MICROECONOMICS 2

LECTURE 6
COSTS

People want economy and they will pay any price to get it.

Lee Iacocca

(former CEO of Chrysler)

Outline

Challenge

Technology Choice at Home Versus Abroad

1. **Measuring Costs**
2. **Short-Run Costs**
3. **Long-Run Costs**
4. **Lower Costs in the Long Run**
5. **Cost of Producing Multiple Goods**

Challenge Solution

Challenge:
Technology Choice at Home Versus Abroad

Background

- A manager of a semiconductor manufacturing firm, who can choose from many different production technologies, must determine whether the firm should use the same technology in its foreign plant that it uses in its domestic plant.
- The semiconductor manufacturer can produce a chip using sophisticated equipment and relatively few workers or many workers and less complex equipment.
- In the United States, firms use a relatively capital-intensive technology, because doing so minimizes their cost of producing a given level of output.

Questions

- Will that same technology be cost minimizing if they move their production abroad?

Lecture 6. Costs

- How does a firm determine **how** to produce a certain amount of output efficiently?
- First, determine which production processes are ***technologically efficient.***
    - Produce the desired level of output with the least inputs.
- Second, select the technologically efficient production process that is also ***economically efficient***.
    - Minimize the cost of producing a specified amount of output.
- Because any profit-maximizing firm minimizes its cost of production, we will spend this lecture examining firms' costs.

1. Measuring Costs

- **Explicit costs** are direct, out-of-pocket payments for inputs such as labor, capital, energy, and materials.
- **Implicit costs** reflect a forgone opportunity.
- The **opportunity cost** of a resource is the value of the best alternative use of that resource. Opportunity cost is the sum of implicit and explicit costs.

  "There's no such thing as a free lunch" refers to the opportunity cost of your time, an often overlooked resource.

- Although many businesspeople only consider explicit costs, economists also take into account implicit costs.

Measuring Costs

- Capital is a **durable good**, which means it is a product that is usable for many years.
- Difficult to measure the cost of a durable good
  - Initial purchase cost must be allocated over some time period
  - Value of capital may change over time; capital depreciation implies opportunity costs fall over time
  - Avoid cost measurement problems if capital is rented
- Example: College's cost of capital
  - Estimates of the cost of providing an education frequently ignore the opportunity cost of the campus real estate

Measuring Costs

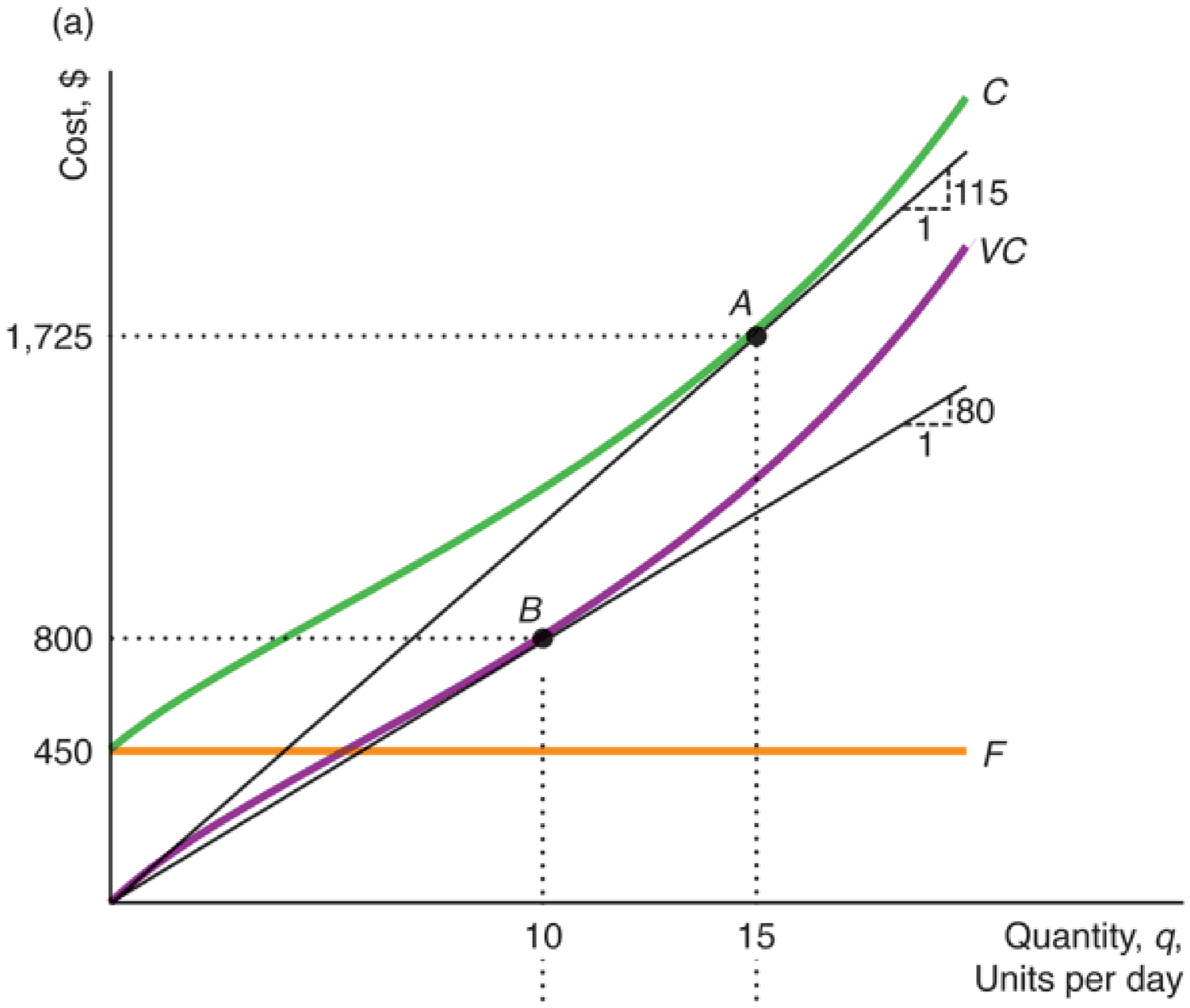
- Opportunity costs are not always easily observed but should always be taken into account in production decisions.
- **Sunk costs,** past expenditures that cannot be recovered, are easily observed, but are never relevant in production decisions.
  - Sunk costs are NOT included in opportunity costs.
  - Example: Grocery store checkout line
    - ✓Time already spent waiting in a slow line should not influence your decision to switch to a different checkout line or stay put.

2. Short-Run Costs

- Recall that the short run is a period of time in which some inputs can be varied, while other inputs are fixed.
- Short run cost measures all assume labor is variable and capital is fixed:
  - **Fixed cost (F):** a cost that doesn't vary with the level of output (e.g. expenditures on land or production facilities).
  - **Variable cost (VC):** production expense that changes with the level of output produced (e.g., labor cost, materials cost).
  - **Total cost (C):** sum of variable and fixed costs

$$C = VC + F$$

Short-Run Cost Curves



Short-Run Costs

To decide how much to produce, a firm uses measures of marginal and average costs:

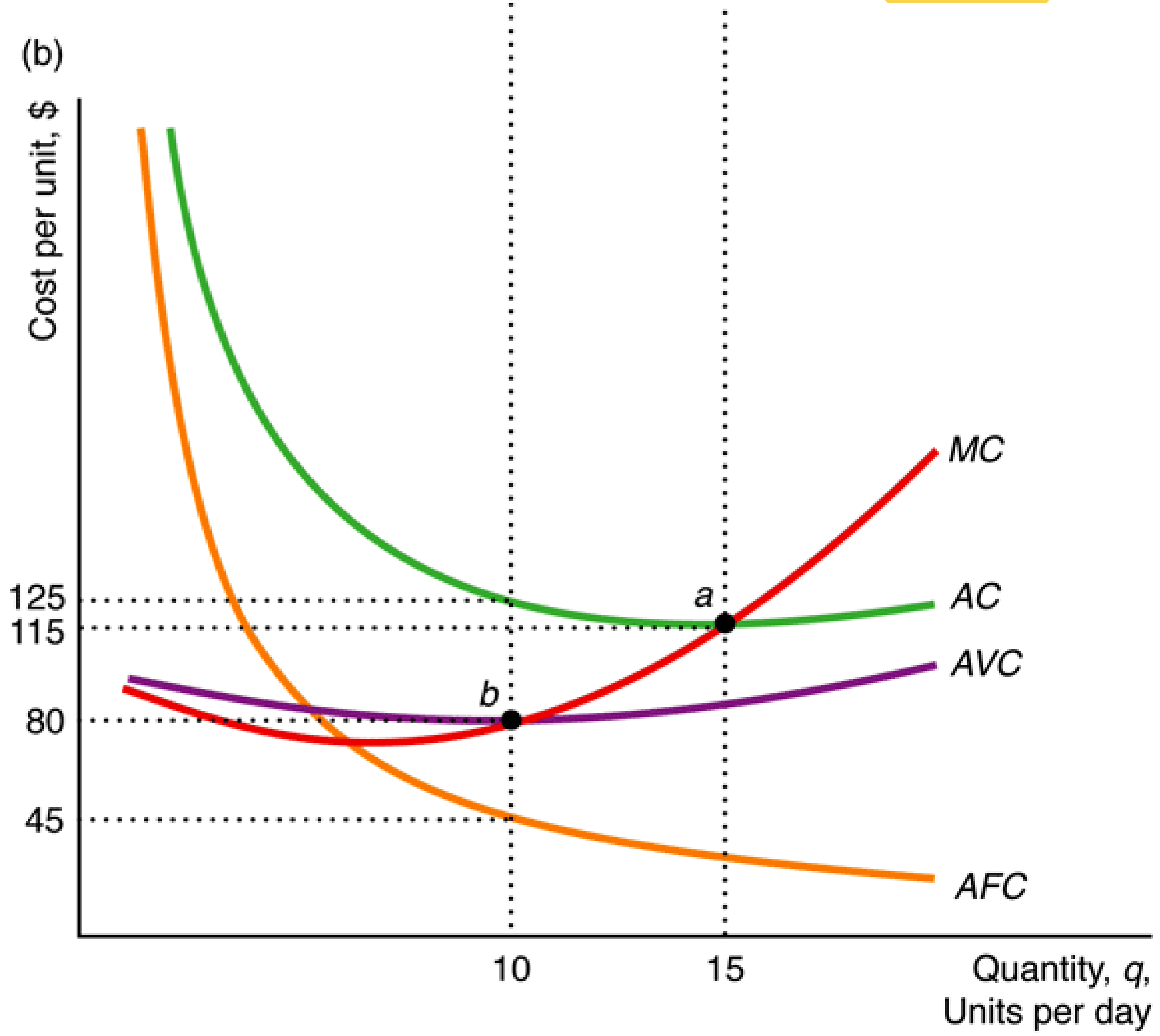
- **Marginal cost (MC):** the amount by which a firm's cost changes if it produces one more unit of output.

