Chapter 7

The Cost of Production

Topics to be Discussed

- Measuring Cost: Which Costs Matter?
- Cost in the Short Run
- Cost in the Long Run
- Long-Run Versus Short-Run Cost Curves

Topics to be Discussed

- Production with Two Outputs--Economies of Scope
- Dynamic Changes in Costs--The Learning Curve
- Estimating and Predicting Cost

Introduction

- The production technology measures the relationship between input and output.

- Given the production technology, managers must choose *how* to produce.

Introduction

- To determine the optimal level of output and the input combinations, we must convert from the unit measurements of the production technology to dollar measurements or costs.

Measuring Cost: Which Costs Matter?

Economic Cost vs. Accounting Cost

- Accounting Cost
  - Actual expenses plus depreciation charges for capital equipment
- Economic Cost
  - Cost to a firm of utilizing economic resources in production, including opportunity cost

Measuring Cost: Which Costs Matter?

- Opportunity cost.
  - Cost associated with opportunities that are foregone when a firm's resources are not put to their highest-value use.

Measuring Cost: Which Costs Matter?

- An Example
  - A firm owns its own building and pays no rent for office space
  - Does this mean the cost of office space is zero?

Measuring Cost: Which Costs Matter?

- Sunk Cost
  - Expenditure that has been made and cannot be recovered
  - Should not influence a firm’s decisions.

Measuring Cost: Which Costs Matter?

- An Example
  - A firm pays $500,000 for an option to buy a building.
  - The cost of the building is $5 million or a total of $5.5 million.
  - The firm finds another building for $5.25 million.
  - Which building should the firm buy?

Choosing the Location for a New Law School Building

- Northwestern University Law School

    1) Current location in downtown Chicago

    2) Alternative location in Evanston with the main campus

Choosing the Location for a New Law School Building

- Northwestern University Law School

  3) Choosing a Site

  - Land owned in Chicago
  - Must purchase land in Evanston
  - Chicago location might appear cheaper without considering the opportunity cost of the downtown land (i.e. what it could be sold for)

Choosing the Location for a New Law School Building

- Northwestern University Law School

  3) Choosing a Site
  - Chicago location chosen--very costly
  - Justified only if there is some intrinsic values associated with being in Chicago
  - If not, it was an inefficient decision if it was based on the assumption that the downtown land was “free”

Measuring Cost: Which Costs Matter?

Fixed and Variable Costs

- Total output is a function of variable inputs and fixed inputs.
- Therefore, the total cost of production equals the fixed cost (the cost of the fixed inputs) plus the variable cost (the cost of the variable inputs), or…

$$TC = FC + VC$$

Measuring Cost: Which Costs Matter?

Fixed and Variable Costs

- Fixed Cost
  - Does not vary with the level of output
- Variable Cost
  - Cost that varies as output varies

Measuring Cost: Which Costs Matter?

- **Fixed Cost**
  - Cost paid by a firm that is in business regardless of the level of output
- **Sunk Cost**
  - Cost that have been incurred and cannot be recovered

Measuring Cost: Which Costs Matter?

- Personal Computers: most costs are variable
  - Components, labor
- Software: most costs are sunk
  - Cost of developing the software

Measuring Cost: Which Costs Matter?

- Pizza
  - Largest cost component is fixed

A Firm’s Short-Run Costs ($)

Rate of Output	Fixed Cost (FC)	Variable Cost (VC)	Total Cost (TC)	Marginal Cost (MC)	Average Fixed Cost (AFC)	Average Variable Cost (AVC)	Average Total Cost (ATC)
0	50	0	50	---	---	---	---
1	50	50	100	50	50	50	100
2	50	78	128	28	25	39	64
3	50	98	148	20	16.7	32.7	49.3
4	50	112	162	14	12.5	28	40.5
5	50	130	180	18	10	26	36
6	50	150	200	20	8.3	25	33.3
7	50	175	225	25	7.1	25	32.1
8	50	204	254	29	6.3	25.5	31.8
9	50	242	292	38	5.6	26.9	32.4
10	50	300	350	58	5	30	35
11	50	385	435	85	4.5	35	39.5

Cost in the Short Run

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

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

Cost in the Short Run

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

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

Cost in the Short Run

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

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

Cost in the Short Run

- The Determinants of Short-Run Cost
  - *The relationship between the production function and cost* can be exemplified by either increasing returns and cost or decreasing returns and cost.

Cost in the Short Run

- The Determinants of Short-Run Cost
  - Increasing returns and cost
    - With increasing returns, output is increasing relative to input and variable cost and total cost will fall relative to output.
  - Decreasing returns and cost
    - With decreasing returns, output is decreasing relative to input and variable cost and total cost will rise relative to output.

Cost in the Short Run

- For Example: Assume the wage rate (w) is fixed relative to the number of workers hired. Then:

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

$$VC = wL$$

Cost in the Short Run

- Continuing:

$$\Delta VC = w\Delta L$$

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

Cost in the Short Run

- Continuing:

$$\Delta MP_L = \frac{\Delta Q}{\Delta L}$$

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

Cost in the Short Run

- In conclusion:

$$MC = \frac{w}{MP_L}$$

- …and a low marginal product (MP) leads to a high marginal cost (MC) and vise versa.

Cost in the Short Run

- Consequently (from the table):
  - MC decreases initially with increasing returns
    - 0 through 4 units of output
  - MC increases with decreasing returns
    - 5 through 11 units of output

A Firm's Short-Run Costs ($)

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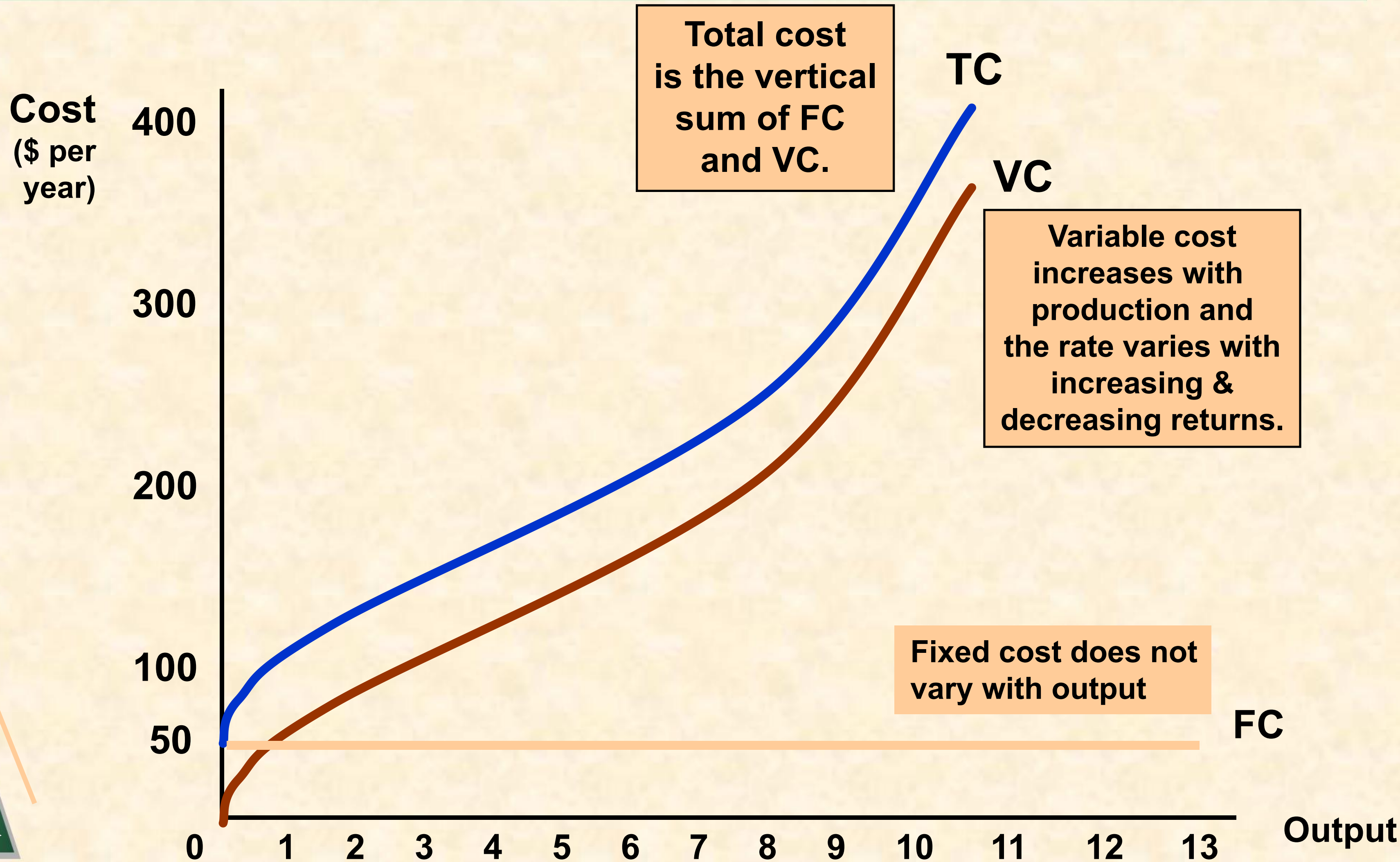
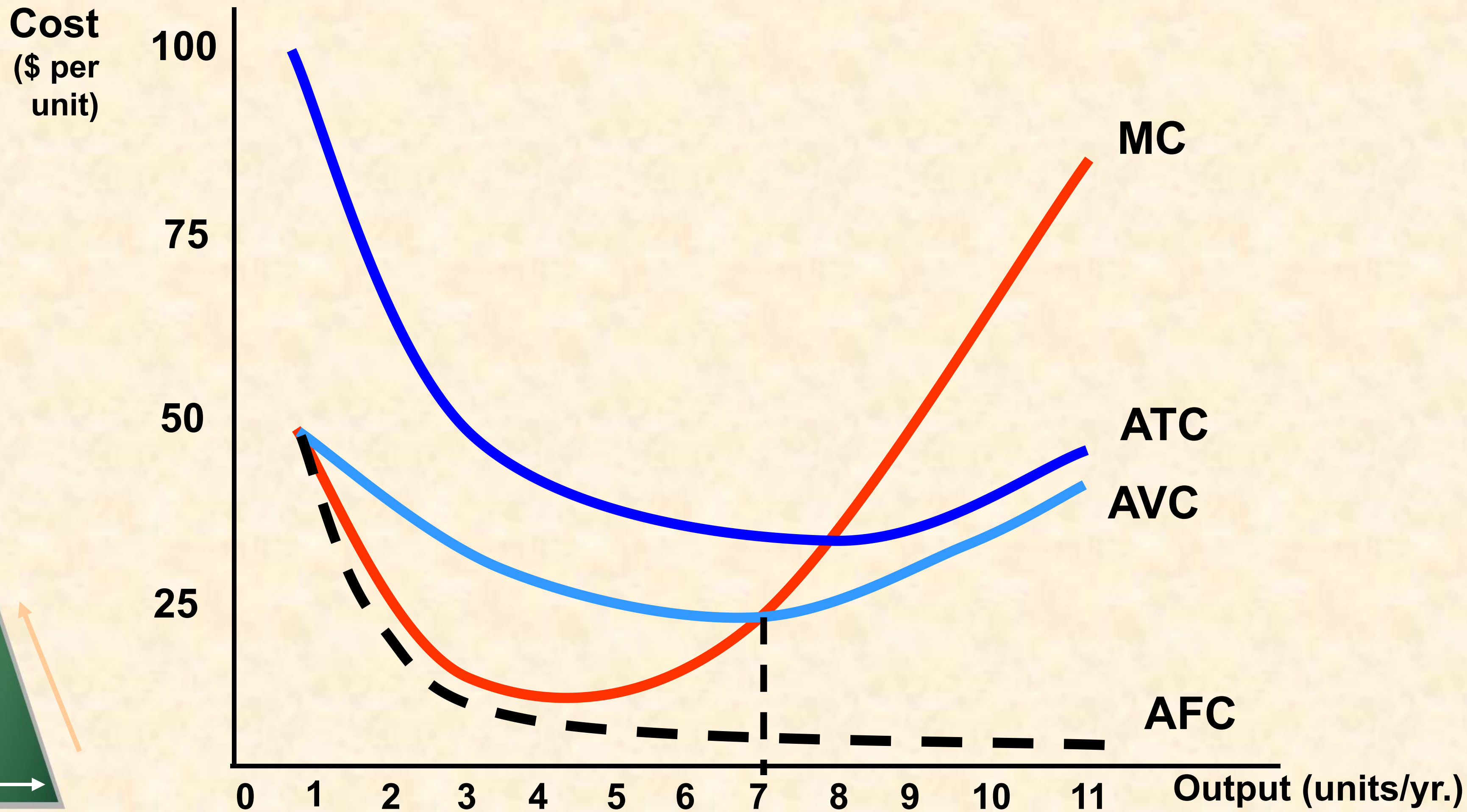
Cost Curves for a Firm

