part three

the economics of markets

chapters

chapter 6

elasticity and its applications

learning objectives

- Introduce the concept of price elasticity of demand and discuss its determinants.
- Relate price elasticity of demand to the changes in total revenue that result from a change in market price.
- Introduce the concept of the elasticity of supply and its relationship to time.
- Define the cross-price and income elasticities of demand.
- Survey some applications of supply and demand analysis.

Introduction

Scarce resources and unlimited wants form the foundation of economics. The efficient use of scarce resources is a major goal of our economic system, to which there are two main aspects. The first centres on the *full employment* of available resources, reflecting the fundamental economic question posed in Chapter 2: 'Can the economy achieve the full employment of its available resources?' This is examined in the companion book, *Macroeconomics*, 7th edition.

Part 3 of this book deals with the second aspect of the economising problem—*allocating employed resources for alternative uses in the most efficient manner*. Four fundamental economic questions relate to this aspect, and may be paraphrased as follows:

- Can the economy produce that output most desired by society?
- Will the production of that output be organised in the most efficient manner?
- Can the economy successfully distribute that output?
- Is the economy capable of maintaining efficiency in the use of its resources in the face of changes in the relative supplies of resources, consumer tastes and technology?

In Chapter 3 we introduced supply and demand analysis, and in Chapter 4 we discussed the role of the market as a coordinating mechanism for economic activity. In Chapter 3 we also discussed ways in which analysis of demand and supply—the analysis of a competitive market—can be a powerful tool in enhancing our economic understanding. In Part 3 we will analyse individual prices under a variety of contrasting market structures, developing an understanding of the operation and relative efficiency of the Australian market system.

In Part 3 we will also increase our understanding of consumer behaviour and the demand side of the market, examine in some detail the interaction of supply and demand under the various market arrangements, and explore the production (supply) side of the market through a discussion of production costs and firms' supply behaviour. Finally, we will examine the functioning of prices in the resource markets.

You should be sure that you clearly understand the material in Chapter 3, perhaps through a quick review of its contents, before proceeding with Chapter 6.

Price elasticity of demand

Elasticity of demand: the measure of how responsive consumers' demand quantity is to a change in the price of a product.

The law of demand says that consumers will respond to a price decline by buying more of a product. But the degree of *responsiveness* of the quantity demanded by consumers to a price change may vary considerably from product to product and between different price ranges for the same product. Economists measure how responsive, or sensitive, consumers' demand quantity is to a change in the price of a product by the *own-price elasticity of demand*. In general, this is referred to simply as the **elasticity of demand**.

Demand for some products is such that consumers' demand quantity is relatively responsive to price changes; small price changes lead to large changes in the quantity demanded. The demand for such products is said to be *relatively elastic*, or simply *elastic*. For other products,

consumers' demand quantity is relatively unresponsive to price changes; that is, large price changes result only in small changes in the quantity demanded. In such cases, demand is *relatively inelastic* or just *inelastic*.

The price elasticity formula

Economists measure the degree of elasticity or inelasticity by the **elasticity coefficient**, or E_d, using this formula:

$$E_d = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in price of product X}}$$

We calculate these *percentage* changes by dividing the change in price by the original price and the corresponding change in quantity demanded by the original quantity demanded. Thus, we can restate our formula as:

$$E_d = \frac{\text{change in quantity demanded of product X}}{\text{original quantity demanded of product X}} \div \frac{\text{change in price of product X}}{\text{original price of product X}}$$

Use of percentages

Why use percentages rather than absolute amounts in measuring responsiveness? The answer is in two parts, relating to choice of units and product comparison.

Choice of units

If we use absolute changes, our impression of buyer responsiveness will be arbitrarily affected by the choice of units. To illustrate: if the price of product X falls from $3 to $2 and consumers increase their demand quantity from 60 to 100 kilograms, we get the impression that demand is quite sensitive to price changes and, therefore, that demand is elastic. After all, a price change of '1' has caused a change in the amount demanded of '40'. But, by changing the monetary unit from dollars to cents (why not?), we find a price change of '100' causes a quantity change of '40', giving the impression of inelasticity. The use of percentage changes avoids this problem. In this case, the price decline is 33 per cent, whether measured in terms of dollars ($1/$3) or in terms of cents (100c/300c).

Product comparison

By using percentages we may compare responsiveness of demand quantity to changes in the prices of different products. It makes no sense to compare the effects of quantity demanded as a result of a $1 increase in the price of a $10 000 second-hand car with the effects of a $1 increase in the price of a $1 icecream. Here the car price is rising by 0.1 per cent, whereas the price of icecream is up by 100 per cent. If we increased the price of both products by 1 per cent—$100 for the car, and 1 cent for the icecream—we would obtain a sensible comparison of response to the price changes.

Ignoring the minus sign

We know from the down-sloping demand curve that there is an inverse relationship between price and quantity demanded. This means that the price elasticity coefficient of demand will always yield a *negative* number. For example, if price declines, then quantity demanded will increase. This means that the numerator in our formula will be positive and the denominator negative, yielding a negative coefficient. Conversely, for an increase in price, the numerator will be negative but the denominator positive, again yielding a negative coefficient.

It is conventional for economists to ignore the minus sign and simply to present the *absolute value* of the elasticity coefficient, to avoid an ambiguity that might otherwise arise. It can be confusing to say that an elasticity coefficient of –4 is 'greater' than one of –2; this possible

confusion can be avoided if we simply say a coefficient of 4 indicates greater elasticity (that is, greater responsiveness) than one of 2. Hence, in the following text we ignore the minus sign in the coefficient of price elasticity of demand and merely show the absolute value. Incidentally, similar ambiguity does not arise with supply, because price and quantity are directly related.

Interpretations

Now let us interpret our formula.

Elastic demand

Demand is **elastic** if a given percentage change in price results in a *larger* percentage change in quantity demanded. For example, if a 2 per cent decline in price results in a 4 per cent increase in quantity demanded, demand is elastic. (In fact, in this case elasticity is 2.) In cases where demand is elastic, the elasticity coefficient (again, ignoring the minus sign) will be greater than 1, or $E_d > 1$.

Inelastic demand

If a given percentage change in price is accompanied by a relatively smaller change in the quantity demanded, demand is **inelastic**. To illustrate, if a 3 per cent decline in price leads to a 1 per cent increase in the amount demanded, demand is inelastic. (In this case, elasticity is $^1/_3$.) It is apparent that the elasticity coefficient will always be less than 1 when demand is inelastic, or $E_d < 1$.

Other cases

The borderline case that separates elastic and inelastic demands occurs when a percentage change in price and the accompanying percentage change in quantity demanded are equal; for example, when a 1 per cent drop in price causes a 1 per cent increase in the amount sold. This special case is termed **unit elasticity**, because the elasticity coefficient is exactly 1, or unity ($E_d = 1$).

When economists say demand is 'inelastic', they do not mean consumers' demand quantity is completely unresponsive to a price change. The term **perfectly inelastic demand** refers to the extreme situation where a change in price results in no change at all in the quantity demanded. A demand curve parallel to the vertical axis—such as D_1D_1 in Figure 6.1—shows this graphically. Conversely, when economists say demand is 'elastic', they do not mean that demand quantity is completely or highly responsive to a price change. In the extreme situation, where a small price reduction would cause buyers to increase their purchases from zero to all they could obtain, we say that demand is **perfectly elastic**. A perfectly elastic demand curve is reflected in a line parallel to the horizontal axis, such as D_2D_2 in Figure 6.1.

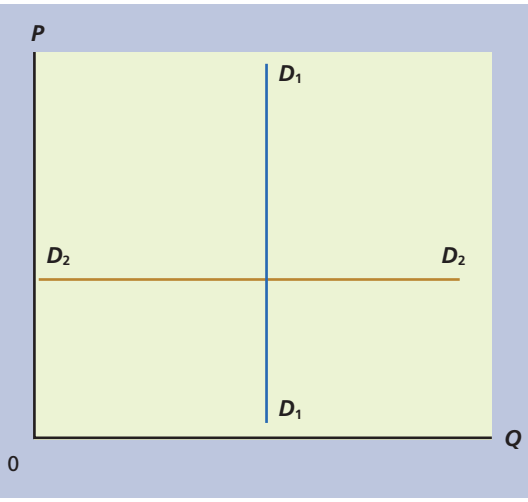


Figure 6.1
Perfectly inelastic and elastic demand
Perfectly inelastic demand at all levels of price is reflected in the demand curve D_1D_1, which graphs as a line parallel to the vertical axis. Perfectly elastic demand at a particular price is reflected in the demand curve D_2D_2, which is drawn parallel to the horizontal axis.

Midpoints formula

A problem arises in applying the price elasticity formula. When calculating the elasticity coefficient for product X in the \$5–\$4 price range in Table 6.1, should we use the \$5 and 2000 units price–quantity combination or the \$4 and 4000 units combination as a point of reference to calculate the percentage changes in price and quantity that the elasticity formula requires? Our choice will influence the outcome.

