# Chapter 3
Basic Economic Concepts

- Supply & Demand
- Pricing
- Productivity
- Measuring and Improving the Economy
- Trade
- Making Decisions

Supply, Demand & Equilibrium

- **Supply Function**:
  - Given the price, how much will suppliers produce?

- **Demand Function**:
  - Given the price, how much will people buy?

- **Equilibrium Price**:
  - Is there a price at which the quantity demanded equals the quantity supplied?
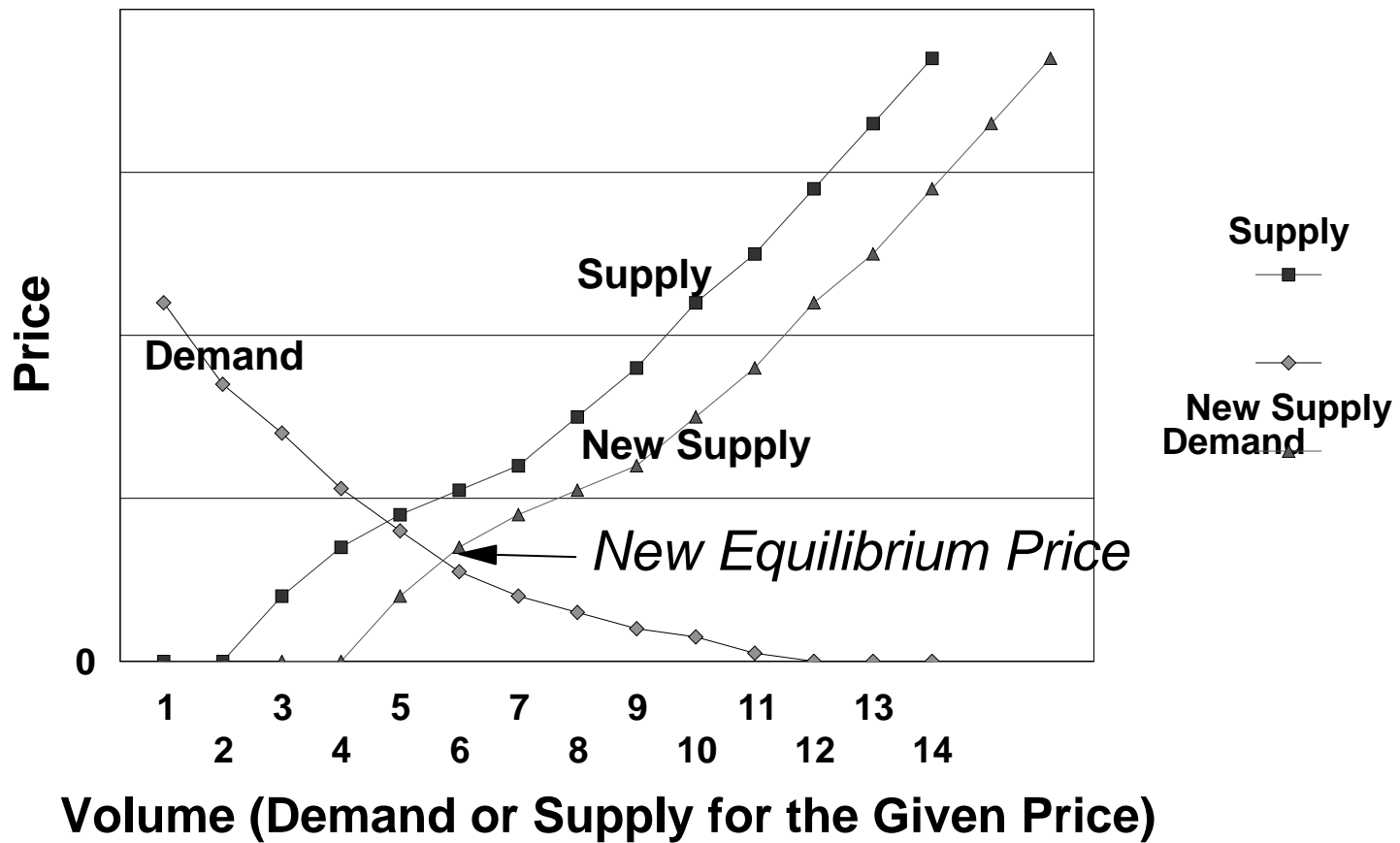
Supply, Demand & Equilibrium
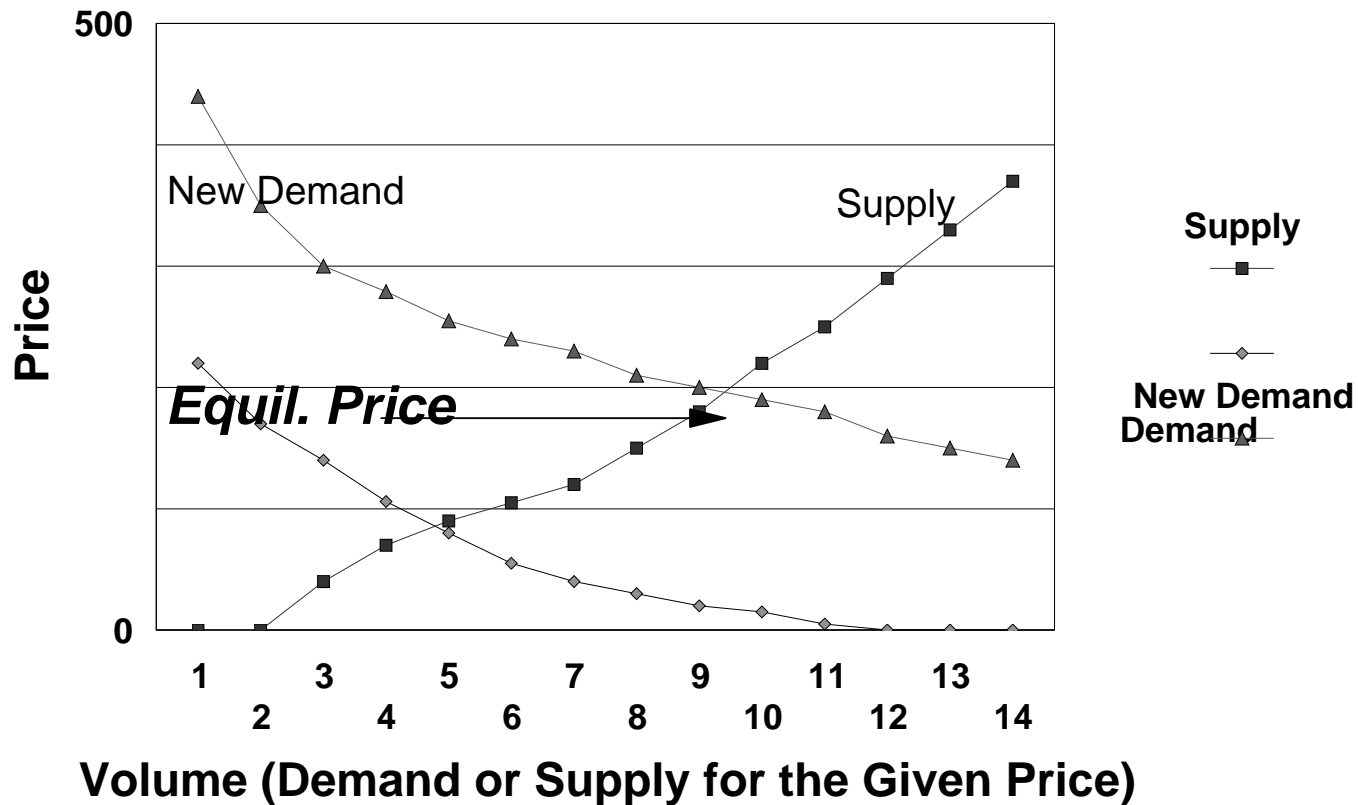
Prices Reflect an Equilibrium Between Supply and Demand
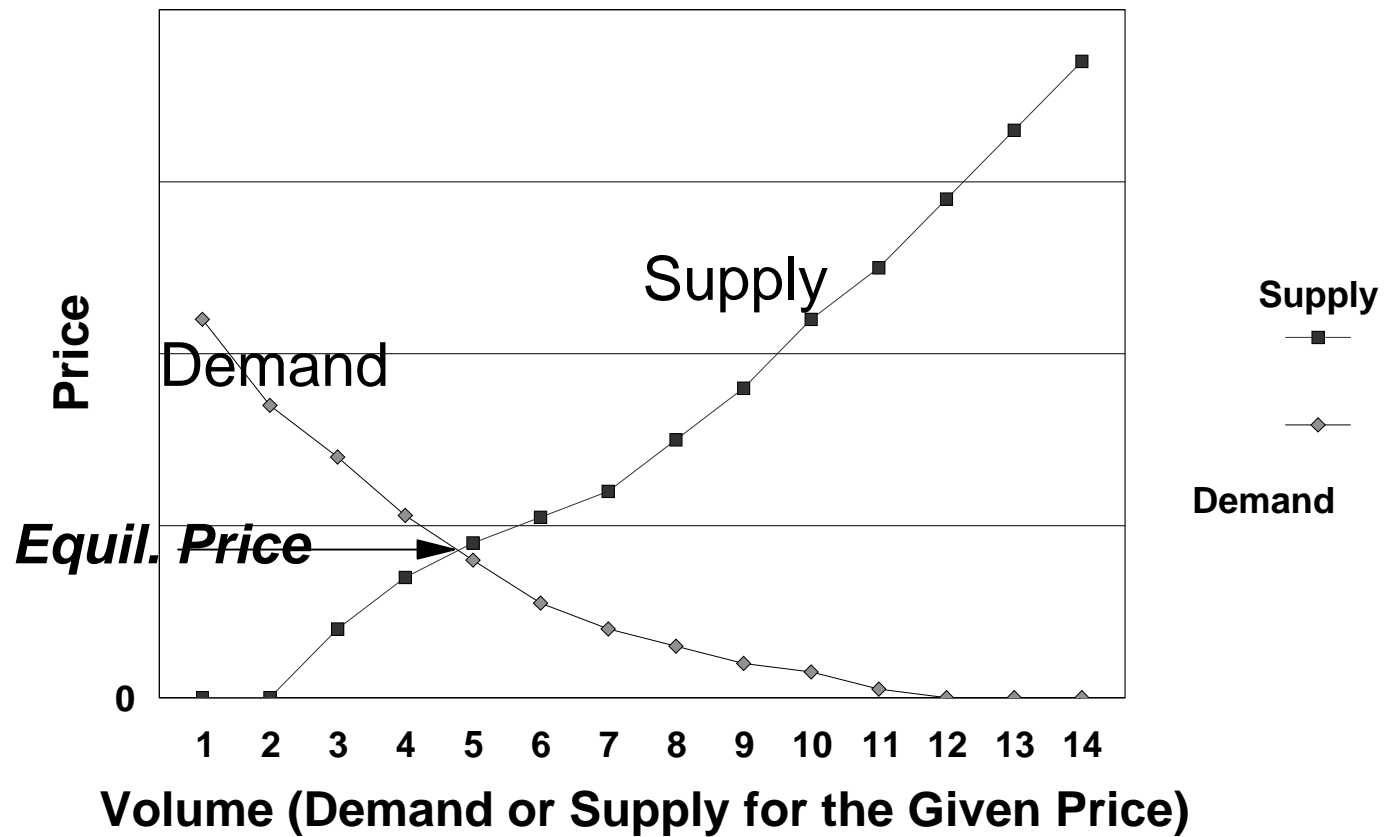
Supply, Demand & Equilibrium

