OXFORD
HIGHER EDUCATION

MANAGERIAL ECONOMICS

Principles and Worldwide Applications

SEVENTH EDITION

Adapted version

Dominick Salvatore

Adapted by

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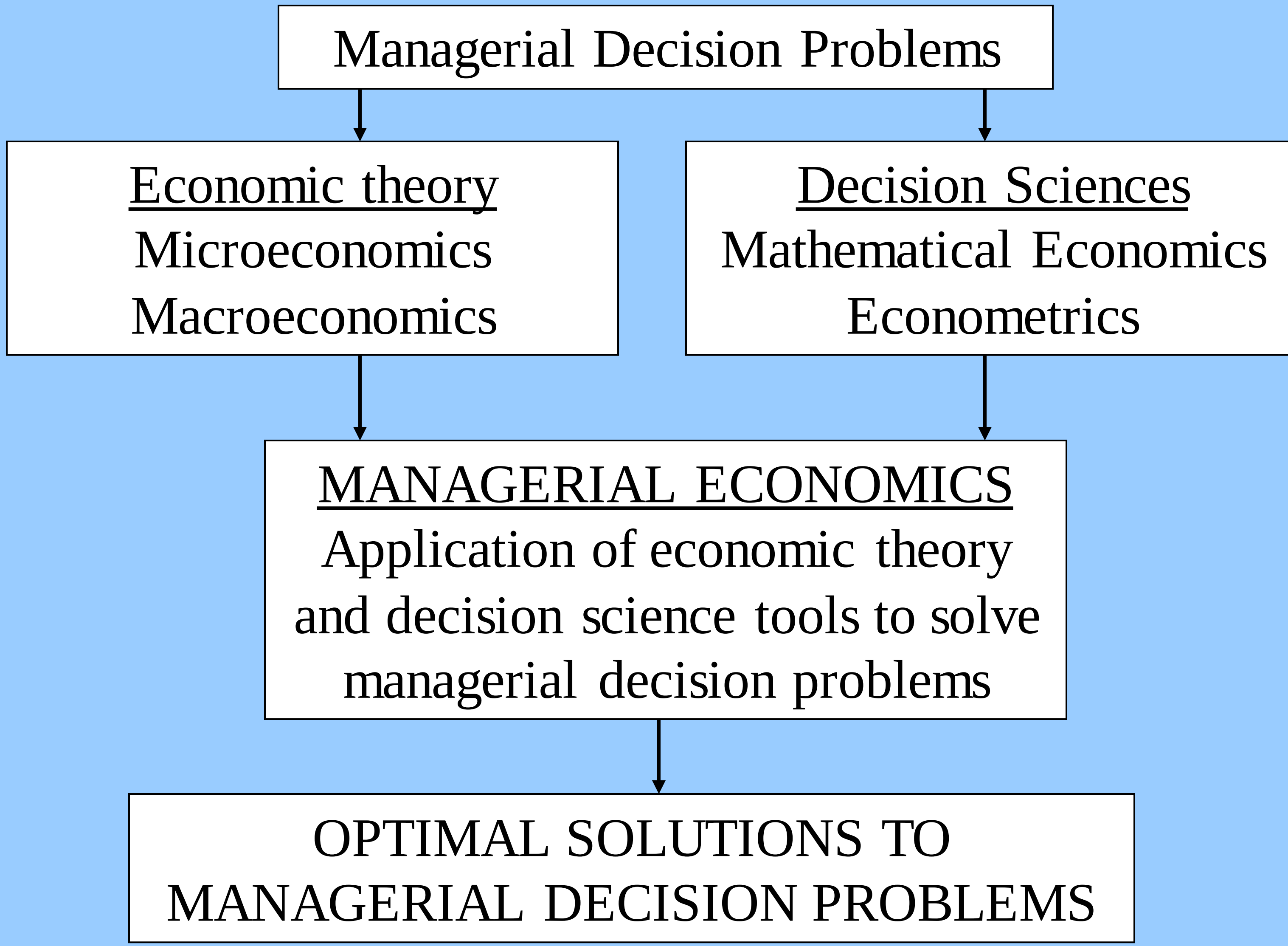
Managerial Economics in a Global Economy, 5th Edition by Dominick Salvatore

Chapter 1

The Nature and Scope of Managerial Economics

Managerial Economics Defined

- The application of economic theory and the tools of decision science to examine how an organization can achieve its aims or objectives most efficiently.


Managerial Decision Problems
Economic theory
Microeconomics
Macroeconomics
Decision Sciences
Mathematical Economics
Econometrics
MANAGERIAL ECONOMICS
Application of economic theory
and decision science tools to solve
managerial decision problems
OPTIMAL SOLUTIONS TO
MANAGERIAL DECISION PROBLEMS

Theory of the Firm

- Combines and organizes resources for the purpose of producing goods and/or services for sale.
- Internalizes transactions, reducing transactions costs.
- Primary goal is to maximize the wealth or value of the firm.

Value of the Firm

The present value of all expected future profits

Alternative Theories

- Sales maximization
  - Adequate rate of profit
- Management utility maximization
  - Principle-agent problem
- Satisficing behavior

Definitions of Profit

- Business Profit: Total revenue minus the explicit or accounting costs of production.
- Economic Profit: Total revenue minus the explicit and implicit costs of production.
- Opportunity Cost: Implicit value of a resource in its best alternative use.

Theories of Profit

- Risk-Bearing Theories of Profit
- Frictional Theory of Profit
- Monopoly Theory of Profit
- Innovation Theory of Profit
- Managerial Efficiency Theory of Profit

Function of Profit

- Profit is a signal that guides the allocation of society's resources.
- High profits in an industry are a signal that buyers want more of what the industry produces.
- Low (or negative) profits in an industry are a signal that buyers want less of what the industry produces.

Business Ethics

- Identifies types of behavior that businesses and their employees should not engage in.
- Source of guidance that goes beyond enforceable laws.

The Changing Environment of Managerial Economics

- Globalization of Economic Activity
  - Goods and Services
  - Capital
  - Technology
  - Skilled Labor
- Technological Change
  - Telecommunications Advances
  - The Internet and the World Wide Web

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Chapter 2

Optimization Techniques and New Management Tools

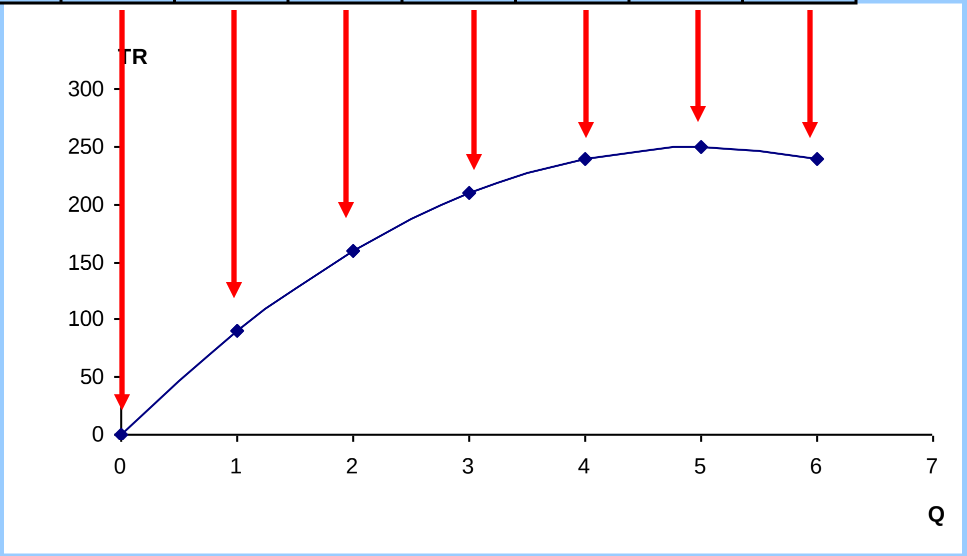
Expressing Economic Relationships

Equations: $TR = 100Q - 10Q^2$

Tables:

Q	0	1	2	3	4	5	6
TR	0	90	160	210	240	250	240

Graphs:



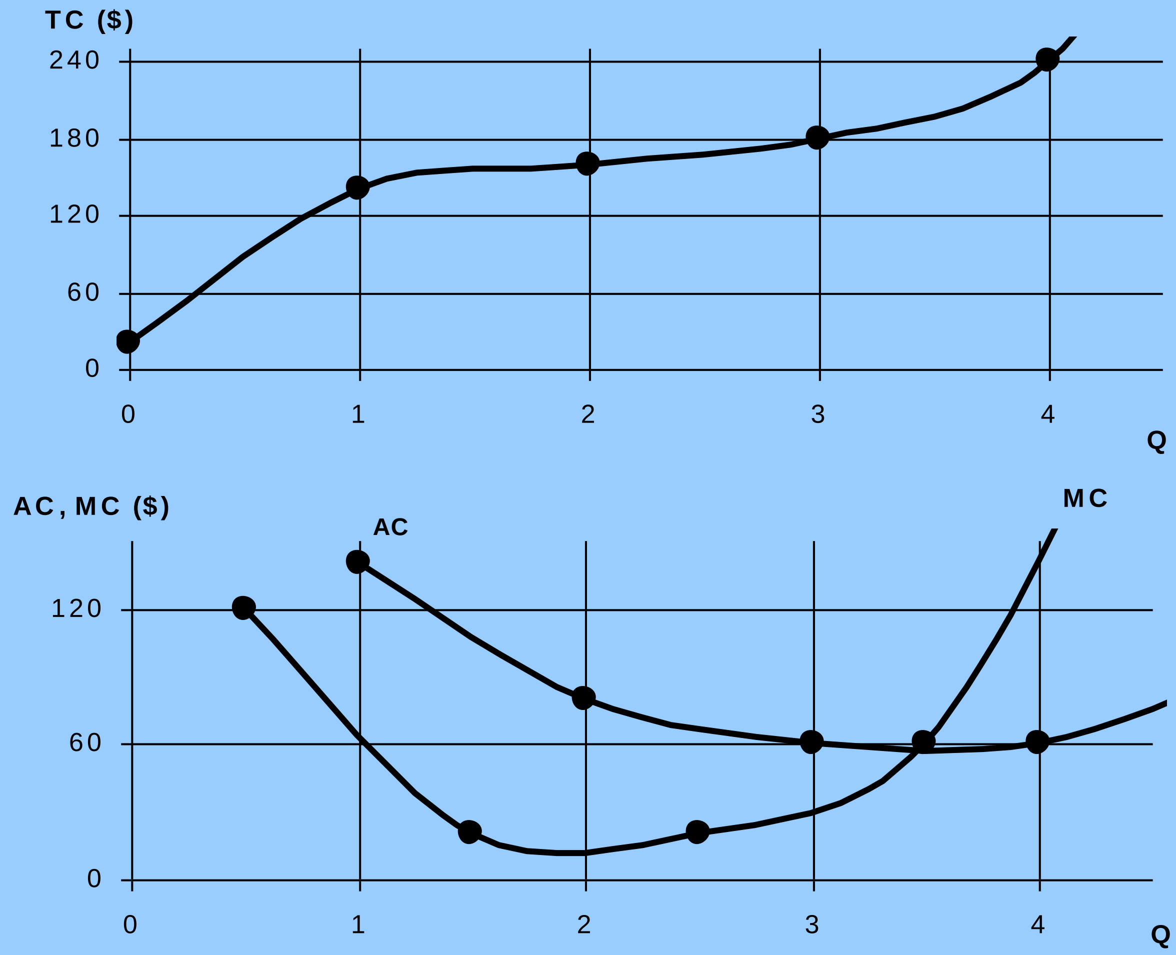
Total, Average, and Marginal Cost

$AC = TC/Q$

$MC = \Delta TC/\Delta Q$

Q	TC	AC	MC
0	20	-	-
1	140	140	120
2	160	80	20
3	180	60	20
4	240	60	60
5	480	96	240

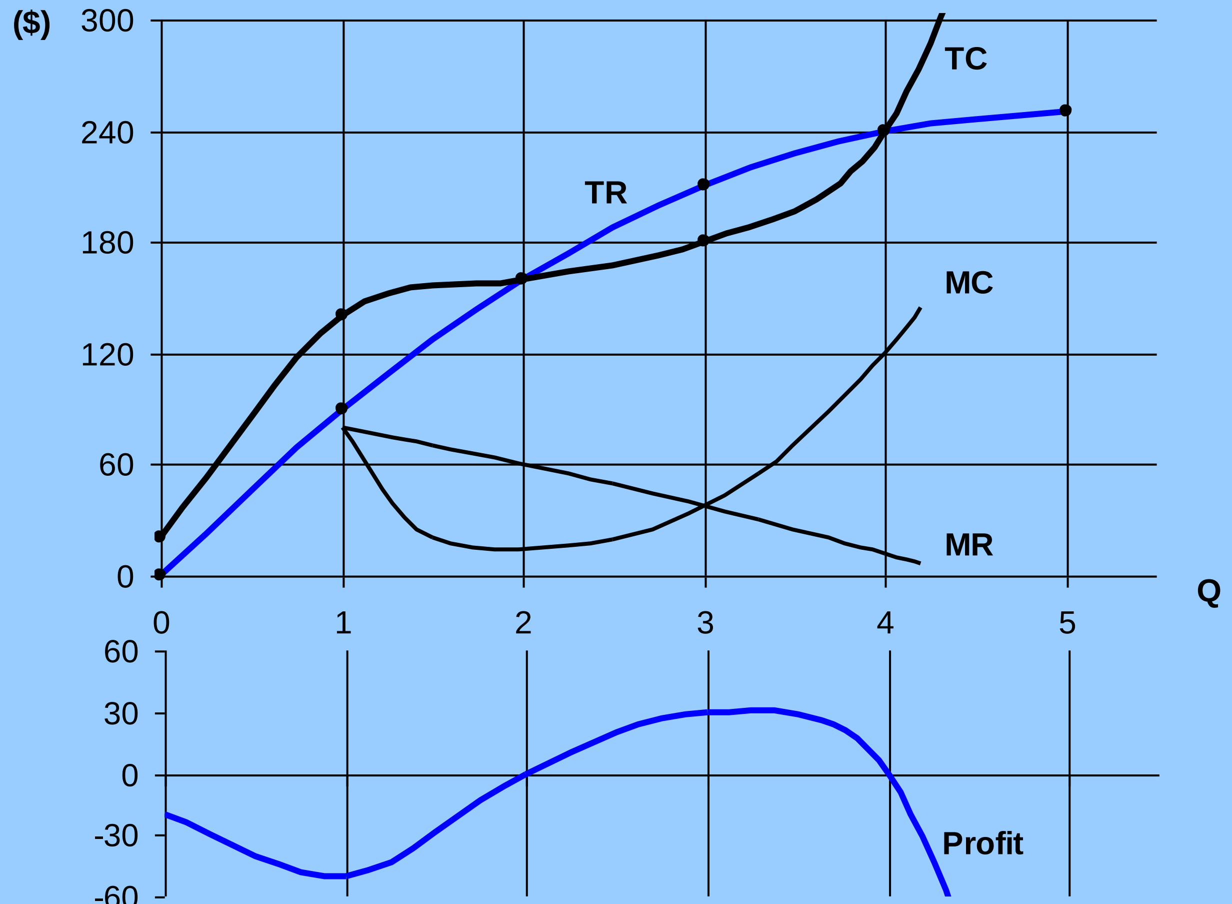
Total, Average, and Marginal Cost



Profit Maximization

Q	TR	TC	Profit
0	0	20	-20
1	90	140	-50
2	160	160	0
3	210	180	30
4	240	240	0
5	250	480	-230

Profit Maximization



Concept of the Derivative

The derivative of Y with respect to X is equal to the limit of the ratio $\Delta Y/\Delta X$ as ΔX approaches zero.

Rules of Differentiation

Constant Function Rule: The derivative of a constant, Y = f(X) = a, is zero for all values of a (the constant).

$$Y = f(X) = a$$

$$\frac{dY}{dX} = 0$$

Rules of Differentiation

Power Function Rule: The derivative of a power function, where a and b are constants, is defined as follows.

$$Y = f(X) = aX^b$$

$$\frac{dY}{dX} = b \cdot a X^{b-1}$$

Rules of Differentiation

Sum-and-Differences Rule: The derivative of the sum or difference of two functions U and V, is defined as follows.

$$U = g(X) \qquad V = h(X) \qquad Y = U \pm V$$

$$\frac{dY}{dX} = \frac{dU}{dX} \pm \frac{dV}{dX}$$

Rules of Differentiation

Product Rule: The derivative of the product of two functions U and V, is defined as follows.

$$U = g(X) \qquad V = h(X) \qquad Y = U \cdot V$$

$$\frac{dY}{dX} = U\frac{dV}{dX} + V\frac{dU}{dX}$$

Rules of Differentiation

Quotient Rule: The derivative of the ratio of two functions U and V, is defined as follows.

$$U = g(X) \qquad V = h(X) \qquad Y = \frac{U}{V}$$

$$\frac{dY}{dX} = \frac{V\left(dU/dX\right) - U\left(dV/dX\right)}{V^2}$$

Rules of Differentiation

Chain Rule: The derivative of a function that is a function of X is defined as follows.

$$Y = f(U) \qquad U = g(X)$$

$$\frac{dY}{dX} = \frac{dY}{dU} \cdot \frac{dU}{dX}$$

Optimization With Calculus

Find X such that $dY/dX = 0$

Second derivative rules:

If $d^2Y/dX^2 > 0$, then X is a minimum.

If $d^2Y/dX^2 < 0$, then X is a maximum.

New Management Tools

- Benchmarking
- Total Quality Management
- Reengineering
- The Learning Organization

Other Management Tools

- Broadbanding
- Direct Business Model
- Networking
- Pricing Power
- Small-World Model
- Virtual Integration
- Virtual Management

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Chapter 3

Demand Theory

Law of Demand

- There is an inverse relationship between the price of a good and the quantity of the good demanded per time period.

- Substitution Effect
- Income Effect

Individual Consumer’s Demand

$$Qd_X = f(P_X, I, P_Y, T)$$

Qd_X = quantity demanded of commodity X by an individual per time period

P_X = price per unit of commodity X

I = consumer’s income

P_Y = price of related (substitute or complementary) commodity

T = tastes of the consumer

$$Qd_X = f(P_X, I, P_Y, T)$$

$\Delta Qd_X/\Delta P_X < 0$

$\Delta Qd_X/\Delta I > 0$ if a good is normal

$\Delta Qd_X/\Delta I < 0$ if a good is inferior

$\Delta Qd_X/\Delta P_Y > 0$ if X and Y are substitutes

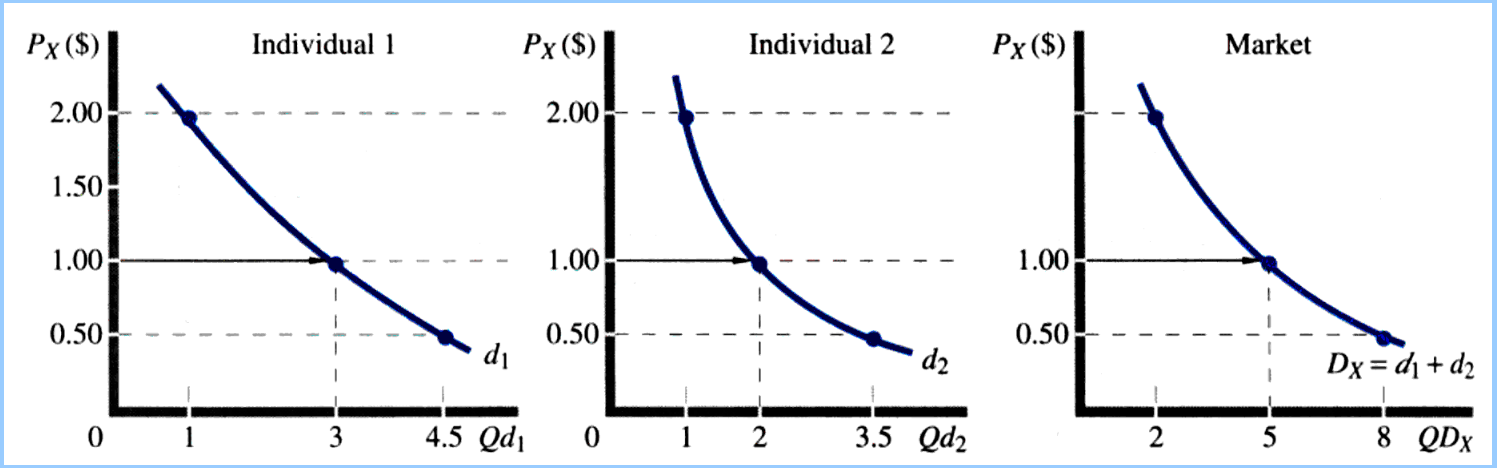
$\Delta Qd_X/\Delta P_Y < 0$ if X and Y are complements

Market Demand Curve

- Horizontal summation of demand curves of individual consumers

- Bandwagon Effect
- Snob Effect

Horizontal Summation: From Individual to Market Demand



Market Demand Function

$$QD_X = f(P_X, N, I, P_Y, T)$$

QD_X = quantity demanded of commodity X

P_X = price per unit of commodity X

N = number of consumers on the market

I = consumer income

P_Y = price of related (substitute or complementary) commodity

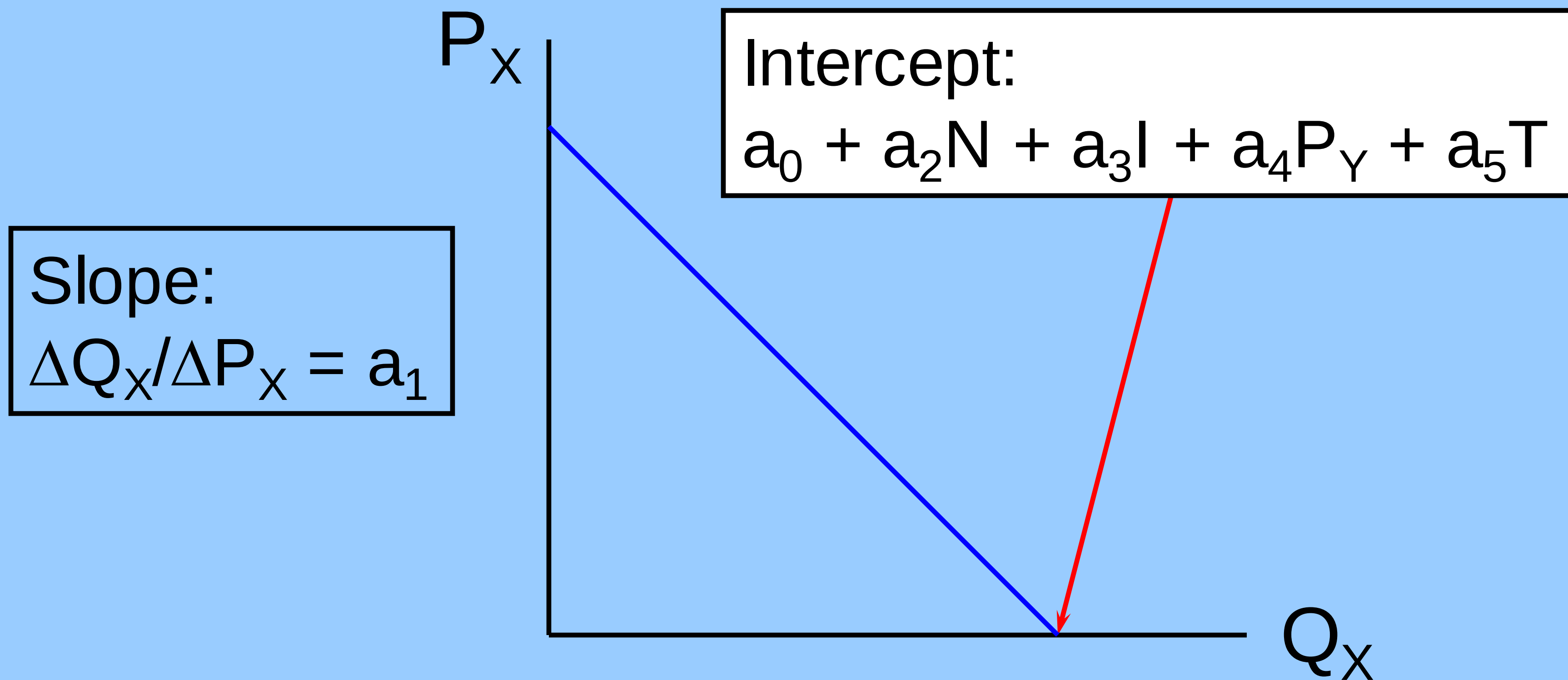
T = consumer tastes

Demand Faced by a Firm

- Market Structure
  - Monopoly
  - Oligopoly
  - Monopolistic Competition
  - Perfect Competition
- Type of Good
  - Durable Goods
  - Nondurable Goods
  - Producers' Goods - Derived Demand

Linear Demand Function

$$Q_X = a_0 + a_1P_X + a_2N + a_3I + a_4P_Y + a_5T$$



Price Elasticity of Demand

Point Definition $$E_P = \frac{\Delta Q / Q}{\Delta P / P} = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q}$$

Linear Function $$E_P = a_1 \cdot \frac{P}{Q}$$

Price Elasticity of Demand

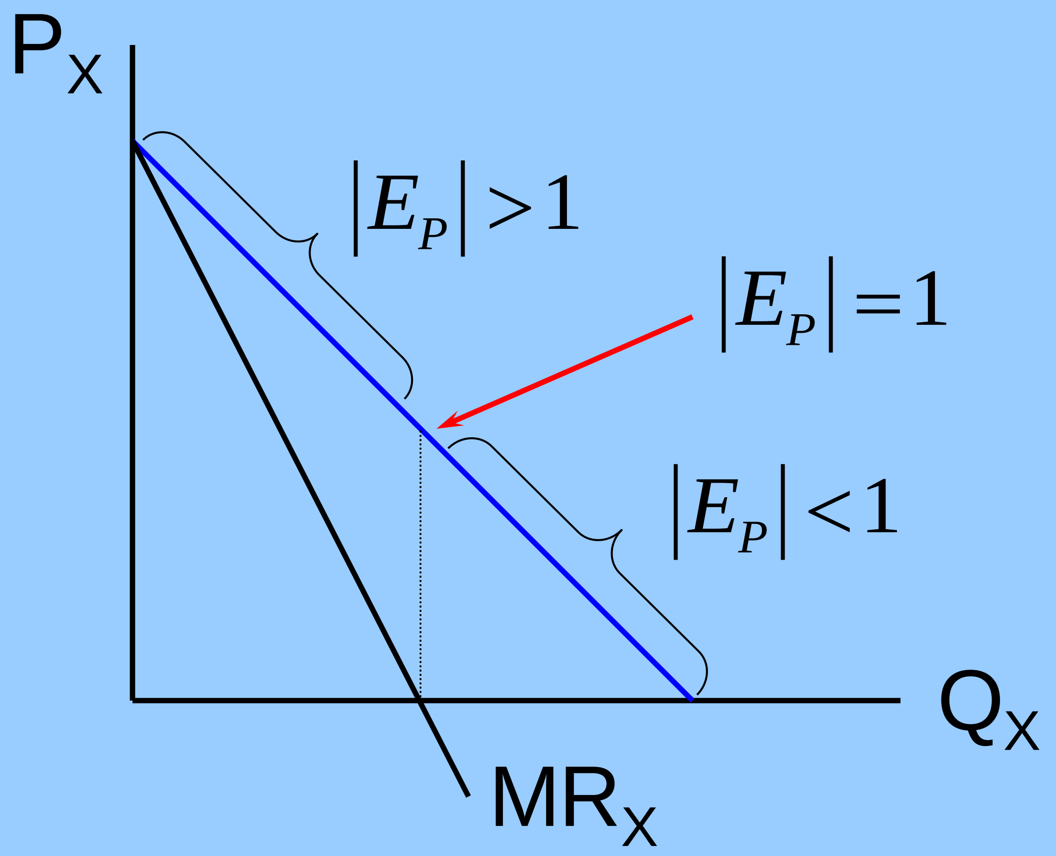
Arc Definition

$$E_P = \frac{Q_2 - Q_1}{P_2 - P_1} \cdot \frac{P_2 + P_1}{Q_2 + Q_1}$$

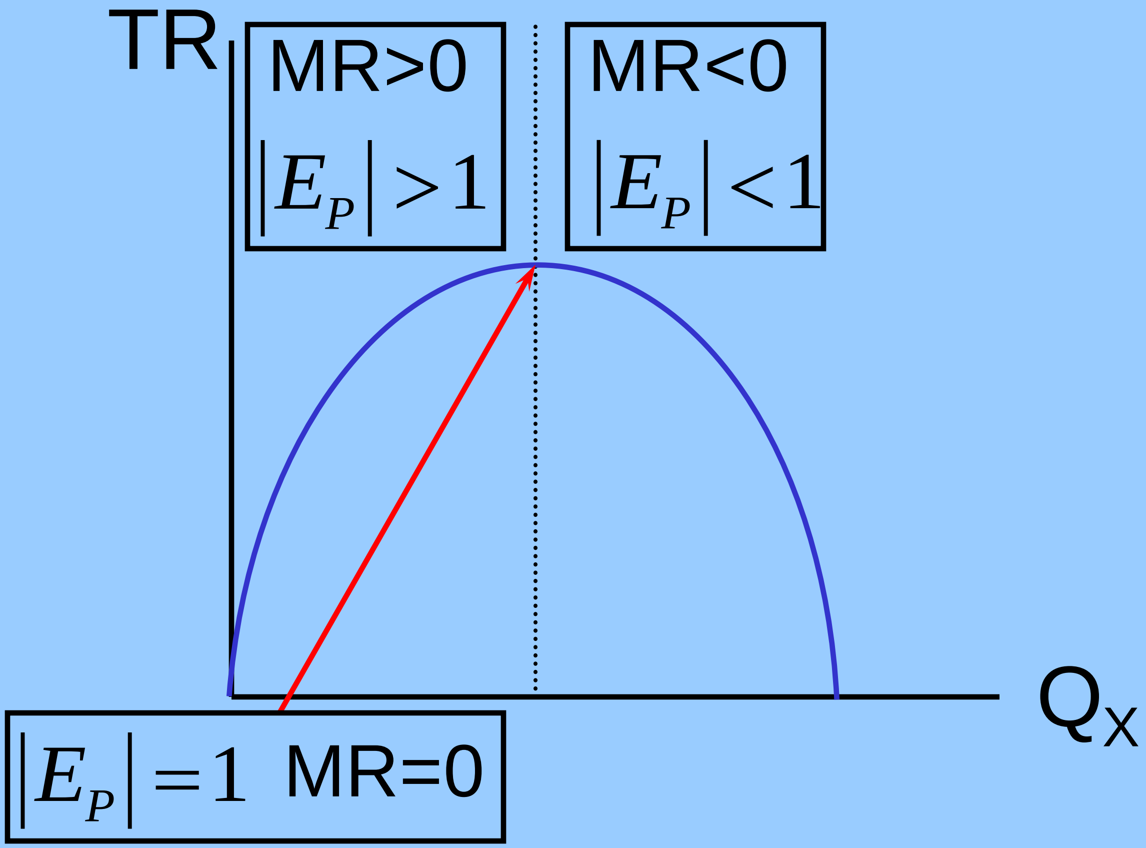
Marginal Revenue and Price Elasticity of Demand

$$MR = P\left(1 + \frac{1}{E_P}\right)$$

Marginal Revenue and Price Elasticity of Demand



Marginal Revenue, Total Revenue, and Price Elasticity



Determinants of Price Elasticity of Demand

Demand for a commodity will be more elastic if:

- It has many close substitutes
- It is narrowly defined
- More time is available to adjust to a price change

Determinants of Price Elasticity of Demand

Demand for a commodity will be less elastic if:

- It has few substitutes
- It is broadly defined
- Less time is available to adjust to a price change

Income Elasticity of Demand

Point Definition

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

Linear Function

$$E_I = a_3 \cdot \frac{I}{Q}$$

Income Elasticity of Demand

Arc Definition

$$E_I = \frac{Q_2 - Q_1}{I_2 - I_1} \cdot \frac{I_2 + I_1}{Q_2 + Q_1}$$

Normal Good

$$E_I > 0$$

Inferior Good

$$E_I < 0$$

Cross-Price Elasticity of Demand

Point Definition

$$E_{XY} = \frac{\Delta Q_X / Q_X}{\Delta P_Y / P_Y} = \frac{\Delta Q_X}{\Delta P_Y} \cdot \frac{P_Y}{Q_X}$$

Linear Function

$$E_{XY} = a_4 \cdot \frac{P_Y}{Q_X}$$

Cross-Price Elasticity of Demand

Arc Definition

$$E_{XY} = \frac{Q_{X2} - Q_{X1}}{P_{Y2} - P_{Y1}} \cdot \frac{P_{Y2} + P_{Y1}}{Q_{X2} + Q_{X1}}$$

Substitutes

$$E_{XY} > 0$$

Complements

$$E_{XY} < 0$$

Other Factors Related to Demand Theory

- International Convergence of Tastes
  - Globalization of Markets
  - Influence of International Preferences on Market Demand
- Growth of Electronic Commerce
  - Cost of Sales
  - Supply Chains and Logistics
  - Customer Relationship Management

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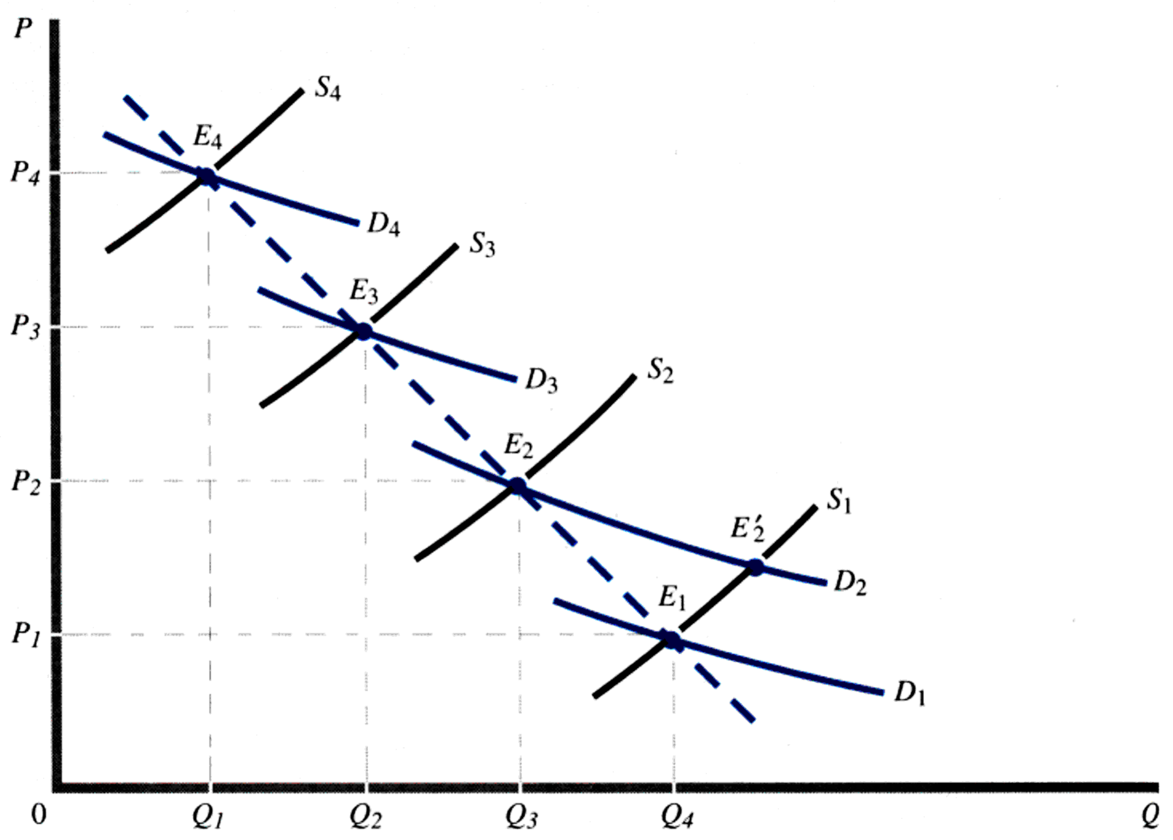
Chapter 4
Demand Estimation

