by shaking a little extra pepper, or even by squeezing some lemon juice onto it. But for most people, these alternatives would fall considerably short of the real thing. Salt's second prominent feature is that it occupies an almost imperceptibly small share of total expenditures. An extremely heavy user of salt might consume a kilogram every month. If this person's income were €1,200/mo, a doubling of the price of salt—say, from €0.30/kg to €0.60/kg—would increase the share of his budget accounted for by salt from 0.00025 to 0.0005. For all practical purposes, the income effect for salt is negligible.

In Figure 5.13, the fact that salt has no close substitutes is represented by indifference curves with a nearly right-angled shape. Salt's negligible budget share is captured by the fact that the cusps of these indifference curves occur at extremely small quantities of salt.

Suppose, as in Figure 5.13, the price of salt is originally €0.30/kg, resulting in the equilibrium bundle *A* in the enlarged region, which contains 1.0002 kg/mo of salt. A price increase to €0.60/kg results in a new equilibrium bundle *D* with 1 kg/mo of salt. The income and substitution effects are measured in terms of the intermediate bundle *C*. Geometrically, the income effect is small because the original tangency occurred so near the vertical intercept of the budget constraint. When we are near the pivot point of the budget constraint, even a very large rotation produces only a small movement. The substitution effect, in turn, is small because of the nearly right-angled shape of the indifference curves.

Let us now contrast salt with housing. The two salient facts about housing are that (1) it accounts for a substantial share of total expenditures (more than 30 per cent for many people), and (2) most people have considerable latitude to substitute other goods for housing. Many Londoners, for example, can afford to live in apartments larger than the ones they now occupy, yet they prefer to spend what they save in rent on restaurant meals, theatre performances, and the like. Another substitution possibility is to consume less conveniently

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The quantity of salt demanded is highly insensitive to price for two reasons: (1) for many people, there are no attractive substitutes for salt, and (2) salt is so cheap that its price simply isn't worth worrying about.

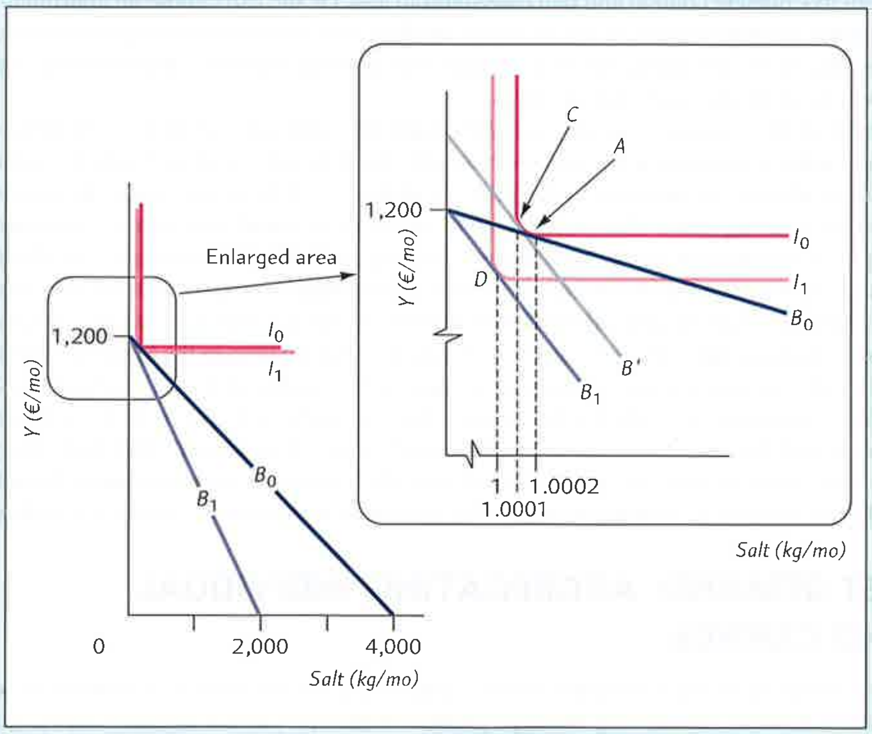
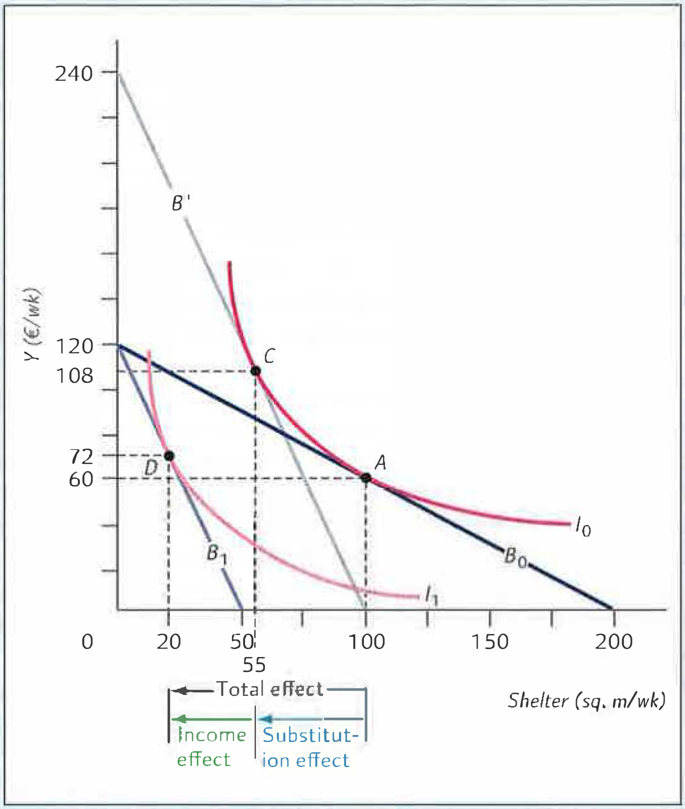


FIGURE 5.13
Income and Substitution Effects of a Price Increase for Salt
The total effect of a price change will be very small when (1) the original equilibrium bundle lies near the vertical intercept of the budget constraint, and (2) the indifference curves have a nearly right-angled shape. The first factor causes the income effect (the reduction in salt consumption associated with the movement from *C* to *D*) to be small; the second factor causes the substitution effect (the reduction in salt consumption associated with the movement from *A* to *C*) to be small.

FIGURE 5.14
Income and Substitution Effects for a Price-Sensitive Good
Because shelter occupies a large share of the budget, its income effect tends to be large. And because it is practical to substitute away from shelter, the substitution effect also tends to be large. The quantities demanded of goods with both large substitution and large income effects are highly responsive to changes in price.



located housing. Someone who works in London can live near her job and pay high rent; alternatively, she can live outside London and pay considerably less. Or she can choose an apartment in a less-fashionable neighbourhood, or one not quite as close to a convenient underground station. The point is that there are many different options for housing, and the choice among them depends strongly on income and relative prices.

In Figure 5.14, the consumer's income is €120/wk and the initial price of shelter is €0.60/sq. m. The resulting budget constraint is B_0, and the best affordable bundle on it is A, which contains 100 sq. m/wk of shelter. An increase in the price of shelter to €2.40/sq. m causes the quantity demanded to fall to 20 sq. m/wk. The smooth convex shape of the indifference curves represents the high degree of substitution possibilities between housing and other goods and accounts for the relatively large substitution effect (the fall in shelter consumption associated with the movement from A to C). Note also that the original equilibrium bundle, A, was far from the vertical pivot point of the budget constraint. By contrast to the case of salt, here the rotation in the budget constraint caused by the price increase produces a large movement in the location of the relevant segment of the new budget constraint. Accordingly, the income effect for shelter (the fall in shelter consumption associated with the movement from C to D) is much larger than for salt. With both a large substitution and a large income effect working together, the total effect of an increase in the price of shelter (the fall in shelter consumption associated with the movement from A to D) is very large.

PRICE ELASTICITY OF DEMAND

An analytical tool of central importance is the **price elasticity of demand.** It is a quantitative measure of the responsiveness of purchase decisions to variations in price, and as we will see in both this and later chapters, it is useful for a variety of practical problems. *Price elasticity of demand is defined as the percentage change in the quantity of a good demanded that results from a 1 per cent change in price.* For example, if a 1 per cent rise in the price of shelter caused a 2 per cent reduction in the quantity of shelter demanded, then the price elasticity of demand for shelter would be –2.

price elasticity of demand the percentage change in the quantity of a good demanded that results from a 1 per cent change in its price.

