Chapter 7

Costs

Capital and Labor Costs

- **Capital** is a **durable good**, useable over a long period of time
    - Assume that firms **rent** units of capital K at a specific price per unit/time of r
- **Labor** L is paid in wages w
    - Simplification — sometimes other compensation is offered to workers

Other Types of Costs

- **Sunk costs:** previous expenditures OR any expenditures you are legally locked into
  - Playing poker, money you've already bet is a sunk cost
  - Sunk costs should not factor into your current decisions under optimal decision making rules
  - Economic thinking is MARGINAL thinking

Short Run Costs: Fixed and Variable

- **Fixed Cost F:** a production expense that does not vary with SR output

- **Variable Cost VC:** a production expense that does vary with SR output

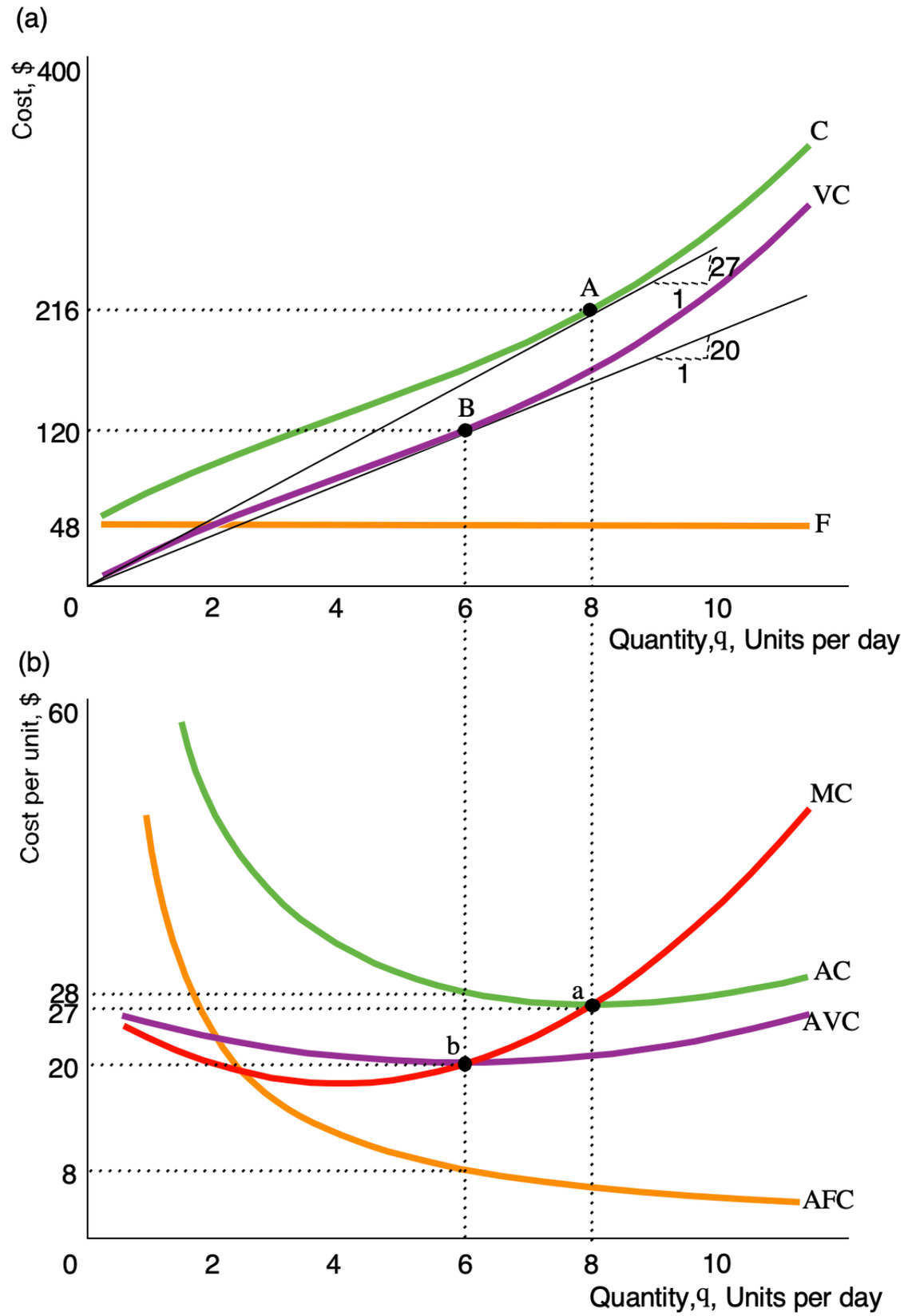
- **Cost C** or **Total Cost TC:** $VC + F$

- **Marginal Cost MC:** the change in C from producing one more unit of output: $MC = \frac{\Delta C}{\Delta q} = \frac{\Delta VC}{\Delta q}$

Short Run Average Costs

- **Average Fixed Cost** AFC: $\frac{F}{q} = \frac{rK}{q}$
- **Average Variable Cost** AVC: $\frac{VC}{q} = \frac{wL}{q} = \frac{w}{AP_L}$
- **Average Cost** AC or **Average Total Cost** ATC: $\frac{c}{q}$
- What shape should each curve have as we increase q?

