Elasticity and Its Application

Chapter 5

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Introduction

Why does elasticity matter?

Consider the following scenario

- There is a wildfire in Oregon and Washington (two states that produce wheat)
- Wheat supply will be affected
- Supply will decrease, causing the price of wheat to increase
- Wheat is an input in the production of bread (the supply of bread will be affected)
- Higher wheat prices will cause the price of bread to increase

What will happen to the demand for bread in this scenario?

- An obvious answer will be: people will buy less bread.
- By how much would bread purchases fall in response to the higher prices?
- To answer the previous question, we need to learn about elasticity

What is elasticity ?

Elasticity is a measure of how buyers and sellers respond to changes in market conidtions.

The Elasticity of Demand

Price elasticity of demand

- The *price elasticity of demand* measures how much the quantity demanded responds to a change in price

- Demand for a good is *elastic* if the quantity demanded responds substantially to changes in the price

- Demand for a good is *inelastic* if the quantity demanded responds only slightly to changes in the price

Availability of close substitutes

- A good with similar substitutes has more elastic demand
- People can switch from one more expensive good to another heaper good
- Pepsi and Coke are close substitutes
- A good with no substitutes has more inelastic demand
- People can't switch to another alternative
- Eggs don't have close substitutes

Necessities vs luxuries

- Necessities have inelastic demands
- Luxuries have elastic demands

Examples:

- If the price of water increases, people will not adjust their consumption dramatically
- If the price of sailboats rises, the number of sailboats sold will fall dramatically

Definition of the market

- The elasticity of demand in any market depends on how we define said market
- Markets that are narrowly defined often have more elastic demand (ice cream)
- Markets that broadly define often have more inelastic demand (food)

Time horizon

- Good tends to have more elastic demand over the longer time horizons
- If the price of gasoline rises, the quantity of purchased gasoline falls slightly
- Over the long run, more efficient cars will be invented
- More efficient cars reduces the amount of gasoline consumed
- The quantity of gasoline will fall more substantially

Computing the Price Elasticity of Demand

Calculating Demand Elasticity

- Elasticity of demand is the percentage change in the quantity demanded over the percentage change in the price

$$\text{Price elasticity of demand} = \frac{\%\Delta\text{in quantity demanded}}{\%\Delta\text{price}}$$

- Example: in response to a 10% increase in the price of ice cream, the quantity of ice cream demanded fell by 20%. Calculate the price elasticity of demand.

$$\text{Ice cream's price elasticity of demand} = \frac{20\%}{10\%} = 2$$

- We can interpret this elasticity as the quantity of ice cream demanded response twice as large to change in the price of ice cream
- Quantities and prices have a negative relationship
- The numerator will always have the opposite sign of the denominator
- The convention in economics is to drop the negative sign when calculating the price elasticity of demand
- Price elasticity of demand is always interpreted as a negative number

The midpoint method

The midpoint method is a better way to calculate percentage changes and elasticities

Example:

$$\text{Point A: } \text{Price} = \$4, \ \text{Quantity} = 120$$
$$\text{Point B: } \text{Price} = \$6, \ \text{Quantity} = 80$$