$$MC = \frac{\mathrm{d}C(q)}{\mathrm{d}q}$$

- **Average fixed cost (AFC):** FC divided by output produced $AFC = F / q$
- **Average variable cost (AVC):** VC divided by output produced $AVC = VC / q$
- **Average cost (AC):** C divided by output produced

$$AC = \frac{C}{q} = \frac{VC}{q} + \frac{F}{q} = AVC + AFC$$

Short-Run Cost Curves



Production Functions and the Shape of Cost Curves

- The SR production function, $q = f\left(L, \overline{K}\right)$, determines the shape of a firm's cost curves.
  - We can write *q = g(L)* because capital is fixed in the SR
  - Amount of L needed to produce q is $L = g^{-1}(q)$
- If the wage paid to labor is w and labor is the only variable input, then variable cost is *VC = wL.*
  - VC is a function of output: $V(q) = wL = w\,g^{-1}(q)$
- Total cost is also a function of output:

$$C(q) = V(q) + F = w\,g^{-1}(q) + F$$

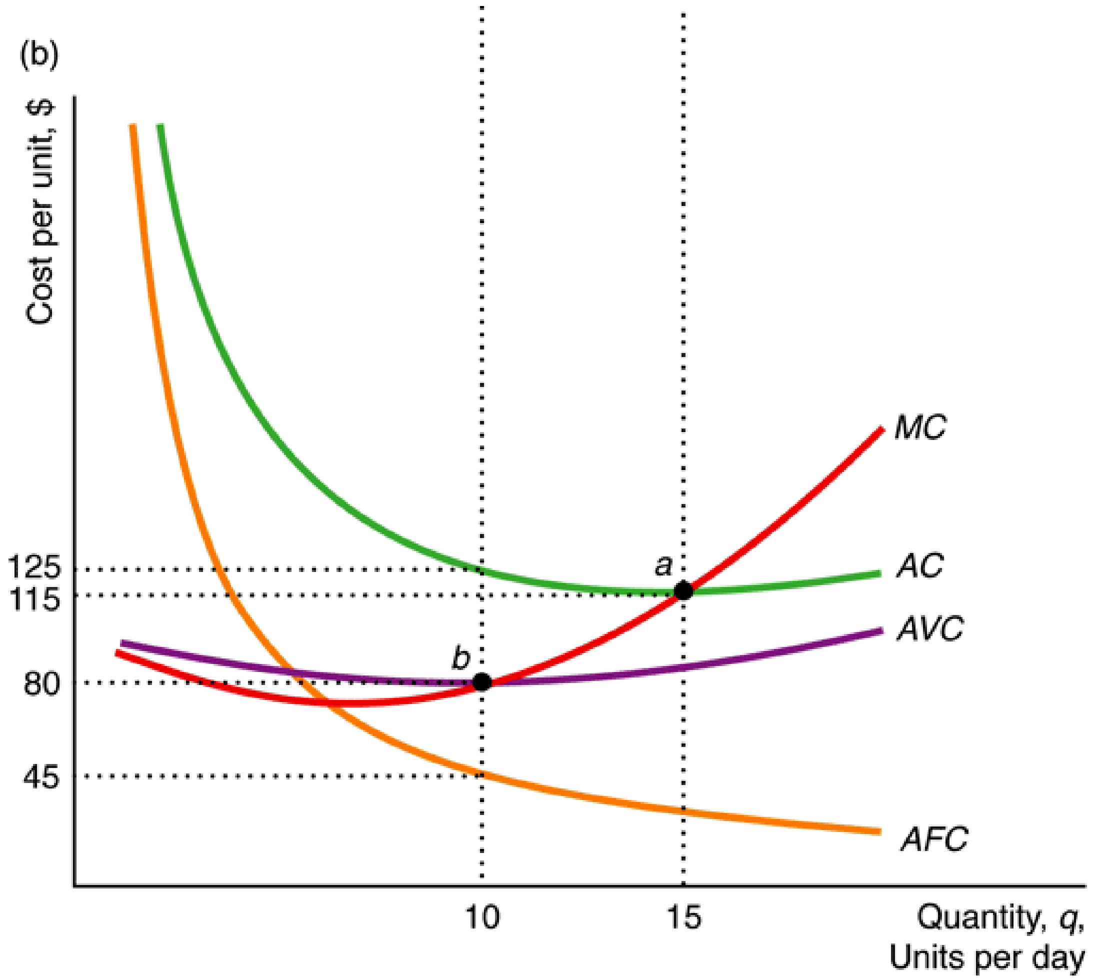
Production Functions and the Shape of Cost Curves

Shape of the MC curve:

$$MC = \frac{\mathrm{d}V(q)}{\mathrm{d}q} = w\frac{\mathrm{d}L}{\mathrm{d}q}$$

- MC moves in the opposite direction of MPL

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



Production Functions and the Shape of Cost Curves

Shape of the AC curve

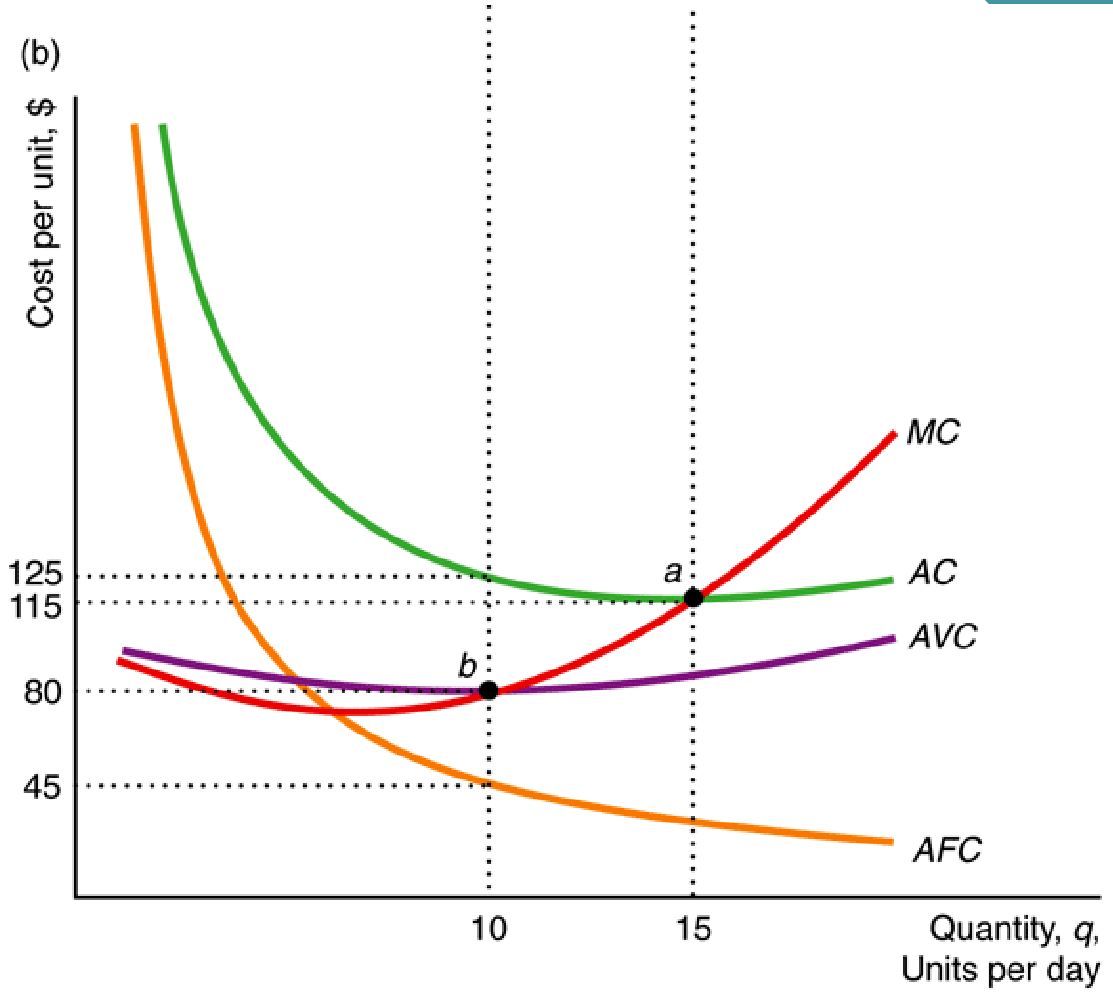
- Two components:
  - spreading fixed cost over output

