Chapter 3
Elasticity of Demand and Supply

What's in It for You?

In the previous chapter, you've learned the law of demand: a higher price will lead to a lower quantity demanded. But how much lower? Similarly, the law of supply states that a higher price causes quantity supplied to increase. By how much? To answer these questions, we need to understand and be able to apply the concept of **elasticity**, which economists use to measure the degree of *responsiveness*, or sensitivity, of one variable to a change in another. Consider the following situations:

- You are a pricing manager at Apple Inc. Your boss asks you to predict what will happen to Apple's receipts from iTunes downloads if it raises the price. What should you tell your boss?
- As the vice president for business and finance at a private college, you are trying to figure out if raising the tuition will increase the college's revenue. Will it?
- You are a soybean farmer. Unfavorable weather decreases soybean production everywhere. Should you prepare to tighten your belt?
- You are running an oil refinery, which uses crude oil to produce gasoline and other petroleum products, so the price of crude oil is a crucial factor influencing your production decisions. Suddenly, a crisis in the Middle East disrupts oil production in the region. How will that influence the price your refinery pays for crude oil?
- You are the manager of a Walmart store. Due to an increase in the federal minimum wage, the average income of your customers rises by 5%. How should you adjust your purchases of goods from suppliers?
- You are an economist at Dell. Hewlett Packard lowers the price of their laptops by 10%. Your boss wants to know how this will affect the sales of Dell laptops with similar characteristics. How can you figure it out?

We can continue this list of questions to include many other situations in which knowing and being able to apply the concept of elasticity helps make better business decisions. In this chapter we explain how.

Learning Objectives

At completion of this learning module you are expected to be able to:

- Define and explain the concepts of price elasticity of demand, income elasticity of demand, cross-price elasticity of demand, and price elasticity of supply.
- Calculate the elasticities mentioned above given the corresponding price and quantity changes.
- Predict changes in quantities demanded and supplied given the corresponding changes in prices or income and relevant elasticities; predict changes in prices given the corresponding changes in quantities and relevant elasticities.
- Predict the effect of a change in price on the firm's total revenue given the price elasticity of demand for its product.

3.1 Price Elasticity of Demand

The price elasticity of demand tells us how sensitive the quantity demanded is to a change in price. Two things are important to keep in mind when defining and measuring price elasticity of demand:

1. Compare *percentage* changes, not absolute changes, in price and quantity.
2. Hold constant all other variables that influence consumers' decisions.

The **price elasticity of demand** for a good is the percentage change in the quantity of the good demanded in response to a one percent change in its price. Or, mathematically:

$$E_D = \frac{\%\Delta Q_D}{\%\Delta P} \tag{1}$$

where E_D is the price elasticity of demand, $\%\Delta Q_D$ is the percentage change in quantity demanded, and $\%\Delta P$ is the percentage change in price.

Note that according to the formula above, if $\%\Delta P = 1\%$, $E_D = \%\Delta Q_D$, which is what the definition says.

To illustrate the concept of price elasticity of demand, let's consider the demand curve for oranges shown in Figure 1. Since we must hold constant all influences on consumer choices other than price, we measure changes in price and quantity along the same demand curve. In the figure, along the demand curve D, when the price of oranges rises by 25% ($\%\Delta P = 25\%$), from P_1 to P_2, the quantity of oranges demanded decreases by 50% ($\%\Delta Q = -50\%$). Thus, the price elasticity of demand for oranges is:

$$E_D = \frac{-50\%}{25\%} = -2$$

This number tells us that for each 1% rise in price, the quantity of oranges demanded decreases by 2%.

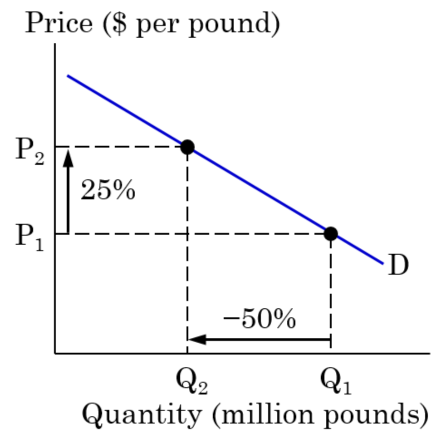


Figure 1 Elasticity of demand for oranges

Recall that according to the law of demand, the relationship between price and quantity demanded is negative: when the price rises, the quantity demanded decreases and when the price falls, the quantity demanded increases. This means the price elasticity of demand is always a negative number. The sensitivity of quantity demanded to a change in price, however, is measured by the magnitude of the elasticity number regardless of its sign: the greater the *absolute value* elasticity, the more price sensitive—i.e. more elastic—the demand is. Therefore, when comparing price elasticities of demand, we should ignore the minus signs and look only at the absolute values. For example, if the price elasticity of demand for grapefruits is −3, then the demand for grapefruits is more elastic than the demand for oranges because $|-3| = 3$, $|-2| = 2$, and $3 > 2$. In general:

The greater the *absolute value* of the elasticity number, the more elastic the demand is.

Given that the magnitude of elasticity is what matters, we will always refer to its absolute value ($|E_D|$) when interpreting and comparing price elasticities of demand.

Checkpoint 1

Which of the following statements about the price elasticity of demand are true and which are false? Explain.

A. It is the same as the slope of the demand curve.

B. It shows the percentage change in quantity demanded caused by a 1 percent change in price.

C. It is a negative number, but what matters when comparing elasticities is its absolute value.

D. It is the sensitivity of price to changes in demand.

Check your answer

Calculating Price Elasticity of Demand

As follows from our discussion above, to calculate elasticity, we need to know the percentage changes in price and quantity. Let's continue our example of demand for oranges to see how to calculate those percentage changes. Figure 2 shows the numbers for the prices and quantities at points A and C on the demand curve D. To calculate the percentage change in price between points A and C, we use the following formula:

$$\%\Delta P = \frac{P_2 - P_1}{P_{AV}} = \frac{\Delta P}{P_{AV}}$$

where P_{AV} is the average of P_1 and P_2:

$$P_{AV} = \frac{P_1 + P_2}{2}$$

This formula, called the *midpoint formula*, is the preferred way to calculate percentage changes when measuring elasticities. In our example:

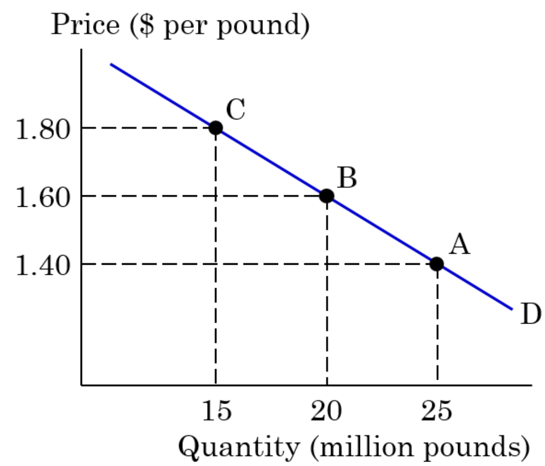


Figure 2 Calculating the elasticity of demand for oranges

$$P_{AV} = \frac{\$1.40 + \$1.80}{2} = \$1.60$$

so the percentage change in price is:

$$\%\Delta P = \frac{\$1.80 - \$1.40}{\$1.60} = \frac{\$0.40}{\$1.60} = 0.25 \text{ or } 25\%$$

Similarly, to calculate the percentage change in quantity, we use the formula:

$$\%\Delta Q = \frac{Q_2 - Q_1}{Q_{AV}} = \frac{\Delta Q}{Q_{AV}}$$

where Q_{AV} is the average of Q_1 and Q_2:

$$Q_{AV} = \frac{Q_1 + Q_2}{2}$$

In our example:

$$Q_{AV} = \frac{25 + 15}{2} = 20$$

so the percentage change in quantity is:

$$\%\Delta Q = \frac{15 - 25}{20} = \frac{-10}{20} = -0.5 \text{ or } -50\%$$

Plugging these numbers into the elasticity formula, we get:

$$E_D = \frac{50\%}{25\%} = -2$$

the same result as we calculated above.