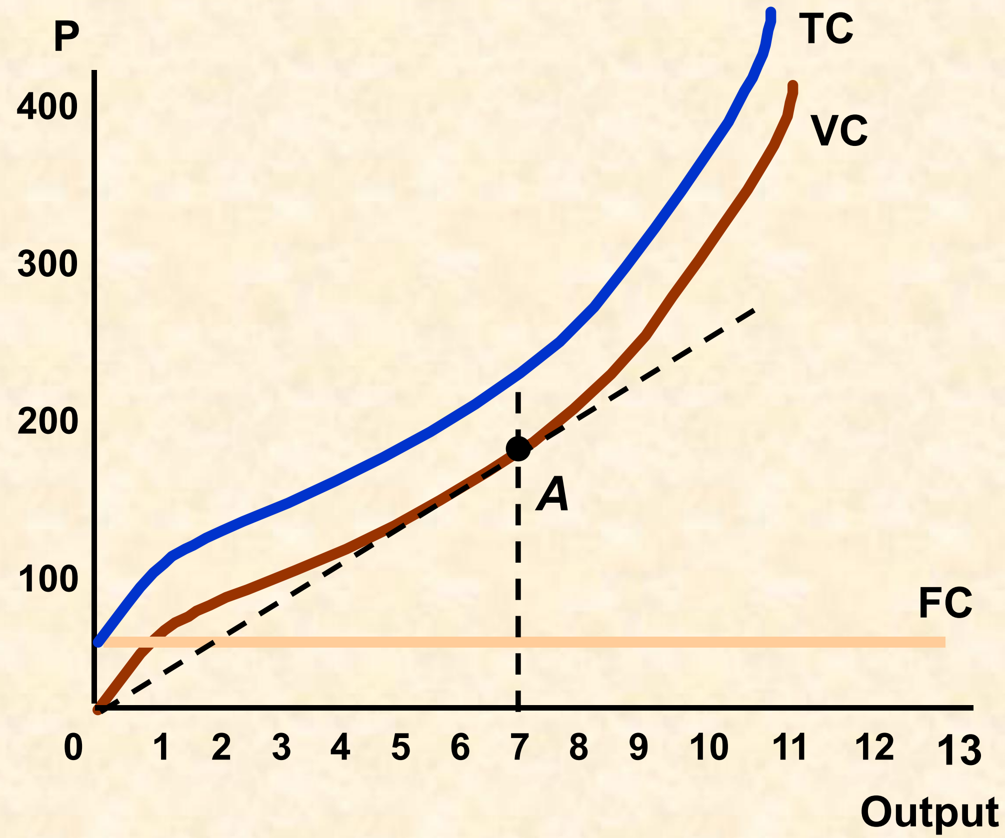


Cost Curves for a Firm



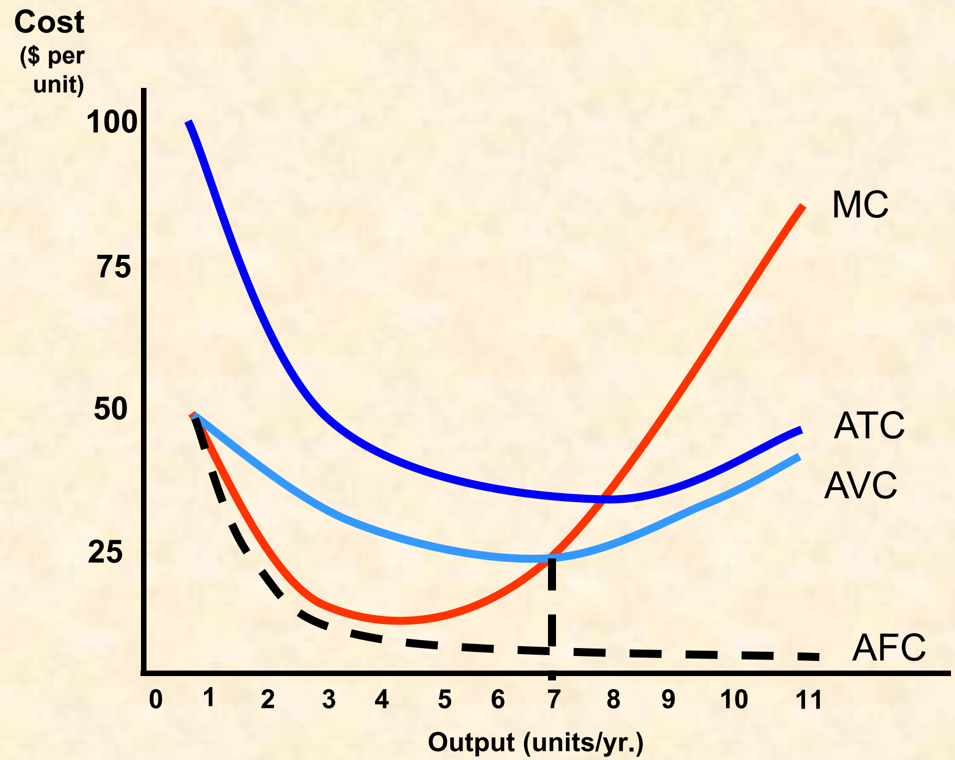
Cost Curves for a Firm

- The line drawn from the origin to the tangent of the variable cost curve:
  - Its slope equals AVC
  - The slope of a point on VC equals MC
  - Therefore, MC = AVC at 7 units of output (point *A*)



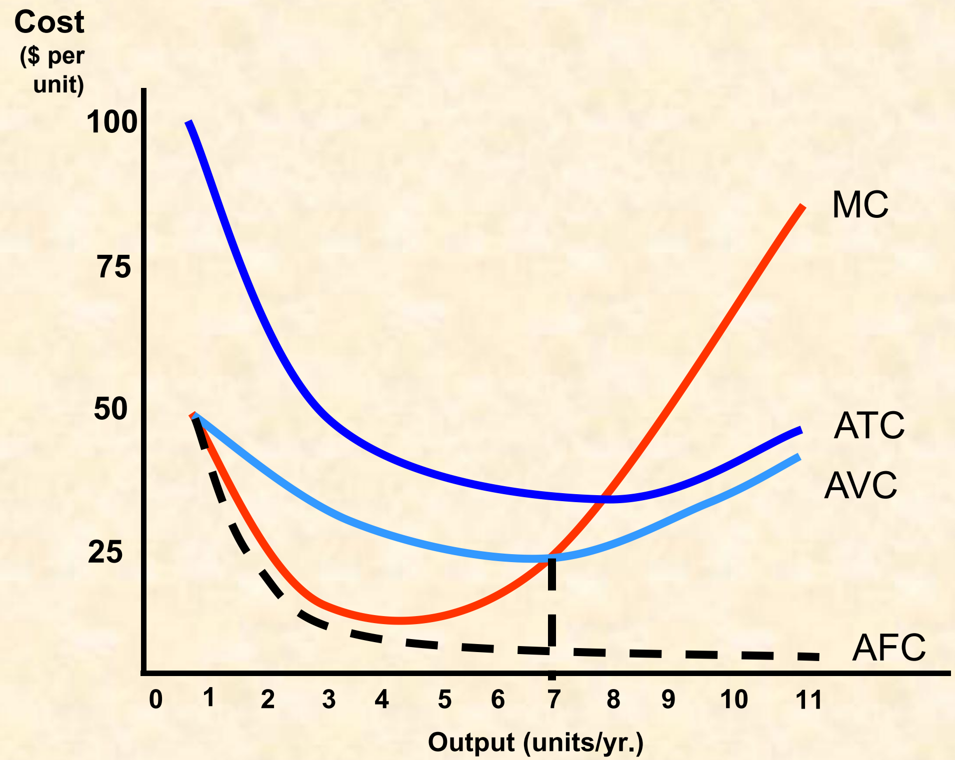
Cost Curves for a Firm

- Unit Costs
  - AFC falls continuously
  - When MC < AVC or MC < ATC, AVC & ATC decrease
  - When MC > AVC or MC > ATC, AVC & ATC increase



Cost Curves for a Firm

- Unit Costs
  - MC = AVC and ATC at minimum AVC and ATC
  - Minimum AVC occurs at a lower output than minimum ATC due to FC



Operating Costs for Aluminum Smelting ($/Ton - based on an output of 600 tons/day)

Variable costs that are constant at all output levels

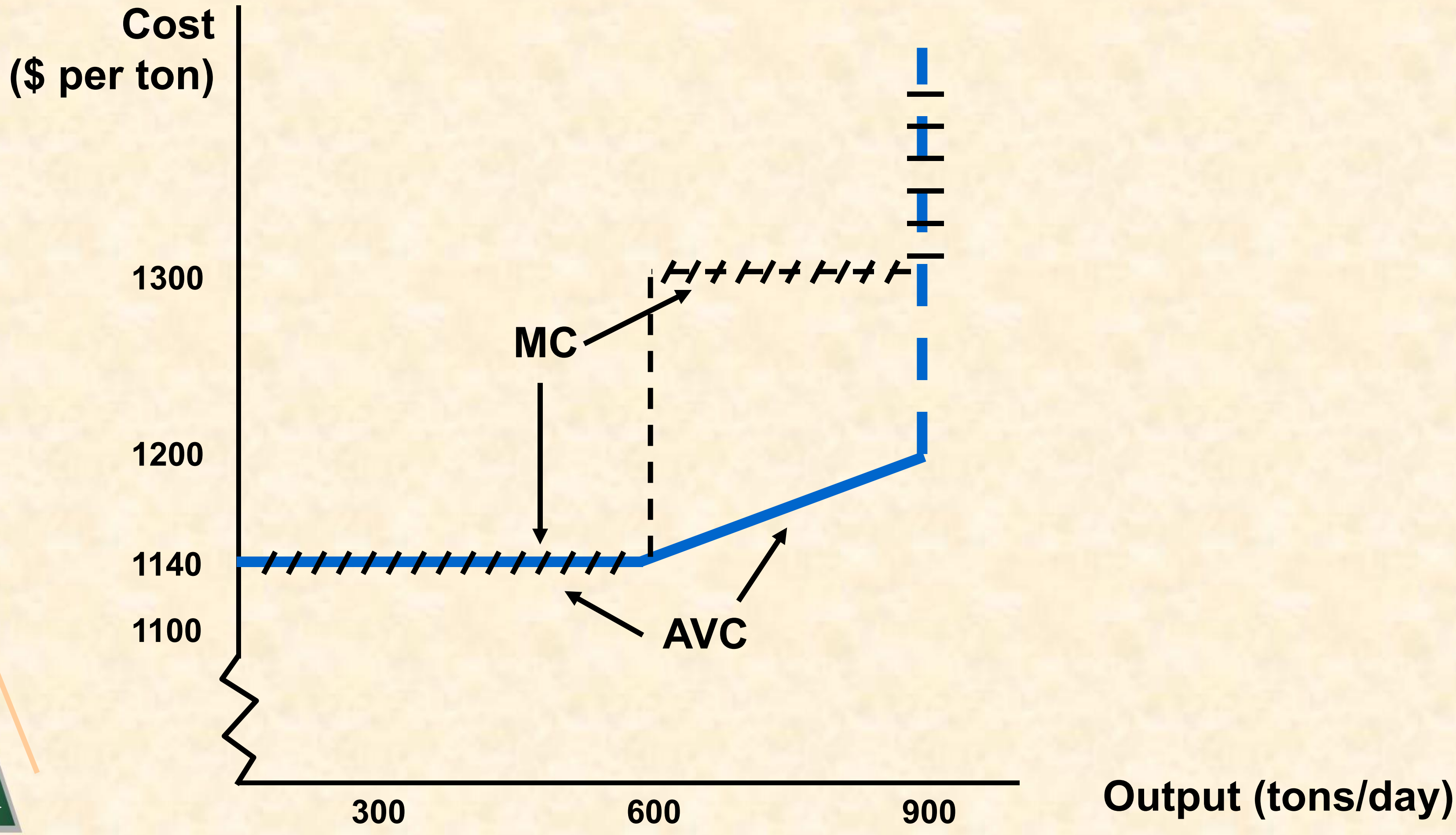
Electricity	$316
Alumina	369
Other raw materials	125
Plant power and fuel	10
Subtotal	$820

Operating Costs for Aluminum Smelting ($/Ton - based on an output of 600 tons/day)

Variable costs that increase when output exceeds 600 tons/day

Labor	$150
Maintenance	120
Freight	50
Subtotal	$320
Total operating costs	$1140

The Short-Run Variable Costs of Aluminum Smelting



Cost in the Long Run

The User Cost of Capital

- User Cost of Capital = Economic Depreciation + (Interest Rate)(Value of Capital)

Cost in the Long Run

The User Cost of Capital

- Example
  - Delta buys a Boeing 737 for $150 million with an expected life of 30 years
    - Annual economic depreciation = $150 million/30 = $5 million
    - Interest rate = 10%

Cost in the Long Run

The User Cost of Capital

- Example
  - User Cost of Capital = $5 million + (.10)($150 million – depreciation)
    - Year 1 = $5 million + (.10)($150 million) = $20 million
    - Year 10 = $5 million + (.10)($100 million) = $15 million

Cost in the Long Run

The User Cost of Capital

- Rate per dollar of capital
  - *r* = Depreciation Rate + Interest Rate

Cost in the Long Run

The User Cost of Capital

- Airline Example
  - Depreciation Rate = 1/30 = 3.33/yr
  - Rate of Return = 10%/yr
- User Cost of Capital
  - r = 3.33 + 10 = 13.33%/yr

Cost in the Long Run

The Cost Minimizing Input Choice

- Assumptions
  - Two Inputs: Labor (*L*) & capital (*K*)
  - Price of labor: wage rate (*w*)
  - The price of capital
    - *R* = depreciation rate + interest rate

Cost in the Long Run

The Cost Minimizing Input Choice

- Question
  - If capital was rented, would it change the value of *r* ?

