Test 1 Results

Grade	Score	Number of Students	Percent
A	85-100	5	31%
B	75-84	8	50%
C	65-74	3	19%
D	< 65	0	0%

Chapter 6

Firms and Production

Ownership of Firms

- A **firm** is an organization that converts inputs such as labor, materials, energy, and capital into outputs (goods or services) that it sells

	Proprietorship	Partnership	Corporation
# of Owners	1	2 or more	Shareholders
% of U.S. Firms	72%	10%	18%
% of U.S. GDP	4%	15%	81%

Big Picture Question

- What do economists assume firms are trying to do?

What do Economists Assume Firms Want?

- **Maximize profit π**, the difference between revenues (R or TR) and costs (C or TC)

- Revenue (R or TR) is the price of the output (p) times the firm's quantity produced (q) — $TR = p \times q$

- In reality, firms may have other objectives (philanthropy, nice offices, paid leave, etc.), but we are not going to deal with these directly

Efficient Production, a.k.a Technological Efficiency

- A condition that means the current output is being produced with the least expensive combination of inputs possible, given current technology

- This is a *necessary condition* for profit maximization but not a *sufficient condition*

Production

- Recall that the firm is an organization that turns inputs into outputs

Inputs ⟶ Outputs

- These inputs will be grouped into two categories:
    1. Capital (K)
    2. Labor (L)
- **Production Functions:** the mathematical relationship between quantities of inputs and the maximum quantities of outputs that can be produced
- For a firm using all two types of inputs above: $q = f(K, L)$

The Role of Time

- **Short-run (SR):** a period of time so brief that at least one factor of production cannot be varied
  - Fixed input: cannot be changed in the SR
  - Variable input: can be changed in the SR
- **Long-run (LR):** a period of time long enough for the firm to be able to vary all inputs

Short-Run Production

- Assume that in the SR, capital K is fixed but labor L is variable:

$$q = f(L, \bar{K})$$

- The choice is only over labor, not capital

- Let's see a few definitions

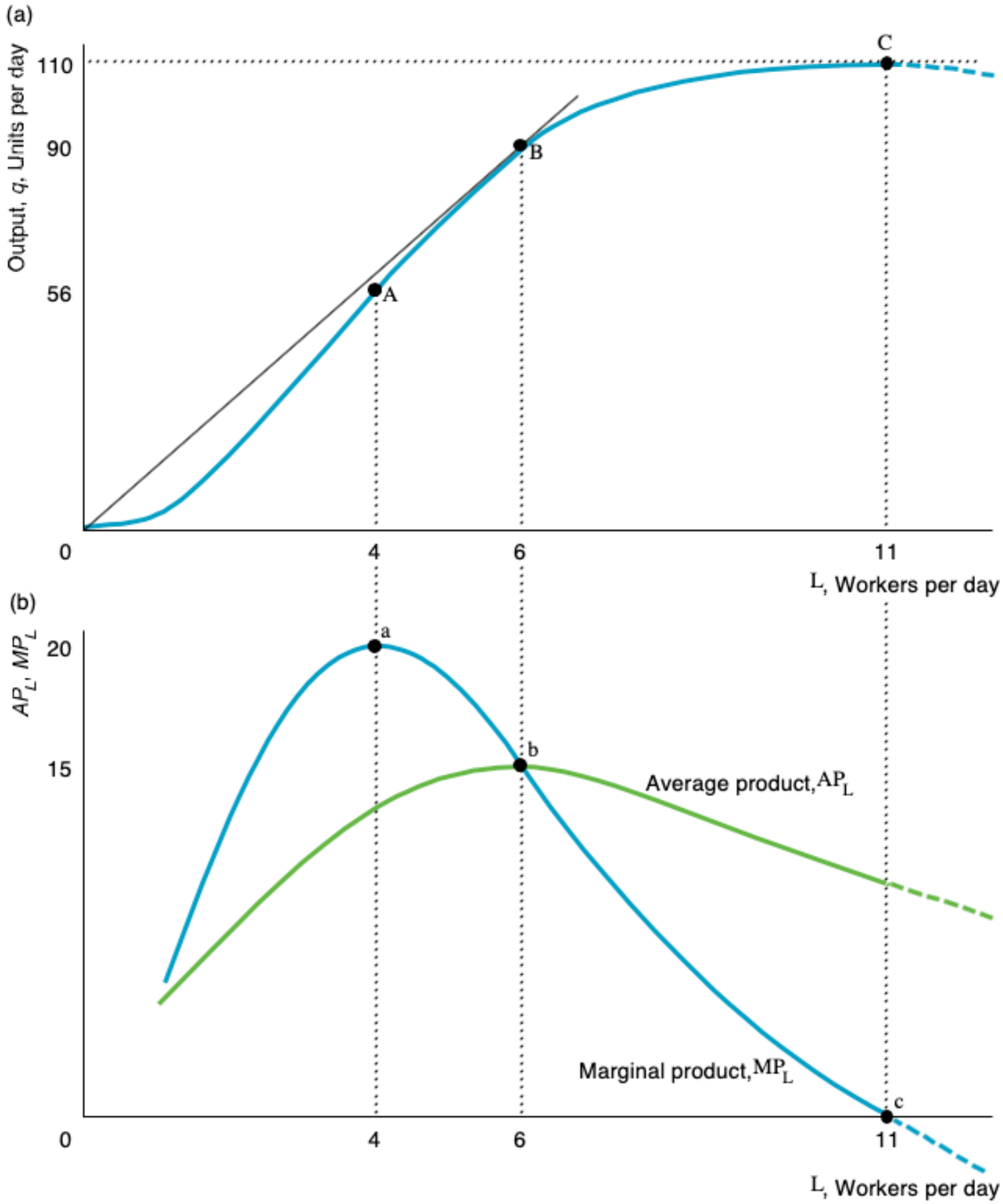
Some (Short Run) Definitions

- Total Product of Labor: output at a given amount of labor
- Marginal Product of Labor: $MP_L = \frac{\Delta q}{\Delta L} = \frac{\delta q}{\delta L} = \frac{\delta f(L,K)}{\delta L}$
- Average Product of Labor: $AP_L = \frac{q}{L}$

Total, Marginal, and Average Product of Labor with Fixed Capital (SR)

Capital	Labor	Output, Total Product of Labor	Marginal Product of Labor	Average Product of Labor
8	0	0		
8	1	5	5	5
8	2	18	13	9
8	3	36	18	12
8	4	56	20	14
8	5	75	19	15
8	6	90	15	15
8	7	98	8	14
8	8	104	6	13
8	9	108	4	12
8	10	110	2	11
8	11	110	0	10
8	12	108	-2	9
8	13	104	-4	8

Production Relationships with Variable Labor



Law of Diminishing Marginal Returns

- **LDMR:** if a firm continues increasing one input, holding other inputs constant, the corresponding increases in output will eventually become smaller
    - Stated another way — marginal product will eventually decline
- LDMR holds true in the short run only
- **BE CAREFUL**: do not to confuse Diminishing Marginal Returns with Diminishing Returns
- Question: where did DMR set in on the previous slide?