Another way to calculate elasticities and see the underlying relationships is to rewrite the elasticity formula as follows:

$$E_D = \frac{\%\Delta Q_D}{\%\Delta P} = \frac{\Delta Q_D}{Q_{AV}} \div \frac{\Delta P}{P_{AV}} = \frac{\Delta Q_D}{Q_{AV}} \times \frac{P_{AV}}{\Delta P}$$

Or, rearranging the terms:

$$E_D = \frac{\Delta Q_D}{\Delta P} \times \frac{P_{AV}}{Q_{AV}}$$

Using the numbers in our example:

$$E_D = \frac{-10}{0.40} \times \frac{1.60}{20} = -2$$

As you can see, the two formulas produce the same result.

In addition to calculating elasticity between two points on the demand curve (A and C in our example), which is called *arc elasticity*, the second formula allows us to calculate the elasticity at a point on the demand curve, called *point elasticity*. While arc elasticity tells us how quantity demanded reacts to a certain change in price, point elasticity shows us the speed at which quantity demanded changes at a certain instant.

To measure elasticity at a point, we assume that the changes in price (ΔP) and quantity (ΔQ_D) are very small, approaching zero. How can we measure those changes then? We can't measure them separately, of course, but we can still calculate their ratio $\frac{\Delta Q_D}{\Delta P}$, as far as we know the slope of the demand curve. In our example, the demand curve is linear (i.e. a straight line). Recall from your math courses that the slope of a straight line is constant and can be calculated between any two points on the line as "the rise over the run."[1] Between points A and C, for example, the rise is ΔP = \$0.40 and the run is ΔQ_D =

Side Note 1

Why use the midpoint formula and not the usual percentage change formula, where we divide the change in a variable by its starting value? For example, for the price rise in our example, the percentage change in quantity would be

$$\%\Delta Q = \frac{Q_2 - Q_1}{Q_1} = \frac{15-25}{25} = -0.4 \text{ or } -40\%$$

But suppose that instead of rising, the price falls. Then the percentage change in quantity is:

$$\%\Delta Q = \frac{25-15}{15} = 0.67 \text{ or } 67\%$$

Thus, the percentage change in quantity will depend on the direction in which the price changes.

The same will be true about the percentage change in price calculated using the conventional percentage change formula. When the price rises, $\%\Delta P = 29\%$, and when it falls, $\%\Delta P = -22\%$. So, when the price rises, the elasticity is

$$|E_D| = \left|\frac{-40\%}{29\%}\right| = 1.4$$

and when the price falls, it is:

$$|E_D| = \left|\frac{67\%}{-22\%}\right| = 3$$

That is, if we use the conventional percentage change formula, the elasticity we calculate will depend on whether the price rises or falls. To avoid this problem, we use the midpoint formula, which allows us to obtain a measure of elasticity that does not depend on the direction in which the variables change.

[1] If the demand curve is not a straight line, we can still calculate its slope at a point as the slope of the straight line tangent to that point.

−10 (it is negative because the quantity decreases, i.e. "runs back," so to speak). So, the slope of the demand curve is $\frac{\Delta P}{\Delta Q_D}$ and the term $\frac{\Delta Q_D}{\Delta P}$ in the formula above is the inverse of its slope, which can be calculated directly as "the run over the rise." Now we can compute the elasticity at point B as follows:

$$E_D = \frac{1}{\text{slope}} \times \frac{P_B}{Q_B} \quad (2)$$

$$E_D = \frac{-10}{0.40} \times \frac{1.60}{20} = -25 \times \frac{1.60}{20} = -2$$

The elasticity at point B is the same as the arc elasticity between points A and C because point B is the midpoint between points A and C. But we can use the same number for the inverse of the slope to calculate the elasticity at any other point on the curve. For example, at point A, the price elasticity of demand is:

$$E_D = -25 \times \frac{1.40}{25} = -1.4$$

Checkpoint 2

Suppose the price of strawberries falls from $2.80 per pound to $2.50 per pound. As a result, the quantity of strawberries demanded increases from 35 million pounds to 45 million pounds. What is the arc price elasticity of demand for strawberries in this price range? What is the elasticity at the point where the price is $2.80 per pound?

Check your answer

Price Elasticity Along a Straight-Line Demand Curve

Throughout this course, we draw demand and supply curves as straight lines. This simplifies our analysis, and within a realistic price range, a straight line is usually a reasonable approximation even if the actual demand curve is not linear. It is worth to discuss then how the price elasticity of demand is related to the slope of the demand curve.

First, note that although both slope and elasticity show how much quantity demanded changes in response to a certain change in price, they are two different concepts. The inverse of the slope tells us by how many *units* the quantity changes when the price rises or falls by *one dollar*. The price elasticity of demand shows the *percentage change* in quantity demanded in response to a *one percent change* in price. Second, while the slope remains constant along a linear demand curve, the elasticity does not.

Let's return to our demand curve for oranges (Figure 3). As we've calculated before, the absolute value of the elasticity at point A is 1.4, while at point B it is 2. Why does the demand become more elastic as we move up along the curve from point A to point B?

Take a look at the point-elasticity formula again:

$$E_D = \frac{1}{\text{slope}} \times \frac{P}{Q}$$

Since a linear demand curve has a constant slope, when we move along the curve, the first term in the formula, $\frac{1}{\text{slope}}$, remains the same. However, the second term, $\frac{P}{Q}$, increases as we move up along the curve because the price rises and the quantity decreases. In our example, it is 1.40÷25 = 0.056 at point A, 1.60÷20 = 0.08 at point B, and 1.80÷15 = 0.12 at point C. Therefore, the absolute values of elasticities are 25×0.056 = 1.4, 25×0.08 = 2, and 25×0.12 = 3 at points A, B, and C, respectively. Thus:

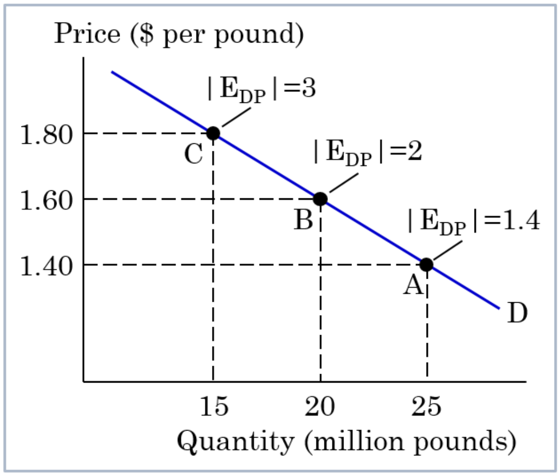


Figure 3 Elasticity along a linear demand curve

Side Note 2

There are two problems with using the slope of a demand curve to measure the responsiveness of quantity to a change in price. First, slopes depend on the units of measurement. If, for example, we measured the quantity of oranges in kilograms instead of pounds (as all the countries in the world, except for the United States, Liberia, and Myanmar, do), the quantities of oranges would be 11.3 million kg and 6.8 million kg at points A and C, respectively, so the |ΔQ| would be |6.8 – 11.3| = 4.5. and the inverse of the slope would be 4.5÷0.40 = 11.25 by the absolute value. But the fact that it is now 11.25 instead of 25 doesn't mean that consumers are 45% as price-sensitive as before, since nothing has changed except for the units of measurement.

The second problem with using the slope to measure the responsiveness of quantity to a change in price is that we can't meaningfully compare the slopes of demand curves across different products. Suppose, for example, that we want to compare consumers' price sensitivity in the market for oranges with that in the market for t-shirts. The inverse of the slope of the demand curve for t-shirts would show how many more t-shirts consumers would buy if the price falls by $1. Say, we've calculated it at 50 million. How can we compare the price sensitivity of 50 million t-shirts per dollar with that of 25 million pounds of oranges per dollar? Such comparisons make no sense.

As the price rises and we move upward and leftward along a linear demand curve, the demand becomes more price elastic.

Obviously, the reverse is also true: as the price falls and we move downward and rightward along a linear demand curve, the demand becomes less elastic.

