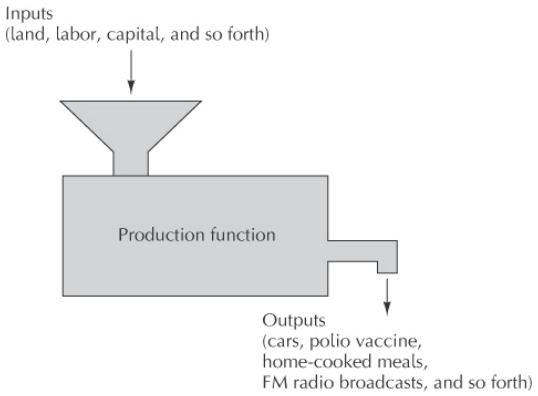
Production and Costs



Objective of a firm

Objective of a firm

- We assume that the firm's goal is to maximize profit.

Profit (π) = **Total revenue (TR)** – **Total cost (TC)**

the amount a firm receives from the sale of its output

the market value of the inputs a firm uses in production

Short Run Vs. Long Run

Production Function in the Short Run

A **production function** shows the relationship between the quantity of inputs used to produce a good, and the quantity of output of that good.
It can be represented by a table, equation, or graph.

- Total product (TP)

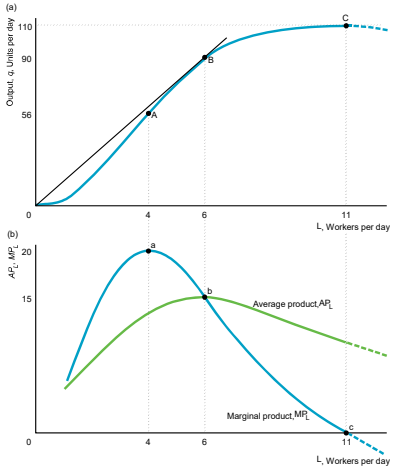
- Average Product (AP)

- Marginal Product (MP) is the increase in output arising from an additional unit of that input, holding all other inputs constant.

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



Law of diminishing marginal returns

- **If other inputs are fixed, the increase in output from an increase in the variable input must eventually decline.**

Why can't all the world's people be fed from the amount of grain grown in a single flowerpot?

The law of diminishing returns suggests that no matter how much labor, fertilizer, water, seed, capital equipment, and other inputs were used, only a limited amount of grain could be grown in a single flowerpot. With the land input fixed at such a low level, increases in other inputs would quickly cease to have any effect on total output.

Costs in the Short Run

Costs: Explicit vs. Implicit

- **Explicit costs** – require an outlay of money, *e.g.* paying wages to workers
- **Implicit costs** – do not require a cash outlay, *e.g.* the opportunity cost of the owner's time
- **Total costs** = Explicit costs + Implicit costs
- Remember one of the Ten Principles: *The cost of something is what you give up to get it*.
- This is true whether the costs are implicit or explicit. Both matter for firms' decisions.

Explicit vs. Implicit Costs: An Example

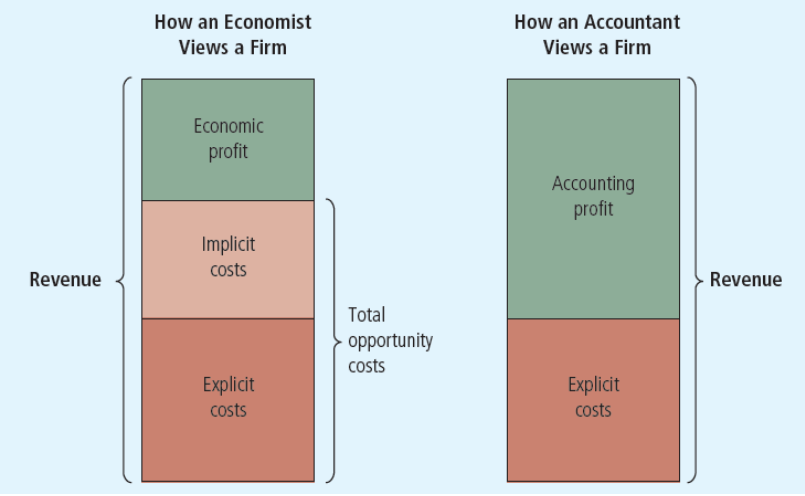
You need $100,000 to start your business. The interest rate is 5%.

