CHAPTER 5

Elasticity and its Application

PRINCIPLES OF
Economics
N. Gregory Mankiw

Premium PowerPoint Slides
by 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 variable responds to changes in another variable.
  - One type of elasticity measures how much demand for your websites will fall if you raise your price.
- Definition:
  Elasticity is a numerical measure of the responsiveness of Q^d or Q^s to one of its determinants.

Price Elasticity of Demand

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

- **Price elasticity of demand** measures how much Q^d responds to a change in P.
- Loosely speaking, it measures the price-sensitivity of buyers' demand.

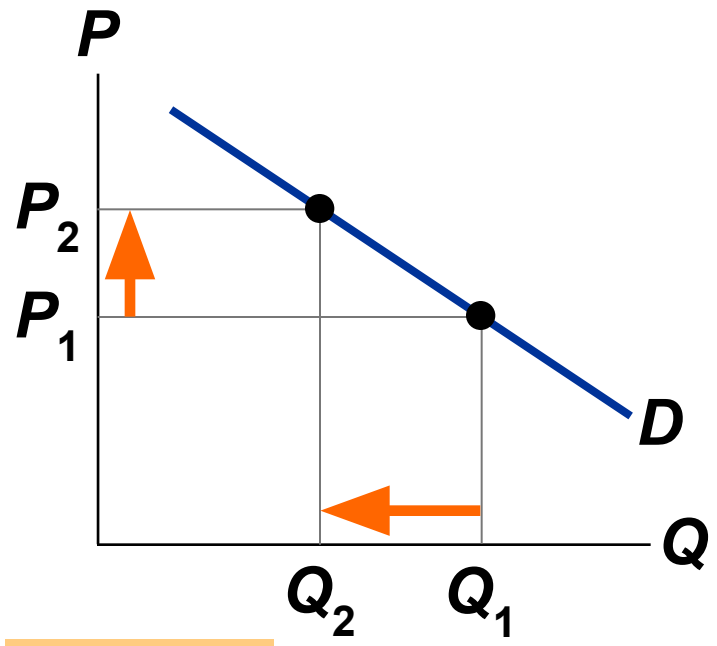
Price Elasticity of Demand

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

Example:

Price elasticity of demand equals

$$\frac{15\%}{10\%} = 1.5$$

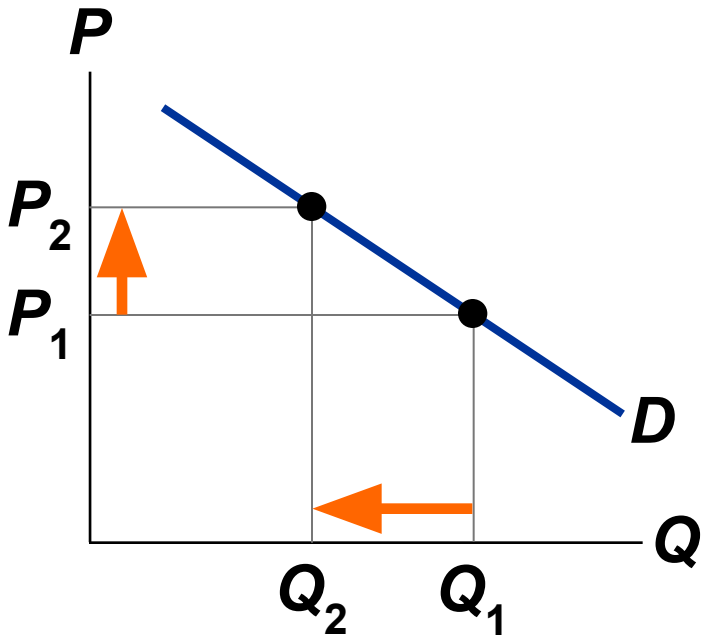


Price Elasticity of Demand

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

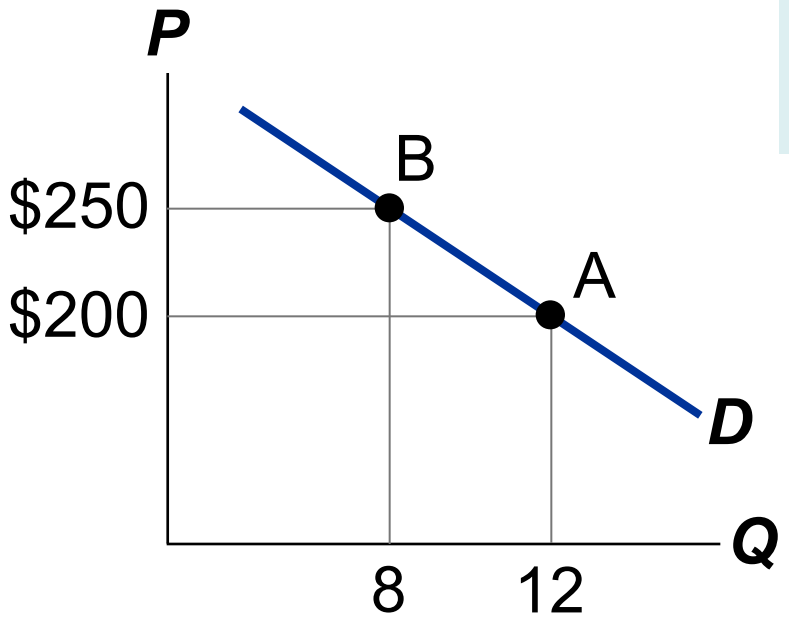
Along a ***D*** curve, ***P*** and ***Q*** move in opposite directions, which would make price elasticity negative.

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 percentage (%) change:

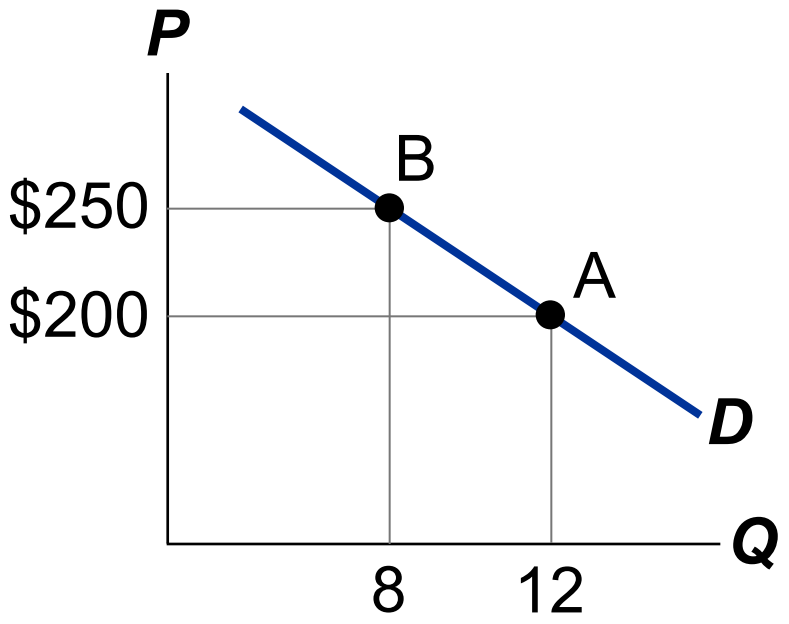
$$\frac{\text{end value} - \text{start value}}{\text{start value}} \times 100\%$$

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 = 33/25 = 1.33

From B to A,

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

elasticity = 50/20 = 2.50

Calculating Percentage Changes

- So, we instead use the **midpoint method**:

$$\frac{\text{end value} - \text{start value}}{\text{midpoint}} \times 100\%$$

- 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

$$\frac{\$250 - \$200}{\$225} \times 100\% = \boxed{22.2\%}$$

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

$$\frac{12 - 8}{10} \times 100\% = \boxed{40.0\%}$$

- The price elasticity of demand equals

$$40/22.2 = \boxed{1.8}$$

ACTIVE LEARNING *1*

Calculate an elasticity

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

if P = \$70, Q^d = 5000

if P = \$90, Q^d = 3000

ACTIVE LEARNING *1*

Answers

Use midpoint method to calculate
% change in Q^d

(5000 – 3000)/4000 = 50%

% change in P

($90 – $70)/$80 = 25%

The price elasticity of demand equals

$$\frac{50\%}{25\%} = 2.0$$

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 higher 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 higher 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 higher 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 higher 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