Now suppose we want to compare the price elasticity of demand for oranges (D_O) with that for grapefruits (D_G). Figure 4 shows the two demand curves. Both are straight lines. Clearly, at the point where the curves intersect (point A), the P to Q ratio is the same for both curves (0.056). However, the demand curve for grapefruits is less steep than the demand curve for oranges, which means absolute value of the inverse of the slope for D_G is greater than that for D_O. As we can calculate from Figure 4, for D_G, the absolute value of the inverse of the slope ("the run over the rise" between points A and F) is $|-10 \div 0.20| = 50$, compared to 25 for D_O. Therefore, the elasticity of demand for grapefruits at point A, $|E_D| = 50 \times 0.056 = 2.8$, is twice that of the demand for oranges (1.4). In general, at a given point, a flatter demand curve is more elastic.

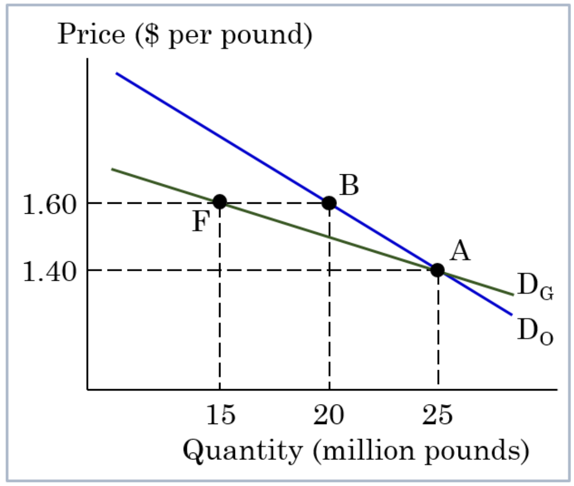
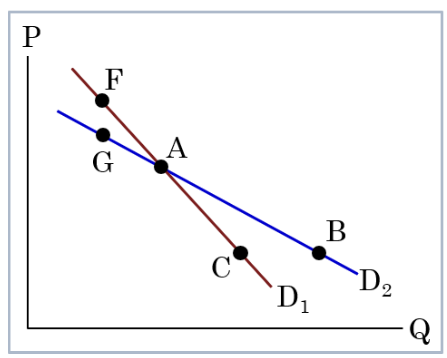


Figure 4 Elasticities of demand for oranges and grapefruits

Figure 4 also shows that when two different linear demand curves have a common point, in a given price range that starts (or ends) at that point, the flatter demand curve is more elastic. As we calculated before, using the midpoint formula, when the price rises from $1.40 to $1.60 (i.e. when we move from point A to point B along D_O and to point F along D_G), the percentage change in price is the same (25%, as we calculated it before). But since D_G is flatter than D_O, the quantity response to that change in price is greater along D_G than along D_O.

Checkpoint 3

Refer to the figure on the right. Which of the following is true? Explain.



The demand is more elastic between points _____ than between points _____.

1. A and B; A and C
2. A and F; A and G
3. A and F; A and C
4. A and B; A and G

Check your answer

Categorizing Elasticities by Magnitude

In is useful to categorize elasticity numbers based on their magnitudes. Let's start with an extreme case where the price elasticity of demand is zero, which means the quantity demanded does not change at all in response to a price change. Figure 5-a shows an example. Jake would buy the same quantity of gas per week, no matter whether the price is $2 or $3 per gallon. That is, his %ΔQ = 0 when the %ΔP = 40%. Thus, the price elasticity of Jake's demand for gas is E_D = 0%÷40% = 0. This is called **perfectly inelastic** demand, and it is reflected by a vertical demand curve. We should always keep in mind, however, that the price elasticity of demand may be different in a different price range. If, for example, the price of gas rises from $3 to $4, Jake's demand will not necessarily—and most likely not—remain perfectly inelastic.

When the price elasticity of demand is between zero and one (0 < $|E_D|$ < 1), the demand is called **inelastic**. An example is shown in Figure 5-b. When the price of gas rises by 40%, Rona's quantity of gas demanded decreases by 5%. That is, the price elasticity of her demand for gas is $|E_D|$ = |−5%÷40%| = 0.125. Since Rona's quantity demanded changes in response to a change in price, her demand is not perfectly inelastic. But as far as the percentage change in quantity is smaller than the percentage change in price, which means $|E_D|$< 1, the demand is categorized as price inelastic.

A notable case of elasticity is when the percentage change in quantity is the same as the percentage change in price so that the price elasticity of demand equals one. This is called

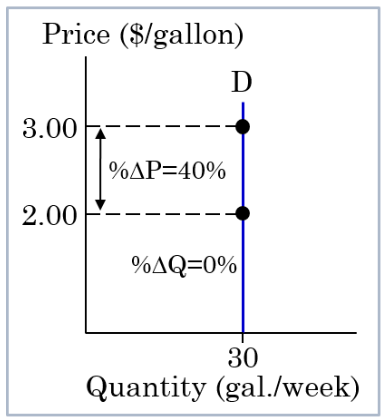


Figure 5-a Jake's perfectly inelastic demand for gas

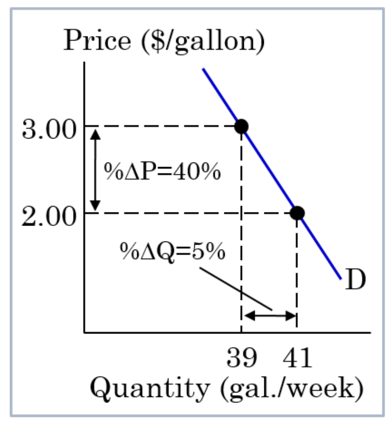


Figure 5-b Rona's inelastic demand for gas

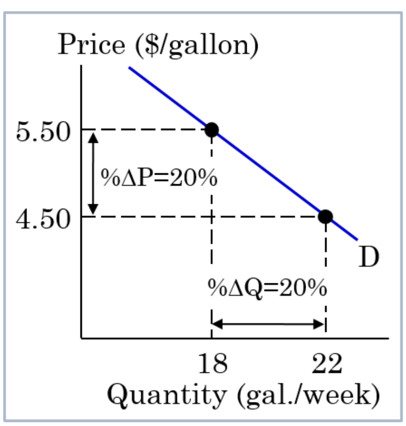


Figure 5-c Rona's unitary elastic demand for gas

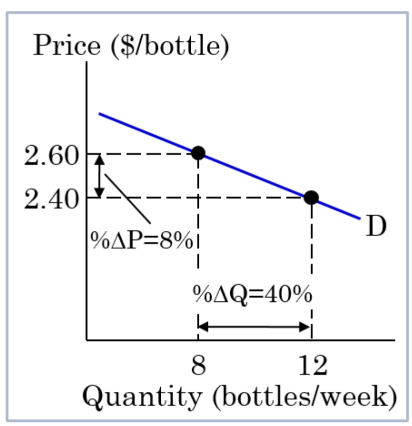


Figure 5-d Susan's elastic demand for Coke

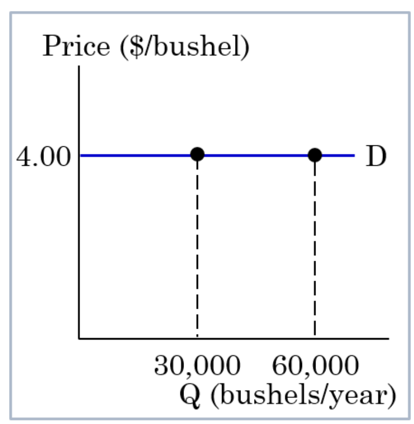


Figure 5-e Perfectly elastic demand for Dean's wheat

unitary elastic demand. For example, in a higher price range, Rona's demand for gas is likely to be more elastic. As shown in Figure 5-c, when the price of gas rises from \$4.50 to \$5.50 per gallon, i.e. by 20%, Rona's quantity demanded decreases also by 20%. That is, the elasticity of her demand in this price range is $|E_D| = |-20\% \div 20\%| = 1$.

