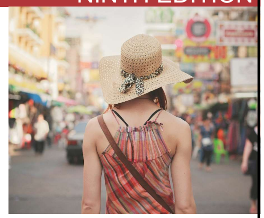
N. GREGORY MANKIW — NINTH EDITION

PRINCIPLES OF

ECONOMICS



CHAPTER 5

Elasticity and Its Application

Modified by Joseph Tao-yi Wang

Interactive PowerPoint Slides by:
V. Andreea Chiritescu
Eastern Illinois University

IN THIS CHAPTER

- 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 and 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?

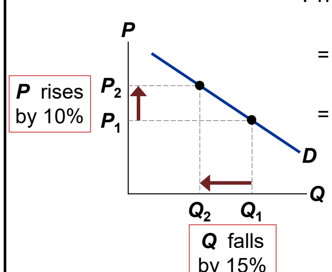
Our Scenario

- You maintain the social media accounts for local businesses
  - You charge NT$6,000 per business, and currently maintain the social media accounts for 12 businesses per year.
- Your costs are rising (including the opportunity cost of your time).
  - You consider raising the price to NT$7,500.
- The law of demand: if you raise your price, you will not have as many accounts to maintain.
  - How many fewer accounts?
  - 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

The Price Elasticity of Demand



Price elasticity of demand is

$$= \frac{\text{Percentage change in } Q^d}{\text{Percentage change in } P}$$

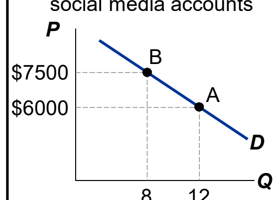
$$= \frac{15\%}{10\%} = 1.5$$

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 (absolute values).

Calculating Percentage Changes

Demand for maintaining social media accounts



Going from B to A:
- % change in P = - 20%
- % change in Q = 50%

Price elasticity =50/20 = **2.5**

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 = 25%
- the % change in Q = - 33%

Price elasticity = 33/25 = **1.33**

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 = $\dfrac{\text{end value} - \text{start value}}{\text{midpoint}}$ x 100%
- Price elasticity of demand = $\dfrac{\dfrac{Q_2 - Q_1}{(Q_2 + Q_1)/2}}{\dfrac{P_2 - P_1}{(P_2 + P_1)/2}}$

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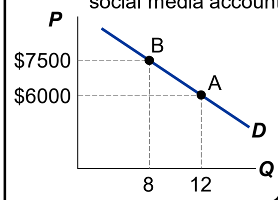
Our Scenario: Calculating Percentage Changes

Demand for maintaining social media accounts



Using the midpoint method of computing % changes:

% change in ***P*** = $\dfrac{\$7{,}500 - \$6{,}000}{\$6{,}750}$ x 100% = $\boxed{22.2\%}$

% change in ***Q*** = $\dfrac{12 - 8}{10}$ x 100% = $\boxed{40.0\%}$

Price elasticity of demand = 40/22.2 = $\boxed{1.8}$

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Active Learning 1: Calculate an Elasticity

Use the following information to calculate the price elasticity of demand for iPhone 12 Pro:

- if ***P*** = NT$35,900, Q^d = 10,600
- if ***P*** = NT$52,400, Q^d = 8,400

A. Use the midpoint method to calculate percentage change in price

B. Use the midpoint method to calculate percentage change in quantity

C. Calculate the price elasticity of demand

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Active Learning 1: Answers

Using the midpoint method to calculate percentage changes:

A. % change in ***P*** =
[($52,400 - $35,900)/$44,150] ×100 = 37.37%

B. % change in Q^d =
[(10,600 – 8,400)/9,500] ×100 = 23.16%

C. Price elasticity of demand =
= % change in Q^d / % change in ***P***
= 23.16/37.37 = 0.62

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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?

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EXAMPLE 1: Samsung S20 vs. iPhone 12 Pro

- Prices of both of these goods rise by 20%. For which good does Q^d drop the most? Why?

- Samsung S20 has many close substitutes, so buyers can easily switch if the price rises
- iPhone 12 Pro has no close substitutes, so a price increase would not affect demand much

Price elasticity is higher when close substitutes are available.