The price elasticity of demand will almost always be negative (or zero) because price changes move in the opposite direction from changes in quantity demanded. The demand for a good is said to be *elastic* with respect to price if its price elasticity is less than –1. So, if shelter has a price elasticity of –2 then demand is elastic with respect to price. The demand for a good is *inelastic* with respect to price if its price elasticity is greater than –1 and *unit elastic* with respect to price if its price elasticity is equal to –1. These definitions are portrayed graphically in Figure 5.18.

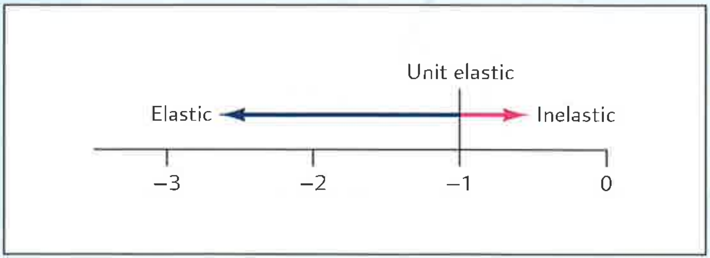


FIGURE 5.18
Three Categories of Price Elasticity
With respect to price, the demand for a good is elastic if its price elasticity is less than –1, inelastic if its price elasticity exceeds –1, and unit elastic if its price elasticity is equal to –1.

For the sake of convenience economists often ignore the negative sign of price elasticity and refer simply to its absolute value. When a good is said to have a 'high' price elasticity of demand, this will always mean that its price elasticity is large in absolute value, indicating that the quantity demanded is highly responsive to changes in price. Similarly, a good whose price elasticity is said to be 'low' is one for which the absolute value of elasticity is small, indicating that the quantity demanded is relatively unresponsive to changes in price.

When interpreting actual demand data, it is often useful to have a more general definition of price elasticity that can accommodate cases in which the observed change in price does not happen to be 1 per cent. Let P be the current price of a good and let Q be the quantity demanded at that price. And let ΔQ be the change in the quantity demanded that occurs in response to a very small change in price, ΔP. The price elasticity of demand at the current price and quantity will then be given by

$$\varepsilon = \frac{\Delta Q/Q}{\Delta P/P} \tag{5.1}$$

The numerator on the right side of Equation 5.1 is the proportional change in quantity. The denominator is the proportional change in price. Equation 5.1 is exactly the same as our earlier definition when ΔP happens to be a 1 per cent change in current price. The advantage is that the more general definition also works when ΔP is any other small percentage change in current price.

A Geometric Interpretation of Price Elasticity

Another way to interpret Equation 5.1 is to rewrite it as

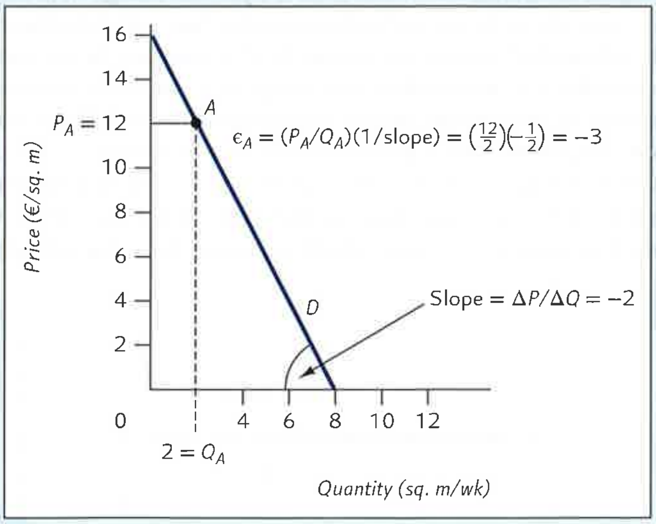
$$\varepsilon = \frac{\Delta Q}{\Delta P}\frac{P}{Q} \tag{5.2}$$

Equation 5.2 suggests a simple interpretation in terms of the geometry of the market demand curve. When ΔP is small, the ratio $\Delta P/\Delta Q$ is the slope of the demand curve, which means that the ratio $\Delta Q/\Delta P$ is the reciprocal of that slope. Thus the price elasticity of demand may be interpreted as the product of the ratio of price to quantity and the reciprocal of the slope of the demand curve:[1]

$$\varepsilon = \frac{P}{Q}\frac{1}{\text{slope}} \tag{5.3}$$

Equation 5.3 is called the *point-slope method* of calculating price elasticity of demand. By way of illustration, consider the demand curve for shelter shown in Figure 5.19. Because this

FIGURE 5.19
The Point-Slope Method
The price elasticity of demand at any point is the product of the price-quantity ratio at that point and the reciprocal of the slope of the demand curve at that point. The price elasticity at A is thus $(\frac{12}{2})(-\frac{1}{2}) = -3$.



[1] In calculus terms, price elasticity is defined as $\varepsilon = (P/Q)[dQ(P)/dP]$.

demand curve is linear, its slope is the same at every point, namely, −2. The reciprocal of this slope is $-\frac{1}{2}$. The price elasticity of demand at point A is therefore given by the ratio of price to quantity at A (which is $\frac{12}{2}$) multiplied by the reciprocal of the slope at A (which is $-\frac{1}{2}$), so we have $\varepsilon_A = (\frac{12}{2})(-\frac{1}{2}) = -3$.

EXERCISE 5.5 Use the point-slope method (Equation 5.3) to determine the elasticity of the demand curve $P = 32 - Q$ at the point where $P = 24$.

The point-slope method makes it readily apparent that elasticity will be inversely related to the slope of the demand curve. The steeper the demand curve, the less elastic is demand at any point along it. This follows from the fact that the reciprocal of the slope of the demand curve is one of the factors used to compute price elasticity.

Two polar cases of demand elasticity are shown in Figure 5.20. In Figure 5.20(a), the horizontal demand curve, with its slope of zero, has an infinitely high price elasticity at every point. Such demand curves are often called *perfectly elastic* and, as we will see, are especially important in the study of competitive firm behaviour. In Figure 5.20(b), the vertical demand curve has a price elasticity everywhere equal to zero. Such curves are called *perfectly inelastic*. In this case demand is not influenced by price.

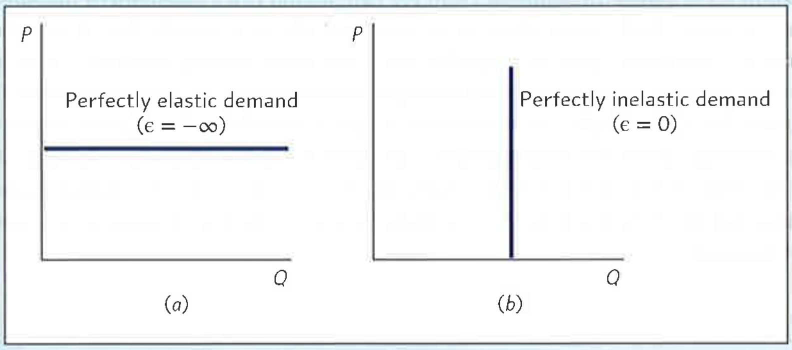


FIGURE 5.20
Two Important Polar Cases
(a) The price elasticity of the demand curve is equal to $-\infty$ at every point. Such demand curves are said to be perfectly elastic. (b) The price elasticity of the demand curve is equal to 0 at every point. Such demand curves are said to be perfectly inelastic.

As a practical matter, it would be impossible for any demand curve to be perfectly inelastic at all prices. Beyond some sufficiently high price, income effects must curtail consumption, even for seemingly essential goods with no substitutes, such as surgery for malignant tumours. Even so, the demand curve for many such goods and services will be perfectly inelastic over an extremely broad range of prices (recall the salt example discussed earlier in this chapter).

