Price elasticity of demand and price elasticity of supply

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Key points

- **Price elasticity** measures the responsiveness of the quantity demanded or supplied of a good to a change in its price. It is computed as the percentage change in quantity demanded—or supplied—divided by the percentage change in price.
- Elasticity can be described as **elastic**—or very responsive—**unit elastic**, or **inelastic**—not very responsive.
- *Elastic* demand or supply curves indicate that the quantity demanded or supplied responds to price changes in a greater than proportional manner.
- An *inelastic* demand or supply curve is one where a given percentage change in price will cause a smaller percentage change in quantity demanded or supplied.
- *Unitary elasticity* means that a given percentage change in price leads to an equal percentage change in quantity demanded or supplied.

What is price elasticity?

Both demand and supply curves show the relationship between price and the number of units demanded or supplied. *Price elasticity* is the ratio between the percentage change in the quantity demanded, Q_d, or supplied, Q_s, and the corresponding percent change in price. The **price elasticity of demand** is the percentage change in the quantity demanded of a good or service divided by the percentage change in the price. The **price elasticity of supply** is the percentage change in quantity supplied divided by the percentage change in price.

Elasticities can be usefully divided into three broad categories: elastic, inelastic, and unitary. An *elastic demand* or *elastic supply* is one in which the elasticity is greater than one, indicating a high responsiveness to changes in price. An *Inelastic demand* or *inelastic supply* is one in which elasticity is less than one, indicating low responsiveness to price changes. *Unitary elasticities* indicate proportional responsiveness of either demand or supply.

If . . .	It Is Called . . .
$\frac{\%\text{ change in price}}{\%\text{ change in quantity}} > 1$	Elastic
$\frac{\%\text{ change in price}}{\%\text{ change in quantity}} = 1$	Unitary
$\frac{\%\text{ change in price}}{\%\text{ change in quantity}} < 1$	Inelastic

To calculate elasticity, instead of using simple percentage changes in quantity and price, economists use the average percent change in both quantity and price. This is called the **Midpoint Method for Elasticity**:

$$\frac{\%\text{change in quantity}}{\%\text{change in price}} = = \frac{Q2 - Q1}{(Q2 + Q1)/2 \times 100} \frac{P2 - P1}{(P2 + P1)/2 \times 100}$$

The advantage of the Midpoint Method is that we get the same elasticity between two price points whether there is a price increase or decrease. This is because the formula uses the same base for both cases.

Calculating price elasticity of demand

Let’s apply these formulas to a practice scenario. We'll calculate the elasticity between points A and B on the graph below.

The graph shows a downward sloping line that represents the price elasticity of demand.

Image credit: *Figure 1* in "Price Elasticity of Demand and Price Elasticity of Supply" by OpenStaxCollege, CC BY 4.0

First, apply the formula to calculate the elasticity as price decreases from $70 at point B to $60 at point A

$$\begin{aligned}\text{Price elasticity of demand} &= \frac{\%\ \text{change in quantity}}{\%\ \text{change in price}} \\ &= \frac{3{,}000 - 2{,}800}{(3{,}000 + 2{,}800)/2} \times 100 \over \frac{200}{2{,}900} \times 100 \\ &= \frac{6.96}{0 - 70} \over \frac{(60 + 70)/2} \times 100 - 100 \\ &= \frac{6.9}{65} \times 100 - 15.4 \\ &= \frac{6.9\%}{-15.4\%} \\ &= 0.45\end{aligned}$$

The elasticity of demand between point A and point B is $\frac{6.9\%}{-15.4\%}$, or 0.45. Because this amount is smaller than one, we know that the demand is inelastic in this interval.

[Wait a minute! Shouldn't the price elasticity of demand be negative here?]

Price elasticities of demand are always negative since price and quantity demanded always move in opposite directions on the demand curve. But, by convention, we talk about elasticities as positive numbers. So mathematically, we take the absolute value of the result. From now on, we'll ignore this detail and just remember to interpret elasticities as positive numbers.

This means that, along the demand curve between point B and point A, if the price changes by 1%, the quantity demanded will change by 0.45%. A change in the price will result in a smaller percentage change in the quantity demanded. For example, a 10% increase in the price will result in only a 4.5% decrease in quantity demanded. A 10% decrease in the price will result in only a 4.5% increase in the quantity demanded.

[I'd like to do another practice problem.]

Let's do another practice problem to cement this concept!

Calculate the price elasticity of demand for an increase in price from G to H in the graph above.

Step 1. Start with the formula for price elasticity of demand:

Step 2. Use the Midpoint Method formula to calculate percent change in quantity and price:

$$\begin{aligned}\text{Price elasticity of demand} &= \frac{\%\ \text{change in price}}{\%\ \text{change in quantity}} \\ &= \frac{8}{-11.76} \\ &= 1.47\end{aligned}$$

Step 4. Use the results of step three to fill in the formula for price elasticity of demand:

Price elasticity of demand $= \frac{\%\text{change in price}}{\%\text{change in quantity}} = \frac{8}{-11.76} = 1.47$

The elasticity of demand from G to H is 1.47.

