2 Supply and Demand

Talk is cheap because supply exceeds demand.

When asked, 'What is the most important thing you know about economics?', many people reply, 'Supply equals demand'. This statement is a shorthand description of one of the simplest yet most powerful models of economics. The supply-and-demand model describes how consumers and suppliers interact to determine the *quantity* of a good or service sold in a perfectly competitive market and the *price* at which it is sold. To use the model, you need to determine three things: buyers' behaviour, sellers' behaviour, and how they interact. After reading this chapter, you should be adept enough at using the supply-and-demand model to analyse some of the most important current policy questions facing Australia today, such as those concerning international trade, minimum wages, and the availability and cost of healthcare.

After reading that grandiose claim, you may ask, 'Is that all there is to economics? Can I become an expert economist that fast?' The answer to both these questions is no (of course). In addition, you need to learn the limits of this model and what other models to use when this one does not apply. (You must also learn the economists' secret handshake.)

Even with its limitations, the supply-and-demand model is a widely used economic model. It provides a good description of how many markets function and works particularly well in relation to markets in which there are many buyers and many sellers, such as in most agriculture, labour and foreign exchange markets. Like all good theories, the supply-and-demand model can be tested—and possibly shown to be false. But in markets where it is applicable, it allows us to make accurate predictions easily.

In this chapter, we examine six main topics

1. **Demand.** The quantity of a good or service that consumers demand depends on price and other factors such as consumers' incomes and the price of related goods.
2. **Supply.** The quantity of a good or service that firms supply depends on price and other factors such as the cost of inputs firms use to produce the good or service.
3. **Market Equilibrium.** The interaction between consumers' demand and firms' supply determines the market price and quantity of a good or service that is bought and sold.
4. **Shocking the Equilibrium.** Changes in a determinant of demand (such as consumers' incomes), supply (such as a rise in the price of inputs), or a new government policy (such as a new tax) alter the market price and quantity of a good.
5. **Effects of Government Interventions.** Government policies may alter the equilibrium and cause the quantity supplied to differ from the quantity demanded.
6. **When to Use the Supply-and-Demand Model.** The supply-and-demand model applies only to highly competitive markets.

2.1 Demand

good
the terms 'good' and 'product' include services

Potential consumers decide how much of a good or service to buy on the basis of its price and many other factors, including their own tastes, information, prices of other goods, income and government actions. (Generally the term 'good' is used synonymously with 'product' and so includes 'service'.) Before concentrating on the role of price in determining demand, let's look briefly at some of the other factors.

Consumers' *tastes* determine what they buy. Consumers do not purchase foods they dislike, artwork they hate, or clothes they view as unfashionable or uncomfortable. Advertising may influence people's tastes.

Similarly, *information* (or misinformation) about the uses of a good affects consumers' decisions. A few years ago when many consumers were convinced that rolled oats could lower their cholesterol level, they rushed to supermarkets and bought large quantities of rolled oats. (They even ate some of it until they remembered that they could not stand how it tastes.)

The *prices of other goods* also affect consumers' purchase decisions. Before deciding to buy jeans from Just Jeans, you might check the prices of other brands. If the price of a close *substitute*—a product that you view as identical or similar to the one you are considering purchasing—is much lower than the price of jeans from Just Jeans, you may buy that brand instead. Similarly, the price of a *complement*—a good that you like to consume at the same time as the product you are considering buying—may affect your decision. If you eat apple pie only with ice cream, the higher the price of ice cream, the less likely you are to buy apple pie.

Income plays a major role in determining what and how much to purchase. A person who suddenly inherits great wealth may purchase an expensive BMW or other luxury items and would probably no longer buy do-it-yourself repair kits.

Government rules and regulations affect purchase decisions. Application of the GST increases the price that a consumer must pay for a good, and government-imposed limits on the use of a good may affect demand. If local governments ban the use of skateboards on their streets, skateboard sales will fall.

Other factors may also affect the demand for specific goods. Consumers are more likely to have mobile phones if most of their friends have mobiles (the network effect). The demand for small pine trees is substantially higher in December than in other months.

Although many factors influence demand, economists usually concentrate on how price affects the quantity demanded. The relationship between price and quantity demanded plays a critical role in determining the market price and quantity in a supply-and-demand analysis. To determine how a change in price affects the quantity demanded, economists must hold constant other factors that affect demand, such as income and tastes.

The Demand Curve

quantity demanded
the amount of a good that consumers are willing to buy at a given price, holding constant the other factors that influence purchases

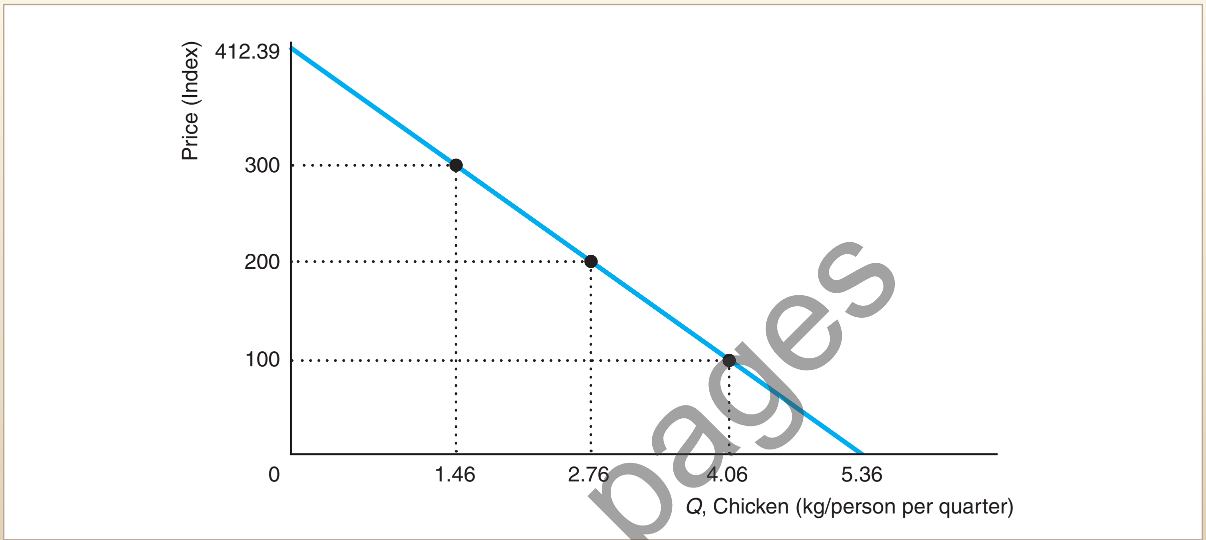
demand curve
the *quantity demanded* at each possible price, holding constant the other factors that influence purchases

The amount of a good that consumers are *willing* to buy at a given price, holding constant the other factors that influence purchases, is the **quantity demanded**. The quantity demanded of a good or service can exceed the quantity *actually* sold. For example, as a promotion, a local store might sell music CDs for $1 each today only. At that low price, you might want to buy 25 CDs, but because the store ran out of stock, you could buy only 10 CDs. The quantity you demanded is 25—it is the amount you *wanted*, even though the amount you *actually bought* was only 10.

We can show graphically the relationship between price and the quantity demanded. A **demand curve** shows the quantity demanded at each possible price, holding constant the other factors that influence purchases of this product. Figure 2.1

Figure 2.1 A Demand Curve

The estimated demand curve, D^1, for processed chicken in Australia (Bhati 1987) shows the relationship between the quantity demanded per person per quarter and the price per kg (expressed as an index). The downward slope of the demand curve shows that, holding constant other factors that influence demand, consumers demand less of a good when its price is high and more when the price is low. A change in price causes a *movement along the demand curve*.



shows the estimated demand curve, D^1, for processed chicken in Australia (Bhati 1987). (This demand curve is a straight line, but demand curves may also be smooth curves or wavy lines.) By convention, the vertical axis of the graph measures the price, P, per unit of the good—here the price is represented by an index which is the quarterly average price received by farmers adjusted for inflation, using the Consumer Price Index (CPI) with 1980–81 as the base year. Economists call this the real price. The horizontal axis measures the quantity, Q, of the good, which is usually expressed in some *physical measure* (kg of chicken per person) *per time period* (per quarter).