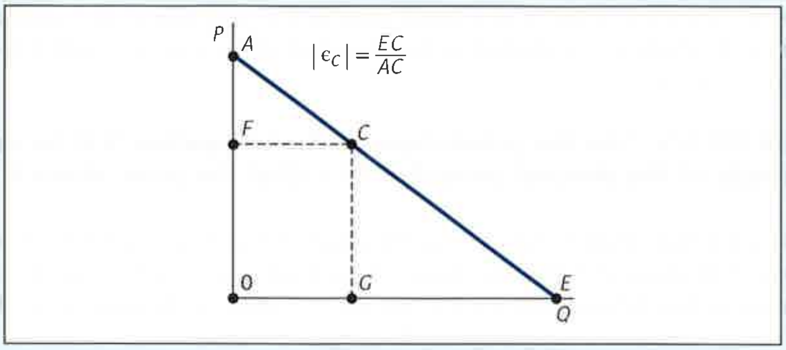
Elasticity along a Linear Demand Curve

The point-slope method makes it clear that when the market demand curve is linear, as in Figure 5.19, *price elasticity is different at every point along the demand curve*. More specifically, we know that the slope of a linear demand curve is constant throughout, which means that the reciprocal of its slope is also constant. The ratio of price to quantity, by contrast, takes a different value at every point along the demand curve. As we approach the vertical intercept, it approaches infinity. It declines steadily as we move downward along the demand curve, finally reaching a value of zero at the horizontal intercept.

To better appreciate this point we can look at a further interpretation of price elasticity along a straight-line demand curve. Suppose we divide the demand curve into two segments AC and CE, as shown in Figure 5.21. The price elasticity of demand (in absolute value) at point C, denoted $|\varepsilon_c|$, will then be equal to the ratio of the two segments:

$$|\varepsilon_c| = \frac{CE}{AC} \tag{5.4}$$

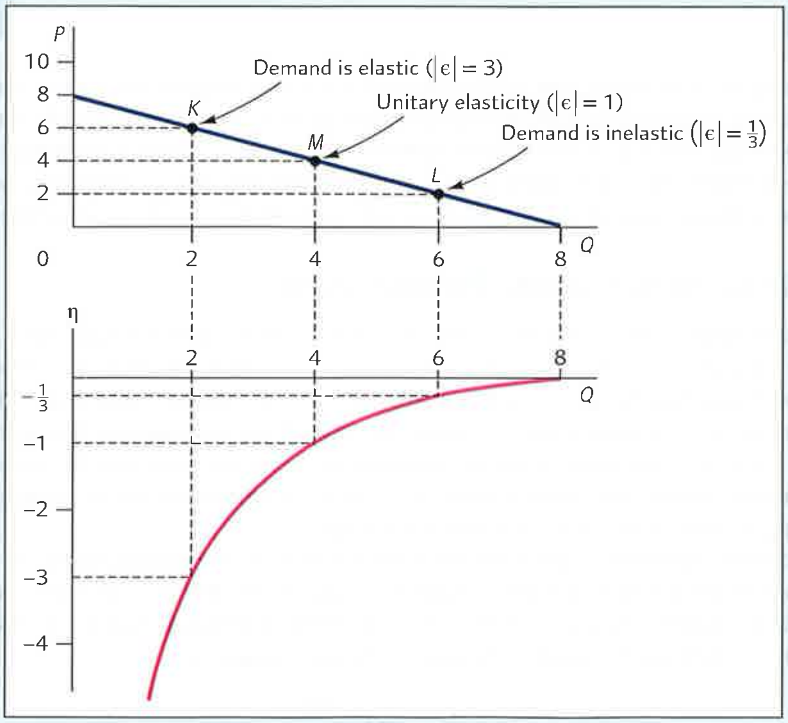
FIGURE 5.21
The Segment-Ratio Method
The absolute value of price elasticity at any point is the ratio of the two demand curve segments from that point. At point *C*, the absolute value of the price elasticity of demand is equal to *CE*/*AC*.



To see why this is so, note that the reciprocal of the slope of the demand curve in Figure 5.21 is the ratio *GE*/*GC*. Also, the ratio of price to quantity at point *C* is *GC*/*FC*. Multiplying these two, we get $|\varepsilon_c| = (GE/GC)(GC/FC) = GE/FC$. Now note that the triangles *AFC* and *CGE* are similar, which means that the ratios of their corresponding sides must be the same. In particular, it means that the ratio *GE*/*FC* must also be equal to the ratio *CE*/*AC*. And this, of course, is just the result we set out to establish. Equation 5.4 is called the *segment-ratio* for calculating price elasticity of demand.

Knowing that the price elasticity of demand at any point along a straight-line demand curve is the ratio of two line segments greatly simplifies the task of making quantitative statements about it. Consider the demand curve shown in the top panel of Figure 5.22. At the midpoint of that demand curve (point *M*), for example, we can see at a glance that the value of price elasticity is -1. One-fourth of the way down the demand curve (point *K* in Figure 5.22), the elasticity is -3; three-fourths of the way down (point *L*), the elasticity is $-\frac{1}{3}$; and so on. The bottom panel of Figure 5.22 summarizes the relation between position on a straight-line demand curve and the price elasticity of demand.

FIGURE 5.22
Elasticity at Different Positions along a Straight-Line Demand Curve
Using the segment-ratio method, the price elasticities at points *K*, *M* and *L* (top panel) can be calculated in an instant.



In the Appendix to this chapter we look at demand curves that have constant price elasticity of demand, meaning that elasticity does not depend on price or quantity. As we have seen these demand curves cannot be linear.

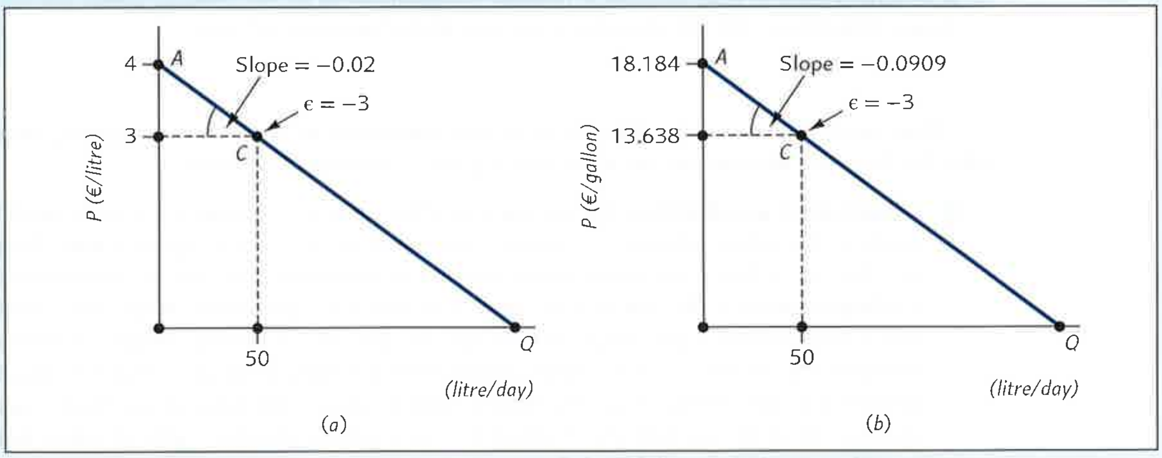
The Unit-Free Property of Elasticity

Since the slope of a demand curve is much simpler to calculate than its elasticity, it may seem natural to ask, 'Why bother with elasticity at all?' One reason is that the slope of the demand curve is sensitive to the units we use to measure price and quantity, while elasticity is not.

By way of illustration, consider a driver in the UK who has to cope with both metric measures, litres of petrol, and imperial measures, gallons of petrol. In Figure 5.23(*a*) we have plotted the demand curve for petrol measured in litres, and in Figure 5.23(*b*) the *same* demand curve measured in gallons (where there are around 4.55 litres per gallon). When price is measured in €/litre, the slope of the demand curve at point *C* is –0.02. By contrast, where price is measured in €/gallon, the slope at *C* is –0.0909. In both cases, however, note that the price elasticity of demand at *C* is –3.

It will always be true that elasticity does not depend on how we measure price and quantity. This is a very useful property. Most people, for instance, find it much more informative to know that a 1 per cent cut in price will lead to a 3 per cent increase in the quantity demanded than to know that the slope of the demand curve is –0.0909.

FIGURE 5.23
Elasticity Is Unit-Free
The slope of the demand curve at any point depends on the units in which we measure price and quantity. The absolute magnitude of the slope at point *C* when we measure the price of petrol in euros per litre (*a*) is more than when we measure the price in euros per gallon (*b*). The price elasticity at any point, by contrast, is completely independent of units of measure.



Determinants of Price Elasticity of Demand

As the entries in Table 5.3 show, the price elasticities of demand for different products often differ substantially. The low elasticity for theatre and opera performances probably reflects the fact that buyers in this market have much larger than average incomes, so that income effects of price variations are likely to be small. Income effects for green peas are also likely to be small, even for low-income consumers, yet the price elasticity of demand for green peas is more than 14 times larger than for theatre and opera performances. The difference is that there are many more close substitutes for green peas than for theatre and opera performances.