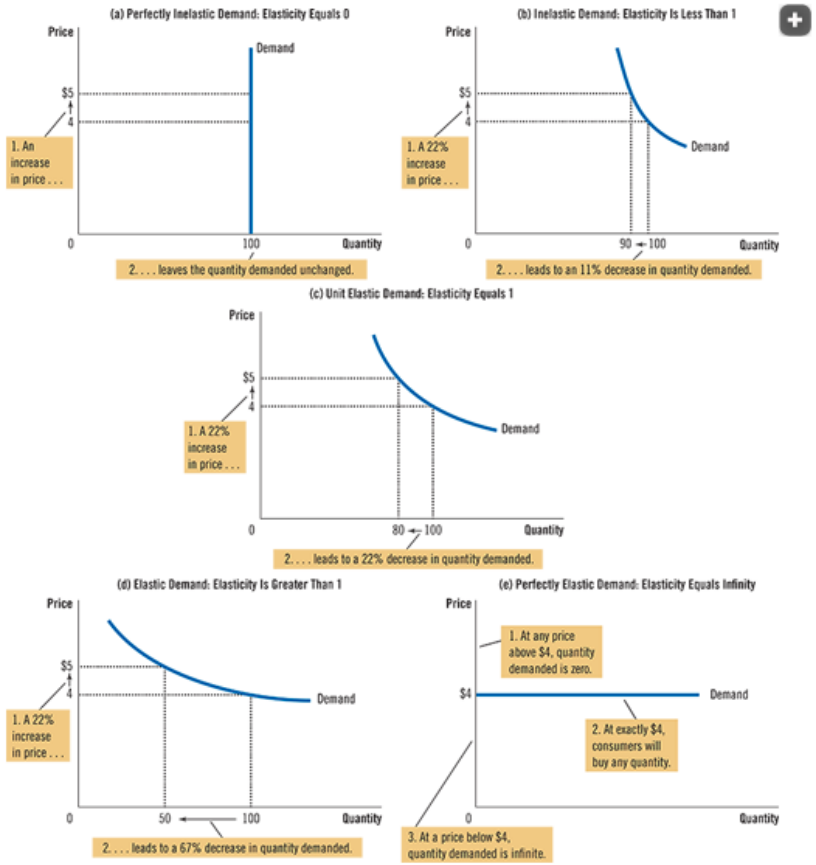
- If you calculate elasticity using the previous equation, elasticity from point A to B will seem different from the elasticity from point B to A
- Elasticity from A to B is 0.66
- Elasticity from B to A is 1.5
- You can avoid this problem by using the *midpoint method*

$$\text{Price elasticity of demand} = \frac{\frac{Q_2 - Q_1}{0.5 \cdot (Q_2 + Q_1)}}{\frac{P_2 - P_1}{0.5 \cdot (P_2 + P_1)}}$$

Variety of demand curves

Figure 1 **The Price Elasticity of Demand**

The price elasticity of demand determines whether the demand curve is steep or flat. Note that all percentage changes are calculated using the midpoint method.

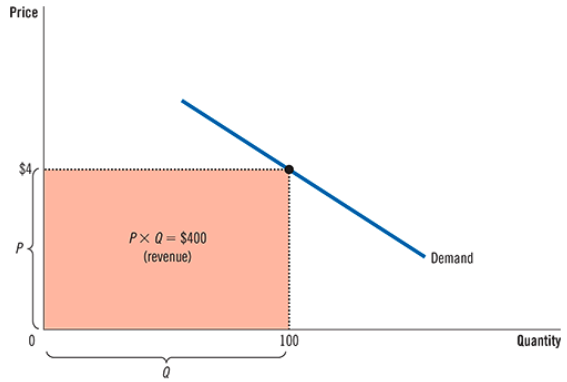


Total revenue and price elasticity of demand

- Total revenue is an important variable to look at when there are changes to supply and demand
- *Total revenue* is the amount paid by buyers and received by sellers of a good
- $R = P \times Q$

Figure 2 **Total Revenue**

The area of the box under the demand curve, $P \times Q$, equals the total amount paid by buyers as well as the total revenue received by sellers. Here, at a price of $\$4$, the quantity demanded is 100 and total revenue is $\$400$.

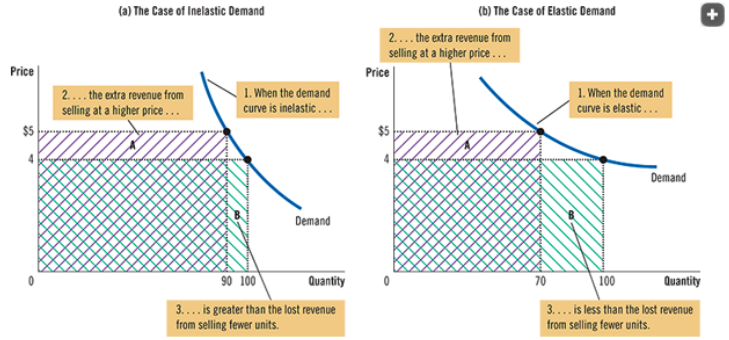


How does total revenue change as we move along the demand curve?

It depends on the elasticity of the demand curve

Figure 3 **How Total Revenue Changes When Price Changes**

The impact of a price change on total revenue (the product of price and quantity) depends on the elasticity of demand. In panel (a), the demand curve is inelastic. In this case, an increase in the price leads to a proportionately smaller decrease in quantity demanded, so total revenue increases. Here an increase in the price from $4 to $5 causes the quantity demanded to fall from 100 to 90. Total revenue rises from $400 to $450. In panel (b), the demand curve is elastic. In this case, an increase in the price leads to a proportionately larger decrease in quantity demanded, so total revenue decreases. Here an increase in the price from $4 to $5 causes the quantity demanded to fall from 100 to 70. Total revenue falls from $400 to $350.