The Variety of Demand Curves

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

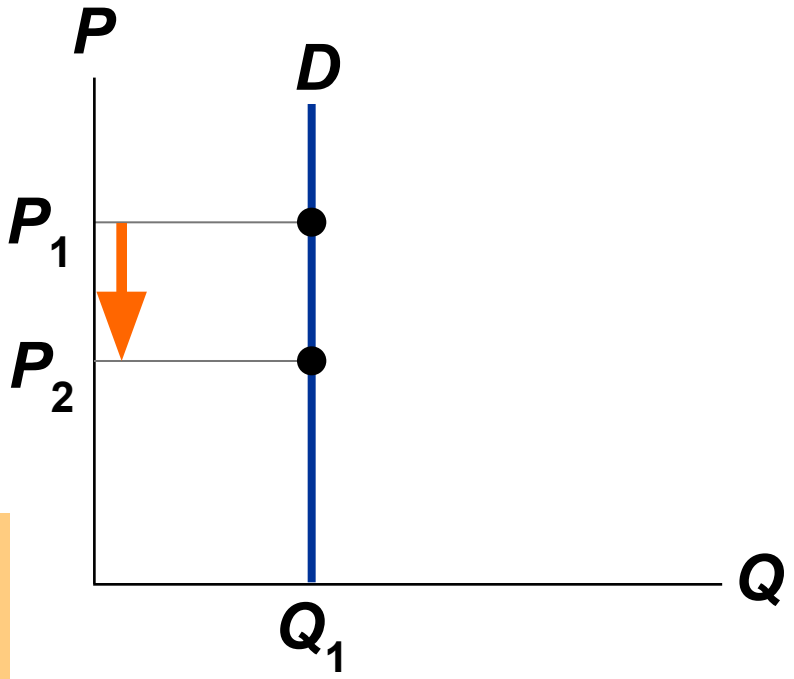
"Perfectly inelastic demand" (one extreme case)

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

D curve:
vertical

Consumers' price sensitivity:
none

Elasticity:
0



P falls by 10%

Q changes by 0%

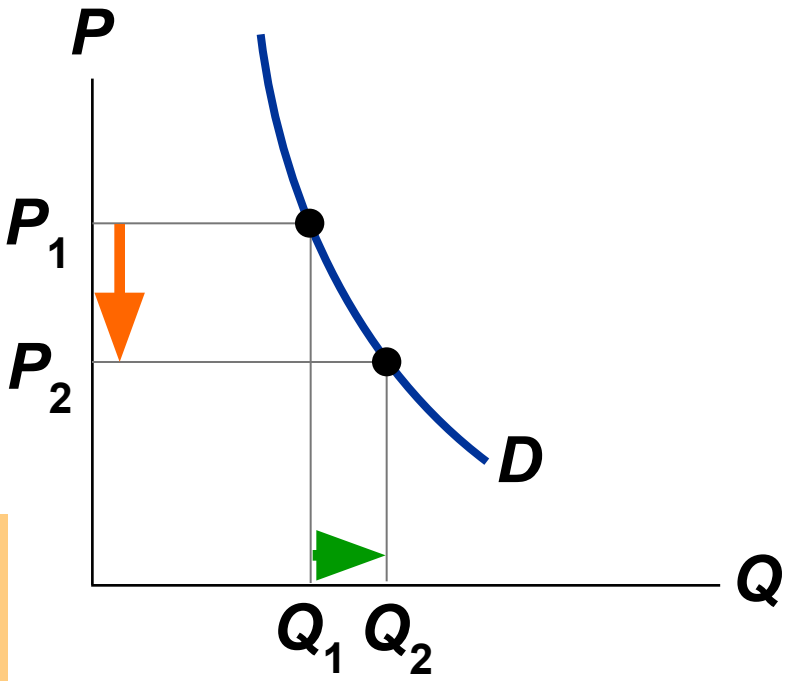
"Inelastic demand"

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

D curve:
relatively steep

Consumers' price sensitivity:
relatively low

Elasticity:
< 1



P falls by 10%

Q rises less than 10%

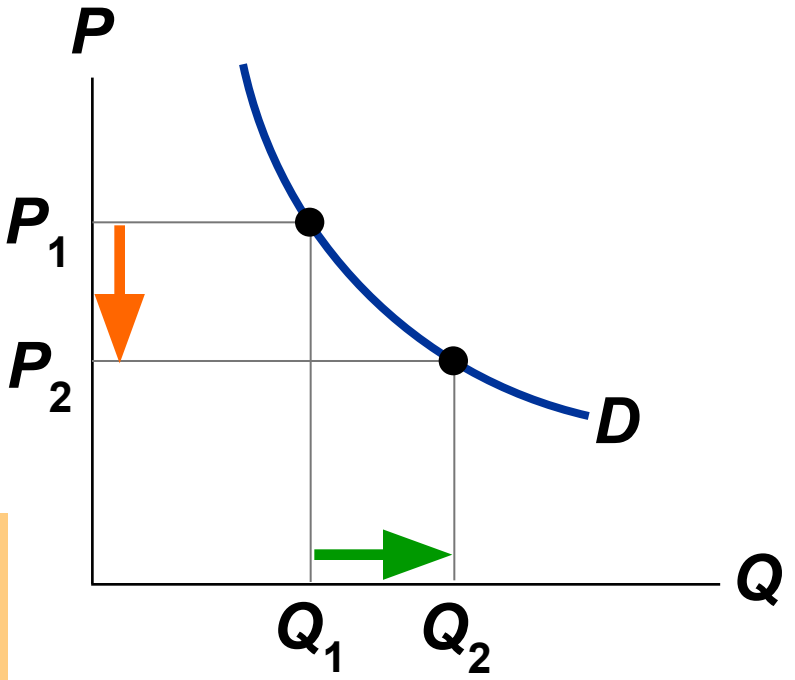
"Unit elastic demand"

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

D curve:
intermediate slope

Consumers' price sensitivity:
intermediate

Elasticity:
1



P falls by 10%

Q rises by 10%

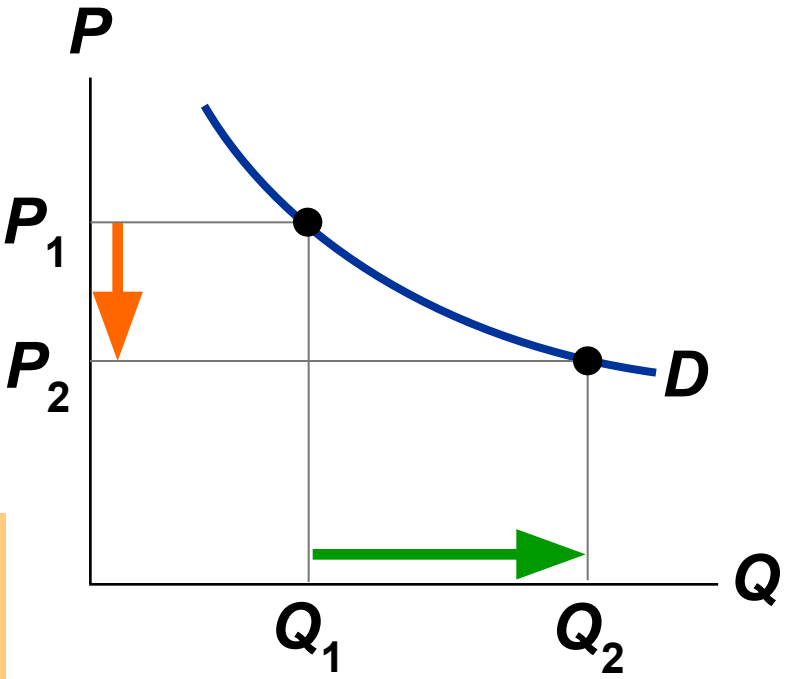
"Elastic demand"

