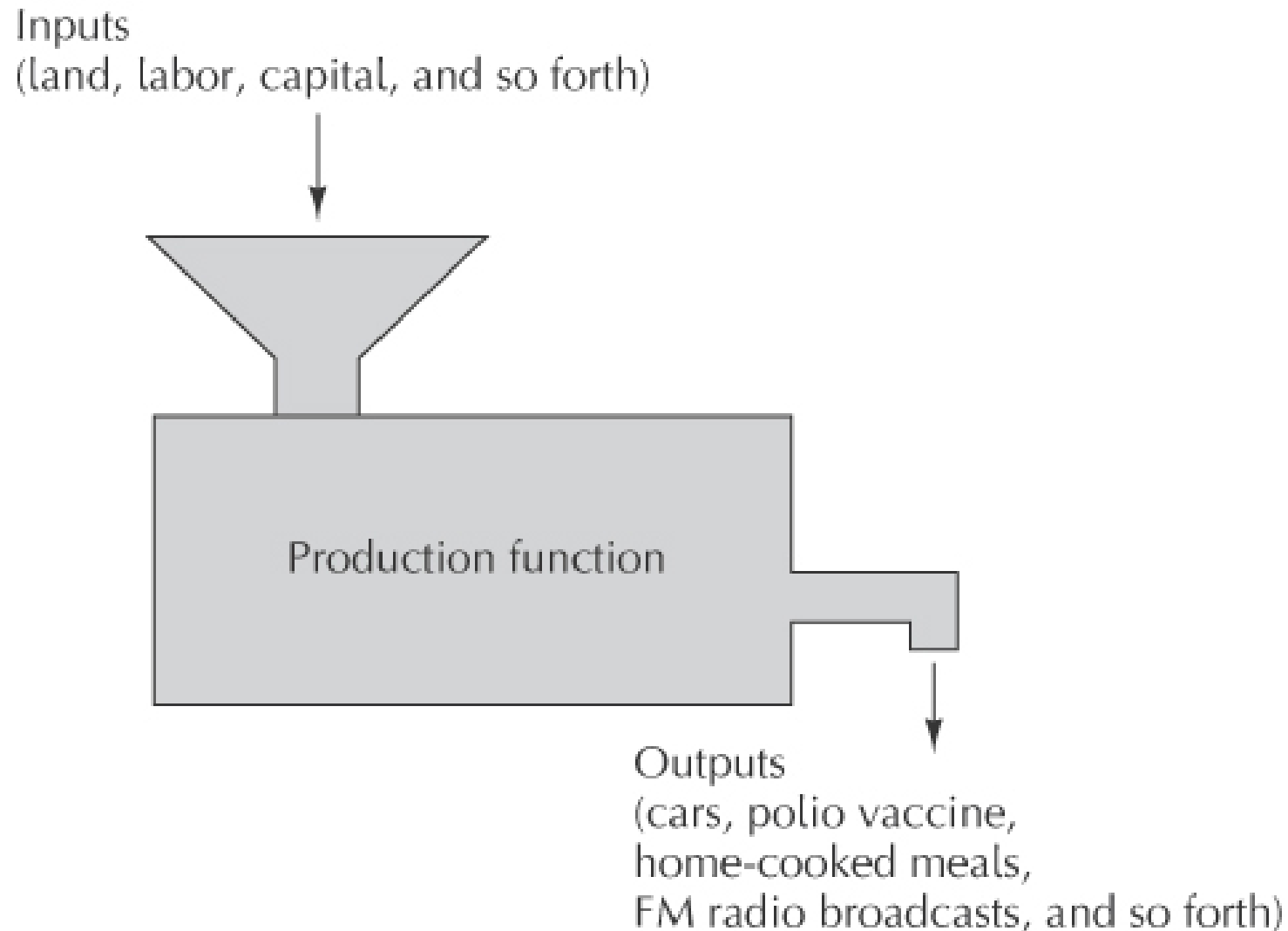


Modelling the producer: Production, Costs, and supply decisions



Figure 9-2: The Production Function



Short-Run Production

- In the short run, the firm's production function is

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

- where q is output, L is workers, and $\bar{K}$ is the fixed number of units of 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

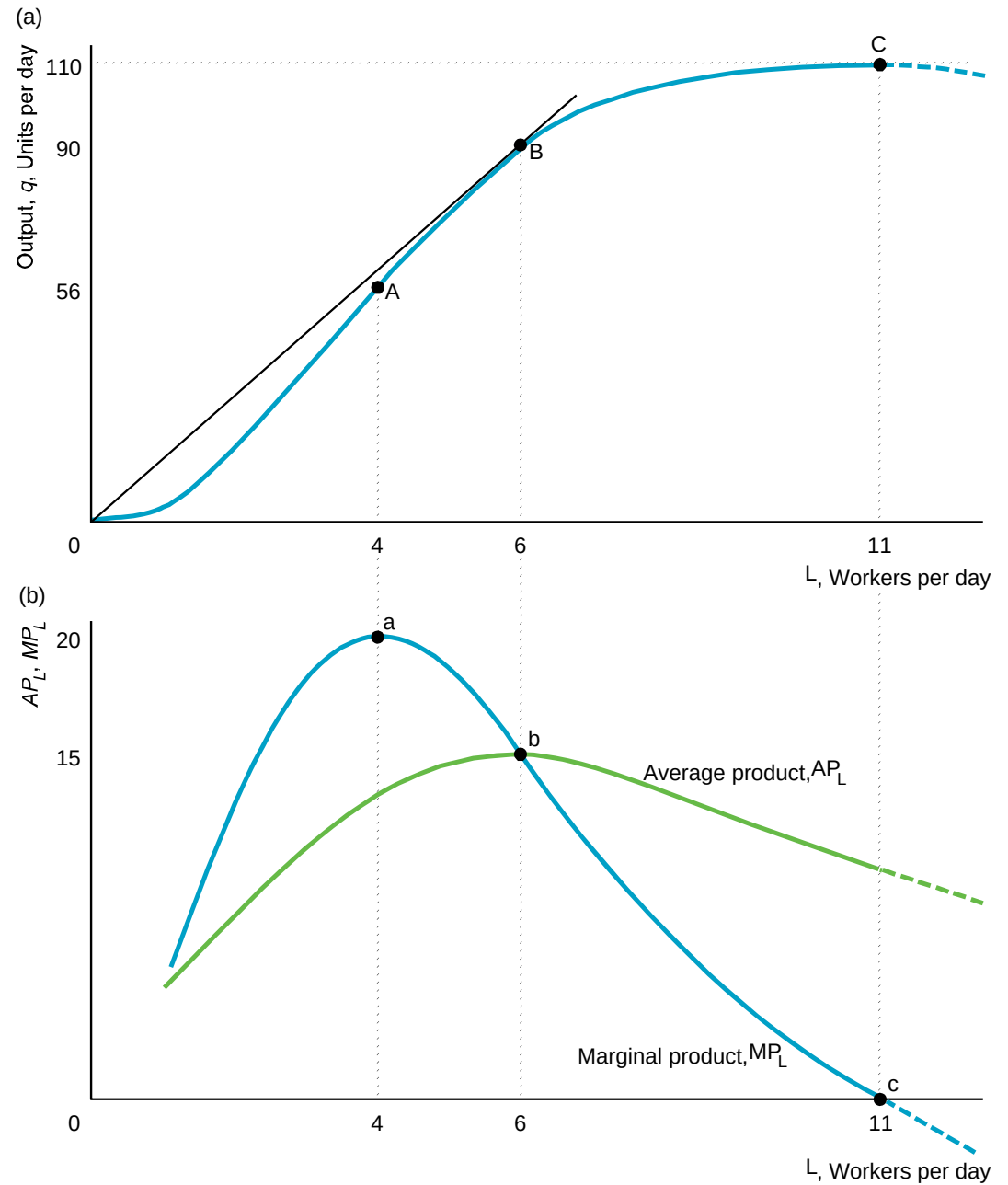
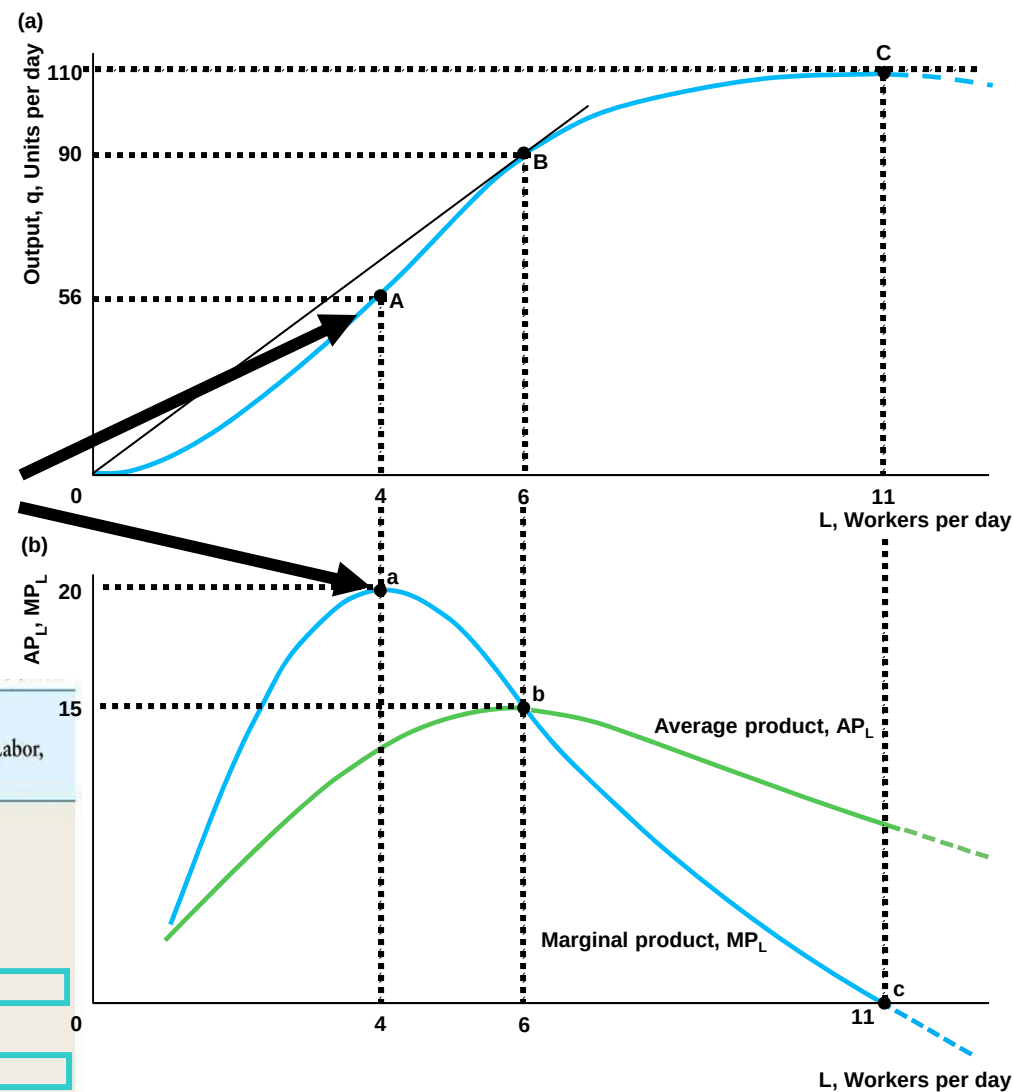