Note that when the demand is unitary elastic, consumers want to spend a *constant amount* on the good no matter what its price is. This is because the amount spent (TX) is the price of the good (P) times the quantity of the good bought (Q): $TX = P \times Q$

So when the quantity decreases (or increases) by the same percentage as the price increases (or decreases), the P×Q remains unchanged. In our example in Figure 5-c, when the price is \$4.50, Rona wants to spend \$4.50×22 = \$99 and when the price is \$5.50, she wants to spend the same amount: \$5.50×18 = \$99.

When the elasticity value is greater than one ($|E_D| > 1$), the demand is called **elastic**. An example is shown in Figure 5-d. When the price of Coke rises from \$2.40 to \$2.60 per bottle, i.e. by 8%, Susan's quantity demanded decreases by 40%, which means the elasticity of Susan's demand for Coke is $|E_D| = |-40\% \div 8\%| = 5$.

In certain situations, the quantity demanded is extremely sensitive to price changes so that the elasticity number is practically infinity. In such cases the demand is considered to be **perfectly elastic**. Figure 5-e shows an example. Dean's farm is one among millions of other farms producing wheat. And wheat is a standardized product, so consumers do not care whether it is produced at Dean's farm or somewhere else. As a result, the price of wheat is determined by the competitive forces of market supply and demand. In Figure 5-e, it is \$4 per bushel. If Dean tries to charge a price that is even slightly above \$4, the quantity demanded for his wheat will be zero, since consumers will be able to buy wheat elsewhere at a lower price. On the other hand, if Dean charges a price just a little below \$4, the quantity of his wheat demanded will become practically infinite: since, Dean's wheat is as good as that produced elsewhere but is sold at a lower price, every potential buyer will want to get it.[2] This means the demand curve for Dean's wheat can be viewed as perfectly elastic — horizontal at the market price of \$4.

Checkpoint 4

Every time Vincent goes to a gas station, he gets 18 gallons of gas without looking at the price. His fiancé, Lisa, however, always wants to spend 36 dollars on gas no matter what the price is. What can you tell about the price elasticity of Vincent's demand for gas? Price elasticity of Lisa's demand for gas? Explain your answers.

Check your answer

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[2] Of course, Dean's farm won't be able to satisfy all that huge demand, but that's not the point here. Recall from Chapter 2 that the quantity demanded and quantity actually bought are two different concepts. Later in the course (in Chapter 7), we will see how the concept of perfectly elastic demand helps us analyze firms' decisions in perfectly competitive markets.

Price Elasticity of Demand and Pricing

Knowing and understanding the price elasticity of demand can help firms optimally price there products. Consider the following example.

Example 1: Does Raising Price Bring in More Revenue?

Suppose you are an economist at Apple Inc. Your boss asks you to predict what will happen to the receipts from iTunes downloads if Apple raises their price from $1.29 to $1.39 per song. Let's see how you can use the information about price elasticity of demand for iTunes downloads to accomplish this task.

The term for total receipts used in economics is **total revenue (TR)**, which is the price per unit (P) times the quantity (number of units) sold (Q):

$$TR = P \times Q$$

As clear from this formula, raising the price, i.e. selling each download for more, will increase the total revenue. On the other hand, according to the law of demand, a higher price will decrease the quantity of downloads demanded, so Apple will be able to sell fewer downloads, which will decrease its total revenue. So the resulting change in total revenue will depend on which of the two effects—the price effect or the quantity effect—is greater. And all we need to know to figure this out is the price elasticity of demand for iTunes downloads.

It can be shown mathematically that

$$\%\Delta TR \approx \%\Delta P + \%\Delta Q \tag{3}$$

Further, recall that according to the law of demand, if $\%\Delta P$ is positive (i.e. the price rises), then $\%\Delta Q$ is negative (i.e. the quantity decreases). Hence, if $|\%\Delta P| > |\%\Delta Q|$, i.e. the price effect prevails, the total revenue increases. And if $|\%\Delta Q_D| > |\%\Delta P|$, i.e. the quantity effect prevails, the total revenue decreases.

How do we know which percentage change, $|\%\Delta P|$ or $|\%\Delta Q|$, will be greater? The price elasticity of demand tells us exactly that. Recall that the price elasticity of demand is

$$E_D = \frac{\%\Delta Q_D}{\%\Delta P}$$

According to this formula, if the demand is inelastic ($|E_D| < 1$), then $|\%\Delta P|$ must be greater than $|\%\Delta Q|$. And if the demand is elastic, ($|E_D| > 1$), then $|\%\Delta Q|$ must be greater than $|\%\Delta P|$.

Back to our example, having realized that you need to know the price elasticity of demand for iTunes downloads, you conduct a market research and estimate it at −1.2. This number tells you that for each 1% rise in price, the quantity of iTunes downloads will decrease by 1.2%. As equation (3) shows, this means the negative effect on the total revenue of the decreased quantity will more than offset the positive effect of the higher price. Therefore, you predict that the total revenue will decrease.

You can even tell your boss by how much (in percentage terms) you predict the total revenue to decrease. When the price is raised from $1.29 to $1.39, the percentage change in price (calculated using the midpoint formula) is 7.5%. So, using the elasticity formula, we can write:

$$-1.2 = \frac{\%\Delta Q}{7.5\%}$$

Solving this equation for %ΔQ, we get:

$$\%\Delta Q = -1.2 \times 7.5\% = -9.0\%$$

And from equation (3):

$$\%\Delta TR \approx 7.5\% - 9.0\% = -1.5\%$$

That is, you predict that raising the price of iTunes downloads from $1.29 to $1.39 will decrease Apple's receipts by about 1.5%.[3]

Example 2: Can Farmers Benefit from Bad Weather?

Suppose unfavorable weather conditions decrease soybean production everywhere. Can you predict what will happen to soybean farms' revenues?

To make our prediction, let's first visualize the situation in the market for soybeans. It is depicted in Figure 6. Suppose that initially, the equilibrium price of soybeans is $4 per bushel, and the equilibrium quantity is 140 million bushels (point E_1).[4] As you've learned from Chapter 2, unfavorable weather will decrease the supply of soybeans, shifting the supply curve leftward (from S_1 to S_2 in Figure 6). As a result, the price of soybeans rises and the quantity of soybeans demanded decreases along the demand curve (D). Therefore, to predict what will happen to the farmers' revenue, we need to know the price elasticity of demand.

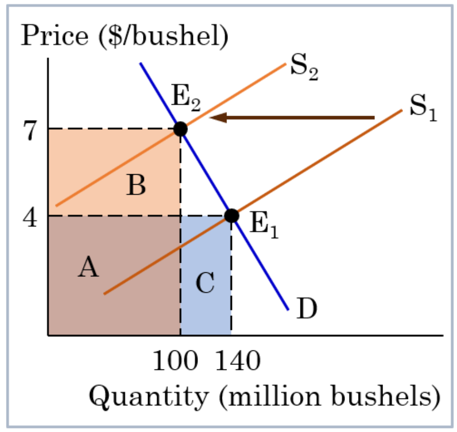


Figure 6 Bad weather decreases soybean production

Suppose the price elasticity of demand for soybeans is estimated at −0.6. This means for each 1% increase in price, the quantity of soybeans demanded will decrease by 0.6%. So, according to equation (3), the gain in total revenue due to a higher price will more than offset the loss of it due to a decreased quantity. As a result, the farmers' total revenue will increase.

This may sound counterintuitive. How can bad weather increase farmers' revenue? Let's take a look at Figure 6 again. Initially (at point E_1), the total revenue is $4×140 million = $560 million (area A+C). When the price rises to $7 and the quantity decreases to 100 million bushels (i.e. when the market moves to the new equilibrium, point E_2), farmers gain $3×100 million = $300 million (area B) due to the rise in price and lose $4×40 million = $160 million (area C) due to the decrease in quantity. Since the price effect on total revenue exceeds the

[3] Using equation (3) to calculate the approximate change in total revenue works pretty well when the percentage changes in P and Q are relatively small. The result is less accurate for larger percentage changes.