Short Run Cost Curves



Variation of Short Run Cost with Output

Output	Fixed Cost	Variable Cost	Total Cost	Marginal Cost	Average Fixed Cost	Average Variable Cost	Average Cost
0	48	0	48				
1	48	25	73	25	48	25	73
2	48	46	94	21	24	23	47
3	48	66	114	20	16	22	38
4	48	82	130	16	12	20.5	32.5
5	48	100	148	18	9.6	20	29.6
6	48	120	168	20	8	20	28
7	48	141	189	21	6.9	20.1	27
8	48	168	216	27	6	21	27
9	48	198	246	30	5.3	22	27.3
10	48	230	278	32	4.8	23	27.8
11	48	272	320	42	4.4	24.7	29.1
12	48	321	369	49	4.0	26.8	30.8

Short Run Costs Summary

- In SR fixed costs are sunk and cannot be avoided, but variable costs can be

- The trait of diminishing marginal returns to labor causes the VC, MC, and C curves to become steep as SR output rises
    - Also causes the average cost curves to rise at high output levels

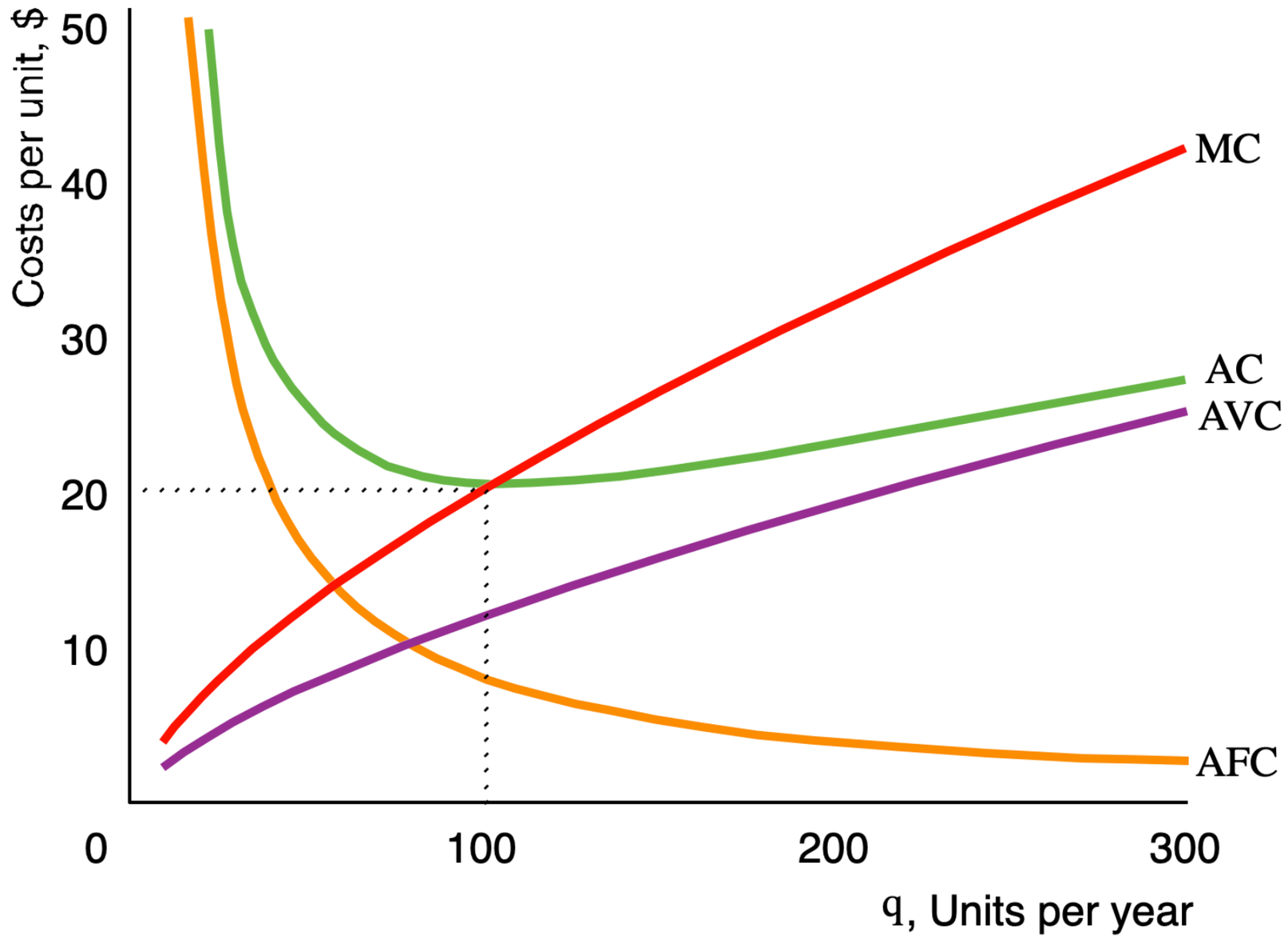
- What causes the MC and other curves to initially fall?

- **Marginal pulls averages** — the intersection of the MC curve with the AVC and AC curves will occur at the minimum levels

Short Run Costs Summary

- Cost of inputs that can't be adjusted are fixed and costs 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
    - AC, AVC, 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 the minimum points
- Short run cost function: $C = 15 - 6q^2 + 3q^3$ – how would this look in the long run?