The Identification Problem



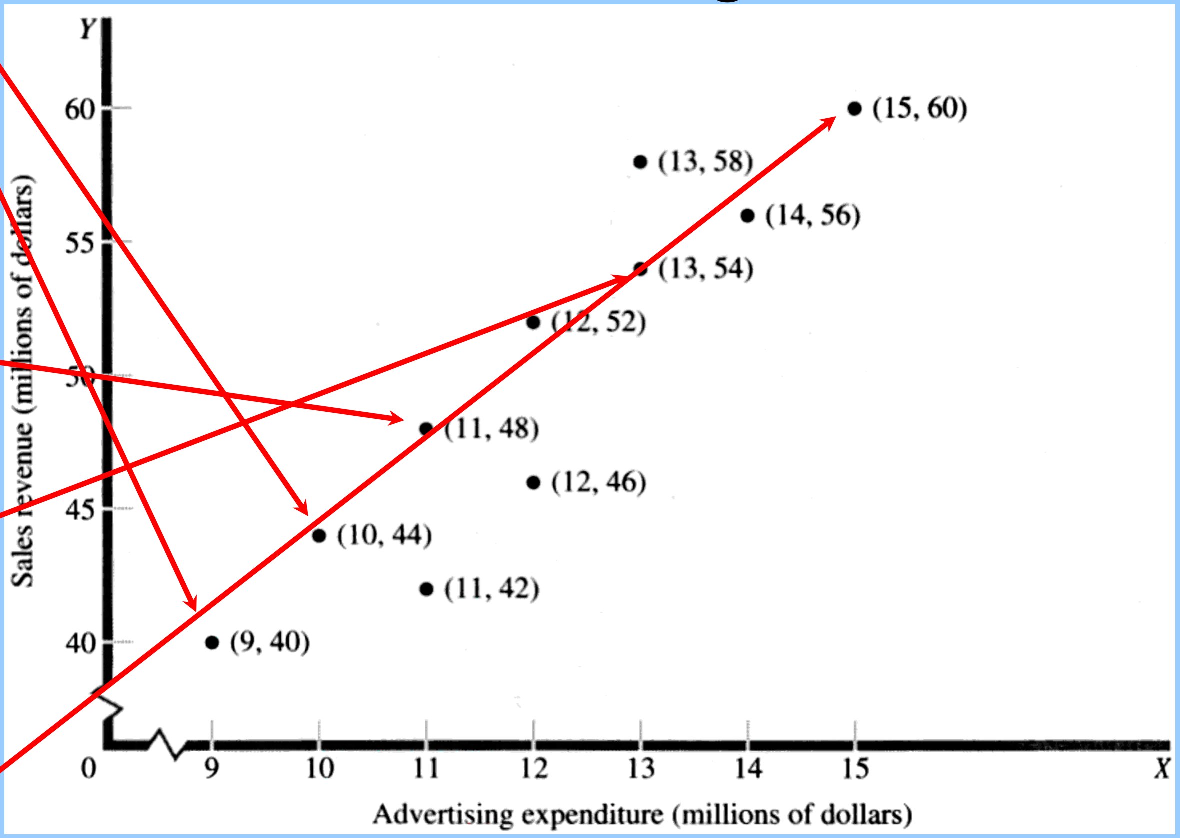
Demand Estimation: Marketing Research Approaches

- Consumer Surveys
- Observational Research
- Consumer Clinics
- Market Experiments
- Virtual Shopping
- Virtual Management

Regression Analysis

Year	X	Y
1	10	44
2	9	40
3	11	42
4	12	46
5	11	48
6	12	52
7	13	54
8	13	58
9	14	56
10	15	60

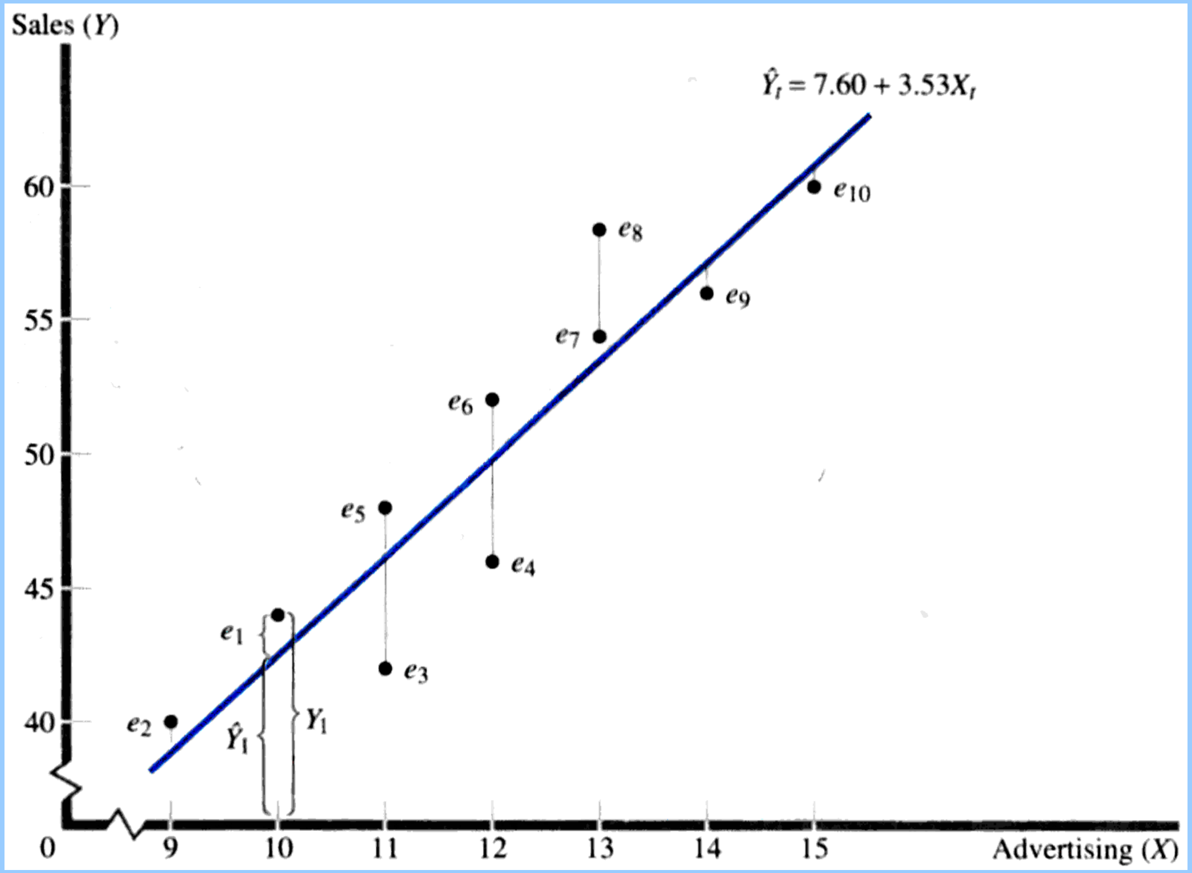
Scatter Diagram



Regression Analysis

- Regression Line: Line of Best Fit
- Regression Line: Minimizes the sum of the squared vertical deviations (e_t) of each point from the regression line.
- Ordinary Least Squares (OLS) Method

Regression Analysis



Ordinary Least Squares (OLS)

Model:

$$Y_t = a + bX_t + e_t$$

$$\hat{Y}_t = \hat{a} + \hat{b}X_t$$

$$e_t = Y_t - \hat{Y}_t$$

Ordinary Least Squares (OLS)

Objective: Determine the slope and intercept that minimize the sum of the squared errors.

$$\sum_{t=1}^{n} e_t^2 = \sum_{t=1}^{n} (Y_t - \hat{Y}_t)^2 = \sum_{t=1}^{n} (Y_t - \hat{a} - \hat{b}X_t)^2$$

Ordinary Least Squares (OLS)

Estimation Procedure

$$\hat{b} = \frac{\sum_{t=1}^{n}(X_t - \bar{X})(Y_t - \bar{Y})}{\sum_{t=1}^{n}(X_t - \bar{X})^2}$$

$$\hat{a} = \bar{Y} - \hat{b}\bar{X}$$

Ordinary Least Squares (OLS)

Estimation Example

Time	X_t	Y_t	$X_t - \bar{X}$	$Y_t - \bar{Y}$	$(X_t - \bar{X})(Y_t - \bar{Y})$	$(X_t - \bar{X})^2$
1	10	44	-2	-6	12	4
2	9	40	-3	-10	30	9
3	11	42	-1	-8	8	1
4	12	46	0	-4	0	0
5	11	48	-1	-2	2	1
6	12	52	0	2	0	0
7	13	54	1	4	4	1
8	13	58	1	8	8	1
9	14	56	2	6	12	4
10	15	60	3	10	30	9
	120	500			106	30

$n = 10$ $\quad \sum_{t=1}^{n} X_t = 120$ $\quad \sum_{t=1}^{n} Y_t = 500$ $\quad \sum_{t=1}^{n} (X_t - \bar{X})^2 = 30$ $\quad \hat{b} = \frac{106}{30} = 3.533$

$\bar{X} = \sum_{t=1}^{n} \frac{X_t}{n} = \frac{120}{10} = 12$ $\quad \bar{Y} = \sum_{t=1}^{n} \frac{Y_t}{n} = \frac{500}{10} = 50$ $\quad \sum_{t=1}^{n} (X_t - \bar{X})(Y_t - \bar{Y}) = 106$ $\quad \hat{a} = 50 - (3.533)(12) = 7.60$

Ordinary Least Squares (OLS)

Estimation Example

$$n = 10$$

$$\bar{X} = \sum_{t=1}^{n} \frac{X_t}{n} = \frac{120}{10} = 12$$

$$\sum_{t=1}^{n} X_t = 120 \qquad \sum_{t=1}^{n} Y_t = 500$$

$$\bar{Y} = \sum_{t=1}^{n} \frac{Y_t}{n} = \frac{500}{10} = 50$$

$$\sum_{t=1}^{n} (X_t - \bar{X})^2 = 30$$

$$\hat{b} = \frac{106}{30} = 3.533$$

$$\sum_{t=1}^{n} (X_t - \bar{X})(Y_t - \bar{Y}) = 106$$

$$\hat{a} = 50 - (3.533)(12) = 7.60$$

Tests of Significance

Standard Error of the Slope Estimate

$$s_{\hat{b}} = \sqrt{\frac{\sum (Y_t - \hat{Y})^2}{(n-k)\sum (X_t - \bar{X})^2}} = \sqrt{\frac{\sum e_t^2}{(n-k)\sum (X_t - \bar{X})^2}}$$

Tests of Significance

Example Calculation

Time	X_t	Y_t	$\hat{Y}_t$	$e_t = Y_t - \hat{Y}_t$	$e_t^2 = (Y_t - \hat{Y}_t)^2$	$(X_t - \bar{X})^2$
1	10	44	42.90	1.10	1.2100	4
2	9	40	39.37	0.63	0.3969	9
3	11	42	46.43	-4.43	19.6249	1
4	12	46	49.96	-3.96	15.6816	0
5	11	48	46.43	1.57	2.4649	1
6	12	52	49.96	2.04	4.1616	0
7	13	54	53.49	0.51	0.2601	1
8	13	58	53.49	4.51	20.3401	1
9	14	56	57.02	-1.02	1.0404	4
10	15	60	60.55	-0.55	0.3025	9
					65.4830	30

$$\sum_{t=1}^{n} e_t^2 = \sum_{t=1}^{n} (Y_t - \hat{Y}_t)^2 = 65.4830 \qquad \sum_{t=1}^{n} (X_t - \bar{X})^2 = 30$$

$$s_{\hat{b}} = \sqrt{\frac{\sum (Y_t - \hat{Y})^2}{(n-k)\sum (X_t - \bar{X})^2}} = \sqrt{\frac{65.4830}{(10-2)(30)}} = 0.52$$

Tests of Significance

Example Calculation

$$\sum_{t=1}^{n} e_t^2 = \sum_{t=1}^{n} (Y_t - \hat{Y}_t)^2 = 65.4830$$

$$\sum_{t=1}^{n} (X_t - \bar{X})^2 = 30$$

$$s_{\hat{b}} = \sqrt{\frac{\sum (Y_t - \hat{Y})^2}{(n-k)\sum (X_t - \bar{X})^2}} = \sqrt{\frac{65.4830}{(10-2)(30)}} = 0.52$$

Tests of Significance

Calculation of the t Statistic

$$t = \frac{\hat{b}}{s_{\hat{b}}} = \frac{3.53}{0.52} = 6.79$$

Degrees of Freedom = (n-k) = (10-2) = 8

Critical Value at 5% level =2.306

Tests of Significance

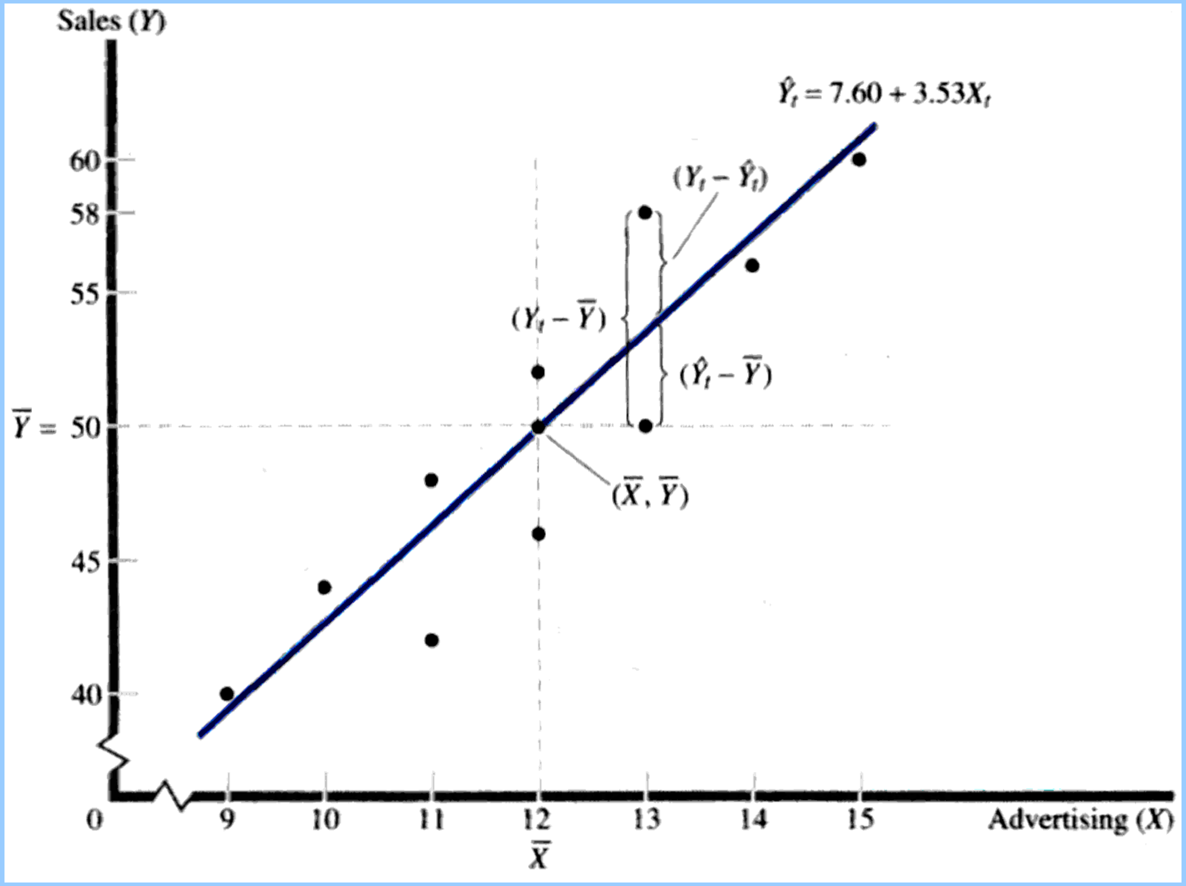
Decomposition of Sum of Squares

Total Variation = Explained Variation + Unexplained Variation

$$\sum(Y_t - \bar{Y})^2 = \sum(\hat{Y} - \bar{Y})^2 + \sum(Y_t - \hat{Y}_t)^2$$

Tests of Significance

Decomposition of Sum of Squares



Tests of Significance

Coefficient of Determination

$$R^2 = \frac{Explained\,Variation}{Total\,Variation} = \frac{\sum(\hat{Y} - \bar{Y})^2}{\sum(Y_t - \bar{Y})^2}$$

$$R^2 = \frac{373.84}{440.00} = 0.85$$

Tests of Significance

Coefficient of Correlation

$$r = \sqrt{R^2} \; with\,the\,sign\,of\; \hat{b}$$

$$-1 \le r \le 1$$

$$r = \sqrt{0.85} = 0.92$$

Multiple Regression Analysis

Model: $$Y = a + b_1 X_1 + b_2 X_2 + \cdots + b_{k'} X_{k'}$$

Multiple Regression Analysis

Adjusted Coefficient of Determination

$$\bar{R}^2 = 1 - (1 - R^2)\frac{(n-1)}{(n-k)}$$

Multiple Regression Analysis

Analysis of Variance and F Statistic

$$F = \frac{Explained\,Variation/(k-1)}{Unexplained\,Variation/(n-k)}$$

$$F = \frac{R^2/(k-1)}{(1-R^2)/(n-k)}$$

Problems in Regression Analysis

- Multicollinearity: Two or more explanatory variables are highly correlated.
- Heteroskedasticity: Variance of error term is not independent of the Y variable.
- Autocorrelation: Consecutive error terms are correlated.

Durbin-Watson Statistic

Test for Autocorrelation

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

If d=2, autocorrelation is absent.

Steps in Demand Estimation

- Model Specification: Identify Variables
- Collect Data
- Specify Functional Form
- Estimate Function
- Test the Results

Functional Form Specifications

Linear Function:

$$Q_X = a_0 + a_1 P_X + a_2 I + a_3 N + a_4 P_Y + \cdots + e$$

Power Function:

$$Q_X = a(P_X^{b_1})(P_Y^{b_2})$$

Estimation Format:

$$\ln Q_X = \ln a + b_1 \ln P_X + b_2 \ln P_Y$$

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Chapter 5

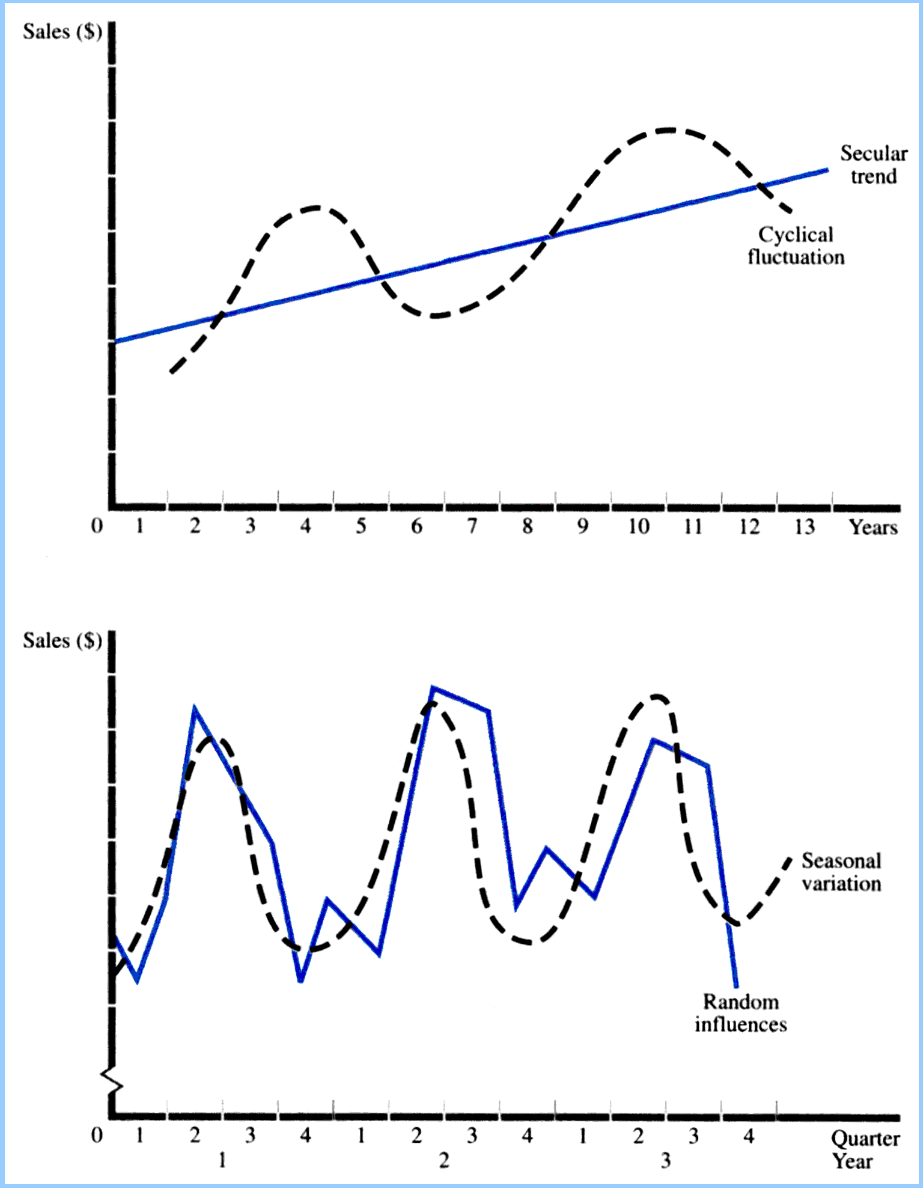
Demand Forecasting

Qualitative Forecasts

- Survey Techniques
  - Planned Plant and Equipment Spending
  - Expected Sales and Inventory Changes
  - Consumers' Expenditure Plans
- Opinion Polls
  - Business Executives
  - Sales Force
  - Consumer Intentions

Time-Series Analysis

- Secular Trend
  - Long-Run Increase or Decrease in Data
- Cyclical Fluctuations
  - Long-Run Cycles of Expansion and Contraction
- Seasonal Variation
  - Regularly Occurring Fluctuations
- Irregular or Random Influences


Sales ($)
Secular trend
Cyclical fluctuation
0 1 2 3 4 5 6 7 8 9 10 11 12 13 Years
Sales ($)
Seasonal variation
Random influences
0 1 2 3 4 1 2 3 4 1 2 3 4 Quarter
1 2 3 Year

Trend Projection

- Linear Trend:
  $S_t = S_0 + b\ t$
  b = Growth per time period
- Constant Growth Rate
  $S_t = S_0 (1 + g)^t$
  g = Growth rate
- Estimation of Growth Rate
  $\ln S_t = \ln S_0 + t \ln(1 + g)$

Seasonal Variation

Ratio to Trend Method

$$\text{Ratio} = \frac{\text{Actual}}{\text{Trend Forecast}}$$

$$\text{Seasonal Adjustment} = \text{Average of Ratios for Each Seasonal Period}$$

$$\text{Adjusted Forecast} = \text{Trend Forecast} \bullet \text{Seasonal Adjustment}$$

Seasonal Variation

Ratio to Trend Method: Example Calculation for Quarter 1

Trend Forecast for 1996.1 = 11.90 + (0.394)(17) = 18.60

Seasonally Adjusted Forecast for 1996.1 = (18.60)(0.8869) = 16.50

Year	Trend Forecast	Actual	Ratio
1992.1	12.29	11.00	0.8950
1993.1	13.87	12.00	0.8652
1994.1	15.45	14.00	0.9061
1995.1	17.02	15.00	0.8813
Seasonal Adjustment =			0.8869

Moving Average Forecasts

Forecast is the average of data from *w* periods prior to the forecast data point.

$$F_t = \sum_{i=1}^{w} \frac{A_{t-i}}{w}$$

Exponential Smoothing Forecasts

Forecast is the weighted average of of the forecast and the actual value from the prior period.

$$F_{t+1} = wA_t + (1-w)F_t$$

$$0 \le w \le 1$$

Root Mean Square Error

Measures the Accuracy
of a Forecasting Method

$$RMSE = \sqrt{\frac{\sum (A_t - F_t)^2}{n}}$$

Barometric Methods

- National Bureau of Economic Research
- Department of Commerce
- Leading Indicators
- Lagging Indicators
- Coincident Indicators
- Composite Index
- Diffusion Index

Econometric Models

Single Equation Model of the Demand For Cereal (Good X)

$$Q_X = a_0 + a_1P_X + a_2Y + a_3N + a_4P_S + a_5P_C + a_6A + e$$

Q_X = Quantity of X

P_X = Price of Good X

Y = Consumer Income

N = Size of Population

P_S = Price of Muffins

P_C = Price of Milk

A = Advertising

e = Random Error

Econometric Models

Multiple Equation Model of GNP

$$C_t = a_1 + b_1 GNP_t + u_{1t}$$

$$I_t = a_2 + b_2 \pi_{t-1} + u_{2t}$$

$$GNP_t \equiv C_t + I_t + G_t$$

Reduced Form Equation

$$GNP_t = \frac{a_1 + a_2}{1 - b_1} + \frac{b_2 \pi_{t-1}}{1} - b_1 + \frac{G_t}{1 - b_1}$$

Input-Output Forecasting

Three-Sector Input-Output Flow Table

	Producing Industry				
Supplying Industry	A	B	C	Final Demand	Total
A	20	60	30	90	200
B	80	90	20	110	300
C	40	30	10	20	100
Value Added	60	120	40		220
Total	200	300	100	220	

Input-Output Forecasting

Direct Requirements Matrix

$$\text{Direct Requirements} = \frac{\text{Input Requirements}}{\text{Column Total}}$$

	Producing Industry		
Supplying Industry	A	B	C
A	0.1	0.2	0.3
B	0.4	0.3	0.2
C	0.2	0.1	0.1

Input-Output Forecasting

Total Requirements Matrix

	Producing Industry		
Supplying Industry	A	B	C
A	1.47	0.51	0.60
B	0.96	1.81	0.72
C	0.43	0.31	1.33

Input-Output Forecasting

Total Requirements Matrix

1.47	0.51	0.60
0.96	1.81	0.72
0.43	0.31	1.33

•

Final Demand Vector

90
110
20

=

Total Demand Vector

200
300
100

Input-Output Forecasting

Revised Input-Output Flow Table

	Producing Industry				
Supplying Industry	A	B	C	Final Demand	Total
A	22	62	31	100	215
B	88	93	21	110	310
C	43	31	10	20	104

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Chapter 6

Production Theory and Estimation

The Organization of Production

- Inputs
  - Labor, Capital, Land
- Fixed Inputs
- Variable Inputs
- Short Run
  - At least one input is fixed
- Long Run
  - All inputs are variable

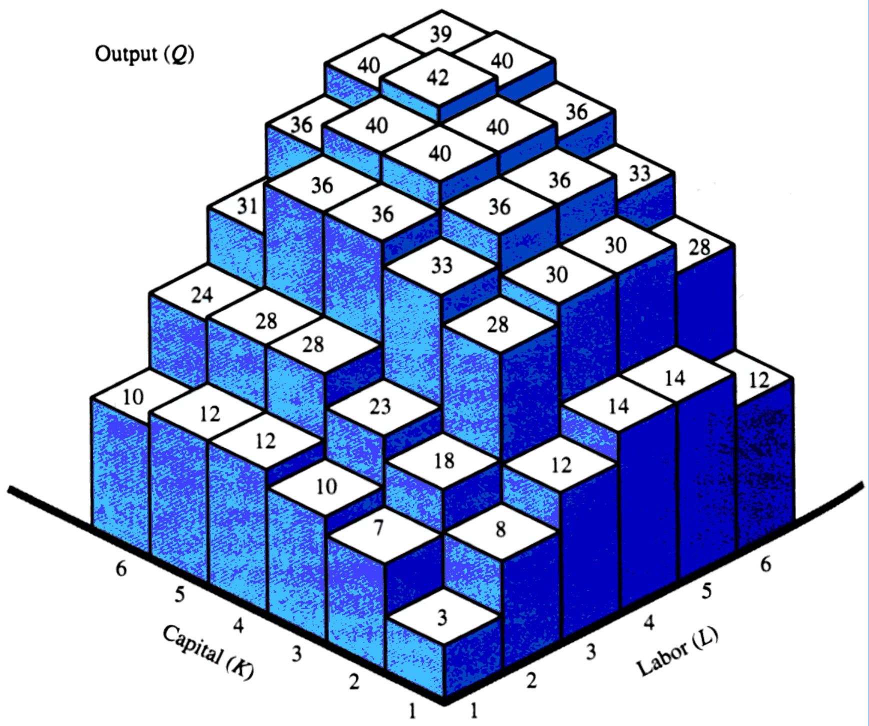
Production Function With Two Inputs

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

K							Q
6	10	24	31	36	40	39	
5	12	28	36	40	42	40	
4	12	28	36	40	40	36	
3	10	23	33	36	36	33	
2	7	18	28	30	30	28	
1	3	8	12	14	14	12	
	1	2	3	4	5	6	L

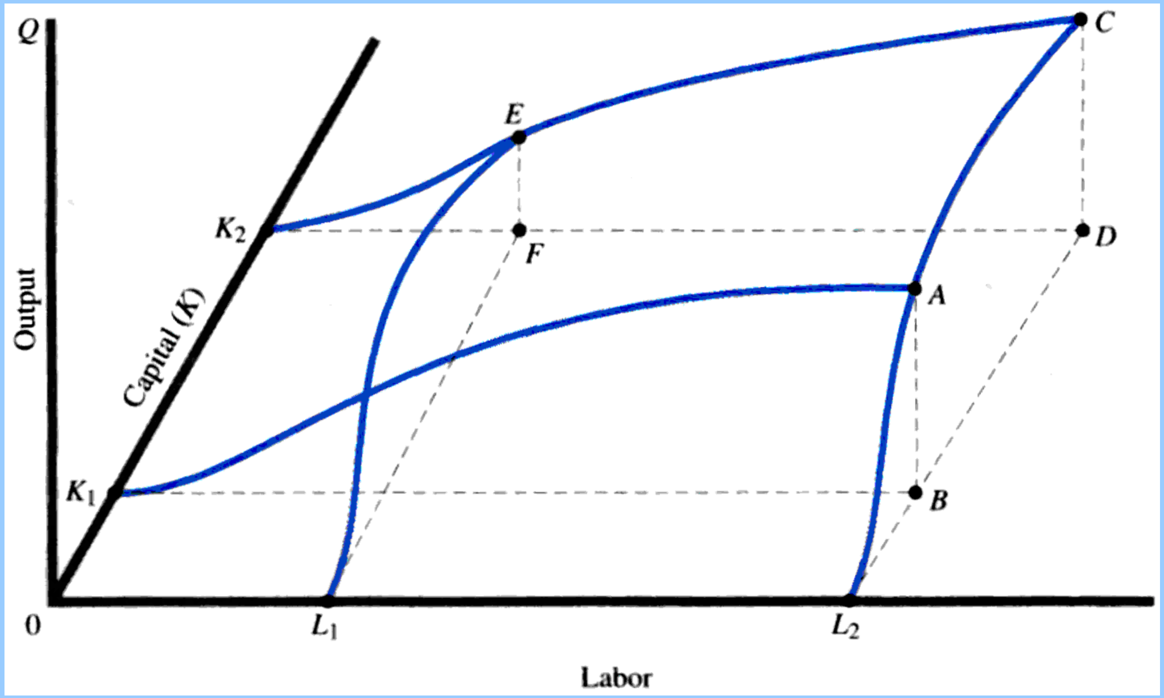
Production Function With Two Inputs

Discrete Production Surface



Production Function With Two Inputs

Continuous Production Surface



Production Function With One Variable Input

Total Product $TP = Q = f(L)$

Marginal Product $MP_L = \frac{\Delta TP}{\Delta L}$

Average Product $AP_L = \frac{TP}{L}$

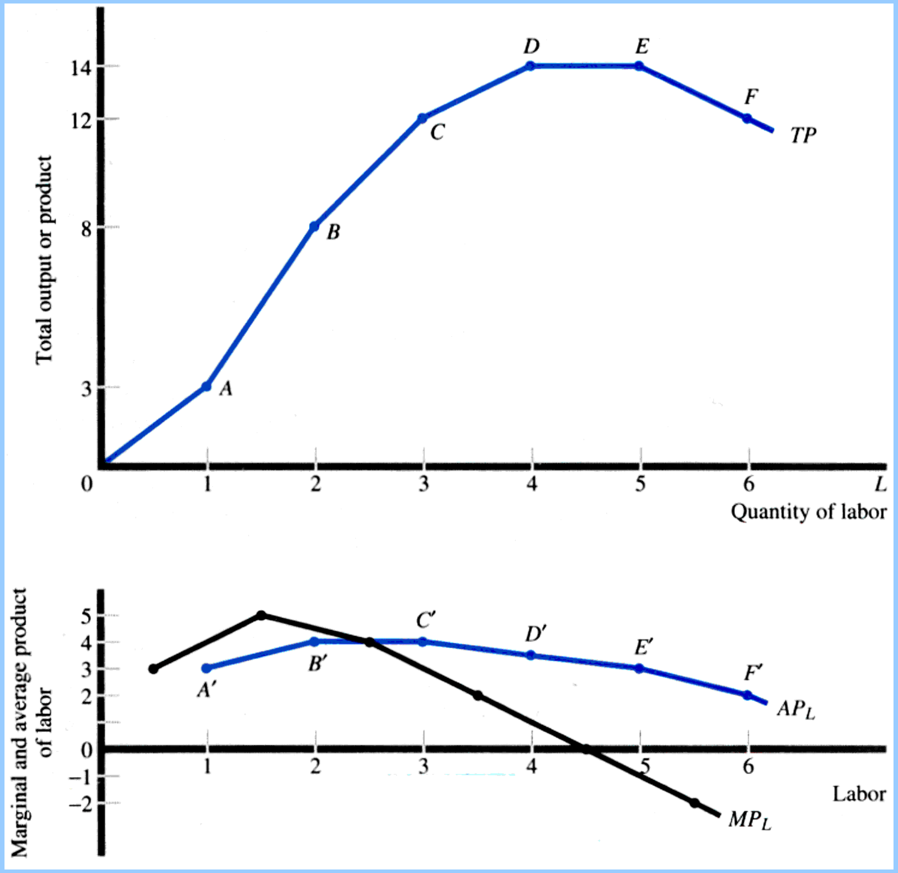
Production or Output Elasticity $E_L = \frac{MP_L}{AP_L}$

Production Function With One Variable Input

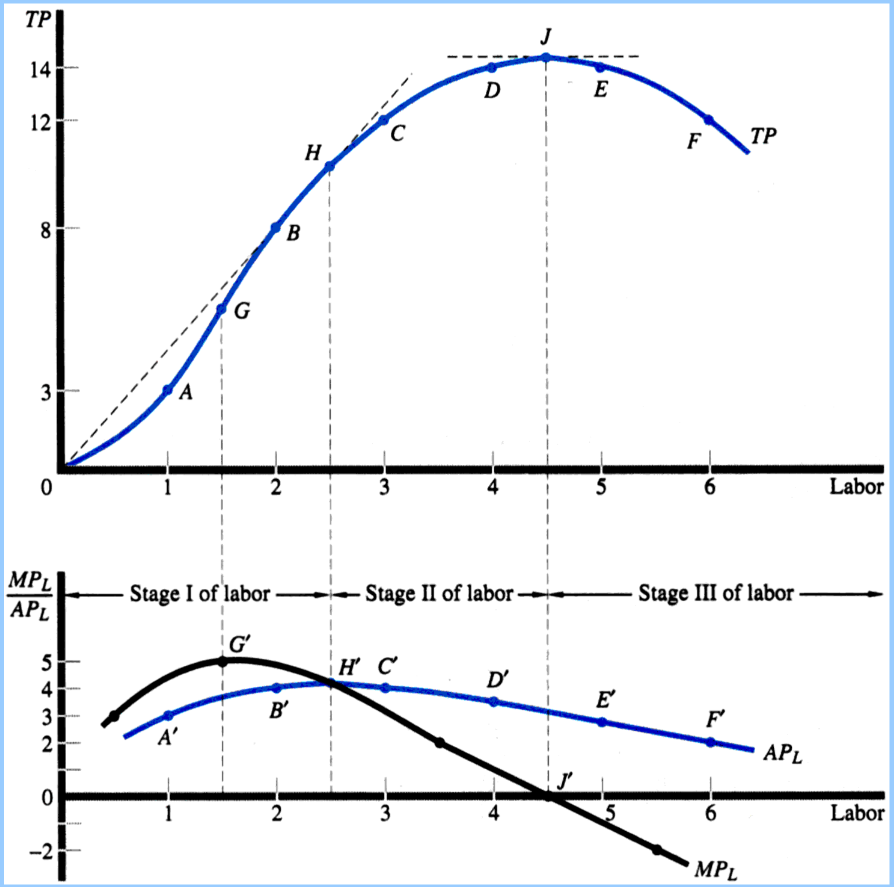
Total, Marginal, and Average Product of Labor, and Output Elasticity

L	Q	MP_L	AP_L	E_L
0	0	-	-	-
1	3	3	3	1
2	8	5	4	1.25
3	12	4	4	1
4	14	2	3.5	0.57
5	14	0	2.8	0
6	12	-2	2	-1

Production Function With One Variable Input



Production Function With One Variable Input



Optimal Use of the Variable Input

Marginal Revenue Product of Labor $MRP_L = (MP_L)(MR)$

Marginal Resource Cost of Labor $MRC_L = \dfrac{\Delta TC}{\Delta L}$

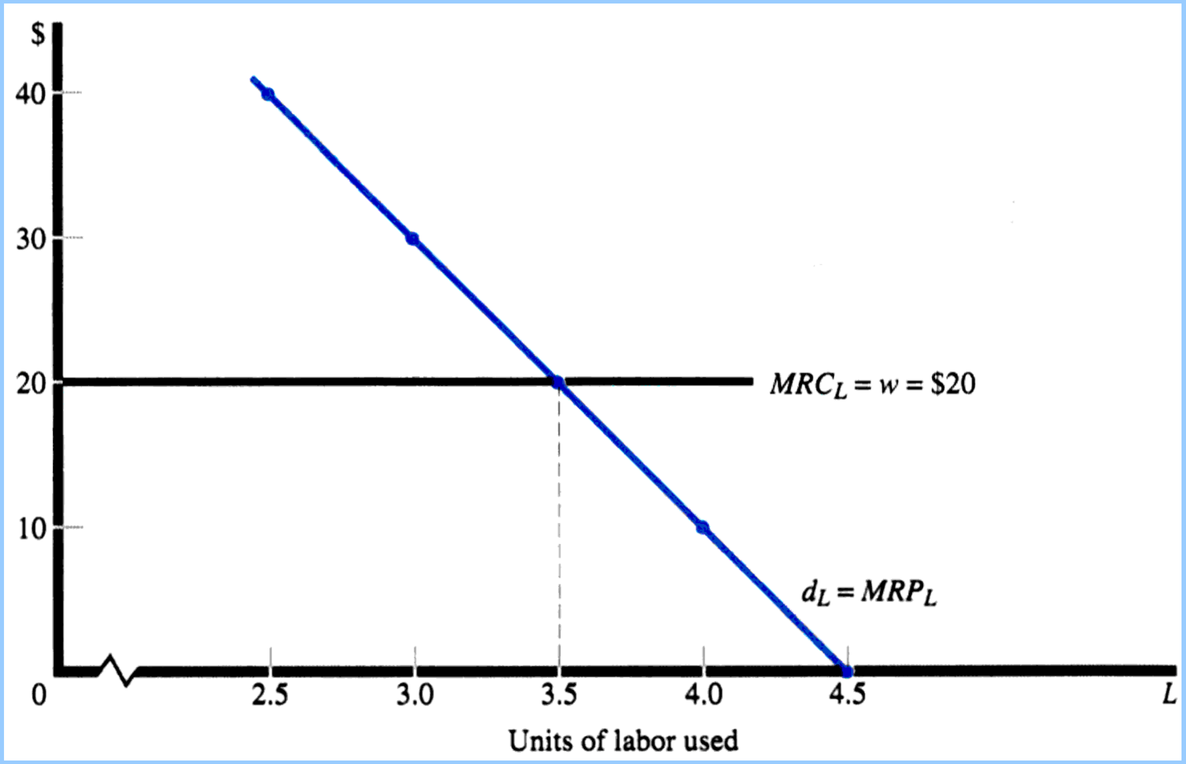
Optimal Use of Labor $MRP_L = MRC_L$

Optimal Use of the Variable Input

Use of Labor is Optimal When L = 3.50

L	MP_L	MR = P	MRP_L	MRC_L
2.50	4	$10	$40	$20
3.00	3	10	30	20
3.50	2	10	20	20
4.00	1	10	10	20
4.50	0	10	0	20

Optimal Use of the Variable Input



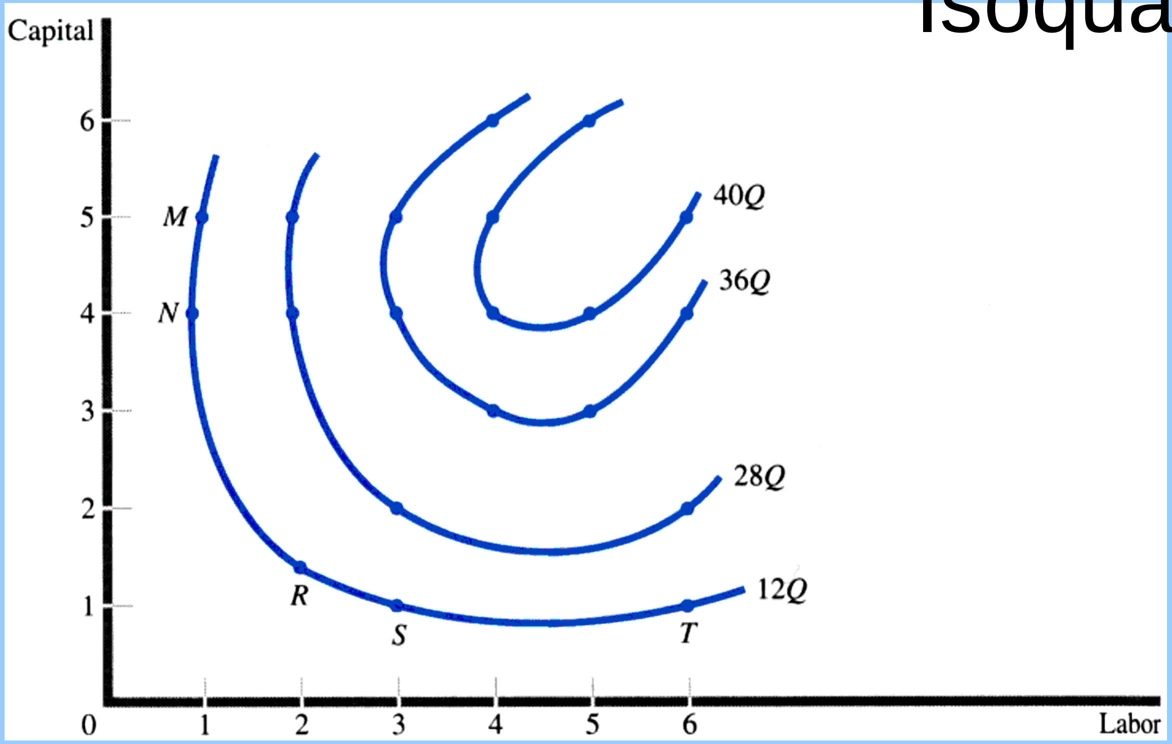
Production With Two Variable Inputs

Isoquants show combinations of two inputs that can produce the same level of output.

