N. GREGORY MANKIW

PRINCIPLES OF

ECONOMICS

Eight Edition

CHAPTER

5

Elasticity and Its Application

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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 $2,000 per website, and currently sell 12 websites per month.
- Your costs are rising (including the opportunity cost of your time)
  - You consider raising the price to $2,500.
- The law of demand: 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?

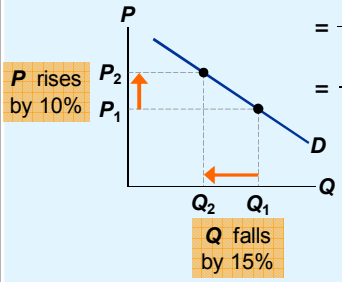
The Elasticity of Demand

- Elasticity
  - Measure of the responsiveness of Q^d or Q^s
    - To a change in one of its determinants
- Price elasticity of demand
  - How much the quantity demanded of a good responds to a change in the price of that good
    - Loosely speaking, it measures the price-sensitivity of buyers' demand

Price Elasticity of Demand

Price elasticity of demand =

$$= \frac{\text{Percentage change in } Q^d}{\text{Percentage change in } P} = \frac{15\%}{10\%} = 1.5$$

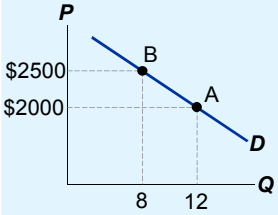


Along a D curve, P and Q move in opposite directions, which would make ***price elasticity negative***.

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 = ($2,500 – $2,000)/$2,000 = 25%
- the % change in Q = - 33%
- Price elasticity = 33/25 = **1.33**

Going from B to A:

- the % change in P = - 20%
- the % change in Q = 50%
- Price elasticity = 50/20 = **2.5**

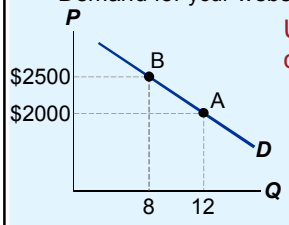
We get different values!

The Price Elasticity of Demand

- Midpoint method
  - The midpoint is the number halfway between the start and end values
    - The average of those values
- % change = $\frac{\text{end value} - \text{start value}}{\text{midpoint}} \times 100\%$
- Price elasticity of demand = $\frac{\frac{Q_2 - Q_1}{(Q_2 + Q_1)/2}}{\frac{P_2 - P_1}{(P_2 + P_1)/2}}$

Calculating Percentage Changes

Demand for your websites



Using the midpoint method of computing % changes:

% change in **P** = $\frac{\$2{,}500 - \$2{,}000}{\$2250} \times 100\% = 22.2\%$

% change in **Q** = $\frac{12 - 8}{10} \times 100\% = 40.0\%$

Price elasticity of demand = 40/22.2 = 1.8

Active Learning 1 — Calculate an elasticity

Use the following information to calculate the price elasticity of demand for iPhone X:

- if P = NT$35,900, Q^d = 10,600
- if P = NT$54,100, Q^d = 8,400
- Use the midpoint method to calculate percentage changes.

Active Learning 1 — Answers

Using the midpoint method to calculate percentage changes:

- % change in P =
  [($54,100 - $35,900)/$45,000] ×100 = 40.44%
- % change in Q^d =
  [(10,600 – 8,400)/9,500] ×100 = 23.16%
- Price elasticity of demand =
  = % change in Q^d / % change in P
  = 23.16/40.44 = 0.57

The Price Elasticity of Demand

- Determinants of price elasticity of demand
  - We look at a series of examples comparing two common goods
- In each example:
  - Suppose prices of both goods rise by 20%
  - Which good has the highest price elasticity of demand? Why?
  - What lesson we learn about the determinants of price elasticity of demand?

The Price Elasticity of Demand

Example 1: Samsung S8+ vs. iPhone X

- Prices of both of these goods rise by 20%.
  - For which good does Q^d drop the most? Why?
  - Samsung S8+ has close substitutes (HTC U11, LG G6, Sony XZ Premium), so buyers can easily switch if the price rises
  - iPhone X has no close substitutes, so a price increase would not affect demand very much
- Price elasticity is higher when close substitutes are available

The Price Elasticity of Demand

Example 2: Blue Jeans vs. Clothing

- Prices of both of these goods rise by 20%.
  - For which good does Q^d drop the most? Why?
  - For a narrowly defined good, blue jeans, there are many substitutes
    There are fewer substitutes available for broadly defined goods (clothing)

Price elasticity is higher for narrowly defined goods than for broadly defined ones.