Investment may allow suppliers to offer lower prices, increasing volume (a movement along the demand curve)

Price

Supply

Demand

New Supply

New Equilibrium Price

0

1   2   3   4   5   6   7   8   9   10   11   12   13   14

Volume (Demand or Supply for the Given Price)

Supply

New Supply
Demand

Supply, Demand & Equilibrium

Population Growth, Advertising, Higher Incomes, or other Factors May Cause an Increase in Demand
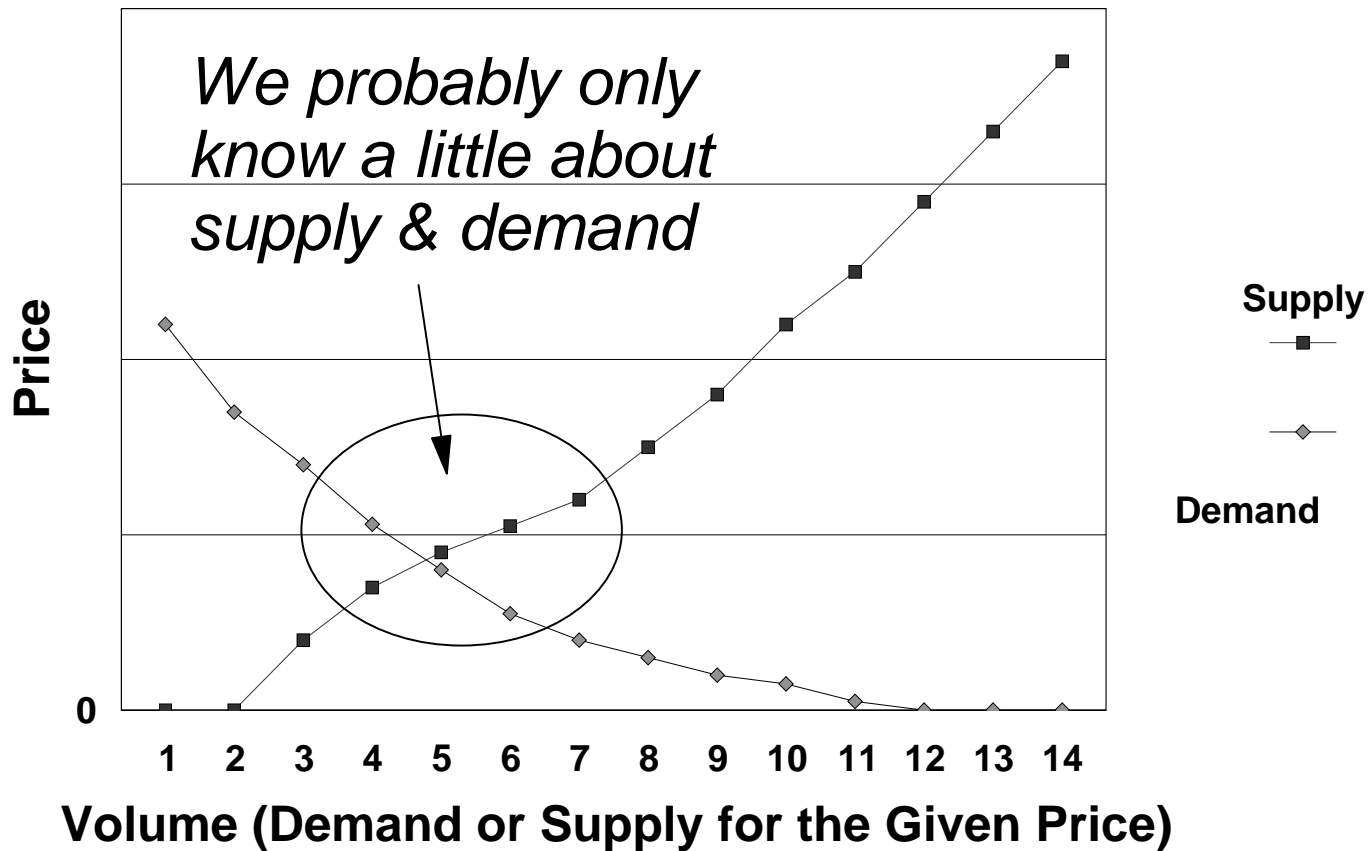# (a shift in the demand curve)

Price

500

New Demand

Supply

Equil. Price ➤

0

1   3   5   7   9   11   13

2   4   6   8   10   12   14

Volume (Demand or Supply for the Given Price)

Supply

New Demand
Demand

How Does the Equilibration Work?

- If demand increases, and there isn't enough supply, then prices rise (or, in the case of some types of infrastructure, congestion and service delays get worse)
- If prices rise, then suppliers make more profits and are willing to increase production
- If production increases, then there may be some producers willing to cut prices to get more market share
- If demand declines, then prices drop and inefficient producers leave the business

Supply, Demand & Equilibrium

Prices Reflect an Equilibrium Between Supply and Demand

We probably only know a little about supply & demand

Price

0

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Volume (Demand or Supply for the Given Price)
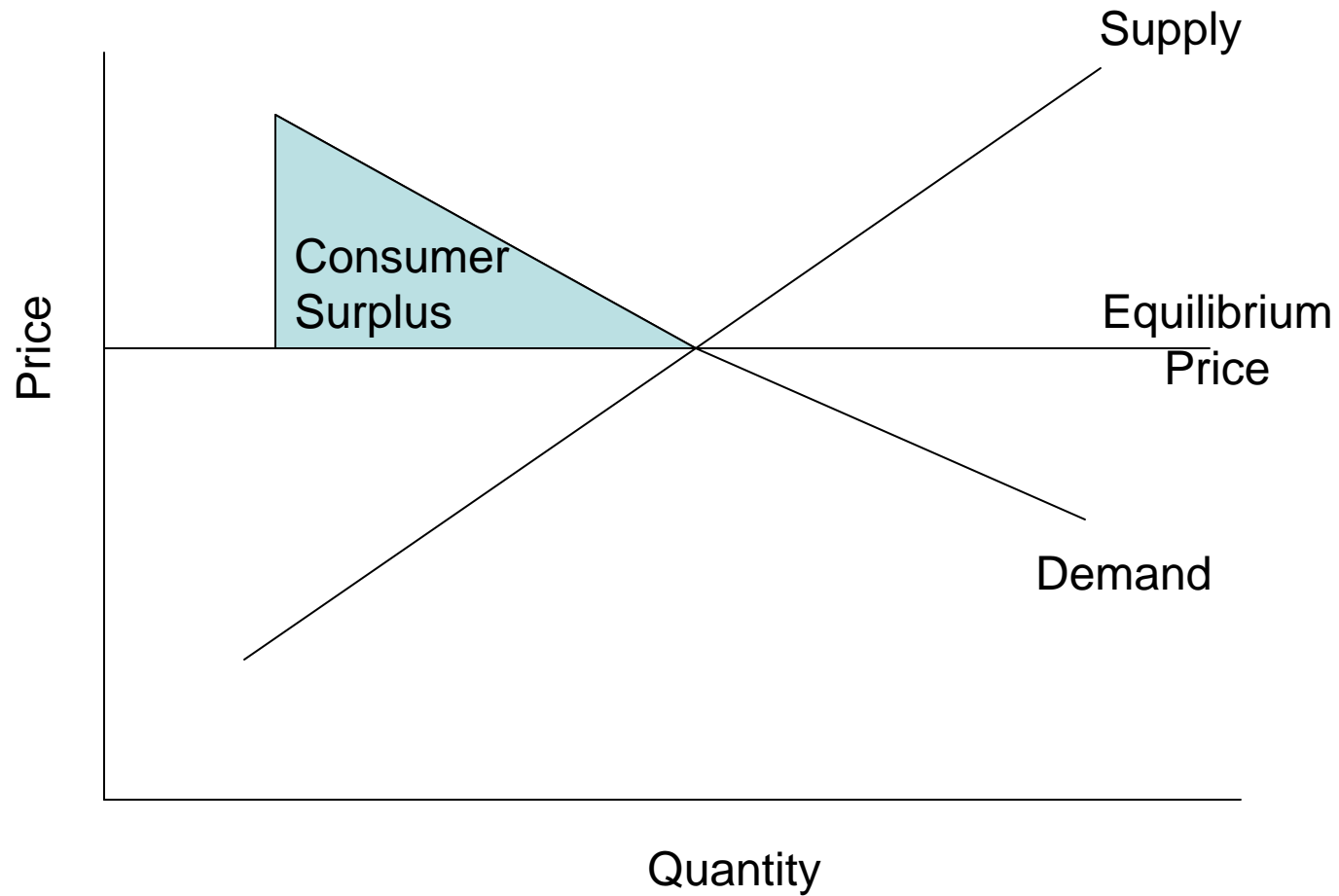
Supply

