<div align="right">**Lesson 1**</div>

ECONOMICS

- ◆ Economics is the study of how societies use scarce resources to produce valuable commodities and distribute them among different people.
- ◆ Microeconomics deals with:
    - Behavior of individual units
        - When Consuming; How we choose what to buy
        - When Producing; How we choose what to produce
    - Markets: The interaction of consumers and producers
    - Analysis of aggregate issues:
        - Economic growth
        - Inflation
        - Unemployment

Microeconomics vs. Macroeconomics
Microeconomics is the foundation of macroeconomic analysis.

Themes of Microeconomics
- ◆ According to Mick Jagger & the Rolling Stones, "You can't always get what you want". Why Not?
    - ◆ Limited Resources
    - ◆ Unlimited Wants
- ◆ Allocation of Scarce Resources and Trade-offs
    - ◆ In a planned economy
    - ◆ In a market economy
- ◆ Microeconomics and Optimal Trade-offs
    - 1. Consumer Theory
    - 2. Workers
    - 3. Theory of the Firm
- ◆ Microeconomics and Prices
    - – The role of prices in a market economy
    - – How prices are determined

Theories and Models
- ◆ Microeconomic Analysis
    - – Theories are used to explain observed phenomena in terms of a set of basic rules and assumptions. For example
        - – The Theory of the Firm
        - – The Theory of Consumer Behavior
    - – Models:
        A mathematical representation of a theory used to make a prediction.
    - – Validating a Theory
        The validity of a theory is determined by the quality of its prediction, given the assumptions.
    - – Evolving the Theory
        Testing and refining theories is central to the development of the science of economics.

Positive versus Normative Economics
- ◆ Positive Economics
    Positive economics deals with the observations or predictions of the facts of economic life. For example:
    What will be the impact of an increase in wages on the price of a product?

- Normative Economics
    - Normative Economics is the value judgments about how economics should operate, based on certain moral principles or preferences?" For example:
        - What wage rate should be paid to the auto workers to make them an active member of the society?

What is a Market?
- Markets
    - A geographically defined area where buyers and sellers interact to determine the price of a product or a set of products.
- Markets vs. Industries
    - Industries are the supply side of the market.
- Defining the Market
    - The market parameters must be set before an analysis of the market can take place.
- Arbitrage
    - Buying a product at a low price in one location and selling at a high price in another.
- Competitive vs. Noncompetitive Markets
    - Competitive Markets
        - Because of the large number of buyers and sellers, no individual buyer or seller can influence the price.
        - Example: Most agricultural markets
    - Noncompetitive Markets
        - Markets where individual producers can influence the price.
        - Example: OPEC
- Market Price
    - Competitive markets establish one price.
    - Noncompetitive markets may set many prices for the same product.
- Market Definition - The Extent of a Market
    - Market Definition
        - Which buyers and sellers should be included in a given market?
    - Market Extent
        - Defines the boundaries of the market
            - Geographic
            - Range of products
    - Examples
    - Geographic boundaries
        - Gold: Lahore vs. Karachi
        - Housing: Islamabad vs. Rawalpindi
    - Range of Products
        - Gasoline: regular, super, & diesel
        - Cameras: Polaroid, point & shoot, digital
    - Markets for Prescription Drugs
        - Well-defined markets - therapeutic drugs
        - Ambiguous markets – painkillers

Lesson 2

Economics; Another Perspective
- Economics is the study of the choices made by people who are faced with scarcity.
- Scarcity is a situation in which resources are limited but can be used in different ways; so one good or service must be sacrificed for another.

Society's Choices
- The decisions of producers, consumers and government determine how an economic system answers three fundamental questions:
    1. What products do we produce?
    2. How do we produce these products?
    3. Who consumes the products?
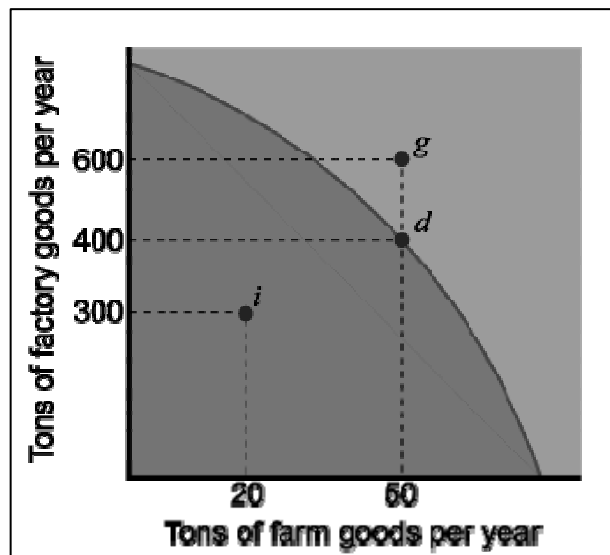
Factors of Production
Factors of production are the resources that are used to produce goods and services:
1. Natural resources:
    The things created by acts of nature such as land, water, mineral, oil and gas deposits, renewable and nonrenewable resources.
2. Labor:
    The human effort, physical and mental, used by workers in the production of goods and services.
3. Physical capital.
    All the machines, buildings, equipment, roads and other objects made by human beings to produce goods and services.
4. Human capital:
    The knowledge and skills acquired by a worker through education and experience.
5. Entrepreneurship:
    The effort to coordinate the production and sale of goods and services.
    Entrepreneurs take risk and commit time and money to a business without any guarantee of profit.

The Production Possibilities Frontier (PPF)

The PPF curve shows the possible combinations of goods and services available to an economy, given that all productive resources are fully and efficiently employed.

When the economy is at point *i*, resources are not fully employed and/or they are not used efficiently. Point *g* is desirable because it yields more of both goods, but not attainable given the amount of resources available. Point *d* is one of the possible combinations of goods produced when resources are fully and efficiently employed.

Scarcity and the PPF
To increase the amount of farm goods by 10 tons, we must sacrifice 100 tons of factory goods.
The PPF curve is bowed out because resources are not perfectly adaptable to the production of the two goods. As we increase the production of one good, we sacrifice progressively more of the other.
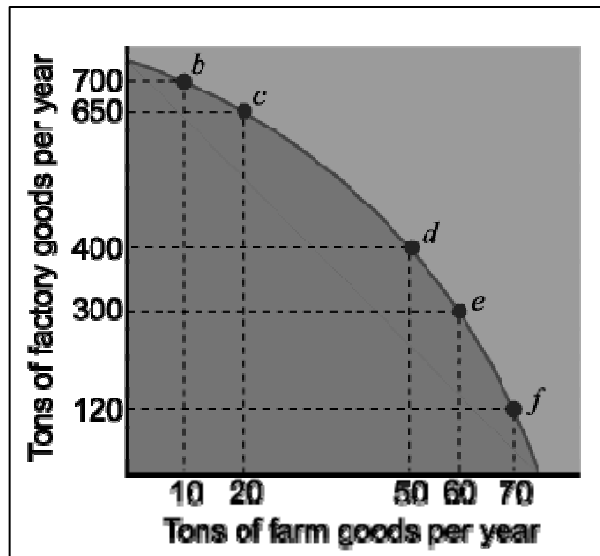
Shifting the PPF Curve
To increase the production of one good without decreasing the production of the other, the PPF curve must shift outward. The PPF curve shifts outward as a result of an increase in the economy's resources OR a technological innovation that increases the output obtained from a given amount of resources. From point *d*, an additional 200 tons of factory goods or 20 tons of farm goods are now possible (or any combination in between).

REAL VERSUS NOMINAL PRICES

- Nominal price is the absolute or current dollar price of a good or service when it is sold.
- Real price is the price relative to an aggregate measure of prices or constant dollar price.
- The Consumer Price Index (CPI) is an aggregate measure. Real prices are emphasized to permit the analysis of relative prices.

- Calculating Real Prices

$$\text{Real Price} = \frac{\text{CPI}_{\text{base year}}}{\text{CPI}_{\text{current year}}} \text{ x Nominal Price}_{\text{current year}}$$

Calculating the Real Price of Milk

Year	Nominal Price of Milk	CPI	Real Price of Milk in 1970 dollars
1970	.40	38.8	.40=38.8/38.8x .40
1980	.65	82.4	.31=38.8/82.4x .65
1999	1.05	167.0	.24=38.8/167.0x 1.05

Calculating Real Prices: An Example - Eggs & College

$$\text{Real Price of Eggs}_{1998 \ (1970 = 100)} = \frac{38.8_{1970}}{163} \text{ x } 1.04$$

$$\text{Real Price of College Education}_{1998 \ (1970 = 100)} = \frac{38.8}{163.0} \text{ x } \$19,213 = \$4,573$$
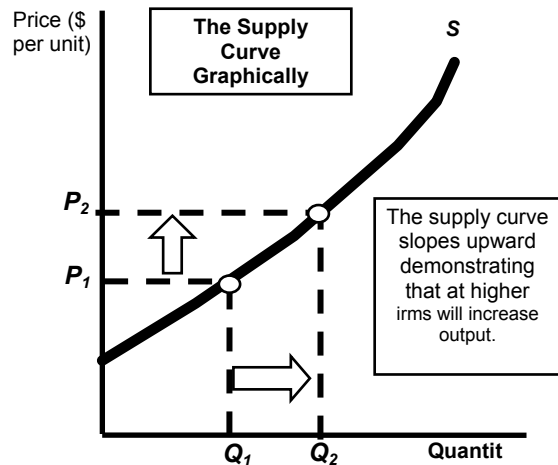
	1970	1975	1980	1985	1990	1998
Consumer Price Index (1983 = 100)	38.3	53.8	82.4	107.6	130.7	163.0
Nominal Prices ($)						
Grade A Large Eggs	0.61	0.77	0.84	0.80	0.98	1.04
College Education	2530	3403	4912	8156	12800	19213
Real Prices ($1970)						
Grade A Large Eggs	0.61	0.56	0.40	0.29	0.30	0.25
College Education	2530	2454	2313	2941	3800	4573

SUPPLY AND DEMAND

- ◆ **The Supply Curve**
    - – The supply curve shows how much of a good producers are willing to sell at a given price, holding constant other factors that might affect quantity supplied
    - – This price-quantity relationship can be shown by the equation:

$$Q_s = Q_s(P)$$

Price ($ per unit)

The Supply Curve Graphically

S

P_2

P_1

The supply curve slopes upward demonstrating that at higher irms will increase output.

Q_1 Q_2 **Quantit**

- ◆ **Non-price Determining Variables of Supply**
    - – Costs of Production
        - • Labor
        - • Capital
        - • Raw Materials

- ◆ The cost of raw materials falls
    - – At P1, produce Q2
    - – At P2, produce Q1
    - – Supply curve shifts right to S'
    - – More produced at any price on S' than on S

P

Change in Supply

S   S'

P_1

P_2
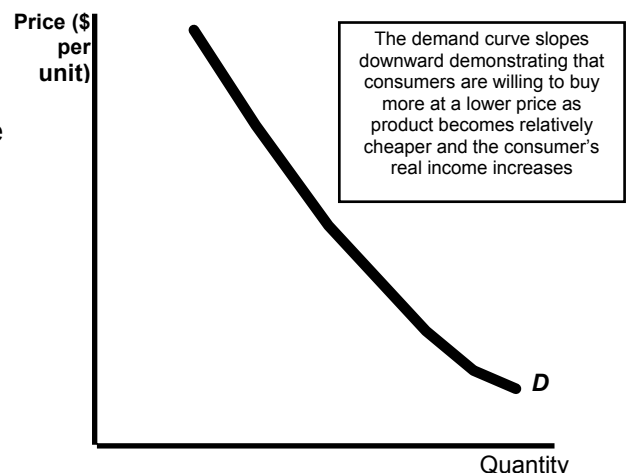
Q_0 Q_1 Q

Q_2
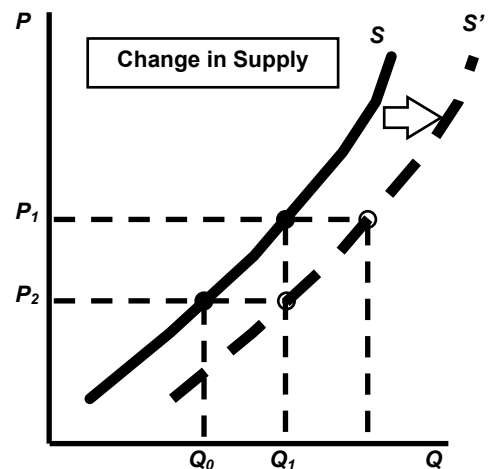
Supply - A Review
- – Supply is determined by non-price supply-determining variables as such as the cost of labor, capital, and raw materials.
- – Changes in supply are shown by shifting the entire supply curve.
- – Changes in quantity supplied are shown by movements along the supply curve and are caused by a change in the price of the product.
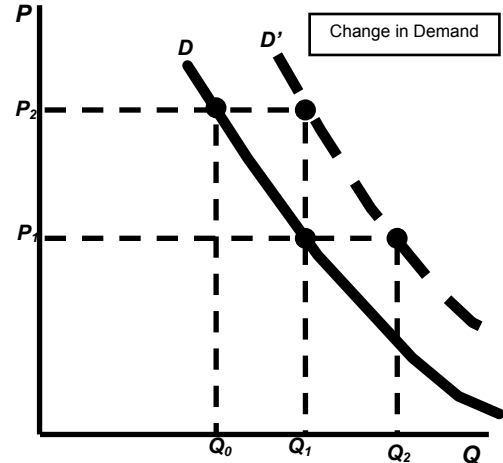
- ◆ **The Demand Curve**
- – The demand curve shows how much of a good consumers are willing to buy as the price per unit changes holding non-price factors constant.
- – This price-quantity relationship can be shown by the equation:

$$Q_D = Q_D(P)$$

Price ($ per unit)

The demand curve slopes downward demonstrating that consumers are willing to buy more at a lower price as product becomes relatively cheaper and the consumer's real income increases

D

Quantity

- ◆ **Non-price Determining Variables of Demand**
    - Income
    - Consumer Tastes
    - Price of Related Goods
        • Substitutes
        • Complements
- ◆ Income Increases
    - At *P1*, produce *Q2*
    - At *P2*, produce *Q1*
    - Demand Curve shifts right
   - More purchased at any price on *D'* than on *D*

- ◆ Demand - A Review
    - Demand is determined by non-price demand-determining variables, such as, income, price of related goods, and tastes.
    - Changes in demand are shown by shifting the entire demand curve.
    - Changes in quantity demanded are shown by movements along the demand curve.

The Market Mechanism
- ◆ Characteristics of the equilibrium or market clearing price:
    - QD = QS
    - No shortage
    - No excess supply
    - No pressure on the price to change
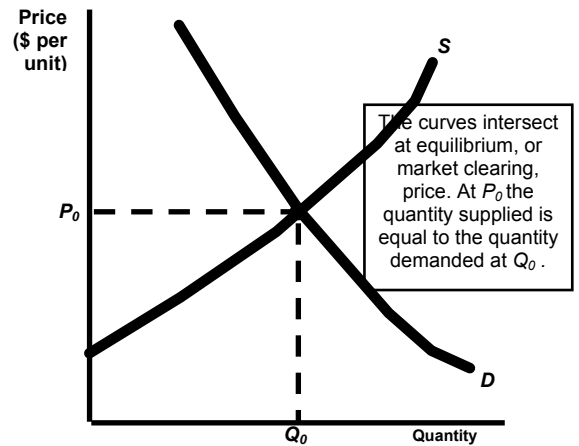
- ◆ The market price is above equilibrium
    - There is excess supply
    - Producers lower prices
    - Quantity demanded increases and quantity supplied decreases
    - The market continues to adjust until the equilibrium price is reached.
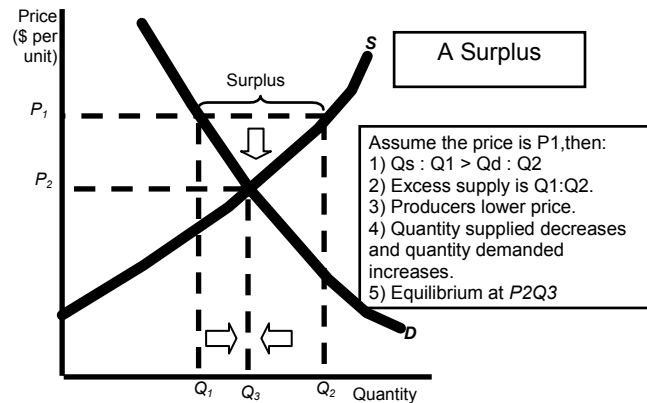
* The market price is below equilibrium:
  – There is a shortage
  – Producers raise prices
  – Quantity demanded decreases and quantity supplied increases
  – The market continues to adjust until the new equilibrium price is reached.
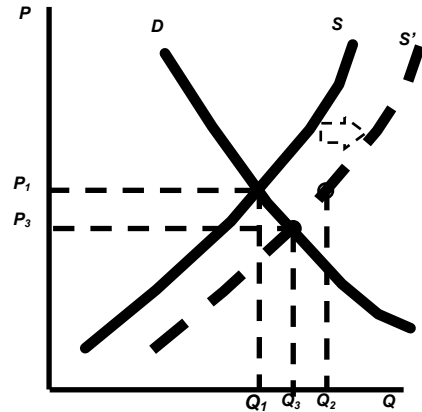

Shortage

Assume the price is P_2,:
1) $Q_d : Q_2 > Q_s : Q_1$
2) Shortage is $Q_1 : Q_2$.
3) Producers raise price.
4) Quantity supplied increases and quantity demanded decreases.
5) Equilibrium at P_3, Q_3
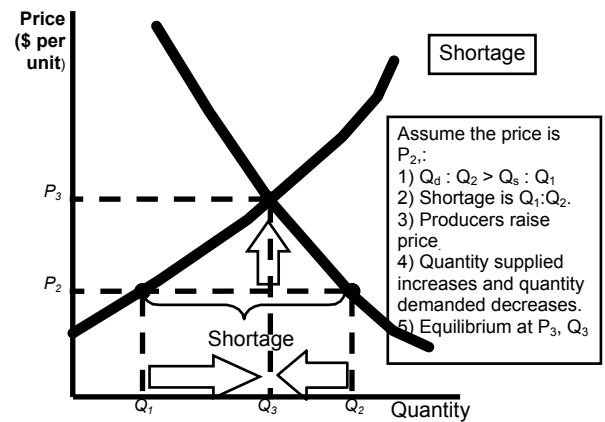
* Market Mechanism Summary
  1) Supply and demand interacts to determine the market-clearing price.
  2) When not in equilibrium, the market will adjust to alleviate a shortage or surplus and return the market to equilibrium.
 3) Markets must be competitive for the mechanism to be efficient.

Changes in Market Equilibrium
- ♦ Equilibrium prices are determined by the relative level of supply and demand.
- ♦ Supply and demand are determined by particular values of supply and demand determining variables.
- ♦ Changes in any one or combination of these variables can cause a change in the equilibrium price and/or quantity.

- ♦ Raw material prices fall
    - – S shifts to S'
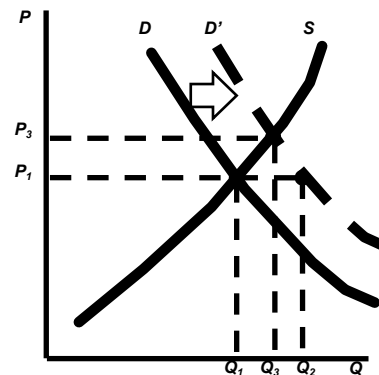   - – Surplus @ P1 of Q1, Q2
    - – Equilibrium @ P3, Q3

Raw material prices Rise
- – S shifts to S'
- – Shortage @ P1 of Q1, Q2
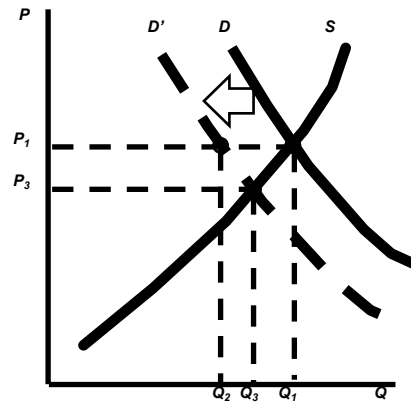- – Equilibrium @ P3, Q3
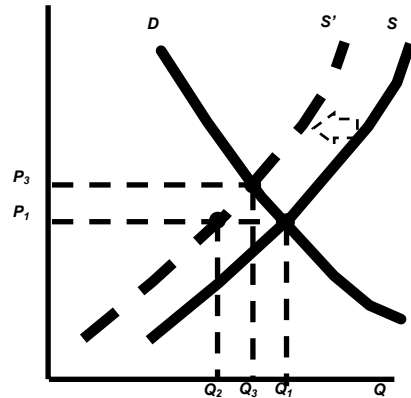
Income Increases
- – Demand shifts to D' Shortage @ P1 of Q1, Q2
- – Equilibrium @ P3, Q3

Income Decreases
   − Demand shifts to *D'*
   − Surplus @ *P1* of *Q1, Q2*
   − Equilibrium @ *P3, Q3*

Income Increases & raw material prices fall
   − The increase in *D* is greater than the increase in *S*
   − Equilibrium price and quantity increase to *P2, Q2*
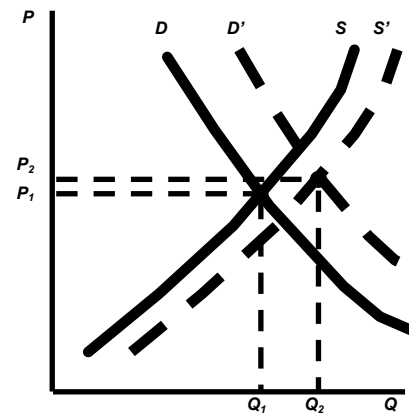
◆ Income Increases & raw material prices fall
   − The increase in *D* is less than the increase in *S*
   − Equilibrium price decrease to *P2* and quantity increase to *Q2*

◆ Income Decreases & raw material prices Fall
   − The decrease in *D* is greater than the increase in *S*
   − Equilibrium price and quantity decrease to *P2 Q2*

♦ Income decreases & raw material prices fall
  – The decrease in *D* is less than the increase in *S*
  – Equilibrium price decrease to *P2* and quantity increase to *Q2*

Shifts in Supply and Demand
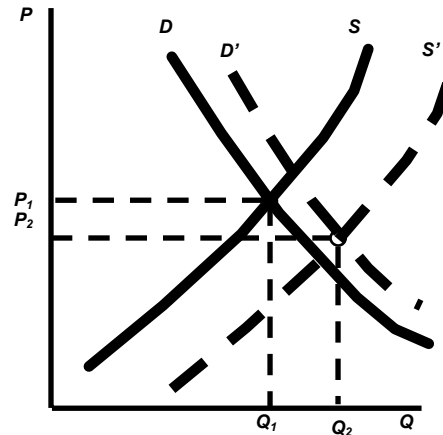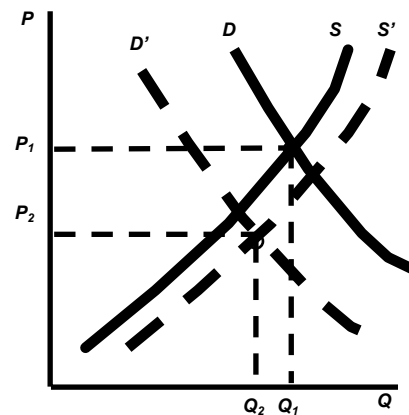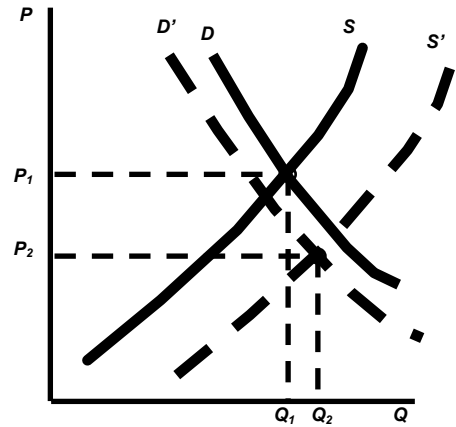♦ When supply and demand change simultaneously, the impact on the equilibrium price and quantity is determined by:
  1) The relative size and direction of the change
  2) The shape of the supply and demand curves

The Prices of Eggs & Education Revisited
♦ The real price of eggs fell 59% from 1970 to 1998.
♦ Supply increased due to the increased mechanization of poultry farming and the reduced cost of production.
♦ Demand decreased due to the increasing consumer concern over the health and cholesterol consequences of eating eggs.

Market for Eggs
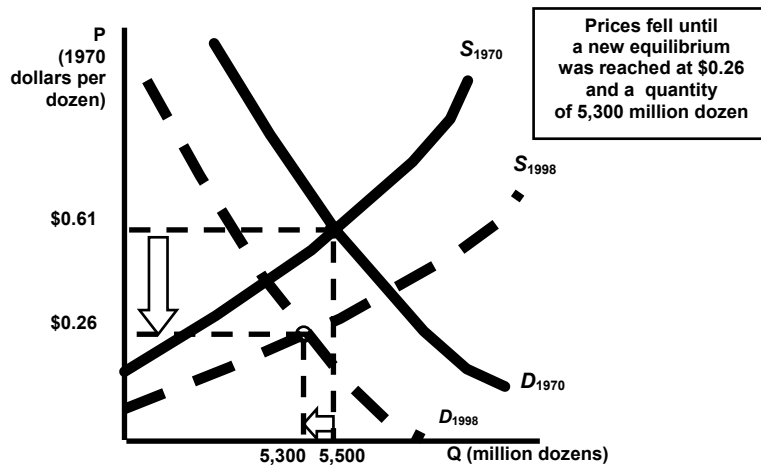
Price of College Education
♦ The real price of a college education rose 68 percent from 1970 to 1995.
♦ Supply decreased due to higher costs of equipping and maintaining modern classrooms, laboratories and libraries, and higher faculty salaries.
♦ Demand increased due a larger percentage of a larger number of high school graduates attending college.

Market for College Education

P
(annual cost
in 1970
dollars)

$4,573

$2,530

S_{1995}

Prices rose until
a new equilibrium
was reached at $4,573
and a quantity
of 12.3 million students

S_{1970}

D_{1995}

D_{1970}

8.6   12.3   Q (millions of students enrolled)
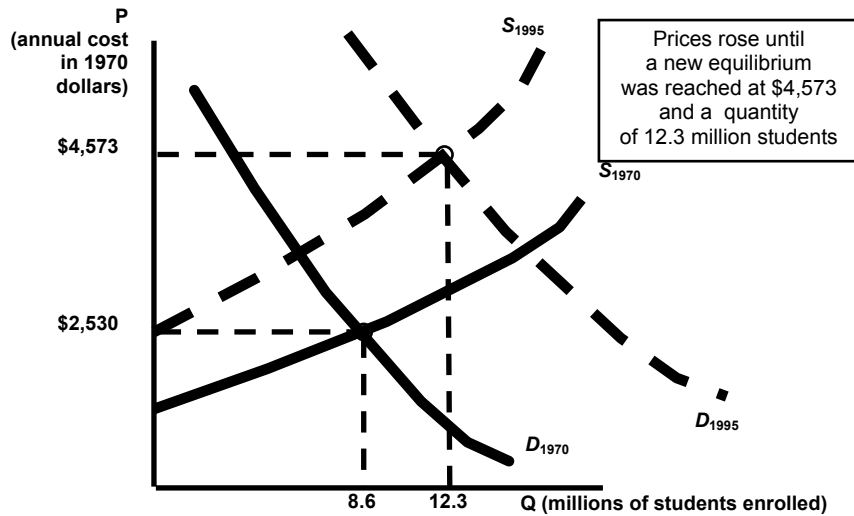
The Long-Run Behavior of Natural Resource Prices
- Observations
    - Consumption of copper has increased about a hundred fold from 1880 through 1998 indicating a large increase in demand.
    - The real price for copper has remained relatively constant.

Changes in Market Equilibrium

Price

S_{1900} S_{1950} S_{1998}

Long-Run Path of
Price and

D_{1900} D_{1950} D_{1998}

Quantity

- Conclusion
    - Decreases in the costs of production have increased the supply by more than enough to offset the increase in demand.

Factors Shifting Demand Curve

Factors Changing Demand	Effect on Demand	Direction of Shift in Demand Curve	Effect on Equilibrium Price	Effect on Equilibrium Quantity
Increase in income (normal good)	Increase	Rightward	Increase	Increase
Decrease in income(normal good)	Decrease	Leftward	Decrease	Decrease
Increase in income (inferior good)	Decrease	Rightward	Decrease	Decrease
Decrease in income(inferior good)	Increase	Rightward	Increase	Increase
Increase in price of Substitute	Increase	Rightward	Increase	Increase
Decrease in price of substitute	Decrease	Rightward	Decrease	Decrease
Increase in price of complement	Decrease	Leftward	Decrease	Decrease
Decrease in price of complement	Increase	Rightward	Increase	Increase
Increase in taste and preference for good	Increase	Rightward	Increase	Increase
Decrease in taste and preference for good	Decrease	Leftward	Decrease	Decrease
Increase in number of consumers	Increase	Rightward	Increase	Increase
Decrease in number of consumers	Decrease	Leftward	Decrease	Decrease

Factors Shifting Supply Curve

Factors Changing Supply	Effect on Supply	Direction of Shift in Supply Curve	Effect on Equilibrium Price	Effect on Equilibrium Quantity
Increase in resource price	Decrease	Leftward	Increase	Decrease
Decrease in resource price	Increase	Rightward	Decrease	Increase
Improved technology	Increase	Rightward	Decrease	Increase
Decline in technology	Decrease	Leftward	Increase	Decrease
Expect a price increase	Decrease	Leftward	Increase	Decrease
Expect a price decrease	Increase	Rightward	Decrease	Increase
Increase in number of suppliers	Increase	Rightward	Decrease	Increase
Decrease in number of suppliers	Decrease	Leftward	Increase	Decrease

ELASTICITIES OF SUPPLY AND DEMAND

- ◆ Generally, elasticity is a measure of the sensitivity of one variable to another.
- ◆ It tells us the percentage change in one variable in response to a one percent change in another variable.
- ◆ Price Elasticity of Demand
  - ◆ Measures the sensitivity of quantity demanded to price changes.
  - ◆ It measures the percentage change in the quantity demanded for a good or services that results from a one percent change in the price of that good or service.

- ◆ The price elasticity of demand is:

  Percentage change in Quantity Demanded
  Percentage change in Price

$$E_P = (\% \, \Delta Q)/(\% \, \Delta P)$$

  – The percentage change in a variable is the absolute change in the variable divided by the original level of the variable.
  – So the price elasticity of demand is also:

$$E_P = \frac{\Delta Q/Q}{\Delta P/P} = \frac{P}{Q} \frac{\Delta Q}{\Delta P}$$

- ◆ Interpreting Price Elasticity of Demand Values
  1) Because of the inverse relationship between P and Q; EP is negative.
  2) If IEPI > 1, the percent change in quantity is greater than the percent change in price. We say the demand is price elastic.
  3) If IEPI < 1, the percent change in quantity is less than the percent change in price. We say the demand is price inelastic.
- ◆ The primary determinant of price elasticity of demand is the availability of substitutes.
  – Many substitutes demand is price elastic
  – Few substitutes demand is price inelastic
  –

Price Elasticities of Demand

Price

A   *Ep = -3*

B

Ep = -1

C   *Ep = -0.4*

D   **D**

12

9

6

3

0   2 3   6   10   Q

Price

Infinitely Elastic Demand

Quantity

Completely Inelastic Demand

Price

$$E_P = 0$$
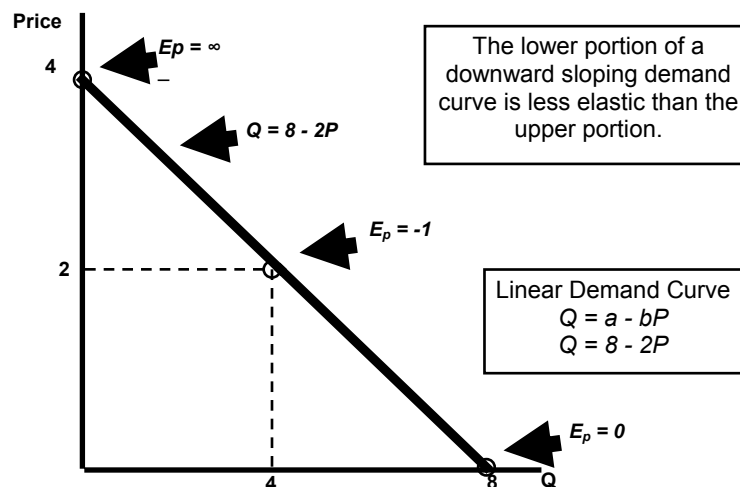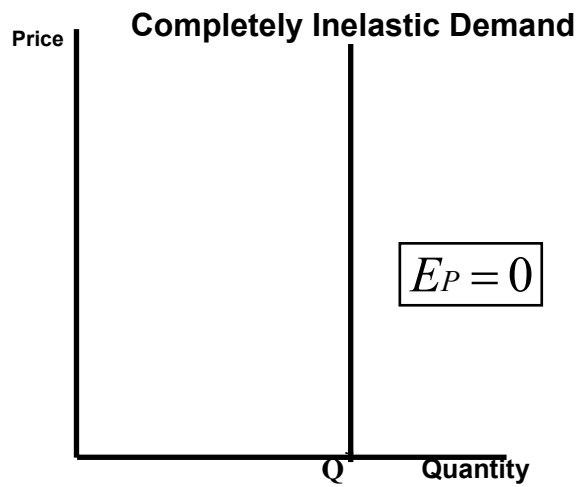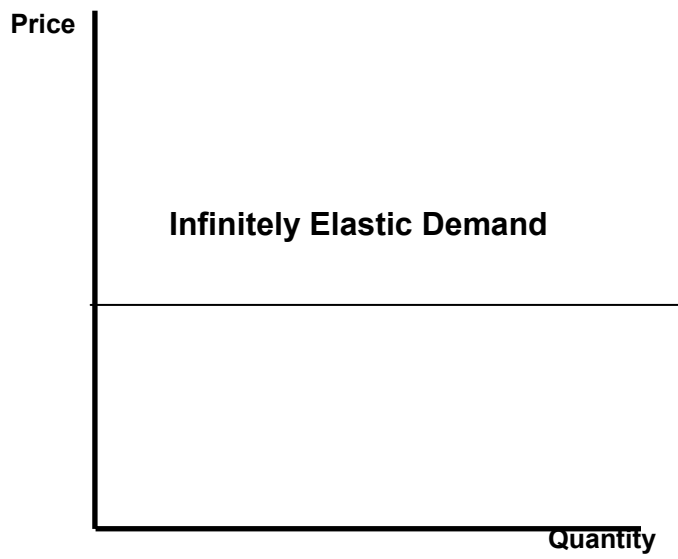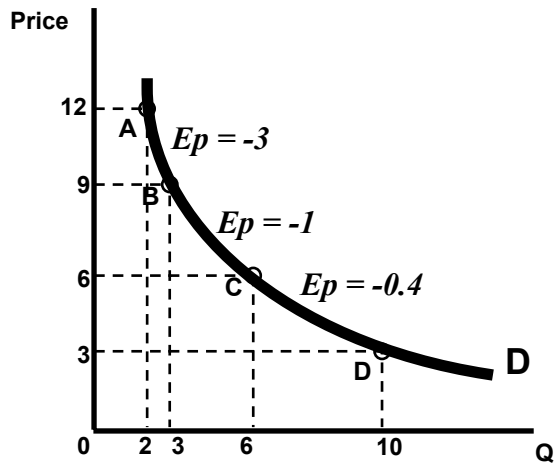
Q   Quantity

LESSON 5

Elasticities of supply and demand

- ◆ Other Demand Elasticities
  - – **Income elasticity of demand** measures the percentage change in quantity demanded resulting from a one percent change in income.
- ◆ The income elasticity of demand is:

$$E_I = \frac{\Delta Q/Q}{\Delta I/I} = \frac{I}{Q}\frac{\Delta Q}{\Delta I}$$

- ◆ Income Elasticity of Demand for:
  - – Normal goods
  - – Superior goods
  - – Inferior goods
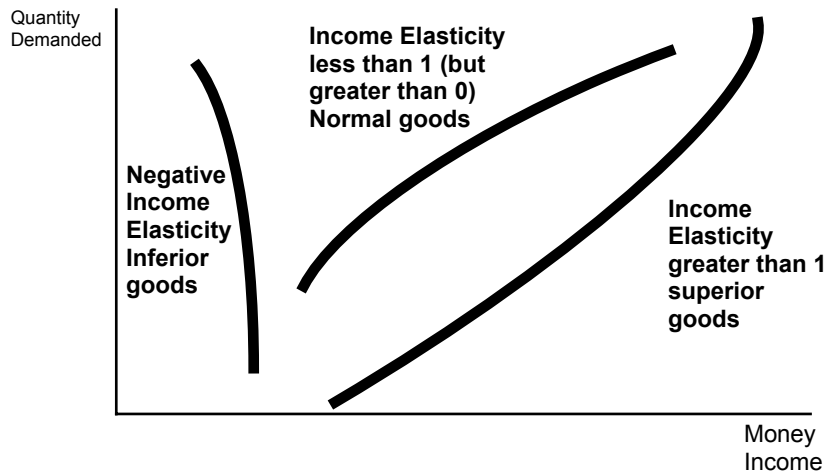
- ◆ Other Demand Elasticities

  - – **Cross elasticity of demand** measures the percentage change in the quantity demanded of one good that results from a one percent change in the price of another good.
  - – For example consider the substitute goods, butter and margarine.
- ◆ The cross elasticity of demand is:

$$E_{Q_b P_m} = \frac{\Delta Q_b/Q_b}{\Delta P_m/P_m} = \frac{P_m}{Q_b}\frac{\Delta Q_b}{\Delta P_m}$$

  - – Cross elasticity for substitutes is positive
  - – Cross elasticity for complements is negative

- ◆ Price elasticity of supply
  - – measures the percentage change in quantity supplied resulting from a 1 percent change in price.
  - – The elasticity is usually positive because price and quantity supplied are directly related.
    We can refer to elasticity of supply with respect to interest rates, wage rates, and the cost of raw materials.

Price ($)	Quantity Demanded	Quantity Supplied
60	22	14
80	20	16
100	18	18
120	16	20

* Recall

$$E_P = \frac{\Delta Q/Q}{\Delta P/P} = \frac{P}{Q} \frac{\Delta Q}{\Delta P}$$

* Elasticity of demand when price is $80 is
  Ep = 80/20 x -2/20 = -0.40
* Elasticity of demand when price is $100 is
  Ep = 100/18 x -2/20 = -0.56
* Elasticity of supply when price is $80 is
  Ep = 80/16 x 2/20 = 0.50
* Elasticity of supply when price is $100 is
  Ep = 100/18 x 2/20 = 0.56

* The Market for Wheat
  – 1981 Supply Curve for Wheat
    – *QS* = 1,800 + 240*P*
  – 1981 Demand Curve for Wheat
    – *QD = 3,550* - 266*P*
  – Equilibrium: Q S = Q D

$$1,800 + 240P = 3,550 - 266P$$
$$506P = 1,750$$
$$P = 3.46 / bushel$$
$$Q = 1,800 + (240)(3.46) = 2,630 \text{ million bushels}$$

$$E_P^D = \frac{P}{Q} \frac{\Delta Q_D}{\Delta P} = \frac{3.46}{2,630}(-2.66) = -.035 \quad \text{Inelastic}$$

$$E_P^S = \frac{P}{Q} \frac{\Delta Q_S}{\Delta P} = \frac{3.46}{2,630}(2.40) = .032 \quad \text{Inelastic}$$

  – Assume the price of wheat is $4.00/bushel

$$Q_D = 3,550 - (266)(4.00) = 2,486$$

$$Q_P^D = \frac{4.00}{2,486}(-266) = -0.43$$

	Supply (Qs)	Demand (Qd)	Equilibrium Price Qs = Qd
1981	1800 + 240P	3550 – 266P	1800 + 240P = 3550 – 266P 506P = 1750 P_{1981} = $3.46 / bushel
1998	1944 + 207P	3244 – 283P	1944 +207P = 3244 – 283P P_{1998} = $2.65 / bushel

Short-Run Versus Long-Run Elasticities
* Price elasticity of demand varies with the amount of time consumers have to respond to a price.
* Most goods and services:
  * Short-run elasticity is less than long-run elasticity. (e.g. gasoline, Drs.)
* Other Goods (durables):
  * Short-run elasticity is greater than long-run elasticity (e.g. automobiles)

Gasoline: Short-Run and Long-Run Demand Curves
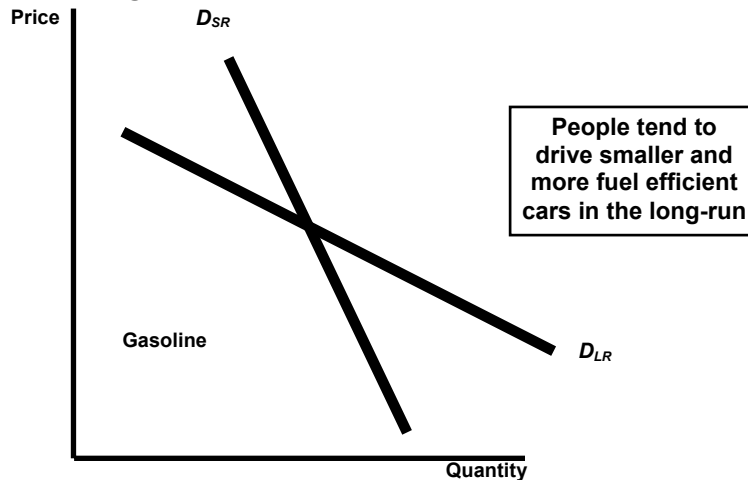
Automobiles: Short-Run and Long-Run Demand Curves
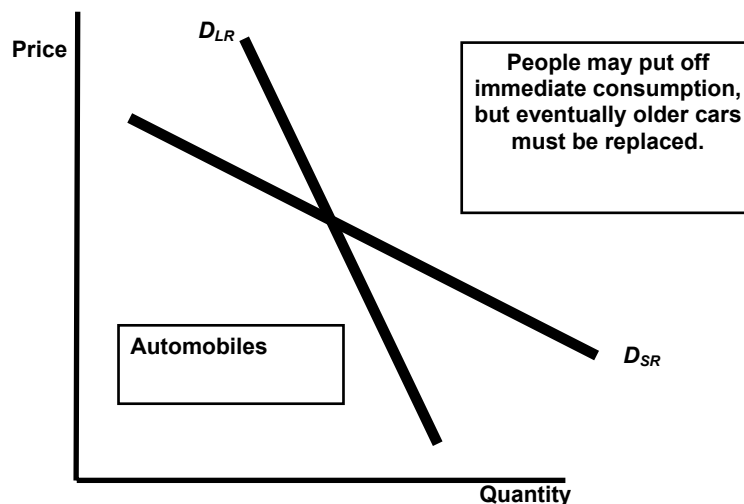
- ◆ Income elasticity also varies with the amount of time consumers have to respond to an income change.
- ◆ Most goods and services:
  - ◆ Income elasticity is greater in the long-run than in the short run.
    - ◆ Higher incomes may be converted into bigger cars so the income elasticity of demand for gasoline increases with time.
- ◆ Other Goods (durables):
  - ◆ Income elasticity is less in the long-run than in the short-run.
    - ◆ Originally, consumers will want to hold more cars.
    - ◆ Later, purchases will only to be to replace old cars.
- ◆ Gasoline and Automobiles are complementary goods.
- ◆ Gasoline
  - ◆ The long-run price and income elasticities are larger than the short-run elasticities.
- ◆ Automobiles
  - ◆ The long-run price and income elasticities are smaller than the short-run elasticities.

The Demand for Gasoline

	Years Following price or income change					
Elasticity	1	2	3	4	5	6
Price	-0.11	-0.22	-0.32	-0.49	-0.82	-1.17
Income	0.07	0.13	0.20	0.32	0.54	0.78

The Demand for Automobiles

	Years Following price or income change					
Elasticity	1	2	3	4	5	6
Price	-1.20	-0.93	-0.75	-0.55	-0.42	-0.40
Income	3.00	2.33	1.88	1.38	1.02	1.00

- ◆ Supply
  - – Most goods and services:
    - • Long-run price elasticity of supply is greater than short-run price elasticity of supply.
  - – Other Goods (durables, recyclables):
    - • Long-run price elasticity of supply is less than short-run price elasticity of supply

Price

S_{SR}

S_{LR}

Primary Copper: Short-Run and Long-Run Supply Curves

Due to limited capacity, firms are limited by output constraints in the short-run. In the long-run, they can expand.

Quantity

Pric

S_L S_S

Secondary Copper: Short-Run and Long-Run Supply Curves

Price increases provide an incentive to convert scrap copper into new supply. In the long-run, this stock of scrap copper begins to fall.

Quantity

Supply of Copper

Price Elasticity of:	Short Run	Long run
Primary Supply	0.20	1.60
Secondary Supply	0.43	0.31
Total Supply	0.25	1.50

Weather in Brazil and the price of Coffee in New York
- Elasticity explains why coffee prices are very volatile.
  - Due to the differences in supply elasticity in the long-run and short run.

Price   **S'**   **S**

P_2

P_0

Intermediate-Run
1) **Supply and demand are**
   more elastic
2) **Price falls back to P_2.**
3) **Quantity falls to Q_2**

D

Quantity

Q_2 Q_0

Price

Long-Run
1 Supply is extremely elastic.
2) Price falls back to P_0.
3) Quantity increase to Q_0.

P_0 **S**

D

Q_0 Quantity
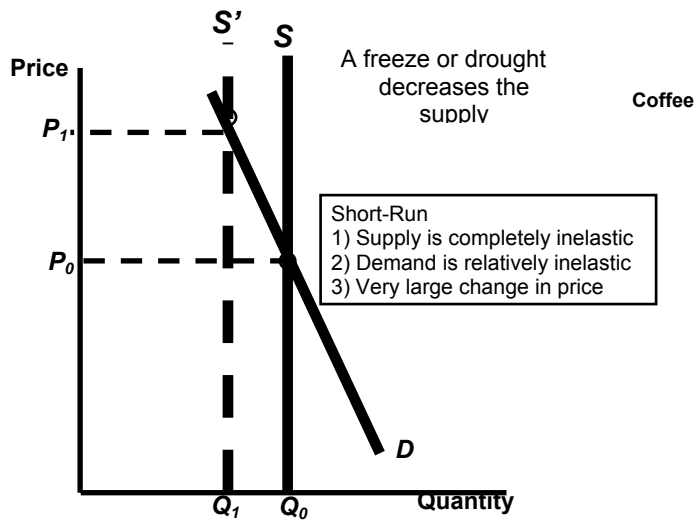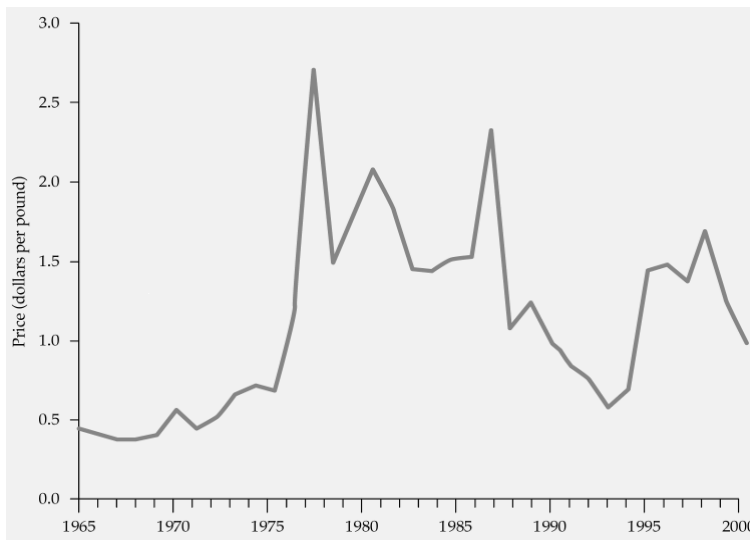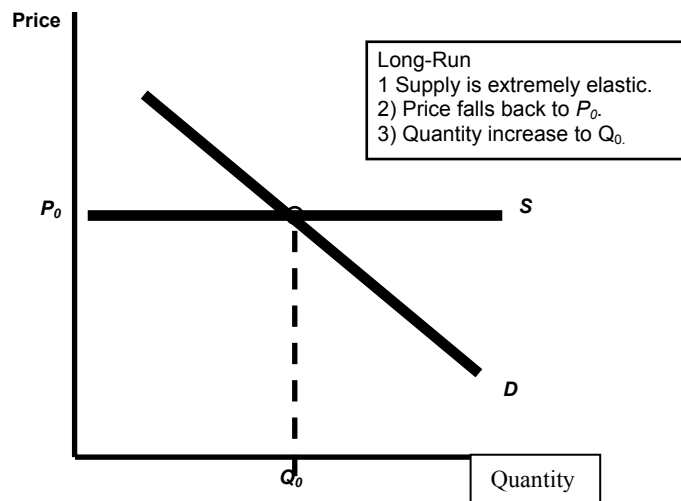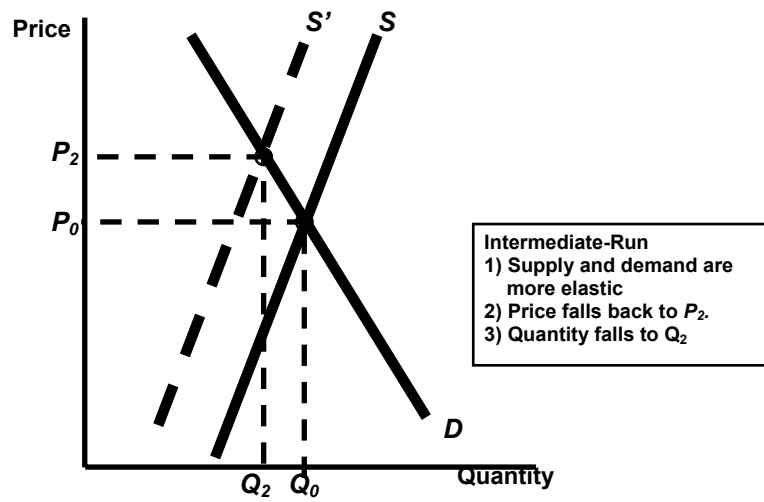
LESSON 6

Consumer Behavior
- ◆ The explanation of how consumers allocate their resources (income) to the purchase of different goods and services to maximize their well being.
- ◆ There are three steps involved in the study of consumer behavior.
  1) We will study consumer preferences.
     - To describe how and why people prefer one good to another.
  2) Then we will turn to budget constraints.
     - People have limited incomes.
  3) Finally, we will combine consumer preferences and budget constraints
  to determine consumer choices.
     - What combination of goods will consumers buy to maximize their satisfaction?

Consumer Preferences
- • Market Baskets
  - • A **market basket** is a collection of one or more commodities.
  - • One market basket may be preferred over another market basket containing a different combination of goods.
  - • Three Basic Assumptions
    1) Preferences are complete.
    2) Preferences are transitive.
    3) Consumers always prefer more of any good to less.

Market Basket	Units of Food	Units of Clothing
A	20	30
B	10	50
D	40	20
E	30	40
G	10	20
H	10	40

- ◆ **Indifference curves** represent all combinations of market baskets that provide the same level of satisfaction to a person.

The consumer prefers *A* to all combinations in the blue box, while all those in the yellow box are preferred to *A*.

**Clothing
(units per
week)**

Combination *B,A, & D*
yield the same satisfaction

•*E* is preferred to U_1

•U_1 is preferred to *H & G*

**Food
(units per week)**
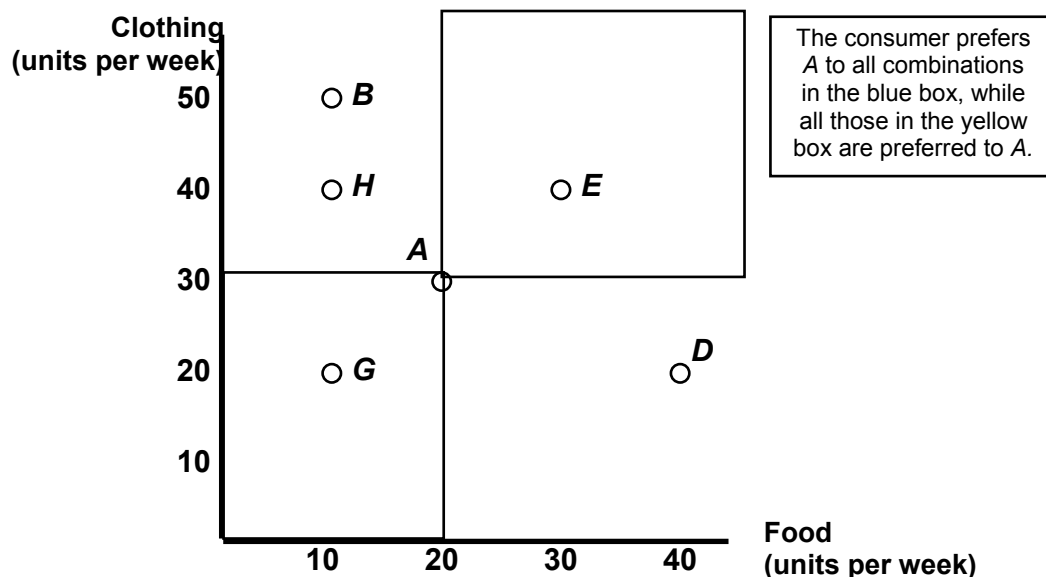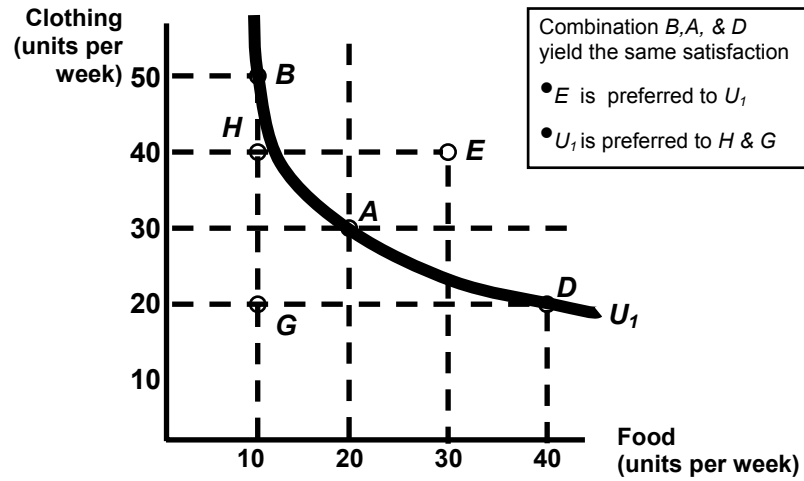
- ◆ Indifference Curves
    - – Indifference curves slope downward to the right.
        - • If it sloped upward it would violate the assumption that more of any commodity is preferred to less.
    - – Any market basket lying above and to the right of an indifference curve is preferred to any market basket that lies on the indifference curve.

- ◆ An **indifference map** is a set of indifference curves that describes a person's preferences for all combinations of two commodities.
    - – Each indifference curve in the map shows the market baskets among which the person is indifferent.

Clothing
(units per
week)

Market basket *A*
is preferred to *B*.
Market basket *B* is
preferred to *D*.

Food
(units per week)
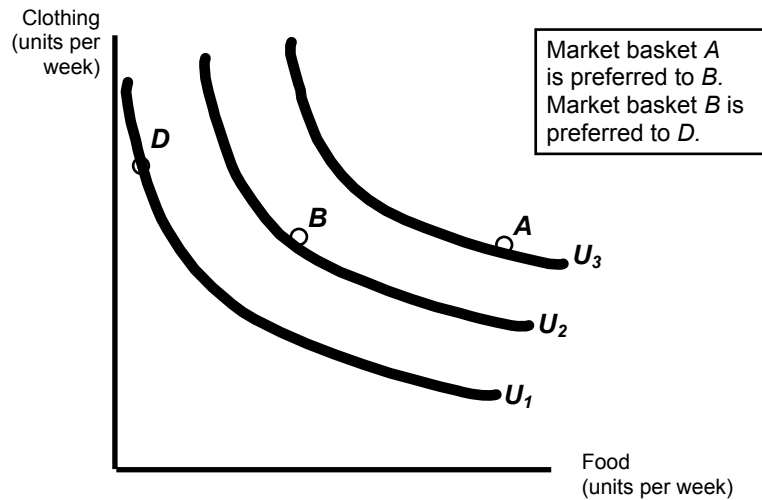
◆ Indifference Curves
  – Finally, indifference curves cannot cross.
    • This would violate the assumption that more is preferred to less.

Clothing
(units per week)

**Indifference Curves
Cannot Cross**

U   *U*

A

The consumer should
be indifferent between
A, *B* and *D*. However,
B contains more of
both goods than *D*.

B

D

Food
(units per week)

Clothing
(units
per week)

16 *A*

14

12 -6

10 *B*
    1
8 -4
        D
6   1
      -2   *E*
4   1 -1   *G*
           1
2

Observation: The amount
of clothing given up for
a unit of food decreases
from 6 to 1

1   2   3   4   5   Food
(units per week)
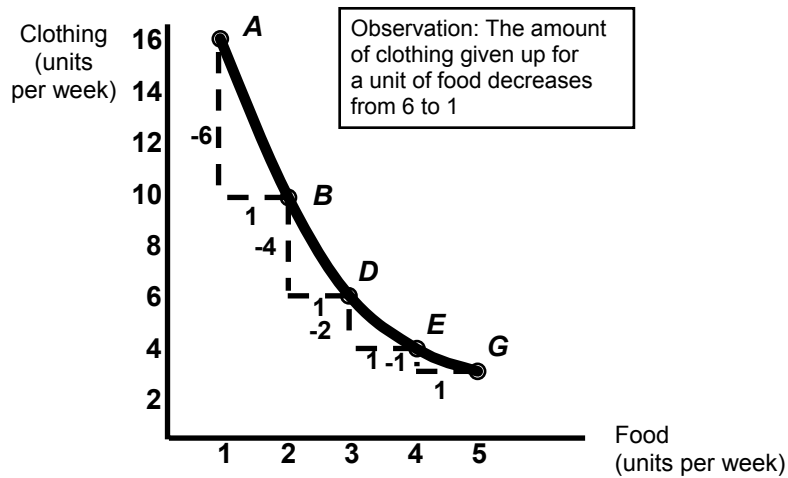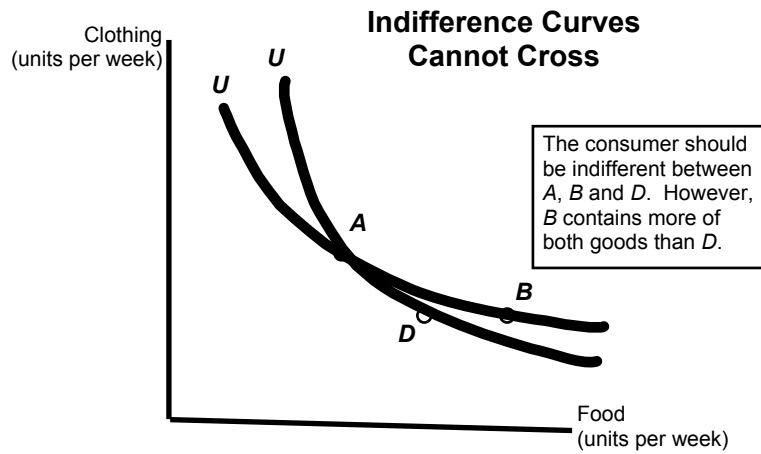
◆ The marginal rate of substitution (MRS*)* quantifies the amount of one good a consumer
  will give up to obtain more of another good.
  – It is measured by the slope of the indifference curve.

Clothing
(units
per week)

16 *A*

14   **MRS = 6**

12 -6 $$MRS = -\frac{\Delta C}{\Delta F}$$

10   *B*
      1
8   -4
         D   **MRS = 2**
6   1
      -2   *E*
4   1 -1   *G*
          1
2

1   2   3   4   5   Food
(units per week)
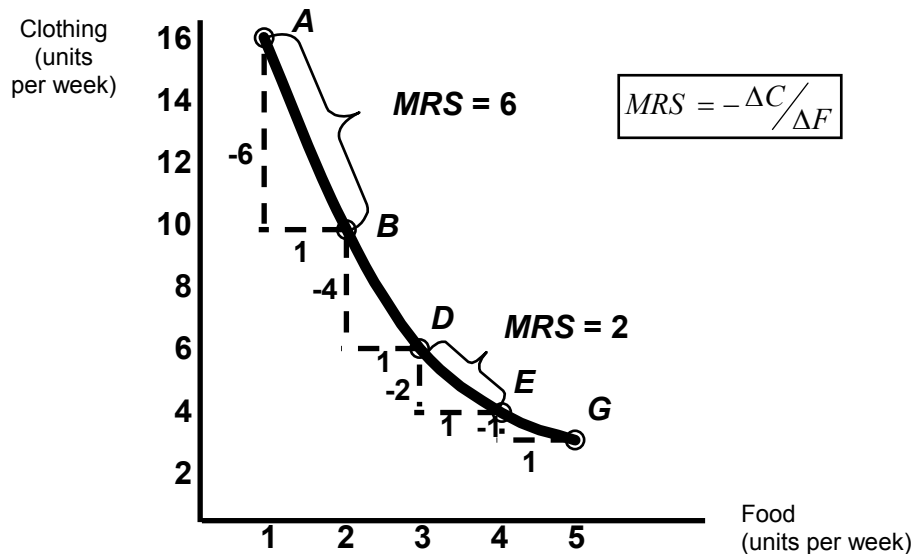
- ◆ We will now add a fourth assumption regarding consumer preference:
    - – Along an indifference curve there is a diminishing marginal rate of substitution*.*
        - • Note the MRS for AB was 6, while that for DE was 2.
- ◆ Marginal Rate of Substitution
    - – Indifference curves are convex because as more of one good is consumed, a consumer would prefer to give up fewer units of a second good to get additional units of the first one.
    - – Consumers prefer a balanced market basket
    - – Perfect Substitutes and Perfect Complements
        - • Two goods are perfect substitutes when the marginal rate of substitution of one good for the other is constant.