$$AFC = F / q$$

  - diminishing marginal returns to labor in the AVC curve

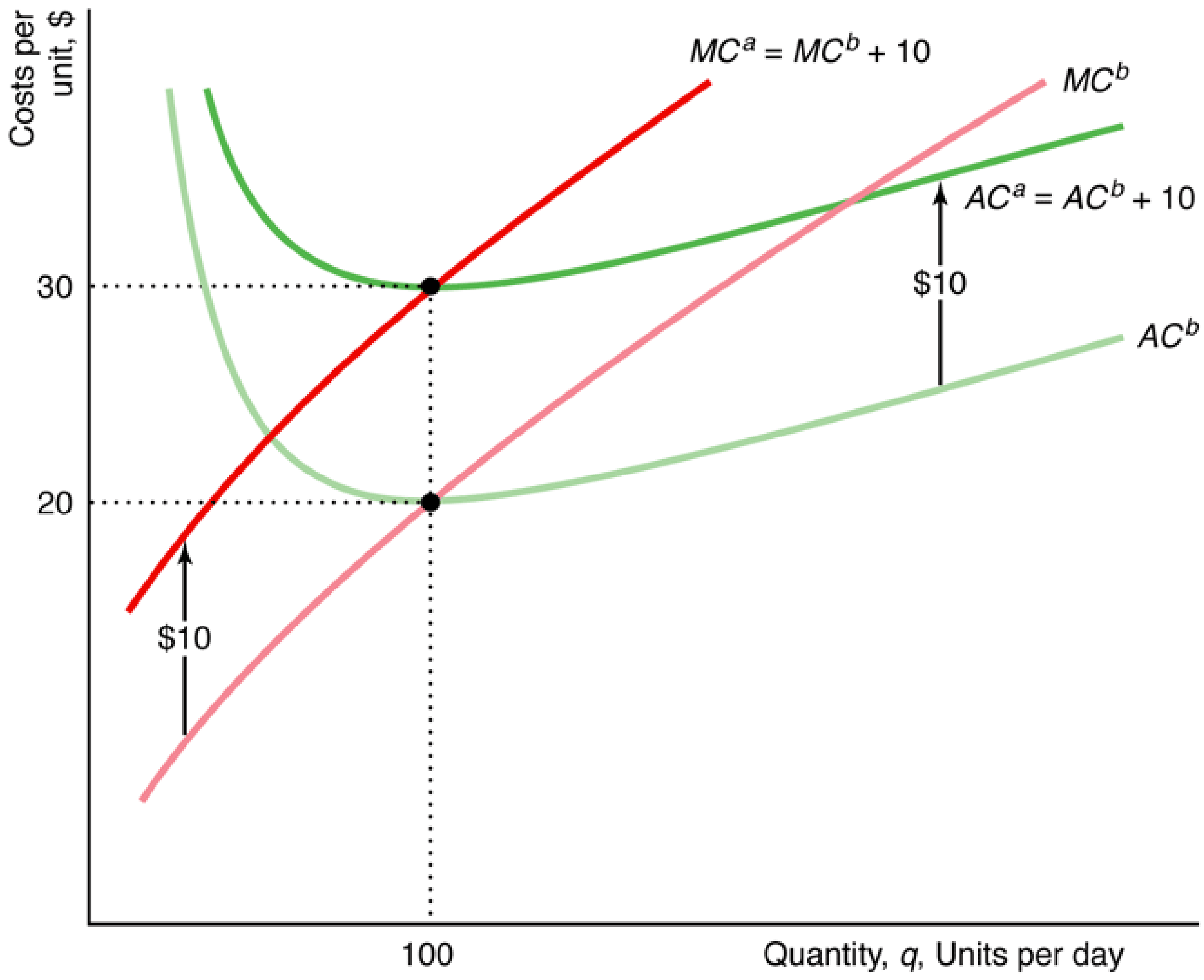
$$AVC = \frac{w}{AP_L}$$

- AC moves in the opposite direction of APL $AVC = \frac{VC}{q} = \frac{wL}{q}$



Effects of Taxes on Costs

A $10 per unit tax increases firm costs, shifting up both AC and MC curves.



Short-Run Cost Summary

- Costs of inputs that can't be adjusted are fixed and costs of inputs that can be adjusted are variable.
- Shapes of SR cost curves (VC, MC, AC) are determined by the production function.
- When a variable input has diminishing marginal returns, VC and C become steeper as output increases.
  - Thus, AC, AVC, and MC curves rise with output.
- When MC lies below AVC and AC, it pulls both down; when MC lies above AVC and AC, it pulls both up.
  - MC intersects AVC and AC at their minimum points.

3. Long-Run Costs

- Recall that the long run is a period of time in which all inputs can be varied.
  - In the LR, firms can change plant size, build new equipment, and adjust inputs that were fixed in the SR.
  - We assume LR fixed costs are zero (F = 0).
- In LR, firm concentrates on C, AC, and MC when it decides how much labor (L) and capital (K) to employ in the production process.

Long-Run Costs and Input Choice

- **Isocost line** summarizes all combinations of inputs that require the same total expenditure
  - If the firm hires L hours of labor at a wage of w per hour, total labor cost is wL.
  - If the firm rents K hours of machine services at a rental rate of r per hour, total capital cost is rK.
  - Cost is fixed at a particular level along a given isocost line: $\bar{C} = wL + rK$
- Rewrite the isocost equation for easier graphing: $$K = \frac{\bar{C}}{r} - \frac{w}{r}L$$

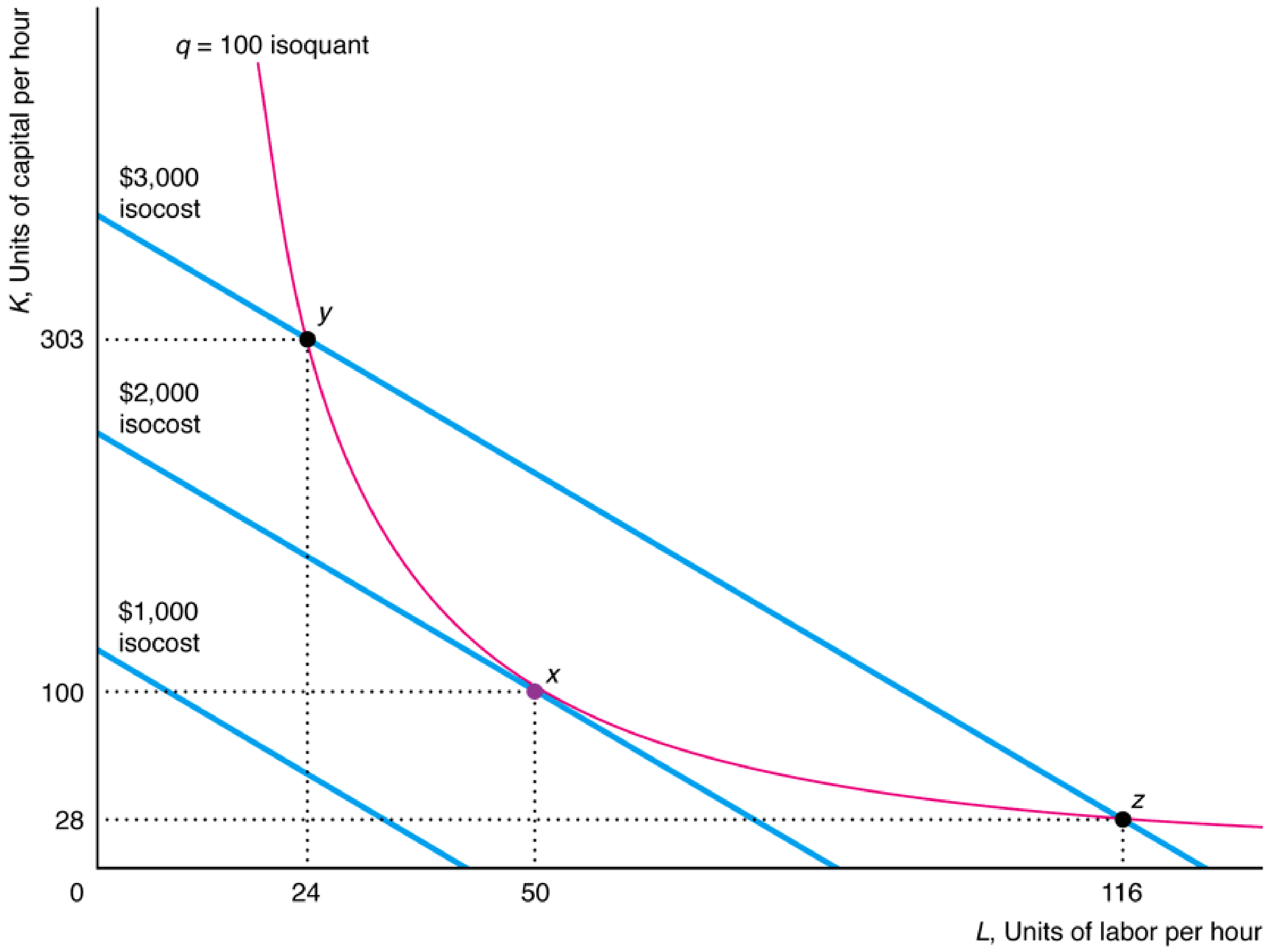
Isocost Lines

- Three properties of isocost lines:
  1) The firm's costs, C, and input prices determine where the isocost line hits the axes.
  2) Isocosts farther from the origin have higher costs than those closer to the origin.
  3) The slope of each isocost is the same and is given by the relative prices of the inputs.