Figure 6.1
Production
Relationships
with Variable
Labor

Diminishing Marginal
Returns sets in!



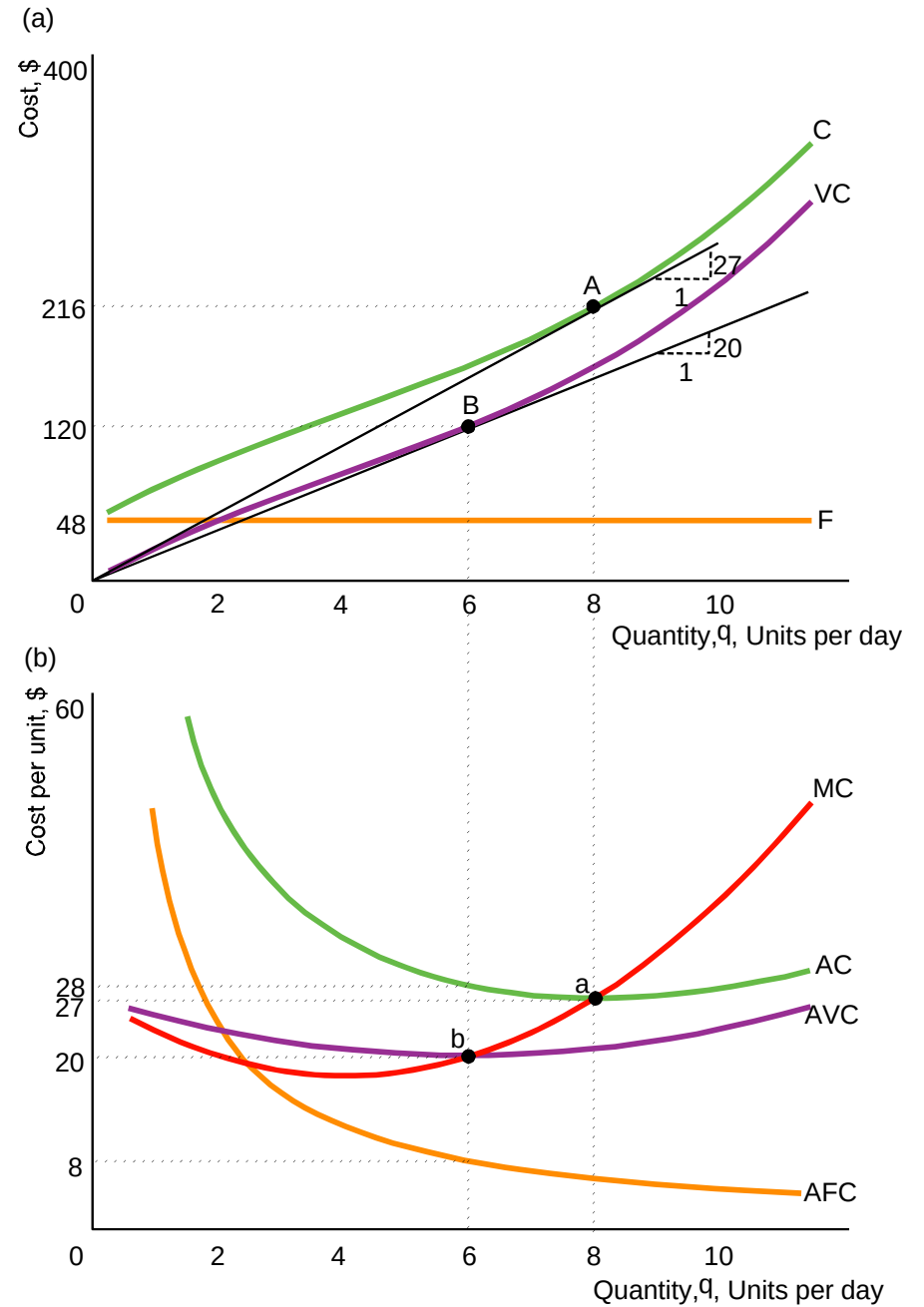
Capital, $\bar{K}$	Labor, L	Output, Total Product of Labor, Q	Marginal Product of Labor, $MP_L = \Delta Q / \Delta L$	Average Product of Labor, $AP_L = Q / L$
8	0	0		
8	1	5	5	5
8	2	18	13	9
8	3	36	18	12
8	4	56	20	14
8	5	75	19	15
8	6	90	15	15
8	7	98	8	14
8	8	104	6	13
8	9	108	4	12
8	10	110	2	11
8	11	110	0	10

DIY

Table 7.1 Variation of Short-Run Cost with Output

Output, q	Fixed Cost, F	Variable Cost, VC	Total Cost, C		Marginal Cost, MC	Average Fixed Cost, $AFC = F/q$	Average Variable Cost, $AVC = VC/q$	Average Cost, $AC = C/q$
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