Using the \$5 and 2000 units reference point, we find that the percentage decrease in price is 20 per cent and the percentage increase in quantity is 100 per cent. Substituting in the formula for elasticity coefficient, we obtain a coefficient of 100/20, or 5. But, using the \$4 and 4000 units reference point, we find that the percentage increase in price is 25 per cent and the percentage decline in quantity is 50 per cent. The elasticity coefficient is therefore 50/25, or 2, in this case. Although the formula indicates that demand is elastic in both cases, the two solutions involve a considerable difference in the degree of elasticity. In other instances—try experimenting, for example, with the \$3–\$2 price range—the formula may indicate a slightly elastic demand for one price–quantity combination and slight inelasticity of demand for the other.

Table 6.1
Elasticity of demand as measured by the total revenue test and the elasticity coefficient (hypothetical data)

1 Total quantity demanded per week	2 Price per unit (\$)	3 Total revenue (expenditures) (\$)	4 Total revenue test	5 Elasticity coefficient E_d (approximate)
2 000	5	10 000		
			Elastic	$\frac{2000}{6000/2} \div \frac{1}{9/2} = 3.00$
4 000	4	16 000		
			Elastic	$\frac{3000}{11\,000/2} \div \frac{1}{7/2} = 1.91$
7 000	3	21 000		
			Elastic	$\frac{4000}{18\,000/2} \div \frac{1}{5/2} = 1.11$
11 000	2	22 000		
			Inelastic	$\frac{5000}{27\,000/2} \div \frac{1}{3/2} = 0.56$
16 000	1	16 000		

A solution to this problem is reached by using the *averages* of the two prices and the two quantities under consideration as reference points. In the \$5–\$4 price-range case, the price reference is \$4.50 and the quantity reference 3000 units. The percentage change in price is now about 22.2 per cent and the percentage change in quantity about 66.6 per cent, giving us an elasticity coefficient of 3. Instead of measuring elasticity at either one of the extremes of this price–quantity range, this solution estimates elasticity at the midpoint of the \$5–\$4 price range. We can refine our earlier statement of the elasticity formula to read:

$$E_d = \frac{\text{change in quantity}}{\text{sum of quantities/2}} \div \frac{\text{change in price}}{\text{sum of prices/2}}$$

Substituting data for the \$5 to \$4 price range, we obtain:

$$E_d = \frac{2000}{6000/2} \div \frac{1}{9/2} = 3.00$$

In column 5 of Table 6.1 we calculate the elasticity coefficients for the demand data, using the midpoints formula.

A useful exercise is to verify all the calculations in Table 6.1. Make sure that you can interpret the coefficients correctly. For example, the 3.0 coefficient means that a 1 per cent increase (decrease) in price will decrease (increase) the quantity demanded by 3 per cent.

Graphical analysis

In Figure 6.2(a) we have plotted the demand curve from Table 6.1. This graph brings two points into focus.

Elasticity and price range

Elasticity usually varies over the different price ranges of the same demand schedule or curve. For most demand curves—including the demand curve for product X in Table 6.1—demand

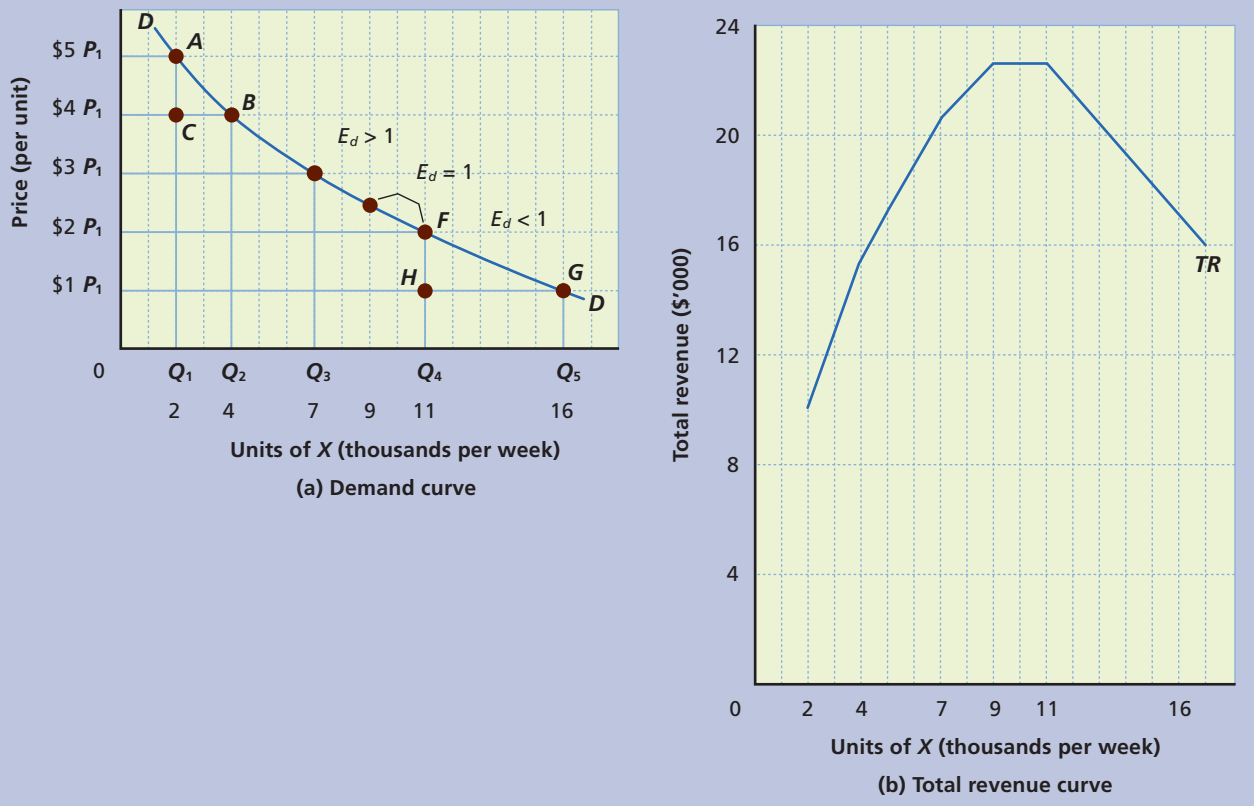


Figure 6.2 *Price elasticity of demand and total revenue*

As shown in (a), the typical demand curve is elastic in high price ranges and inelastic in lower price ranges. In (b), total revenue (*TR*) rises in the elastic range as price is reduced. As price falls in the inelastic range, revenue falls. Total revenue will be at a maximum at the intermediate point of unit elasticity.

tends to be more elastic in the upper left portion than in the lower right portion. This is a consequence of the arithmetic properties of the elasticity measure. Specifically, in the upper left portion the percentage change in quantity tends to be large because the original quantity from which the percentage quantity change is derived is small. Similarly, in this portion the percentage change in price tends to be small because the original price from which the percentage price change is calculated is large. The relatively large percentage change in quantity, divided by the relatively small change in price, gives a coefficient representing an elastic demand.

The reverse holds true for the lower right portion of the demand curve. Here the percentage change in quantity tends to be small because the original quantity from which the percentage change is determined is large. Similarly, the percentage change in price tends to be large because the original price from which the relative price change is calculated is small. The relatively small percentage change in quantity divided by the relatively large change in price gives a coefficient representing an inelastic demand.

Elasticity versus slope

The graphical appearance—that is, the slope—of a demand curve is not a sound basis on which to judge its elasticity. The catch lies in the fact that the slope—the relative flatness or steepness—of a demand curve is based on *absolute* changes in price and quantity, whereas elasticity has to do with *percentage* changes in price and quantity. The difference between slope and elasticity can also be made quite clear by calculating elasticity for various price–quantity combinations on a straight-line demand curve. Although the slope is obviously constant throughout, demand is elastic in the high price range and inelastic in the low price range.[1]

The total revenue test

The easiest way to tell whether demand is elastic or inelastic is to use the **total revenue test**. Here we observe what happens to total revenue—total expenditures from the buyer's viewpoint—when product price changes.

Elastic demand

If demand is elastic, a decline in price will result in an increase in total revenue. Why? Because even though a lesser price is being received per unit, enough additional units are now being

Business insight

Discounts for the financially disadvantaged—social conscience or just good business?

Why do cinema chains like Hoyts offer student and pensioner discounts on movie tickets? Is it about social conscience or is it just good business? The answer to these questions lies in the differences between groups within the community with respect to their elasticity of demand for purchasing tickets to the movies. What is the source of this difference? Mainly the presence of a clearly identifiable difference in disposable incomes. The price of a ticket represents a larger share of the disposable income of students and pensioners, making their demand more highly elastic than for other groups. Student and pensioner cards provide the cinema chains with an ability to differentiate between these and other groups within the community. The result is that the cinema chains can increase their total revenues by equating the marginal revenues received from each of the identified groups, and charging each a different price.

sold to more than make up for the lower price. This is illustrated in Figure 6.2(a) for the \$5–\$4 price range of our demand curve from Table 6.1. Total revenue is calculated as price multiplied by quantity. Hence, the area shown by the rectangle $0P_1AQ_1$ is total revenue (\$10 000) when price is P_1 (\$5) and quantity demanded is Q_1 (2000). When price declines to P_2 (\$4), causing the quantity demanded to increase to Q_2 (4000), total revenue changes to $0P_2BQ_2$ (\$16 000), which is obviously larger than $0P_1AQ_1$. It is larger because the *loss* in revenue due to the lower price per unit (area P_2P_1AC) is less than the *gain* in revenue due to the larger sales (area Q_1CBQ_2) that accompanies the lower price. The \$1 price reduction applies to the original 2000 units (Q_1) for a total loss of \$2000. However, the lower price increases sales by 2000 units (Q_1 to Q_2) with a resulting gain in revenue of \$8000 (= 2000 × \$4). Hence, the *net increase* in total revenue is \$6000 (= \$8000 – \$2000).