The demand curve hits the vertical axis when the price index is approximately 412, indicating that no quantity is demanded when the price index is approximately 412 (or higher). The demand curve hits the horizontal quantity axis at 5.4 kg—the amount of chicken that consumers want per quarter if the price is zero. To find out what quantity is demanded at a price between these extremes, pick that price (price index) on the vertical axis—say, a price index of 100—then draw a horizontal line across until you hit the demand curve, and then draw a line straight down to the horizontal quantity axis: approximately 4.1 kg of chicken per person per quarter is demanded at that price.

One of the most important things to know about a graph of a demand curve is what is *not* shown. All relevant economic variables that are not explicitly shown on the demand curve graph—tastes, information, prices of other goods (such as beef and lamb), income of consumers, and so on—are held constant. Thus the demand curve shows how quantity varies with price but not how quantity varies with tastes, information, the price of substitute goods, or other variables.[1]

Law of Demand
consumers demand more of a good the lower its price, holding constant tastes, the prices of related goods and other factors that influence consumption

Effect of Prices on the Quantity Demanded. Many economists claim that the most important *empirical* finding in economics is the **Law of Demand**: consumers demand more of a good the lower its price, holding constant tastes, the prices of other goods, and other factors that influence the amount they consume. According to the Law of Demand, *demand curves slope downward*, as in Figure 2.1.[2]

A downward-sloping demand curve illustrates that consumers demand more of this good when its price is lower and less when its price is higher. What happens to the quantity of chicken demanded if the price of chicken drops and all other variables remain constant? If the price of chicken falls from 200 to 100, in Figure 2.1, the quantity consumers want to buy increases from 2.8 to 4.1 kg per person per quarter.[3] Similarly, if the price increases from 200 to 300, the quantity consumers demand decreases from 2.8 to 1.5 kg per person per quarter. These changes in the quantity demanded in response to changes in price are *movements along the demand curve*. Thus the demand curve is a concise summary of the answers to the question, 'What happens to the quantity demanded as the price changes, when all other factors are held constant?'

Effects of Other Factors on Demand. If a demand curve measures the effects of price changes when all other factors that affect demand are held constant, how can we use demand curves to show the effects of a change in one of these other factors, such as the price of other meat? One solution is to draw the demand curve in a three-dimensional diagram with the price of chicken on one axis, the price of other meat (such as beef) on a second axis, and the quantity of chicken on the third axis. But just thinking about drawing such a diagram probably makes your head hurt.

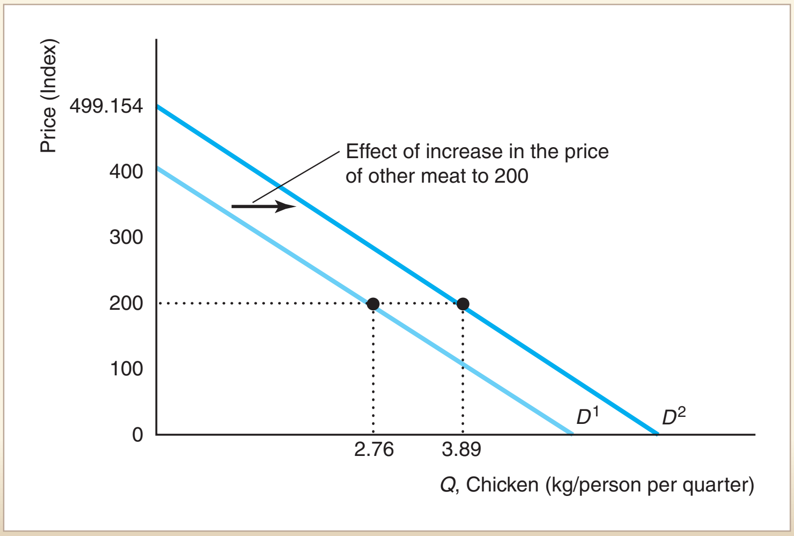
Economists use a simpler approach to show the effect on demand of a change in a factor that affects demand other than the price of the good. A change in any factor other than the price of the good itself causes a *shift of the demand curve* rather than a *movement along the demand curve*.

Many people view other meats as a close substitute for chicken. Thus, at a given price for chicken, if the price of other meat rises, some people will switch from other meat to chicken. Figure 2.2 shows how the demand curve for chicken shifts to the right from the original demand curve D^1 to a new demand curve D^2 as the price of other meat rises from 87.2 (its mean value) to 200.[4]

On the new demand curve, D^2, more chicken is demanded at any given price than on D^1. When the price index for chicken is 200, the quantity of chicken

Figure 2.2 A Shift of the Demand Curve

The demand curve for chicken shifts to the right from D^1 to D^2 as the price index for other meat rises from 87.2 to 200. As a result of the increase in other meat prices, more chicken is demanded at any given price (as represented by the price index).



demanded goes from 2.8 on D^1, before the change in the price of other meat, to 3.9 on D^2, after the price change.

Similarly, a change in information can shift the demand curve. For example, a wine company that wins a prestigious and publicised award for one of its labels finds that the demand for this label increases significantly thereafter. Thus, holding price constant, demand for the label is greater at each price level, so that the demand curve for this particular wine shifts to the right. However, the demand curve for the products of other wineries (or even for the producer's other labels) does not increase—indeed, if the additional demand is at the expense of the wines of these other suppliers and labels, the demand curve for their wines will shift to the left.

Increased nicotine levels in cigarettes may cause the demand curve for cigarettes of existing smokers to shift to the right. While in Australia the nicotine content of cigarettes has fallen,[5] a 2007 Harvard School of Public Health study concluded that cigarette manufacturers had raised nicotine levels in cigarettes by 11% over the last decade to make them more addictive. Although some cigarette makers denied such actions, the Massachusetts Department of Public Health issued a study citing the industry's own reports that the amount of nicotine that could be inhaled from cigarettes had risen by an average of 10% from 1998 through 2004. Presumably, if cigarettes become more addictive, the demand curve of existing smokers would shift to the right.[6]

To properly analyse the effects of a change in some variable on the quantity demanded, we must distinguish between a *movement along a demand curve* and a *shift of a demand curve*. A change in the *price of a good* causes a *movement along a demand curve*. A change in *any other factor besides the price of the good* causes a *shift of the demand curve*.

The Demand Function

In addition to drawing the demand curve, you can write it as a mathematical relationship called the *demand function*. The processed chicken demand function is

$$Q_d = f(Q_{d(t-1)}, P_c, P_s, Y, S_2, S_3, S_4) \tag{2.1}$$

where Q_d is the quantity of chicken demanded per person per quarter, P_c is the price index for chicken, P_s is the price index for other meat, and Y is real final consumption expenditure per person, used as a proxy to represent the income of consumers, as consumption expenditure usually varies with income. This expression says that the amount of chicken demanded varies with the price of chicken, the price of substitutes (other meats), and the income of consumers. In addition, in order to allow for the time taken for tastes to change, the demand for chicken in the preceding period ($Q_{d(t-1)}$) may be included in the demand equation, and because demand is measured per quarter, seasonal variations are also allowed for in the demand equation (S_2, S_3, S_4).

Any other factors that are not explicitly listed in the demand function are assumed to be irrelevant (the price of llamas in Peru) or held constant (the price of fish).

By writing the demand function in this general way, we are not explaining exactly how the quantity demanded varies as P_c, P_s, Y *or* S_2, S_3 or S_4 change. Instead, we can rewrite Equation 2.1 as a specific function:

$$Q_d = 0.192 + 0.412\, Q_{d(t-1)} - 0.013P_c + 0.010P_s + 0.002Y + 0.084S_2 + 0.040S_3 - 0.102S_4 \tag{2.2}$$

Equation 2.2 is the estimated demand function that corresponds to the demand curve D^1 in Figures 2.1 and 2.2.