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

D curve:
relatively flat

Consumers' price sensitivity:
relatively high

Elasticity:
> 1



P falls by 10%

Q rises more than 10%

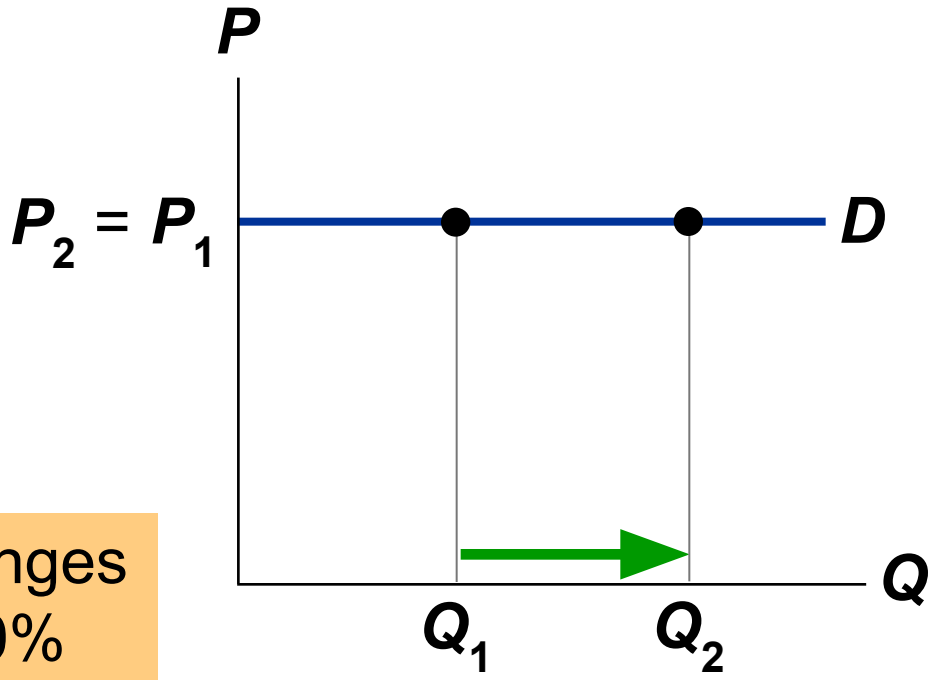
"Perfectly elastic demand" (the other extreme)

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

D curve:
horizontal

Consumers' price sensitivity:
extreme

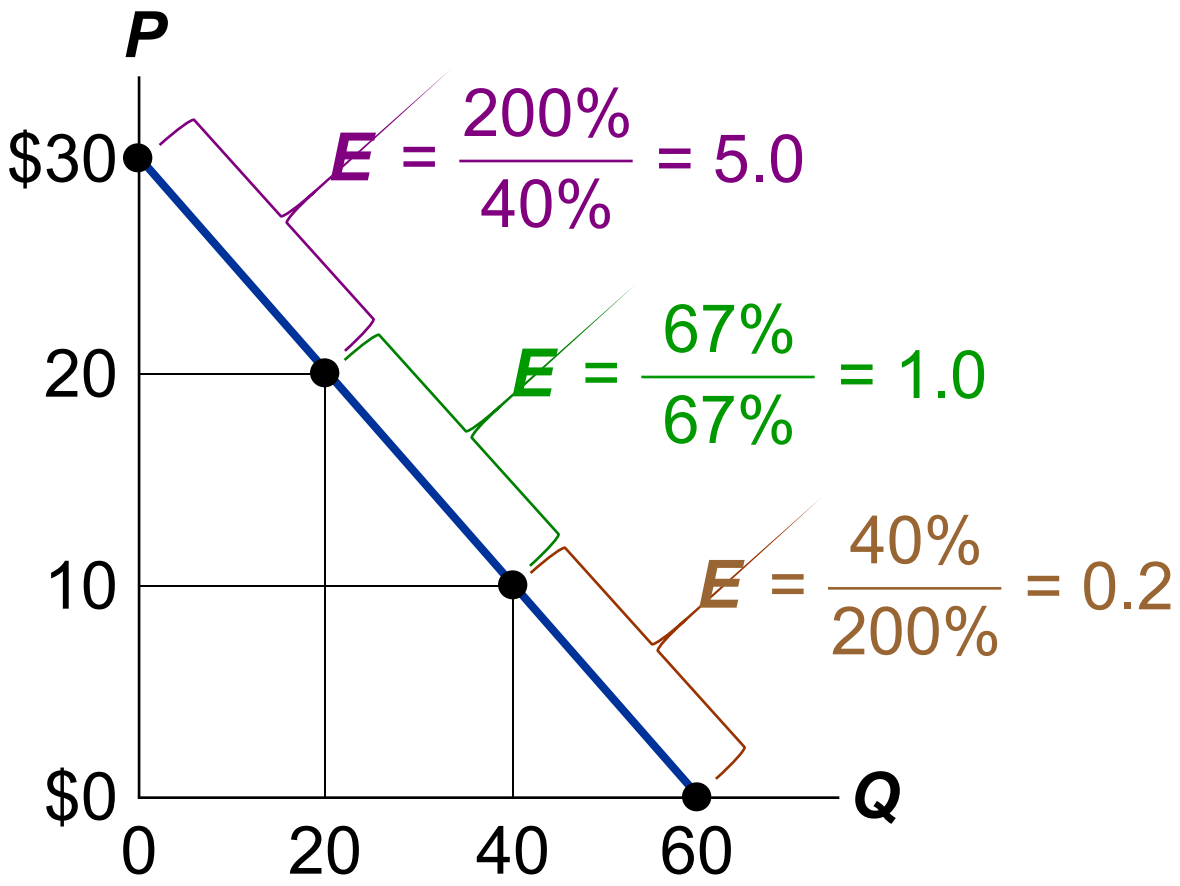
Elasticity:
infinity



P changes by 0%

Q changes by any %

Elasticity of a Linear Demand Curve



The slope of a linear demand curve is constant, but its elasticity is not.

Price Elasticity and Total Revenue

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

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

- 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 of demand.

Price Elasticity and Total Revenue

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

Revenue = $\boldsymbol{P}$ x $\boldsymbol{Q}$

- If demand is elastic, then

  price elast. of demand > 1

  % change in $\boldsymbol{Q}$ > % change in $\boldsymbol{P}$

- The fall in revenue from lower $\boldsymbol{Q}$ is greater than the increase in revenue from higher $\boldsymbol{P}$, so revenue falls.