TABLE 5.3
Price Elasticity Estimates for Selected Products*

Good or service	Price elasticity
Green peas	−2.8
Air travel (vacation)	−1.9
Frying chickens	−1.8
Beer	−1.2
Marijuana	−1.0
Movies	−0.9
Air travel (non-vacation)	−0.8
Shoes	−0.7
Cigarettes	−0.3
Theatre, opera	−0.2
Local telephone calls	−0.1

*Some of these short-run elasticity estimates represent the midpoint of the corresponding range of estimates. Sources: Fred Nordhauser and Paul L. Farris, 'An Estimate of the Short-Run Price Elasticity of Demand for Fryers', *Journal of Farm Economics,* November 1959; H. S. Houthakker and Lester Taylor, *Consumer Demand in the United States: Analyses and Projections,* 2nd edn, Cambridge, MA: Harvard University Press, 1970; Charles T. Nisbet and Firouz Vakil, 'Some Estimates of Price and Expenditure Elasticities of Demand for Marijuana among UCLA Students', *Review of Economics and Statistics,* November 1972; L. Taylor, 'The Demand for Electricity: A Survey', *Bell Journal of Economics,* Spring 1975; K. Elzinga, 'The Beer Industry', in Walter Adams (ed.), *The Structure of American Industry,* New York: Macmillan, 1977; Rolla Edward Park, Bruce M. Wetzel, and Bridger Mitchell, *Charging for Local Telephone Calls: Price Elasticity Estimates from the GTE Illinois Experiment,* Santa Monica, CA: Rand Corporation, 1983; Tae H. Oum, W. G. Waters II, and Jong Say Yong, 'A Survey of Recent Estimates of Price Elasticities of Demand for Transport', World Bank Infrastructure and Urban Development Department Working Paper 359, January 1990; M. C. Farrelly and J. W. Bray, 'Response to Increases in Cigarette Prices by Race/Ethnicity, Income, and Age Groups—United States, 1976–1993', *Journal of the American Medical Association,* 280, 1998.

More generally, our earlier discussion of substitution and income effects suggests primary roles for the four following factors in influencing price elasticity of demand:

- **Substitution possibilities.** The substitution effect of a price change tends to be small for goods with no close substitutes. Consider, for example, the vaccine against rabies. People who have been bitten by rabid animals have no substitute for this vaccine, so demand for it is highly inelastic. We saw that the same was true for a good such as salt. But consider now the demand for a particular brand of salt. Despite the advertising claims of salt manufacturers, one brand of salt is a more-or-less perfect substitute for any other. Because the substitution effect between specific brands is large, a rise in the price of one brand should sharply curtail the quantity of it demanded. In general, the absolute value of price elasticity will rise with the availability of attractive substitutes.

- **Budget share.** The larger the share of total expenditures accounted for by the product, the more important will be the income effect of a price change. Goods such as salt, rubber bands, clingfilm and a host of others account for such small shares of total expenditures that the income effects of a price change are likely to be negligible. For goods like housing and higher education, by contrast, the income effect of a price increase is likely to be large. In general, the smaller the share of total expenditure accounted for by a good, the less elastic demand will be.

- **Direction of income effect.** A factor closely related to the budget share is the direction—positive or negative—of its income effect. While the budget share tells us whether the income

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The price of elasticity of demand for petrol is higher in the long run because when the price of petrol rises, it takes time for people to switch from inefficient vehicles . . .

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. . . to more efficient ones.

effect of a price change is likely to be large or small, the direction of the income effect tells us whether it will offset or reinforce the substitution effect. Thus, a normal good will have a higher price elasticity than an inferior good, other things equal, because the income effect reinforces the substitution effect for a normal good but offsets it for an inferior good.

- **Time.** Our analysis of individual demand did not focus explicitly on the role of time. But it too has an important effect on responses to changes in prices. Consider the increase in petrol prices over the last 20 years. One possible response is simply to drive less. But many car trips cannot be abandoned, or even altered, very quickly. A person cannot simply stop going to work, for example. He can cut down on his daily commute by joining a car pool or by purchasing a house closer to where he works. He can also curtail his petrol consumption by trading in his current car for one that gets better mileage. But all these steps take time, and as a result, the demand for petrol will be much more elastic in the long run than in the short run.

To illustrate the role of time in a little more detail, let us consider the short- and long-run effects of a supply shift in the market for petrol. This initial equilibrium at A in Figure 5.24 is disturbed by a supply reduction from S to S'. In the short run, the effect is for price to rise to P_{SR} = €2.80/litre and for quantity to fall to $Q_{SR} = 5$ million litres/day. The long-run demand curve is more elastic than the short-run demand curve. As consumers have more time to adjust,

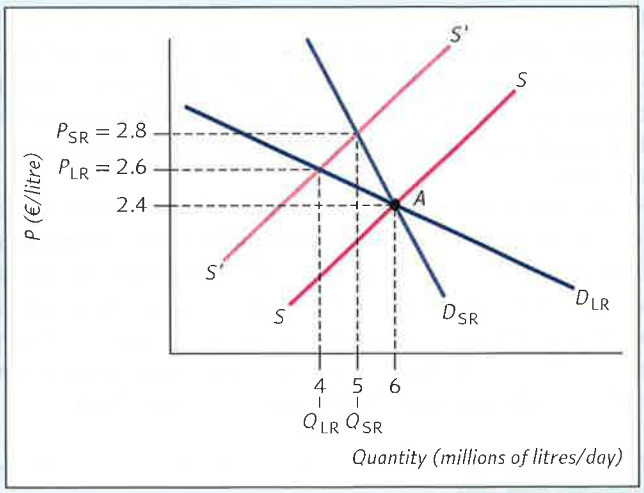


FIGURE 5.24
Price Elasticity Is Greater in the Long Run Than in the Short Run
The more time people have, the more easily they can switch to substitute products. The price effects of supply alterations are therefore always more extreme in the short run than in the long run.

therefore, price effects tend to moderate while quantity effects tend to become more pronounced. Thus the new long-run equilibrium in Figure 5.24 occurs at a price of P_{LR} = €2.60/litre and a quantity of Q_{LR} = 4 million litres/day.

We see an extreme illustration of the difference between short- and long-run price elasticity values in the case of natural gas used in households. The price elasticity for this product is only −0.1 in the short run but a whopping −10.7 in the long run![2] This difference reflects the fact that once consumers have chosen appliances to heat and cook with, they are virtually locked in for the short run. People aren't going to cook their rice for only 10 minutes just because the price of natural gas has gone up. In the long run, however, consumers can and do switch between fuels when there are significant changes in relative prices.

ECONOMIC NATURALIST 5.3

Why has demand for university places in England and Wales increased despite the introduction of tuition fees?

In the early 1990s university students in the UK typically received a maintenance grant to support their studies. Since then, things have changed dramatically. In 1998 a tuition fee of £1,000 per year was introduced. In 2004 the fee was increased to £3,000 per year and in 2012 it went up to £9,000 per year. The price, therefore, of a three-year degree increased by £27,000 over the course of 15 years.

Surely such a dramatic increase in price would have a big effect on demand? To many people's surprise the answer seems to be no. Sure, some students were strategic and went to university before the tuition fee increases. And some expect more of their lecturers now that they are paying £9,000 a year in fees! Demand for university places in England and Wales remains, however, buoyant.[3]

To understand why demand for university has stayed so buoyant we need to look at substitution possibilities. In a highly competitive labour market there are few substitutes for a university education. Indeed many careers in finance, medicine, education, the legal profession, and so forth are simply not open to someone without a degree. With no alternative substitutes (and few students heading abroad for an education) demand will be inelastic.

We do, though, still need to take account of income effects. Clearly, £27,000 is a lot of money and would make up a big share of most people's budget. Note, however, that education has lifelong benefits and student loans allow repayment of tuition fees over many years. This attenuates the income effect. The price of a university education, for instance, is considerably less than that of a house. ■

Elasticity and Total Expenditure

Our discussion of price elasticity of demand has focused exclusively on the demand side. We have seen, however, that price elasticity is likely to be different at different points along a demand curve. This means that the price elasticity that exists in a particular market at a particular time will depend crucially on the supply side of the market because it is supply that will determine where on the demand curve we find ourselves. If prices are high we are likely to be on the elastic portion of the demand curve. While if prices are low we are likely to be on the inelastic portion of the demand curve.