Production in the Long-Run

- Now, ALL INPUTS are variable

- Production of a given amount can occur *with different combinations of inputs*

Output Produced Entirely with Variable Inputs

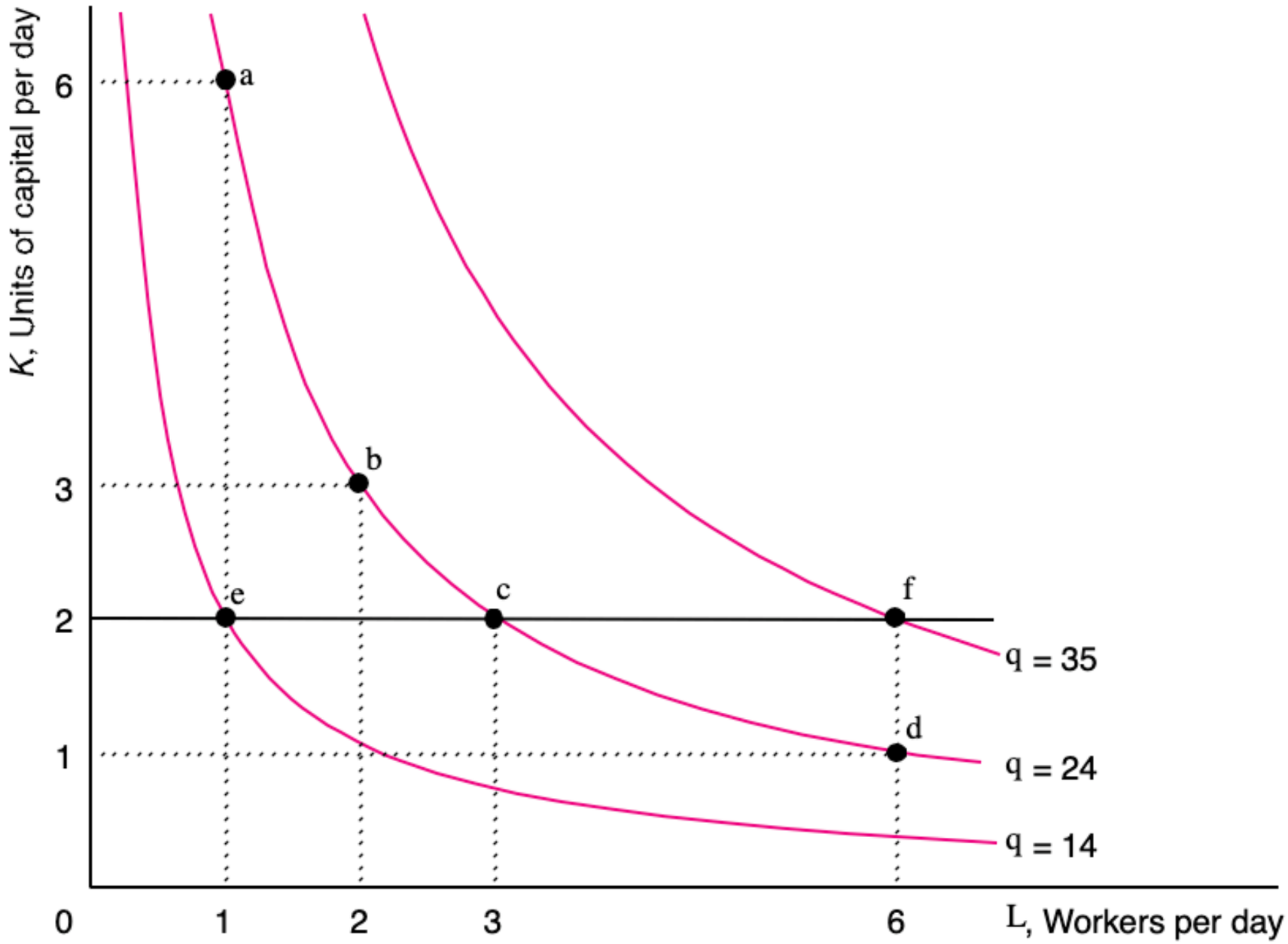
Capital	Labor					
	1	2	3	4	5	6
1	10	14	17	20	22	**24**
2	14	20	**24**	28	32	35
3	17	**24**	30	35	39	42
4	20	28	35	40	45	49
5	22	32	39	45	50	55
6	**24**	35	42	49	55	60

Isoquants

- An **isoquant** is a curve that shows the different efficient combinations of labor and capital that can produce a single or same (iso) level of output (quant)