Cost in the Long Run

The Cost Minimizing Input Choice

- The Isocost Line
  - $C = wL + rK$
  - Isocost: A line showing all combinations of *L* & *K* that can be purchased for the same cost

Cost in the Long Run

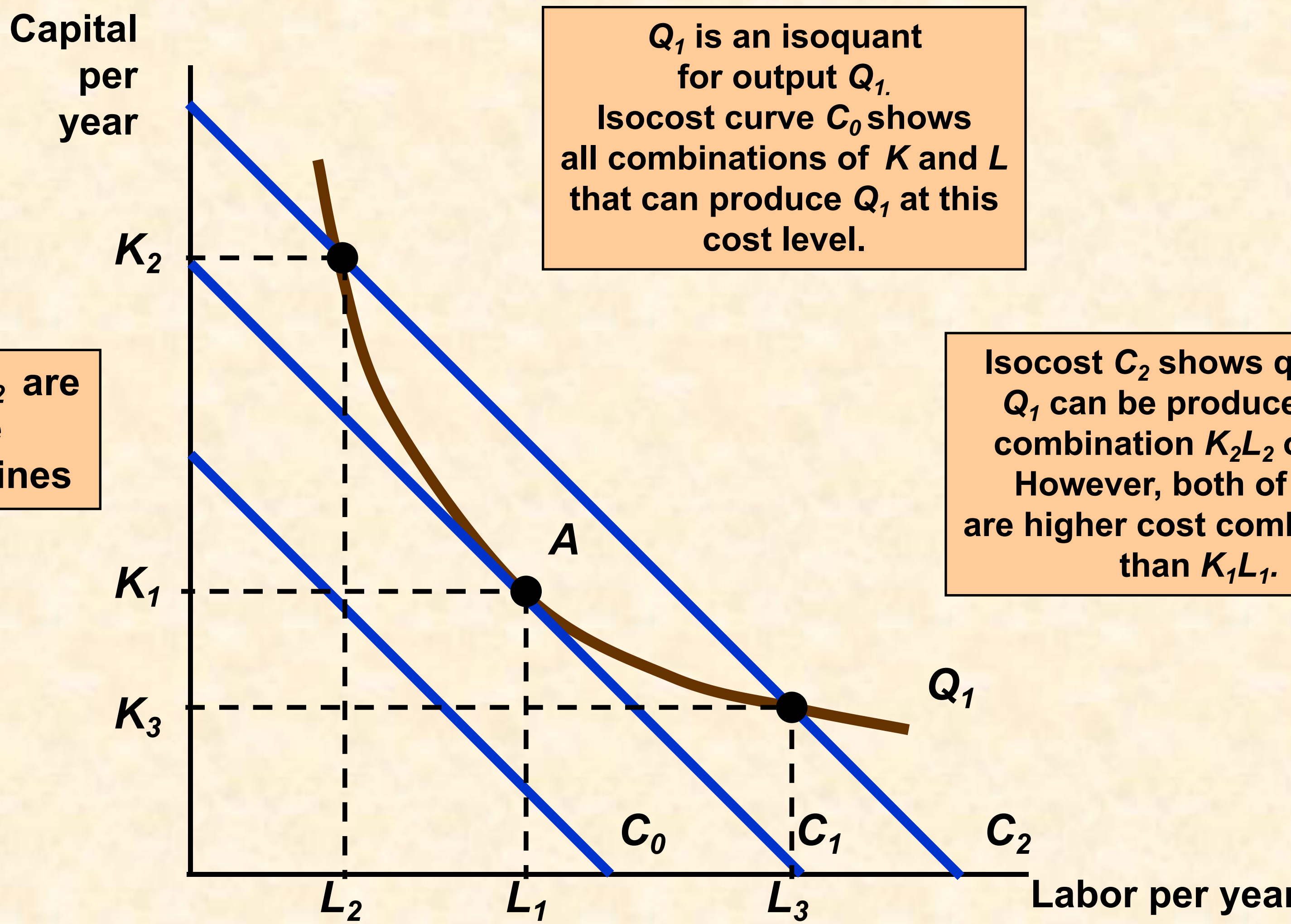
The Isocost Line

- Rewriting *C* as linear:
  - $K = C/r - (w/r)L$
  - Slope of the isocost: $\Delta K / \Delta L = -\left(w / r \right)$
    - is the ratio of the wage rate to rental cost of capital.
    - This shows the rate at which capital can be substituted for labor with no change in cost.

Choosing Inputs

- We will address how to minimize cost for a given level of output.
  - We will do so by combining isocosts with isoquants

Producing a Given Output at Minimum Cost

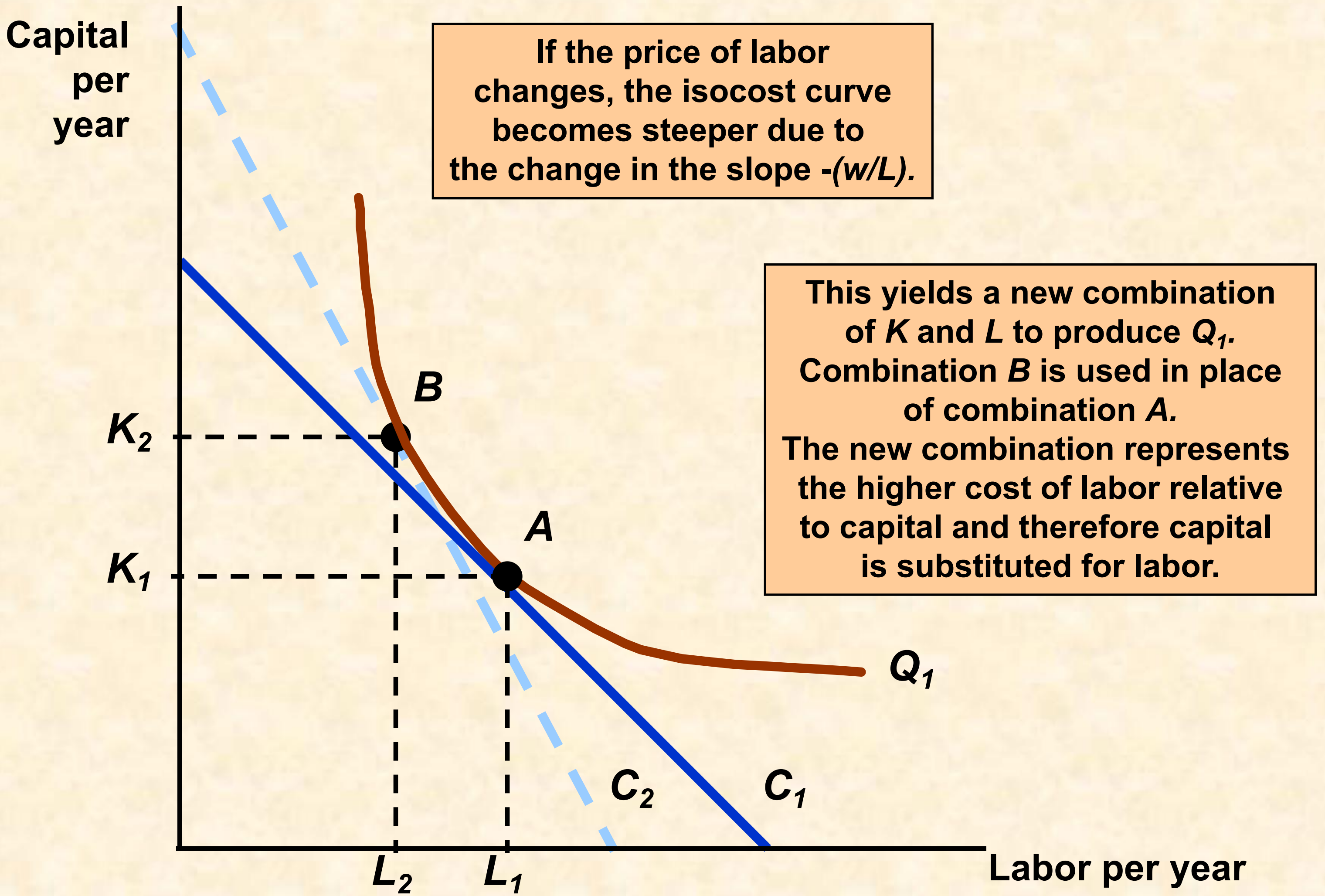


Q_1 is an isoquant for output Q_1. Isocost curve C_0 shows all combinations of *K* and *L* that can produce Q_1 at this cost level.

C_O C_1 C_2 are three isocost lines

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

Input Substitution When an Input Price Change



Cost in the Long Run

- Isoquants and Isocosts and the Production Function

$$\text{MRTS} = -\Delta K / \Delta L = \text{MP}_\text{L} / \text{MP}_\text{K}$$

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

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

Cost in the Long Run

- The minimum cost combination can then be written as:

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

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

Cost in the Long Run

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

The Effect of Effluent Fees on Firms' Input Choices

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

The Effect of Effluent Fees on Firms' Input Choices

- The Scenario: Steel Producer

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

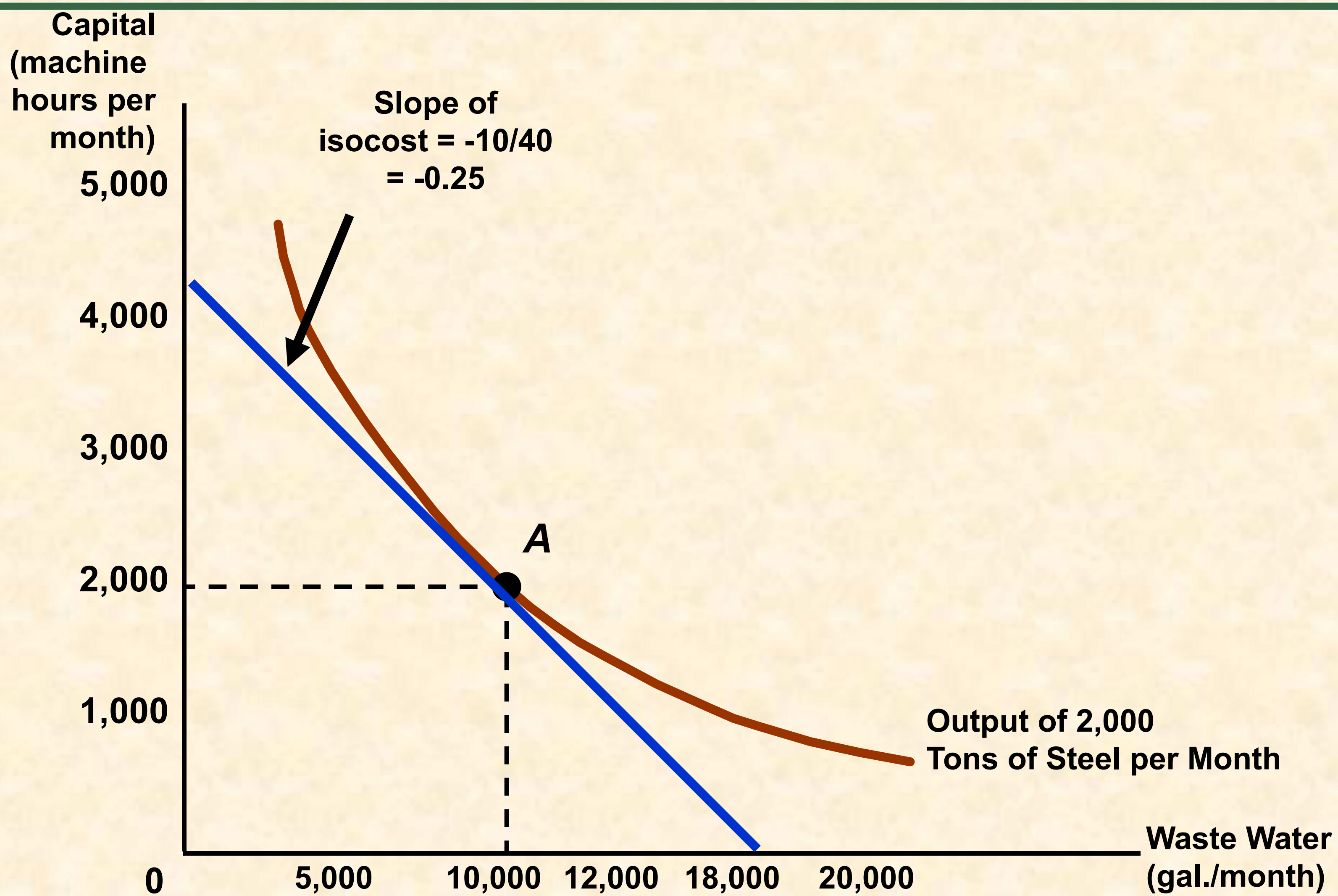
   2) EPA imposes a per unit effluent fee to reduce the environmentally harmful effluent.