Apple Juice (glasses) — Orange Juice (glasses) — **Perfect Substitutes**
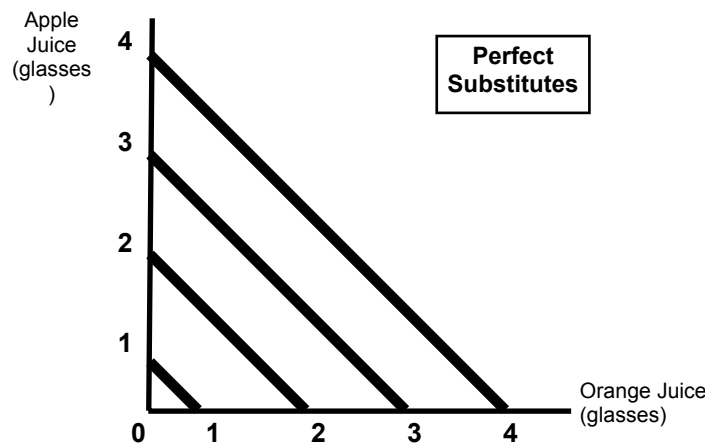
- • Two goods are complements when the indifference curves for the goods are shaped as right angles.

Left Shoes — Right Shoes — **Perfect Complements**
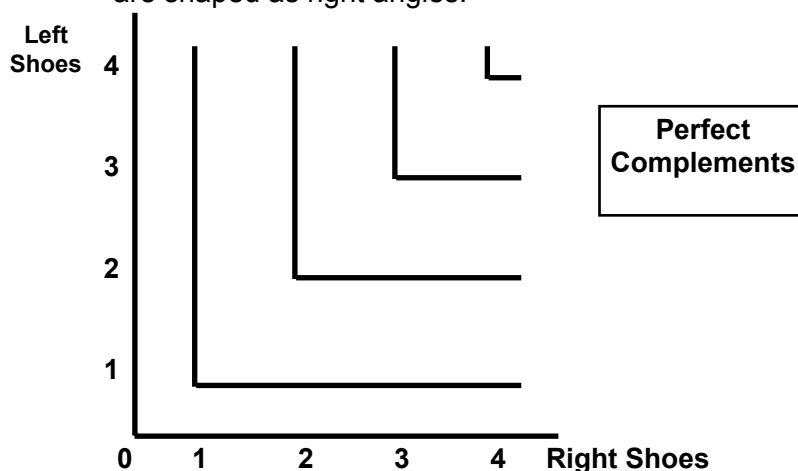
- ◆ BADS
    - – Things for which less is preferred to more
- ◆ Example
    - – Air pollution
- ◆ Designing New Automobiles
    - – Automobile executives must regularly decide when to introduce new models and how much money to invest in restyling.
    - – An analysis of consumer preferences would help to determine when and if car companies should change the styling of their cars.

Styling

| Consumer
Preference *A*:
High *MRS* |

| These consumers are
willing to give up
considerable
styling for additional
performance |

Performance

Styling

| Consumer
Preference B:
Low MRS |

| These consumers are
willing to give up
considerable
performance for
additional styling |

Performance
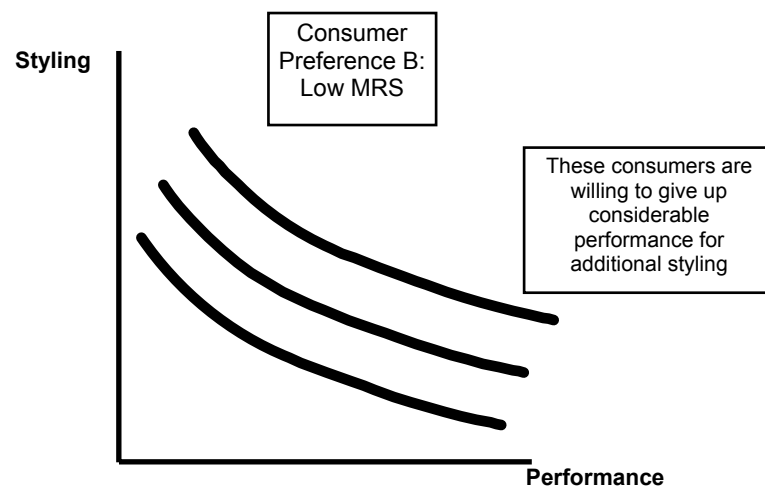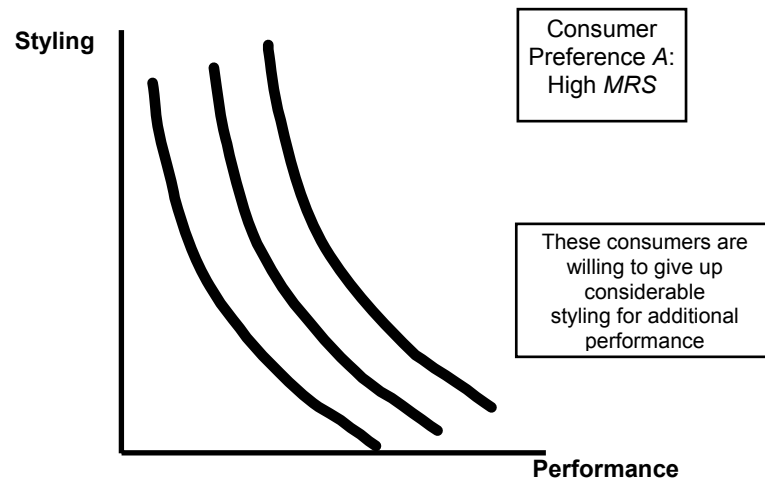
- ◆ Designing New Automobiles
  - – What Do You Think?
    - • How can we determine the consumers preference?
- ◆ Designing New Automobiles
  - – A recent study of automobile demand in the USA shows that over the past two decades most consumers have preferred styling over performance.
- ◆ Growth of Japanese Imports
  - – 1970's and 1980's
    - • 15% of domestic cars underwent a style change each year
    - • This compares to 23% for imports

LESSON 7

CONSUMER PREFERENCES

- ◆ Utility
  - – Numerical score representing the satisfaction that a consumer gets from a given market basket.
  - – If buying 3 copies of Microeconomics makes you happier than buying one shirt, then we say that the books give you more utility than the shirt.
- ◆ Utility Functions
  - – Assume: The utility function for food (F) and clothing (C)

  $$U(F,C) = F + 2C$$

Market Baskets:	F units	C units	U (F, C) = F + 2C
A	8	3	8 + 2(3) = 14
B	6	4	6 + 2(4) = 14
C	4	4	4 + 2(4) = 12

  - – The consumer is indifferent to A & B
  - – The consumer prefers A & B to C
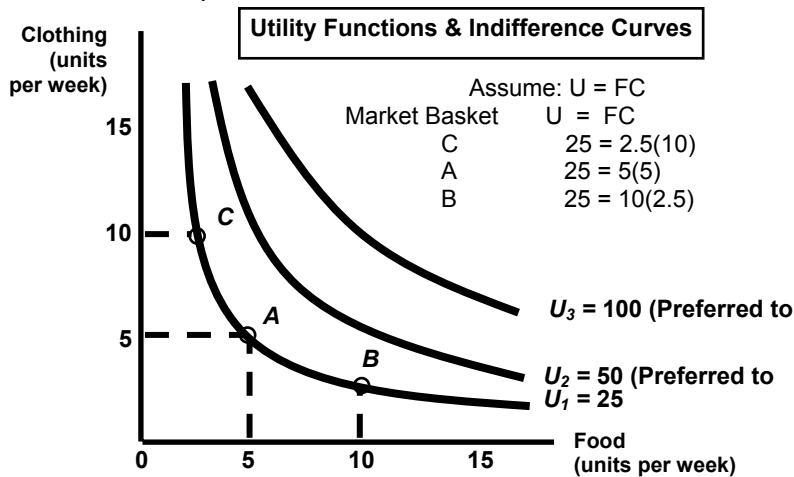
- ◆ Ordinal Versus Cardinal Utility
  - – **Ordinal Utility Function:** places market baskets in the order of most preferred to least preferred, but it does not indicate how much one market basket is preferred to another.
  - – **Cardinal Utility Function:** utility function describing the extent to which one market basket is preferred to another.
- ◆ Ordinal Versus Cardinal Rankings
  - – The actual unit of measurement for utility is not important.
  - – Therefore, an ordinal ranking is sufficient to explain how most individual decisions are made.

Budget Constraints
- ◆ Preferences do not explain all of consumer behavior.
- ◆ Budget constraints also limit an individual's ability to consume in light of the prices they must pay for various goods and services.
- ◆ The Budget Line
  - ◆ The budget line indicates all combinations of two commodities for which total money spent equals total income.
  - ◆

- ◆ The Budget Line
  - ◆ Let F equal the amount of food purchased, and C is the amount of clothing.
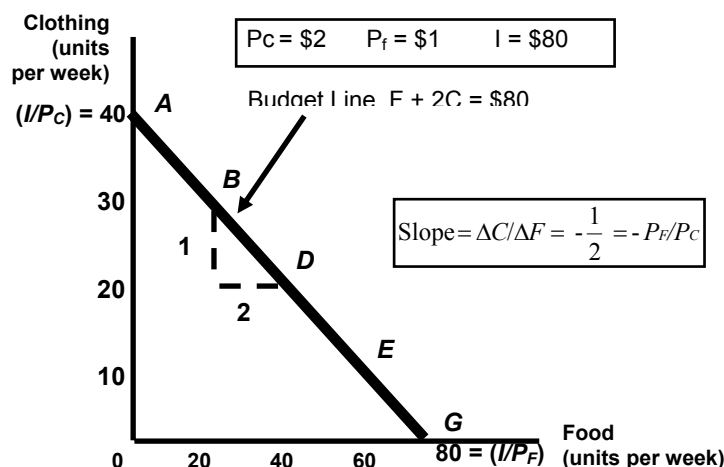 - ◆ Price of food = Pf and price of   clothing = Pc
  - ◆ Then Pf F is the amount of money spent on food, and Pc C is the amount of money spent on clothing.
- ◆ The budget line then can be written:

$$P_F F + P_C C = I$$

Market Basket	Food (F) $Pf = (\$1)$	Clothing (C) $Pc = (\$2)$	Total Spending $PfF + PcC = I$
A	0	40	$80
B	20	30	$80
D	40	20	$80
E	60	10	$80
G	80	0	$80

Clothing (units per week)

Pc = $2   Pf = $1   I = $80

Budget Line F + 2C = $80

$Slope = \Delta C / \Delta F = -\frac{1}{2} = -P_F/P_C$

- ◆ The Budget Line
  - – As consumption moves along a budget line from the intercept, the consumer spends less on one item and more on the other.
  - – The slope of the line measures the relative cost of food and clothing.
  - – The slope is the negative of the ratio of the prices of the two goods.
  - – The slope indicates the rate at which the two goods can be substituted without changing the amount of money spent.
  - – The vertical intercept (I/PC), illustrates the maximum amount of C that can be purchased with income I.
  - – The horizontal intercept (I/PF), illustrates the maximum amount of F that can be purchased with income I.

- ◆ **The Effects of Changes in Income and Prices**
  - – Income Changes
    - ◆ An increase in income causes the budget line to shift outward, parallel to the original line (holding prices constant).
    - ◆ A decrease in income causes the budget line to shift inward, parallel to the original line (holding prices constant).
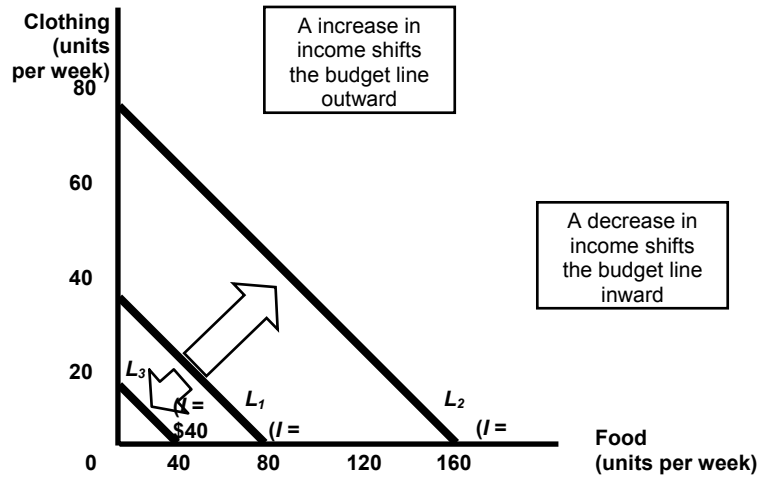
- – Price Changes
  - • If the price of one good increases, the budget line shifts inward, pivoting from the other good's intercept.
  - • If the price of one good decreases, the budget line shifts outward, pivoting from the other good's intercept.
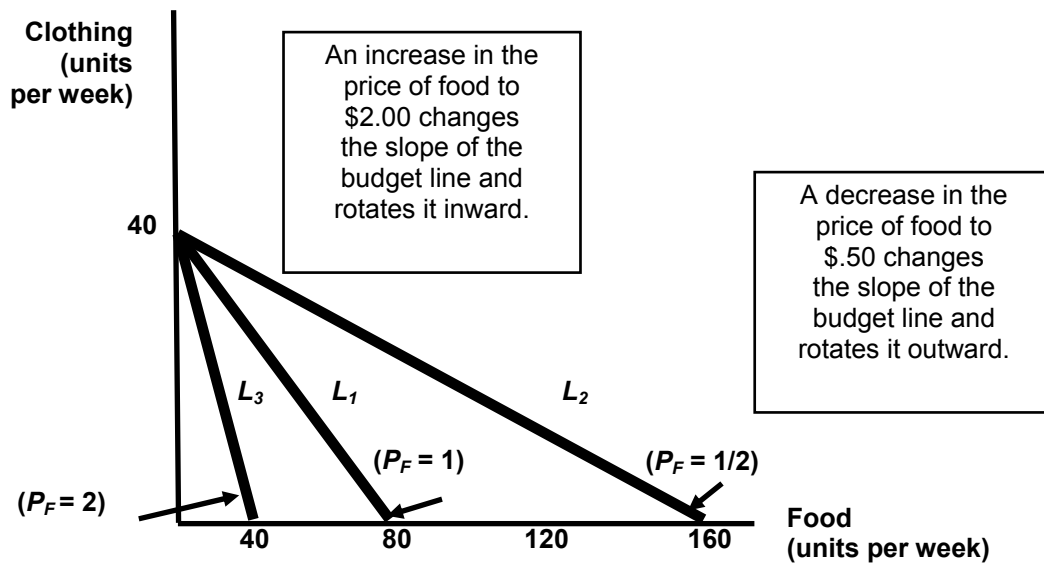
- ◆ The Effects of Changes in Income and Prices
  - – Price Changes
    - • If the two goods increase in price, but the *ratio* of the two prices is unchanged, the slope will not change.
    - • However, the budget line will shift inward to a point parallel to the original budget line.
    - • If the two goods decrease in price, but the ratio of the two prices is unchanged, the slope will not change.
    - • However, the budget line will shift outward to a point parallel to the original budget line.

Consumer Choice
- ◆ Consumers choose a combination of goods that will maximize the satisfaction they can achieve, given the limited budget available to them.
- ◆ The maximizing market basket must satisfy two conditions:
  - 1) It must be located on the budget line.

2) Must give the consumer the most preferred combination of goods and services.

Recall, the slope of an indifference curve is:

$$MRS = -\frac{\Delta C}{\Delta F}$$

Further, the slope of the budget line is:

$$Slope = -\frac{P_F}{P_C}$$

- ◆ Therefore, it can be said that satisfaction is maximized where:

$$MRS = \frac{P_F}{P_C}$$

- ◆ It can be said that satisfaction is maximized when marginal rate of substitution (of F and C) is equal to the ratio of the prices (of F and C).

Clothing (units per week)

Pc = $2   P_f = $1   I = $80

40

30

20

A

At market basket *A* the budget line and the indifference curve are tangent and no higher level of satisfaction can be attained.

At A:
MRS = P_f/P_c = .5

U_2

Budget

0   20   40   80   **Food (units per week)**

- ◆ Designing New Automobiles (II)
  - – Consider two groups of consumers, each wishing to spend $10,000 on the styling and performance of cars.
  - – Each group has different preferences.
  - – By finding the point of tangency between a group's indifference curve and the
  - – budget constraint auto companies can design a production and marketing plan.

Styling
$10,000

These consumers are willing to trade off a considerable amount of styling for some additional performance

$3,000

$7,000 $10,000   **Performance**

Styling
$10,000

These consumers are willing to trade off a considerable amount of performance for some additional styling

$7,000

$3,000   **$10,000**   **Performance**

- ◆ Decision making & Public Policy
  - – Choosing between a non-matching and matching grant to fund police expenditures

Private Expenditures ($)

Non-matching Grant

Before Grant
- • Budget line: *PQ*
- • *A*: Preference maximizing market basket
- • Expenditure
  - • *OR:* Private
  - • *OS:* Police

P

R ⊙ *A*

U₁

O   *S*   *Q*   **Police Expenditures ($)**

Private Expenditures ($)

Non-matching Grant

After Grant
- • Budget line: *TV*
- • B: Preference maximizing market basket
- • Expenditure
  - • *OU:* Private
  - • *OZ:* Police

T

P

U ⊙ *B*

R ⊙ *A*   *U₃*

U₁

O   *S*   *Z*   *Q*   *V*   **Police Expenditures ($)**

Private Expenditures ($)

Matching Grant

Before Grant
- • Budget line: *PQ*
- • A: Preference maximizing market basket

After Grant
- • C: Preference maximizing market basket

Expenditures
- • OW: Private
- • OX: Police

T

P

W
R ⊙ *C*

U₂

U₁

O   *S*   *X*   *Q*   *R*   **Police ($)**

Private Expenditures ($)

| Matching Grant |

Non-matching Grant
•Point B
  •OU: Private expenditure
  •OZ: Police expenditure
Matching Grant
•Point C
  •OW: Private expenditure
  •OX: Police expenditure

T

P

U   *B*
W   *A*
         C U_3
            U_2

              U

O   *X*   *Q*   *R*   **Police ($)**

- ◆ Corner Solution
  - – A corner solution exists if a consumer buys in extremes, and buys all of one category of good and none of another.
    - • This exists where the indifference curves are tangent to the horizontal and vertical axis.

    - • MRS is not equal to PA/PB

Frozen Yogurt (cups monthly) *A*

A corner solution exists at point *B*.

U_1 U_2 U_3

B   **Ice Cream (cup/month)**
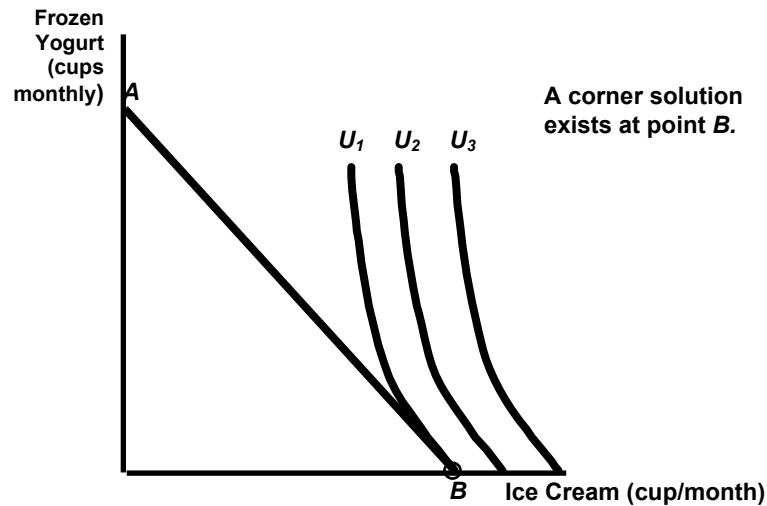
- ◆ A Corner Solution
  - – At point B, the MRS of ice cream for frozen yogurt is greater than the slope of the budget line.
  - – This suggests that if the consumer could give up more frozen yogurt for ice cream he would do so.
  - – However, there is no more frozen yogurt to give up!
  - – When a corner solution arises, *the consumer's MRS does not necessarily equal the price ratio.*
- ◆ In this instance it can be said that:

$$MRS \geq P_{IceCream} / P_{Frozen\ Yogurt}$$

- If the MRS is, in fact, significantly greater than the price ratio, then a small decrease in the price of frozen yogurt *will not* alter the consumer's market basket.
- A college Trust Fund
    - Suppose Jane Doe's parents set up a trust fund for her college education.
    - Originally, the money must be used for education.
    - If part of the money could be used for the purchase of other goods, her consumption preferences change.

A College Trust Fund

Other Consumption ($)

A: Consumption before the trust fund
  The trust fund shifts the budget line
B: Requirement that the trust fund
  must be spent on education

C

P   *U*   C: If the trust could be spent on
           B   other goods
    A   *U*

        U

Q   **Education ($)**
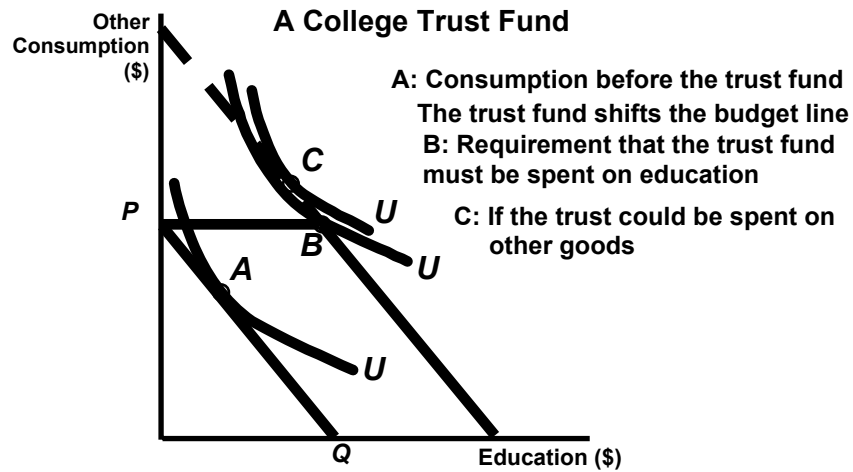
Note it is repeated

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Consumer Preferences
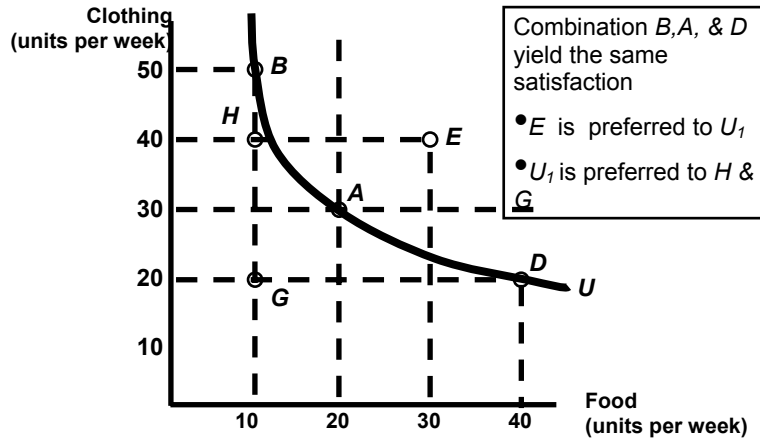
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- The Budget Line
    - The budget line indicates all combinations of two commodities for which total money spent equals total income.
- The Budget Line
    - Let F equal the amount of food purchased, and C is the amount of clothing.
    - Price of food = Pf and price of clothing = Pc
    - Then Pf F is the amount of money spent on food, and PcC is the amount of money spent on clothing.
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Recall, the slope of an indifference curve is:

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Further, the slope of the budget line is:

$$Slope = - \frac{P_F}{P_C}$$

Therefore, it can be said that satisfaction is maximized where:

$$MRS = \frac{P_F}{P_C}$$

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  - – Consider two groups of consumers, each wishing to spend $10,000 on the styling and performance of cars.
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$3,000

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$7,000 $10,000   **Performance**

Styling

$10,000

$7,000

These consumers are willing to trade off a considerable amount of performance for some additional styling

$3,00 $10,000   **Performance**
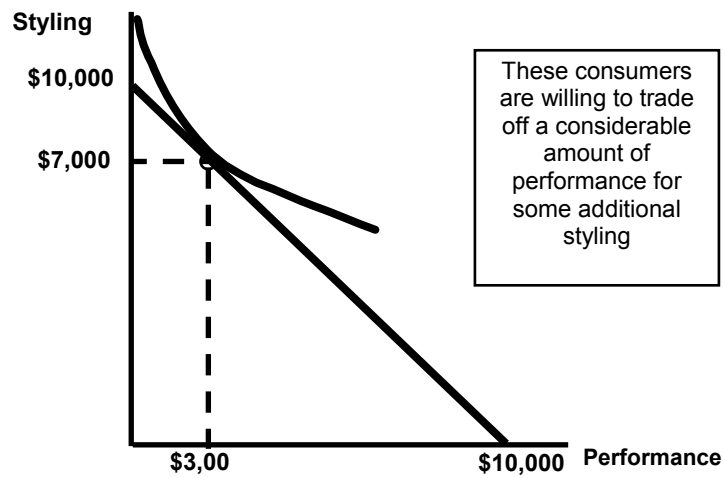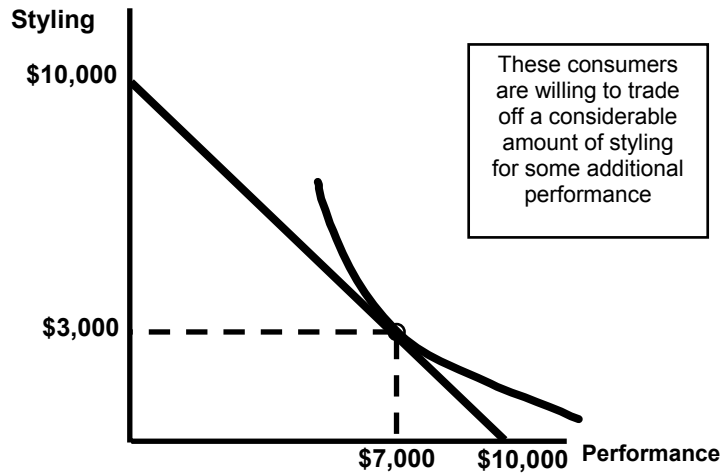
Consumer Choice
  ◆ Decision making & Public Policy
    – Choosing between a non-matching and matching grant to fund police expenditures

Private Expenditures ($)

Non-matching Grant

P

R ⌐ ─ ─ ─ ─ A

U

O   S   Q

Police Expenditures ($)

Before Grant

• Budget line: *PQ*

• *A*: Preference maximizing market basket

• Expenditure

  • *OR:* Private

  • *OS:* Police

Non-matching Grant

Private Expenditures ($)

After Grant
- Budget line: *TV*
- B: Preference maximizing market basket
- Expenditure
  - *OU:* Private
  - *OZ:* Police

Police Expenditures ($)

Matching Grant

Private Expenditures ($)

Before Grant
- Budget line: *PQ*
- A: Preference maximizing market basket

After Grant
- C: Preference maximizing market basket

Expenditures
- OW: Private
- OX: Police

Police ($)

Matching Grant

Private Expenditures ($)

Non-matching Grant
- Point B
  - OU: Private expenditure
  - OZ: Police expenditure

Matching Grant
- Point C
  - OW: Private expenditure
  - OX: Police expenditure

Police ($)

Revealed Preferences

♦ If we know the choices a consumer has made, we can determine what her preferences are if we have information about a sufficient number of choices that are made when prices and incomes vary.

Revealed Preferences--Two Budget Lines

I_1: Chose A over B
   A is revealed preferred to B
I_2: Choose B over D
   B is revealed preferred to D
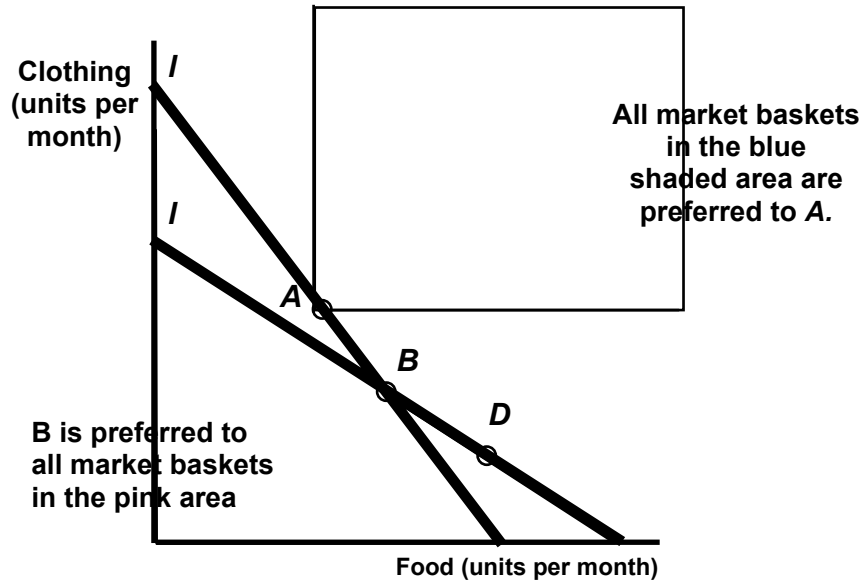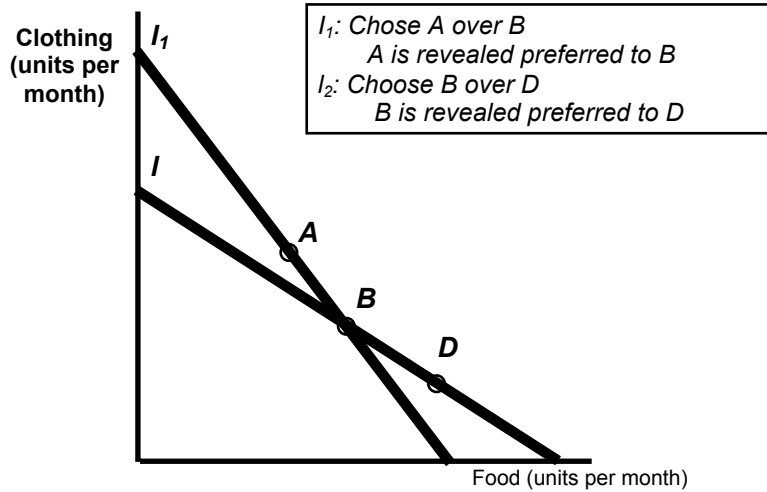
Revealed Preferences--Four Budget Lines

I₃: **E revealed preferred to A**

Clothing
(units per
month)

I₃

All market baskets in the
blue area preferred to A

I₁ E

I₄

A

I₂

B   G

A: preferred to all
market baskets in
the pink area

I₄: **G revealed preferred to A**

Food (units per month)

Scenario

• Roberta's recreation budget = $100/wk

• Price of exercise = $4/hr/week

• Exercises 10 hrs/wk at *A* given *U₁* & I₁

Other
Recreational
Activities
($)

• The rate changes to $1/hr +
$30/wk

• New budget line *I₂* &
combination *B*

100 C

80

• Reveal preference of *B* to A

60 A   B

40   *U₁*   *U₂*

Would the Club's
profits increase?

20

I   I

Amount of Exercise
0   25   50   75   (hours)

MARGINAL UTILITY AND CONSUMER CHOICE

- ◆ Marginal utility
  - − measures the additional satisfaction obtained from consuming one additional unit of a good.
- ◆ Marginal Utility: An Example
  - − The marginal utility derived from increasing from 0 to 1 units of food might be 9
  - − Increasing from 1 to 2 might be 7
  - − Increasing from 2 to 3 might be 5
- ◆ Observation: Marginal utility is diminishing
- ◆ Diminishing Marginal Utility
  - − The principle of diminishing marginal utility states that as more and more of a good is consumed, consuming additional amounts will yield smaller and smaller additions to utility.

Relationship of Total and Marginal Utility

- ◆ Diminishing Marginal Utility: An Example

Quantity of good consumed	Total utility	Marginal utility
0	0	
1	4	4
2	7	3
3	9	2
4	10	1
5	10	0
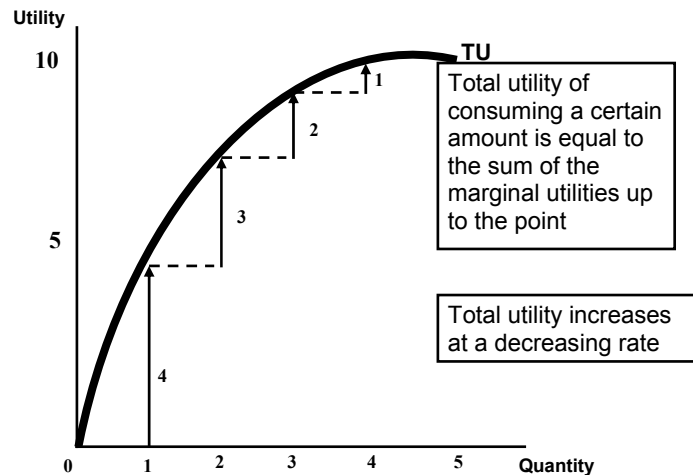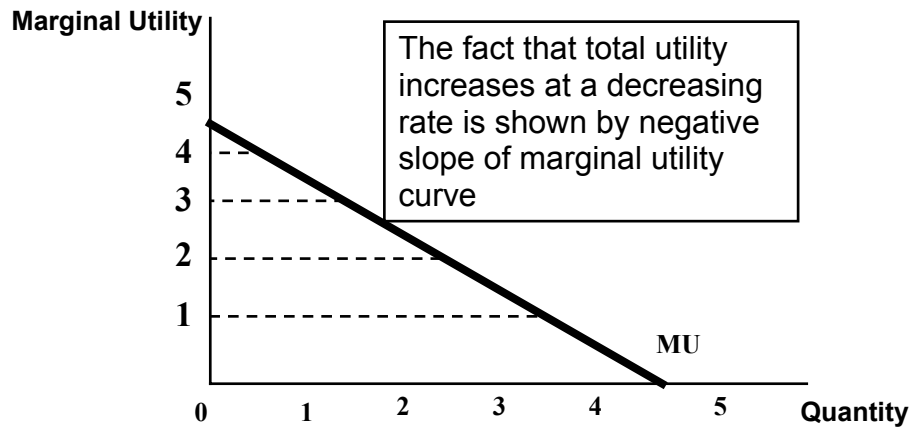
Marginal Utility and
Consumer Choice

- Marginal Utility and the Indifference Curve
  - If consumption moves along an indifference curve, the additional utility derived from an increase in the consumption of one good, food (F), must balance the loss of utility from the decrease in the consumption in the other good, clothing (C).
- Formally:

$$0 = MU_F (\Delta F) + MU_C (\Delta C)$$

- Rearranging:

$$- (\Delta C / \Delta F) = MU_F / MU_C$$

  Because:

$$-(\Delta C / \Delta F) = MRS \text{ of F for C}$$
$$MRS = MU_F/MU_C$$

- When consumers maximize satisfaction the:

$$MRS = P_F/P_C$$

- Since the MRS is also equal to the ratio of the marginal utilities of consuming F and C, it follows that:

$$MU_F/MU_C = P_F/P_C$$

- Which gives the equation for utility maximization?

$$MU_F / P_F = MU_C / P_C$$

- Total utility is maximized when the budget is allocated so that the marginal utility per dollar of expenditure is the same for each good.
- This is referred to as the **equal marginal principle.**

* Gasoline Rationing
  - In 1974 and again in 1979, the government imposed price controls on gasoline.
  - This resulted in shortages and gasoline was rationed.
  - Non-price rationing is an alternative to market rationing.
  - Under one form everyone has an equal chance to purchase a rationed good.
  - Gasoline is rationed by long lines at the gas pumps.
* Rationing hurts some by limiting the amount of gasoline they can buy.
* This can be seen in the following model.
* It applies to a woman with an annual income of $20,000.
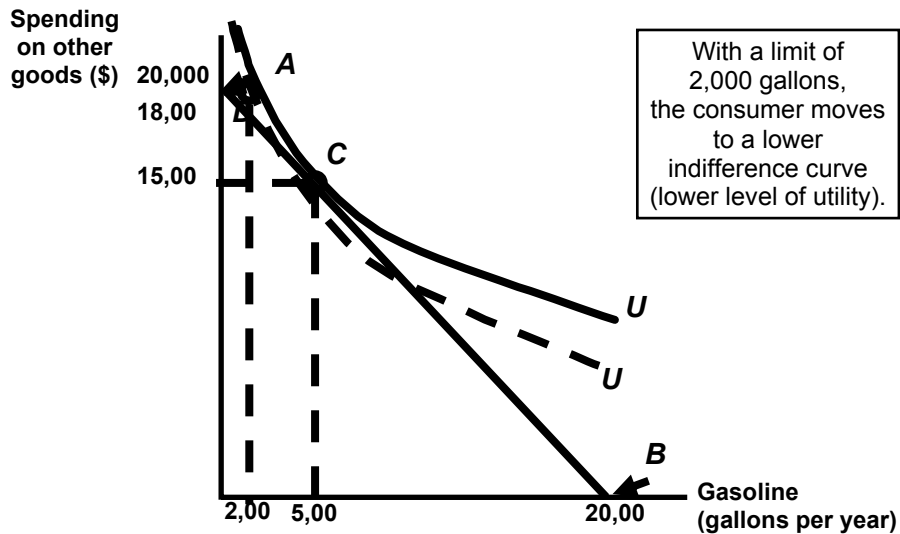
COST-OF-LIVING INDEXES

*

* The CPI is calculated each year as the ratio of the cost of a typical bundle of consumer goods and services today in comparison to the cost during a base period.
* Example
  - Two sisters, Raheela and Sarah, have identical preferences.
  - Sarah began college in 1987 with a $500 discretionary budget.
  - In 1997, Raheela started college and her parents promised her a budget that was equivalent in purchasing power.

Price of books	$20/book	$100/book
Number of books	15	6
Price of food	$2.00/lb	$2.20/lb
Pounds of food	100	300
Expenditure	$500	$1,260

  * Sarah' Expenditure

  * $500=100 lbs of food x $2.00/lb +15 books x $20/book
  * Raheela' Expenditure for Equal Utility
  * $1,260=300 lbs of food x $2.20/lb +6 books x $100/book

- The ideal cost-of-living adjustment for Raheela is $760.
  - The ideal cost-of-living index is $1,260/$500 = 2.52 or 252.
  - This implies a 152% increase in the cost of living.

Books (per quarter)

For Raheela to achieve the same level of utility as Sarah, with the higher prices, her budget must be sufficient to allow her to consume the bundle shown by point *B*.

U_1

25

20

A

15

10

B

5

I_1 I_2

Food (lb./quarter)

0 50 100 200 250 300 350 400 450 500 550 600
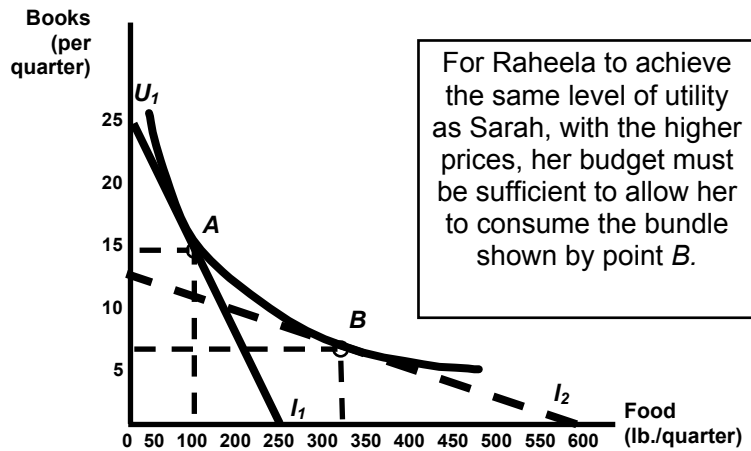
◆ The ideal cost of living index represents the cost of attaining a given level of utility at current (1997) prices relative to the cost of attaining the same utility at base (1987) prices.
◆ To do this on an economy-wide basis would entail large amounts of information.
◆ Price indexes, like the CPI, use a fixed consumption bundle in the base period. Called a <u>Laspeyres price index.</u>

◆ The Laspeyres index tells us:
  − The amount of money at current year prices that an individual requires to purchase the bundle of goods and services that was chosen in the base year divided by the cost of purchasing the same bundle at base year prices.
◆ Calculating Raheela's Laspeyres cost of living index
  − Setting the quantities of goods in 1997 equal to what were bought by her sister, but setting their prices at their 1997 levels result in an expenditure of
      $1,720 (100 x 2.20 + 15 x $100)
◆ Her cost of living adjustment would now be $1,220.
◆ The Laspeyres index is: $1,720/$500 = 344.
◆ This overstates the true cost-of-living increase.

Books (per quarter)

Using the Laspeyres index results in the budget line shifting up from I_2 to I_3.

U_1

25

20

A

15

10

B I_3

5

I_1 I_2

Food (lb./quarter)

0 50 100 200 250 300 350 400 450 500 550 600
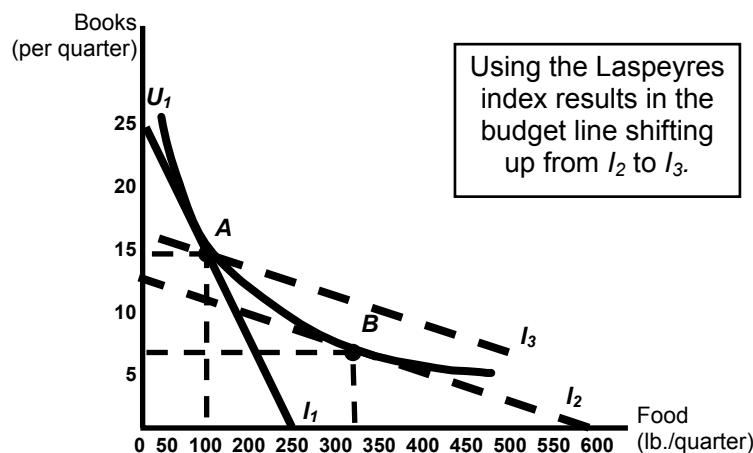
What Do You Think?
- – Does the Laspeyres index always overstate the true cost-of-living index?
- ◆ Yes!
  - – The Laspeyres index assumes that consumers do not alter their consumption patterns as prices change.
  - – By increasing purchases of those items that have become relatively cheaper, and decreasing purchases of the relatively more expensive items consumers can achieve the same level of utility without having to consume the same bundle of goods.
- ◆ The Paasche Index
  - – Calculates the amount of money at current-year prices that an individual requires to purchase a current bundle of goods and services divided by the cost of purchasing the same bundle in the base year.
- ◆ Comparing the Two Indexes
  - – Suppose:
  - – Two goods: Food (F) and Clothing (C)
- ◆ Comparing the Two Indexes
  - – Let:
    - • P_{Ft} & P_{Ct} be current year prices
    - • P_{Fb} & P_{Cb} be base year prices
    - • F_t & C_t be current year quantities
    - • F_b & C_b be base year quantities
  - – Both indexes involve ratios that involve today's current year prices, P_{Ft} and P_{Ct}.
  - – However, the Laspeyres index relies on base year consumption, F_b and C_b.
  - – Whereas, the Paasche index relies on today's current consumption, F_t and C_t .
- ◆ Then a comparison of the Laspeyres and Paasche indexes gives the following equations:

$$LI = \frac{P_{Ft}\,F_b + P_{Ct}\,C_b}{P_{Fb}\,F_b + P_{Cb}\,C_b}$$

$$PI = \frac{P_{Ft}\,F_t + P_{Ct}\,C_t}{P_{Fb}\,F_t + P_{Cb}\,C_t}$$

- – Sarah (1990)
  - • Cost of base-year bundle at current prices equals
    $1,720 (100 lbs x $2.20/lb + 15 books x $100/book)
  - • Cost of same bundle at base year prices is
    $500 (100 lbs x $2.00/lb + 15 books x $20/book)
- – Sarah (1990)

$$LI = \frac{\$1,720}{\$500} = 344$$

- • Cost of buying current year bundle at current year prices is
    $1,260 (300 lbs x $2.20/lb + 6 books x $100/book)

- Cost of the same bundle at base year prices is
    $720 (300 lbs x $2/lb + 6 books x $20/book)

$$PI = \frac{\$1,260}{\$720} = 175$$

The Paasche index will understate the cost of living because it assumes that the individual will buy the current year bundle in the base year.

Review of Consumer Equilibrium
- ◆ Consumer Preferences
- ◆ Budget Constraint
- ◆ Consumer Choices

INDIVIDUAL DEMAND

- ◆ Price Changes
  - – Using the figures developed in the previous chapter, the impact of a change in the price of food can be illustrated using indifference curves.

Effect of a Price Change

Assume:
- • $I = \$20$
- • $P_C = \$2$

Three separate indifference curves are tangent to each budget line.

Effect of a Price Change

The price-consumption curve traces out the utility maximizing market basket for the various prices for food.

Price-Consumption Curve

Effect of a Price Change

Price
of Food

E

$2.00

Individual Demand relates
the quantity of a good that
a consumer will buy to the
price of that good.

G

$1.00

Demand Curve

$.50

H

Food (units
per month)

4   12   20
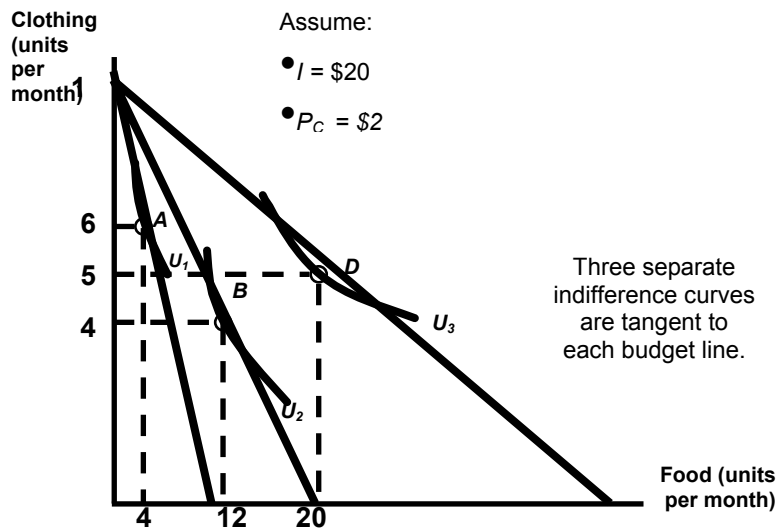
Individual Demand

* The Individual Demand Curve

  – Two Important Properties of Demand Curves

  – 1) The level of utility that can be attained changes as we move along the curve.

  – 2) At every point on the demand curve, the consumer is maximizing utility by satisfying
    the condition that the *MRS* of food for clothing equals the ratio of the prices of food and
    clothing.

Effect of a Price Change
When the price falls: P_f/P_c & MRS also fall

Price
of Food

E

$2.00

E: $P_f/P_c = 2/2 = 1 = MRS$

G

$1.00

G: $P_f/P_c = 1/2 = .5 = MRS$

Demand Curve

H: $P_f/P_c = .5/2 = .25 = MRS$

$.50

H

Food (units
per month)

4   12   20
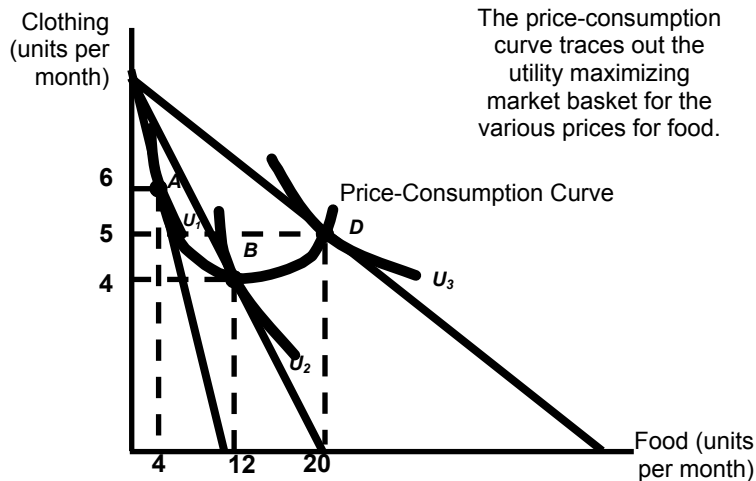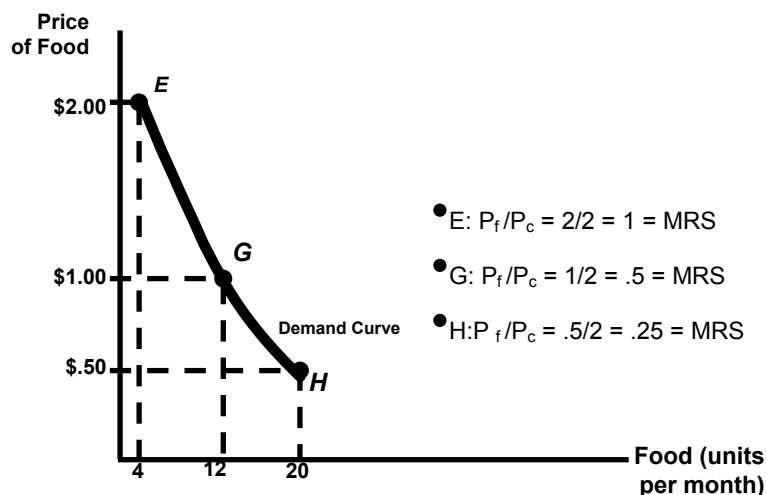
Individual Demand

* Income Changes

  – Using the figures developed in the previous chapter, the impact of a change in the
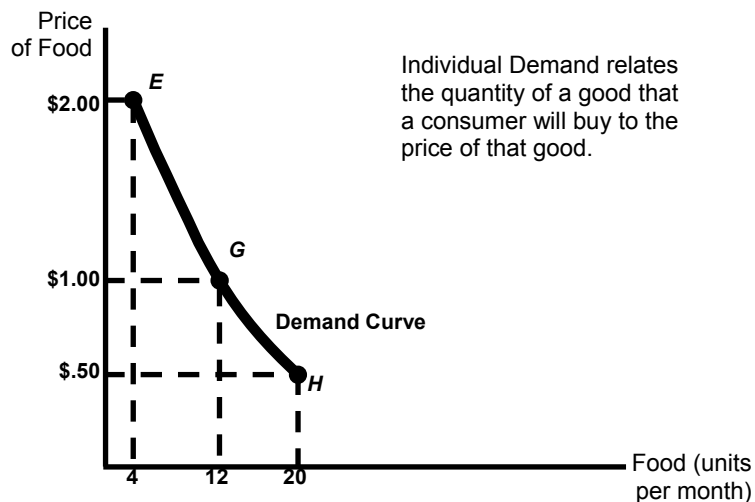   income can be illustrated using indifference curves.

Effects of Income Changes

Assume: P_f = $1
          P_c = $2
          I = $10,
          $20, $30

Clothing
(units per
month)

Income-Consumption
Curve

7 — — — — — — — D U_3

5 — — — — — U_2

         B

3 —

    A U_1

An increase in income,
with the prices fixed,
causes consumers to alter
their choice of
market basket.

Food (units
per month)

4   10   16

Effects of Income Changes

Price
of
food

An increase in income,
from $10 to $20 to $30,
with the prices fixed,
shifts the consumer's
demand curve to the right.

        E   G   H
$100

                                    D_3

                            D_2

                    D_1

Food (units
per month)

4   10   16
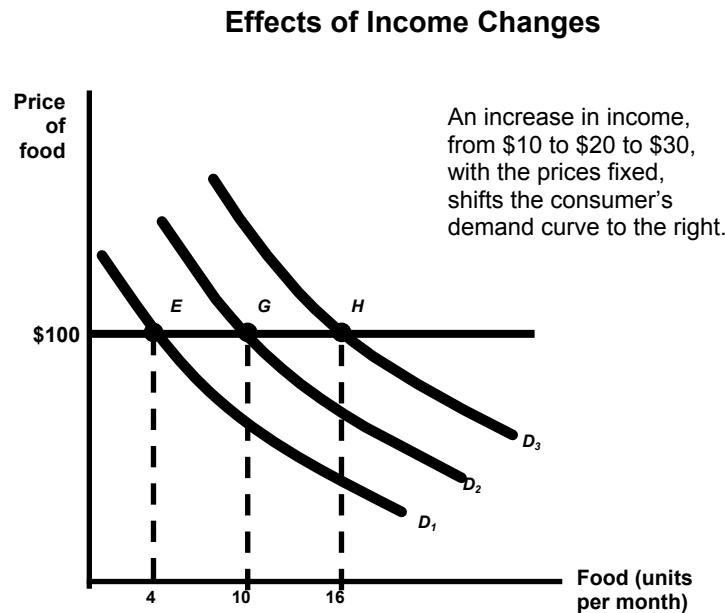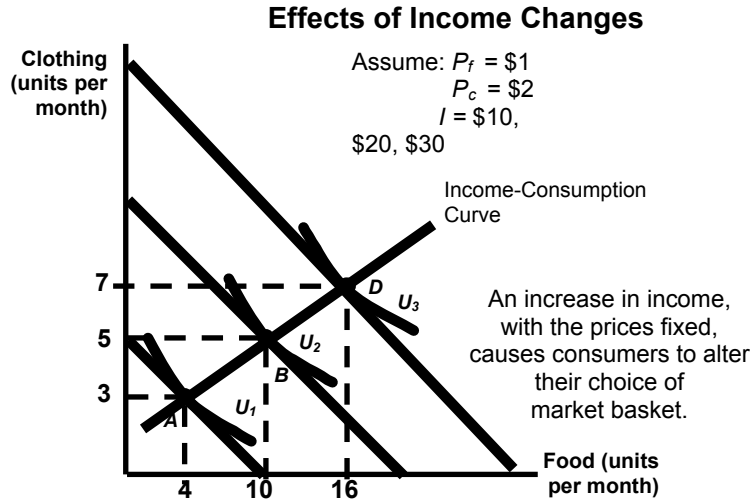
- The income-consumption curve traces out the utility-maximizing combinations of food and clothing associated with every income level.
- An increase in income shifts the budget line to the right, increasing consumption along the income-consumption curve.
- Simultaneously, the increase in income shifts the demand curve to the right.

◆ Normal Good vs. Inferior Good

- Income Changes
  - When the income-consumption curve has a positive slope:
    - The quantity demanded increases with income.
    - The income elasticity of demand is positive.
    - The good is a **normal good.**
  - When the income-consumption curve has a negative slope:

–The quantity demanded decreases with income.

–The income elasticity of demand is negative.

–The good is an **inferior good.**

An Inferior Good

Coffee
(units per
month)

15

**Income-Consumption
Curve**

C

10

U_3

Both Tea
and Coffee behave
as a normal good,
between *A* and *B...*

…but Tea
becomes an inferior
good when the income
consumption curve
bends backward
between *B* and *C.*

5

B

A

U_2

U_1

Tea
(units per month)

5   10   20   30
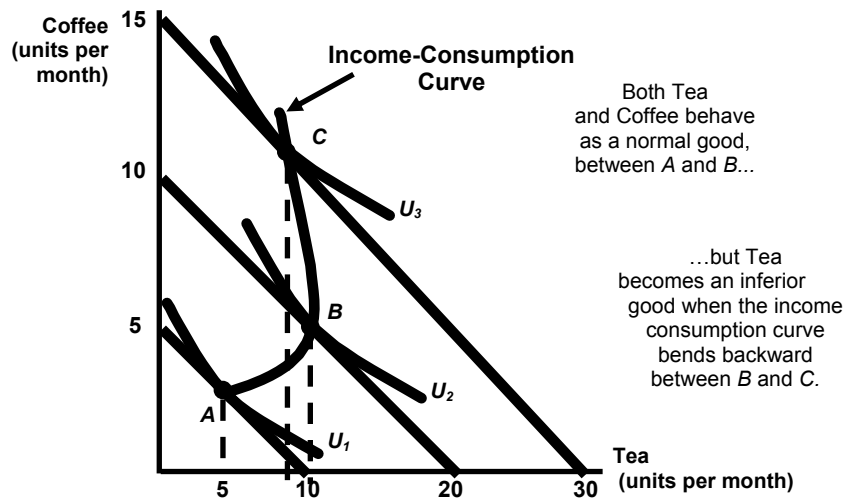
Engel Curves

◆Engel Curves

–Engel curves relate the quantity of good consumed to income.

–If the good is a normal good, the Engel curve is upward sloping.

–If the good is an inferior good, the Engel curve is downward sloping.

Income
($ per
month)

30

20

10

Engel curves
slope
upward for
normal
goods.

Food (units
per month)

0   4   8   12   16

Income
($ per
month)

30

20

10

Engel curves slope
backward bending
for inferior goods.

Inferior

Normal

**Food (units
per month)**

0   4   8   12   16
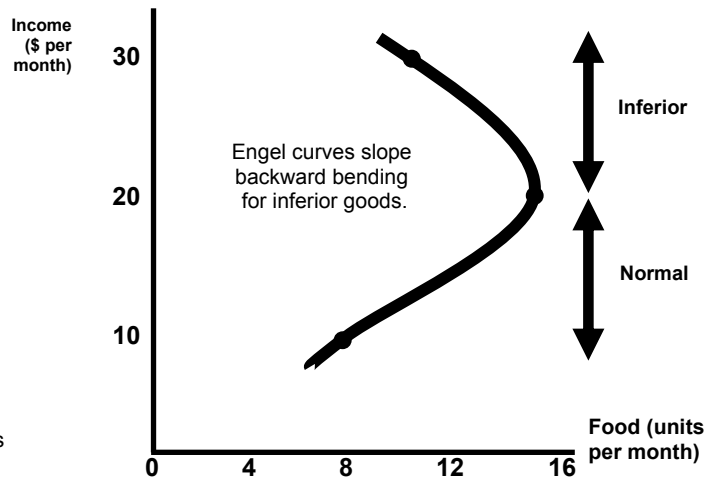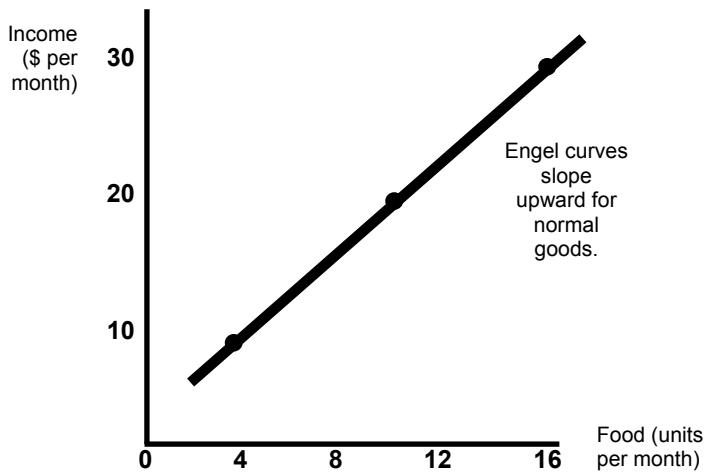
Consumer Expenditures in US

Income Group (1997 $)

Expenditure ($) on	Less than $10,000	1,000-19,000	20,000-29,000	30,000-39,000	40,000-49,000	50,000-69,000	70,000-and above
Entertainment	700	947	1274	1514	2054	2654	4300
Owned Res.	1116	1725	253	3243	4454	5793	9898
Rented Res.	1957	2170	2371	2536	2137	1540	1266
Health Care	1031	1697	1918	820	2052	2214	2642
Food	656	3385	4109	4888	5429	6220	8279
Clothing	859	978	1363	1772	1778	2614	3442

Individual Demand

◆Substitutes and Complements

1) Two goods are considered **substitutes** if an increase (decrease) in the price of one leads to an increase (decrease) in the quantity demanded of the other.

•e.g. movie tickets and video rentals

2) Two goods are considered **complements** if an increase (decrease) in the price of one leads to a decrease (increase) in the quantity demanded of the other.

•e.g. gasoline and motor oil

3) Two goods are independent when a change in the price of one good has no effect on the quantity demanded of the other

─If the price consumption curve is downward-sloping, the two goods are considered substitutes.

─If the price consumption curve is upward-sloping, the two goods are considered complements.
◆They could be both!

◆

Income & Substitution Effects

◆A fall in the price of a good has two effects: Substitution & Income

─Substitution Effect

●Consumers will tend to buy more of the good that has become relatively cheaper, and less of the good that is now relatively more expensive.

- Income Effect
- Consumers experience an increase in real purchasing power when the price of one good falls.