[4] We use these price and quantity numbers for demonstration purposes only. You don't really need to know them to make the prediction in question. As you'll see shortly, the only number that you need to know is the price elasticity of demand for soybeans.

quantity effect by \$300 million − \$160 million = \$140 million (area B – area C), the total revenue increases by that amount. In the new equilibrium (E_2), TR = \$7×100 million = \$700 million (area A+B), which is \$140 million more than the \$560 million in the initial equilibrium.

The same reasoning applies when we want to figure out what will happen to total revenue if the price falls. Table 1 shows all possible scenarios. Note that when the demand is inelastic, the total revenue changes in the same direction as does the price because in that case the price effect prevails. And when the demand is elastic, the total revenue changes in the direction opposite to the price change because now the quantity effect prevails. Note also that when the demand is unitary elastic ($E_D = 1$), the total revenue remains the same no matter whether the price rises or falls.

Table 1 Effects of price changes on total revenue

Price elasticity of demand	Effect on total revenue	
	Price rises:	Price falls:
Inelastic ($\mid E_D \mid < 1$)	Increases	Decreases
Unitary elastic ($\mid E_D \mid = 1 \mid$)	No change	No change
Elastic ($\mid E_D \mid > 1$)	Decreases	Increases

Checkpoint 5

Suppose Netflix lowers the price of its monthly streaming subscription from \$9.99 to \$8.99. In this price range, the price elasticity of demand for Netflix subscriptions is −1.4. What will be the percentage change in the number of subscriptions demanded? What will happen to Netflix's total revenue?

Check your answer

What Determines Price Elasticity of Demand?

What makes demand more price elastic and what makes it less price elastic? Table 2 shows price elasticities of demand for some goods and services drawn from a variety of studies by economists. So, why is the price elasticity of demand for restaurant meals ($\mid E_D = 2.27 \mid$) so much higher than that for salt ($\mid E_D = 0.10 \mid$)? Let's discuss factors that could cause this and other differences in price elasticity of demand. To better understand the influences on elasticity, keep in mind that it measures the responsiveness of quantity demanded to a change in price. That is, when consumers are more responsive to price changes, the demand is more elastic and when they are less responsive, the demand is less elastic.

Availability and Closeness of Substitutes

As you can see in Table 2, the demand for beef is more elastic than the demand for electricity. One reason is that there are several rather close substitutes available for beef (e.g., pork, lamb, or turkey), so if the price of beef rises, consumers can pretty easily switch to those substitutes, which will result in a substantial decrease in the quantity of beef demanded. But there are practically no good substitutes for electricity. So, when electric power suppliers raise the price, households may try to reduce their electricity consumption by using more energy-efficient electric appliances, but this only can be done to a certain extent. Therefore, the demand for electricity is significantly less sensitive to a change in price than the demand for beef. In general, other things being equal:

> The more and/or closer substitutes for a good are available, the more price elastic the demand for that good is.

Table 2 Price elasticities of demand for some goods and services

Good or service	Elasticity (absolute value)
Salt	0.10
Housing	0.12
Electricity	0.20
Gasoline — short run	0.26
Gasoline — long run	0.58
Beef	0.59
Soft drinks	0.75
Air travel — business	0.80
Motor vehicles	1.40
Air travel — leisure	1.60
Coke	1.71
Restaurant meals	2.27

Note that the availability of close substitutes depends on how broadly we define the market. For example, if we are looking at the market for Coke, than Pepsi, Sprite, and other soft drinks are very close substitutes. So, if the price of Coke rises, the quantity of Coke demanded is likely to decrease substantially as consumers switch to those substitutes. If, however, we define the market more broadly, e.g., as the market for all soft drinks, then substitutes will be harder to find. As a result, when the price of all soft drinks rises, the quantity demanded is not likely to decrease that much. As you can see in Table 2, the demand for Coke is much more elastic ($|E_D = 1.71|$) than the demand for soft drinks in general ($|E_D = 0.75|$).

Whether the Good is a Necessity or a Luxury

Most people consider goods such as, housing, electricity, and gasoline to be essential for living. These goods are called "necessities." When the price of such a good rises, consumers can "tighten their belts" to some extent, but given that the good is a necessity, these possibilities are rather limited, so the quantity demanded is not likely to change much. On the other hand, there are goods that consumers can easily do without, called "luxuries." Examples are entertainment, exotic vacations, and meals at fine restaurants. If the price of such goods rises, consumers can reduce their purchases substantially or even not buy those goods at all, since they can easily live without them. As shown in Table 2, the demand for luxuries such as restaurant meals and leisure air travel, is distinctly more elastic than the demand for necessities, such as housing, gasoline, and business air travel. In general, other things being equal:

> Demand for necessities tends to be less price elastic then the demand for luxuries.

Proportion of Income Spent on the Good

Compare the price elasticities of demand for salt and for motor vehicles shown in Table 2. Most consumers would view both goods as necessities. Both markets are rather broadly defined (as they include all kinds of salt and motor vehicles). Why then is the price elasticity of demand for motor vehicles ($|E_D| = 1.4$) much higher than that of salt ($|E_D| = 0.1$). The answer is, this is because motor vehicles are much more expensive than salt and hence account for a much larger share of consumers' budgets.

To illustrate this point, let's say the prices of both goods double. Since the price of salt is very low and people usually don't need much of it, to buy the same quantity of salt, an average household would probably spend about $1 instead of $0.50 per month. Clearly, the impact on consumers' budgets and therefore on the quantity of salt demanded would be negligible. But imagine what will happen if the average monthly car loan payments increase from $250 to $500. Since this will significantly impact most households' budgets, many people would have to postpone buying a new car and some would not be able to afford it at all. Thus, the quantity of motor vehicles demanded would likely decrease quite substantially. In general, other things being equal:

> The larger proportion of households' budgets the good is accounted for, the more elastic the demand tends to be.

Time Span

The more time consumers have adjust for a price change, the more responsive their quantity demanded is likely to be. Consider, for example, the demand for gasoline. If the price of gasoline rises significantly, how can consumers respond in the short run? Surely, some may be able to use public transportation more frequently, arrange car pools, or eliminate nonessential trips. But these possibilities are limited. In a longer run, however, people can do more to reduce their gas consumption, e.g., buy more fuel-efficient vehicles, move closer to their jobs or to areas where public transit is better. Therefore, as you can see in Table 2, the demand for gas is about twice as elastic in the long run as it is in the short run. In general, other things being equal:

> Demand tends to be more elastic in the long run than in the short run.

Checkpoint 6

Which of the following statements are true and which are false? Explain.

A. The demand for coal is likely to be more price elastic in the short run than in the long run.

B. The demand for all oats cereals is likely to be less elastic than the demand for Kellogg's oats cereals and more elastic than the demand for all cereals.

C. The demand for basic cable TV subscriptions is likely to be more elastic than the demand for subscription with premium channels.

D. The demand for taxi services in a city is likely to be more elastic than the demand for public transportation.

Check your answer

3.2 Income Elasticity of Demand

As we've noted previously, the concept of elasticity can be applied to measure the responsiveness of any variable to a change in another variable. The income elasticity of demand tells us how responsive quantity demanded is to changes in consumers' incomes.

The **income elasticity of demand** for a good is the percentage change in the quantity of the good demanded in response to a one percent change in potential buyers' income. Or, mathematically:

$$E_I = \frac{\%\Delta Q_D}{\%\Delta I} \quad (4)$$

where E_I is the income elasticity of demand, $\%\Delta Q_D$ is the percentage change in quantity demanded, and $\%\Delta I$ is the percentage change in income.

For example, if a 5% increase in consumers' income causes a 4% increase in quantity demanded, the income elasticity of demand is:

$$E_I = \frac{4\%}{5\%} = 0.8$$

It is important to keep in mind that, as with the price elasticity of demand, when determining income elasticity, we must hold constant all other variables influencing consumers' decisions. There are two important differences, however, between the income elasticity of demand and the price elasticity of demand.

First, while we measure price elasticity along the same demand curve, moving from one price to another, we measure income elasticity as the percentage increase in quantity demanded at a *given* price when the demand curve *shifts* in response to a change in income.