General rules on elasticity

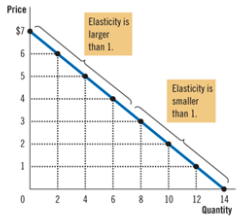
- When demand is inelastic (a price elasticity less than one), price and total revenue move in the same direction: If the price increases, total revenue also increases.
- When demand is elastic (a price elasticity greater than one), price and total revenue move in opposite directions: If the price increases, total revenue decreases.
- If demand is unit elastic (a price elasticity exactly equal to one), total revenue remains constant when the price changes.

Elasticity and total revenue along a linear demand curve

Even though the slope of a linear curve is constant, elasticity is not. The slope is the ratio of changes in two variables, whereas elasticity is the ratio of percentage changes in the two variables

Figure 4 **Elasticity along a Linear Demand Curve**

The slope of a linear demand curve is constant, but its elasticity is not. The price elasticity of demand is calculated using the demand schedule in the table and the midpoint method. At points with a low price and high quantity, the demand curve is inelastic. At points with a high price and low quantity, the demand curve is elastic.



Price	Quantity	Total Revenue (Price × Quantity)	Percentage Change in Price	Percentage Change in Quantity	Elasticity	Description
$7	0	$0				
			15	200	13.0	Elastic
6	2	12				
			18	67	3.7	Elastic
5	4	20				
			22	40	1.8	Elastic
4	6	24				
			29	29	1.0	Unit elastic
3	8	24				
			40	22	0.6	Inelastic
2	10	20				
			67	18	0.3	Inelastic
1	12	12				
			200	15	0.1	Inelastic
0	14	0				

Other Demand Elasticities

Income elasticity of demand

- Income elasticity of demand is a measure of how the quantity demanded changes as consumer income changes.

$$\text{Income elasticity of demand} = \frac{\%\Delta\text{in quantity demanded}}{\%\Delta\text{income}}$$

Cross-price elasticity of demand

- Cross-price elasticity of demand is a measure of how the quantity demanded of one good response to a change in the price of another good

$$\text{Cross-price elasticity of demand} = \frac{\%\Delta\text{in quantity demanded of good one}}{\%\Delta\text{price of good two}}$$

The Elasticity of Supply

Price elasticity of supply

- Price elasticity of supply measures how much the quanitity supplied responds to changes in the price
- The supply of a good is *elastic* if the quantity supplied response substantially to a change in price
- The supply of a good is *inelastic* if the quantity supplied response slightly to a change in price