We shall explore this issue in more detail in subsequent chapters when we look at the supply side of the market (see, in particular, Chapter 13). An important relationship between price elasticity and total expenditure is, however, worth explaining at this point. The questions we want to be able to answer are of the form, 'If the price of a product changes, how will total spending on the product be affected?' and 'Will more be spent if we sell more units at a lower price or fewer units at a higher price?' In Figure 5.25, for example, we might want to know how total expenditures for shelter are affected when the price falls from €12/sq. m to €10/sq. m.

[2] H. S. Houthakker and Lester Taylor, *Consumer Demand in the United States: Analyses and Projections*, 2nd edn, Cambridge, MA: Harvard University Press, 1970.
[3] Scotland does not have tuition fees, except for students from England.

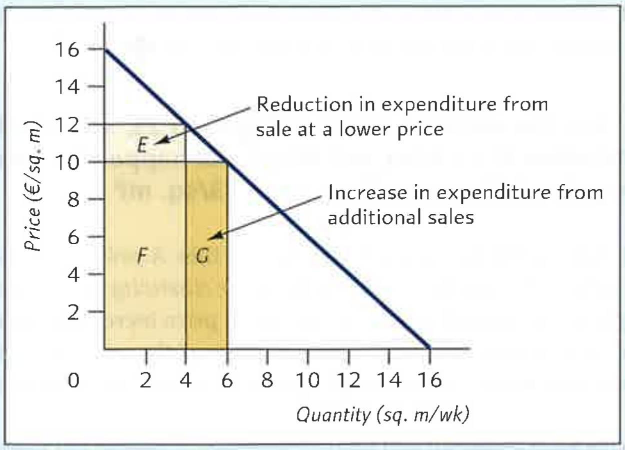


FIGURE 5.25
The Effect on Total Expenditure of a Reduction in Price
When price falls, people spend less on existing units (*E*). But they also buy more units (*G*). Here, *G* is larger than *E*, which means that total expenditure rises.

The total expenditure, R, at any quantity-price pair (Q, P) is given by the product

$$R = PQ \tag{5.5}$$

In Figure 5.25, the total expenditure at the original quantity–price pair is thus (€12/sq. m)(4 sq. m/wk) = €48/wk. Geometrically, it is the sum of the two shaded areas E and F. Following the price reduction, the new total expenditure is (€10/sq. m) (6 sq. m/wk) = €60/wk, which is the sum of the shaded areas F and G. These two total expenditures have in common the shaded area F. The change in total expenditure is thus the difference in the two shaded areas E and G. The area E, which is (€2/sq. m)(4 sq. m/wk) = €8/wk, may be interpreted as the reduction in expenditure caused by selling the original 4 sq. m/wk at the new, lower price. G, in turn, is the increase in expenditure caused by the additional 2 sq. m/wk of sales. This area is given by (€10/sq. m)(2 sq. m/wk) = €20/wk. Whether total expenditure rises or falls thus boils down to whether the gain from additional sales exceeds the loss from lower prices. Here, the gain exceeds the loss by €12, so total expenditure rises by that amount following the price reduction.

If the change in price is small, we can say how total expenditure will move if we know the initial price elasticity of demand. Recall that one way of expressing price elasticity is the percentage change in quantity divided by the corresponding percentage change in price. If the absolute value of that quotient exceeds 1, we know that the percentage change in quantity is larger than the percentage change in price. And when that happens, the increase in expenditure from additional sales will always exceed the reduction from sales of existing units at the lower price. In Figure 5.25, note that the elasticity at the original price of €12 is –3.0, which confirms our earlier observation that the price reduction led to an increase in total expenditure. Suppose, on the contrary, that the absolute value of price elasticity is less than unity. Then the percentage change in quantity will be smaller than the corresponding percentage change in price, and the additional sales will not compensate for the reduction in expenditure from sales at a lower price. Here, a price reduction will lead to a reduction in total expenditure.

EXAMPLE 5.5 You are the administrator in charge of setting tolls for the Oresund Bridge, which links Copenhagen to Malmo. Suppose that with the toll at €30/trip, 100,000 trips per day are taken across the bridge. If the price elasticity of demand for trips is –2.0, what will happen to total expenditure if you raise the toll by 10 per cent? What if the price elasticity was –0.5?

With an elasticity of –2.0, a 10 per cent increase in price will produce a 20 per cent reduction in quantity. Thus the number of trips will fall to 80,000/day. Total expenditure at the higher toll will be (80,000 trips/day)(€33/trip) = €2,640,000/day. Note that this is smaller than the total expenditure of €3,000,000/day that occurred under the €30 toll. You would actually do best to lower the toll.

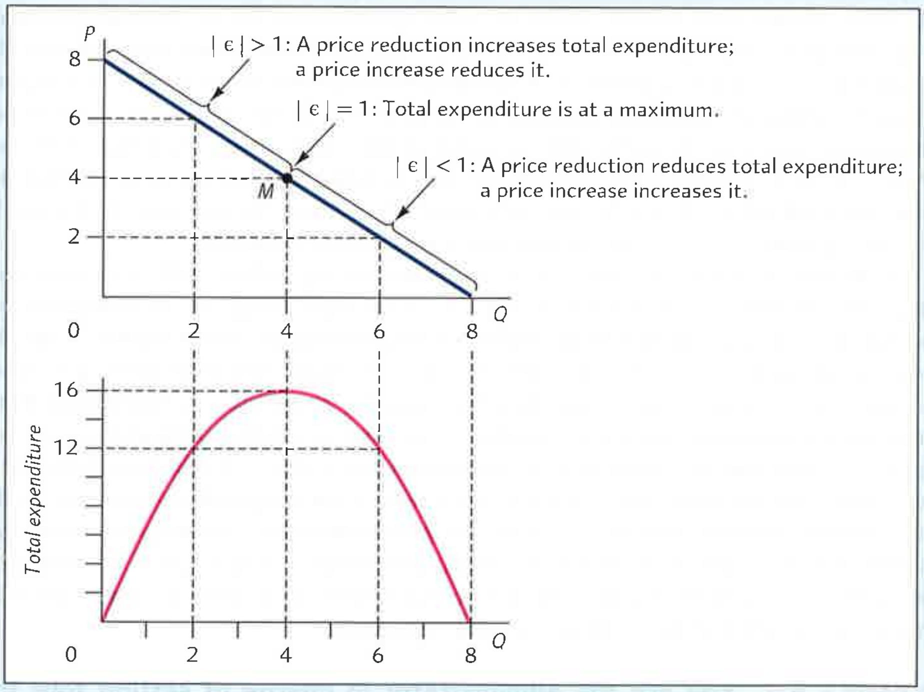
Now suppose that the price elasticity is –0.5. This time the number of trips will fall by 5 per cent to 95,000/day, which means that total expenditure will rise to (95,000 trips/day) (€33/trip) = €3,135,000/day. This time it does make sense to increase the toll. ◆

EXERCISE 5.6 For the demand curve in Figure 5.25, what is the price elasticity of demand when *P* = €4/sq. m? What will happen to total expenditure on shelter when price falls from €4/sq. m to €3/sq. m?

The general rule for small price reductions, then, is this: *A price reduction will increase total revenue if and only if the absolute value of the price elasticity of demand is greater than 1.* Parallel reasoning leads to an analogous rule for small price increases: *An increase in price will increase total revenue if and only if the absolute value of the price elasticity is less than 1.* These rules are summarized in the top panel of Figure 5.26, where the point *M* is the midpoint of the demand curve.

The relationship between elasticity and total expenditure is spelled out in greater detail in the relationship between the top and bottom panels of Figure 5.26. The top panel shows a straight-line demand curve. For each quantity, the bottom panel shows the corresponding total expenditure. As indicated in the bottom panel, total expenditure starts at zero when Q is zero and increases to its maximum value at the quantity corresponding to the midpoint of the demand curve (point *M* in the top panel). At that quantity, price elasticity is unity. Beyond that quantity, total expenditure declines with output, reaching zero at the horizontal intercept of the demand curve.

FIGURE 5.26
Demand and Total Expenditure
When demand is elastic, total expenditure changes in the opposite direction from a change in price. When demand is inelastic, total expenditure and price both move in the same direction. At the midpoint of the demand curve (*M*), total expenditure is at a maximum.