$$\frac{\mathrm{d}K}{\mathrm{d}L} = -\frac{w}{r}$$

Cost Minimization

This firm is seeking the least cost way of producing 100 units of output.



Cost Minimization

Three equivalent approaches to minimizing cost:

- **Lowest-isocost rule:** Pick the bundle of inputs where the lowest isocost line touches the isoquant associated with the desired level of output.
- **Tangency rule:** Pick the bundle of inputs where the desired isoquant is tangent to the budget line.

$$MRTS = -\frac{w}{r}$$

- **Last-dollar rule:** Pick the bundle of inputs where the last dollar spent on one input yields as much additional output as the last dollar spent on any other input.

$$\frac{MP_L}{MP_K} = \frac{w}{r}$$ or rewrite as $$\frac{MP_L}{w} = \frac{MP_K}{r}$$

Using Calculus to Minimize Cost

- Minimizing cost subject to a production constraint yields the Lagrangian and its first-order conditions:

$$\min_{L,K,\lambda} \mathcal{L} \approx wL + rK + \lambda\left[\bar{q} - f\left(L, K\right)\right]$$

$$\frac{\partial \mathcal{L}}{\partial L} = w - \lambda \frac{\partial f}{\partial L} = 0$$

$$\frac{\partial \mathcal{L}}{\partial K} = r - \lambda \frac{\partial f}{\partial K} = 0$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = \bar{q} - f\left(L, K\right) = 0$$

- Rearranging terms reveals the last-dollar rule: $\dfrac{w}{r} = \dfrac{\frac{\partial f}{\partial L}}{\frac{\partial f}{\partial K}} = \dfrac{MP_L}{MP_K}$

Output Maximization with Calculus

- The "dual" problem to cost minimization is **output maximization**.
- Maximizing output subject to a cost constraint yields the Lagrangian and its first-order conditions:

$$\max_{L, K, \lambda} \mathcal{L} = f(L, K) + \lambda(\bar{C} - wL - rK)$$

$$\frac{\partial \mathcal{L}}{\partial L} = \frac{\partial f}{\partial L} - \lambda w = 0$$

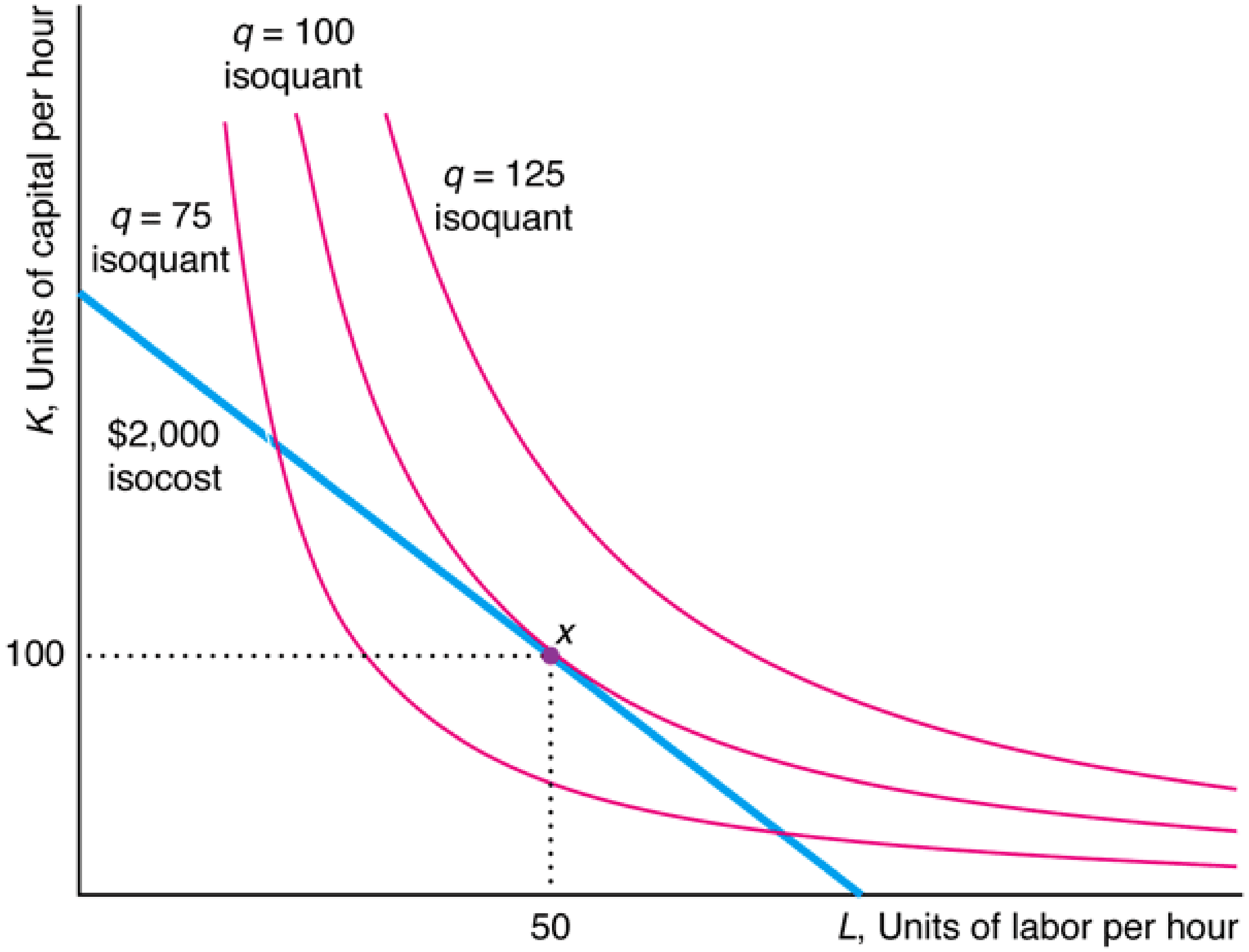
$$\frac{\partial \mathcal{L}}{\partial K} = \frac{\partial f}{\partial K} - \lambda r = 0$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = \bar{C} - wL - rK = 0$$

- Rearranging terms reveals the tangency rule: $\frac{w}{r} = \frac{\frac{\partial f}{\partial L}}{\frac{\partial f}{\partial K}} = \frac{MP_L}{MP_K}$

