CHAPTER

Elasticity and its Application

PRINCIPLES OF
Economics
N. Gregory Mankiw

Premium PowerPoint Slides
by Vance Ginn & Ron Cronovich

In this chapter, look for the answers to these questions:

- What is elasticity? What kinds of issues can elasticity help us understand?
- What is the price elasticity of demand? How is it related to the demand curve? How is it related to revenue & expenditure?
- What is the price elasticity of supply? How is it related to the supply curve?
- What are the income and cross-price elasticities of demand?

A scenario…

You design websites for local businesses.
You charge $200 per website,
and currently sell 12 websites per month.

Your costs are rising
(including the opportunity cost of your time),
so you consider raising the price to $250.

The law of demand says that you won't sell as many websites if you raise your price.
How many fewer websites? How much will your revenue fall, or might it increase?

Elasticity

- Basic idea:
  Elasticity measures how much
  _____.
  - One type of elasticity measures how much demand for your websites will fall if you raise your price.
- Definition:
  Elasticity (video) is a numerical measure of the responsiveness of Q^d or Q^s to one of its determinants.

Price Elasticity of Demand

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } \boldsymbol{Q^d}}{\text{Percentage change in } \boldsymbol{P}}$$

- _____ measures how much $\boldsymbol{Q^d}$ responds to a change in $\boldsymbol{P}$.
- Loosely speaking, it measures the price-sensitivity of buyers' demand.

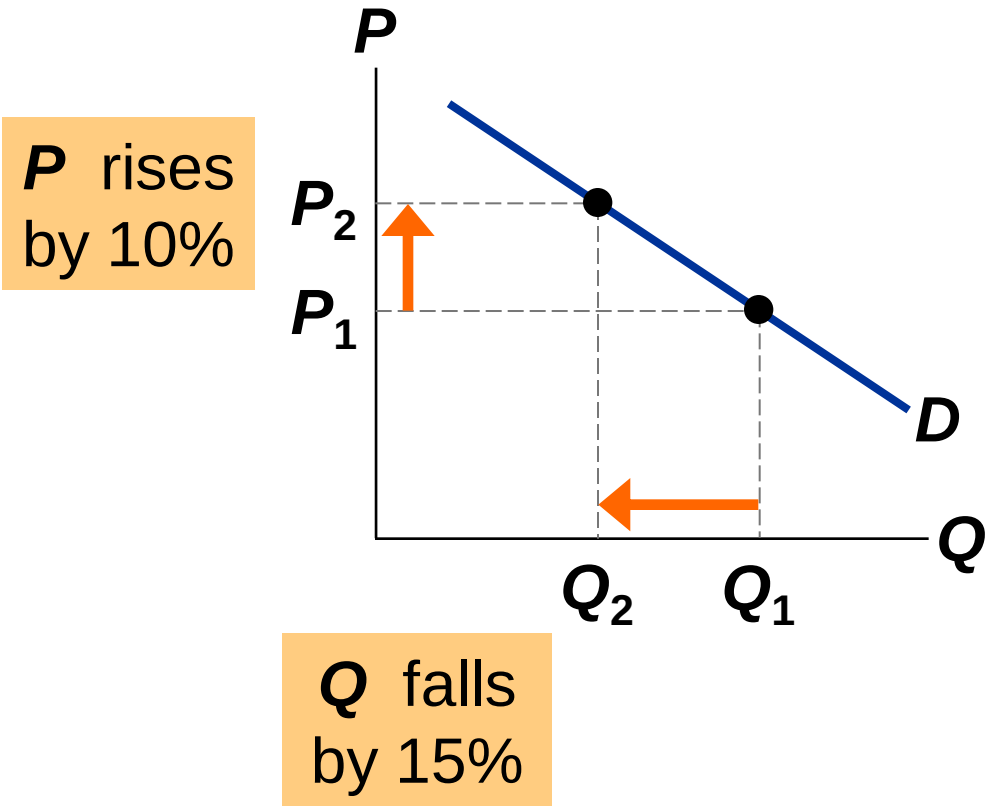
Price Elasticity of Demand

Price elasticity of demand = $\frac{\quad}{\quad}$

Example:

Price elasticity of demand equals

$$\frac{15\%}{10\%} = \_\_\_$$

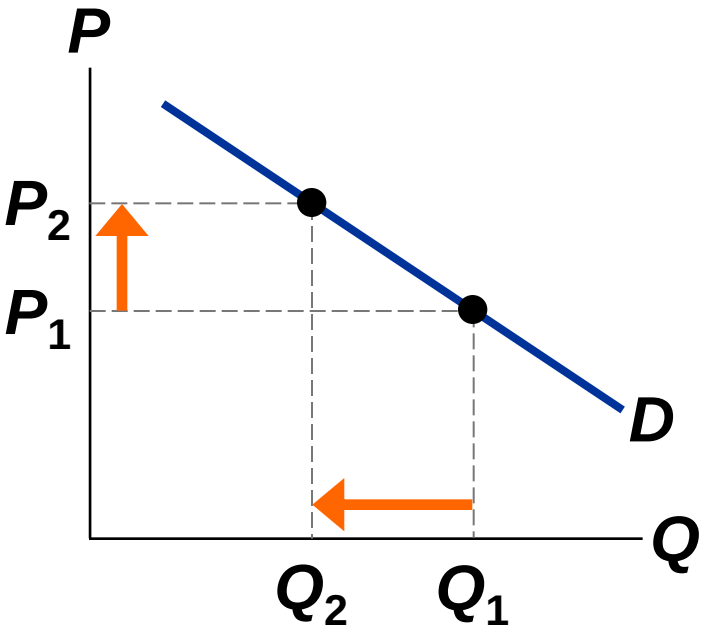


Price Elasticity of Demand

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } Q^d}{\text{Percentage change in } P}$$

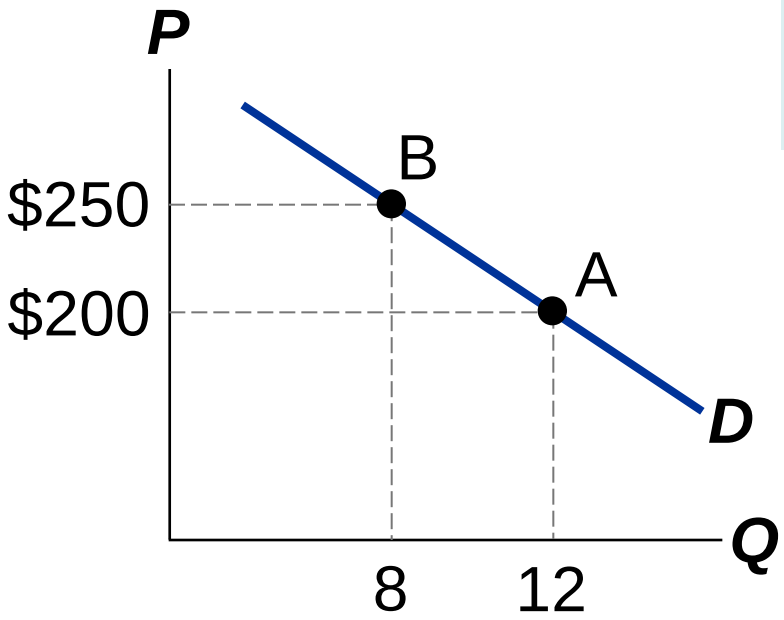
Along a ***D*** curve, ***P*** and ***Q*** move in opposite directions, which would make price elasticity negative.

We will drop the minus sign and report all price elasticities as positive numbers.