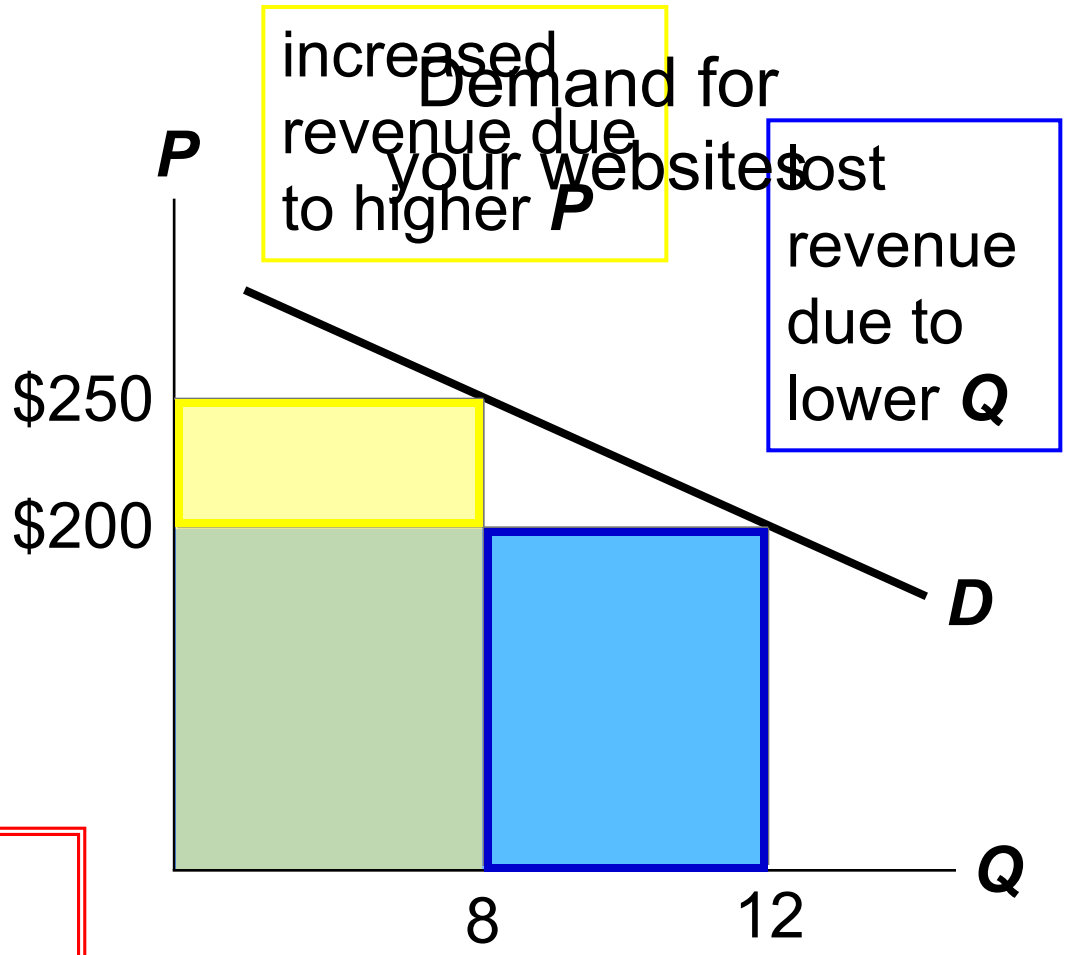
Price Elasticity and Total Revenue

Elastic demand
(elasticity = 1.8)

If ***P*** = \$200,
Q = 12 and
revenue = \$2400.

If ***P*** = \$250,
Q = 8 and
revenue = \$2000.

When ***D*** is elastic,
a price increase
causes revenue to fall.



Price Elasticity and Total Revenue

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

Revenue = $\boldsymbol{P} \times \boldsymbol{Q}$

- If demand is inelastic, then

  price elast. of demand $<$ 1

  % change in $\boldsymbol{Q}$ $<$ % change in $\boldsymbol{P}$

- The fall in revenue from lower $\boldsymbol{Q}$ is smaller than the increase in revenue from higher $\boldsymbol{P}$, so revenue rises.

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

Price Elasticity and Total Revenue

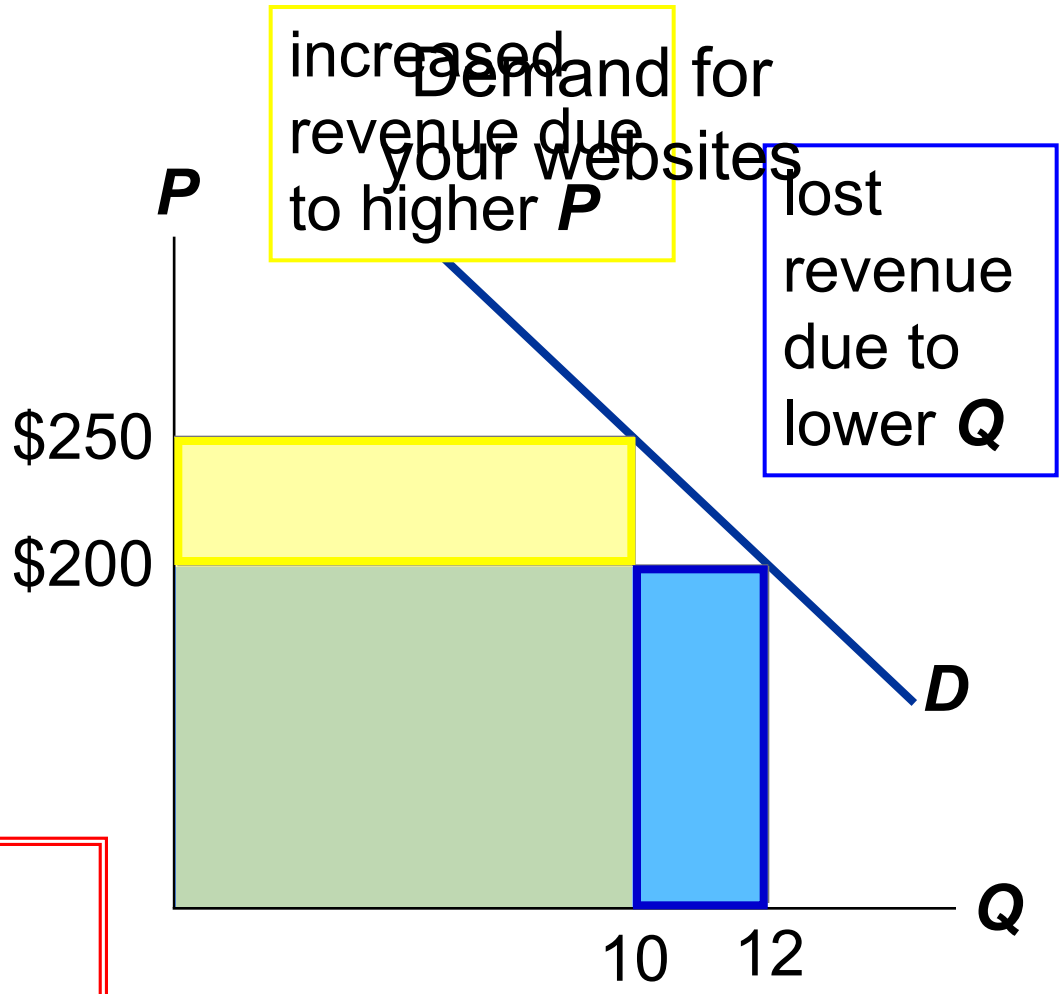
Now, demand is inelastic:

elasticity = 0.82

If ***P*** = \$200, ***Q*** = 12 and revenue = \$2400.

If ***P*** = \$250, ***Q*** = 10 and revenue = \$2500.

When ***D*** is inelastic, a price increase causes revenue to rise.



ACTIVE LEARNING *2*

Elasticity and expenditure/revenue

A. Pharmacies raise the price of insulin by 10%.
Does total expenditure on insulin rise or fall?

B. As a result of a fare war, the price of a luxury cruise falls 20%.
Does luxury cruise companies' total revenue rise or fall?

ACTIVE LEARNING *2*

Answers

A. Pharmacies raise the price of insulin by 10%. Does total expenditure on insulin rise or fall?

Expenditure = ***P*** x ***Q***

Since demand is inelastic, ***Q*** will fall less than 10%, so expenditure rises.

ACTIVE LEARNING 2

Answers

B. As a result of a fare war, the price of a luxury cruise falls 20%.
Does luxury cruise companies' total revenue rise or fall?

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

The fall in ***P*** reduces revenue,
but ***Q*** increases, which increases revenue.
Which effect is bigger?

Since demand is elastic, ***Q*** will increase more than 20%, so revenue rises.