Short-Run Cost Curves When MC is Increasing



Practice Question

- Assume a firm has a short-run cost function of $C(q) = 200q - 6q^2 + 0.3q^3 + 450$

1. Solve for the firm's marginal cost (as a function of q)
2. Solve for the firm's average variable cost
3. Solve for the firm's average total cost
4. Solve for the quantity produced that minimizes the firm's AVC function
    - Hint: there are two ways to do #4, think about what hits the AVC at its lowest point

Long Run Costs

- ALL costs are avoidable (variable)
    - **NO FIXED COSTS — NO INTERCEPT IN COST FUNCTION**

$$C = 100q - 3q^2 + q^3$$

- This means instead of 7 types of cost curves like in the SR, we only have 3 to worry about in the LR
    1. Total Cost TC
    2. Average Cost AC
    3. Marginal Cost MC

Input Choices in Production

- Recall from Chapter 6 that in the LR, firms have choice over which inputs to use to produce the desired output level
- How did we say they would choose between different combinations of inputs that produced the exact same level of output?
- Firms' LR decisions determine their SR costs
- We can examine costs using the simple equation $C = wL + rK$

Bundles of Labor and Capital that Cost the Firm $100

Bundle	Labor, L	Capital, K	Labor Cost, $wL = \$5L$	Capital Cost, $rK = \$10K$	Total Cost, $wL + RK$
a	20	0	$100	$0	$100
b	14	3	$70	$30	$100
c	10	5	$50	$50	$100
d	6	7	$30	$70	$100
e	0	10	$0	$100	$100

Isocost Lines

- Combinations of inputs that require the same (iso) total expenditure (cost)

$$\bar{C} = wL + rK$$

- Important point: the slope of the isocost line will always the the negative of the price ratio between labor and capital, $-\frac{w}{r}$

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

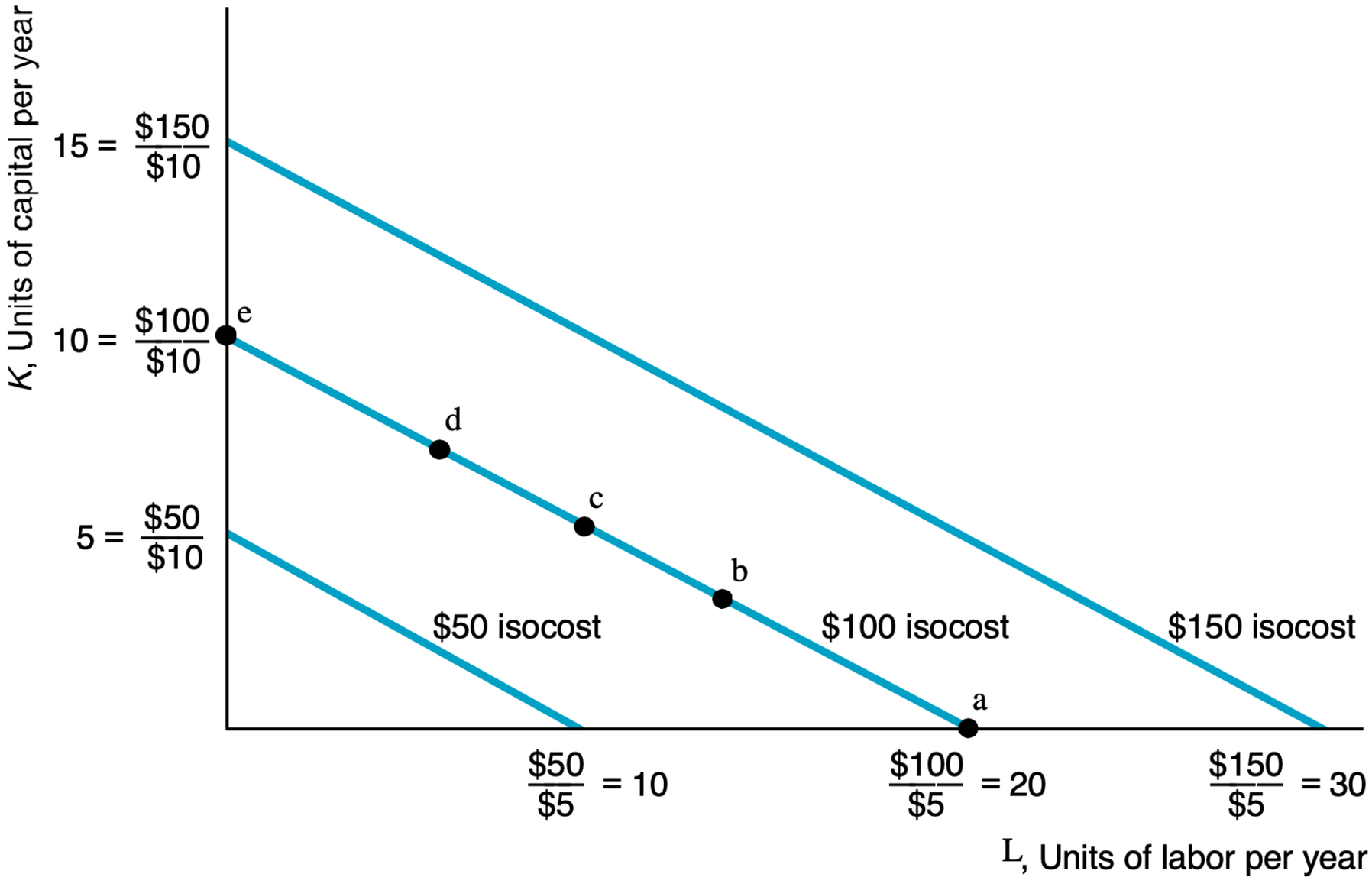
$$\frac{dK}{dL} = -\frac{w}{r}$$

Similarity to Budget Constraints

- Isocost curves are very similar to the budget constraints faced by consumers

- One very important difference…what is it?