This reasoning is reversible—if demand is elastic, a price increase will reduce total revenue. The *gain* in total revenue caused by the higher unit price (area P_2P_1AC) is less than the loss to revenue associated with the fall in sales that accompanies it (Q_1CBQ_2). *If demand is elastic, a change in price will cause total revenue to change in the opposite direction.*

Inelastic demand

If demand is *inelastic*, a price decline will lower total revenue. The small increase in sales that occurs will not offset the decline in revenue per unit, and the net result will be that total revenue declines. This situation exists for the \$2–\$1 price range of our demand curve, as shown in Figure 6.2(a). Initially, total revenue is $0P_4FQ_4$ (\$22 000) when price is P_4 (\$2) and quantity demanded is Q_4 (\$11 000). If we reduce price to P_5 (\$1), quantity demanded will increase to Q_5 (16 000). Total revenue will change to $0P_5GQ_5$ (\$16 000), which is obviously less than $0P_4FQ_4$. It is less because the *loss* in revenue due to the lower unit price (area P_5P_4FH) is larger than the *gain* in revenue due to the accompanying increase in sales (area Q_4HGQ_5). The \$1 decline in price applies to all 11 000 units (Q_4) with a revenue loss of \$11 000. The sales increase at the lower price is 5000 units (16 000 – 11 000), which results in a revenue gain of \$5000 (\$1 × 5000). The result is a *net decrease* in total revenue of \$6000 (= \$11 000 – \$5000).

Again our analysis is reversible—if demand is inelastic, a price increase will increase total revenue. *If demand is inelastic, a change in price will cause total revenue to change in the same direction.*

Unit elasticity

In the special case of *unit elasticity*, an increase or decrease in price will leave total revenue unchanged. The revenue loss due to a lower unit price will be exactly offset by the revenue gain brought about by the accompanying increase in sales. Conversely, the gain in revenue due to a higher unit price will be exactly offset by the loss in revenue associated with the accompanying decline in the amount demanded.

Columns 3 and 4 of Table 6.1 apply the total revenue test to the entire demand curve for product X.

Graphical portrayal

The relationship between price elasticity of demand and total revenue can be illustrated graphically by comparing Figures 6.2(a) and (b). In Figure 6.2(b) we have graphed the revenue – quantity demanded points from Table 6.1 as well as the points in between. Figure 6.2(b) thus represents a total revenue curve and shows what happens to total revenue as quantity demanded varies (and thus price changes).

Note that in the elastic portion of the demand curve, total revenue is increasing as quantity increases (and price falls). In the inelastic portion of the demand curve, total revenue falls as quantity increases (and as the price is still falling). You should check that the total revenue curve is consistent with the verbal and numerical explanations given in the points just

described. Table 6.2 provides a convenient summary of the characteristics of price elasticity of demand and is worth studying carefully.

Table 6.2
Price elasticity of demand: a summary

Absolute value of elasticity coefficient	Terminology	Description	Impact on total revenue (expenditures) of:	
			Price increase	Price decrease
Greater than 1 ($E_d > 1$)	'Elastic' or 'relatively elastic'	Quantity demanded changes by a larger percentage than price	Total revenue decreases	Total revenue increases
Equal to 1 ($E_d = 1$)	'Unit' or 'unitary elastic'	Quantity demanded changes by the same percentage as price	Total revenue is unchanged	Total revenue is unchanged
Less than 1 ($E_d < 1$)	'Inelastic' or 'relatively inelastic'	Quantity demanded changes by a smaller percentage than price	Total revenue increases	Total revenue decreases

Determinants of price elasticity of demand

Few generalisations can be made about the determinants of the price elasticity of demand. The following four points, however, are valid and helpful.

Substitutability

Generally, the larger the number of good substitute products available, the greater the elasticity of demand. If the price of a good increases and there are many substitutes available, then the quantity demanded will fall off very quickly as consumers move to the cheaper substitutes. On the other hand, a diabetic's demand for insulin is probably highly inelastic because there are no substitutes.

Business insight

The decision is in the marginal revenue, not in the price

On their return from a trip to the United States or the United Kingdom, you may hear friends or family comment that they have bought a particular Australian wine more cheaply overseas than locally. Although differences in taxation can explain some of the difference in prices, a consideration of marginal revenue provides a more complete answer.

Companies like Southcorp (the producers of Penfolds' Grange) know that they face a downward-sloping domestic demand curve, but an almost horizontal demand curve for international sales. To sell a greater volume of their premium wines locally, Southcorp would need to allow a significant fall in both price and marginal revenue. However, by equating the local and foreign marginal revenues from the last bottles of wine sold, Southcorp may maximise its total revenues, even though the domestic price of wine must exceed the price received from its export. Marginal revenue, not always price, should determine where you sell.

The elasticity of demand for a product depends on how narrowly the product is defined. The demand for Shell motor oil is more elastic than is the overall demand for motor oil. Many other brands are readily substitutable for Shell's oil, but there is no good substitute for motor oil itself.

Proportion of income

Other things being equal, the higher the price of a good relative to your budget, the greater will be the elasticity of demand for it. A 10 per cent increase in the price of pens, chewing gum or telephone calls will amount to only a few cents and mean little response in terms of amount demanded. A 10 per cent increase in the price of cars or housing may mean price increases of, say, $2500 and $30 000 respectively. These increases are significant fractions of the annual incomes of many households, and quantities purchased could be expected to diminish significantly.

Luxuries versus necessities

The demand for 'necessities' tends to be inelastic whereas the demand for 'luxuries' tends to be elastic. Bread and electricity are generally regarded as necessities; we 'can't get along' without them. A price increase will not reduce significantly the amount of bread consumed or the amounts of lighting and power used in a household. As a more extreme example, we do not decline an operation for acute appendicitis because the hospital fee has just gone up.

On the other hand, Porsche cars and emeralds are luxuries that, by definition, can be forgone. If the price of Porsches or emeralds rises, we need not purchase them and will suffer no real hardship.

The demand for milk and bread tends to be highly inelastic on several counts. They are 'necessities'; there are no good substitutes available, and they are a negligible expense in the overall household budget.

Time

In general, the longer the period under consideration, the more elastic is the demand. This generalisation partly has to do with the fact that many consumers are creatures of habit. When the price of a product rises, it takes time to find and experiment with other products to see if they are acceptable. For example, social drinkers may not immediately reduce purchases to any significant degree when the price of Scotch rises by, say, 20 per cent. Given time, however, they may shift their affections to gin or vodka, for which they have now 'developed a taste'. Another aspect of this generalisation is *product durability*. Studies show that the 'short-run' demand for petrol is more inelastic, at an elasticity coefficient of 0.2, than is the 'long-run' demand, at a coefficient of 0.7. In the long run, large, petrol-guzzling cars wear out and, with rising petrol prices, are replaced by smaller, fuel-efficient cars.

Some practical applications

The concept of elasticity of demand can have great practical significance, as the following examples show.

Bumper crops

The demand for most farm products is highly inelastic. As a result, increases in the output of farm products due to a good growing season or to productivity increases depress both the prices of farm products and the total receipts (incomes) of farmers. For farmers as a group, the relatively inelastic nature of the demand for their products means that a bumper crop may be a mixed blessing. For policy makers, it means that higher farm incomes may depend on the restriction of farm output.

Automation

The impact of automation—that is, of rapid technological advance—on the level of employment depends in part on the elasticity of demand for the product being manufactured. Suppose a firm installs new labour-saving machinery, resulting in the unemployment of, say, 500 workers. Suppose, too, that part of the cost reduction resulting from this technological advance is passed on to consumers in the form of reduced product prices. The effect of this price reduction on the firm's sales and, therefore, the quantity of labour it needs, will be reflected by the elasticity of product demand. An elastic demand might increase sales to the

Global watch

Slippery stuff

The price of oil can fluctuate widely, responding to a range of economic and political factors.