EXAMPLE 5.6 The market demand curve for bus rides in a small community is given by *P* = 100 – (*Q*/10), where *P* is the fare per ride in cents and *Q* is the number of rides each day. If the price is 50 cents/ride, how much revenue will the bus system collect each day? What is the price elasticity of demand for rides? If the system needs more revenue, should it raise or lower the price? How would your answers have differed if the initial price had been not 50 cents/ride but 75?

Total revenue for the bus system is equal to total expenditure by riders, which is the product PQ. First, we solve for Q from the demand curve and get $Q = 1{,}000 - 10P$. When P is 50 cents/ride, Q will be 500 rides/day and the resulting total revenue will be €250/day. To compute the price elasticity of demand, we can use the formula $\varepsilon = (P/Q)(1/slope)$. Here, the slope is $-\frac{1}{10}$, so 1/slope $= -10$.[4] P/Q takes the value $50/500 = \frac{1}{10}$. Price elasticity is thus the product $(-\frac{1}{10})(10) = -1$. With a price elasticity of unity, total revenue attains its maximum value. If the bus company either raises or lowers its price, it will earn less than it does at the current price.

At a price of 50 cents, the company was operating at the midpoint of its demand curve. If the price had instead been 75 cents, it would be operating above the midpoint. More precisely, it would be halfway between the midpoint and the vertical intercept (point K in Figure 5.27). Quantity would be only 250 rides/day, and price elasticity would have been -3 (computed, for example, by multiplying the price–quantity ratio at K, $\frac{3}{10}$, by the reciprocal of the demand curve slope, $-\frac{1}{10}$). Operating at an elastic point on its demand curve, the company could increase total revenue by cutting its price.

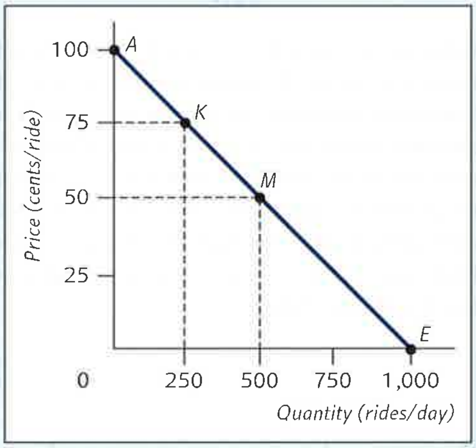


FIGURE 5.27
The Demand for Bus Rides
At a price of 50 cents/ride, the bus company is maximizing its total revenues. At a price of 75 cents/ride, demand is elastic with respect to price, and so the company can increase its total revenues by cutting its price.

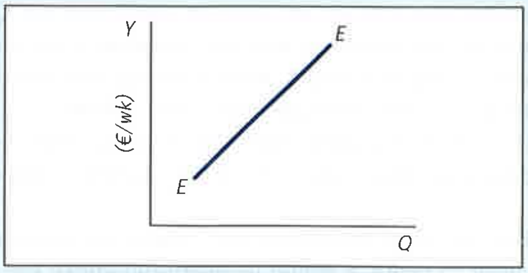
INCOME ELASTICITY OF DEMAND

Engel curves at the market level are schedules that relate the quantity demanded to the average income level in the market. The existence of a stable relationship between average income and quantity demanded is by no means certain for any given product because of a distributional complication. In particular, we cannot construct Engel curves at the market level by simply adding individual Engel curves horizontally. Horizontal summation works as a way of generating market demand curves from individual demand curves because all consumers in the market face the same price for the product. But when incomes differ widely from one consumer to another, it makes no sense to hold income constant and add quantities across consumers.

As a practical matter, however, reasonably stable relationships between various aggregate income measures and quantities demanded in the market may nonetheless exist. Suppose such a relationship exists for the good X and is as pictured by EE in Figure 5.28, where Y denotes the average income level of consumers in the market for X, and Q denotes the quantity of X. This locus is the market analogue of the individual Engel curves discussed earlier.

[4]The slope here is from the formula $P = 100 - (Q/10)$.

FIGURE 5.28
An Engel Curve at the Market Level
The market Engel curve tells what quantities will be demanded at various average levels of income.



income elasticity of demand the percentage change in the quantity of a good demanded that results from a 1 per cent change in income.

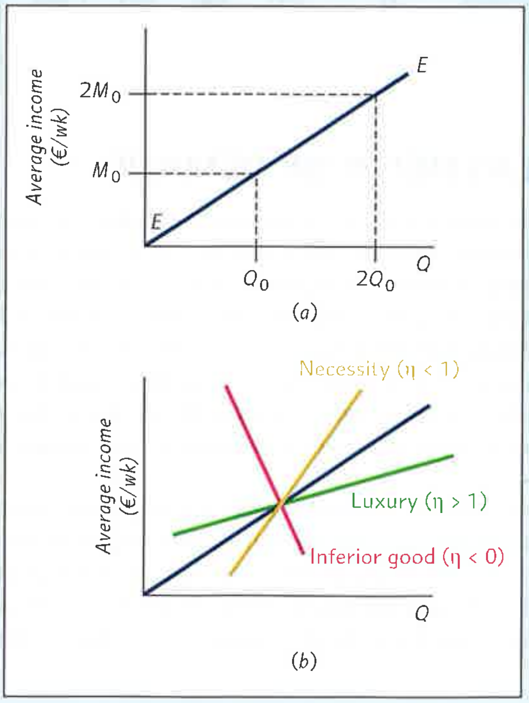
If a good exhibits a stable Engel curve, we may then define its **income elasticity of demand**, a formal measure of the responsiveness of purchase decisions to variations in the average market income. Denoted η, it is given by a formula analogous to the one for price elasticity:[5]

$$\eta = \frac{\Delta Q/Q}{\Delta Y/Y} \tag{5.6}$$

where Y denotes average market income and ΔY is a small change therein.

Goods such as food, for which a change in income produces a less than proportional change in the quantity demanded at any price, thus have an income elasticity less than 1. Such goods are called *necessities*, and their income elasticities must lie in the interval $0 < \eta < 1$. Food is a commonly cited example. *Luxuries* are those goods for which $\eta > 1$. Common examples are expensive jewellery and foreign travel. Inferior goods are those for which $\eta < 0$. Goods for which $\eta = 1$ will have Engel curves that are straight lines through the origin, as pictured by the locus EE in Figure 5.29(a). The market Engel curves for luxuries, necessities and inferior goods, where these exist and are stable, are pictured in Figure 5.29(b).

FIGURE 5.29
Engel Curves for Different Types of Goods
(a) The good whose Engel curve is shown has an income elasticity of 1. For such goods, a given proportional change in income will produce the same proportional change in quantity demanded. Thus when average income doubles, from M_0 to $2M_0$, the quantity demanded also doubles, from Q_0 to $2Q_0$. (b) The Engel curves show that consumption increases more than in proportion to income for a luxury and less than in proportion to income for a necessity, and it falls with income for an inferior good.



[5]In calculus terms, the corresponding formula is $\eta = (Y/Q)\,[dQ(Y)/dY]$.

The income elasticity formula in Equation 5.6 is easier to interpret geometrically if we rewrite it as

$$\eta = \frac{Y}{Q}\frac{\Delta Q}{\Delta Y} \tag{5.7}$$

The first factor on the right side of Equation 5.7 is simply the ratio of income to quantity at a point along the Engel curve. It is the slope of the line from the origin (a ray) to that point. The second factor is the reciprocal of the slope of the Engel curve at that point. If the slope of the ray exceeds the slope of the Engel curve, the product of these two factors must be greater than 1 (the luxury case). If the ray is less steep, η will be less than 1 but still positive, provided the slope of the Engel curve is positive (the necessity case). Thus, in distinguishing between the Engel curves for necessities and luxuries, what counts is not the slopes of the Engel curves themselves but how they compare with the slopes of the corresponding rays. Finally, if the slope of the Engel curve is negative, η must be less than zero (the inferior case).

ECONOMIC NATURALIST 5.4

Why have pubs become good at cooking food?

The public house, or pub, has long been a cornerstone of British and Irish community life. It's a place to go for fine ale, boisterous conversation and a smoke. But, times change. Now you are more likely to see a children's play area than people smoking. And you are more likely to go to the pub for a meal than a drink. In 2003 the proportion of pubs selling food was 90 per cent, up from 60 per cent only ten years before. This dramatic increase in the proportion of pubs selling food has coincided with equally dramatic increases in the quality and price of food. In the 1990s, 'pub grub' was likely to consist of 'steak and ale pie' for £5. Now you are likely to find 'Walmerstone tomato tarte fine' for £25.