APPLICATION: Does Drug Interdiction Increase or Decrease Drug-Related Crime?

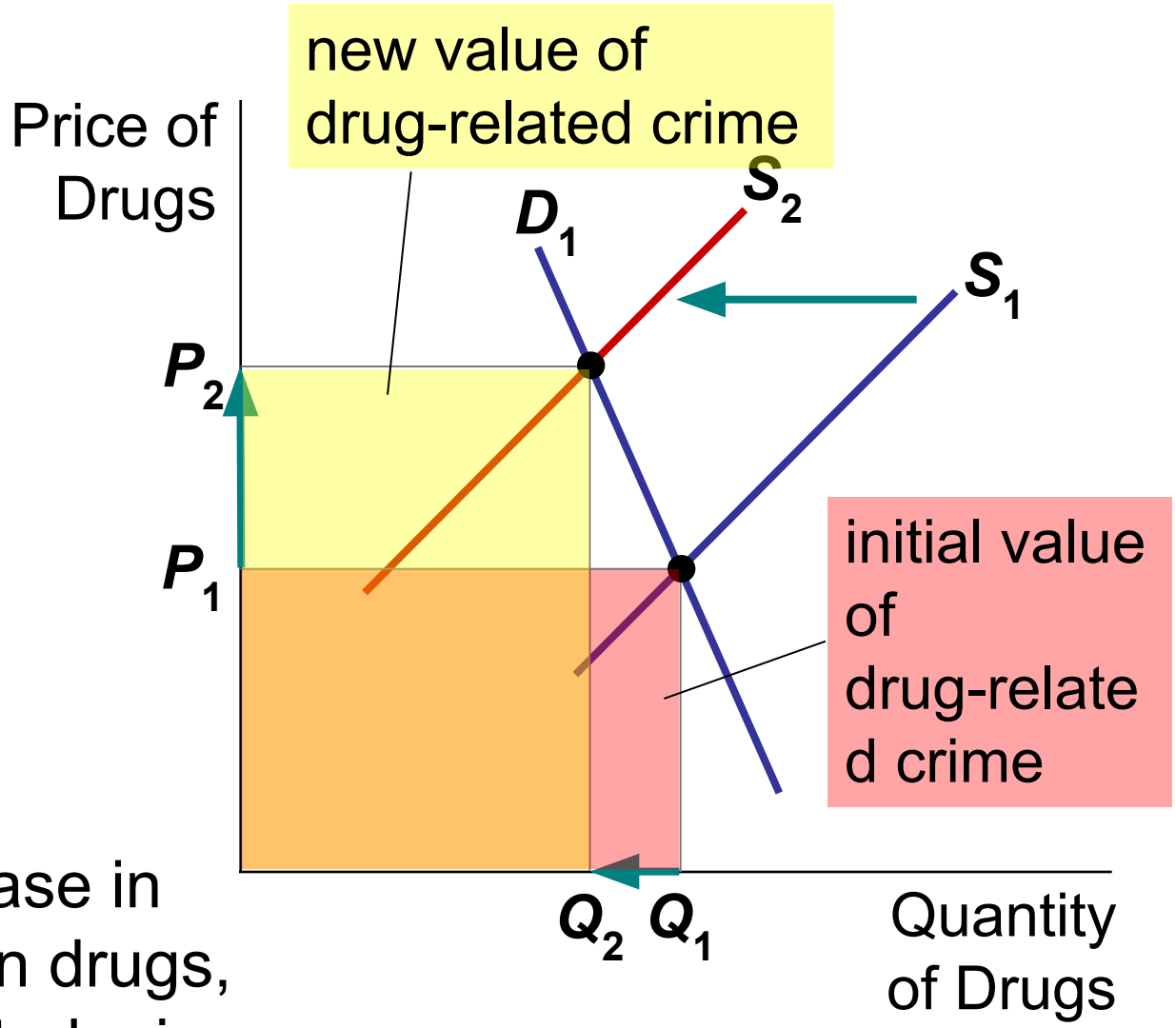
- One side effect of illegal drug use is crime: Users often turn to crime to finance their habit.
- We examine two policies designed to reduce illegal drug use and see what effects they have on drug-related crime.
- For simplicity, we assume the total dollar value of drug-related crime equals total expenditure on drugs.
- Demand for illegal drugs is inelastic, due to addiction issues.

Policy 1: Interdiction

Interdiction reduces the supply of drugs.

Since demand for drugs is inelastic, ***P*** rises propor-tionally more than ***Q*** falls.

Result: an increase in total spending on drugs, and in drug-related crime

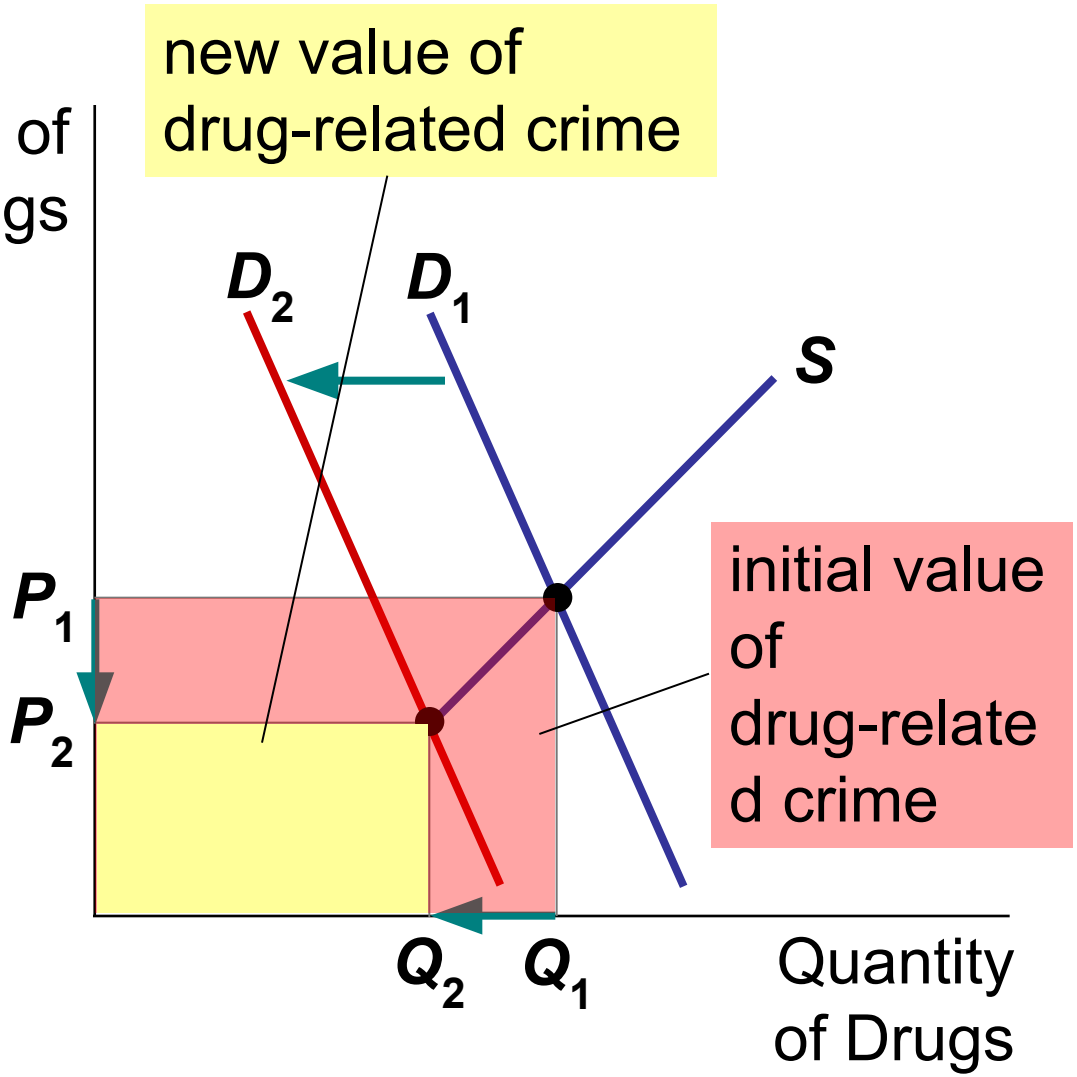


Policy 2: Education

Education reduces the demand for drugs.

