Microeconomics: Elasticity & Total Revenue Test

Price Elasticity OF Demand (ε^D)

Price elasticity of demand tells us how sensitive the quantity demanded of a good is to a change in price. The formula below uses the midpoint method, where subscript "2" represents the value after the price change and subscript "1" before:

$$\varepsilon = \frac{\text{Percentage change in quantity}}{\text{Percentage change in price}} = \frac{\frac{Q_2 - Q_1}{(Q_2 + Q_1)/2}}{\frac{P_2 - P_1}{(P_2 + P_1)/2}}$$

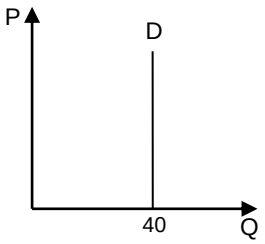
Price and quantity demanded are negatively correlated (as one moves up the other moves down), so price elasticity of demand is negative. However, the norm is to take the absolute value (make it positive) of the price elasticity of demand and comment on it based on where it falls in the three ranges below:

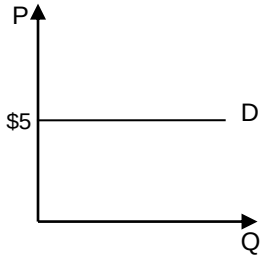
(1) When $\infty > |\varepsilon^D| > 1$, the good is **elastic**. The percent change in quantity is greater than the percent change in price, meaning people alter their buying patterns a lot in response to a small difference in price (very sensitive to price).

(2) When $|\varepsilon^D| = 1$, the good is **unit elastic**. The percentage change in quantity demanded (or supplied) is the same as the percentage change in price.

(3) When $0 < |\varepsilon^D| < 1$ for a good, the good is **inelastic**. A change in price will not have much effect on the quantity demanded (or supplied).

There are also two special cases: perfectly inelastic and perfectly elastic goods. For a **perfectly inelastic good** $\varepsilon = 0$, and the quantity demanded will remain exactly the same regardless of price. This is the graph on the left below, with a vertical demand curve. For a **perfectly elastic good** $\varepsilon = \infty$, when price increases, no matter how small the change is, quantity demanded becomes 0. This appears in the graph on the right below as a horizontal demand curve (think about drawing the three horizontal lines in an E).





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Determinants of Elasticity of Demand

1. **Substitutability** (lots of substitutes = more elastic)
2. **Luxury vs necessity item** (luxury items = elastic; necessities = inelastic)
3. **Percentage of household budget** (the larger the percentage, the more elastic; the smaller the percentage the more inelastic)
4. **Length of time since price change** (the more time that has passed the more elastic demand is; in the short run it is harder to change consumption habits/find substitutes = more inelastic)

Income Elasticity of Demand (ε^Y)

Similar to price elasticity of demand, instead of looking at how quantity demanded responds to a price change, now we look at how quantity demanded of a good changes in response to changes in consumer income. This is called income elasticity of demand.

$$\varepsilon^Y = \frac{\text{Percentage change in quantity}}{\text{Percentage change in income}} = \frac{\frac{Q_2 - Q_1}{(Q_2+Q_1)/2}}{\frac{I_2 - I_1}{(I_2+I_1)/2}}$$

The three important ranges to know for ε^Y are:

- $\varepsilon^Y < 0$ (negative): inferior good, ex: canned meat (the amount of good desired/consumed is negatively correlated to income – buy less of it the more income we make and vice versa)
- $0 < \varepsilon^Y < 1$ (positive, but less than one): normal/necessity good, ex: milk
- $\varepsilon^Y > 1$: normal/luxury good, ex: big screen TV (the amount of good desired/consumed is positively correlated to income – buy more of it the more income we make and vice versa)

Cross-Price Elasticity of Demand (ε^{XY})

Cross-price elasticity of demand measures how a price change of one good affects the quantity demanded of another good.

$$\varepsilon^{XY} = \frac{\text{Percentage change in quantity of good X}}{\text{Percentage change in price of good Y}} = \frac{\frac{Q_2 - Q_1}{(Q_2+Q_1)/2}}{\frac{P_2 - P_1}{(P_2+P_1)/2}}$$

- ε^{xy} **is negative** = goods are complements (consumed together, e.g. cookies and milk)
- ε^{xy} **is positive** = goods are substitutes (can use good B in place of good A, e.g. Lucerne butter and Dairyland butter)
- $\varepsilon^{xy} = +/-\infty$, goods are either perfect complements or perfect substitutes
- $\varepsilon^{xy} = 0$, goods are unrelated

Price Elasticity of Supply (ε^S)

We can also measure the price elasticity of supply. This is similar to the definition for price elasticity of demand, but now we measure how the quantity supplied of a good changes in response to the selling price (market price) of a good. ε^S is always positive since price and the quantity supplied are positively correlated.

$$\varepsilon^S = \frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}} = \frac{\frac{Q_2 - Q_1}{(Q_2 + Q_1)/2}}{\frac{P_2 - P_1}{(P_2 + P_1)/2}}$$

The ranges identified for price elasticity of demand apply here as well.