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EXAMPLE 2: Mountain Dew vs. Soda (Pop)

- Prices of both of these goods rise by 20%. For which good does Q^d drop the most? Why?

- For a narrowly defined good, Mountain Dew, there are many substitutes
- There are fewer substitutes available for broadly defined goods (soda / pop)

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

EXAMPLE 3: Insulin vs. Rolex Watches

- 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 quantity demanded
- A Rolex watch is a luxury. If the price rises, some people will forego it.

Price elasticity is higher for luxuries than for necessities.

EXAMPLE 4: Gasoline, Short Run vs. 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 Variety of Demand Curves – 1

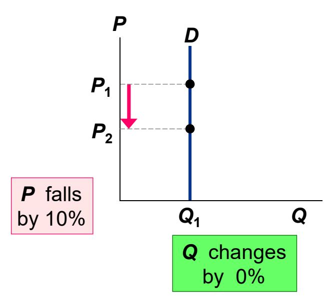
- Demand is elastic
  - Price elasticity of demand > 1
- Demand is inelastic
  - Price elasticity of demand < 1
- Demand has unit elasticity
  - Price elasticity of demand = 1

The Variety of Demand Curves – 2

- 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

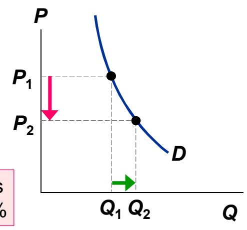
$$\text{Price elasticity of demand} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{0\%}{10\%} = 0$$



- D curve: Vertical
- Consumers' price sensitivity: None
- Elasticity: 0

Inelastic Demand

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



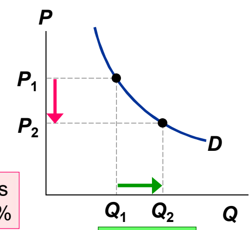
P falls by 10%

Q rises less than 10%

- ***D*** curve
  - relatively steep
- Consumers' price sensitivity:
  - relatively low
- Elasticity:
  - <1

Unit Elastic Demand

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



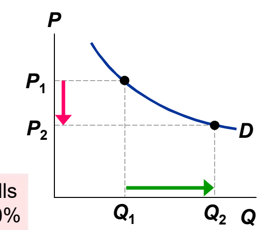
P falls by 10%

Q rises by 10%

- ***D*** curve
  - intermediate slope
- Consumers' price sensitivity:
  - intermediate
- Elasticity:
  - =1

Elastic Demand

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



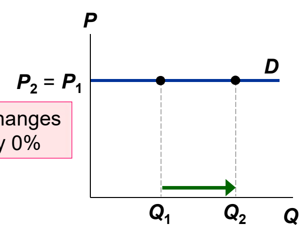
P falls by 10%

Q rises more than 10%

- ***D*** curve
  - relatively flat
- Consumers' price sensitivity:
  - relatively high
- Elasticity:
  - >1

Perfectly Elastic Demand

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



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

Very inelastic

Very elastic

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: HH 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)

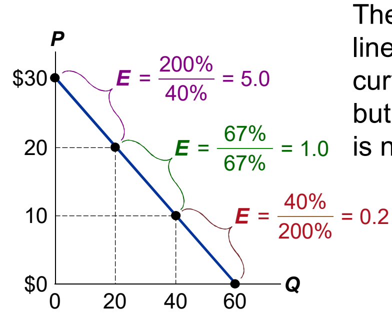
Selected Price Elasticity (from Wiki)

- 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 (Pleasure Travel)
- 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.

Our Scenario: Total Revenue

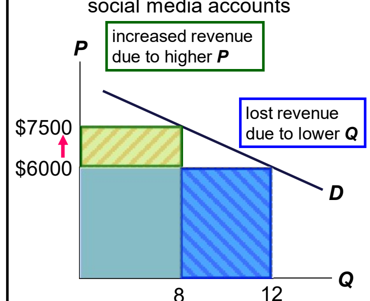
Continuing our scenario, if you raise your price from $6,000 to $7,500, would your revenue rise or fall?