When we drew the demand curve D^1 in Figures 2.1 and 2.2, we held $Q_{d(t-1)}$, P_s, and Y at their average values during the period studied where t represents the current period and $t - 1$ represents the previous period: $Q_{d(t-1)} = 4$ (kg per capita per quarter), $P_s = 87.2$ (1980–81 dollars per quarter), and $Y = 1313.6$ (1980–81 dollars per quarter) and the three seasonal dummies are given a value of 1.[7] If we substitute these values into Equation 2.2, we can rewrite the quantity demanded as a function of only the price of chicken:

$$Q_d = 0.192 + 0.412\, Q_{d(t-1)} - 0.013P_c + 0.010P_s + 0.002Y + 0.084S_2 + 0.040S_3 - 0.102S_4$$

$$Q_d = 0.192 + (0.412 \times 4) - 0.013P_c + (0.010 \times 87.16) + (0.002 \times 1313.58) + (0.084 \times 1) + (0.040 \times 1) - (0.102 \times 1)$$

$$Q_d = 5.361 - 0.013P_c \tag{2.3}$$

The straight-line demand curve D^1 in Figures 2.1 and 2.2—where we hold the price of other meat, and income, as well as the seasonal dummies, constant at their typical values—is described by the *linear* demand function in Equation 2.3.

The constant term, 5.361,[8] in Equation 2.3 is the quantity demanded if the price is zero. Setting the price equal to zero in Equation 2.3, we find that the quantity demanded is $Q_d = 5.361 - (0.013 \times 0)$ = approximately 5.4 kg per capita per quarter. Figure 2.1 shows that $Q_d = 5.4$ where D^1 hits the quantity axis at a price of zero.

This equation also shows us how quantity demanded changes with a change in price: a movement *along* the demand curve. If the price increases from P_1 to P_2, the change in price, ΔP, equals $P_2 - P_1$. (The Δ symbol, the Greek letter delta, means 'change in' the following variable, so ΔP means 'change in price'.) As Figure 2.1 illustrates, if the price (price index) of chicken increases from $P_1 = 100$ to $P_2 = 200$

$$\Delta P = 100 \text{ and } \Delta Q = Q_2 - Q_1 = 2.8 - 4.1 = -1.3 \text{ kg per person per quarter}$$

More generally, the quantity demanded at P_1 is $Q_1 = D(P_1)$, and the quantity demanded at P_2 is $Q_2 = D(P_2)$. The change in the quantity demanded, $\Delta Q = Q_2 - Q_1$ in response to the price change (using Equation 2.3) is

$$\begin{aligned}\Delta Q &= Q_2 - Q_1\\ &= \Delta(P_{c2}) - \Delta(P_{c1})\\ &= (5.361 - 0.013P_{c2}) - (5.361 - 0.013P_{c1})\\ &= -\,0.013\,(P_{c2} - P_{c1})\\ &= -\,0.013\,\Delta P_c \end{aligned} \tag{2.4}$$

Thus the change in the quantity demanded, ΔQ, is –0.013 times the change in the price, ΔP.

$$\text{If } \Delta P = 100$$
$$\Delta Q = -0.013\,\Delta P = -1.3$$

The slope of a demand curve is $\Delta P/\Delta Q$, the 'rise' (ΔP, the change along the vertical axis) divided by the 'run' (ΔQ, the change along the horizontal axis). The slope of demand curve D^1 in Figures 2.1 and 2.2 is

$$\text{Slope} = \Delta P/\Delta Q = 100/-1.3 = -76.9$$

The negative sign of this slope is consistent with the Law of Demand. The slope says that as the price index rises by 100 the quantity demanded falls by 1.3 kg per person per quarter. Turning that statement around: the quantity demanded falls by 1.3 kg per person per quarter as the price rises by 100.

Thus, we can use the demand curve to answer questions about how a change in price affects the quantity demanded and how a change in the quantity demanded affects price.

Solved Problem 2.1

How much would the price have to fall for consumers to be willing to buy one more kg of chicken per person per quarter?

Answer

1. *Express the price that consumers are willing to pay as a function of quantity*. We use algebra to rewrite the demand function as an *inverse demand function,* where price depends on the quantity demanded. Subtracting Q from both sides of Equation 2.3 and adding $0.013P_c$ to both sides, we find that $0.013P_c = 5.361 - Q$. Dividing both sides of the equation by 0.013, we obtain the inverse demand function:

$$P_c = 412.4 - 76.9Q \qquad (2.5)$$

2. *Use the inverse demand curve to determine how much the price must change for consumers to buy 1 more kg of chicken per person per quarter*. We take the difference between the inverse demand function, Equation 2.5, at the new quantity, $Q_2 + 1$, and at the original quantity, Q_1, to determine how the price must change:

$$\begin{aligned}\Delta P &= (P_2 - P_1)\\ &= (412.4 - 76.9Q_2) - (412.4 - 76.9Q_1)\\ &= -76.9\,(Q_2 - Q_1)\\ &= -76.9\,\Delta Q\end{aligned}$$

The change in quantity is $\Delta Q = Q_2 - Q_1 = (Q_1 + 1) - Q_1 = 1$, so the change in price is $\Delta P = -76.9$. That is, for consumers to demand 1 more kg of chicken per person per quarter, the price index must fall by almost 77 points, which is a *movement along the demand curve*.

Summing Demand Curves

If we know the demand curve for each of two consumers, how do we determine the total demand for the two consumers combined? The total quantity demanded *at a given price* is the sum of the quantity each consumer demands at that price.

We can use the demand functions to determine the total demand of several consumers. Suppose that the demand function for Consumer 1 is

$$Q_1 = D^1(P)$$

and the demand function for Consumer 2 is

$$Q_2 = D^2(P)$$

At price P, Consumer 1 demands Q_1 units, Consumer 2 demands Q_2 units, and the total demand of both consumers is the sum of the quantities each demands separately:

$$Q = Q_1 + Q_2 = D^1(P) + D^2(P)$$

We can generalise this approach to look at the total demand for three or more consumers.

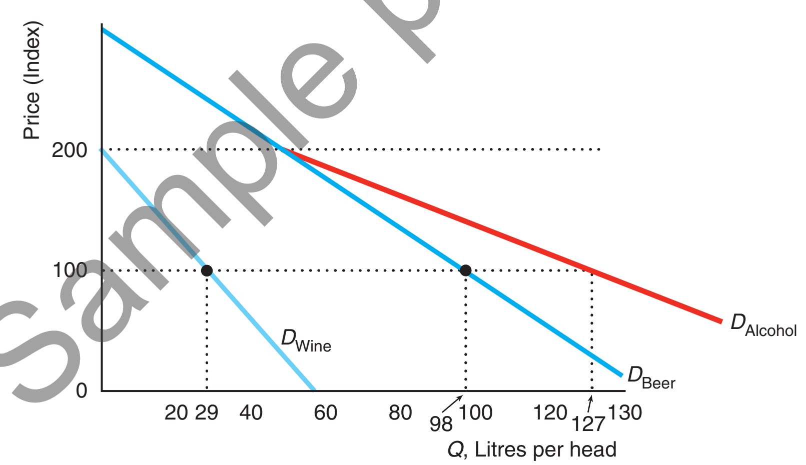
It makes sense to add the quantities demanded only when all consumers face the same price. Adding the quantity Consumer 1 demands at one price to the quantity Consumer 2 demands at another price would be like adding apples and oranges.

APPLICATION

Aggregating the Demand for Alcohol in Australia

We illustrate how to combine individual demand curves to get a total demand curve graphically, using estimated demand curves for various types of alcohol in Australia (excluding spirits). The figure shows a demand curve for beer, a demand curve for wine, and a total demand curve for alcohol (excluding spirits), which is the horizontal sum of the demand curves. Note that we ignore the different alcoholic content of beer and wine.