The Effect of Effluent Fees on Firms' Input Choices

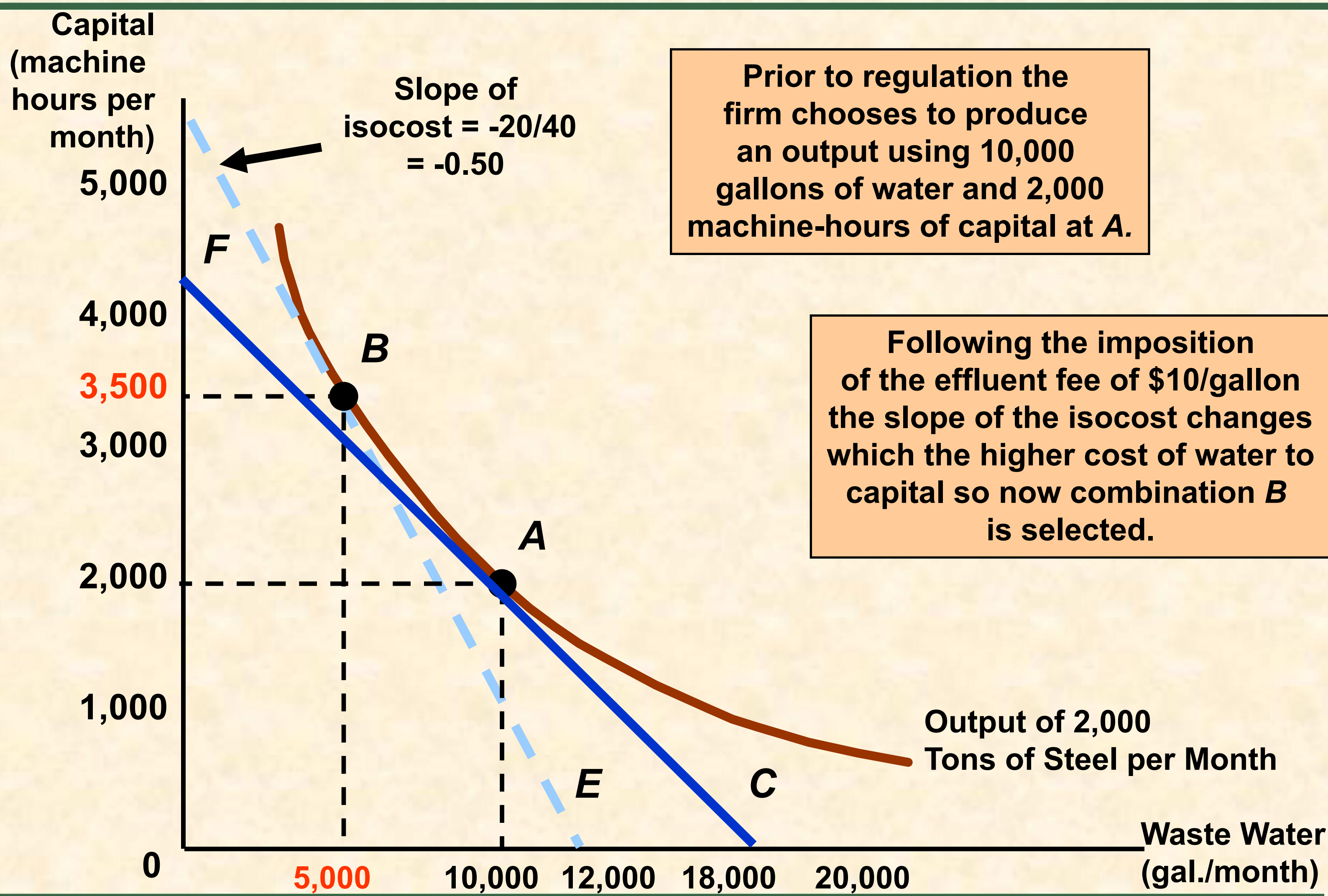
- The Scenario: Steel Producer

  3) How should the firm respond?

The Cost-Minimizing Response to an Effluent Fee



The Cost-Minimizing Response to an Effluent Fee



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

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

The Effect of Effluent Fees on Firms' Input Choices

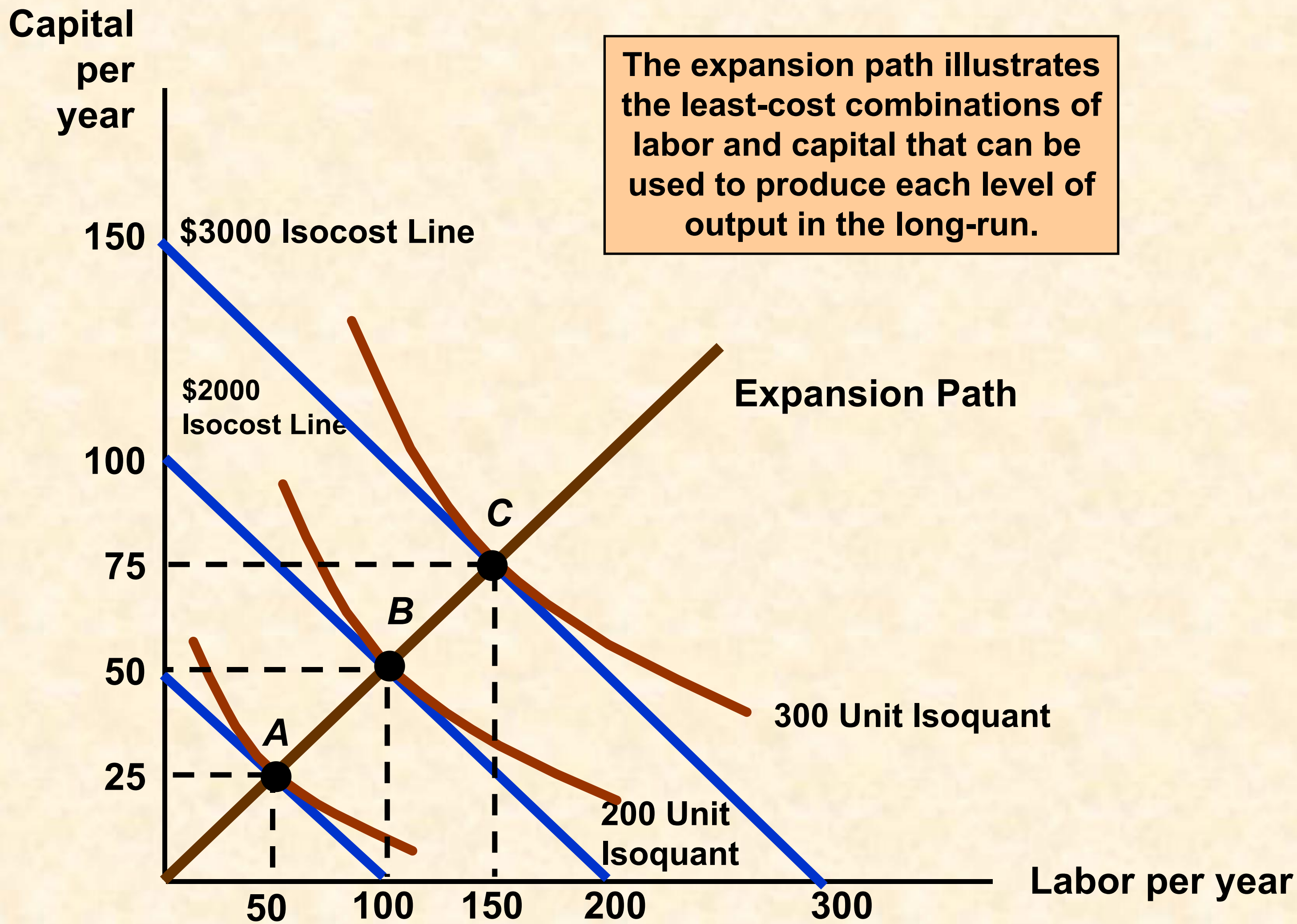
- Observations:
  - The more easily factors can be substituted, the more effective the fee is in reducing the effluent.
  - The greater the degree of substitutes, the less the firm will have to pay (for example: $50,000 with combination *B* instead of $100,000 with combination *A*)

Cost in the Long Run

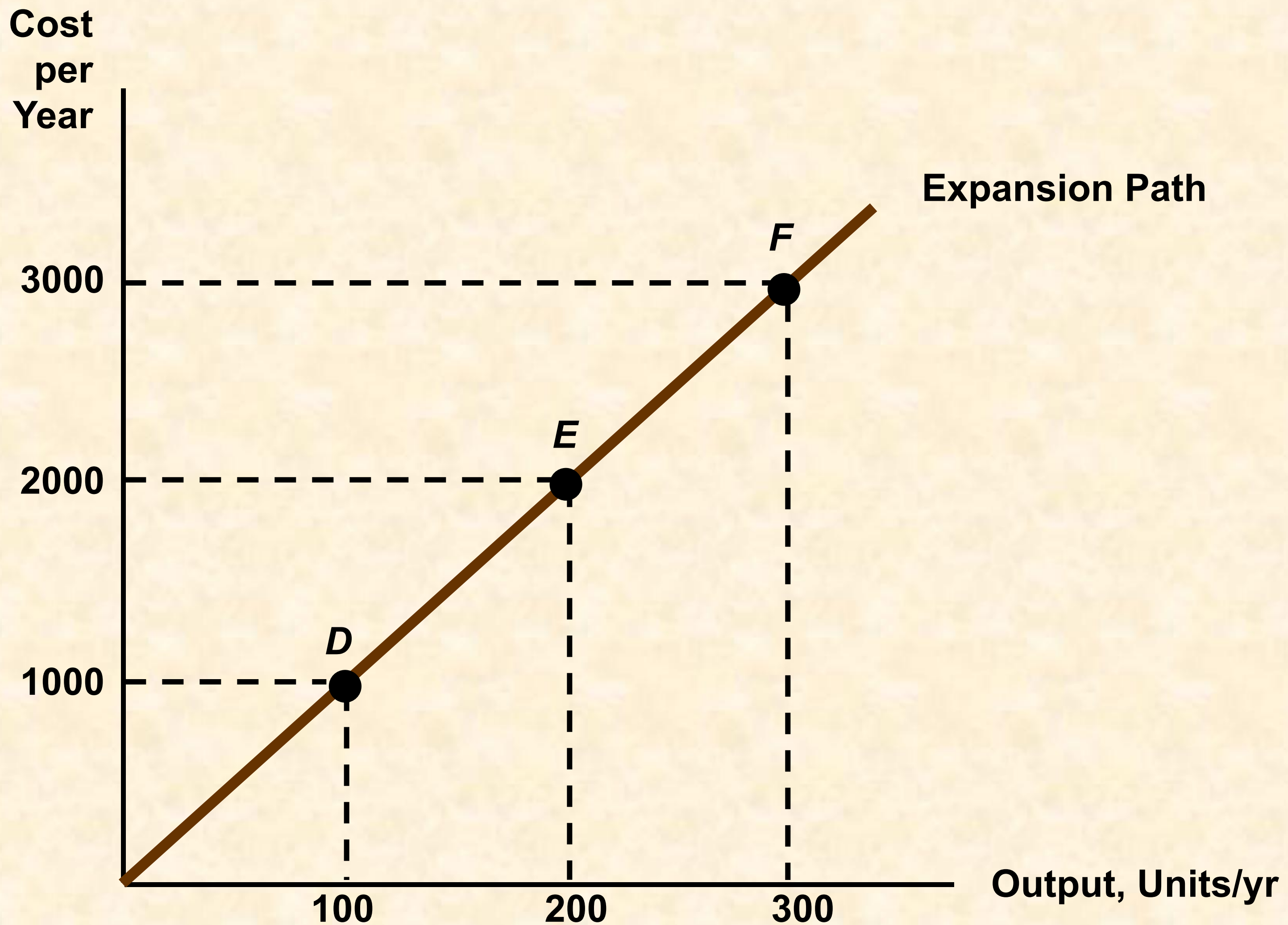
- Cost minimization with Varying Output Levels
  - A firm's expansion path shows the minimum cost combinations of labor and capital at each level of output.

A Firm’s Expansion Path

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



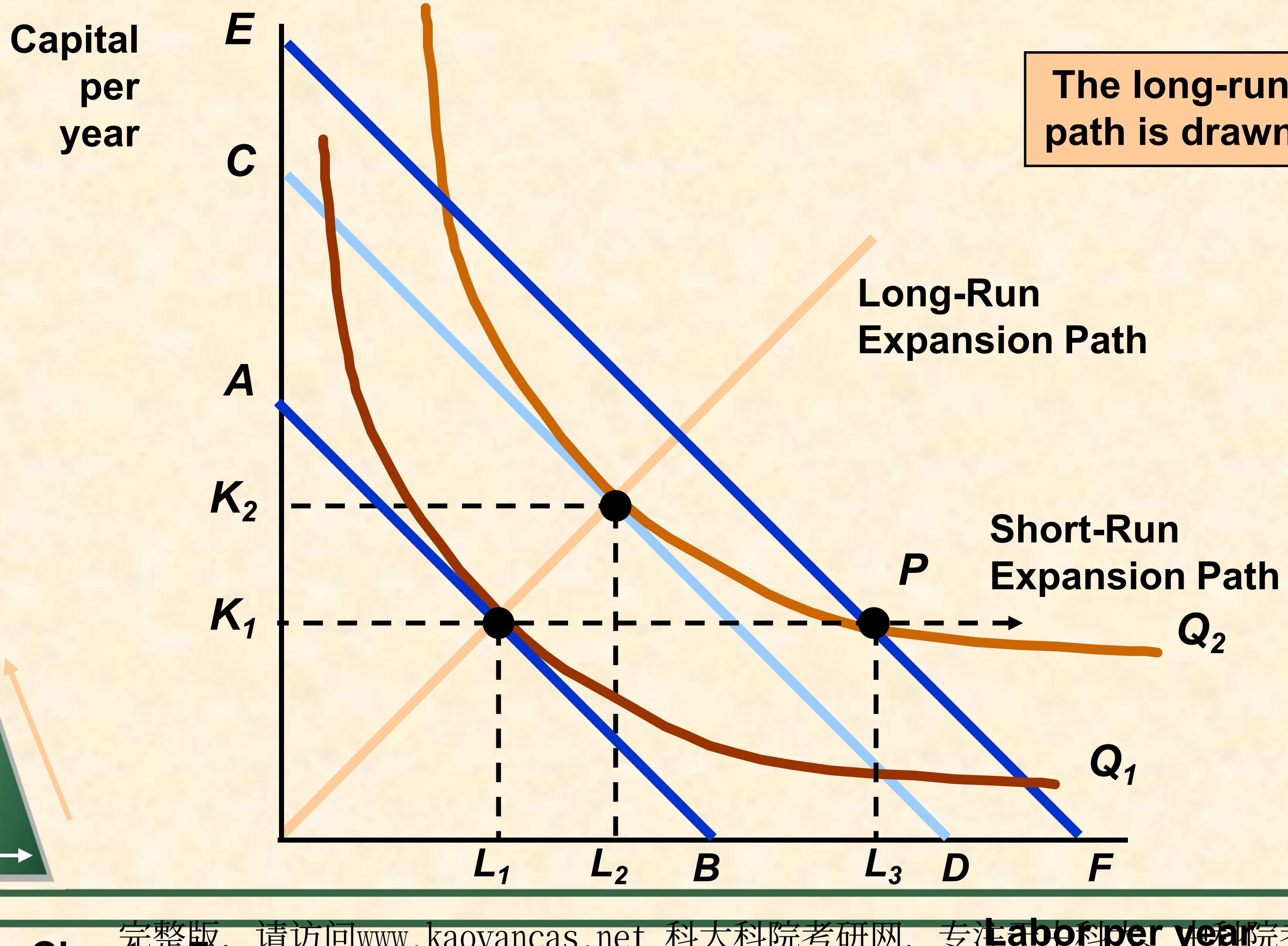
A Firm’s Long-Run Total Cost Curve



Long-Run Versus Short-Run Cost Curves

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

The Inflexibility of Short-Run Production



The long-run expansion path is drawn as before..