Calculating Percentage Changes

Demand for your websites



Standard method of computing the

_____:

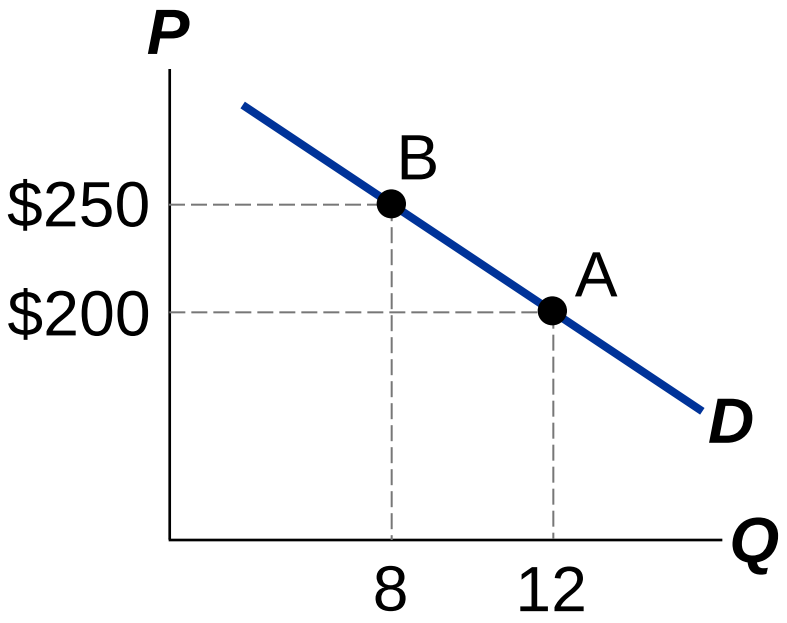
$$\frac{\text{New value} - \text{old value}}{\text{old value}} \times 100\%$$

Going from A to B, the % change in ***P*** equals

($250–$200)/$200 = 25%

Calculating Percentage Changes

Demand for your websites



Problem:

The standard method gives different answers depending on where you start.

From A to B,

P rises 25%, ***Q*** falls 33%,

elasticity = _____

From B to A,

P falls 20%, ***Q*** rises 50%,

elasticity = _____

Calculating Percentage Changes

- So, we instead use the _____:

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

- The midpoint is the number halfway between the start & end values, the average of those values.
- It doesn't matter which value you use as the "start" and which as the "end" – you get the same answer either way!

Calculating Percentage Changes

- Using the midpoint method, the % change in ***P*** equals

$$\frac{\$250 - \$200}{\$225} \times 100\% = \underline{\qquad\qquad}$$

- The % change in ***Q*** equals

$$\frac{12 - 8}{10} \times 100\% = \underline{\qquad\qquad}$$

- The price elasticity of demand equals

$$\underline{\qquad\qquad\qquad\qquad}$$

ACTIVE LEARNING ***1***

Calculate an elasticity

Use the following information to calculate the price elasticity of demand for hotel rooms:

if $\boldsymbol{P}$ = \$70, $\boldsymbol{Q}^{\mathbf{d}}$ = 5000

if $\boldsymbol{P}$ = \$90, $\boldsymbol{Q}^{\mathbf{d}}$ = 3000

ACTIVE LEARNING ***1***

Answers

Use midpoint method to calculate

% change in $\boldsymbol{Q^d}$

(5000 – 3000)/4000 = _____

% change in ***P***

($90 – $70)/$80 = _____

The price elasticity of demand equals

$$\frac{50\%}{25\%} = \_\_$$

What determines price elasticity?

To learn the determinants of price elasticity,
we look at a series of examples.
Each compares two common goods.

In each example:

- Suppose the prices of both goods rise by 20%.
- The good for which Q^d falls the most (in percent) has the highest price elasticity of demand. Which good is it? Why?
- What lesson does the example teach us about the determinants of the price elasticity of demand?

EXAMPLE 1:
Breakfast cereal vs. Sunscreen

- The prices of both of these goods rise by 20%. For which good does Q^d drop the most? Why?
  - Breakfast cereal has close substitutes (*e.g.*, pancakes, Eggo waffles, leftover pizza), so buyers can easily switch if the price rises.
  - Sunscreen has no close substitutes, so consumers would probably not buy much less if its price rises.
- Lesson:. *Price elasticity is* _____ *when close substitutes are available*

EXAMPLE 2:
"Blue Jeans" vs. "Clothing"

- The prices of both goods rise by 20%.
  For which good does Q^d drop the most? Why?
  - For a narrowly defined good such as blue jeans, there are many substitutes (khakis, shorts, Speedos).
  - There are fewer substitutes available for broadly defined goods.
    (There aren't too many substitutes for clothing, other than living in a nudist colony.)
- Lesson: *Price elasticity is _____ for narrowly defined goods than broadly defined ones.*

EXAMPLE 3:
Insulin vs. Caribbean Cruises

- The prices of both of these goods rise by 20%. For which good does Q^d drop the most? Why?
  - To millions of diabetics, insulin is a necessity. A rise in its price would cause little or no decrease in demand.
  - A cruise is a luxury. If the price rises, some people will forego it.
- Lesson: *Price elasticity is* _____ *for luxuries than for necessities.*

EXAMPLE 4:
Gasoline in the Short Run vs. Gasoline in the Long Run

- The price of gasoline rises 20%. Does Q^d drop more in the short run or the long run? Why?
  - There's not much people can do in the short run, other than ride the bus or carpool.
  - In the long run, people can buy smaller cars or live closer to where they work.
- Lesson: *Price elasticity is _____ in the long run than the short run.*

The Determinants of Price Elasticity: A Summary

The price elasticity of demand depends on:

- the extent to which close substitutes are available
- whether the good is a necessity or a luxury
- how broadly or narrowly the good is defined
- the time horizon – elasticity is higher in the long run than the short run

"Perfectly inelastic demand" (Ex: Insulin)

$$\text{Price elasticity of demand} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{0\%}{10\%} = -$$

D curve:

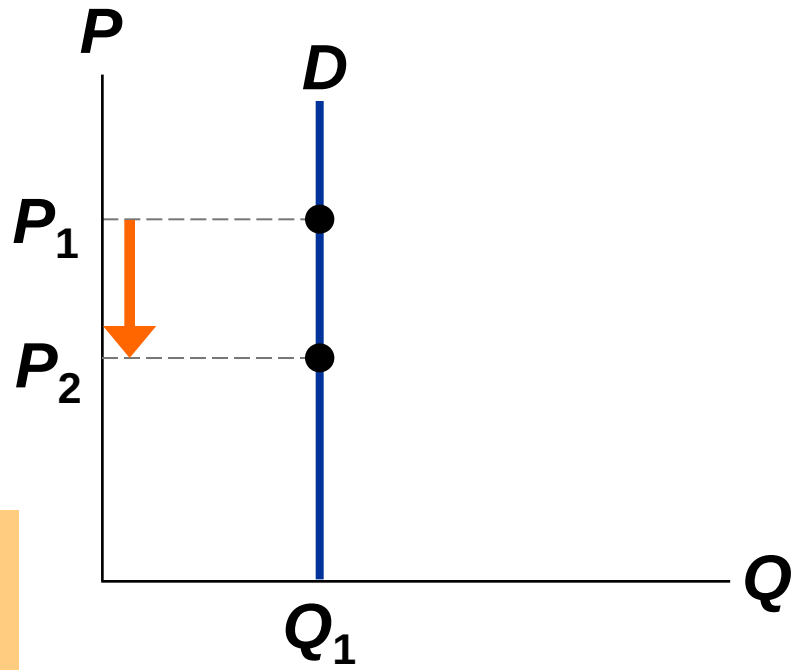
vertical

Consumers' price sensitivity:

none

Elasticity:

0



P falls by 10%

Q changes by 0%

"Inelastic demand" (Ex: Gasoline)

$$\text{Price elasticity of demand} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{< 10\%}{10\%} = -$$

D curve:

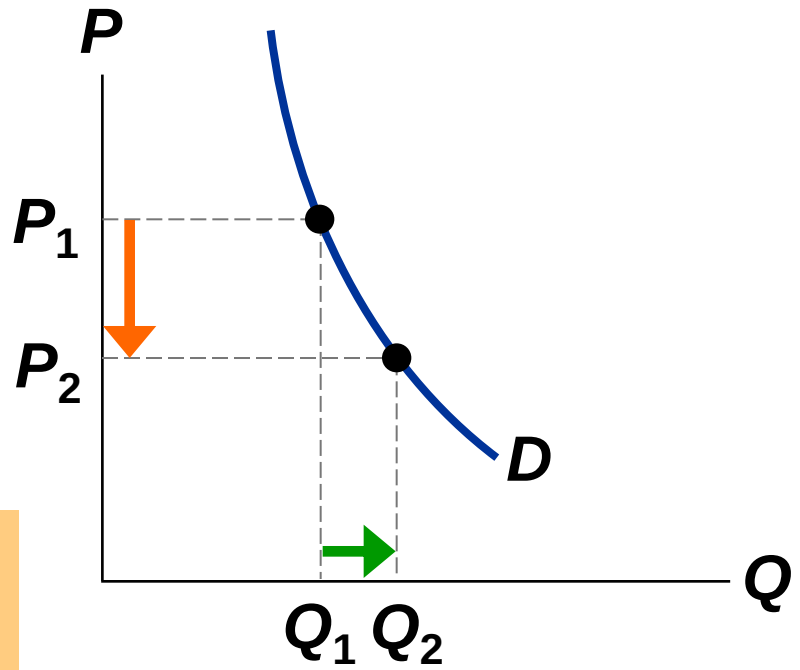
relatively steep

Consumers' price sensitivity:

relatively low

Elasticity:

< 1



P falls by 10%

Q rises less than 10%

"Unit elastic demand" (Ex: Clothes)

$$\text{Price elasticity of demand} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{10\%}{10\%} = 1$$

D curve:

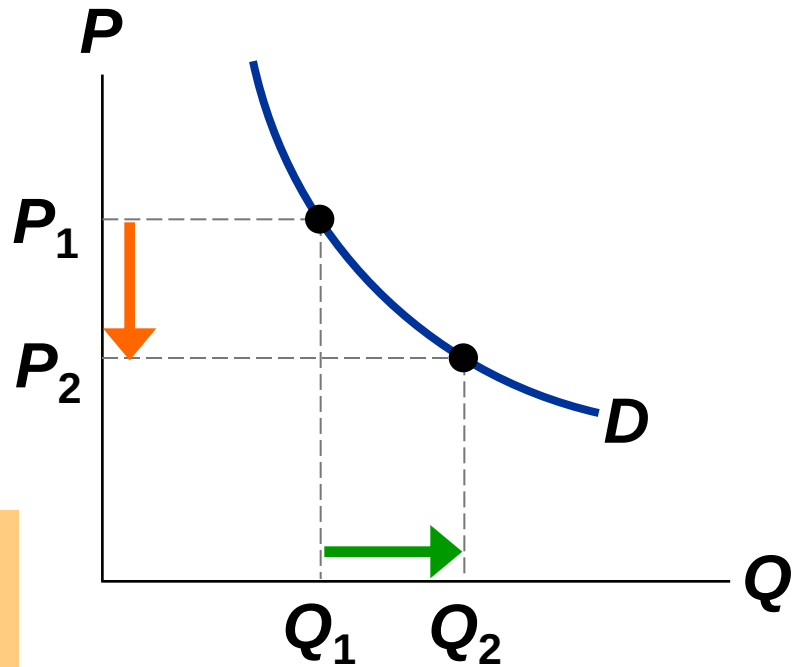
intermediate slope

Consumers' price sensitivity:

intermediate

Elasticity:

1



P falls by 10%

Q rises by 10%

"Elastic demand" (Ex: Flights)

$$\text{Price elasticity of demand} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{> 10\%}{10\%} \quad -$$

D curve:

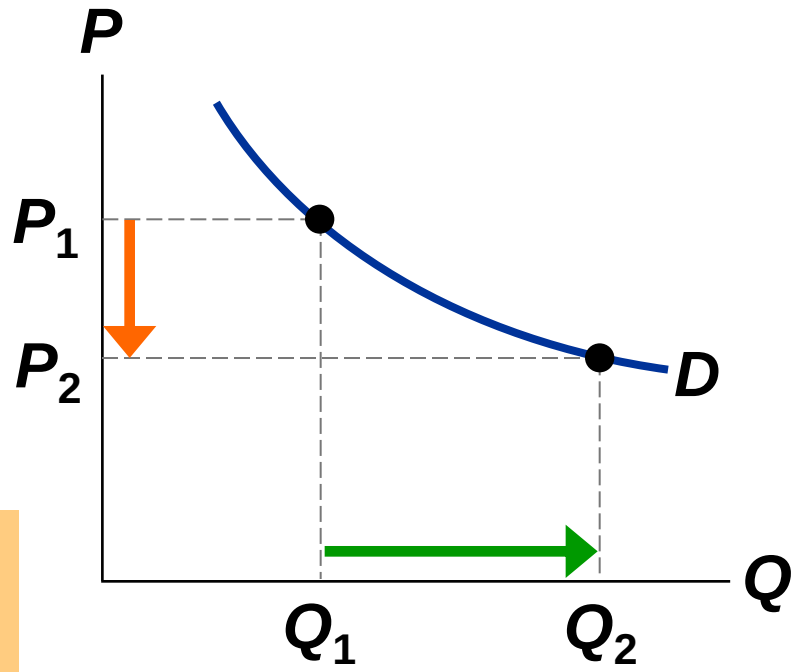
relatively flat

Consumers' price sensitivity:

relatively high

Elasticity:

> 1



P falls by 10%

Q rises more than 10%

"Perfectly elastic demand" (Ex: Wheat-perf sub)

$$\text{Price elasticity of demand} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{\text{any }\%}{0\%}$$

D curve:

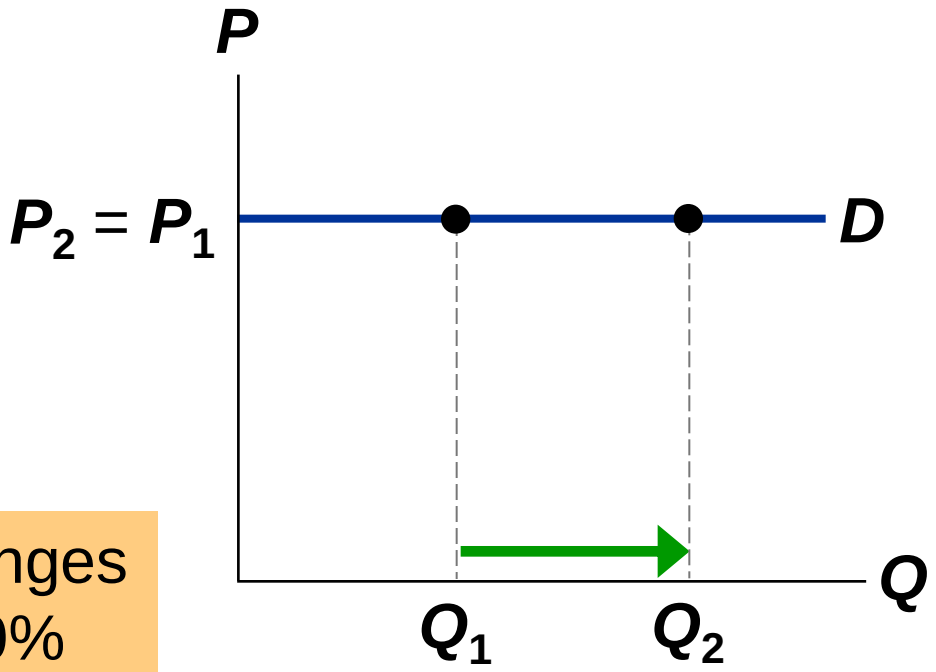
horizontal

Consumers' price sensitivity:

extreme

Elasticity:

infinity



P changes by 0%

Q changes by any %

Other Elasticities

- _____: measures the response of Q^d to a change in consumer income

Income elasticity of demand	=	$\frac{\_\_\_\_\_}{\_\_\_\_\_}$

- Recall: An increase in income causes an increase in demand for a *normal* good.
- Hence, for normal goods, _____.
- For *inferior* goods, _____.