- Case 1: borrow $100,000
  - explicit cost = $5000 interest on loan
- Case 2: use $40,000 of your savings, borrow the other $60,000
  - explicit cost = $3000 (5%) interest on the loan
  - implicit cost = $2000 (5%) *foregone* interest you could have earned on your $40,000.

In both cases, total (exp + imp) costs are $5000.

Economic Profit vs. Accounting Profit

- **Accounting profit**
  = total revenue minus total explicit costs
- **Economic profit**
  = total revenue minus total costs (including explicit and implicit costs)
- Accounting profit ignores implicit costs, so it's higher than economic profit.



Economists include all opportunity costs when analyzing a firm, whereas accountants measure only explicit costs. Therefore, economic profit is smaller than accounting profit.

ACTIVE LEARNING 2:

Economic profit vs. accounting profit

The equilibrium rent on office space has just increased by $500/month.

Compare the effects on accounting profit and economic profit if

a. you rent your office space

b. you own your office space

ACTIVE LEARNING 2:

Answers

The rent on office space increases $500/month.

a. You rent your office space.
Explicit costs increase $500/month.
Accounting profit & economic profit each fall $500/month.

b. You own your office space.
Explicit costs do not change,
so accounting profit does not change.
Implicit costs increase $500/month (opp. cost of using your space instead of renting it),
so economic profit falls by $500/month.

Total Costs (TC),
Total fixed cost (TFC or FC)
Total variable costs (TVC or VC)

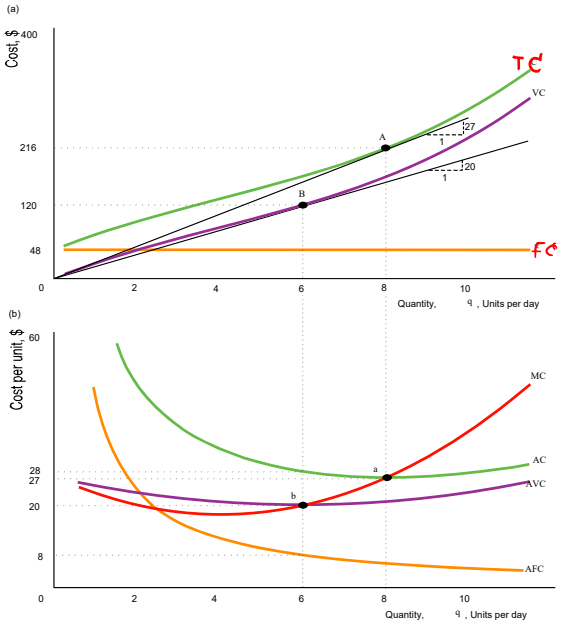
Average total cost (Atc or AC)
Average fixed cost (AFC)
Average variable cost (AVC)

Marginal cost (MC)

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

Short-Run Cost Curves



Facts about TC, FC, VC

Facts about AFC

Why AFC has rectangular hyperbola shape?

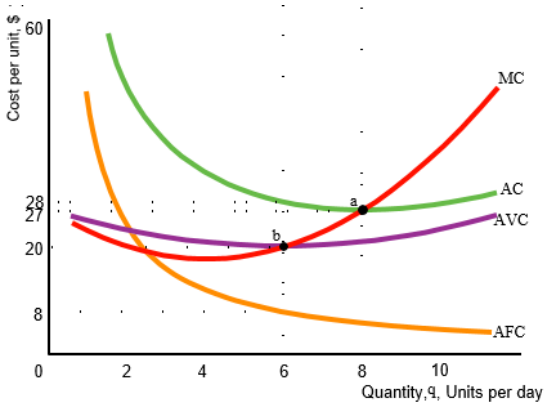
(Spreading effect)

Facts about AVC:

Why AVC is U-shaped?