The Price Elasticity of Demand

Example 3: Insulin vs. Yacht

- Prices of both of these goods rise by 20%.
  - For which good does Q^d drop the most? Why?
  - Insulin is a necessity to diabetics. A rise in price would cause little or no decrease in demand
  - A yacht is a luxury. If the price rises, some people will forego it.

- Price elasticity is higher for luxuries than for necessities.

The Price Elasticity of Demand

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 work.

- Price elasticity is higher in the long run

The Price Elasticity of Demand

- Variety of demand curves
  - Demand is elastic
    - Price elasticity of demand > 1
  - Demand is inelastic
    - Price elasticity of demand < 1
  - Demand has unit elasticity
    - Price elasticity of demand = 1

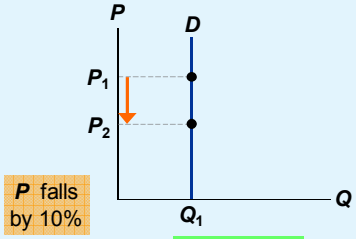
The Price Elasticity of Demand

- Variety of demand curves
  - Demand is perfectly inelastic
    - Price elasticity of demand = 0
    - Demand curve is vertical
  - Demand is perfectly elastic
    - Price elasticity of demand = infinity
    - Demand curve is horizontal

- The flatter the demand curve
  - The greater the price elasticity of demand

Perfectly inelastic demand

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



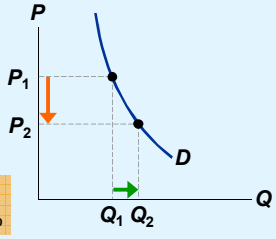
D curve
Vertical

Consumers' price sensitivity:
None

Elasticity:
0

Inelastic demand

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



P falls by 10%

Q rises less than 10%

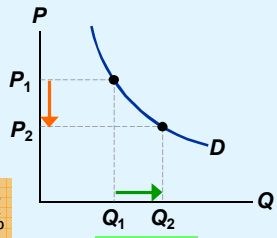
D curve: relatively steep

Consumers' price sensitivity: relatively low

Elasticity: <1

Unit elastic demand

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



P falls by 10%

Q rises by 10%

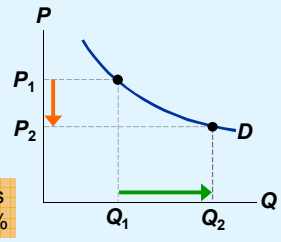
D curve: intermediate slope

Consumers' price sensitivity: intermediate

Elasticity: =1

Elastic demand

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



P falls by 10%

Q rises more than 10%

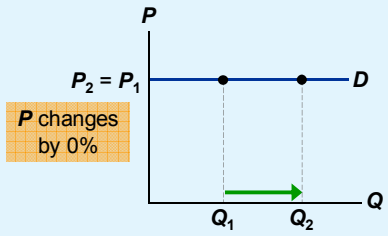
D curve: relatively flat

Consumers' price sensitivity: relatively high

Elasticity: >1

Perfectly elastic demand

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



P changes by 0%

Q changes by any %

D curve: horizontal

Consumers' price sensitivity: extreme

Elasticity: infinity

A Few Elasticities from the Real World

Eggs	0.1
Healthcare	0.2
Cigarettes	0.4
Rice	0.5
Housing	0.7
Beef	1.6
Peanut Butter	1.7
Restaurant meals	2.3
Mountain Dew	4.4

Selected Price Elasticity (from Wiki)

- Rice[48]
  - -0.47 (Austria)
  - -0.80 (Bangladesh)
  - -0.80 (China)
  - -0.25 (Japan)
  - -0.55 (US)
- Eggs
  - -0.1 (US: Household only),[54]
  - -0.35 (Canada),[55]
  - -0.55 (South Africa)[56]
- Livestock
  - -0.5 to -0.6 (Broiler Chickens)[44]

Selected Price Elasticity (from Wiki)

- Soft drinks
  - -0.8 to -1.0 (general)[51]
  - -3.8 (Coca-Cola)[52]
  - -4.4 (Mountain Dew)[52]
- Cigarettes (US)[41]
  - -0.3 to -0.6 (General)
  - -0.6 to -0.7 (Youth)
- Alcoholic beverages (US)[42]
  - -0.3 or -0.7 to -0.9 as of 1972 (Beer)
  - -1.0 (Wine)
  - -1.5 (Spirits)