Second, although both income elasticity and price elasticity measure the degree of responsiveness of quantity demanded by the absolute value of the number, unlike the price elasticity (which is always negative), the sign of the income elasticity—which can be positive or negative—must be given attention. A positive income elasticity means that when income increases, the demand for the good increases. That is, as you learned in Chapter 2, the good is *normal*. A negative income elasticity means an increase in income causes demand to decrease. That is, in this case, the good is *inferior*. So:

> A positive income elasticity indicates a normal good, while a negative income elasticity indicates an inferior good.

The following example illustrate a practical use of information on income elasticity.

Example 3: How Much Canned Tuna to Order?

Suppose you are the manager of a grocery store. Due to an increase of the federal minimum wage, the average income of your customers has increased by 5%. How should you adjust your purchases of canned tuna from suppliers? Your market research suggests that the income elasticity of demand for canned tuna is −0.7.

To properly adjust your orders from supplier, you need to know how the demand for canned tuna will change in response to a higher customers' income. We can use the information on the income elasticity of demand for canned tuna to figure it out. Note first that the income elasticity is negative, which means canned tuna is an inferior good, i.e. a higher consumer income will decrease the demand for it. But by how much? Using the income elasticity formula (4) we can write:

$$-0.7 = \frac{\%\Delta Q}{5\%}$$

Solving this equation for $\%\Delta Q$, we get:

$$\%\Delta Q = -0.7 \times 5\% = -3.5\%$$

That is, you should reduce your purchases of canned tuna from suppliers by 3.5%.

Checkpoint 7

Suppose you are the manager of a Walmart store in a small town. The average income of your customers has decreased by 6%. How should you adjust your purchases of canned chicken from suppliers? Your market research consultant estimates the income elasticity of demand for canned chicken in the area you serve at −0.3.

Check your answer

3.3 Cross-Price Elasticity of Demand

The cross price elasticity of demand tells us how responsive the quantity demanded of a good is to changes in the price of *another* good.

The **cross-price elasticity of demand** for a good is the percentage change in the quantity of the good demanded in response to a one percent change in the price of another good. Or, mathematically:

$$E_{XY} = \frac{\%\Delta Q_{DX}}{\%\Delta P_Y} \tag{5}$$

where E_{XY} is the cross-price elasticity of the demand for good X with respect to the price of good Y, $\%\Delta Q_{DX}$ is the percentage change in the quantity demanded of good X, and $\%\Delta P_Y$ is the percentage change in the price of good Y.

For example, if a 5% decrease in the price of organic apples causes a 6% decrease in the quantity of conventional apples demanded, the cross-price elasticity of the demand for conventional apples with respect to the price organic apples is:

$$E_{CO} = \frac{6\%}{5\%} = 1.2$$

Again, it is important to keep in mind that we must hold constant all other variables influencing consumers' decisions when determining cross-price elasticity of demand.

As with income elasticity, we measure the cross-price elasticity of demand as the percentage increase in quantity demanded at a *given* price of the good when the demand curve *shifts* in response to a change in the price of another good. And as with income elasticity, the sign of a cross-price elasticity maters. A positive cross-price elasticity means that the two goods are *substitutes*, such as conventional apples and organic apples in the example above. A negative cross-price elasticity means that the two goods are *complements*, so a fall in the price of one good increases the demand for the other. In general:

A positive cross-price elasticity of demand indicates that the two goods are substitutes, while a negative cross-price elasticity indicates that they are complements.

The cross-price elasticity of demand has useful business applications. Here is an example.

Example 4: How Will a Competitor's Pricing Affect Your Sales?

You are an economist at Dell. Hewlett Packard (HP), Dell's competitor, lowers the price of their laptops by 10%. Your boss wants to know how this will affect the sales of Dell laptops with similar characteristics. How can you figure it out?

Again, you'll need to conduct an econometric study to estimate the cross-price elasticity of demand for Dell laptops with respect to the price of HP laptops. Let's say you estimate it at 1.1. Note that the number is positive, which is no wonder, since Dell laptops and HP laptops with similar characteristics are obvious substitutes. Now you can use the cross-price elasticity formula (5) to write:

$$1.1 = \frac{\%\Delta Q}{-10\%}$$

Solving this equation for $\%\Delta Q$, you get:

$$\%\Delta Q = 1.1\times(-10\%) = -11\%$$

So, you report to your boss that she should expect the demand for Dell's laptops to drop by 11%.

Checkpoint 8

Suppose you are an economist at Google. Apple, lowers the price of their music downloads by 8%. Your boss wants to know how this will affect the number of Google music downloads. You estimate the cross-price elasticity of demand for Google downloads with respect to the price of Apple downloads at 0.9. What should you tell your boss?

Check your answer

3.4 Price Elasticity of Supply

All the elasticities we've discussed so far refer to the buyers' responsiveness to changes in factors that influence their demand decisions. The sellers' responsiveness to a change in the market price of their products is measured by the price elasticity of supply.

The **price elasticity of supply** of a good is the percentage change in the quantity of the good supplied in response to a one percent change in its price. Or, mathematically:

$$E_S = \frac{\%\Delta Q_S}{\%\Delta P} \tag{6}$$

where E_S is the price elasticity of supply, $\%\Delta Q_S$ is the percentage change in quantity supplied, and $\%\Delta P$ is the percentage change in price.

Recall that according to the law of supply, the relationship between price and quantity supplied is positive: when the price rises, the quantity supplied increases and when the price falls, the quantity supplied decreases. This means the price elasticity of supply is a positive number.

In many ways, the concept of the price elasticity of supply is similar to the price elasticity of demand. Like the price elasticity of demand, we can calculate it using the midpoint formula. Let's consider the market for oranges again (Figure 7). Suppose the price of oranges rises from \$1.40 to \$1.80 per pound, so the percentage change in price is:

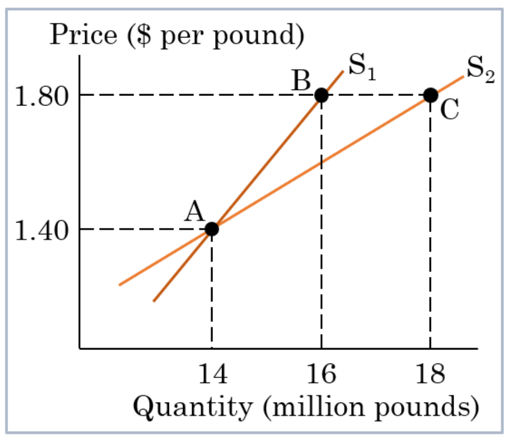


Figure 7 Elasticity of supply of oranges

$$\%\Delta P = \frac{P_2 - P_1}{P_{AV}} = \frac{\Delta P}{P_{AV}} = \frac{\$0.40}{\$1.60} = 0.25 = 25\%$$

As shown in the figure, this price change causes the quantity supplied to increase along the supply curve S_1 from 14 million pounds to 16 million pounds, so the percentage change in quantity is:

$$\%\Delta Q = \frac{Q_2 - Q_1}{Q_{AV}} = \frac{\Delta Q}{Q_{AV}} = \frac{2}{15} = 0.133 = 13.3\%$$

Thus, the price elasticity of supply is:

$$E_S = \frac{\%\Delta Q_S}{\%\Delta P} = \frac{13.3\%}{25\%} = 0.53$$

The determinants of the price elasticity of supply are also similar to those of the price elasticity of demand. The major factors are the following.

Sellers' Ability to Supply Products to Alternative Markets

The price elasticity of supply depends on the extent to which producers can realize more profitable alternatives to sell their products once they arise.

When can we expect suppliers to be able to realize such alternatives? First, this happens when producers can easily switch their existing resources or obtain additional resources to produce more profitable alternative goods. For example, when the price of SUVs rises due to a higher demand, auto producers can fairly easily switch their resources from producing cars or pickup trucks to producing SUVs, so the quantity of SUVs supplied can be expected to increase substantially in response to a higher price, i.e. the supply of SUVs is likely to be rather price-elastic. On the other hand, if the price of fine wines rises, the quantity supplied is not likely to increase much because the production of fine wines requires rare or unique resources.