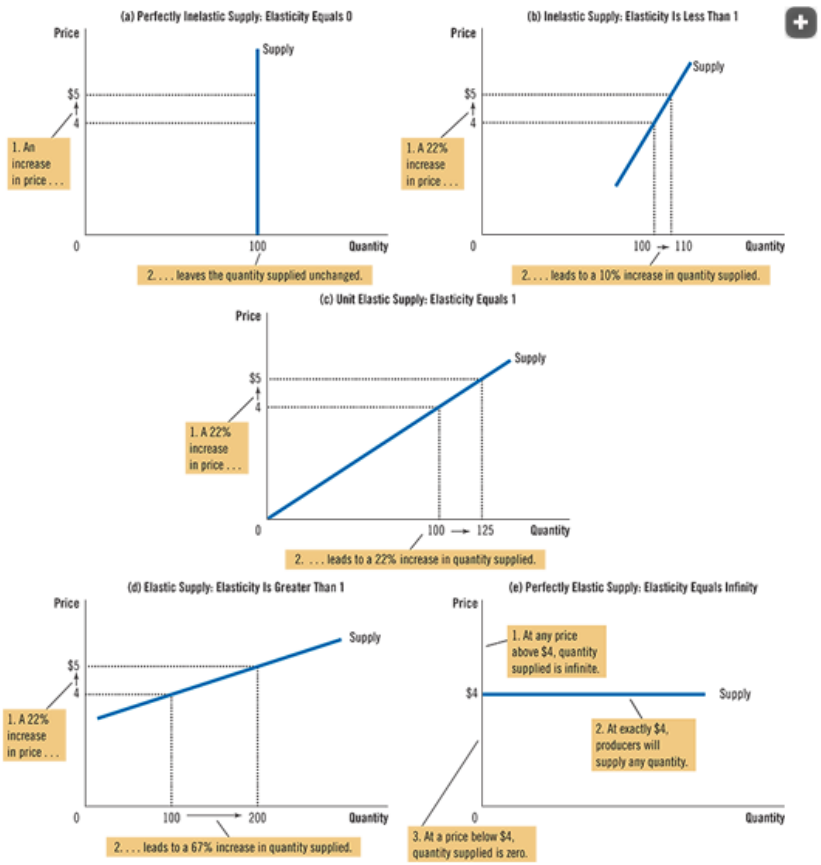
Calculating Supply Elasticity

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

The different supply curves

Figure 5 **The Price Elasticity of Supply**

The price elasticity of supply determines whether the supply curve is steep or flat. Note that all percentage changes are calculated using the midpoint method.

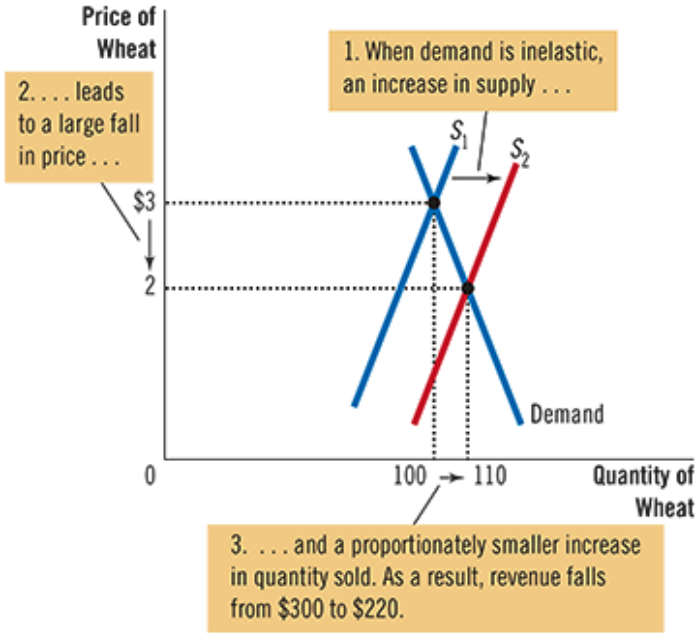


Three Applications of Supply, Demand and Elasticity

Wheat farmers

Figure 7 **An Increase in Supply in the Market for Wheat**

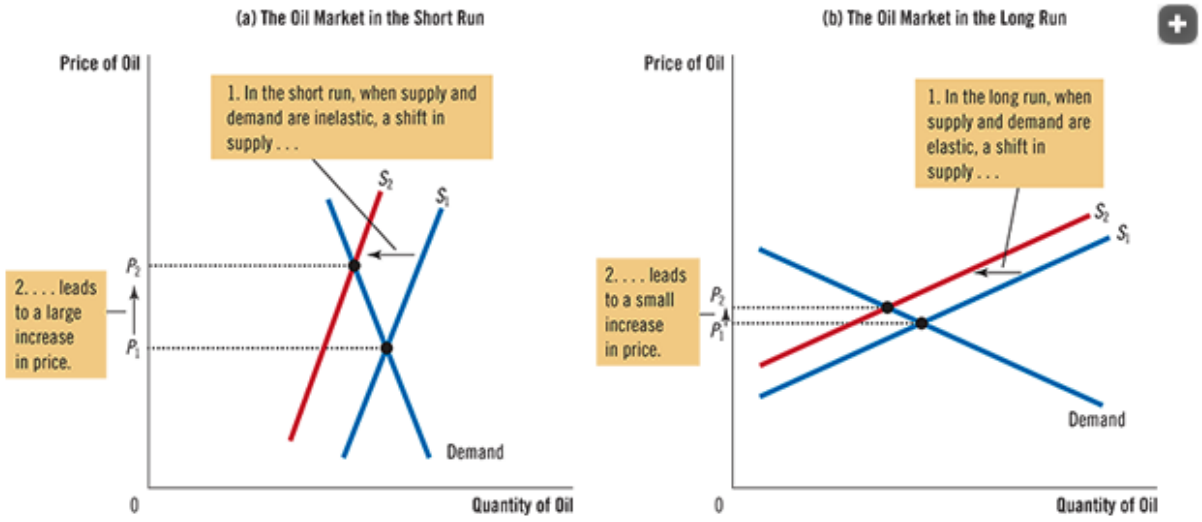
When an advance in farm technology increases the supply of wheat from S_1 to S_2, the price of wheat falls. Because the demand for wheat is inelastic, the increase in the quantity sold from 100 to 110 is proportionately smaller than the decrease in the price from \$3 to \$2. As a result, farmers' total revenue falls from \$300 (\$3 × 100) to \$220 (\$2 × 110).