$$\bar{q} = f(L, K)$$

A Family of Isoquants



Properties of Isoquants

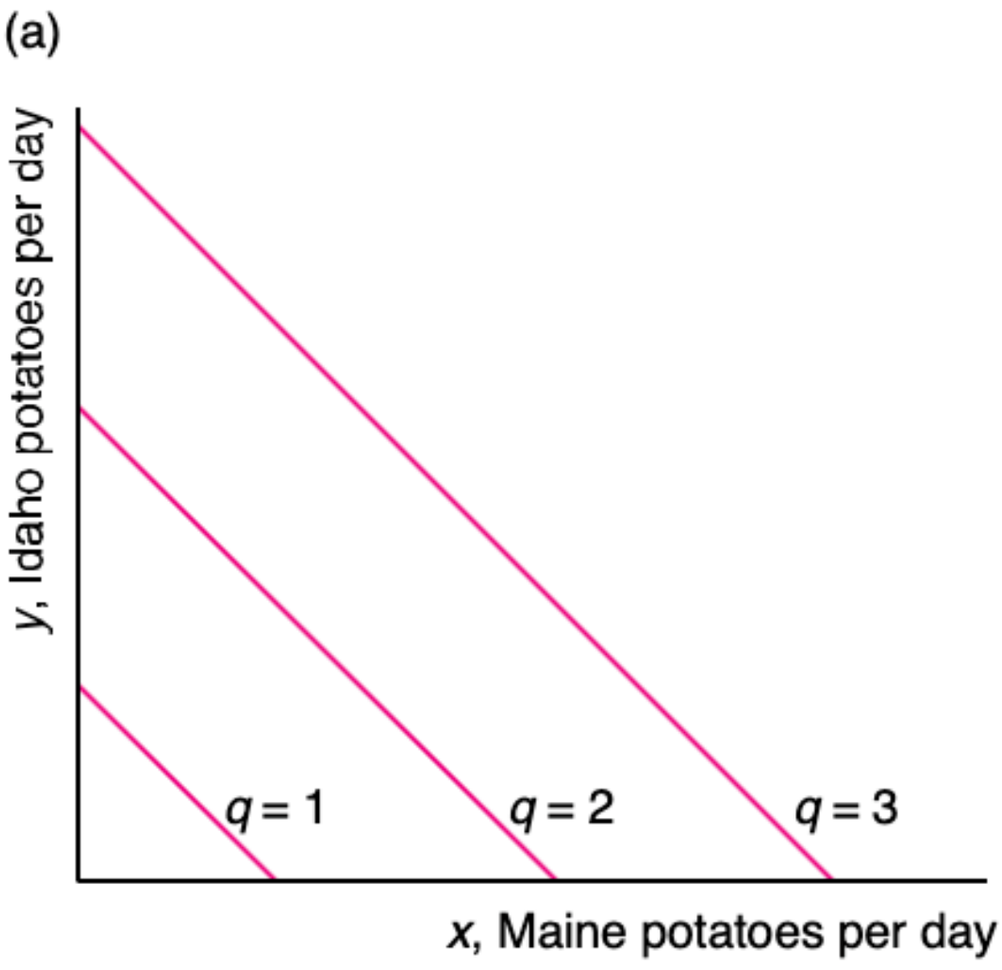
- Isoquants have several important properties:

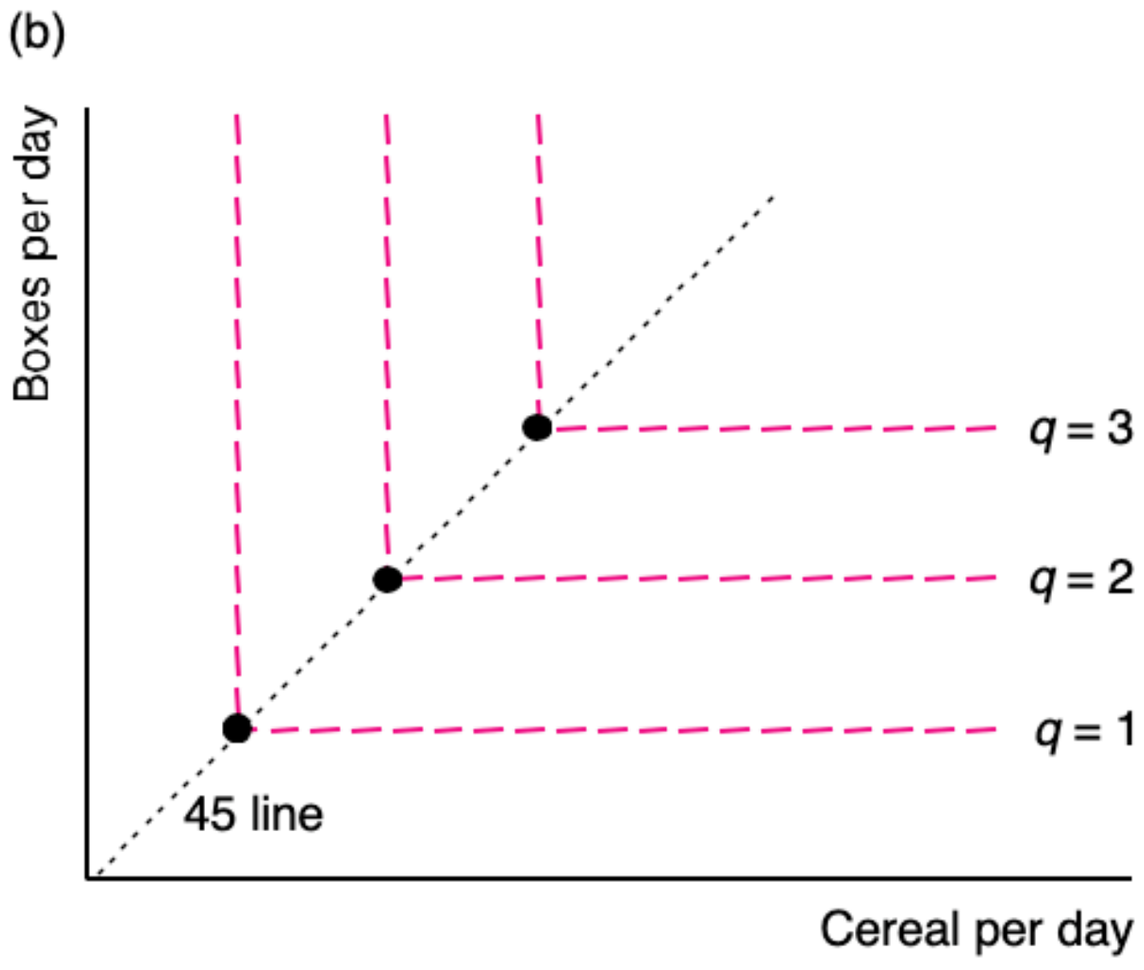
    1. Farther from the origin means more output, so firms prefer isoquants further from the origin
    2. They cannot cross
    3. They must slope downward
    4. They can't be "thick"

- **What do isoquants look similar to?**

- Also, a typical isoquant will be convex with respect to the origin — why is that?