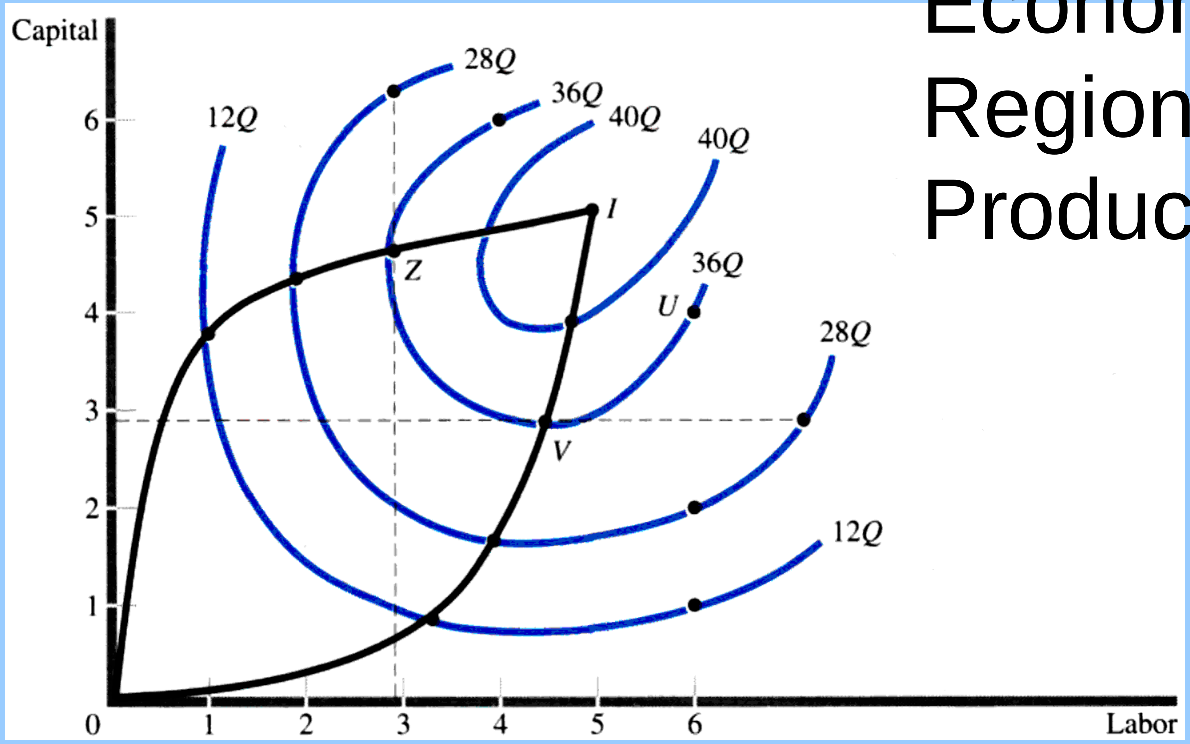
Firms will only use combinations of two inputs that are in the economic region of production, which is defined by the portion of each isoquant that is negatively sloped.

Production With Two Variable Inputs

Isoquants



Production With Two Variable Inputs



Economic Region of Production

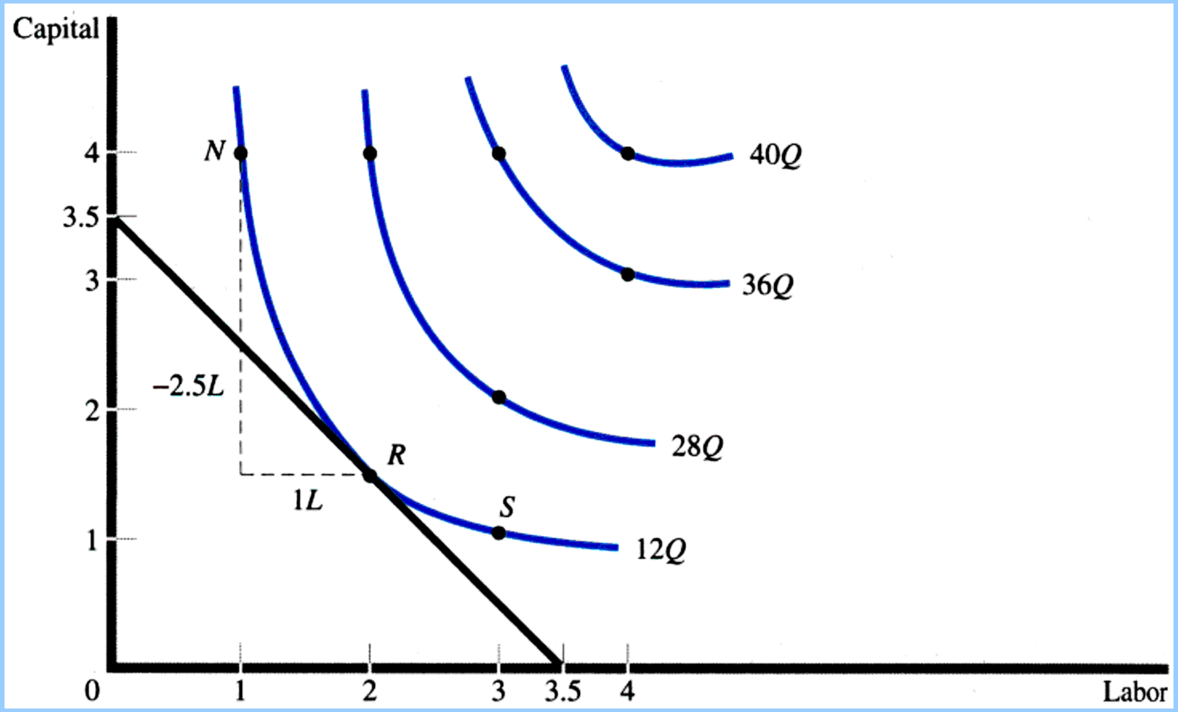
Production With Two Variable Inputs

Marginal Rate of Technical Substitution

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

Production With Two Variable Inputs

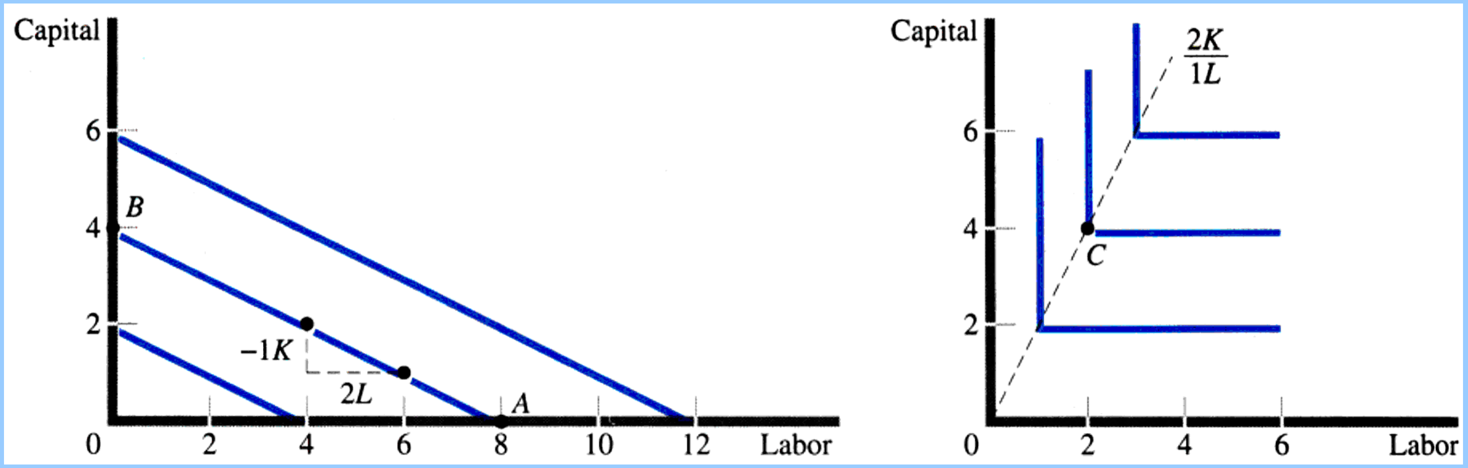
MRTS = -(-2.5/1) = 2.5



Production With Two Variable Inputs

Perfect Substitutes

Perfect Complements



Optimal Combination of Inputs

Isocost lines represent all combinations of two inputs that a firm can purchase with the same total cost.

$$C = wL + rK$$

$$K = \frac{C}{r} - \frac{w}{r}L$$

$$C = Total\ Cost$$

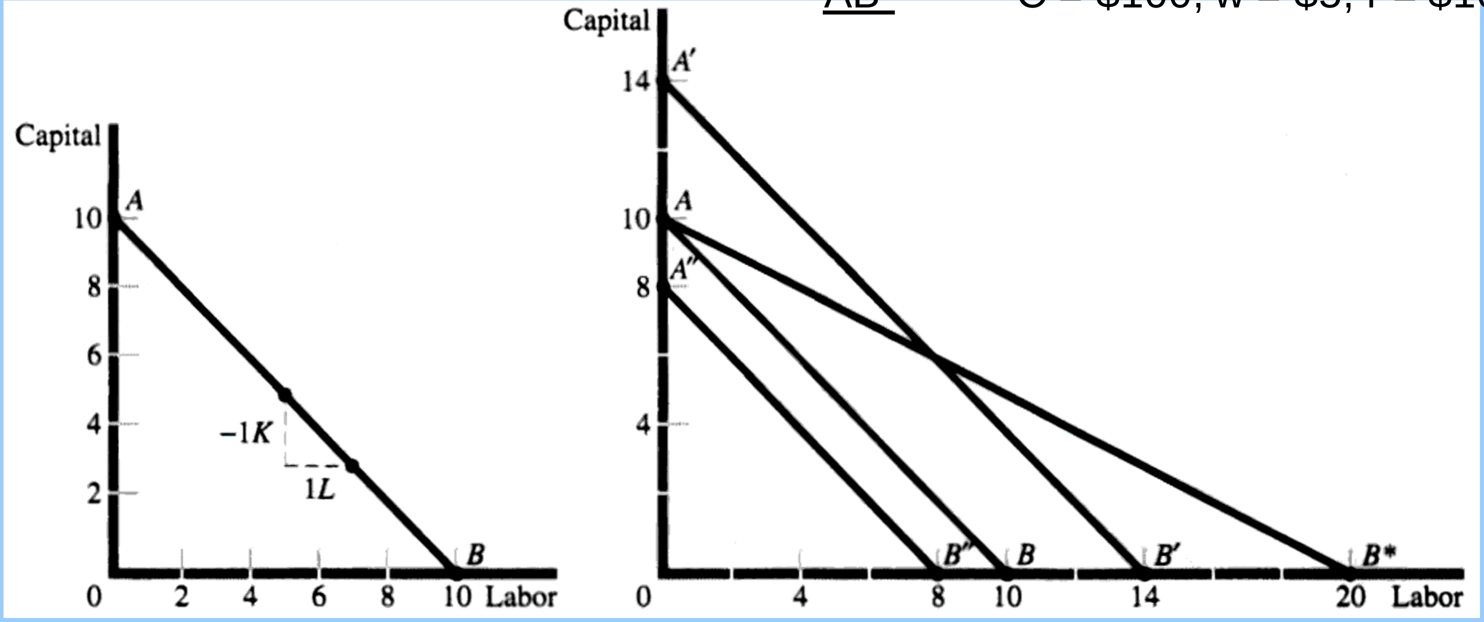
$$w = Wage\ Rate\ of\ Labor\ (L)$$

$$r = Cost\ of\ Capital\ (K)$$

Optimal Combination of Inputs

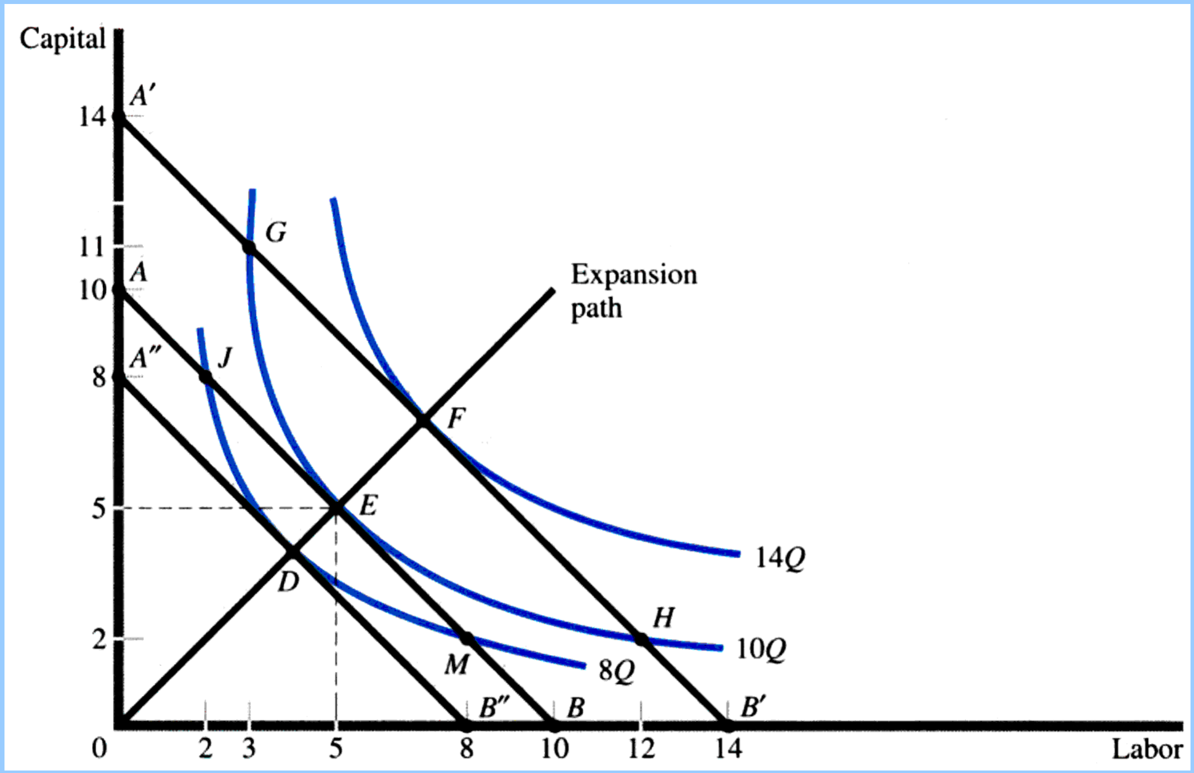
Isocost Lines

AB	C = $100, w = r = $10
A'B'	C = $140, w = r = $10
A''B''	C = $80, w = r = $10
AB*	C = $100, w = $5, r = $10



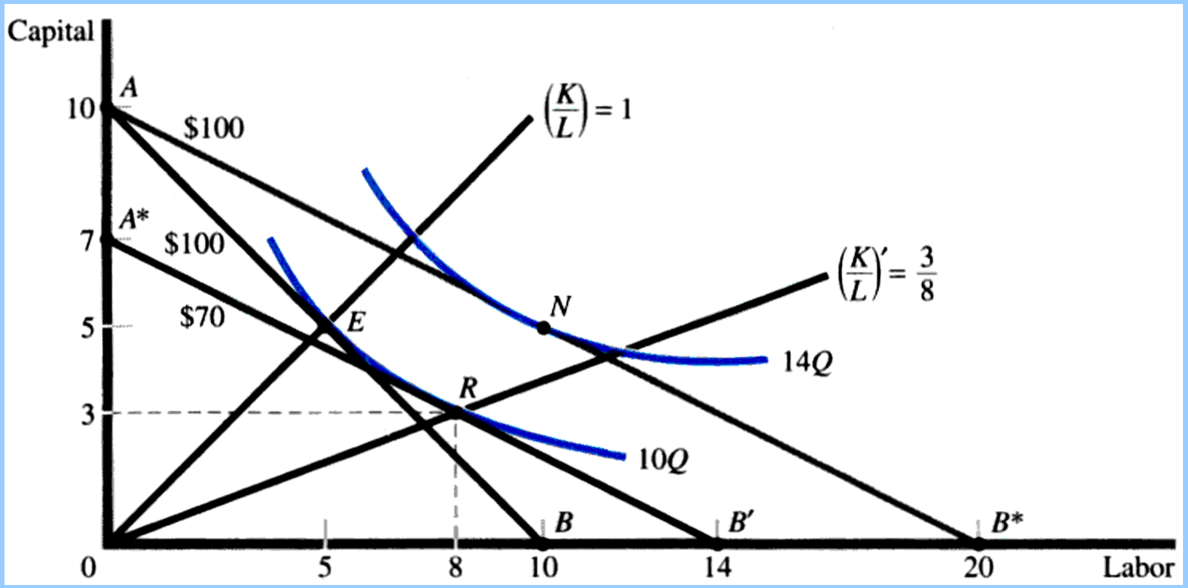
Optimal Combination of Inputs

MRTS = w/r



Optimal Combination of Inputs

Effect of a Change in Input Prices



Returns to Scale

Production Function $Q = f(L, K)$

$$\lambda Q = f(hL, hK)$$

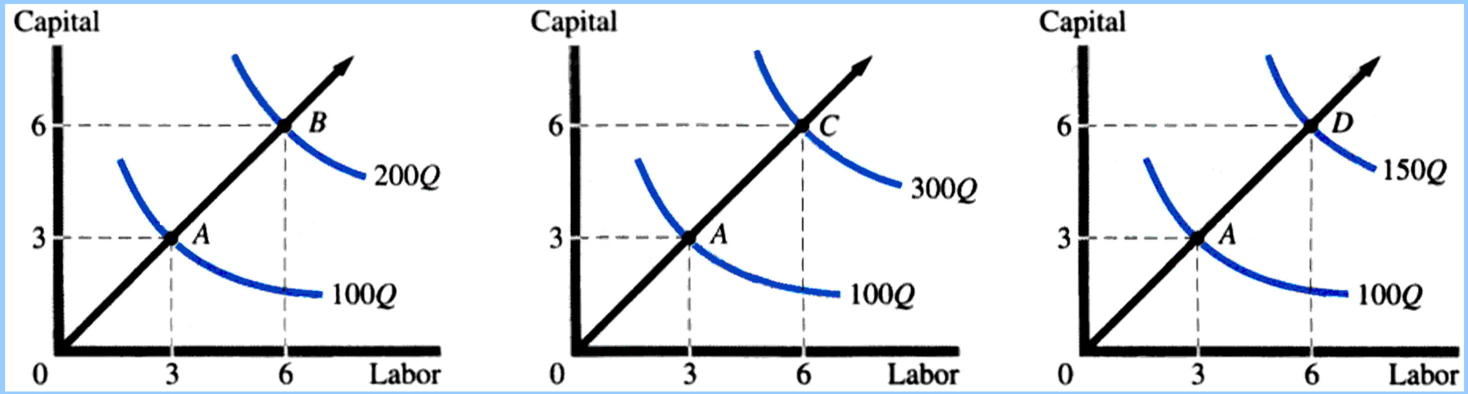
If $\lambda = h$, then f has constant returns to scale.

If $\lambda > h$, then f has increasing returns to scale.

If $\lambda < h$, the f has decreasing returns to scale.

Returns to Scale

Constant Returns to Scale	Increasing Returns to Scale	Decreasing Returns to Scale



Empirical Production Functions

Cobb-Douglas Production Function

$$Q = AK^aL^b$$

Estimated using Natural Logarithms

$$\ln Q = \ln A + a \ln K + b \ln L$$

Innovations and Global Competitiveness

- Product Innovation
- Process Innovation
- Product Cycle Model
- Just-In-Time Production System
- Competitive Benchmarking
- Computer-Aided Design (CAD)
- Computer-Aided Manufacturing (CAM)

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Chapter 7

Cost Theory and Estimation

The Nature of Costs

- Explicit Costs
  - Accounting Costs
- Economic Costs
  - Implicit Costs
  - Alternative or Opportunity Costs
- Relevant Costs
  - Incremental Costs
  - Sunk Costs are Irrelevant

Short-Run Cost Functions

Total Cost = TC = f(Q)

Total Fixed Cost = TFC

Total Variable Cost = TVC

TC = TFC + TVC

Short-Run Cost Functions

Average Total Cost = ATC = TC/Q

Average Fixed Cost = AFC = TFC/Q

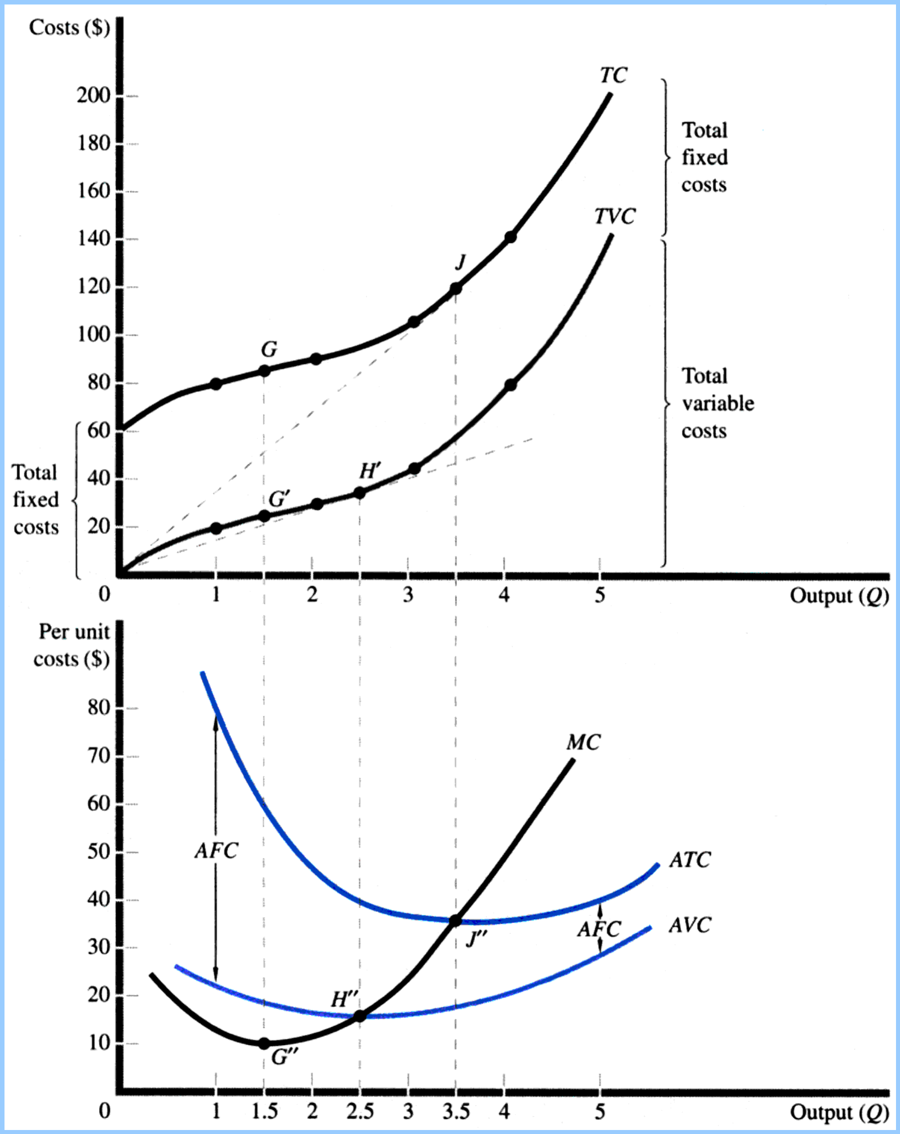
Average Variable Cost = AVC = TVC/Q

ATC = AFC + AVC

Marginal Cost = ΔTC/ΔQ = ΔTVC/ΔQ

Short-Run Cost Functions

Q	TFC	TVC	TC	AFC	AVC	ATC	MC
0	$60	$0	$60	-	-	-	-
1	60	20	80	$60	$20	$80	$20
2	60	30	90	30	15	45	10
3	60	45	105	20	15	35	15
4	60	80	140	15	20	35	35
5	60	135	195	12	27	39	55


Costs ($)
200
180
160
140
120
100
80
60
40
20
0
TC
TVC
G
J
G′
H′
Total fixed costs
Total variable costs
Total fixed costs
1
2
3
4
5
Output (Q)
Per unit costs ($)
80
70
60
50
40
30
20
10
0
MC
ATC
AVC
AFC
AFC
J″
H″
G″
1
1.5
2
2.5
3
3.5
4
5
Output (Q)

Short-Run Cost Functions

Average Variable Cost

$$AVC = TVC/Q = w/AP_L$$

Marginal Cost

$$\Delta TC/\Delta Q = \Delta TVC/\Delta Q = w/MP_L$$

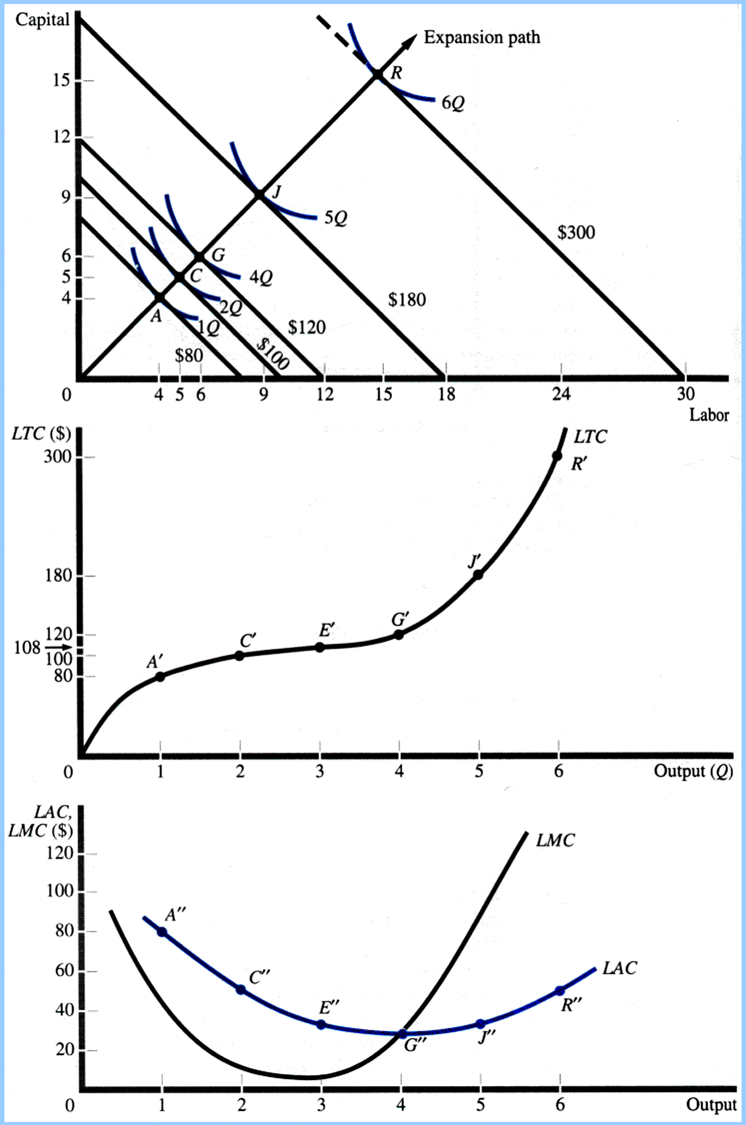
Long-Run Cost Curves

Long-Run Total Cost = LTC = f(Q)

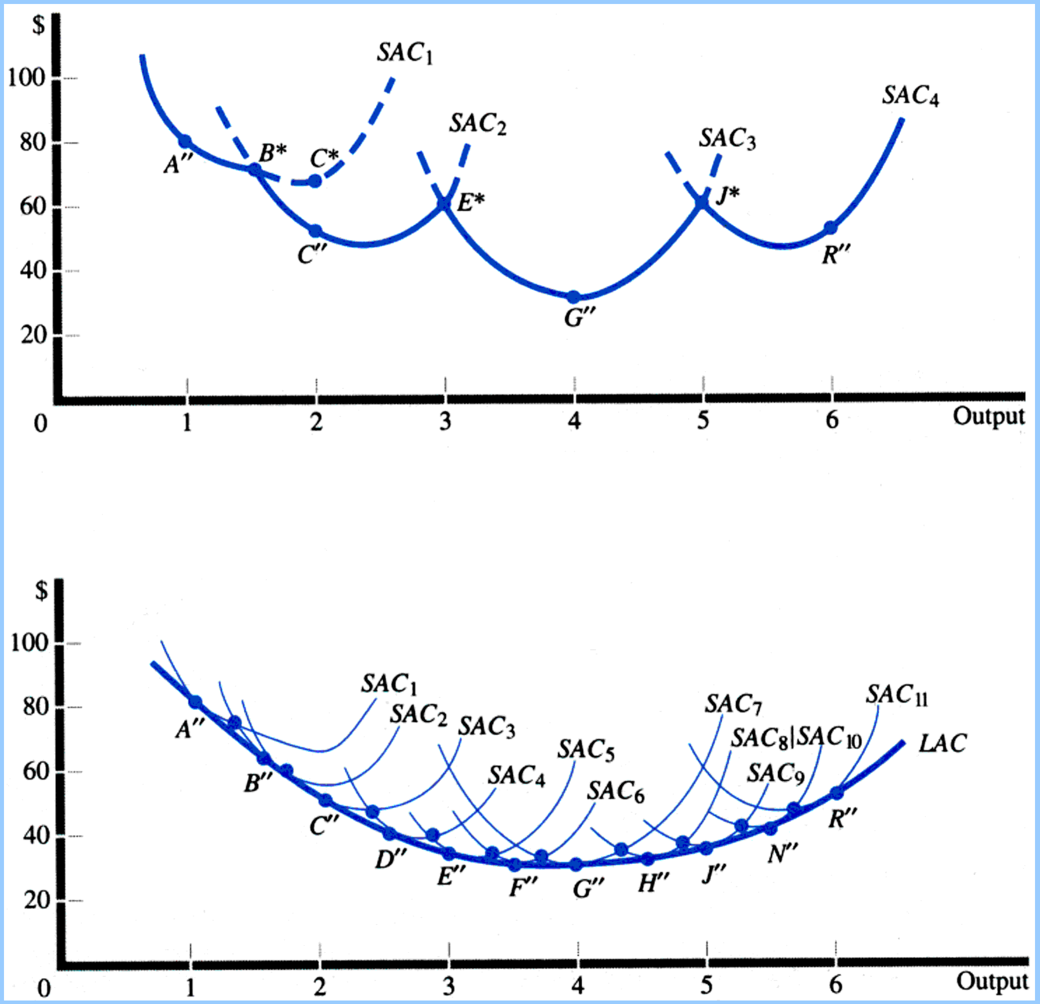
Long-Run Average Cost = LAC = LTC/Q

Long-Run Marginal Cost = LMC = ΔLTC/ΔQ

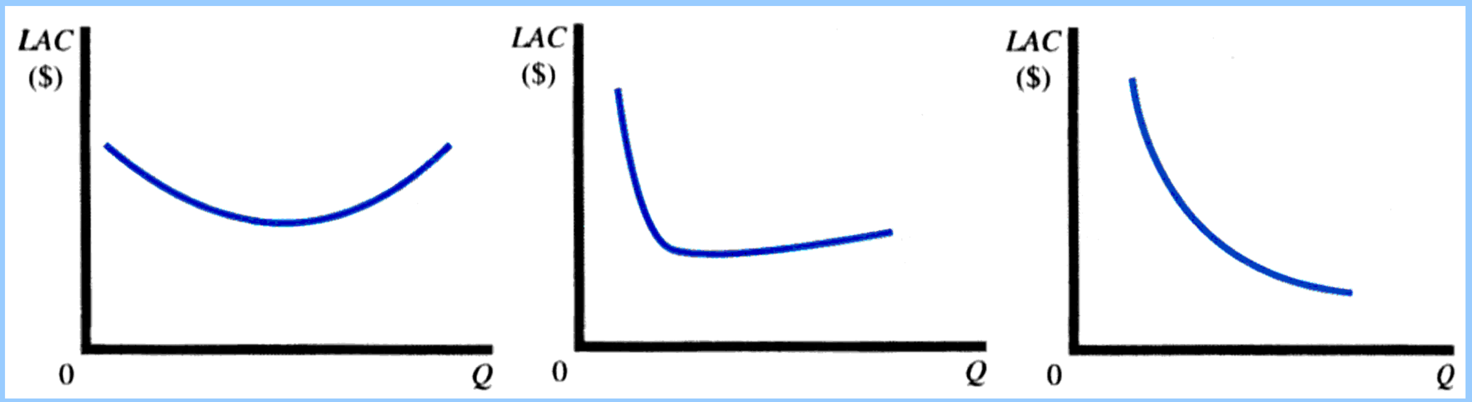
Derivation of Long-Run Cost Curves



Relationship Between Long-Run and Short-Run Average Cost Curves



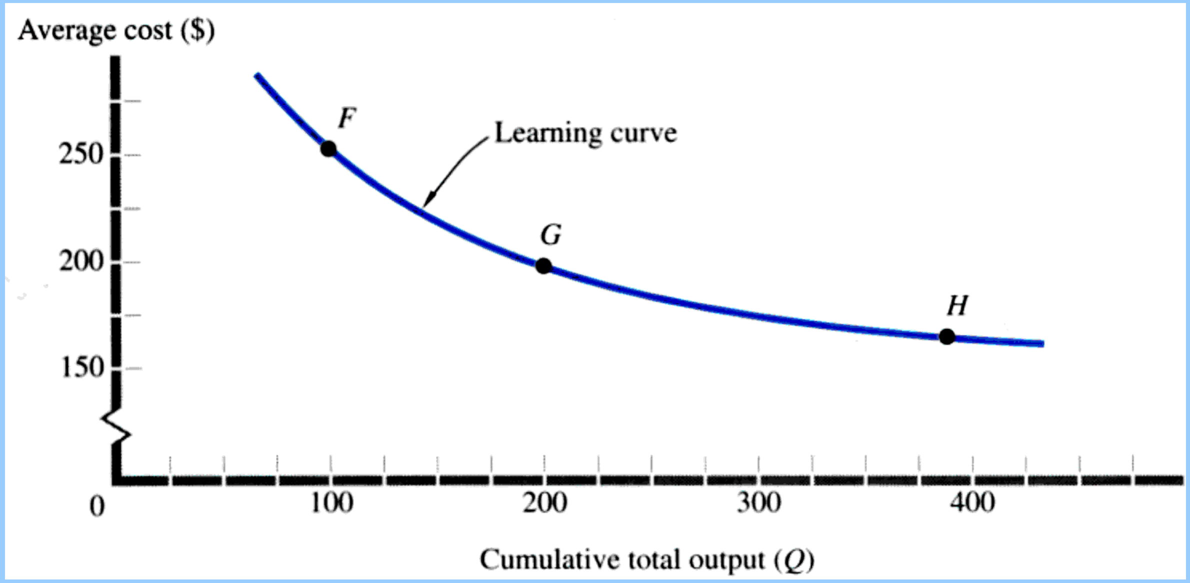
Possible Shapes of the LAC Curve



Learning Curves

Average Cost of Unit Q = C = aQ^b

Estimation Form: log C = log a + b Log Q



Minimizing Costs Internationally

- Foreign Sourcing of Inputs
- New International Economies of Scale
- Immigration of Skilled Labor
- Brain Drain