A Family of Isocost Lines



Combining Input Costs and Production Functions

- The firm wants to produce a given output (isoquant) at the lowest possible cost

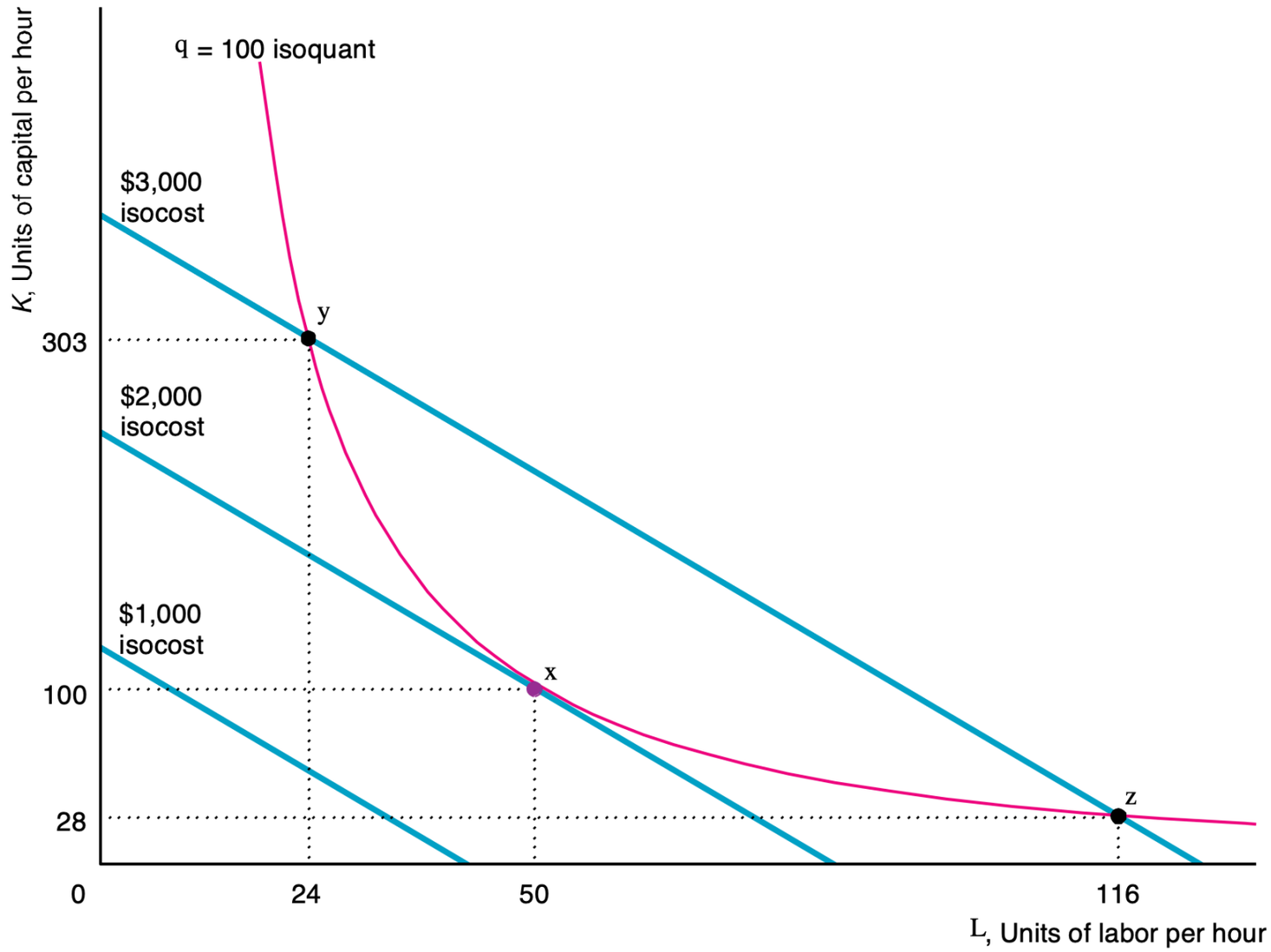
- There are three equivalent rules they can follow:

1. Lowest-isocost rule: pick the bundle of inputs where the lowest possible isocost line that touches the isoquant lies

2. Tangency rule: pick the bundle of inputs where the isoquant is tangent to the isocost line

3. Last-dollar rule: pick the bundle of inputs where the last dollar spent on one input has the same marginal product as the last dollar spent on any other input

