AP Economics
Understanding Price Elasticity of Demand
Topic 2.3: Micro

Price elasticity of demand is a measure of the response in quantity demanded to a change in price.

This is useful for firms who want to see what effect price will have on **total revenue** (the amount of money a company receives by selling its goods as determined by price and quantity sold). $TR = P \times Q$

Calculating Price Elasticity

To compute price elasticity of demand, you would use the following formula:

$$\text{Elasticity} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

"Q over P equals elasticallyee!"

Because it yields more reliable results, economists most commonly use a variation of this formula called the midpoint or arc method:

$$\text{Price elasticity of demand} = \frac{\frac{Q_2 - Q_1}{(Q_1 + Q_2)/2}}{\frac{P_2 - P_1}{(P_1 + P_2)/2}}$$

$$\epsilon_d = \frac{\frac{Q_2 - Q_1}{(Q_1 + Q_2)/2}}{\frac{P_2 - P_1}{(P_1 + P_2)/2}}$$

← to find midpoint

same thing Q

When you calculate price elasticity of demand, it always results in a negative number. For the sake of simplicity, economists drop the negative sign. (just the absolute value of the number)

If elasticity is:

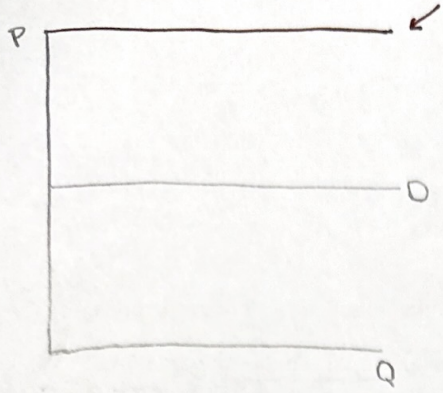
- Greater than 1, demand is said to be ***elastic***, indicating a large response to price change. ↳ tennis ball ↳ had a large response when it hit the group
- Equal to 1, demand is said to be ***unitary elastic***. ← if they raise price, no effect on total revenue
  ↳ both math signs
- Less than 1, demand is said to be ***inelastic***, indicative of a small response to change in price.
  ↳ baseball!
  ↳ small bounce but still a response

Factors Affecting Elasticity

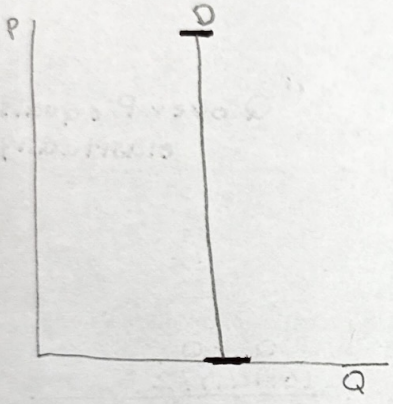
Elastic demand for a good results from one or more of these factors:

1. Availability of substitute goods
2. A limited budget that does not allow for price changes : not paying rent
3. The perception of the good as a luxury item

capital E = perfect Elastic!

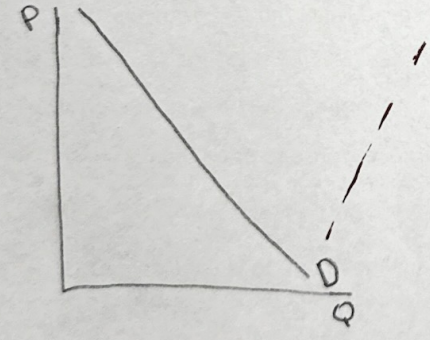


- Perfectly Elastic Demand -



- Perfectly inelastically Demand -

← an I means inelastic



- Unitary Elastic -

- demand half way
- could make it into a V or U for unitary

20,000 gal Milk = $2.00
10,000 gal Milk = $3.50

$$\frac{\frac{20{,}000 - 10000}{20000 + 10000\,|\,2}}{\frac{2.00 - 3.50}{2.00 + 3.50\,|\,2}} = \frac{66.6}{54.2} = 1.22$$

= 1.022

Elastic

~ GRAPHS ~

Elasticity: An Introduction

Student Alert: Elasticity measures the ***strength*** of your response to a change in a variable.