The price of oil fell to a five-month low this week, despite an impending war in Iraq. The reason for this paradox is that markets doubt OPEC's ability to control supply, which is running well above agreed quotas. It is rather curious that the price of oil, which topped $30 a barrel in September, had by the middle of this week fallen by around $5 to a five-month low. The price has since ticked up somewhat, to about $26 a barrel for the American crude-oil benchmark, but still languishes far below its autumn peak. This is odd because the prospect of war in Iraq has increased, and Middle Eastern wars usually push the oil price up as concerns grow about supply security. What has happened to the 'fear premium', at one point reckoned to be around $5 a barrel? Is it still in the price? Or has it been offset by other factors, such as an increase in supply? Probably the latter. The OPEC oil-producers' cartel (excluding Iraq) is now producing close to 24m barrels per day (bpd), more than 2m barrels above the quota agreed by its members. But the implications of this overproduction differ dramatically depending on whether you believe it to be the result of individual members cheating (a perennial OPEC problem) or a deliberate and perhaps coordinated attempt to place supplies well out of harm's way ahead of the expected American invasion of Iraq. The level of OPEC's production is surprising. As recently as September, when the cartel's members last met formally, OPEC resisted pressure from oil-consuming countries to increase its supply quota. There were several arguments for raising production. The northern hemisphere was moving into winter, a period in which demand there is estimated to rise by around 1.6m bpd. The International Energy Agency, a quasi-governmental watchdog for oil consumers, warned that stocks of crude were 'uncomfortably low'. And the $30-per-barrel price at the time, it seemed, threatened to tip an already fragile world economy back into recession . . .

SOURCE: Economist.com/Global Agenda, 8 November 2002, p. 1, © the Economist Newspaper Limited, London.

Questions

1. Use a simple supply and demand model to describe how price is determined in the oil market.
2. How should fears of war affect the price? How should attempts to restrict supply affect price?
3. What are the 'paradoxes' this article refers to?
4. Revisit these questions when you have completed all the market structure chapters.

extent that some or all of the 500 displaced workers will be reabsorbed by the firm (and possibly even more workers employed). An inelastic demand will mean that few, if any, of the displaced workers will be re-employed, because the increase in the volume of the firm's business will be small.

Excise taxes

Government pays attention to the elasticity of demand when selecting goods and services on which to levy excise taxes. Let us assume that a $1 tax is currently levied on a product and 10 000 units are sold. Tax revenue is obviously $10 000. If the tax is now raised to $1.50 and sales decline to 5000 because of an elastic demand, tax revenue will *decline* to $7500. A higher tax on a product with elastic demand will bring in less revenue. It is not surprising, then, that excise taxes are levied on goods with relatively inelastic demand, such as alcohol, tobacco and petrol.

Heroin and crime

The fact that the demand for heroin by addicts is highly inelastic poses some awkward trade-offs in the area of law enforcement. The approach typically used in attempting to reduce heroin addiction is to restrict supply—that is, to make the drug less readily available by cracking down on its shipment into the country. But what will happen if this policy is successful? Given the highly inelastic demand, the street price to addicts will rise sharply while the amount purchased will decrease only slightly. From the drug dealers' point of view, this means increased revenues and profits. From the addicts' point of view, it means greater total expenditures on heroin. Because much of the income addicts spend on heroin is derived from crime—shoplifting, burglary, prostitution, muggings, and so on—these crimes will increase as addicts increase their total expenditures on heroin. Here, the efforts of law-enforcement authorities to control the spread of drug addiction may increase the amount of crime committed by addicts.

CHECKPOINT

- Price elasticity of demand is a measure of the responsiveness of the quantity of a product demanded by consumers to a change in its price. If E_d, the elasticity coefficient, is greater than 1, demand is relatively elastic and demand quantities will be highly sensitive to price changes. If E_d is less than 1, demand is relatively inelastic and demand quantities will be relatively unresponsive to price changes. Unit elasticity, when E_d equals 1, is a special case, in which changes in price are exactly balanced by changes in quantity demanded.
- To measure the price elasticity of demand, we use the averages of the prices and quantities along the points on the demand curve that we are moving between as reference points for determining the percentage changes in price and quantity. Price elasticity (E_d) is then estimated as the percentage change in quantity demanded of *X* divided by the percentage change in price of *X*.
- The determinants of the price elasticity of demand are the number of available substitutes, the size of an item in the household's budget, whether the product is a luxury or necessity, and the time period involved in the product's consumption.
- Price elasticity of demand can be determined by observing the effect of a price change on total revenue from the sale of the product. If price and total revenue move in opposite directions, demand is elastic. If price and total revenue move in the same direction, demand is inelastic. If price and revenue change in the same proportion, demand is unit elastic.

Price elasticity of supply

The concept of price elasticity can also be applied to supply. If producers' supply quantity is responsive to price changes, supply is elastic. If it is relatively insensitive to price changes, supply is said to be inelastic.

The elasticity formula developed earlier is used, but we substitute 'percentage change in quantity supplied' for 'percentage change in quantity demanded':

$$E_s = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in price of product X}}$$

Note that, because price and quantity supplied are directly related, the coefficient will be positive. If supply quantity is elastic then $E_s > 1$; if it is inelastic, then $E_s < 1$.

An important influence on the **price elasticity of supply** is the production period in which the supplier may respond to a given change in product price. This is because a producer's response to an increase in the price of product X depends on the producer's ability to shift resources from the production of other products[2] to the production of X. The longer the time period, the greater is the resource 'shiftability' and, therefore, the greater will be both the output response and the elasticity of supply.

When analysing the price elasticity of supply, it is useful to distinguish between the immediate market period, the short run and the long run.

The market period

Market period: a period of time in which producers of a product are unable to change the quantity produced in response to a change in its price.

The immediate **market period** is one in which producers cannot respond to a change in demand and price. Suppose a small-scale grower brings an entire season's output of tomatoes, one truckload, to market. The supply curve will be perfectly inelastic; the grower will sell the truckload whether the price is high or low. Why? Because the grower cannot offer more tomatoes than one truckload if the price of tomatoes should be higher than anticipated. Though the grower might like to offer more, more tomatoes cannot be produced. Similarly, because the product is perishable, it cannot be withheld from the market. If the price is lower than anticipated, the grower will still sell the whole truckload. Costs of production, incidentally, will not be important in making this decision. Though the price of tomatoes may fall far short of production costs, the grower will sell out to avoid a total loss through spoilage. Our grower's supply of tomatoes is fixed; one truckload will be offered whatever the price.

Figure 6.3(a) illustrates the individual grower's perfectly inelastic supply curve in the market period. Note that growers are unable to respond to an assumed increase in demand. The price increase from P_0 to P_M simply rations a fixed supply to buyers, but elicits no increase in output.

The short run

Short run: a period of time in which at least one factor of production is fixed.

In the **short run**, the plant capacity of individual producers and of the industry is presumed fixed. But firms may use their plants more or less intensively. Thus, in the short run, the single grower's plant—which we shall consider as land and farm machinery—is fixed. But the grower can vary some inputs in the short run and cultivate tomatoes more intensively by applying more labour and more fertiliser and pesticides to the crop. The result is a greater output response to the presumed increase in demand; this greater output response is reflected in a more elastic supply of tomatoes, as shown by $S_S S_S$ in Figure 6.3(b). Note that the increase in demand is met through a larger quantity adjustment (Q_0 to Q_S) and a smaller price adjustment (P_0 to P_S) than in the market period; price is therefore lower than in the market period. Note that *the short-run period is one where we assume that at least one factor of production is fixed and the others are variable.*

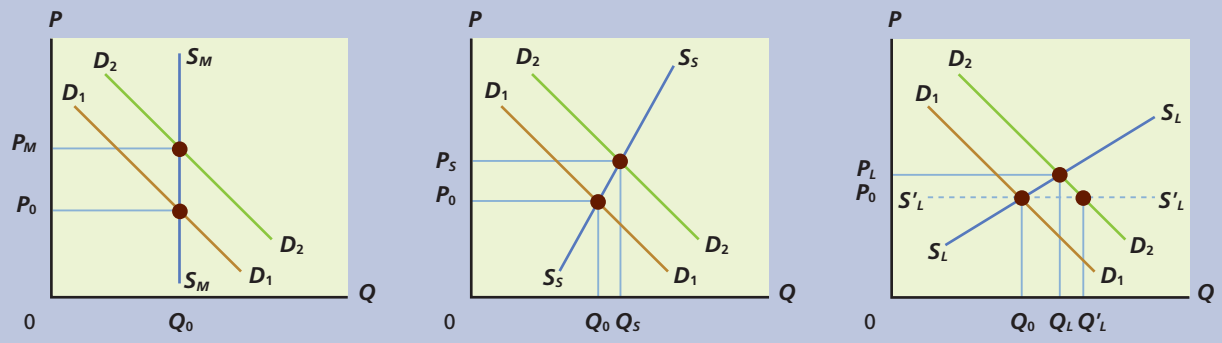


Figure 6.3 *Production period and elasticity of supply*

The greater the amount of time producers have for adjusting to a change in demand, the greater will be their output response. In the immediate market period, as in (a), it is not possible to change output, and so supply is perfectly inelastic at all price levels. In the short run, as in (b), plant capacity is fixed, but output can be altered by changing the intensity of its use; supply is therefore more elastic at all price levels. In the long run, as in (c), all desired adjustments—including changes in plant capacity—can be made, and the elasticity of supply increases, becoming perfectly elastic at the current price level in extreme cases.

The long run

Long run: a period of time in which all necessary adjustments to factors of production can be made.

The long run is a production period in which firms can make all desired resource adjustments; individual firms can expand (or contract) their plant capacities, and new firms can enter (or existing firms can leave) the industry. *In the long run all factors are variable*. In the tomato industry, our individual grower can use additional land and more machinery and equipment. Further, more growers may be attracted to tomato production by the increased demand and higher price. These adjustments mean an even greater supply response—that is, an even more elastic supply curve $S_L S_L$. The result, shown in Figure 6.3(c), is a small price effect (P_0 to P_L) and a large output effect (Q_0 to Q_L) in response to the assumed increase in demand.