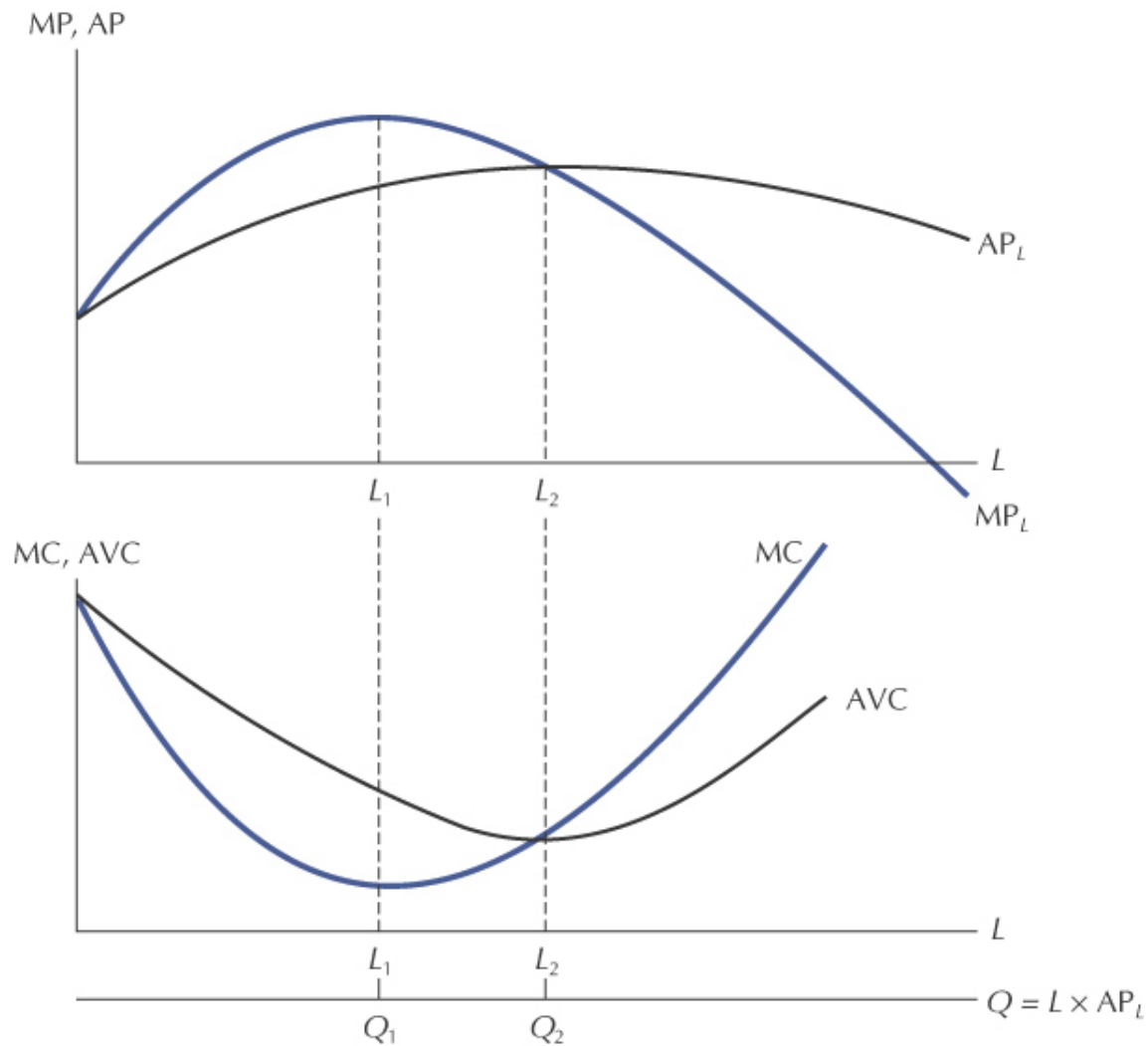
Figure 7.1 Short-Run Cost Curves



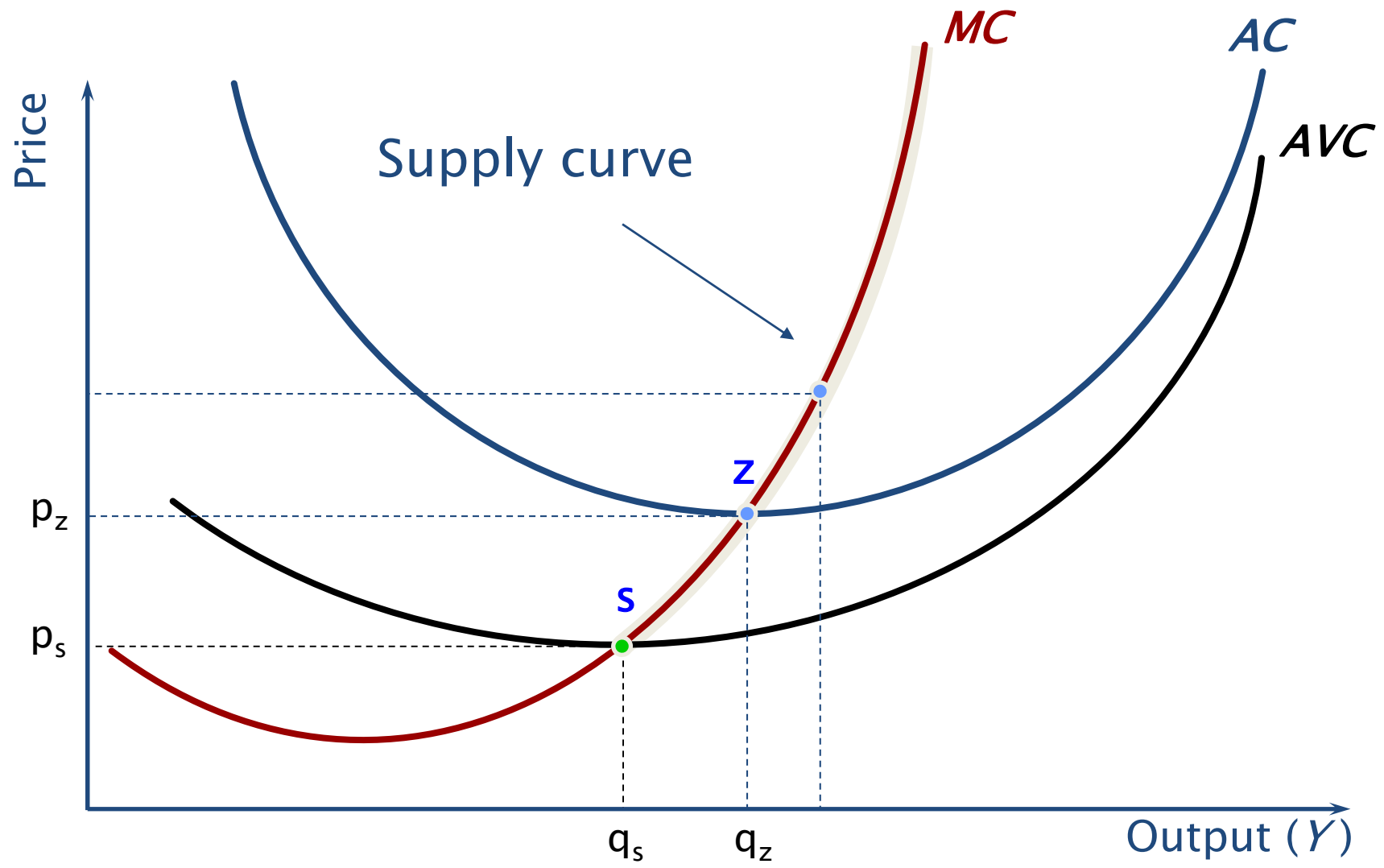
DIY

DIY

Figure 10.9: The Relationship Between MP, AP, MC, and AVC



Costs and supply



Long-Run Production

- In the long run, the firm's production function is

$$q = f(L, K)$$

- where q is output, L is workers, and K is the number of units of capital.
- Both L and K can be varied.