Demand

Consumer Surplus

- The equilibrium price is less than what many would be willing to pay

- Consumer surplus is the difference between:

  - The demand curve (what people would be willing to pay)

 - The equilibrium price (what people actually pay)
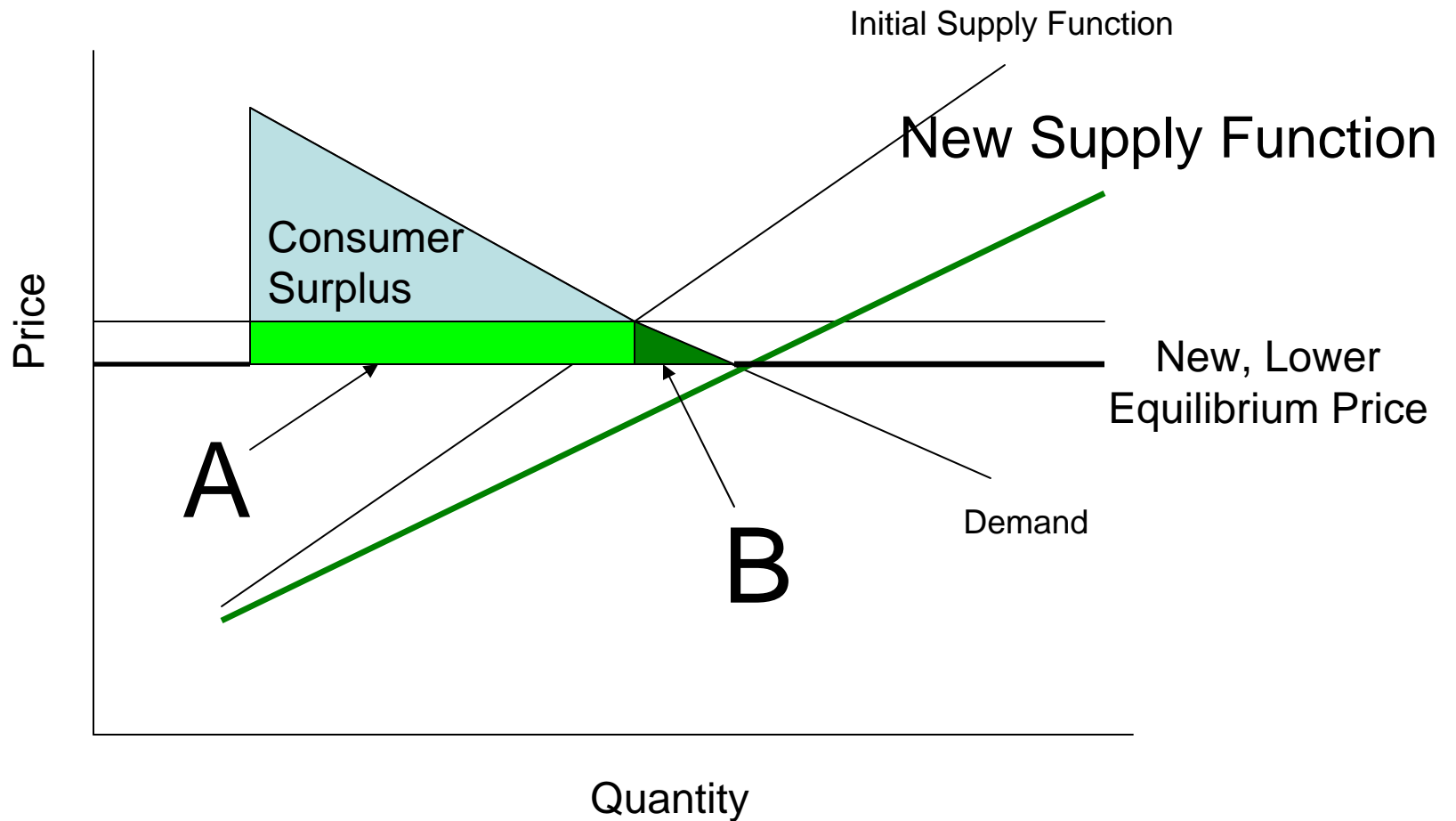
Consumer surplus

A Successful Project May Allow Suppliers to Reduce their Costs

- Supply function: shifts down and to the right (more will be supplied for a given price).

- Demand function: unchanged – but the quantity demanded will increase because of the shift in the supply function.

- Equilibrium price: reduced.

- Consumer surplus: increased.