In many circumstances, it is not enough for an economist, policymaker, firm, or consumer to simply know the direction in which a variable will be moving. For example, if I am a producer, the law of demand tells me that if I increase the price of my good, the quantity demanded by consumers will decrease. The law of demand tells me the *direction* of the consumer response to the price change, but it does not tell me the *strength* of the consumer response. The law of demand doesn't tell me what will happen to my total revenue (the price of the good times the number of units sold). Whether total revenue increases or decreases depends on how responsive the quantity demanded is to the price change. Will total revenue increase or decrease by a little or a lot? Throughout the discipline of economics, in fact, the responsiveness of one variable to changes in another variable is an important piece of information. In general, *elasticity* is a measurement of how responsive one variable is to a change in another variable, *ceteris paribus* (holding all other variables constant).

Because elasticity measures responsiveness, changes in the variables are measured relative to some base or starting point. Each variable's change is measured as a percentage change. Consider the following elasticity measurements:

The price elasticity of demand, ε_d

$$\varepsilon_d = \frac{\text{percentage change in quantity demanded of Good X}}{\text{percentage change in price of Good X}}.$$

The income elasticity of demand, ε_I

$$\varepsilon_I = \frac{\text{percentage change in quantity demanded of Good X}}{\text{percentage change in income}}.$$

The cross-price elasticity of demand, ε_{CP}

$$\varepsilon_{CP} = \frac{\text{percentage change in quantity demanded of Good X}}{\text{percentage change in price of Good W}}.$$

The price elasticity of supply, ε_S

$$\varepsilon_S = \frac{\text{percentage change in quantity supplied of Good X}}{\text{percentage change in price of Good X}}.$$

Part A: Bonus Pay at Work

1. You have a job stocking items on the shelves at the local home improvement store. To increase productivity, your boss says a bonus will be paid based on how many items you put on the shelves each hour. Write the equation of the "elasticity of productivity" for this situation:

$$\varepsilon_{\text{productivity}} = \frac{\textit{percentage change in quantity}}{\textit{percentage change in price}}.$$

2. Assume your boss wants you to double your output, which would be a 100 percent increase in the number of items you shelve each hour. Underline the correct answer in each of these statements.

   (A) If your productivity is very responsive to a pay increase, then a given increase in your pay results in a large increase in your hourly output. In this case, your boss will need to increase the bonus pay by (*more than / less than / exactly*) 100 percent.

   (B) If your productivity is not very responsive to a pay increase, then a given increase in your pay results in a small increase in your hourly output. In this case, your boss will need to increase the bonus pay by (*more than / less than / exactly*) 100 percent.

Part B: The Price Elasticity of Demand

It's easy to imagine that there are many applications for the elasticity concept. Here we will concentrate on the price elasticity of demand for goods and services. For convenience, the measure is repeated here:

$$\varepsilon_d = \frac{\text{percentage change in quantity demanded of Good X}}{\text{percentage change in price of Good X}}.$$

Note the following points:

- Price elasticity of demand is always measured *along* a demand curve. When measuring the responsiveness of quantity demanded to a change in price, all other variables must be held constant.
- Because of the law of demand, which states that price and quantity demanded move in opposite directions, when you calculate the value of the price elasticity of demand, expect it to be a negative number. When we interpret that value, we consider the absolute value of ε_d.
- Along a linear, downward sloping demand curve, there are price ranges over which demand is elastic, unit elastic, and inelastic.

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Table 2-3.1
Relationship between Changes in Quantity Demanded and Price

%ΔQd compared to %ΔP	Absolute value of ε_d	Interpretation
%ΔQd > %ΔP	> 1	Elastic
%ΔQd = %ΔP	= 1	Unit elastic
%ΔQd < %ΔP	< 1	Inelastic

Part C: Calculating the Arc Elasticity Coefficient

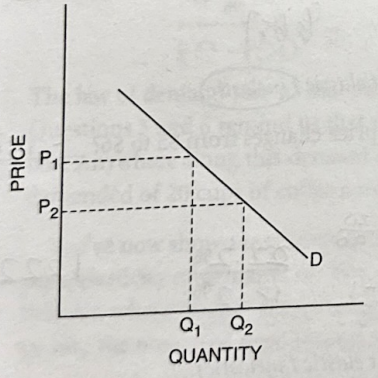
The arc elasticity calculation method is obtained when the midpoint or average price and quantity are used in the calculation. This is reflected in the formula below.

$$\varepsilon_d = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}} = \frac{\left(\frac{Q_2 - Q_1}{(Q_2 + Q_1)/2}\right)}{\left(\frac{P_2 - P_1}{(P_2 + P_1)/2}\right)} = \frac{\left(\frac{\Delta Q}{(Q_2 + Q_1)/2}\right)}{\left(\frac{\Delta P}{(P_2 + P_1)/2}\right)}.$$

$$\varepsilon_d = \frac{\left(\frac{\text{the actual change in Q}}{\text{the average value of Q}}\right)}{\left(\frac{\text{the actual change in P}}{\text{the average value of P}}\right)}.$$

Suppose in Figure 2-3.1 that price is decreased from P_1 to P_2 and so quantity demanded increases from Q_1 to Q_2.