Second, the supply is more price elastic when sellers can supply their products to alternative locations. For example, the supply of oranges to the market in Georgia is likely to be highly elastic. If the price of oranges in Georgia falls due to a lack of demand, the producers of oranges can easily find alternative markets in other states.

Time Span

Just like with the price elasticity of demand, the more time producers have to adjust their quantity supplied after a price change, the greater the price elasticity of supply. For example, if the price of oranges rises, in the short run, orange producers can use more fertilizer and improved irrigation to increase the yield of the existing trees, but they can't increase the number of orange-producing trees. In the long run, however, when they have enough time to plant new trees and grow them to full maturity, the quantity of oranges supplied can increase substantially.

In Figure 7, we can view S_1 as a less elastic short-run supply curve for oranges and S_2 as a more elastic long-run supply curve. Note that, as with the price elasticity of demand, when two different linear supply curves have a common point, in a given price range that starts (or ends) at that point, the flatter supply curve is more elastic. As we've calculated earlier, when the price rises from \$1.40 to \$1.80, the elasticity of supply along S_1 is 0.53. Along S_2, however (as you can calculate using the midpoint formula), the price elasticity of supply is 1.

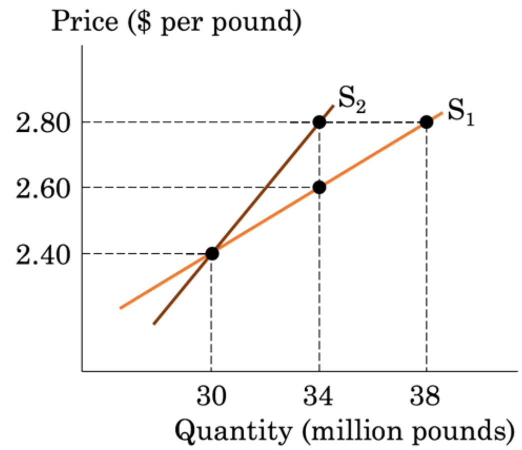
Checkpoint 9

The graph shows the supply curves in a market for apples.

a. What is the price elasticity of supply along the supply curve S_1 in the price range between \$2.40 and \$2.80?

b. Which of the supply curves, S_1 or S_2, is more price elastic? Explain.

c. Which of the curves do you think is a short-run supply curve and which is a long-run supply curve? Explain.



Check your answer

Economics at Work: Oil Prices Revisited

Recall from our discussion of the dynamics of the world oil prices in Chapter 2 that in early 2016, the world price of oil fell to almost \$30 per barrel. In this situation, the OPEC countries, which were losing their revenue from oil sales, faced a tough choice: cut their oil production to prop up the price, as they've done in the past, or maintain their output and let the price continue to fall with the purpose of driving the producers of the more costly shale oil out of the market. As we could see, OPEC decided not just to go with the latter choice, but increase their oil production substantially. What we've learned above about the price elasticities of demand and supply will help us better understand why OPEC made that decision.

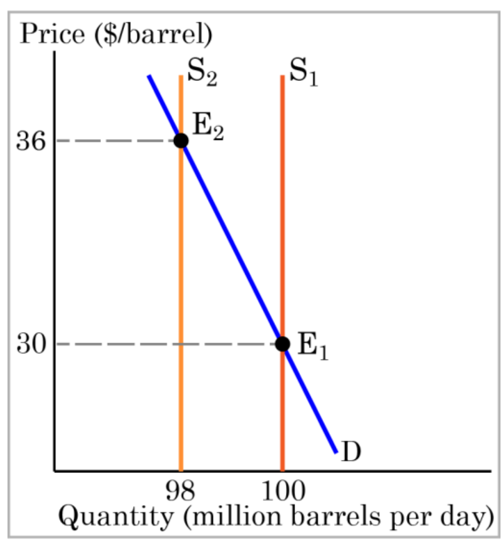


Figure 8-a OPEC cuts oil production—very short run

Let's see what would have happened had OPEC decided to cut its oil production instead of increasing it. Suppose OPEC is making its decision when the price of oil has fallen to \$30 and the world production of oil is 100 million barrels per day. OPEC accounts for about 40% of the world oil production, i.e. produces 40 million barrels per day, so its total revenue from oil is \$30×40 million = \$1,200 million or $1.2 billion. Will OPEC be able to increase its oil revenue if it reduces its production target by, say, 5%, to boost the price?

Let's first consider what will happen in a very short run, when other countries don't have enough time to increase their oil production. Figure 8-a illustrates this situation. The world market is initially in equilibrium at point E_1, where the price of oil is $30 per barrel and 100 million barrels per day is supplied. In the very short run, the supply of oil is practically perfectly inelastic; that is, the supply curve is vertical.

If OPEC cuts its oil production by 5% (i.e. by 40 million × 0.05 = 2 million barrels per day),[5] the world production will decrease from 100 million to 98 million barrels per day. That is, the OPEC's production cut will shift the supply curve from S_1 to S_2, so the market will move along the demand curve (D) from the initial equilibrium, E_1, to a new equilibrium, E_2, where the price is higher.

We can predict what the new price of oil will be given that the short-run price elasticity of demand for oil is estimated at −0.1. Since the percentage change in quantity is −2% (using the conventional formula, $\%\Delta Q = (98 - 100)/100 = -0.02$ or −2%), we can write:

$$E_D = \frac{\%\Delta Q_D}{\%\Delta P}$$

$$-0.1 = \frac{-2\%}{\%\Delta P}$$

Solving this equation for %ΔP, we get:

$$-0.1 \times \%\Delta P = -2\%$$

$$\%\Delta P = \frac{-2\%}{-0.1} = 20\%$$

That is, the price rises by $30×0.2 = $6, from $30 to $36.

Since OPEC is now selling 38 million barrels of oil at $36 per barrel, its total revenue is $36×38 million = $1,368 million. This is $168 million or 14% more than the revenue OPEC received before the oil production cut. Thus, by reducing its oil production OPEC was able to boost the price of oil, which increased its total revenue from oil sales. This should come as no surprise. As we've learned in this chapter, when the demand is price inelastic, raising the price increases total revenue. And when the demand is very price inelastic (which is the case here), even small reductions in quantity can lead to substantial price hikes and total revenue gains. This, however, is only true if the competition does not influence the market quantity supplied.

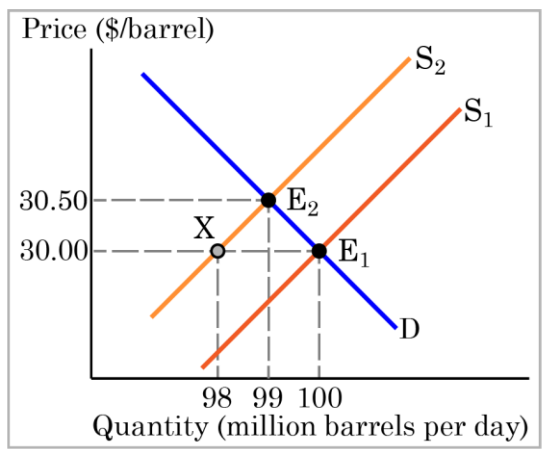


Figure 8-b OPEC cuts oil production—longer run

[5] Here and further in this analysis, to simplify calculations, we use the conventional percentage-change formula rather than the midpoint formula.

And in the case of the present day's world market for oil, that could be true in a very short run, but not in a longer run.

Let's see how the world market for oil will respond to OPEC's production cuts in a longer run, when other countries—including such major world oil producers as the United States and Russia—increase their production of oil in response to a higher price. As we know, both demand and supply are more price elastic in the long run than in the short run. Figure 8-b shows what happens if the world supply of oil is still inelastic, but no longer perfectly inelastic (say, $E_S = 0.2$) and the demand for oil becomes less inelastic (say, $E_D = -0.2$).

Now, when OPEC reduces its production of oil by 2 million barrels shifting the world supply curve from S_1 to S_2, other oil producers respond to the initial excess demand for oil and a higher price resulting from it by increasing their production, which partly compensates the OPEC's reduced supply. The market moves along the supply curve S_2 from point X to the new equilibrium at point E_2, where the price of oil is $30.50 per barrel and the quantity is 99 million barrels per day. As you can see, because both demand and supply are now less price inelastic, the price rises only by $1.50 (5%).