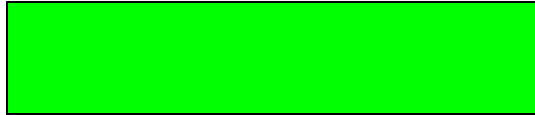# With the New Supply Curve, Consumer Surplus Increases
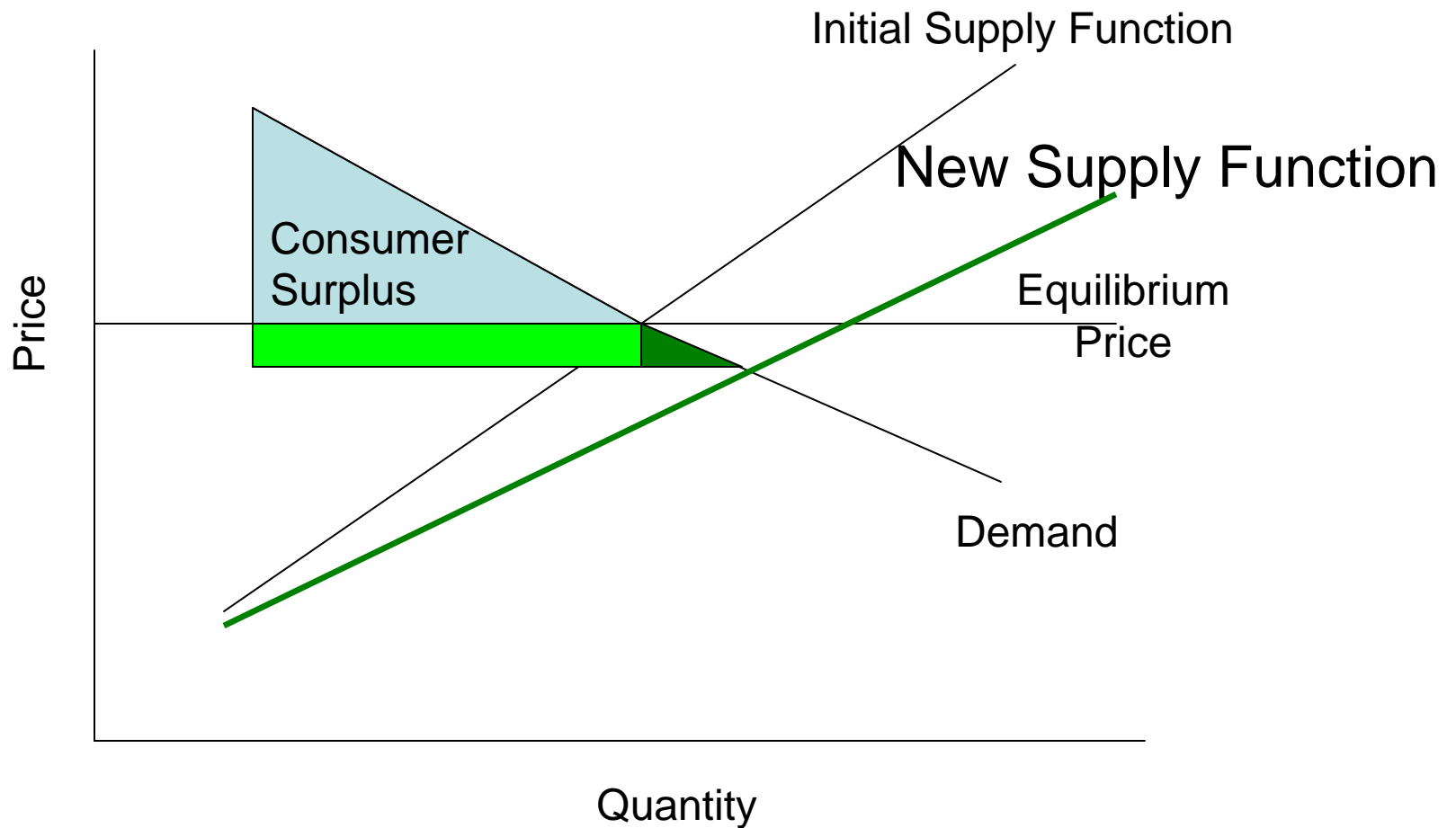
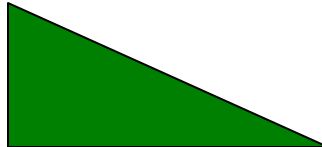# The Increase in Consumer Surplus Includes Areas A and B

Estimating the Change in Consumer Surplus

- Area A = ΔP (Q_0)

  = (Change in Price) (Initial Quantity Demanded)

- Area B = ½ ΔP ΔQ

  = ½ (Change in Price) (Change in Quantity Demanded)

The Rule of 1/2

- Note that the new customers would not have purchased anything at the old equilibrium price. In order to increase the quantity demanded, suppliers had to cut the price. Therefore, their benefit must be less than the amount of the price reduction.

- The *"Rule of ½":* for small changes, for any demand curve, Area B will be approximately a triangle. The increase in consumer surplus for any can therefore be estimated as the area of a triangle for non-linear demand curves.

$$\Delta \text{ Consumer Surplus} = \Delta P \, (Q_0) + \tfrac{1}{2} \, \Delta P \, \Delta Q$$

Elasticity of Demand: Motivation

How sensitive is demand to price?

- How much will the quantity demanded change if prices are increased or reduced?

- Will total revenue increase or decrease if prices are changed?

Elasticity of Demand: Definition

- If supply and demand functions are known and differentiable:

  Elasticity of Demand = - dQ/dP

- The sign is negative because quantity is expected to go up if price goes down.

- Elasticity of demand can always be estimated as the percentage increase in quantity divided by the percentage decrease in price.

  Elasticity of Demand = $- (\Delta Q/Q_0) / (\Delta P/P_0) = (P_0 \Delta Q)/(Q_0 \Delta P)$

Elasticity of Demand & Total Revenue

- Initial Revenue = $P_o Q_o$
- If price is reduced from P_o to P_1, then the change in revenue is approximately equal to:

  Reduced revenue from original customers = $\Delta P \, (Q_0)$

  Added revenue from new customers = $(P_1) \, \Delta Q$

- The ratio of these = $(P_1) \, \Delta Q \, / \, \Delta P \, (Q_0)$ which, for small ΔP, will equal the elasticity of demand.

Elasticity of Demand & Total Revenue

Elasticity of Demand	Change in Revenue if Price is Reduced
<1	Revenue decreases
1	No change
>1	Revenue increases

Elasticity of Demand: Implications

- If demand is inelastic, then suppliers can increase revenue by raising prices.
- If demand is elastic, then suppliers can increase revenue by lowering prices.
- Importance for infrastructure-based systems:
  - Operating costs are likely to be low relative to the high fixed costs of owning and maintaining the infrastructure.
  - Increases in revenue are therefore likely to be increases in profit (or reductions in deficits).
- In the short-run, demand will be less elastic than in the long run: high prices will encourage new technologies, increased competition, and efforts by customers to reduce consumption.

Pricing: Two Extreme Situations

- Perfect Competition
  - Many similar suppliers provide the same services or products.
  - Prices fall to marginal costs of production.
  - Individual suppliers cannot determine prices.

- Monopolies
  - One supplier dominates a market.
  - The monopolist will charge prices so as to maximize its profits.

Pricing: Many Intermediate Situations

- Extensive Competition
  - Many suppliers provide the similar services or products.
  - Competition is based upon quality of products or services as well as on price.
  - Prices fall to marginal costs of production for the average or least efficient supplier.
  - More efficient suppliers can make a profit at prevailing prices.
  - Efficient suppliers have some pricing power.
- Limited Competition
  - A few suppliers dominate a market.
  - The level of competition, costs, and prices will vary with location, type of customer, and other factors.

Common Pricing Problems

- Destructive competition
  - If marginal costs are lower than average costs, then prices fall to the point where no one can make a profit.
- Monopolistic excesses
  - A monopoly can charge prices that are much higher than its marginal or average costs.
  - A monopoly may have little incentive to improve service or to deal fairly with customers.

The Role of Regulation

- In competitive systems, restrictions on entry and regulated prices allow prices to remain above average costs while ensuring an adequate supply.
  - Examples: taxis, many transportation systems, water supply.