◆Substitution Effect

- The **substitution effect** is the change in an item's consumption associated with a change in the price of the item, with the level of utility held constant.
- When the price of an item declines, the substitution effect always leads to an increase in the quantity of the item demanded.
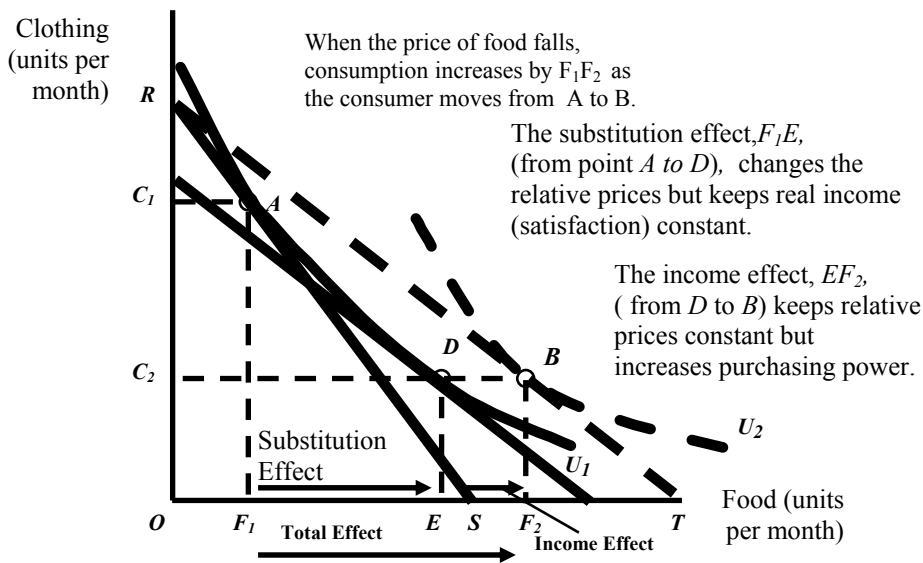
◆Income Effect

- The **income effect** is the change in an item's consumption brought about by the increase in purchasing power, with the price of the item held constant.
- When a person's income increases, the quantity demanded for the product may increase or decrease.
- Even with inferior goods, the income effect is rarely large enough to outweigh the substitution effect.

Income & Substitution Effects: Normal Good

Clothing (units per month)

When the price of food falls, consumption increases by F_1F_2 as the consumer moves from A to B.

The substitution effect, F_1E, (from point *A to D*), changes the relative prices but keeps real income (satisfaction) constant.

The income effect, EF_2, (from D to B) keeps relative prices constant but increases purchasing power.

Substitution Effect

U_2

U_1

Food (units per month)

O F_1 Total Effect   E   S F_2 T

Income Effect

Clothing (units per month)

Since food is an inferior good, the income effect is negative. However, the substitution effect is larger than the income effect.

Substitution

Food (units per month)

♦ A Special Case--**The Giffen Good**
  − The income effect may theoretically be large enough to cause the demand curve for a good to slope upward.
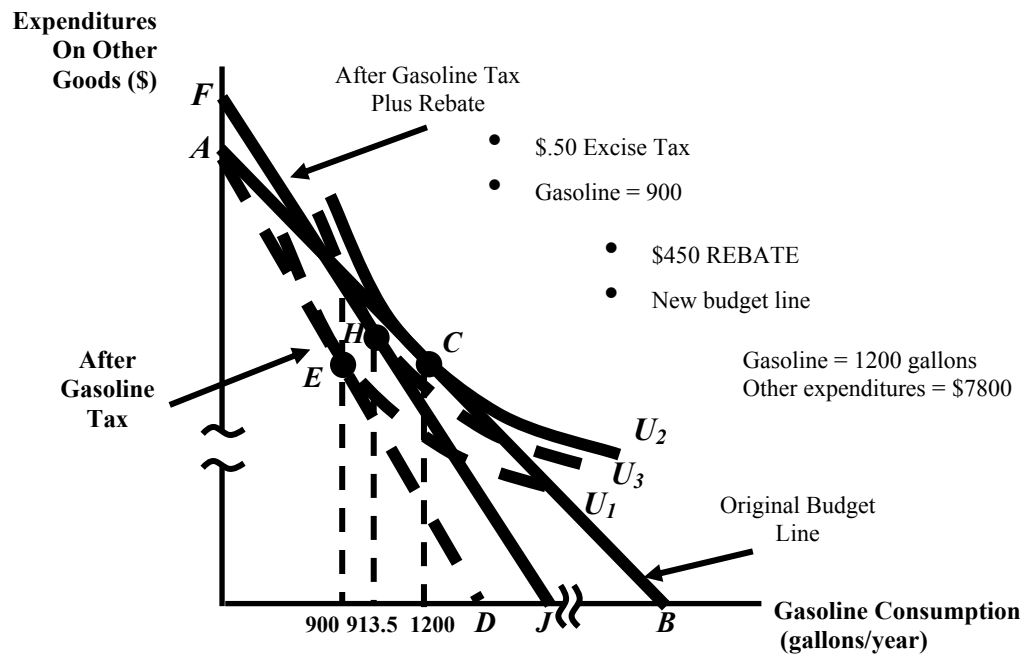 − This rarely occurs and is of little practical interest.

Effect of a Gasoline Tax with a Rebate

♦*Assume*

−P_e^d = -0.5

−Income = $9,000
  − Price of gasoline = $1

Expenditures On Other Goods ($)

After Gasoline Tax Plus Rebate

• $.50 Excise Tax
• Gasoline = 900

• $450 REBATE
• New budget line

Gasoline = 1200 gallons
Other expenditures = $7800

After Gasoline Tax

U_2

U_3

U_1

Original Budget Line

900 913.5 1200 D J B **Gasoline Consumption (gallons/year)**
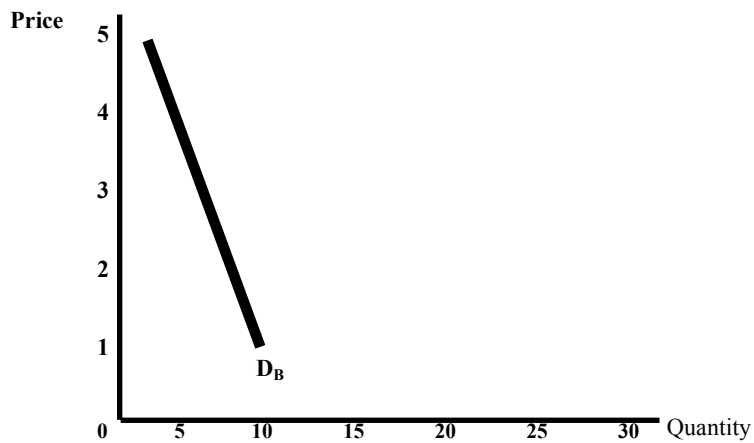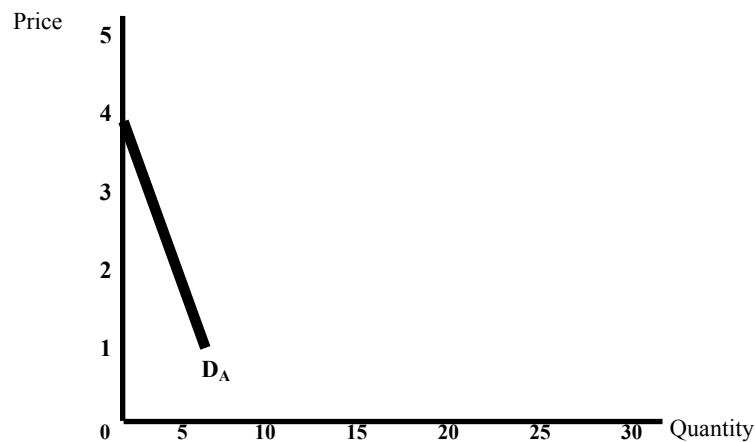
Market Demand

◆Market Demand Curves
   – A curve that relates the quantity of a good that all consumers in a market buy to the price of that good.

Determining the Market Demand Curve

Price ($)	Individual A (units)	Individual B (units)	Individual C (units)	Market (units)
1	6	10	16	32
2	4	8	13	25
3	2	6	10	18
4	0	4	7	11
5	0	2	4	6

Summing to Obtain a Market Demand Curve

The market demand curve is obtained by summing the consumer's demand curves
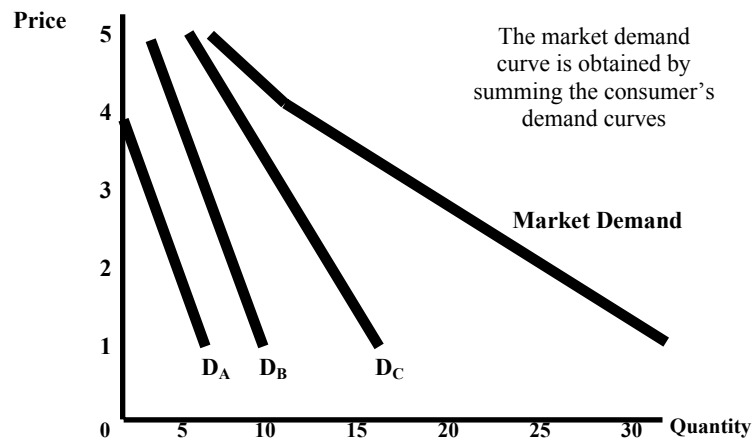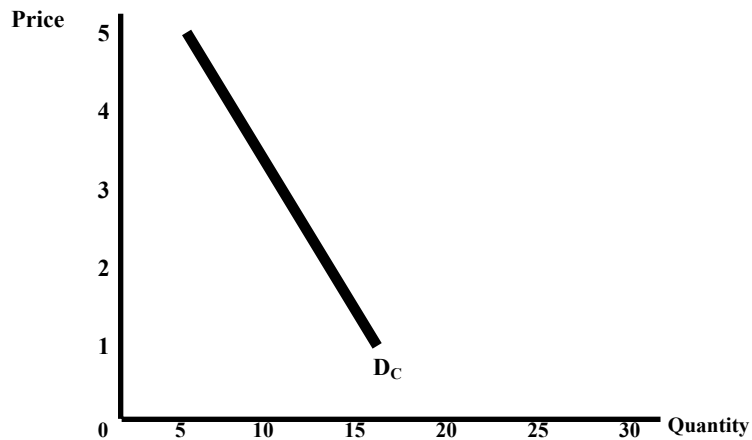
♦   Two Important Points

1) The market demand will shift to the right as more consumers enter the market.

2) Factors that influence the demands of many consumers will also affect the market demand.

♦Elasticity of Demand
        Recall: Price elasticity of demand measures the percentage change in the quantity demanded resulting from a 1-percent change in price.

$$E_P = \frac{\Delta Q/Q}{\Delta P/P} = \frac{\Delta Q \ / \ \Delta P}{Q \ / \ P}$$

Price Elasticity and Consumer Expenditure

Demand	If Price Increases, Expenditures:	If Price Decreases, Expenditures:
Inelastic(E_p <1)	Increase	Decrease
Unit Elastic (E_p = 1)	Are unchanged	Are unchanged
Elastic (E_p >1)	Decrease	Increase

◆Point Elasticity of Demand
– For large price changes (e.g. 20%), the value of elasticity will depend upon where the price and quantity lie on the demand curve.
– Point elasticity measures elasticity at a point on the demand curve.
– Its formula is:

$$E_P = (P/Q)(1/slope)$$

Problems Using Point Elasticity

– We may need to calculate price elasticity over portion of the demand curve rather than at a single point.
– The price and quantity used as the base will alter the price elasticity of demand.
◆Point Elasticity of Demand: An Example
–Assume
  • Price increases from 8$ to $10 quantity demanded falls from 6 to 4
  • Percent change in price equals: $2/$8 = 25% or $2/$10 = 20%
  • Percent change in quantity equals: -2/6 = -33.33% or -2/4 = -50%

 Elasticity equals:
    -33.33/.25 = -1.33 or -.50/.20 = -2.54
–Which one is correct?
◆Arc Elasticity of Demand
– Arc elasticity calculates elasticity over a range of prices
– Its formula is:

$$E_P = (\Delta Q/\Delta P)(\overline{P}/\overline{Q})$$

$$\overline{P} = the\ averag\ e\ price$$

$$\overline{Q} = the\ averag\ e\ quantity$$

◆   Arc Elasticity of Demand: An Example

$$E_P = (\Delta Q/\Delta P)(\overline{P}/\overline{Q})$$

$$P_1 = 8, P_2 = 10, Q_1 = 6, Q_2 = 4$$

$$\overline{P} = 18/2 = 9 \,\&\, \overline{Q} = 10/2 = 5$$

$$E_p = (-2/\$2)(\$9/5) = -1.8$$

The Aggregate Demand For Wheat

◆The demand for U.S. wheat is comprised of domestic demand and export demand.

◆The domestic demand for wheat is given by the equation:

   $-Q_{DD}$ = 1700 - 107P

◆The export demand for wheat is given by the equation:

   $-Q_{DE}$ = 1544 - 176P

◆Domestic demand is relatively price inelastic (-0.2), while export demand is more price elastic (-0.4).
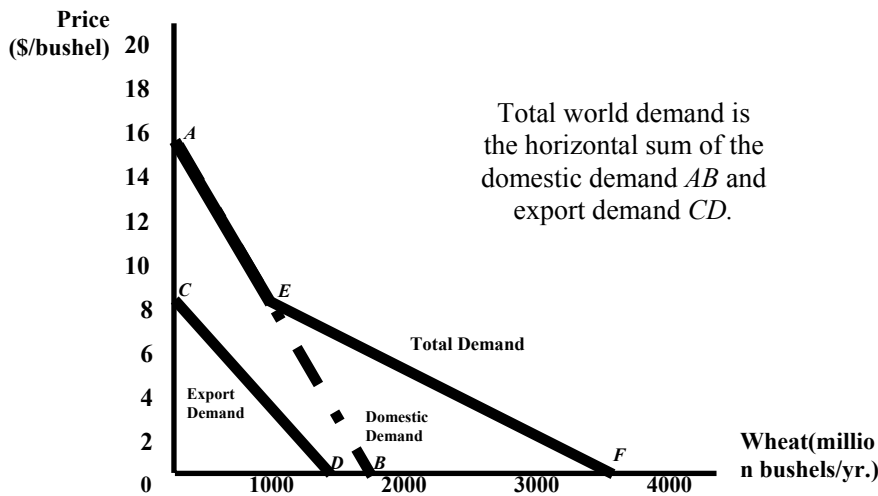
Consumer Surplus

◆Consumer Surplus

   – The difference between the maximum amount a consumer is willing to pay for a good and the amount actually paid.

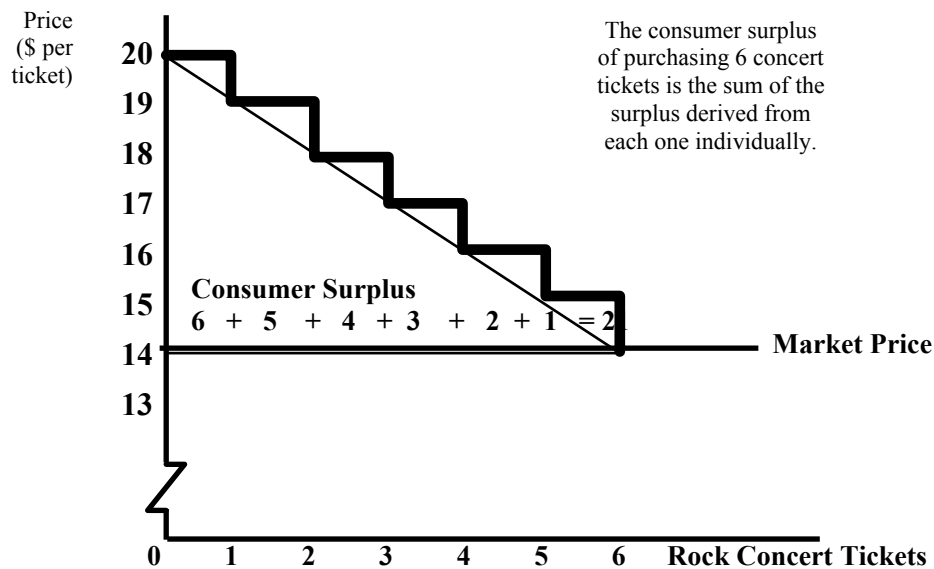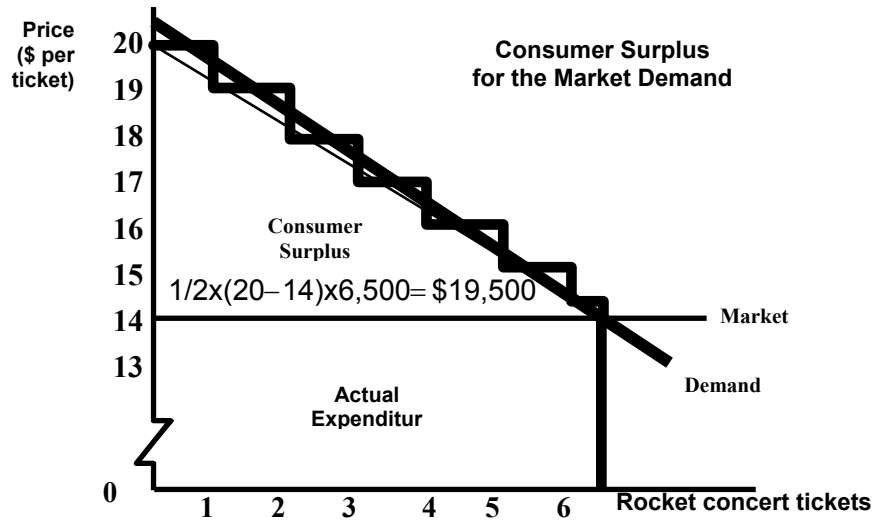The stepladder demand curve can be converted into a straight-line demand curve by making the units of the good smaller.
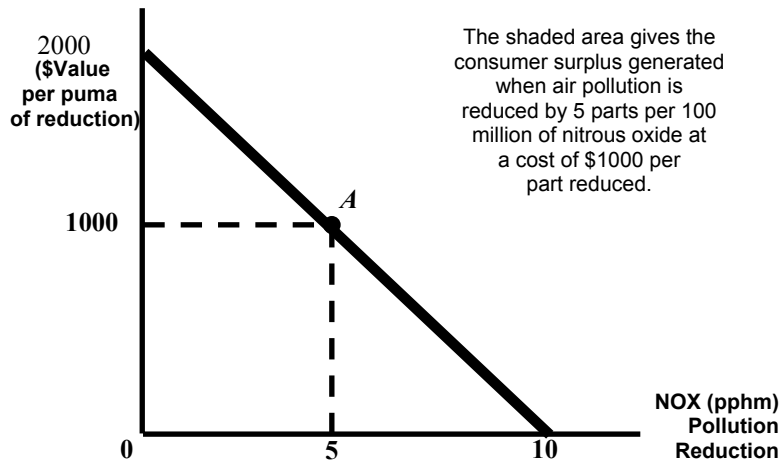
Price ($ per ticket)

Consumer Surplus for the Market Demand

Consumer Surplus

1/2x(20–14)x6,500= $19,500

Market

Demand

Actual Expenditur

0   1   2   3   4   5   6   Rocket concert tickets

◆Combining consumer surplus with the aggregate profits that producers obtain we can evaluate:

1) Costs and benefits of different market structures

2) Public policies that alter the behavior of consumers and firms

An Example: The Value of Clean Air

◆Air is free in the sense that we don't pay to breathe it.
◆Question: Are the benefits of cleaning up the air worth the costs?
◆People pay more to buy houses where the air is clean.
◆ Data for house prices among neighborhoods of Lahore and Rawalpindi were compared with the various air pollutants.

2000 ($Value per puma of reduction)

The shaded area gives the consumer surplus generated when air pollution is reduced by 5 parts per 100 million of nitrous oxide at a cost of $1000 per part reduced.

A

1000

NOX (pphm) Pollution Reduction
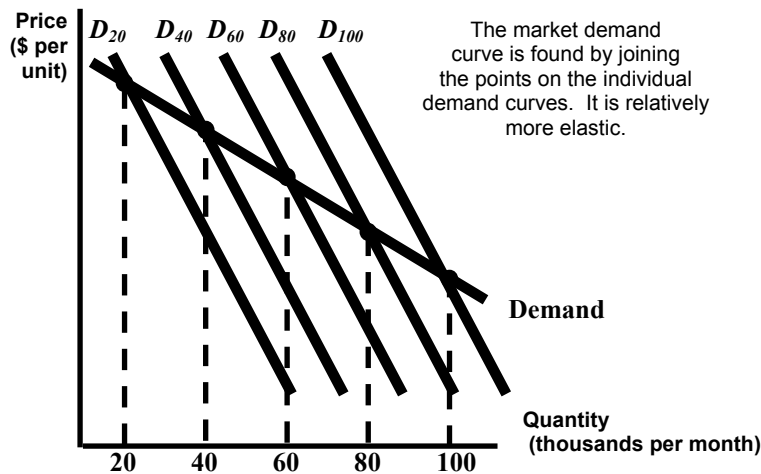
0   5   10

NETWORK EXTERNALITIES

◆Up to this point we have assumed that people's demands for a good are independent of one another.

◆If fact, a person's demand may be affected by the number of other people who have purchased the good.

◆If this is the case, a network externality exists.

◆Network externalities can be positive or negative.

◆A positive network externality exists if the quantity of a good demanded by a consumer increases in response to an increase in purchases by other consumers.

◆Negative network externalities are just the opposite.

◆ The Bandwagon Effect
  – This is the desire to be in style, to have a good because almost everyone else has it, or to indulge in a fad.
  – This is the major objective of marketing and advertising campaigns (e.g. toys, clothing).

Positive Network Externality: Bandwagon Effect

Suppose the price falls from \$30 to \$20. If there were no bandwagon effect, quantity demanded would only increase to 48,000

But as more people buy the good, it becomes stylish to own it and the quantity demanded increases further.
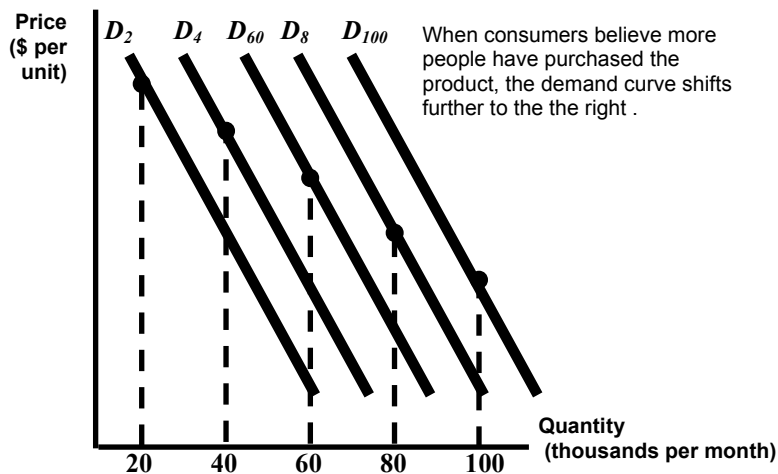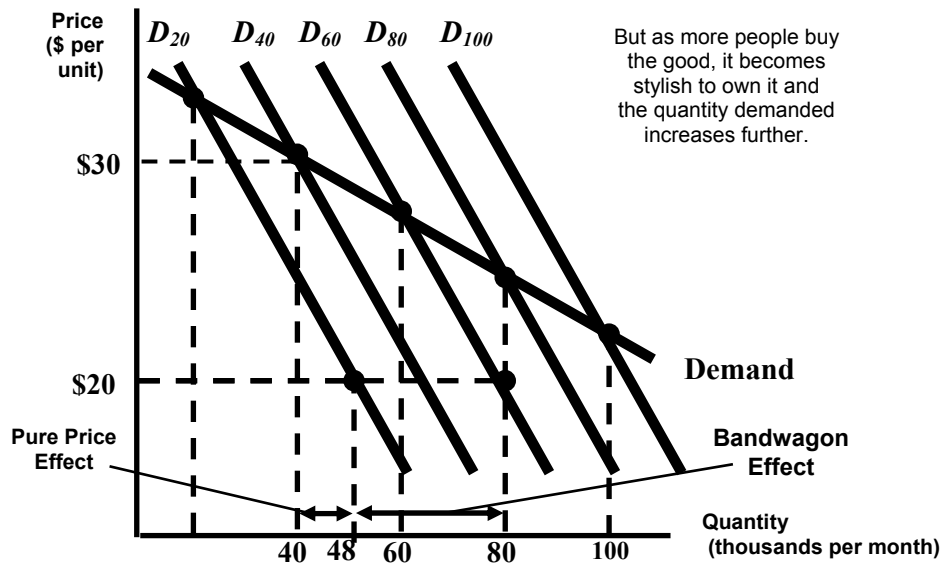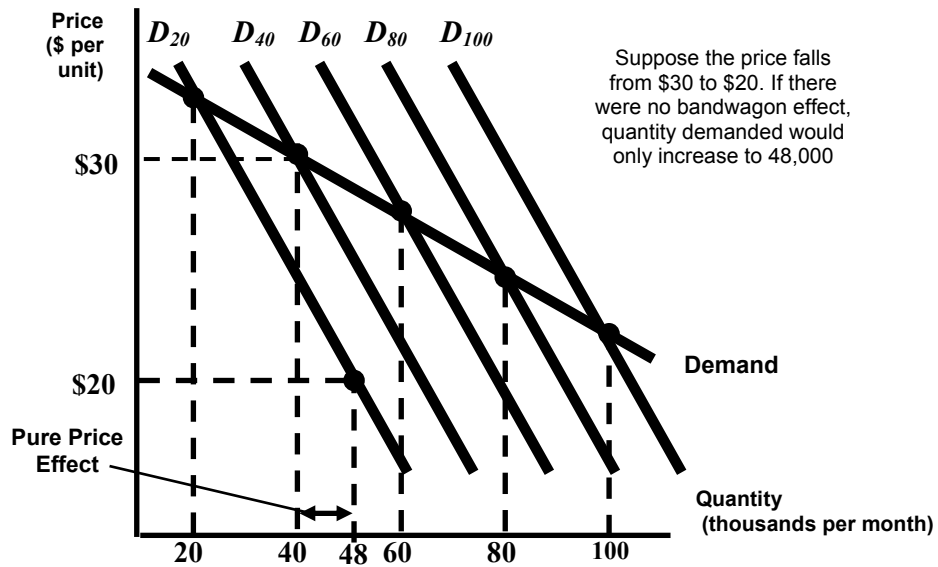
- ◆ The Snob Effect
  - – If the network externality is negative, a **snob effect** exists.
- ◆ The **snob effect** refers to the desire to own exclusive or unique goods.
- ◆ The quantity demanded of a "snob" good is higher the fewer the people who own it.

Price ($ per unit)

Demand

Originally demand is D_2, when consumers think 2000 people have bought a good.

$30,000

However, if consumers think 4,000 people have bought the good, demand shifts from D_2 to D_6 and its snob value has been reduced.

$15,000

D_2

D_4

D_6

D_8

Quantity (thousands per month)

2   4   6   8   14

Pure Price Effect

Price ($ per unit)

Demand

$30,000

The demand is less elastic and as a snob good its value is greatly reduced if more people own it. Sales decrease as a result. Examples: Rolex watches and long lines at the ski lift.

Net Effect

Snob Effect

$15,000

D_2

D_4

D_6

D_8

Quantity (thousands per month)

2   4   6   8   14

Pure Price Effect

Network Externalities and the Demands

for Computers and Fax Machines

- Examples of Positive Feedback Externalities
    - Mainframe computers: 1954 - 1965
    - Microsoft Windows PC operating system
    - Fax-machines and e-mail

Introduction
- Choice with certainty is reasonably straightforward.
- How do we choose when certain variables such as income and prices are uncertain (i.e. making choices with risk)?

Describing Risk
- To measure risk we must know:

  1) All of the possible outcomes.

  2) The likelihood that each outcome will occur (its probability).
- Interpreting Probability
  – The likelihood that a given outcome will occur
  – Objective Interpretation
    • Based on the observed frequency of past events
  – Subjective
    • Based on perception or experience with or without an observed frequency
      – Different information or different abilities to process the same information can influence the subjective probability
- Expected Value
  – The weighted average of the payoffs or values resulting from all possible outcomes.
    • The probabilities of each outcome are used as weights
    • Expected value measures the central tendency; the payoff or value expected on average
  – An Example
    • Investment in drilling exploration:
    • Two outcomes are possible
      – Success -- the stock price increase from $30 to $40/share
      – Failure -- the stock price falls from $30 to $20/share
    • Objective Probability
      – 100 explorations, 25 successes and 75 failures
      – Probability (Pr) of success = 1/4 and the probability of failure = 3/4

$$EV = Pr(success)(\$40/share) + Pr(failure)(\$20/share)$$

$$EV = 1/4\,(\$40/share) + 3/4\,(\$20/share)$$

$$EV = \$25/share$$

- Given:
  – Two possible outcomes having payoffs X_1 and X_2
  – Probabilities of each outcome is given by Pr_1 & Pr_2
- Generally, expected value is written as:

$$E(X) = Pr_1 X_1 + Pr_2 X_2 + ... + Pr_n X_n$$

Variability
- The extent to which possible outcomes of an uncertain event may differ
◆ Variability: A Scenario
  - Suppose you are choosing between two part-time sales jobs that have the same expected income ($1,500)
  - The first job is based entirely on commission.
  - The second is a salaried position.
  - There are two equally likely outcomes in the first job--$2,000 for a good sales job and $1,000 for a modestly successful one.
  - The second pays $1,510 most of the time (.99 probability), but you will earn $510 if the company goes out of business (.01 probability).

Income from Sales Jobs					
	Outcome 1		Outcome 2		
	Probability	Income($)	probability	Income($)	Expected income
Job 1: Commission	.5	2000	.5	1000	1500
Job 2: Fixed salary	.99	1510	.01	510	1500

$$E(X_1) = .5(\$2000) + .5(\$1000) = \$1500$$

Job 2 Expected Income

$$E(X_2) = .99(\$1510) + .01(\$510) = \$1500$$

◆ While the expected values are the same, the variability is not.
◆ Greater variability from expected values signals greater risk.
◆ Deviation
  - Difference between expected payoff and actual payoff

Deviations from Expected Income ($)

	Outcome 1	Deviation	Outcome 2	Deviation
Job 1	$2,000	$500	$1,000	-$500
Job 2	1,510	10	510	-900

─ Adjusting for negative numbers

─ The standard deviation measures the square root of the average of the squares of the deviations of the payoffs associated with each outcome from their expected value.
- The standard deviation is written:

$$\sigma = \sqrt{Pr_1\left[X_1 - E(X)^2\right] + Pr_2\left[X_2 - E(X)^2\right]}$$

Calculating Variance ($)

	Outcome 1	Deviation Squared	Outcome 2	Deviation Squared	Deviation Squared	Standard Deviation
Job 1	$2,000	$250,000	$1,000	$250,000	$250,000	$500.00
Job 2	1,510	100	510	980,100	9,900	99.50

- The standard deviations of the two jobs are:

$$\sigma_1 = \sqrt{.5(\$250,00 \quad 0) + .5(\$250,00 \quad 0}$$

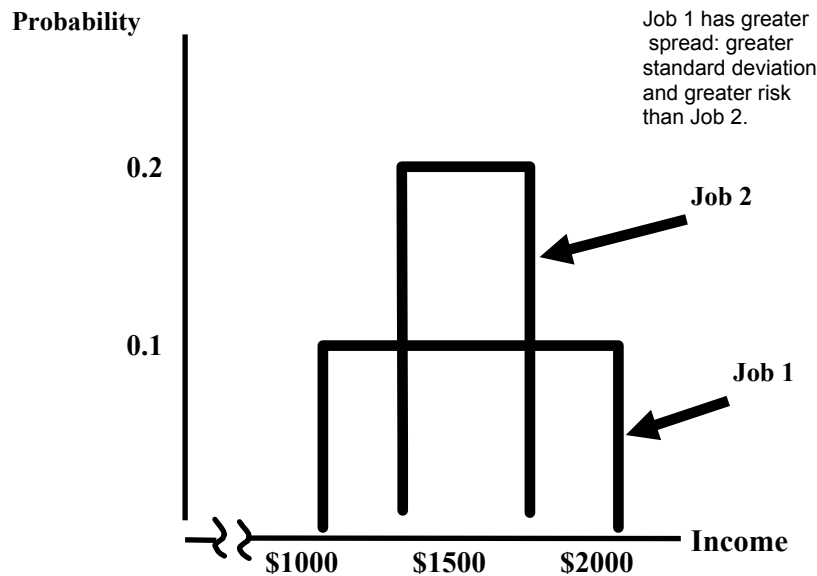$$\sigma_1 = \sqrt{\$250,000}$$

$$\sigma_1 = 500 \quad \textbf{*Greater Risk}$$

$$\sigma_2 = \sqrt{.99(\$100 \quad + .01(\$980,1 \quad 00)}$$

$$\sigma_2 = \sqrt{\$9,900}$$

$$\sigma_2 = 99.50$$

- The standard deviation can be used when there are many outcomes instead of only two.
- An Example
  - Job 1 is a job in which the income ranges from $1000 to $2000 in increments of $100 that are all equally likely.
  - Job 2 is a job in which the income ranges from $1300 to $1700 in increments of $100 that, also, are all equally likely.

- Outcome Probabilities of Two Jobs (unequal probability of outcomes)
  - Job 1: greater spread & standard deviation

- – Peaked distribution: extreme payoffs are less likely
- ◆ Decision Making
  - – A risk avoider would choose Job 2: same expected income as Job 1 with less risk.
  - – Suppose we add $100 to each payoff in Job 1 which makes the expected payoff = $1600.

Unequal Probability Outcomes

The distribution of payoffs associated with Job 1 has a greater spread and standard deviation than those with Job 2.
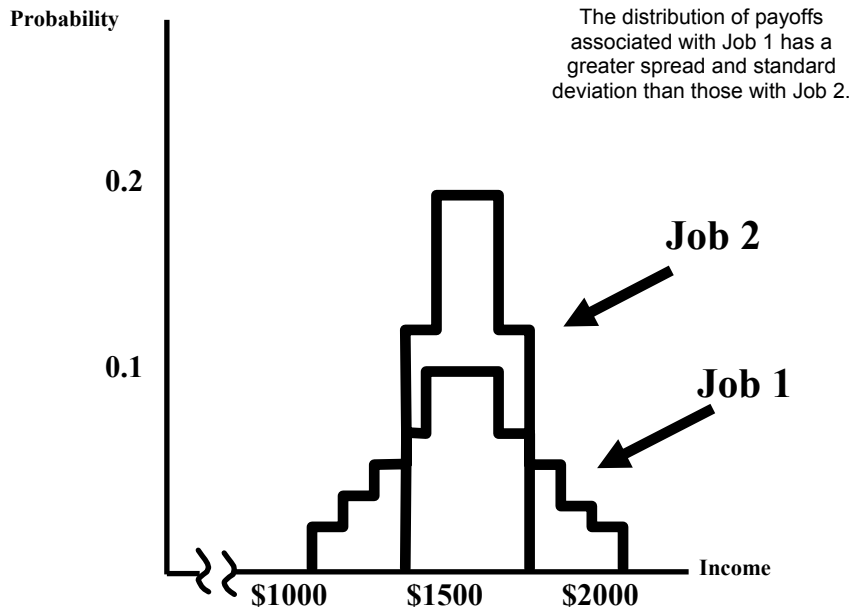
Income from Sales Jobs--Modified ($)

	Outcome 1	Deviation Squared	Outcome 2	Deviation Squared	Deviation Squared	Standard Deviation
Job 1	$2,100	$250,000	$1,100	$250,000	$1, 600	$500
Job 2	1510	100	510	980,100	1, 500	99.50

Recall: The standard deviation is the square root of the deviation squared.
- ◆ Decision making
  - – Job 1: expected income $1,600 and a standard deviation of $500.
  - – Job 2: expected income of $1,500 and a standard deviation of $99.50
  - – Which job?
    - • Greater value or less risk?
- ◆ Example
  - – Suppose a city wants to deter people from wrong parking.
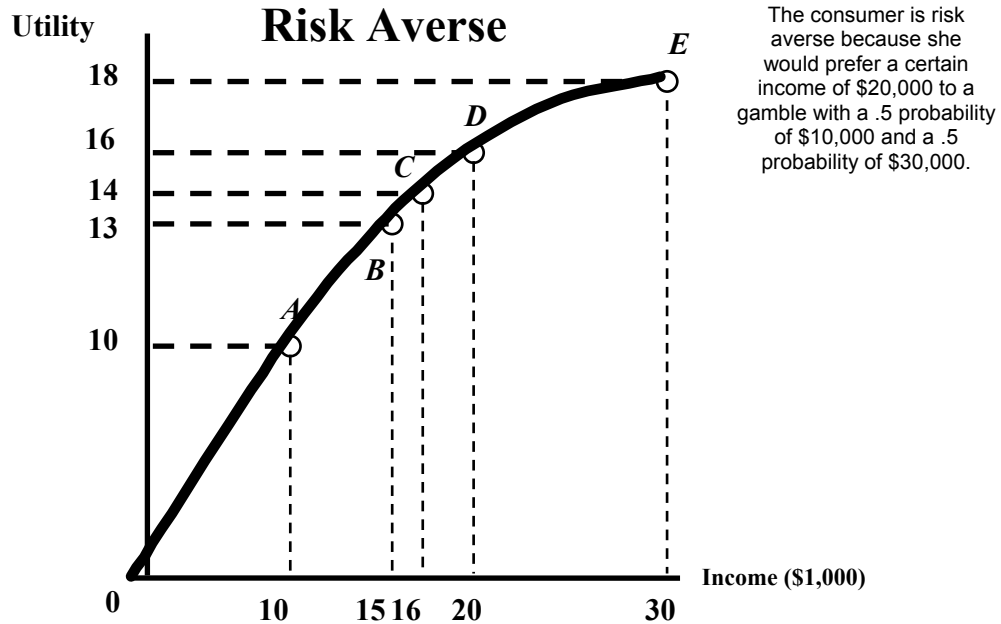 - – The alternatives …...

◆ Assumptions:

  1) Wrong parking saves a person $5 in terms of time spent searching for a parking space.

  2) The driver is risk neutral.

  3) Cost of apprehension is zero.

◆ A fine of $5.01 would deter the driver from double parking.

  – Benefit of wrong parking ($5) is less than the cost ($5.01) equals a net benefit that is less than 0.

◆ Increasing the fine can reduce enforcement cost:

  – A $50 fine with a .1 probability of being caught results in an expected penalty of $5.

  – A $500 fine with a .01 probability of being caught results in an expected penalty of $5.

◆ The more risk averse drivers are, the lower the fine needs to be in order to be effective.
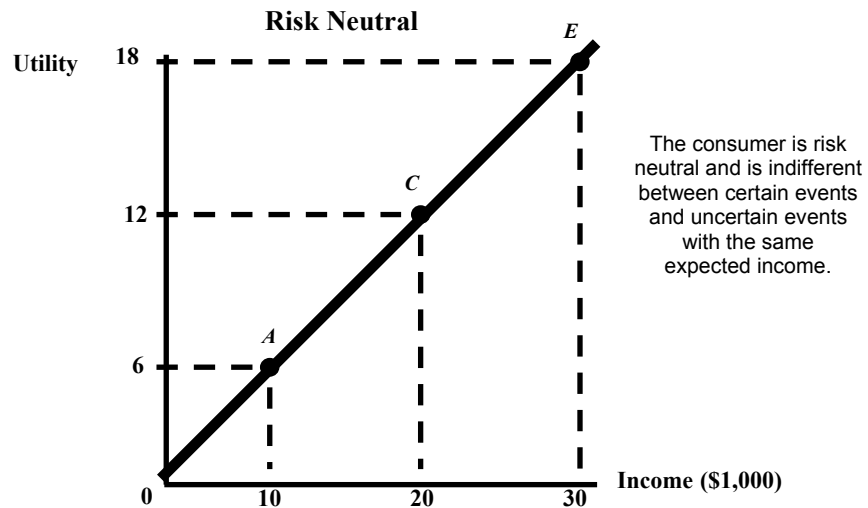
PREFERENCES TOWARD RISK

◆ Choosing Among Risky Alternatives
   – Assume
      – Consumption of a single commodity
      – The consumer knows all probabilities
      – Payoffs measured in terms of utility
      – Utility function given
◆ Example
   – A person is earning $15,000 and receiving 13 units of utility from the job.
   – She is considering a new, but risky job.
◆ She has a .50 chance of increasing her income to $30,000 and a .50 chance of decreasing her income to $10,000.
◆ She will evaluate the position by calculating the expected value (utility) of the resulting income.
◆ The expected utility of the new position is the sum of the utilities associated with all her possible incomes weighted by the probability that each income will occur.
◆ The expected utility can be written:
   – E(u) = (1/2)u($10,000) + (1/2)u($30,000)
                         = 0.5(10) + 0.5(18)
                         = 14

   – E(u) of new job is 14 which is greater than the current utility of 13 and therefore preferred.

◆ **Different Preferences Toward Risk**
   – People can be
      • Risk averse
      • Risk neutral or
      • Risk loving
   – Risk Averse*:*
   – A person who prefers a certain given income to a risky income with the same expected value.
   – A person is considered risk averse if they have a diminishing marginal utility of income
      – The use of insurance demonstrates risk aversive behavior.
◆ Risk Averse*:* A Scenario
   – A person can have a $20,000 job with 100% probability and receive a utility level of 16.
   – The person could have a job with a .5 chance of earning $30,000 and a .5 chance of earning $10,000.
◆ Expected Income =

            (0.5)($30,000) + (0.5) ($10,000) = $20,000
◆ Expected income from both jobs is the same -- risk averse may choose current job
◆ The expected utility from the new job is found:
   – E(u) = (1/2)u ($10,000) + (1/2)u($30,000)
   – E(u) = (0.5)(10) + (0.5)(18) = 14
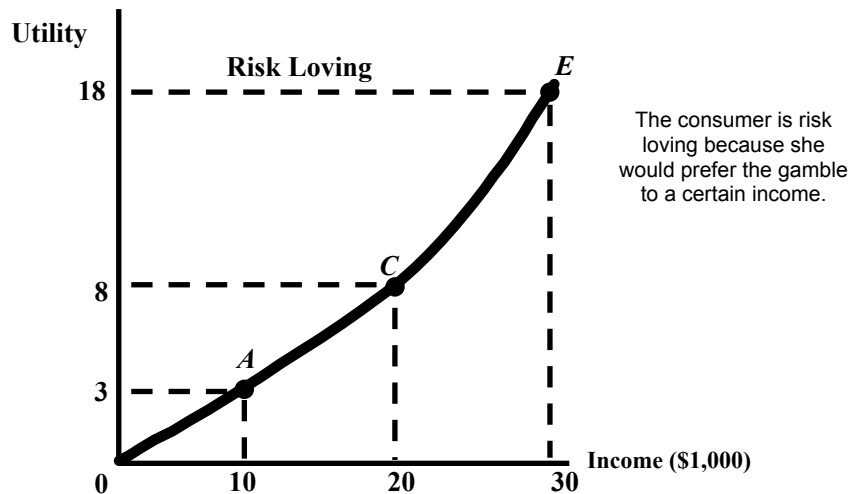   – E(u) of Job 1 is 16 which is greater than the E(u) of Job 2 which is 14.

♦ This individual would keep their present job since it provides them with more utility than the risky job.
♦ They are said to be risk averse.

Risk Averse

Utility

The consumer is risk averse because she would prefer a certain income of $20,000 to a gamble with a .5 probability of $10,000 and a .5 probability of $30,000.

18
16
14
13
10

E
D
C
B
A

0   10   15 16   20   30   Income ($1,000)

♦   Risk Neutral
  – A person is said to be **risk neutral** if they show no preference between a certain income, and an uncertain one with the same expected value.

Risk Neutral

Utility   18

12

6

E
C
A

0   10   20   30   Income ($1,000)

The consumer is risk neutral and is indifferent between certain events and uncertain events with the same expected income.

♦ Risk Loving
  – A person is said to be **risk loving** if they show a preference toward an uncertain income over a certain income with the same expected value.
    • Examples: Gambling, some criminal activity

Utility

Risk Loving

18 — — — — — — — — — — — E

The consumer is risk
loving because she
would prefer the gamble
to a certain income.

8 — — — — — — — C

A

3 — — — A

0   10   20   30   **Income ($1,000)**

◆ **Risk Premium**
  – The **risk premium** is the amount of money that a risk-averse person would pay to avoid taking a risk.
◆ Risk Premium: A Scenario
  – The person has a .5 probability of earning $30,000 and a .5 probability of earning $10,000 (expected income = $20,000).
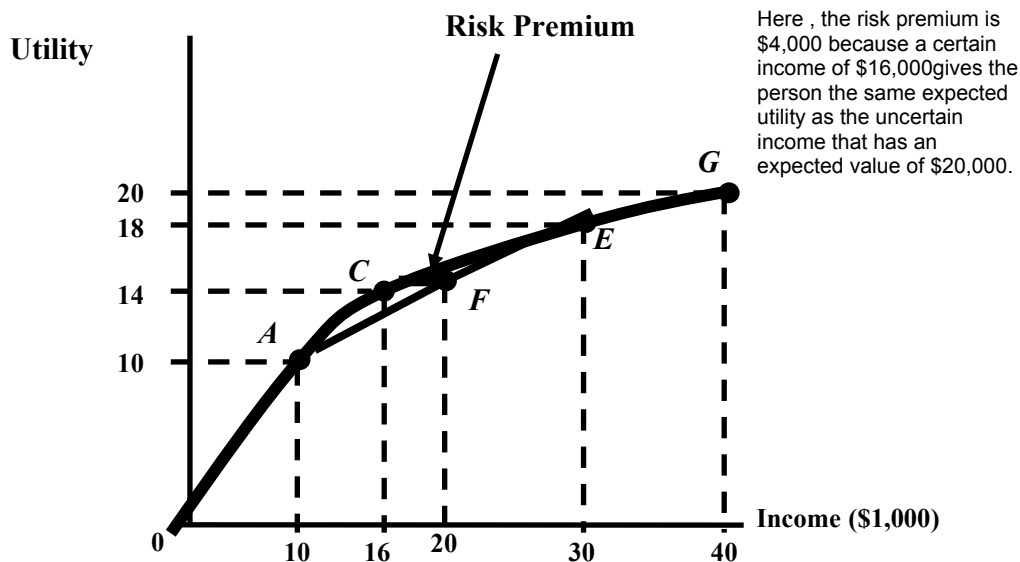 – The expected utility of these two outcomes can be found:
    − E(u) = .5(18) + .5(10) = 14
◆ Question
  – How much would the person pay to avoid risk?

Risk Premium

Risk Premium

Utility

Here , the risk premium is
$4,000 because a certain
income of $16,000gives the
person the same expected
utility as the uncertain
income that has an
expected value of $20,000.

G

20 — — — — — — — — — — — — — — —
18 — — — — — — — — — — — E

C

14 — — — — — — F

A

10 — — —

0   10   16   20   30   40   **Income ($1,000)**

◆ Risk Aversion and Income
  – Variability in potential payoffs increases the risk premium.

- – Example:
    - • A job has a .5 probability of paying $40,000 (utility of 20) and a .5 chance of paying 0 (utility of 0).
- ◆ The expected income is still $20,000, but the expected utility falls to 10.
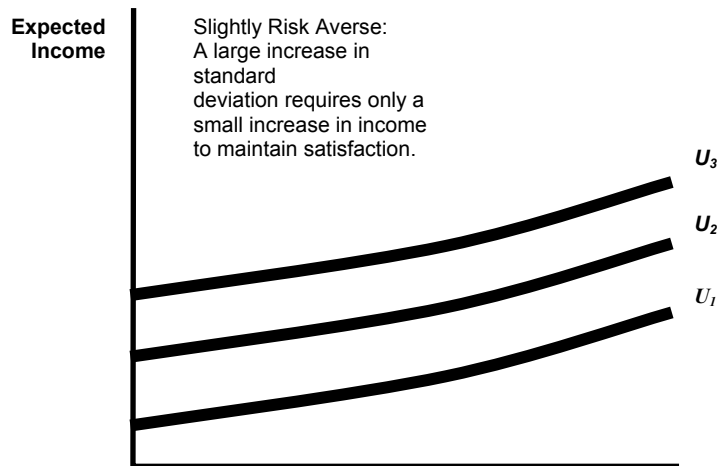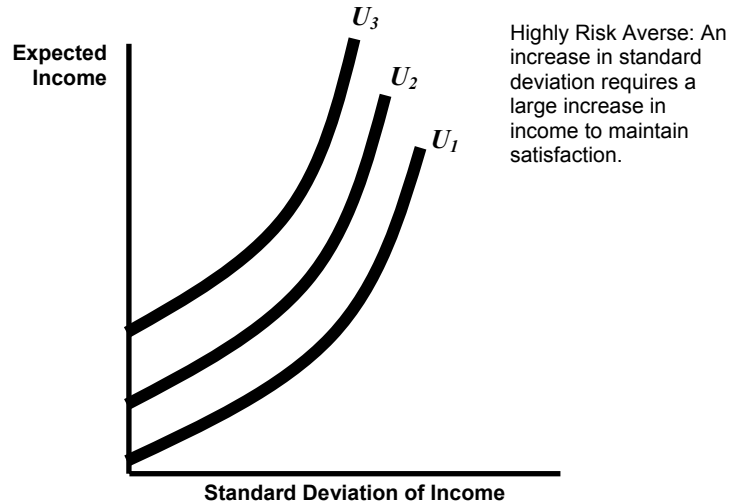- ◆ Expected utility = .5u($) + .5u($40,000)

$$= 0 + .5(20) = 10$$

- ◆ The certain income of $20,000 has a utility of 16.
- ◆ If the person is required to take the new position, their utility will fall by 6.
- ◆ The risk premium is $10,000 (i.e. they would be willing to give up $10,000 of the $20,000 and have the same E(u) as the risky job.
- ◆ Therefore, it can be said that the greater the variability, the greater the risk premium.

- ◆ **Indifference Curve**
    - – Combinations of expected income & standard deviation of income that yield the same utility.

Risk Aversion and Indifference Curves

Expected Income

U_3

U_2

U_1

Highly Risk Averse: An increase in standard deviation requires a large increase in income to maintain satisfaction.

Standard Deviation of Income

Expected Income

Slightly Risk Averse: A large increase in standard deviation requires only a small increase in income to maintain satisfaction.

U_3

U_2

U_1

Business Executives and the Choice of Risk

- Example
  - Study of 464 executives found that:
    - 20% were risk neutral
    - 40% were risk takers
    - 20% were risk averse
    - 20% did not respond
- Those who liked risky situations did so when losses were involved.
- When risks involved gains the same, executives opted for less risky situations.
- The executives made substantial efforts to reduce or eliminate risk by delaying decisions and collecting more information.

◆
LESSON 15

Reducing Risk
◆ Three ways consumers attempt to reduce risk are:

    1) Diversification

    2) Insurance

    3) Obtaining more information
◆ Diversification
– Suppose a firm has a choice of selling air conditioners, heaters, or both.
– The probability of it being hot or cold is 0.5.
– The firm would probably be better off by diversification.

Income from Sales of Appliances

	Hot Weather	Cold Weather
Air conditioner sales	$30,000	$12,000
Heater sales	12,000	30,000

    * 0.5 probability of hot or cold weather
◆ If the firm sells only heaters or air conditioners their income will be either $12,000 or $30,000.
◆ Their expected income would be:
– 1/2($12,000) + 1/2($30,000) = $21,000
◆ If the firm divides their time evenly between appliances their air conditioning and heating sales would be half their original values.
◆ If it were hot, their expected income would be $15,000 from air conditioners and $6,000 from heaters, or $21,000.
◆ If it were cold, their expected income would be $6,000 from air conditioners and $15,000 from heaters, or $21,000.
◆ With diversification, expected income is $21,000 with no risk
◆ Firms can reduce risk by diversifying among a variety of activities that are not closely related.
◆ Stock Market
– How can diversification reduce the risk of investing in the stock market?
– Can diversification eliminate the risk of investing in the stock market?
◆ Insurance
– Risk averse are willing to pay to avoid risk.
– If the cost of insurance equals the expected loss, risk averse people will buy enough insurance to recover fully from a potential financial loss.

The Decision to Insure

Insurance	Burglary (Pr = .1)	No Burglary (Pr = .9)	Expected Wealth	Standard Deviation
No	$40,000	$50,000	$49,000	$9,055
Yes	49,000	49,000	49,000	0

- While the expected wealth is the same, the expected utility with insurance is greater because the marginal utility in the event of the loss is greater than if no loss occurs.
- Purchases of insurance transfers wealth and increases expected utility.
- The Law of Large Numbers
  - Although single events are random and largely unpredictable, the average outcome of many similar events can be predicted.
- Examples
  - A single coin toss vs. large number of coins
  - Whom will have a car wreck vs. the number of wrecks for a large group of drivers
- Assume:
  - 10% chance of a $10,000 loss from a home burglary
  - Expected loss = .10 x $10,000 = $1,000 with a high risk (10% chance of a $10,000 loss)
  - 100 people face the same risk
- Then:
  - $1,000 premium generates a $100,000 fund to cover losses
  - Actuarial Fairness
    - When the insurance premium = expected payout

The Value of Title Insurance When Buying a House
- A Scenario:
  - Price of a house is $200,000
  - 5% chance that the seller does not own the house
- Risk neutral buyer would pay:

$$(.95 [200,000] + .05 [0] = 190,000$$

- Risk averse buyer would pay much less
- By reducing risk, title insurance increases the value of the house by an amount far greater than the premium.
- Value of Complete Information
  - The difference between the expected value of a choice with complete information and the expected value when information is incomplete.
- Suppose a store manager must determine how many fall suits to order:
  - 100 suits cost $180/suit
  - 50 suits cost $200/suit
  - The price of the suits is $300

- Suppose a store manager must determine how many fall suits to order:
  - Unsold suits can be returned for half cost.
  - The probability of selling each quantity is .50.

The Decision to Insure

	Sale of 50	Sale of 100	Expected Profit
1. Buy 50 suits	$5,000	$5,000	$5,000
2. Buy 100 suits	1,500	12,000	6,750

With incomplete information:
- Risk Neutral: Buy 100 suits
- Risk Averse: Buy 50 suits
- The expected value with complete information is $8,500.
  - 8,500 = .5(5,000) + .5(12,000)
- The expected value with uncertainty (buy 100 suits) is $6,750.
- The value of complete information is $1,750, or the difference between the two (the amount the store owner would be willing to pay for a marketing study).
- An Example
  - Per capita packed milk consumption has fallen over the years
  - The milk producers engaged in market research to develop new sales strategies to encourage the consumption of packed milk.
- Findings
  - Packed milk demand is seasonal with the greatest demand in the summer
  - E_p is negative and small
  - E_I is positive and large
- Milk advertising increases sales most in the summer.
- Allocating advertising based on this information in Karachi increased sales by Rs. 400,000 and profits by 9%.
- The cost of the information was relatively low, while the value was substantial.

The Demand for Risky Assets
- Assets
  - Something that provides a flow of money or services to its owner.
    - The flow of money or services can be explicit (dividends) or implicit (capital gain).
- Capital Gain
  - An increase in the value of an asset, while a decrease is a capital loss.
- Risky & Riskless Assets
  - Risky Asset
    - Provides an uncertain flow of money or services to its owner.
    - Examples
      - Apartment rent, capital gains, corporate bonds, stock prices
  - Riskless Asset
    - Provides a flow of money or services that is known with certainty.
    - Examples
      - Short-term government bonds, short-term certificates of deposit

◆ Asset Returns
  – Return on an Asset
    –The total monetary flow of an asset as a fraction of its price.
  – Real Return of an Asset
    –The simple (or nominal) return less the rate of inflation.
◆ Asset Returns

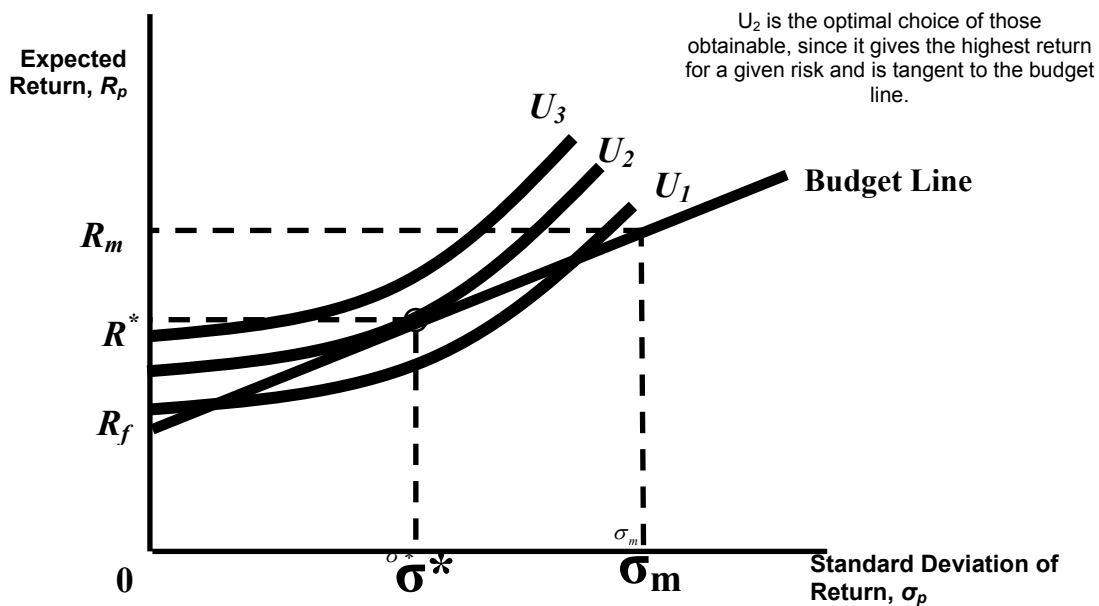$$\text{Asset Return} = \frac{\text{Monetary Flow}}{\text{Purchase Price}}$$

$$\text{Asset Return} = \frac{\text{Flow}}{\text{Bond Price}} = \frac{\$100/\text{yr.}}{\$1,000} = 10\%$$

◆ Expected vs. Actual Returns
  – Expected Return
    • Return that an asset should earn on average
  – Actual Return
    • Return that an asset earns
  – Higher returns are associated with greater risk.
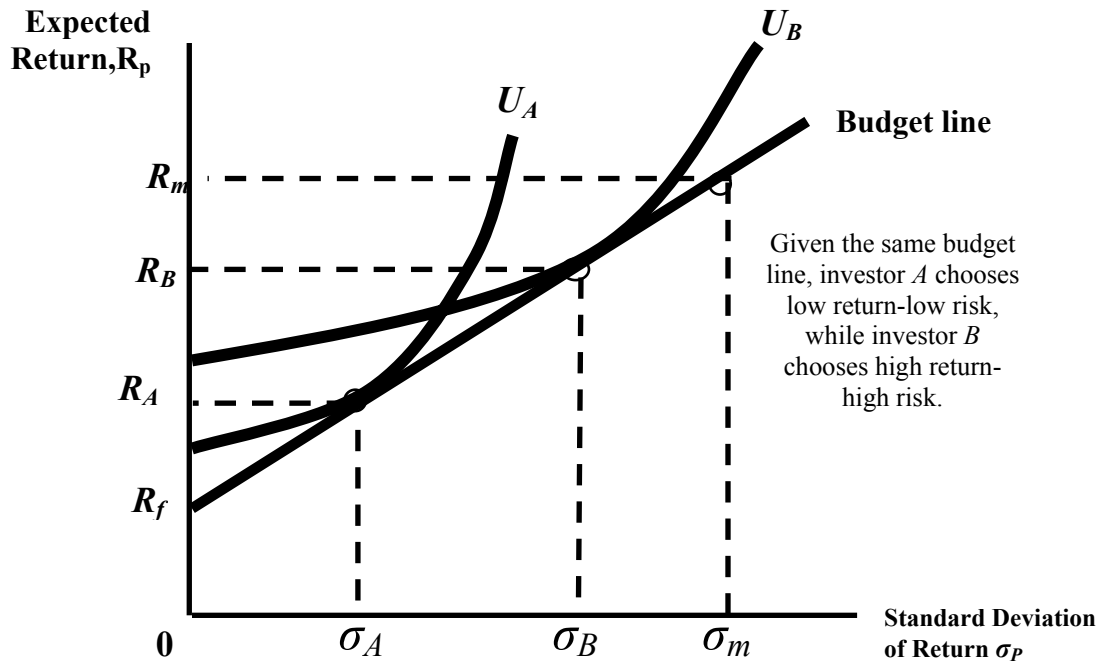 – The risk-averse investor must balance risk relative to return
◆ Risk and Budget Line

  Expected return, R_P, increases as risk increases.

  The slope is the price of risk or the risk-return trade-off.

Choosing Between Risk and Return

U_2 is the optimal choice of those obtainable, since it gives the highest return for a given risk and is tangent to the budget line.

The Choices of Two Different Investors

Given the same budget line, investor *A* chooses low return-low risk, while investor *B* chooses high return-high risk.

Introduction
- Our focus is the supply side.
- The theory of the firm will address:
  - How a firm makes cost-minimizing production decisions
  - How cost varies with output
  - Characteristics of market supply

The Technology of Production
- The Production Process
  - Combining inputs or factors of production to achieve an output
- Categories of Inputs (factors of production)
  - Labor
  - Materials
  - Capital
- Production Function:
  - Indicates the highest output that a firm can produce for every specified combination of inputs given the state of technology.
  - Shows what is technically feasible when the firm operates efficiently.
- The production functions for two inputs:

$$Q = F(K,L)$$

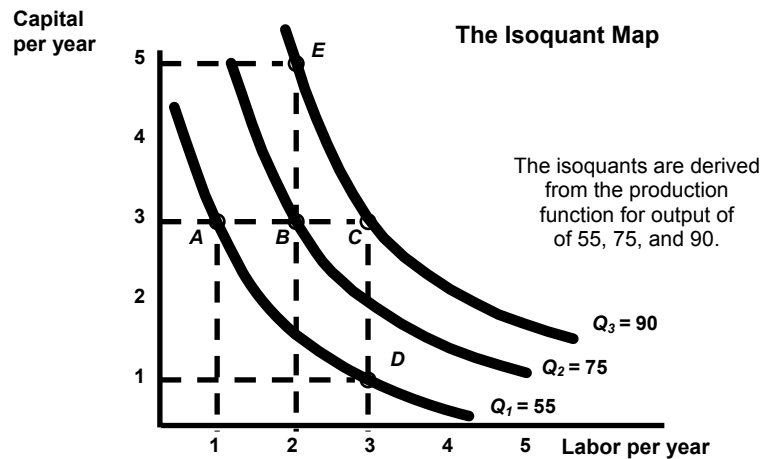Q = Output, K = Capital, L = Labor
- For a given technology

Isoquants
- Assumptions
  - Food producer has two inputs
    - Labor (L) & Capital (K)
- Observations:

  1) For any level of K, output increases with more L.