Other Elasticities

- **Cross-price elasticity of demand**: measures the response of demand for one good to changes in the price of another good

Cross-price elast. of demand = _____ / _____

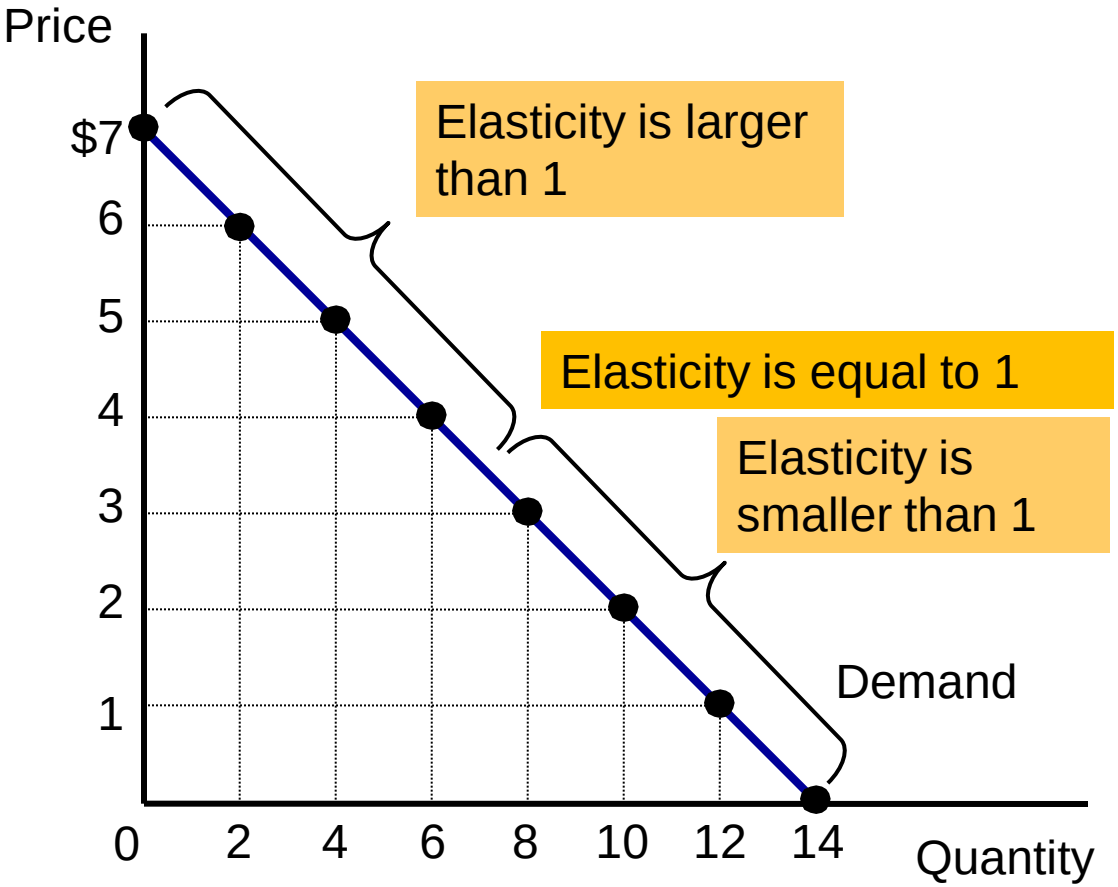
- For _____, cross-price elasticity > 0 (e.*g*., an increase in price of beef causes an increase in demand for chicken)
- For _____, cross-price elasticity < 0 (*e.g*., an increase in price of computers causes decrease in demand for software)

The Elasticity of Demand

- Linear demand curve characteristics:
  - Constant slope
    - Rise over run
  - Different price elasticities
    - Points with low price & high quantity
      - Inelastic demand
    - Points with high price & low quantity
      - Elastic demand

Figure 4

Elasticity of a Linear Demand Curve (graph)



The slope of a linear demand curve is constant, but its elasticity is not. The demand schedule in the table was used to calculate the price elasticity of demand by 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.

Figure 4

Elasticity of a Linear Demand Curve (schedule)

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				

The slope of a linear demand curve is constant, but its elasticity is not. The demand schedule in the table was used to calculate the price elasticity of demand by 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 Elasticity and Total Revenue

- Continuing our scenario, if you raise your price from $200 to $250, would your revenue rise or fall?

  _____

- A price increase has two effects on revenue:
  - Higher ***P*** means more revenue on each unit you sell.
  - But you sell fewer units (lower ***Q***), due to Law of Demand.
- Which of these two effects is bigger?
  It depends on the _____.

Price Elasticity and Total Revenue

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } \boldsymbol{Q}}{\text{Percentage change in } \boldsymbol{P}}$$

Revenue = ***P*** x ***Q***

- If demand is elastic, then

  price elast. of demand > 1

  % change in ***Q*** > % change in ***P***

- The fall in revenue from lower ***Q*** is greater than the increase in revenue from higher ***P***, so _____.

Price Elasticity and Total Revenue

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in } \boldsymbol{Q}}{\text{Percentage change in } \boldsymbol{P}}$$

Revenue = ***P*** x ***Q***

- If demand is inelastic, then

  price elast. of demand < 1

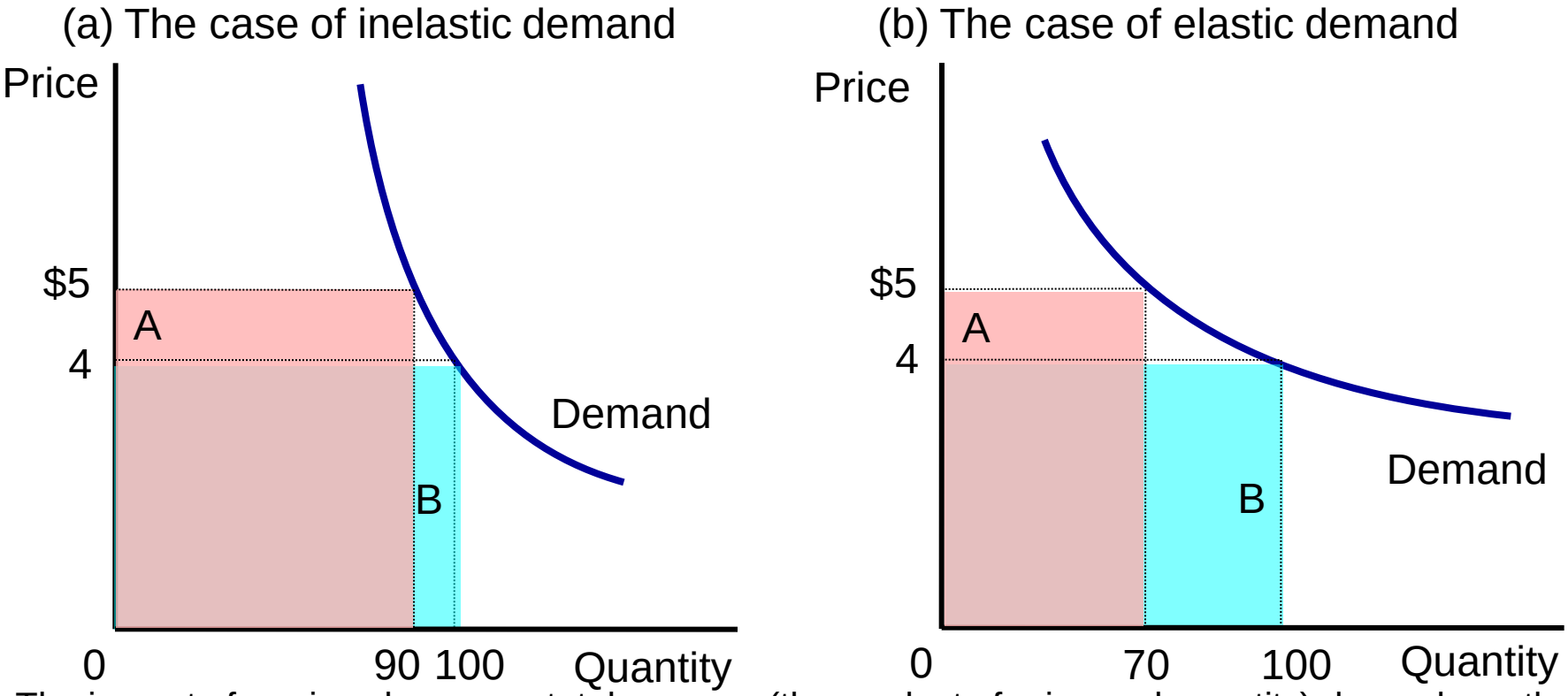
  % change in ***Q*** < % change in ***P***

- The fall in revenue from lower ***Q*** is smaller than the increase in revenue from higher ***P***, so _____.

- In our example, suppose that ***Q*** only falls to 10 (instead of 8) when you raise your price to $250.

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 decrease in quantity demanded that is proportionately smaller, 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 decrease in quantity demanded that is proportionately larger, 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.