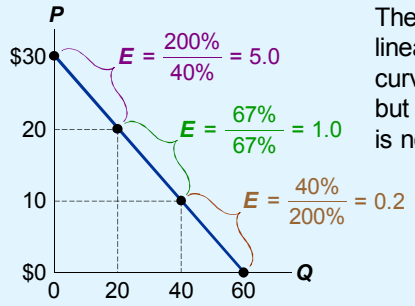
Selected Price Elasticity (from Wiki)

- Transport
  - -0.20 (Bus travel US)[46]
  - -2.80 (Ford compact automobile)[50]
- Airline travel (US)[43]
  - -0.3 (First Class)
  - -0.9 (Discount)
  - -1.5 (for Pleasure Travelers)
- Car fuel[45]
  - -0.25 (Short run)
  - -0.64 (Long run)

Selected Price Elasticity (from Wiki)

- Medicine (US)
  - -0.31 (Medical insurance)[46]
  - -.03 to -.06 (Pediatric Visits) [47]
- Oil (World)
  - -0.4
- Cinema visits (US)
  - -0.87 (General)[46]
- Live Performing Arts (Theater, etc.)
  - -0.4 to -0.9 [49]
- Steel
  - -0.2 to -0.3[53]

Elasticity along 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 $2,000 to $2,500, would your revenue rise or fall?

Total Revenue (TR) = P x Q

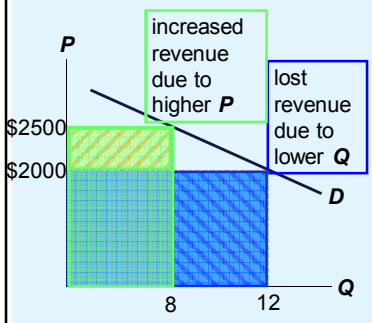
- A price increase has two effects on revenue:
  - Higher revenue: because of the higher P
  - Lower revenue: you sell fewer units (lower Q)
- Which of these two effects is bigger?
  - It depends on the price elasticity of demand

Price Elasticity and Total Revenue

- For a price increase, if demand is elastic
  - E > 1: % change in Q > % change in P
  - TR decreases: the fall in revenue from lower Q > the increase in revenue from higher P
- For a price increase, if demand is inelastic
  - E < 1: % change in Q < % change in P
  - TR increases: the fall in revenue from lower Q < the increase in revenue from higher P

Price Elasticity and Total Revenue

Demand for your websites



Elastic demand (elasticity = 1.8)

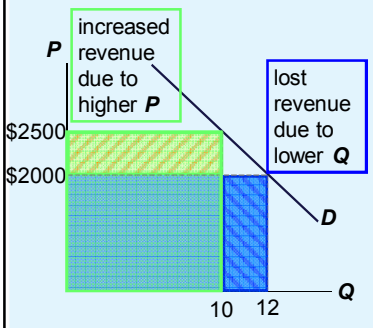
If ***P*** = $2,000, ***Q*** = 12, and revenue = $24,000

If ***P*** = $2,500, ***Q*** = 8, and revenue = $20,000

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

Price Elasticity and Total Revenue

Demand for your websites



Inelastic demand (elasticity = 0.82)

If ***P*** = $2,000, ***Q*** = 12, and revenue = $24,000

If ***P*** = $2,500, ***Q*** = 10, and revenue = $25,000

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

Active Learning 2 — Elasticity and 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.

Does Drug Interdiction Increase or Decrease Drug-related Crime?

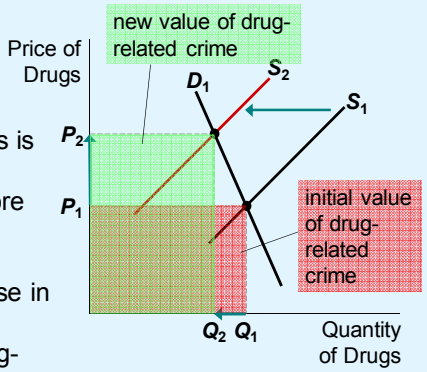
1. Increase the number of federal agents devoted to the war on drugs
   - Illegal drugs: supply curve shifts left
     - Higher price and lower quantity
   - Amount of drug-related crimes
     - Inelastic demand for drugs
     - Higher drugs price: higher total revenue
     - Increase drug-related crime

Policy 1: Interdiction

Interdiction reduces the supply of drugs.

Demand for drugs is inelastic: ***P*** rises proportionally more than ***Q*** falls.

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



Does Drug Interdiction Increase or Decrease Drug-related Crime?