When the retail price index is 100 for each type of alcohol, the figure shows that the amount of beer demanded annually per capita in litres is approximately 98 and the amount of wine demanded annually per capita in litres is around 29. Thus, a total of approximately 127 litres of alcohol is demanded per person. Similar aggregation of the quantity demanded for different price levels enables the aggregate demand curve to be identified.



2.2 Supply

Knowing how much consumers want is not enough, by itself, to tell us what price and quantity are observed in a market. To determine the market price and quantity, we also need to know how much firms want to supply at any given price.

Firms determine how much of a good to supply on the basis of the price of that good and other factors, including the costs of production and government rules and regulations. Usually, we expect firms to supply more at a higher price. Before concentrating on the role of price in determining supply, we'll briefly describe the role of some of the other factors.

Costs of production affect how much firms want to sell of a good. As a firm's cost falls, it is willing to supply more, all else the same. If the firm's cost exceeds what it can earn from selling the good, the firm sells nothing. Thus, factors that affect costs, also affect supply. A technological advance that allows a firm to produce a good at lower cost leads the firm to supply more of that good, all else the same.

Government rules and regulations affect how much firms want to sell or are allowed to sell. Taxes and many government regulations—such as those covering pollution, sanitation and health insurance—alter the costs of production. Other regulations affect when and how the product can be sold. In Australia, for example, most stores are not allowed to trade on Good Friday, and hotels may not open until after noon on Anzac Day. In Germany, retailers may not sell most goods and services on Sundays or during evening hours. In the United States, the sale of cigarettes and liquor to children is prohibited. New York, San Francisco and many other cities (including cities in Australia) restrict the number of taxis operating.

The Supply Curve

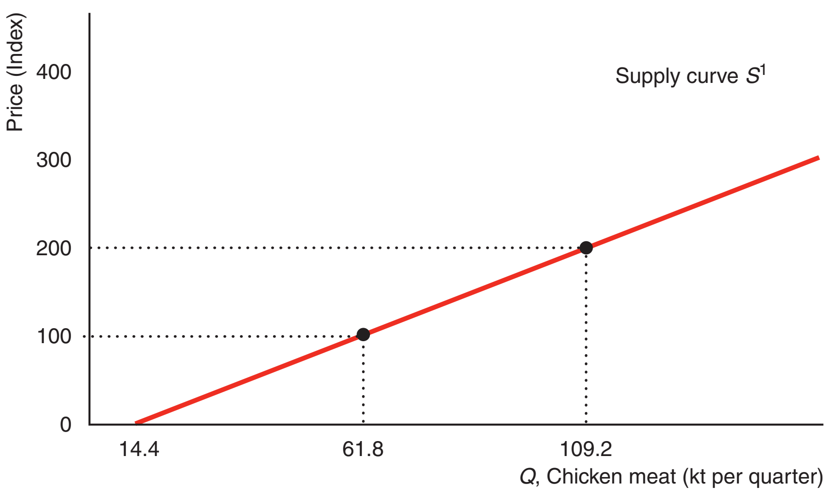
quantity supplied
the amount of a good that firms *want* to sell at a given price, holding constant other factors that influence firms' supply decisions, such as costs and government actions

supply curve
the *quantity supplied* at each possible price, holding constant the other factors that influence firms' supply decisions

The **quantity supplied** is the amount of a good that firms *want* to sell at a given price, holding constant other factors that influence firms' supply decisions, such as costs and government actions. We can show graphically the relationship between price and the quantity supplied. A **supply curve** shows the quantity supplied at each possible price, holding constant the other factors that influence firms' supply decisions. Figure 2.3 shows the estimated supply curve, S^1, for processed chicken (Bhati 1987). As with the demand curve, the price (price index) on the vertical axis is measured in 1980–81 dollars and the quantity on the horizontal axis is measured in physical units per time period (kilotonnes [thousand tonnes – kt] per quarter). Because we hold fixed other variables that may affect the supply, such as costs and government rules, the supply curve concisely answers the question, 'What happens to the quantity supplied as the price changes, holding all other factors constant?'

Figure 2.3 A Supply Curve

The estimated supply curve, S^1, for chicken in Australia (Bhati 1987) shows the relationship between the quantity supplied per quarter and the price index (based on price per kg), holding cost and other factors that influence supply constant. The upward slope of this supply curve indicates that firms supply more of this good when its price is high and less when the price is low. An increase in the price of chicken causes a movement *along the supply curve*, resulting in a larger quantity of chicken being supplied.



Effect of Price on Supply. We illustrate how price affects the quantity supplied using the supply curve for processed chicken in Figure 2.3. The supply curve for chicken is upward sloping. As the price index for chicken increases, firms supply more. If the price index is 100, firms supply a quantity of 61.8 kt per quarter. If the price index rises to 200, the quantity supplied rises to 109.2 An increase in the price index for chicken causes a *movement along the supply curve*, resulting in more chicken being supplied.

Although the Law of Demand requires that the demand curve slope downward, there is *no* 'Law of Supply' that requires the market supply curve to have a particular slope. The market supply curve can be upward sloping, vertical, horizontal or downward sloping. Many supply curves slope upward, such as the one for chicken. Along such supply curves, the higher the price, the more firms are willing to sell, holding costs and government regulations fixed.

Effects of Other Variables on Supply. A change in a variable other than the price of chicken causes the entire *supply curve to shift*. Suppose the price of feed, represented by an index, P_f—an important input used to produce chicken—increases from 94 (its mean value) to 200. Because it is now more expensive to produce chicken, the supply curve shifts to the left, from S^1 to S^2 in Figure 2.4.[9] Firms want to supply less chicken at any given price than before the price of feed rose. At a price of 100, the quantity supplied falls to 27.9 kt, rather than 61.8 kt.

Again, it is important to distinguish between a *movement along a supply curve* and a *shift of the supply curve*. When the price of chicken changes, the change in the quantity supplied reflects a *movement along the supply curve*. When costs, government rules, or other variables that affect supply change, the entire *supply curve shifts*.

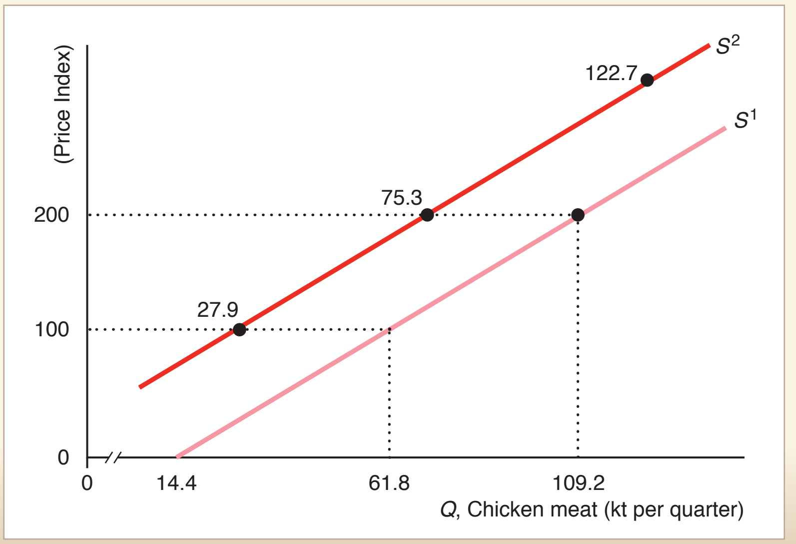
The Supply Function

We can write the relationship between the quantity supplied and price and other factors as a mathematical relationship called the *supply function*. Written generally, the chicken supply function is

$$Q_s = S(Q_{s(t-1)}, P_c, P_f, T, S_i) \tag{2.6}$$

Figure 2.4 A Shift of a Supply Curve

An increase in the price index for feed—an input into the production of chicken—from its mean of 94 to 200 causes the supply curve for chicken to shift from S^1 to S^2. When the price of feed rises from 94 to 200, the quantity of chicken supplied falls from 61.8 kt on S^1 to 27.9 kt on S^2 when P_c is 100.



where Q is the quantity of chicken supplied per quarter, Q_{t-1} is the quantity supplied in the previous quarter, P_c is the price of chicken, P_f is the price of feed, T is time and $S_1 - S_3$ are the seasonal dummies. The supply function, Equation 2.6, may also be a function of other factors such as wages, but by leaving them out, we are implicitly holding them constant.

