Chapter 6

Firms and
Production

Microeconomics

Third Edition

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Table 6.1 Total Product, Marginal Product, and Average Product of Labor with Fixed Capital
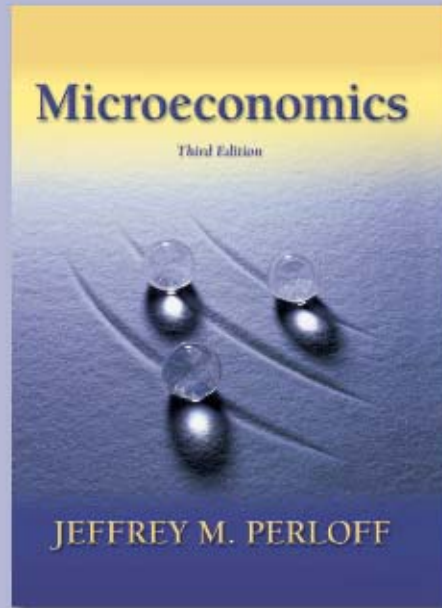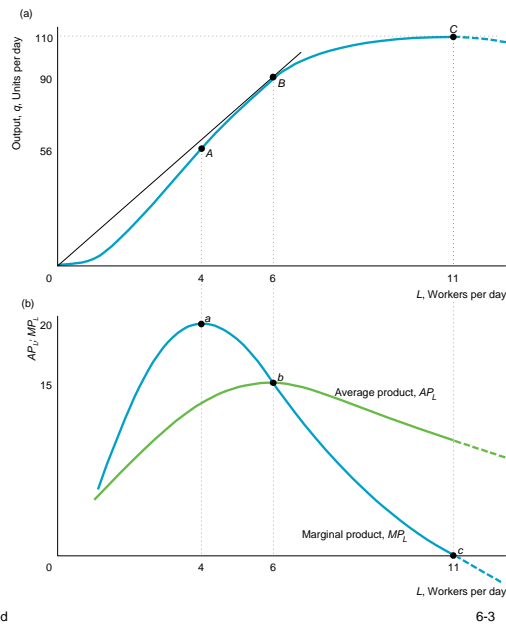
Table 6.1   Total Product, Marginal Product, and Average Product of Labor with Fixed Capital

Capital, $\bar{K}$	Labor, L	Output, Total Product of Labor, Q	Marginal Product of Labor, $MP_L = \Delta Q/\Delta L$	Average Product of Labor, $AP_L = Q/L$
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

Figure 6.1
Production Relationships with Variable Labor

Table 6.2 Output Produced with Two Variable Inputs

Table 6.2	Output Produced with Two Variable Inputs					
	Labor, L					
Capital, K	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

Figure 6.2 Family of Isoquants
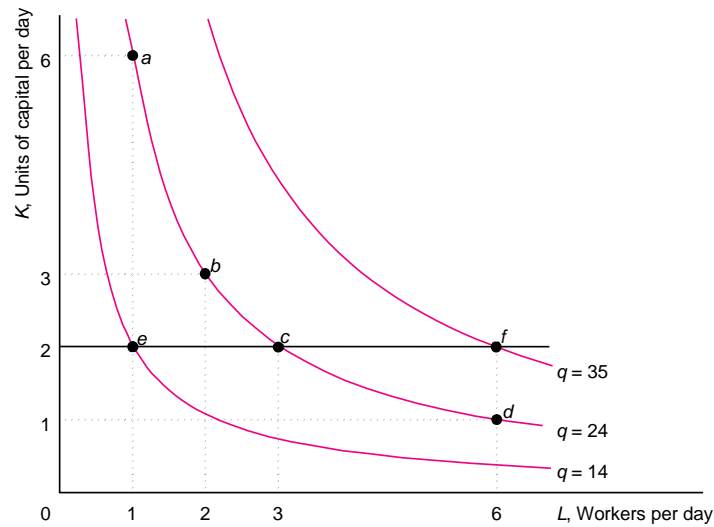
Figure 6.3
Substitutability of Inputs
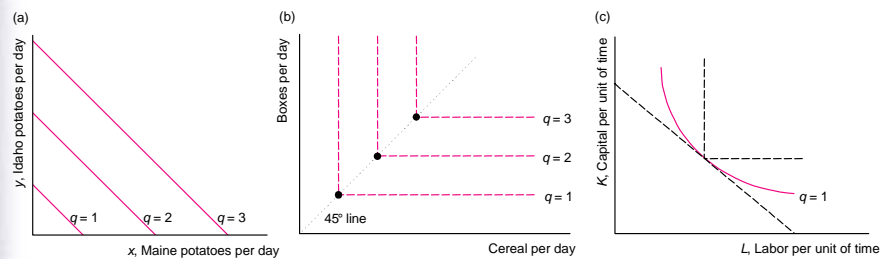
Figure 6.3a
Substitutability of Inputs