  2) For any level of L, output increases with more K.

  3) Various combinations of inputs produce the same output.
- Isoquants
  - Curves showing all possible combinations of inputs that yield the same output

Production Function for Food

Labor Input

Capitan Input	1	2	3	4	5
1	20	40	55	65	75
2	40	60	75	85	90
3	55	75	90	100	105
4	65	85	100	110	115
5	75	90	105	115	120

Production with Two Variable Inputs (*L,K*)

The Isoquant Map

The isoquants are derived from the production function for output of of 55, 75, and 90.

$Q_3 = 90$

$Q_2 = 75$

$Q_1 = 55$

- Input Flexibility
  - The isoquants emphasize how different input combinations can be used to produce the same output.
  - This information allows the producer to respond efficiently to changes in the markets for inputs.

- The Short Run vs. long Run
  - Short-run:
    - Period of time in which quantities of one or more production factors cannot be changed.
    - These inputs are called fixed inputs.
  - Long-run
    - Amount of time needed to make all production inputs variable.

Production with One Variable Input (Labor)

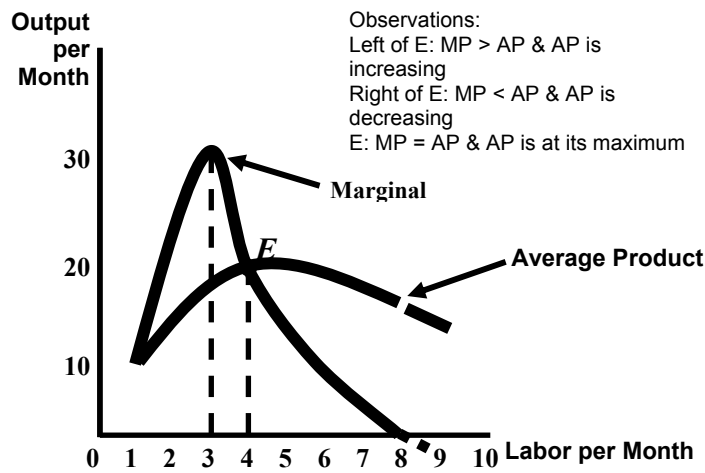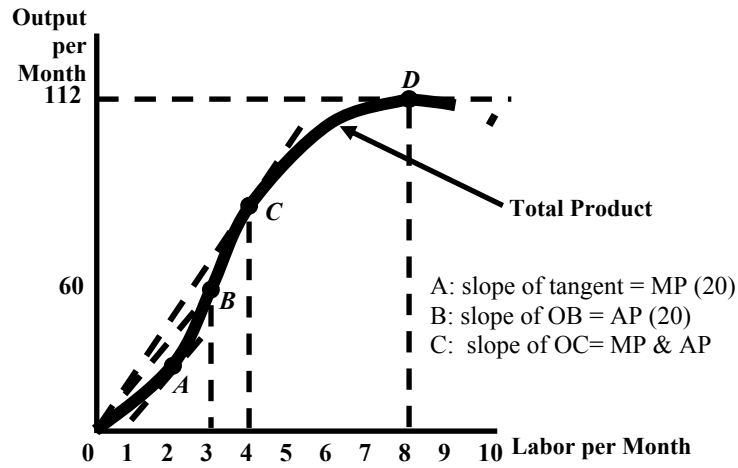| Amount of Labor (L)	Amount of Capital (K)	Total Output (Q)	Average Product	Marginal Product
0	10	0	---	---
1	10	10	10	10
2	10	30	15	20
3	10	60	20	30
4	10	80	20	20
5	10	95	19	15
6	*10*	*108*	*18*	*13*
7	10	112	16	4
8	10	112	14	0
9	10	108	12	-4
10	10	100	10	-8

◆ Observations:

1) With additional workers, output (Q) increases, reaches a maximum, and   then decreases.

2) The average product of labor (AP), or output per worker, increases and   then decreases.

$$AP = \frac{Output}{Labor\ \ Input} = \frac{Q}{L}$$

3) The marginal product of labor (MP), or output of the additional worker,
   increases rapidly initially and then decreases and becomes negative..

$$MP_L = \frac{\Delta Output}{\Delta Labor\ Input} = \frac{\Delta Q}{\Delta L}$$

A: slope of tangent = MP (20)
B: slope of OB = AP (20)
C: slope of OC= MP & AP

Observations:
Left of E: MP > AP & AP is increasing
Right of E: MP < AP & AP is decreasing
E: MP = AP & AP is at its maximum

- Observations:
  – When MP = 0, TP is at its maximum
  – When MP > AP, AP is increasing
  – When MP < AP, AP is decreasing
  – When MP = AP, AP is at its maximum

AP = slope of line from origin to a point on *TP*, lines *b, & c.*
MP = slope of a tangent to any point on the *TP* line, lines a & c.
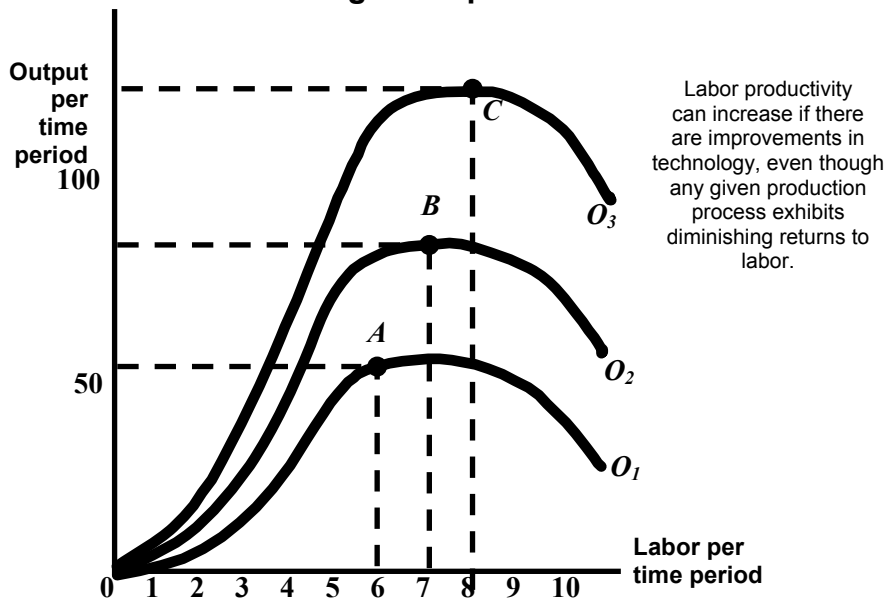
♦ **The Law of Diminishing Marginal Returns**
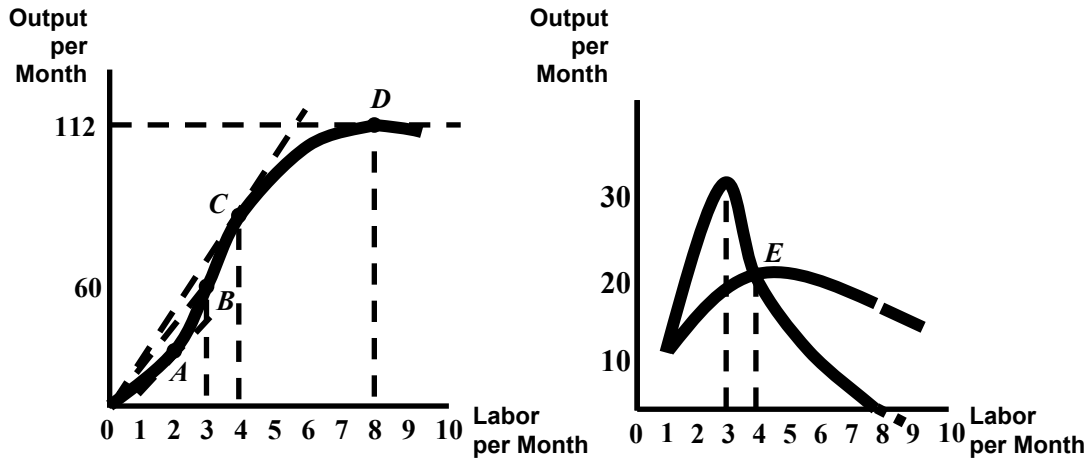
– As the use of an input increases in equal increments, a point will be reached at which the resulting additions to output decreases (i.e. MP declines).
– When the labor input is small, MP increases due to specialization.
– When the labor input is large, MP decreases due to inefficiencies.
♦ The Law of Diminishing Marginal Returns
  – Can be used for long-run decisions to evaluate the trade-offs of different plant configurations
  – Assumes the quality of the variable input is constant
  – Explains a declining *MP*, not necessarily a negative one
  – Assumes a constant technology

The Effect of Technological Improvement

Labor productivity can increase if there are improvements in technology, even though any given production process exhibits diminishing returns to labor.

Malthus and the Food Crisis

- Malthus predicted mass hunger and starvation as diminishing returns limited agricultural output and the population continued to grow.
- Why did Malthus' prediction fail?

Index of World Food Consumption Per Capita

Year	Index
1948-1952	100
1960	115
1970	123
1980	128
1990	137
1995	135
1998	140

- The data show that production increases have exceeded population growth.
- Malthus did not take into consideration the potential impact of technology which has allowed the supply of food to grow faster than demand.
- Technology has created surpluses and driven the price down.
- Question
  - If food surpluses exist, why is there hunger?
- Answer
  - The cost of distributing food from productive regions to unproductive regions and the low income levels of the non-productive regions.
- Labor Productivity

$$\text{Average Productivity} = \frac{\text{Total Output}}{\text{Total Labor Input}}$$

- Labor Productivity and the Standard of Living
  - Consumption can increase only if productivity increases.
  - Determinants of Productivity
    - Stock of capital
    - Technological change

Labor Productivity in Developed Countries

	France	Germany	Japan	United Kingdom	United States
Output per Employed Person (1997)					
	$54,507	$55,644	$46,048	$42,630	$60,915
Annual Rate of Growth of Labor Productivity (%)					
1960-1973	4.75	4.04	8.30	2.89	2.36
1974-1986	2.10	1.85	2.50	1.69	0.71
1987-1997	1.48	2.00	1.94	1.02	1.09

◆ Trends in Productivity

    1) U.S. productivity is growing at a slower rate than other countries.

    2) Productivity growth in developed countries has been decreasing.

◆ Explanations for Productivity Growth Slowdown

    1) Growth in the stock of capital is the primary determinant of the growth in productivity.

    2) Rate of capital accumulation in the U.S. was slower than other developed countries because the   others were rebuilding after WWII.

    3) Depletion of natural resources

    4) Environment regulations

Production with Two Variable Inputs
* There is a relationship between production and productivity.
* Long-run production K& L are variable.
* Isoquants analyze and compare the different combinations of K & L and output
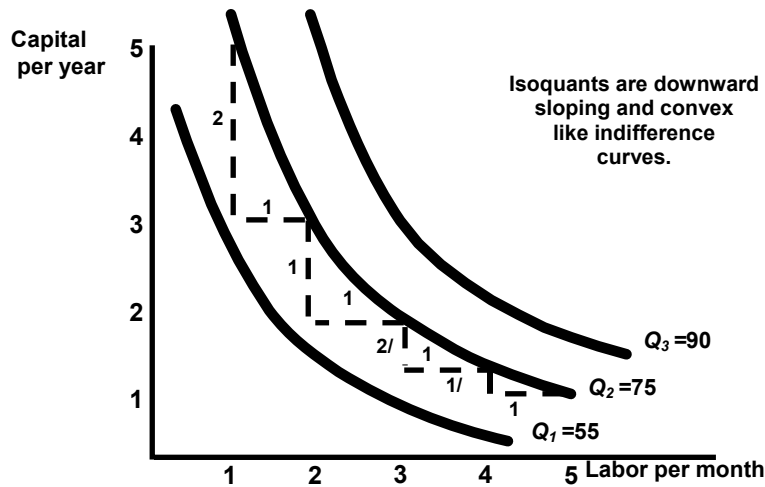
The Shape of Isoquants
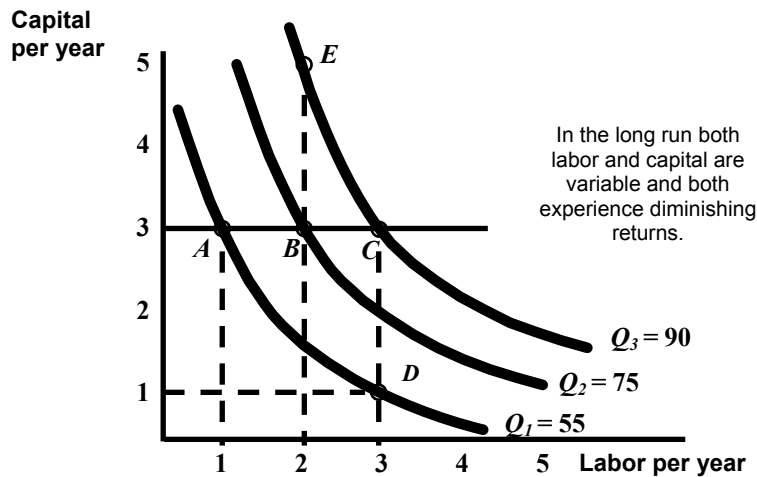
* Diminishing Marginal Rate of Substitution
  - Reading the Isoquant Model
    1) Assume capital is 3 and labor increases from 0 to 1 to 2 to 3.
       - Notice output increases at a decreasing rate (55, 20, 15) illustrating diminishing returns from labor in the short-run and long-run.
    2) Assume labor is 3 and capital increases from 0 to 1 to 2 to 3.
       - Output also increases at a decreasing rate (55, 20, 15) due to diminishing returns from capital.
* Substituting Among Inputs
  - Managers want to determine what combination if inputs to use.
  - They must deal with the trade-off between inputs.
  - The slope of each isoquant gives the trade-off between two inputs while keeping output constant.
  - The marginal rate of technical substitution equals:

$$MRTS = - \text{Change in capital/Change in labor input}$$

$$MRTS = {}^{-}\Delta K \big/ \Delta L \text{ (for a fixed level of } Q)$$

Marginal Rate of Technical Substitution

Capital per year plot with axes; curves labeled $Q_3 = 90$, $Q_2 = 75$, $Q_1 = 55$.

Text annotation: **Isoquants are downward sloping and convex like indifference curves.**

X-axis: **Labor per month** (1, 2, 3, 4, 5)

- Observations:

   1. Increasing labor in one unit increments from 1 to 5 results in a decreasing MRTS from 1 to 1/2.

   2. Diminishing MRTS occurs because of diminishing returns and implies isoquants are convex.

MRTS and Marginal Productivity

- The change in output from a change in labor equals:

$$(MP_L)(\Delta L)$$
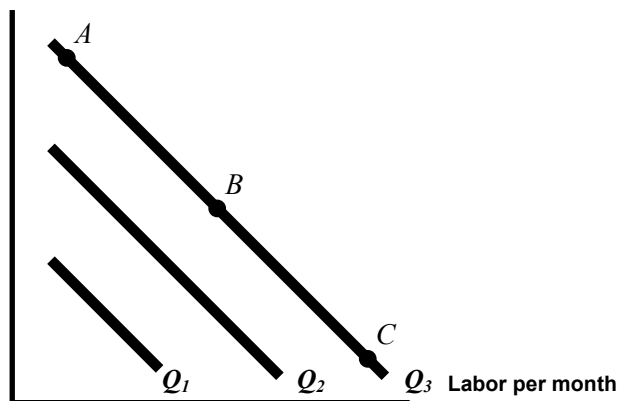
- The change in output from a change in capital equals:

$$(MP_K)(\Delta K)$$

- If output is constant and labor is increased, then:

$$(MP_L)(\Delta L) + (MP_K)(\Delta K) = 0$$

$$(MP_L)(MP_K) = - (\Delta K/\Delta L) = MRTS$$

Isoquants When Inputs are perfectly substitutable

Graph with lines labeled at points A, B, C; curves labeled Q_1, Q_2, Q_3.

X-axis: **Labor per month**

 ◆ Perfect Substitute
 ◆ Observations when inputs are perfectly substitutable:

   1) The MRTS is constant at all points on the isoquant.

   2) For a given output, any combination of inputs can be chosen (A, B, or C) to
   generate the same level of output (e.g. toll booths & musical instruments).
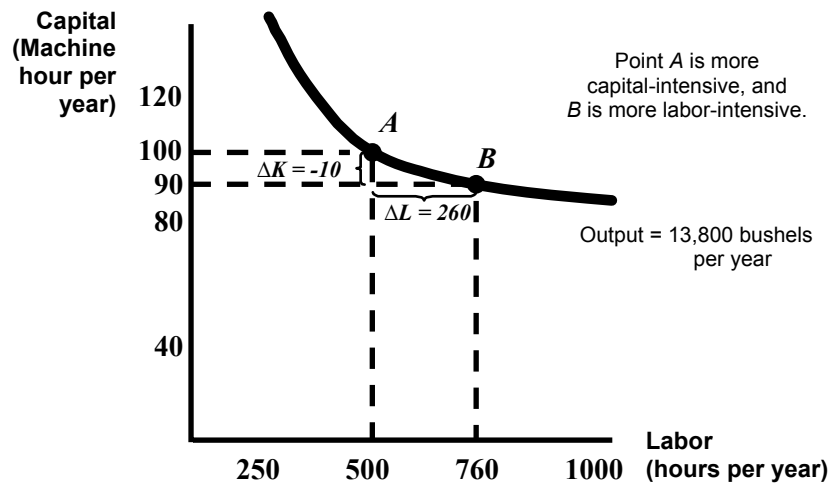
Fixed-Proportions Production Function
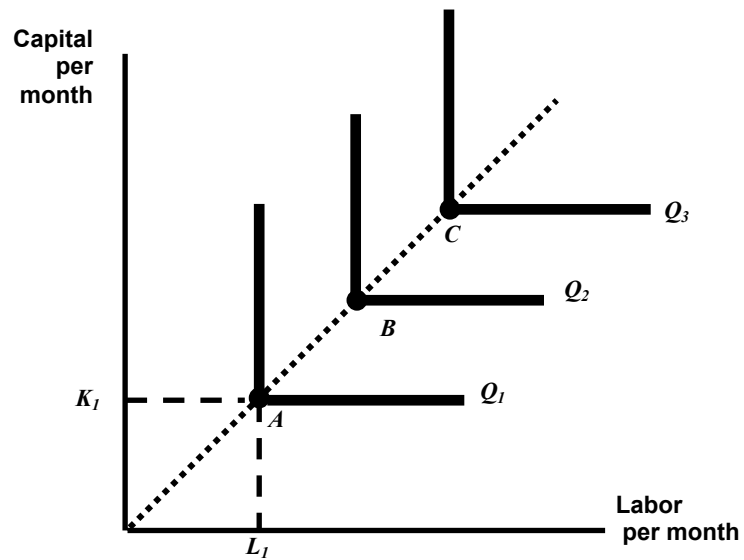
Fixed-Proportions Production Function
 – Observations when inputs must be in a fixed-proportion:
   1) No substitution is possible. Each output requires a specific amount of each input
   (e.g. labor and jackhammers).
   2)To increase output requires more labor and capital (i.e. moving from A to B to C
   which is technically efficient).

A Production Function for Wheat
 ◆ Farmers must choose between a capital intensive or labor intensive technique of
   production.

Isoquant Describing the Production of Wheat

Capital
(Machine
hour per
year)

120

A

100
90
$\Delta K = -10$
B
80
$\Delta L = 260$

Output = 13,800 bushels
per year

Point *A* is more
capital-intensive, and
B is more labor-intensive.

40

Labor

250   500   760   1000   (hours per year)

◆ Observations:

1) Operating at A:

● L = 500 hours and K = 100 machine hours.

2) Operating at B

● Increase L to 760 and decrease K to 90 the MRTS < 1:
$$MRTS = \frac{-\Delta K}{\Delta L} = -(10/260) = 0.04$$

3) MRTS < 1, therefore the cost of labor must be less than capital in order for the farmer substitute labor for capital.

4) If labor is expensive, the farmer would use more capital (e.g. U.S.).

5) If labor is inexpensive, the farmer would use more labor (e.g. India).

Returns to Scale

Measuring the relationship between the scale (size) of a firm and output

1. <u>**Increasing returns to scale**</u>: output more than doubles when all inputs are doubled
   – Larger output associated with lower cost (autos)
   – One firm is more efficient than many (utilities)
   – The isoquants get closer together

Capital
(machine
hours)

Increasing Returns:
The isoquants move closer
together

A

4

30

2

20

10

Labor (hours)

0   5   10
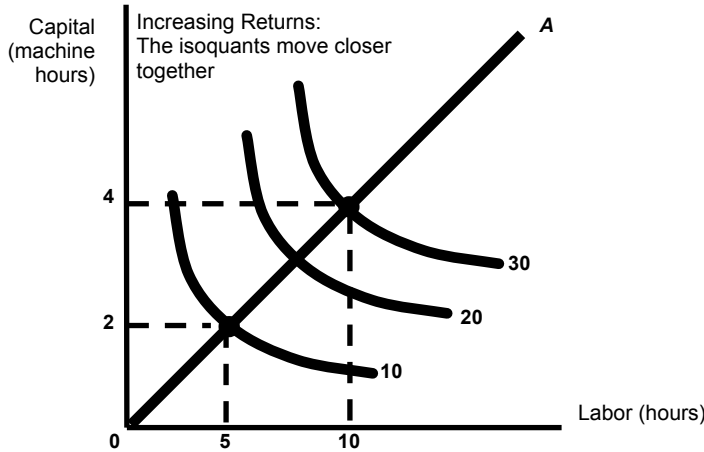
2. <u>**Constant returns to scale**</u>: output doubles when all inputs are doubled.
   • Size does not affect productivity
   • May have a large number of producers
   • Isoquants are equidistant apart

Capital
(machine
hours)

<u>**Decreasing returns to scale**</u>: output less than doubles when all inputs are doubled

A

30

4

Constant Returns:
Isoquants are
equally spaced

20

2

10

Labor (hours)

0   5   10   15
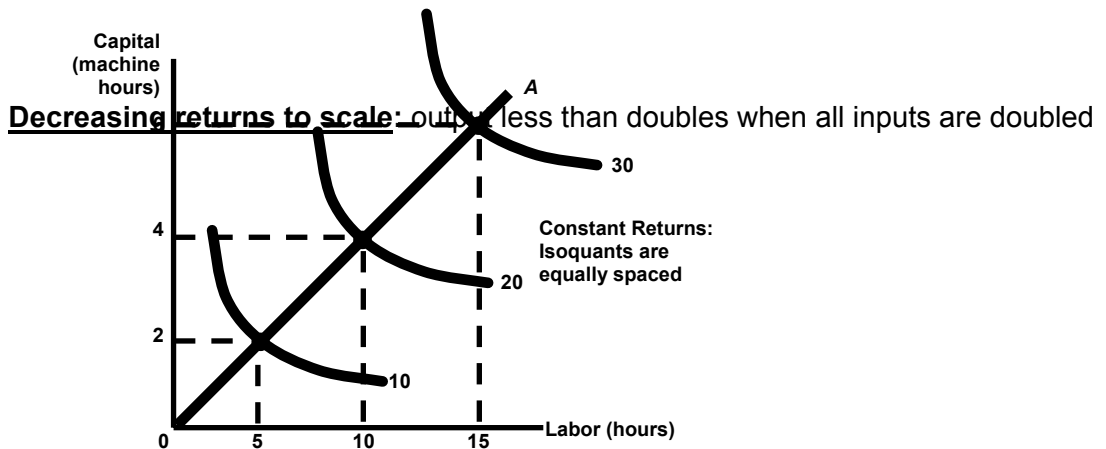
3. **Decreasing returns to scale:** output less than doubles when all inputs are doubled

- Decreasing efficiency with large size
- Reduction of entrepreneurial abilities
- Isoquants become farther apart
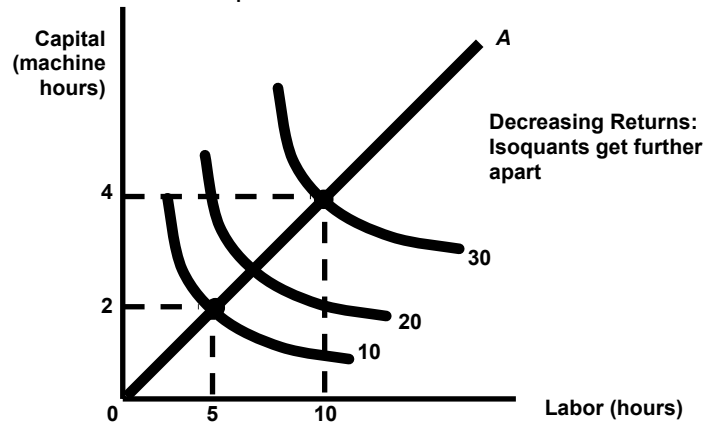
Returns to Scale in the Carpet Industry
- The carpet industry has grown from a small industry to a large industry with some very large firms.
- Question
  - Can the growth be explained by the presence of economies to scale?

The U.S. Carpet Industry
Carpet Shipments, 1996
(Millions of Dollars per Year)

1. Shaw Industries	$3,202	6. World Carpets	$475
2. Mohawk Industries	1,795	7. Burlington Industries	450
3. Beaulieu of America	1,006	8. Collins & Aikman	418
4. Interface Flooring	820	9. Masland Industries	380
5. Queen Carpet	775	10. Dixied Yarns	280

- Are there economies of scale?
  - Costs (percent of cost)
    - Capital -- 77%
    - Labor -- 23%
- Large Manufacturers
  - Increased in machinery & labor
  - Doubling inputs has more than doubled output
  - Economies of scale exist for large producers
- Small Manufacturers
  - Small increases in scale have little or no impact on output
  - Proportional increases in inputs increase output proportionally

– Constant returns to scale for small producers

–

LESSON 18

Introduction

◆The production technology measures the relationship between input and output.
◆Given the production technology, managers must choose how to produce.
◆To determine the optimal level of output and the input combinations, we must convert from the unit measurements of the production technology to dollar measurements or costs.

Measuring Cost: Which Costs Matter?

◆Accounting Cost vs. Economic Cost
    – Accounting Cost

        • Actual expenses plus depreciation charges for capital equipment
    – Economic Cost

        • Cost to a firm of utilizing economic resources in production, including opportunity cost
◆Opportunity cost.
    – Cost associated with opportunities that are foregone when a firm's resources are not put to their highest-value use.
◆An Example
    – A firm owns its own building and pays no rent for office space
    – Does this mean the cost of office space is zero?
◆Sunk Cost
    – Expenditure that has been made and cannot be recovered
    – Should not influence a firm's decisions.
◆An Example
    – A firm pays $500,000 for an option to buy a building.
    – The cost of the building is $5 million or a total of $5.5 million.
    – The firm finds another building for $5.25 million.
    – Which building should the firm buy?
◆Fixed and Variable Costs
    – Total output is a function of variable inputs and fixed inputs.
    – Therefore, the total cost of production equals the fixed cost (the cost of the fixed inputs) plus the variable cost (the cost of the variable inputs), or…

    – Fixed Cost $$TC = FC + VC$$

        • Does not vary with the level of output
    – Variable Cost

        • Cost that varies as output varies
◆Fixed Cost
    – Cost paid by a firm that is in business regardless of the level of output
◆Sunk Cost
    – Cost that have been incurred and cannot be recovered
◆Personal Computers: most costs are variable
    – Components, labor
◆Software: most costs are sunk
    – Cost of developing the software

◆Pizza
  – Largest cost component is fixed

A Firm's Short-Run Costs ($)

Rate of output	Fixed cost FC	Variable cost VC	Total cost TC	Marginal cost MC	Average fixed cost AFC	Average variable cost AVC	Average total cost ATC
0	50	0	50				
1	50	50	100	50	50	50	100
2	50	78	128	28	25	39	64
3	50	98	148	20	16.5	32.7	49.3
4	50	112	162	14	12.5	28	40.5
5	50	130	180	18	10	26	36
6	50	150	200	20	8.3	25	33.3
7	50	175	225	25	7.1	25	32.1
8	50	204	254	29	6.3	25.5	31.8
9	50	242	292	38	5.6	26.9	32.4
10	50	300	350	58	5	30	35
11	50	385	435	85	4.5	35	39.5

Cost in the Short Run

◆Marginal Cost (MC) is the cost of expanding output by one unit. Since fixed costs have no impact on marginal cost, it can be written as:

$$MC = \frac{\Delta\ VC}{\Delta\ Q} = \frac{\Delta\ TC}{\Delta\ Q}$$

◆Average Total Cost (ATC) is the cost per unit of output, or average fixed cost (AFC) plus average variable cost (AVC). This can be written:

$$ATC = \frac{TFC}{Q} + \frac{TVC}{Q}$$

◆Average Total Cost (ATC) is the cost per unit of output, or average fixed cost (AFC) plus average variable cost (AVC). This can be written:

◆ $$ATC = AFC + AVC \quad or \quad \frac{TC}{Q}$$

◆The Determinants of Short-Run Cost
  – The relationship between the production function and cost can be exemplified by either increasing returns and cost or decreasing returns and cost.
  – Increasing returns and cost
•With increasing returns, output is increasing relative to input and variable cost and total cost will fall relative to output.
  – Decreasing returns and cost
•With decreasing returns, output is decreasing relative to input and variable cost and total cost will rise relative to output.
◆For Example: Assume the wage rate (w) is fixed relative to the number of workers hired. Then:

$$MC = \frac{\Delta VC}{\Delta Q}$$

$$VC = w\text{L}$$

$$MC = \frac{w\Delta\text{L}}{\Delta\text{Q}}$$

$$\Delta MP_\text{L} = \frac{\Delta Q}{\Delta\text{L}}$$

$$\Delta\text{L for a 1 unit } \Delta\text{Q} = \frac{\Delta\text{L}}{\Delta\text{Q}} = \frac{1}{\Delta MP_\text{L}}$$

◆In conclusion:

$$MC = \frac{w}{MP_\text{L}}$$

A Firm's Short-Run Costs ($)

Rate of output	Fixed cost FC	Variable cost VC	Total cost TC	Marginal cost MC	Average fixed cost AFC	Average variable cost AVC	Average total cost ATC
0	50	0	50				
1	50	50	100	50	50	50	100
2	50	78	128	28	25	39	64
3	50	98	148	20	16.5	32.7	49.3
4	50	112	162	14	12.5	28	40.5
5	50	130	180	18	10	26	36
6	50	150	200	20	8.3	25	33.3
7	50	175	225	25	7.1	25	32.1
8	50	204	254	29	6.3	25.5	31.8
9	50	242	292	38	5.6	26.9	32.4
10	50	300	350	58	5	30	35
11	50	385	435	85	4.5	35	39.5

- ◆ Consequently (from the table):
  - – MC decreases initially with increasing returns
    - • 0 through 4 units of output
  - – MC increases with decreasing returns
    - • 5 through 11 units of output
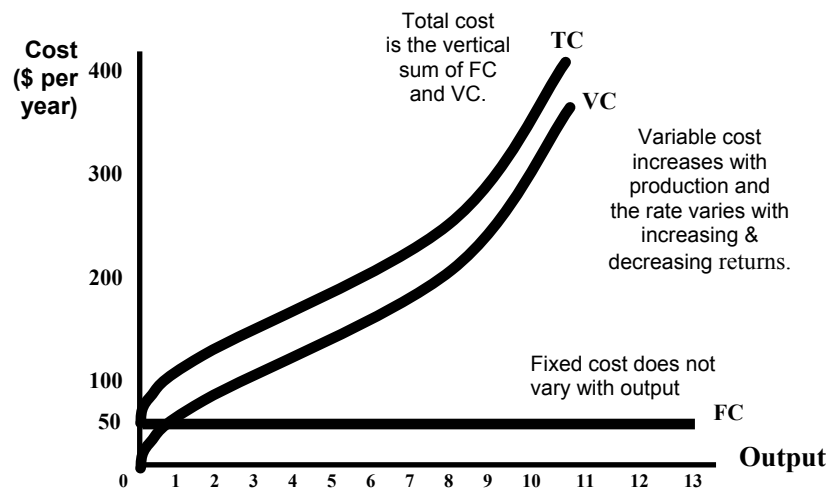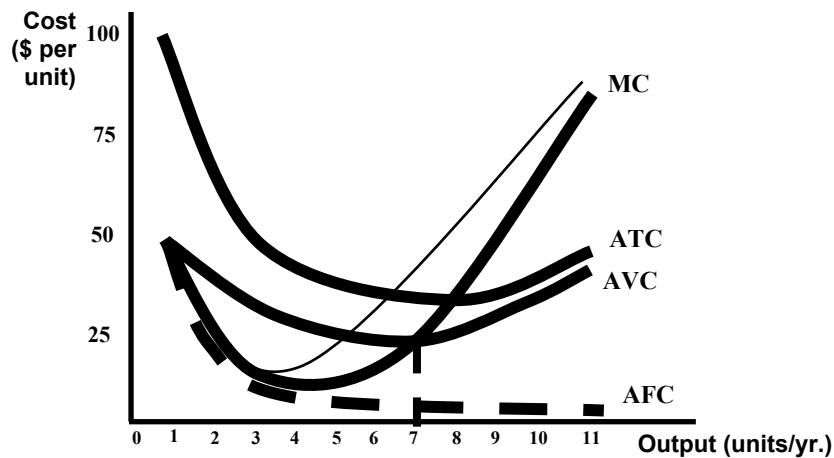
◆   The line drawn from the origin to the tangent of the variable cost curve:

   —   Its slope equals AVC

   —   The slope of a point on VC equals MC

   —   Therefore, MC = AVC at 7 units of output (point A)

◆   Unit Costs

   —   AFC falls continuously

   —   When MC < AVC or MC < ATC, AVC & ATC decrease

   —   When MC > AVC or MC > ATC, AVC & ATC increase

   —   MC = AVC and ATC at minimum AVC and ATC

   —   Minimum AVC occurs at a lower output than minimum ATC due to FC

◆ The User Cost of Capital
◆ User Cost of Capital = Economic Depreciation + (Interest Rate)(Value of Capital)
  – Example
     • An Airline buys a Boeing 737 for $150 million with an expected life of 30 years
       – Annual economic depreciation = $150 million/30 = $5 million
       – Interest rate = 10%

     • User Cost of Capital = $5 million + (.10) ($150 million – depreciation)
       – Year 1 = $5 million + (.10)($150 million) = $20 million
       – Year 10 = $5 million + (.10) ($100 million) = $15 million
  – Rate per dollar of capital

     • r = Depreciation Rate + Interest Rate
  – Airline Example

     • Depreciation Rate = 1/30 = 3.33/yr

     • Rate of Return = 10%/yr
  – User Cost of Capital

     • r = 3.33 + 10 = 13.33%/yr

◆ The Cost Minimizing Input Choice
- – Assumptions
  - • Two Inputs: Labor (L) & capital (K)
  - • Price of labor: wage rate (w)
  - • The price of capital
    - – R = depreciation rate + interest rate
- – Question
  - • If capital was rented, would it change the value of r ?

◆ The Isocost Line
- – $C = wL + rK$
- – Isocost: A line showing all combinations of L & K that can be purchased for the same cost
- – Rewriting C as linear:
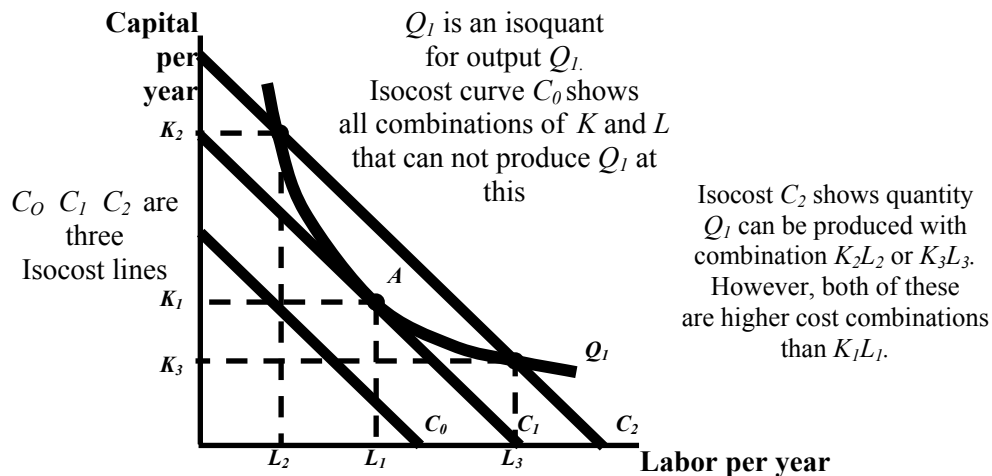 - • K = C/r - (w/r)L
  - • Slope of the Isocost:

$$\Delta K \Big/ \Delta L = -\left(w \Big/ r \right)$$

  - ▪ is the ratio of the wage rate to rental cost of capital.
  - ▪ This shows the rate at which capital can be substituted for labor with no change in cost.
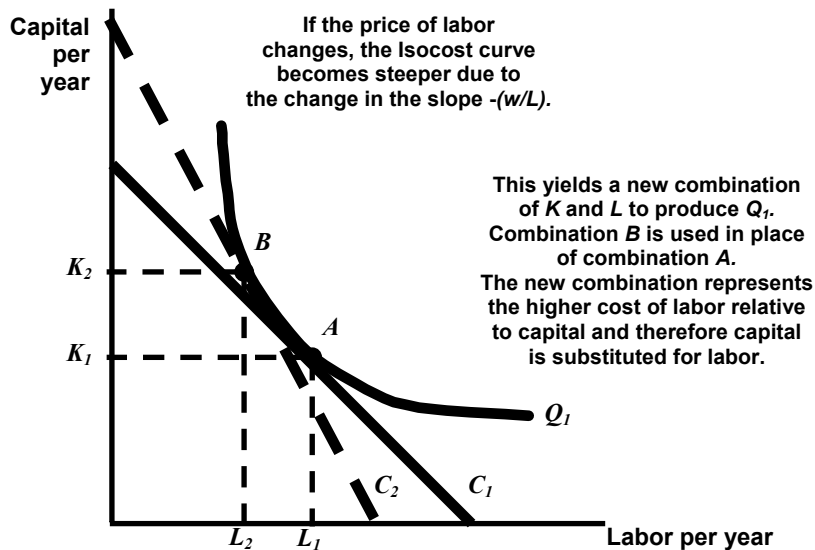
Choosing Inputs
- • We will address how to minimize cost for a given level of output.
- • We will do so by combining Isocosts with Isoquants

Producing a Given Output at Minimum Cost

Q_1 is an isoquant
for output Q_1.
Isocost curve C_0 shows
all combinations of K and L
that can not produce Q_1 at
this

Isocost C_2 shows quantity
Q_1 can be produced with
combination K_2L_2 or K_3L_3.
However, both of these
are higher cost combinations
than K_1L_1.

C_O C_1 C_2 are
three
Isocost lines

Input Substitution When an Input Price Change

♦ Isoquants and Isocosts and the Production Function

Capital per year (vertical axis), **Labor per year** (horizontal axis)

If the price of labor changes, the Isocost curve becomes steeper due to the change in the slope -(w/L).

This yields a new combination of *K* and *L* to produce *Q₁*. Combination *B* is used in place of combination *A*. The new combination represents the higher cost of labor relative to capital and therefore capital is substituted for labor.

$$\text{MRTS} = \frac{-\Delta K}{\Delta L} = \frac{\text{MP}_L}{\text{MP}_K}$$

$$\text{Slope of isocost line} = \frac{\Delta K}{\Delta L} = -\frac{w}{r}$$

$$\text{and} = \frac{MP_L}{MP_K} = \frac{w}{r}$$

♦ The minimum cost combination can then be written as:

$$\frac{\text{MP}_L}{w} = \frac{\text{MP}_K}{r}$$

– Minimum cost for a given output will occur when each dollar of input added to the production process will add an equivalent amount of output.

♦ Question
  – If w = $10, r = $2, and $MP_L = MP_K$, which input would the producer use more of? Why?

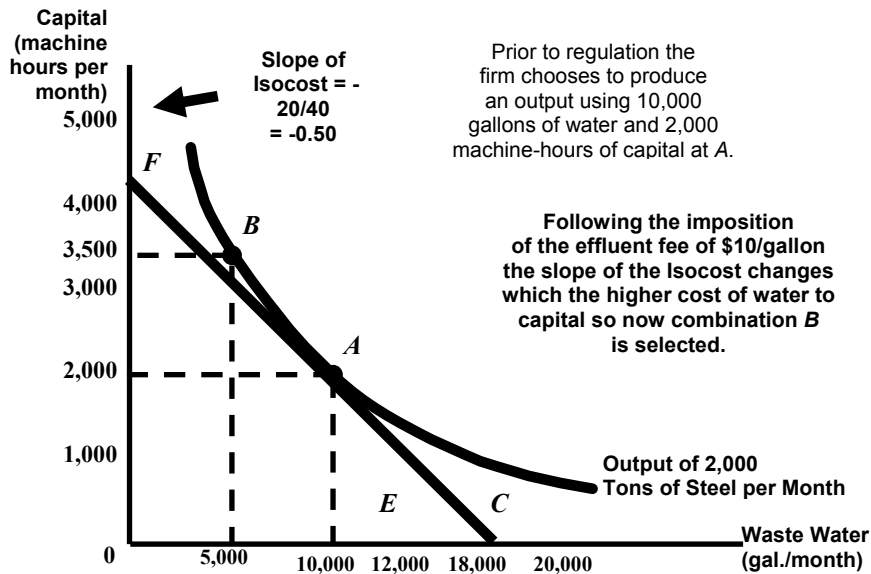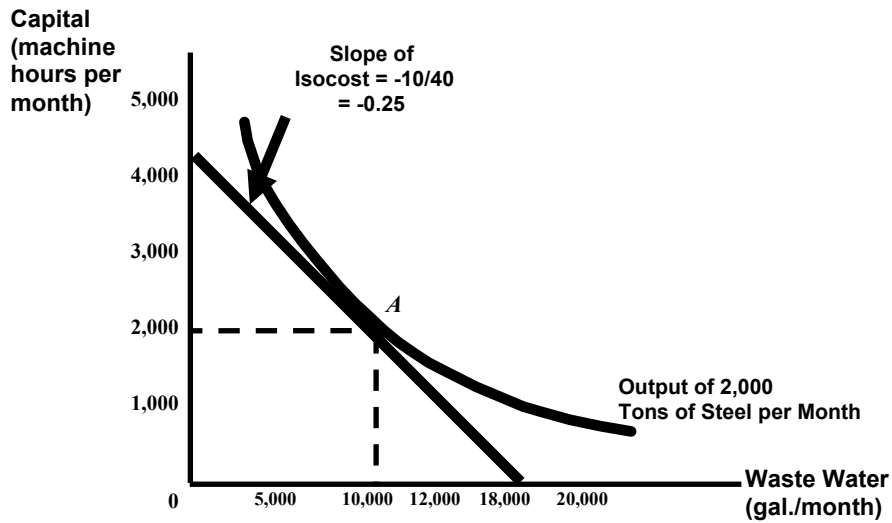**The Effect of Effluent Fees on Firms' Input Choices**

The Effect of Effluent Fees on Firms' Input Choices

♦ Firms that have a by-product to production produce an effluent.
♦ An effluent fee is a per-unit fee that firms must pay for the effluent that they emit.
♦ How would a producer respond to an effluent fee on production?

♦ The Scenario: Steel Producer

1) Located on a river: Low cost transportation and emission disposal   (effluent).

2) EPA imposes a per unit effluent fee to reduce the environmentally harmful effluent.

3) How should the firm respond?

The Cost-Minimizing Response to an Effluent Fee

Capital (machine hours per month)

Slope of
Isocost = -10/40
= -0.25

5,000

4,000

3,000

2,000 — — — — — — *A*

Output of 2,000
Tons of Steel per Month

1,000

0   5,000   10,000 12,000 18,000   20,000   **Waste Water (gal./month)**

Capital (machine hours per month)

Slope of
Isocost = -
20/40
= -0.50

5,000

F

Prior to regulation the firm chooses to produce an output using 10,000 gallons of water and 2,000 machine-hours of capital at *A*.

4,000

B

3,500

3,000

Following the imposition of the effluent fee of $10/gallon the slope of the Isocost changes which the higher cost of water to capital so now combination *B* is selected.

A

2,000 — — — — — —

1,000

E   *C*

Output of 2,000
Tons of Steel per Month

0   5,000   10,000 12,000 18,000   20,000   **Waste Water (gal./month)**

◆ Observations:
  – The more easily factors can be substituted; the more effective the fee is in reducing the effluent.
The greater the degree of substitutes, the less the firm will have to pay (e.g.: $50,000 with combination B instead of $100,000 with combination A).
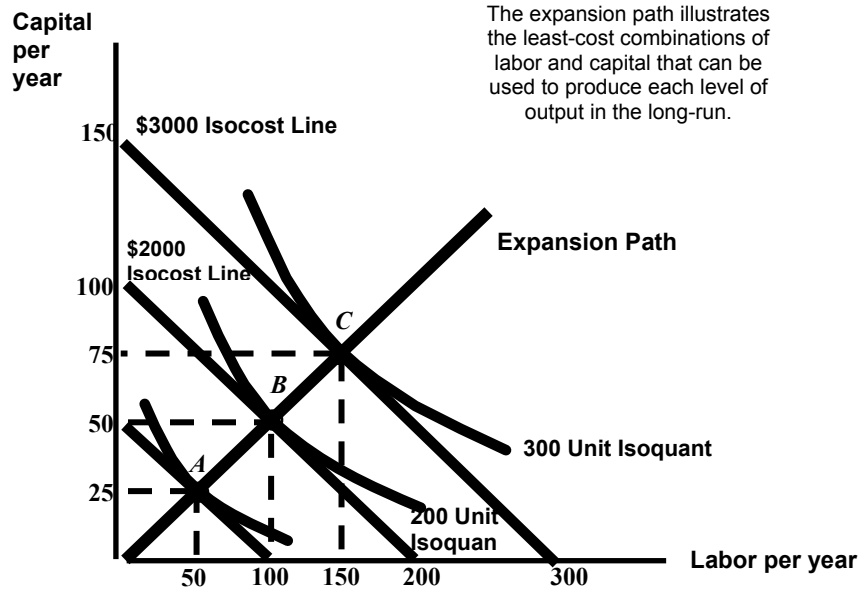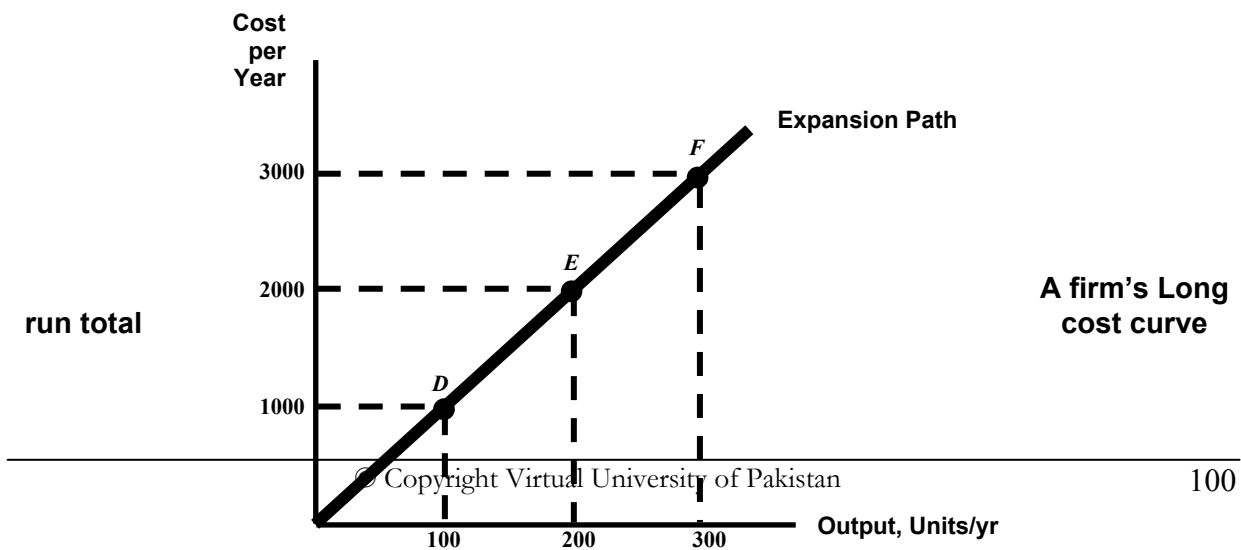
Cost in the Long Run

◆Cost minimization with Varying Output Levels

─A firm's expansion path shows the minimum cost combinations of labor and capital at each level of output.

A Firm's

Capital per year

The expansion path illustrates the least-cost combinations of labor and capital that can be used to produce each level of output in the long-run.

150 **$3000 Isocost Line**

Expansion Path

$2000 Isocost Line

100

75

C

B

50

300 Unit Isoquant

A

25

200 Unit Isoquan

50   100   150   200   300

Labor per year

Expansion Path

Cost per Year

Expansion Path

F

3000

E

A firm's Long

2000

run total   **cost curve**

D

1000

100   200   300

Output, Units/yr

Long-Run Versus Short-Run Cost Curves

◆What happens to average costs when both inputs are variable (long run) versus only having one input that is variable (short run)?

The Inflexibility of Short-Run Production
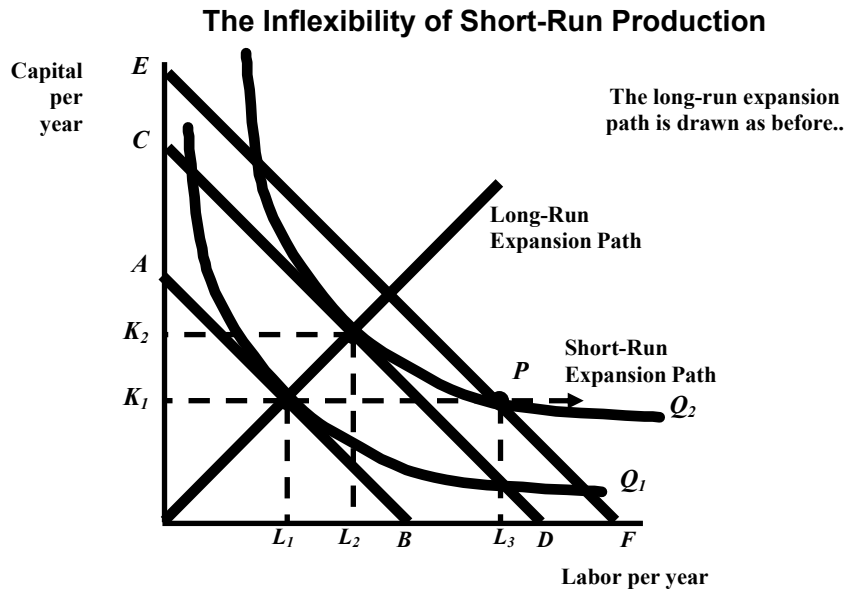
◆Long-Run Average Cost (LAC)

—Constant Returns to Scale

•If input is doubled, output will double and average cost is constant at all levels of output.

—Increasing Returns to Scale

•If input is doubled, output will more than double and average cost decreases at all levels of output.

—Decreasing Returns to Scale

•If input is doubled, the increase in output is less than twice as large and average cost increases with output.

—In the long-run:

•Firms experience increasing and decreasing returns to scale and therefore long-run average cost is "U" shaped.

—Long-run marginal cost leads long-run average cost:

•If LMC < LAC, LAC will fall

•If LMC > LAC, LAC will rise

•Therefore, LMC = LAC at the minimum of LAC

Long-Run Average and Marginal Cost
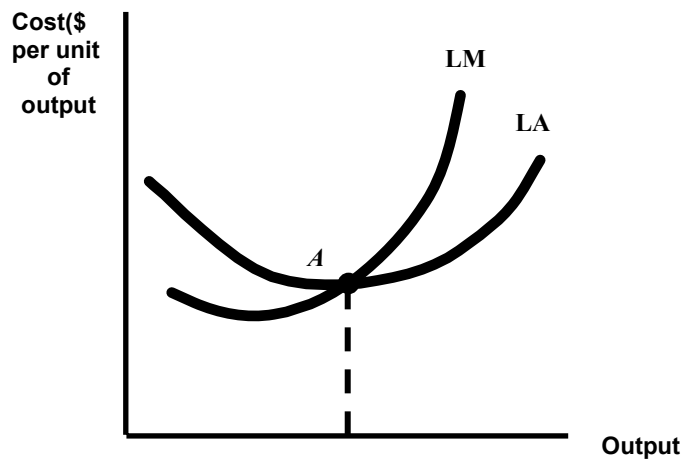
◆Question

–What is the relationship between long-run average cost and long-run marginal cost when long-run average cost is constant?

◆Economies and Diseconomies of Scale

–Economies of Scale

•Increase in output is greater than the increase in inputs.

–Diseconomies of Scale

•Increase in output is less than the increase in inputs.

◆Measuring Economies of Scale

$$E_c = Cost \ - \ output \ elasticity$$

$$= \ \%\Delta \ in \ cost \ from \ a \ 1\% \ increase$$

$$in \ output$$

◆Therefore, the following is true:

–$E_C < 1$: MC < AC

•Average cost indicate decreasing economies of scale

–$E_C = 1$: MC = AC

•Average cost indicate constant economies of scale

–$E_C > 1$: MC > AC

•Average cost indicate increasing economies of scale

◆The Relationship Between Short-Run and Long-Run Cost

–We will use short and long-run cost to determine the optimal plant size

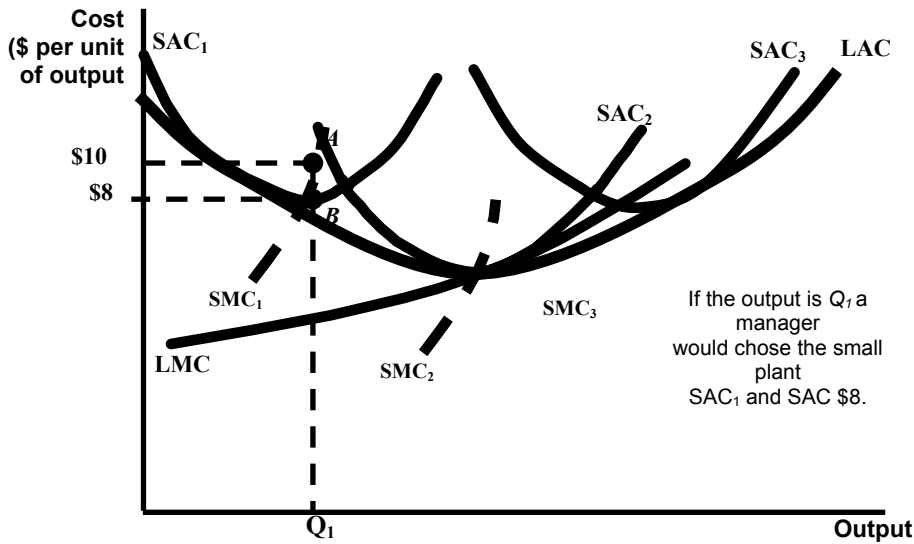**Long-Run Cost with Constant Returns to Scale**

◆Observation

–The optimal plant size will depend on the anticipated output (e.g. Q_1 choose SAC_1, etc).

–The long-run average cost curve is the envelope of the firm's short-run average cost curves.

◆Question

–What would happen to average cost if an output level other than that shown is chosen?

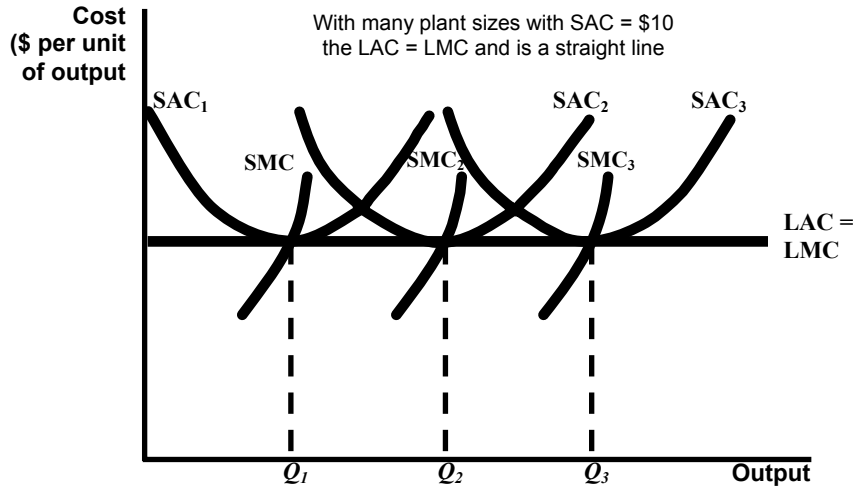## Long-Run Cost with Economies & Diseconomies of Scale

◆What is the firms' long-run cost curve?

–Firms can change scale to change output in the long-run.

–The long-run cost curve is the dark blue portion of the SAC curve which represents the minimum cost for any level of output.

◆Observations

–The LAC does not include the minimum points of small and large size plants? Why not?

–LMC is not the envelope of the short-run marginal cost. Why not?

◆Measuring Economies of Scale

$$E_c = (\Delta C / C)/(\Delta Q / Q)$$
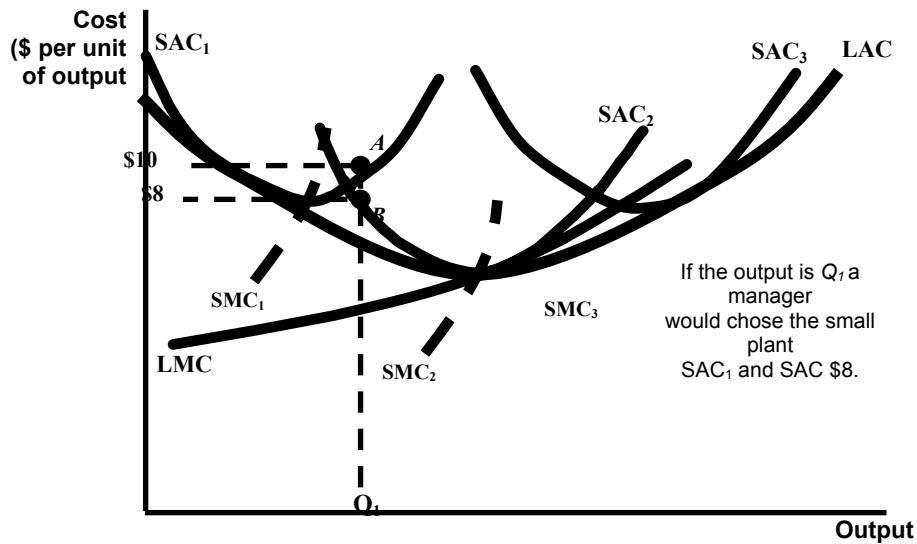
$$E_c = (\Delta C / \Delta Q)/(C / Q) = MC/AC$$

◆ Therefore, the following is true:

— $E_C < 1$: MC < AC

• Average cost indicate decreasing economies of scale

— $E_C = 1$: MC = AC

• Average cost indicate constant economies of scale

— $E_C > 1$: MC > AC

• Average cost indicate increasing economies of scale

◆ The Relationship Between Short-Run and Long-Run Cost

— We will use short and long-run cost to determine the optimal plant size

Long-Run Cost with Constant Returns to Scale

Cost ($ per unit of output)

With many plant sizes with SAC = $10
the LAC = LMC and is a straight line

SAC_1 SAC_2 SAC_3

SMC SMC_2 SMC_3

LAC = LMC

Q_1 Q_2 Q_3 **Output**

- ◆ Observation
  - – The optimal plant size will depend on the anticipated output (e.g. Q_1 choose SAC_1, etc).
  - – The long-run average cost curve is the envelope of the firm's short-run average cost curves.
- ◆ Question
  - – What would happen to average cost if an output level other than that shown is chosen?

Long-Run Cost with Economies & Diseconomies of Scale

Cost ($ per unit of output) SAC_1 SAC_3 **LAC**

SAC_2

$10

$8

A

B

SMC_1 SMC_3

LMC SMC_2

If the output is Q_1 a manager would chose the small plant SAC_1 and SAC $8.

Q_1

Output

- ◆ What is the firms' long-run cost curve?
  - – Firms can change scale to change output in the long-run.
  - – The long-run cost curve is the dark blue portion of the SAC curve which represents the minimum cost for any level of output.
- ◆ Observations
  - – The LAC does not include the minimum points of small and large size plants? Why not?
  - – LMC is not the envelope of the short-run marginal cost. Why not?

Production with Two Outputs--Economies of Scope
 ◆ Economies of scope exist when the joint output of a single firm is greater than the output that could be achieved by two different firms each producing a single output.
 ◆ Examples:
   – Chicken farm--poultry and eggs
   – Automobile company--cars and trucks
   – University--Teaching and research
 ◆ What are the advantages of joint production?
   – Consider an automobile company producing cars and tractors
 ◆ Advantages

   1) Both use capital and labor.

   2) The firms share management resources.

   3) Both use the same labor skills and type of machinery.
 ◆ Production:
   – Firms must choose how much of each to produce.
   – The alternative quantities can be illustrated using product transformation curves.