OPEC

Figure 8 **A Reduction in Supply in the World Market for Oil**

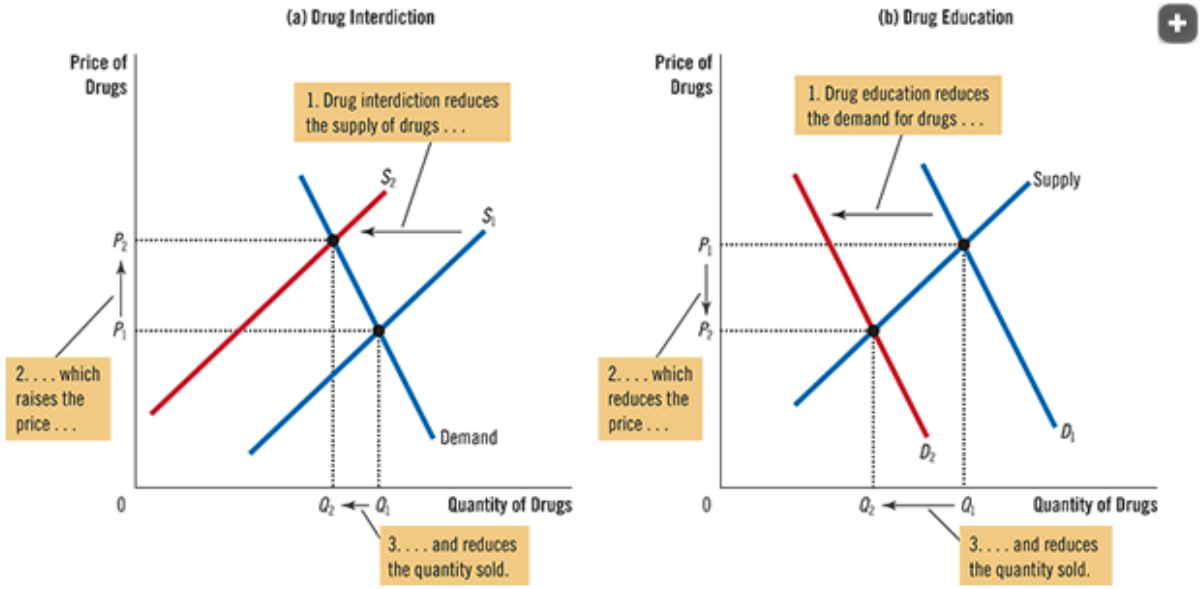
When the supply of oil falls, the response depends on the time horizon. In the short run, supply and demand are relatively inelastic, as in panel (a). Thus, when the supply curve shifts from S_1 to S_2, the price rises substantially. In the long run, however, supply and demand are relatively elastic, as in panel (b). In this case, the same size shift in the supply curve (S_1 to S_2) causes a smaller increase in the price.



Drug policies

Figure 9 **Policies to Reduce the Use of Illegal Drugs**

Drug interdiction reduces the supply of drugs from S_1 to S_2, as in panel (a). If the demand for drugs is inelastic, then the total amount paid by drug users rises, even as the amount of drug use falls. By contrast, drug education reduces the demand for drugs from D_1 to D_2, as in panel (b). Because both price and quantity fall, the amount paid by drug users falls.



Problems and Applications

Question 1

For each of the following pairs of goods, which good would you expect to have more elastic demand and why?