Special Isoquants: Substitutability of Inputs





Imperfect Substitutes as Inputs

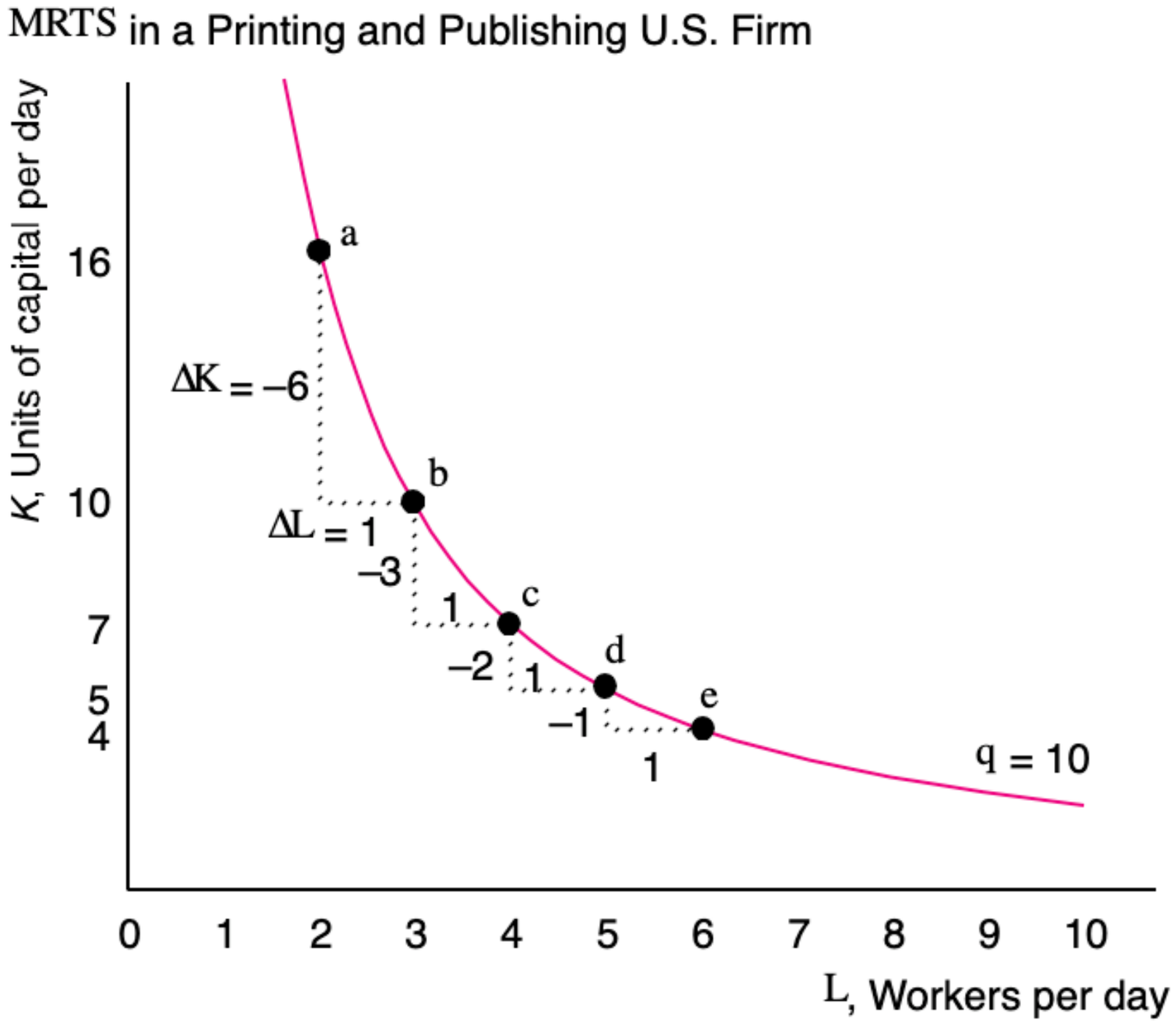
The Shape (Slope) of the Isoquant

- **The Slope of the Isoquant** reflects the manner in which a firm can substitute one factor of production for another, holding production constant

- We call this slope the **Marginal Rate of Technical Substitution (MRTS)**

$$MRTS = \frac{\Delta K}{\Delta L} = \frac{MP_L}{MP_K}$$

Diminishing Marginal Rate of Technical Substitution Along an Isoquant



Elasticity of Substitution Between Inputs

- Intuitively, you can probably think of industries that have limited substitution between labor and capital and others with decent substitutability
  - Firm A is a law firm specializing in divorce cases
  - Firm B is an organic vegetable farm

Returns to Scale

- Since all inputs are variable in the long-run, one interesting question to examine is:
    - What happens when the firm increases all of their inputs proportionally?
- The answer to this question determines what we will call the "scale" of production in the long-run
- There will be three types of cases:
    1. Constant returns to scale (CRS)
    2. Increasing returns to scale (IRS)
    3. Decreasing returns to scale (DRS)
    4. Plus combinations (varying returns to scale)

Returns to Scale

- If we have a production function and we were to increase each input by a certain percentage, output could increase by:
  - The same percentage (CRS)
  - A greater percentage (IRS)
  - A lesser percentage (DRS)
- Example of a hypothetical “doubling” of all inputs — and the method to use to consider the scale of any case

A Special Production Function

- A popular functional form estimated for production functions in different industries is called the **Cobb-Douglas Production Function**