Output Maximization

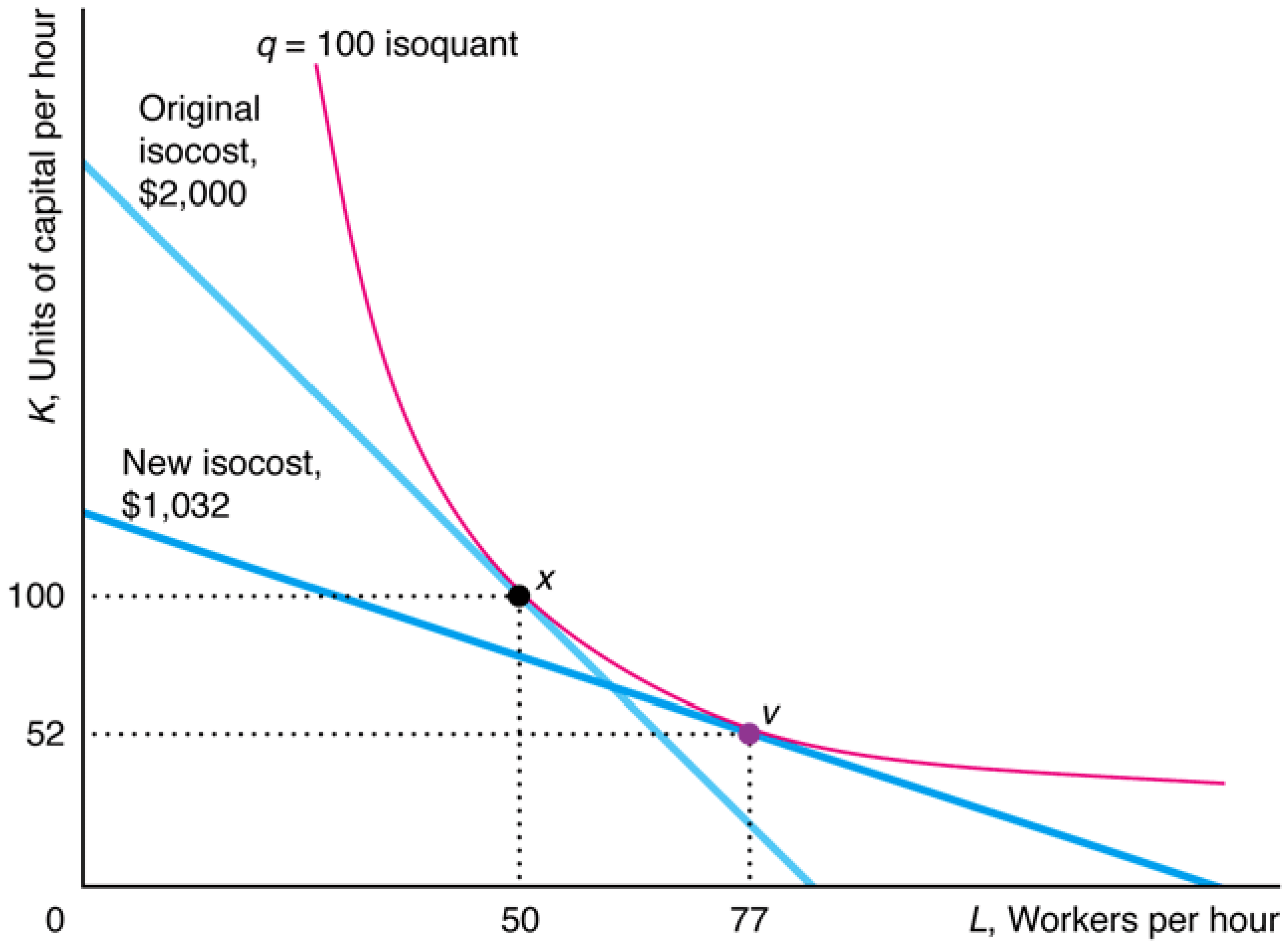
This firm is seeking the maximum output way of spending $2,000.



Factor Price Changes

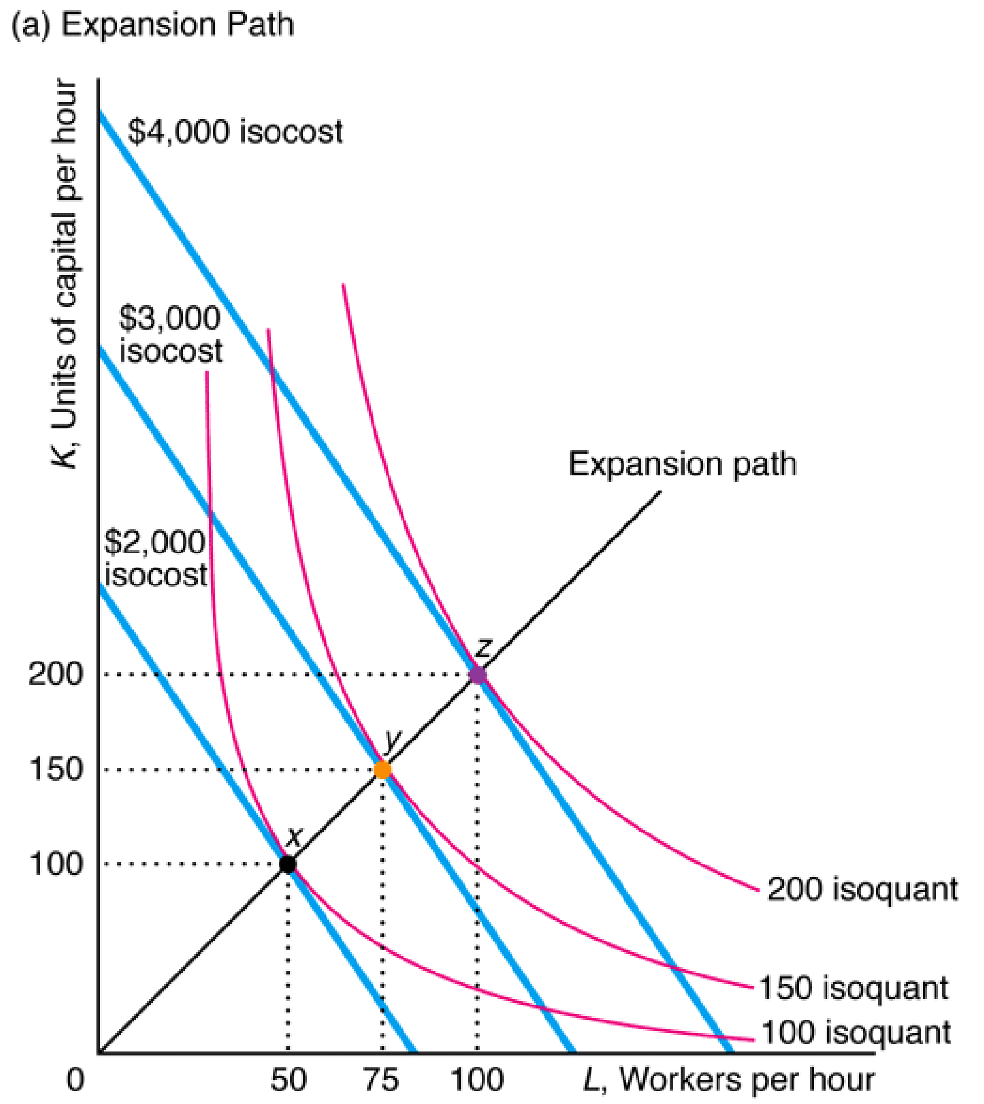
Originally, w = \$24 and r = \$8. When w falls to \$8, the isocost becomes flatter and the firm substitutes toward labor, which is now relatively cheaper.

Firm can now produce same q=100 more cheaply.



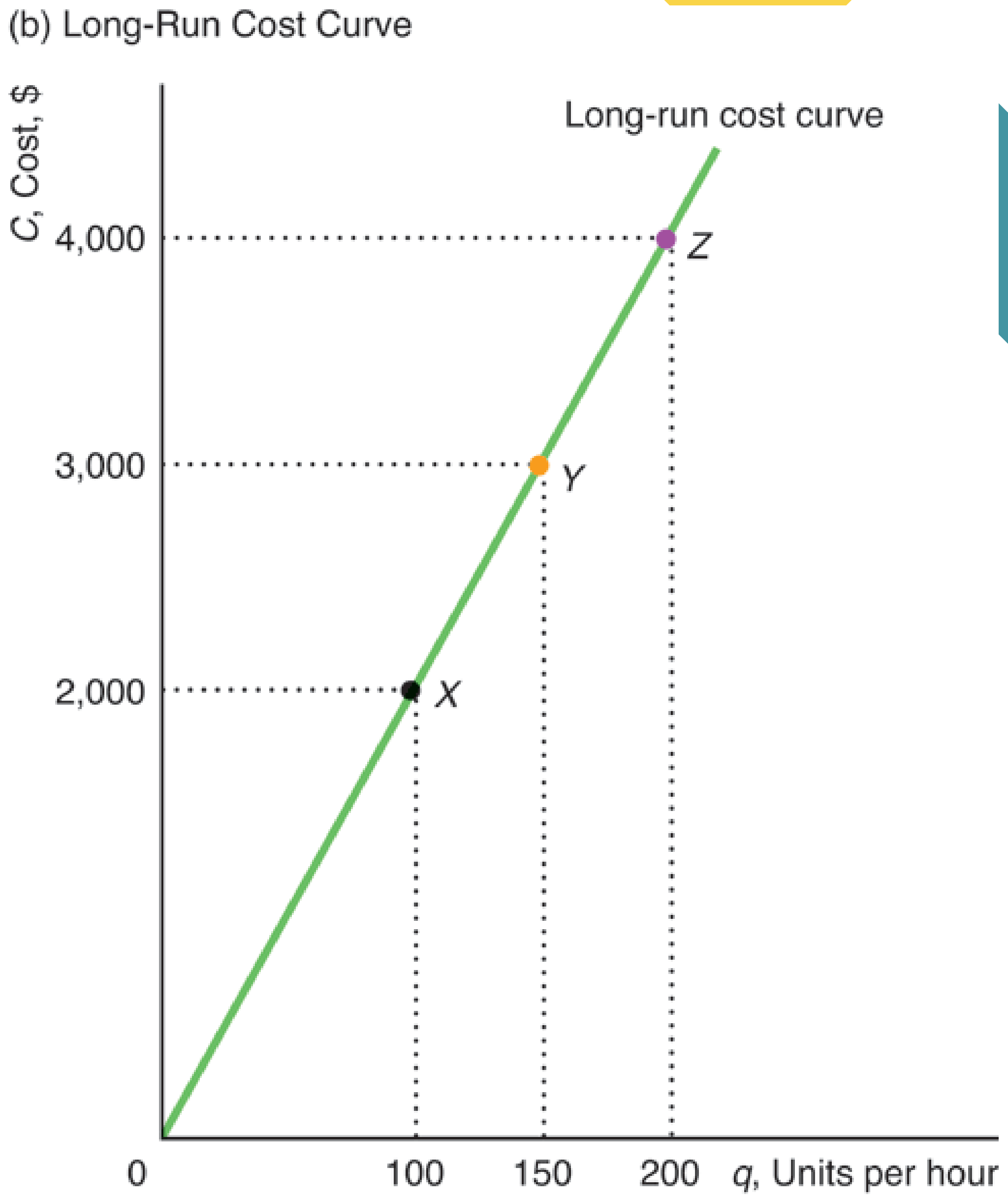
How LR Cost Varies with Output

As a firm increases output, the **expansion path** traces out the cost-minimizing combinations of inputs employed.