Figure 2-3.1
Calculating the Arc Elasticity Coefficient



Because price decreased, our calculations will show the percentage change in price is negative. Because quantity demanded increased, the percentage change in quantity demanded is positive. The ratio of the two percentage changes thus will have a negative value. When we interpret the calculated value of ε_d, we consider its absolute value in deciding whether demand over this price range is elastic, unit elastic, or inelastic. Note that we have used the average of the two prices and the two quantities. We have done this so that the elasticity measured will be the same whether we are moving from Q_1 to Q_2 or the other way around.

Part D: Coffee Problems

Suppose Moonbucks, a national coffee-house franchise, finally moves into the little town of Middleofnowhere. Moonbucks is the only supplier of coffee in town and faces the weekly demand schedule as shown in Table 2-3.2. Answer the questions that follow.

Table 2-3.2

Cups of Coffee Demanded per Week

Price (per cup)	Quantity demanded	Price (per cup)	Quantity demanded
$10	0	$4	120
$9	20	$3	140
$8	40	$2	160
$7	60	$1	180
$6	80	$0	200
$5	100		

3. What is the arc price elasticity of demand when the price changes from $1 to $2? .18

$$\varepsilon_d = \frac{\left(\frac{\Delta Q}{(Q_2+Q_1)/2}\right)}{\left(\frac{\Delta P}{(P_2+P_1)/2}\right)} = \frac{\frac{180-160}{180+160/2}}{\frac{2-1}{2+1/2}} = \frac{\frac{20}{170}}{\frac{1}{2.5}} = \frac{11.8\%}{66.7\%} = 0.18$$

So, over this range of prices, demand is (*elastic / unit elastic* / inelastic).

4. What is the arc price elasticity of demand when the price changes from $5 to $6? -1.22

$$\varepsilon_d = \frac{\frac{\Delta Q}{(Q_2+Q_1)/2}}{\frac{\Delta P_1}{(P_2+P_1)/2}} = \frac{\frac{100-80}{100+80/2}}{\frac{\$5-6}{5+6/2}} = \frac{\frac{20}{90}}{\frac{-1}{5.5}} = \frac{22.2\%}{18.2\%} = 1.22$$

So, over this range of prices, demand is (*elastic* / *unit elastic* / *inelastic*).

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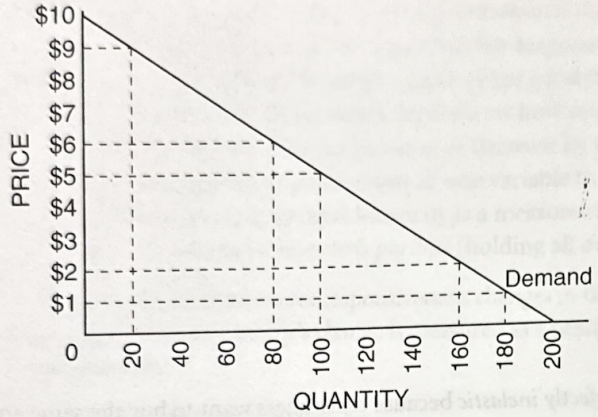
Part E: Comparing Slope and Price Elasticity of Demand

Now, consider Figure 2-3.2, which graphs the demand schedule given in Table 2-3.2.

Recall that the slope of a line is measured by the rise over the run: slope = rise / run = $\Delta P / \Delta Q$.

Figure 2-3.2
Elasticity of Demand for Coffee



5. Using your calculations of ΔP and ΔQ from Question 3, calculate the slope of the demand curve between the prices of $1 and $2.

$\frac{Y_2 - Y_1}{X_2 - X_1}$ $\frac{2-1}{160-180} = \frac{1}{20} = -\frac{1}{20}$

6. Using your calculations of ΔP and ΔQ from Question 4, calculate the slope of the demand curve between the prices of $5 and $6.

$\frac{6-5}{80-100} = -\frac{1}{20}$

7. The law of demand tells us that an increase in price results in a decrease in the quantity demanded. Questions 5 and 6 remind us that the slope of a straight line is *constant everywhere along the line.* Anywhere along this demand curve, a change in price of $1 generates a change in quantity demanded of 20 cups of coffee a week.