Long-Run Versus Short-Run Cost Curves

- Long-Run Average Cost (LAC)
  - Constant Returns to Scale
    - If input is doubled, output will double and average cost is constant at all levels of output.

Long-Run Versus Short-Run Cost Curves

- Long-Run Average Cost (LAC)
  - Increasing Returns to Scale
    - If input is doubled, output will more than double and average cost decreases at all levels of output.

Long-Run Versus Short-Run Cost Curves

- Long-Run Average Cost (LAC)
  - Decreasing Returns to Scale
    - If input is doubled, the increase in output is less than twice as large and average cost increases with output.

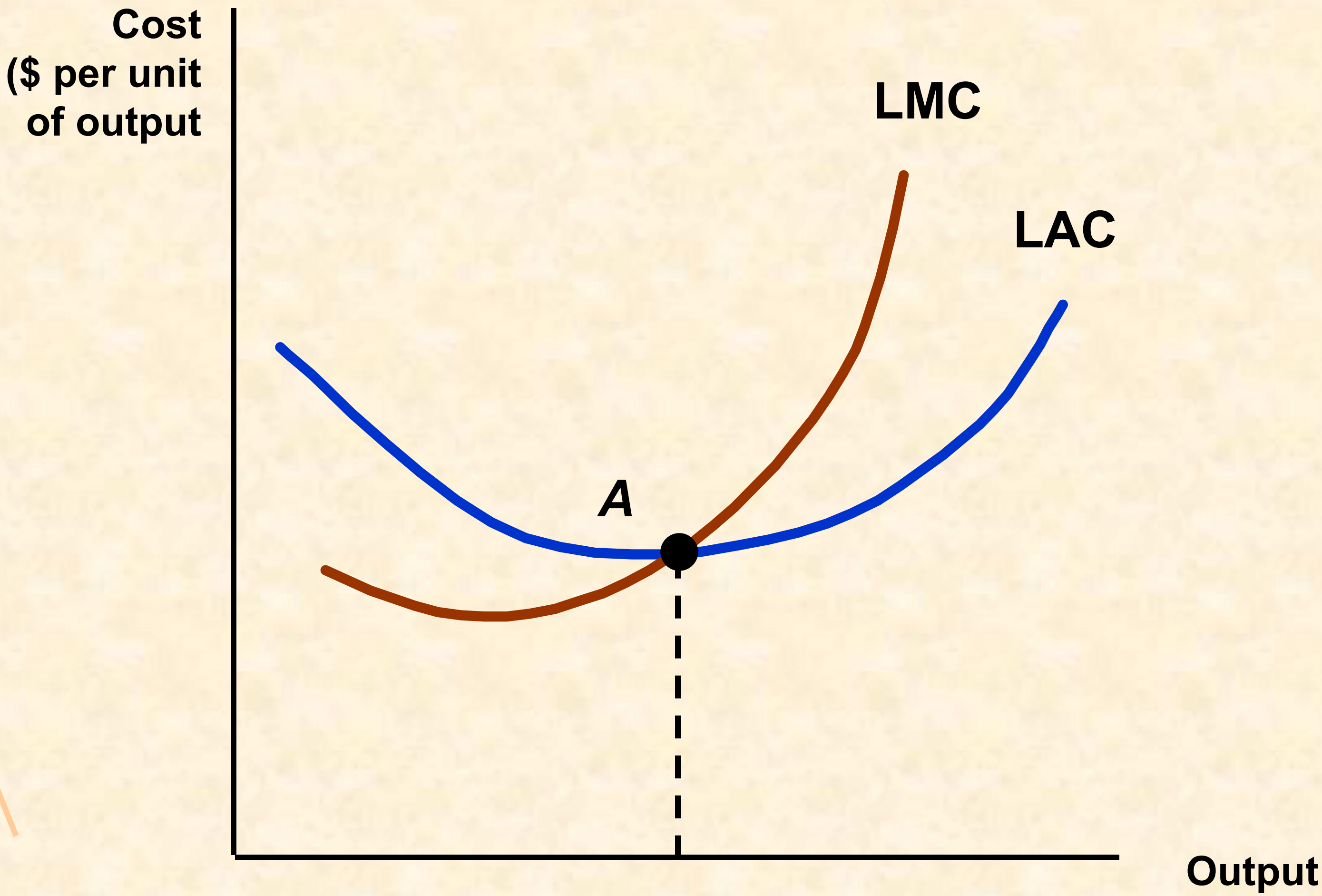
Long-Run Versus Short-Run Cost Curves

- Long-Run Average Cost (LAC)
  - In the long-run:
    - Firms experience increasing and decreasing returns to scale and therefore long-run average cost is “U” shaped.

Long-Run Versus Short-Run Cost Curves

- Long-Run Average Cost (LAC)
  - Long-run marginal cost leads long-run average cost:
    - If LMC < LAC, LAC will fall
    - If LMC > LAC, LAC will rise
    - Therefore, LMC = LAC at the minimum of LAC

Long-Run Average and Marginal Cost



Long-Run Versus Short-Run Cost Curves

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

Long-Run Versus Short-Run Cost Curves

- Economies and Diseconomies of Scale
  - Economies of Scale
    - Increase in output is greater than the increase in inputs.
  - Diseconomies of Scale
    - Increase in output is less than the increase in inputs.

Long-Run Versus Short-Run Cost Curves

- Measuring Economies of Scale

$$E_c = \text{Cost} - \text{output elasticity}$$
$$= \%\Delta \text{ in cost from a } 1\% \text{ increase in output}$$

Long-Run Versus Short-Run Cost Curves

- Measuring Economies of Scale

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

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

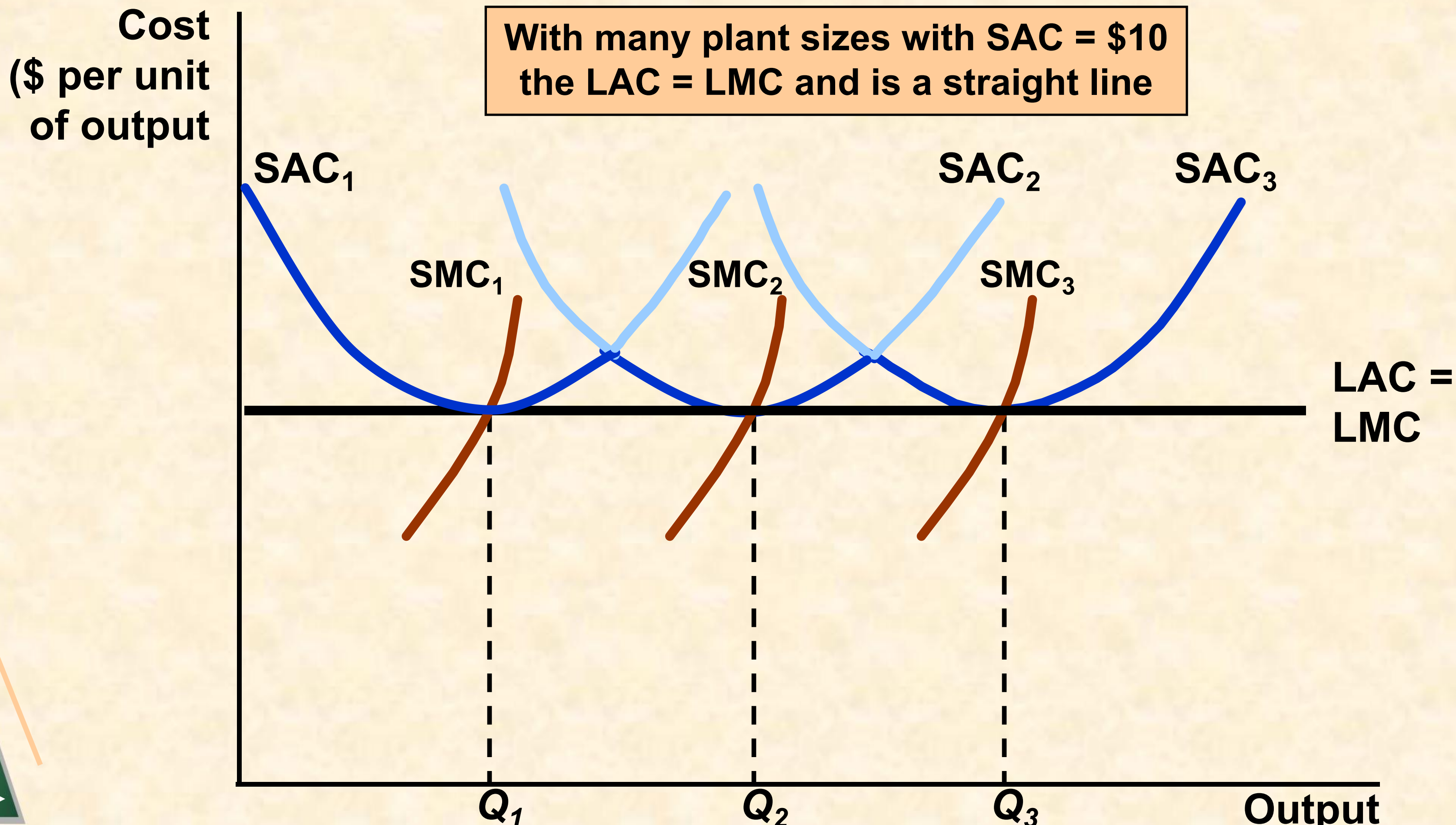
Long-Run Versus Short-Run Cost Curves

- Therefore, the following is true:
  - E_C < 1: MC < AC
    - Average cost indicate decreasing economies of scale
  - E_C = 1: MC = AC
    - Average cost indicate constant economies of scale
  - E_C > 1: MC > AC
    - Average cost indicate increasing diseconomies of scale

Long-Run Versus Short-Run Cost Curves

- The Relationship Between Short-Run and Long-Run Cost
  - We will use short and long-run cost to determine the optimal plant size

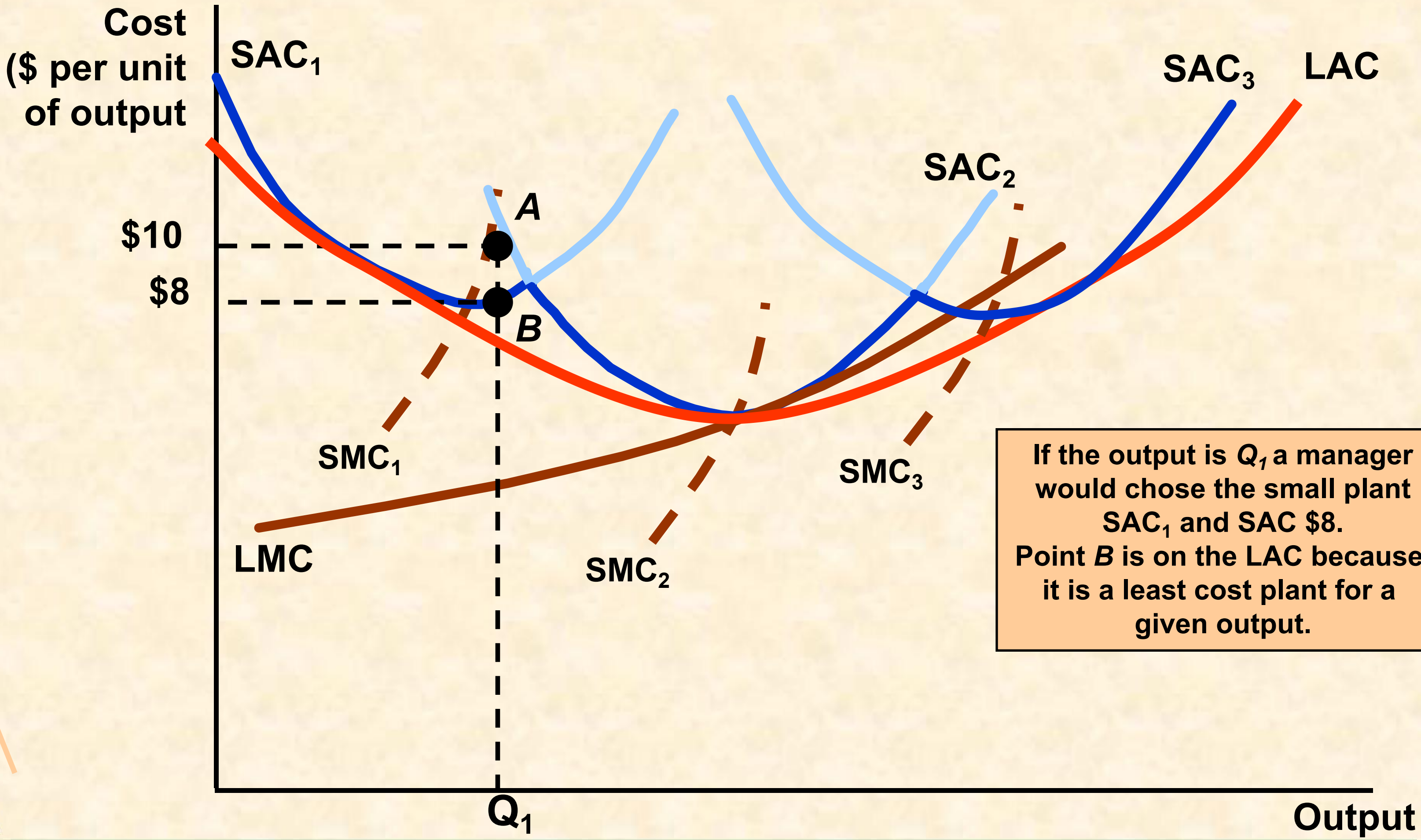
Long-Run Cost with Constant Returns to Scale