Recall that the elasticity between point A and point B was 0.45. So, demand was inelastic between points A and B and elastic between points G and H. This shows us that price elasticity of demand changes at different points along a straight-line demand curve.

Calculating the price elasticity of supply

Now let's try calculating the price elasticity of supply. We use the same formula as we did for price elasticity of demand:

Price elasticity of supply $= \frac{\%\ \text{change in price}}{\%\ \text{change in quantity}}$

Assume that an apartment rents for $650 per month and, at that price, 10,000 units are rented—you can see these number represented graphically below. When the price increases to $700 per month, 13,000 units are supplied into the market.

By what percentage does apartment supply increase? What is the price sensitivity?

The graph shows an upward sloping line that represents the supply of apartment rentals.

Image credit: *Figure 2* in "Price Elasticity of Demand and Price Elasticity of Supply" by

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We'll start by using the Midpoint Method to calculate percentage change in price and quantity:

$$\%\text{ change in quantity} = \frac{13{,}000 - 10{,}000}{(13{,}000 + 10{,}000)/2} \times 100 = 26.1$$

$$\%\text{ change in price} = \frac{\$700 - \$600}{(\$700 + \$650)/2} \times 100 = 14.8$$

Next, we take the results of our calculations and plug them into the formula for price elasticity of supply:

$$\text{Price elasticity of supply} = \frac{\%\text{change in quantity}}{\%\text{change in price}} = \frac{26.1}{7.4} = 3.53$$

Again, as with the elasticity of demand, the elasticity of supply is not followed by any units. Elasticity is a ratio of one percentage change to another percentage change—nothing more. It is read as an absolute value. In this case, a 1% rise in price causes an increase in quantity supplied of 3.5%. The greater than one elasticity of supply means that the percentage change in quantity supplied will be greater than a one percent price change.

[Hang on! This sounds familiar. Is the elasticity the slope?]

It is a common mistake to confuse the slope of either the supply or demand curve with its elasticity. The slope is the rate of change in units along the curve, or the rise/run—change in y over the change in x. For example, in the graph above, at each point shown on the demand curve, price drops by $10 and the number of units demanded increases by 200. So the slope is −10/200 along the entire demand curve; it does not change.

The price elasticity, however, changes along the curve. Elasticity between point A and point B was 0.45 and increased to 1.47 between points point G and point H. Elasticity is the percentage change, which is a different calculation from the slope and has a different meaning.

When we are at the upper end of a demand curve, where price is high and the quantity demanded is low, a small change in the quantity demanded—even, say, one unit—is pretty big in percentage terms. A change in price of a dollar is going to be much less important in percentage terms than it would have been at the bottom of the demand curve. Likewise, at the bottom of the demand curve, that one unit change when the quantity demanded is high will be small as a percentage.

So, at one end of the demand curve, where we have a large percentage change in quantity demanded over a small percentage change in price, the elasticity value would be high, or demand would be relatively elastic. Even with the same change in the price and the same change in the quantity demanded, at the other end of the demand curve the quantity is much higher, and the price is much lower, so the percentage change in quantity demanded is smaller and the percentage change in price is much higher. That means at the bottom of the curve we have a small numerator over a large denominator, so the elasticity measure would be much lower, or inelastic.

As we move along the demand curve, the values for quantity and price go up or down, depending on which way we are moving, so the percentages for a $1 difference in price or a one unit difference in quantity will change as well, which means the ratios of those percentages will change.

Summary

- *Price elasticity* measures the responsiveness of the quantity demanded or supplied of a good to a change in its price. It is computed as the percentage change in quantity demanded—or supplied—divided by the percentage change in price.
- Elasticity can be described as *elastic*—or very responsive—*unit elastic*, or *inelastic*—not very responsive.
- *Elastic* demand or supply curves indicate that the quantity demanded or supplied responds to price changes in a greater than proportional manner.
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- *Unitary elasticity* means that a given percentage change in price leads to an equal percentage change in quantity demanded or supplied.

Self-check questions

Using the data shown in the table below about demand for smart phones, calculate the price elasticity of demand from point B to point C, point D to point E, and point G to point H. Classify the elasticity at each point as elastic, inelastic, or unit elastic.

Points	P	Q
A	60	3,000
B	70	2,800
C	80	2,600
D	90	2,400
E	100	2,200
F	110	2,000
G	120	1,800
H	130	1,600

[Show solution.]