Based on Bhati (1987), the linear chicken supply function in Australia is

$$Q_s = -38.038 + 0.833Q_{s(t-1)} + 0.474P_c - 0.320P_f + 0.944T - 0.005T^2 + 4.029S_1 + 2.355S_2 + 2.634S_3 \tag{2.7}$$

where quantity is in kilotonnes (kt) per quarter and the prices are expressed as an index (base 1980–81). If we hold the factors affecting supply constant at their mean values, we can rewrite the supply function in Equation 2.6 as[10]

$$Q_s = 14.401 + 0.474P_c \tag{2.8}$$

What happens to the quantity supplied if the price of chicken increases by $\Delta P = P_2 - P_1$? Using the same approach as before, we learn from Equation 2.8 that $\Delta Q = 0.474P$.[11] An increase in the price index of $\Delta P = 100$ causes the quantity supplied to increase by $\Delta Q = 47.4$ kt per quarter. This change in the quantity of chicken supplied as P_c increases is a *movement along the supply curve*.

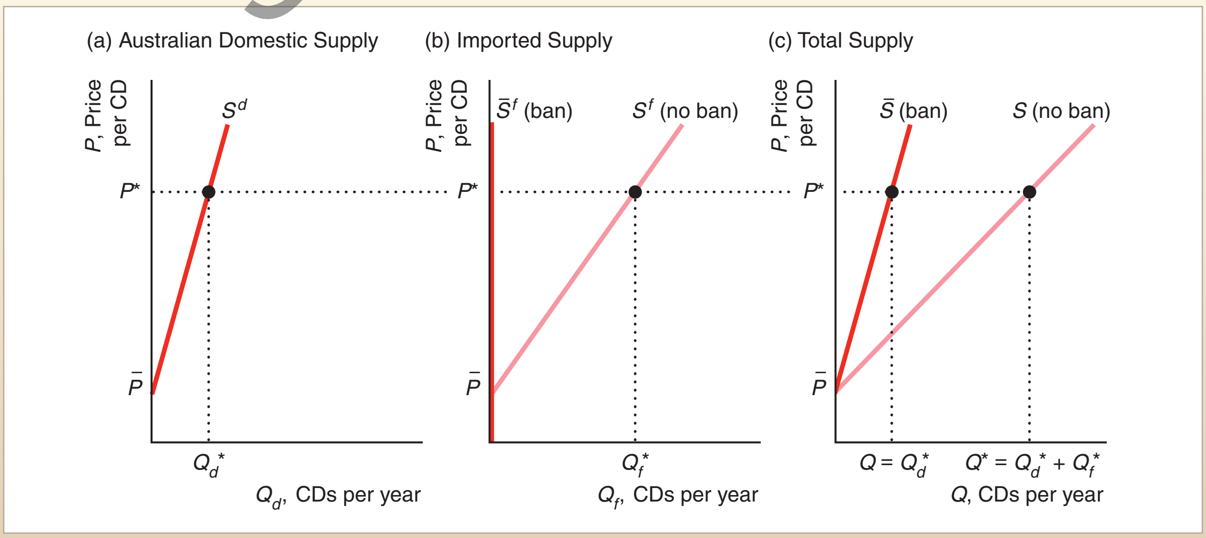
Summing Supply Curves

The total supply curve shows the total quantity produced by all suppliers at each possible price. For example, the total supply of CDs in Australia is the sum of the domestic and foreign supply curves of CDs.

Suppose that the domestic supply curve (panel a) and foreign supply curve (panel b) for CDs in Australia are as Figure 2.5 shows. The total supply curve, S in panel c, is the horizontal sum of the Australian *domestic* supply curve, S^d, and

Figure 2.5 Total Supply: The Sum of Domestic and Foreign Supply

If foreigners may sell their CDs in Australia, the total Australian supply for CDs, S, is the horizontal sum of the domestic Australian supply, S^d, and the imported foreign supply, S^f. With a ban on foreign imports, the foreign supply curve, $\underline{S}^f$ is zero at every price, so the total supply curve, $\underline{S}$ is the same as the domestic supply curve, S^d.



the *foreign* supply curve, S^f. In the figure, the Australian domestic and foreign supplies are zero at any price equal to or less than $\overline{P}$, so the total supply is zero. At prices above $\overline{P}$, the Australian domestic and foreign supplies are positive, so the total supply is positive. For example, when price is P^*, the quantity supplied by Australian firms is Q_d^* (panel a), the quantity supplied by foreign firms is Q_f^* (panel b), and the total quantity supplied is $Q^* = Q_d^* + Q_f^*$(panel c). Because the total supply curve is the horizontal sum of the domestic and foreign supply curves, the total supply curve is flatter than either of the other two supply curves.

Effects of Government Import Policies on Supply Curves

We can use this approach for deriving the total supply curve to analyse the effect of government policies on the total supply curve. Until about 1998, the Australian government banned the importation of CDs (the bans were referred to as parallel import restrictions, meaning that even copyright-compliant CDs could not be imported into Australia). We want to determine how much less is supplied at any given price to the Australian market because of this ban.

Without a ban, the foreign supply curve is S^f in panel b of Figure 2.5. A ban on imports eliminates the foreign supply, so the foreign supply curve after the ban is imposed, $\overline{S}^f$, is a vertical line at $Q_f = 0$. The import ban has no effect on the domestic supply curve, S^d, so the supply curve is the same as in panel a.

Because the foreign supply with a ban, $\overline{S}^f$, is zero at every price, the total supply with a ban, $\overline{S}$, in panel c is the same as the Australian domestic supply, S^d, at any given price. The total supply curve under the ban lies to the left of the total supply curve without a ban, S. Thus the effect of the import ban is to rotate the total supply curve toward the vertical axis.

quota
the limit that a government sets on the quantity of a foreign-produced good that may be imported

The limit that a government sets on the quantity of a foreign-produced good that may be imported is called a **quota**. By absolutely banning the importation of CDs, the Australian government set a quota of zero on CD imports. Sometimes governments set positive quotas, $\overline{Q} > 0$. The foreign firms may supply as much as they want, Q_f, as long as they supply no more than the quota: $Q_f \le \overline{Q}$.

We investigate the effect of such a quota in Solved Problem 2.2. In most of the solved problems in this book, you are asked to determine how a *change* in a variable or policy *affects* one or more variables. In this problem, the policy *changes* from no quota to a quota, which *affects* the total supply curve.

Solved Problem 2.2

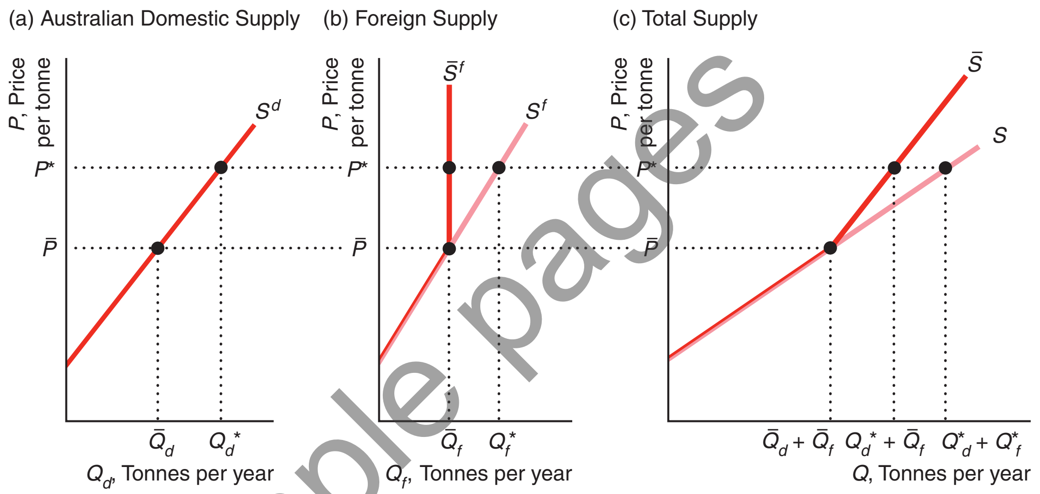
How does a quota set by the Australian government on imported salmon of $\overline{Q}_f$ affect the total Australian supply curve for salmon given the domestic supply, S^d in panel a of the graph, and foreign supply, $\overline{S}^f$ in panel b?