- In situations where marginal costs are very low, as in most infrastructure-based systems, it may be beneficial for society to allow monopolies in order to minimize cost while regulating prices to protect customers.
  - Examples: public transportation, utilities, cable TV.

- Regulation is often established to promote productivity and and equity in systems that operate over networks.

Productivity

- Definition:

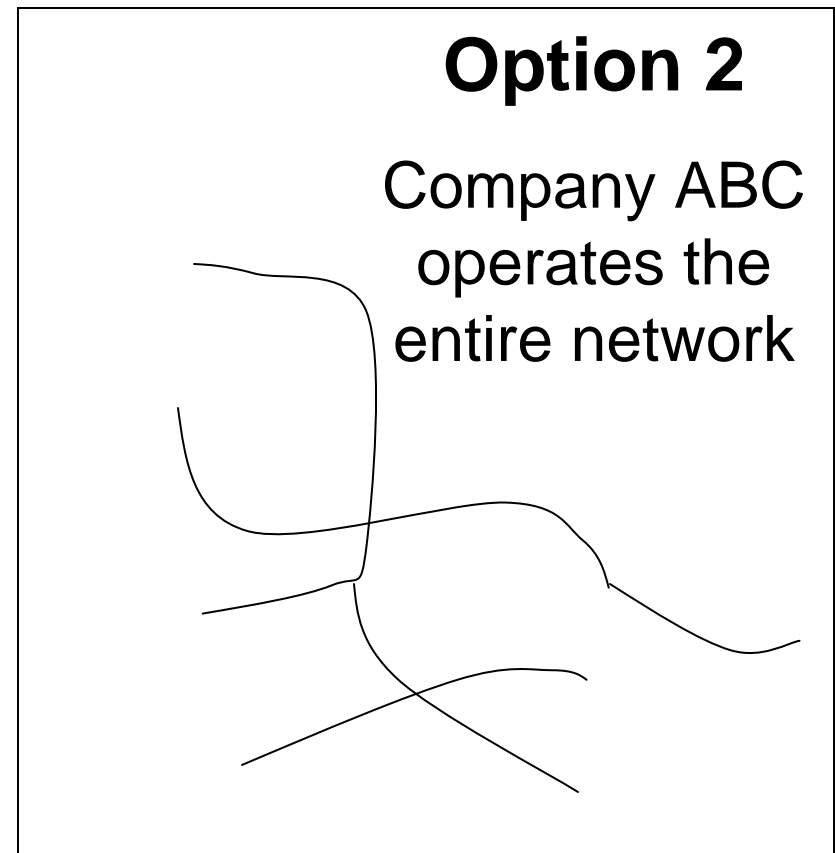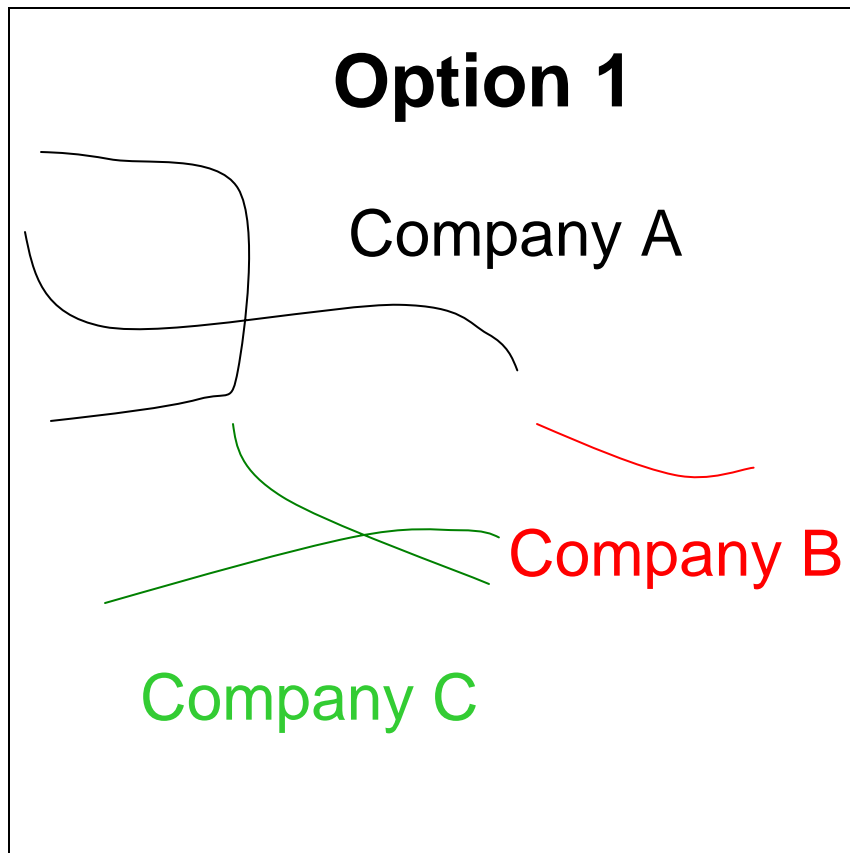 PRODUCTIVITY = OUTPUT/INPUT

- Importance:
  - Improving productivity increases economic efficiency.
  - By maximizing productivity, society can get more output from existing resources.

Network Considerations

- How can we best to structure the network?

  - **Economies of scale**: average costs decline if the network is larger.

  - **Economies of density**: average costs decline if more volume is carrier over an existing network.

  - **Economies of scope**: average costs decline if multiple services are provided.

- How can we operate the system so as to provide reasonable cost, capacity, and service quality over the entire network?

Economies of Scale: An Example

Option 1

Company A

Company B

Company C

Option 2

Company ABC operates the entire network

There are economies of scale if merging Companies A, B, and C reduces total costs:

Cost(ABC) < Cost(A) + Cost(B) + Cost(C)

Productivity Measurement - Not a Simple Task!

- Commonly used measures of output
  - ► ton-miles, tons, shipments of freight
  - ► passengers or passenger-miles
- Problems:
  - ► transporting 1 ton for 100 miles is different from transporting 100 tons for 1 miles
  - ► transporting 1 ton of automobiles is different from transporting 1 ton of coal or of jewelry
  - ► commuters are different from shoppers or tourists
- Possible Solutions (which may or may not help!):
  - ► outputs could be weighted by the inputs required or by their prices
  - ► an index could be built for representative outputs

Economies of Density

It may be cheaper to handle traffic on one facility rather than two:

$$C(V1 + V2) < C(V1) + C(V2)$$

Larger grain elevators, fewer branch lines, longer truck trips from the farm

Coal trains at UP fueling facility in North Platte; triple track line handles 150 trains/day

Economies of Scope

Courtesy of Samuel Martland. Used with permission.