Cost Minimization



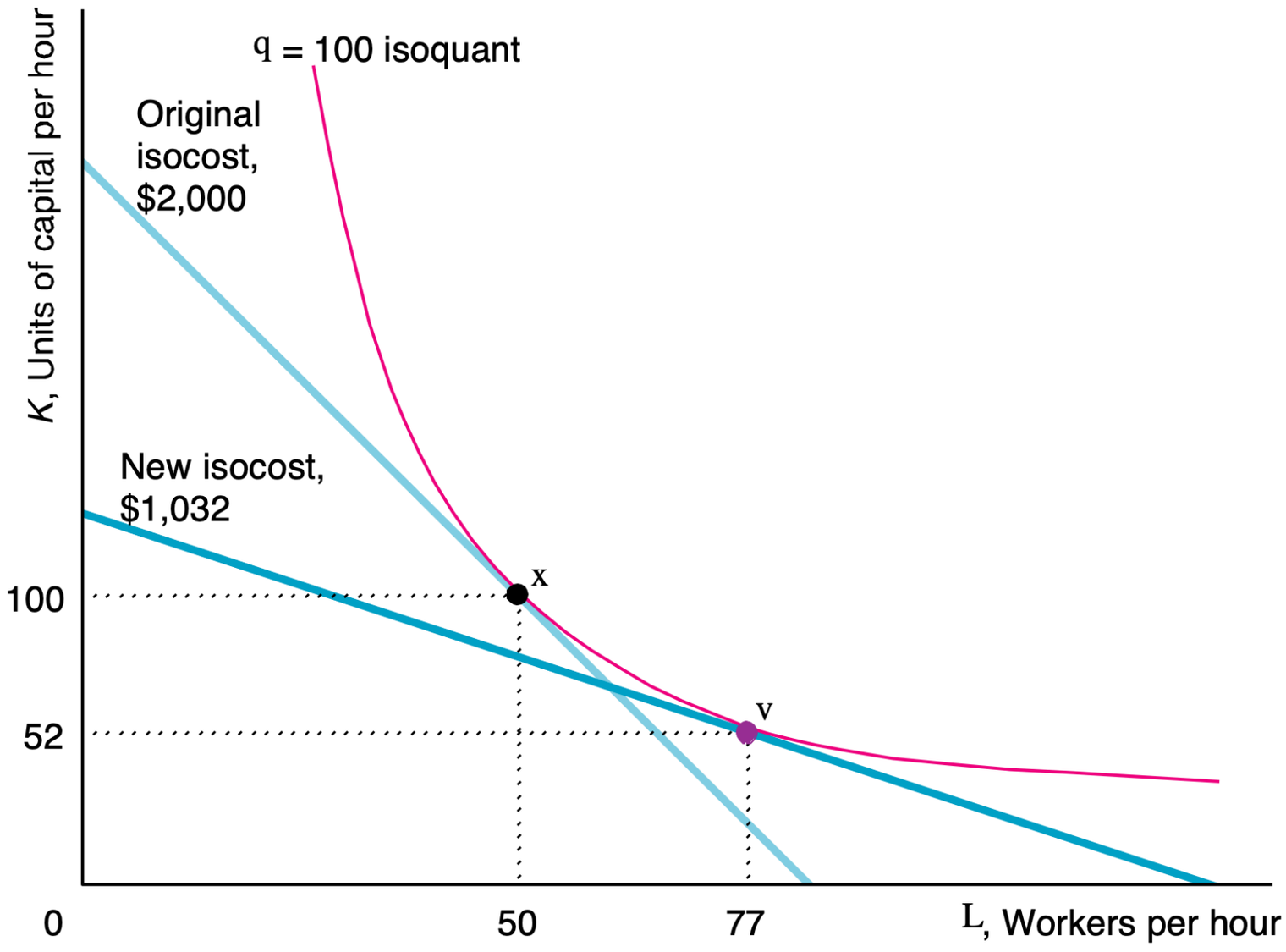
What point should the firm produce at and why?

Cost Minimization

- If we follow a constrained cost minimization problem, subject to a production constraint, we find that the follow condition must hold:

$$\frac{MP_L}{MP_K} = \frac{w}{r} \quad \text{or} \quad \frac{MP_L}{w} = \frac{MP_K}{r}$$