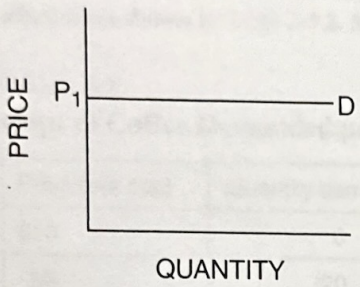
You've now shown mathematically that while the slope of the demand curve is related to the price elasticity of demand, the two concepts are not the same thing. Briefly discuss the relationship between where you are along the demand curve and the price elasticity of demand. How does this tie into the notion of *responsiveness*?

this ties into responiveness because quanity and price rely on each other to maintain a healthy relationship.

Part F: Two Extreme Cases of Price Elasticity of Demand

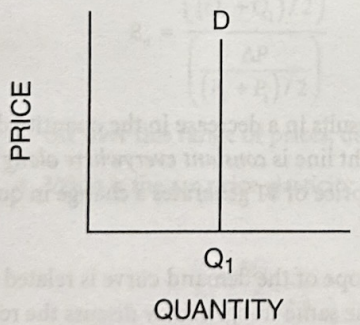
8. A horizontal demand curve is *perfectly elastic* because consumers will completely stop buying the good if the price is increased even by a small amount. This extreme case is shown by the demand curve facing a perfectly competitive firm. Such a firm can sell all it wants at the current market price (P_1), but if it raises its price it will lose all of its customers to other firms selling the same product at price P_1.

Figure 2-3.3
Perfectly Elastic Demand



9. A vertical demand curve is *perfectly inelastic* because consumers want to buy the same amount (Q_1) of the good, no matter what the price. If the price increases, there is no response by consumers. This extreme case is approximated by the demand for a life-saving drug for which there are no acceptable substitutes.

Figure 2-3.4
Perfectly Inelastic Demand



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1. Which of the following statements is true?
   a. When a good absorbs only a small share of the typical consumer's income, the income effect explains the demand curve's negative slope.
   b. A change in consumption brought about by a change in purchasing power describes the substitution effect.
   c. In the case of an inferior good, the income effect is usually larger than the substitution effect.
   d. In the case of an inferior good, the income and substitution effects work in opposite directions.
   e. Normal goods and inferior goods differ in regard to the direction of the substitution effect caused by a price increase.

2. If there is an increase in the price of an inferior good on which consumers spend a large share of their income, which of the following will decrease the quantity of that good demanded?
   a. the Giffen effect
   b. the income effect only
   c. the substitution effect only
   d. the income effect and the substitution effect
   e. neither the income effect nor the substitution effect

3. If a decrease in price from $2 to $1 causes an increase in quantity demanded from 100 to 120, using the midpoint method, price elasticity of demand equals
   a. 0.17.
   b. 0.27.
   c. 0.40.
   d. 2.5.
   e. 3.72.

4. Which of the following is likely to have the highest price elasticity of demand?
   a. eggs
   b. beef
   c. housing
   d. gasoline
   e. foreign travel

5. If a 2% change in the price of a good leads to a 10% change in the quantity demanded of a good, what is the price elasticity of demand?
   a. 0.02
   b. 0.2
   c. 5
   d. 10
   e. 20

6. A perfectly elastic demand curve is
   a. upward-sloping.
   b. vertical.
   c. not a straight line.
   d. horizontal.
   e. downward-sloping.

7. Which of the following would cause the demand for a good to be relatively inelastic?
   a. The good has a large number of close substitutes.
   b. Expenditures on the good represent a large share of consumer income.
   c. There is ample time to adjust to price changes.
   d. The good is a necessity.
   e. The price of the good is in the upper left section of a linear demand curve.

8. Which of the following is correct for a price increase? When demand is _____, total revenue will _____.

Demand	*Total Revenue*
a. inelastic	decrease
b. elastic	decrease
c. unit-elastic	increase
d. unit-elastic	decrease
e. elastic	increase

9. Total revenue is maximized when demand is
   a. elastic.
   b. inelastic.
   c. unit-elastic.
   d. zero.
   e. infinite.

10. If you are addicted to chocolate cake such that you buy one piece per day regardless of the price, your price elasticity of demand for chocolate cake is
    a. infinity.
    b. 1.
    c. more than 1 but less than infinity.
    d. 0.
    e. more than 0 but less than 1.

Tackle the AP® Test: Multiple-Choice Questions

1. d
2. c
3. b
4. e
5. c
6. d
7. d
8. b
9. c
10. d