The rise of the so-called 'gastropub' epitomizes this change in focus. The term was first used in 1991 by the owners of the Eagle Pub to capture the idea of fine dining within a pub. In 2001 the Stagg Inn became the first gastropub to earn the coveted Michelin star. In 2011 the Hand and Flowers went one better by becoming the first gastropub to earn two Michelin stars. There are not many restaurants that can boast two Michelin stars and so things have clearly come a long way from the days of 'pub grub'.

What spawned this dramatic boom in pub food? The short answer is that incomes have increased a lot and pubs have adapted accordingly. Median after-tax income in the UK increased by 70 per cent between 1992 and 2010. For the top 1 per cent of earners it has increased by 132 per cent.[6] Dining in fine restaurants is clearly a luxury good. Drinking ale in a smoke-filled room is arguably an inferior good. As incomes have risen, therefore, pubs have had to adapt to changes in consumer demand. Rapid income growth among those with already high incomes spawned demand for a broad spectrum of other luxury goods as well.

The Importance of Income Distribution

As we briefly discussed above, the existence of a stable relationship between average income and quantity demanded is by no means certain. Different consumers will naturally have different incomes and so the average income of consumers in a market may not be sufficient information to determine market demand. The following example illustrates the point.

EXAMPLE 5.7 Two consumers, Alfred and Betty, are in a market for food. Their tastes are identical, and each has the same initial income level, €120/wk. If their individual Engel curves for food are as given by *EE* in Figure 5.30, how will the demand for food be affected if Alfred's income goes down by 50 per cent while Betty's goes up by 50 per cent?

[6] HM Revenue and Customs.

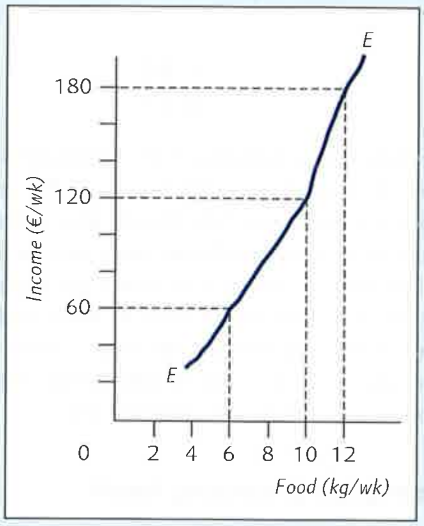


FIGURE 5.30
The Engel Curve for Food of Alfred and Betty
When individual Engel curves take the non-linear form shown, the increase in food consumption that results from a given increase in income will be smaller than the reduction in food consumption that results from an income reduction of the same amount.

The non-linear shape of the Engel curve pictured in Figure 5.30 is plausible considering that a consumer can eat only so much food. Beyond some point, increases in income should have no appreciable effect on the amount of food consumed. The implication is that Betty's new income (€180/wk) will produce an increase in her consumption (2 kg/wk) that is smaller than the reduction in Alfred's consumption (4 kg/wk) caused by his new income (€60/wk).

Note that the average income of Alfred and Betty is the same before and after the change in individual incomes, namely, €120. The change in the distribution of income has, however, resulted in a 2 kg/wk fall in the quantity of food demanded. Should we equate an average income of €120 with a market demand of 20 kg/wk or 18 kg/wk? There is no good answer to that question and so there is no stable relationship between average income and quantity demanded. ◆

The dependence of market demands on the distribution of income is important to bear in mind when the government considers policies to redistribute income. A policy that redistributes income from rich to poor, for example, is likely to increase demand for goods like food and reduce demand for luxury items such as jewellery and foreign travel.

Demand in many markets, though, is relatively insensitive to variations in the distribution of income. In particular, the distribution of income is not likely to matter much in markets in which individual demands tend to move roughly in proportion to changes in income. In such markets we can meaningfully talk of Engel curves at the market level.

Forecasting Economic Trends

If the income elasticity of demand for every good and service were 1, the composition of GNP would be completely stable over time (assuming technology and relative prices remain unchanged). Each year, the proportion of total spending devoted to food, travel, clothing, and indeed to every other consumption category would remain unchanged.

As the entries in Table 5.4 show, however, the income elasticities of different consumption categories differ markedly. And therein lies one of the most important applications of the income elasticity concept, namely, forecasting the composition of future purchase patterns. Ever since the industrial revolution in the West, real purchasing power per capita has grown at roughly 2 per cent per year. Our knowledge of income elasticity differences enables us to predict how consumption patterns in the future will differ from the ones we see today.

TABLE 5.4
Income Elasticities of Demand for Selected Products*

Good or service	Income elasticity
Automobiles	2.46
Furniture	1.48
Restaurant meals	1.40
Water	1.02
Tobacco	0.64
Petrol and oil	0.48
Electricity	0.20
Margarine	−0.20
Pork products	−0.20
Public transportation	−0.36

*These estimates come from H. S. Houthakker and Lester Taylor, *Consumer Demand in the United States: Analyses and Projections*, 2nd edn, Cambridge, MA: Harvard University Press, 1970; L. Taylor and R. Halvorsen, 'Energy Substitution in U.S. Manufacturing', *Review of Economics and Statistics*, November 1977; H. Wold and L. Jureen, *Demand Analysis*, New York: Wiley, 1953.

Thus, a growing share of the consumer's budget will be devoted to goods like restaurant meals and automobiles, whereas ever smaller shares will go to tobacco, fuel and electricity. And if the elasticity estimates are correct, the absolute amounts spent per person on margarine, pork products and public transportation will be considerably smaller in the future than they are today.

CROSS-PRICE ELASTICITIES OF DEMAND

cross-price elasticity of demand the percentage change in the quantity of a good demanded that results from a 1 per cent change in its price.

The quantity of a good purchased in the market depends not only on its price and consumer incomes but also on the prices of related goods. **Cross-price elasticity of demand** is the percentage change in the quantity demanded of one good caused by a 1 per cent change in the price of the other. More generally, for any two goods, X and Z, the cross-price elasticity of demand may be defined as follows:[7]

$$\varepsilon_{XZ} = \frac{\Delta Q_X / Q_X}{\Delta P_Z / P_Z} \qquad (5.8)$$

where ΔQ_X is a small change in Q_X, the quantity of X, and ΔP_Z is a small change in P_Z, the price of Z. ε_{XZ} measures how the quantity demanded of X responds to a small change in the price of Z.

Unlike the elasticity of demand with respect to a good's own price (the *own-price elasticity*), which is never greater than zero, the cross-price elasticity may be either positive or negative. X and Z are defined as *complements* if $\varepsilon_{XZ} < 0$. If $\varepsilon_{XZ} > 0$, they are *substitutes*. Thus, a rise in the price of ham will reduce not only the quantity of ham demanded, but also, because ham and eggs are complements, the demand for eggs. A rise in the price of coffee, by contrast, will tend to increase the demand for tea. Estimates of the cross-price elasticity of demand for selected pairs of products are shown in Table 5.5.

[7]In calculus terms, the corresponding expression is given by $\varepsilon_{XZ} = (P_Z/Q_X)(dQ_X/dP_Z)$.

TABLE 5.5
Cross-Price Elasticities for Selected Pairs of Products*

Good or service	Good or service with price change	Cross-price elasticity
Butter	Margarine	+0.81
Margarine	Butter	+0.67
Natural gas	Fuel oil	+0.44
Beef	Pork	+0.28
Electricity	Natural gas	+0.20
Entertainment	Food	−0.72
Cereals	Fresh fish	−0.87

*From H. Wold and L. Jureen, *Demand Analysis*, New York: Wiley, 1953; L. Taylor and R. Halvorsen, 'Energy Substitution in U.S. Manufacturing', *Review of Economics and Statistics*, November 1977; E. T. Fujii et al., 'An Almost Ideal Demand System for Visitor Expenditures', *Journal of Transport Economics and Policy*, 19, May 1985, 161–171; A. Deaton, 'Estimation of Own- and Cross-Price Elasticities from Household Survey Data', *Journal of Econometrics*, 36, 1987, 7–30.