CHECKPOINT

- The elasticity of supply shows the sensitivity of the quantity of a product supplied by producers to changes in the price of the product.
- The elasticity of supply depends on the shiftability of resources between alternative employments, which, in turn, depends on the production period under consideration during which producers may adjust to the price change.
- The periods over which the adjustment process is considered are: the market or immediate period, during which no adjustment in quantity supplied is possible; the short run, during which at least one of the factors of supply is fixed, limiting the adjustment of quantity supplied; and the long run, during which the quantity supplied is most elastic due to the ability to expand or contract the use of all economic resources.

Idea of the moment

Bundling for greater profit

We know when we consider the market equilibrium price that there are many consumers who would have paid more for a unit of the product and others who would make a purchase only if the equilibrium price were lower. That is, some consumers place a greater value on consumption of a unit of a product than on the equilibrium price, and some place a value on consumption of a unit of a product only when it is less than the equilibrium price. The rationing function of the market is built on this principle. An important question is whether we could have extracted revenue from those who were not willing to pay the equilibrium price. This is where the idea of bundling may allow us to increase both revenue and profit through the packaging and sale of complementary products.

Consider the following two markets for the complementary products *A* and *B* (e.g. cable TV and fast Internet connection), and two of the potential consumers for indivisible units of these products, consumers 1 and 2 (see graphs below).

At equilibrium in the market for product *A*, consumer 1 purchases a unit of the product, and would have been willing and able to pay P_{1A} (say \$65) to do so, although the price actually paid is P_{EQA} (say \$40). Consumer 2 would have been willing to pay P_{2A} (say \$20) and so does not purchase a unit of the product. In the market for product *B* we find the reverse situation, with consumer 2 willing to pay P_{2B} (\$65) to do so, with equilibrium price P_{EQB} (\$40), and consumer 1 willing to pay only P_{1B} (\$20) and not purchasing a unit of product *B*. The total revenue from these two customers for products *A* and *B* is $P_{EQA} + P_{EQB}$ (\$80). If products *A* and *B* are complementary in use or production, we may be able to increase our revenues from these customers by more than our costs by *bundling* the two products.

Assume that we offer both consumers 1 and 2 the opportunity to buy products *A* and *B* as a bundle, *AB*, at a combined price of $P_{EQA} + P_{EQB}$ (\$80). In this case both consumers will value the bundle of the products at more than the combined price (i.e. at \$85), and so will wish to purchase the bundled products. We will have

increased our revenue through this simple measure (by $80), and the customers will have benefited by gaining both products at a price to them that is lower than the total value that they placed on the combination.

Will this bundling strategy add profit? It will where:

- individuals value components of the bundle differently, but the package as a whole at a similar level.
- the incremental cost of selling the additional product to each customer is less than the extra revenue available through sale of the package.

Cross-price and income elasticity of demand

Price elasticities measure the responsiveness of supply quantities or demand quantities to change in price. It is also useful to know how demand quantity may respond to changes in the price of a related good and to changes in income.

Cross-price elasticity of demand

Suppose Reebok announce a permanent price reduction in the prices of all their sports shoes. How responsive will be the quantity demanded of competing brands, such as Nike, when this happens?

Cross-price elasticity of demand, E_{XY}, measures how sensitive consumer purchases of one product (say, X) are to a change in the price of some other product (say, Y). Our formula for the coefficient of cross-price elasticity of demand is similar to simple price elasticity of demand, except that we relate the percentage change in the consumption of X to a percentage change in the price of Y:

Cross-price elasticity of demand: a measure of how sensitive consumer purchases of one product are to a change in the price of some other product.

$$E_{XY} = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in price of product Y}}$$

This elasticity concept allows us to quantify and more fully understand substitute and complementary goods as introduced in Chapter 3.

Substitute goods

If cross-price elasticity of demand is *positive*—that is, the quantity demanded of X varies directly with a change in the price of Y—then X and Y are considered *substitute goods*. For example, an increase in the price of butter (Y) may cause consumers to buy more margarine (X). The larger the positive coefficient, the greater the substitutability between the two products.

Complementary goods

When cross-price elasticity is *negative*, then we know that X and Y 'go together' and are considered *complementary goods*. Thus an increase in the price of cameras will decrease the amount of photographic film purchased. The larger the negative coefficient, the greater the complementarity between the two goods.

Independent goods

A zero or near-zero coefficient suggests that the two products are *unrelated* or *independent goods*. For example, we would not expect a change in the price of butter to have any significant impact on the purchase of a CD.

Income elasticity of demand

The coefficient of **income elasticity of demand**, E_i, measures the percentage change in the quantity of a product demanded that results from some percentage change in consumer incomes:

$$E_i = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in income } (i)}$$

Normal goods

For most goods the income elasticity coefficient will be *positive*. Again recalling Chapter 3, products of which more is purchased as incomes increase are called *normal* or *superior goods*. However, the positive elasticity coefficient varies greatly among products. For example, the income elasticity of demand for cars has been estimated to be about +3.00, whereas for most farm products it is only about +0.20.

Inferior goods

A *negative* income elasticity coefficient designates an *inferior good*. Retreaded tyres, cabbage, bus tickets, used clothing and cask wine are likely candidates. Consumers *decrease* their purchases of such products as incomes *increase*.

One practical significance of income elasticity coefficients is that they help us predict which industries are likely to be prosperous, expanding industries and which will probably be unprosperous, declining industries. Other things being equal, a high positive income elasticity implies that the industry will share more than proportionately in the overall income growth of the economy. A small positive or, worse yet, a negative, coefficient implies a declining industry. For example, a high positive income elasticity of demand for cars means a greater likelihood of long-run prosperity for that industry in comparison to agriculture's low coefficient, which suggests chronic problems. Table 6.3 presents a summary of the results relating to both cross-price and income elasticity of demand.

Table 6.3
Cross-price and income elasticity of demand: a summary

Value of elasticity coefficient	Description	Type of good(s)
Cross-price elasticity		
Positive ($E_{AB} > 0$)	Quantity demanded of product *A* changes in the same direction as price of product *B*	Substitutes
Zero ($E_{AB} = 0$)	Quantity demanded of product *A* does not change when the price of product *B* changes	Independent
Negative ($E_{AB} < 0$)	Quantity demanded of product *A* changes in the opposite direction to the price of product *B*	Complements
Income elasticity		
Positive ($E_i > 0$)	Quantity demanded of the product changes in same direction as income	Normal or superior
Negative ($E_i < 0$)	Quantity demanded of the product changes in opposite direction to income	Inferior

CHECKPOINT

- Cross-price elasticity measures how sensitive the purchases of one product are to the price of another product. It is measured by dividing the percentage change in the quantity demanded of product *X* by the percentage change in the price of product *Y*.
- Positive cross-price elasticity identifies substitute goods, and negative cross-price elasticity identifies complementary goods.
- Income elasticity measures the responsiveness of quantity demanded to changes in income. It is measured by dividing the percentage change in quantity demanded by the percentage change in income.
- Income elasticity is positive for normal or superior goods and services and negative for inferior ones.

Legal prices and the incidence of sales taxes

Supply and demand analysis and the elasticity concepts will be applied repeatedly in the remainder of this book. Let us strengthen our understanding of these analytical tools and their significance by examining two interesting and important applications: legal prices and the incidence of sales taxes (for example, the GST at the retail level).

Legal prices

Sometimes the general public and government are of the opinion that the forces of supply and demand result in prices that are either unfairly high to buyers or unfairly low to sellers. In such instances government may intervene by legally limiting how high or low the price may go.

Price ceilings and shortages

A **price ceiling** is the *maximum legal price a seller may charge for a product or service*. The rationale for fixing ceiling prices for specific products is that these supposedly enable consumers to obtain some 'essential' good or service that they could not afford at the equilibrium price. Historically, rent controls and usury laws (regulations specifying the maximum interest rates that may be charged to borrowers) are examples. Ceiling prices or general price controls have been used to try to restrain the overall rate of inflation in the economy.

Wartime price controls

Let us turn back the clock to World War II and analyse the effects of a ceiling price on butter. Further, assume that, as in Figure 6.4, the equilibrium or market price P was, say, 40 cents per 500 grams. During the war period, inflation tended to ration out of the butter market those families whose money incomes were not keeping pace with the soaring cost of living. To control this inflation and make butter more accessible, let us say that the government imposed a ceiling price P_c of 30 cents per 500 grams.

What would be the effects of this ceiling price? The rationing ability of the free market would be ineffective. At the ceiling price there would be a persistent shortage of butter. The quantity of butter demanded at P_c would be Q_d and the quantity supplied only Q_s, hence a persistent excess demand, or shortage, of Q_sQ_d occurs. Stated differently, the legal price P_c prevents the usual market adjustment where competition among buyers would bid up price. Simultaneously this price induces more production, and forces some buyers out of the market until the shortage disappears, at the equilibrium price and quantity of P_e and Q_e respectively.