Production Function With Two Inputs

$$Q = f(L, K)$$

K							Q
6	10	24	31	36	40	39	
5	12	28	36	40	42	40	
4	12	28	36	40	40	36	
3	10	23	33	36	36	33	
2	7	18	28	30	30	28	
1	3	8	12	14	14	12	
	1	2	3	4	5	6	L

Discrete Production Surface



Production Function With Two Inputs

Continuous Production Surface

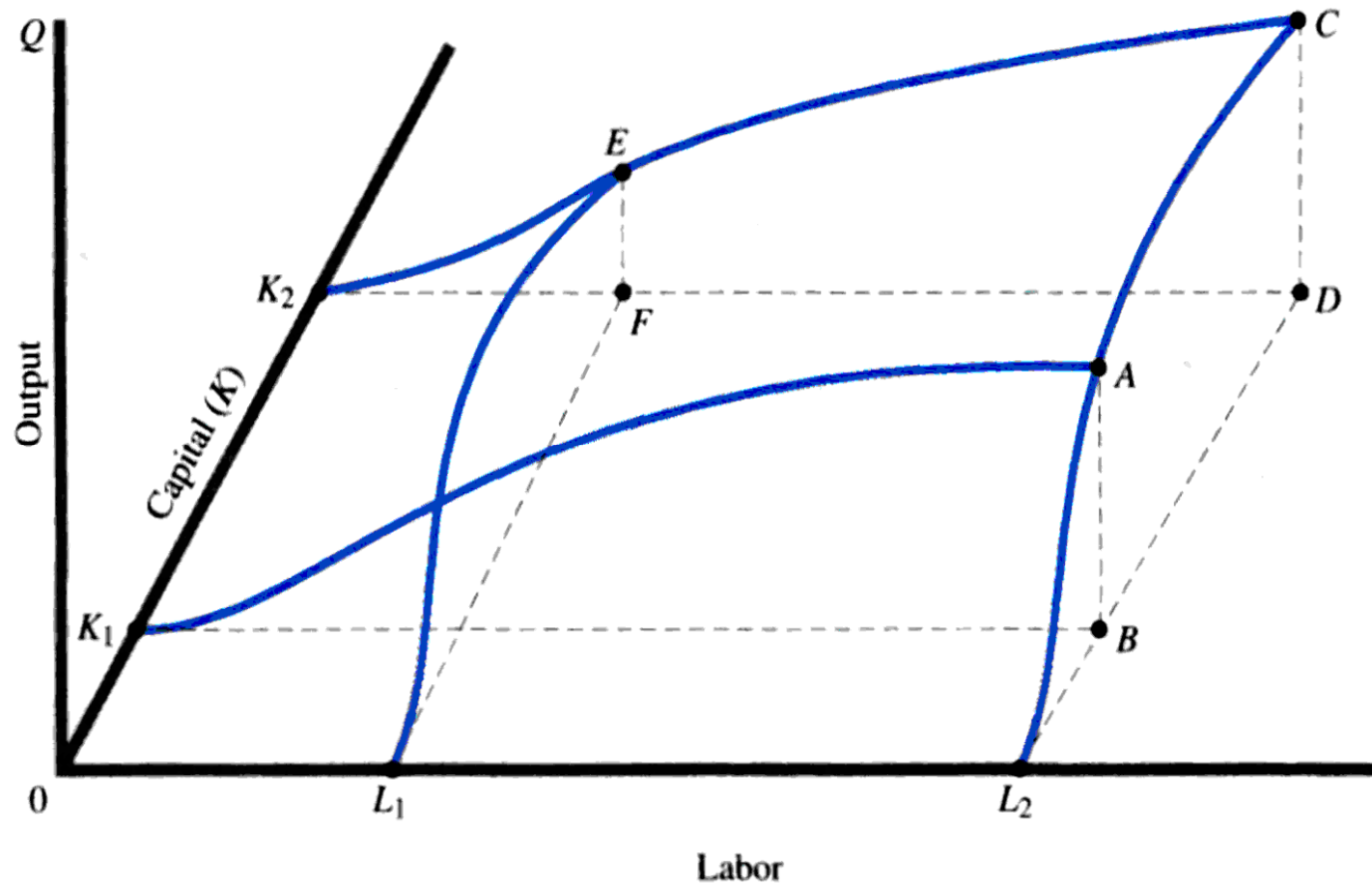