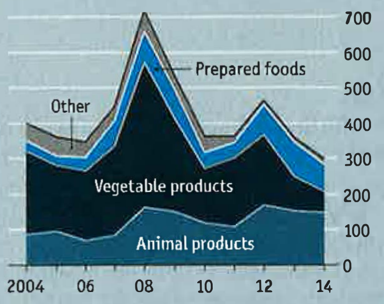
EXERCISE 5.7 **Would the cross-price elasticity of demand be positive or negative for the following pairs of goods: (*a*) apples and oranges, (*b*) airline tickets and car tyres, (*c*) computer hardware and software, (*d*) pens and paper, (*e*) pens and pencils?**

SUMMARY

- Our focus in this chapter was on how individual and market demands respond to variations in prices and incomes. To generate a demand curve for an individual consumer for a specific good *X*, we first trace out the price–consumption curve in the standard indifference curve diagram. The PCC is the line of optimal bundles observed when the price of *X* varies, with both income and preferences held constant. We then take the relevant price–quantity pairs from the PCC and plot them in a separate diagram to get the individual demand curve.
- The income analogue to the PCC is the income–consumption curve, or ICC. It too is constructed using the standard indifference curve diagram. The ICC is the line of optimal bundles traced out when we vary the consumer's income, holding preferences and relative prices constant. The Engel curve is the income analogue to the individual demand curve. We generate it by retrieving the relevant income–quantity pairs from the ICC and plotting them in a separate diagram.
- Normal goods are those the consumer buys more of when income increases, and inferior goods are those the consumer buys less of as income rises.
- The total effect of a price change can be decomposed into two separate effects: (1) the substitution effect, which denotes the change in the quantity demanded that results because the price change makes substitute goods seem either more or less attractive, and (2) the income effect, which denotes the change in quantity demanded that results from the change in real purchasing power caused by the price change. The substitution effect always moves in the opposite direction from the movement in price: price increases (reductions) always reduce (increase) the quantity demanded. For normal goods, the income effect also moves in the opposite direction from the price change and thus tends to reinforce the substitution effect. For inferior goods, the income effect moves in the same direction as the price change and thus tends to undercut the substitution effect.
- The fact that the income and substitution effects move in opposite directions for inferior goods suggests the theoretical possibility of a Giffen good, one for which the total effect of a price increase is to increase the quantity demanded. There have been no documented examples of Giffen goods, and in this text we adopt the convention that all goods, unless otherwise stated, are demanded in smaller quantities at higher prices.
- Goods for which purchase decisions respond most strongly to price tend to be ones that have large income and substitution effects that work in the same direction. For example, a normal good that occupies a large share of total expenditures and for which there are many direct or indirect substitutes will tend to respond sharply to changes in price. For many consumers, housing is a prime example of such a good. The goods least responsive to price changes will be those that

A la Cubano

US exports to Cuba, $m



Source: United Nations

worth of corn, soyabeans and poultry to the island. Since then, that figure has declined; last year food exports were only $286m, and this year is shaping up to be especially disappointing. One reason is that Cuba is paying down its debts to Russia, Japan and Mexico and so has less money to spend. Another is Cuba's decision to stop importing American poultry after an outbreak of bird flu. And a third is that Cubans must pay American exporters in cash because they are not allowed to give them credit, which puts Americans at a disadvantage to exporters in other countries. Mr Obama has helpfully redefined Cubans' obligation to pay cash in advance as "cash before transfer of title", but it remains a cumbersome process.

Despite these discouragements, several companies are venturing into the socialist paradise. As well as allowing more Americans to visit Cuba without special permits and to send more remittances to relatives on the island, Mr Obama's administration has let telecoms firms as well as banks take steps towards operating in Cuba. In February IDT, a telecoms firm in New Jersey, said it had reached an agreement with Empresa de Telecomunicaciones de Cuba, the national telecom provider, to exchange long-distance traffic. (Other telecoms firms are likely to find suspicion of the NSA an impediment to doing business.) In May banks felt easier about doing business in Cuba when the State Department took it off the list of state sponsors of terror. In July Stonegate, a Florida-based bank, signed a correspondent banking agreement with Banco Internacional de Comercio, a government-controlled Cuban bank.

For trade to return to anything like its pre-revolutionary health, though, the embargo will have to go. According to a Pew poll published on July 21st, 72% of Americans would like to end it. More surprisingly, 55% of conservative Republicans now agree, compared with just 40% in January. Among Republican presidential hopefuls, Marco Rubio, Ted Cruz and Jeb Bush (all with strong connections to Cuban exile groups in Miami) want the embargo to stay. Hillary Clinton, who has a keen sense of what voters want to hear, once backed the embargo (her husband Bill signed the Helms-Burton Act, which toughened it, in 1996, though he later regretted having done so). She now wants to scrap it.

America's farmers look forward to that day. According to Parr Rosson of Texas A&M University, agricultural exports to Cuba could exceed $1 billion annually, which, he says, would create an extra 6,000 jobs in America. Yet this will only happen if Cubans become a bit more prosperous and if Raúl Castro's government, which has done little to make trade easier since the thaw in December, embraces commerce with the old enemy (see page 40). Until then American hoteliers, and most of the American business travellers they would like to profit from, will continue to fret that they are missing out. ■

Taxis v Uber

A tale of two cities

NEW YORK

Does Uber substitute for cabs or attract new riders? It depends where you live

EVER since Uber arrived in New York in 2011, the days of the city's yellow taxis have seemed numbered. Catching a cab requires standing outside until one drives by, giving directions if necessary and rummaging for cash. In contrast, Uber lets riders summon a car by phone, informs them when it is outside, feeds the destination into navigation software and lets them walk out upon arrival.

The markets believe yellow cabs are in trouble. The average price for New York's 13,771 medallions (licences to drive taxis) has fallen from $1m during the summer of 2014 to $690,000 over the past three months. But attributing these woes to Uber is difficult. Not all Uber passengers would otherwise have hopped in a cab—some might have taken the subway or bus, walked, cycled or stayed at home. Moreover, Uber is not taxis' only new source of competition. In 2013 the city introduced apple-green "boro taxis", which serve passengers outside the Manhattan core, and launched a bicycle-sharing scheme.

Only now has the picture begun to clear up, as both Uber and New York's taxi regulator recently released detailed data. The best news for the Uber camp is that ridership has spiked since its entrance. Although Uber has not shared 2013 statistics, a leak to *Business Insider*, a news website, revealed an average of 140,000 Uber trips per week in December 2013. Assuming a steady compound growth rate over the two years to June 2015, that yields an estimate of 333,000 Uber rides in June 2013. Adding that to the 14.4m yellow-taxi trips that month, plus a handful of green-cab rides, produces a sum of 14.8m. In contrast, the total this June was 17.5m. This 18% increase makes clear that the market is not zero-sum.

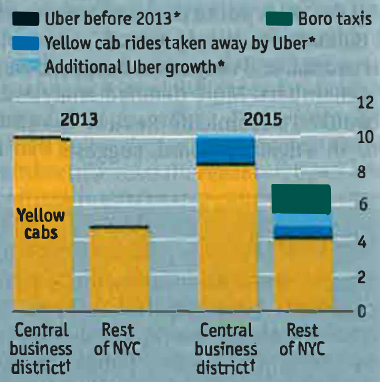
Virtually all of these gains have come in the taxi-starved areas outside Manhattan's central business district (CBD), which sits south of 59th Street and is off-limits to green cabs. Monthly ridership in these zones has soared from 4.8m to 7.3m in two years, while yellow-taxi hails have fallen by some 600,000. As a first approximation, that suggests that just 20% of the increase in Uber and boro-taxi trips in these districts were taken away from yellow cabs, with 80% representing growth in the market.

However, figures for the taxi-saturated CBD tell the opposite story. During the two years to June 2015, Uber's pickups in the CBD rose from an estimated 175,000 to 1.8m, while yellow cabs' hails in the area fell by around 1.4m. This implies that where Uber and yellow cabs compete most directly, just 13% of the growth in Uber rides has added to prior demand. The remaining 87% has replaced trips that would otherwise have gone to taxis.

A further signal that Uber bears responsibility for the drop in cab hails is that the decline is most extreme late at night, when passengers place the most value on Uber's convenience and comfort. Citywide, yellow-taxi rides from 11pm to 5am have fallen by 22% since June 2013, whereas trips at all other times are only off by 12%. Given such fierce competition, medallion prices probably have further to fall before they hit bottom.

What's app

Rides in New York City, June, m



*Estimate †Below 59th Street, Manhattan

Sources: New York City Taxi and Limousine Commission; Uber; Google BigQuery; *The Economist*