P and ***Q*** fall.

Result:
A decrease in total spending on drugs, and in drug-related crime.



Price Elasticity of Supply

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

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

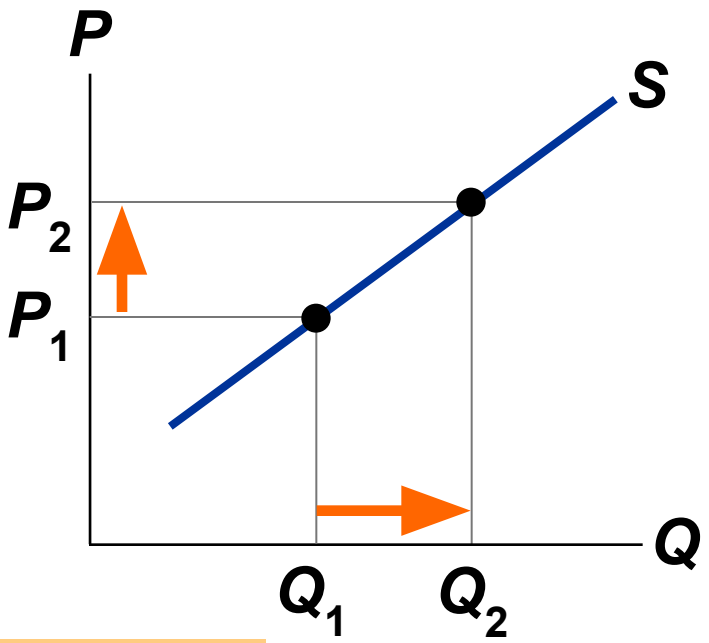
Price Elasticity of Supply

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

Example:

Price elasticity of supply equals

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



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….

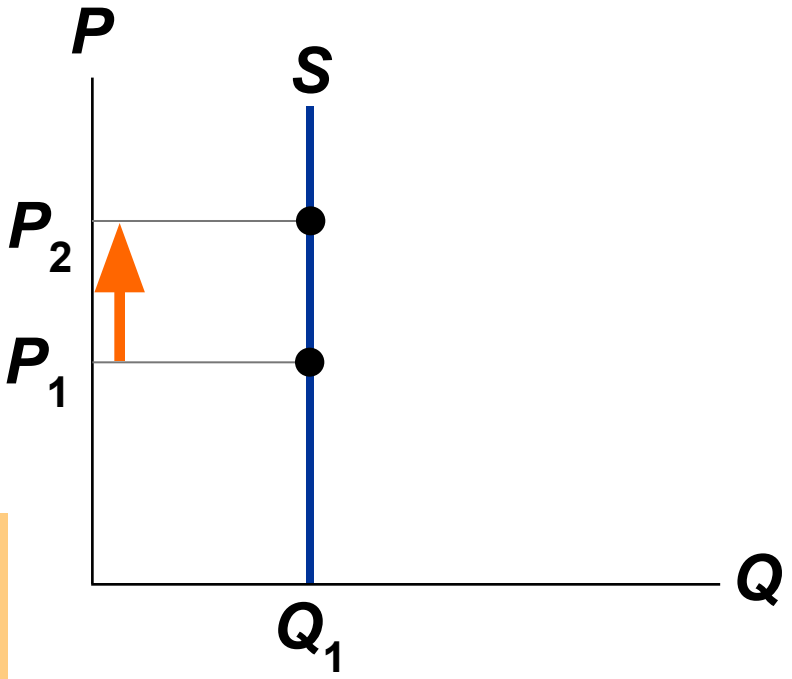
"Perfectly inelastic" (one extreme)

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

S curve:
vertical

Sellers' price sensitivity:
none

Elasticity:
0



P rises by 10%

Q changes by 0%

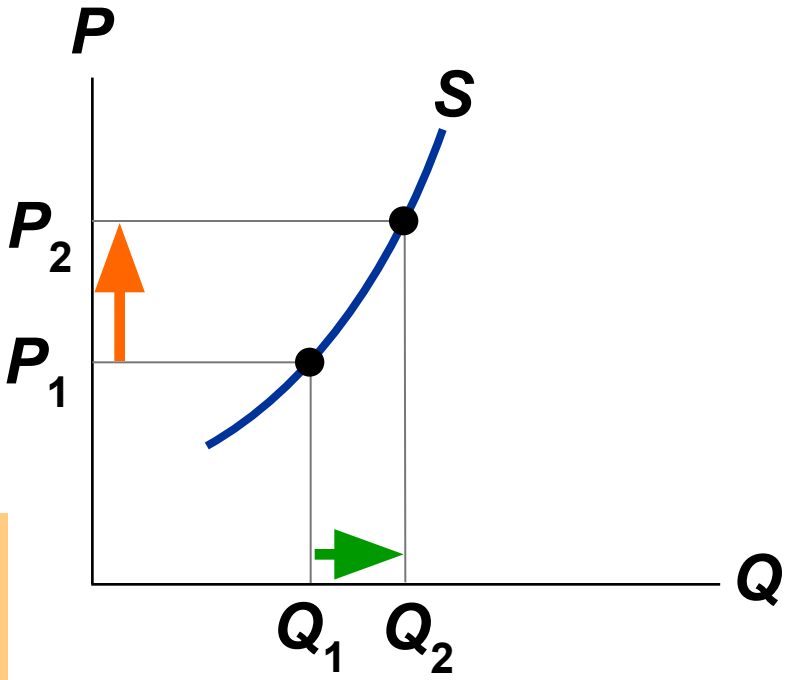
"Inelastic"

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

S curve:
relatively steep

Sellers' price sensitivity:
relatively low

Elasticity:
< 1



P rises by 10%

Q rises less than 10%

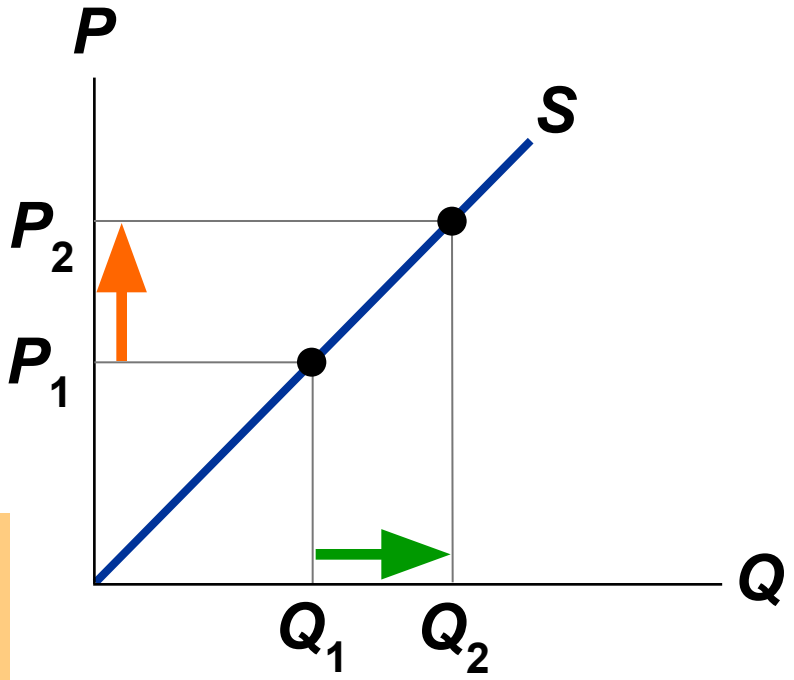
"Unit elastic"