Long-Run Cost with Constant Returns to Scale

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

Long-Run Cost with Economies and Diseconomies of Scale



If the output is Q_1 a manager would chose the small plant SAC_1 and SAC $8.
Point *B* is on the LAC because it is a least cost plant for a given output.

Long-Run Cost with Constant Returns to Scale

- What is the firms' long-run cost curve?
  - Firms can change scale to change output in the long-run.
  - The long-run cost curve is the dark blue portion of the SAC curve which represents the minimum cost for any level of output.

Long-Run Cost with Constant Returns to Scale

- Observations
  - The LAC does not include the minimum points of small and large size plants? Why not?
  - LMC is not the envelope of the short-run marginal cost. Why not?

Production with Two Outputs--Economies of Scope

- Examples:
  - Chicken farm--poultry and eggs
  - Automobile company--cars and trucks
  - University--Teaching and research

Production with Two Outputs--Economies of Scope

- Economies of scope exist when the joint output of a single firm is greater than the output that could be achieved by two different firms each producing a single output.
- What are the advantages of joint production?
  - Consider an automobile company producing cars and tractors

Production with Two Outputs--Economies of Scope

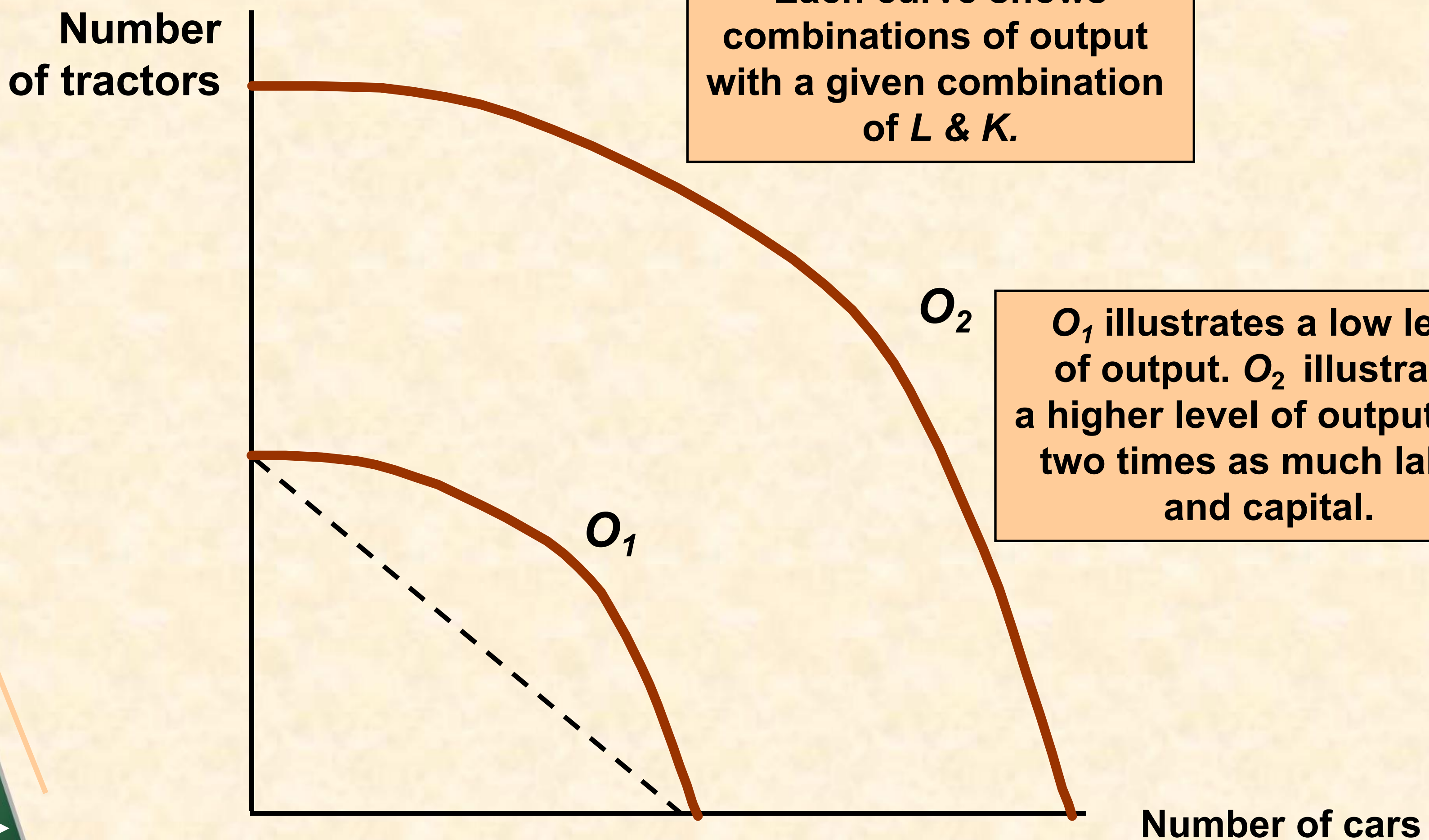
- Advantages

1) Both use capital and labor.
2) The firms share management resources.
3) Both use the same labor skills and type of machinery.

Production with Two Outputs--Economies of Scope

- Production:
  - Firms must choose how much of each to produce.
  - The alternative quantities can be illustrated using product transformation curves.

Product Transformation Curve



Each curve shows combinations of output with a given combination of *L* & *K*.

O_1 illustrates a low level of output. O_2 illustrates a higher level of output with two times as much labor and capital.

Production with Two Outputs--Economies of Scope

- Observations
  - Product transformation curves are negatively sloped
  - Constant returns exist in this example
  - Since the production transformation curve is concave is joint production desirable?

Production with Two Outputs--Economies of Scope

- Observations
  - There is no direct relationship between economies of scope and economies of scale.
    - May experience economies of scope and diseconomies of scale
    - May have economies of scale and not have economies of scope

Production with Two Outputs--Economies of Scope

- The *degree of economies of scope* measures the savings in cost and can be written:

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

  - $C(Q_1)$ is the cost of producing Q_1
  - $C(Q_2)$ is the cost of producing Q_2
  - $C(Q_1Q_2)$ is the joint cost of producing both products

Production with Two Outputs--Economies of Scope

- Interpretation:
  - If SC > 0 -- Economies of scope
  - If SC < 0 -- Diseconomies of scope

Economies of Scope in the Trucking Industry

- Issues
  - Truckload versus less than truck load
  - Direct versus indirect routing
  - Length of haul

Economies of Scope in the Trucking Industry

- Questions:
  - Economies of Scale
    - Are large-scale, direct hauls cheaper and more profitable than individual hauls by small trucks?
    - Are there cost advantages from operating both direct and indirect hauls?

Economies of Scope in the Trucking Industry

- Empirical Findings
  - An analysis of 105 trucking firms examined four distinct outputs.
    - Short hauls with partial loads
    - Intermediate hauls with partial loads
    - Long hauls with partial loads
    - Hauls with total loads

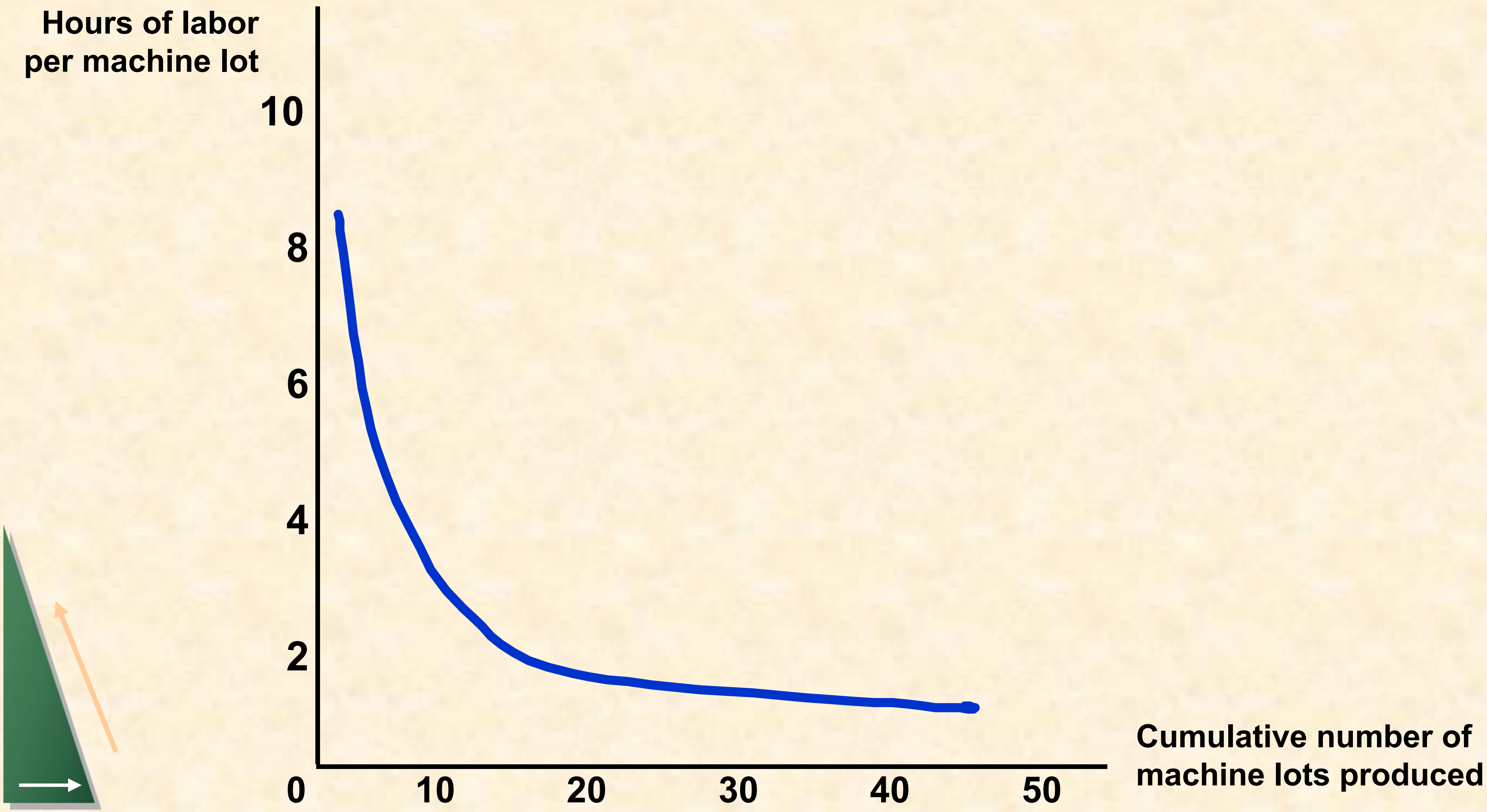
Economies of Scope in the Trucking Industry

- Empirical Findings
  - Results
    - SC = 1.576 for reasonably large firm
    - SC = 0.104 for very large firms
  - Interpretation
    - Combining partial loads at an intermediate location lowers cost management difficulties with very large firms.