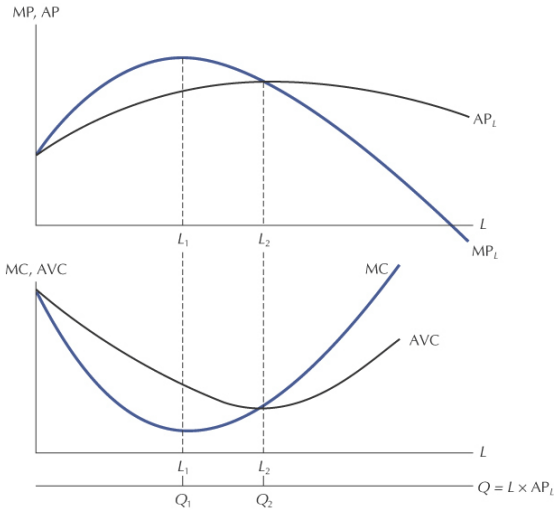
(Diminishing return effect)

Facts about AC: Why AC is U-shaped?



Why AC is U-shaped?

The Relationship Between MP, AP, MC, and AVC



Swans Reflecting Elephants (1937) is a painting by the Spanish surrealist Salvador Dalí.

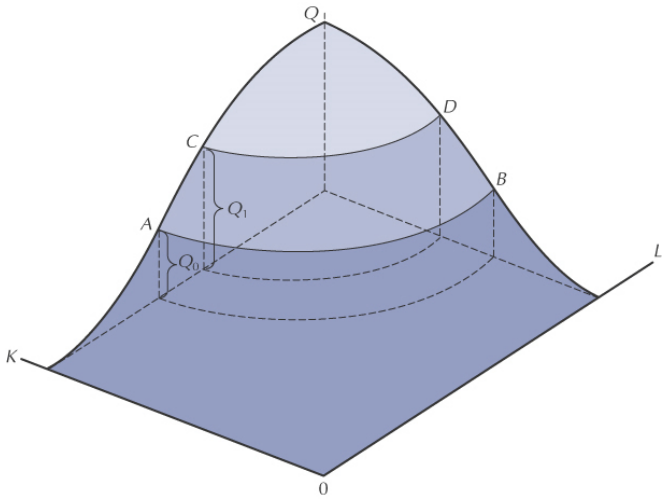
Average-Marginal Relationship holds when we consider MC and AC.

Term	Definition	Mathematical Description
Explicit costs	Costs that require an outlay of money by the firm	
Implicit costs	Costs that do not require an outlay of money by the firm	
Fixed costs	Costs that do not vary with the quantity of output produced	*FC*
Variable costs	Costs that vary with the quantity of output produced	*VC*
Total cost	The market value of all the inputs that a firm uses in production	$TC = FC + VC$
Average fixed cost	Fixed cost divided by the quantity of output	$AFC = FC / Q$
Average variable cost	Variable cost divided by the quantity of output	$AVC = VC / Q$
Average total cost	Total cost divided by the quantity of output	$ATC \text{ or } AC = TC / Q$
Marginal cost	The increase in total cost that arises from an extra unit of production	$MC = \Delta TC / \Delta Q$

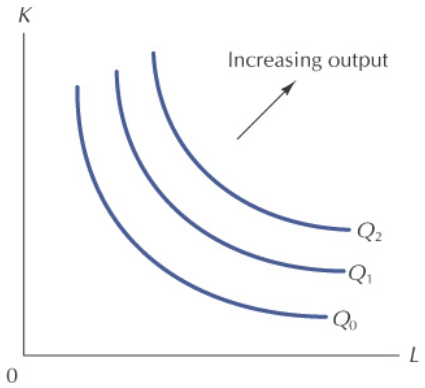
Production and Costs in the Long Run

- Q=f(L,K)
- Where Q = output, L= amount of labor, and K= amount of capital
- Let w = wage (price of labor) and r = rental rate (price of capital)
- Isocost: wL+rK= TC