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

S curve:
intermediate slope

Sellers' price sensitivity:
intermediate

Elasticity:
= 1



P rises by 10%

Q rises by 10%

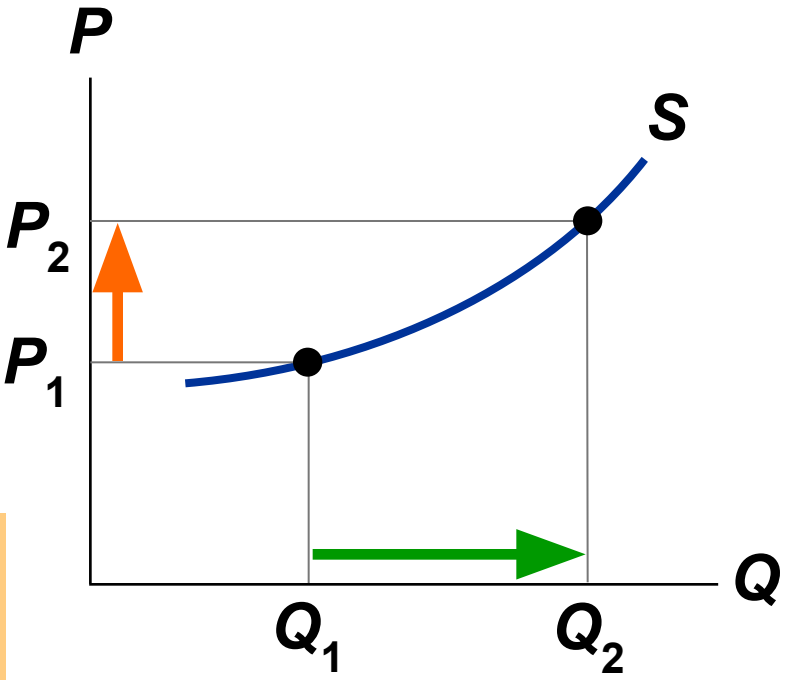
"Elastic"

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

S curve:
relatively flat

Sellers' price sensitivity:
relatively high

Elasticity:
> 1



P rises by 10%

Q rises more than 10%

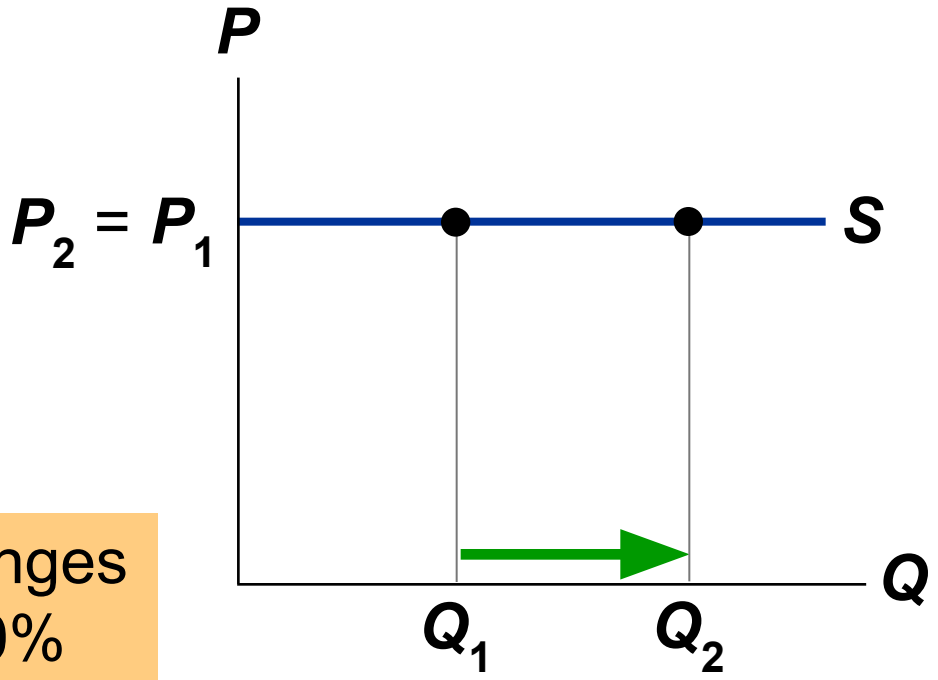
"Perfectly elastic" (the other extreme)

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

S curve:
horizontal

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*

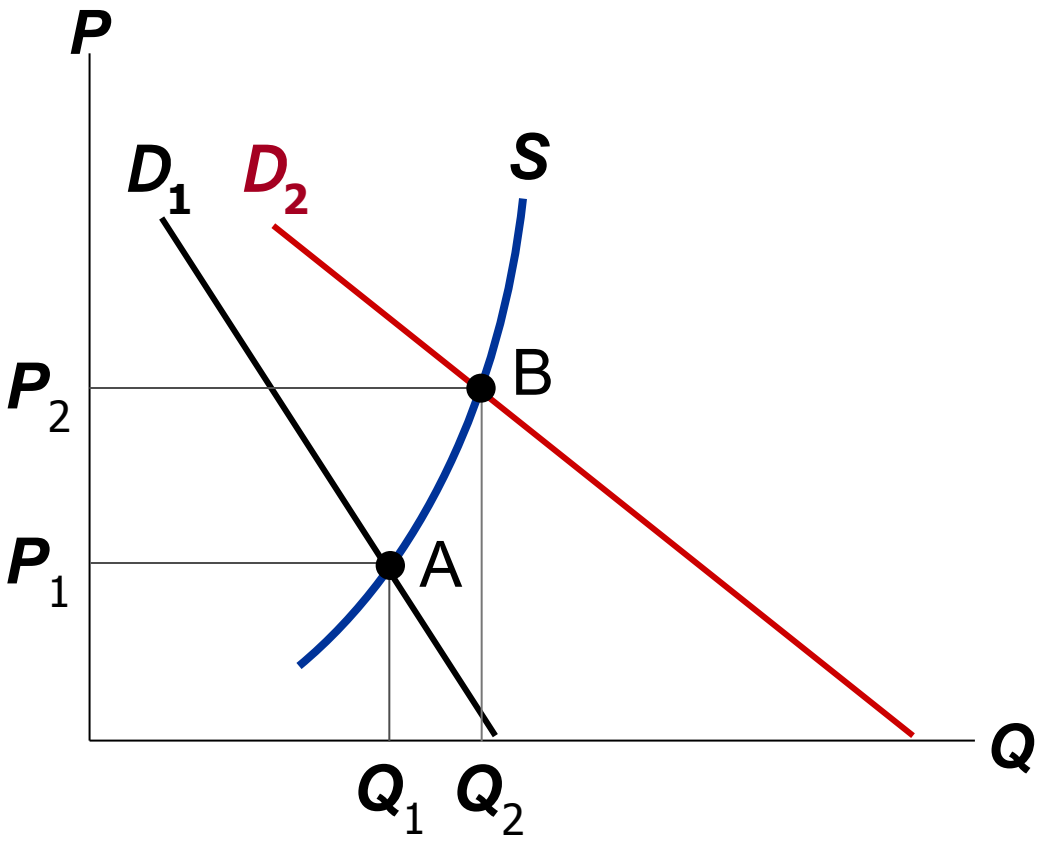
Elasticity and changes in equilibrium

- 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.