2. Policy of drug education

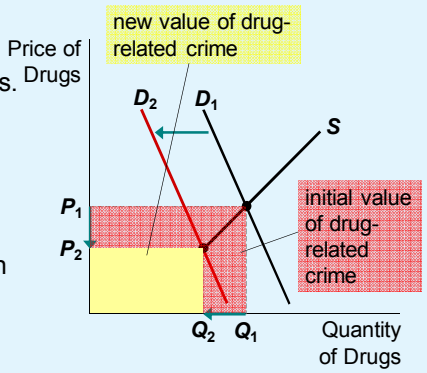
- Reduce demand for illegal drugs
- Left shift of demand curve
- Lower quantity
- Lower price
- Reduce drug-related crime

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.



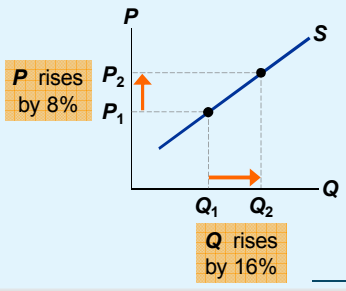
The Price Elasticity of Supply

- Price elasticity of supply
  - How much the quantity supplied of a good responds to a change in the price of that good
  - Percentage change in quantity supplied
    - Divided by the percentage change in price
  - Loosely speaking, it measures sellers' price-sensitivity

Price Elasticity of Supply

$$\text{Price elasticity of supply} = \frac{\text{Percentage change in } Q^s}{\text{Percentage change in } P} = \frac{16\%}{8\%} = 2$$

Again, we use the midpoint method to compute the percentage changes.



The Price Elasticity of Supply

- Variety of supply curves
  - Supply is unit elastic
    - Price elasticity of supply = 1
  - Supply is elastic
    - Price elasticity of supply > 1
  - Supply is inelastic
    - Price elasticity of supply < 1

The Price Elasticity of Supply

- Variety of supply curves
  - Supply is perfectly inelastic
    - Price elasticity of supply = 0
    - Supply curve is vertical
  - Supply is perfectly elastic
    - Price elasticity of supply = infinity
    - Supply curve is horizontal
- The flatter the supply curve
  - The greater the price elasticity of supply

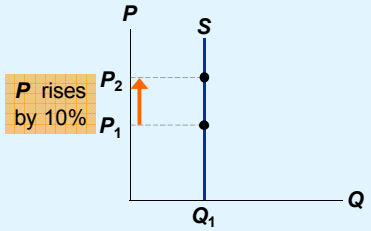
Perfectly inelastic supply

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



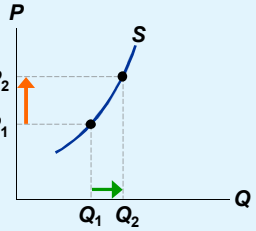
Inelastic supply

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



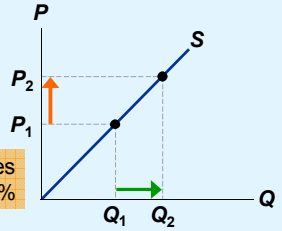
Unit elastic supply

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



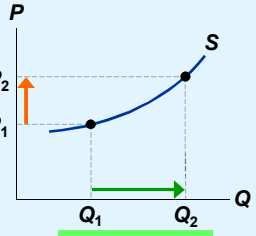
Elastic supply

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

S curve: relatively flat

Sellers' price sensitivity: relatively high

Elasticity: > 1



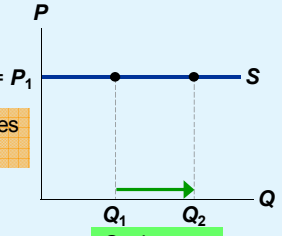
Perfectly elastic supply

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



The Determinants of Supply Elasticity

- Greater price elasticity of supply
  - The more easily sellers can change the quantity they produce
    - Supply of beachfront property - harder to vary and thus less elastic than supply of new cars
- Price elasticity of supply is greater in the long run than in the short run
  - In the long run: 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.

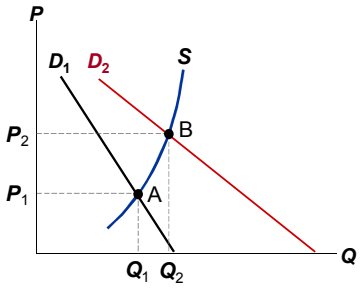
Suppose population growth causes demand for both goods to double (at each price, Q^d doubles).

- 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.