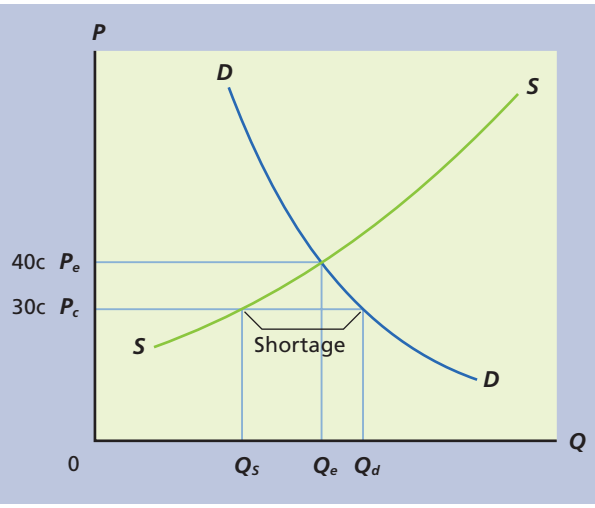


Figure 6.4
Ceiling prices result in persistent shortages
Because the imposition of a price ceiling such as P_c results in a persistent product shortage, as indicated by the distance Q_sQ_d, government must undertake the job of rationing the product in order to achieve an equitable distribution.

(You might like to demonstrate that the size of the shortage will be greater the more elastic are both supply and demand in this price range.)

By preventing this market-clearing adjustment process from occurring, the ceiling price poses some problems because of the market disequilibrium it causes.

Rationing problem

How is the available supply Q_s to be apportioned among buyers who want the amount Q_d? Should the supply be distributed on a first-come, first-served basis—that is, to those who are willing and able to stand in line the longest? Should the grocer distribute butter on the basis of favouritism?

An unregulated shortage is hardly conducive to the equitable distribution of butter. To avoid inappropriate distribution, the government may establish some formal system of rationing the product to consumers. This was accomplished during World War II by issuing ration coupons to individuals on an equitable basis. An effective rationing system involves printing ration coupons equal to Q_s amounts of butter and the equitable distribution of these coupons among consumers so that, for example, the wealthier family of 4 and the poorer family of 4 will both receive the same number of coupons.

Black markets

But the use of rationing coupons does not prevent a second problem from arising. The demand curve in Figure 6.4 tells us there are many buyers who are willing to pay more than the ceiling price. And, of course, it is more profitable for grocers to sell above the ceiling price. Hence, despite the sizeable enforcement bureaucracy that accompanied World War II price controls, *black markets*—illegal markets where products were bought and sold at prices above the legal limits—flourished for many goods.

Rent controls

For many years, rent controls in England ironically contributed to a persistent housing shortage. Although the short-term effect of such controls may have had the desired effect—to keep housing within reach of some of the poor—their longer term impact was to inhibit alleviation of the housing shortage. Given low rents, investors were reluctant to construct new housing, and investing in repairs was unprofitable. The point is that rent controls prevented the rent increases needed to signal the profitable allocation of more resources to the construction of new housing and the renovation of old housing. Shortages persisted and even worsened.

Price supports and surpluses

Price supports, sometimes called 'price floors', are *minimum prices fixed by government that are above equilibrium prices.* They have generally been used when society has felt that the free functioning of the market system has failed to provide a 'sufficient' income for certain groups. Minimum-wage legislation and the support of agricultural prices are the two most widely discussed examples of government price supports. Let us examine price supports as applied to a specific farm commodity.

Suppose the market price for wheat is $3 per unit and, as a result of this price, farmers obtain extremely low incomes. Government decides to lend a helping hand by establishing a legal support price of, say, $4 per unit.

What will be the effects? At any price above the equilibrium price, quantity supplied will obviously exceed quantity demanded; there will be a persistent surplus, or excess supply of the product. Farmers will be willing to produce and offer for sale more than private buyers are willing to purchase at the supported price. The size of this surplus will vary directly with the elasticity of demand and supply. The greater the elasticity of demand and supply in the region

Asia in focus

Telecoms among the largest Asian companies

Telecommunications—that indispensable tool of business and that important means of contact for consumers—is a growth industry in the [Asian] region. Telecoms are also among the largest companies in the region, on the back of expansion in such areas as mobile phone services. The following table shows the top ten Telecoms, their country of location, value (US$) and ranking by value among companies in the Asian region.

Company	Country	2002 value (US$ million)	Rank in region (by value)
NTT DoCoMo	Japan	92 933.36	2
NTT Corp	Japan	61 127.67	3
China Mobile	Hong Kong	52 720.03	4
Telstra Corp	Australia	33 959.30	11
SK Telecom	South Korea	16 212.21	21
SingTel	Singapore	14 884.57	25
Chunghwa Telecom	Taiwan	13 140.49	29
KT Corp	South Korea	13 043.08	30
China United	China	7 115.15	50
Telekom Malaysia	Malaysia	6 374.27	55

SOURCE: 'Asia's top companies by market cap', *Business Asia,* November 2002.

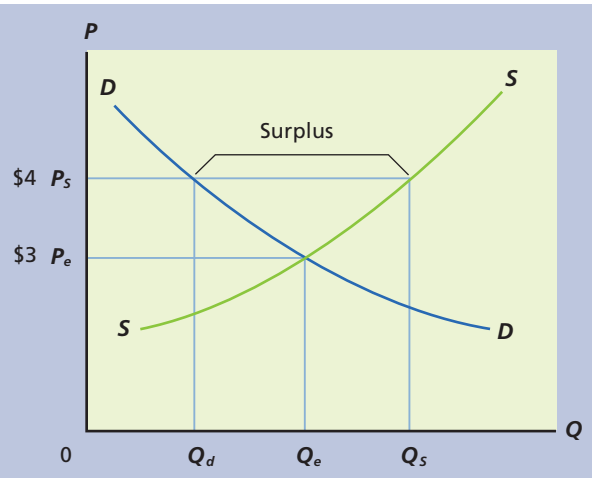
Questions

1. Are phone services a necessity or luxury? Do you think that the definition chosen will differ by country? Explain.
2. What are the implications for the price elasticity of demand for phone services if these are a necessity? What are the implications if phone services are a luxury? Explain.
3. Is the income elasticity of demand for mobile phone services likely to be greater than or less than 1? What are the implications of this for the rate of growth of revenue associated with the provision of these services in the Asian region? Is this a driving factor behind the value of Telecoms in the region?

of the equilibrium price, the greater the resulting surplus. As is the case with a ceiling price, the rationing ability of the free market will obviously have been disrupted by the imposition of a legal price.

Figure 6.5 provides us with a graphical illustration of the effect of a supported price. Let *SS* and *DD* be the supply and demand curves for wheat. Equilibrium price and quantity are P_e and Q_e respectively. If government imposes a supported price of P_s, farmers will be willing to produce Q_s but private buyers will take only Q_d off the market at that price. The surplus is measured by the excess of Q_s over Q_d.

Figure 6.5
Supported prices result in persistent surpluses
A price support such as P_s gives rise to a persistent product surplus, as indicated by the distance Q_dQ_s. Government must either purchase these surpluses or take measures to eliminate them by restricting product supply or increasing product demand.



Government, through two general approaches, attempts to cope with the surplus that a supported price creates:

- Government might use certain programs to restrict supply (i.e. quotas) or to increase demand (e.g. research programs on new uses for agricultural products). These are attempts to reduce the difference between the equilibrium price and the supported price and, therefore, the size of the resulting surplus.
- If these efforts are not successful, then government may have to purchase the surplus output (thereby subsidising farmers), and store or otherwise dispose of it.

Incidence of taxes

The concepts of supply and demand and the notion of elasticity are useful in determining who pays or bears the burden of sales or excise tax. Suppose that Figure 6.6 (page 164) shows the market for a certain wine and that the no-tax equilibrium price and quantity are $4 and 15 000 bottles respectively. Now, let us assume that government levies a specific sales or excise tax of $1 per bottle on this wine. Who actually pays this tax—producers or consumers? What is the **incidence** of this tax?