The Elasticity of Demand

- When demand is inelastic (_____)
  - Price and total revenue move in the same direction
- When demand is elastic (_____)
  - Price and total revenue move in opposite directions
- If demand is unit elastic (_____)
  - Total revenue remains constant when the price changes

Price Elasticity of Supply

$$\text{Price elasticity of supply} = \frac{\text{Percentage change in } \boldsymbol{Q^s}}{\text{Percentage change in } \boldsymbol{P}}$$

- **Price elasticity of supply** measures how much $\boldsymbol{Q^s}$ responds to a change in $\boldsymbol{P}$.
- Loosely speaking, it measures sellers' price-sensitivity.
- Again, use the midpoint method to compute the percentage changes.

The Elasticity of Supply

- Computing price elasticity of supply
  - Percentage change in quantity supplied divided by percentage change in price
  - Always positive
- _____
  - Two points: (Q_1, P_1) and (Q_2, P_2)

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

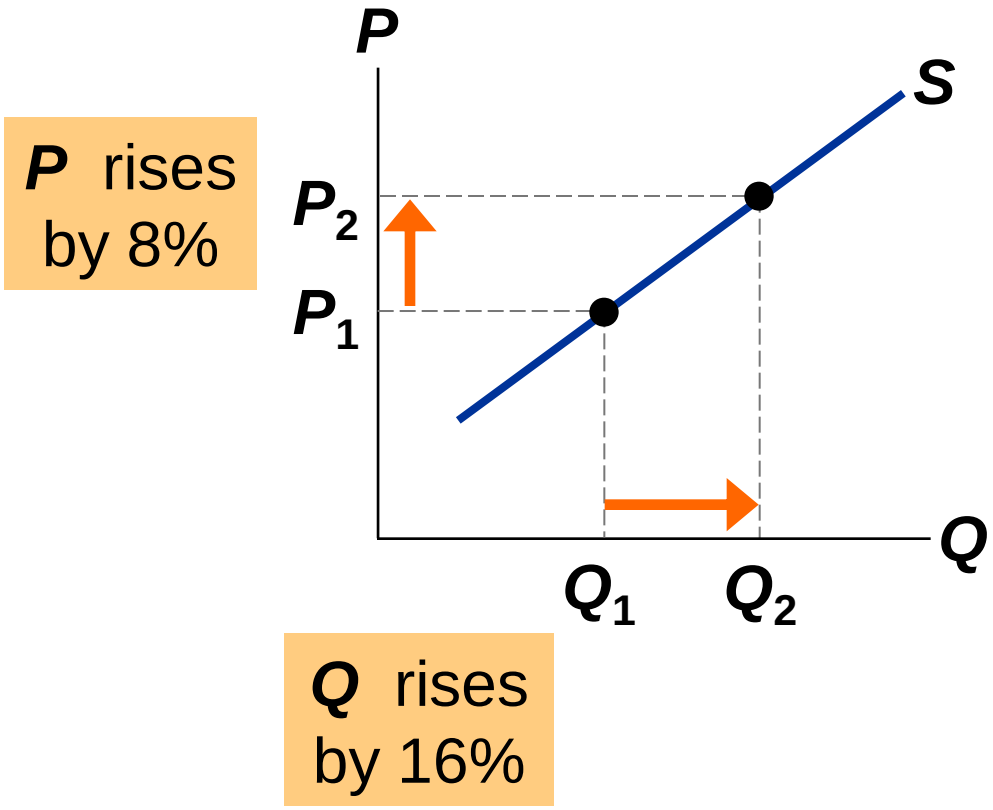
Price Elasticity of Supply

$$\text{Price elasticity of supply} = \frac{\text{Percentage change in } Q^s}{\text{Percentage change in } P}$$

Example:

Price elasticity of supply equals

$$\frac{16\%}{8\%} = \underline{\mathbf{2.0}}$$



The Variety of Supply Curves

- The slope of the supply curve is closely related to price elasticity of supply.
- Rule of thumb:
  The flatter the curve, the bigger the elasticity.
  The steeper the curve, the smaller the elasticity.
- Five different classifications….

"Perfectly inelastic" (one extreme)

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{0\%}{10\%} = 0$$

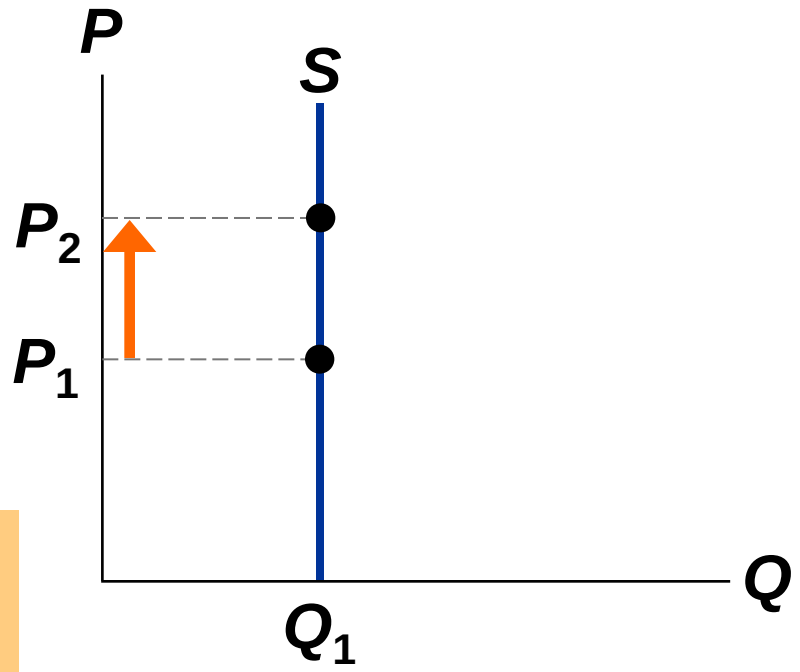
S curve:

Sellers' price sensitivity:

none

Elasticity:

0



P rises by 10%

Q changes by 0%

"Inelastic"

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{< 10\%}{10\%} < 1$$

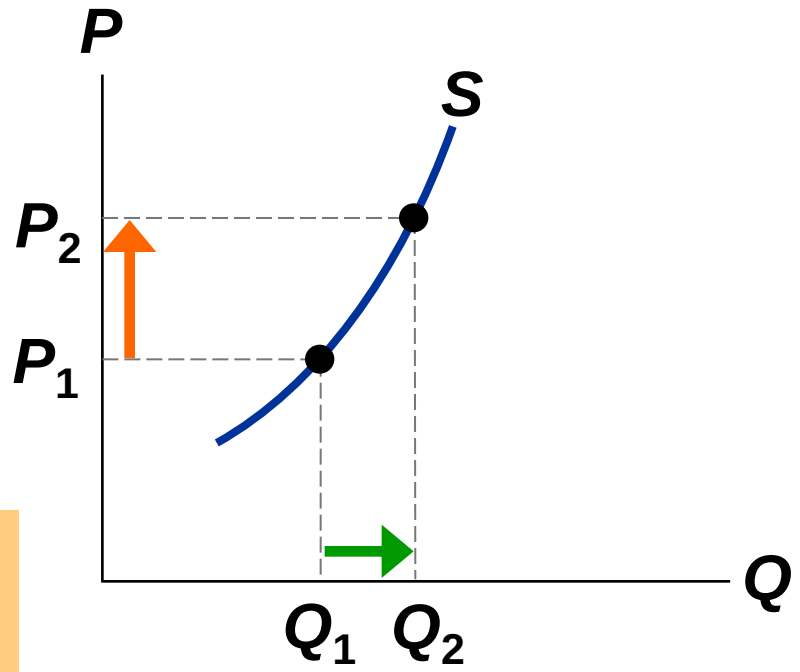
S curve:

Sellers' price sensitivity:

relatively low

Elasticity:

< 1



P rises by 10%

Q rises less than 10%

"Unit elastic"