Figure A9-4: The Production Mountain

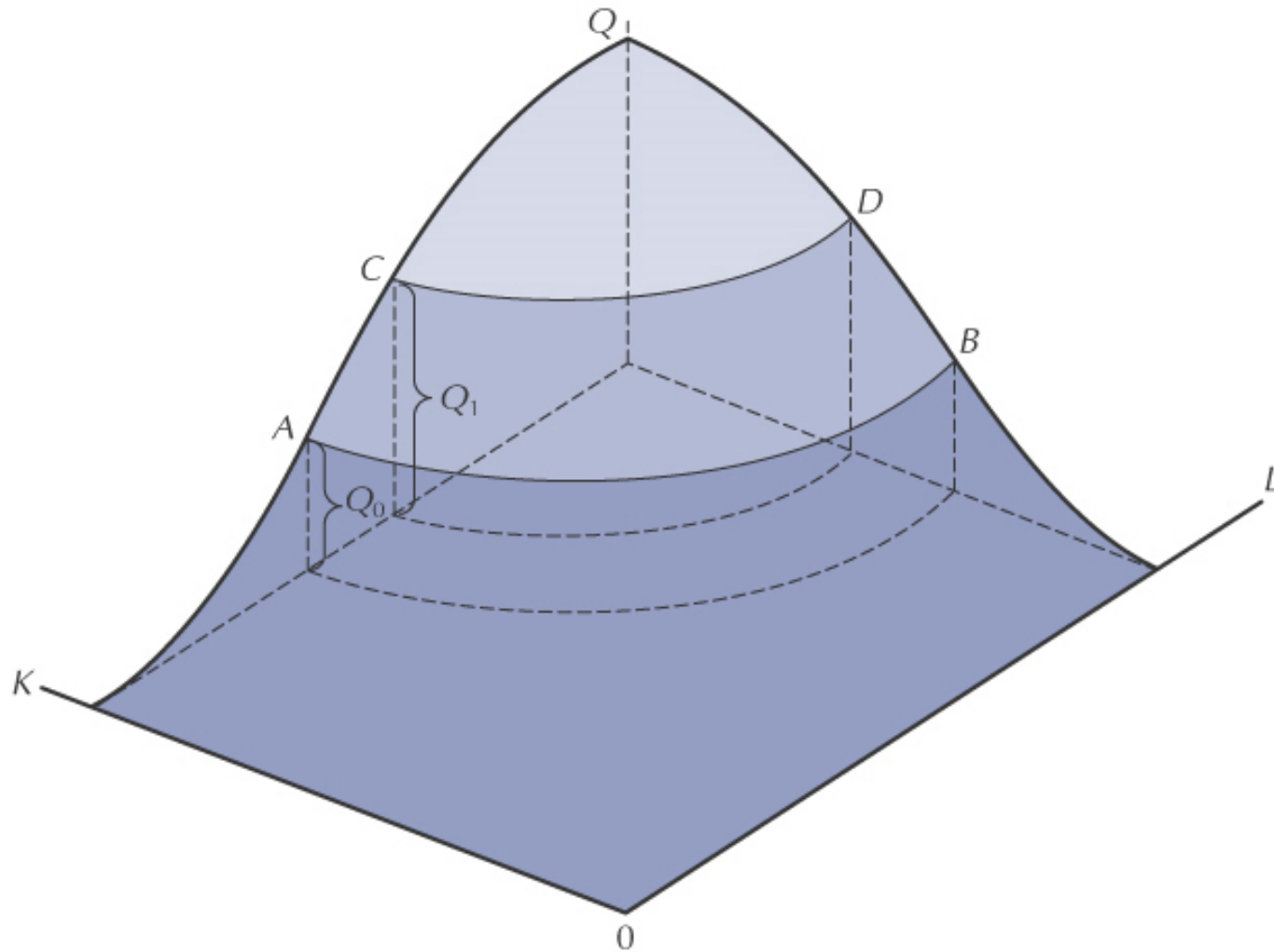


Figure A9-5: The Isoquant Map Derived from the Production Mountain

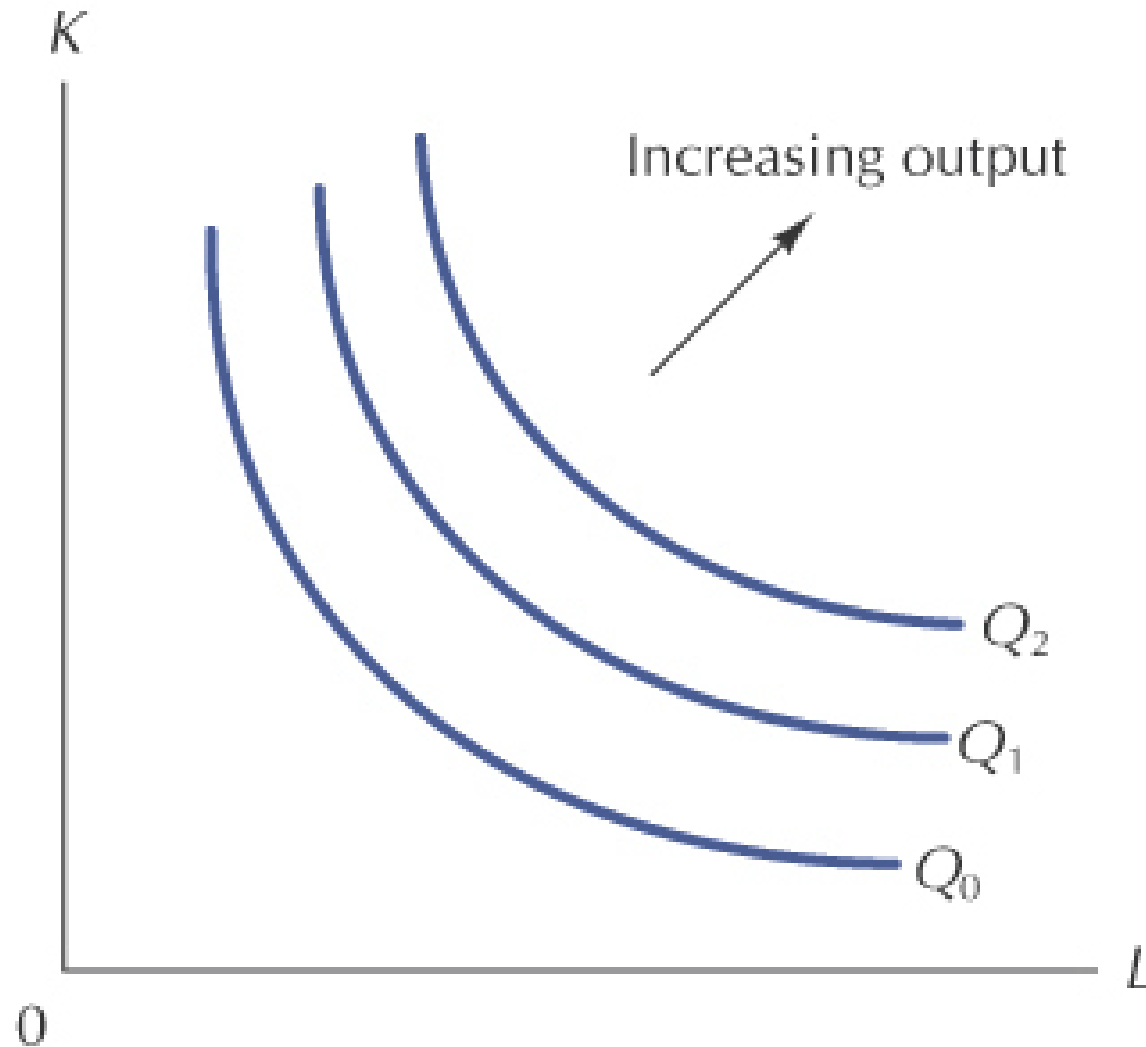


Figure 9-9: The Marginal Rate of Technical Substitution

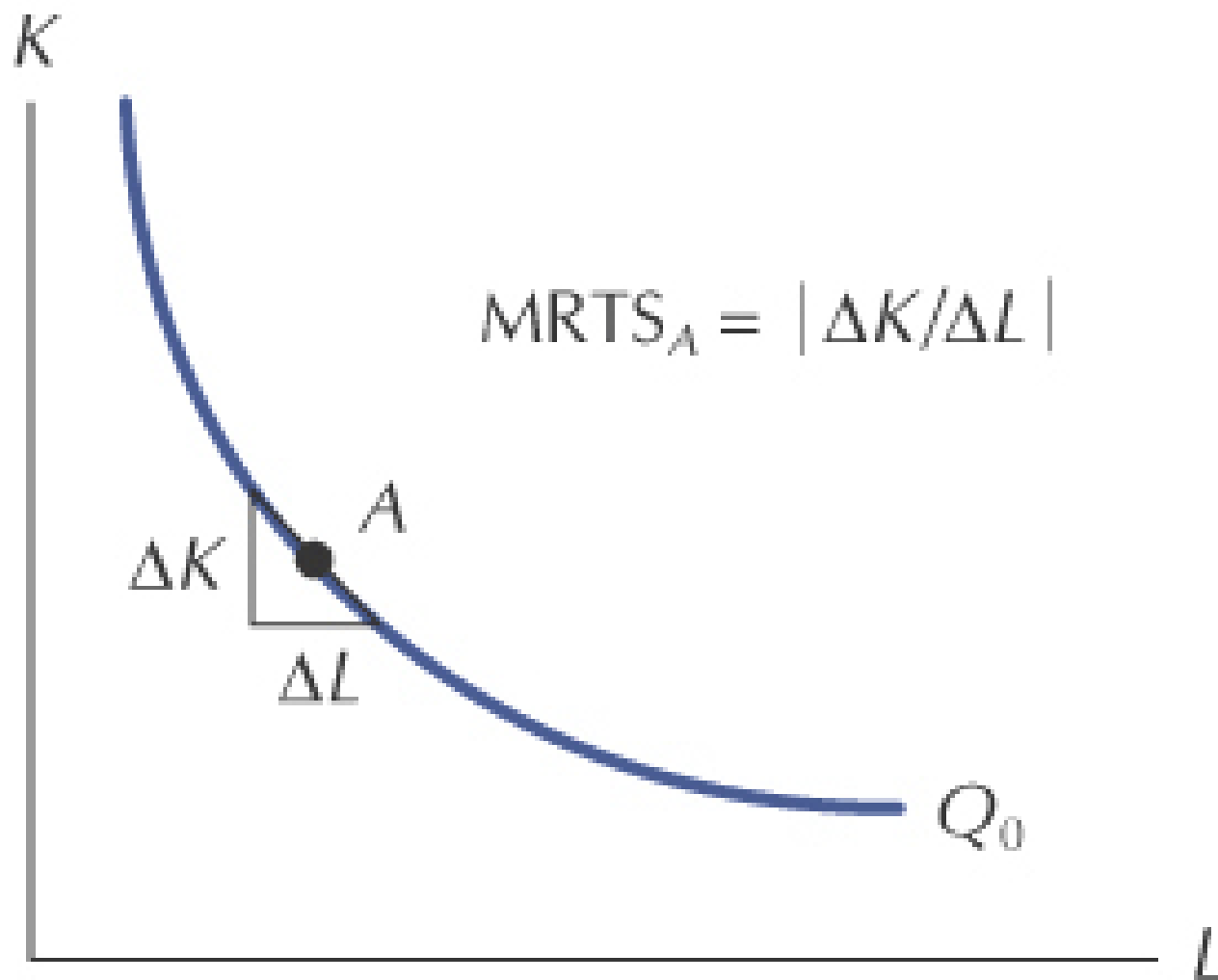


Figure A9-6: Isoquant Map
for the Cobb-Douglas Production Function $Q = K^{1/2}L^{1/2}$