Product Transformation Curve
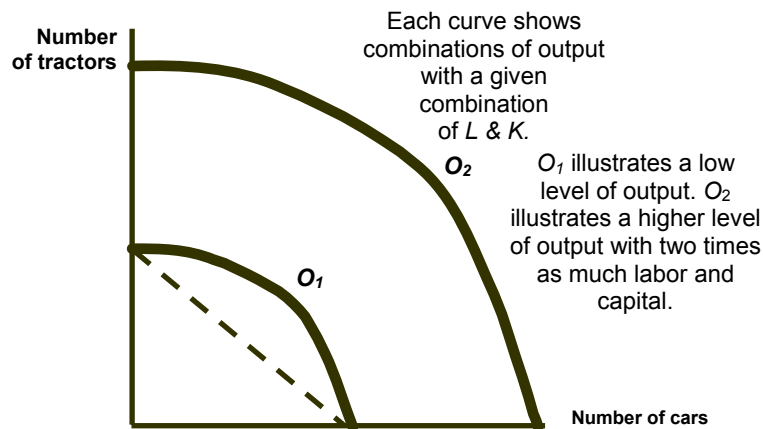
 ◆ Observations
   – Product transformation curves are negatively sloped
   – Constant returns exist in this example
   – Since the production transformation curve is concave is joint production desirable?
   – There is no direct relationship between economies of scope and economies of scale.
     – May experience economies of scope and diseconomies of scale
     – May have economies of scale and not have economies of scope
 ◆ *The* degree of economies of scope *measures the savings in cost and can be written:*

$$SC = \frac{C(Q_1) + C(Q_2) - C(Q_1, Q_2)}{C(Q_1, Q_2)}$$

- _ C(Q$_1$) is the cost of producing Q$_1$
- _ C(Q$_2$) is the cost of producing Q$_2$
- − C(Q$_1$Q$_2$) is the joint cost of producing both products
- ◆ Interpretation:
  - – If SC > 0 -- Economies of scope
  - – If SC < 0 -- Diseconomies of scope
- ◆ Issues
  - – Truckload versus less than truck load
  - – Direct versus indirect routing
  - – Length of haul

Economies of Scope in the Trucking Industry
- ◆ Questions:
  - – Economies of Scope
    - − Are large-scale, direct hauls cheaper and more profitable than individual hauls by small trucks?
    - − Are there cost advantages from operating both direct and indirect hauls?
- ◆ Empirical Findings
  - – An analysis of 105 trucking firms examined four distinct outputs.
    - − Short hauls with partial loads
    - − Intermediate hauls with partial loads
    - − Long hauls with partial loads
    - − Hauls with total loads
  - – Results
    - − SC = 1.576 for reasonably large firm
    - − SC = 0.104 for very large firms
  - – Interpretation
    - − Combining partial loads at an intermediate location lowers cost management difficulties with very large firms.

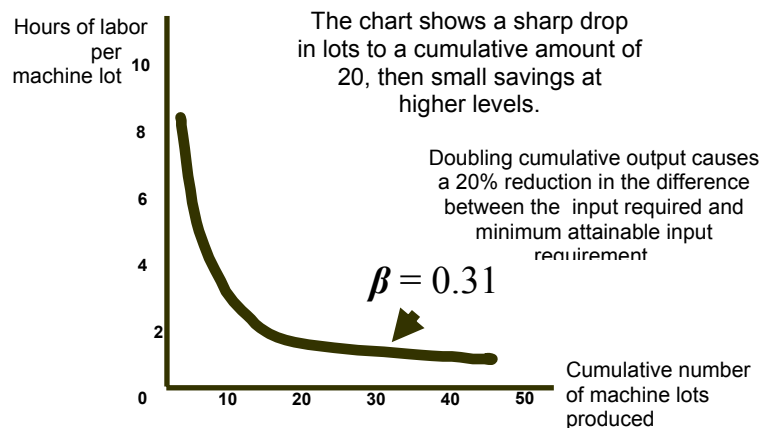**Dynamic Changes in Costs--The Learning Curve**
- ◆ The **learning curve** measures the impact of worker's experience on the costs of production.
- ◆ It describes the relationship between a firm's cumulative output and amount of inputs needed to produce a unit of output.
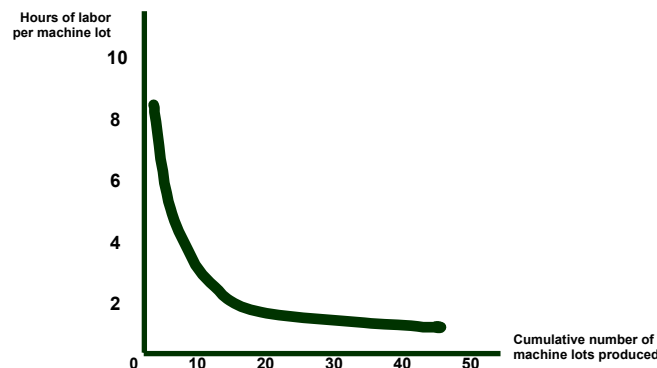
- The horizontal axis measures the cumulative number of hours of machine tools the firm has produced
- The vertical axis measures the number of hours of labor needed to produce each lot.
- The learning curve in the figure is based on the relationship:

$$L = A + BN^{-\beta}$$

- If N=1
  - L equals A + B and this measures labor input to produce the first unit of output
- If β = 0
  - Labor input remains constant as the cumulative level of output increases, so there is no learning
- If β > 0 and N increases
  - L approaches A, and A represent minimum labor input/unit of output after all learning has taken place.
- The larger β:
  - The more important the learning effect.

Hours of labor per machine lot

The chart shows a sharp drop in lots to a cumulative amount of 20, then small savings at higher levels.

Doubling cumulative output causes a 20% reduction in the difference between the input required and minimum attainable input requirement

$$\beta = 0.31$$

Cumulative number of machine lots produced

- Observations

    1) New firms may experience a learning curve, not economies of scale.

    2) Older firms have relatively small gains from learning.

Economies of Scale Versus Learning

Cost ($ per unit of output)

Economies

A

B

AC$_1$

Learning

C

AC$_2$
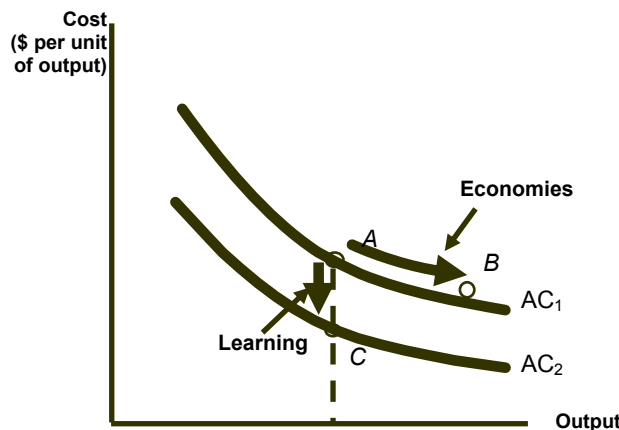
Output

Predicting the Labor Requirements of Producing a Given Output

Cumulative Output (N)	Per-Unit Labor Requirement for each 10 units of Output (L)	Total Labor Requirement
10	1.00	10.0
20	.80	18.0 (10.0 + 8.0)
30	.70	25.0 (18.0 + 7.0)
40	.64	31.4 (25.0 + 6.4)
50	.60	37.4 (31.4 + 6.0)
60	.56	43.0 (37.4 + 5.6)
70	.53	48.3 (43.0 + 5.3)
80 and over	.51	53.4 (48.3 + 5.1)

- The learning curve implies:

    1) The labor requirement falls per unit.

    2) Costs will be high at first and then will fall with learning.

    3) After 8 years the labor requirement will be 0.51 and per unit cost will be half   what it was in the first year of production?

Learning Curve in Practice
- Scenario
    – A new firm enters the chemical processing industry.
- Do they:
1) Produce a low level of output and sell at a high price?
2)   Produce a high level of output and sell at a low price?
- How would the learning curve influence your decision?
- The Empirical Findings
    – Study of 37 chemical products
        –Average cost fell 5.5% per year
        –For each doubling of plant size, average production costs fall by 11%
        –For each doubling of cumulative output, the average cost of production falls by 27%
- Which is more important, the economies of scale or learning effects?
- Other Empirical Findings
    – In the semi-conductor industry a study of seven generations of DRAM semiconductors from 1974-1992 found learning rates averaged 20%.
   – In the aircraft industry the learning rates are as high as 40%.
- Applying Learning Curves

1)   To determine if it is profitable to enter an industry.

2)   To determine when profits will occur based on plant size and cumulative output.

Estimating and Predicting Cost

- Estimates of future costs can be obtained from a cost function, which relates the cost of production to the level of output and other variables that the firm can control.
- Suppose we wanted to derive the total cost curve for automobile production.

Total Cost Curve for the Automobile Industry
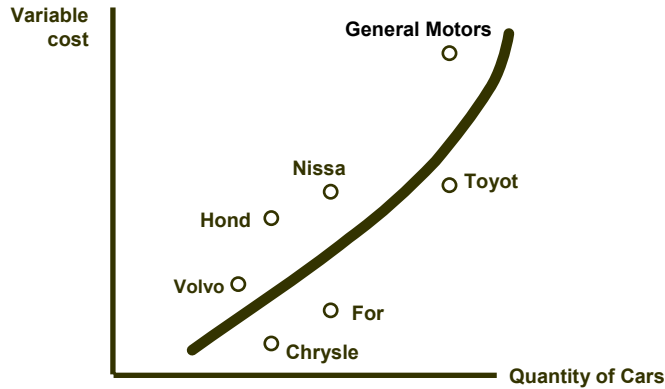
Estimating and Predicting Cost

- A linear cost function (does not show the U-shaped characteristics) might be:

$$VC = \beta Q$$

- The linear cost function is applicable only if marginal cost is constant.
    - Marginal cost is represented by β.
- If we wish to allow for a U-shaped average cost curve and a marginal cost that is not constant, we might use the quadratic cost function:

$$VC = \beta Q + \gamma Q^2$$

- If the marginal cost curve is not linear, we might use a cubic cost function:

$$VC = \beta Q + \gamma Q^2 + \delta Q^3$$
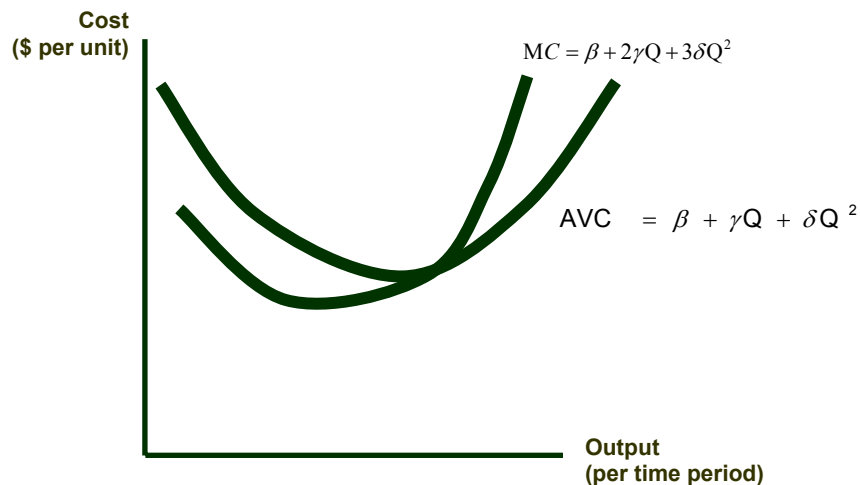
Cubic Cost Function

◆ Difficulties in Measuring Cost

1) Output data may represent an aggregate of different type of products.

2) Cost data may not include opportunity cost.

3) Allocating cost to a particular product may be difficult when there is more than one product line.

◆ Cost Functions and the Measurement of Scale Economies
— Scale Economy Index (SCI)
• E_C = 1, SCI = 0: no economies or diseconomies of scale
• E_C > 1, SCI is negative: diseconomies of scale
• E_C < 1, SCI is positive: economies of scale

Cost Functions for Electric Power

Scale Economies in the Electric Power Industry

Output (million kwh)	43	338	1109	2226	5819
Value of SCI, 1955	.41	.26	.16	.10	.04

Average Cost of Production in the Electric Power Industry
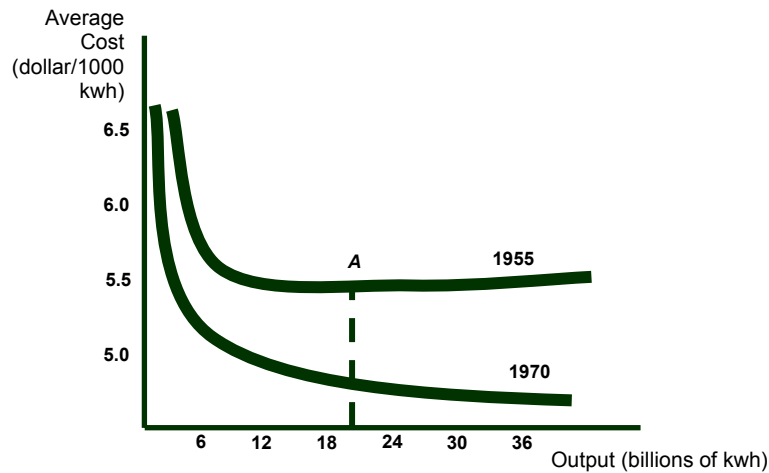
◆ Findings
— Decline in cost
• Not due to economies of scale
• Was caused by:
— Lower input cost (coal & oil)
— Improvements in technology

A Cost Function for the Savings and Loan Industry

◆ The empirical estimation of a long-run cost function can be useful in the restructuring of the savings and loan industry in the wake of the savings and loan collapse in the 1980s.
◆ Data for 86 savings and loans for 1975 & 1976 in six western states

- – Q = total assets of each S&L
- – LAC = average operating expense
- – Q & TC are measured in hundreds of millions of dollars
- – Average operating cost are measured as a percentage of total assets.
- ◆ A quadratic long-run average cost function was estimated for 1975:

$$LAC = 2.38 - 0.6153Q + 0.0536Q^2$$

- ◆ Minimum long-run average cost reaches its point of minimum average total cost when total assets of the savings and loan reach $574 million.
- ◆ Average operating expenses are 0.61% of total assets.
- ◆ Almost all of the savings and loans in the region being studied had substantially less than $574 million in assets.
- ◆ Questions

    1) What are the implications of the analysis for expansion and mergers?

    2) What are the limitations of using these results?

Perfectly Competitive Markets

 ◆ Characteristics of Perfectly Competitive Markets

    1) Price taking

    2) Product homogeneity

    3) Free entry and exit

 ◆ Price Taking
   – The individual firm sells a very small share of the total market output and, therefore, cannot influence market price.
   – The individual consumer buys too small a share of industry output to have any impact on market price.
 ◆ Product Homogeneity
   – The products of all firms are perfect substitutes.
   – Examples
     • Agricultural products, oil, copper, iron, lumber
 ◆ Free Entry and Exit
   – Buyers can easily switch from one supplier to another.
   – Suppliers can easily enter or exit a market.
 ◆ Discussion Questions
   – What are some barriers to entry and exit?
   – Are all markets competitive?
   – When is a market highly competitive?
 ◆ Do firms maximize profits?
   – Possibility of other objectives
     • Revenue maximization
     • Dividend maximization
     • Short-run profit maximization
   – Implications of non-profit objective
     • Over the long-run investors would not support the company
     • Without profits, survival unlikely
   – Long-run profit maximization is valid and does not exclude the possibility of altruistic behavior.
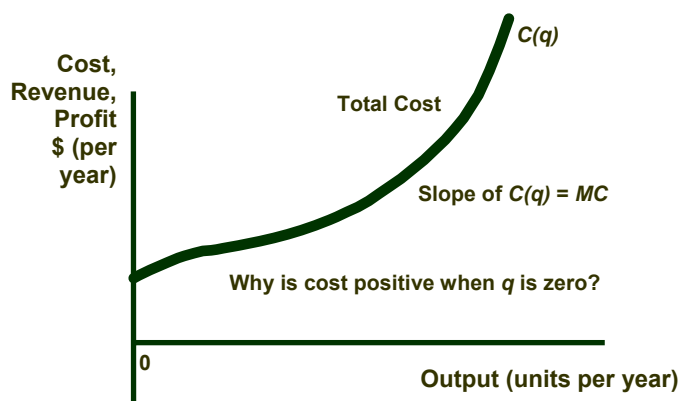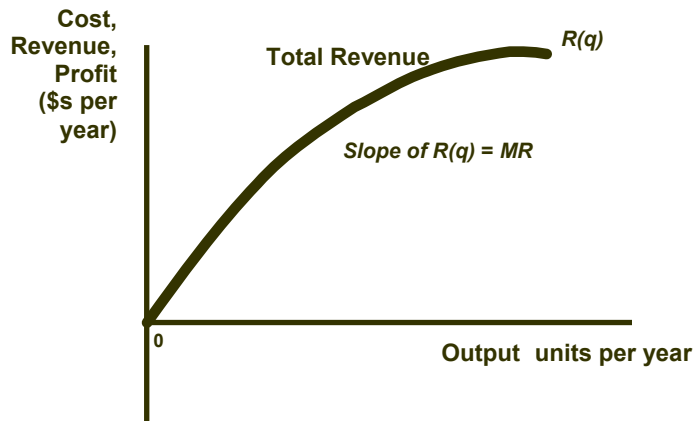
Marginal Revenue, Marginal Cost & Profit Maximization
 ◆ Determining the profit maximizing level of output
   – Profit (π) = Total Revenue - Total Cost
   – Total Revenue (R) = Pq
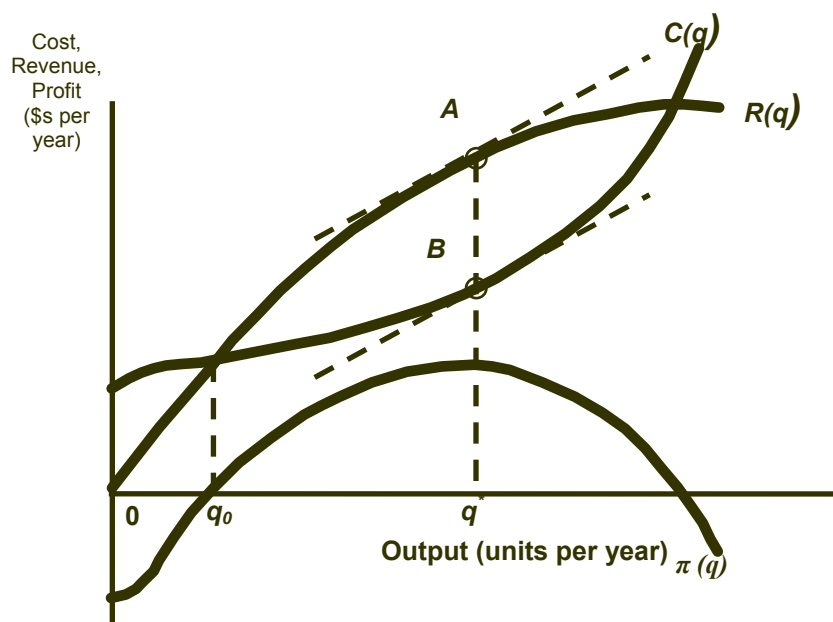   – Total Cost (C) = Cq
   – Therefore:
$$\pi(q) = R(q) - C(q)$$

Profit Maximization in the Short Run

Marginal Revenue, Marginal Cost & Profit Maximization

- ◆ **Marginal revenue** is the additional revenue from producing one more unit of output.
- ◆ **Marginal cost** is the additional cost from producing one more unit of output.

- ◆ Comparing R(q) and C(q)
  - – Output levels: 0- q_0:
    - • C(q)> R(q)

Negative profit
    - • FC + VC > *R(q)*
    - • MR > MC
      Indicates higher profit at higher output
  - – Question: Why is profit negative when output is zero?
  - – Output levels: q_0 - q^*
    - • R*(q)> C(q)*
    - • MR > MC
      Indicates higher profit at higher output while Profit is increasing
  - – Output level: q^*
    - • R*(q)= C(q)*
    - • MR = MC
    - • Profit is maximized
    - • Question
      – Why is profit reduced when producing more or less than q*?
  - – Output levels beyond q^*:
    - • R*(q)> C(q)*
    - • MC > MR
    - • Profit is decreasing
- ◆ Therefore, it can be said:
  - – Profits are maximized when MC = MR.

$$\pi \ = \ R - C \quad MR = \frac{\Delta R}{\Delta q} \quad MC = \frac{\Delta C}{\Delta q}$$

Profits   are   maximized   when   :

$$\frac{\Delta \pi}{\Delta q} = \frac{\Delta R}{\Delta q} - \frac{\Delta C}{\Delta q} = 0 \ or \qquad \begin{aligned} MR - MC &= 0 \ so \ that \\ MR(q) &= MC(q) \end{aligned}$$
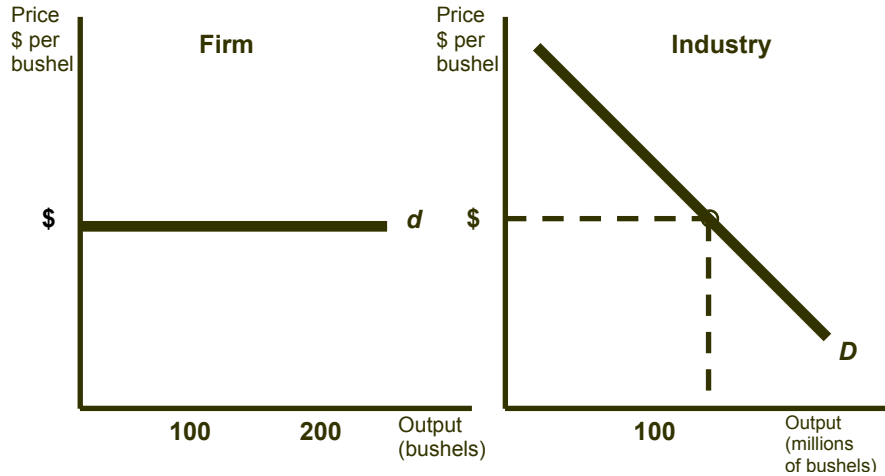
- ◆ The Competitive Firm
  - – Price taker
  - – Market output (Q) and firm output (q)
  - – Market demand (D) and firm demand (d)
  - – R(q) is a straight line

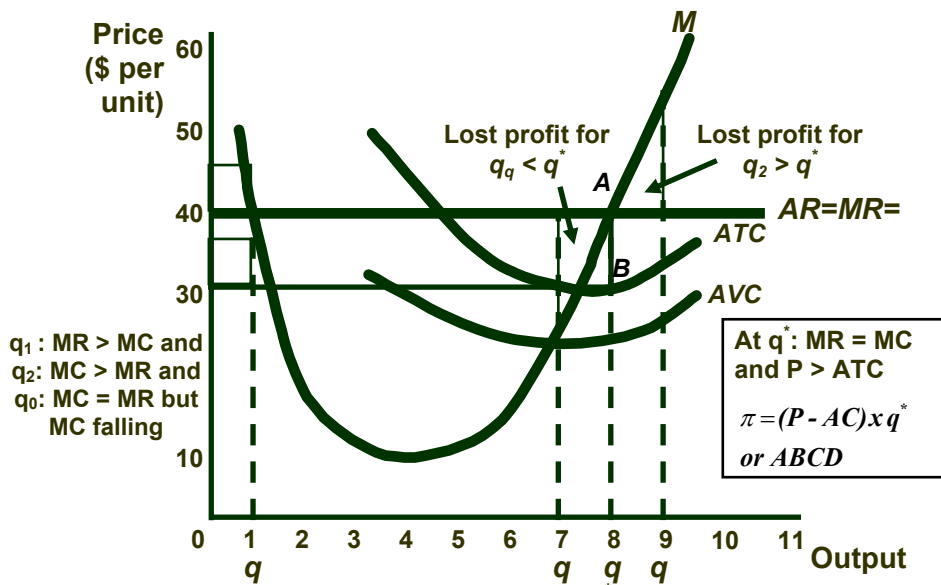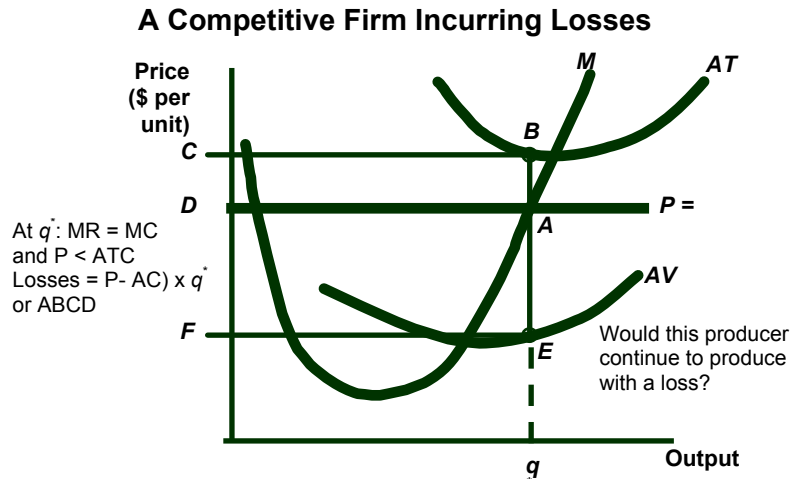**Demand & Marginal Revenue Faced by a Competitive Firm**

- − The
  competitive firm's demand
  - Individual producer sells all units for $4 regardless of the producer's level of output.
  - If the producer tries to raise price, sales are zero.
  - If the producers tries to lower price he cannot increase sales
  - $P = D = MR = AR$
- − Profit Maximization
  - $MC(q) = MR = P$

Choosing Output in Short Run

- ◆ We will combine production and cost analysis with demand to determine output and profitability.

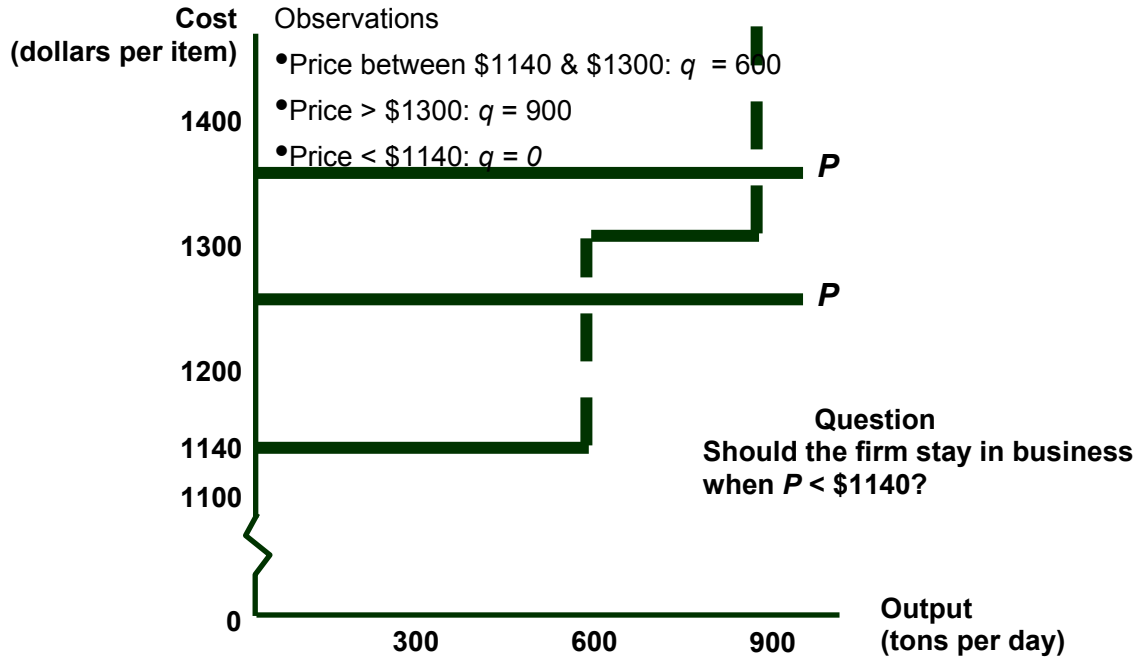**A Competitive Firm Making a Positive Profit**

A Competitive Firm Incurring Losses

At q^*: MR = MC
and P < ATC
Losses = P- AC) x q^*
or ABCD

Would this producer
continue to produce
with a loss?

Choosing Output in Short Run

 ◆ Summary of Production Decisions
  – Profit is maximized when *MC = MR*
  – If *P > ATC* the firm is making profits.
  – If *AVC < P < ATC* the firm should produce at a loss.
  – If *P < AVC < ATC* the firm should shut-down.

The Short-Run Output of an Aluminum Smelting Plant

Observations
•Price between $1140 & $1300: *q* = 600
•Price > $1300: *q* = 900
•Price < $1140: *q = 0*

Question
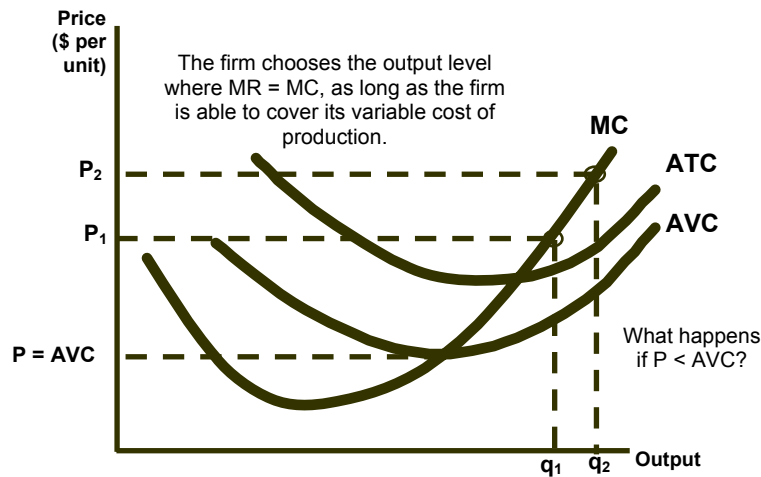**Should the firm stay in business**
**when *P* < $1140?**

Some Cost Considerations for Managers

 ◆ Three guidelines for estimating marginal cost:

1) Average variable cost should not be used as a substitute for marginal cost.

2) A single item on a firm's accounting ledger may have two components, only one of which involves marginal cost.

3) All opportunity cost should be included in determining marginal cost.

A Competitive Firm's Short-Run Supply Curve

The firm chooses the output level where MR = MC, as long as the firm is able to cover its variable cost of production.

What happens if P < AVC?

- Observations:
  - $P = MR$
  - $MR = MC$
  - $P = MC$
- Supply is the amount of output for every possible price. Therefore:
  - If $P = P_1$, then $q = q_1$
 - If $P = P_2$, then $q = q_2$

S = MC above AVC

Shut-down
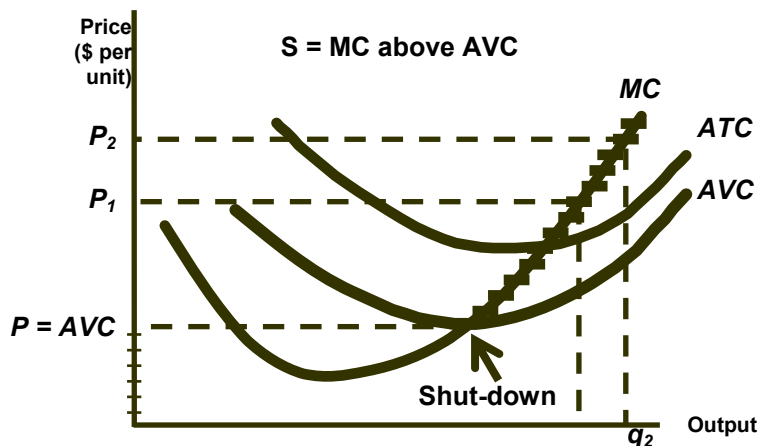
-
- Observations:
  - Supply is upward sloping due to diminishing returns.
  - Higher price compensates the firm for higher cost of additional output and increases total profit because it applies to all units.
- Firm's Response to an Input Price Change

– When the price of a firm's product changes, the firm changes its output level, so that the marginal cost of production remains equal to the price.
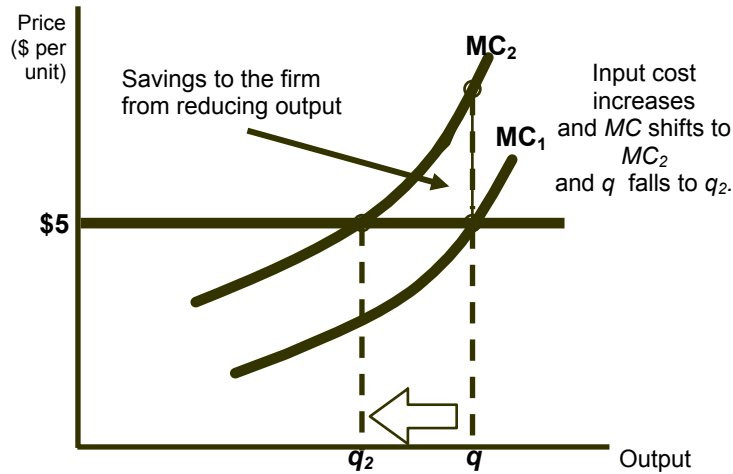
The Short-Run Production of Petroleum Products
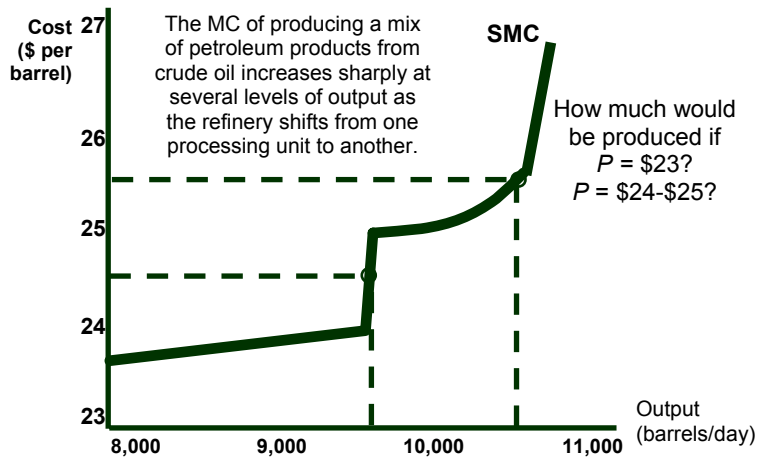
- Stepped SMC indicates a different production (cost) process at various capacity levels.
- Observation:
  – With a stepped MC function, small changes in price may not trigger a change in output.
- The short-run market supply curve shows the amount of output that the industry will produce in the short-run for every possible price.
- Consider, for simplicity, a competitive market with three firms:

Industry Supply in Short Run
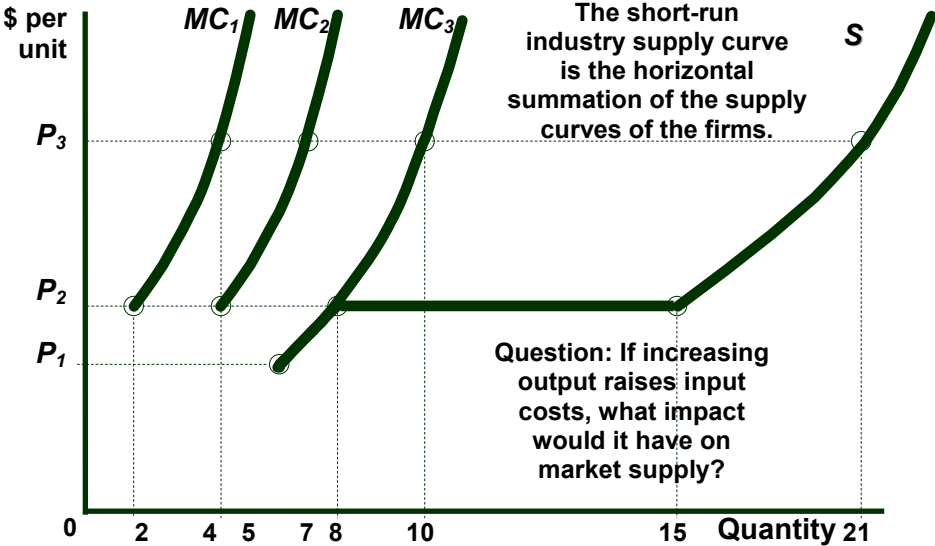
Elasticity of Market Supply

$$E_s = (\Delta Q / Q) / (\Delta P / P)$$

- Perfectly inelastic short-run supply arises when the industry's plant and equipment are so fully utilized that new plants must be built to achieve greater output.
- Perfectly elastic short-run supply arises when marginal costs are constant.

The World Copper Industry (1999)

Country	Annual Production (thousand metric tons)	Marginal Cost (dollars/pound)
Australia	600	0.65
Canada	710	0.75
Chile	3660	0.50
Indonesia	750	0.55
Peru	450	0.70
Poland	420	0.80
Russia	450	0.50
United States	1850	0.55

The Short-Run World Supply of Copper
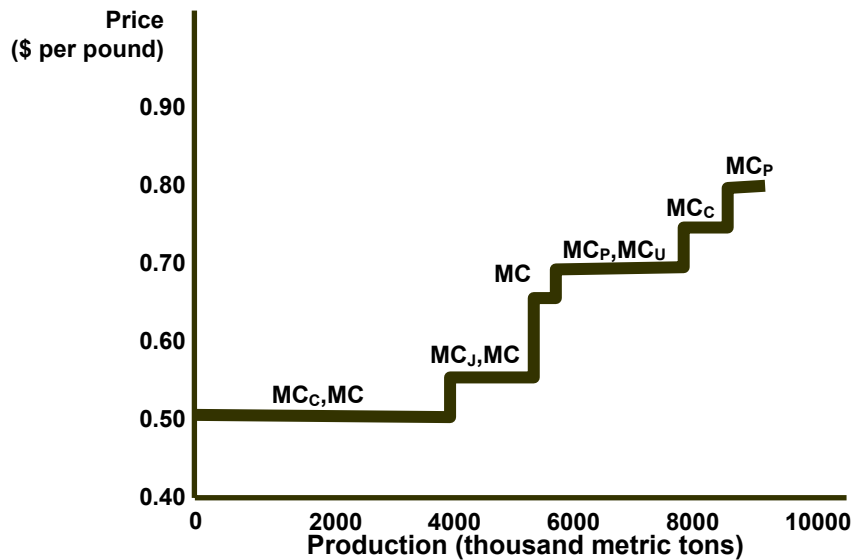
- ◆ Producer Surplus in the Short Run
  - ‒ Firms earn a surplus on all but the last unit of output.
  - ‒ The **producer surplus** is the sum over all units produced of the difference between the market price of the good and the marginal cost of production.

At q^* $MC = MR$.
Between 0 and q,
$MR > MC$ for all units.

Price ($ per unit of output)

Producer Surplus

MC   **AVC**

B

A - **P**

Alternatively, VC is the sum of MC or ODCq^*.
R is P x q^* or OABq^*.
Producer surplus = R - VC or ABCD.

D - - - - - - - - - - - -
                        C
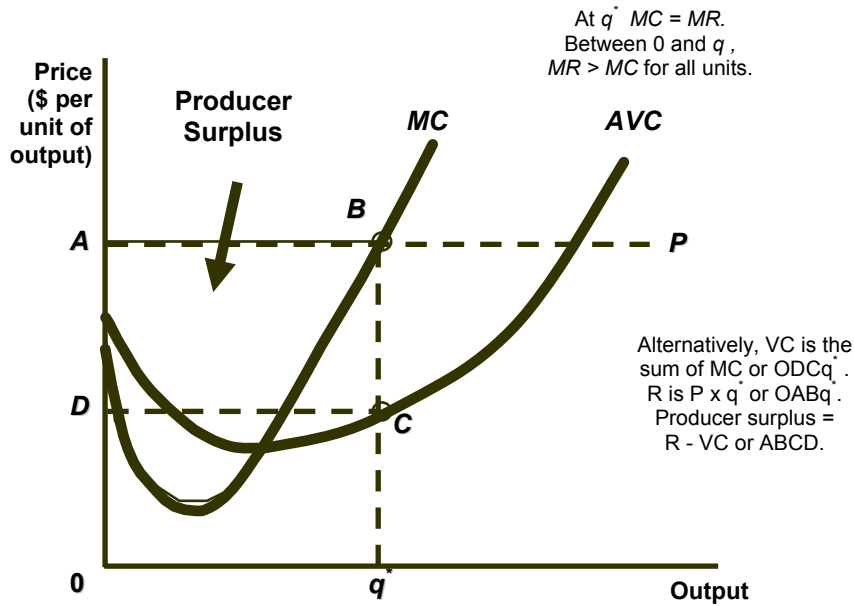
0   **q^***   **Output**

◆ Producer Surplus in the Short-Run

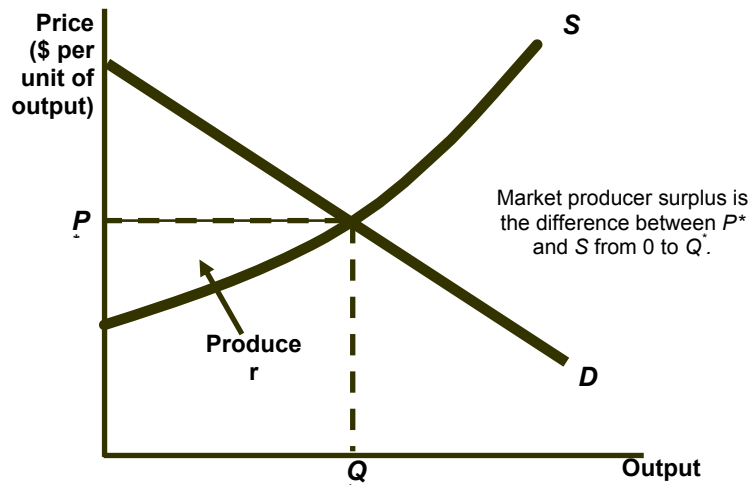$$Producer\ Surplus\ =\ PS\ =\ R - VC$$

$$Profit\ =\ \pi\ -\ R\ -\ VC\ -\ FC$$

◆ Observation
  − Short-run with positive fixed cost

$$PS\ >\ \pi$$

Producer Surplus for a Market

Price ($ per unit of output)

S

P - - - - - - - - - - - -

Market producer surplus is the difference between *P** and *S* from 0 to *Q**.

Producer

D

Q   **Output**

Choosing Output in Long Run

◆ In the long run, a firm can alter all its inputs, including the size of the plant.
◆ We assume free entry and free exit.

Price ($ per unit of output)

In the long run, the plant size will be increased and output increased to q_3. Long-run profit, *EFGD* > short run profit *ABCD*.

In the short run, the firm is faced with fixed inputs. *P* = $40 > *ATC*. Profit is equal to *ABCD*.

Price ($ per unit of output)

Question: Is the producer making a profit after increased output lowers the price to $30?
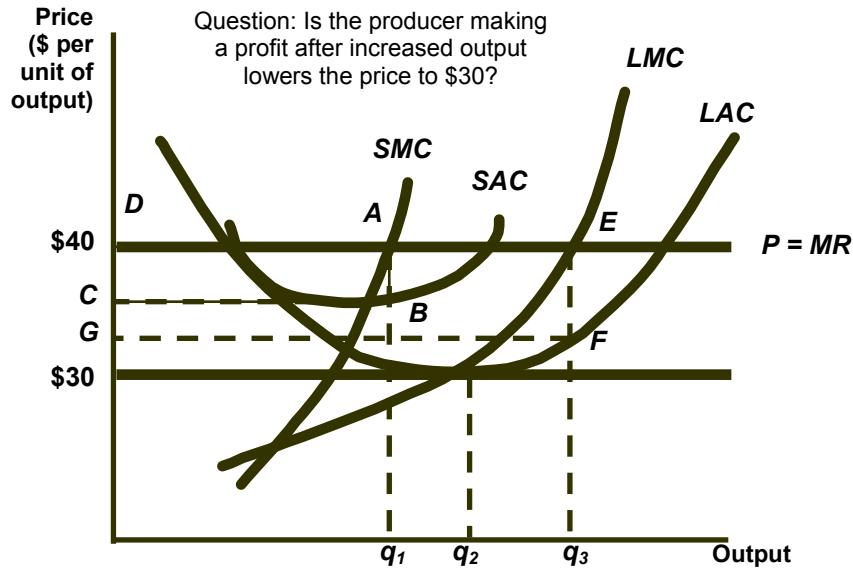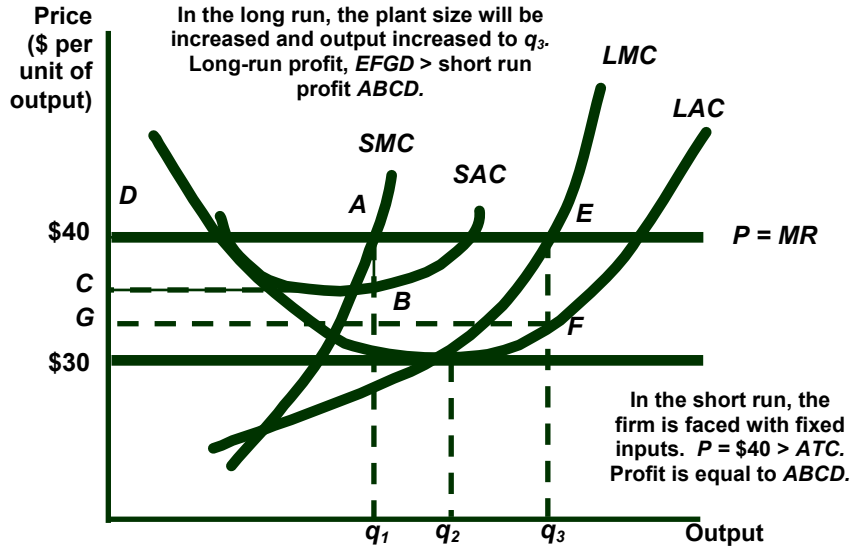
- ◆ Accounting Profit & Economic Profit
    - – Accounting profit (π) = R - wL
    - – Economic profit (π) = R - wL - rK
   - • wL = labor cost
        - • rk = opportunity cost of capital
- ◆ Long-Run Competitive Equilibrium
    - – Zero-Profit
        - • If R > wL + rk, economic profits are positive
        - • If R = wL + rk, zero economic profits, but the firms is earning a normal rate of return; indicating the industry is competitive
        - • If R < wl + rk, consider going out of business
    - – Entry and Exit

- The long-run response to short-run profits is to increase output and profits.
- Profits will attract other producers.
- More producers increase industry supply which lowers the market price.

Long-Run Competitive Equilibrium

- **Profit attracts firms**
- **Supply increases until profit = 0**
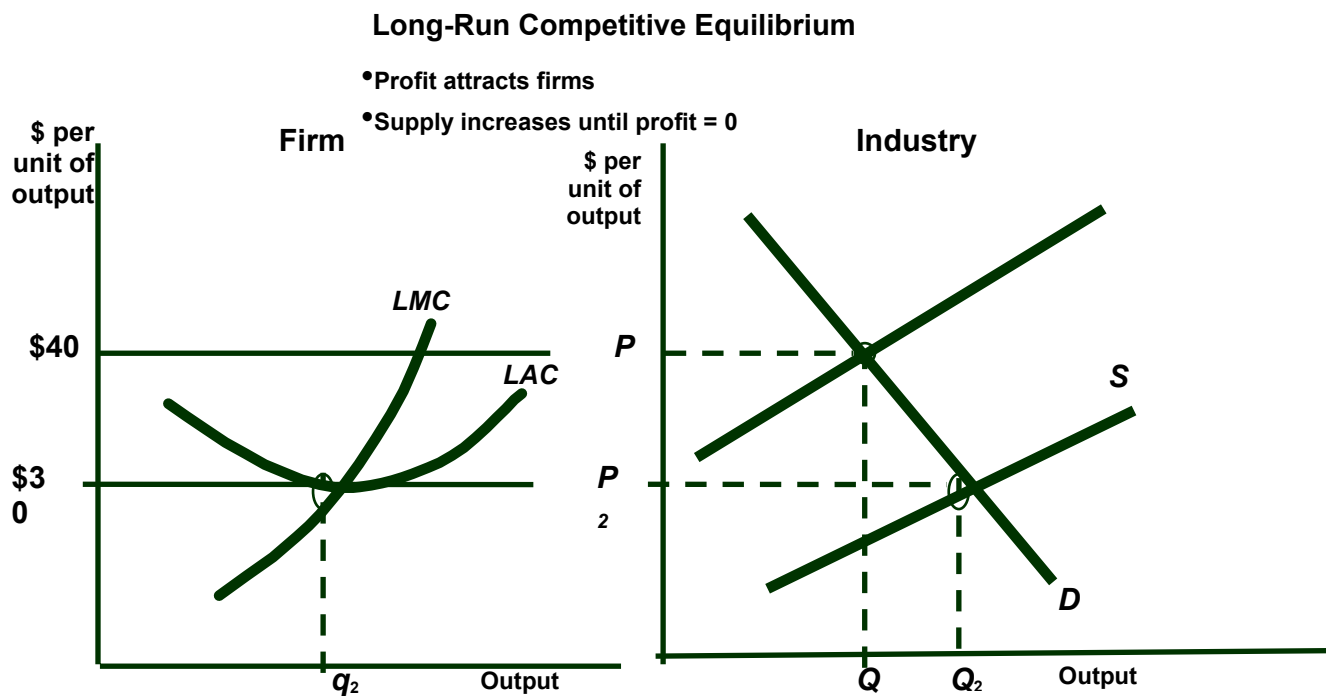
- Long-Run Competitive Equilibrium

    1) MC = MR

    2) P = LAC

    - No incentive to leave or enter
    - Profit = 0

    3) Equilibrium Market Price

- Questions

    1) Explain the market adjustment when P < LAC and firms have identical costs.

    2) Explain the market adjustment when firms have different costs.

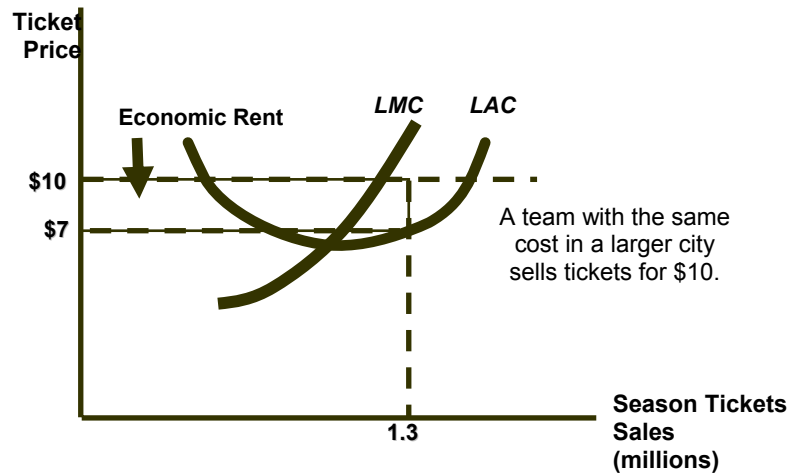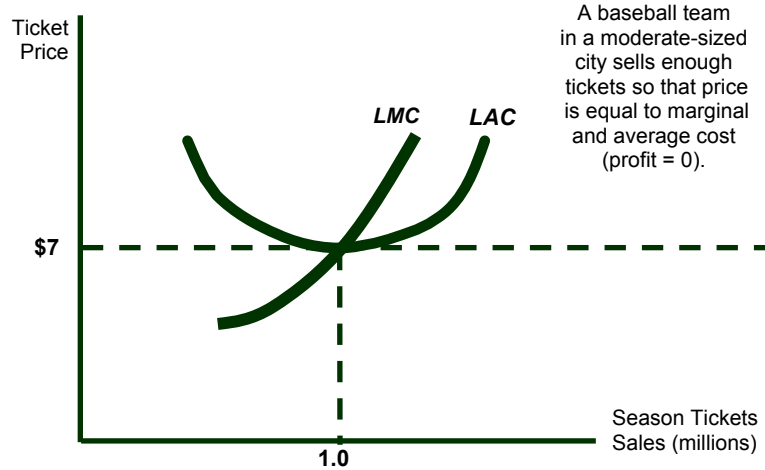   3) What is the opportunity cost of land?

- Economic Rent
    - Economic rent is the difference between what firms are willing to pay for an input less the minimum amount necessary to obtain it.
- An Example
    - Two firms *A* & *B*
    - Both own their land
    - *A* is located on a river which lowers *A's* shipping cost by $10,000 compared to *B*
    -

  – The demand for *A's* river location will increase the price of *A's* land to $10,000
  – Economic rent = $10,000

   • $10,000 - zero cost for the land
  – Economic rent increases
  – Economic profit of *A* = 0

Firms Earn Zero Profit in Long-Run Equilibrium

A baseball team in a moderate-sized city sells enough tickets so that price is equal to marginal and average cost (profit = 0).

A team with the same cost in a larger city sells tickets for $10.

 ◆ With a fixed input such as a unique location, the difference between the cost of production (LAC = 7) and price ($10) is the value or opportunity cost of the input (location) and represents the economic rent from the input.
 ◆ If the opportunity cost of the input (rent) is not taken into consideration it may appear that economic profits exist in the long-run.

◆
                                                                                    Lesson 26

The Industry's Long-Run Supply Curve
◆ Long-Run Elasticity of Supply

    1) Constant-cost industry

    • Long-run supply is horizontal

    • Small increase in price will induce an extremely large output increase

    • Long-run supply elasticity is infinitely large

    • Inputs would be readily available

    2) Increasing-cost industry

    • Long-run supply is upward-sloping and elasticity is positive

    • The slope (elasticity) will depend on the rate of increase in input cost

    • Long-run elasticity will generally be greater than short-run elasticity of supply

The Industry's Long-Run Supply Curve
◆ Question:
  – Describe the long-run elasticity of supply in a decreasing -cost industry.

The Long-Run Supply of Housing
◆ Scenario 1: Owner-occupied housing
  – Suburban or rural areas
  – National market for inputs
◆ Questions
  – Is this an increasing or a constant-cost industry?
  – What would you predict about the elasticity of supply?
◆ Scenario 2: Rental property
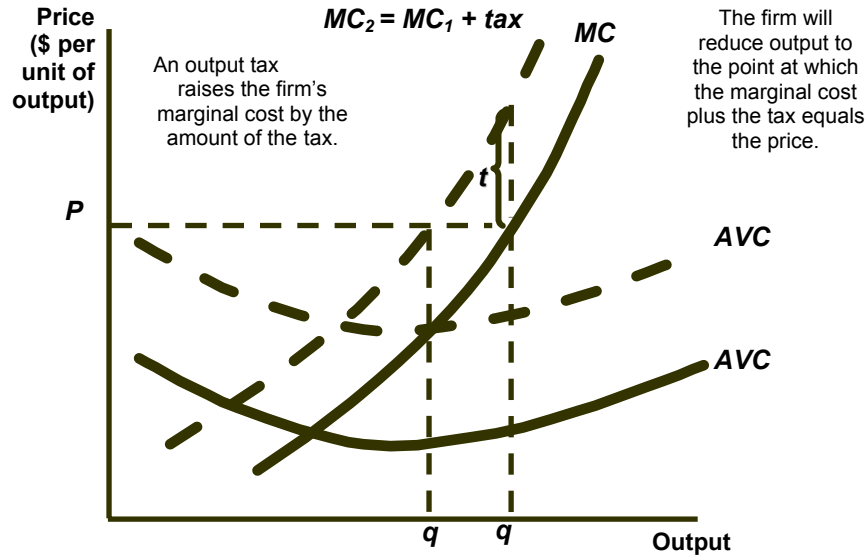 – Urban location
  – High-rise construction cost
◆ Questions
  – Is this an increasing or a constant-cost industry?
  – What would you predict about the elasticity of supply?

The Industry's Long-Run Supply Curve
◆ The Effects of a Tax
  – In an earlier chapter we studied how firms respond to taxes on an input.
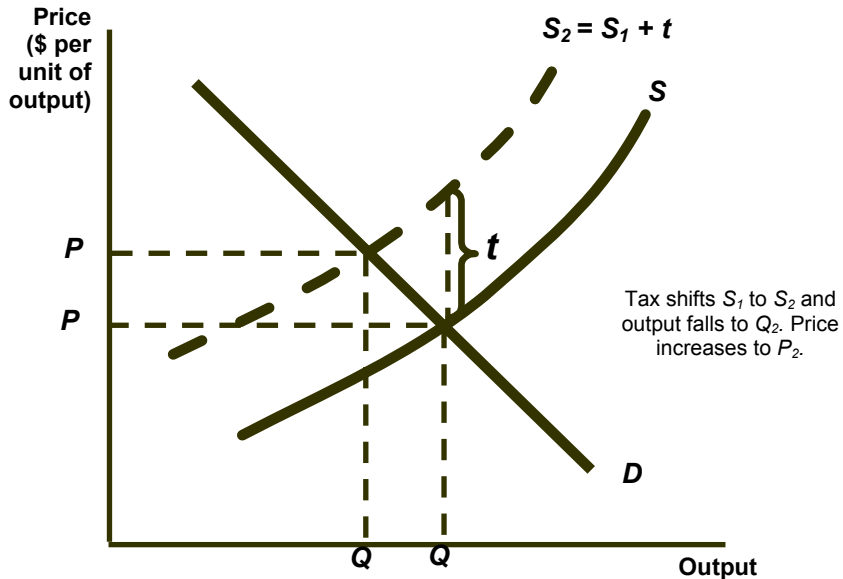 – Now, we will consider how a firm responds to a tax on its output.

Effect of an Output Tax on a Competitive Firm's Output

MC₂ = MC₁ + tax   **MC**

Price
($ per
unit of
output)

An output tax
raises the firm's
marginal cost by the
amount of the tax.

The firm will
reduce output to
the point at which
the marginal cost
plus the tax equals
the price.

P

t

AVC

AVC

q   q   **Output**

Effect of an

Output Tax on Industry Output

Price
($ per
unit of
output)

S₂ = S₁ + t

S

P

P

t

Tax shifts S_1 to S_2 and
output falls to Q_2. Price
increases to P_2.
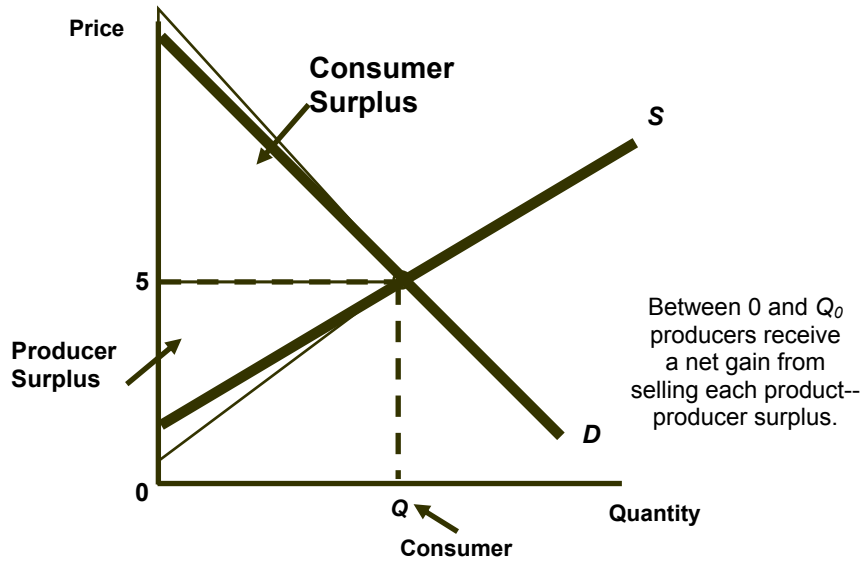
D

Q   Q   **Output**

Evaluating
## the Gains & Losses from Government Policies:

Consumer & Producer Surplus

- ◆ Review
  - – **Consumer surplus** is the total benefit or value that consumers receive beyond what they pay for the good.
  - – **Producer surplus** is the total benefit or revenue that producers receive beyond what it cost to produce a good.