Division of burden

Assuming that government requires the tax to be collected by the sellers/suppliers (as is the case with the GST), it can be viewed as an addition to the supply price of the product. Therefore, the tax has the effect of shifting the supply curve upwards by the amount of the tax. Thus, whereas sellers were willing to offer 5000 bottles of untaxed wine at $2 per bottle, they must now receive $3 per bottle—$2 plus the $1 tax per bottle—to offer the same 5000 bottles. Sellers

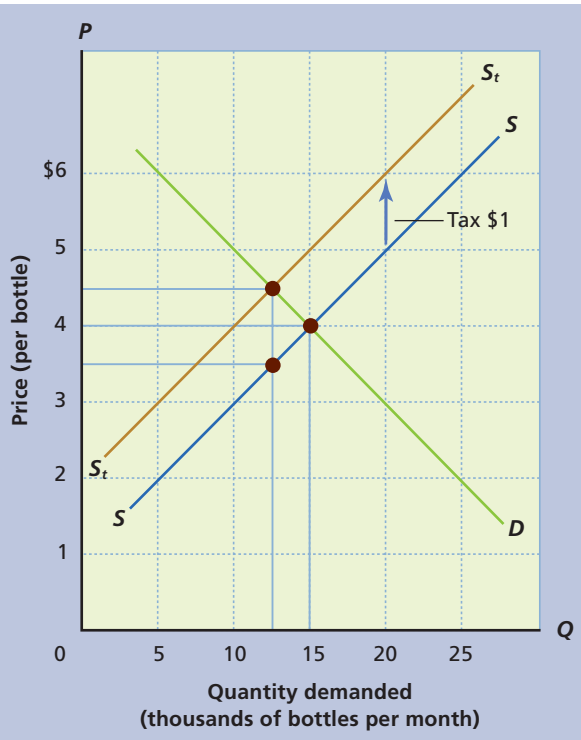


Figure 6.6
The incidence of a sales tax
The imposition of a sales tax of a specified amount, say $1 per unit, shifts the supply curve upwards by the amount of the tax. This results in a higher price ($4.50) to the consumer and a lower after-tax price ($3.50) to the producer. In this particular case, the burden of the tax is shared equally by consumers and producers.

must now receive $1 more at each quantity supplied in order to receive the same per-unit price as they were receiving before tax. The tax-caused upshift in the supply curve is shown in Figure 6.6, where SS is the 'no-tax' supply curve and S_tS_t is the 'after-tax' supply curve.

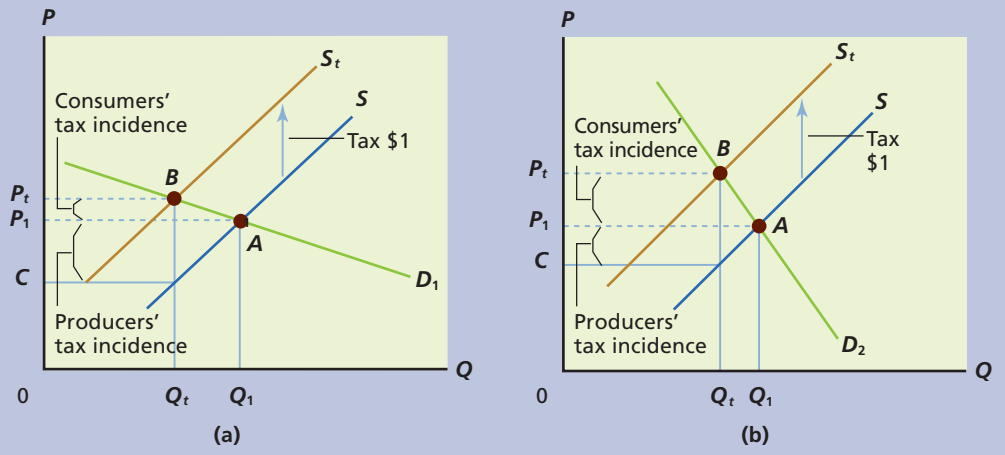
Careful comparison of after-tax supply and demand with the pre-tax equilibrium reveals that the new equilibrium price is $4.50, compared with the before-tax price of $4.00. In this particular case, half of the tax is paid by consumers in the form of a higher price and the other half by producers in the form of a lower after-tax price. Consumers pay 50 cents more per bottle and, after paying the $1 tax per unit to government, producers receive $3.50, or 50 cents less than the $4.00 before-tax price. In this instance, consumers and producers share the burden of the tax equally; producers shift half the tax forwards to consumers in the form of a higher price and carry the other half themselves.

Note, incidentally, that the equilibrium quantity has fallen from 15 000 to 12 500 bottles. This reduction in output may well have been an intended outcome of the imposition of the tax. That is, government may have reasoned that certain spillover or social costs result from the consumption of alcoholic beverages, and therefore imposed an excise tax to adjust the market supply curve for these costs and reduce the amount of resources allocated to wine production (see Chapter 17).

We can show that the relatively more inelastic the good in question, the more likely is the incidence of the tax to be borne by the consumer; that is, more of the tax is passed on to the consumer. Consider Figure 6.7(a). Here the consumers' tax incidence (increase in market price) is $P_t - P_1$. In this example, this is a minor fraction of the $1 tax. The major part of the tax ($P_1 - C$) is borne by the producer. In Figure 6.7(b) we have made demand relatively more inelastic in the price–quantity range A to B. Note that the consumers' tax incidence is now relatively much larger. The consumers' incidence ($P_t - P_1$) is a major part of the $1 tax. We can deduce that, in this price range, the more inelastic is demand, the greater the incidence of the tax on consumers.

Figure 6.7
Varying the tax incidence

In (a), the consumers' tax incidence (increase in price) $P_t - P_1$ is a fraction of the $1 tax; the majority of the tax ($P_1 - C$) is borne by the producers. In (b), demand is relatively less elastic (in the region *A* to *B*) than in (a). Note that the consumers' tax incidence is now relatively much larger.



CHECKPOINT

- Ceiling and supported prices rob the free-market forces of supply and demand of their rationing ability, leading to the presence of shortages or surpluses at the legal price.
- Government must accept the administrative problem of rationing that stems from price ceilings and the problem of buying or eliminating surpluses that price supports create.
- Sales taxes—such as the GST at the retail level—and excise taxes affect supply, and therefore equilibrium price and quantity, reducing quantity below the level that would prevail under a free market, and raising the price paid by the consumer above its free-market level.
- The incidence of the tax is determined by the interaction of the elasticities of demand and supply. The more inelastic the demand for a product in the relevant price range, the greater will be the portion of the tax that is shifted to consumers; the less elastic the supply, the lower the portion borne by consumers.

summary

1 Price elasticity of demand (also known as the own-price elasticity of demand) measures the responsiveness of consumers' demand quantity to price changes. If demand quantity is highly sensitive to price changes, demand is relatively elastic. If quantity is relatively unresponsive to price changes, demand is inelastic.

2 The price elasticity formula is used to estimate the degree of elasticity or inelasticity of demand for a product X. The formula is:

$$E_d = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in price of product X}}$$

The averages of the prices and quantities between the two points on the demand curve that are under consideration are used for reference points in determining the percentage changes in price and quantity. If E_d is greater than 1, demand is elastic. If E_d is less than 1, demand is inelastic. Unit elasticity is the special case in which E_d equals 1.

3 A perfectly *inelastic* demand 'curve' is shown by a line parallel to the *vertical axis*; a perfectly *elastic* demand 'curve' is shown by a line parallel to the *horizontal axis*.

4 Elasticity varies at different price ranges on a demand curve. It is not safe to judge elasticity by the steepness or flatness of a demand curve on a graph, because the units of measurement used in the graph may influence the slope of the demand curve.

5 Price elasticity of demand can be determined by observing the effect of a price change on total revenue derived from the sale of the product. If price and total revenue move in opposite directions, demand is in an elastic portion of the demand curve. If price and total revenue move in the same direction, demand is in an inelastic portion of the demand curve.

6 The determinants of the elasticity of demand include the number of available substitutes, the size of an item in one's budget, whether the product is a luxury or necessity, and the time period over which consumption decisions are to be made. The greater the number of substitutes available, the higher the elasticity of demand. The larger the budget share of the product, the higher the elasticity of demand. The demand for necessities tends to be relatively inelastic, whereas the demand for luxuries is relatively elastic. In general, the longer the time horizon under consideration, the greater will be the elasticity of demand.

7 The elasticity concept is also applicable to supply. Elasticity of supply depends on the shiftability of resources between alternative employments. This shiftability depends, in turn, on the production period under consideration in which producers adjust to the price change. This period may be market, short run or long run. During the market period no extra product is available, making supply perfectly inelastic. During the short run, the plant and equipment available to producers is fixed, allowing some, although limited, expansion of the quantity supplied through more intensive use of this plant and equipment. Thus supply is more elastic than in the market period. In the long run, all resource inputs may be adjusted, leading to an even more elastic supply curve than in the short run.

8 Cross-price elasticity measures how sensitive the purchases of one product are to the price of another product. It is calculated using the following formula:

$$E_{XY} = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in price of product Y}}$$

MaxMARK

Max your marks!
Thirty interactive questions on elasticity and its applications are available now at the Online Learning Centre that accompanies this book: www.mhhe.com.au/jackson7e_micro (for access to MaxMark, please refer to the front of this text).

A positive cross-price elasticity identifies X and Y as substitutes. A negative cross-price elasticity identifies X and Y as complements.

9 Income elasticity measures the responsiveness of quantity demanded to changes in income. It is calculated using the following formula:

$$E_i = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in income } (i)}$$

E_i is positive for normal goods and negative for inferior ones.

10 Legally fixed prices upset the rationing function of market prices. Effective price ceilings result in persistent product shortages, and if an equitable distribution of the product is sought, government will have to ration the product to consumers. Price supports give rise to product surpluses; governments must purchase these surplus products, or eliminate them either by imposing restrictions on production or by increasing demand.

11 Sales taxes—such as the GST as it is applied at the retail level—and excise taxes affect supply (are included in the price paid by consumers), and therefore equilibrium price and quantity. The more inelastic the demand for a product in the relevant price range, the greater will be the portion of the tax that is shifted from producers to consumers.