Answer

1. Determine the Australian supply curve without the quota. The *no-quota* total supply curve, S in panel *c*, is the horizontal sum of the Australian domestic supply curve, S^d, and the no-quota import supply curve, S^f.

2. Show the effect of the quota on import supply. At prices less than $\overline{P}$ foreign suppliers want to supply quantities less than the quota, $\overline{Q}$. As a result, the import supply curve under the quota, $\overline{S}^f$, is the same as the no-quota foreign supply curve, S^f, for prices less than $\overline{P}$. At prices above $\overline{P}$, foreign suppliers want to supply more but are limited to $\overline{Q}$. Thus the import supply curve with a quota, $\overline{S}^f$, is vertical at $\overline{Q}$ for prices above $\overline{P}$.

3. Determine the Australian total supply curve with the quota. The total supply curve with the quota, $\overline{S}$, is the horizontal sum of S^d and $\overline{S}^f$. At any price above $\overline{P}$, the total supply equals the quota plus the domestic supply. For example at P^*, the domestic supply is Q_d^* and the foreign supply is $\overline{Q}_f$, so the total supply is $Q_d^* + \overline{Q}_f$. Above $\overline{P}$, $\overline{S}$ is the domestic supply curve shifted $\overline{Q}_f$ units to the right. As a result, the portion of $\overline{S}$ above $\overline{P}$ has the same slope as S^d.
4. Compare the Australian total supply curves with and without the quota. At prices less than or equal to $\overline{P}$, the same quantity is supplied with and without the quota, so $\overline{S}$ is the same as S. At prices above $\overline{P}$, less is supplied with the quota than without one, so $\overline{S}$ is steeper than S, indicating that a given increase in price raises the quantity supplied by less with a quota than without one.



Salmon supply in Australia

2.3 Market Equilibrium

The supply and demand curves determine the price and quantity at which goods and services are bought and sold. The demand curve shows the quantities consumers want to buy at various prices, and the supply curve shows the quantities firms want to sell at various prices. Unless the price is set so that consumers want to buy exactly the same amount that suppliers want to sell, either some buyers cannot buy as much as they want or some sellers cannot sell as much as they want.

equilibrium
a situation in which no one wants to change their behaviour

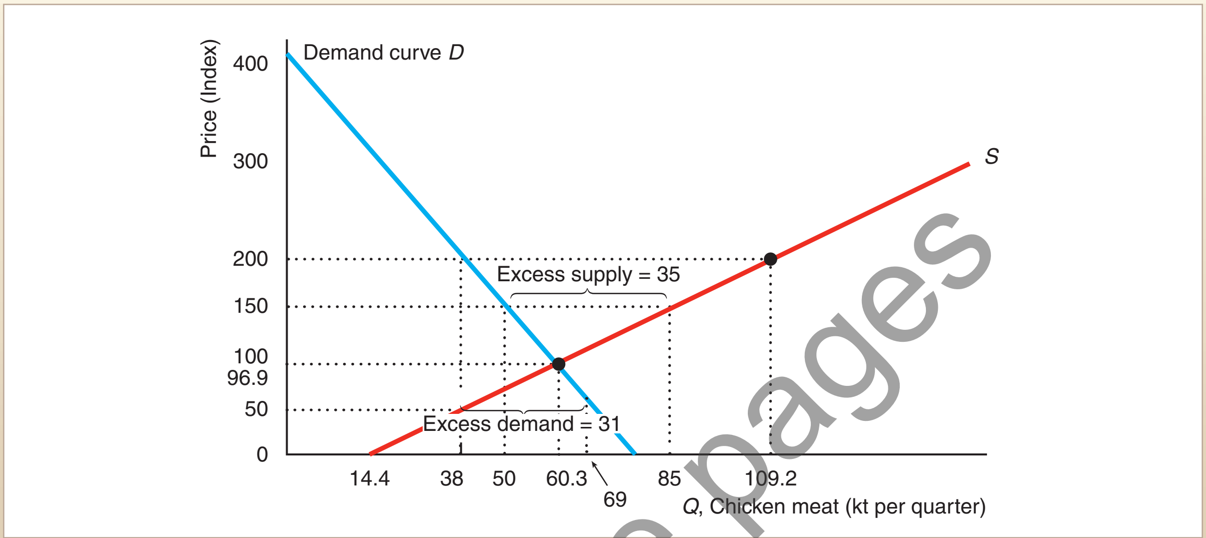
When all traders are able to buy or sell as much as they want, we say that the market is in **equilibrium**: a situation in which no participant wants to change its behaviour. A price at which consumers can buy as much as they want and sellers can sell as much as they want is called an *equilibrium price*. The quantity that is bought and sold at the equilibrium price is called the *equilibrium quantity*.

Using a Graph to Determine the Equilibrium

To illustrate how supply and demand curves determine the equilibrium price and quantity, we use the chicken example.[12] Figure 2.6 shows the supply, *S*, and demand, *D*, curves for chicken. The supply and demand curves intersect at point *e*, the market equilibrium, where the equilibrium price index value is approximately 96.9

Figure 2.6 Market Equilibrium

The intersection of the supply curve, S, and the demand curve, D, for chicken determines the market equilibrium point, e, where $P_c = 96.9$ and $Q = 60.3$ kt per quarter. At the lower price of $P_c = 50$, the quantity supplied is approximately 38.1 kt, whereas the quantity demanded is approximately 69.3 kt, so there is excess demand of approximately 31 kt. At $P_c = 150$, a price higher than the equilibrium price, there is excess supply of approximately 35 kt because the quantity demanded, 50 kt, is less than the quantity supplied, 85.5 kt. When there is excess demand or supply, market forces drive the price back to the equilibrium price of 96.9.



and the equilibrium quantity is approximately 60.3 kt per quarter, which is the quantity firms want to sell *and* the quantity consumers want to buy.

Using Maths to Determine the Equilibrium

We can determine the chicken market equilibrium mathematically, using the supply and demand functions. We use these two functions to solve for the equilibrium price at which the quantity demanded equals the quantity supplied (the equilibrium quantity).

The demand function, Equation 2.3, shows the relationship between the quantity demanded per capita, Q_d, and the price:

$$Q_d = 5.361 - 0.013P_c$$

The supply function, Equation 2.8, tells us the relationship between the aggregate quantity supplied, Q_s, and the price:

$$Q_s = 14.401 + 0.474P_c$$

As noted above, the demand equation needs to be multiplied by the mean population of 14 714 754 in order to compare it with aggregate supply. Thus

$$Q_d = 78.886 - 0.191P_c$$

We want to find the P at which $Q_d = Q_s = Q$, the equilibrium quantity. Because the left sides of the two equations are equal in equilibrium, $Q_s = Q_d$, the right sides of the two equations must be equal:

$$78.886 - 0.191P_c = 14.401 + 0.474P_c$$

Adding $0.191P_c$ to both sides of this expression and subtracting 14.401 from both sides, we find that $0.665P_c = 64.481$. Dividing both sides of this last expression by 0.665, we learn that the equilibrium price is $P_c = 96.920$. We can determine the equilibrium quantity by substituting this P_c into either the supply or the demand equation:

$$Q_d = Q_s$$
$$Q_e = 14.401 + 0.474 \times 96.92$$
$$\simeq 60.3 \text{ (with rounding)}$$

Thus the equilibrium quantity is 60.3 kt.