$$q = A \times L^{\alpha} \times K^{\beta}$$

- α, β, and A are all positive constants

- It can be shown that the parameters α and β determine the returns to scale

    - CRS: $\alpha + \beta = 1$

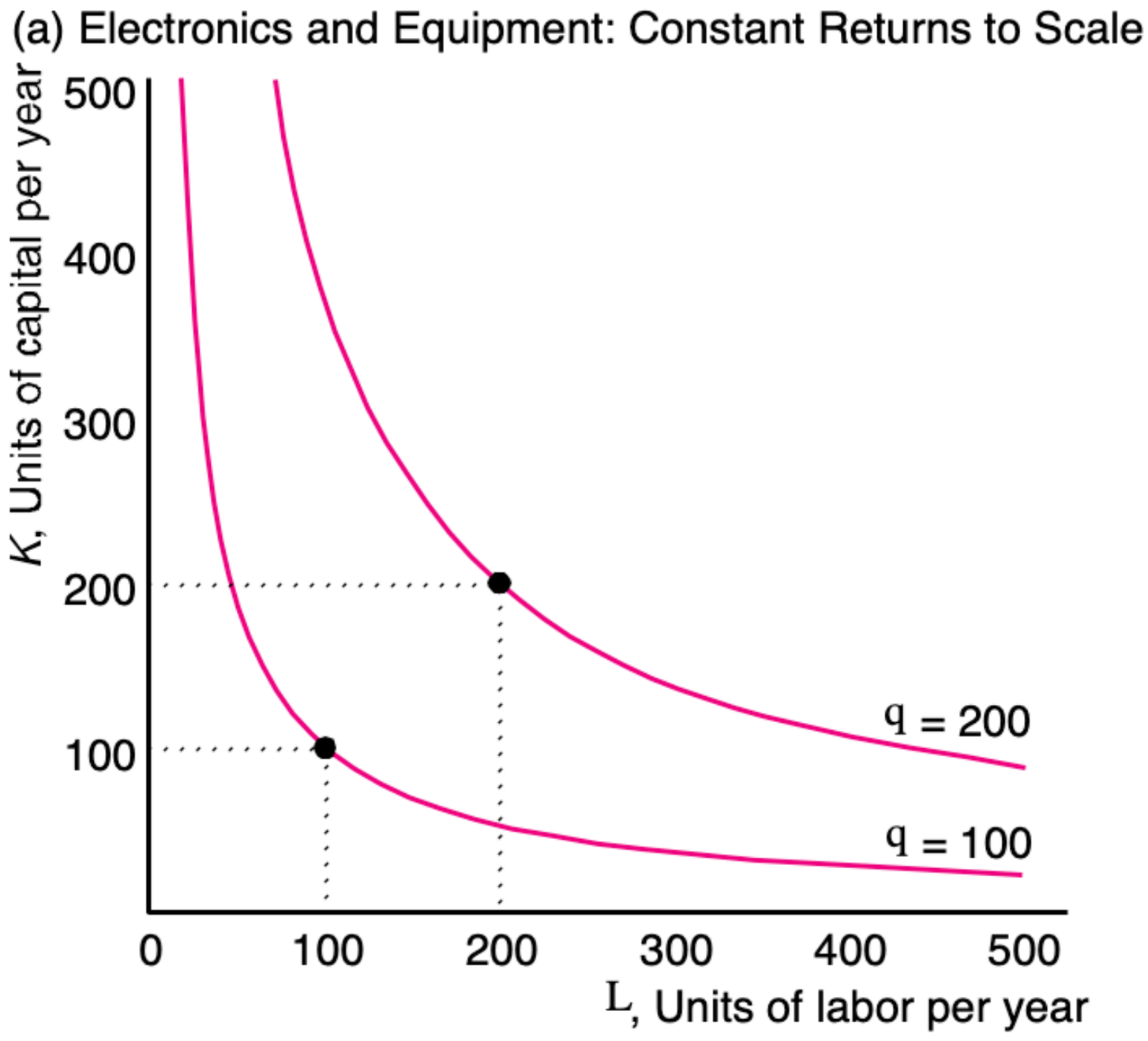
    - IRS: $\alpha + \beta > 1$

    - DRS: $\alpha + \beta < 1$

Returns to Scale in U.S. Manufacturing

	Labor, α	Capital, β	Scale, $\gamma = \alpha + \beta$
Decreasing Returns to Scale			
Tobacco products	0.18	0.33	0.51
Food and kindred products	0.43	0.48	0.91
Transportation equipment	0.44	0.48	0.92
Constant Returns to Scale			
Apparel and other textile products	0.70	0.31	1.01
Furniture and fixtures	0.62	0.40	1.02
Electronic and other electric equipment	0.49	0.53	1.02
Increasing Returns to Scale			
Paper and allied products	0.44	0.65	1.09
Petroleum and coal products	0.30	0.88	1.18
Primary metal	0.51	0.73	1.24

Constant Returns to Scale Example



Varying Scale Economies

- There is no reason to assume that the production function *must* exhibit the same scale over all output ranges

- Varying scale economies means the scale (CRS, IRS, DRS) of production can change over different output levels

Varying Scale Economies