(a)

y, Idaho potatoes per day

q = 1   *q* = 2   *q* = 3

x, Maine potatoes per day
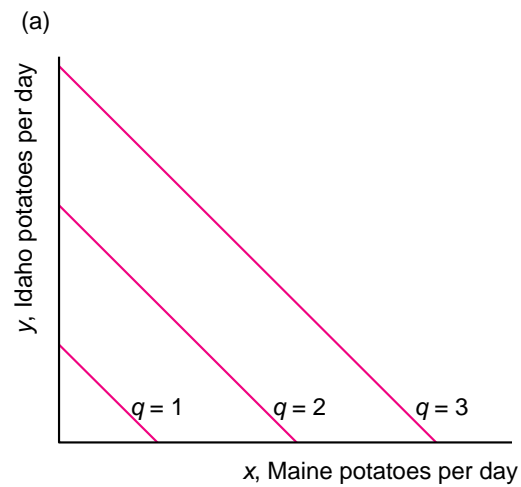
Figure 6.3b
Substitutability of Inputs

(b)

Boxes per day

q = 3

q = 2

q = 1

45° line

Cereal per day
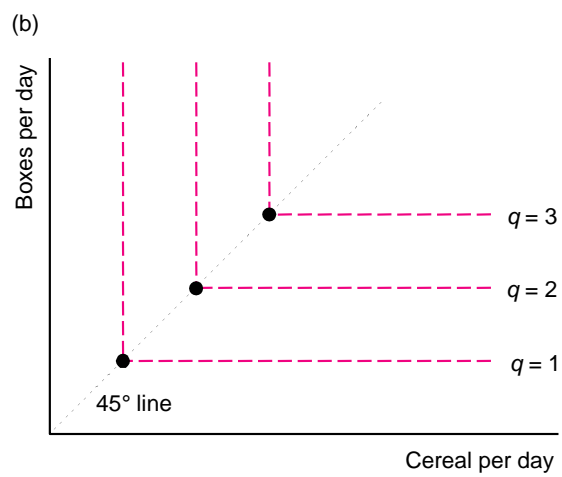
Figure 6.3c
Substitutability of Inputs

(c)

K, Capital per unit of time

q = 1

L, Labor per unit of time
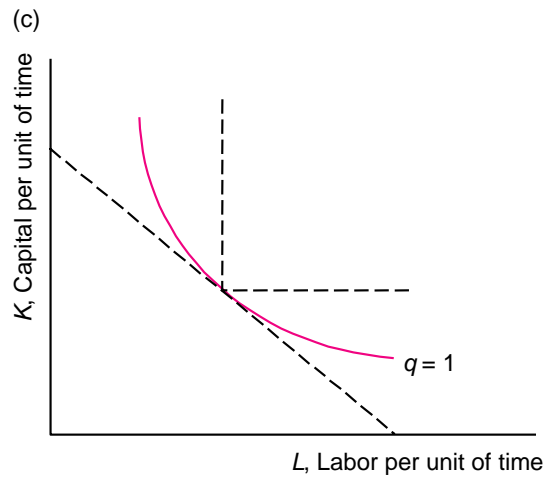
Application (Page 164) Semiconductor Integrated Circuit Isoquants