Forces that Drive the Market to Equilibrium

A market equilibrium is not just an abstract concept or a theoretical possibility. We can observe markets in equilibrium. Indirect evidence that a market is in equilibrium is that you can buy as much as you want of the good at the market price. You can almost always buy as much as you want of such common goods as milk and ballpoint pens.

Amazingly, a market equilibrium occurs without any explicit coordination between consumers and firms. In a competitive market such as that for many agricultural goods, millions of consumers and thousands of firms make their buying and selling decisions independently. Yet each firm can sell as much as it wants; each consumer can buy as much as he or she wants. It is as though an unseen market force, like an *invisible hand*, directs people to coordinate their activities to achieve a market equilibrium.

What really causes the market to move to an equilibrium? If the price is not at the equilibrium level, consumers or firms have an incentive to change their behaviour in a way that will drive the price to the equilibrium level, as we now illustrate.

If the price were initially lower than the equilibrium price, consumers would want to buy more than suppliers want to sell. If the price index for chicken is 50 in Figure 2.6, firms are willing to supply 38.1 kt per quarter but consumers demand 69.3 kt. At this price, the market is in *disequilibrium*, meaning that the quantity demanded is not equal to the quantity supplied. There is **excess demand**—the amount by which the quantity demanded exceeds the quantity supplied at a specified price—of approximately 31 (= 69.3 − 38.1) kt per quarter at a price index of 50.

excess demand
the amount by which the *quantity demanded* exceeds the *quantity supplied* at a specified price

Some consumers are lucky enough to buy chicken at 50. Other consumers cannot find anyone who is willing to sell them chicken at that price. What can they do? Some frustrated consumers may offer to pay suppliers more than 50. Alternatively, suppliers, noticing these disappointed consumers, may raise their prices. Such actions by consumers and producers cause the market price to rise. As the price rises, the quantity that firms want to supply increases and the quantity that consumers want to buy decreases. This upward pressure on price continues until it reaches the equilibrium price index value, 96.9, where there is no excess demand.

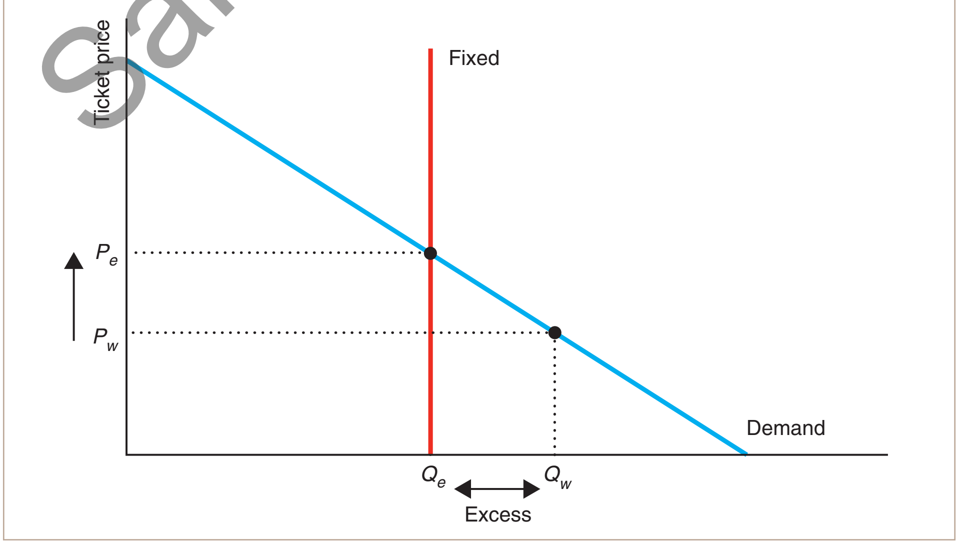
If, instead, the price is initially above the equilibrium level, suppliers want to sell more than consumers want to buy. For example, if the price index for chicken is 150, suppliers want to sell 85.5 kt per quarter but consumers want to buy only 50.2 kt, as Figure 2.6 shows. At 150, the market is in disequilibrium. There is an **excess supply**—the amount by which the quantity supplied is greater than the quantity demanded at a specified price of 35.3 (= 85.5 − 50.2) at a price index value of 150. Not all firms can sell as much as they want. Rather than incur storage costs (and possibly have their unsold chicken spoil), firms lower the price to attract

excess supply
the amount by which the *quantity supplied* is greater than the *quantity demanded* at a specified price

additional customers. As long as the price remains above the equilibrium price, some firms have unsold chicken and want to lower the price further. The price falls until it reaches the equilibrium level, 96.9, where there is no excess supply and hence no more pressure to lower the price further.

Ticket Scalping. The supply of tickets for popular events such as concerts and football finals is often insufficient to satisfy demand. This imbalance provides the incentive for the unauthorised on-sale of tickets at a substantial mark-up: this is sometimes referred to as 'ticket scalping'. Although scalping is not outlawed, there is legislation in some states and territories that prohibits scalping in relation to specific events. In a report on ticket on-selling, the Commonwealth Consumer Affairs Advisory Council (2010) concluded that this practice 'does not cause significant consumer detriment' (p. v).

Assume a single event, such as a concert or a football game, which will be held at a venue with fixed capacity. While the demand curve for tickets for the event is downward sloping, the supply of tickets is fixed by the capacity of the venue. If those staging the event have sufficient information about the value potential purchasers will place on the tickets, the price of the tickets will be set at P_e and the quantity of tickets demanded will equal the quantity supplied. However, information about demand may be imperfect and for various reasons prices may be set conservatively (for example, to stimulate interstate demand or because attendees can be charged relatively high prices for programs, refreshments and the like, a fact which first time attendees may not know and which regular attendees may discount as being small in relation to the ticket price). The result will be excess demand of $Q_w - Q_e$ when tickets are sold for P_w, as shown in the diagram below. Especially when tickets are sold on a 'first-come-first-served' basis, potential buyers who value the tickets in excess of the offer price may not acquire tickets—a situation which from an economic perspective is inefficient, as we shall discuss in Chapter 6. However, if some people who have obtained tickets decide to on-sell them because other people are prepared to pay them more for the tickets than their original purchase price, this helps to overcome the disequilibrium resulting from the original underpricing.



Source: Adapted from Commonwealth Consumer Affairs Advisory Council, *Consumers and the Ticket Market: Ticket Onselling in the Australian Market*, Final Report, November 2010, figure 4, p. 86, http://archive.treasury.gov.au/documents/1914/PDF/Ticket_scalping_report.pdf

In summary, at any price other than the equilibrium price, either consumers or suppliers are unable to trade as much as they want. These disappointed people act to change the price, driving the price to the equilibrium level. The equilibrium price is called the *market clearing price* because it removes from the market all frustrated buyers and sellers: there is no excess demand or excess supply at the equilibrium price.