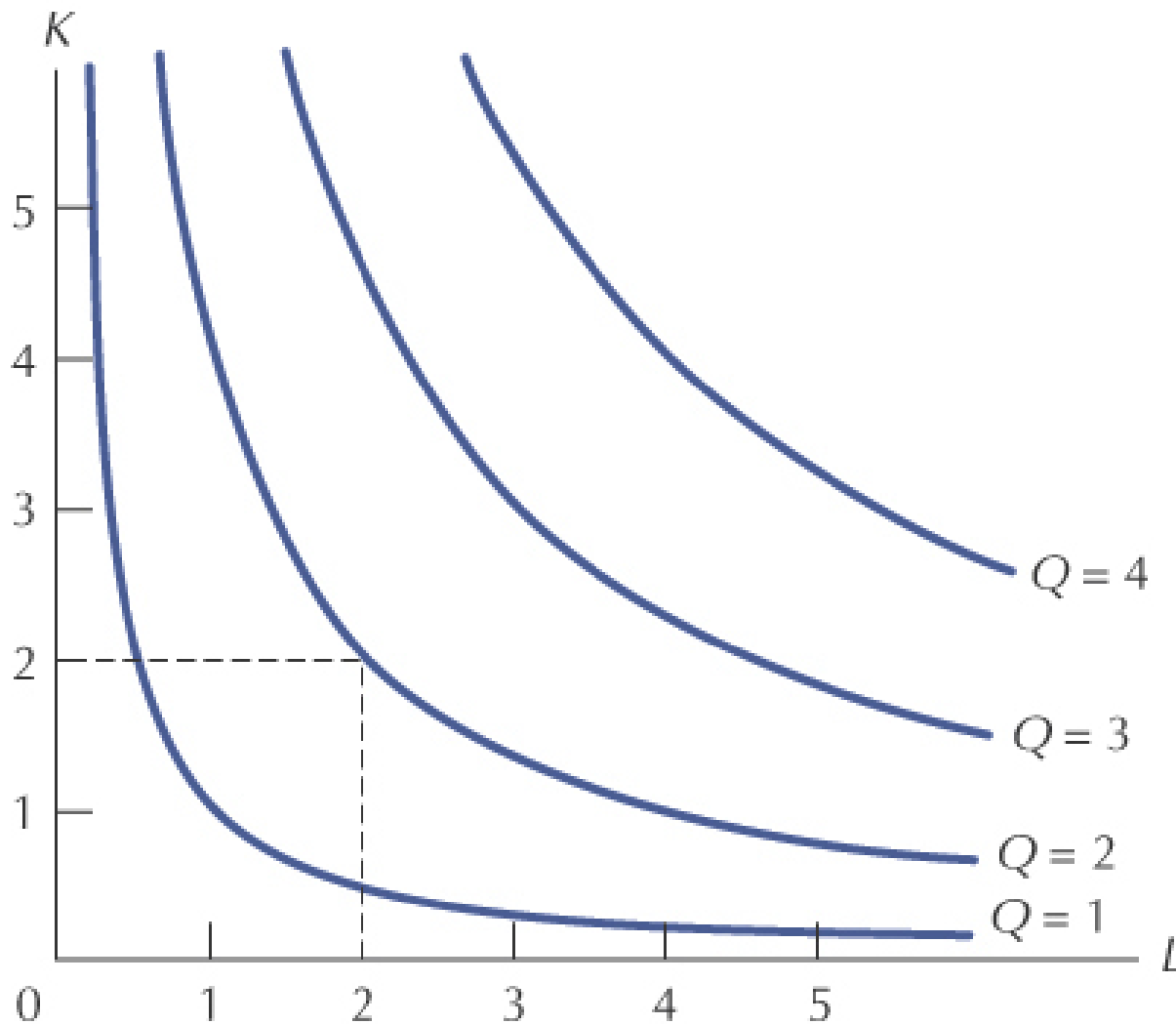
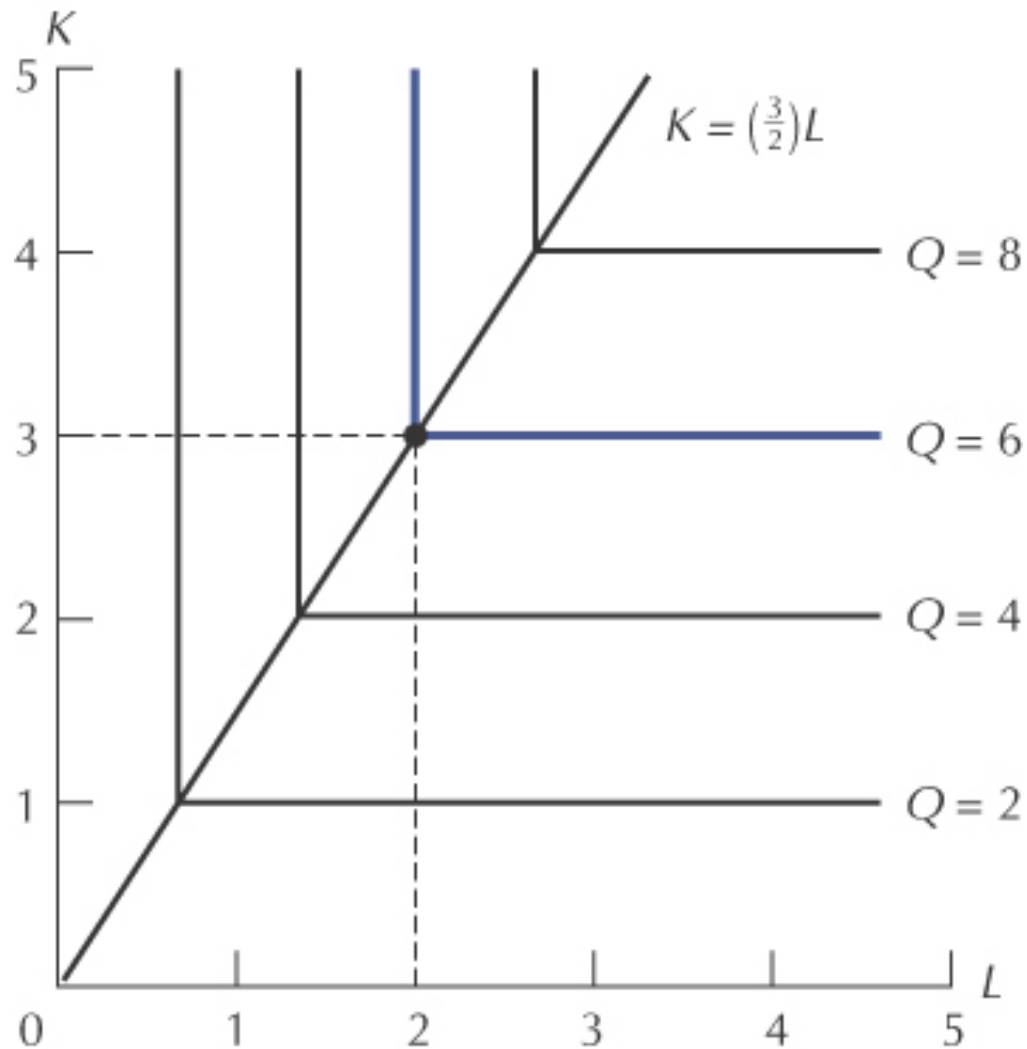
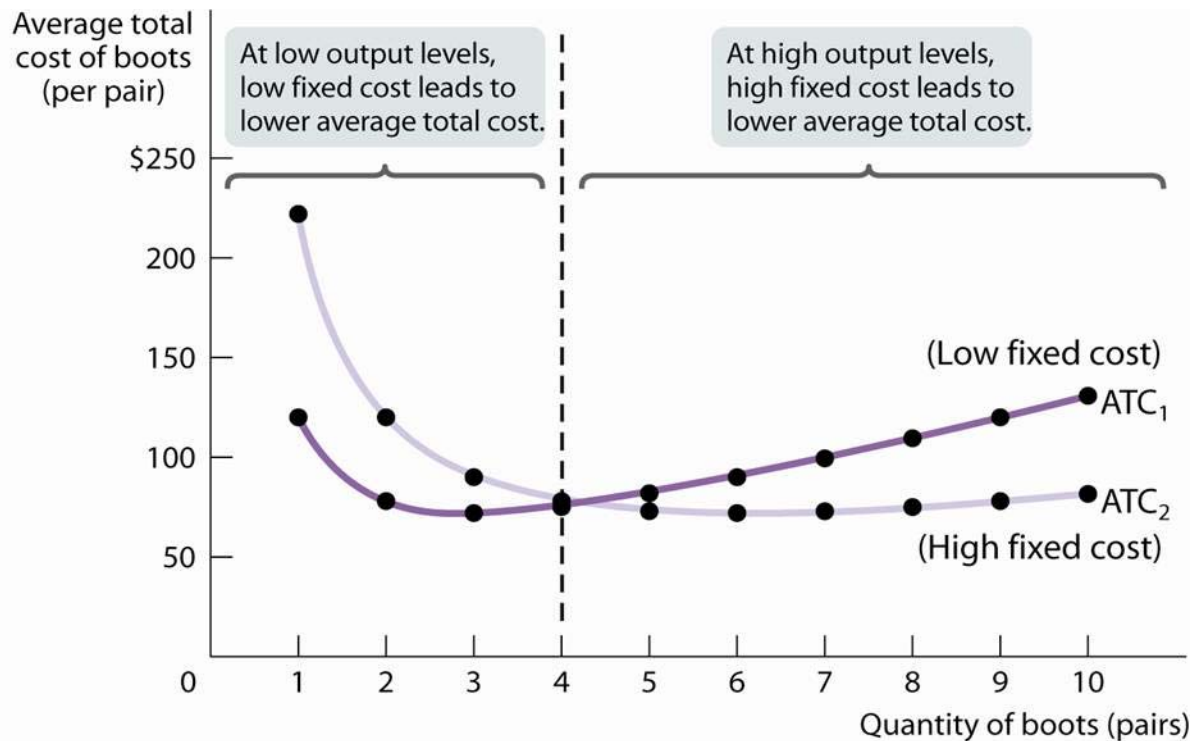


Figure A9-7: Isoquant Map
for the Leontief Production Function
 $Q = \min(2K, 3L)$





Choosing the Level of Fixed Cost for Ben's Boots

There is a trade-off between higher fixed cost and lower variable cost for any given output level, and vice versa. But as output goes up, average total cost is lower with the higher amount of fixed cost.