Logistics or Supply Chain Management

- Merges and integrates functions
  - – Purchasing
  - – Transportation
  - – Warehousing
  - – Distribution
  - – Customer Services
- Source of competitive advantage

Logistics or Supply Chain Management

- Reasons for the growth of logistics
  - Advances in computer technology
    - Decreased cost of logistical problem solving
  - Growth of just-in-time inventory management
    - Increased need to monitor and manage input and output flows
  - Globalization of production and distribution
    - Increased complexity of input and output flows

Cost-Volume-Profit Analysis

$$\text{Total Revenue} = TR = (P)(Q)$$

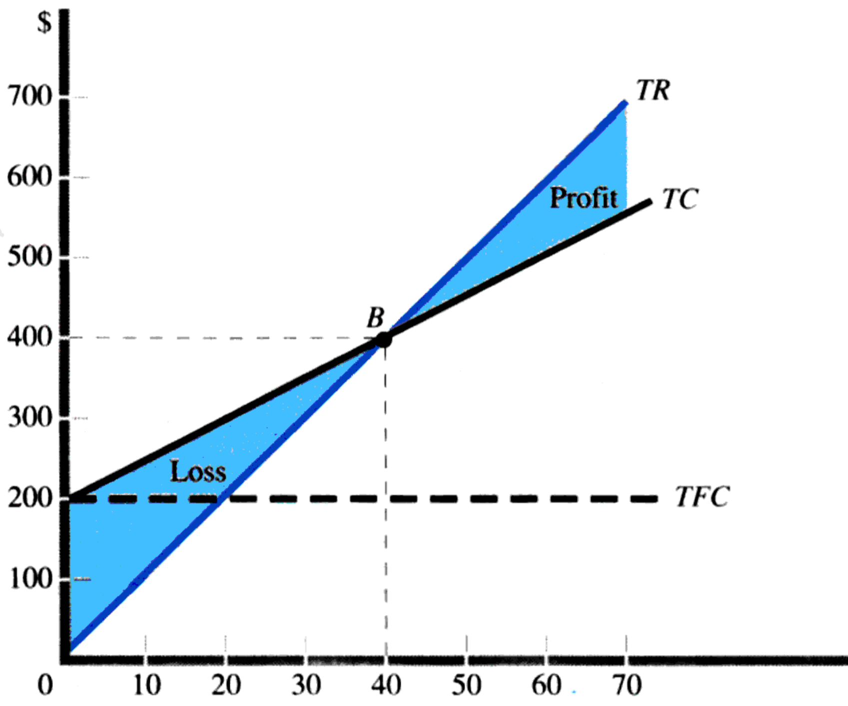
$$\text{Total Cost} = TC = TFC + (AVC)(Q)$$

$$\text{Breakeven Volume } TR = TC$$

$$(P)(Q) = TFC + (AVC)(Q)$$

$$Q_{BE} = TFC/(P - AVC)$$

Cost-Volume-Profit Analysis



P = 40

TFC = 200

AVC = 5

Q_{BE} = 40

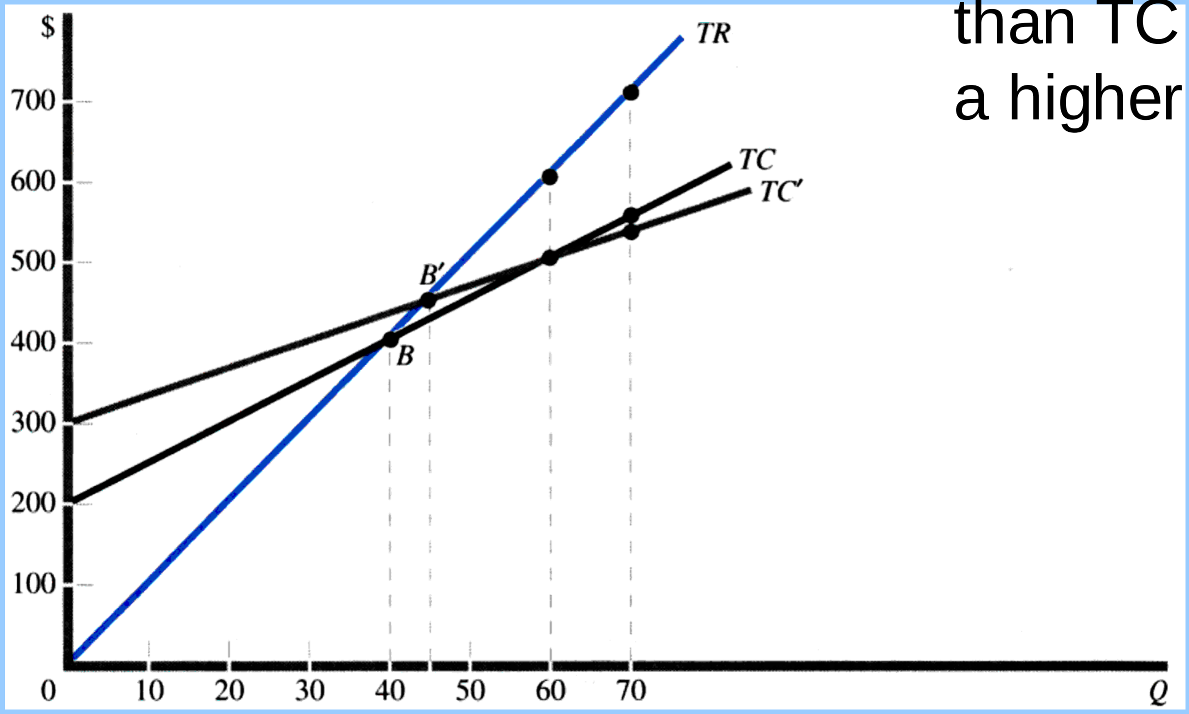
Operating Leverage

Operating Leverage = TFC/TVC

Degree of Operating Leverage = DOL

$$DOL = \frac{\%\Delta\pi}{\%\Delta Q} = \frac{Q(P - AVC)}{Q(P - AVC) - TFC}$$

Operating Leverage



TC' has a higher DOL than TC and therefore a higher Q_{BE}

Empirical Estimation
Data Collection Issues

- Opportunity Costs Must be Extracted from Accounting Cost Data
- Costs Must be Apportioned Among Products
- Costs Must be Matched to Output Over Time
- Costs Must be Corrected for Inflation

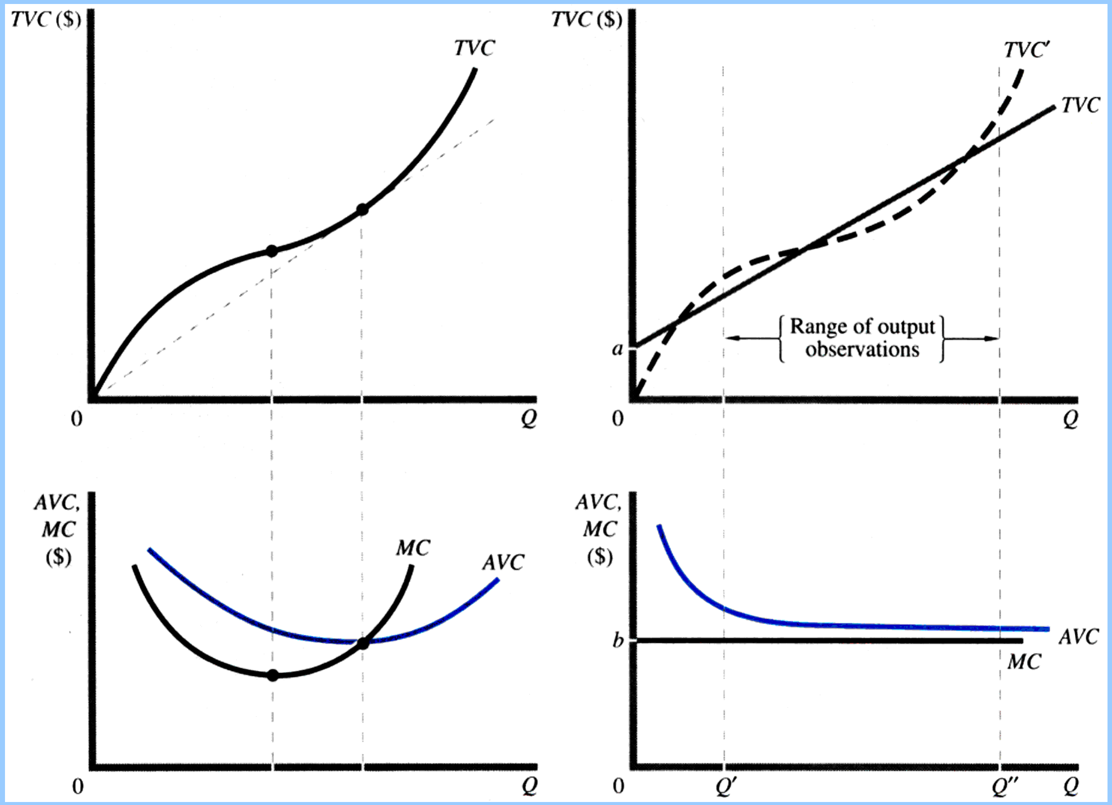
Empirical Estimation

Functional Form for Short-Run Cost Functions

Theoretical Form	Linear Approximation
$TVC = aQ + bQ^2 + cQ^3$	$TVC = a + bQ$
$AVC = \frac{TVC}{Q} = a + bQ + cQ^2$	$AVC = \frac{a}{Q} + b$
$MC = a + 2bQ + 3cQ^2$	$MC = b$

Empirical Estimation

Theoretical Form Linear Approximation

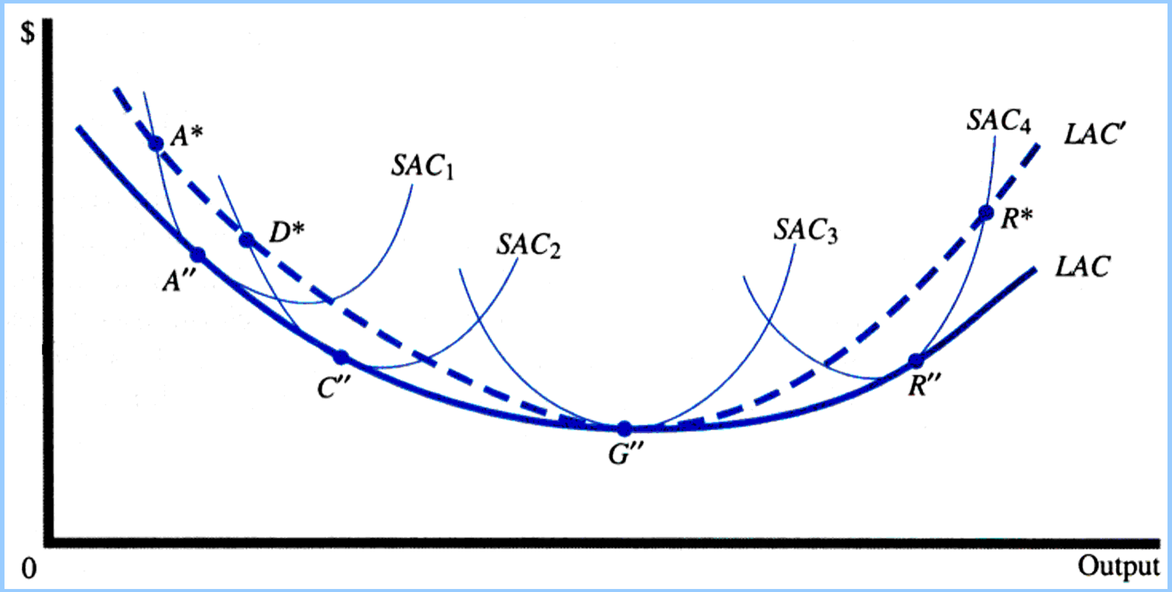


Empirical Estimation
Long-Run Cost Curves

- Cross-Sectional Regression Analysis
- Engineering Method
- Survival Technique

Empirical Estimation

Actual LAC versus empirically estimated LAC’



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Chapter 8

Market Structure: Perfect Competition, Monopoly and Monopolistic Competition

Market Structure

More Competitive

Perfect Competition

Monopolistic Competition

Oligopoly

Monopoly

Less Competitive

Perfect Competition

- Many buyers and sellers
- Buyers and sellers are price takers
- Product is homogeneous
- Perfect mobility of resources
- Economic agents have perfect knowledge
- Example: Stock Market

Monopolistic Competition

- Many sellers and buyers
- Differentiated product
- Perfect mobility of resources
- Example: Fast-food outlets

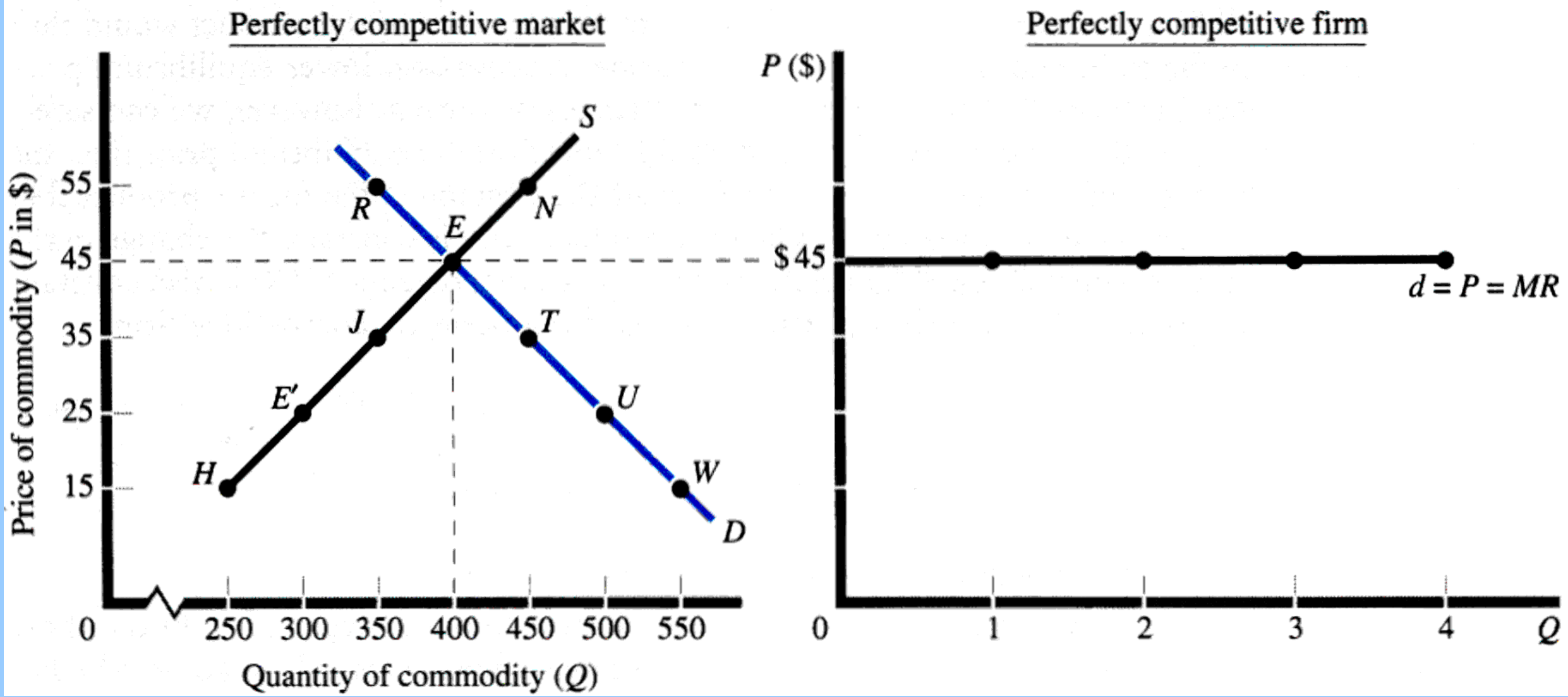
Oligopoly

- Few sellers and many buyers
- Product may be homogeneous or differentiated
- Barriers to resource mobility
- Example: Automobile manufacturers

Monopoly

- Single seller and many buyers
- No close substitutes for product
- Significant barriers to resource mobility
  - Control of an essential input
  - Patents or copyrights
  - Economies of scale: Natural monopoly
  - Government franchise: Post office

Perfect Competition: Price Determination



Perfect Competition: Price Determination

$$QD = 625 - 5P \quad QD = QS \quad QS = 175 + 5P$$

$$625 - 5P = 175 + 5P$$

$$450 = 10P$$

$$P = \$45$$

$$QD = 625 - 5P = 625 - 5(45) = 400$$

$$QS = 175 + 5P = 175 + 5(45) = 400$$

Perfect Competition: Short-Run Equilibrium

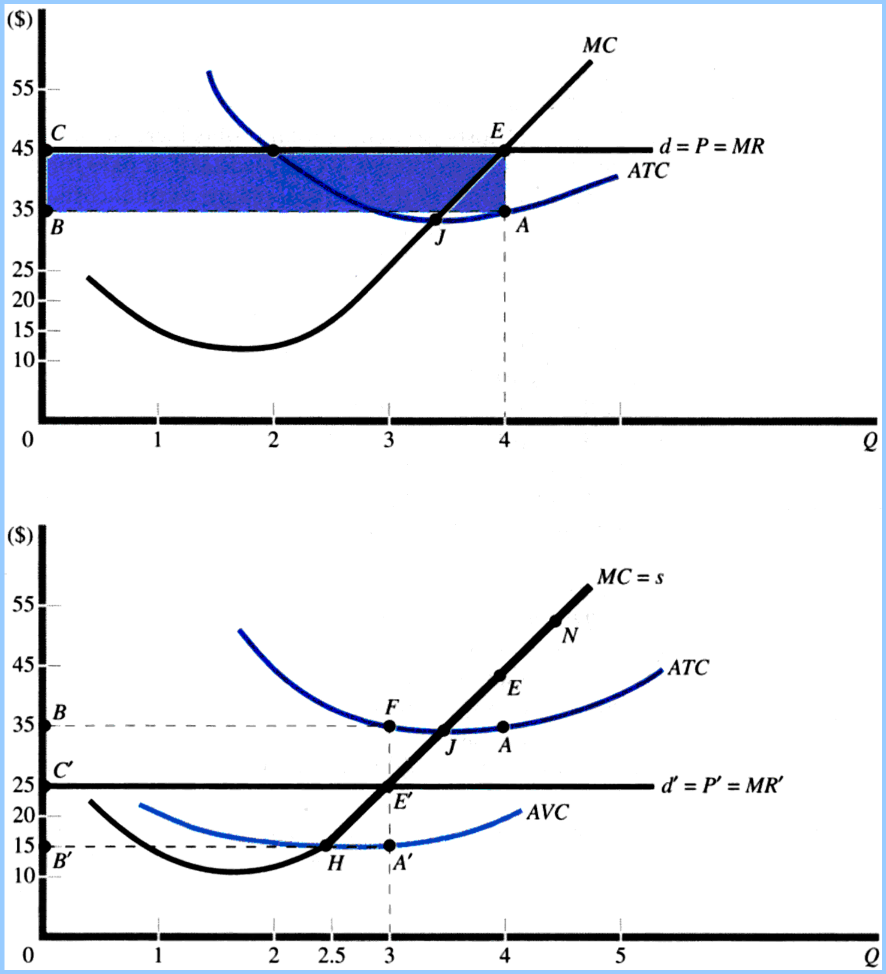
Firm’s Demand Curve = Market Price

= Marginal Revenue

Firm’s Supply Curve = Marginal Cost

where Marginal Cost > Average Variable Cost

Perfect Competition: Short-Run Equilibrium



Perfect Competition: Long-Run Equilibrium

Quantity is set by the firm so that short-run:

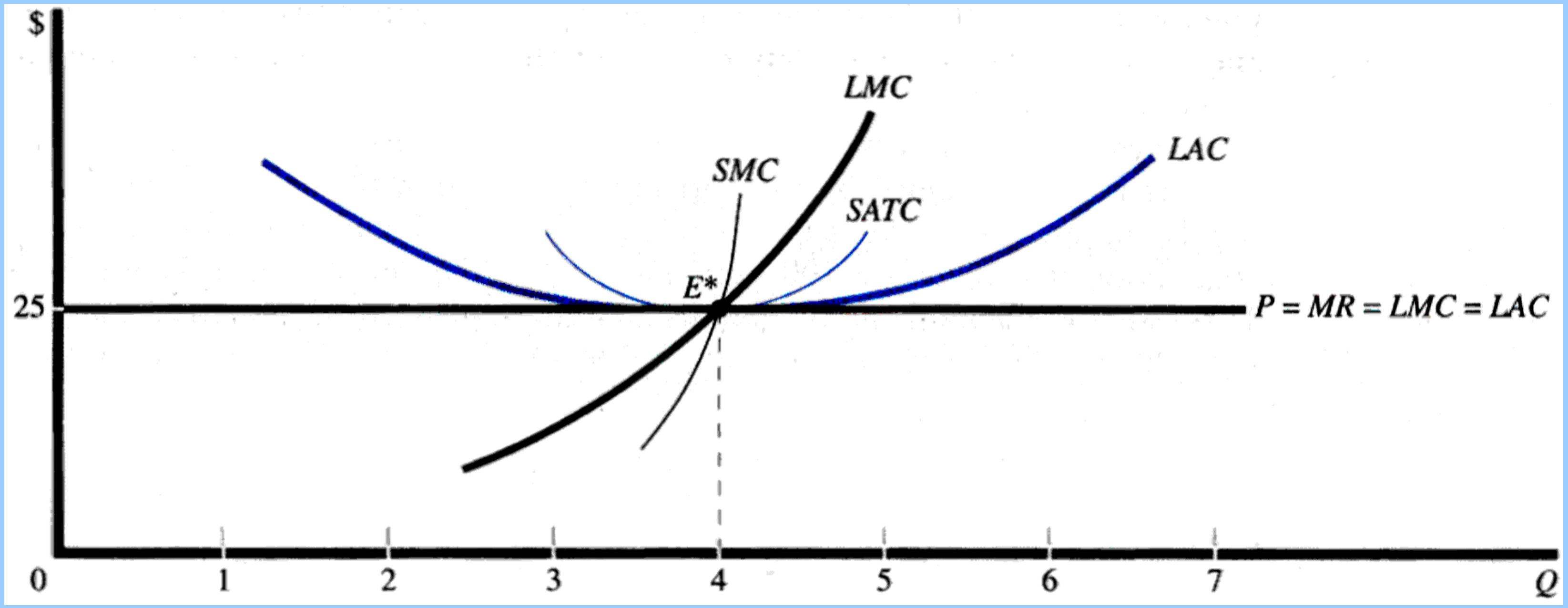
Price = Marginal Cost = Average Total Cost

At the same quantity, long-run:

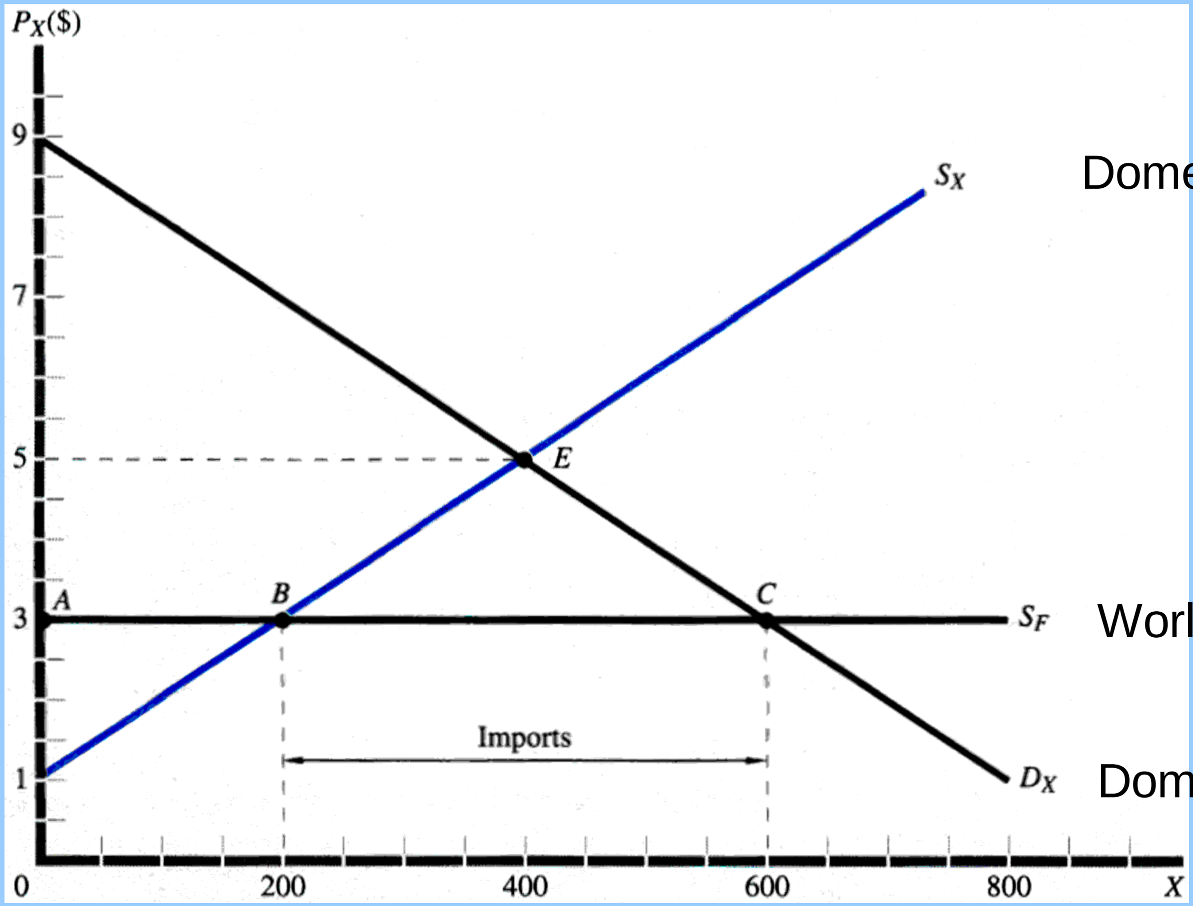
Price = Marginal Cost = Average Cost

Economic Profit = 0

Perfect Competition: Long-Run Equilibrium



Competition in the Global Economy



Domestic Supply

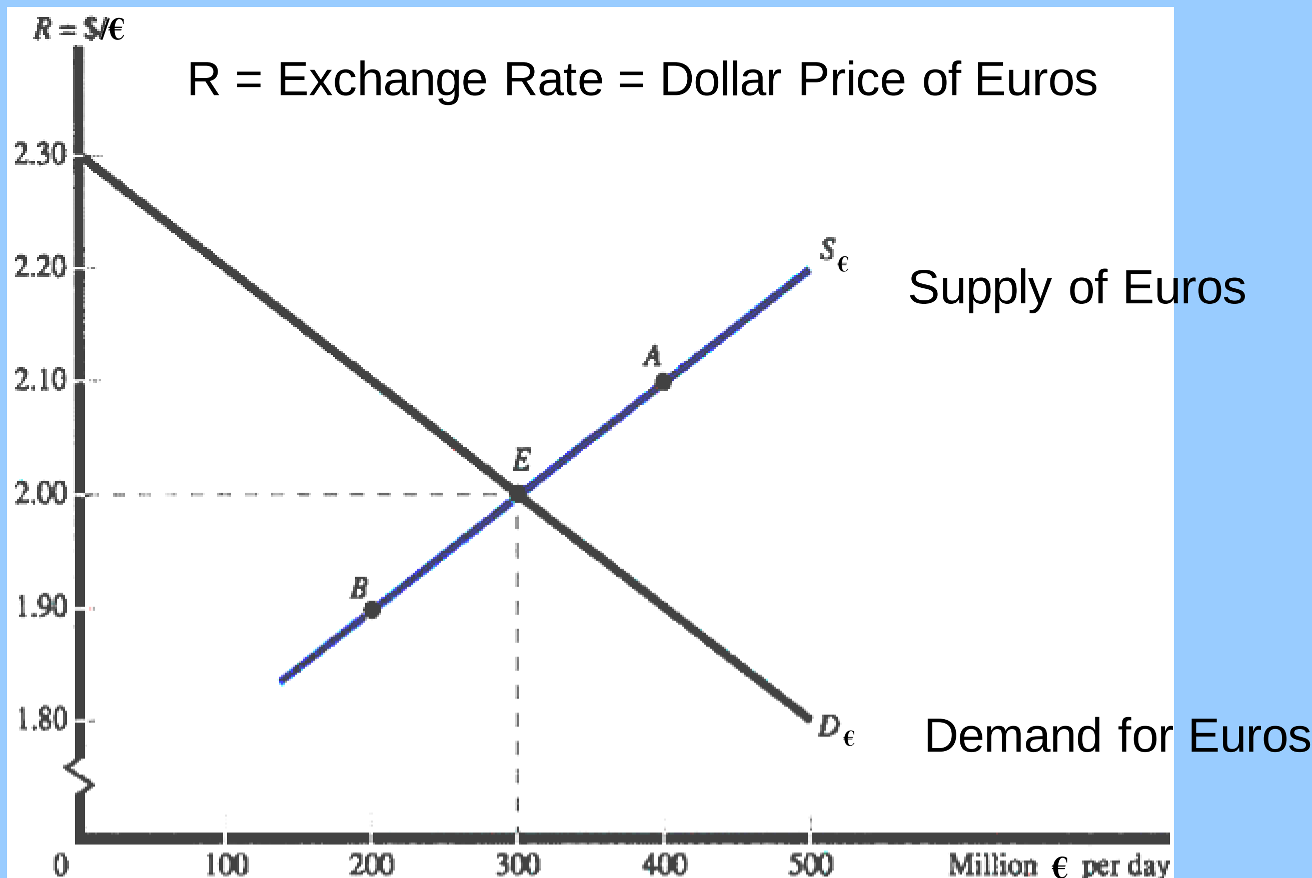
World Supply

Domestic Demand

Competition in the Global Economy

- Foreign Exchange Rate
  - Price of a foreign currency in terms of the domestic currency
- Depreciation of the Domestic Currency
  - Increase in the price of a foreign currency relative to the domestic currency
- Appreciation of the Domestic Currency
  - Decrease in the price of a foreign currency relative to the domestic currency

Competition in the Global Economy



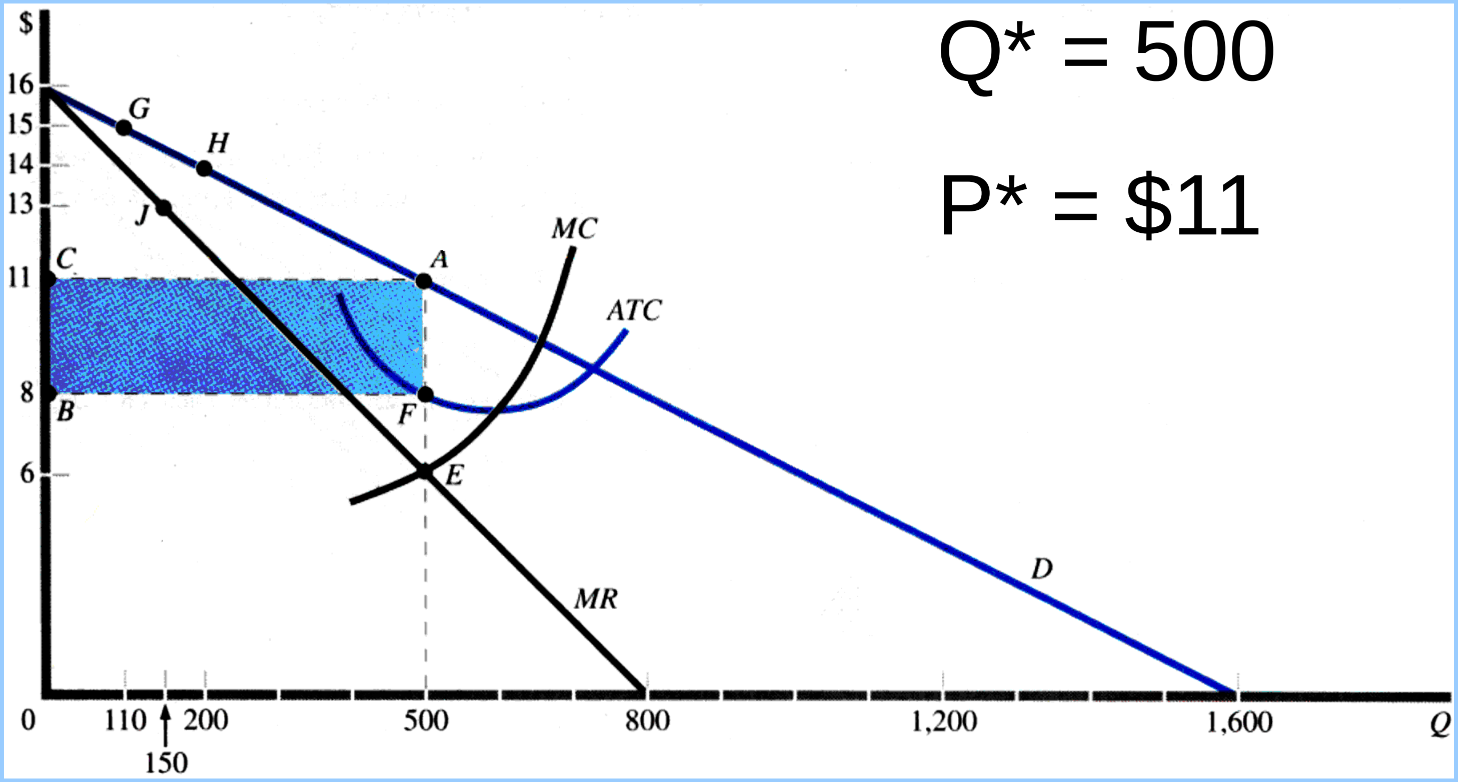
Monopoly

- Single seller that produces a product with no close substitutes
- Sources of Monopoly
  - Control of an essential input to a product
  - Patents or copyrights
  - Economies of scale: Natural monopoly
  - Government franchise: Post office

Monopoly
Short-Run Equilibrium

- Demand curve for the firm is the market demand curve
- Firm produces a quantity (Q*) where marginal revenue (MR) is equal to marginal cost (MR)
- Exception: Q* = 0 if average variable cost (AVC) is above the demand curve at all levels of output