2.4 Shocking the Equilibrium

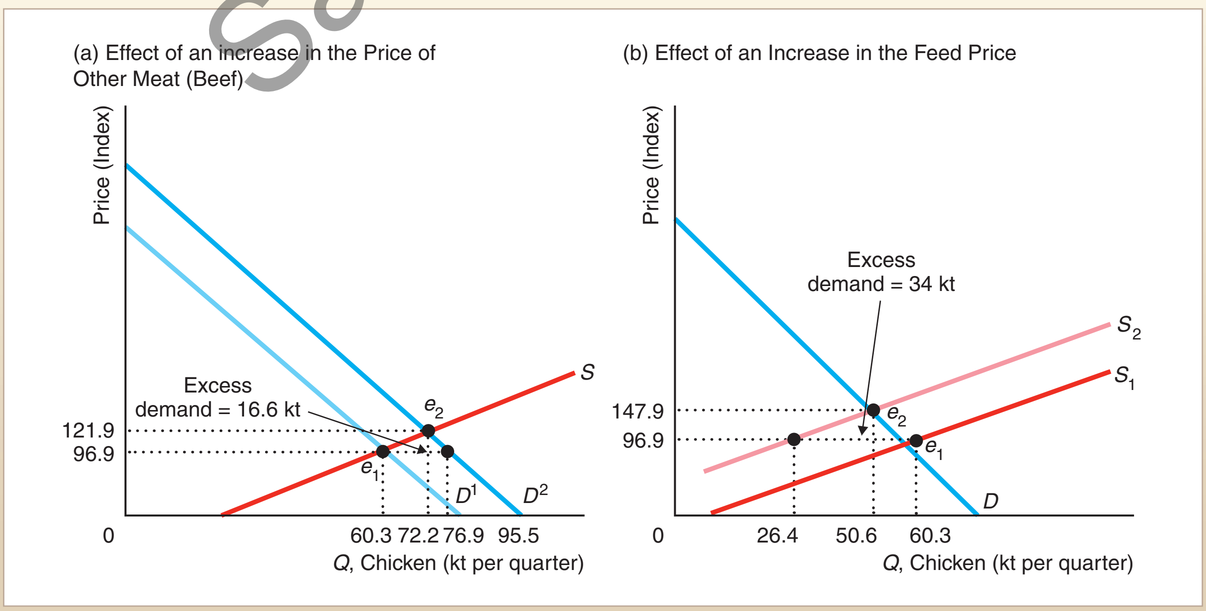
Once an equilibrium is achieved, it can persist indefinitely because no one applies pressure to change the price. *The equilibrium changes only if a shock occurs that shifts the demand curve or the supply curve. These curves shift if one of the variables we were holding constant changes.* If tastes, income, government policies, or the cost of production change, the demand curve or the supply curve or both shift, and the equilibrium changes.

Effects of a Shift in the Demand Curve

Suppose that the price index for other meat (beef) increases from its mean value of 87.2 to 200, and so consumers substitute chicken for beef. As a result, the demand curve for chicken shifts outward from D^1 to D^2 in panel a of Figure 2.7. At any given price, consumers want more chicken than they did before the price of beef rose. In particular, at the original equilibrium price index value of 96.9, chicken

Figure 2.7 Equilibrium Effects of a Shift of a Demand or Supply Curve

(a) An increase in the price index for other meat (beef) from 87.2 to 200 causes the demand curve for chicken to shift outward from D^1 to D^2. At the original equilibrium, e_1, with a price index value of approximately 96.9, there is excess demand of 16.6 kt. Market pressures drive the price index up until it reaches 121.9 at the new equilibrium, e_2.
(b) An increase in the price of feed causes the supply curve for chicken to shift to the left from S^1 to S^2, driving the market equilibrium from e_1 to e_2.



consumers now want to buy approximately 76.9 kt of chicken per quarter. At that price, however, suppliers still want to sell only 60.3 kt. As a result, there is excess demand of approximately 16.6 kt. Market pressures drive the price up until it reaches a new equilibrium at approximately 121.9. At that price, firms want to sell 72.2 kt and consumers want to buy 72.2 kt, the new equilibrium quantity. Thus the equilibrium goes from e_1 to e_2 as a result of the increase in the price of other meat (beef). Both the equilibrium price and the equilibrium quantity of chicken rise as a result of the outward shift of the chicken demand curve. Here the increase in the price of other meat (beef) causes a *shift of the demand curve*, causing a *movement along the supply curve*.

Effects of a Shift in the Supply Curve

Now suppose that the price of other meat (beef) stays constant at its original level but the price index for feed increases from its mean of 94.0 to 200. It is now more expensive to produce chicken because the price of a major input, feed, has increased. As a result, the supply curve for chicken shifts to the left from S^1 to S^2 in panel b of Figure 2.7. At any given price, firms want to supply less chicken than they did before the price of feed increased. At the original equilibrium price index for chicken of 96.9, consumers still want 60.3 kt, but suppliers are now willing to supply only 26.4 kt, so there is excess demand of 33.9 kt. Market pressure forces the price of chicken up until it reaches a new equilibrium at e_2, where the equilibrium price index value is approximately 147.9 and the equilibrium quantity is 50.6 kt. The increase in the feed price causes the equilibrium price to rise but the equilibrium quantity to fall. Here a *shift of the supply curve* results in a *movement along the demand curve*.

In summary, a change in an underlying factor, such as the price of a substitute or the price of an input, shifts the demand or supply curve. As a result of a shift in either the demand curve or the supply curve, the equilibrium changes. To describe the effect of this change in the underlying factor on the market, we compare the original equilibrium price and quantity to the new equilibrium values.

Solved Problem 2.3

Mathematically, how does the equilibrium price of chicken vary as the price of feed changes if the variables that affect demand are held constant at their typical values?

Answer

1. Solve for the equilibrium price of chicken in terms of the price of feed. The demand function does not depend on the price of feed, so we can use the equivalent of Equation 2.3 from before but converted into aggregate demand,

$$Q_d = 78.886 - 0.191P_c$$

To see how the equilibrium depends on the price of feed, we use supply function Equation 2.7:

$$Q_s = -38.038 + 48.397 + 0.474P_c - 0.320P_f + 30.208 - 5.120 + 4.029 + 2.355 + 2.634$$

The equilibrium is determined by equating the right sides of these demand-and-supply equations:

$$78.886 - 0.191P_c = 44.466 + 0.474P_c - 0.320P_f$$

Rearranging terms in this last expression, we find that $0.665P_c = 34.416 + 0.320P_f$. Dividing both sides by 0.665, we have an expression for the equilibrium price of chicken as a function of the price of feed:

$$P_c = 51.753 + 0.481P_f \tag{2.9}$$

(As a check, when P_f equals its typical value, 93.95, Equation 2.9 states that the equilibrium price of chicken is $P_c = 96.9$ (approximately), which we know is correct from our earlier calculations.)

We find the equilibrium quantity as a function of the price of feed by substituting this expression for the equilibrium price, Equation 2.9, into the demand equation (though we could use the supply function instead):

$$Q_d = 78.882 - 0.191(51.753 + 0.471 \times 93.95)$$

(Again, as a check, if P_f equals its typical value of 93.95, $Q = 60.3$, which we know is the original equilibrium quantity.)

2. Show how the equilibrium price of chicken varies with the price of feed. We know from Equation 2.9 that $\Delta P = \Delta P_f$. Any increase in the price of feed causes an increase in the price of chicken. As panel b of Figure 2.7 illustrates, if the price of feed increases by $\Delta P_f = 106$ (from 94 to 200), the price of chicken, P_c, increases by $\Delta P_c = \Delta P_f = 51$ $(0.481\ \Delta P_f)$, from 96.9 to 147.9.

Effects of a Shift in the Supply and Demand Curves

Some events cause both the supply curve and the demand curve to shift. If both shift, then the qualitative effect on the equilibrium price and quantity may be difficult to predict, even if we know the direction in which each curve shifts. Changes in the equilibrium price and quantity depend on exactly how the curves shift—see the following application and solved problem and the related questions at the end of the chapter.

APPLICATION

Mad Cow: Shifting Supply and Demand Curves

Government announcements that the fatal disease known as mad cow (bovine spongiform encephalopathy, or BSE) has been found in a country's cattle affects both supply and demand curves. Humans who consume beef products made from diseased animal parts can develop the new variant Creutzfeldt-Jakob disease, a deadly affliction that slowly eats holes in sufferers' brains. Mad cow disease can take years to develop in cattle, and symptoms in its human version may not appear for decades. Consequently, identifying the presence of the disease has been difficult.

In 1986, the British government disclosed a case of mad cow disease, but initially asserted that humans were not at risk from eating infected beef. Since then, 180 000 cases of mad cow have been reported in the United Kingdom. Not until 1996 did the British government announce that people were falling victim to a degenerative new brain disease linked to BSE. Following this announcement and similar reports in France, Italy and Germany, many British and other European consumers stopped buying beef, causing the beef demand curves in European countries to shift to the left. Over time, many cattle were removed from the food chain as European beef producers reduced their herds, so