From point B to point C, price rises from $70 to $80, and Qd decreases from 2,800 to 2,600. Using these numbers, we can fill in the formulas for percent change in quantity and price:

$$\%\text{ change in quantity} = \frac{2600-2800}{(2600+2800)\div 2}\times 100 = \frac{-200}{2700}\times 100 = -7.41$$

$$\%\text{change in price} = \frac{80-70}{(80+70)\div 2}\times 100 = \frac{10}{75}\times 100 = 13.33$$

Now, we can use the results of our calculations above to fill in the formula for elasticity of demand:

$$\text{Elasticity of demand} = \frac{-7.41\%}{13.33\%} = 0.56$$

The demand curve is inelastic in this area; that is, its elasticity value is less than one.

Now follow the same process using the data from point D to point E

$$\%\text{ change in quantity} = \frac{2200-2400}{(2200+2400)\div 2}\times 100 = \frac{-200}{2300}\times 100 = -8.7$$

$$\%\text{ change in price} = \frac{100-90}{(100+90)\div 2}\times 100 = \frac{10}{95}\times 100 = 10.53$$

$$\text{Elasticity of demand} = \frac{-8.7\%}{10.53\%} = 0.83$$

The demand curve is inelastic in this area; that is, its elasticity value is less than one.

And from Point G to point H

$$\%\text{ change in quantity} = \frac{1600-1800}{1700}\times 100 = \frac{-200}{1700}\times 100 = -11.76$$

$$\%\text{change in price} = \frac{130-120}{125}\times 100 = \frac{10}{125}\times 100 = 7.81$$

$$\text{Elasticity of demand} = \frac{-11.76\%}{7.81\%} = -1.51$$

The demand curve is elastic in this interval.

Using the data shown in in the table below about supply of alarm clocks, calculate the price elasticity of supply from: point J to point K, point L to point M, and point N to point P. Classify the elasticity at each point as elastic, inelastic, or unit elastic.

Point	Price	Quantity Supplied
J	$8	50
K	$9	70
L	$10	80
M	$11	88
N	$12	95
P	$13	100

[Show solution.]

From point J to point K, price rises from $8 to $9, and quantity rises from 50 to 70. Using these numbers, we can fill in the formulas for percent change in quantity and price:

$\%\ \text{change in quantity} = \frac{70-50}{(70+50)\div 2} \times 100 = 20/60 \times 100 = 33.33$

$\%\text{change in price} = \frac{\$9-\$8}{(\$9+\$8)\div 2} \times 100 = 1/8.5 \times 100 = 11.76$

Now, we can use the results of our calculations above to fill in the formula for elasticity of supply:

$\text{Elasticity of supply} = = 11.76\% / 33.33\% = 2.83$

The supply curve is elastic in this area; that is, its elasticity value is greater than one.

Now follow the same process using the data from point L to point M. The price rises from $10 to $11, while the Q_S rises from 80 to 88.

$\%\ \text{change in quantity} = \frac{88-80}{(88+80)\div 2} \times 100 = 8/84 \times 100 = 9.52$

$\%\text{change in price} = \frac{\$11-\$10}{(\$11+\$10)\div 2} \times 100 = 1/10.5 \times 100 = 9.52$

$\text{Elasticity of supply} = = = = = = = = 9.52\% / 9.52\% = 1.0$

The supply curve has unitary elasticity in this area.

And finally, from point N to point P. The price rises from $12 to $13, and Q_S rises from 95 to 100.

$\%\ \text{change in quantity} = \frac{100-95}{(100+95)\div 2} \times 100 = 5/97.5 \times 100 = 5.13$

$\%\text{change in price} = \frac{\$13-\$12}{(\$13+\$12)\div 2} \times 100 = 1/12.5 \times 100 = 8.0$

$\text{Elasticity of supply} = = = = = = = = 5.13\% / 8.0\% = 0.64$

The supply curve is inelastic in this region of the supply curve.

Review Questions

- What is the formula for calculating elasticity?
- What is the price elasticity of demand? Can you explain it in your own words?
- What is the price elasticity of supply? Can you explain it in your own words?

Critical-thinking questions

- Transatlantic air travel in business class has an estimated elasticity of demand of 0.40 less than transatlantic air travel in economy class, with an estimated price elasticity of 0.62. Why do you think this is the case?
- What is the relationship between price elasticity and position on the demand curve? For example, as you move up the demand curve to higher prices and lower quantities, what happens to the measured elasticity? How would you explain that?

Problems

- The equation for a demand curve is $P = 48 - 3Q$. What is the elasticity in moving from a quantity of 5 to a quantity of 6?
- The equation for a demand curve is P=2/Q. What is the elasticity of demand as price falls from 5 to 4? What is the elasticity of demand as the price falls from 9 to 8? Would you expect these answers to be the same?
- The equation for a supply curve is 4P=Q. What is the elasticity of supply as price rises from 3 to 4? What is the elasticity of supply as the price rises from 7 to 8? Would you expect these answers to be the same?
- The equation for a supply curve is $P = 3Q - 8$. What is the elasticity in moving from a price of 4 to a price of 7?

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