Monopoly
Short-Run Equilibrium



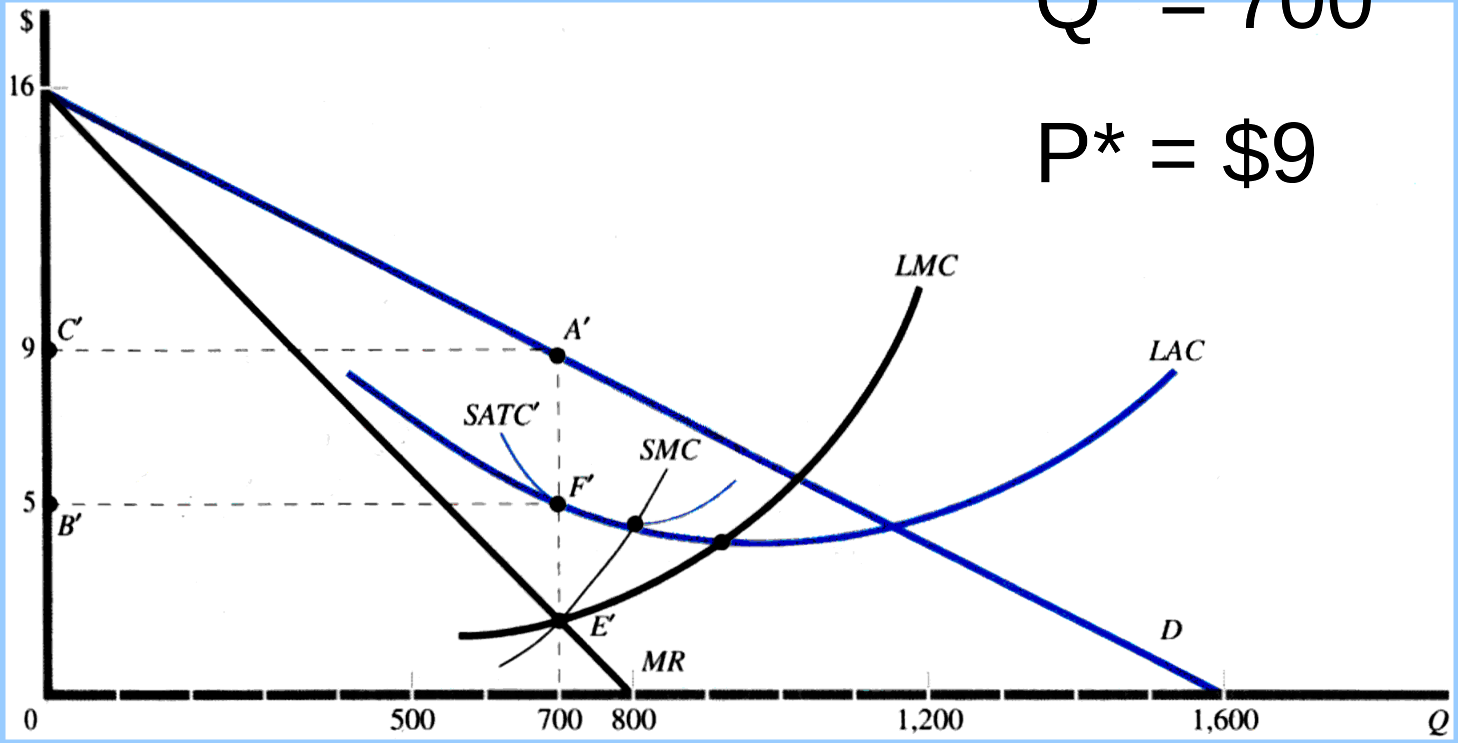
Q* = 500

P* = $11

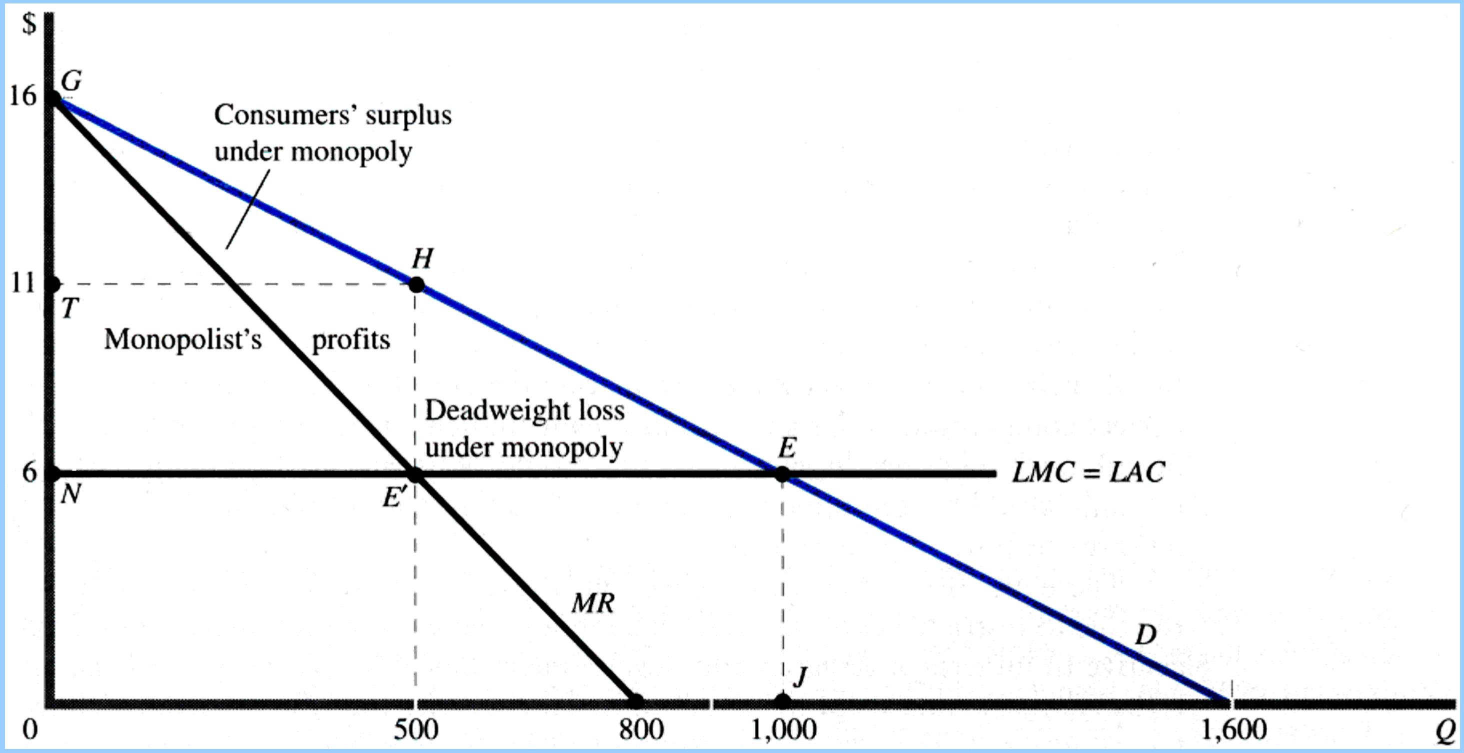
Monopoly
Long-Run Equilibrium

Q* = 700

P* = $9



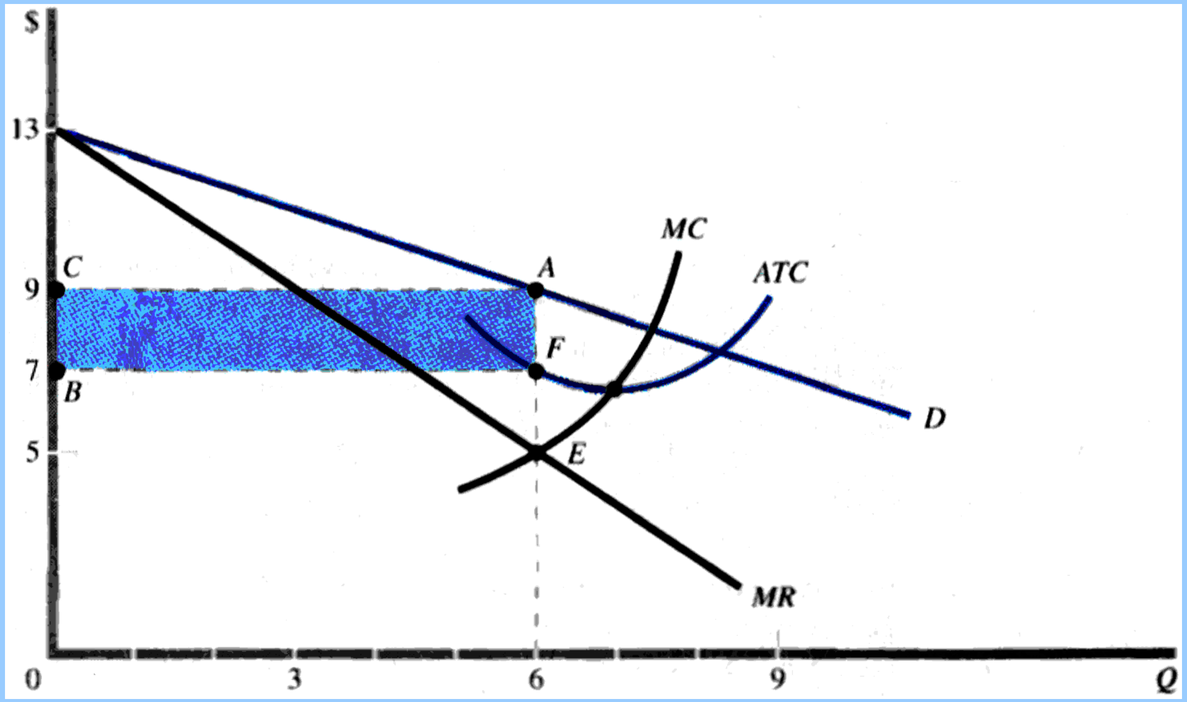
Social Cost of Monopoly



Monopolistic Competition

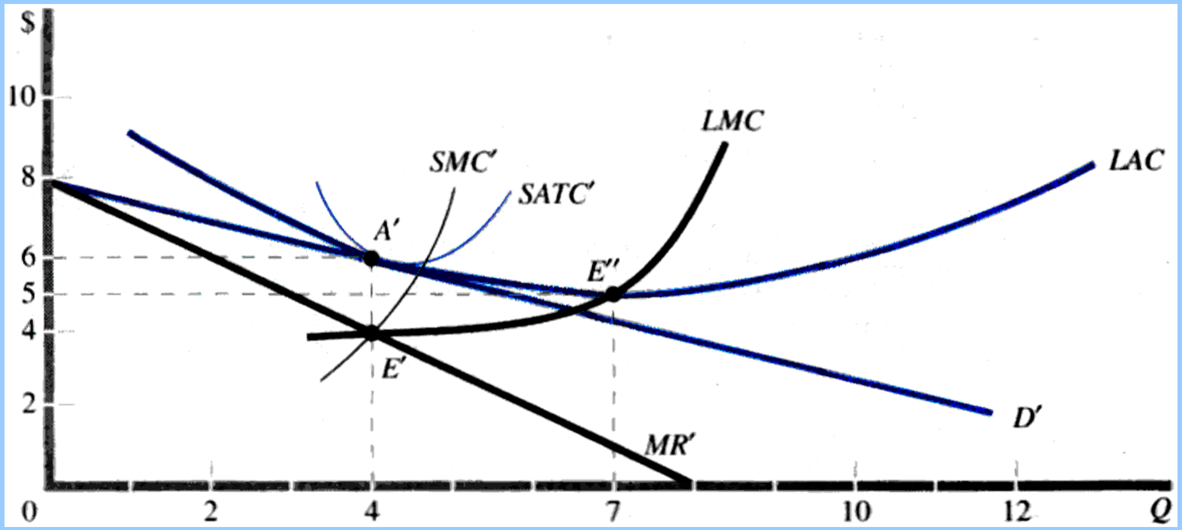
- Many sellers of differentiated (similar but not identical) products
- Limited monopoly power
- Downward-sloping demand curve
- Increase in market share by competitors causes decrease in demand for the firm’s product

Monopolistic Competition Short-Run Equilibrium



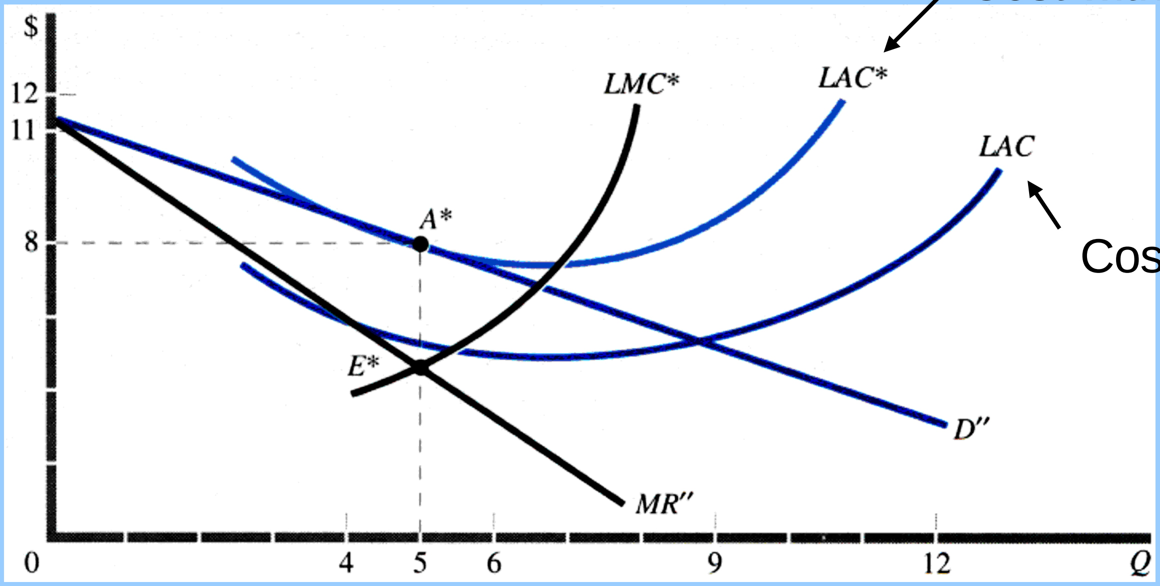
Monopolistic Competition Long-Run Equilibrium

Profit = 0



Monopolistic Competition Long-Run Equilibrium

Cost with selling expenses



Cost without selling expenses

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Chapter 9

Oligopoly and Firm Architecture

Oligopoly

- Few sellers of a product
- Nonprice competition
- Barriers to entry
- Duopoly - Two sellers
- Pure oligopoly - Homogeneous product
- Differentiated oligopoly - Differentiated product

Sources of Oligopoly

- Economies of scale
- Large capital investment required
- Patented production processes
- Brand loyalty
- Control of a raw material or resource
- Government franchise
- Limit pricing

Measures of Oligopoly

- Concentration Ratios
  – 4, 8, or 12 largest firms in an industry
- Herfindahl Index (H)
  – H = Sum of the squared market shares of all firms in an industry
- Theory of Contestable Markets
  – If entry is absolutely free and exit is entirely costless then firms will operate as if they are perfectly competitive

Cournot Model

- Proposed by Augustin Cournot
- Behavioral assumption
  - Firms maximize profits under the assumption that market rivals will not change their rates of production.
- Bertrand Model
  - Firms assume that their market rivals will not change their prices.

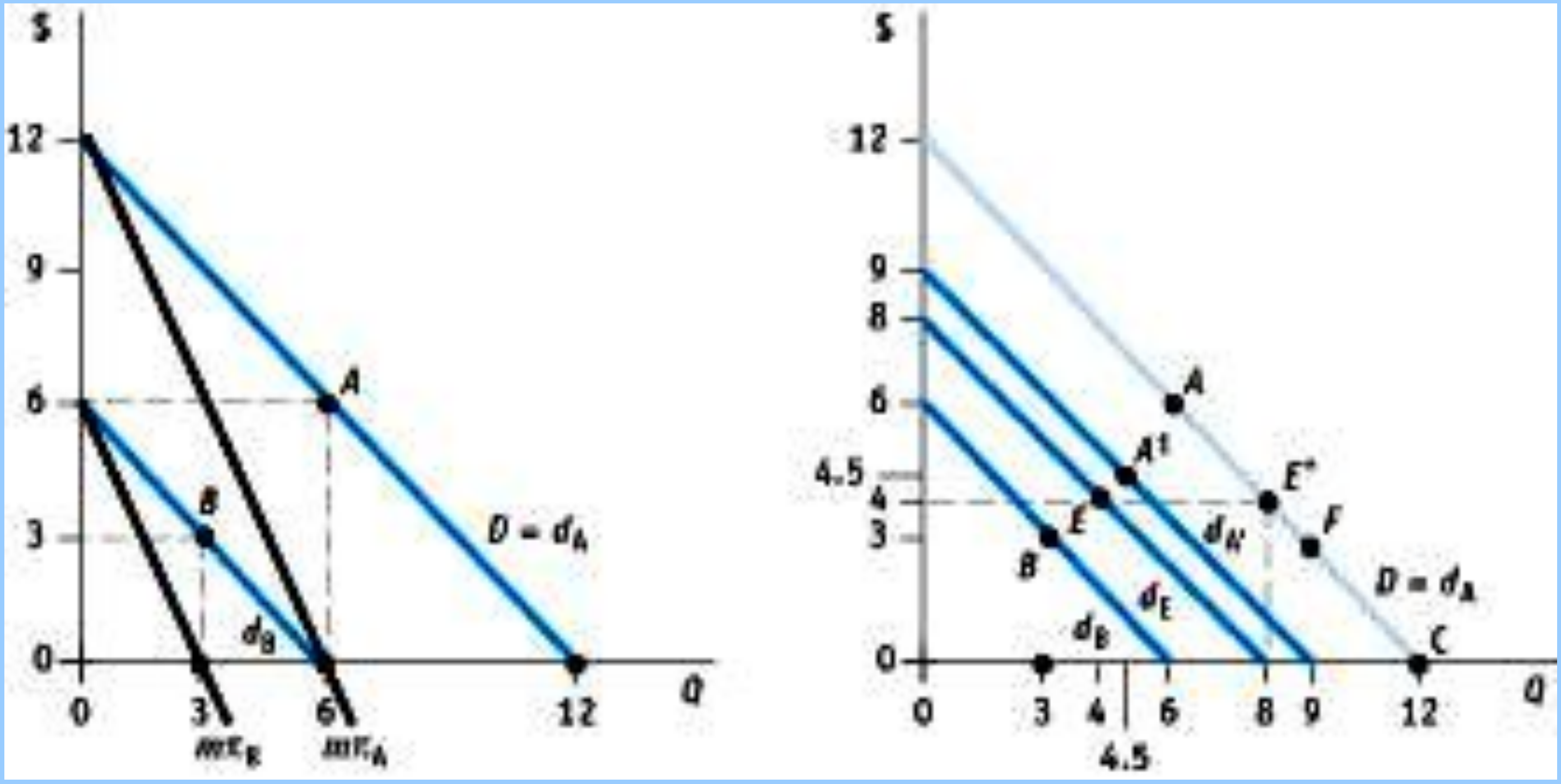
Cournot Model

- Example
  - Two firms (duopoly)
  - Identical products
  - Marginal cost is zero
  - Initially Firm A has a monopoly and then Firm B enters the market

Cournot Model

- Adjustment process
  - Entry by Firm B reduces the demand for Firm A's product
  - Firm A reacts by reducing output, which increases demand for Firm B's product
  - Firm B reacts by increasing output, which reduces demand for Firm A's product
  - Firm A then reduces output further
  - This continues until equilibrium is attained

Cournot Model



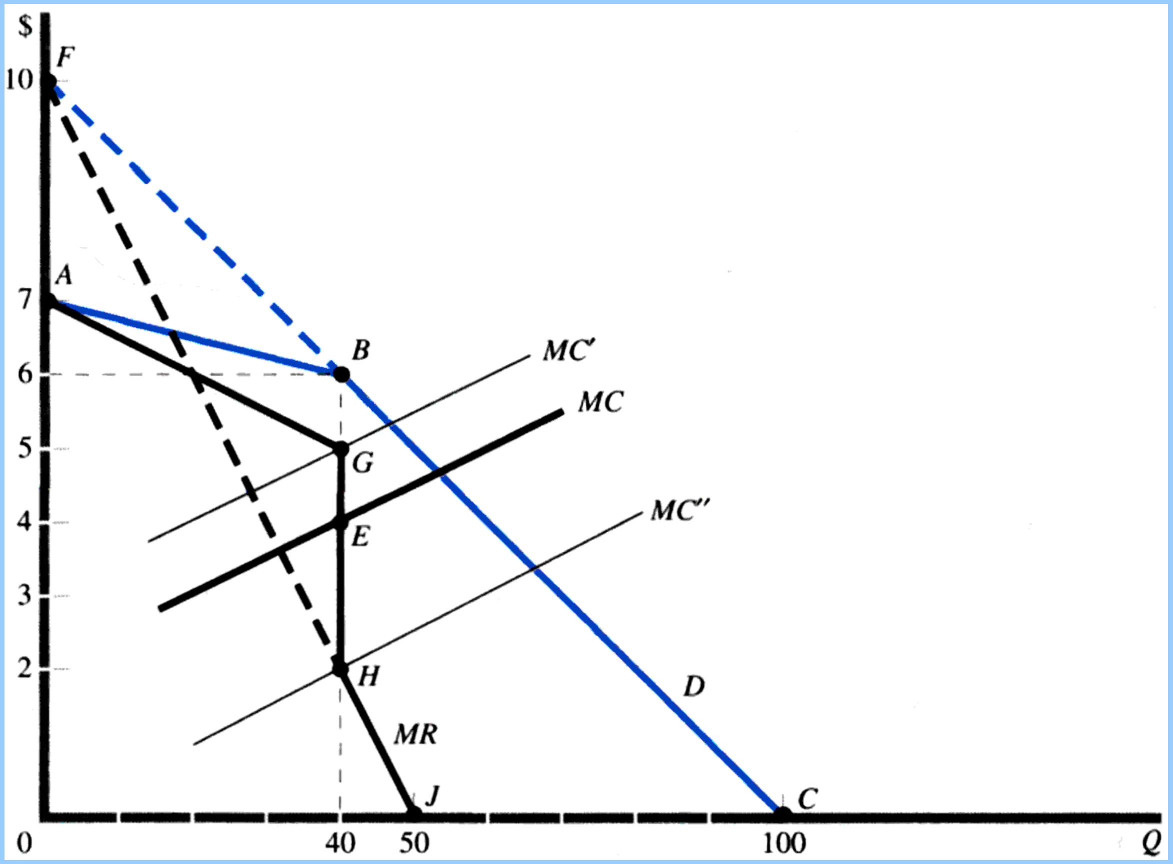
Cournot Model

- Equilibrium
  - Firms are maximizing profits simultaneously
  - The market is shared equally among the firms
  - Price is above the competitive equilibrium and below the monopoly equilibrium

Kinked Demand Curve Model

- Proposed by Paul Sweezy
- If an oligopolist raises price, other firms will not follow, so demand will be elastic
- If an oligopolist lowers price, other firms will follow, so demand will be inelastic
- Implication is that demand curve will be kinked, MR will have a discontinuity, and oligopolists will not change price when marginal cost changes

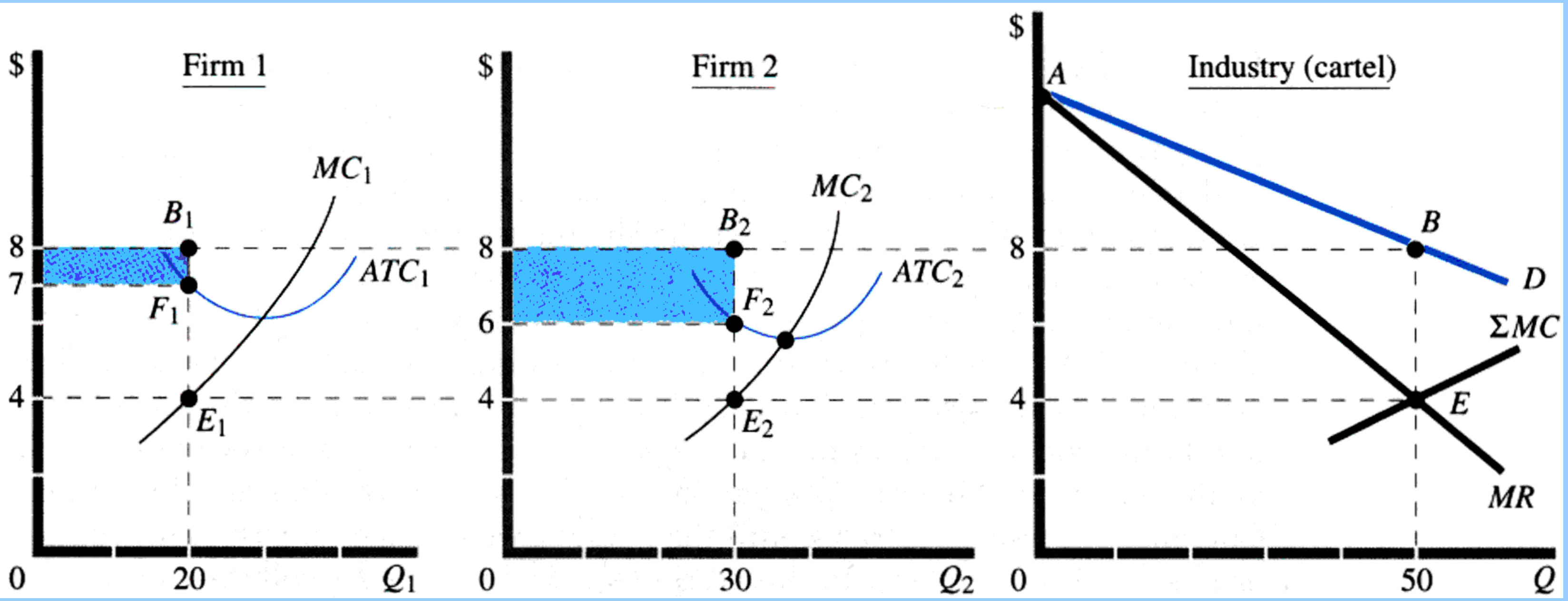
Kinked Demand Curve Model



Cartels

- Collusion
  - Cooperation among firms to restrict competition in order to increase profits
- Market-Sharing Cartel
  - Collusion to divide up markets
- Centralized Cartel
  - Formal agreement among member firms to set a monopoly price and restrict output
  - Incentive to cheat

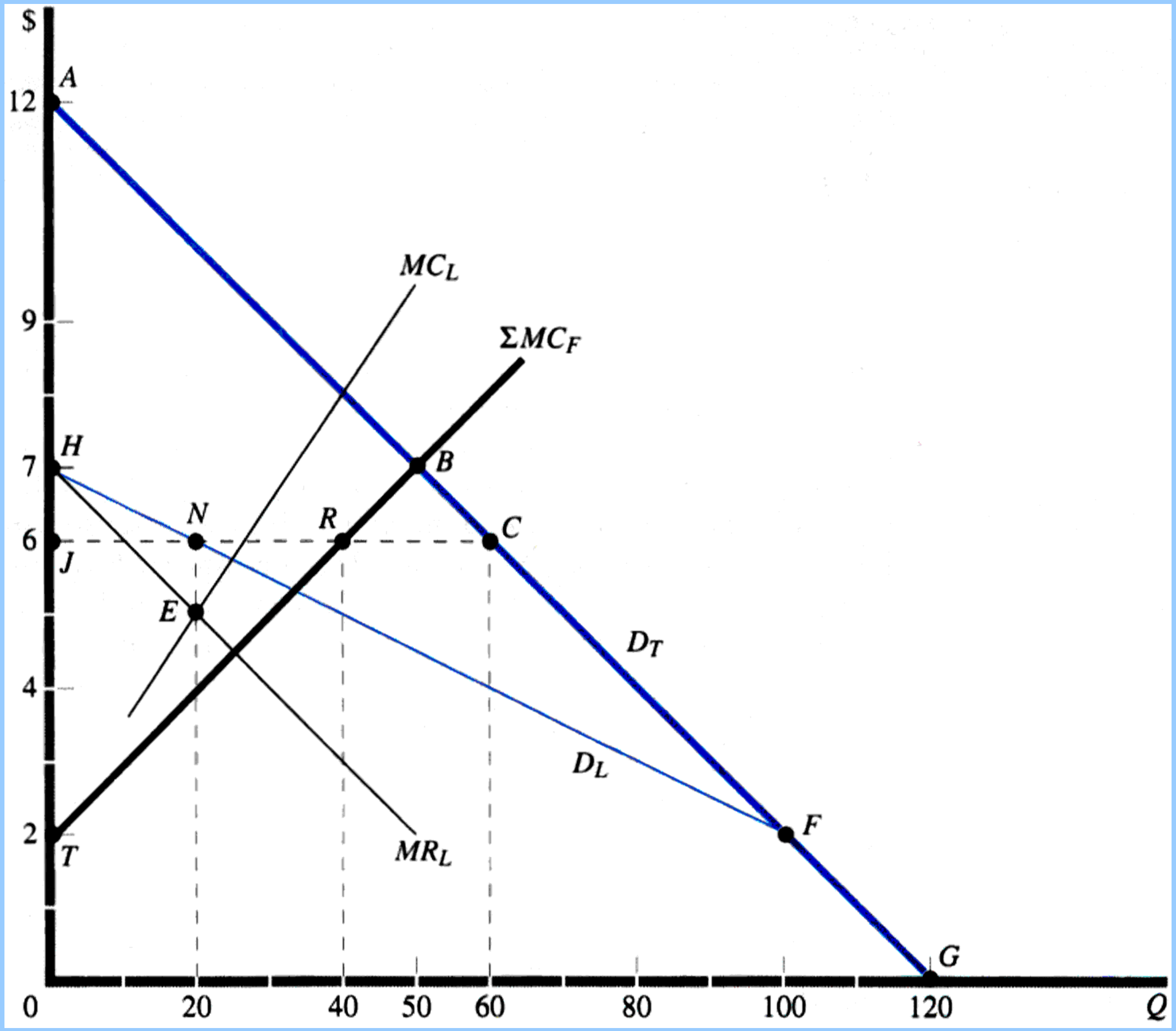
Centralized Cartel



Price Leadership

- Implicit Collusion
- Price Leader (Barometric Firm)
  - Largest, dominant, or lowest cost firm in the industry
  - Demand curve is defined as the market demand curve less supply by the followers
- Followers
  - Take market price as given and behave as perfect competitors

Price Leadership



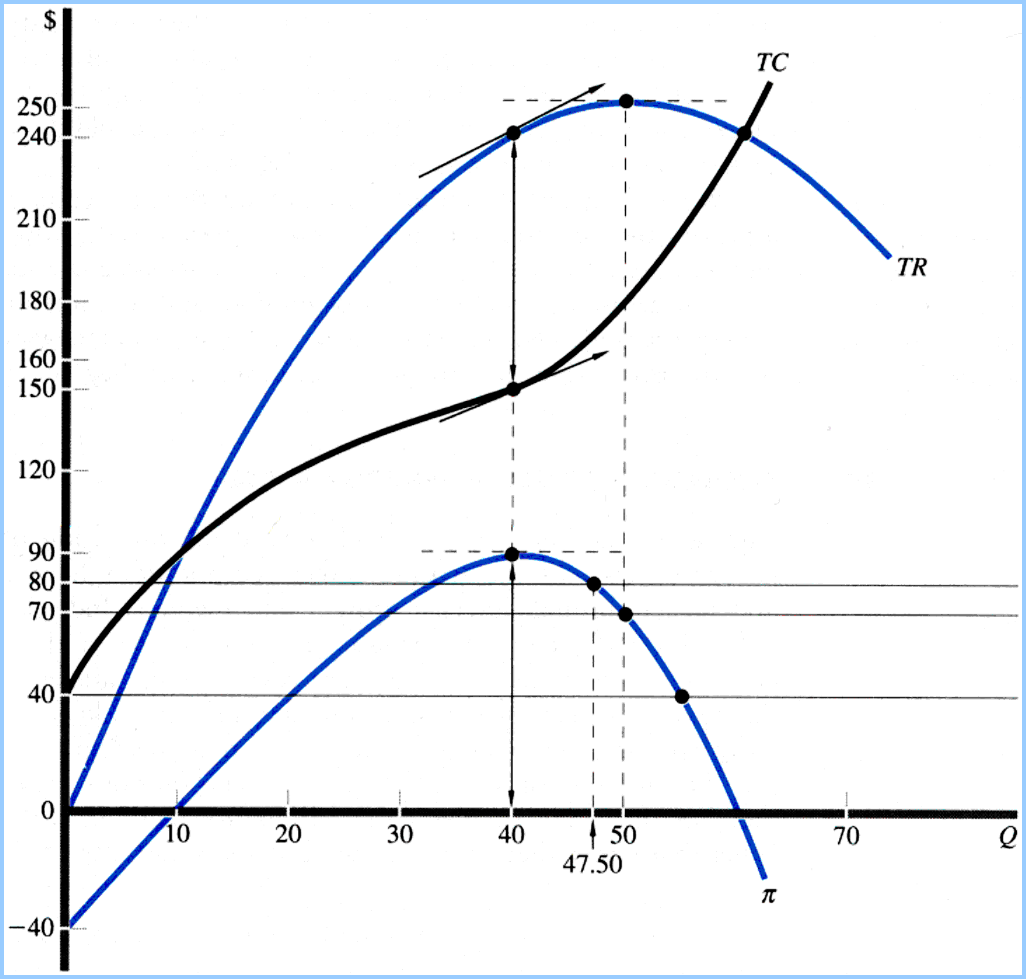
Efficiency of Oligopoly

- Price is usually greater then long-run average cost (LAC)
- Quantity produced usually does correspond to minimum LAC
- Price is usually greater than long-run marginal cost (LMC)
- When a differentiated product is produced, too much may be spent on advertising and model changes

Sales Maximization Model

- Proposed by William Baumol
- Managers seek to maximize sales, after ensuring that an adequate rate of return has been earned, rather than to maximize profits
- Sales (or total revenue, TR) will be at a maximum when the firm produces a quantity that sets marginal revenue equal to zero (MR = 0)

Sales Maximization Model



MR = 0
where
Q = 50

MR = MC
where
Q = 40

Global Oligopolists

- Impetus toward globalization
  - Advances in telecommunications and transportation
  - Globalization of tastes
  - Reduction of barriers to international trade

Architecture of the Ideal Firm

- Core Competencies
- Outsourcing of Non-Core Tasks
- Learning Organization
- Efficient and Flexibile
- Integrates Physical and Virtual
- Real-Time Enterprise

Extending the Firm

- Virtual Corporation
  – Temporary network of independent companies working together to exploit a business opportunity
- Relationship Enterprise
  – Strategic alliances
  – Complementary capabilities and resources
  – Stable longer-term relationships

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Chapter 10

Game Theory and Strategic Behavior

Strategic Behavior

- Decisions that take into account the predicted reactions of rival firms
  - Interdependence of outcomes
- Game Theory
  - Players
  - Strategies
  - Payoff matrix

Strategic Behavior

- Types of Games
  - Zero-sum games
  - Nonzero-sum games
- Nash Equilibrium
  - Each player chooses a strategy that is optimal given the strategy of the other player
  - A strategy is dominant if it is optimal regardless of what the other player does

Advertising Example 1

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

What is the optimal strategy for Firm A if Firm B chooses to advertise?

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

What is the optimal strategy for Firm A if Firm B chooses to advertise?

If Firm A chooses to advertise, the payoff is 4. Otherwise, the payoff is 2. The optimal strategy is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

What is the optimal strategy for Firm A if Firm B chooses not to advertise?

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

What is the optimal strategy for Firm A if Firm B chooses not to advertise?

If Firm A chooses to advertise, the payoff is 5. Otherwise, the payoff is 3. Again, the optimal strategy is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

Regardless of what Firm B decides to do, the optimal strategy for Firm A is to advertise. The dominant strategy for Firm A is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

What is the optimal strategy for Firm B if Firm A chooses to advertise?

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

What is the optimal strategy for Firm B if Firm A chooses to advertise?

If Firm B chooses to advertise, the payoff is 3. Otherwise, the payoff is 1. The optimal strategy is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

What is the optimal strategy for Firm B if Firm A chooses not to advertise?

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

What is the optimal strategy for Firm B if Firm A chooses not to advertise?

If Firm B chooses to advertise, the payoff is 5. Otherwise, the payoff is 2. Again, the optimal strategy is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

Regardless of what Firm A decides to do, the optimal strategy for Firm B is to advertise. The dominant strategy for Firm B is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 1

The dominant strategy for Firm A is to advertise and the dominant strategy for Firm B is to advertise. The Nash equilibrium is for both firms to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Advertising Example 2

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

What is the optimal strategy for Firm A if Firm B chooses to advertise?

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

What is the optimal strategy for Firm A if Firm B chooses to advertise?

If Firm A chooses to advertise, the payoff is 4. Otherwise, the payoff is 2. The optimal strategy is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

What is the optimal strategy for Firm A if Firm B chooses not to advertise?

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

What is the optimal strategy for Firm A if Firm B chooses not to advertise?

If Firm A chooses to advertise, the payoff is 5. Otherwise, the payoff is 6. In this case, the optimal strategy is not to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

The optimal strategy for Firm A depends on which strategy is chosen by Firms B. Firm A does not have a dominant strategy.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

What is the optimal strategy for Firm B if Firm A chooses to advertise?

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

What is the optimal strategy for Firm B if Firm A chooses to advertise?

If Firm B chooses to advertise, the payoff is 3. Otherwise, the payoff is 1. The optimal strategy is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

What is the optimal strategy for Firm B if Firm A chooses not to advertise?

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

What is the optimal strategy for Firm B if Firm A chooses not to advertise?