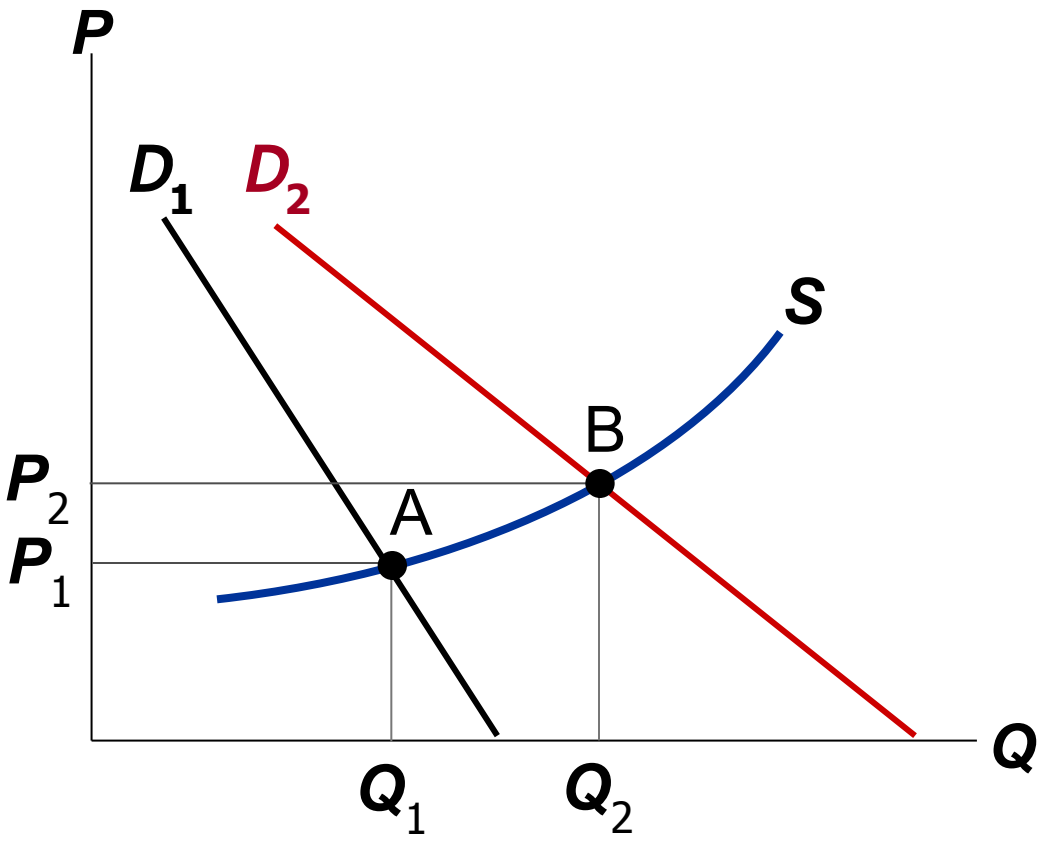
Beachfront property (inelastic supply):



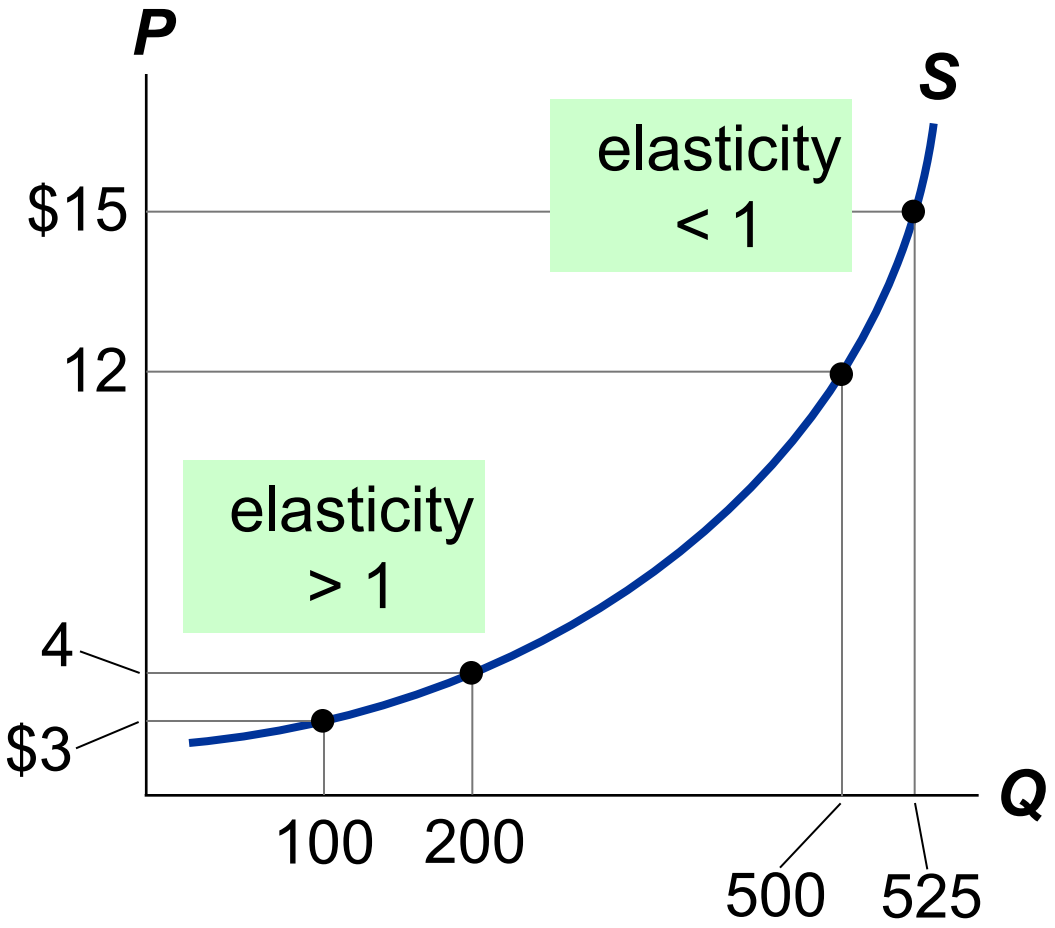
ACTIVE LEARNING 3
Answers

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.

Other Elasticities

- **Income elasticity of demand**: measures the response of Q^d to a change in consumer income

$$\text{Income elasticity of demand} = \frac{\text{Percent change in } Q^d}{\text{Percent change in income}}$$

- Recall from Chapter 4: An increase in income causes an increase in demand for a *normal* good.
- Hence, for normal goods, income elasticity > 0.
- For *inferior* goods, income elasticity < 0.

Other Elasticities

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

$$\text{Cross-price elast. of demand} = \frac{\%\text{ change in } Q^d \text{ for good 1}}{\%\text{ change in price of good 2}}$$

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

Cross-Price Elasticities in the News

"As Gas Costs Soar, Buyers Flock to Small Cars"
-*New York Times*, 5/2/2008

"Gas Prices Drive Students to Online Courses"
-*Chronicle of Higher Education*, 7/8/2008

"Gas prices knock bicycle sales, repairs into higher gear"
-*Associated Press*, 5/11/2008

"Camel demand soars in India"
(as a substitute for "gas-guzzling tractors")
-*Financial Times*, 5/2/2008

"High gas prices drive farmer to switch to mules"
-*Associated Press*, 5/21/2008

CHAPTER SUMMARY

- Elasticity measures the responsiveness of Q^d or Q^s to one of its determinants.
- Price elasticity of demand equals percentage change in Q^d divided by percentage change in P. When it's less than one, demand is "inelastic." When greater than one, demand is "elastic."
- When demand is inelastic, total revenue rises when price rises. When demand is elastic, total revenue falls when price rises.

CHAPTER SUMMARY

- Demand is less elastic in the short run, for necessities, for broadly defined goods, or for goods with few close substitutes.
- Price elasticity of supply equals percentage change in Q^s divided by percentage change in P. When it's less than one, supply is "inelastic." When greater than one, supply is "elastic."
- Price elasticity of supply is greater in the long run than in the short run.

CHAPTER SUMMARY

- The income elasticity of demand measures how much quantity demanded responds to changes in buyers' incomes.
- The cross-price elasticity of demand measures how much demand for one good responds to changes in the price of another good.