- To determine the welfare effect of a governmental policy we can measure the gain or loss in consumer and producer surplus.
- Welfare Effects
  - Gains and losses caused by government intervention in the market.
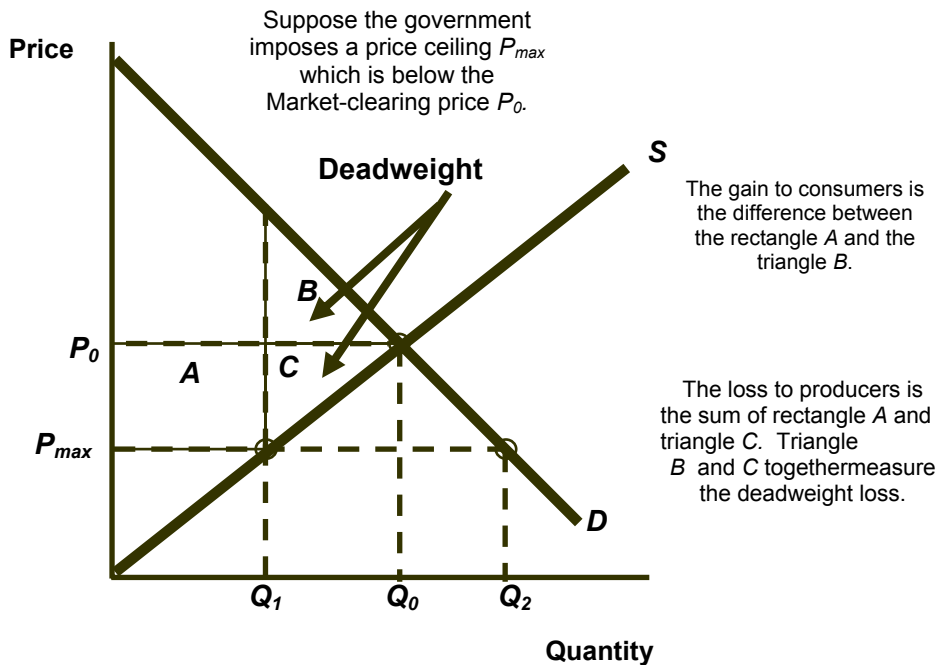
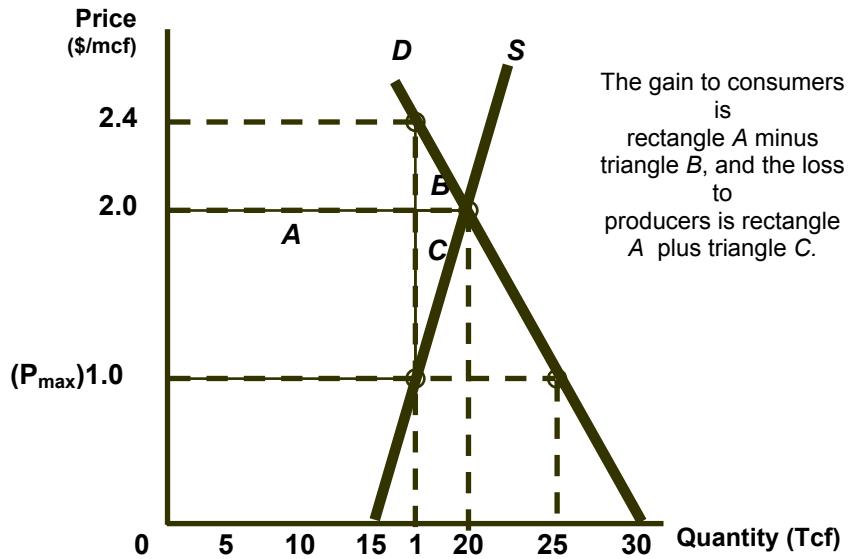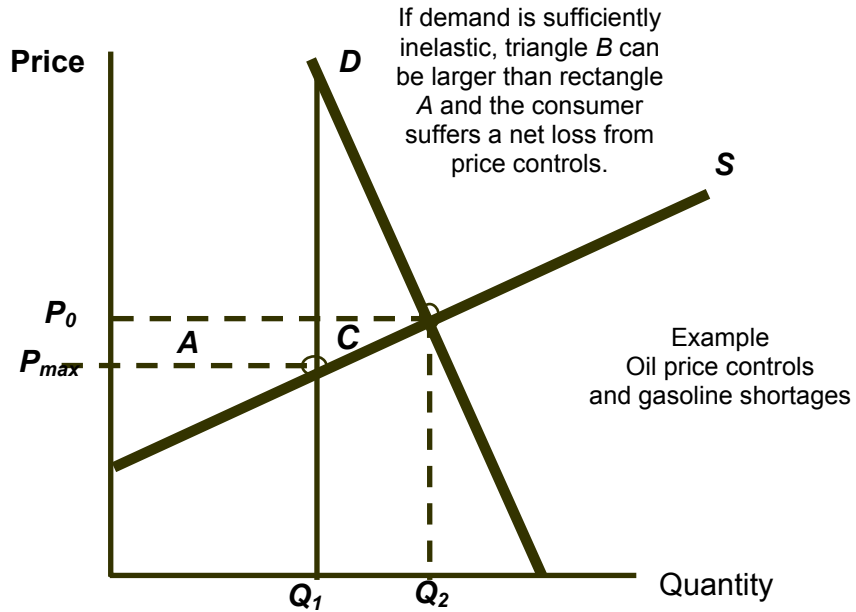**Change   in consumer & producer surplus from price controls**

- Observations:
  - The total loss is equal to area B + C.
  - The total change in surplus = (A - B) + (-A - C) = -B - C
  - The **deadweight loss** is the inefficiency of the price controls or the loss of the producer surplus exceeds the gain from consumer surplus.

◆ Observation
  – Consumers can experience a net loss in consumer surplus when the demand is sufficiently inelastic

Effect of Price Controls When Demand Is Inelastic

If demand is sufficiently inelastic, triangle *B* can be larger than rectangle *A* and the consumer suffers a net loss from price controls.

Example
Oil price controls
and gasoline shortages

The gain to consumers is rectangle *A* minus triangle *B*, and the loss to producers is rectangle *A* plus triangle *C*.

Price Controls and Natural Gas Shortages

The Efficiency of a Competitive Market

- When do competitive markets generate an inefficient allocation of resources or market failure?

    1) Externalities

    - Costs or benefits that do not show up as part of the market price (e.g. pollution)

    2) Lack of Information

    - Imperfect information prevents consumers from making utility-maximizing decisions.
- Government intervention in these markets can increase efficiency.
- Government intervention without a market failure creates inefficiency or deadweight loss.

Welfare loss if price is held below market-clearing level

When price is regulated to be no higher than P_1, the deadweight loss given by triangles B and C results.

When price is regulated to be no lower than P_2 only Q_3 will be demanded. The deadweight loss is given by triangles B and C

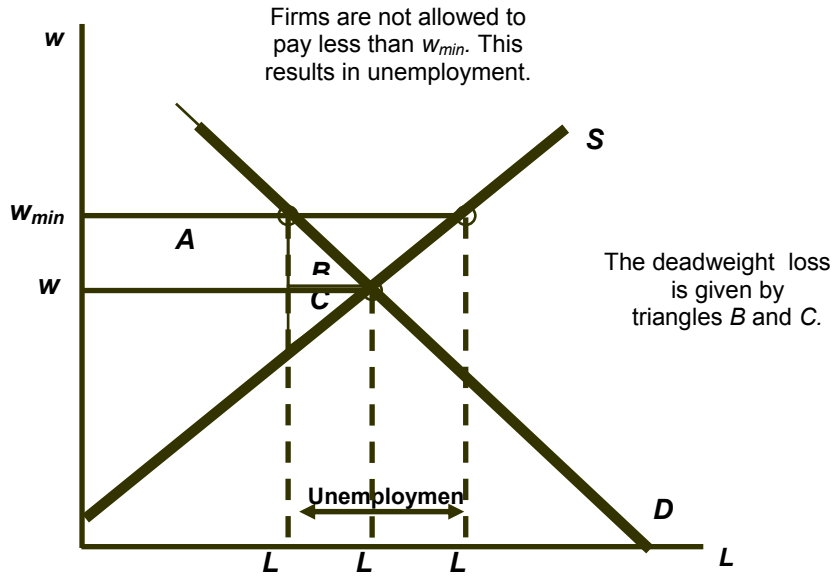What would the deadweight loss be if $Q_S = Q_2$?
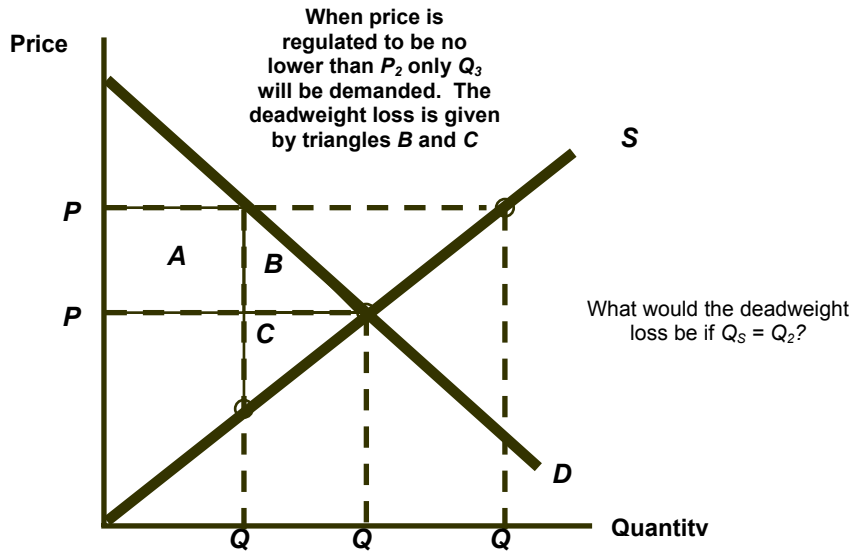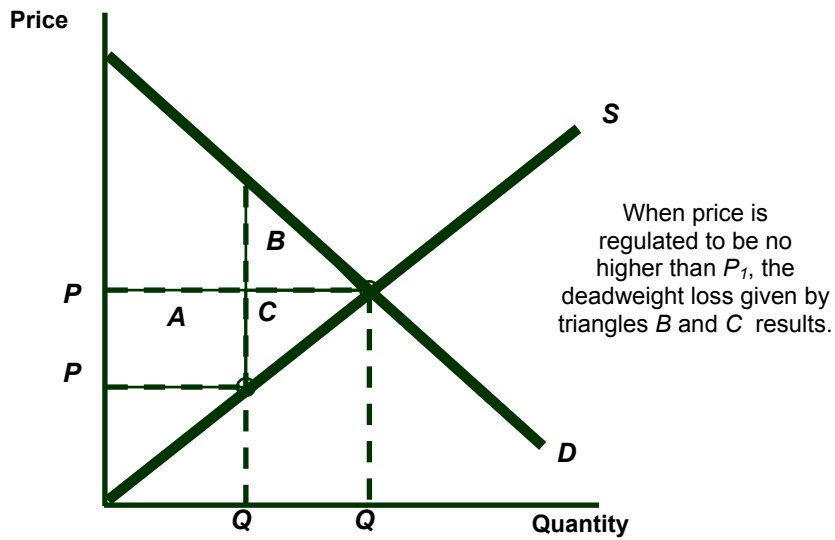
Welfare loss if price is held above market-clearing level

Minimum Prices

- Periodically government policy seeks to raise prices above market-clearing levels.
- We will investigate this by looking at a price floor and the minimum wage.

Price Minimum

The Minimum Wage

Firms are not allowed to
pay less than w_{min}. This
results in unemployment.

The deadweight loss
is given by
triangles *B* and *C*.
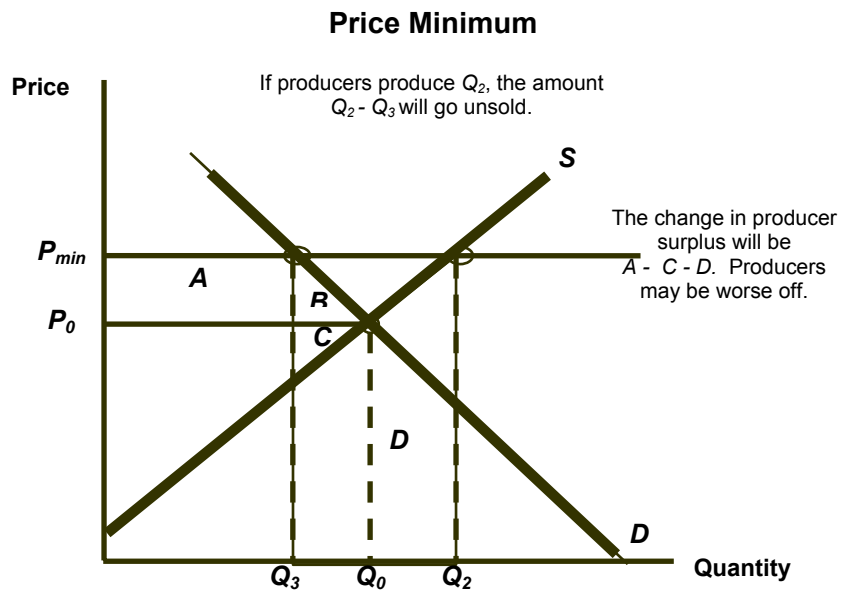
Airline Regulation

- During 1976-1981 the airline industry in the U.S. changed dramatically.
- Deregulation lead to major changes in the industry.
- Some airlines merged or went out of business as new airlines entered the industry.

Effect of Airline Regulation by the Civil Aeronautics Board

Prior to deregulation
price was at P_{min} and
$Q_D = Q_1$ and $Q_s = Q_2$.

Area *D* is the cost
of unsold output.

After deregulation:
Prices fell to P_O. The
change in consumer
surplus is *A + B.*

Price Supports

To maintain a price P_s the government buys quantity Q_g. The change in consumer surplus = $-A - B$, and the change in producer surplus is $A + B + D$

The cost to the government is the speckled rectangle $P_s(Q_2-Q_1)$

Total welfare loss $D-(Q_2-Q_1)p_s$

- ◆ Question:
  - − Is there a more efficient way to increase farmer's income by $A + B + D?$

Price Supports and Production Quotas
- ◆ Production Quotas
  - − The government can also cause the price of a good to rise by reducing supply.
- ◆ What is the impact of controlling entry into the taxicab market?

Supply Restrictions

- Supply restricted to Q_1
- Supply shifts to S' @ Q_1

- CS reduced by $A + B$
- Change in PS = $A - C$

- P_s is maintained with and incentive
- Cost to government = $B + C + D$
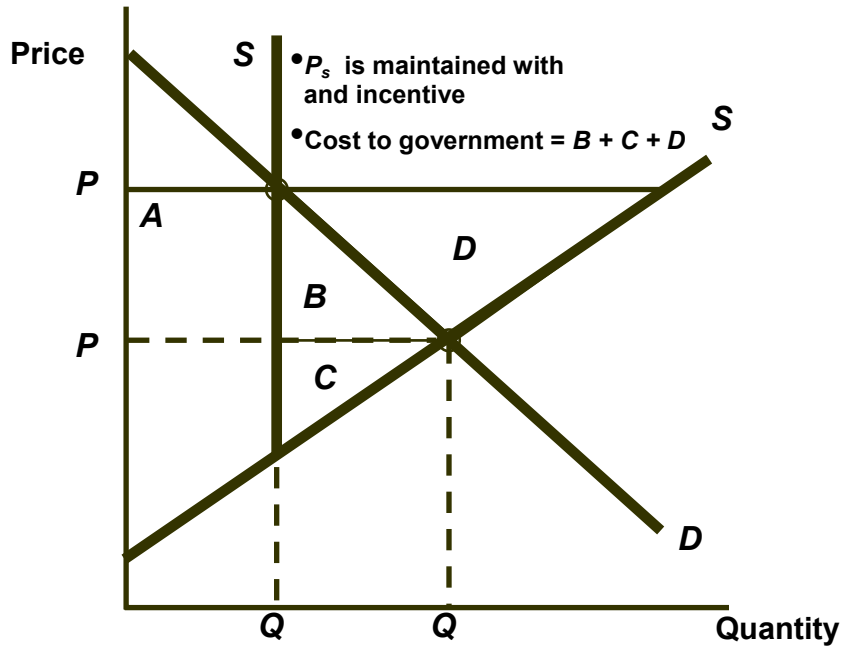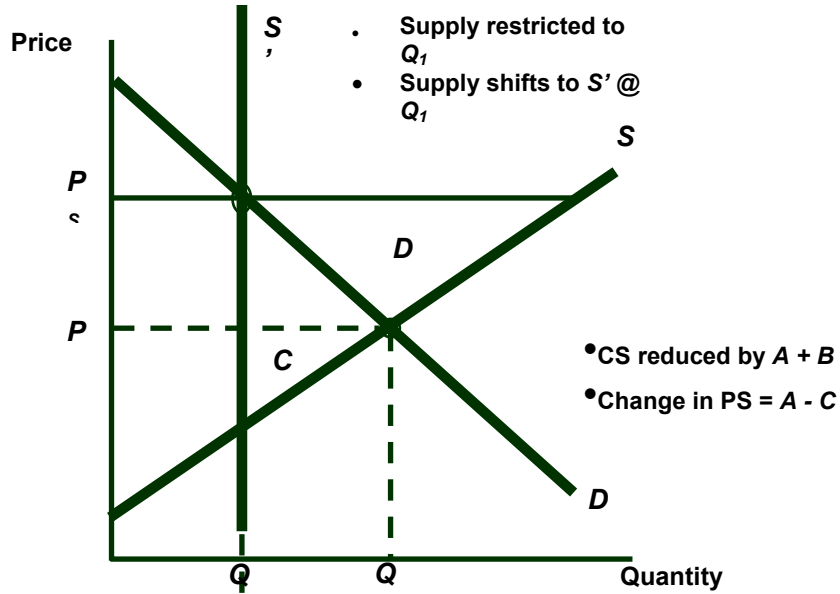
- ΔPS = A - C + B + C + D
  = A + B + D.
- The change in consumer and producer surplus is the same as with price supports.
- Δwelfare = -A - B + A + B + D - B - C - D = -B - C.

- Questions:
  - How could the government reduce the cost and still subsidize the farmer?
  - Which is more costly: supports or acreage limitations?

The Wheat Market in 1981

Price
e

- AB consumer loss
- ABC producer gain

S

By buying 122 million bushels the government increased the market-clearing price.

$P_0 = \$3.70$

A   B   C

$P_0 = \$3.46$

$D + Q_g$

D

1,800   2,630   **Quantity**
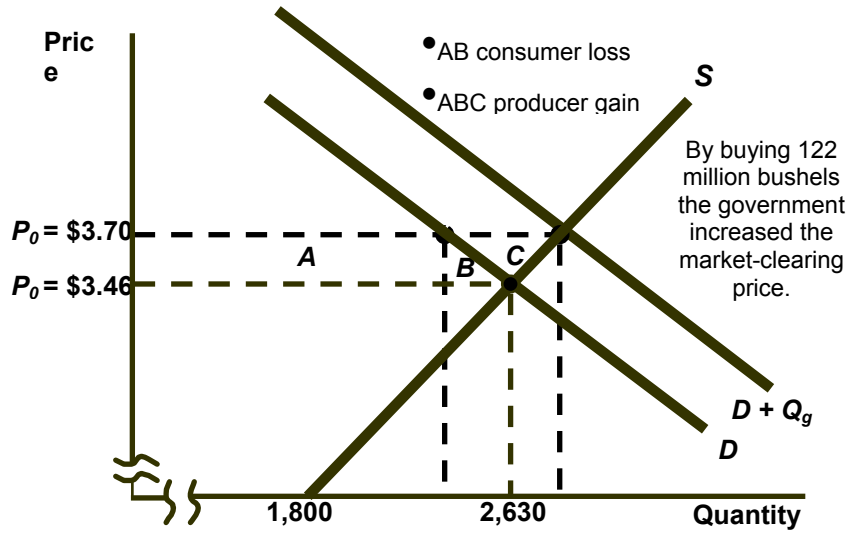
Supporting the Price of Wheat

- 1981
  - Change in consumer surplus=(-A -B)

A = (3.70 - 3.46)(2,566) = $616 million

B = (1/2)(3.70 - 3.46)(2,630 - 2,566)

= $8 million

- Change in consumer surplus: -$624 million.
  - Cost to the government:
    $3.70 x 122 million bushels = $452 million
  - Total cost = $624 + 452 = $1,076 million
  - Total gain = A + B + C = $638 million
  - Government also paid 30 cents/bushel = $806 million

The Wheat Market in 1985

Price

S

S

Q

To increase the price to $3.20, the government bought 466 million bushels and imposed a production quota of 2,425 bushels.

$P_0 = \$3.20$

$P_0 = \$1.80$

D +

D

1,80 1,95   2,23 2,42   **Quantity**
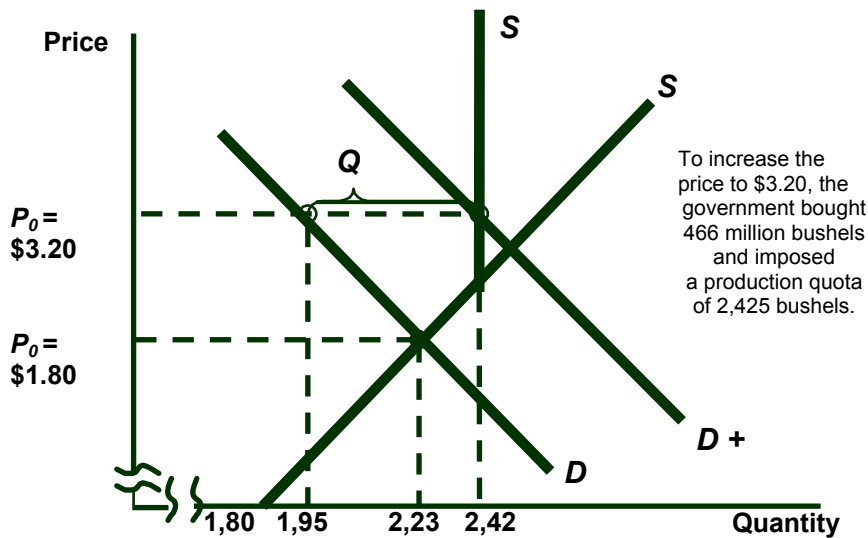
1985
  – Government Purchase:
    • Government cost = $3.20 x 466 = $1,491million
    • 80 cent subsidy = .80 x 2,425 = $1,940 million
    • Total cost = $3.5 billion

Import Quotas and Tariffs

◆ Many countries use import quotas and tariffs to keep the domestic price of a product above world levels
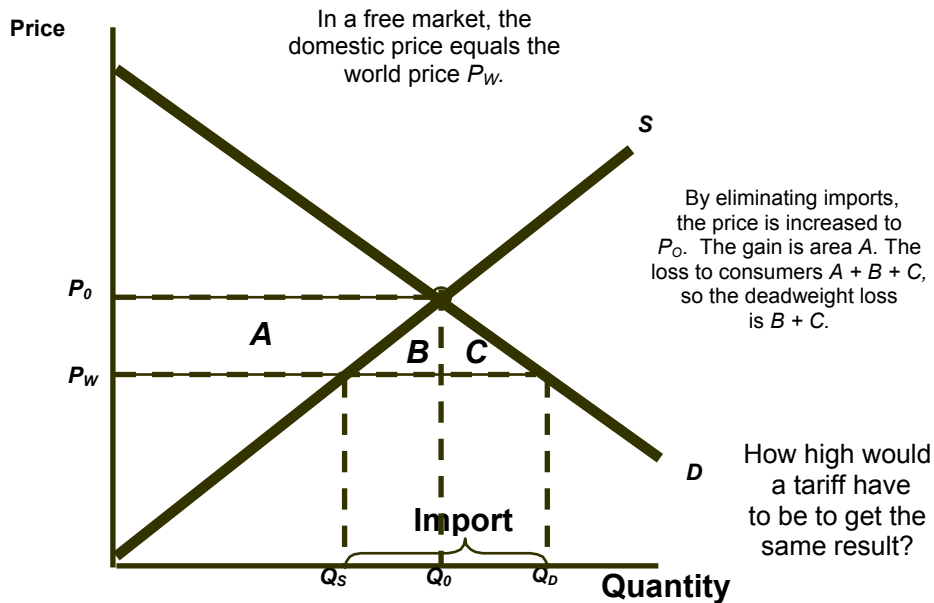
Import Tariff or Quota That Eliminates Imports

In a free market, the domestic price equals the world price P_W.

By eliminating imports, the price is increased to P_O. The gain is area A. The loss to consumers A + B + C, so the deadweight loss is B + C.

How high would a tariff have to be to get the same result?

◆ The increase in price can be achieved by a quota or a tariff.
◆ Area A is again the gain to domestic producers.
◆ The loss to consumers is A + B + C + D.
◆ If a tariff is used the government gains D, so the net domestic product loss is B + C.
◆ If a quota is used instead, rectangle D becomes part of the profits of foreign producers, and the net domestic loss is B + C + D.
◆ Question:
  – Would a country be better off or worse off with a quota instead of a tariff?

—

The Sugar Quota

◆ The world price of sugar has been as low as 4 cents per pound, while in the U.S. the price has been 20-25 cents per pound.
◆ The Impact of a Restricted Market (1997)
   − U.S. production = 15.6 billion pounds
   − U.S. consumption = 21.1 billion pounds
   − U.S. price = 22 cents/pound
   − World price = 11 cents/pound

Sugar Quota in 1997

Sugar Quota in 1997

The cost of the quotas to consumers was A + B + C + D, or $2.4b. The gain to producers was area A, or $1b.

P_{US} = 21.9
P_W = 11
Q_d = 24.2
Q_S = 4.0
Q'_S = 15.6
Q'_d = 21.1

Rectangle D was the gain to foreign producers who obtained quota allotments, or $600 million. Triangles B and C represent the deadweight loss of $800 million.

P_{US} = 21.9
P_W = 11
Q_d = 24.2
Q_S = 4.0
Q'_S = 15.6
Q'_d = 21.1
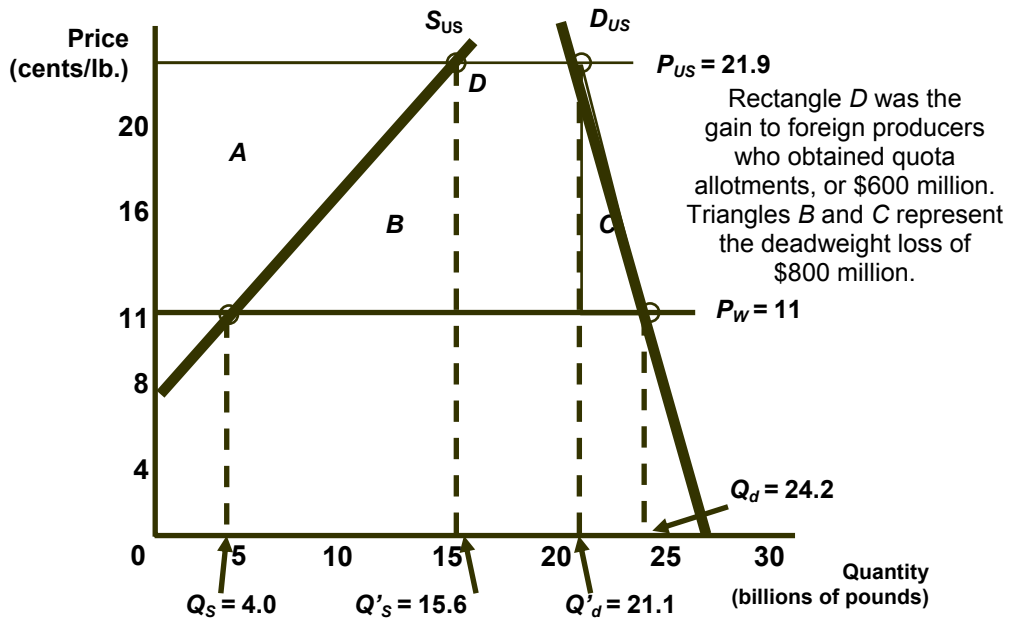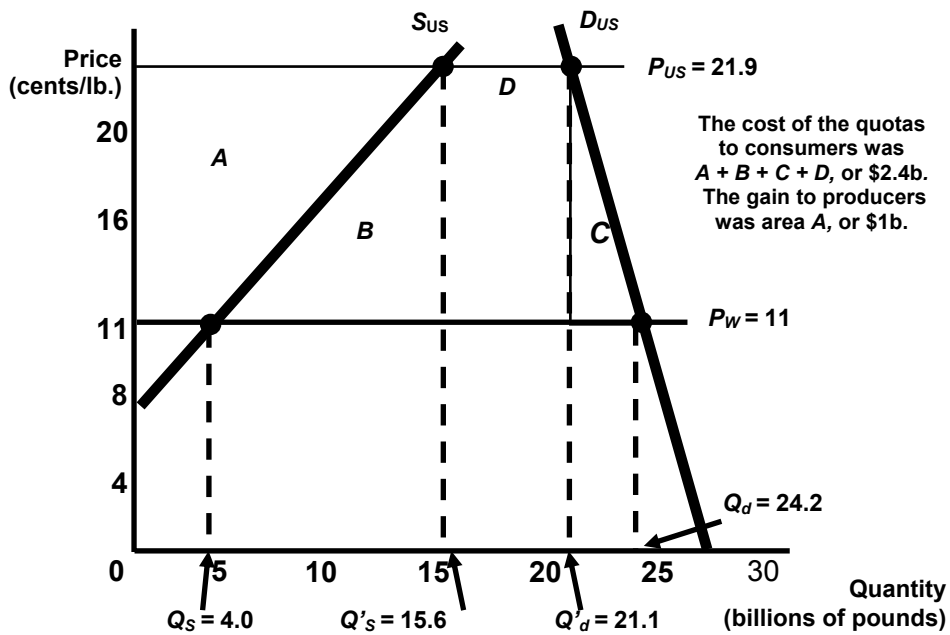
The Impact of a Tax or Subsidy

◆ The burden of a tax (or the benefit of a subsidy) falls partly on the consumer and partly on the producer.
◆ We will consider a specific tax which is a tax of a certain amount of money per unit sold.

Incidence of a Specific Tax

P_b is the price (including the tax) paid by buyers.
P_S is the price sellers receive, net of the tax. The burden of the tax is split evenly.

Buyers lose $A + B$, and sellers lose $D + C$, and the government earns $A + D$ in revenue. The deadweight loss is $B + C$.
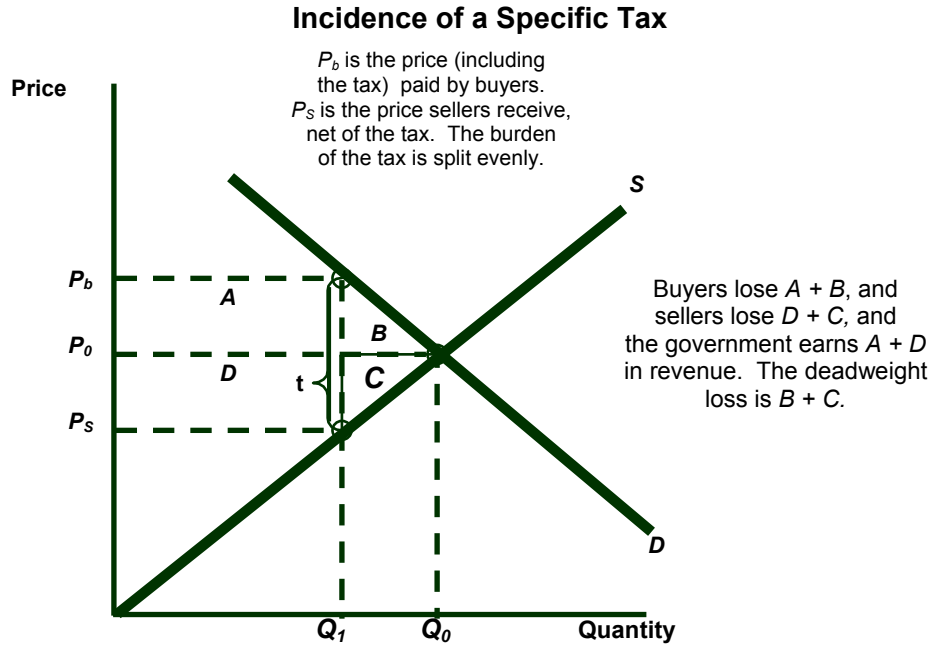
◆ Four conditions that must be satisfied after the tax is in place:
   1. Quantity sold and P_b must be on the demand line: $Q^D = Q^D(P_b)$
   2. Quantity sold and P_S must be on the supply line: $Q^S = Q^S(P_S)$
   3. $Q^D = Q^S$
   4. $P_b - P_S = $ tax

Impact of Tax Depends on Elasticities of Supply & Demand
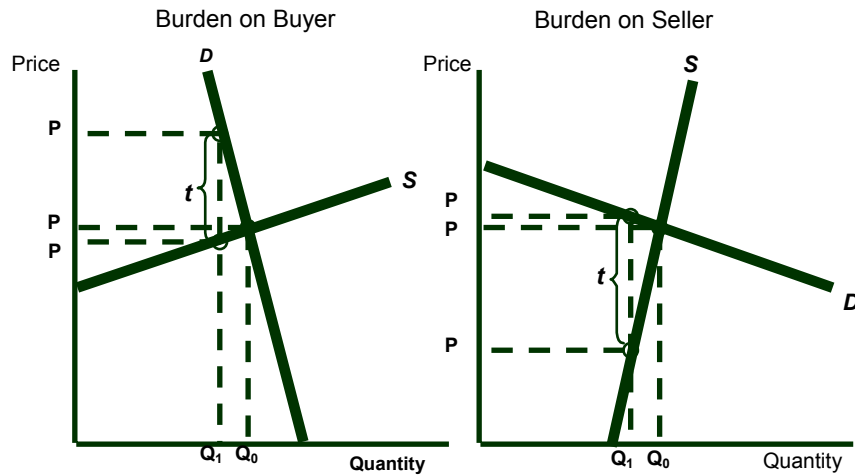
The Impact of a Tax or Subsidy

- Pass-through fraction
  - $E_S/(E_S - E_d)$
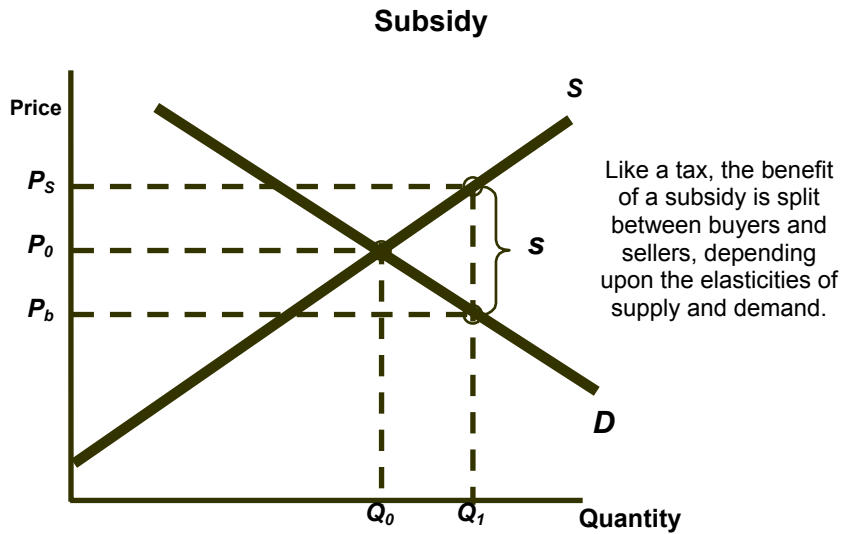 - For example, when demand is perfectly inelastic ($E_d = 0$), the pass-through fraction is 1, and all the tax is borne by the consumer.
- A subsidy can be analyzed in much the same way as a tax.
- It can be treated as a negative tax.
- The seller's price exceeds the buyer's price.

Subsidy

Like a tax, the benefit of a subsidy is split between buyers and sellers, depending upon the elasticities of supply and demand.

- With a subsidy (s), the selling price P_b is below the subsidized price P_S so that:
  - $s = P_S - P_b$
- The benefit of the subsidy depends upon E_d/E_S.
  - If the ratio is small, most of the benefit accrues to the consumer.
  - If the ratio is large, the producer benefits most.

Impact of a $0.50 Gasoline Tax

The annual revenue from the tax is .50(89) or $44.5 billion. The buyer pays 22 cents of the tax, and the producer pays 28 cents.

Price
($ per
gallon)   **1.50**

$P_b = 1.22$

**Lost
Consumer**

A

$P_0 = 1.00$

Deadweight loss = $2.75 billion/yr

D t = 0.50

$P_S = .72$

**Lost
Producer**

.50

D   **S**

1

0   **50 60**   **89 100**   **150**   Quantity (billion
gallons per year)
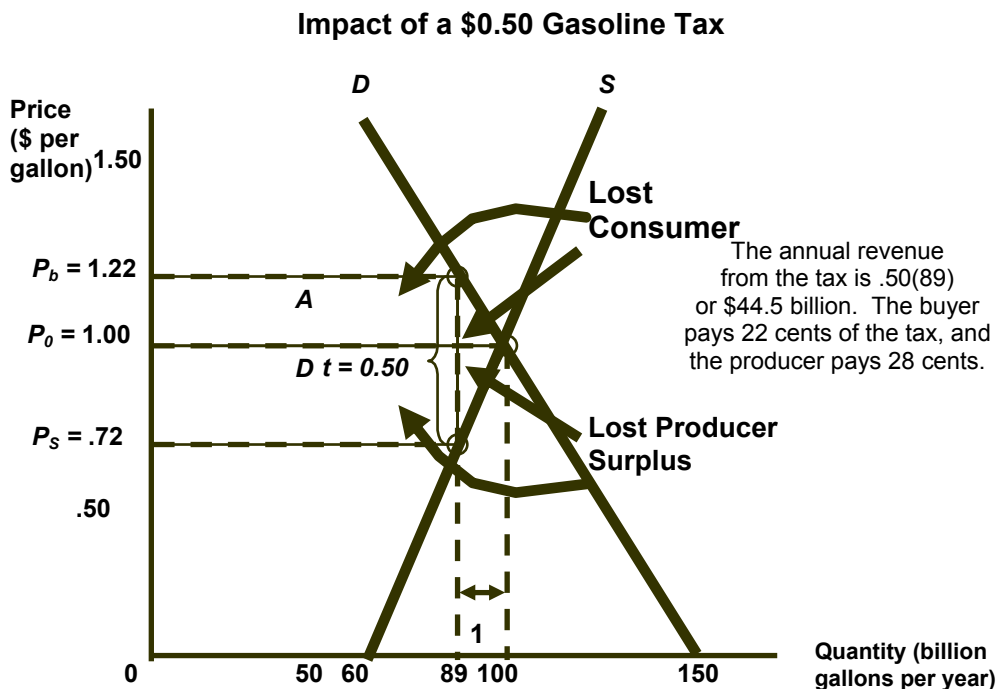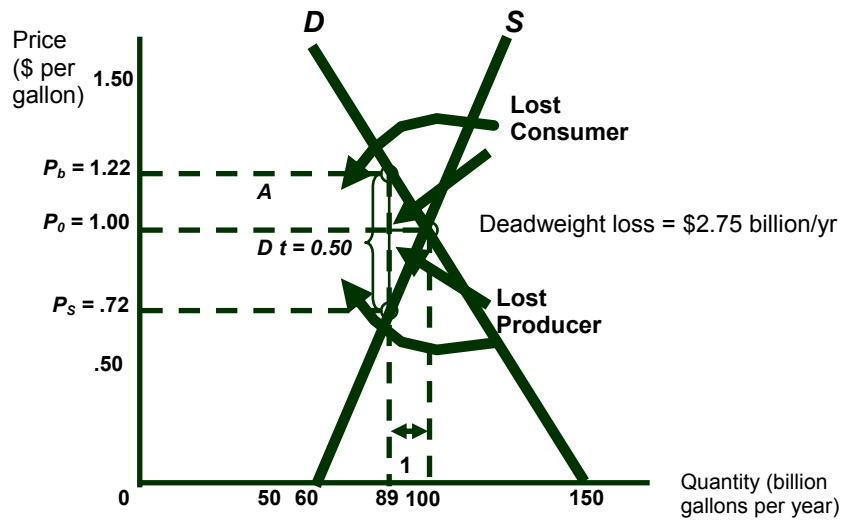
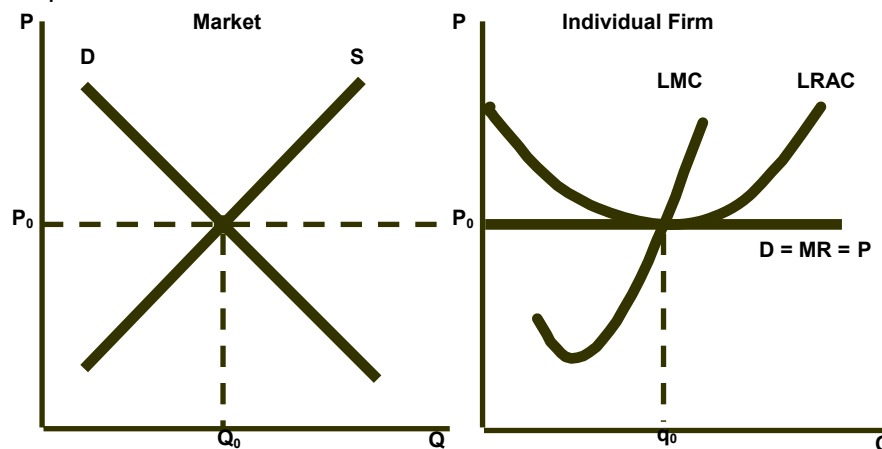**Perfect Competition**

♦ Review of Perfect Competition
  – P = LMC = LRAC
  – Normal profits or zero economic profits in the long run
  – Large number of buyers and sellers
  – Homogenous product
  – Perfect information
  – Firm is a price taker

Monopoly

♦ Monopoly

  1) One seller - many buyers

  2) One product (no good substitutes)

  3) Barriers to entry

♦ The monopolist is the supply-side of the market and has complete control over the amount offered for sale.
♦ Profits will be maximized at the level of output where marginal revenue equals marginal cost.
♦ Finding Marginal Revenue
  – As the sole producer, the monopolist works with the market demand to determine output and price.
  – Assume a firm with demand:

    • $P = 6 - Q$

Total, Marginal, and Average Revenue

Price P	Total Quantity Q	Marginal Revenue R	Average Revenue MR	Revenue AR
$6	0	$0	---	---
5	1	5	$5	$5
4	2	8	3	4
3	3	9	1	3
2	4	8	-1	2
1	5	5	-3	1
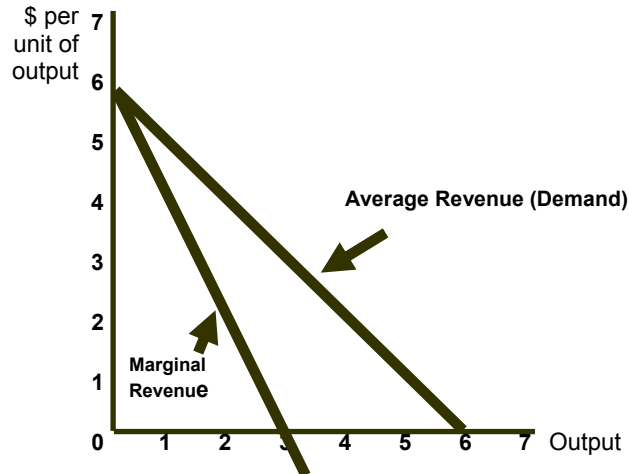
◆ Observations

    1) To increase sales the price must fall

    2) MR < P

    3) Compared to perfect competition

    • No change in price to change sales

    • MR = P

◆ Monopolist's Output Decision

    1) Profits maximized at the output level where MR = MC

    2) Cost functions are the same

$$\pi(Q) = R(Q) - C(Q)$$
$$\Delta\pi / \Delta Q = \Delta R / \Delta Q - \Delta C / \Delta Q = 0 = MC - MR$$
$$or\ MC = MR$$

Maximizing Profit When Marginal Revenue Equals Marginal Cost

◆ The Monopolist's Output Decision

 − At output levels below MR = MC the decrease in revenue is greater than the decrease in cost (MR > MC).

 − At output levels above MR = MC the increase in cost is greater than the decrease in revenue (MR < MC)
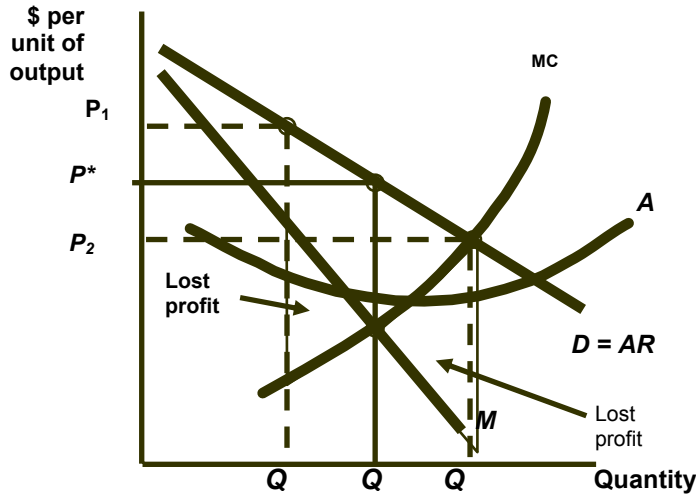
Monopoly

◆ The Monopolist's Output Decision

 − An Example

  • By setting marginal revenue equal to marginal cost, it can be verified that profit is maximized at P = \$30 and Q = 10.

  • This can be seen graphically:

Example of Profit Maximization

◆

◆
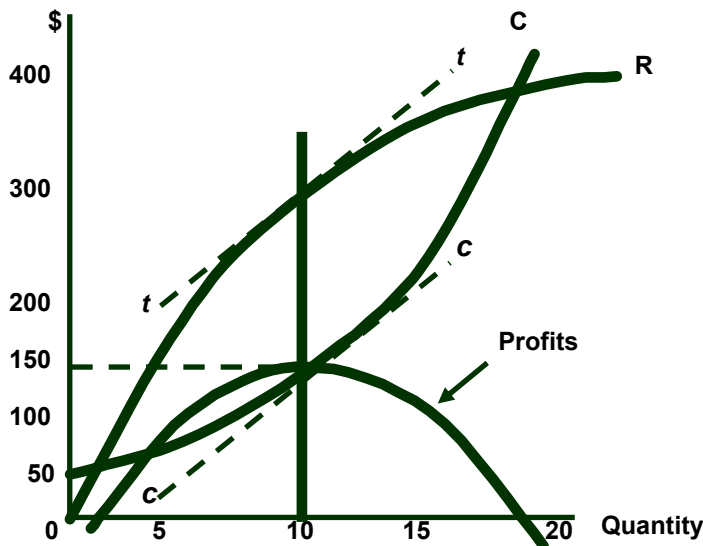
- ◆
- ◆ Observations
    - – Slope of *rr'* = slope *cc'* and they are parallel at 10 units
    - – Profits are maximized at 10 units
    - – P = $30, Q = 10,   TR = P x Q= $300
    - – AC = $15, Q = 10,   TC = AC x Q = 150
        - – Profit = TR - TC
            - • $150 = $300 - $150

$/Q

MC

AC

Profit

AR

MR

Quantity
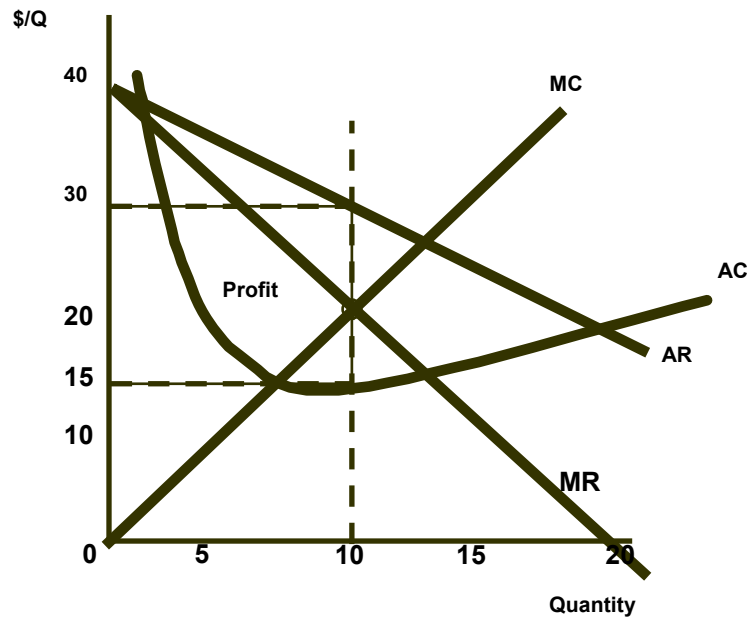
- ◆ Observations

    - ▬ AC = $15, Q = 10,   TC = AC x Q =150

    - ▬ Profit = TR = TC = $300 - $150= $150 or

    - ▬ Profit = (P-AC) x Q = ($30 -$15)(10)   = $150

 ◆ A Rule of Thumb for Pricing
   – We want to translate the condition that marginal revenue should equal marginal cost into a rule of thumb that can be more easily applied in practice.
   – This can be demonstrated using the following steps:

$1. \; MR \; = \dfrac{\Delta R}{\Delta Q} = \dfrac{\Delta(PQ)}{\Delta Q}$

$2. \; MR \; = P + Q\,\dfrac{\Delta P}{\Delta Q} = P + P\left(\dfrac{Q}{P}\right)\left(\dfrac{\Delta P}{\Delta Q}\right)$

$3. \; E_d \; = \left(P/Q\right)\left(\Delta Q/\Delta P\right)$

$4. \; \left(Q/P\right)\left(\Delta P/\Delta Q\right) = \dfrac{1}{E_d}$

$5. \; MR \; = \; P \; + P\left(\dfrac{1}{E_d}\right)$

$6. \; \pi$ is maximized @ MR = MC

$$P + P\left[\dfrac{1}{E_D}\right] = -\dfrac{1}{E_D}$$

$$P = \dfrac{MC}{1 + (1/E_D)}$$

$7. \; -\dfrac{1}{E_d}$ = the markup over MC as a percentage of price (P-MC)/P

8. The markup should equal the inverse of the elasticity of demand.

$9. \; P = \dfrac{MC}{1 + \left(1/E_d\right)}$

Assume

$E_d = -4 \quad MC = 9$

$P = \dfrac{9}{1 + \left(1/{-4}\right)} = \dfrac{9}{.75} = \$12$

 ◆   Monopoly pricing compared to perfect competition pricing:
   –   Monopoly
        P > MC
   –   Perfect Competition
        P = MC
 ◆ Monopoly pricing compared to perfect competition pricing:

   – The more elastic the demand the closer price is to marginal cost.
   – If E_d is a large negative number, price is close to marginal cost and vice versa.

A Monopolist's Pricing

* The Monopolist's Output Decision
    – Price of Medicine A = $3.50/daily dose
    – Price of Medicine B and Medicine C = $1.50 - $2.25/daily dose
    – MC of Medicine A = 30 - 40 cents/daily dose
♦The Monopolist's Output Decision

$$P = \frac{MC}{1 + \left[1/E_D\right]} = \frac{.35}{1 + \left[1/-1.1\right]} =$$

$$\frac{MC}{1 + \left(-.91\right)} = \frac{.35}{.09} = \$3.89$$

♦Price of $3.50 is consistent with "the rule of thumb pricing"
* Shifts in Demand
    – In perfect competition, the market supply curve is determined by marginal cost.
    – For a monopoly, output is determined by marginal cost and the shape of the demand curve.

Shift in Demand Leads to Change in Price but Same Output
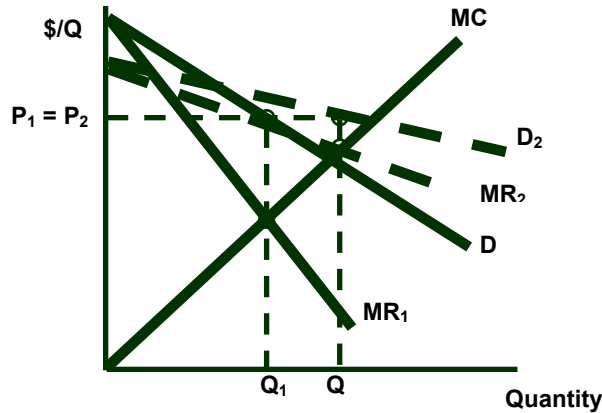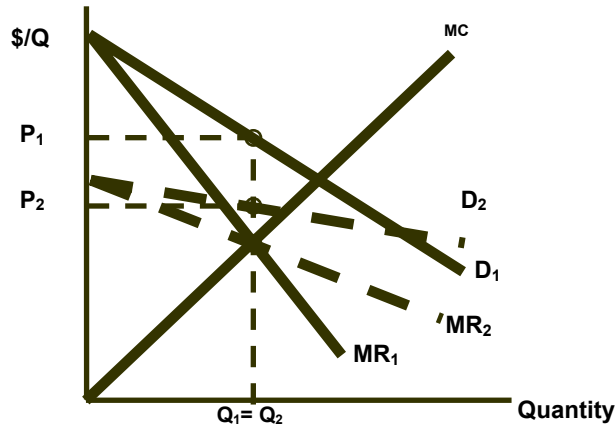
Monopoly

- Observations
  - Shifts in demand usually cause a change in both price and quantity.
  - A monopolistic market has no supply curve.
  - Monopolist may supply many different quantities at the same price.
  - Monopolist may supply the same quantity at different prices.
- The Effect of a Tax
  - Under monopoly price can sometimes rise by *more* than the amount of the tax.
- To determine the impact of a tax:
  - t = specific tax
  - MC = MC + t
  - MR = MC + t : optimal production decision

Effect of Excise Tax on Monopolist
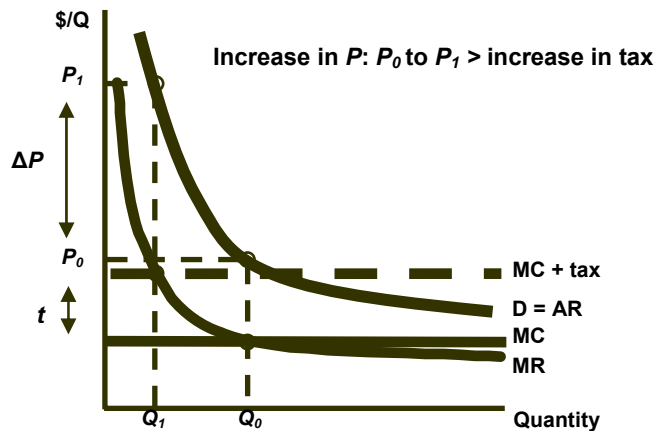
- Question
  - Suppose: E_d = -2
  - How much would the price change?
- Answer

$$P = \frac{MC}{1 + \left(\dfrac{1}{E_d} \right)}$$

If $E_d = -2 \rightarrow P = 2\,MC$

If MC increases to $MC + t$

$\Delta P = 2(MC + t) = 2\,MC + 2t$

Price increases by twice the tax.

- What would happen to profits?

Monopoly

- ◆ The Multiplant Firm
  - – For many firms, production takes place in two or more different plants whose operating cost can differ.
  - – Choosing total output and the output for each plant:
    - • The marginal cost in each plant should be equal.
    - • The marginal cost should equal the marginal revenue for each plant.
  - – Algebraically:

$$Q_1 \text{ \& } C_1 \Rightarrow \text{Output \& Cost for Plant 1}$$

$$Q_2 \text{ \& } C_2 \Rightarrow \text{Output \& Cost for Plant 2}$$

$$- \quad \text{Total Output} = Q_T = Q_1 + Q_2$$

  - – Algebraically:

$$\pi = PQ_T - C_1(Q_1) - C_2(Q_2)$$

$$\frac{\Delta \pi}{\Delta Q_1} = \frac{\Delta(PQ_T)}{\Delta Q_1} - \frac{\Delta C_1}{\Delta Q_1} = 0$$

$$(MR)\frac{\Delta(PQ_T)}{\Delta Q_1} - (MC)\frac{\Delta C_1}{\Delta Q_1} = 0$$

$$MR = MC_1$$

$$MR - MC_1$$

$$MR = MC_2$$

$$MR = MC_1 = MC_2$$
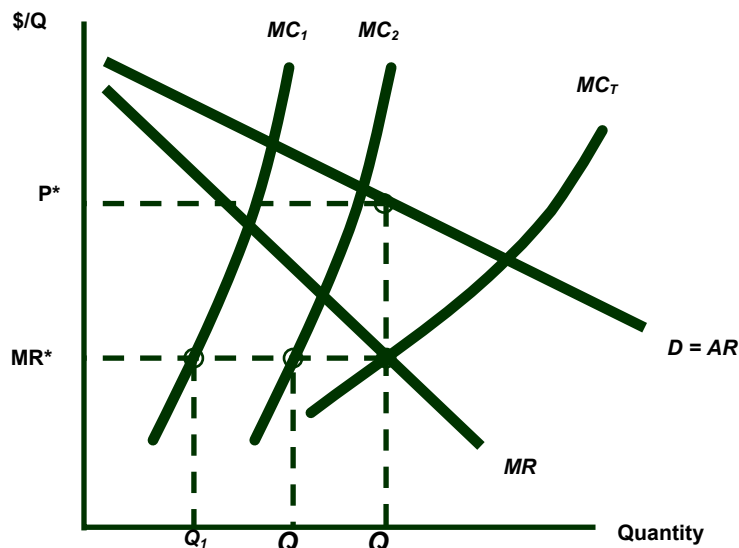
◆   Observations:
    1) $MC_T = MC_1 + MC_2$
    2)   Profit maximizing
    output:

- $MC_T = MR$ at Q_T and P^*
- $MR = MR^*$
- $MR^* = MC_1$ at Q_1, $MR^* = MC_2$ at Q_2
- $MC_1 + MC_2 = MC_T$, $Q_1 + Q_2 = Q_T$, and $MR = MC_1 + MC_2$
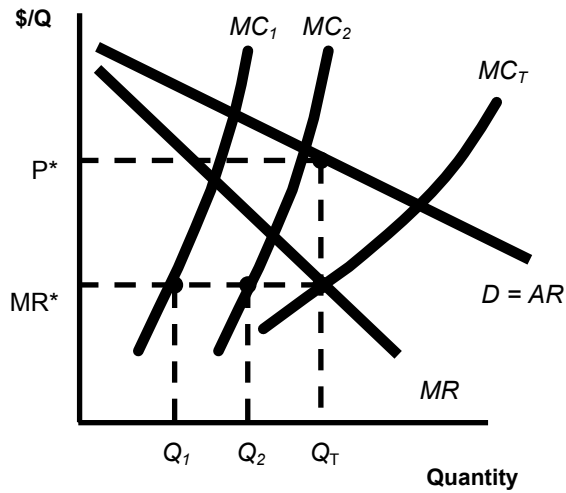
Monopoly Power

- Monopoly is rare.
- However, a market with several firms, each facing a downward sloping demand curve will produce so that price exceeds marginal cost.
- Scenario:
    - Four firms with equal share (5,000) of a market for 20,000 toothbrushes at a price of $1.50.

The Demand for Toothbrushes
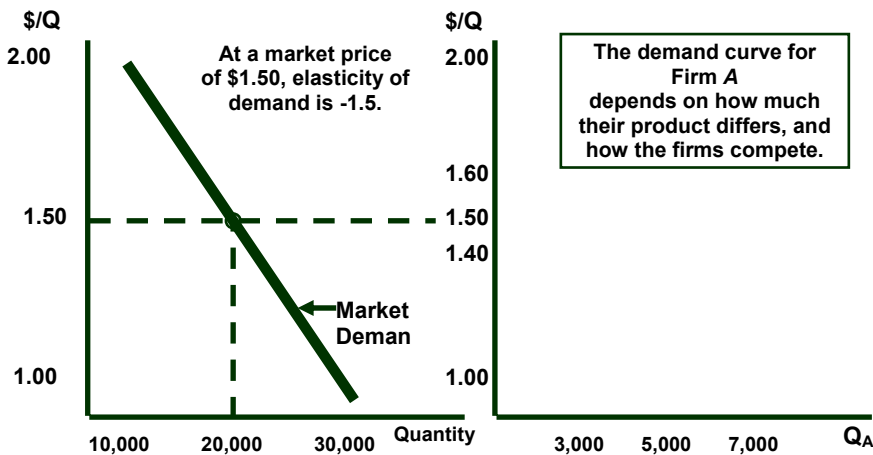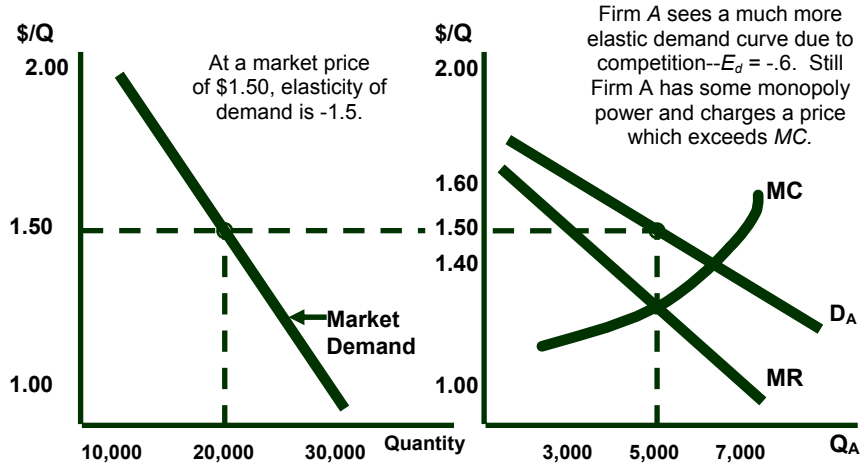
- ◆ Measuring Monopoly Power
    - – In perfect competition: *P = MR = MC*
    - – Monopoly power: *P > MC*
- ◆ Lerner's Index of Monopoly Power
    - – L = (P - MC)/P
        - • The larger the value of *L* (between 0 and 1) the greater the monopoly power.
    - – *L* is expressed in terms of E_d
        - • L = (P - MC)/P = $-1/E_d$
        - • E_d is elasticity of demand for a firm, not the market
- ◆ Monopoly power does not guarantee profits.
- ◆ Profit depends on average cost relative to price.
- ◆ The Rule of Thumb for Pricing

$$ P = \frac{MC}{1 + \left(1 \big/ E_d\right)} $$

- – Pricing for any firm with monopoly power
    - • If E_d is large, markup is small
    - • If E_d is small, markup is large

Elasticity of Demand and Price Markup
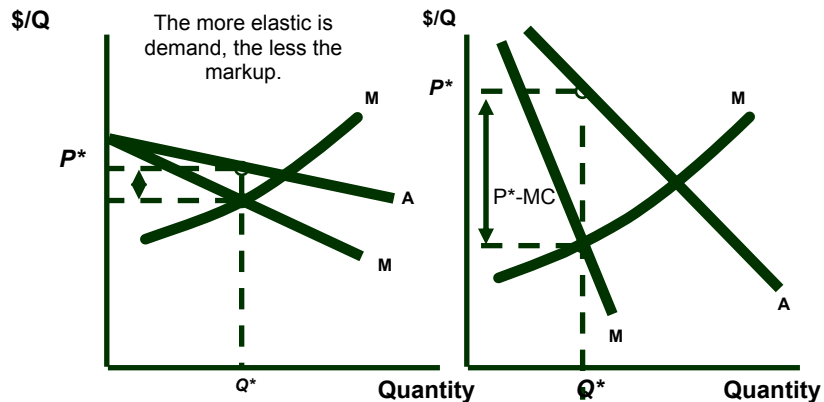
Markup Pricing: Supermarkets to Designer Jeans

◆   Supermarkets
  –   Several firms
  –   Similar product
  – E_d = -10 for individual stores
  – $P = \dfrac{MC}{1+\left(1/-.1\right)} = \dfrac{MC}{0.9} = 1.11(MC)$

  –   Prices set about 10 – 11% above MC.
◆   Convenience Stores
  –   Higher prices than supermarkets
  –   Convenience differentiates them
  – E_d = -5
  – $P = \dfrac{MC}{1+\left(1/-5\right)} = \dfrac{MC}{0.8} = 1.25(MC)$

  –   Prices set about 25% above MC.
  – Convenience stores have more monopoly power.
  – Question:

      • Do convenience stores have higher profits than supermarkets?
  – Designer jeans
E_d = -3 to -4

      • Price 33 - 50% > *MC*

      • *MC* = $12 - $18/pair

      • Wholesale price = $18 - $27

Sources of Monopoly Power

◆ Why do some firm's have considerable monopoly power, and others have little or none?
◆ A firm's monopoly power is determined by the firm's elasticity of demand.
◆ The firm's elasticity of demand is determined by:

    1) Elasticity of market demand

    2) Number of firms

    3) The interaction among firms

The Social Costs of Monopoly Power

◆ Monopoly power results in higher prices and lower quantities.
◆ However, does monopoly power make consumers and producers in the aggregate better or worse off?