Dynamic Changes in Costs--The Learning Curve

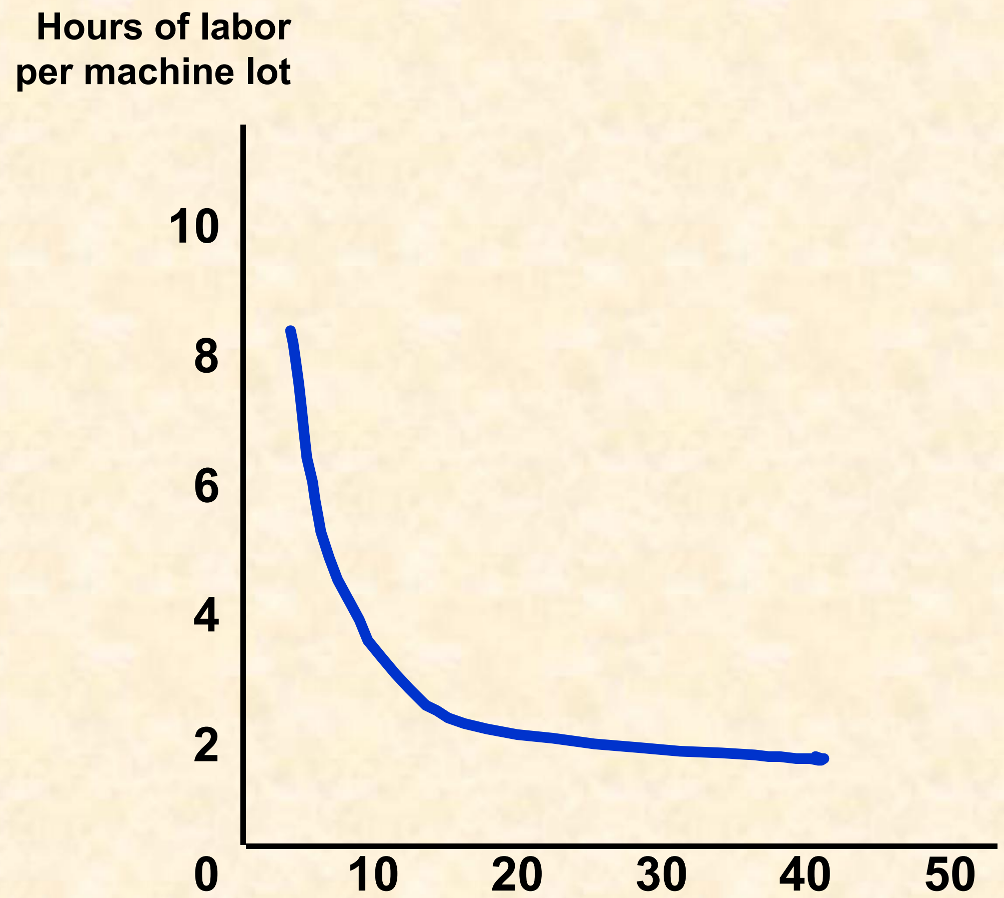
- The learning curve measures the impact of worker's experience on the costs of production.
- It describes the relationship between a firm's cumulative output and amount of inputs needed to produce a unit of output.

The Learning Curve



The Learning Curve

- The horizontal axis measures the cumulative number of hours of machine tools the firm has produced
- The vertical axis measures the number of hours of labor needed to produce each lot.



Dynamic Changes in Costs--The Learning Curve

- The learning curve in the figure is based on the relationship:

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

$N =$ cumulative units of output produced

$L =$ labor input per unit of output

A, B and β are constants

A & B are positive and β is between 0 and 1

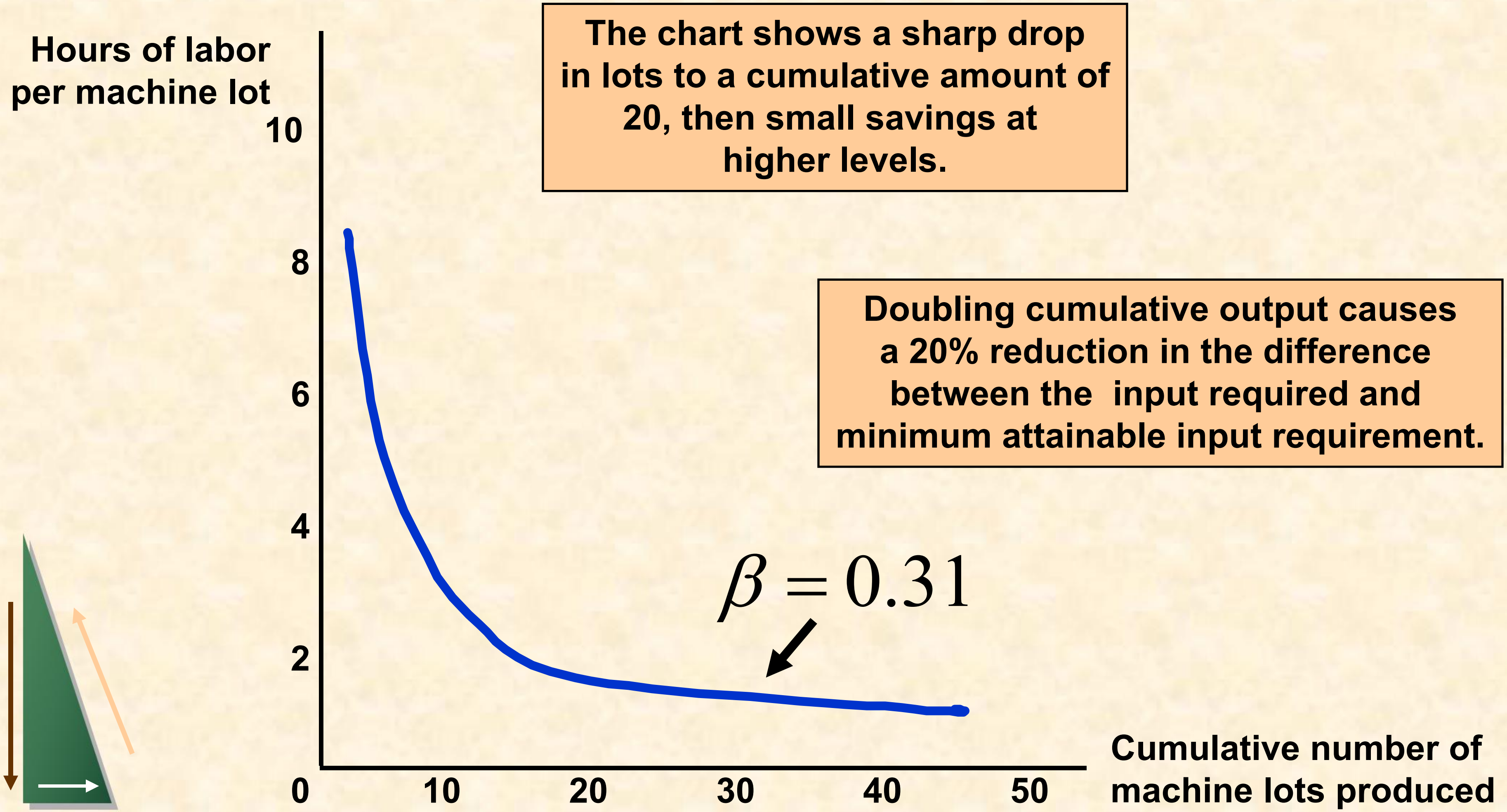
Dynamic Changes in Costs--The Learning Curve

- $If \ N = 1:$
  - L equals $A + B$ and this measures labor input to produce the first unit of output
- $If \ \beta = 0:$
  - Labor input remains constant as the cumulative level of output increases, so there is no learning

Dynamic Changes in Costs--The Learning Curve

- $\mathit{If}\ \beta > 0$ and N increases:
  - *L* approaches *A*, and *A* represent minimum labor input/unit of output after all learning has taken place.
- The larger β:
  - The more important the learning effect.

The Learning Curve



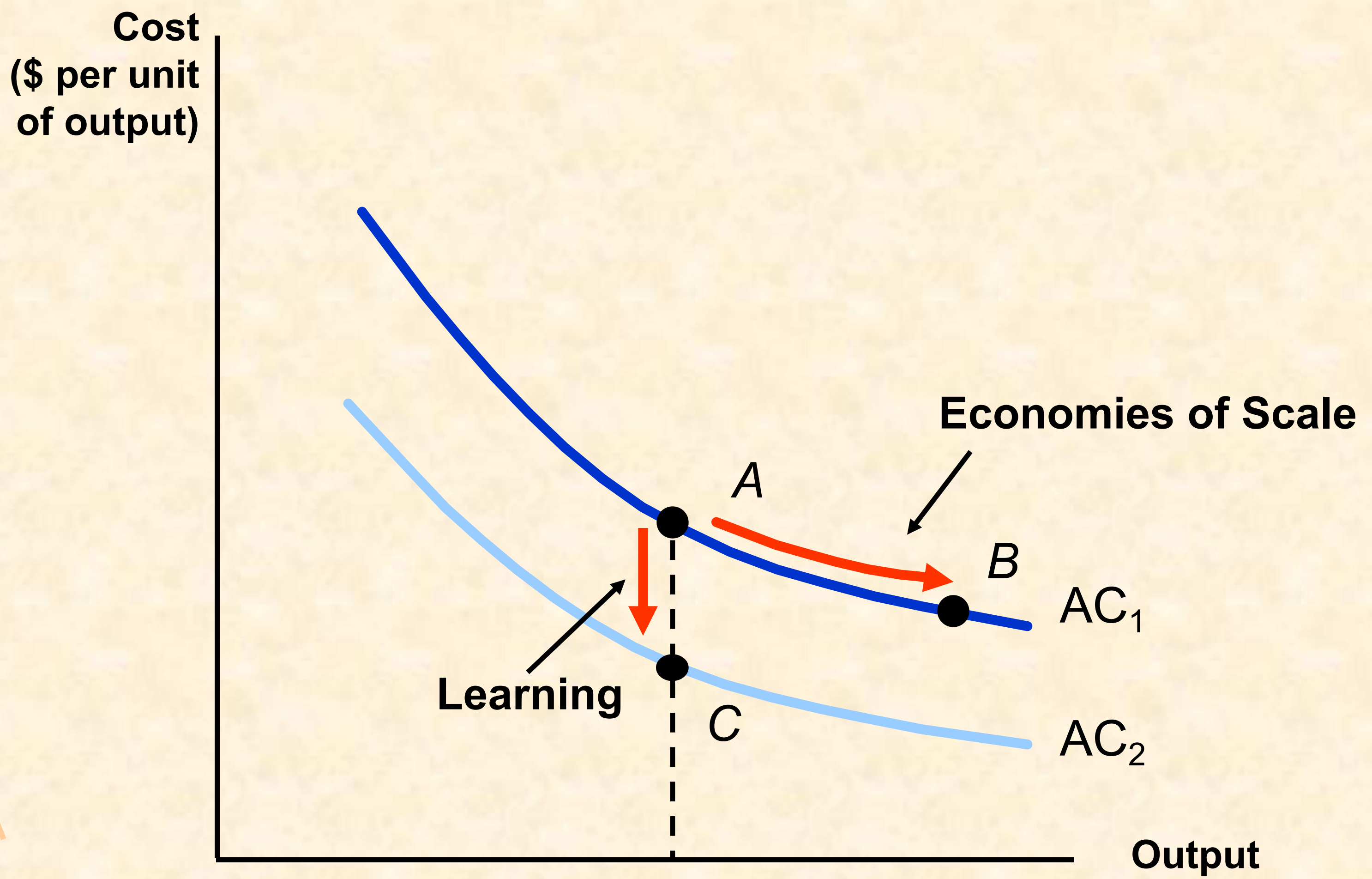
Dynamic Changes in Costs--The Learning Curve

- Observations

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

  2) Older firms have relatively small gains from learning.

Economies of Scale Versus Learning



Predicting the Labor Requirements of Producing a Given Output

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

Dynamic Changes in Costs--The Learning Curve

- The learning curve implies:

  1) The labor requirement falls per unit.

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

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

The Learning Curve in Practice

- Scenario
  - A new firm enters the chemical processing industry.
- Do they:

1) Produce a low level of output and sell at a high price?

2) Produce a high level of output and sell at a low price?

The Learning Curve in Practice

- How would the learning curve influence your decision?

The Learning Curve in Practice

- The Empirical Findings
  - Study of 37 chemical products
    - Average cost fell 5.5% per year
    - For each doubling of plant size, average production costs fall by 11%
    - For each doubling of cumulative output, the average cost of production falls by 27%
- Which is more important, the economies of scale or learning effects?

The Learning Curve in Practice

- Other Empirical Findings
  - In the semi-conductor industry a study of seven generations of DRAM semiconductors from 1974-1992 found learning rates averaged 20%.
  - In the aircraft industry the learning rates are as high as 40%.