It may be cheaper to provide facilities for multiple services than to provide separate facilities for both. Highways serve auto, bus and many kinds of trucks; transport projects can service multiple modes, plus fiber optics, and other functions.

Triple transport tiers in a gorge – interstate plus bike path on opposite side of river from Amtrak (Colorado)

Causes of Poor Productivity

Peak Traffic
Demands Cause
Delays at
Bottlenecks

Clark Junction,
CTA

Photo: C.D. Martland, January 2003

Causes of Poor Productivity:
Lack of Demand

Tate Modern Subway Station, London

Photo: C.D. Martland, October 2002)

Causes of Poor Productivity:
Limits on Vehicle Size/Weights

Photos: C.D. Martland

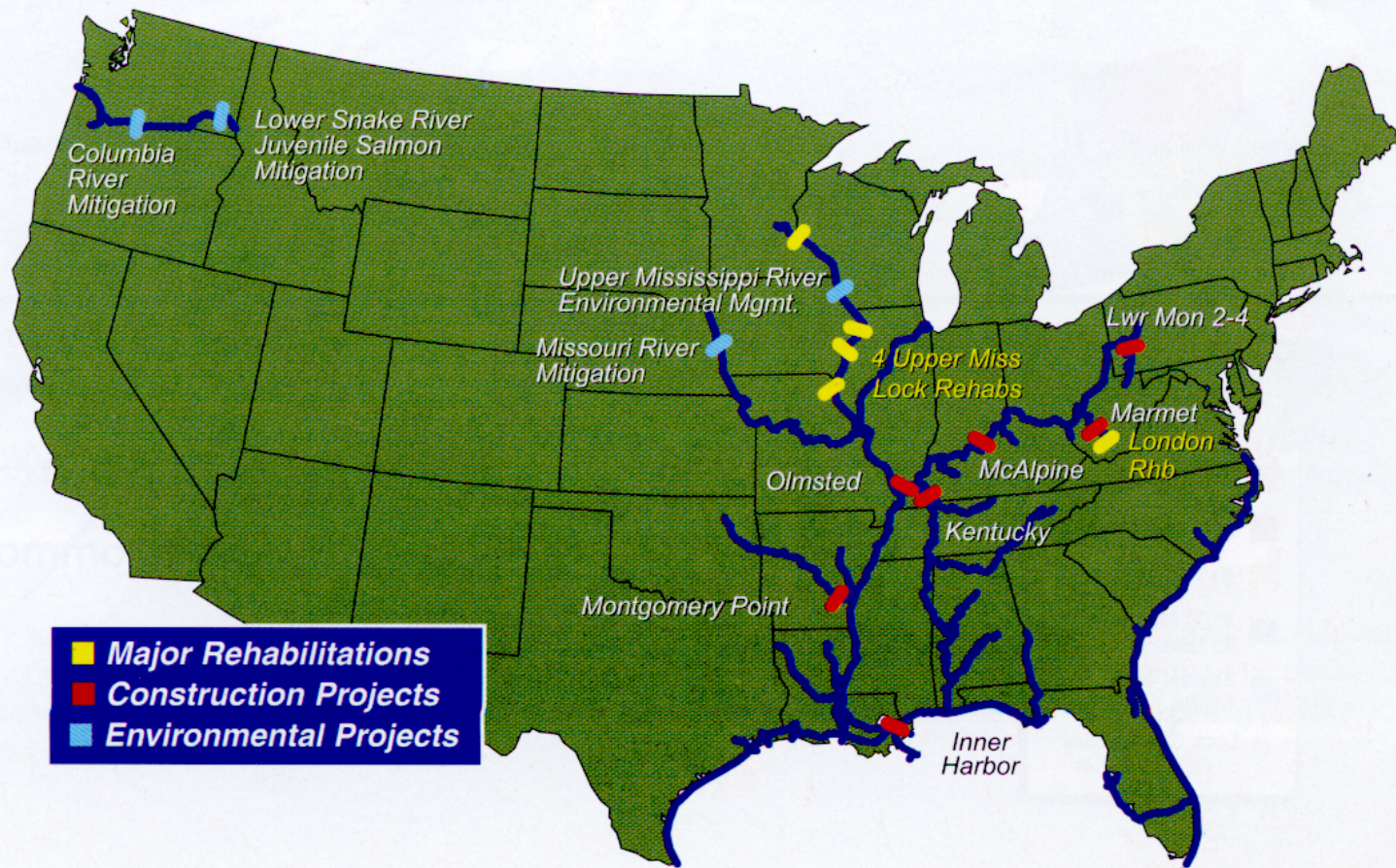# Improving Productivity:
Tailoring Services to Demand

San Juan, Puerto Rico (Photo: C.D. Martland)

Improving Productivity: Strategic Plans for Networks

Source: US Army Corps of Engineers

Other Concepts Related to Improving Productivity

- Eliminate "X-Inefficiency"
  - ► The current operation may be inefficient, so that it is possible to reduce inputs by moving to the production possibility frontier (i.e. bring operations up to the state-of-the-art)
- Input substitution
  - ► As prices of inputs change, make appropriate technical substitutions
- Innovation
  - ► Find a better technology
- Market power
  - ► Combine with other carriers or organizations in order to obtain lower costs for your inputs

Improving Productvity:
Better Information & Control

Photo: C.D. Martland

Improving Productivity:
Increasing Vehicle Size/Weight

Photos: C.D. Martland

Some Basic Approaches to Productivity Improvement

- Technology
  - better vehicles, signals, materials
- Communications & Planning
  - a special case of technology that is critical for transportation, as it relates to the quality of the operating plan, the ability to implement the plan, and the flexibility to adjust to actual conditions
- Management
  - the ability to use resources effectively in developing and implementing plans
- Design
  - design of services and facilities given technology

Freight Transport Productivity in the Early 19th Century

	Cost/Mile to Construct	Tons/ vehicle	Miles/ day	Ton-miles Per Vehicle day	Typical Prices (cents/ ton-mile
Early 19th Century					
Rough Road	$1-2,000	1 per wagon	12	12	20 to 40
Turnpike	$5-10,000	1.5 per Wagon	18	27	15 to 20
Canal	>$20,000	10 to 100 per canal boat	20 to 30	200 to 3,000	5 to 10
Railroad	$15-50,000	500 per train	200	100,000 per train	3 to 5

Freight Transport Productivity in the Early 21st Century

	Cost/Mile to Construct ($mill.)	Tons/ vehicle	Miles/ day	Ton-miles Per Vehicle day	Typical Prices (cents/ ton-mile
Early 21st Century					
Arterial Roads	$1-5	10 per truck	100	1,000	10 to 50
Interstate Highway	$5-100	20 per trailer	500	10,000	10 to 15
Heavy-Haul Railroad	$1-5	5-15,000 per train	500	5 million per train	2
Inland Waterway	Highly Variable	1500 per barge; up to 40 barges/tow	50-200	Up to 6 million per tow	1

Impacts of Infrastructure Projects on the Economy

- ## Short-term
  - – Jobs and expenditures directly related to the planning and construction of the project.
  - – Additional jobs and expenditures (the **Multiplier Effect**)

- ## Long-term
  - – Permanent jobs related to the project.
  - – Economic growth

The Multiplier Effect

- A construction project provides jobs and income to local workers and companies.