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{10\%}{10\%} = 1$$

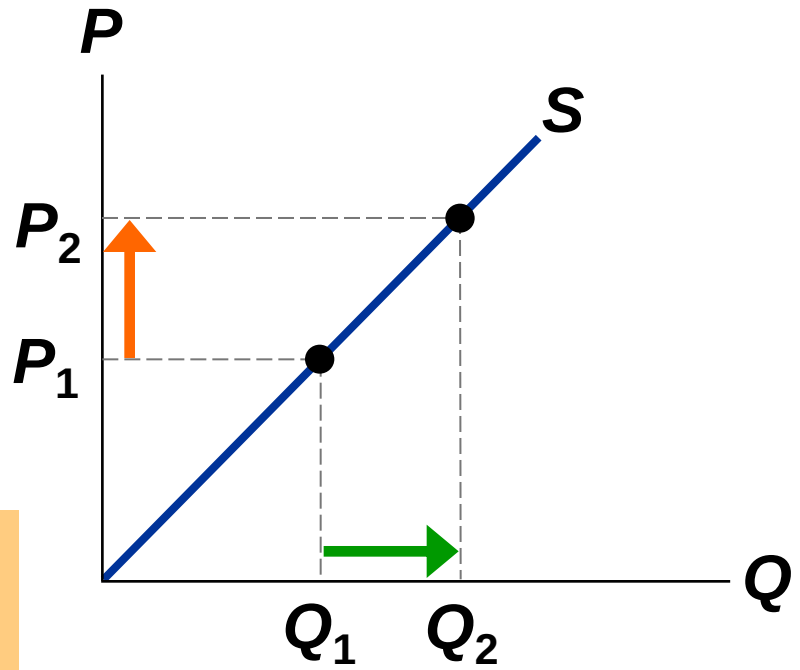
S curve:

Sellers' price sensitivity:

intermediate

Elasticity:

= 1



P rises by 10%

Q rises by 10%

"Elastic"

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{> 10\%}{10\%} > 1$$

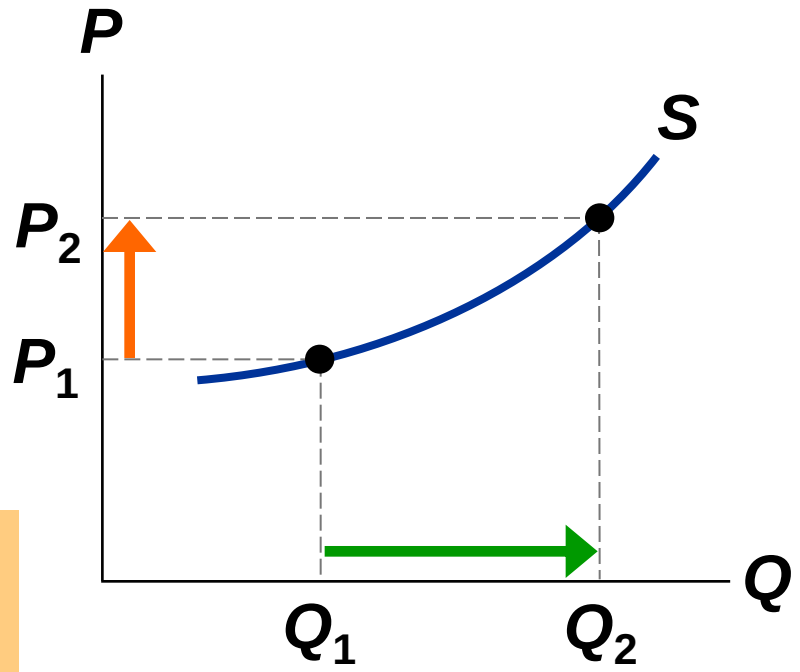
S curve:

Sellers' price sensitivity:

relatively high

Elasticity:

> 1



P rises by 10%

Q rises more than 10%

"Perfectly elastic" (the other extreme)

$$\text{Price elasticity of supply} = \frac{\%\text{ change in } \boldsymbol{Q}}{\%\text{ change in } \boldsymbol{P}} = \frac{\text{any }\%}{0\%} = \text{infinity}$$

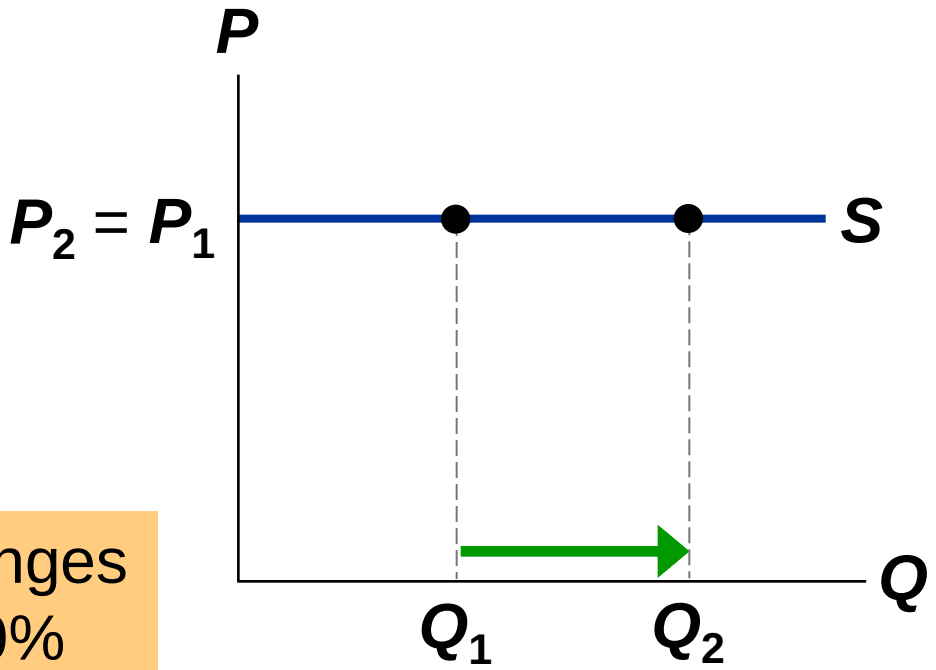
S curve:

Sellers' price sensitivity:

extreme

Elasticity:

infinity



P changes by 0%

Q changes by any %

The Determinants of Supply Elasticity

- The more easily sellers can change the quantity they produce, the greater the price elasticity of supply.
  - Example: Supply of beachfront property is harder to vary and thus less elastic than supply of new cars.
- For many goods, price elasticity of supply is greater in the long run than in the short run, because firms can build new factories, or new firms may be able to enter the market.

ACTIVE LEARNING ***3***

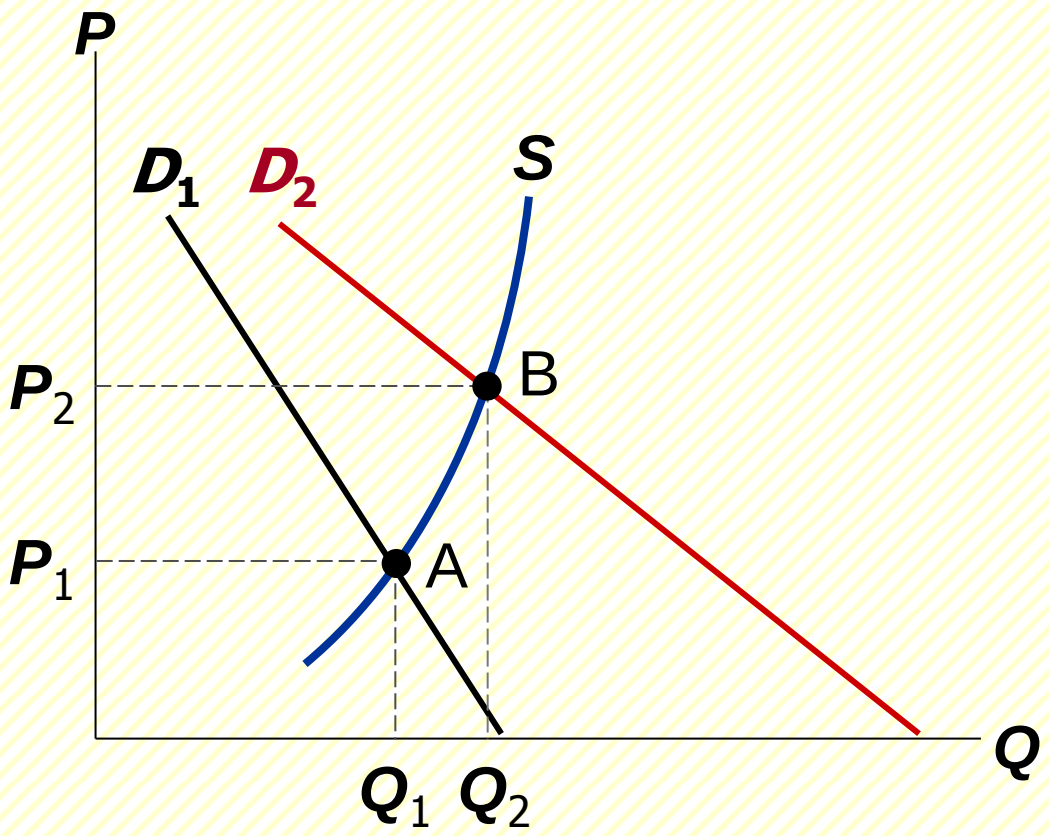
Elasticity and changes in equilibrium

- The supply of beachfront property is inelastic. The supply of new cars is elastic.
- Suppose population growth causes demand for both goods to double (at each price, Q^d doubles).
- For which product will ***P*** change the most?
- For which product will ***Q*** change the most?