Will the OPEC's total revenue from oil still increase? Note first that since other countries increase their oil production while the OPEC countries reduce theirs, the OPEC's market share decreases from 40% to 38.4% (as OPEC is now producing 38 million barrels per day out of the total world production of 99 million barrels per day). The OPEC's total revenue then is $30.50×38 million = $1,159 million, which is 3.4% less than its revenue before the production cut ($1,200 million).

Of course, in an even longer run, when both demand and supply are even more elastic, OPEC's oil production cuts to prop up the price will result in even greater losses of their oil revenues.

Checkpoint Answers

1

A. False. The price elasticity of demand is the *percentage* change in quantity demanded in response to a certain *percentage* change in price:

$$E_D = \frac{\%\Delta Q_D}{\%\Delta P}$$

The slope of the demand curve is the *absolute* change in price divided by the *absolute* change in quantity:

$$\text{Slope} = \frac{\Delta P}{\Delta Q}$$

that is, the "rise" over the "run."

B. True. The price elasticity of demand for a good is the percentage change in the quantity of the good demanded in response to a one percent change in its price.

C. True. Since the relationship between price and quantity demanded is negative the price elasticity of demand is always a negative number. The sensitivity of quantity demanded to a change in price, however, is measured by the magnitude of the elasticity number regardless of its sign. For example, if the elasticity of demand for potatoes is −0.9, and the elasticity of demand for onions is −0.6, then the demand for potatoes is more elastic than the demand for onions because $|-0.9| = 0.9$, $|-0.6| = 0.6$, and $0.9 > 0.6$.

D. False. The price elasticity of demand measure the sensitivity of the quantity demanded to a change in price, not the other way around. Also, it is about the change in *quantity demanded*, not demand, since it's measured along the same demand curve.

Back to Checkpoint

2

The change in quantity is ΔQ_D = 10 million pounds. The midpoint Q_{AV} = 40 million pounds. So the percentage change in quantity is 10/40 = 0.25 or 25%. The change in price is ΔP = −\$0.30. The midpoint P_{AV} = \$2.65. So the percentage change in price is −\$0.30/\$2.65 = −0.113 or −11.3%. Thus, the arc price elasticity of demand in this price range is

$$E_D = \frac{\%\Delta Q_D}{\%\Delta P} = \frac{25\%}{-11.3\%} = -2.2$$

The inverse of the slope of the demand curve is $\Delta Q_D/\Delta P = -33.3$. When the price is \$2.80, the price to quantity ratio is $P/Q_D = 2.80/35 = 0.08$. Thus, the elasticity at the point where the price is \$2.80 per pound is

$$E_D = \frac{1}{\text{slope}} \times \frac{P}{Q} = -33.3 \times 0.08 = -2.7$$

Back to Checkpoint

3

1. True. The two demand curves intersect at point A and the demand curve D_2 is less steep than the demand curve D_1. Therefore, the demand is more elastic along D_2.
2. False. The two demand curves intersect at point A and the demand curve D_1 is steeper than the demand curve D_2. Therefore, the demand is more elastic along D_2.
3. True. As we move upward along the linear demand curve D_1, the demand becomes more price elastic.
4. False. As we move downward along the linear demand curve D_2, the demand becomes less price elastic.

Back to Checkpoint

4

Vincent wants to buy a constant quantity of gas no matter what the price is, which means his demand for gas is perfectly inelastic ($E_D = 0$). Lisa wants to spend a constant amount on gas, no matter what the price is, which means her demand is unitary elastic. For example, if the price is \$2 per gallon, her quantity demanded would be \$36÷\$2 = 18 gallons and if the price is \$2.40 per gallon, it would be \$36÷\$2.40 = 15 gallons. In either case the amount she wants to spend (P×Q = \$36) would not change.

Back to Checkpoint

5

To calculated the percentage change in the number of subscriptions, we first calculate the percentage change in price. Using the midpoint formula, we get:

$$\%\Delta P = \frac{\Delta P}{P_{AV}} = \frac{-\$1}{\$9.49} = -10.5\%$$

Given that the price elasticity of demand for Netflix subscriptions is −1.4, we can write:

$$-1.4 = \frac{\%\Delta Q_D}{-10.5}$$

Solving this equation for %ΔQ, we get:

$$\%\Delta Q = -1.4\times(-10.5\%) = 14.7\%$$

Given that

$$\%\Delta TR \approx \%\Delta P + \%\Delta Q$$

we can now calculate the approximate percentage change in Netflix's total revenue:

$$\%\Delta TR \approx -10.5\% + 14.7\% = 4.2\%$$

That is, Netflix's total revenue will increase by about 4.2%. Due to the fact that the demand for Netflix subscriptions is price elastic, the negative effect on the total revenue of the lower price is more than offset by the positive effect on it of the greater quantity demanded.

Back to Checkpoint

6

A. False. If the price of coal rises, in the short run, coal consumers (e.g., electric power plants) have only limited possibilities to reduce their use of coal, such as adjusting their equipment to make it more efficient and eliminating waste throughout the production process. In a longer run, however, when consumers have enough time to switch to alternative fuels, such as natural gas, the quantity of coal demanded can be reduced substantially. Thus, the demand for coal is more price elastic in the long run than in the long run.

B. True. "All oats cereals" is a broader definition of the market than "Kellogg's oats cereals." So, it is easier to find close substitutes for Kellogg's oats cereals (e.g., Post oats cereals) than for all oats breakfast cereals. Therefore, the demand for all oats cereals is likely to be less elastic than the demand for Kellogg's oats cereals. But "all cereals" is an even broader definition of the market than "all oats cereals." Therefore, the demand for oats cereals is likely to be more elastic than the demand for all cereals.

C. False. Basic cable TV can be viewed as more of a necessity, while premium channels as more of a luxury. Therefore, the demand for basic cable TV subscriptions is likely to be less elastic than the demand for subscription with premium channels.

D. True. The demand for taxi services is likely to be more elastic for two reasons. First, compared to public transit, taxi services can be considered a luxury. Second, taxis are substantially more expensive than public transportation and therefore account for a greater share of consumers' budgets.

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Given that the income elasticity is negative, you know that canned chicken is an inferior good, i.e. a lower consumer income will increase the demand for it. To calculate by how much, you can use the income elasticity formula (4) to write:

$$-0.3 = \frac{\%\Delta Q}{-6\%}$$

Solving this equation for %ΔQ, you get:

$$\%\Delta Q = -0.3 \times (-6\%) = 1.8\%$$

That is, you should increase the quantity of canned chicken you order by 1.8%.

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You can use the cross-price elasticity formula (5) to write:

$$0.9 = \frac{\%\Delta Q}{-8\%}$$

Solving this equation for %ΔQ, you get:

$$\%\Delta Q = 0.9 \times (-8\%) = -7.2\%$$

So, you report to your boss that you expect the demand for Google downloads to drop by 7.2%.

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a. The change in price is ΔP = \$0.40. The midpoint P_{AV} = \$2.60. So the percentage change in price is \$0.40/\$2.60 = 0.154 or 15.4%. The change in quantity is ΔQ_S = 8 million pounds. The midpoint Q_{AV} = 34 million pounds. So the percentage change in quantity is 8/34 = 0.235 or 23.5%. Thus, the price elasticity of supply is

$$E_D = \frac{\%\Delta Q_S}{\%\Delta P} = \frac{23.5\%}{15.4\%} = 1.5$$

b. When two linear supply curves have a common point, in a given price range that starts at that point, the flatter supply curve is more elastic. The supply curves on the graph intersect at P = $2.40 and Q = 30 million pounds. Thus, in the price range between $2.40 and $2.80, the flatter supply curve, S_1, is more price elastic.

c. The more time producers have to adjust their quantity supplied after a price change, the greater the price elasticity of supply. Therefore, the more elastic supply curve, S_1, must be the long-run curve and the less elastic supply curve, S_2, must be the short-run curve.

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