Change in Factor Price: Substituting Towards a Factor When it Becomes Cheaper



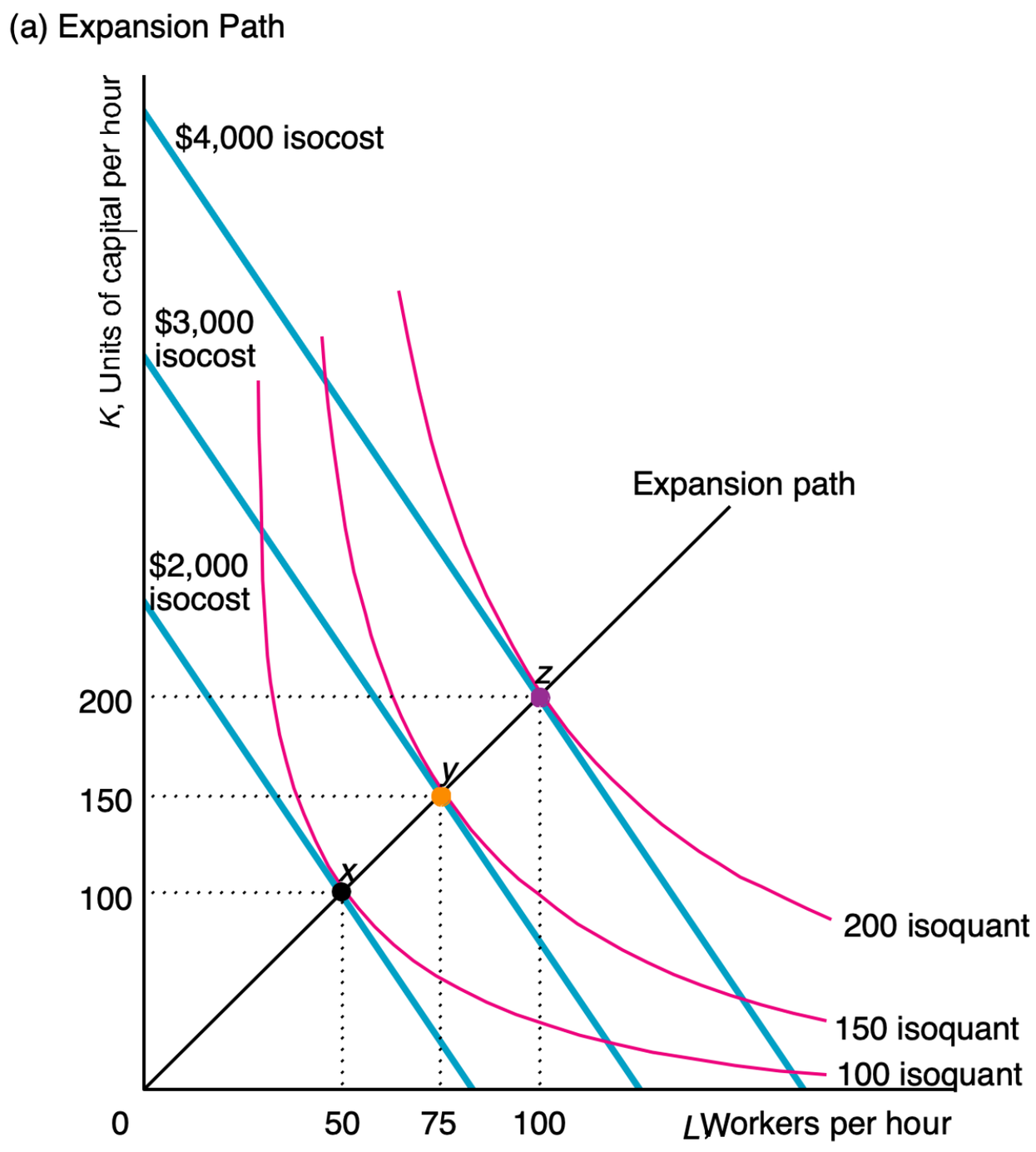
What point should the firm produce at and why?

How do Long Run Costs Vary with Output Levels?

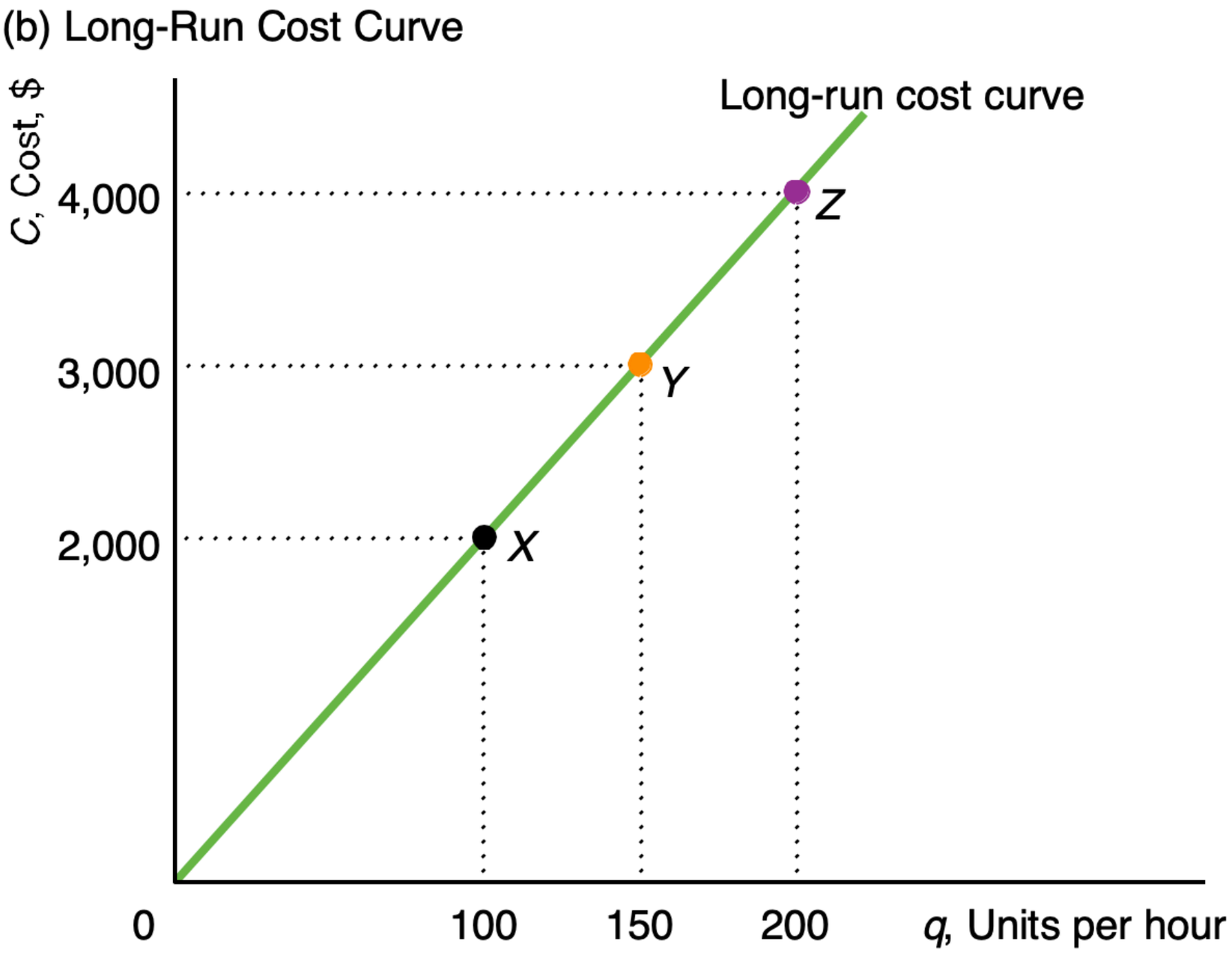
- **Expansion Path:** the cost-minimizing combination of labor and capital for every possible output level