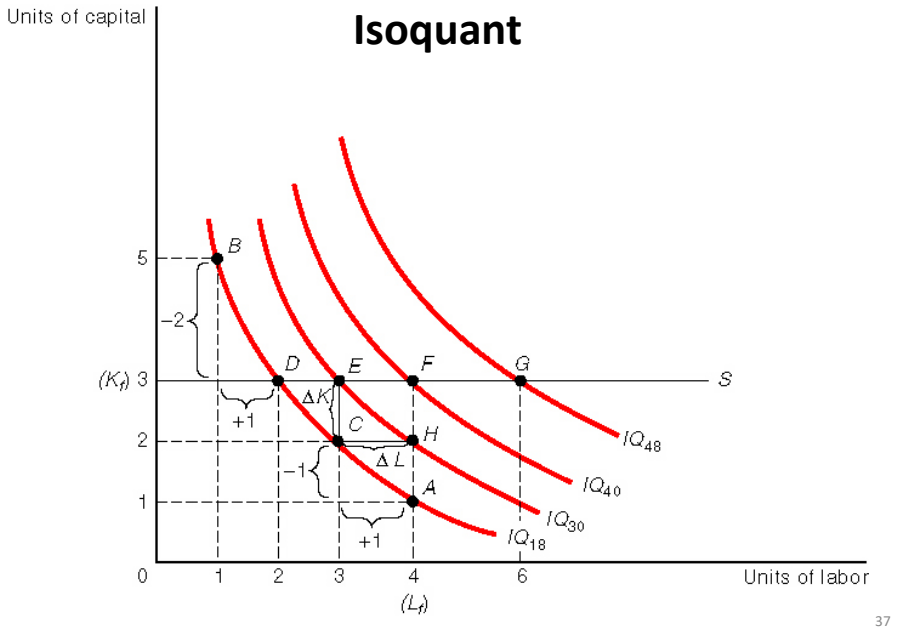
The Production Mountain



The Isoquant Map Derived from the Production Mountain

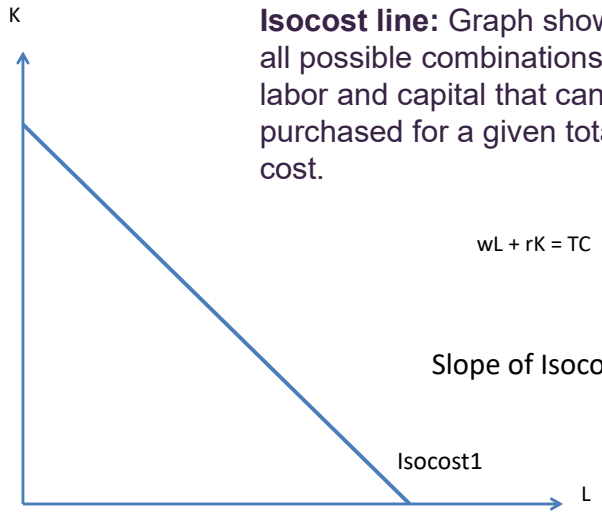


Isoquant



Isoquant for perfect substitutes

Isoquant for perfect complements



Isocost line: Graph showing all possible combinations of labor and capital that can be purchased for a given total cost.

wL + rK = TC

Slope of Isocost =

7.3 COST IN THE LONG RUN

The Isocost Line

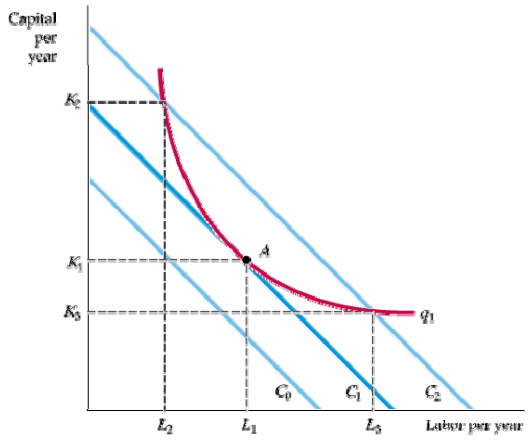
Figure 7.3

Producing a Given Output at Minimum Cost

Isocost curves describe the combination of inputs to production that cost the same amount to the firm.