K, Units of capital per day

Wafer-handling stepper

Stepper

Aligner

200 ten-layer chips per day isoquant

0   1   3   8

L, Workers per day
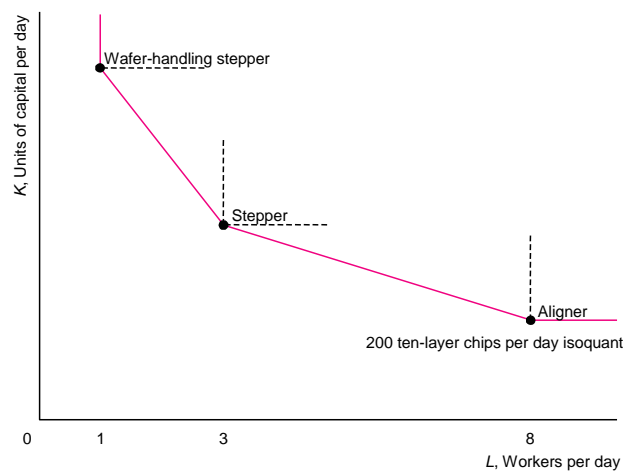
Figure 6.4 How the Marginal Rate of Technical Substitution Varies Along an Isoquant
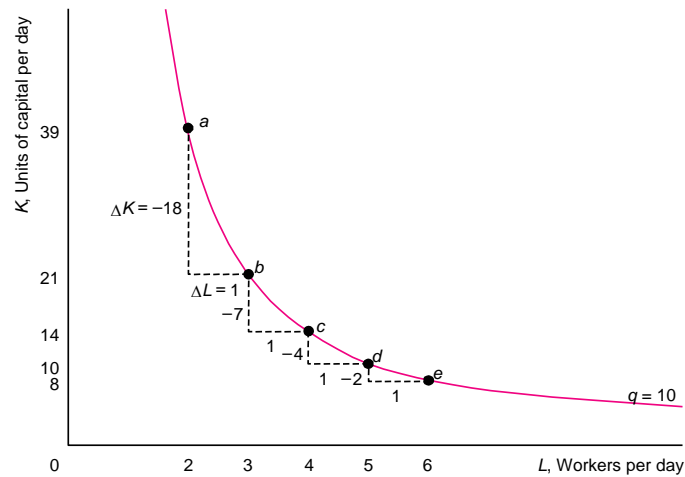
Application (Page 171)
Returns to Scale in Manufacturing

	Labor, α	Capital, β	Scale, $\gamma = \alpha + \beta$
Decreasing Returns to Scale			
Thread mill	0.64	0.18	0.82
Knitted fabrics	0.55	0.36	0.90
Lime manufacturers	0.60	0.25	0.84
Constant Returns to Scale			
Shoe factories	0.82	0.18	1.00
Hosiery mills	0.55	0.46	1.01
Jewelry and silverware	0.60	0.41	1.01
Increasing Returns to Scale			
Concrete blocks and bricks	0.93	0.40	1.33
Paint	0.71	0.61	1.32
Orthopedic and surgical appliances	0.30	0.99	1.30

Application (Page 171)
Returns to Scale in Manufacturing

(a) Thread Mill: Decreasing Returns to Scale

$q = 100$ $q = 177$ $q = 200$

K, Units of capital per year

L, Units of labor per year

(b) Shoe Factory: Constant Returns to Scale

$q = 100$ $q = 200$

K, Units of capital per year

L, Units of labor per year

(c) Concrete Blocks and Bricks: Increasing Returns to Scale

$q = 100$ $q = 200$ $q = 251$

K, Units of capital per year

L, Units of labor per year

Application (Page 171)
Returns to Scale in Manufacturing

(a) Thread Mill: Decreasing Returns to Scale

$q = 177$ $q = 200$

$q = 100$

K, Units of capital per year

L, Units of labor per year
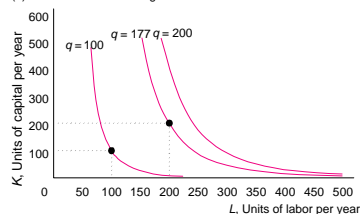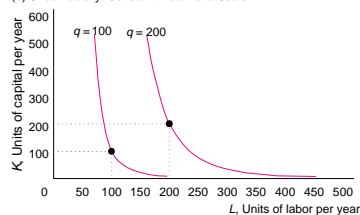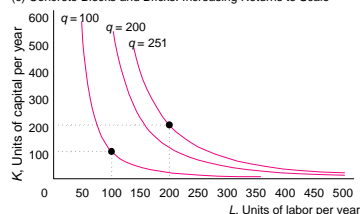
Application (Page 172)
Returns to Scale in Manufacturing