- Another name for the expansion path is the **Long Run Cost Curve**

Expansion Path and Long Run Cost Curve



Expansion Path and Long Run Cost Curve (cont'd)



Working with LR Total Costs

- Once we have LR total cost levels, we can use them to find marginal and average costs in the LR

- Same formulas as the SR costs

- Marginal Cost: $LRMC = \frac{\Delta C}{\Delta q}$

- Average Cost: $LRAC = \frac{C}{q}$

Relating Economies of Scale to SR Production

- In the short run:
  - SRAC initially slopes down because of fixed costs
  - SRAC slopes up at higher levels of production — diminishing returns
- What would the LRAC look like?

Relating Economies of Scale to LR Production

- Economies of scale: property of a cost function whereby the average cost of production falls as output expands (i.e. increasing returns to scale)
    - Visually, a downward slope to the LRAC curve
- Diseconomies of scale: Property of a cost function whereby the average cost of production increases as output rises (i.e. decreasing returns to scale)
    - Visually, an upward sloping LRAC curve
- Note that if the LRAC is flat, constant returns to scale

Question

- Which product do you think has stronger economies of scale present in the production technology for making it?

A. Commercial Airplanes

B. Fresh donuts

Application

- Would the presence of persistent economies of scale lead to a market with lots of small firms or a few large ones?

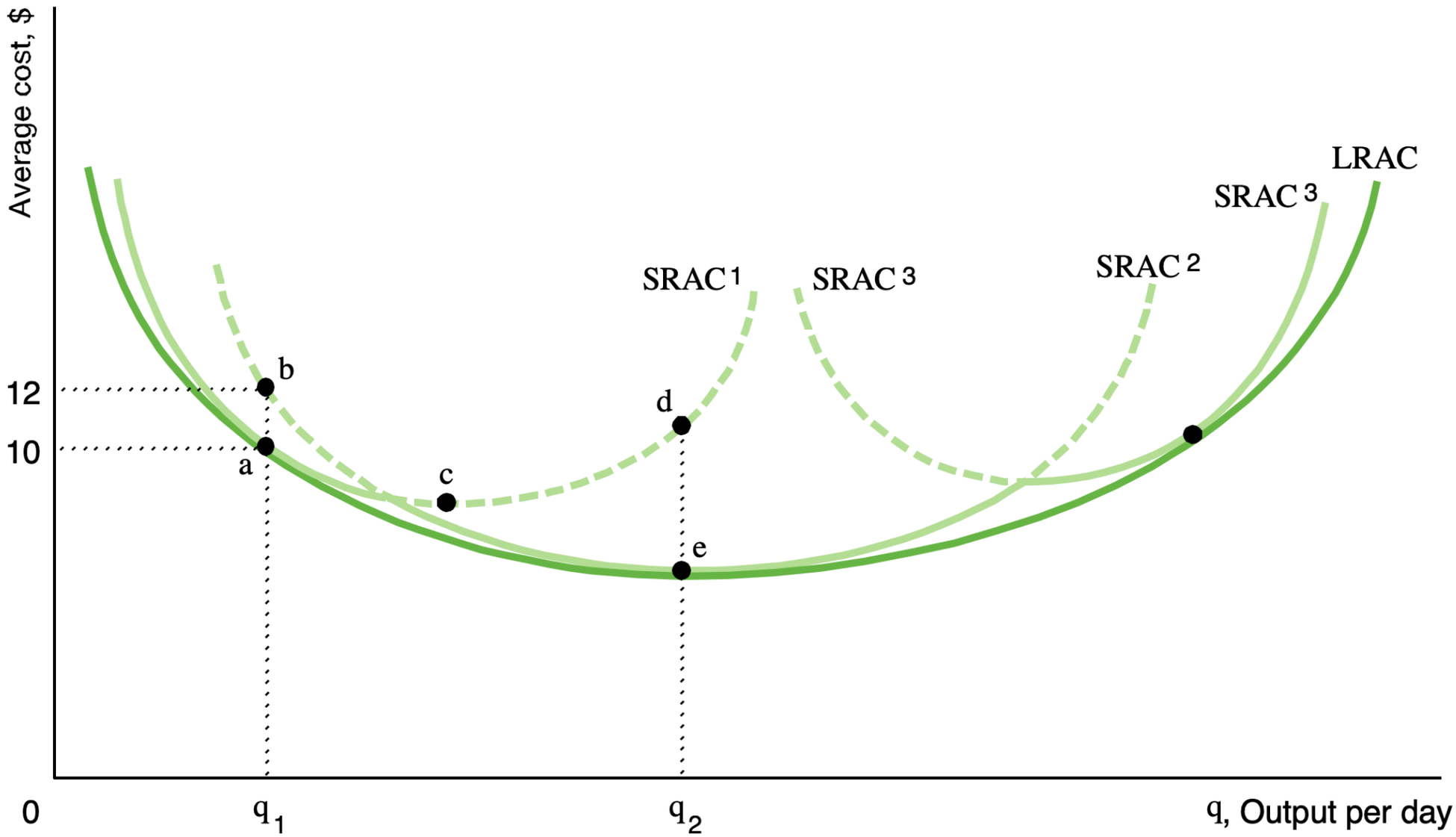
- What about the case where there are little or no economies (or diseconomies) of scale?