Total Revenue (***TR***) = ***P*** x ***Q***

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

Our Scenario: Elastic Demand

Demand for maintaining social media accounts



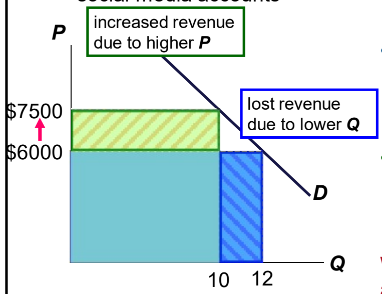
Price elasticity of demand = 1.8

- If ***P*** = NT$6,000, ***Q*** = 12, and TR = NT$72,000
- If ***P*** = NT$7,500, ***Q*** = 8, and TR = $60,000

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

Our Scenario: Inelastic Demand

Demand for maintaining social media accounts



Price elasticity of demand = 0.82

- If ***P*** = NT$6,000, ***Q*** = 12, TR = NT$72,000
- If ***P*** = NT$7,500, ***Q*** = 10, and TR= NT$75,000

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

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***

Active Learning 2: Elasticity and Total 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

A. Pharmacies raise the price of insulin by 10%.
   – Does total expenditure on insulin rises or falls?

- Expenditure = total revenue = ***P*** x ***Q***
- Since demand for insulin is inelastic, ***Q*** will fall less than 10%, so expenditure rises.

Active Learning 2: Answers, B

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

- 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

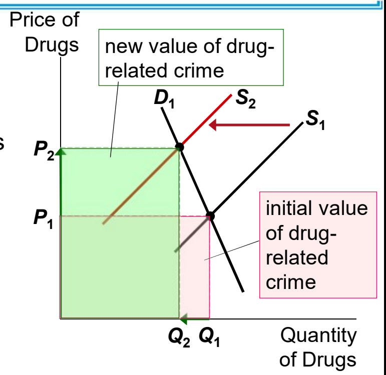
2. Policy of drug education
   – Reduce demand for illegal drugs
   – Left shift of demand curve

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?

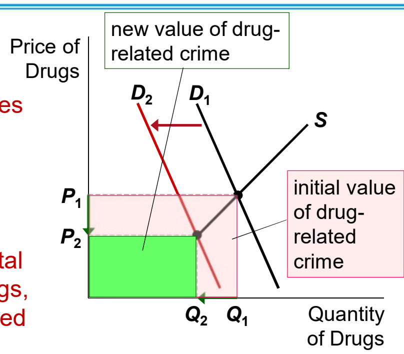
1. Increase the number of federal agents devoted to the war on drugs
   - Illegal drugs: supply curve shifts left
     - Higher price and lower quantity
   - Amount of drug-related crimes
     - Inelastic demand for drugs
     - Higher drugs price: higher total revenue
     - Increase drug-related crime

Policy 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.



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

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

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

The Price Elasticity of Supply

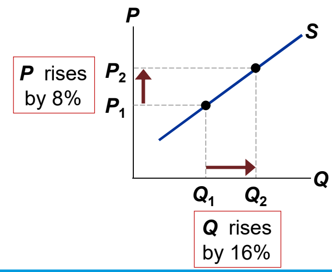
- How much the quantity supplied of a good responds to a change in the price of that good
- Percentage change in quantity supplied
- Divided by the percentage change in price

- Loosely speaking, it measures sellers' price-sensitivity

Calculating 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 Variety of Supply Curves – 1

- 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

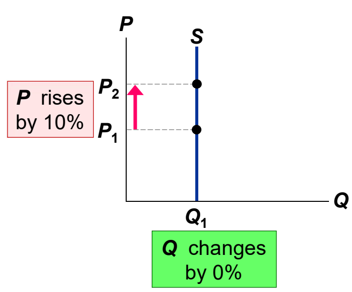
The Variety of Supply Curves – 2

- 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

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

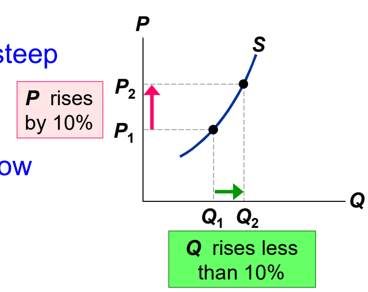
- ***S*** curve:
  vertical
- Sellers' price sensitivity:
  none
- Elasticity:
  0