Required textbooks or mystery novels

- Mystery novels because they have close substitutes are a luxury good. Required textbooks are a necessity with no close substitutes

Beethoven recordings or classical music recordings in general

- Beethoven recordings have more elastic demand than classical music recordings in general. Beethoven recordings are a narrower market

Subway rides during the next 6 months or subway rides during the next 5 years

- Subway rides during the next five years have more elastic demand. Goods have a more elastic demand over longer time horizons

Root beer or water

- Root beer has more elastic demand than water. Root beer is a luxury with close substitutes, while water is a necessity with no close substitutes

Question 2

Suppose that business travelers and vacationers have the following demand for airline tickets from New York to Boston:

Price	Quantity Demanded (business travelers)	Quantity Demanded (vacationers)
$150	2,100 tickets	1,000 tickets
200	2,000	800
250	1,900	600
300	1,800	400

a. As the price of tickets rises from $200 to $250, what is the price elasticity of demand for (i) business travelers and (ii) vacationers? (Use the midpoint method in your calculations.)

$$E_B = \frac{\frac{Q_2 - Q_1}{0.5 \cdot (Q_2 + Q_1)}}{\frac{P_2 - P_1}{0.5 \cdot (P_2 + P_1)}} = \frac{\frac{2{,}000 - 1{,}900}{1{,}950}}{\frac{250 - 200}{225}} = 0.23$$

$$E_V = \frac{\frac{800 - 600}{700}}{\frac{250 - 200}{225}} = 1.32$$

Question 2 (cont.)

b. Why might vacationers have a different elasticity from business travelers?

- The price elasticity of demand for vacationers is higher than the elasticity for business travelers because vacationers can choose a substitute more easily than business travelers
- For example, vacationers can choose a different mode of transportation (like driving or taking the train), a different destination, a different departure date, and a different return date. They may also choose to not travel at all. Business travelers are less likely to do so because their schedules are less adaptable.

Question 3

Suppose the price elasticity of demand for heating oil is 0.2 in the short run and 0.7 in the long run.

If the price of heating oil rises from $1.80 to $2.20 per gallon, what happens to the quantity of heating oil demanded in the short run? In the long run?

- The percentage change in price is equal to $(2.20 - 1.80)/2.00 \times 100 = 20\%$
- If the price elasticity of demand is 0.2, quantity demanded will fall by $0.2 \times 0.2 = 0.04 \Rightarrow 4\%$ in the short run
- If the price elasticity of demand is 0.7, quantity demanded will fall by $0.7 \times 0.2 = 0.14 \Rightarrow 14\%$ in the short run

Why might this elasticity depend on the time horizon?

- Over time, consumers can make adjustments to their homes by purchasing alternative heat sources such as natural gas or electric furnaces. Thus, they can respond more easily to the change in the price of heating oil in the long run than in the short run.

Question 4

A price change causes the quantity demanded of a good to decrease by 30 percent, while the total revenue of that good increases by 15 percent. Is the demand curve elastic or inelastic? Explain.

- If quantity demanded fell, price must have increased according to the law of demand
- For a price increase to increase total revenue, the percentage increase in the price must be greater than the percentage decline in quantity demanded
- Therefore, demand is inelastic

Question 5

Cups of coffee and donuts are complements. Both have inelastic demand. A hurricane destroys half the coffee bean crop. Use appropriately labeled diagrams to answer the following questions.

a. What happens to the price of coffee beans?

The effect on the market for coffee beans is shown in Figure 2. When a hurricane destroys half of the crop, the supply of coffee beans decreases, the price of coffee beans increases, and the quantity decreases.

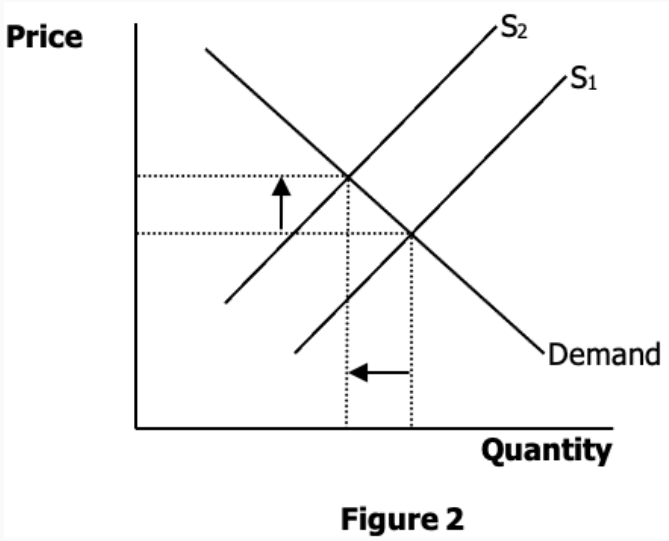


Figure 2

Question 5

Cups of coffee and donuts are complements. Both have inelastic demand. A hurricane destroys half the coffee bean crop. Use appropriately labeled diagrams to answer the following questions.

b. What happens to the price of a cup of coffee? What happens to total expenditure on cups of coffee?