How LR Cost Varies with Output

The expansion path enables construction of a LR cost curve that relates output to the least cost way of producing each level of output.



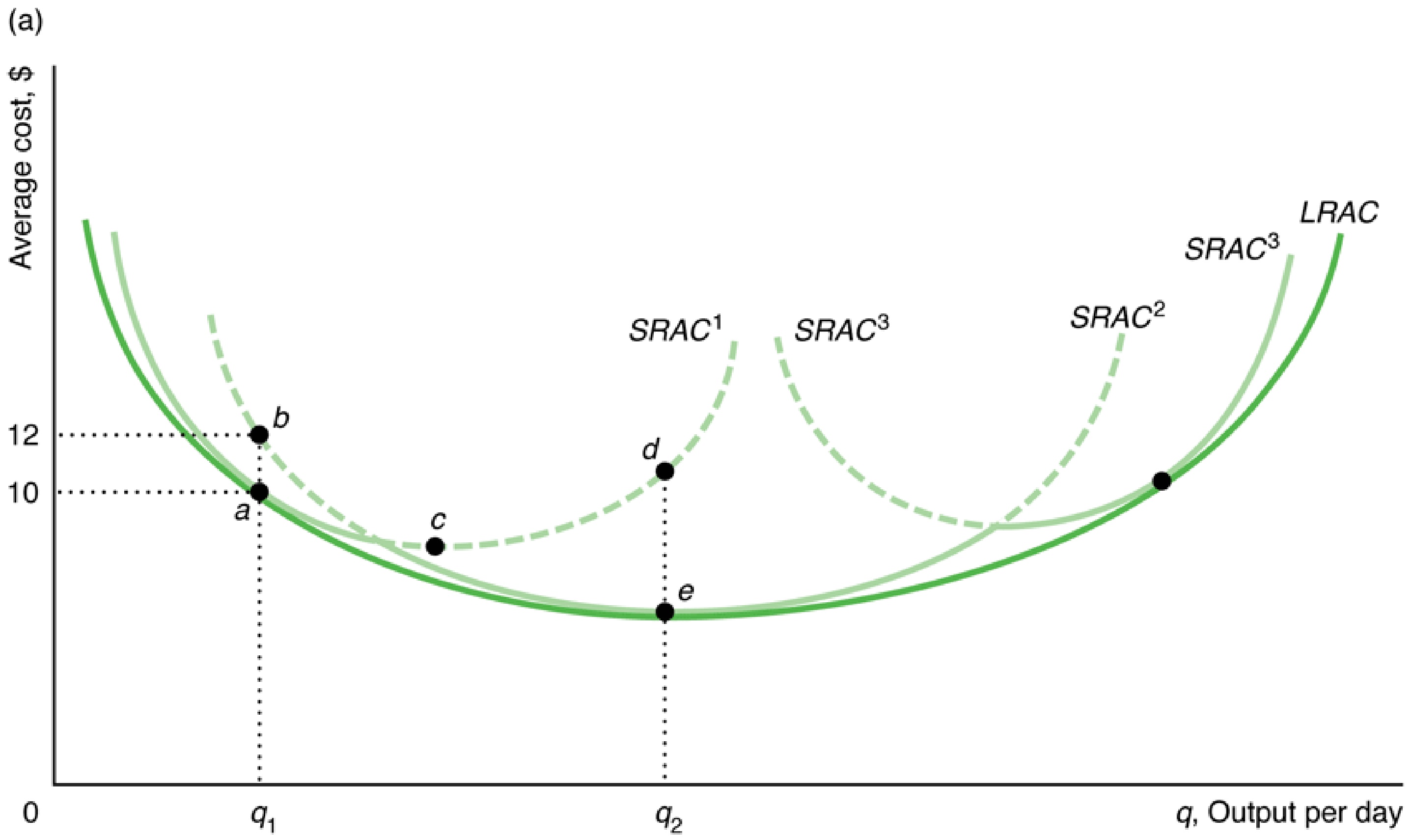
The Shape of LR Cost Curves

- The LR AC curve may be U-shaped
  - Not due to downward-sloping AFC or diminishing marginal returns, both of which are SR phenomena, as it is for SR AC.
  - Shape is due to economies and diseconomies of scale.
- A cost function exhibits economies of scale if the average cost of production falls as output expands.
  - Doubling inputs more than doubles output, so AC falls with higher output.
- A cost function exhibits diseconomies of scale if the average cost of production rises as output expands.
  - Doubling inputs less than doubles output, so AC rises with higher output.

4. Lower Costs in the Long Run

Because a firm cannot vary K in the SR but it can in the LR, SR cost is as least as high as LR cost.

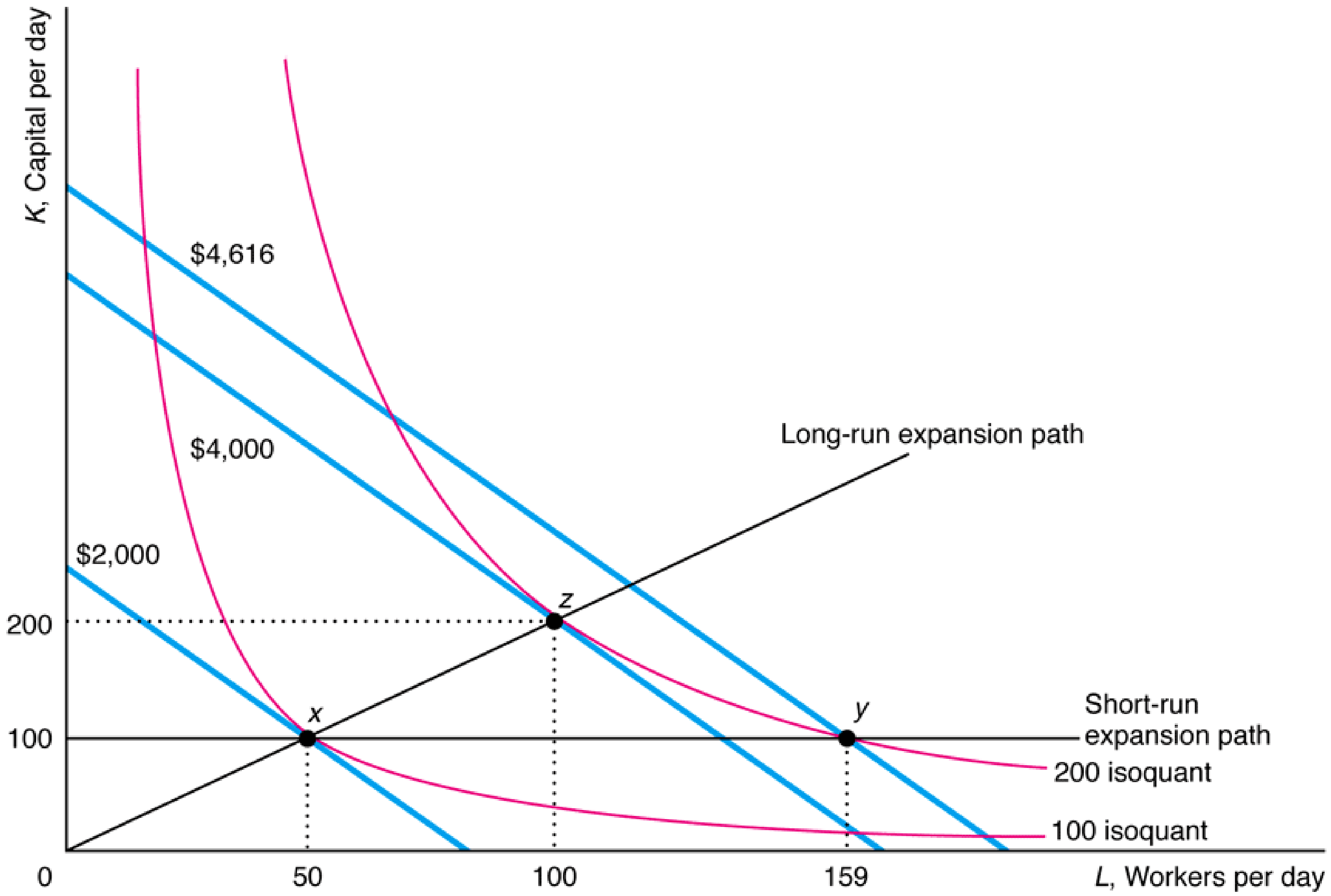
- … and even higher if the “wrong” level of K is used in the SR.