The Learning Curve in Practice

- Applying Learning Curves

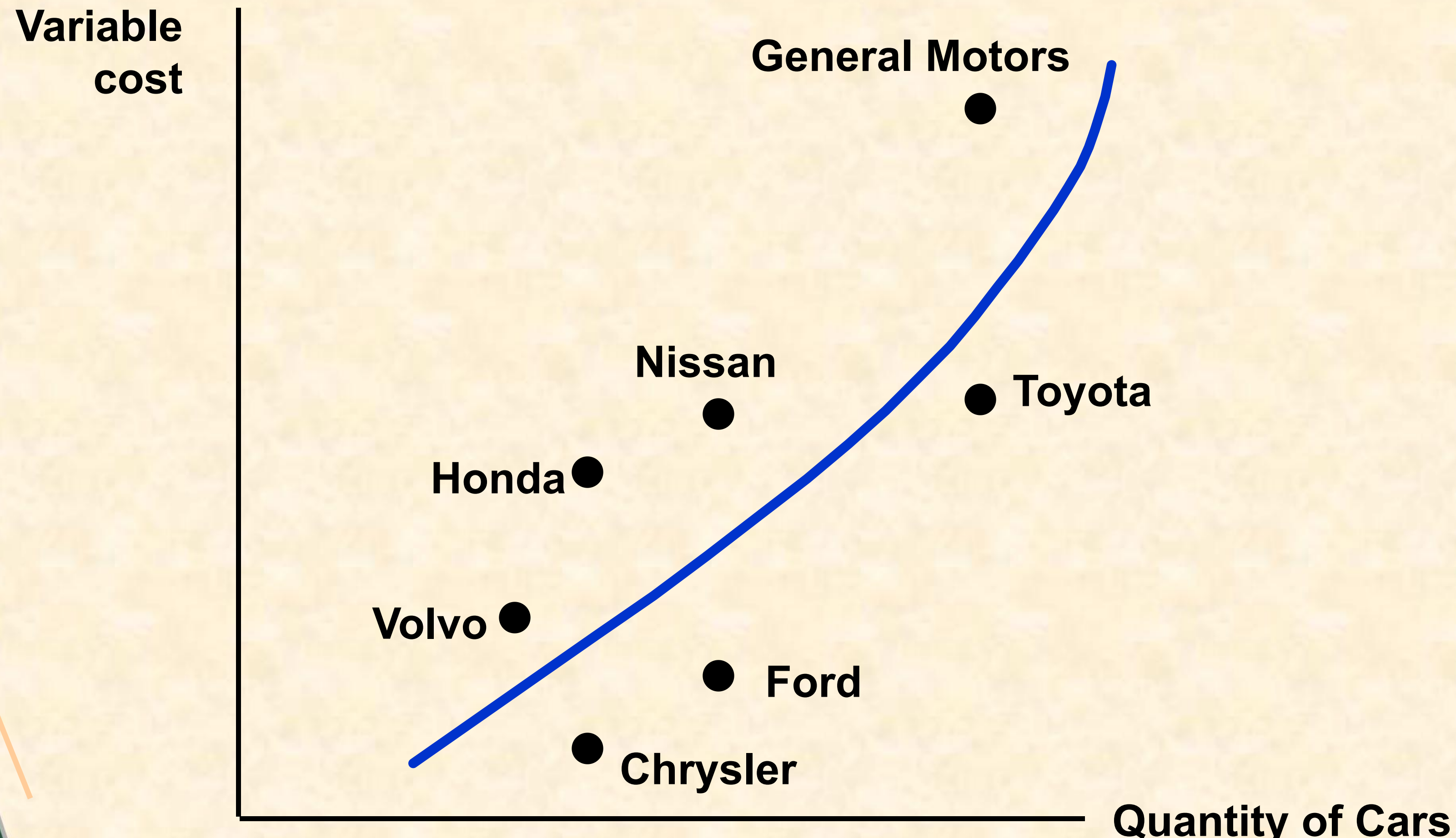
  1) To determine if it is profitable to enter an industry.

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

Estimating and Predicting Cost

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

Total Cost Curve for the Automobile Industry



Estimating and Predicting Cost

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

$$VC = \beta Q$$

- The linear cost function is applicable only if marginal cost is constant.
  - Marginal cost is represented by β .

Estimating and Predicting Cost

- If we wish to allow for a U-shaped average cost curve and a marginal cost that is not constant, we might use the *quadratic* cost function:

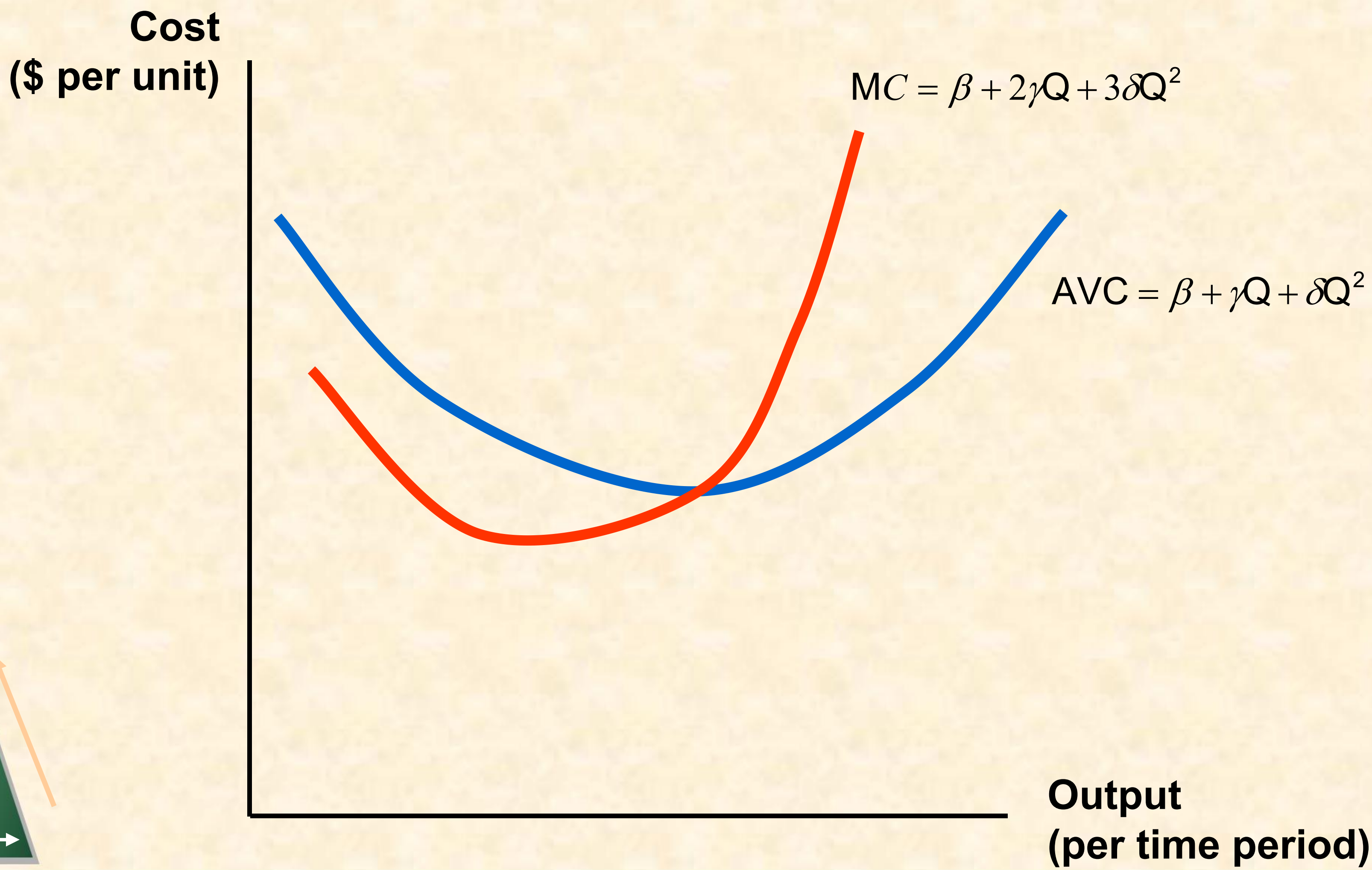
$$VC = \beta Q + \gamma Q^2$$

Estimating and Predicting Cost

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

$$\mathrm{VC} = \beta Q + \gamma Q^2 + \delta Q^3$$

Cubic Cost Function



Estimating and Predicting Cost

- Difficulties in Measuring Cost

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

  2) Cost data may not include opportunity cost.

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

Estimating and Predicting Cost

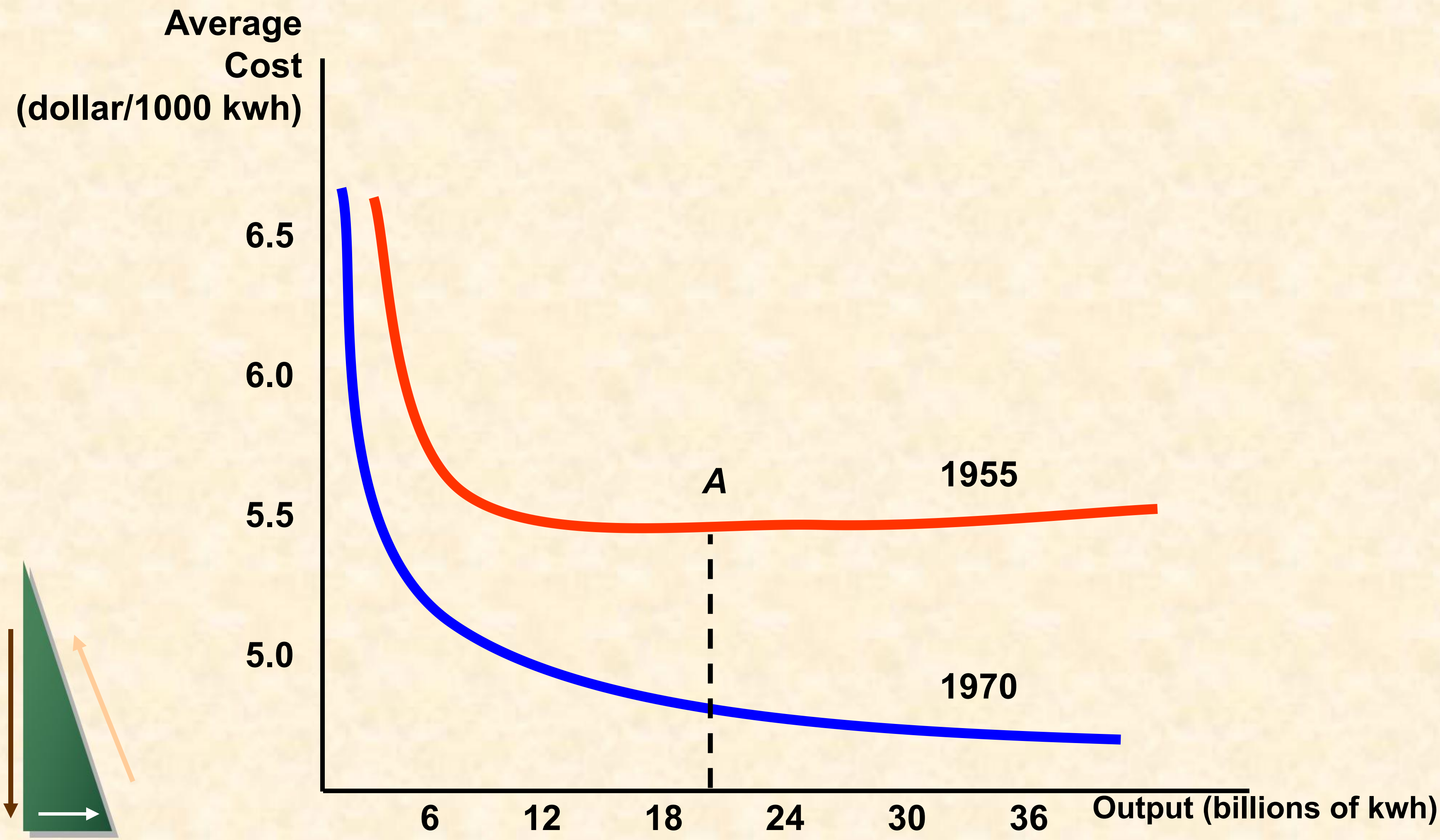
- Cost Functions and the Measurement of Scale Economies
  - Scale Economy Index (SCI)
    - $E_C = 1$, SCI = 0: no economies or diseconomies of scale
    - $E_C > 1$, SCI is negative: diseconomies of scale
    - $E_C < 1$, SCI is positive: economies of scale

Cost Functions for Electric Power

Scale Economies in the Electric Power Industry

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

Average Cost of Production in the Electric Power Industry



Cost Functions for Electric Power

- Findings
  - Decline in cost
    - Not due to economies of scale
    - Was caused by:
      - Lower input cost (coal & oil)
      - Improvements in technology

A Cost Function for the Savings and Loan Industry

- The empirical estimation of a long-run cost function can be useful in the restructuring of the savings and loan industry in the wake of the savings and loan collapse in the 1980s.

A Cost Function for the Savings and Loan Industry

- Data for 86 savings and loans for 1975 & 1976 in six western states
  - Q = total assets of each S&L
  - LAC = average operating expense
  - Q & TC are measured in hundreds of millions of dollars
  - Average operating cost are measured as a percentage of total assets.

A Cost Function for the Savings and Loan Industry

- A quadratic long-run average cost function was estimated for 1975:

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

- Minimum long-run average cost reaches its point of minimum average total cost when total assets of the savings and loan reach $574 million.

A Cost Function for the Savings and Loan Industry

- Average operating expenses are 0.61% of total assets.
- Almost all of the savings and loans in the region being studied had substantially less than $574 million in assets.

A Cost Function for the Savings and Loan Industry

- Questions

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

2) What are the limitations of using these results?

Summary

- Managers, investors, and economists must take into account the opportunity cost associated with the use of the firm’s resources.
- Firms are faced with both fixed and variable costs in the short-run.

Summary

- When there is a single variable input, as in the short run, the presence of diminishing returns determines the shape of the cost curves.
- In the long run, all inputs to the production process are variable.

Summary

- The firm's expansion path describes how its cost-minimizing input choices vary as the scale or output of its operation increases.
- The long-run average cost curve is the envelope of the short-run average cost curves.

Summary

- A firm enjoys economies of scale when it can double its output at less than twice the cost.

- Economies of scope arise when the firm can produce any combination of the two outputs more cheaply than could two independent firms that each produced a single product.

Summary

- A firm's average cost of production can fall over time if the firm "learns" how to produce more effectively.
- Cost functions relate the cost of production to the level of output of the firm.

End of Chapter 7

The Cost of Production