If Firm B chooses to advertise, the payoff is 5. Otherwise, the payoff is 2. Again, the optimal strategy is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

Regardless of what Firm A decides to do, the optimal strategy for Firm B is to advertise. The dominant strategy for Firm B is to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(6, 2)

Advertising Example 2

The dominant strategy for Firm B is to advertise. If Firm B chooses to advertise, then the optimal strategy for Firm A is to advertise. The Nash equilibrium is for both firms to advertise.

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(4, 3)	(5, 1)
	Don't Advertise	(2, 5)	(3, 2)

Prisoners’ Dilemma

Two suspects are arrested for armed robbery. They are immediately separated. If convicted, they will get a term of 10 years in prison. However, the evidence is not sufficient to convict them of more than the crime of possessing stolen goods, which carries a sentence of only 1 year.

The suspects are told the following: If you confess and your accomplice does not, you will go free. If you do not confess and your accomplice does, you will get 10 years in prison. If you both confess, you will both get 5 years in prison.

Prisoners' Dilemma

Payoff Matrix (negative values)

		Individual B	
		Confess	Don't Confess
Individual A	Confess	(5, 5)	(0, 10)
	Don't Confess	(10, 0)	(1, 1)

Prisoners' Dilemma

Dominant Strategy
Both Individuals Confess

(Nash Equilibrium)

		Individual B	
		Confess	Don't Confess
Individual A	Confess	(5, 5)	(0, 10)
	Don't Confess	(10, 0)	(1, 1)

Prisoners' Dilemma

Application: Price Competition

		Firm B	
		Low Price	High Price
Firm A	Low Price	(2, 2)	(5, 1)
	High Price	(1, 5)	(3, 3)

Prisoners' Dilemma

Application: Price Competition

Dominant Strategy: Low Price

		Firm B	
		Low Price	High Price
Firm A	Low Price	(2, 2)	(5, 1)
	High Price	(1, 5)	(3, 3)

Prisoners' Dilemma

Application: Nonprice Competition

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(2, 2)	(5, 1)
	Don't Advertise	(1, 5)	(3, 3)

Prisoners' Dilemma

Application: Nonprice Competition

Dominant Strategy: Advertise

		Firm B	
		Advertise	Don't Advertise
Firm A	Advertise	(2, 2)	(5, 1)
	Don't Advertise	(1, 5)	(3, 3)

Prisoners' Dilemma

Application: Cartel Cheating

		Firm B	
		Cheat	Don't Cheat
Firm A	Cheat	(2, 2)	(5, 1)
	Don't Cheat	(1, 5)	(3, 3)

Prisoners' Dilemma

Application: Cartel Cheating

Dominant Strategy: Cheat

		Firm B	
		Cheat	Don't Cheat
Firm A	Cheat	(2, 2)	(5, 1)
	Don't Cheat	(1, 5)	(3, 3)

Extensions of Game Theory

- Repeated Games
  - Many consecutive moves and countermoves by each player
- Tit-For-Tat Strategy
  - Do to your opponent what your opponent has just done to you

Extensions of Game Theory

- Tit-For-Tat Strategy
  - Stable set of players
  - Small number of players
  - Easy detection of cheating
  - Stable demand and cost conditions
  - Game repeated a large and uncertain number of times

Extensions of Game Theory

- Threat Strategies
  - Credibility
  - Reputation
  - Commitment
  - Example: Entry deterrence

Entry Deterrence

No Credible Entry Deterrence

		Firm B	
		Enter	Do Not Enter
Firm A	Low Price	(4, -2)	(6, 0)
	High Price	(7, 2)	(10, 0)

Credible Entry Deterrence

		Firm B	
		Enter	Do Not Enter
Firm A	Low Price	(4, -2)	(6, 0)
	High Price	(3, 2)	(8, 0)

Entry Deterrence

No Credible Entry Deterrence

		Firm B	
		Enter	Do Not Enter
Firm A	Low Price	(4, -2)	(6, 0)
	High Price	(7, 2)	(10, 0)

Credible Entry Deterrence

		Firm B	
		Enter	Do Not Enter
Firm A	Low Price	(4, -2)	(6, 0)
	High Price	(3, 2)	(8, 0)

International Competition

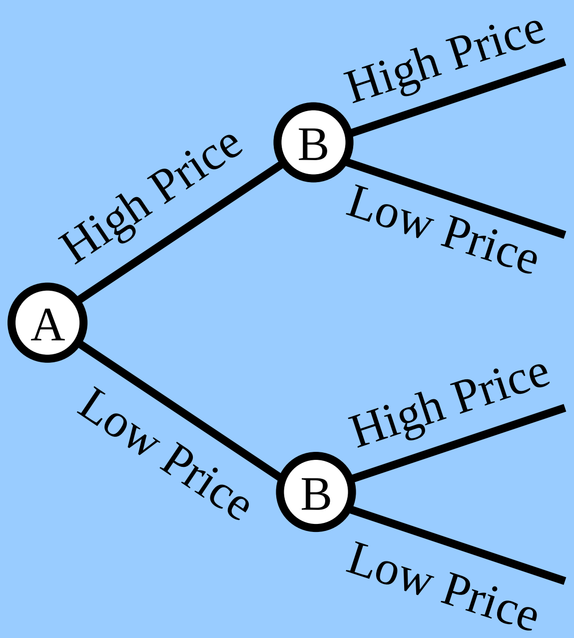
Boeing Versus Airbus Industrie

		Airbus	
		Produce	Don't Product
Boeing	Produce	(-10, -10)	(100, 0)
	Don't Produce	(0, 100)	(0, 0)

Sequential Games

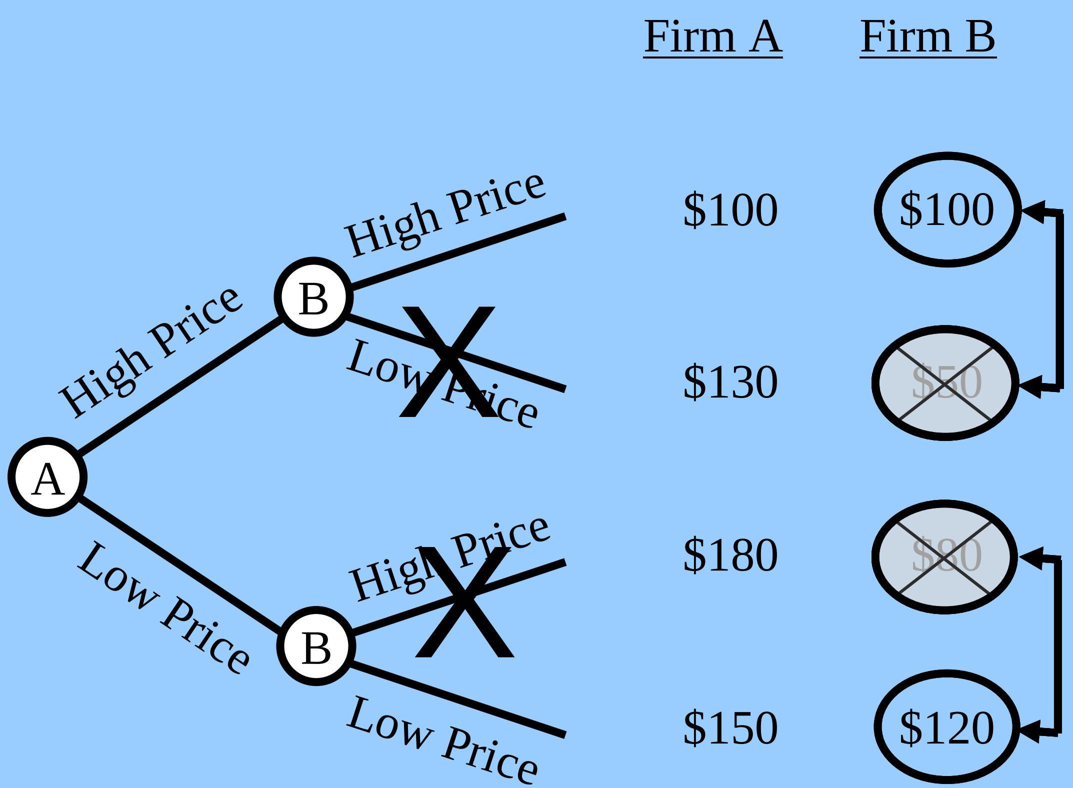
- Sequence of moves by rivals
- Payoffs depend on entire sequence
- Decision trees
  – Decision nodes
  – Branches (alternatives)
- Solution by reverse induction
  – From final decision to first decision

High-price, Low-price Strategy Game

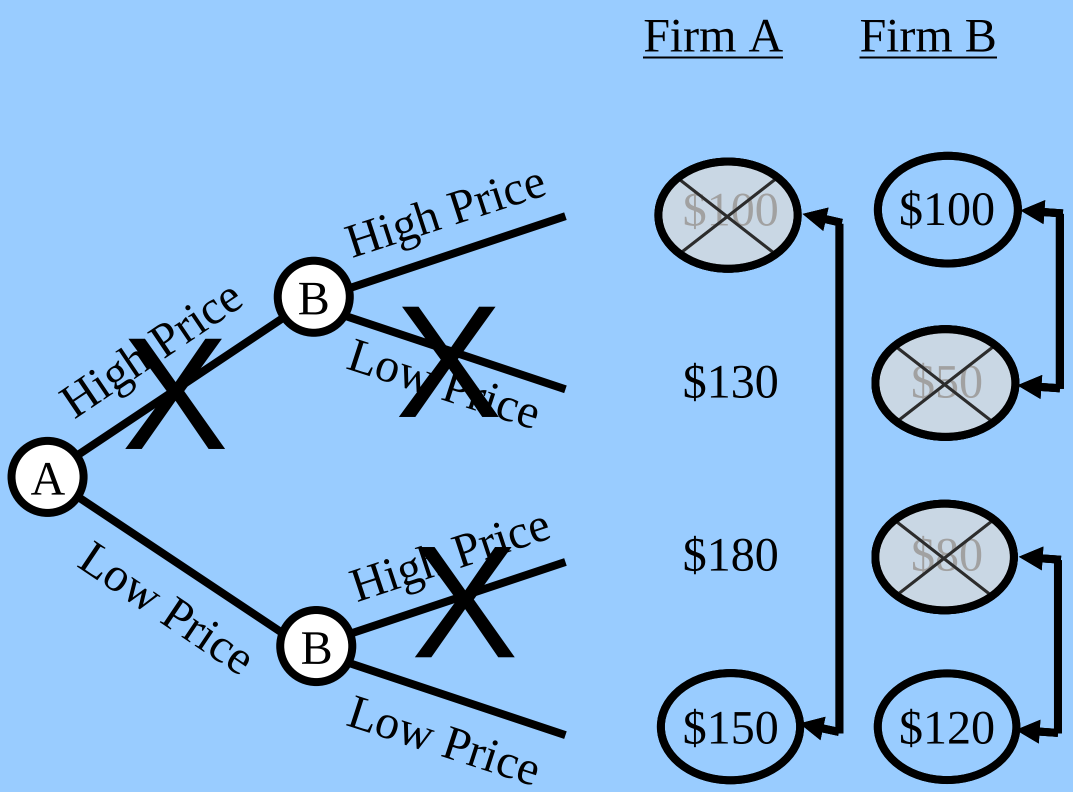


Firm A	Firm B
$100	$100
$130	$50
$180	$80
$150	$120

High-price, Low-price Strategy Game

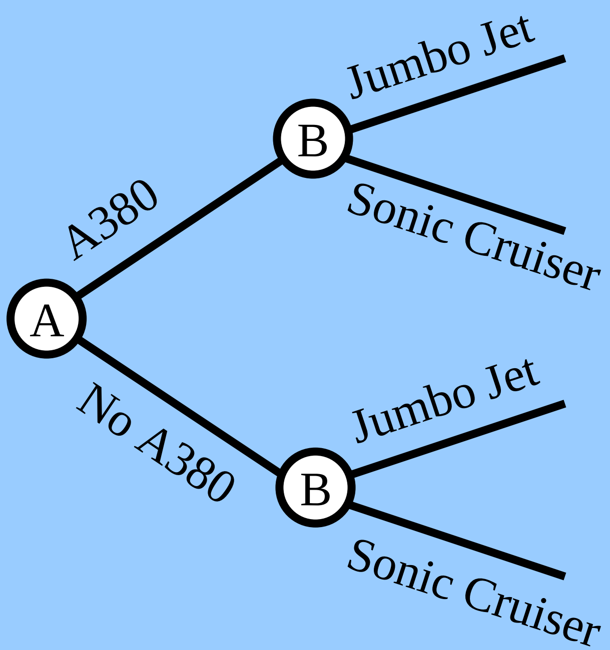


High-price, Low-price Strategy Game



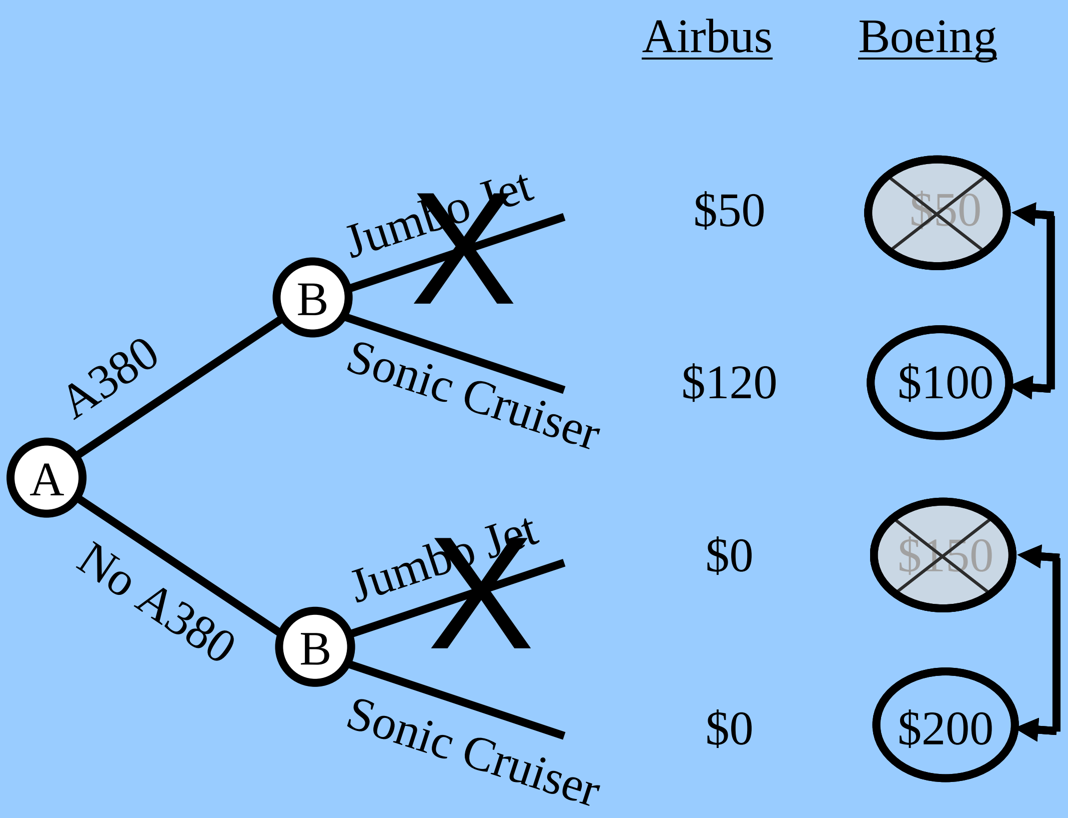
Solution: Both firms choose low price.

Airbus and Boeing

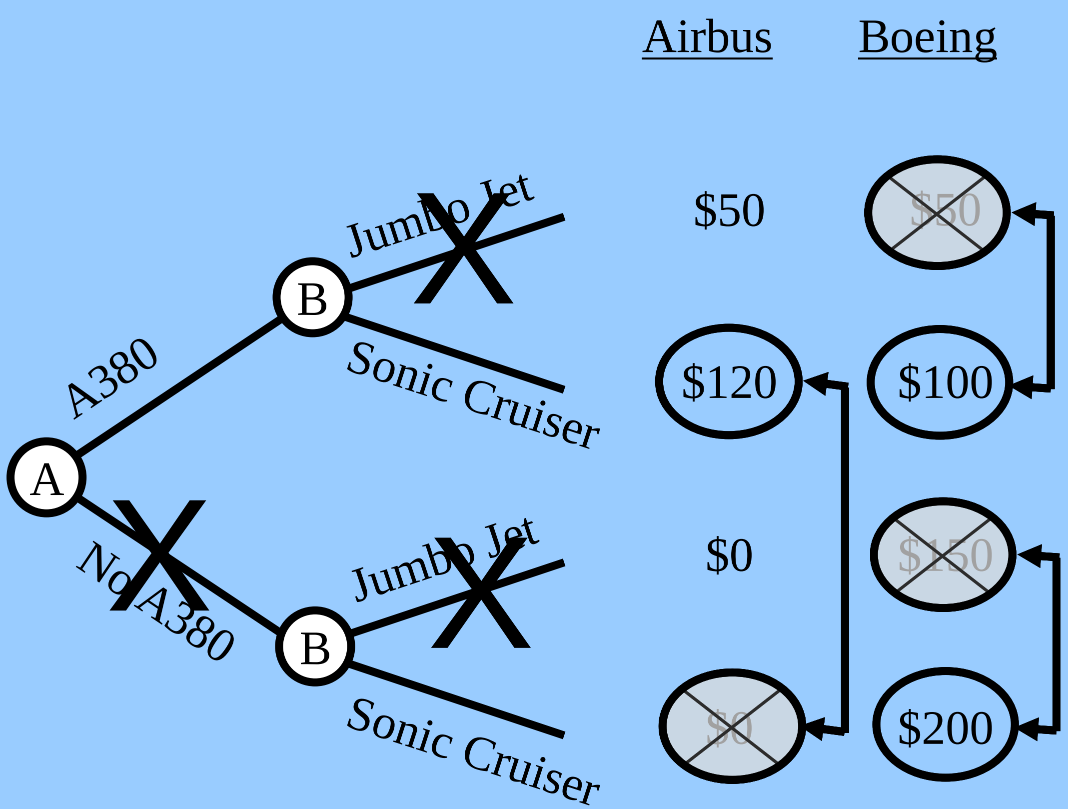


Airbus	Boeing
$50	$50
$120	$100
$0	$150
$0	$200

Airbus and Boeing

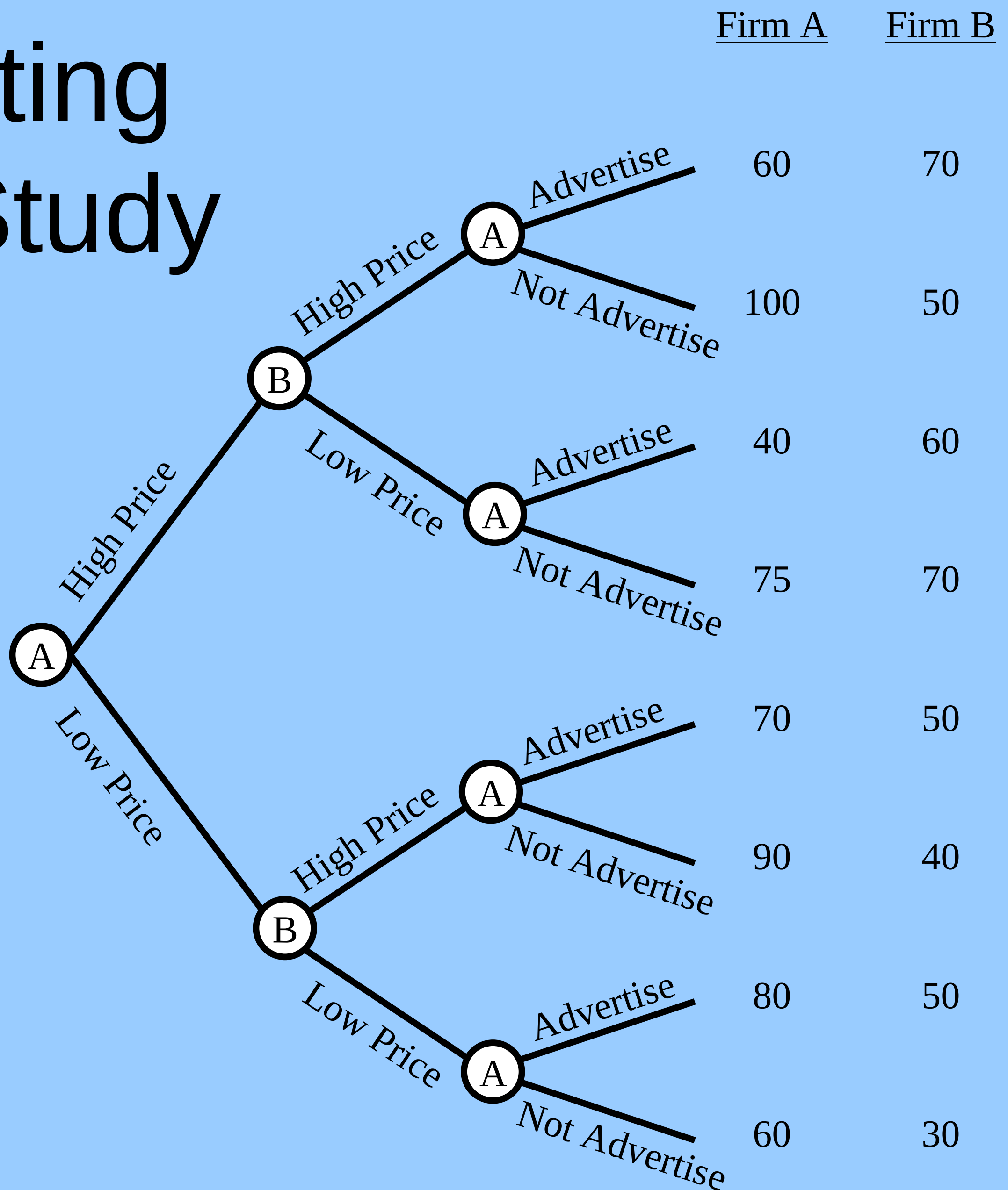


Airbus and Boeing



Solution: Airbus builds A380 and Boeing builds Sonic Cruiser.

Integrating Case Study



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Chapter 11

Pricing Practices

Pricing of Multiple Products

- Products with Interrelated Demands
- Plant Capacity Utilization and Optimal Product Pricing
- Optimal Pricing of Joint Products
  - Fixed Proportions
  - Variable Proportions

Pricing of Multiple Products

Products with Interrelated Demands

For a two-product (A and B) firm, the marginal revenue functions of the firm are:

$$MR_A = \frac{\Delta TR_A}{\Delta Q_A} + \frac{\Delta TR_B}{\Delta Q_A}$$

$$MR_B = \frac{\Delta TR_B}{\Delta QB} + \frac{\Delta TR_A}{\Delta Q_B}$$

Pricing of Multiple Products

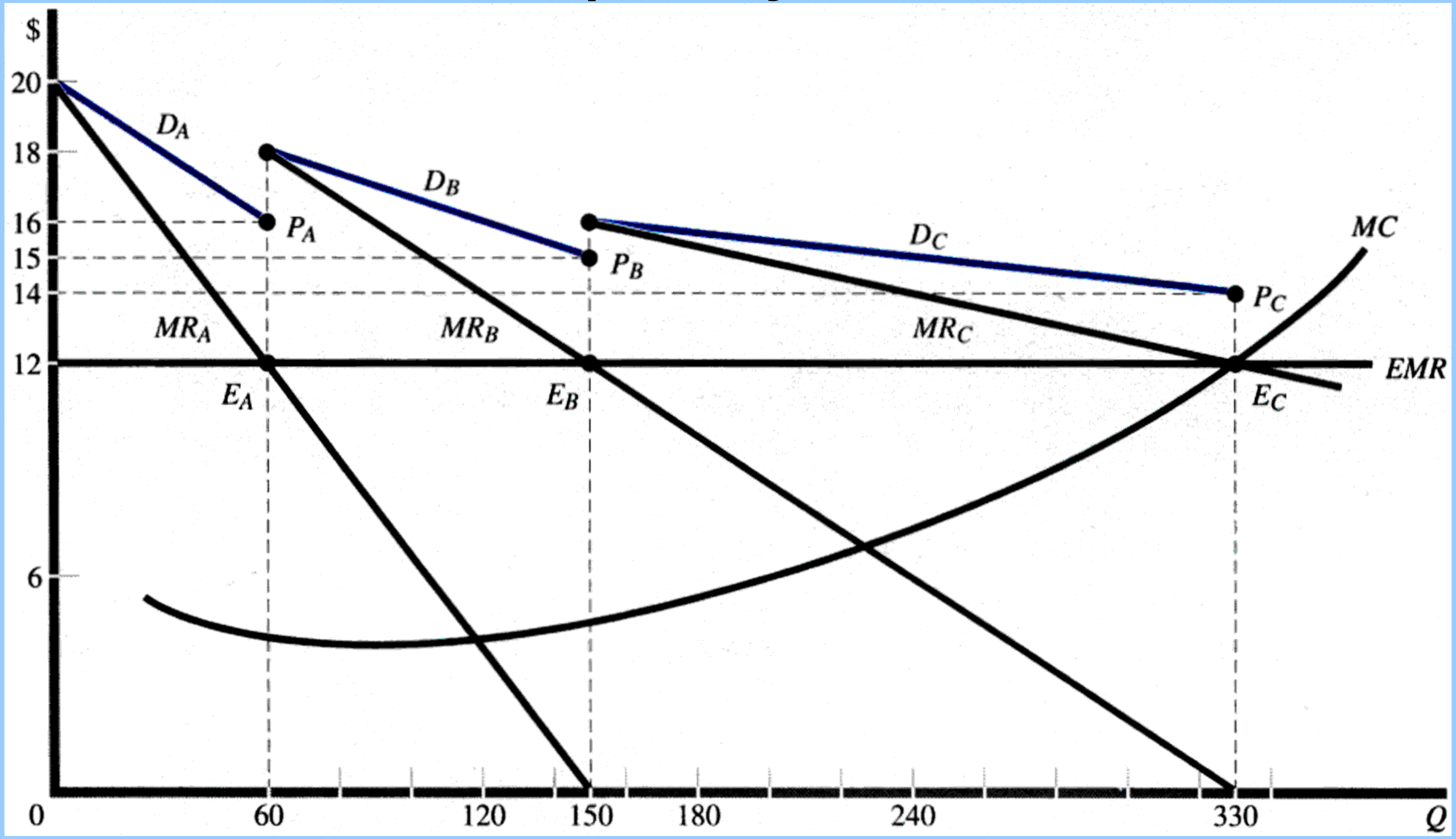
Plant Capacity Utilization

A multi-product firm using a single plant should produce quantities where the marginal revenue (MR_i) from each of its k products is equal to the marginal cost (MC) of production.

$$MR_1 = MR_2 = \cdots = MR_k = MC$$

Pricing of Multiple Products

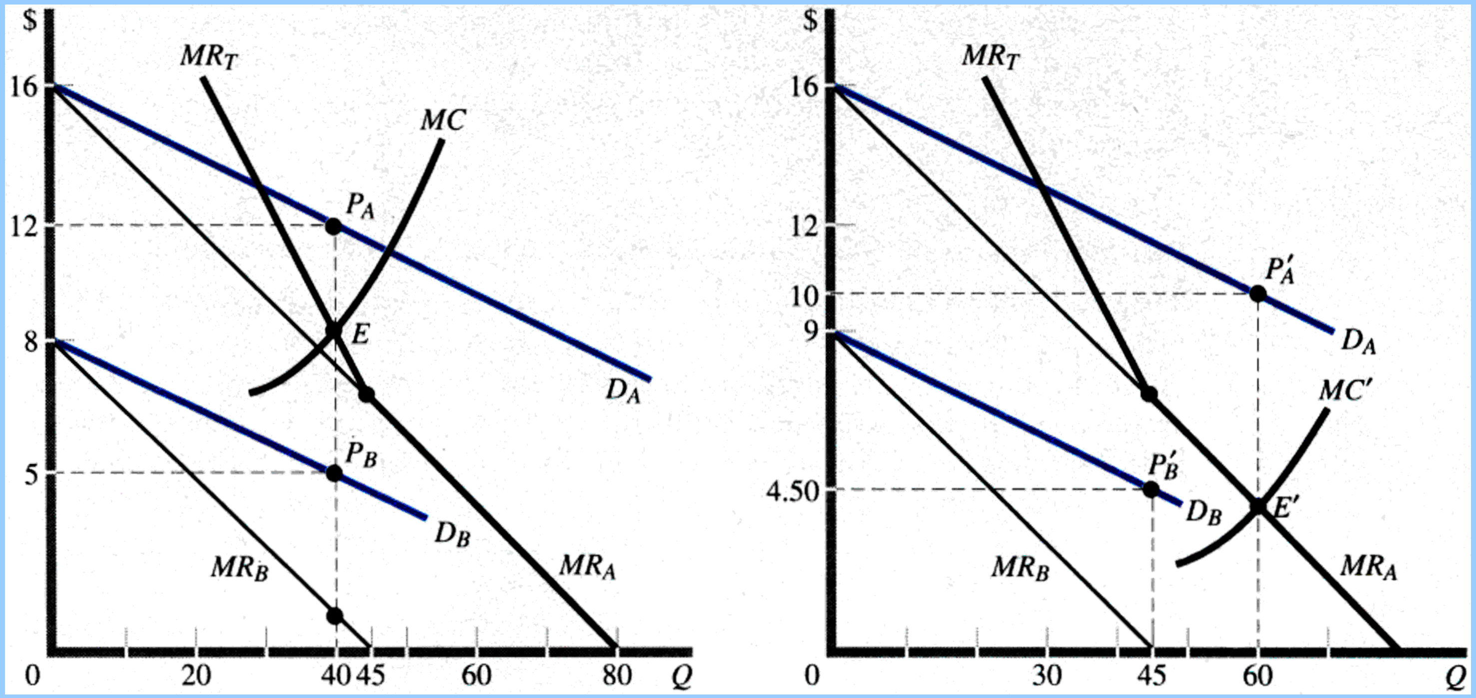
Plant Capacity Utilization



Prepared by Robert F. Brooker, Ph.D.

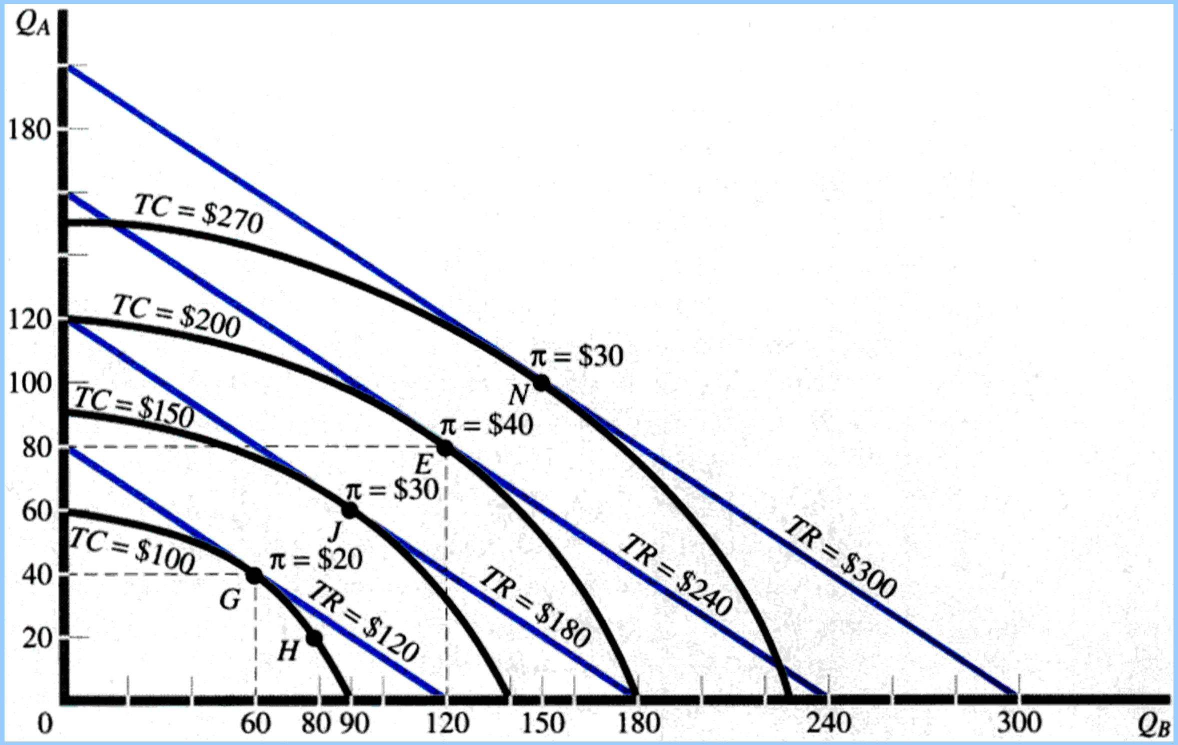
Pricing of Multiple Products

Joint Products in Fixed Proportions



Pricing of Multiple Products

Joint Products in Variable Proportions



Price Discrimination

Charging different prices for a product when the price differences are not justified by cost differences.

Objective of the firm is to attain higher profits than would be available otherwise.

Price Discrimination

1. Firm must be an imperfect competitor (a price maker)
2. Price elasticity must differ for units of the product sold at different prices
3. Firm must be able to segment the market and prevent resale of units across market segments

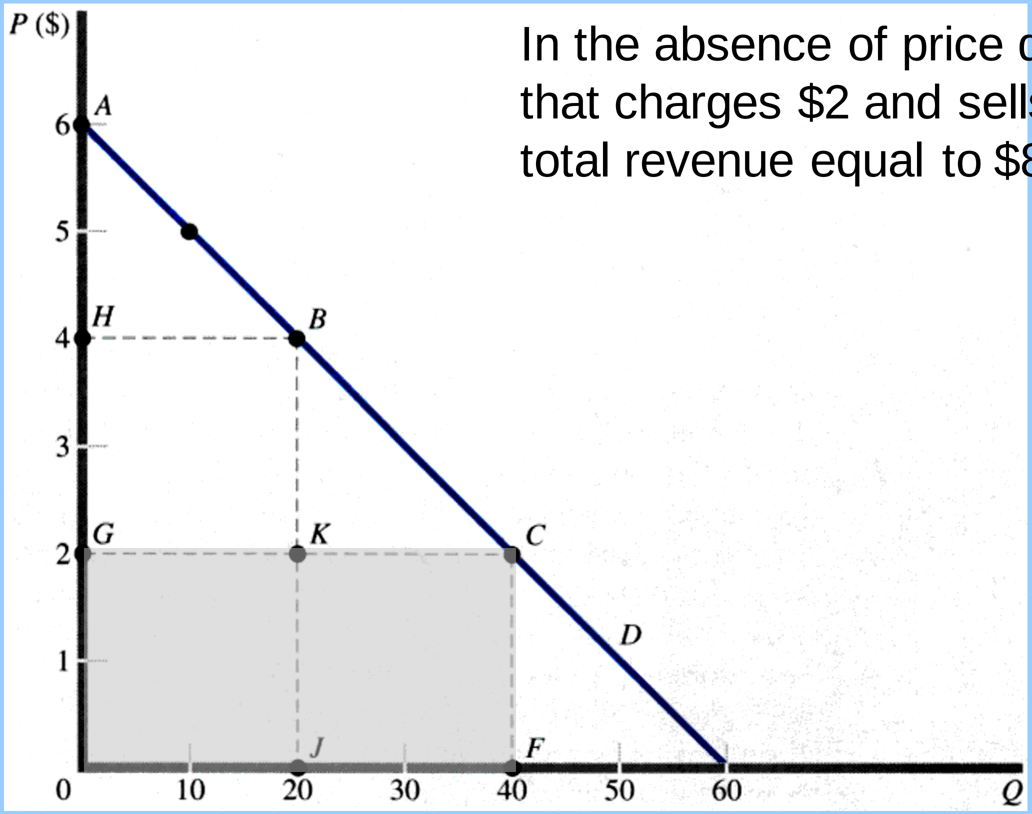
First-Degree Price Discrimination

- Each unit is sold at the highest possible price
- Firm extracts all of the consumers' surplus
- Firm maximizes total revenue and profit from any quantity sold

Second-Degree Price Discrimination

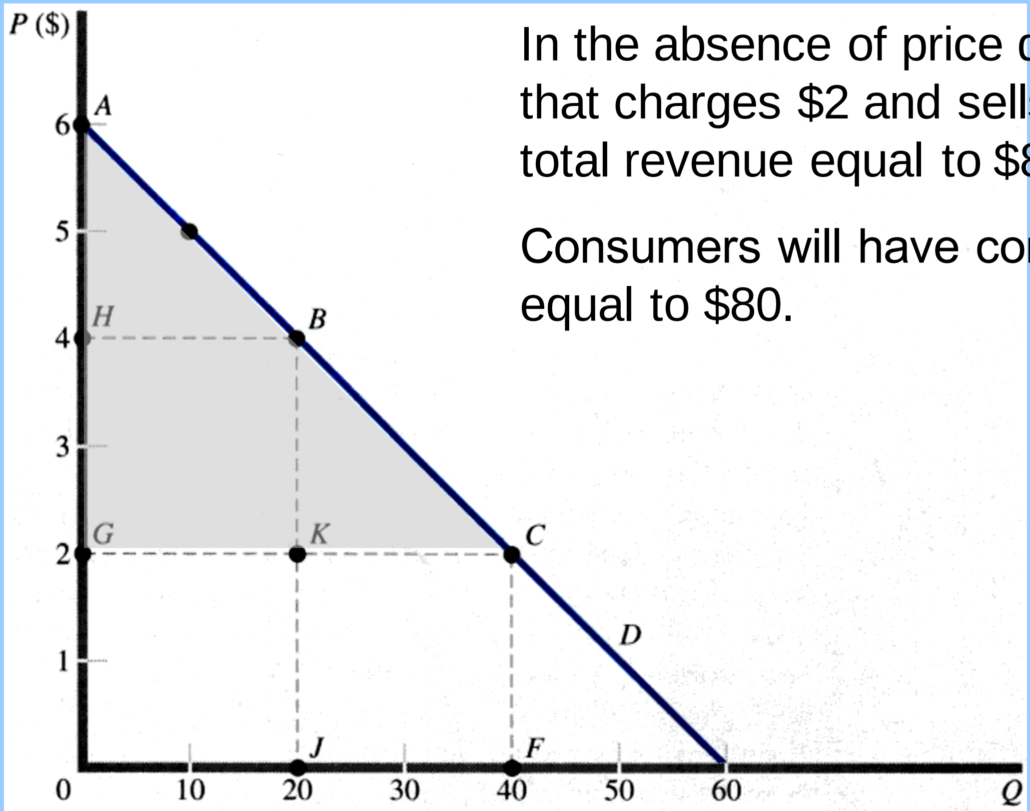
- Charging a uniform price per unit for a specific quantity, a lower price per unit for an additional quantity, and so on
- Firm extracts part, but not all, of the consumers' surplus

First- and Second-Degree Price Discrimination



In the absence of price discrimination, a firm that charges $2 and sells 40 units will have total revenue equal to $80.