	Low fixed cost (FC = \$108)			High fixed cost (FC = \$216)		
Quantity of boots (pairs)	Variable cost	Total cost	Average total cost of boots ATC_1 (per pair)	Variable cost	Total cost	Average total cost of boots ATC_2 (per pair)
1	\$12	\$120	\$120	\$6	\$222	\$222
2	48	156	78	24	240	120
3	108	216	72	54	270	90
4	192	300	75	96	312	78
5	300	408	81.6	150	366	73.2
6	432	540	90	216	432	72
7	588	696	99.4	294	510	72.9
8	768	876	109.5	384	600	75
9	972	1,080	120	486	702	78
10	1,200	1,308	130.8	600	816	81.6

7.4



The Inflexibility of Short-Run Production

Figure 7.7

The Inflexibility of Short-Run Production

When a firm operates in the short run, its cost of production may not be minimized because of inflexibility in the use of capital inputs.

Output is initially at level q_1 .

In the short run, output q_2 can be produced only by increasing labor from L_1 to L_3 because capital is fixed at K_1 .

In the long run, the same output can be produced more cheaply by increasing labor from L_1 to L_2 and capital from K_1 to K_2 .

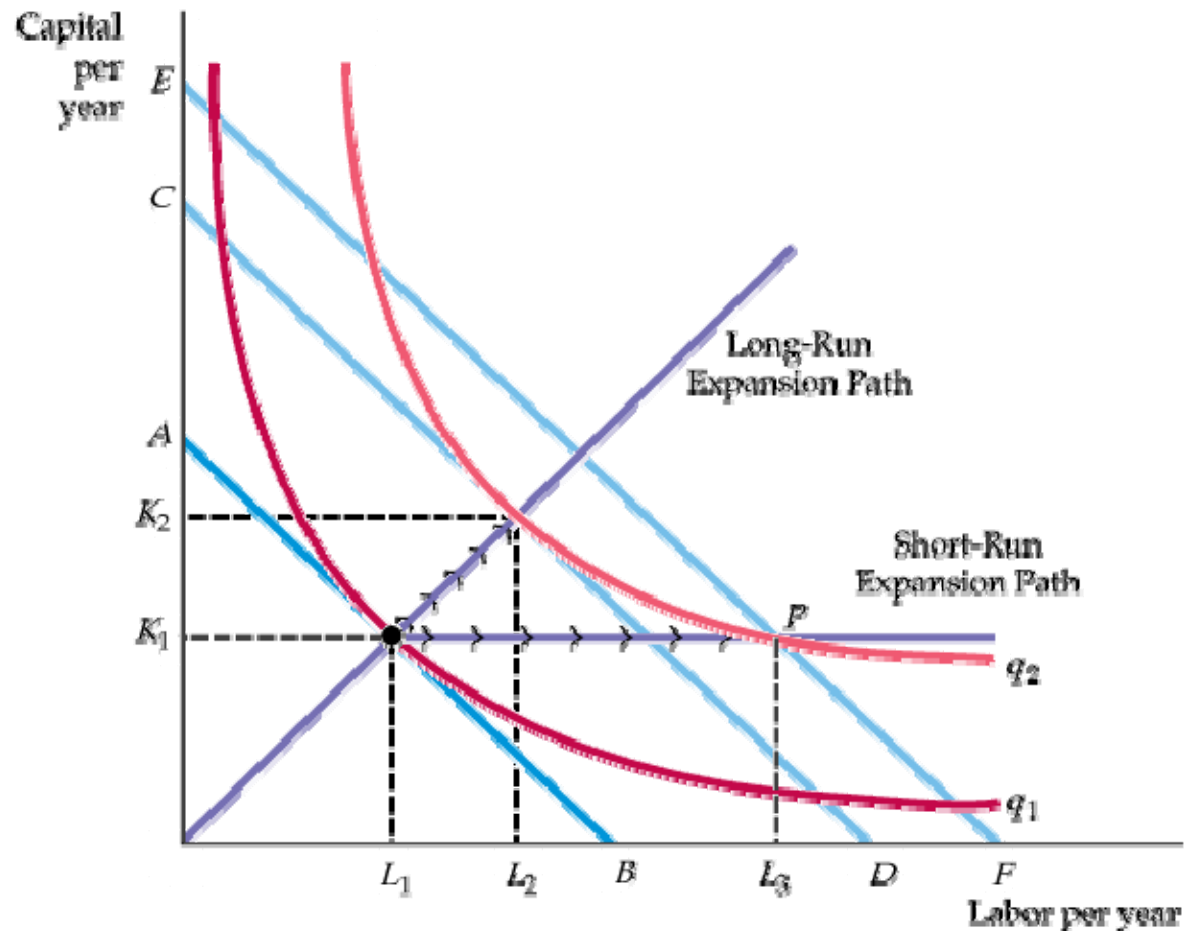
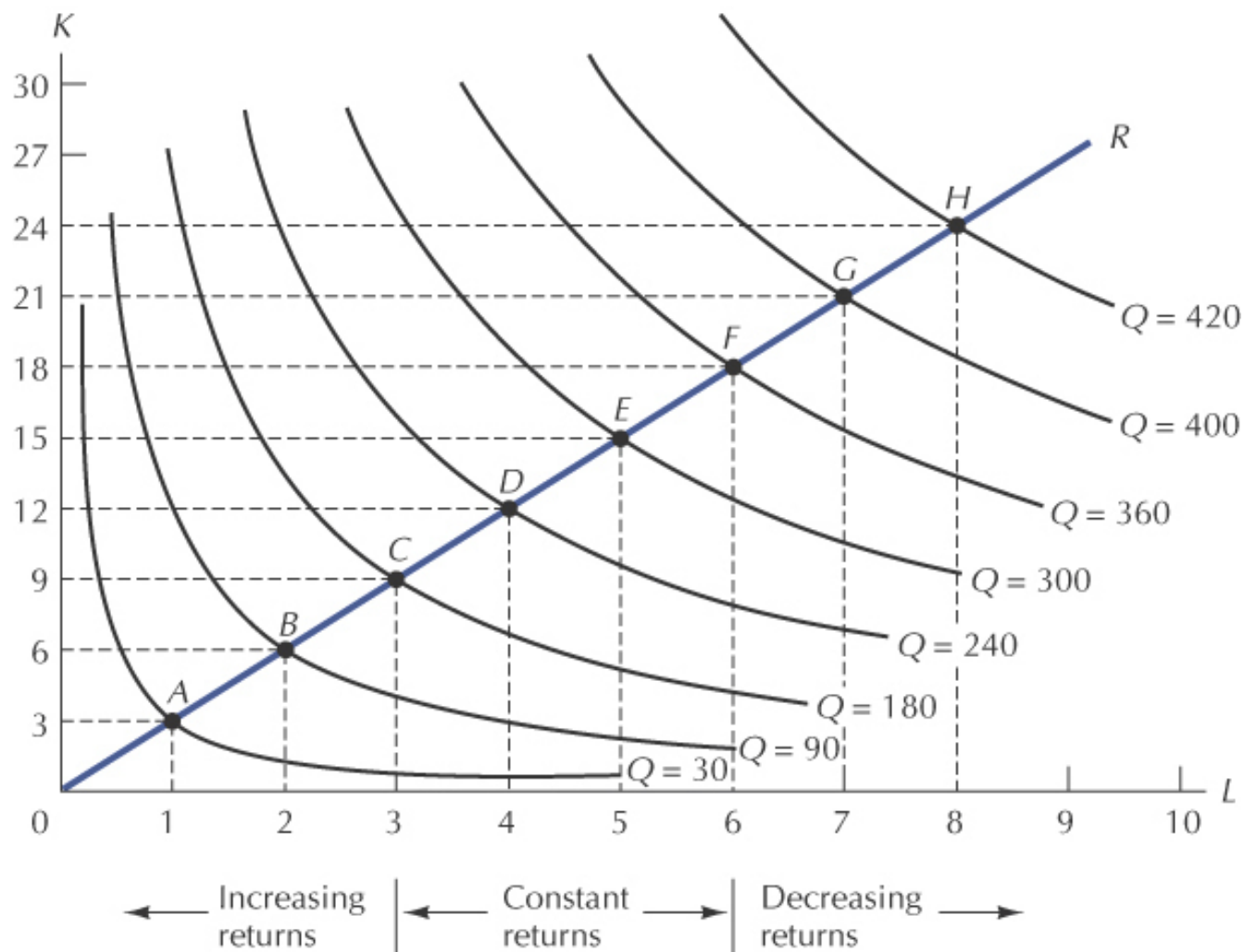