(b) Shoe Factory: Constant Returns to Scale

K, Units of capital per year

$q = 100$ $q = 200$

L, Units of labor per year
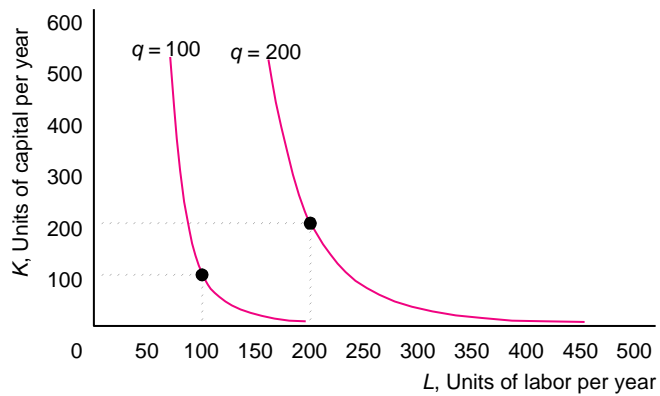
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Application (Page 172)
Returns to Scale in Manufacturing

(c) Concrete Blocks and Bricks: Increasing Returns to Scale

K, Units of capital per year

$q = 100$ $q = 200$ $q = 251$

L, Units of labor per year
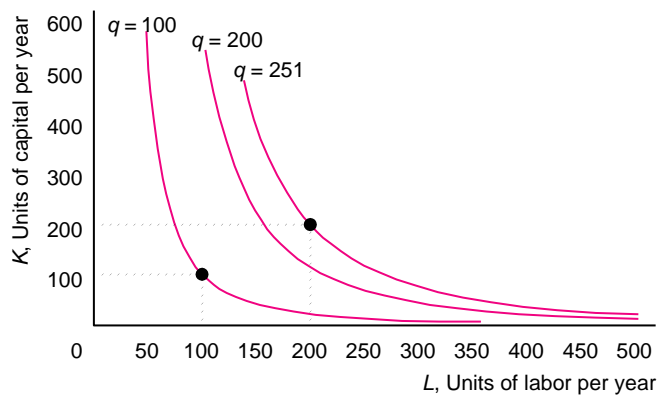
6-16

Figure 6.5
Varying Scale Economies

$c \to d$: Decreasing returns to scale

$b \to c$: Constant returns to scale

$a \to b$: Increasing returns to scale

Table 6.3
Annual Rates of Productivity Growth
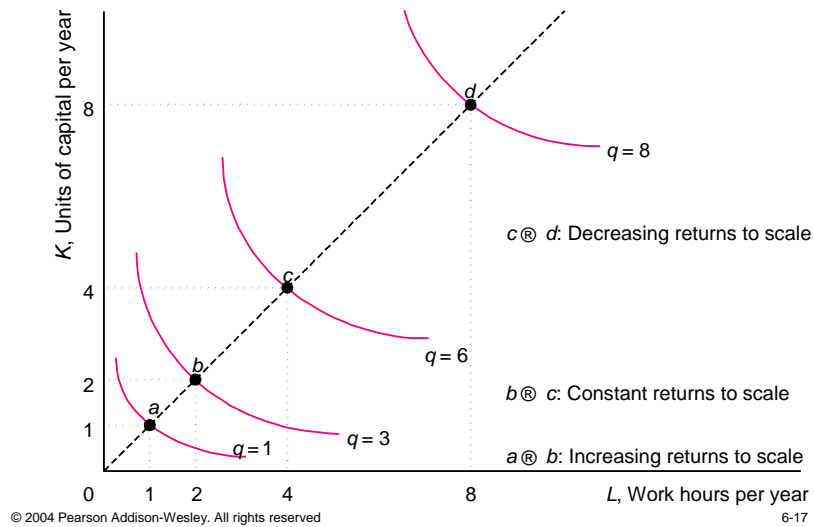
Table 6.3   Annual Rates of Productivity Growth

United States, 1949–1983[a]		Poland, 1962–1983[b]	
Industry	*Growth Rate, %*	*Industry*	*Growth Rate, %*
Food and kindred products	0.7	Food and tobacco	4.9
Tobacco manufactures	0.2		
Lumber and wood products	1.3	Wood and paper	2.5
Paper and allied products	0.9		
Chemicals and allied products	1.5	Chemicals	8.0
Total manufacturing	1.1	Light industry	1.3

[a]Gullickson and Harper (1987) calculated the annual percentage change in output for various U.S. manufacturing industries, holding labor, capital, energy, material, and business service inputs constant.
[b]Terrell (1993) estimated the annual percentage change in output for various Polish industries, holding labor, domestic capital, and Western capital constant.