The effect on the market for cups of coffee is shown in Figure 2. When the price of coffee beans, an important input into the production of a cup of coffee, increases, the supply of cups of coffee decreases, the price of a cup of coffee increases, and the quantity decreases. Because cups of coffee have an inelastic demand, when the price of a cup of coffee increases, the total expenditure on coffee increases.

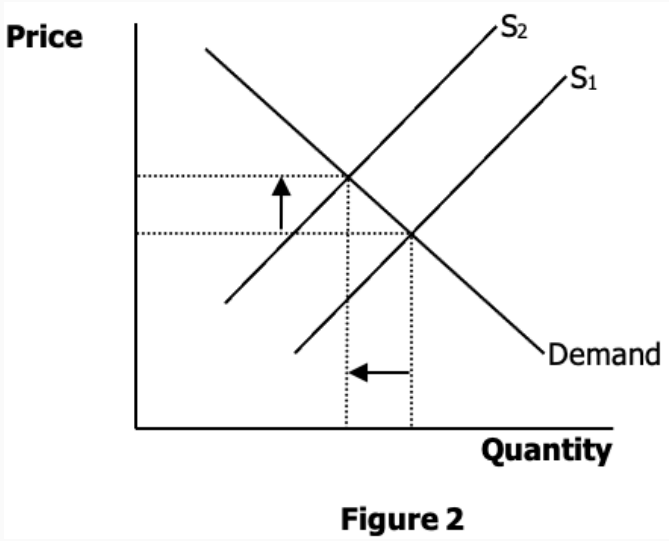


Figure 2

Question 5

Cups of coffee and donuts are complements. Both have inelastic demand. A hurricane destroys half the coffee bean crop. Use appropriately labeled diagrams to answer the following questions.

c. What happens to the price of donuts? What happens to total expenditure on donuts?

The effect on the market for donuts is shown in Figure 3. When the price of coffee increases and the quantity demanded of coffee decreases, consumers demand fewer donuts because coffee and donuts are complements. When demand decreases, the price of donuts decreases.

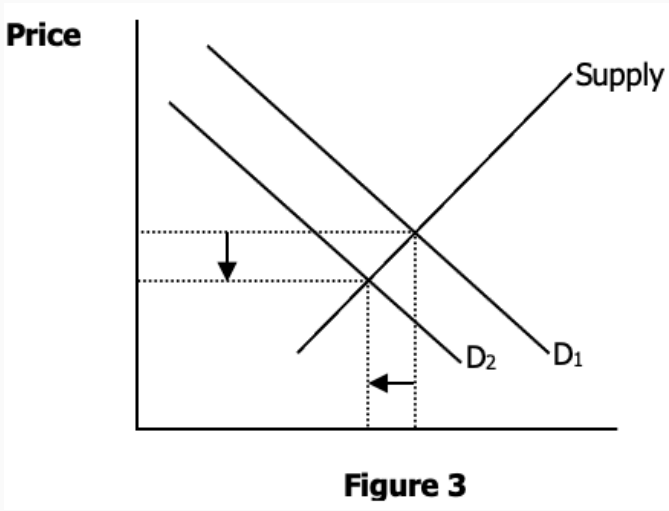


Figure 3

Question 6

The price of coffee rose sharply last month, while the quantity sold remained the same. Five people suggest various explanations:

- Leonard:Demand increased, but supply was perfectly inelastic
- Sheldon:Demand increased, but it was perfectly inelastic
- Penny:Demand increased, but supply decreased at the same time
- Howard:Supply decreased, but demand was unit elastic
- Raj:Supply decreased, but demand was perfectly inelastic

Who could possibly be right? Use graphs to explain your answer.

If the price of coffee rose sharply while the quantity sold remained the same, the explanations offered by Leonard, Penny, and Raj could be correct while the explanations offered by Sheldon and Howard are incorrect