Key terms and concepts

review questions

1. To what does the concept of elasticity of demand refer? What useful information does it provide?
2. What are the major determinants of the price elasticity of demand? Explain, clearly, the impact that each has on the estimated value of elasticity.
3. Why is it difficult to judge elasticity of demand or supply if you are merely observing the appearance of a demand or supply curve on a graph?
4. Into what periods do we divide supply when discussing the elasticity of supply? What are the key characteristics of each of these periods?
5. What information do cross-price elasticity and income elasticity of demand convey? What is the significance of the signs on the cross-price elasticity and income elasticity measures?

6 Why is it desirable for ceiling prices to be accompanied by government rationing?

7 Why is it desirable for price supports to be accompanied by surplus-purchasing or output-restricting or demand-increasing programs?

8 From a revenue-maximising viewpoint, explain why the government would be more likely to impose excise taxes on cigarettes and beer rather than on mangoes and mineral water.

problem-solving exercises

1 'Empirical estimates suggest the following demand elasticities: 0.6 for physicians' services; 4.0 for foreign travel; 0.1 for newspapers; and 1.2 for radio and television receivers.' Use the generalisations for the determinants of elasticity developed in this chapter to explain each of these figures.

2 How will the following changes in price affect total revenue (expenditures)—that is, will total revenue *increase*, *decline* or *remain unchanged*?
(a) Price falls, and demand is inelastic.
(b) Price rises, and demand is elastic.
(c) Price rises, and supply is elastic.
(d) Price rises, and supply is inelastic.
(e) Price rises, and demand is inelastic.
(f) Price falls, and demand is elastic.
(g) Price falls, and demand is of unit elasticity.

3 The price–quantity data in the following table will graph to give a straight-line demand curve. Use both the elasticity coefficient and the total revenue test to determine the elasticity of demand for each price change. What can you conclude about the relationship between the slope of the curve and its elasticity? Answer the question using both numerical and graphical methods.

Product price ($)	Quantity demanded	Total revenue ($)
7	0	
6	1	
5	2	
4	3	
3	4	
2	5	
1	6	

4 Determine the elasticity of demand and supply for the following demand and supply schedules. Use the total revenue test to check the answers given by the E_d formula.

E_s	Quantity supplied	Product price ($)	Quantity demanded	Total revenue ($)	E_d
	28 000	10	10 000		
	22 500	9	13 000		
	17 000	8	17 000		
	15 500	7	22 000		
	11 000	6	25 000		

5 If the cross-elasticity of demand for products *A* and *B* is +3.6 and for products *C* and *D* is –5.4, what can you conclude about how these pairs of products are related?

6 Suppose the income elasticities of demand for movies, dental treatment and clothing are +3.4, +1.0 and +0.5 respectively. Interpret these coefficients. What does it mean if such a coefficient is negative?

7 'Empirical estimates indicate that the elasticity of supply for cabbages is 0.36 in the short run and 1.20 in the long run.' Explain the different figures.

8 (a) Show graphically why price ceilings entail shortages and price supports result in surpluses.
(b) What effect, if any, does the elasticity of demand and supply have on the size of these shortages and surpluses? Explain.

9 (a) What is the incidence of (i) a sales tax and (ii) a subsidy when demand is highly inelastic around the equilibrium price?
(b) How will your answer change if demand is highly elastic at this price?
(c) What effect does the elasticity of supply have on the incidence of (i) a sales tax and (ii) a subsidy?

application questions

1 Suppose you are a government official responsible for establishing a scheme to raise new revenue by the use of excise taxes. Would elasticity of demand be important to you in deciding which products to tax? Explain.

2 What would the consumers' and producers' tax incidences be equal to if the government imposed an excise tax when:
(a) demand was perfectly elastic
(b) demand was perfectly inelastic
(c) supply was perfectly elastic
(d) supply was perfectly inelastic?
Draw graphs to support your arguments.

3 In many oligopolistic industries—for example, the petroleum industry—producers justify their reluctance to lower prices by arguing that the demand for their products is inelastic. Explain.

4 Can you find any 'real world' estimates of elasticities? Search the Internet, and see if you have any luck. A good place to start your search is at the Productivity Commission's home page at:
www.pc.gov.au
You will find that one of the Productivity Commission's predecessor organisations—the Industry Commission—has a number of elasticity estimates in its research publications.

Economics in reality

Drowning in glass

In the United States, investors threw tens of billions of dollars at new telecoms that were laying fibre networks in competition with the incumbents. When the stock market tumbled, the industry realised it was looking at an unprecedented overhang of raw fibre. One consequence was a gap between the main supply potential bandwidth capacity and the main source of new demand. Price elasticity may help the industry's plight.

Can you have too much of a good thing? The history of technology says not, but that was before the fibre-optic bubble. Dreamy it may seem, but 'build it and they will come' is one of the most fundamental and lasting laws of technology. Each year the labs of Silicon Valley find ways to increase the capacity of everything, from processors to storage space, seemingly beyond all sense and reasonable demand. Yet somehow ways are always found to use it all. In technology, capacity drives demand, rather than the other way round. The same has been true for communications capacity, which has been growing quickest of all, thanks to fibre optics. But here, the recent stock market bubble changed the picture. Investors threw tens of billions of dollars at new telecoms companies that were laying fibre networks in competition with the incumbents. The pace of new fibre laying, already fast, became frenetic . . .

When the stock market tumbled, the industry realised that it was looking at an unprecedented overhang of raw fibre. As expensive as it is to lay fibre, it is far more expensive to 'light' it with lasers, amplifiers and other optical equipment, and thus turn potential capacity into usable bandwidth. To light the new fibre that American carriers have already announced they are adding to their networks would cost more than $500 billion over the next three years, more than ten times current spending rates . . . Telecoms carriers tend to lay fibre speculatively, but only light it when they have an actual buyer. Now, with the stock market in a spin, they do not have as many of those as they were counting on . . . There is plenty of evidence to support the fear of a fibre glut. Technologies that were expected to consume huge amounts of capacity have been slow to arrive . . .

One consequence of all this is a gap between the main supply of potential bandwidth capacity (the long-haul networks between cities) and the main sources of new demand (small businesses and homes). From now on, there will be fewer companies connecting these consumers to networks than before, and at slower rates. This 'last mile' bottleneck keeps millions of homes and businesses using dial-up modems, consuming trickles of bandwidth when they might want floods, and leaves much of the fibre in long-haul networks unused. But there is a big difference between a temporary mismatch in supply and demand and a rejection of the 'build it and they will come' rule of technology consumption. The industry clearly overshot in the heady days when money was easy and growth was everything. Yet hardly anybody doubts that almost all the fibre in the ground today will be used eventually. The question is whether the companies that made the investment will be able to stay in business long enough to see the day . . .

But here, price elasticity may help the industry's plight. One of the good things about the fibre glut is that the price of unused fibre, which had remained relatively stable (since it reflects the cost of construction workers more than technology), is now falling quickly. As more companies get in trouble and are forced to dump capacity, the price will fall even faster. The result may be that once the shakeout is over, the survivors will be able to offer unprecedented amounts of bandwidth for unheard-of prices . . .

With that kind of capacity, applications such as video-on-demand suddenly become economically attractive. If people start watching TV over the Internet, the fibre now in the ground may no longer be enough. And so the cycle will start again, just as it does in Intel's chips and Seagate's hard drives. The only difference is that billions of dollars of investment will have been burned up waiting for that day. Fibre is not so different from other technologies, except for the cost of getting it wrong.

SOURCE: Economist, 24 March 2002, p. 76, © the Economist Newspaper Limited, London.

Questions

1. Outline the nature of the raw fibre market referred to in this article. What is the demand for raw fibre derived from?
2. Is 'laid fibre' essentially a different resource from raw fibre?
3. What oversupply problem emerged in the market described and what was its impact? Explain.
4. How does the price elasticity concept apply in this particular example?

Search for more on elasticity and its applications on PowerWeb, available from the Online Learning Centre that accompanies this book: www.mhhe.com.au/jackson7e_micro (for access to PowerWeb, please refer to the front of this text).

notes

1 Further, the use of percentages in the elasticity formula disguises the fact that E_d can be regarded as a 'point' concept, so that calculation would require measuring proportionate changes of price and quantity at a point on the demand curve. Thus, at point A in the figure below we find that (where Δ means 'change in'):

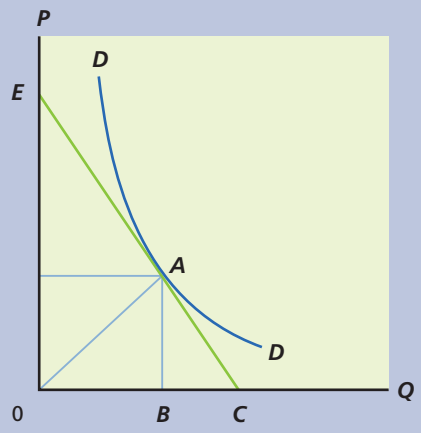
$$E_d = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{Q}}$$

$$= \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

$$= \frac{BC}{AB} \times \frac{AB}{0B}$$

$$= \frac{BC}{0B}$$

$$= \frac{AC}{AE}$$



This point measurement method can easily be used to show how E_d varies around most demand curves, and again illustrates the difference between E_d and slope.

2 The prices of which we assume to remain constant.