SR and LR Expansion Paths

Firms have more flexibility in the LR.

- Expanding output is cheaper in LR than in SR because of ability to move away from fixed capital choice.



5. Cost of Producing Multiple Goods

- If a firm produces multiple goods, the cost of one good may depend on the output level of the other.
  - Outputs are linked if a single input is used to produce both.
- There are **economies of scope** if it is cheaper to produce goods jointly than separately.
  - Measure: $$SC = \frac{C(q_1, 0) + C(0, q_2) - C(q_1, q_2)}{C(q_1, q_2)}$$

C(q1, 0) = cost of producing q1 units of good 1 by itself

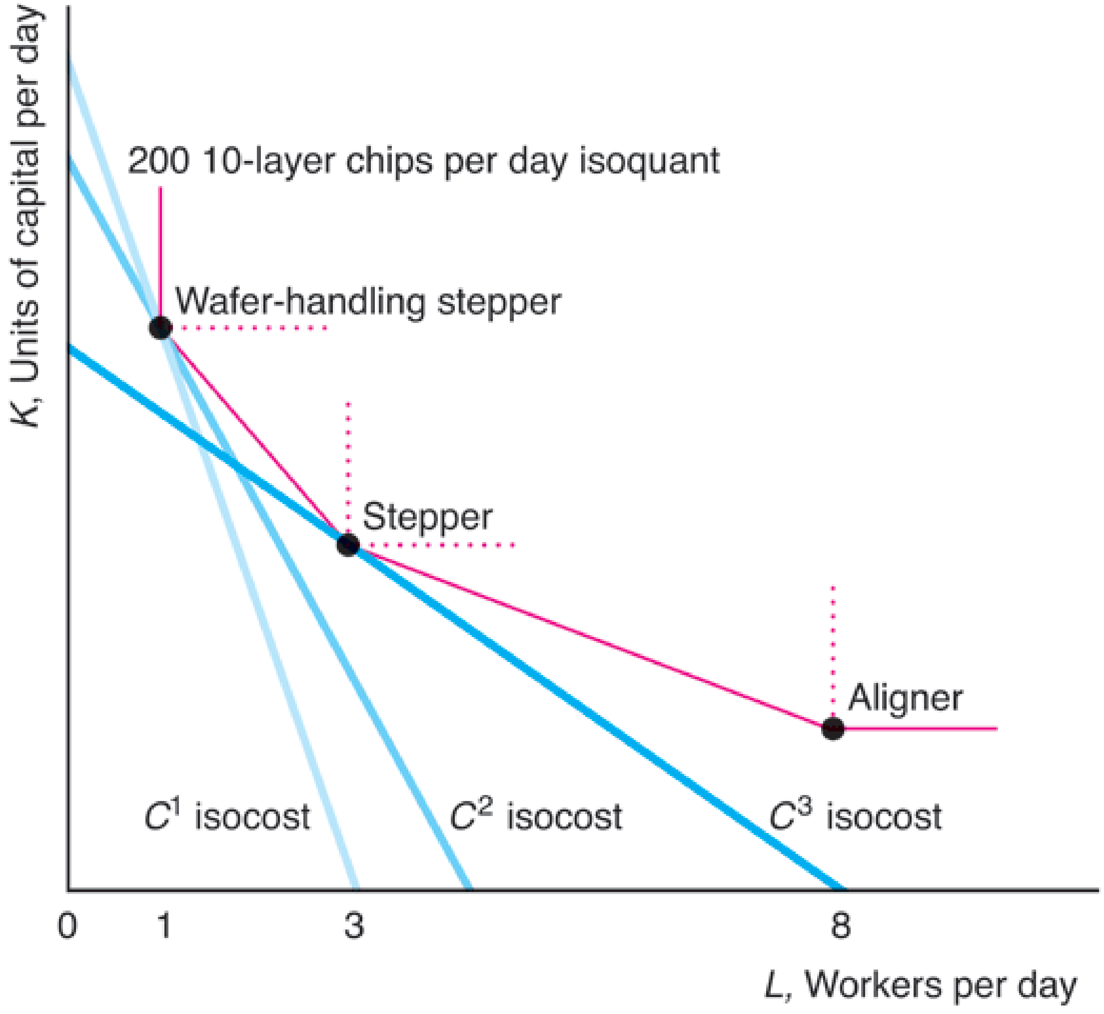
C(0, q2) = cost of producing q2 units of good 2 by itself

C(q1, q2) = cost of producing both goods together

- SC > 0 implies it is cheaper to produce the goods jointly.

Challenge Solution

- A semiconductor manufacturer can use one of three manufacturing technologies: water-handling stepper, stepper, or aligner.
- The U.S. isocost line, with relatively higher labor costs, is C1. Use water-handling stepper technology in the U.S.
- If the foreign isocost line is C2, then same manufacturing technology as in the U.S. If the isocost line is C3, then the stepper technology. If even flatter isocost lines, then the aligner technology.



Cost of Producing Multiple Goods

Production possibilities frontier (PPF) bows away from the origin if there are economies of scope.