Determinants of Elasticity of Supply

1. **Length of time since price change** (same as for ε^D, relatively inelastic in the short term but more elastic in the long term)
2. **Perishability of good** (perishable goods are relatively inelastic)
3. **Substitutability in output** (if the input goods can easily be switched to produce an alternate final product, then supply is more elastic)

NOTE: *For all elasticity calculations, choose the correct version of the formula based on the information given in the problem. If you are given percentage changes, use the percentage change version. If you are given quantities and prices, use that version of the formula.*

Total Revenue (TR) Test

The TR test is another way to measure elasticity of demand. Recall that TR is calculated by price multiplied by quantity sold [TR = P x Q]. When demand is elastic, a decrease in price results in an increase in total revenue. The reverse is also true. When demand is inelastic, a decrease in price results in a decrease in total revenue. Similarly, when $|\varepsilon^D| < 1$, an increase in price results in an increase in TR.

Practice Problems

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1. True or false: If the elasticity of demand is greater than 1, than an increase in price will cause TR to decrease. Include an example as a demonstration of your answer.
2. When demand is price inelastic, total revenues will **increase/decrease/stay the same** as the price falls.
3. If Ali's income increases from $36,000 to $40,000 and the amount of donuts he consumes increases from 52 per year to 86, calculate the income elasticity of demand. What type of goods are donuts for Ali?
4. Sukhpreet received a 10% raise in income. As a result, her demand for ground beef decreased by 15%. Calculate the income elasticity of demand. Is ground beef a normal or inferior good?
5. The price of tea increased from $1.20 to $1.50 per box. The quantity of scones demanded changed from 10 units to 8 units. Calculate the cross-elasticity of demand and comment on the relationship between the two goods.
6. A 12% rise in the price of cookies increases the quantity of muffins demanded by 24% and decreases the quantity of cookies demanded by 18%. Calculate the cross elasticity of demand between cookies and muffins.
7. If good A has a positive cross-price elastic of demand with good B and good A also has a positive income elasticity of demand, then
    a. A and B are complementary goods, and A is a normal good
    b. A and B are complementary goods, and A is an inferior good
    c. A and B are substitute goods, and A is a normal good
    d. A and B are substitute good, and A is an inferior good
8. Determine the elasticity of supply when the percentage change in price is 5% and percentage change in quantity supplied is 15%. Is this an inelastic or elastic good?
9. The price elastic of supply for soap is estimated to be 0.25. What change in quantity of soap supplied is expected with a 20% increase in price?
10. True or false: When supply is relatively inelastic, a 5% change in price will result in a greater than 5% change in quantity supplied.
11. Determine the elasticity of demand for white paper when the price increases from 30 to 40¢ and the quantity demanded changes from 85 to 80 boxes. Is this an elastic good?
12. The price elasticity of demand of the product you are selling is 0.6 and you wish to increase your sales levels by 30%. You could accomplish that result by decreasing your price by ___ %?

Solutions

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1. T. For this example, let's say a 5% increase in price results in a 10% decrease in quantity demanded. How is TR affected? Let $P_{original}$ = \$1. Then P_{new} = \$1.05. Let $Q_{original}$ = 10. Then Q_{new} will be 9.
   $TR_{old} = P_{orig} \times Q_{orig}$ = \$1 × 10 = \$10
   $TR_{new} = P_{new} \times Q_{new}$ = \$1.05 × 9 = \$9.45
2. decrease
3. ε^{Y} = 4.7; donuts are a normal/luxury good.
4. $\varepsilon^{Y} = \frac{-15\%}{10\%}$ = -1.5; ground beef is an inferior good.
5. ε^{XY} = -1; tea and scones are complements.
6. $\varepsilon^{XY} = \frac{24\%}{12\%}$ = 2; cookies and muffins are substitutes.
7. c
8. ε^{S} = 3; Since $\varepsilon^{S} > 1$ this is an elastic good.
9. A 5% increase in quantity supplied is expected.
10. F. Relatively inelastic means the change in quantity supplied is small relative to the change in price. For an inelastic good, we expect the change in quantity supplied to be less than 5%.
11. ε^{D} = 0.21; No, since $\varepsilon^{D} < 1$ this is an inelastic good.

12. 50%