Deadweight Loss from Monopoly Power
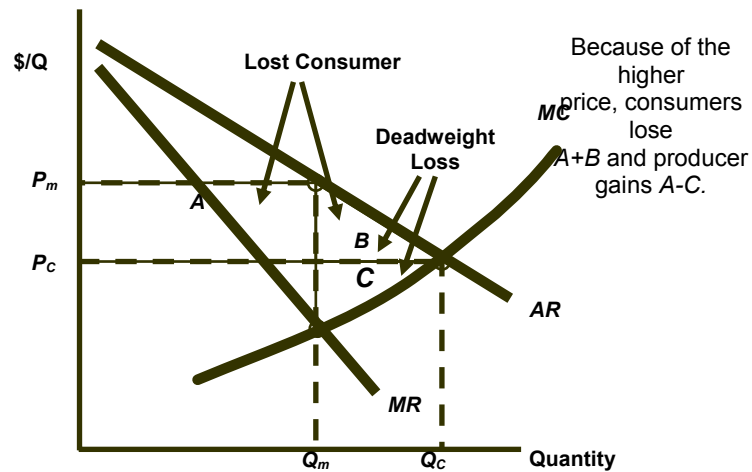
◆ Rent Seeking
  – Firms may spend to gain monopoly power

    • Lobbying

    • Advertising

    • Building excess capacity
◆ The incentive to engage in monopoly practices is determined by the profit to be gained.
◆ The larger the transfer from consumers to the firm, the larger the social cost of monopoly.
◆ Price Regulation
  – Recall that in competitive markets, price regulation created a deadweight loss.
◆ Question:
  – What about a monopoly?

Price Regulation

$/Q

MR

Marginal revenue curve
when price is regulated
to be no higher that P_1.

P_m

P_1

MC

$P_2 = P_C$

AC

P_3

**If price is lowered to P_3 output
decreases and a shortage exists.**

AR

**If left alone, a monopolist
produces Q_m and charges P_m.**

Q_m Q_1 Q_3 Q_c Q'_3 Quantity
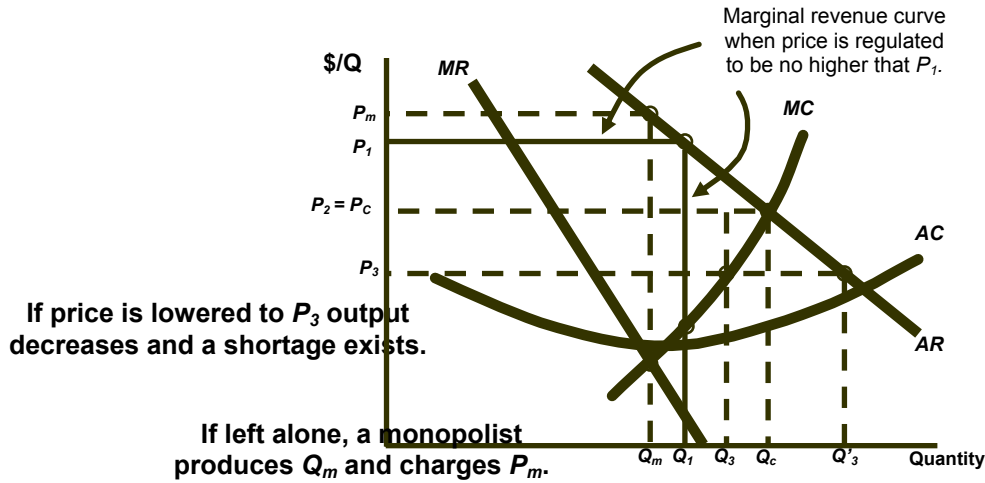
◆ Natural Monopoly
  – A firm that can produce the entire output of an industry at a cost lower than what it would
    be if there were several firms.

**Regulating the Price
of a Natural Monopoly**

$/Q

**Natural monopolies occur
because of extensive
economies of scale**

Quantity
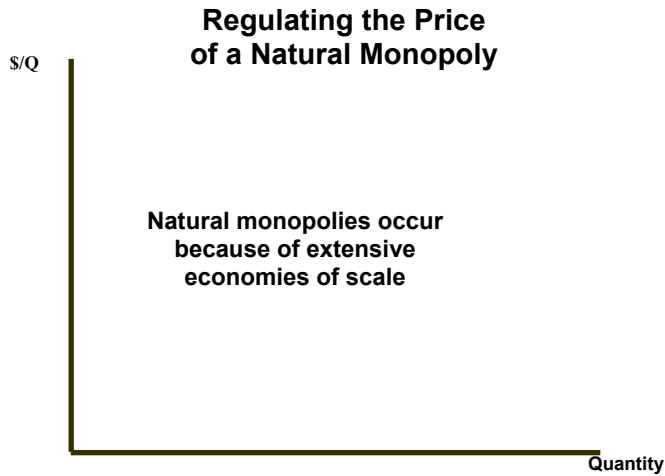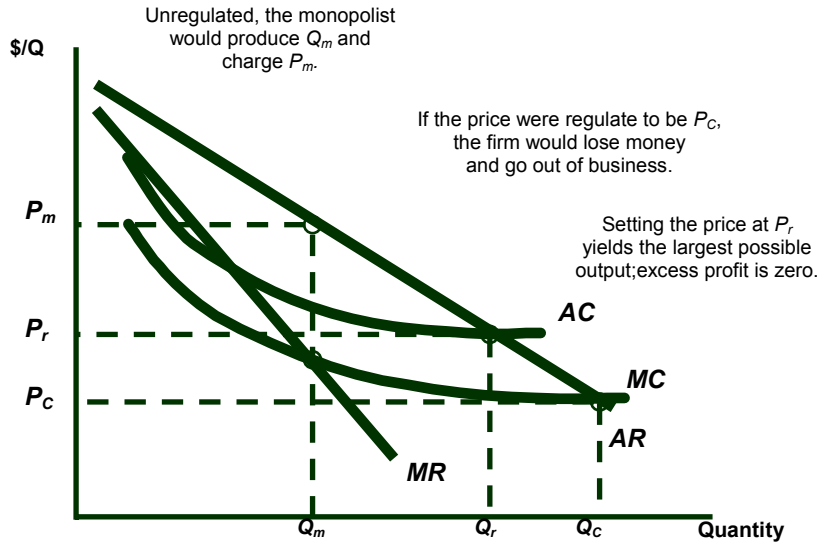
- ◆ Regulation in Practice
  - – It is very difficult to estimate the firm's cost and demand functions because they change with evolving market conditions
  - – An alternative pricing technique---rate-of-return regulation allows the firms to set a maximum price based on the expected rate or return that the firm will earn.
    - • P = AVC + (D + T + sK)/Q, where
      - − P = price, AVC = average variable cost
      - − D = depreciation, T = taxes
      - − s = allowed rate of return, K = firm's capital stock

Monopsony

- ◆ A monopsony is a market in which there is a single buyer.
- ◆ Monopsony power is the ability of the buyer to affect the price of the good and pay less than the price that would exist in a competitive market.
- ◆ Competitive Buyer
  - – Price taker
  - – P = Marginal expenditure = Average expenditure
  - – D = Marginal value

Competitive Buyer: Compared to Competitive Seller
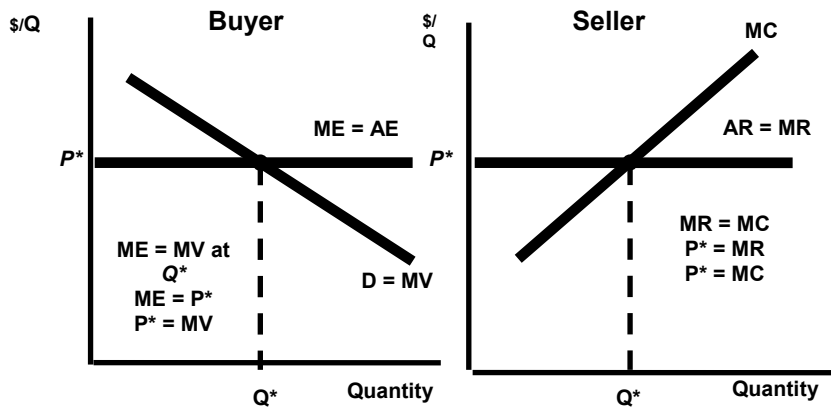
Monopsonist Buyer

The market supply curve is the monopsonist's average expenditure curve

$/Q

Monopsony

- **ME > P & above S**

P_C

Competitive

$P*_m$

- **P = P_C**

- **Q = Q_C**

ME

S = AE

MV

$Q*_m$ Q_C   **Quantity**

$/Q

Monopoly
Note: MR = MC;
AR > MC; P > MC **MC**

P*

P_c

AR

MR

Q*   **Q_C**   Quantity

Monopoly and Monopsony

$/Q

ME

Monopsony
Note: ME = MV;
ME > AE; MV > P

S = AE

P_C

P*

MV
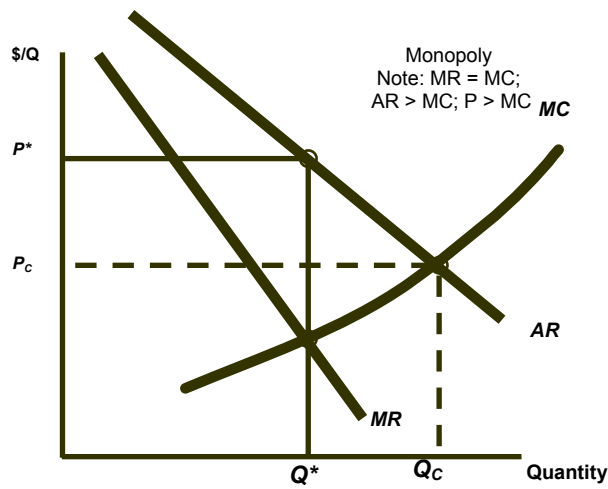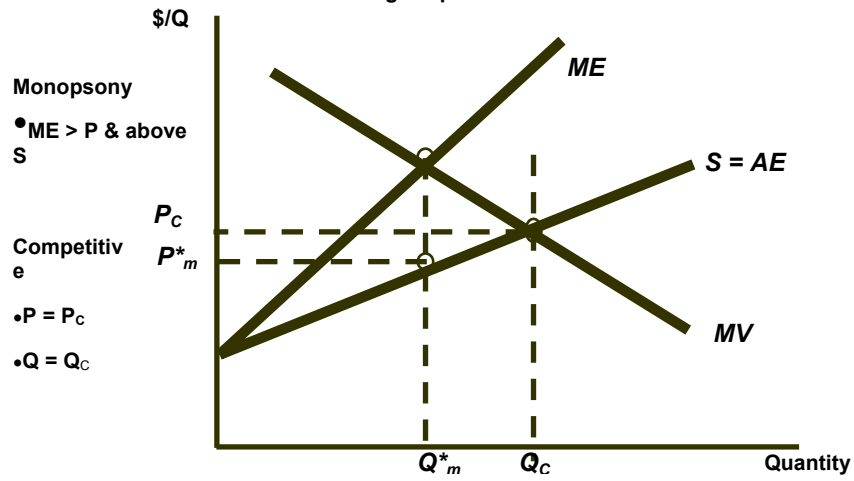
Q*   **Q_C**   **Quantity**
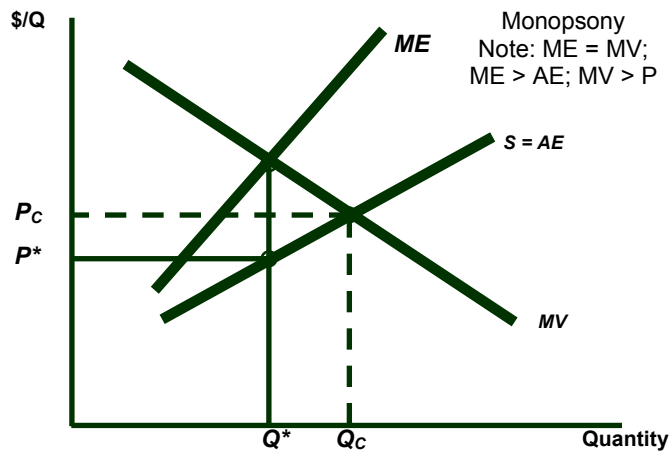
- Monopoly
    - $MR < P$
    - $P > MC$
    - $Q_m < Q_C$
    - $P_m > PC$

- Monopsony
    - $ME > P$
    - $P < MV$
    - $Q_m < Q_C$
    - $P_m < P_C$

Monopsony Power

◆A few buyers can influence price (e.g. automobile industry).
◆Monopsony power gives them the ability to pay a price that is less than marginal value.
◆The degree of monopsony power depends on three similar factors.

      1) Elasticity of market supply

●The less elastic the market supply, the greater the monopsony power.

      2) Number of buyers

●The fewer the number of buyers, the less elastic the supply and the greater the monopsony power.

      3) Interaction Among Buyers

●The less the buyers compete, the greater the monopsony power.

Monopsony Power:
If the Elastic versus Inelastic Supply
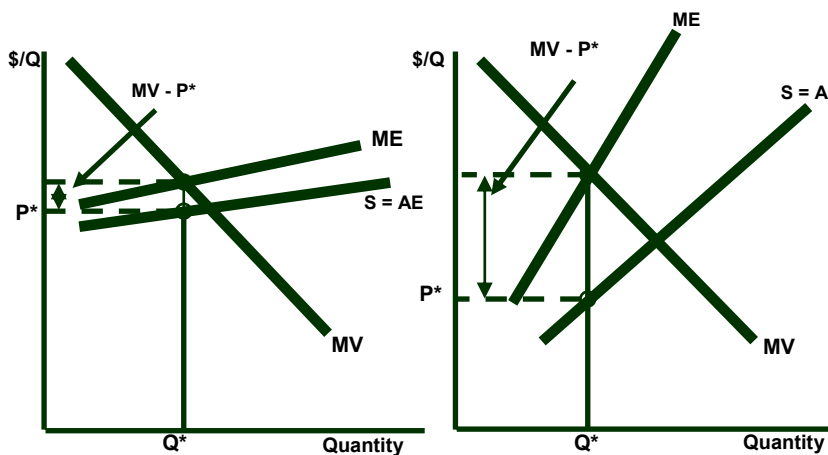
Deadweight Loss from Monopsony Power in the
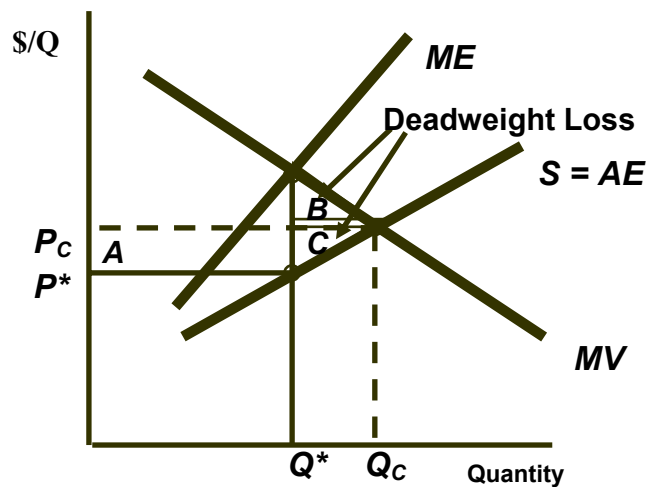
- ◆ Determining the deadweight loss in monopsony
  - – Change in seller's surplus = -A-C
  - – Change in buyer's surplus = A - B
  - – Change in welfare = -A - C + A - B = -C - B
  - – Inefficiency occurs because less is purchased
- ◆ The Social Cost of Monopsony Power

  - ▬ Bilateral Monopoly

    - • Bilateral monopoly is rare, however, markets with a small number of sellers with monopoly power selling to a market with few buyers with monopsony power is more common.

  - ▬ Question

    - • In this case, what is likely to happen to price?

Limiting Market Power: The Antitrust Laws

- ◆ Antitrust Laws:

  - ▬ Promote a competitive economy

  - ▬ Rules and regulations designed to promote a competitive economy by:

    - • Prohibiting actions that restrain or are likely to restrain competition

    - • Restricting the forms of market structures that are allowable

Pricing With Market Power

- ◆ Pricing without market power (perfect competition) is determined by market supply and demand.
- ◆ The individual producer must be able to forecast the market and then concentrate on managing production (cost) to maximize profits.
- ◆ Pricing with market power (imperfect competition) requires the individual producer to know much more about the characteristics of demand as well as manage production.

Capturing Consumer Surplus

Between 0 and Q*, consumers will pay more than P*--consumer surplus (A).

P_C is the price that would exist in a perfectly competitive

If price is raised above P*, the firm will lose sales and reduce profit.

Beyond Q*, price will have to fall to create a consumer surplus (B).
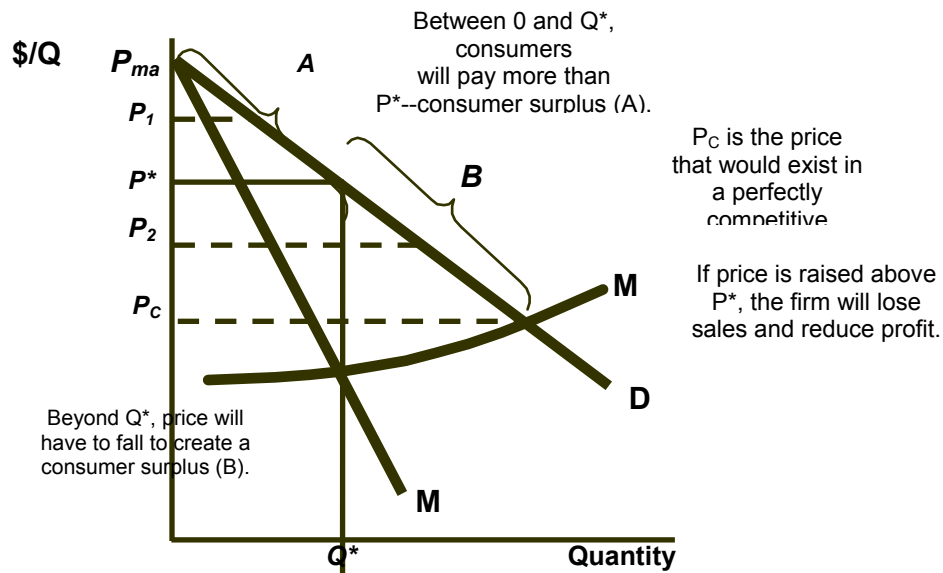
Capturing Consumer Surplus

- P*Q*: single *P* & *Q* @ *MC=MR*

- *A:* consumer surplus with *P**

- *B: P>MC* & consumer would buy
    at a lower price

- P_1: less sales and profits

- P_2 : increase sales & and reduce
      revenue and profits

- P_C: competitive price

Question How can the firm capture the consumer surplus in *A* and sell profitably in *B?*

Answer Price discrimination Two-part tariffs Bundling

◆ Price discrimination is the charging of different prices to different consumers for similar goods.

Price Discrimination

◆ First Degree Price Discrimination
  − Charge a separate price to each customer: the maximum or *reservation price* they are willing to pay.

Additional Profit From Perfect First-Degree Price Discrimination

Without price discrimination, output is Q* and price is P*. Variable profit is the area between the MC & MR.

$/Q   **P_max**

Consumer surplus is the area above P* and between 0 and Q* output.

MC

*P**

With perfect discrimination, each consumer pays the maximum price they are willing to pay.

P_C

D = AR

Output expands to Q** and price falls to P_C where MC = MR = AR = D.Profits increase by the area above MC between old MR and D to output Q**

MR

*Q**   *Q***   **Quantity**

With perfect discrimination

- Each customer pays their reservation price
- Profits increase

- ◆ Question
  - – Why would a producer have difficulty in achieving first-degree price discrimination?
- ◆ Answer
1) Too many customers (impractical)
2) Could not estimate the reservation price for each customer
- ◆ First Degree Price Discrimination
  - – The model does demonstrate the potential profit (incentive) of practicing price discrimination to some degree.
  - – Examples of imperfect price discrimination where the seller has the ability to segregate the market to some extent and charge different prices for the same product:
    - – Lawyers, doctors, accountants
    - – Car salesperson (15% profit margin)
    - – Colleges and universities

First-Degree Price Discrimination in Practice

Six prices exist resulting in higher profits. With a single price P^*_4, there are few consumers and those who pay P_5 or P_6 may have a surplus.

Second-Degree Price Discrimination

Second-degree price discrimination is pricing according to quantity consumed--or in blocks.

Without discrimination: $P = P_0$ and $Q = Q_0$. With second-degree discrimination there are three prices P_1, P_2, and P_3. (e.g. electric utilities)
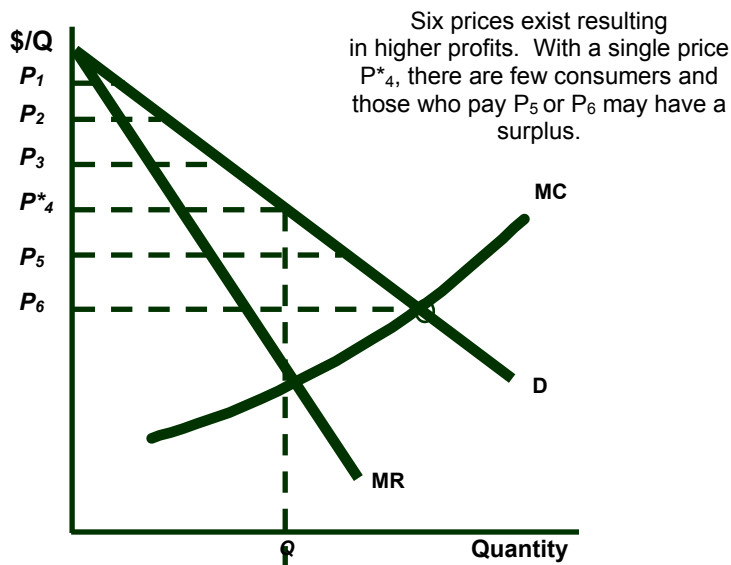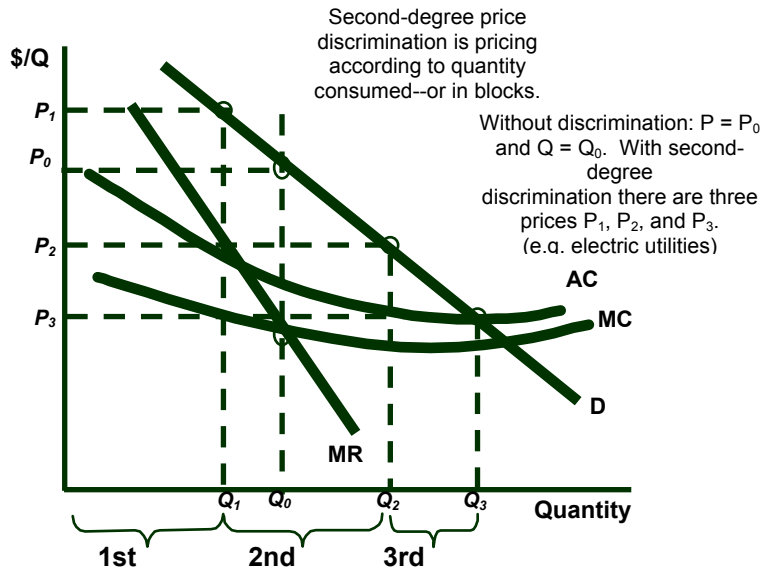
Economies of scale permit:

•Increase consumer welfare

•Higher profits

-

◆ Third Degree Price Discrimination

    1) Divides the market into two-groups.

    2) Each group has its own demand function.

    3) Most common type of price discrimination.

    − Examples: airlines, vegetables, discounts to students and senior citizens.

    4) Third-degree price discrimination is feasible when the seller can separate his/her market into groups who have different price elasticities of demand.

    (e.g. business air travelers versus vacation air travelers)

− Objectives
    − $MR_1 = MR_2$
    _ $MC_1 = MR_1$ and $MC_2 = MR_2$
    − $MR_1 = MR_2 = MC$
− P_1: price first group
− P_2: price second group
− $C(Q_r)$ = total cost of $Q_T = Q_1 + Q_2$
− Profit (π) = $P_1Q_1 + P_2Q_2 - C(Q_r)$
− Set incremental π for sales to group 1=0

$$\frac{\Delta \pi}{\Delta Q_1} = \frac{\Delta(P_1 Q_1)}{\Delta Q_1} - \frac{\Delta C}{\Delta Q_1} = 0$$

$$\frac{\Delta(P_1 Q_1)}{\Delta Q_1} = MR_1 - \frac{\Delta C}{\Delta Q_1} = MC$$

− Second group of customers: $MR_2 = MC$
− $MR_1 = MR_2 = MC$
− Determining relative prices
    Recall: $MR = P (1 + 1/E_d)$
    Then : $MR_1 = P_1 (1 + 1/E_1) = MR_2 = P_2 (1 + 1/E_2)$
− Determining relative prices

$$\text{And} \quad : \frac{P_1}{P_2} = \frac{(1 + 1/E_2)}{(1 + 1/E_1)}$$

− Pricing: Charge higher price to group with a low demand elasticity
− Example: $E_1 = -2$ & $E_2 = -4$

$$\frac{P_1}{P_2} = \frac{(1 - 1/4)}{(1 - 1/2)} = 3/4 /1/2 = 1.5$$

− P_1 should be 1.5 times as high as P_2

Consumers are divided into two groups, with separate demand curves for each group.

$MR_T = MR_1 + MR_2$

$D_2 = AR_2$

MR_T

MR_2

MR_1 $D_1 = AR_1$

Quantity

$\$/Q$

$MC = MR_1$ at Q_1 and P_1

- Q_T: $MC = MR_T$
- Group 1: P_1Q_1 ; more elastic
- Group 2: P_2Q_2; more inelastic
- $MR_1 = MR_2 = MC$
- Q_T control MC

MC

$D_2 = AR_2$

MR_T

MR_2

MR_1 $D_1 = AR_1$

Q_1 Q_2 Q_T **Quantity**

P_1

P_2
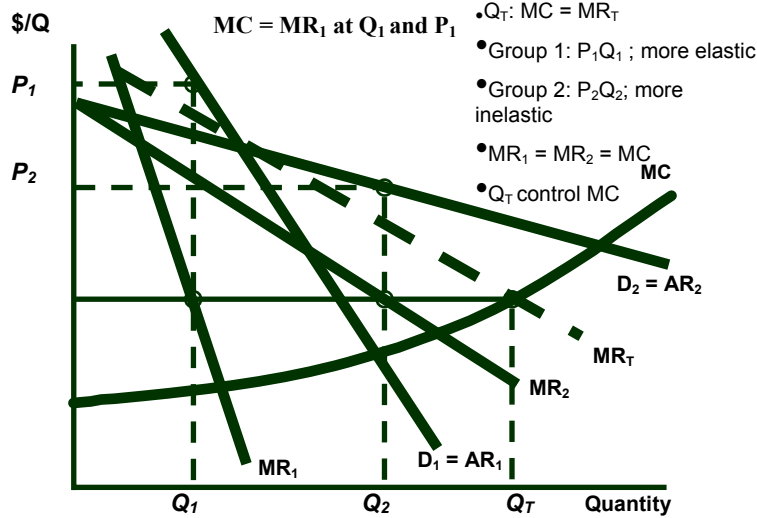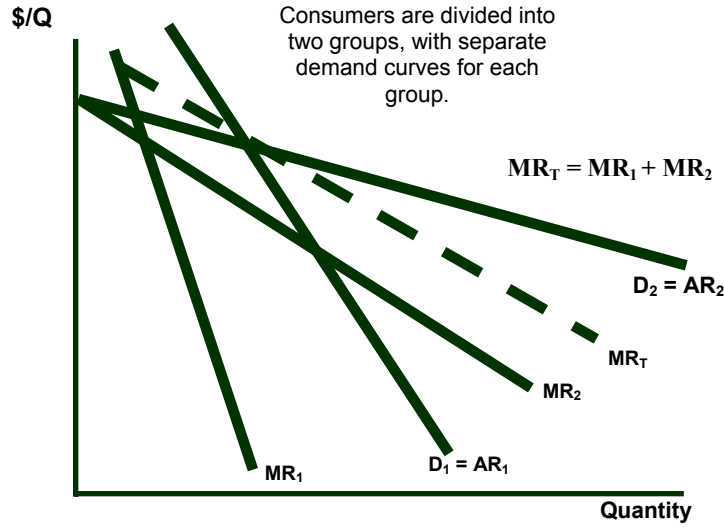
No Sales to Smaller Market

Even if third-degree price discrimination is feasible, it doesn't always pay to sell to both groups of consumers if marginal cost is rising.

$\$/Q$

MC

Group one, with demand D_1, are not willing to pay enough for the good to make price discrimination profitable.

D_2

P

MR_2

D_1

MR_1 Q^* **Quantity**
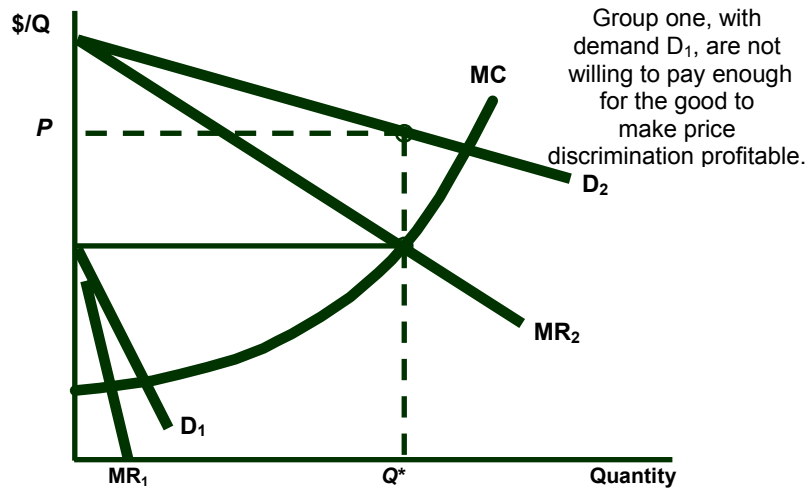
THE ECONOMICS OF COUPONS AND REBATES

◆ Price Discrimination

– Those consumers who are more price elastic will tend to use the coupon/rebate more often when they purchase the product than those consumers with a less elastic demand.

– Coupons and rebate programs allow firms to price discriminate.

Price Elasticities of Demand for Users Versus Nonusers of Coupons

	Price Elasticity	
Product	Nonusers	Users
Toilet tissue	-0.60	-0.66
Stuffing/dressing	-0.71	-0.96
Shampoo	-0.84	-1.04
Cooking/salad oil	-1.22	-1.32
Dry mix dinner	-0.88	-1.09
Cake mix	-0.21	-0.43
Cat food	-0.49	-1.13
Frozen entrée	-0.60	-0.95
Gelatin	-0.97	-1.25
Spaghetti sauce	-1.65	-1.81
Crème rinse/conditioner	-0.82	-1.12
Soup	-1.05	-1.22
Hot dogs	-0.59	-0.77

◆ Cake Mix

– Nonusers of coupons: P_E = -0.21

– Users: P_E = -0.43

◆ Cake Mix Brand A

– P_E: 8 to 10 times cake mix P_E

◆ Example

– P_E Users: -4

– P_E Nonusers: -2

◆ Using:

$$\frac{P_1}{P_2} = \frac{(1+1/E_2)}{(1+1/E_1)}$$

- ◆ Price of nonusers should be 1.5 times users
  - – Or, if cake mix sells for $1.50, coupons should be 50 cents

Airline Fares

- ◆ Differences in elasticities imply that some customers will pay a higher fare than others.
- ◆ Business travelers have few choices and their demand is less elastic.
- ◆ Casual travelers have choices and are more price sensitive.

Elasticities of Demand for Air Travel

Elasticity	First-Class	Economy Plus	Economy
Price	-0.3	-0.4	-0.9
Income	1.2	1.2	1.8

- ◆ The airlines separate the market by setting various restrictions on the tickets.
  - ─ Less expensive: notice, stay over the weekend, no refund
  - ─ Most expensive: no restrictions

Intertemporal Price Discrimination and Peak-Load Pricing

- ◆ Separating the Market With Time
  - ─ Initial release of a product, the demand is inelastic
    - ─Book
    - ─Movie
    - ─Computer
  - ─ Once this market has yielded a maximum profit, firms lower the price to appeal to a general market with a more elastic demand
    - ─Paper back books
    - ─Dollar Movies
    - ─Discount computers
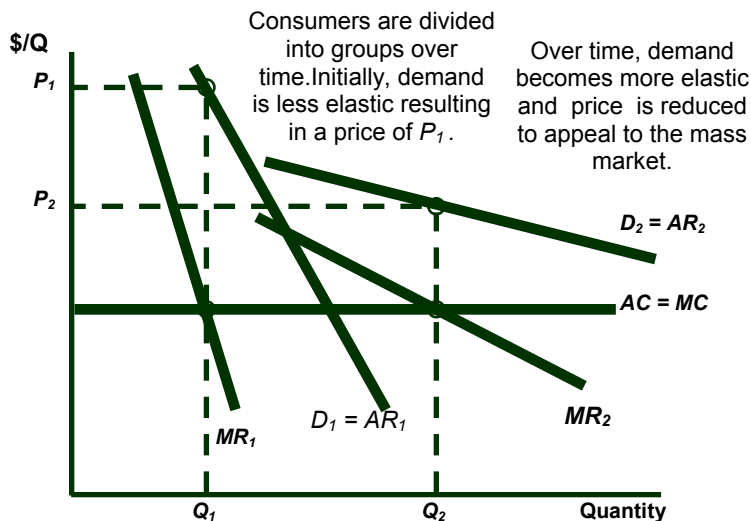
◆ Peak-Load Pricing

– Demand for some products may peak at particular times.

– Rush hour traffic

– Electricity - summer season

– Restaurants on weekends

– Capacity restraints will also increase MC.

– Increased MR and MC would indicate a higher price.

– MR is not equal for each market because one market does not impact the other market.
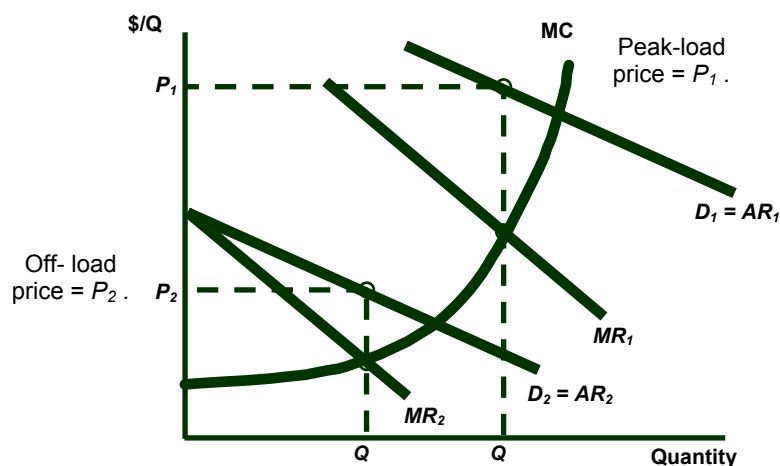
How to Price a Best Selling Novel

◆ What Do You Think?

1) How would you arrive at the price for the initial release of the hardbound edition of a book?

2) How long do you wait to release the paperback edition? Could the popularity of the book impact your decision?

3) How do you determine the price for the paperback edition?

The Two-Part Tariff

◆ The purchase of some products and services can be separated into two decisions, and therefore, two prices.

◆ Examples

1) Amusement Park

– Pay to enter

– Pay for rides and food within the park

2)Tennis Club

> ─Pay to join

> ─Pay to play

3) Safety Razor

> ─Pay for razor

> ─Pay for blades

4) Polaroid Film

> ─Pay for the camera

> ─Pay for the film

* Pricing decision is setting the entry fee (T) and the usage fee (P).
* Choosing the trade-off between free-entry and high use prices or high-entry and zero use prices.

Two-Part Tariff with a Single Consumer

$/Q

Usage price *P**is set where
MC = D. Entry price *T**
is equal to the entire
consumer surplus.

T

P   M

                                                                  D

Quantity

$/Q

T*

The price, *P*,* will be
greater than MC. Set *T**
at the surplus value of D₂.

A

$$\pi = 2T^{*} + (P^{*} - MC)x(Q_1 + Q_2)$$

π more than twice ABC

P*

                                                                  MC

B

C

                                                                  D₁ = consumer 1

                                                                  D₂ = consumer 2

Q₂   *Q₁*   Quantity
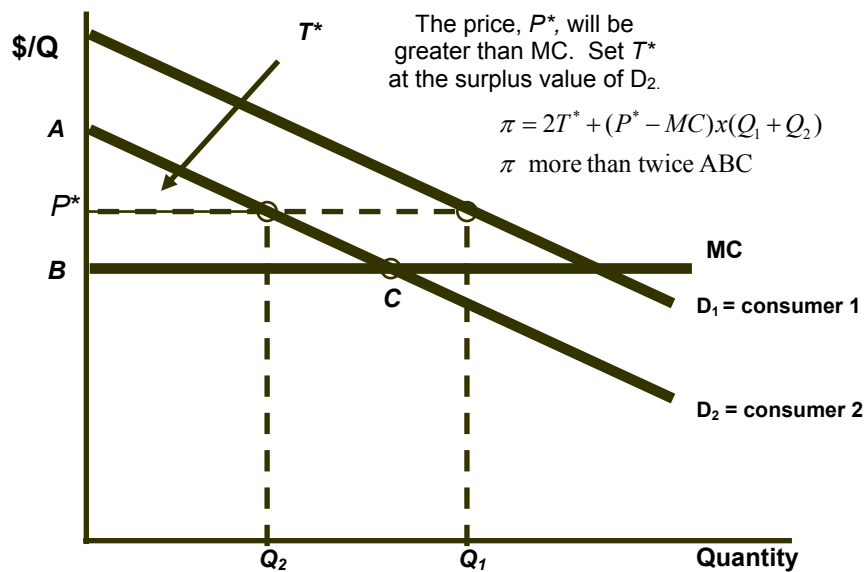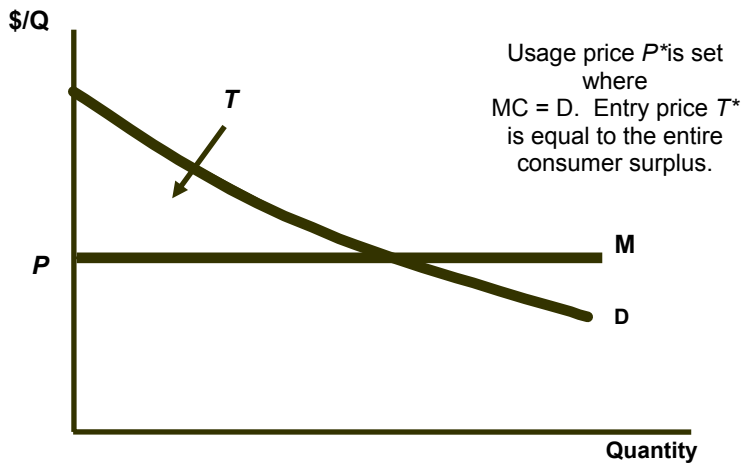
Two-Part Tariff with Two Consumers

◆ The Two-Part Tariff With Many Different Consumers

－ No exact way to determine P* and T*.

－ Must consider the trade-off between the entry fee *T** and the use fee P*.

　　－ Low entry fee: High sales and falling profit with lower price and more entrants.

－ To find optimum combination, choose several combinations of *P,T*.

－ Choose the combination that maximizes profit.

Profit

$$\pi = \pi_a + \pi_s = n(T)T + (P - MC)Q(n)$$

$$n = entrants$$

Total profit is the sum of the profit from the entry fee and the profit from sales. Both depend on *T*.

π *Total*

π_a: **entry fee**

π_S: **sales**

T*　　　　　　　　　　　　　　　　　　*T*
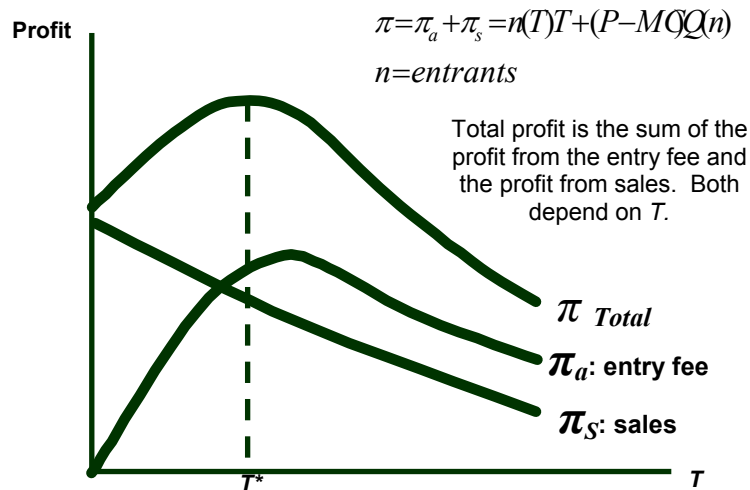
◆ Rule of Thumb

－ Similar demand: Choose *P* close to MC and high *T*

－ Dissimilar demand: Choose high *P* and low *T*.

◆ Two-Part Tariff With A Twist

－ Entry price *(T)* entitles the buyer to a certain number of free units

　　－ Razors with several blades

　　－ Amusement parks with some tokens

　　－ On-line with free time

Bundling

♦ Bundling is packaging two or more products to gain a pricing advantage.
♦ Conditions necessary for bundling

─ Heterogeneous customers

─ Price discrimination is not possible

─ Demands must be negatively correlated

♦ An example: Leasing Movie X & Movie Y

─ The reservation prices for each theater and movie are:

	Movie X	Movie Y
Theater *A*	$12,000	$3,000
Theater *B*	$10,000	$4,000

♦ Renting the movies separately would result in each theater paying the lowest reservation price for each movie:

─ Maximum price *X* = $10,000

─ Maximum price *Y* = $3,000

♦ Total Revenue = $26,000
♦ If the movies are bundled:

─ Theater *A* will pay $15,000 for both

─ Theater *B* will pay $14,000 for both

♦ If each were charged the lower of the two prices, total revenue will be $28,000.
♦ Relative Valuations

─ Negative Correlated: Profitable to Bundle

─*A* pays more for *X* ($12,000) than *B* ($10,000).

─*B* pays more for *Y* ($4,000) than *A* ($3,000).

─ If the demands were positively correlated (Theater A would pay more for both films as shown) bundling would not result in an increase in revenue.

	Movie X	Movie Y
Theater *A*	$12,000	$4,000
Theater *B*	$10,000	$3,000

♦ If the movies are bundled:

─ Theater *A* will pay $16,000 for both

─ Theater *B* will pay $13,000 for both

♦ If each were charged the lower of the two prices, total revenue will be $26,000, the same as by selling the films separately.
♦ Bundling Scenario: Two different goods and many consumers

─ Many consumers with different reservation price combinations for two goods

Reservation Prices

r_2
(reservation
price Good 2)

Consumer
C

$10

Consumer A is
willing to pay up to
$3.25 for good 1 and
up to $6 for good 2.

Consumer
A

$6

$5

Consumer
B

$3.25

r_1
(reservation price
Good 1)

$3.25 $5 $8.25 $10
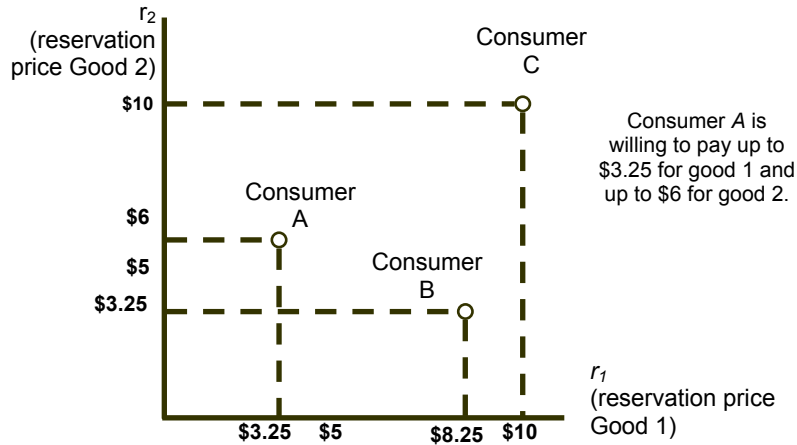
Consumption Decisions When Products are Sold Separately

r_2

$R_1 < P_1$
$R_2 > P_2$

II

**Consumers
buy**

$R_1 > P_1$
$R_2 > P_2$

I

**Consumers
buy**

Consumers fall into
four categories based
on their reservation
price.

P_2

$R_1 < P_1$
$R_2 < P_2$

III

**Consumers
buy**

$R_1 > P_1$
$R_2 < P_2$

IV

**Consumers
buy**

P_1 r_1
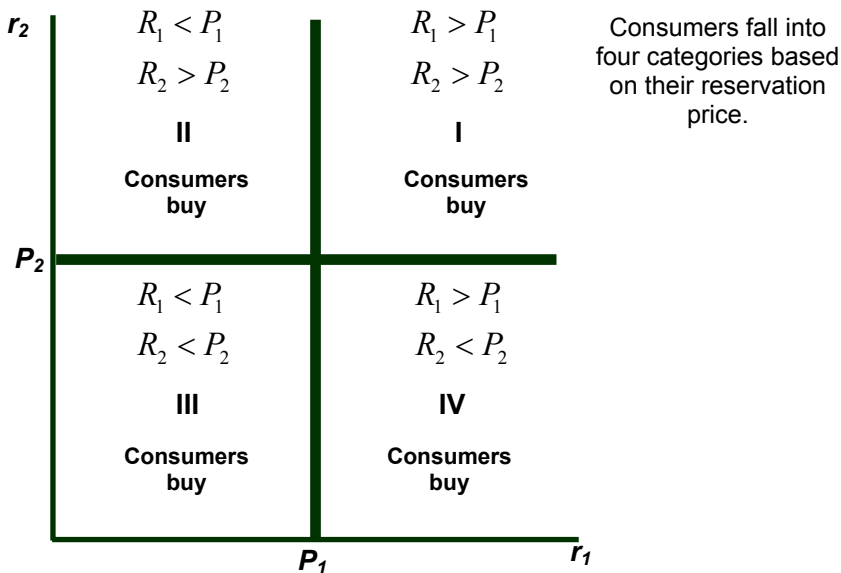
Consumption Decisions When Products are Bundled

r_2

I

Consumers buy the bundle
when $r_1 + r_2 \geq P_B$
(P_B = bundle price).
$P_B = r_1 + r_2$ or $r_2 = P_B - r_1$
Region 1: $r > P_B$
Region 2: $r < P_B$

Consumers
buy bundle
$(r > P_B)$

$r_2 = P_B - r_1$

I
Consumers do
not buy bundle
$(r < P_B)$

r_1
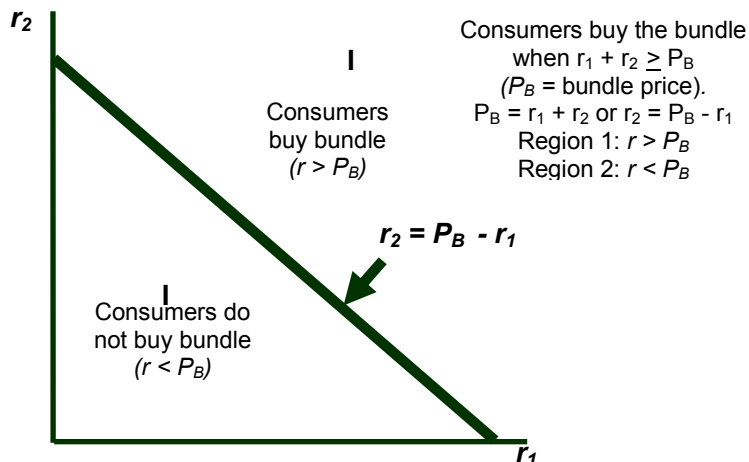
◆ The effectiveness of bundling depends upon the degree of negative correlation between the two demands.

Reservation Prices

If the demands are perfectly positively correlated, the firm will not gain by bundling. It would earn the same profit by selling the goods separately.

Reservation Prices

If the demands are perfectly negatively correlated bundling is the ideal strategy--all the consumer surplus can be extracted and a higher profit results.
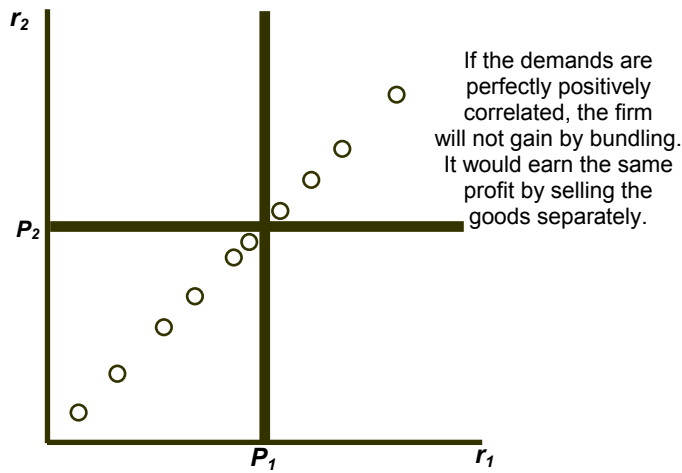
Movie Example
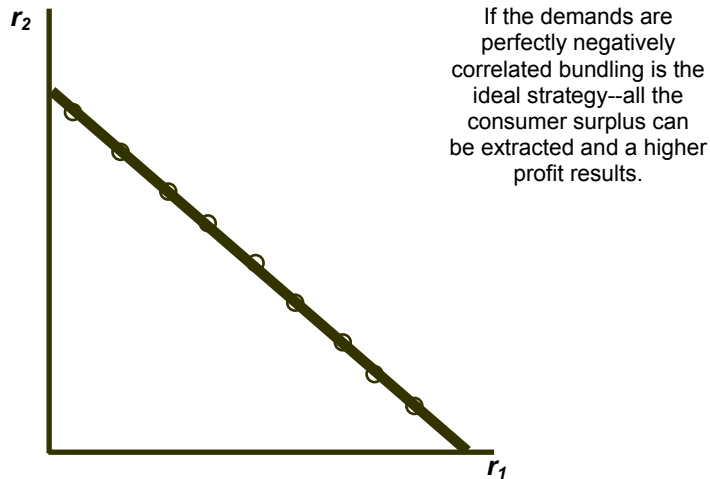
Bundling pays due to negative correlation
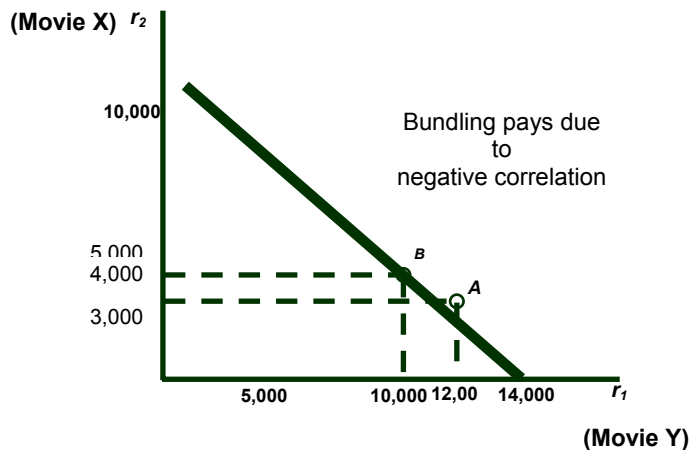
Bundling
- Mixed Bundling
  - Selling both as a bundle and separately
- Pure Bundling
  - Selling only a package

Mixed Versus Pure Bundling

-

$C_1 = MC_1$
$C_1 = 20$

r_2

$C_2 = MC_2$
$C_2 = 30$

With positive marginal costs, mixed bundling may be more profitable than pure bundling.

Consumer A, for example, has a reservation price for good 1 that is below marginal cost c_1. With mixed bundling, consumer A is induced to buy only good 2, while consumer D is induced to buy only good 1, reducing the firm's cost.

A   B   C   D

r_1
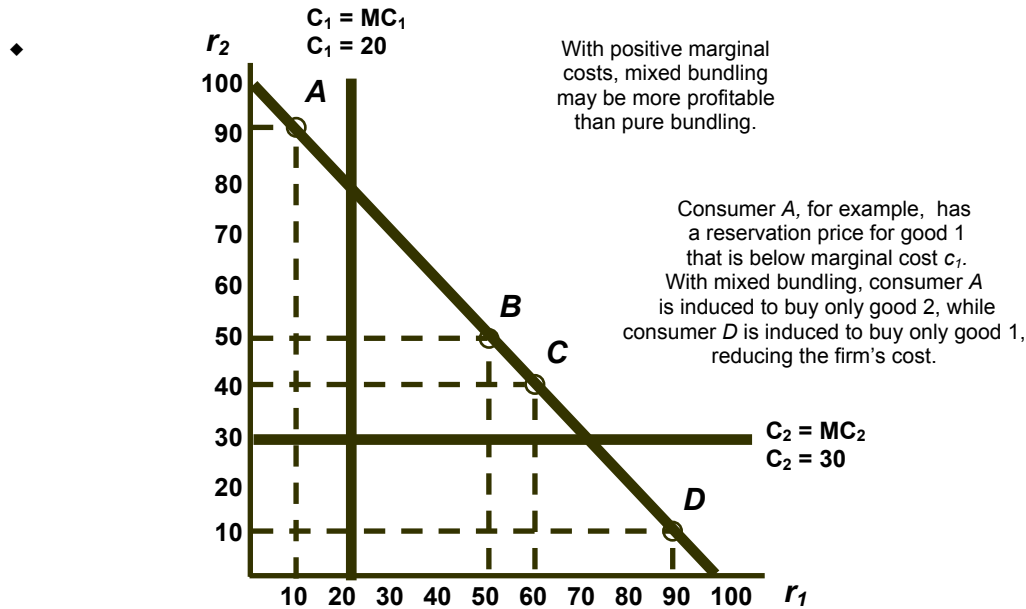
- Mixed vs. Pure Bundling
  - Scenario
    - Perfect negative correlation
    - Significant marginal cost
  - Observations
    - Reservation price is below MC for some consumers
    - Mixed bundling induces the consumers to buy only goods for which their reservation price is greater than MC

Bundling Example
- Sell Separately
  - Consumers *B,C,* and *D* buy 1 and *A* buys 2
- Pure Bundling
  - Consumers *A, B, C,* and *D* buy the bundle
- Mixed Bundling
  - Consumer *D* buys 1, *A* buys 2, and *B & C* buys the bundle

	P1	P2	PB	Profit
Sell separately	$50	$90	----	$150
Pure bundling	----	----	$100	$200
Mixed bundling	$89.95	$89.95	$100	$229.90

$C_1 = \$20$

$C_2 = \$30$

- Sell Separately
  - 3($50 - $20) + 1($90 - $30) = $150
- Pure Bundling
  - 4($100 - $20 - $30) = $200
- Mixed Bundling
  - ($89.95 - $20) + ($89.95 - $30) - 2($100 - $20 - $30) = $229.90
  - $C_1 = \$20$ $C_2 = \$30$
- Question
  - If MC = 0, would mixed bundling still be the most profitable strategy with perfect negative correlation?

Mixed Bundling with Zero Marginal Costs

In this example, consumers B and C are willing to pay $20 more for the bundle than are consumers A and D. With mixed bundling, the price of the bundle can be increased to $120. A & D can be charged $90 for a single good.
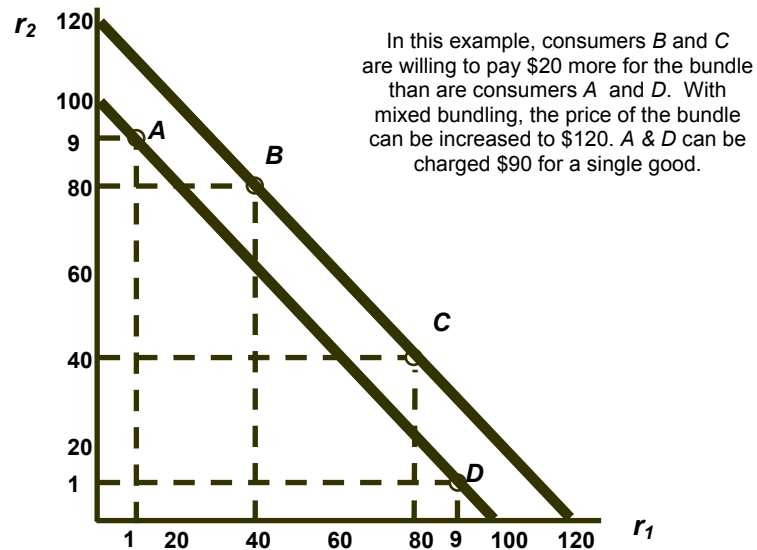
	P1	P2	PB	Profit
Sell separately	$80	$80	----	$320
Pure bundling	----	----	$100	$400
Mixed bundling	$90	$90	$120	$420

- ◆ Bundling in Practice
  - ─ Automobile option packages
  - ─ Vacation travel
  - ─ Cable television
- ◆ Mixed Bundling in Practice
  - ─ Use of market surveys to determine reservation prices
  - ─ Design a pricing strategy from the survey results
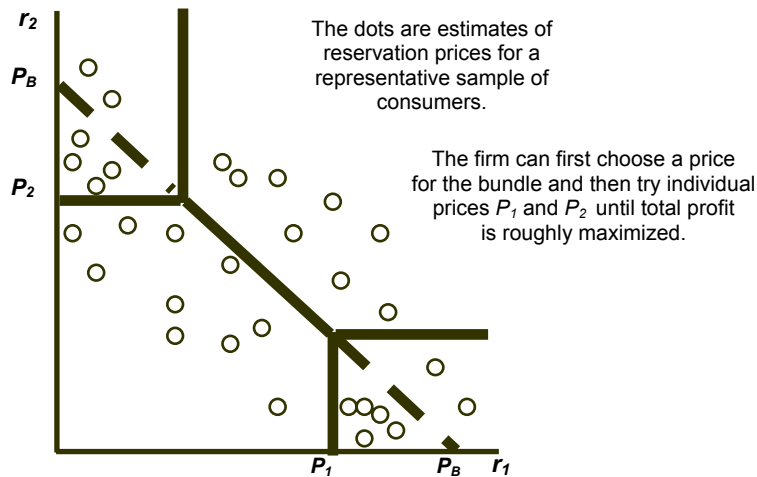
The Complete Dinner vs. a la Carte:
A Restaurant's Pricing Problem

- ◆ Pricing to match consumer preferences for various selections
- ◆ Mixed bundling allows the customer to get maximum utility from a given expenditure by allowing a greater number of choices.

Bundling

- ◆ Tying
  - ─ Practice of requiring a customer to purchase one good in order to purchase another.
  - ─ Examples
    - ─ Xerox machines and the paper
    - ─ IBM mainframe and computer cards
  - ─ Allows the seller to meter the customer and use a two-part tariff to discriminate against the heavy user
  - ─ McDonald's
    - ─ Allows them to protect their brand name.

Advertising

- ◆ Assumptions
  - ─ Firm sets only one price
  - ─ Firm knows Q(P,A)
    - ─ How quantity demanded depends on price and advertising

Effects of Advertising

AR and MR are average and marginal revenue when the firm doesn't advertise.