Inelastic Supply

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

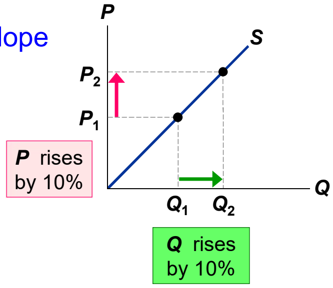
- ***S*** curve:
  relatively steep
- Sellers' price sensitivity:
  relatively low
- Elasticity:
  < 1



Unit Elastic Supply

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

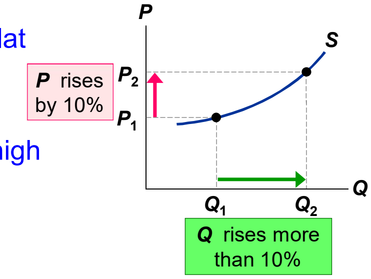
- ***S*** curve:
  - intermediate slope
- Sellers' price sensitivity:
  - intermediate
- Elasticity:
  - = 1



Elastic Supply

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

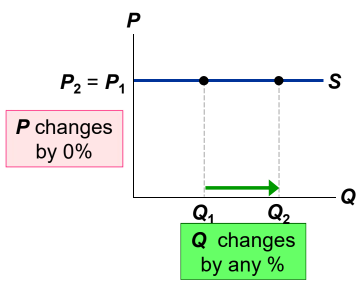
- ***S*** curve:
  - relatively flat
- Sellers' price sensitivity:
  - relatively high
- Elasticity:
  - > 1



Perfectly Elastic Supply

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

- ***S*** curve:
  - horizontal
- Sellers' price sensitivity:
  - extreme
- Elasticity:
  - infinity



The Determinants of Supply Elasticity

- Greater price elasticity of supply
  - The more easily sellers can change the quantity they produce
- 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

Assume the supply of residential apartments is inelastic and the supply of pork 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?

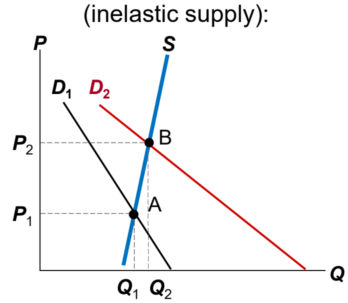
A. Draw a graph with the new equilibrium in the market for housing

B. Draw a graph with the new equilibrium in the market for pork

Active Learning 3**A**. Residential Apartments

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

Residential Apartments (inelastic supply):

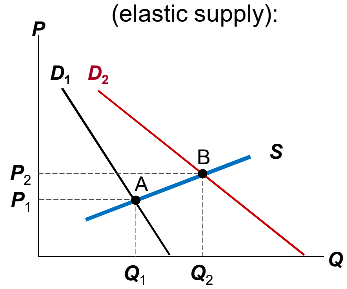


Active Learning 3B. Pork

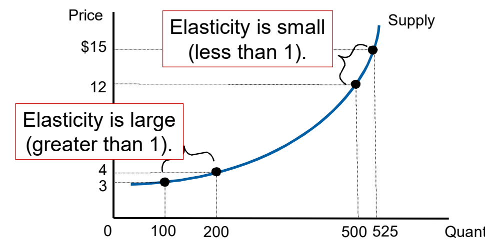
When supply is *elastic*, an increase in demand has a bigger impact on quantity than on price.

Pork

(elastic supply):



How the Price Elasticity of Supply Can Vary



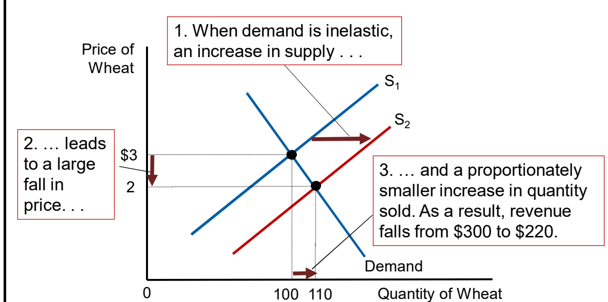
- Supply often becomes less elastic as ***Q*** rises, due to capacity limits.