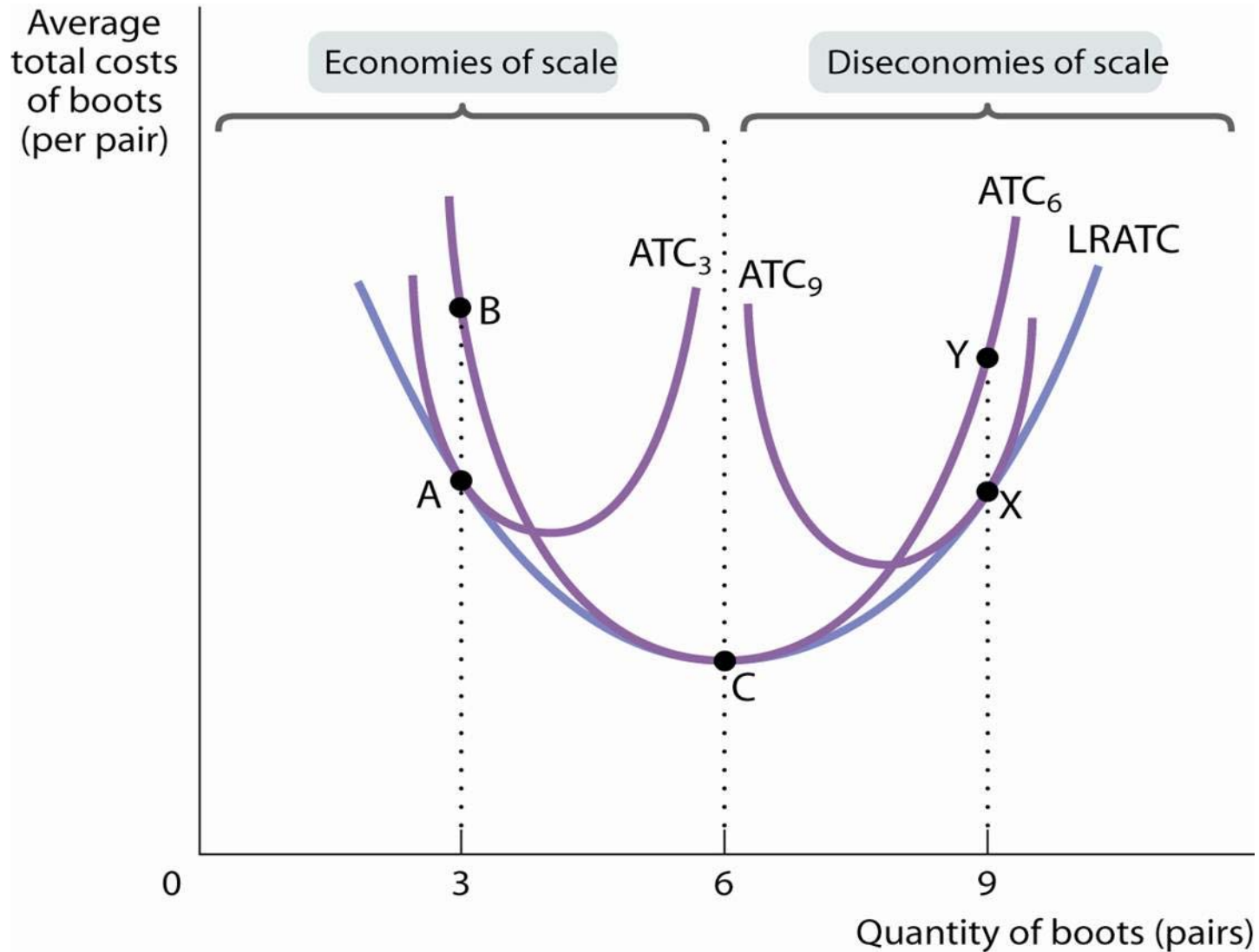
Figure 9-11: Returns to Scale Shown on the Isoquant Map



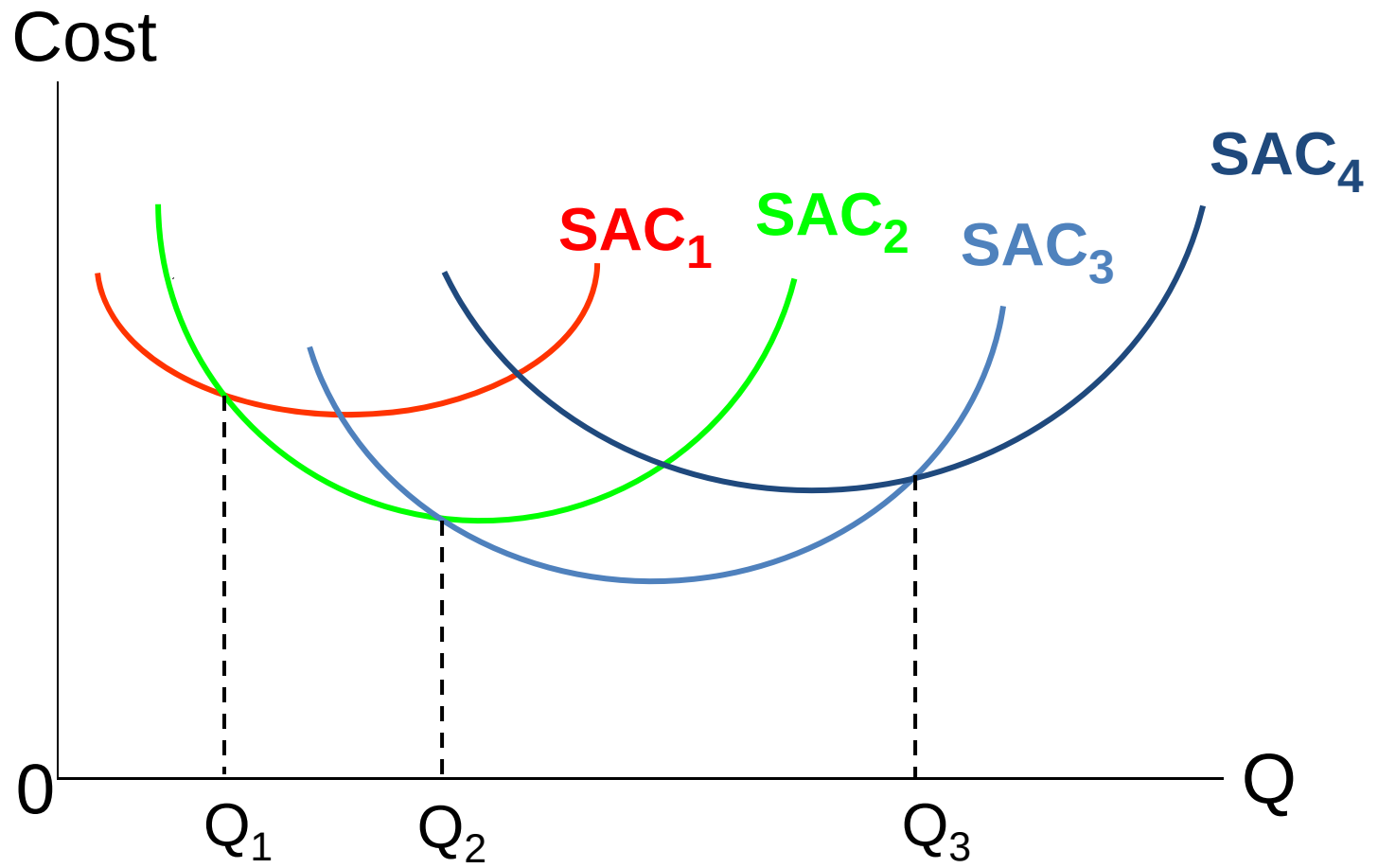
Point	L	% change	K	% change	Q	% change	
A	1		3		30		
B	2	100.00%	6	100.00%	90	200%	IRS
C	3	50.00%	9	50.00%	180	100%	IRS
D	4	33.33%	12	33.33%	240	33.3%	CRS
E	5	25.00%	15	25.00%	300	25%	CRS
F	6	20.00%	18	20.00%	360	20%	CRS
G	7	16.67%	21	16.67%	400	11%	DRS
H	8	14.29%	24	14.29%	420	5%	DRS

Note: Calculated from Figure 9-11: Returns to Scale Shown on the Isoquant Map, Frank (2006).

Short-Run and Long-Run Average Total Cost Curves



LAC



Why would a bathroom equipment manufacturer bake the image of a housefly onto the center of its ceramic urinals?



This example is base on Stefan Verhagen, "Fly in the Pot," Cornell Business, April 21, 1992.