ACTIVE LEARNING 3
Answers

When supply is *inelastic*, an increase in demand has a bigger impact on price than on quantity.

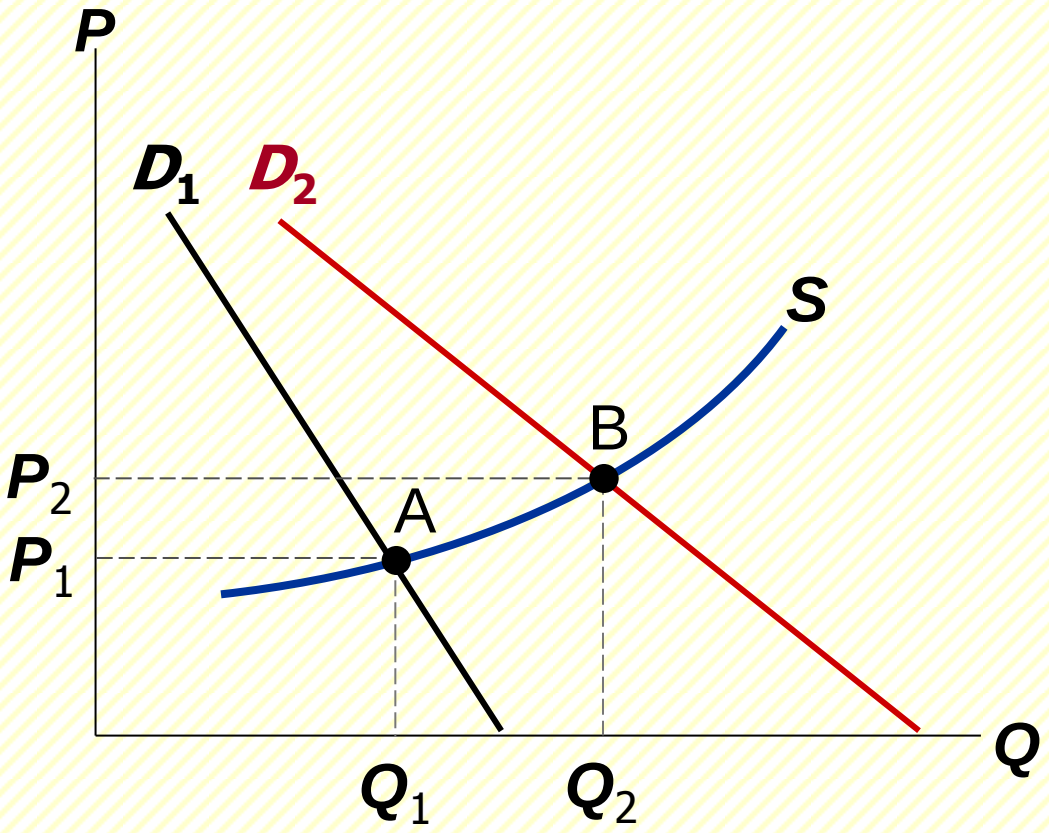
Beachfront property (inelastic supply):



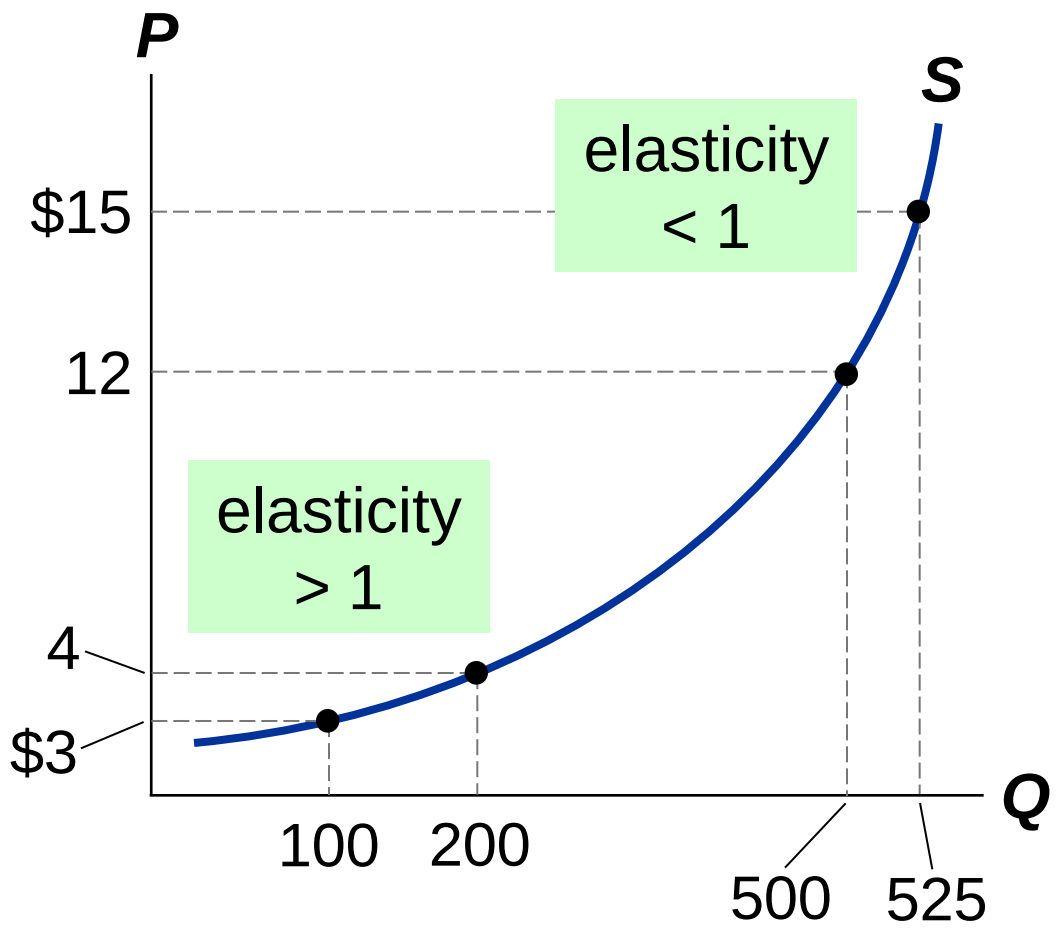
ACTIVE LEARNING 3
Answers

When supply is *elastic*, an increase in demand has a bigger impact on quantity than on price.