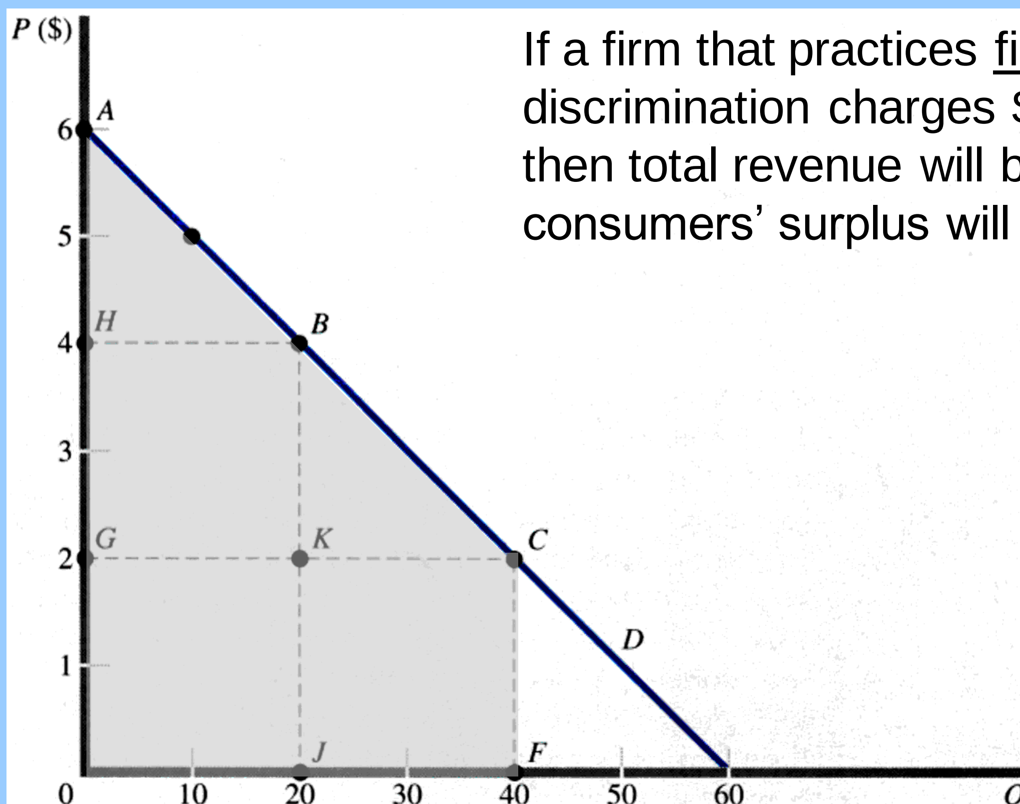
First- and Second-Degree Price Discrimination



In the absence of price discrimination, a firm that charges $2 and sells 40 units will have total revenue equal to $80.

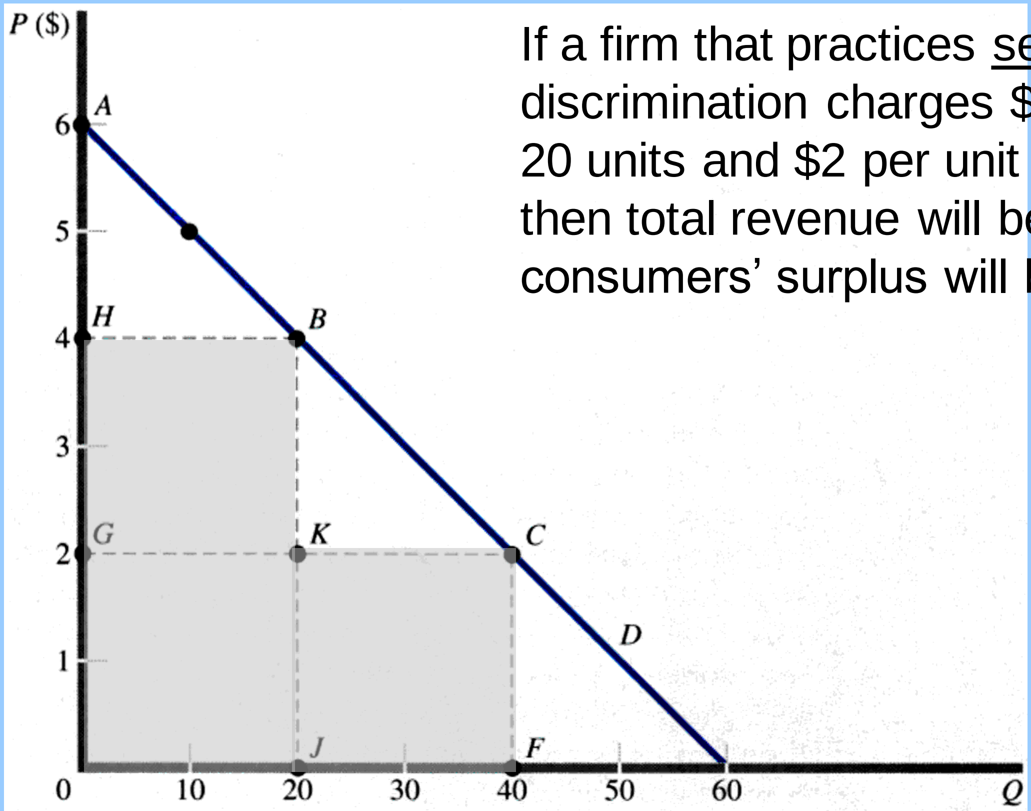
Consumers will have consumers' surplus equal to $80.

First- and Second-Degree Price Discrimination



If a firm that practices <u>first-degree</u> price discrimination charges $2 and sells 40 units, then total revenue will be equal to $160 and consumers' surplus will be zero.

First- and Second-Degree Price Discrimination



If a firm that practices <u>second-degree</u> price discrimination charges $4 per unit for the first 20 units and $2 per unit for the next 20 units, then total revenue will be equal to $120 and consumers' surplus will be $40.

Third-Degree Price Discrimination

- Charging different prices for the same product sold in different markets
- Firm maximizes profits by selling a quantity on each market such that the marginal revenue on each market is equal to the marginal cost of production

Third-Degree Price Discrimination

$Q_1 = 120 - 10\ P_1$ or $P_1 = 12 - 0.1\ Q_1$ and $MR_1 = 12 - 0.2\ Q_1$

$Q_2 = 120 - 20\ P_2$ or $P_2 = 6 - 0.05\ Q_2$ and $MR_2 = 6 - 0.1\ Q_2$

$MR_1 = MC = 2$

$MR_1 = 12 - 0.2\ Q_1 = 2$

$Q_1 = 50$

$P_1 = 12 - 0.1\ (50) = \$7$

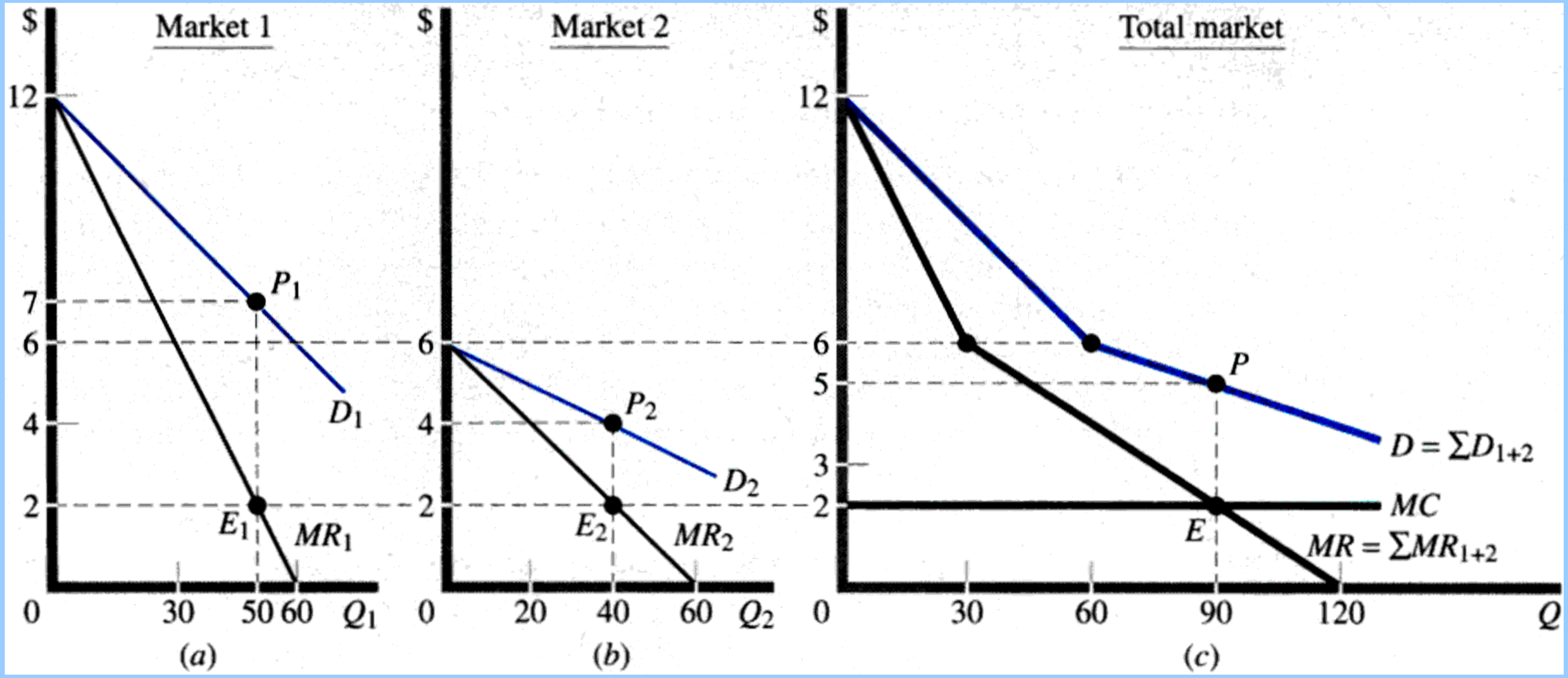
$MR_2 = MC = 2$

$MR_2 = 6 - 0.1\ Q_2 = 2$

$Q_2 = 40$

$P_2 = 6 - 0.05\ (40) = \$4$

Third-Degree Price Discrimination



International Price Discrimination

- Persistent Dumping
- Predatory Dumping
  – Temporary sale at or below cost
  – Designed to bankrupt competitors
  – Trade restrictions apply
- Sporadic Dumping
  – Occasional sale of surplus output

Transfer Pricing

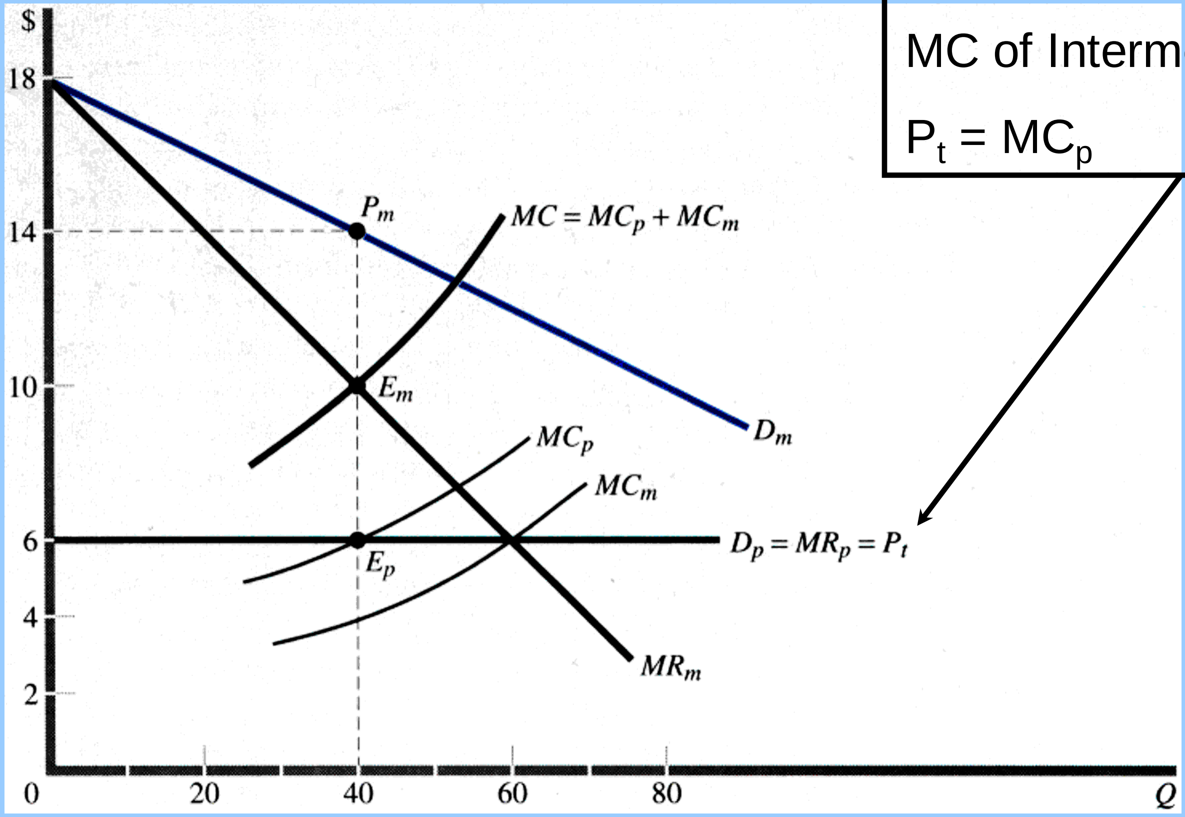
- Pricing of intermediate products sold by one division of a firm and purchased by another division of the same firm
- Made necessary by decentralization and the creation of semiautonomous profit centers within firms

Transfer Pricing
No External Market

Transfer Price = P_t

MC of Intermediate Good = MC_p

$P_t = MC_p$

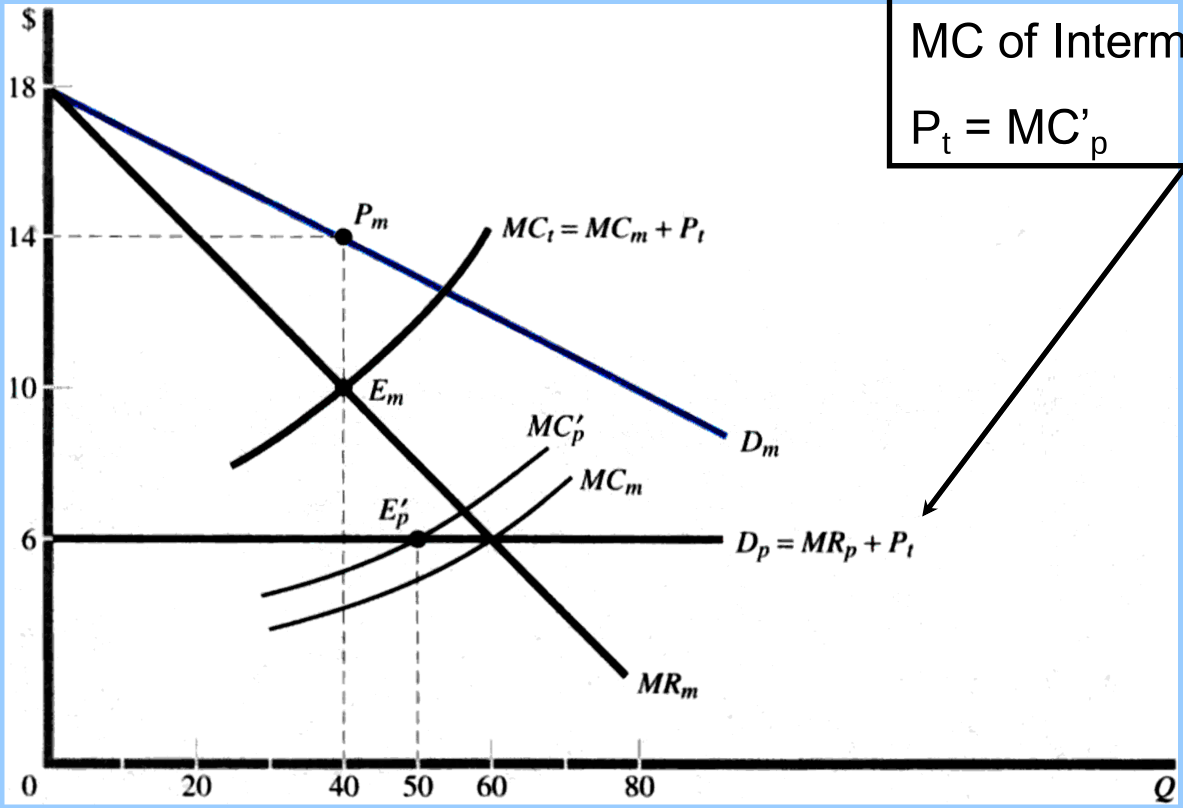


Transfer Pricing
Competitive External Market

Transfer Price = P_t

MC of Intermediate Good = MC'_p

$P_t = MC'_p$

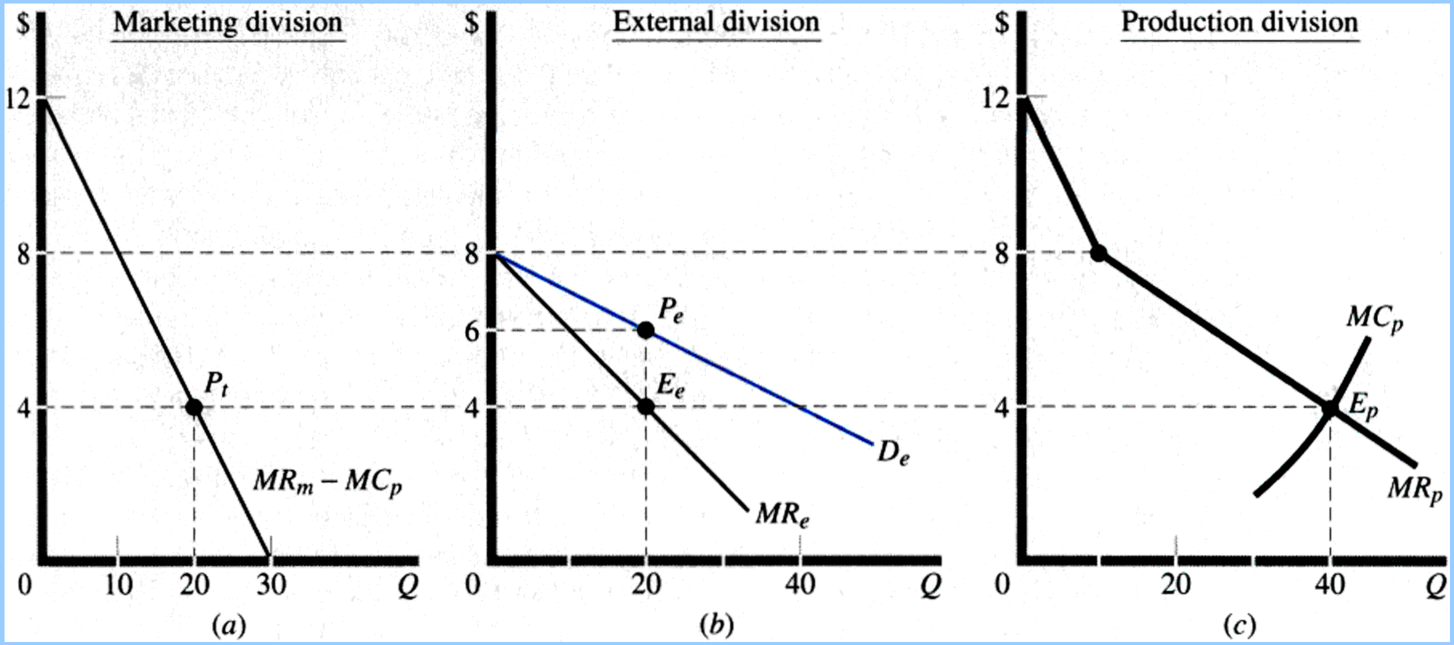


Transfer Pricing

Imperfectly Competitive External Market

Transfer Price = P_t = \$4

External Market Price = P_e = \$6



Pricing in Practice
Cost-Plus Pricing

- Markup or Full-Cost Pricing
- Fully Allocated Average Cost (C)
  - Average variable cost at normal output
  - Allocated overhead
- Markup on Cost (m) = (P - C)/C
- Price = P = C (1 + m)

Pricing in Practice
Optimal Markup

$$MR = P\left(1 + \frac{1}{E_P}\right)$$

$$P = MR\left(\frac{E_P}{E_p + 1}\right)$$

$$MR = C$$

$$P = C\left(\frac{E_P}{E_p + 1}\right)$$

Pricing in Practice
Optimal Markup

$$P = C\left(\frac{E_P}{E_p + 1}\right)$$

$$P = C(1 + m)$$

$$C(1 + m) = C\left(\frac{E_P}{E_p + 1}\right)$$

$$m = \frac{E_P}{E_P + 1} - 1$$

Pricing in Practice
Incremental Analysis

A firm should take an action if the incremental increase in revenue from the action exceeds the incremental increase in cost from the action.

Pricing in Practice

- Two-Part Tariff
- Tying
- Bundling
- Prestige Pricing
- Price Lining
- Skimming
- Value Pricing

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Chapter 12

Regulation and Antitrust: The Role of Government in the Economy

Government Regulation Restriction of Competition

- Licensing
  - Ensure a minimum degree of competence
  - Restriction on entry
- Patent
  - Exclusive use of an invention for 17 years
  - Limited monopoly
- Robinson-Patman Act (1936)
  - Restrictions on price competition

Government Regulation Consumer Protection

Food and Drug Act of 1906

- Forbids adulteration and mislabeling of foods and drugs sold in interstate commerce
- Recently expanded to include cosmetics

Government Regulation Consumer Protection

Federal Trade Commission Act of 1914

- Protects firms against unfair methods of competition based on misrepresentation
- Price of products
- Country of origin
- Usefulness of product
- Quality of product
- Wheeler-Lea Act of 1938 prohibits false or deceptive advertising

Government Regulation Consumer Protection

1990 Nutrition Labeling Act

- Food and Drug Administration (FDA)
- Labeling requirements on all foods sold in the United States

Government Regulation
Consumer Protection

- Consumer Credit Protection Act of 1968
  - Requires lenders to disclose credit terms to borrowers
- Consumer Product Safety Commission
  - Protect consumers from dangerous products
  - Provide product information to consumers
  - Set safety standards

Government Regulation Consumer Protection

- Fair Credit Reporting Act of 1971
  - Right to examine credit file
  - Bans credit discrimination
- Warranty Act of 1975
  - Requires clear explanations of warranties
- National Highway Traffic Safety Administration (NHTSA)
  - Imposes safety standards on traffic

Government Regulation Worker Protection

- Occupational Safety and Health Administration (OSHA)
  - Safety standards in the work place
- Equal Employment Opportunity Commission (EEOC)
  - Hiring and firing standards
- Minimum Wage Laws

Government Regulation Protection of the Environment

- Environmental Protection Agency (EPA)
  - Regulates environmental usage
  - Enforces environmental legislation
- Clean Air Act of 1990
  - Requires reduction in overall pollution
  - Established a market for pollution permits

Externalities

- Externalities are harmful or beneficial side effects of the production or consumption of some products
- Public Interest Theory of Regulation
  - Regulation is justified when it is undertaken to overcome market failures
  - Externalities can cause market failures

Externalities

- External Diseconomies of Production or Consumption
  - Uncompensated costs

- External Economies of Production or Consumption
  - Uncompensated benefits

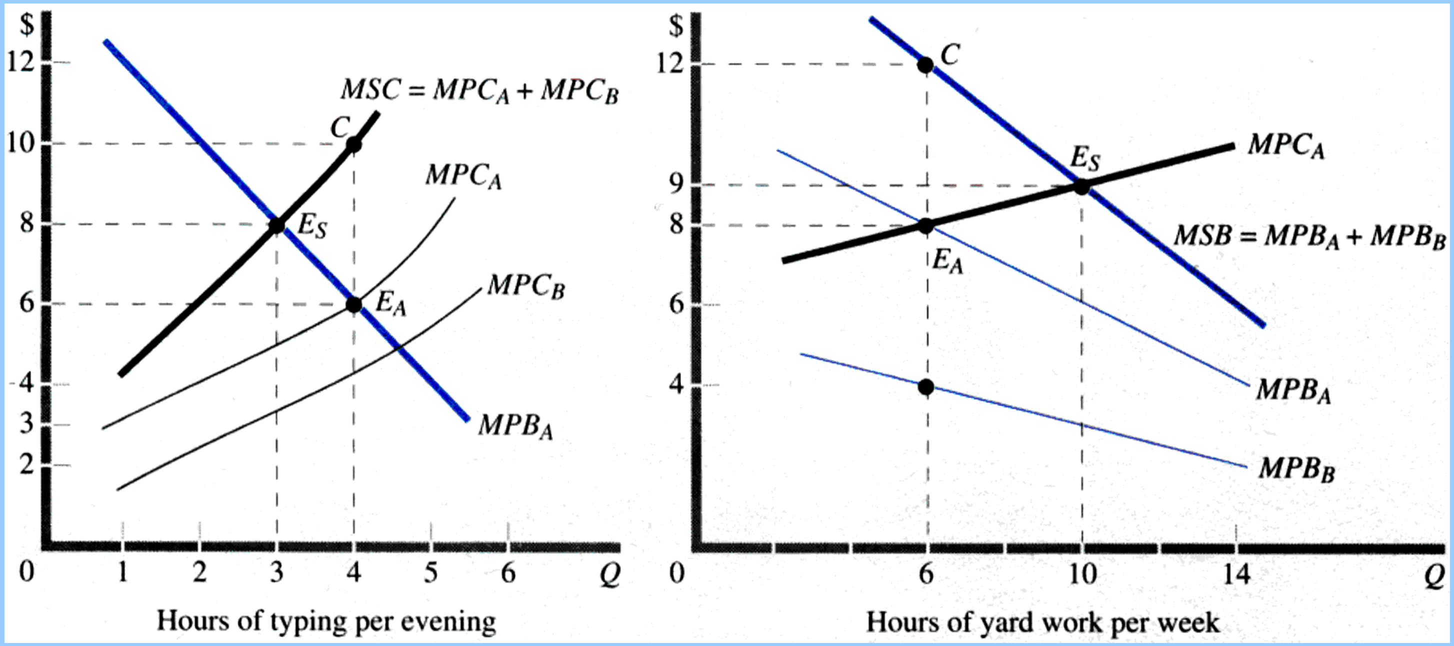
Externalities

MSC = Marginal Social Cost

Activity of A imposes external cost on B. Socially optimal output is 3.

MSB = Marginal Social Benefit

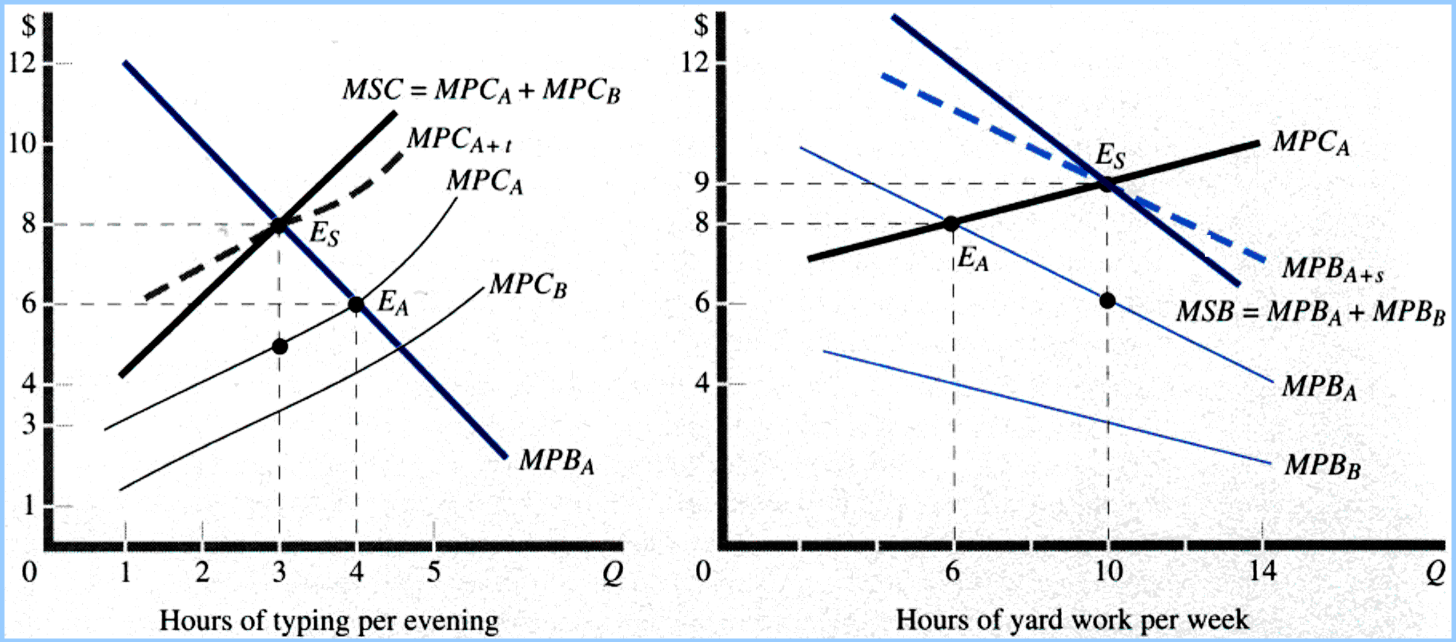
Activity of A causes external benefit for B. Socially optimal output is 10.



Externalities

Activity of A imposes external cost on B. Socially optimal output is 3. Tax yields this result

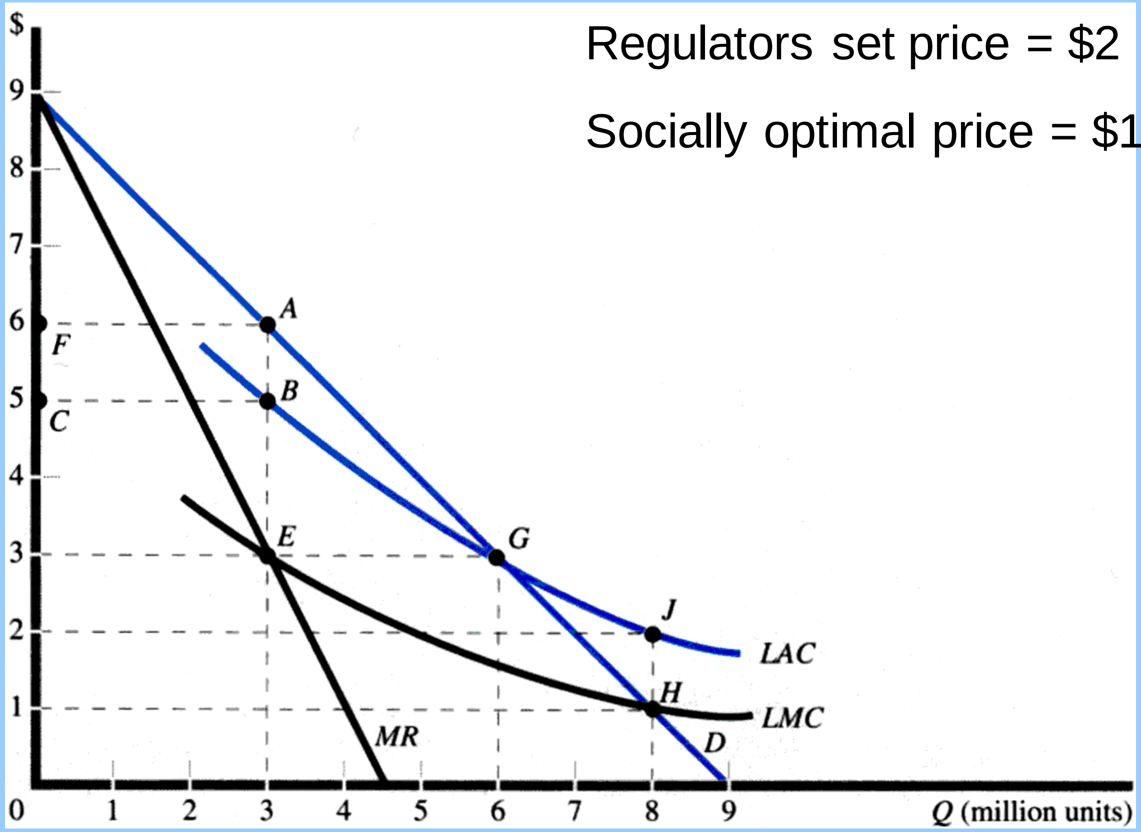
Activity of A causes external benefit for B. Socially optimal output is 10. Subsidy yields this result.



Public Utility Regulation

- Natural Monopolies
- Long-Run Average Cost (LAC) has a negative slope
- Long-Run Marginal Cost (LMC) is below LAC
- Regulators Set Price = LAC

Public Utility Regulation



Regulators set price = $2

Socially optimal price = $1

Public Utility Regulation

- Rate regulation is difficult in practice
- Guaranteed return gives little incentive to control costs
- Averch-Johnson Effect
  - Rates that are set too high or too low can lead to over- or under-investment by in plant and equipment by utility
- Regulatory Lag or 9-12 Months

Antitrust
Sherman Act (1890)

- Made any contract, combination in the form of a trust or otherwise, or conspiracy, in restraint of trade illegal
- Made monopolization or conspiracies to monopolize markets illegal

Antitrust
Clayton Act (1914)

- Made it illegal to engage in any of the following if the effect was to lessen competition or create a monopoly
  - Price discrimination
  - Exclusive or tying contracts
  - Acquisition of competitors stocks
  - Interlocking directorates among competitors

Antitrust
Clayton Act (1914)

- Federal Trade Commission Act (1914)
  - Prohibited "unfair methods of competition"
- Robinson-Patman Act (1936)
  - Prohibited "unreasonable low prices"
- Wheeler-Lea Act (1938)
  - Prohibited false or deceptive advertising to protect consumers
- Celler-Kefauver Antimerger Act (195)

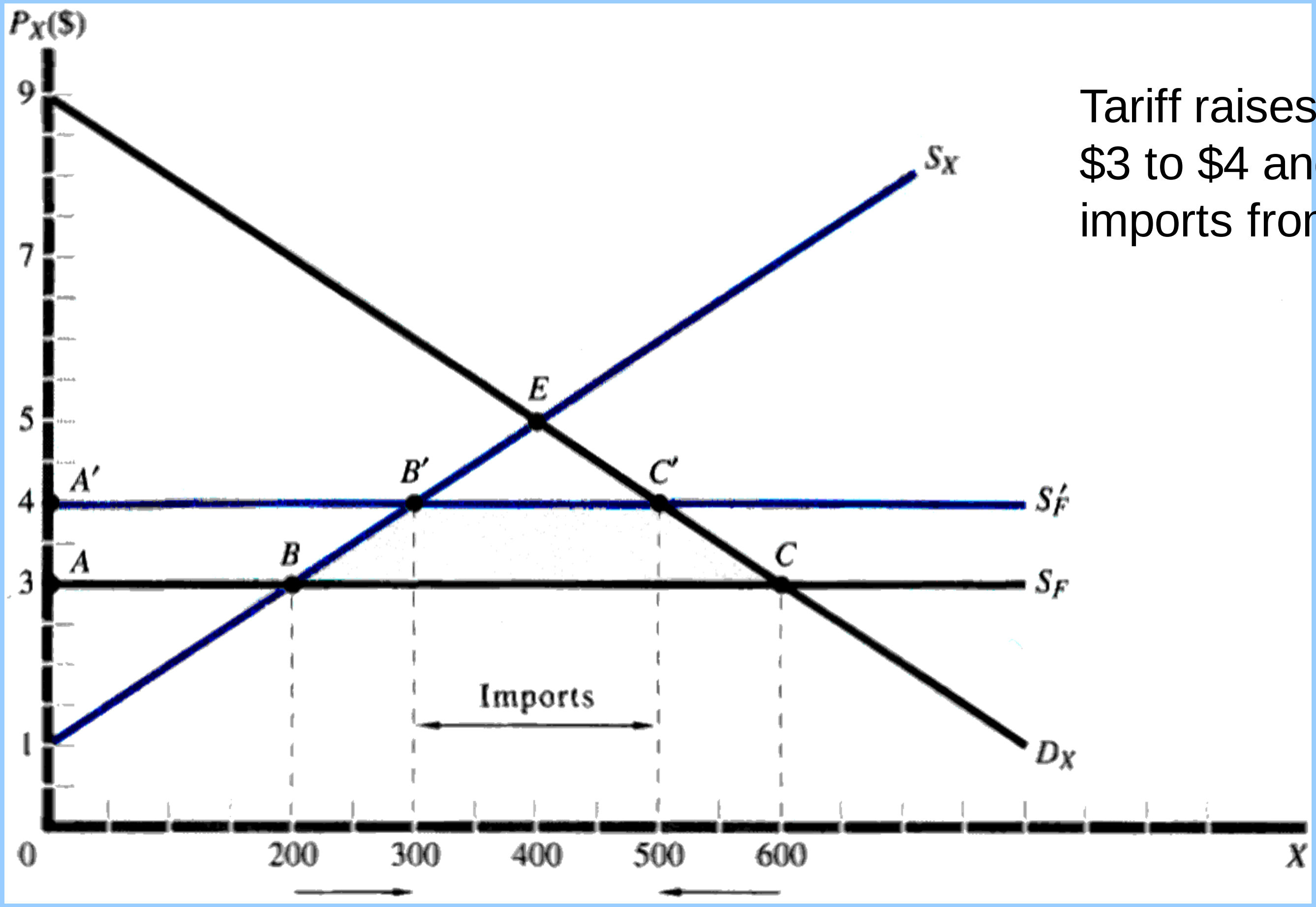
Antitrust Enforcement

- Remedies
  - Dissolution and divestiture
  - Injunction
  - Consent decree
  - Fines and jail sentences
- Anticompetitive Conduct
  - Conscious parallelism
  - Predatory pricing

Regulation
International Competition

- Tariff
  - – Tax on imports
- Import Quota
  - – Restricts quantity of imports
- Voluntary Export Restraint
  - – Exporter restricts quantity of exports
- Antidumping Complaints

Regulation
International Competition



Tariff raises price from $3 to $4 and reduces imports from 400 to 200.