If the firm advertises, its average and marginal revenue curves shift to the right -- average costs rise, but marginal cost does not.
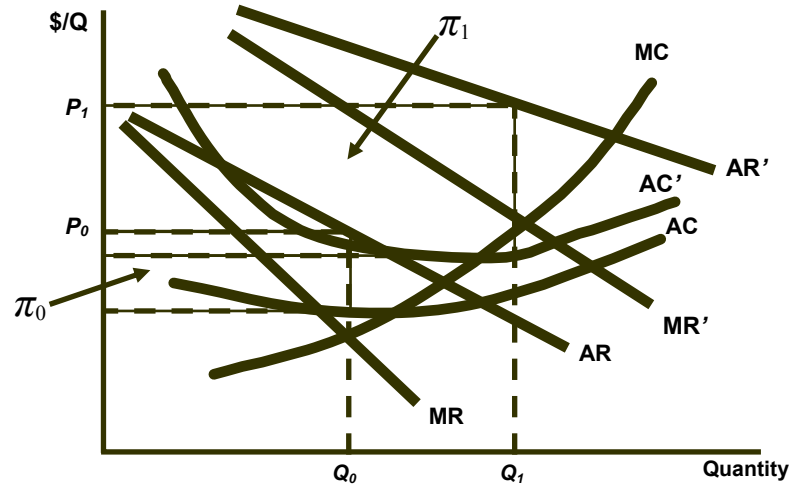
Advertising

$$\pi = PQ\,(P,A) - C\,(Q) - A$$

$$MR_{Ads} = P\,\frac{\Delta Q}{\Delta A} = 1 + MC\,\frac{\Delta Q}{\Delta A} = \text{full MC of adv.}$$

- Choosing Price and Advertising Expenditure

- A Rule of Thumb for Advertising

$$(A/Q)(\Delta Q/\Delta A) = E_A = \text{Adv. elasticity of demand}$$

$$(P - MC)/P = -1/E_P$$

$$A/PQ = -(E_A/E_P) = \text{Rule of Thumb}$$

  – To maximize profit, the firm's advertising-to-sales ratio should be equal to minus the ratio of the advertising and price elasticities of demand.
  – R(Q) = $1 million/yr
  – $10,000 budget for A (advertising--1% of revenues)
  – E_A = .2 (increase budget $20,000, sales increase by 20%
  – E_P = -4 (markup price over MC is substantial)
- Question
  – Should the firm increase advertising?

- ◆ YES
  - ─ A/PQ = -(2/-.4) = 5%
  - ─ Increase budget to $50,000
- ◆ Questions
  - ─ When E_A is large, do you advertise more or less?
  - ─ When E_P is large, do you advertise more or less?
- ◆ Advertising: In Practice
  - ─ Estimate the level of advertising for each of the firms
    - ─Supermarkets E_P= -10; E_A = 0.1 to 0.3
    - ─Convenience stores E_P= -5; E_A = very small
    - ─Designer jeans E_P= -3 to -4; E_A= 0.3 to 1
    - ─ Laundry detergents E_P= -3 to -4; E_A= very large

MONOPOLISTIC COMPETITION

◆ Characteristics

    1) Many firms

    2) Free entry and exit

    3) Differentiated product

◆ The amount of monopoly power depends on the degree of differentiation.
◆ Examples of this very common market structure include:
  – Toothpaste
  – Soap
  – Cold remedies
◆ Toothpaste
  – Brand J and monopoly power

    • Suppose an MNC is the sole producer of Brand J

    • Consumers can have a preference for Brand J---taste, reputation, decay preventing efficacy

    • The greater the preference (differentiation) the higher the price.

◆ The Makings of Monopolistic Competition
  – Two important characteristics

    • Differentiated but highly substitutable products

    • Free entry and exit

A Monopolistically Competitive Firm in the Short and Long Run
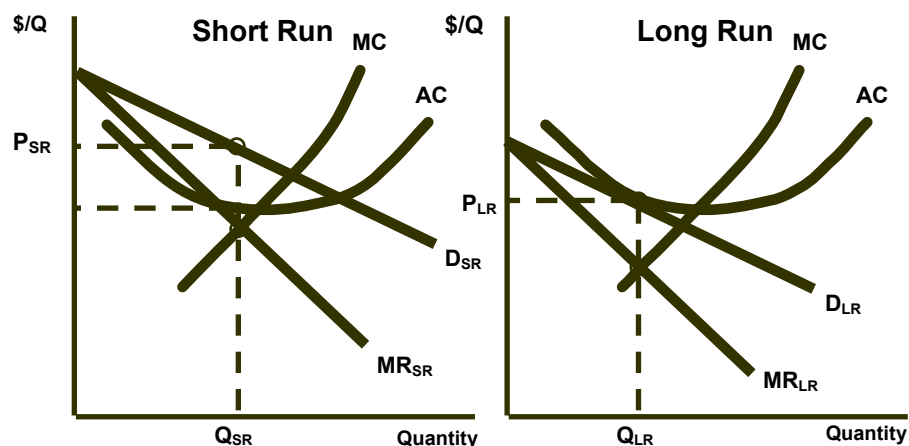
◆ Observations (short-run)
  – Downward sloping demand--differentiated product
  – Demand is relatively elastic--good substitutes
  – $MR < P$
  – Profits are maximized when $MR = MC$

- – This firm is making economic profits
- ◆ Observations (long-run)
  - – Profits will attract new firms to the industry   (no barriers to entry)
  - _ The old firm's demand will decrease to D_{LR}
  - – Firm's output and price will fall
  - – Industry output will rise
  - – No economic profit (P = AC)
  - – P > MC -- some monopoly power

Monopolistically Competitive vs. Perfectly Competitive Equilibrium
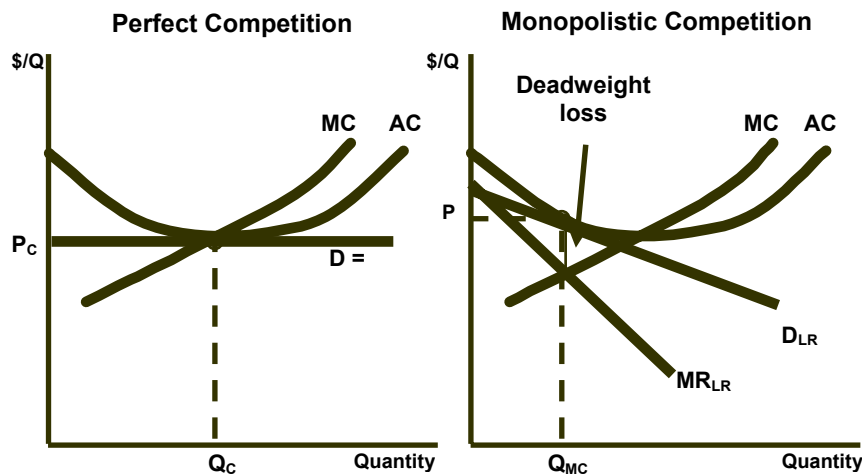
- ◆ Monopolistic Competition and Economic Efficiency
  - – The monopoly power (differentiation) yields a higher price than perfect competition. If price was lowered to the point where MC = D, consumer surplus would increase by the shaded triangle.
  - – With no economic profits in the long run, the firm is still not producing at minimum AC and excess capacity exists.
- ◆ Questions

    1) If the market became competitive, what would happen to output and price?

    2) Should monopolistic competition be regulated?

Monopolistic Competition in the Market for Colas and Coffee
- ◆ The markets for soft drinks and coffee illustrate the characteristics of monopolistic competition.

Elasticities of Demand for Brands of Colas and Coffee

Colas: Brand X   -2.4

Brand Y   -   5.2 to -5.7

Ground Coffee: Hills Brothers -7.1

Maxwell House   -8.9

Chase and Sanborn   -5.6

◆ Questions

1) Why is the demand for Brand X more price inelastic than for Brand Y?

2) Is there much monopoly power in these two markets?

3) Define the relationship between elasticity and monopoly power.

OLIGOPOLY

◆ Characteristics
  – Small number of firms
  – Product differentiation may or may not exist
  – Barriers to entry
◆ Examples
  – Automobiles
  – Steel
  – Aluminum
  – Petrochemicals
  – Electrical equipment
  – Computers
◆ The barriers to entry are:
  – Natural

    • Scale economies

    • Patents

    • Technology

    • Name recognition
  – Strategic action

    • Flooding the market

    • Controlling an essential input
◆ Management Challenges
  – Strategic actions
  – Rival behavior
◆ Question
  – What are the possible rival responses to a 10% price cut by an automobile company?
◆ Equilibrium in an Oligopolistic Market
  – In perfect competition, monopoly, and monopolistic competition the producers did not have to consider a rival's response when choosing output and price.
  – In oligopoly the producers must consider the response of competitors when choosing output and price.
  – Defining Equilibrium

    • Firms doing the best they can and have no incentive to change their output or price

    • All firms assume competitors are taking rival decisions into account.
◆ Nash Equilibrium
  – Each firm is doing the best it can given what its competitors are doing.
◆ The Cournot Model
  – Duopoly

    • Two firms competing with each other

    • Homogenous good

• The output of the other firm is assumed to be fixed

Firm 1's Output Decision

If Firm 1 thinks Firm 2 will produce nothing, its demand curve, $D_1(0)$, is the market demand curve.

If Firm 1 thinks Firm 2 will produce 50 units, its demand curve is shifted to the left by this amount.

If Firm 1 thinks Firm 2 will produce 75 units, its demand curve is shifted to the left by this amount.

What is the output of Firm 1 if Firm 2 produces 100 units?
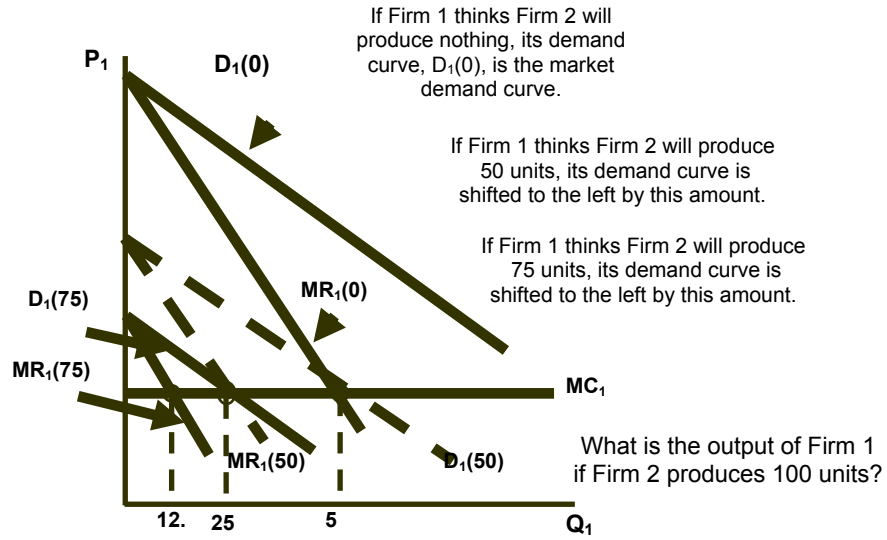
The Reaction Curve
  – A firm's profit-maximizing output is a decreasing schedule of the expected output of Firm 2.

Firm 1's reaction curve shows how much it will produce as a function of how much it thinks Firm 2 will produce. The x's correspond to the previous model.

Firm 2's reaction curve shows how much itwill produce as a function of how much

In Cournot equilibrium, each firm correctly assumes how much its competitors will produce and thereby maximize its own profits.

Firm 2's Reaction Curve $Q*2(Q_2)$

Cournot Equilibrium

Firm 1's Reaction Curve $Q*_1(Q_2)$

Questions

1) If the firms are not producing at the Cournot equilibrium, will they adjust until the Cournot equilibrium is reached?

2) When is it rational to assume that its competitor's output is fixed?

◆ The linear Demand Curve

  – An Example of the Cournot Equilibrium
    • Duopoly
Market demand is $P = 30 - Q$
where $Q = Q1 + Q2$
MC1 = MC2 = 0

Duopoly Example
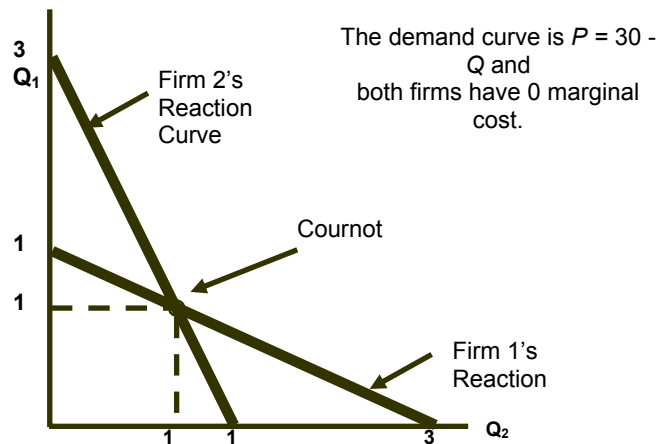
- ◆ Profit Maximization with Collusion
    - ─ Collusion Curve
        - • $Q_1 + Q_2 = 15$
            - ─Shows all pairs of output Q_1 and Q_2 that maximizes total profits
        - • $Q_1 = Q_2 = 7.5$
            - ─Less output and higher profits than the Cournot equilibrium
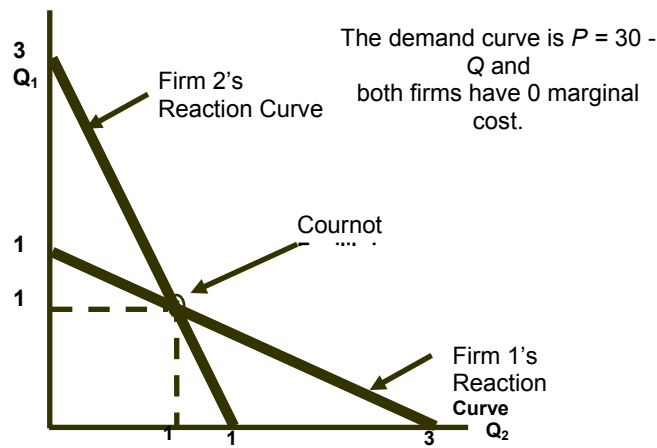
First Mover Advantage- The Stackelberg Model

- ◆ Assumptions
    - ─ One firm can set output first
    - ─ MC = 0
    - ─ Market demand is P = 30 - Q where Q = total output
    - ─ Firm 1 sets output first and Firm 2 then makes an output decision
- ◆ Firm 1
    - ─ Must consider the reaction of Firm 2
- ◆ Firm 2

‒ Takes Firm 1's output as fixed and therefore determines output with the Cournot reaction curve

◆ Firm 1

─ Choose Q_1 so that:

$$MR = MC, MC = 0 \text{ therefore } MR \ = \ 0$$

$$R_1 = PQ_1 = 30Q_1 - Q_1^2 - Q_2Q_1$$

◆ Conclusion

– Firm 1's output is twice as large as firm 2's

– Firm 1's profit is twice as large as firm 2's

Price Competition

◆ Competition in an oligopolistic industry may occur with price instead of output.
◆ The Bertrand Model is used to illustrate price competition in an oligopolistic industry with homogenous goods.
◆ Bertrand Model

─ Assumptions
  • Homogenous good
  . Market demand is P = 30 - Q where $Q = Q_1 + Q_2$
  • MC = $3 for both firms and $MC_1 = MC_2 = \$3$

─ Assumptions
  • The Cournot equilibrium:

  P = 12

  π for both firms = $81

  • Assume the firms compete with price, not quantity.

─ How will consumers respond to a price differential?

  • The Nash equilibrium:

    ─P = MC; $P_1 = P_2 = \$3$

    ─Q = 27; Q_1 & Q_2 = 13.5

    ─π = 0

◆ Price Competition with Differentiated Products

– Market shares are now determined not just by prices, but by differences in the design, performance, and durability of each firm's product.

◆ Differentiated Products

─ Assumptions
  • Duopoly
  • FC = $20
  • VC = 0
  . Firm 1's demand is Q_1 = 12 - 2P_1 + P_2
  . Firm 2's demand is Q_2 = 12 - 2P_1 + P_1

    ─P_1 and P_2 are prices firms 1 and 2 charge respectively

---

─Q$_1$ and Q$_2$ are the resulting quantities they sell

Nash Equilibrium in Prices
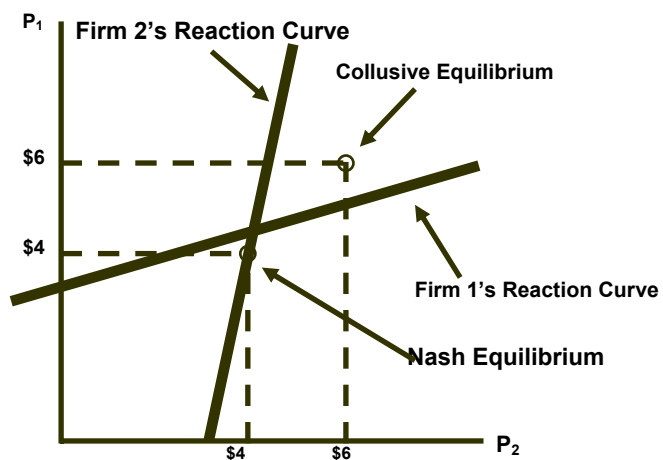
Lesson 41

Competition Versus Collusion:

The Prisoners' Dilemma

◆ Why wouldn't each firm set the collusion price independently and earn the higher profits that occur with explicit collusion?

◆ Assume:

$$FC = \$20 \text{ and } VC = \$0$$
$$\text{Firm 1's Demand} : Q = 12 - 2P_1 + P_2$$
$$\text{Firm 2's Demand} : Q = 12 - 2P_2 + P_1$$
$$\text{Nash Equilibrium} : P = \$4 \quad \pi = \$12$$
$$\text{Collusion} : \quad P = \$6 \quad \pi = \$16$$

◆ Possible Pricing Outcomes:

$$\text{Firm 1}: P = \$6 \quad \text{Firm 2}: P = \$6 \quad \pi = \$16$$
$$P = \$6 \quad\quad\quad P = \$4$$
$$\pi_2 = P_2Q_2 - 20$$
$$= (4)\big[12 - (2)(4) + 6\big] - 20 = \$20$$
$$\pi_1 = P_1Q_1 - 20$$
$$= (6)\big[12 - (2)(6) + 4\big] - 20 = \$4$$

Payoff Matrix for Pricing Game

		Firm 2	
		Charge $4	**Charge $6**
Firm 1	**Charge $4**	$12,	$20,
	Charge $6	$4,	$16,

◆ These two firms are playing a non co-operative game.

  – Each firm independently does the best it can taking its competitor into account.

◆ Question

  – Why will both firms both choose $4 when $6 will yield higher profits?

◆ An example in game theory, called the Prisoners' Dilemma, illustrates the problem oligopolistic firms face.

♦ Scenario
  − Two prisoners have been accused of collaborating in a crime.
  − They are in separate jail cells and cannot communicate.
  − Each has been asked to confess to the crime.

Payoff Matrix for Prisoners' Dilemma

Payoff Matrix for Pricing Game

Firm 2

	Charge $4	Charge $6
Charge $4	$12,	$20,
Charge $6	$4,	$16,

Firm 1

♦ Conclusions: Oligipolistic Markets
    1) Collusion will lead to greater profits

    2) Explicit and implicit collusion is possible

    3) Once collusion exists, the profit motive to break and lower price is significant

Implications of the Prisoners'

Dilemma for Oligipolistic Pricing

♦ Observations of Oligopoly Behavior

    1) In some oligopoly markets, pricing behavior in time can create a predictable pricing environment and implied collusion may occur.

♦ Observations of Oligopoly Behavior

    2) In other oligopoly markets, the firms are very aggressive and collusion is not possible.

    • Firms are reluctant to change price because of the likely response of their competitors.

    • In this case prices tend to be relatively rigid.

•

• **The Kinked Demand Curve**

$/Q

If the producer raises price the
competitors will not and the
demand will be elastic.

If the producer lowers price the
competitors will follow and the
demand will be inelastic.

D

Quantity

MR

$/Q

So long as marginal cost is in the
vertical region of the marginal
revenue curve, price and output
will remain constant.

MC′

P*   MC

D

Q*   Quantity

MR
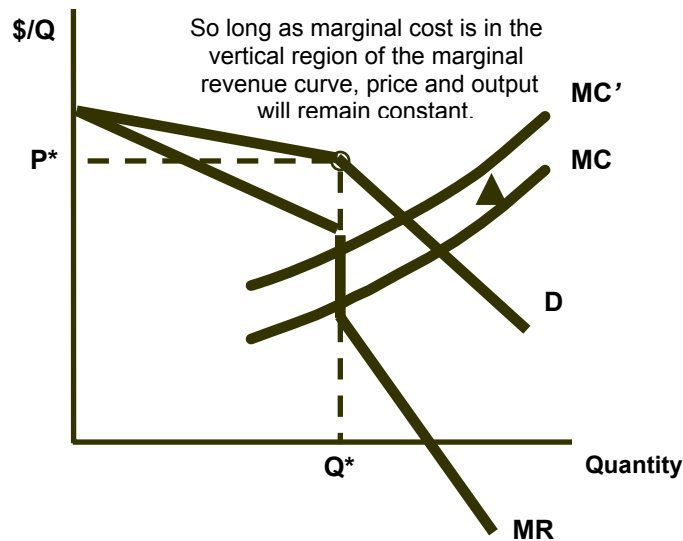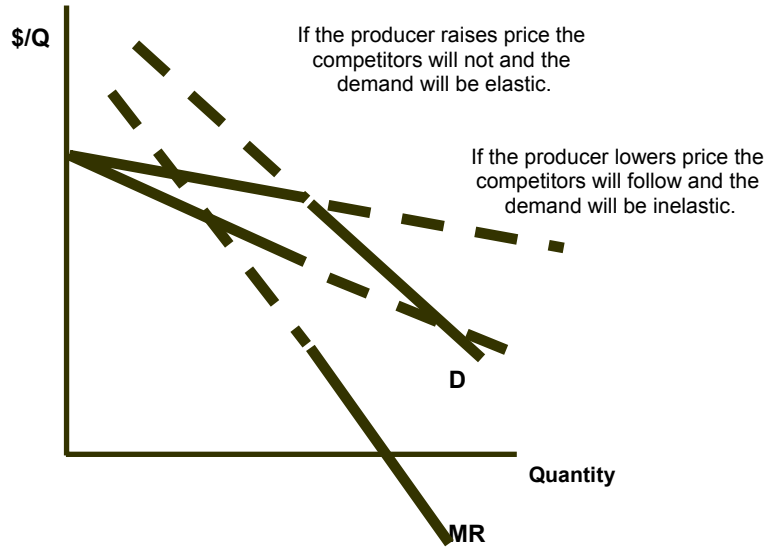
PRICE SIGNALING & PRICE LEADERSHIP

− Price Signaling

- Implicit collusion in which a firm announces a price increase in the hope that other
firms will follow suit

− Price Leadership

- Pattern of pricing in which one firm regularly announces price changes that other
firms then match

◆ The Dominant Firm Model

– In some oligopolistic markets, one large firm has a major share of total sales, and a
group of smaller firms supplies the remainder of the market.

– The large firm might then act as the dominant firm, setting a price that maximized its
own profits.

Price Setting by a Dominant Firm

The dominant firm's demand curve is the difference between market demand (*D*) and the supply of the fringe firms (S_F).

At this price, fringe firms sell Q_F, so that total sales are Q_T.
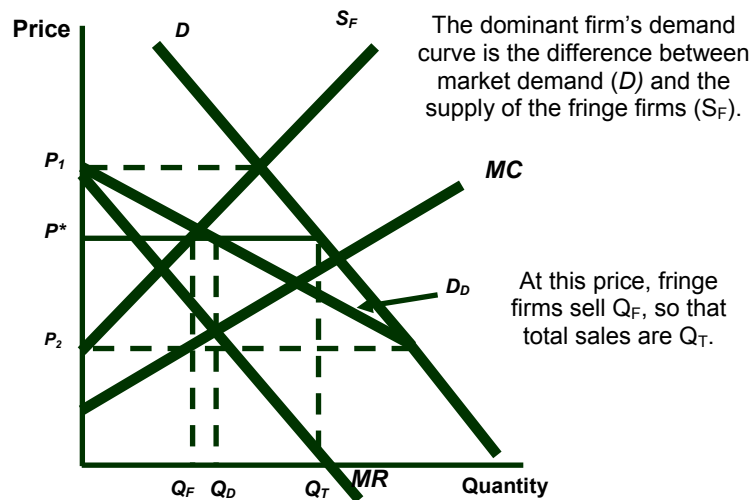
CARTELS

◆ Characteristics

    1) Explicit agreements to set output and price

    2) May not include all firms

    3) Most often international

  – Examples of successful cartels

    • OPEC

    • International Bauxite Association

  – Examples of unsuccessful cartels

    • Copper

    • Tin

    • Coffee

    • Tea

    • Cocoa

    4) Conditions for success

    • Competitive alternative sufficiently deters cheating

    • Potential of monopoly power--inelastic demand

The OPEC Oil Cartel

TD is the total world demand curve for oil, and S_C is the Competitive supply. OPEC's demand is the difference between the two.

OPEC's profits maximizing quantity is found at the intersection of its MR and MC curves. At this quantity OPEC charges price P*.
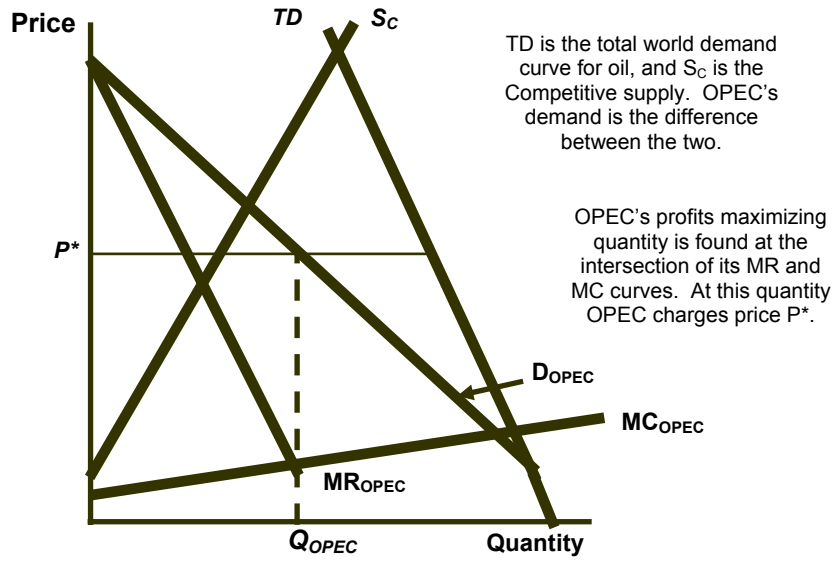
Cartels

◆ About OPEC
  − Very low MC
  − TD is inelastic
  − Non-OPEC supply is inelastic
  − D_{OPEC} is relatively inelastic

The OPEC Oil Cartel

The price without the cartel:

● Competitive price (P_C) where D_{OPEC} = MC_{OPEC}

The CIPEC Copper Cartel

- TD and S_C are relatively elastic
- D_{CIPEC} is elastic
- CIPEC has little monopoly power
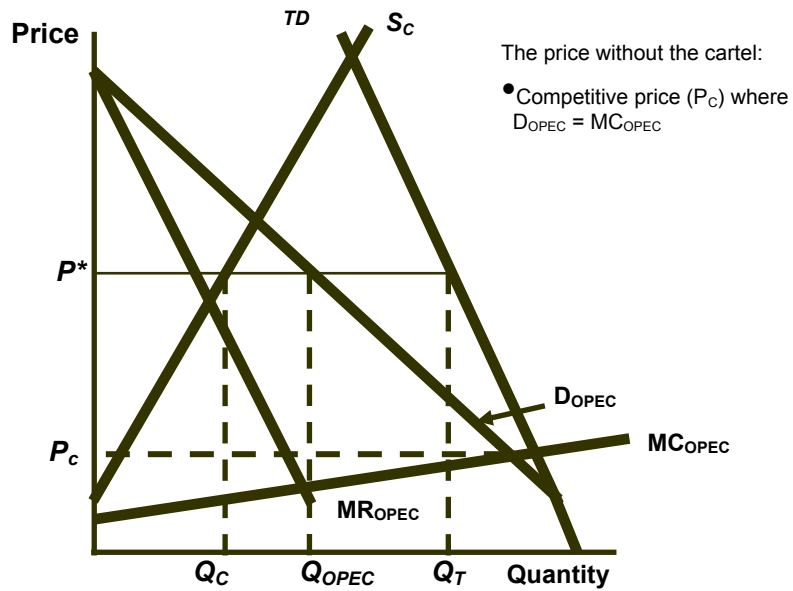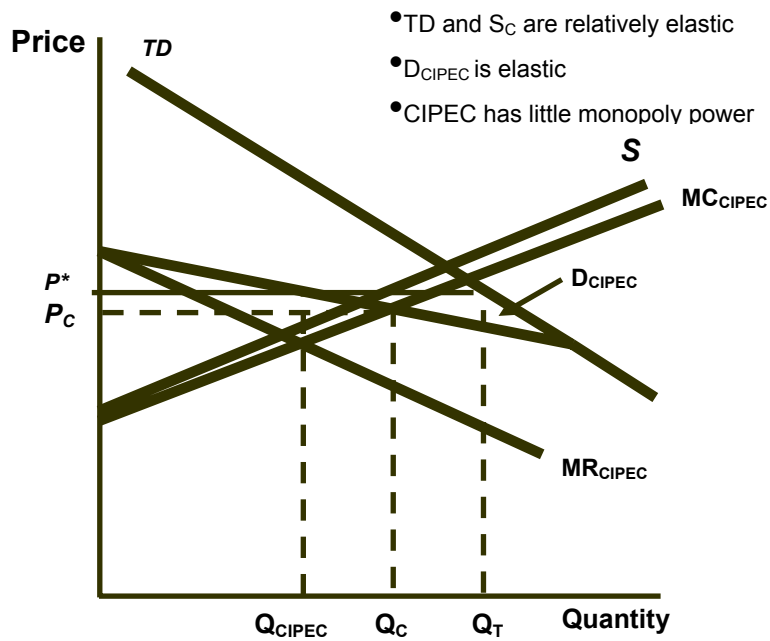
Cartels

◆ Observations

   – To be successful:

- Total demand must not be very price elastic

- Either the cartel must control nearly all of the world's supply or the supply of noncartel producers must not be price elastic.

-

COMPETITIVE FACTOR MARKETS

- Characteristics

    1) Large number of sellers of the factor of production

    2) Large number of buyers of the factor of production

    3) The buyers and sellers of the factor of production are price takers
- Demand for a Factor Input When Only One Input Is Variable
    - Demand for factor inputs is a derived demand…
        - Derived from factor cost and output demand
    - Assume
        - Two inputs: Capital (K) and Labor (L)
        - Cost of K is r and the cost of labor is w
        - K is fixed and L is variable
    - Problem
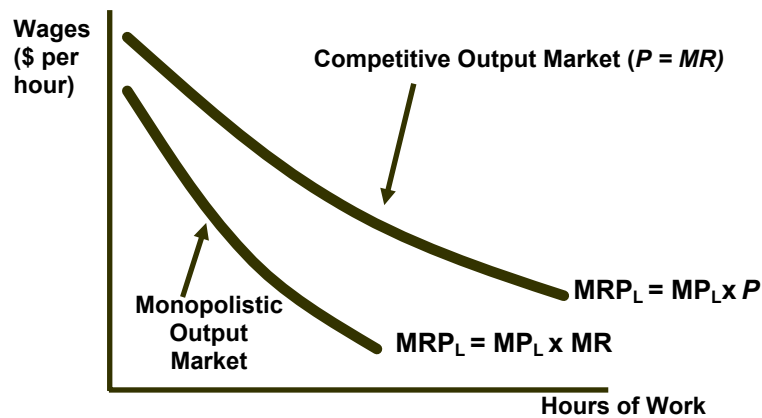   - How much labor to hire?
    - Measuring the Value of a Worker's Output
        - Marginal Revenue Product of Labor (MRP_L)
        - $MRP_L = (MP_L)(MR)$
    - Assume perfect competition in the product market
        - Then $MR = P$
    - Question
        - What will happen to the value of MRP_L when more workers are hired?

Marginal Revenue Product

Wages ($ per hour)

Competitive Output Market ($P = MR$)

Monopolistic Output Market

$MRP_L = MP_L \times P$

$MRP_L = MP_L \times MR$

Hours of Work
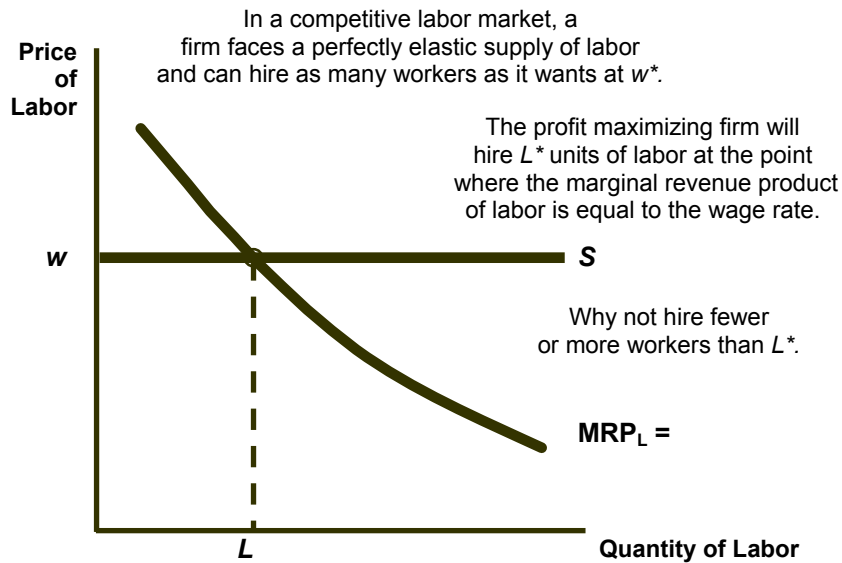
- Choosing the profit-maximizing amount of labor
    - If $MRP_L > w$ (the marginal cost of hiring a worker): hire the worker

- If MRP_L < *w:* hire less labor
- If MRP_L = *w*: profit maximizing amount of labor

Hiring by a Firm in the Labor Market (with Capital Fixed)

In a competitive labor market, a
firm faces a perfectly elastic supply of labor
and can hire as many workers as it wants at *w*.*

The profit maximizing firm will
hire *L** units of labor at the point
where the marginal revenue product
of labor is equal to the wage rate.

Why not hire fewer
or more workers than *L**.

Price of Labor

w ———————— **S**

MRP_L =

Quantity of Labor

L

Competitive Factor Markets

- ◆ Demand for a Factor Input When Only One Input Is Variable
  - — If the market supply of labor increased relative to demand (baby boomers or female entry), a surplus of labor would exist and the wage rate would fall.
  - — Question
    - • How would this impact the quantity demanded for labor?

A Shift in the Supply of Labor

Price of Labor

w_1 ———————— S_1

w_2 ———————— S_2

$MRP_L = D_L$

Quantity of Labor

L_1 L_2
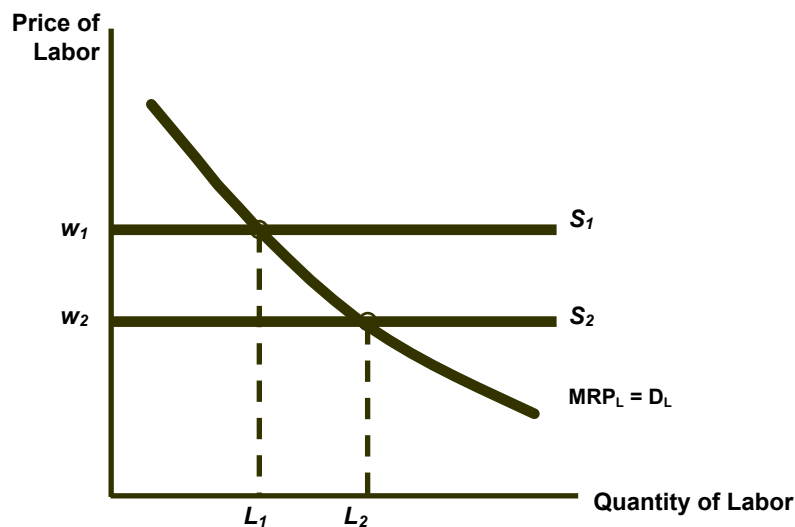
◆ Comparing Input and Output Markets

$$MRP_L = (MP_L)(MR)$$

and at profit maximizing

number of workers $MRP_L = w$

$$(MP_L)(MR) = w$$

$$MR = w/MP_L$$

$$w/MP_L = MC \text{ of production}$$
  – In both markets, input and output choices occur where MR = MC

- • MR from the sale of the output

- • MC from the purchase of the input

◆ Demand for a Factor Input When Several Inputs Are Variable

  – Scenario
    • Producing farm equipment with two variable inputs:
      – Labor
      – Assembly-line machinery
    • Assume the wage rate falls

  – Question
    • How will the decrease in the wage rate impact the demand for labor?

Firm's Demand Curve for Labor (with Variable Capital)

When two or more inputs are variable, a firm's demand for one input depends on the marginal revenue product of both inputs.

When the wage rate is $20, A represents one point on the firm's demand for labor curve.
When the wage rate falls to $15, the MRP curve shifts, generating a new point C on the firm's demand for labor curve. Thus A and C are on the demand for labor curve, but B is not.

Wages ($ per hour)

20 ⋯⋯⋯⋯⋯ A

C

15 ⋯⋯⋯⋯⋯ B

D

10

MRP_L   MRP_L

5

0   40   80   120   160   Hours of Work

Competitive Factor Markets

◆ Industry Demand for Labor

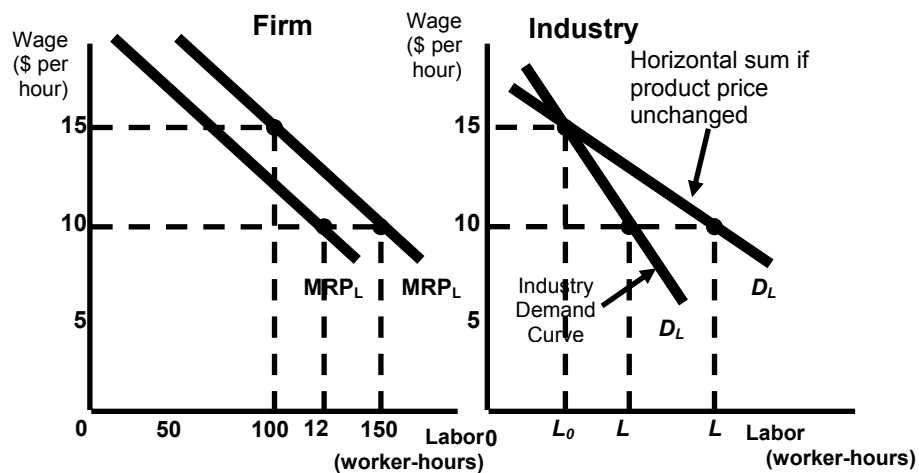– Assume that all firms respond to a lower wage

• All firms would hire more workers.
• Market supply would increase.
• The market price will fall.
• The quantity demanded for labor by the firm will be smaller.

The Industry Demand for Labor

◆ Question
– How would a change to a non-competitive market impact the derivation of the market demand for labor?

The Demand for Jet Fuel

◆ Observations
– Jet fuel is a factor (input) cost
– Cost of jet fuel

• 1971--Jet fuel cost equaled 12.4% of total operating cost

• 1980--Jet fuel cost equaled 30.0% of total operating cost

• 1990's--Jet fuel cost equaled 15.0% of total operating cost
– The demand for jet fuel impacts the airlines and refineries alike
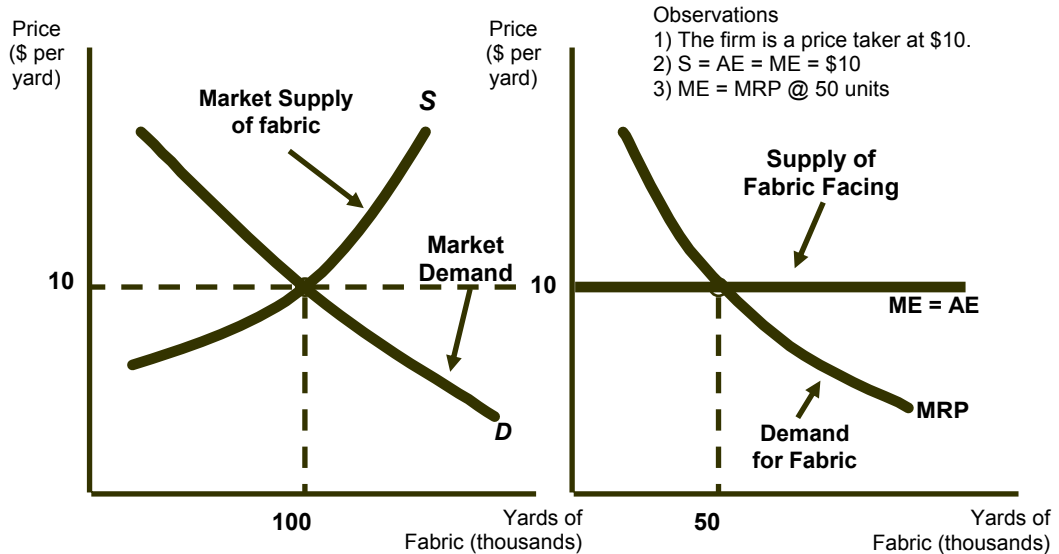– The short-run price elasticity of demand for jet-fuel is very inelastic
◆ Question
– How would the long-run price elasticity of demand compare to the short-run?

The Short- and Long-Run

Price

MRP$_{SR}$ MRP$_{LR}$

Quantity of Jet Fuel
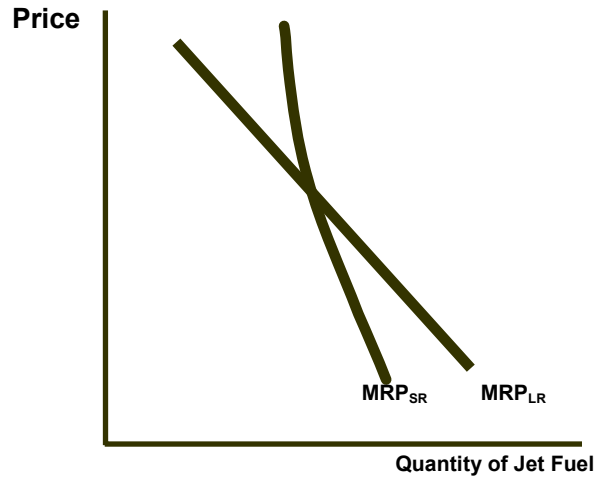
- The Supply of Inputs to a Firm
  - Determining how much of an input to purchase
    - Assume a perfectly competitive factor market

A Firm's Input Supply in a Competitive Factor Market

Price
($ per
yard)

**Market Supply
of fabric**

S

**Market
Demand**

10

D

100   Yards of
Fabric (thousands)

Price
($ per
yard)

Observations
1) The firm is a price taker at $10.
2) S = AE = ME = $10
3) ME = MRP @ 50 units

**Supply of
Fabric Facing**

10   **ME = AE**

MRP

**Demand
for Fabric**

50   Yards of
Fabric (thousands)

- The Market Supply of Inputs
  - The market supply for physical inputs is upward sloping
    - Examples: jet fuel, fabric, steel
  - The market supply for labor may be upward sloping and backward bending
- The Supply of Labor
  - The choice to supply labor is based on utility maximization
  - Leisure competes with labor for utility
  - Wage rate measures the price of leisure
  - Higher wage rate causes the price of leisure to increase

- Higher wages encourage workers to substitute work for leisure (i.e. the substitution effect)
- Higher wages allow the worker to purchase more goods, including leisure which reduces work hours (i.e. the income effect)
- If the income effect exceeds the substitution effect the supply curve is backward bending

Backward-Bending Supply of Labor

Wage ($ per hour)

Supply of Labor

Income Effect > Substitution Effect

Income Effect < Substitution Effect

Hours of Work per Day
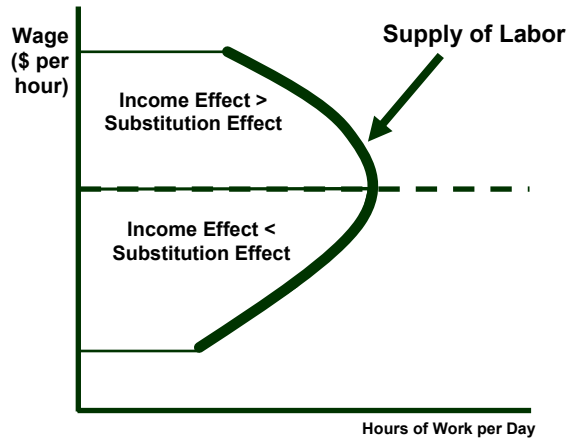
Substitution and Income Effects of a Wage Increase

Income ($ per day)

480

w = $20

Worker chooses point *A*:

16 hours leisure, 8 hour work

Suppose wages increase to $20

Increase wage to $20 worker chooses:
20 hour leisure, 4 hours work
income = $80

240 *P*

w = $10

C

A   *B*

0   8   12   15   20   24   **Hours of Leisure**

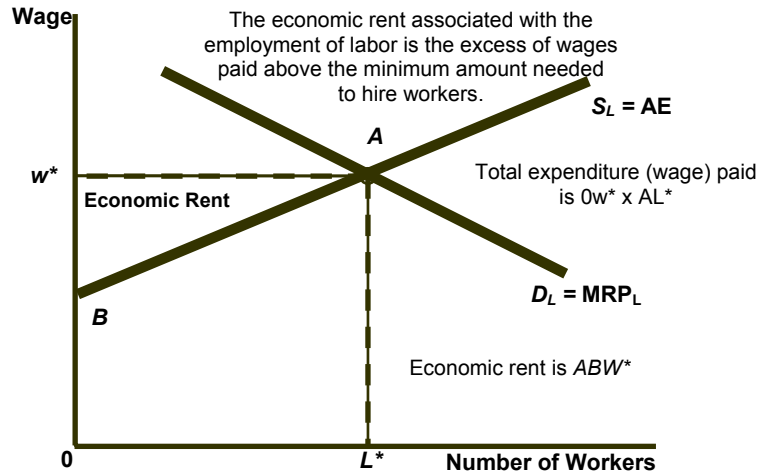**Substitution effect**

Income effect
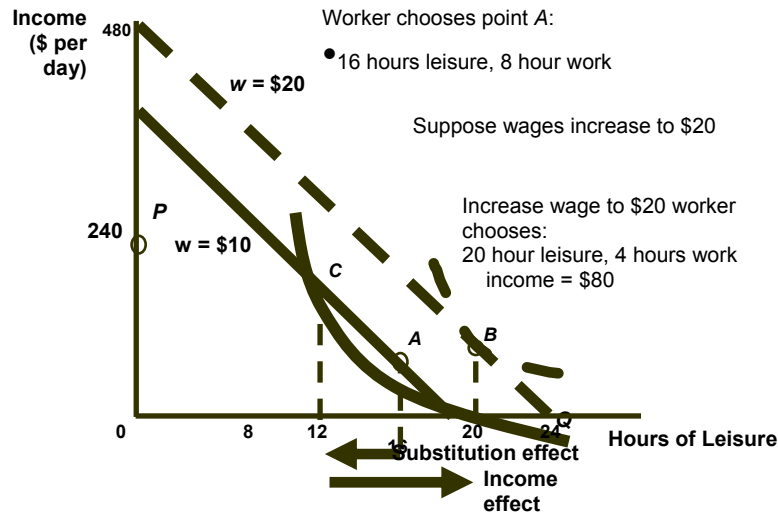
Equilibrium in a Competitive Factor Market

◆ A competitive factor market is in equilibrium when the price of the input equates the quantity demanded to the quantity supplied.

Labor Market Equilibrium
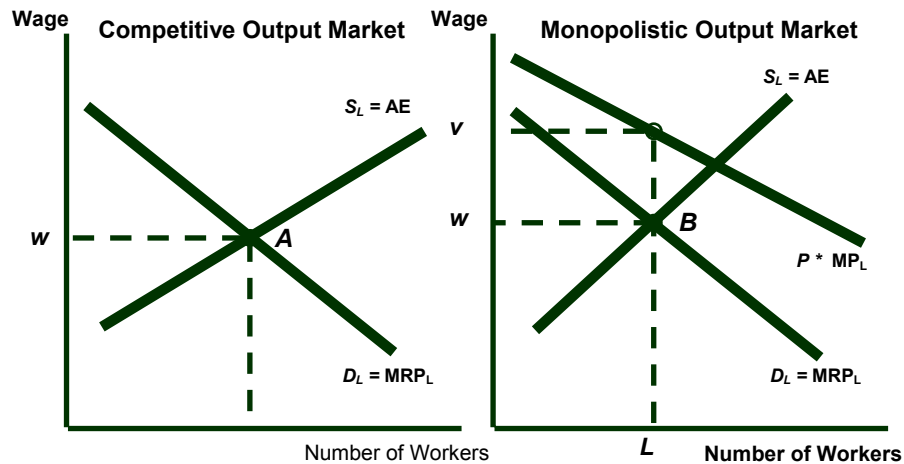
◆ Equilibrium in a Competitive Output Market
  – $D_L(MRP_L) = S_L$
  – $w_C = MRP_L$
  – $MRP_L = (P)(MP_L)$
  – Markets are efficient
◆ Equilibrium in a Monopolistic Output Market
  – $MR < P$
  – $MRP = (MR)(MP_L)$
  – Hire L_M at wage w_M
  – v_M = marginal benefit to consumers
  – w_M = marginal cost to the firm
  – Profits maximized
  – Using less than efficient level of input
◆ Economic Rent
  – For a factor market, economic rent is the difference between the payments made to a factor of production and the minimum amount that must be spent to obtain the use of that factor.

Wage

The economic rent associated with the employment of labor is the excess of wages paid above the minimum amount needed to hire workers.

$S_L = AE$

A

w^*

Economic Rent

Total expenditure (wage) paid is $0w^* \times AL^*$

$D_L = MRP_L$

B

Economic rent is *ABW**

0   *L**   **Number of Workers**

- ◆ Question
  - – What would be the economic rent if S_L is perfectly elastic or perfectly inelastic?
- ◆ Land: A Perfectly Inelastic Supply
  - – With land inelastically supplied, its price is determined entirely by demand, at least in the short run.

Land Rent

Price ($ per acre)

Supply of Land

s_2

Economic Rent

s_1

Economic Rent

D_2

D_1

Number of Acres
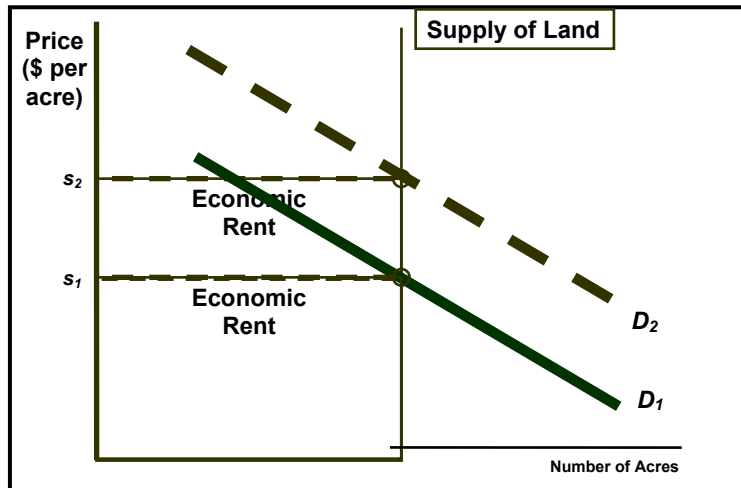
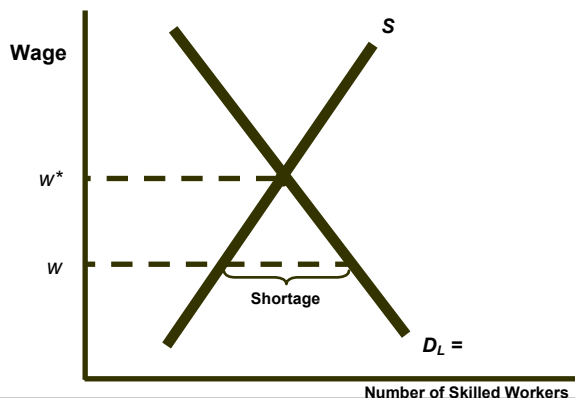Pay   in   the   Public Sector

- ◆ The percentage of personnel working in public sector has been declining
- ◆ Shortages of skilled personnel has occurred? Why?
  - – If there is a shortage, the wage must be below the competitive wage rate

The Shortage of Skilled Personnel

Wage

S

w^*

w

Shortage

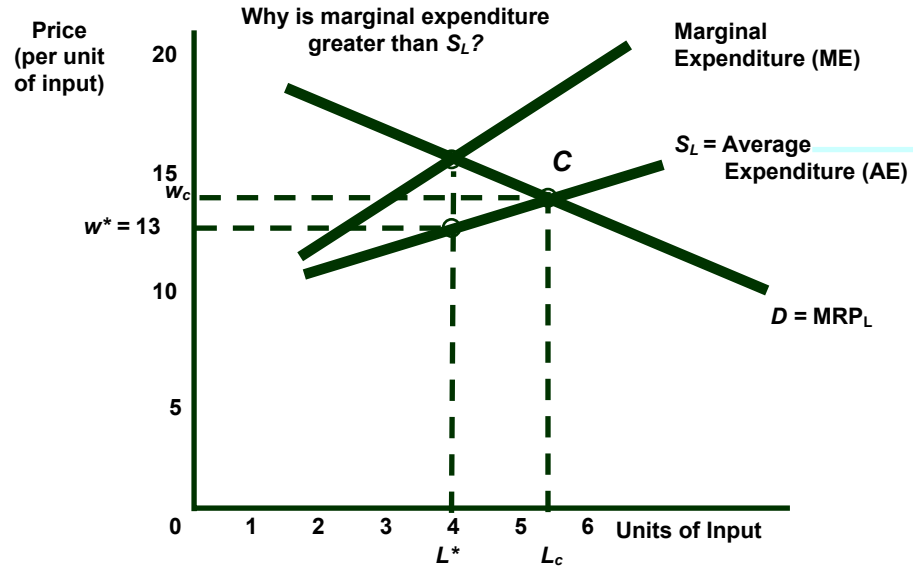$D_L =$

Number of Skilled Workers

- ◆ Public sector pay is based on years of service not MRP.
- ◆ MRP increases and the private sector pay is greater than public sector pay.
- ◆ Many leave the public sector.

Factor Markets with Monopsony Power

- ◆ *Assume*
  - – The output market is perfectly competitive.
  - – Input market is pure monopsony.

Marginal and Average Expenditure

Factor Markets with Monopsony Power

- ◆ Examples of Monopsony Power
  - – Government
    - • Soldiers
    - • Missiles
    - • B2 Bombers
  - – NASA
    - • Astronauts
  - – Company town

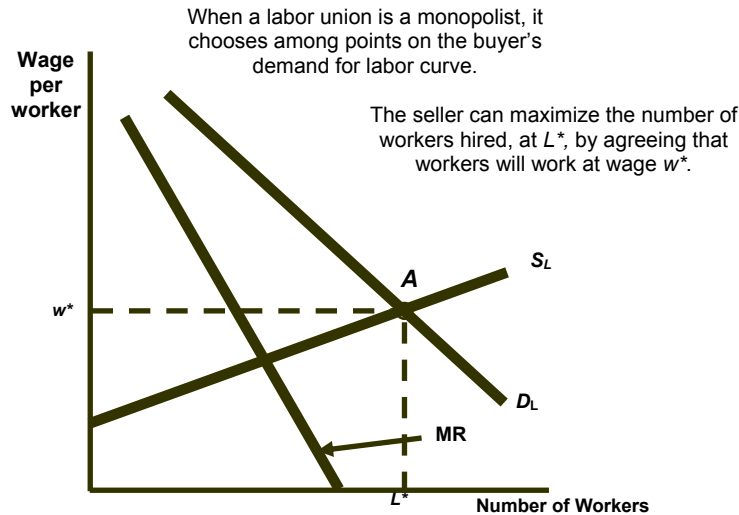## Monopsony Power in the Market for Baseball Players

- ◆ Baseball owners created a monopsonistic cartel
  - – Reserve clause prevented competition for players
  - – 1969--Average salary was $42,000
  - – 1997--Average salary was $1,383,578
  - – 1975 salaries were 25% of team expenditures
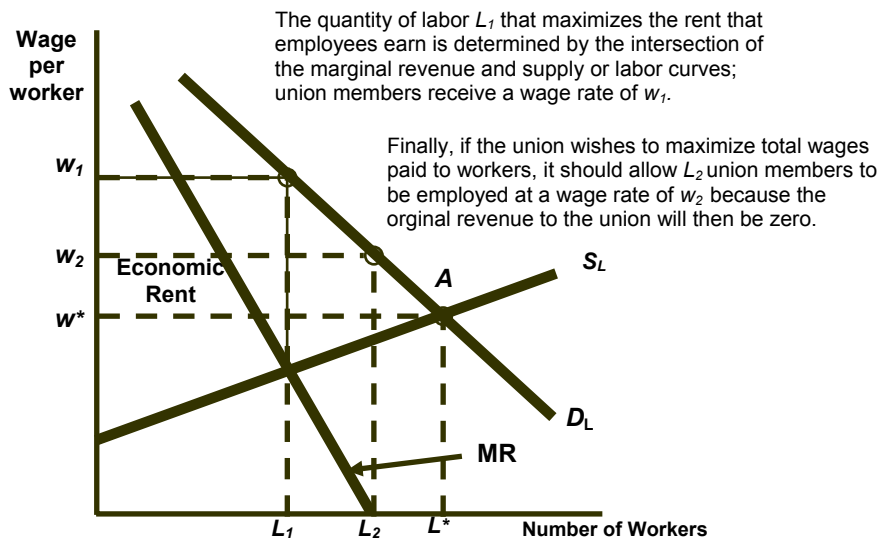 - – 1980 salaries were 40% of team expenditures

–

Factor Markets with Monopoly Power

* Just as buyers of inputs can have monopsony power, sellers of inputs can have monopoly power.
* The most important example of monopoly power in factor markets involves labor unions.

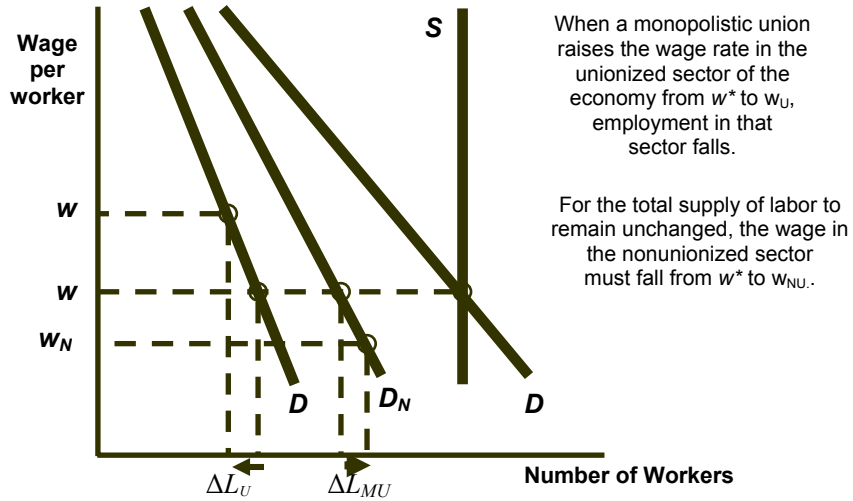### Monopoly Power of Sellers of Labor

When a labor union is a monopolist, it chooses among points on the buyer's demand for labor curve.

The seller can maximize the number of workers hired, at L^*, by agreeing that workers will work at wage w^*.

Monopoly Power of Sellers of Labor

The quantity of labor L_1 that maximizes the rent that employees earn is determined by the intersection of the marginal revenue and supply or labor curves; union members receive a wage rate of w_1.

Finally, if the union wishes to maximize total wages paid to workers, it should allow L_2 union members to be employed at a wage rate of w_2 because the orginal revenue to the union will then be zero.
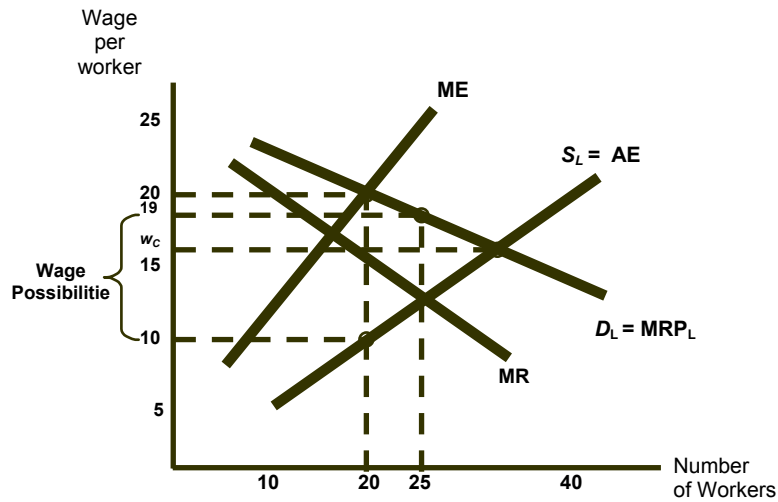

* The primary determinant of controlling wage and economic rent is controlling the supply of labor
* A Two-Sector Model of Labor Employment
  – Union monopoly power impacts the nonunionized part of the economy.

Wage Determination in Unionized & Nonunionized Sectors

Wage per worker

S

When a monopolistic union raises the wage rate in the unionized sector of the economy from w^* to w_U, employment in that sector falls.

For the total supply of labor to remain unchanged, the wage in the nonunionized sector must fall from w^* to w_{NU}.

w

w

w_N

D D_N *D*

Number of Workers

ΔL_U ΔL_{MU}

◆ Bilateral Monopoly
  − Market in which a monopolist sells to a monopsonist.

Wage per worker

ME

25

S_L = AE

20
19

w_C

Wage Possibilitie { 15

D_L = MRP_L

10

MR

5

10   20   25   40

Number of Workers

◆ Observations
  − Hiring without union monopoly power

    • MRP = ME at 20 workers and w = $10/hr
  − Union's objective

    • *MR = MC* at 25 workers and *w* = $19/hr
◆ Who Will Win?
  ▪ The union will if its threat to strike is credible.
  ▪ The firm will if its threat to hire non-union workers is credible.
  ▪ If both make credible threats the wage will be