- The workers and companies will spend a portion of their new income on other goods and services in the region.

- Each dollar spent directly on the project will therefore generate more expenditures in the local economy.

- The key factor is the **Marginal Propensity to Consume (MPC).**

The Multiplier Effect and the MPC: An Example

- $1 million in wage payments related to a project.
- If the MPC = 0.5, employees will spend half their wages on other products and services, so that another $0.5 million will be spent.
- That extra $0.5 million will be received as income by other people or companies, and they will also spend some of their earnings.
- Etc., etc., etc.
- Total = $1M + $0.5M + $0.25M + …. = $2M

The Multiplier Effect and the MPC: The Basic Relationship

Total Expenditures = TE

TE = Initial Expenditure (1 + MPC + MPC2 + MPC3 + …)

TE = Initial Expenditure (1/(1-MPC))

The multiplier effect is therefore 1/(1-MPC).

Long Term Economic Impacts

- Permanent Jobs
- Regional Income
- Gross Regional Product

Gross Domestic Product (GDP)

GDP = C + I + G + E – M

Where:

  C = Consumption
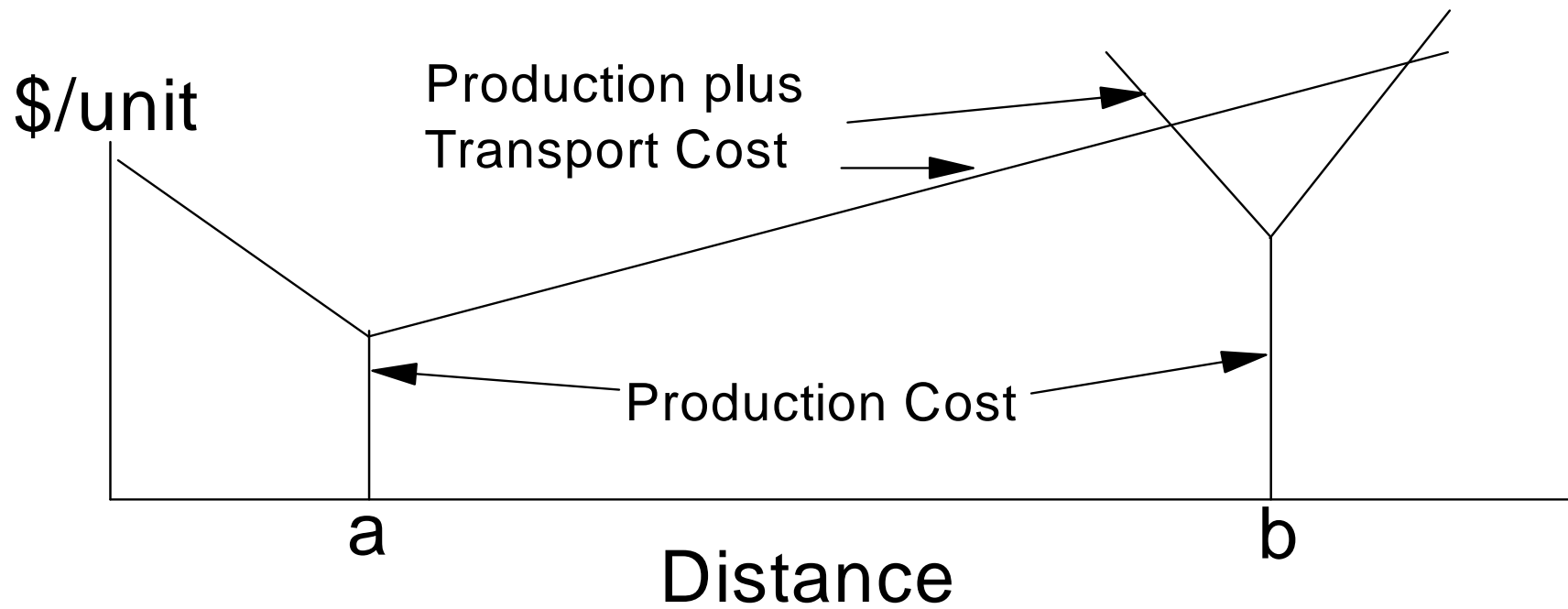
  I = Investment

  G = Government expenditures

  E = Exports

  M = Imports

Trade: Key Concepts

- Economic geography
- Technological change
- Spatial price equilibrium
- Comparative advantage
- Exchange rates

Spatial Price Equilibrium

$/unit

Production plus
Transport Cost

Production Cost

a

b

Distance

Comparative Advantage

- Regions can benefit by specialization: doing what it does best relative to other regions.
- By specializing, each region earns income from exports that can be used to import more goods than it could have produced itself.
- Trade allows all regions to become more productive and to have higher wages.

Comparative Advantage: An Example
Option 1. No Specialization

	Unit Cost (A)	Total Cost (A)	Unit Cost (B)	Total Cost (B)
Autos	$20,000	$20 B	$25,000	$25 B
Grain	$250/ton	$25 B	$200/ton	$20 B
Total Cost		$45 B		$45 B

Demand is identical in each country: 1 million autos and 100 million tons of grain per year at a cost of $45 in each country.

Comparative Advantage: An Example
Option 2. A produces autos; B produces grain

	Unit Cost (A)	Total Cost (A)	Unit Cost (B)	Total Cost (B)
Autos	$20,000	$40 B	$25,000	No production
Grain	$250/ton	No production	$200/ton	$40 B
Total Cost		$40 B		$40 B

If transport costs are less than $5 billion for each country, then both countries benefit from trade.

Making Decisions

- The concept of **utility**
  - People make decisions so as to maximize their utility.
  - People trade off such factors as cost, time, safety, and excitement.
- Studies can be done to find out what factors influence choices:
  - **Stated preferences**
  - **Observed preferences**
- **Sunk costs**: money already spent should not affect what we decide to do today.

Making Decisions

- Role in project evaluation:
  - Understand what factors are most important to potential users.
  - Estimate impacts of various designs and operating strategies on demand.
  - Devise pricing strategies.

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1.011 Project Evaluation

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