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Chapter 13
Risk Analysis

Risk and Uncertainty

- Risk
  - Situation where there is more than one possible outcome to a decision and the probability of each outcome is known
- Uncertainty
  - Situation where there is more than one possible outcome to a decision and the probability of each outcome is unknown

Measuring Risk
Probability Distributions

- Probability
  - Chance that an event will occur
- Probability Distribution
  - List of all possible events and the probability that each will occur
- Expected Value or Expected Profit

$$E(\pi) = \bar{\pi} = \sum_{i=1}^{n} \pi_i \cdot P_i$$

Measuring Risk
Probability Distributions

Calculation of Expected Profit

Project	State of Economy	Probability (P)	Outcome (π)	Expected Value
A	Boom	0.25	$600	$150
	Normal	0.50	500	250
	Recession	0.25	400	100
	Expected profit from Project A			$500
B	Boom	0.25	$800	$200
	Normal	0.50	500	250
	Recession	0.25	200	50
	Expected profit from Project B			$500

Measuring Risk
Probability Distributions

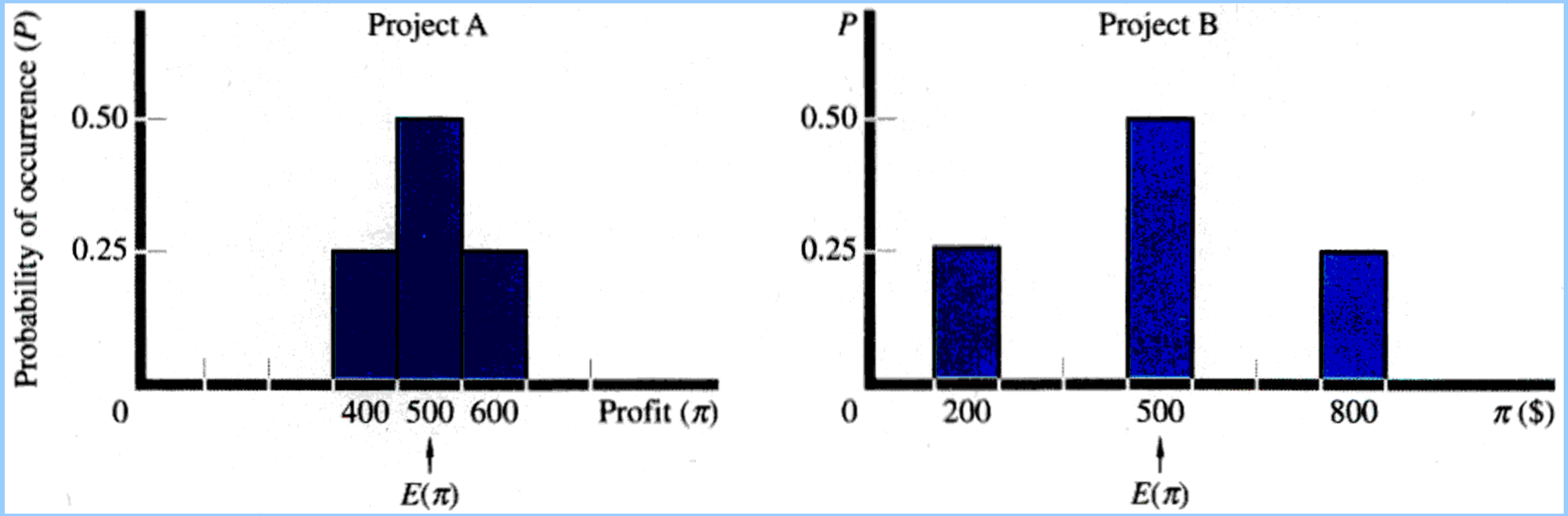
- Discrete Probability Distribution
  - List of individual events and their probabilities
  - Represented by a bar chart or histogram
- Continuous Probability Distribution
  - Continuous range of events and their probabilities
  - Represented by a smooth curve

Measuring Risk Probability Distributions

Discrete Probability Distributions

Project A; E(π) = 500, Low Risk

Project B: E(π) = 500, High Risk

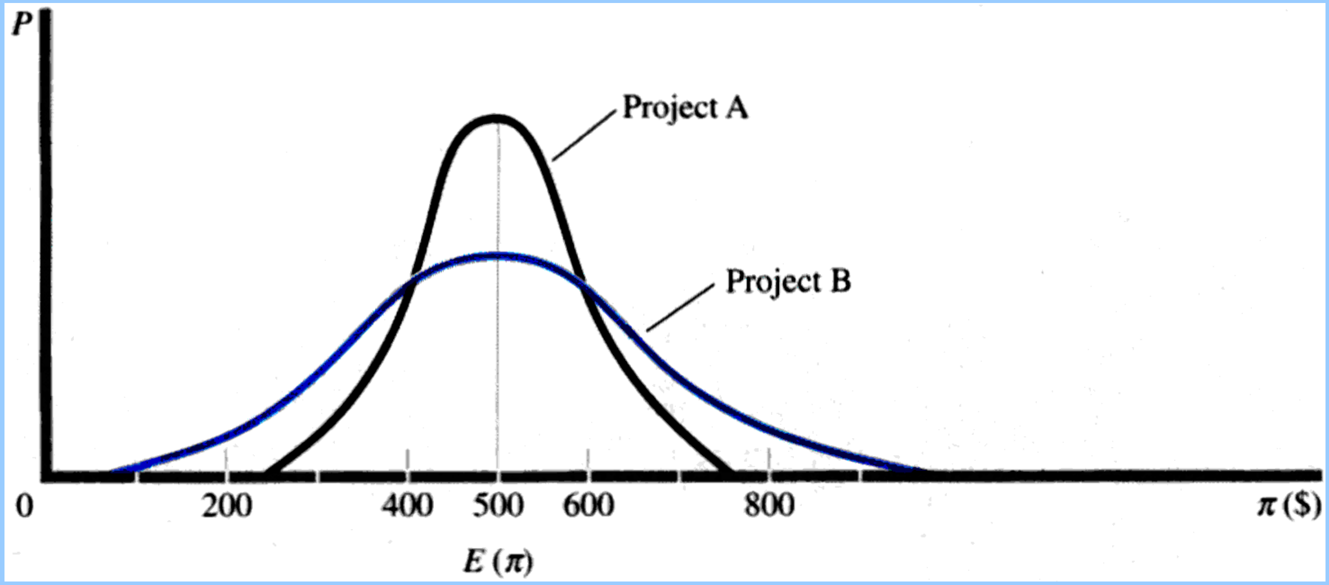


Measuring Risk
Probability Distributions

Continuous Probability Distributions

Project A: $E(\pi) = 500$, Low Risk

Project B: $E(\pi) = 500$, High Risk



Measuring Risk
Probability Distributions

An Absolute Measure of Risk:
The Standard Deviation

$$\sigma = \sqrt{\sum_{i=1}^{n} (X_i - \bar{X})^2 \cdot P_i}$$

Measuring Risk
Probability Distributions

Calculation of the Standard Deviation
Project A

$$\sigma = \sqrt{(600-500)^2(0.25)+(500-500)^2(0.50)+(400-500)^2(0.25)}$$

$$\sigma = \sqrt{5,000} = \$70.71$$

Measuring Risk
Probability Distributions

Calculation of the Standard Deviation
Project B

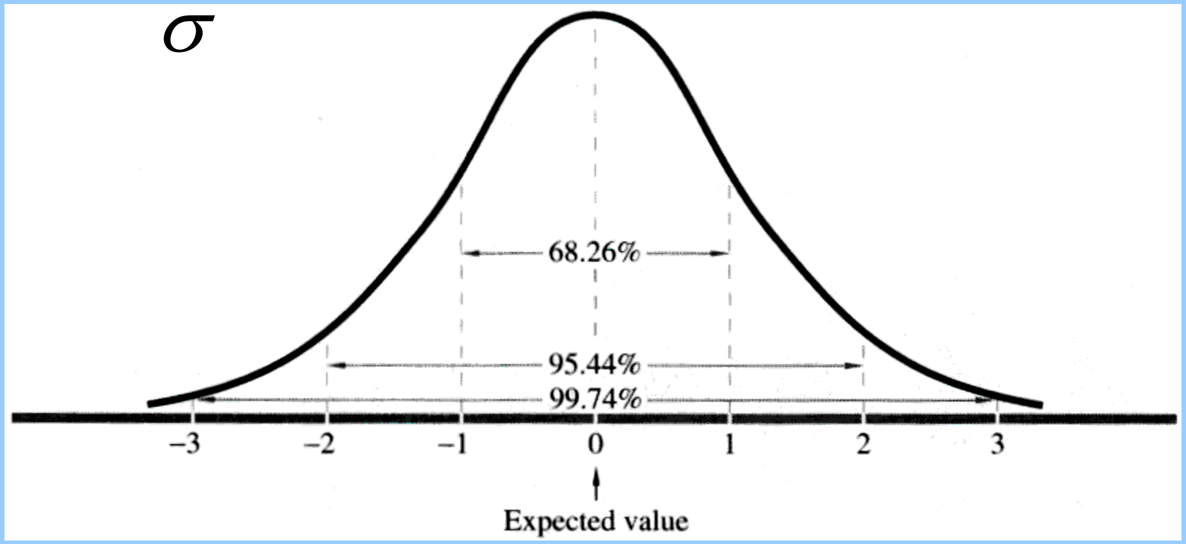
$$\sigma = \sqrt{(800-500)^2(0.25)+(500-500)^2(0.50)+(200-500)^2(0.25)}$$

$$\sigma = \sqrt{45,000} = \$212.13$$

Measuring Risk
Probability Distributions

The Normal Distribution

$$Z = \frac{\pi_i - \bar{\pi}}{\sigma}$$



Measuring Risk
Probability Distributions

A Relative Measure of Risk:
The Coefficient of Variation

$$v = \frac{\sigma}{\bar{\pi}}$$

Project A

$$v_A = \frac{70.71}{500} = 0.14$$

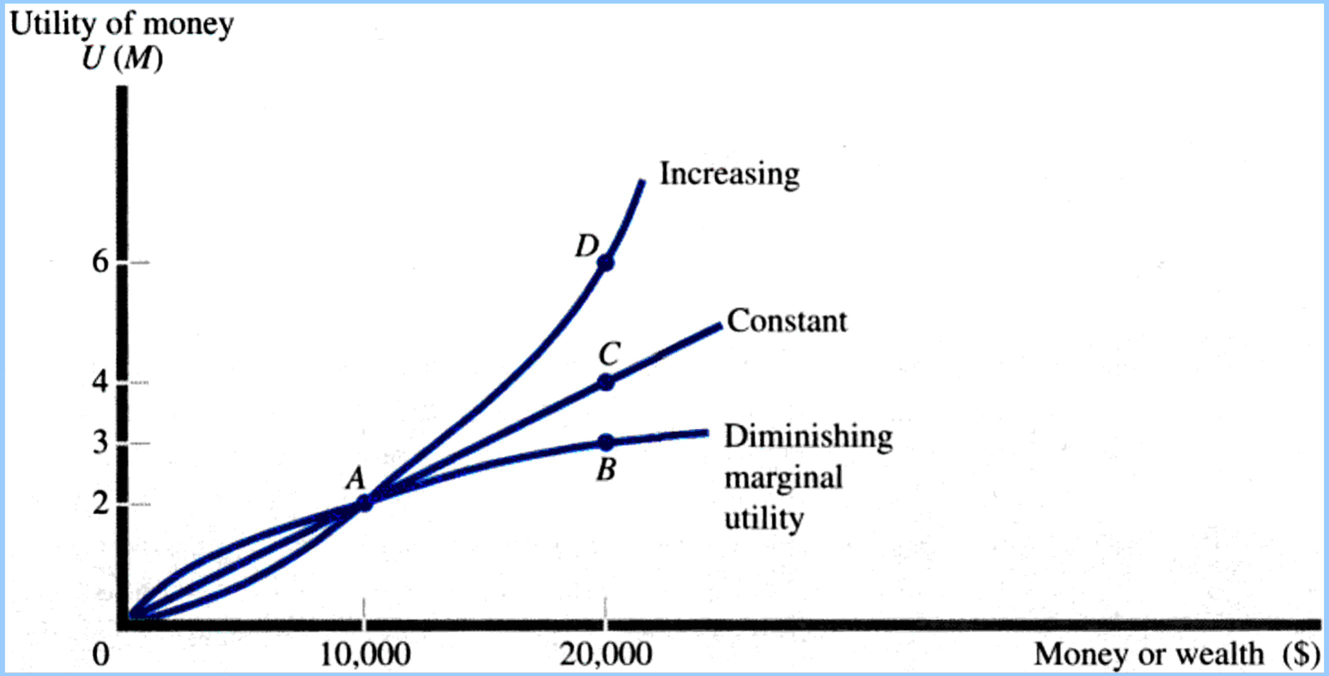
Project B

$$v_B = \frac{212.13}{500} = 0.42$$

Utility Theory

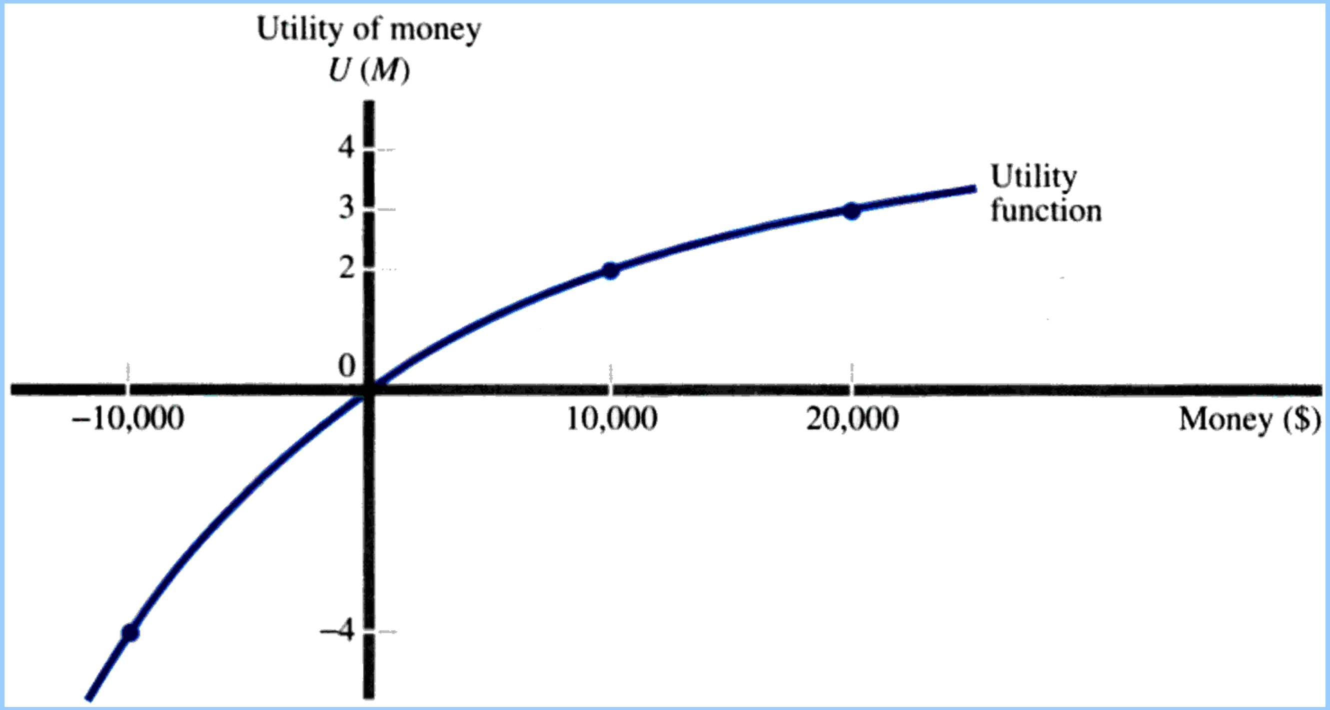
- Risk Averse
  - Must be compensated for taking on risk
  - Diminishing marginal utility of money
- Risk Neutral
  - Are indifferent to risk
  - Constant marginal utility of money
- Risk Seeking
  - Prefer to take on risk
  - Increasing marginal utility of money

Utility Theory



Utility Theory

Utility Function of a Risk Averse Manager



Adjusting Value for Risk

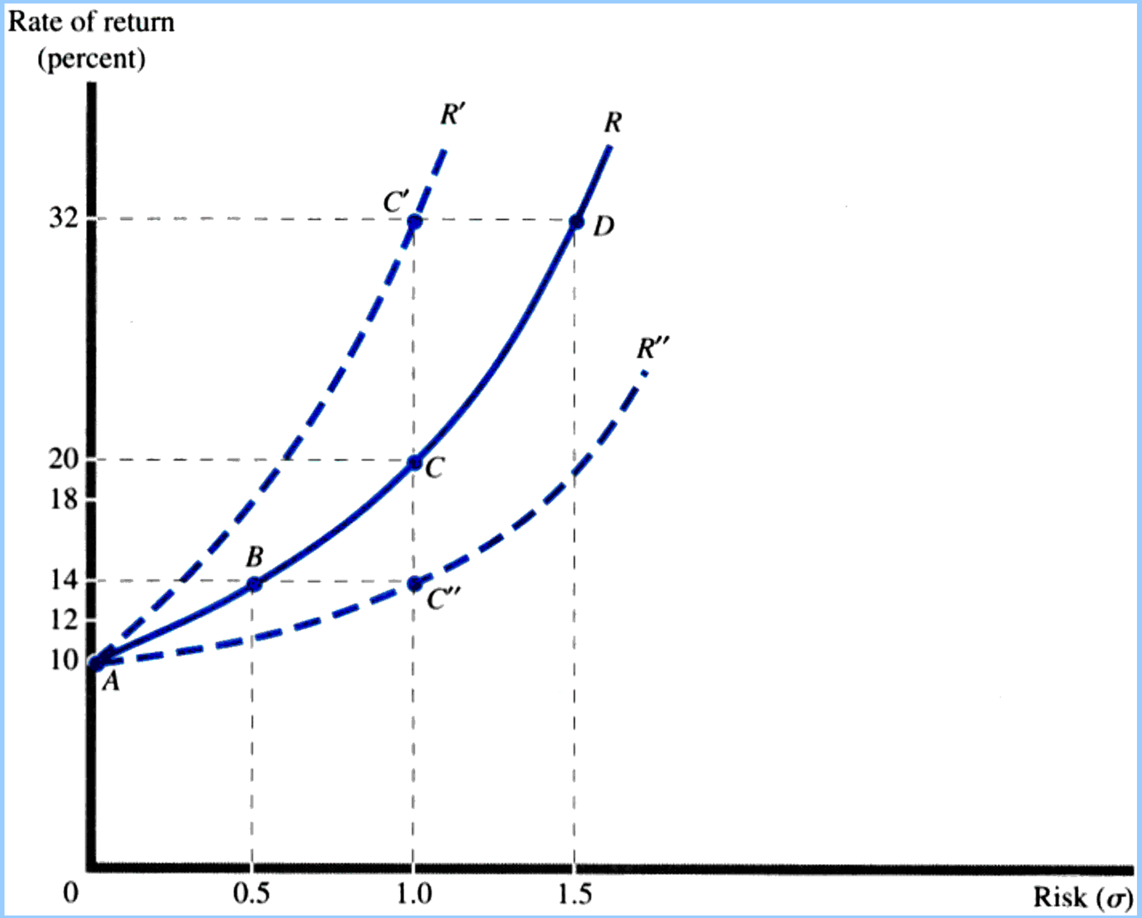
- Value of the Firm = Net Present Value

$$NPV = \sum_{t=1}^{n} \frac{\pi_t}{(1+r)^t}$$

- Risk-Adjusted Discount Rate

$$k = r + Risk\ Premium \qquad NPV = \sum_{t=1}^{n} \frac{\pi_t}{(1+k)^t}$$

Adjusting Value for Risk



Adjusting Value for Risk

- Certainty Equivalent Approach

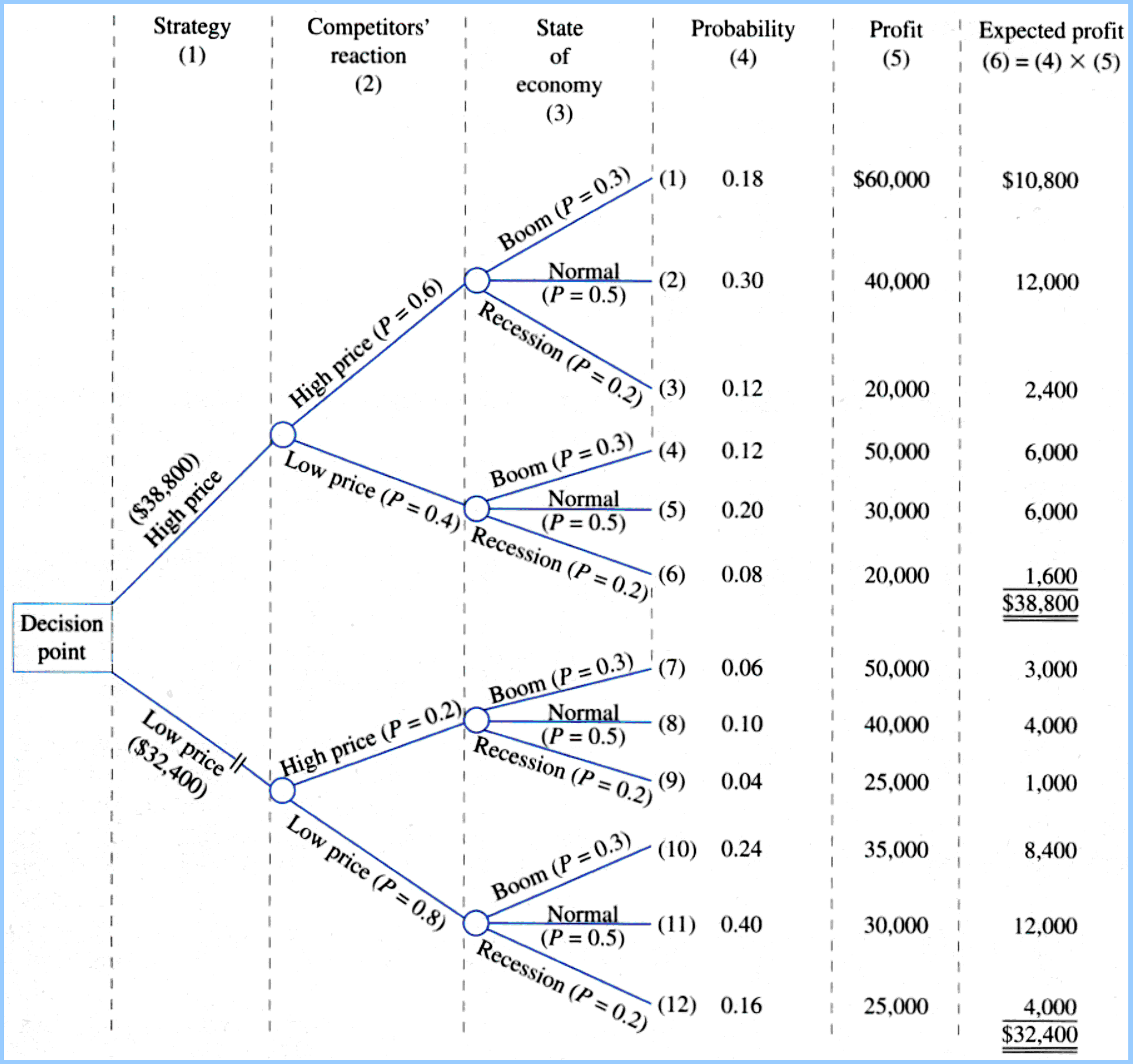
$$NPV = \sum_{t=1}^{n} \frac{\alpha R_t}{(1+r)^t}$$

- Certainty Equivalent Coefficient

$$\alpha = \frac{equivalent\ certain\ sum}{expected\ risky\ sum} = \frac{R_t^*}{R_t}$$

Other Techniques

- Decision Trees
  - Sequence of possible managerial decisions and their expected outcomes
  - Conditional probabilities
- Simulation
  - Sensitivity analysis


Strategy (1)
Competitors' reaction (2)
State of economy (3)
Probability (4)
Profit (5)
Expected profit (6) = (4) × (5)
Decision point
High price ($38,800)
Low price ($32,400)
High price (P = 0.6)
Low price (P = 0.4)
High price (P = 0.2)
Low price (P = 0.8)
Boom (P = 0.3)
Normal (P = 0.5)
Recession (P = 0.2)
(1) 0.18 $60,000 $10,800
(2) 0.30 40,000 12,000
(3) 0.12 20,000 2,400
(4) 0.12 50,000 6,000
(5) 0.20 30,000 6,000
(6) 0.08 20,000 1,600
$38,800
(7) 0.06 50,000 3,000
(8) 0.10 40,000 4,000
(9) 0.04 25,000 1,000
(10) 0.24 35,000 8,400
(11) 0.40 30,000 12,000
(12) 0.16 25,000 4,000
$32,400

Uncertainty

- Maximin Criterion
  - Determine worst possible outcome for each strategy
  - Select the strategy that yields the best of the worst outcomes

Uncertainty: Maximin

The payoff matrix below shows the payoffs from two states of nature and two strategies.

	State of Nature		
Strategy	Success	Failure	Maximin
Invest	20,000	-10,000	-10,000
Do Not Invest	0	0	0

Uncertainty: Maximin

The payoff matrix below shows the payoffs from two states of nature and two strategies.

For the strategy “Invest” the worst outcome is a loss of 10,000. For the strategy “Do Not Invest” the worst outcome is 0. The maximin strategy is the best of the two worst outcomes - Do Not Invest.

	State of Nature		
Strategy	Success	Failure	Maximin
Invest	20,000	-10,000	-10,000
Do Not Invest	0	0	0

Uncertainty: Minimax Regret

The payoff matrix below shows the payoffs from two states of nature and two strategies.

	State of Nature	
Strategy	Success	Failure
Invest	20,000	-10,000
Do Not Invest	0	0

Uncertainty: Minimax Regret

The regret matrix represents the difference between the a given strategy and the payoff of the best strategy under the same state of nature.

	State of Nature		Regret Matrix	
Strategy	Success	Failure	Success	Failure
Invest	20,000	-10,000	0	10,000
Do Not Invest	0	0	20,000	0

Uncertainty: Minimax Regret

For each strategy, the maximum regret is identified. The minimax regret strategy is the one that results in the minimum value of the maximum regret.

	State of Nature		Regret Matrix		Maximum
Strategy	Success	Failure	Success	Failure	Regret
Invest	20,000	-10,000	0	10,000	10,000
Do Not Invest	0	0	20,000	0	20,000

Uncertainty: Informal Methods

- Gather Additional Information
- Request the Opinion of an Authority
- Control the Business Environment
- Diversification

Foreign-Exchange Risk

- Foreign-Exchange Rate
  - Price of a unit of a foreign currency in terms of domestic currency
- Hedging
  - Covering foreign exchange risk
  - Typically uses forward currency contracts

Foreign-Exchange Risk

- Forward Contract
  - Agreement to purchase or sell a specific amount of a foreign currency at a rate specified today for delivery at a specified future date.
- Futures Contract
  - Standardized, and more liquid, type of forward contract for predetermined quantities of the currency and selected calendar dates.

Information and Risk

- Asymmetric Information
  - Situation in which one party to a transaction has less information than the other with regard to the quality of a good
- Adverse Selection
  - Problem that arises from asymmetric information
  - Low-quality goods drive high-quality goods out of the market

Information and Risk

- Moral Hazard
  – Tendency for the probability of loss to increase when the loss is insured
- Methods of Reducing Moral Hazard
  – Specifying precautions as a condition for obtaining insurance
  – Coinsurance

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Chapter 14

Long-Run Investment Decisions: Capital Budgeting

Capital Budgeting Defined

Process of planning expenditures that give rise to revenues or returns over a number of years

Categories of Investment

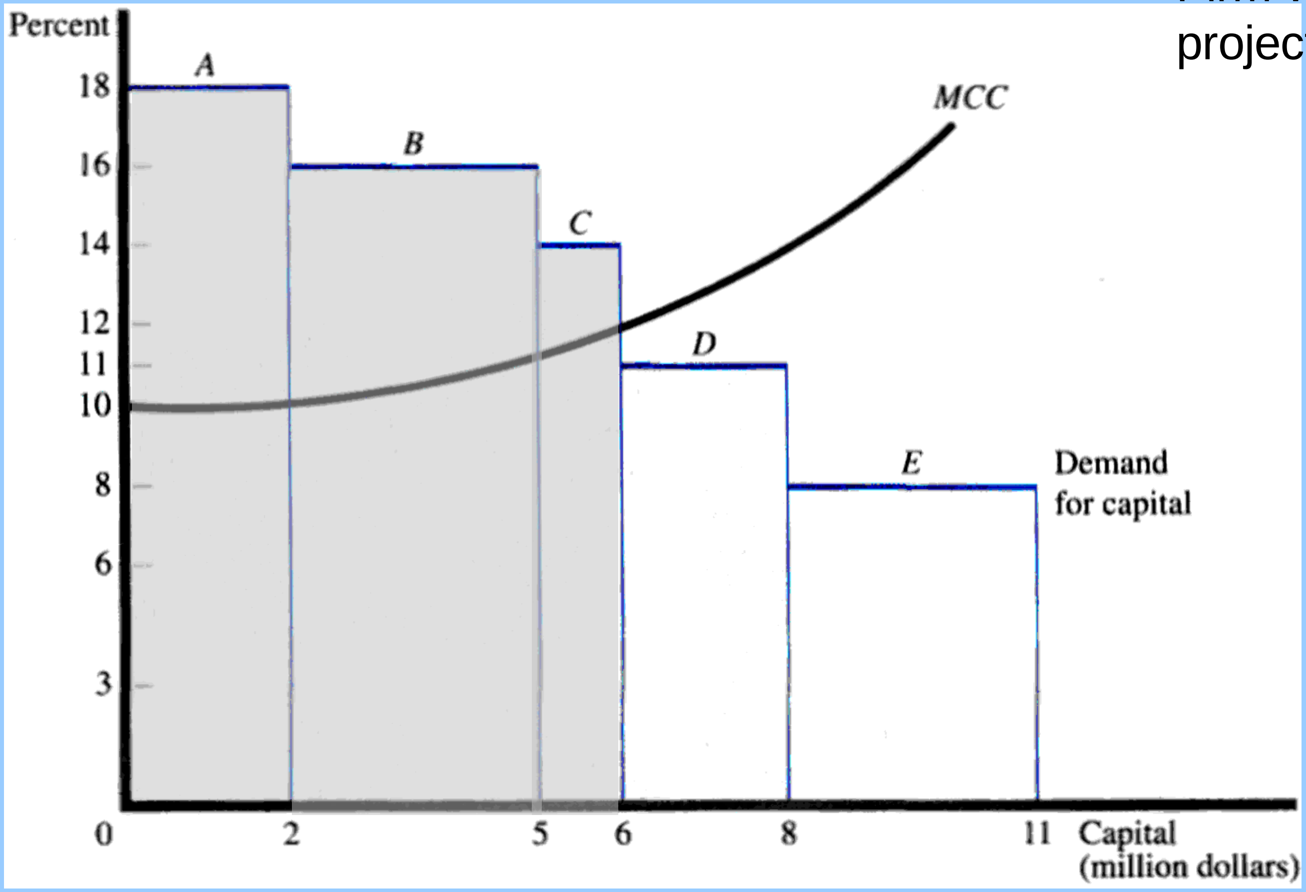
- Replacement
- Cost Reduction
- Output Expansion to Accommodate Demand Increases
- Output Expansion for New Products
- Government Regulation

Capital Budgeting Process

- Demand for Capital
  – Schedule of investment projects
  – Ordered from highest to lowest return
- Supply of Capital
  – Marginal cost of capital
  – Increasing marginal cost
- Optimal Capital Budget
  – Undertake all projects where return is greater than marginal cost

Capital Budgeting Process

Firm will undertake projects A, B, and C



Capital Budgeting Process

Projecting Net Cash Flows

– Incremental basis

– After-tax basis

– Depreciation is a non-cash expense that affects cash flows through its effect on taxes

Capital Budgeting Process

Example: Calculation of Net Cash Flow

Sales		$1,000,000
Less:	Variable costs	500,000
	Fixed costs	150,000
	Depreciation	200,000
Profit before taxes		$150,000
Less:	Income tax	60,000
Profit after taxes		$90,000
Plus:	Depreciation	200,000
Net cash flow		$290,000

Capital Budgeting Process

Net Present Value (NPV)

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+k)^t} - C_0$$

R_t = Return (net cash flow)

k = Risk-adjusted discount rate

C_0 = Initial cost of project

Capital Budgeting Process

Internal Rate of Return (IRR)

$$\sum_{t=1}^{n} \frac{R_t}{(1+k^*)^t} = C_0$$

R_t = Return (net cash flow)

k^* = IRR

C_0 = Initial cost of project

Capital Rationing

Profitability Index (PI)

$$PI = \frac{\sum_{t=1}^{n} \frac{R_t}{(1+k)^t}}{C_0}$$

R_t = Return (net cash flow)

k = Risk-adjusted discount rate

C_0 = Initial cost of project

The Cost of Capital

Cost of Debt (k_d)

$$k_d = r(1-t)$$

r = Interest rate

t = Marginal tax rate

k_d = After-tax cost of debt

The Cost of Capital

Cost of Equity Capital (k_e):

Risk-Free Rate Plus Premium

$$k_e = r_f + r_p$$

$$ke = r_f + p_1 + p_2$$

r_f = Risk free rate of return

r_p = Risk premium

p_1 = Additional risk of firm's debt

p_2 = Additional risk of firm's equities

The Cost of Capital

Cost of Equity Capital (k_e):

Dividend Valuation Model

$$P = \sum_{t=1}^{\infty} \frac{D}{(1+k_e)^t} = \frac{D}{k_e} \qquad k_e = \frac{D}{P}$$

P = Price of a share of stock

D = Constant dividend per share

k_e = Required rate of return

The Cost of Capital

Cost of Equity Capital (k_e):

Dividend Valuation Model

$$P = \frac{D}{K_e - g} \qquad k_e = \frac{D}{P} + g$$

$P =$ Price of a share of stock

$D =$ Dividend per share

$k_e =$ Required rate of return

$g =$ Growth rate of dividends

The Cost of Capital

Cost of Equity Capital (k_e):

Capital Asset Pricing Model (CAPM)

$$k_e = r_f + \beta(k_m - r_f)$$

r_f = Risk-free rate of return

β = Beta coefficient

k_m = Average rate of return on all shares of common stock

The Cost of Capital

Weighted Cost of Capital:

Composite Cost of Capital (k_c)

$$k_c = w_d k_d + w_e k_e$$

w_d = Proportion of debt

k_d = Cost of debt

w_e = Proportion of equity

k_e = Cost of equity