New cars (elastic supply):



How the Price Elasticity of Supply Can Vary



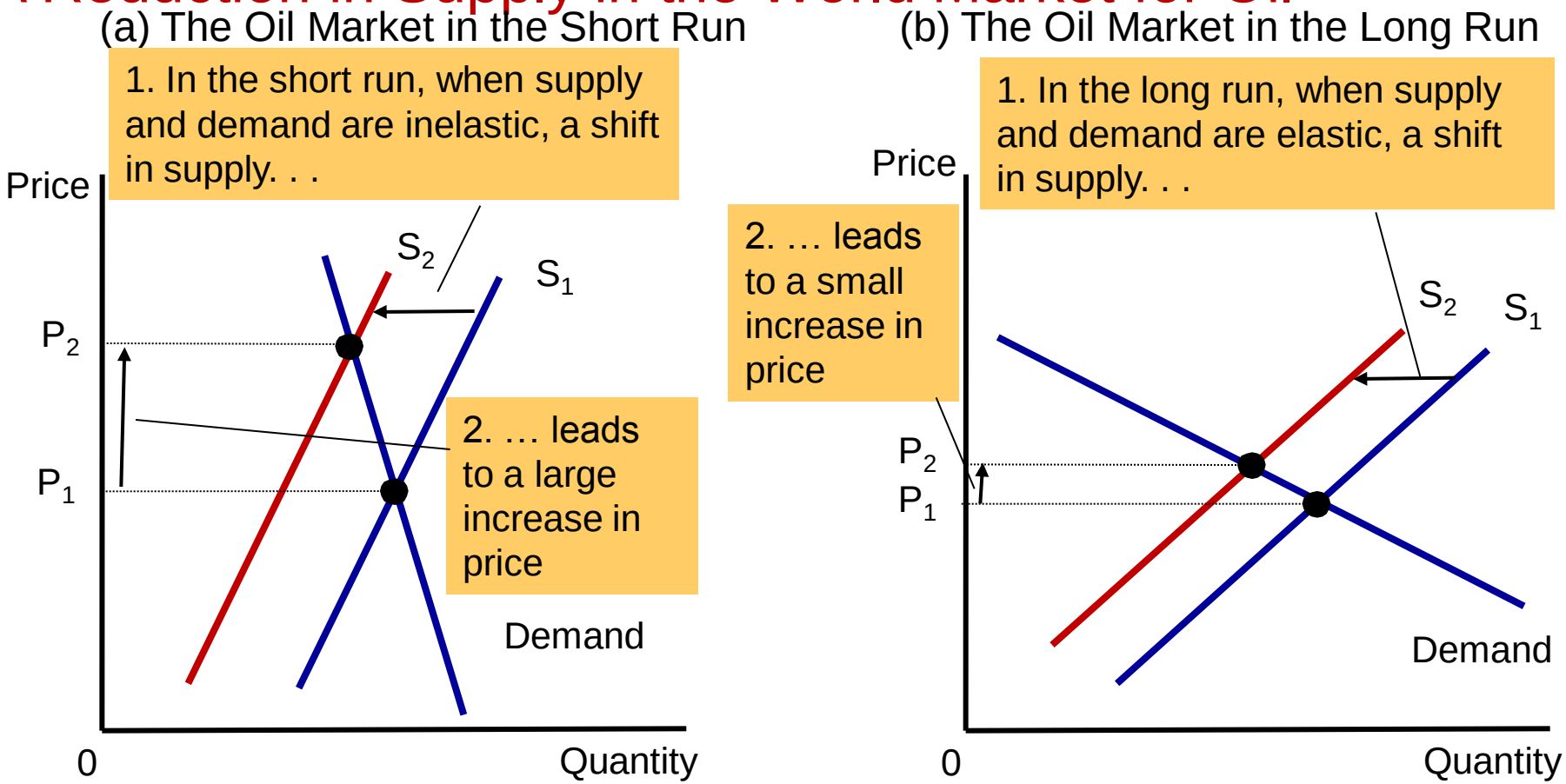
Supply often becomes less elastic as ***Q*** rises, due to capacity limits.

Applications

- Why Did OPEC Fail to Keep the Price of Oil High?
  - Increase in prices 1973-1974 (OPEC oil embargo), 1979-1981 (Iran-Iraq War)
  - Short-run: supply and demand are inelastic
    - Decrease in supply: large increase in price
  - Long-run: supply and demand are elastic
    - Decrease in supply: small increase in price

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. By contrast, in the long run, 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.

Applications

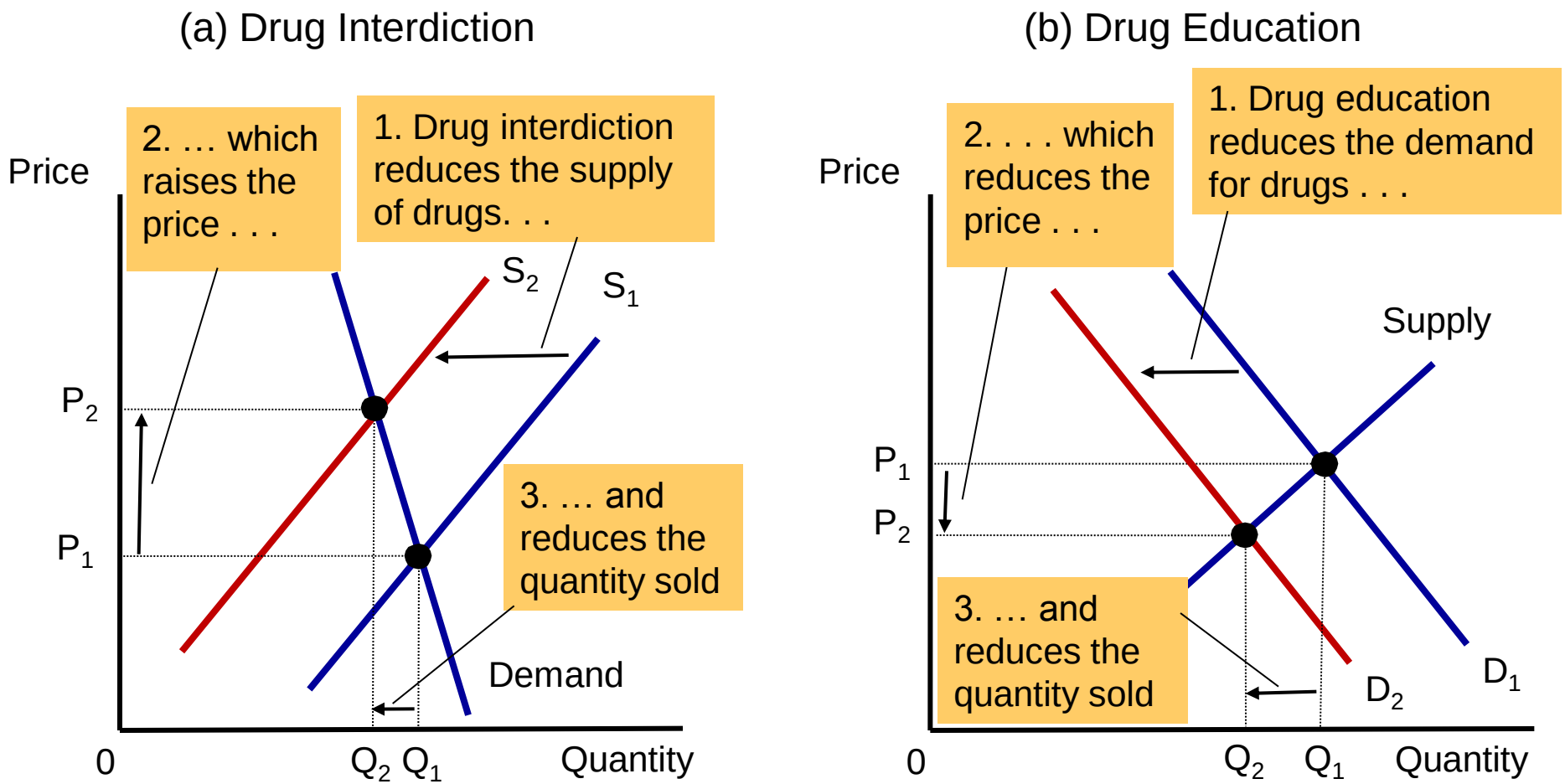
- Does Drug Interdiction Increase or Decrease Drug-related Crime?
  - Increase the number of federal agents devoted to the war on drugs
    - Illegal drugs - Supply curve shifts left
      - Higher price; lower quantity
    - Amount of drug-related crimes
      - Inelastic demand for drugs
      - Higher drugs price – higher total revenue
      - Increase drug-related crime

Applications

- Does Drug Interdiction Increase or Decrease Drug-related Crime?
  - Policy of drug education
    - Reduce demand for illegal drugs
    - Left shift of demand curve
    - Lower quantity
    - Lower price
    - Reduce drug-related crime

Exhibit 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