Question 6

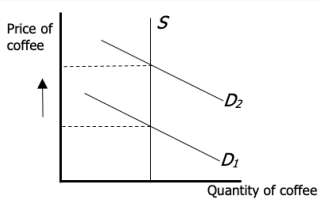


Figure 4:
Leonard's Explanation

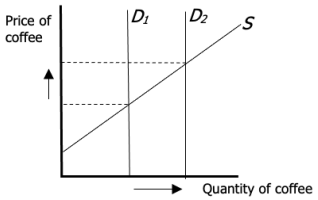


Figure 5:
Sheldon's Explanation

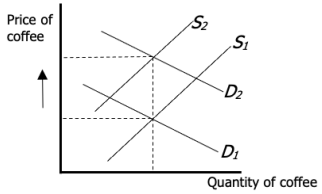


Figure 6:
Penny's Explanation

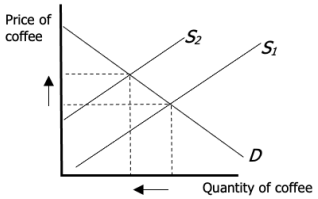


Figure 7:
Howard's Explanation

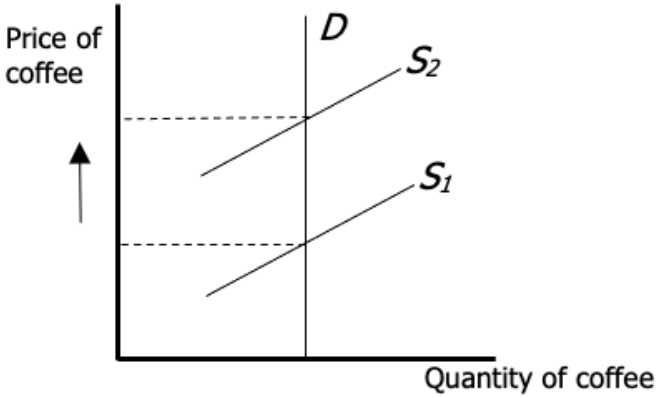


Figure 8:
Raj's Explanation

Question 7

Suppose that your demand schedule for pizza is as follows:

Price	Quantity Demanded (income = $20,000)	Quantity Demanded (income = $24,000)
$8	40 pizza	50 pizza
10	32	45
12	24	30
14	16	20
16	8	12

a. Use the midpoint method to calculate your price elasticity of demand as the price of pizza increases from $8 to $10 if

(i) your income is $20,000 and

(ii) your income is $24,000

$$E_i = \frac{\frac{Q_2 - Q_1}{0.5 \cdot (Q_2 + Q_1)}}{\frac{P_2 - P_1}{0.5 \cdot (P_2 + P_1)}} = \frac{\frac{40-32}{36}}{\frac{10-8}{9}} = 0.22/0.22 = 1$$

$$E_{ii} = \frac{\frac{50-45}{47.5}}{\frac{10-8}{9}} = 0.11/0.22 = 0.5$$

Question 7

Suppose that your demand schedule for pizza is as follows:

Price	Quantity Demanded (income = $20,000)	Quantity Demanded (income = $24,000)
$8	40 pizza	50 pizza
10	32	45
12	24	30
14	16	20
16	8	12

b. Calculate your income elasticity of demand as your income increases from $20,000 to $24,000 if

(i) the price is $12 and

(ii) the price is $16

$$E_i = \frac{\frac{Q_2 - Q_1}{0.5 \cdot (Q_2 + Q_1)}}{\frac{I_2 - I_1}{0.5 \cdot (I_2 + I_1)}} = \frac{\frac{30-24}{27}}{\frac{24{,}000 - 20{,}000}{22{,}000}} = 0.22/0.18 = 1.22$$

$$E_{ii} = \frac{\frac{12-8}{10}}{\frac{24{,}000 - 20{,}000}{22{,}000}} = 0.40/0.18 = 2.22$$

Question 8

The New York Times reported (Feb. 17, 1996) that subway ridership declined after a fare increase: “There were nearly four million fewer riders in December 1995, the first full month after the price of a token increased 25 cents to $1.50, than in the previous December, a 4.3 percent decline.”

a. Use these data to estimate the price elasticity of demand for subway rides.

- The percentage change in price (using the midpoint formula) is (1.50 − 1.25)/(1.375) × 100% = 18.18%. Therefore, the price elasticity of demand is 4.3/18.18 = 0.24, which is very inelastic

b. According to your estimate, what happens to the Transit Authority’s revenue when the fare rises?

- Because the demand is inelastic, the Transit Authority's revenue rises when the fare rises.

Question 8

c. Why might your estimate of the elasticity be unreliable?

- The elasticity estimate might be unreliable because it is only the first month after the fare increase. As time goes by, people may switch to other means of transportation in response to the price increase. So the elasticity may be larger in the long run than it is in the short run