More Applications – 1

1. Can Good News for Farming Be Bad News for Farmers?

- New hybrid of wheat: 20% increased production per acre
  - Supply curve shifts to the right
  - Higher quantity and lower price
  - Demand is inelastic: total revenue falls
  - Total profit falls if per acre cost is the same
- Paradox of public policy: induce farmers not to plant crops

An increase in supply in the market for wheat

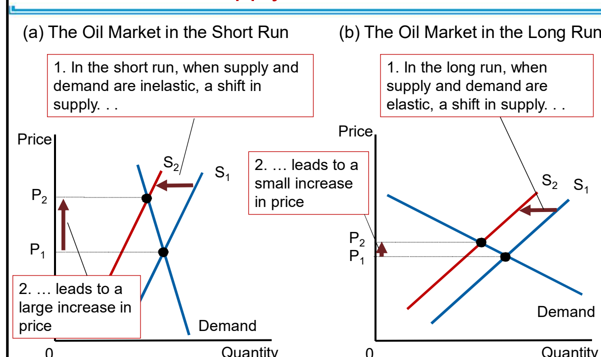


More Applications – 2

2. 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

A Reduction in Supply in the World Market for Oil



THINK-PAIR-SHARE

In order to reduce teen smoking, the government places NT$20 per pack tax on cigarettes. After one month, the quantity demanded of cigarettes has been reduced only slightly. Discuss the following:

A. What conclusion can you draw about the one-month demand for cigarettes?
B. Caleb suggests that the cigarette industry should get together and raise the price of cigarettes further to increase total revenue.
C. Keisha suggests that only your firm should raise the price of your cigarettes to increase total revenue.

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CHAPTER IN A NUTSHELL

- The price elasticity of demand
  - Measures how much the quantity demanded responds to changes in the price.
  - Is the percentage change in quantity demanded divided by the percentage change in price.
  - If < 1, inelastic demand: quantity demanded moves proportionately less than the price
  - If > 1, elastic demand: quantity demanded moves proportionately more than the price

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CHAPTER IN A NUTSHELL

- Demand tends to be more elastic if
  - Close substitutes are available
  - The good is a luxury rather than a necessity
  - The market is narrowly defined
  - If buyers have substantial time to react to a price change.
- Total revenue (***P***x***Q***), total amount paid for a good
  - Moves in the same direction as ***P*** (inelastic ***D***)
  - Moves in the opposite direction as ***P*** (elastic ***D***)

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CHAPTER IN A NUTSHELL

- The income elasticity of demand
  - Measures how much the quantity demanded responds to changes in consumers' income
- The cross-price elasticity of demand
  - Measures how much the quantity demanded of one good responds to changes in the price of another good
- The tools of supply and demand can be applied to 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.

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CHAPTER IN A NUTSHELL

- The price elasticity of supply
  - Measures how much the quantity supplied responds to changes in the price.
  - Is the percentage change in quantity supplied divided by the percentage change in price
  - If < 1, inelastic supply: quantity supplied moves proportionately less than the price
  - If > 1, elastic supply: quantity supplied moves proportionately more than the price
  - Depends on the time horizon under consideration. In most markets, supply is more elastic in the long run than in the short run.

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Chapter 5: Elasticity

- Different Types of Elasticities
  - Price Elasticity
  - Income Elasticity
  - Cross Price Elasticity
- Homework:
  - Mankiw, Ch. 5, Problem 2, 7-12
- Challenge Questions/ex-Midterm
  - 2007 - Q2
  - 2008 - Part D (+ Multi-Choice Q4-Q5)

Chapter 5: Challenge Questions/ex-Midterm

- 2009 - Part C5-C8 (+ Multiple Choice Q10)
- 2010 - (True/False Q4)
- 2012 - Part C (+ True/False Q5-6)
- 2013 - Part A3-A4, B (+ True/False Q4-5)
- 2014 - Part C1
- 2015 - Part B1-B3 (+ True/False A6)
- 2016 - Part A, B3-B4, F
- 2017 - Part B (except possibly B3)
- 2018 - Part A2-A4
- 2019 - Part A4-A10, C1-C4