Another Question

- True or false, ignoring the changes in the prices of inputs over time: to produce a given level of output, average costs in the LR are always equal to or less than average costs in the SR

- The answer leads us to the envelope relationship between SRAC curves and the LRAC curve

Long Run Average Cost as the Lower Envelope of SRAC Curves



Application

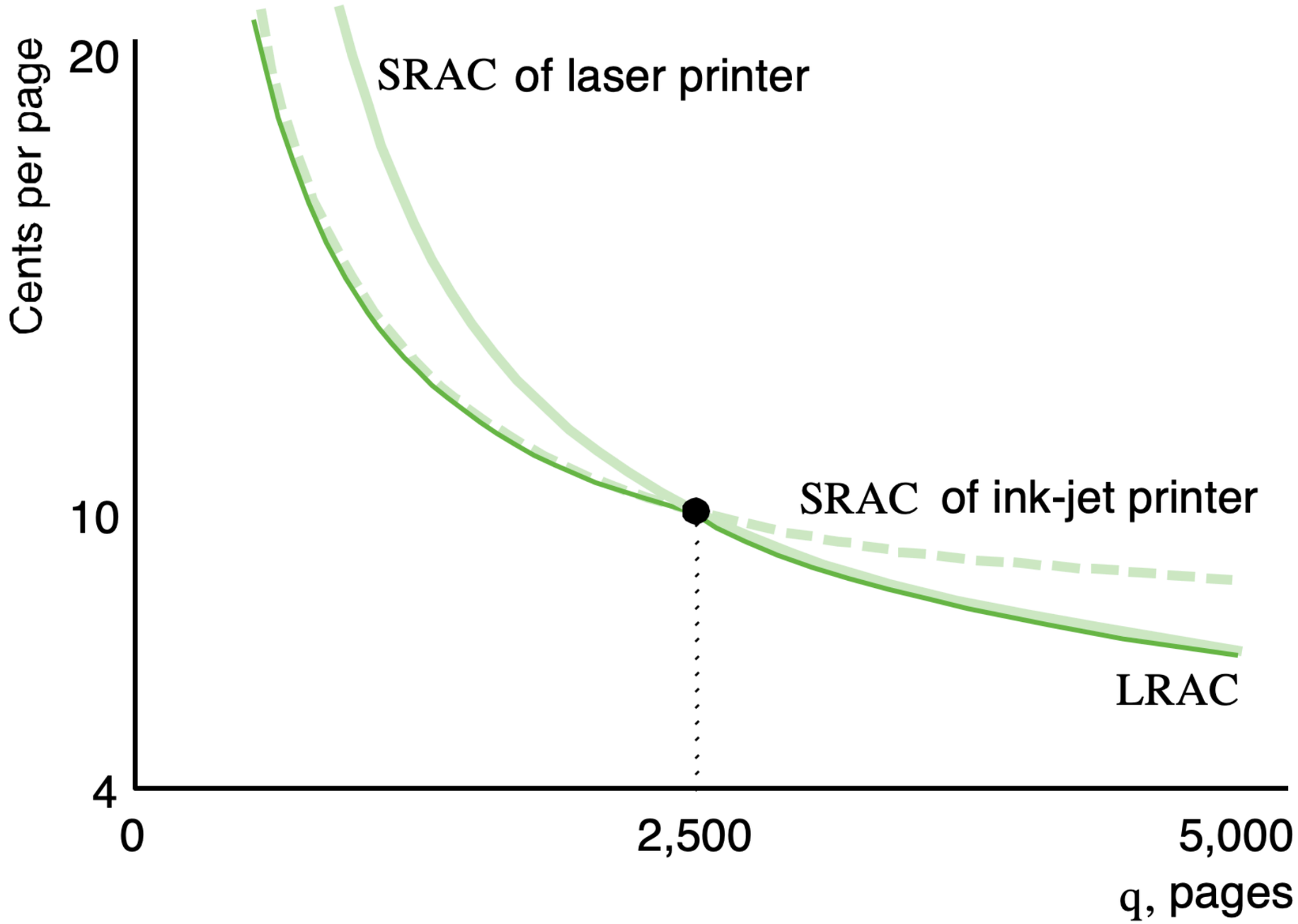
- You are trying to choose between buying a laser printer and an ink-jet printer. Assume for now that each is the same speed and provides the same quality print job. The only differences are:

    1. The laser printer costs $150, ink-jet costs $75

    2. Laser printer pages will cost 4 cents per page and ink-jet pages will cost 7 cents per page

- Which one do you buy?

Choosing a Printer



Learning by Doing

- Long run costs are lower than short run costs for 3 reasons:

1. Flexibility in the LR
2. Technological innovations
3. Learning by doing

    - Process where the first time you do a task it takes a long time, but the more you do it the faster, better, and more efficient you become