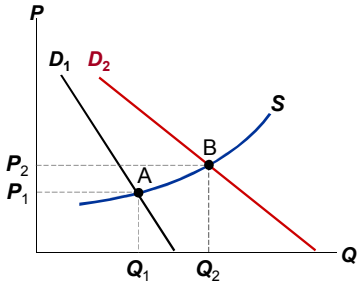
Beachfront property (inelastic supply):



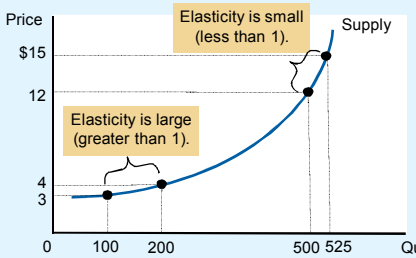
Active Learning 3 — Answers

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 of Demand

- Income elasticity of demand
  - How much the quantity demanded of a good responds to a change in consumers' income
  - Percentage change in quantity demanded
    - Divided by the percentage change in income
  - Normal goods: income elasticity > 0
  - Inferior goods: income elasticity < 0

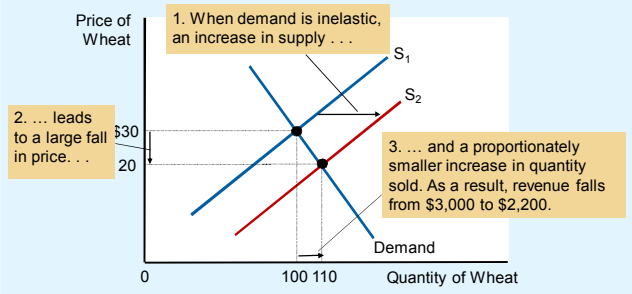
Other Elasticities of Demand

- Cross-price elasticity of demand
  - How much the Q^d of one good responds to a change in the price of another good
  - Percentage change in Q^d of the first good
    - Divided by the percentage change in price of the second good
  - Substitutes: cross-price elasticity > 0
  - Complements: cross-price elasticity < 0

Applications

- Can Good News for Farming Be Bad News for Farmers?
  - New hybrid of wheat – increase production per acre 20%

An Increase in Supply in the Market for Wheat



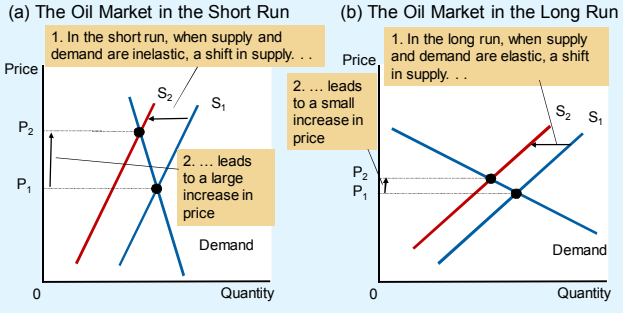
Applications

- Can Good News for Farming Be Bad News for Farmers?
  - New hybrid of wheat – increase production per acre 20%
    - Supply curve shifts to the right
    - Higher quantity and lower price
    - Demand is inelastic: total revenue falls
  - Paradox of public policy: induce farmers not to plant crops

Applications

- Why Did OPEC Fail to Keep the Price of Oil High?
  - Increase in prices 1973-1974, 1971-1981

A Reduction in Supply in the World Market for Oil



Applications

- Why Did OPEC Fail to Keep the Price of Oil High?
  - Increase in prices 1973-1974, 1971-1981
  - 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

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.

Summary

- Demand is less elastic in the short run, for necessities, for broadly defined goods, and 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.

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.
- The tools of supply and demand can be applied in many different kinds of markets. This chapter uses them to analyze the market for wheat, the market for oil, and the market for illegal drugs.

Chapter 5: Elasticity

- Different Types of Elasticities
  - Price Elasticity
  - Income Elasticity
  - Cross Price Elasticity
- Homework:
  - Mankiw, Ch. 5, Problem 2, 7-12

Chapter 5: Challenge Questions/ex-Midterm

- 2007 - Essay Q2
- 2008 - Essay D (Multi-Choice Q4-5)
- 2009 - Essay C5-C8 (Multiple Choice Q10)
- 2010 - (True/False Q4)
- 2012 - Essay C (True/False Q5-6)
- 2013 - Essay A3-A4, B (True/False Q4-5)
- 2014 - Essay C1
- 2015 - Essay B1-B3 (True/False A6)
- 2016 - Essay A, B3-B4, F