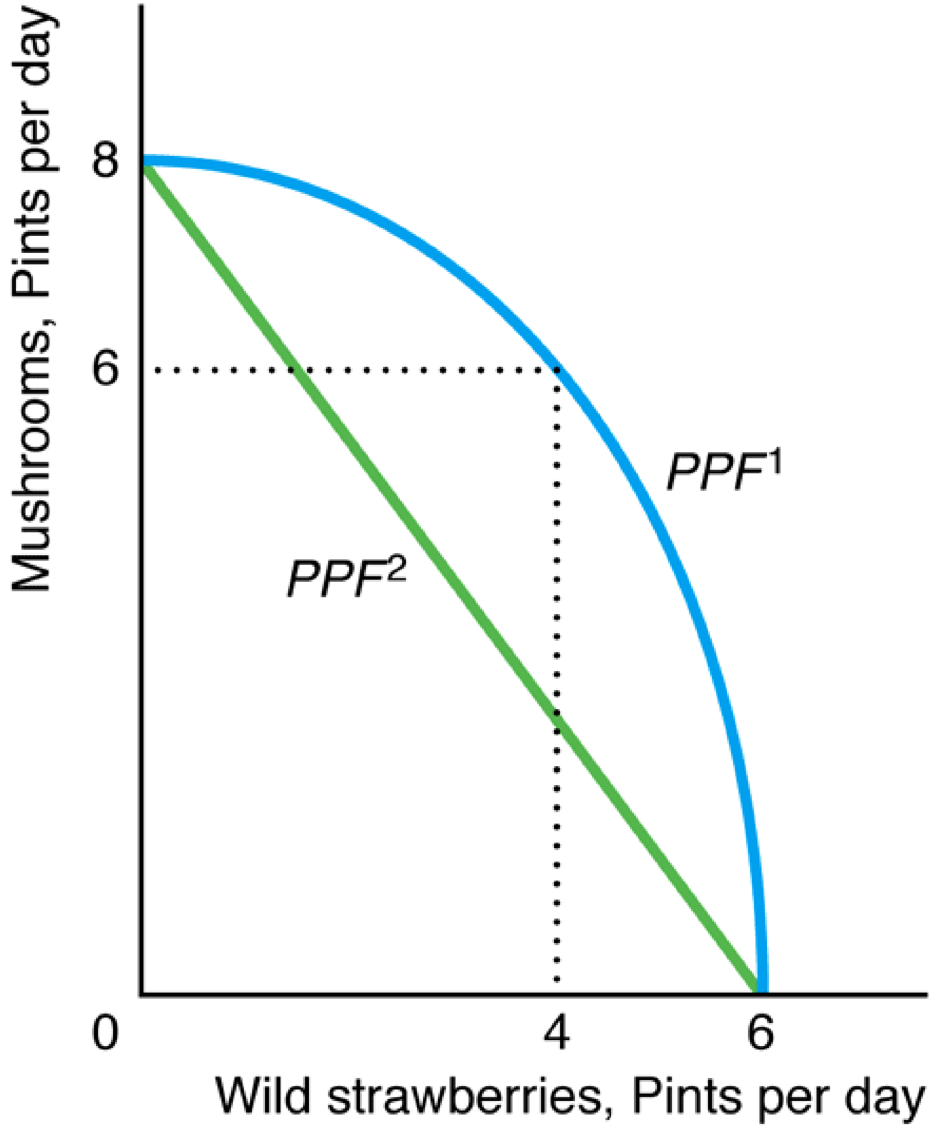


Figure 7.7(b) SR and LR Cost Curves

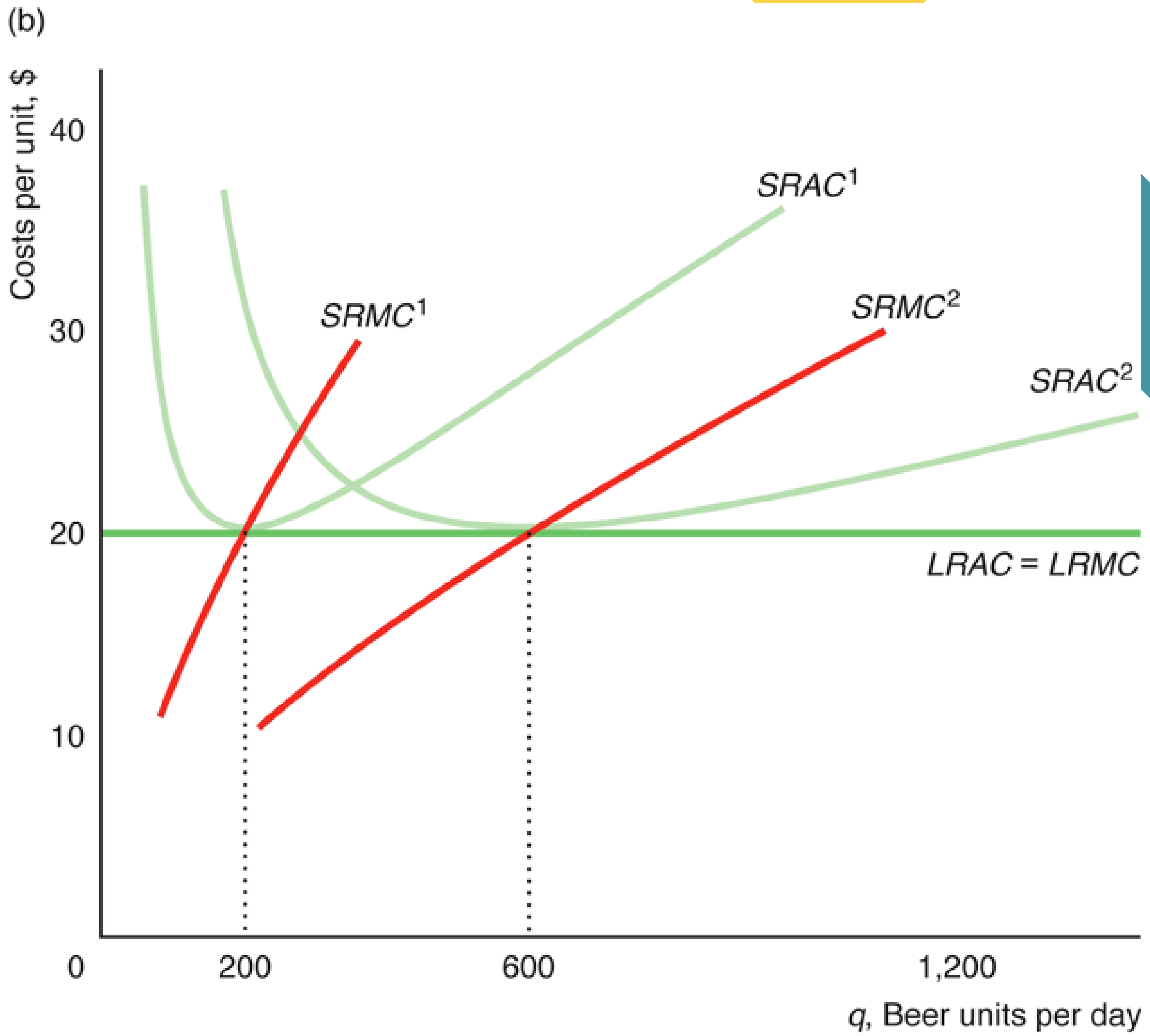
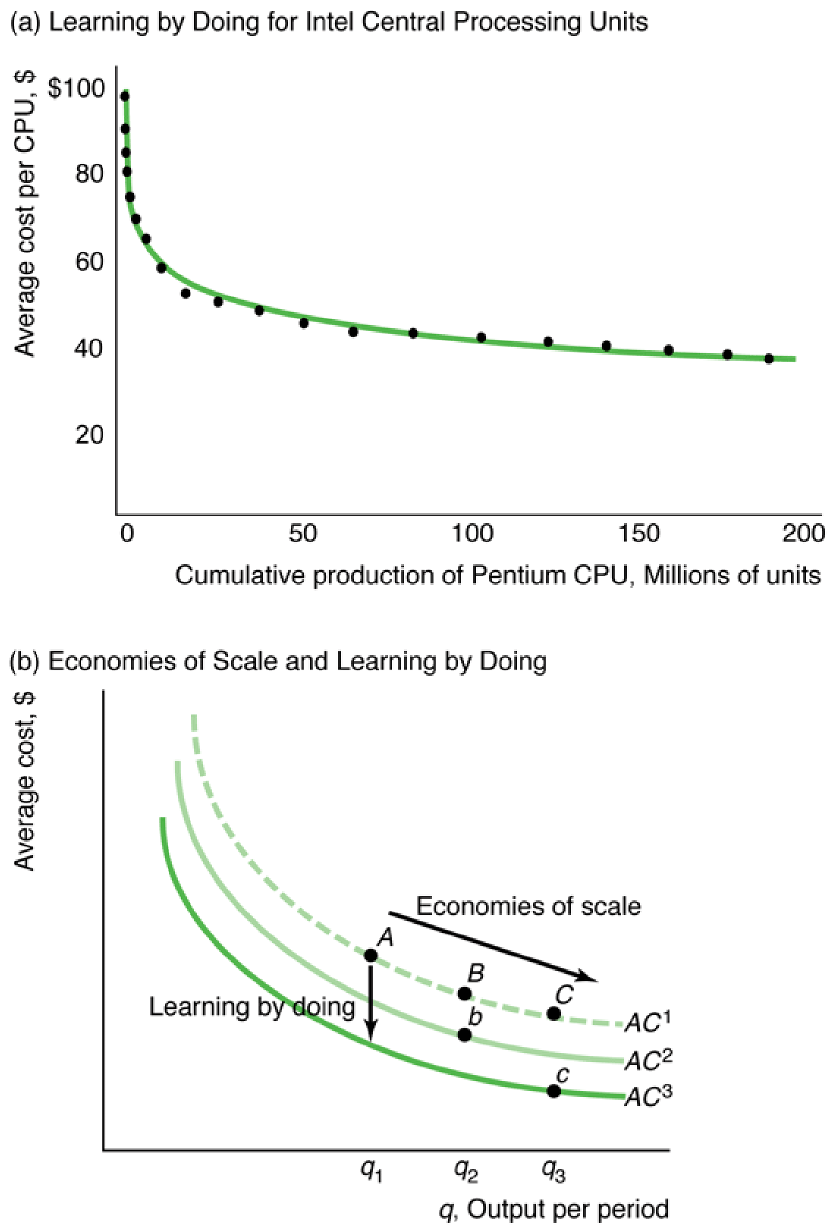
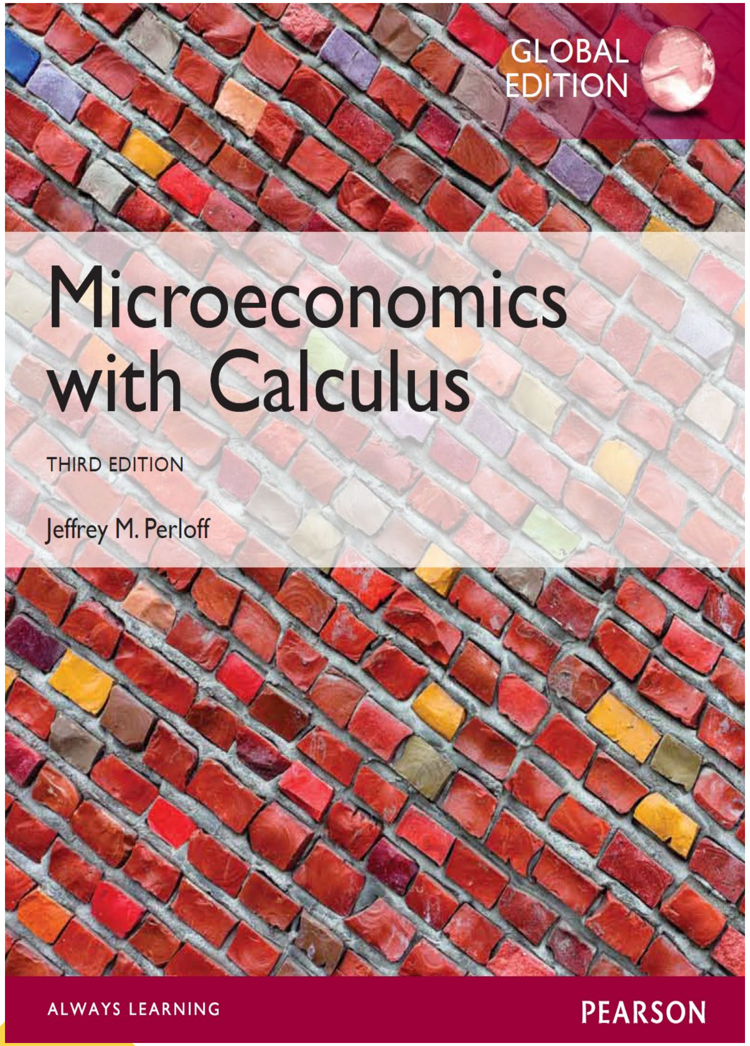


Figure 7.9 Learning by Doing





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Chapter 7 - Microeconomics: Theory and Applications with Calculus, 3rd Edition. By Jeffrey M. Perloff. 2014 Pearson Education.