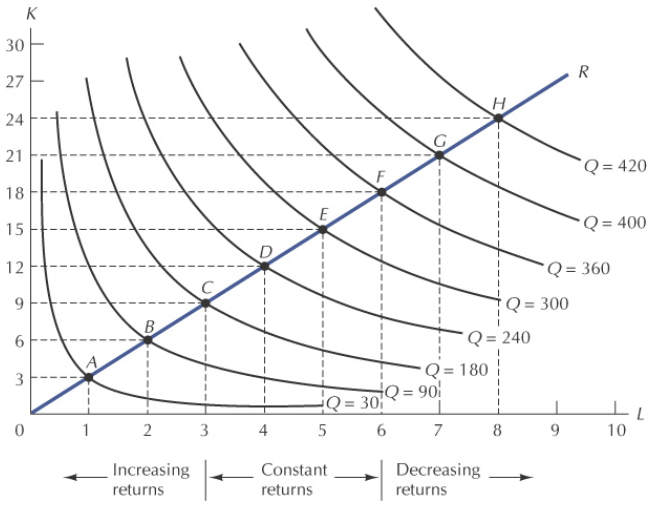
Isocost curve C_1 is tangent to isoquant q_1 at A and shows that output q_1 can be produced at minimum cost with labor input L_1 and capital input K_1.

Other input combinations–L_2, K_2 and L_3, K_3–yield the same output but at higher cost.



Cost Minimization Rule

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



Point	L	% change	K	% change	Q	% change	RTS
A	1	-	3	-	30	-	
B	2	**100.0%**	6	**100.0%**	90	**200%**	IRS
C	3	**50.0%**	9	**50.0%**	180	**100%**	IRS
D	4	**33.3%**	12	**33.3%**	240	**33%**	CRS
E	5	**25.0%**	15	**25.0%**	300	**25%**	CRS
F	6	**20.0%**	18	**20.0%**	360	**20%**	CRS
G	7	**16.7%**	21	**16.7%**	400	**11%**	DRS
H	8	**14.3%**	24	**14.3%**	420	**5%**	DRS

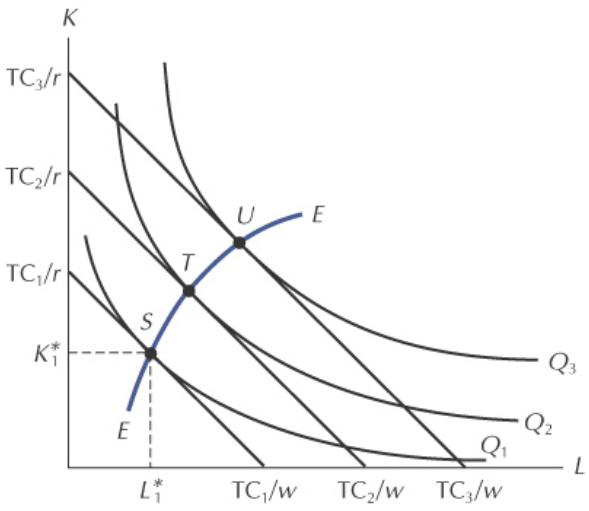
Note: Calculated from Figure 9-11: Returns to Scale Shown on the Isoquant Map, Frank (2006).

Math Note on Return to Scale

Returns to Scale: The bigger, The better?

- There are **increasing returns to scale (economies of scale)** when long-run average total cost declines as output increases.
- There are decreasing returns to scale (**diseconomies of scale)** when long-run average total cost increases as output increases.
- There are **constant returns to scale** when long-run average total cost is constant as output increases.

Figure 10.15: The Long-Run Expansion Path



7.4

The Inflexibility of Short-Run Production

Figure 7.7

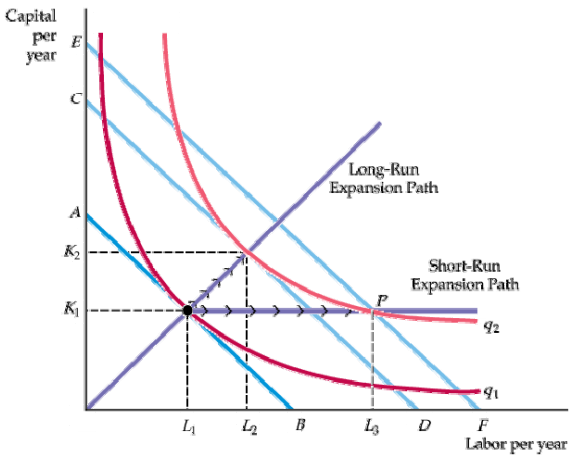
The Inflexibility of Short-Run Production

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.

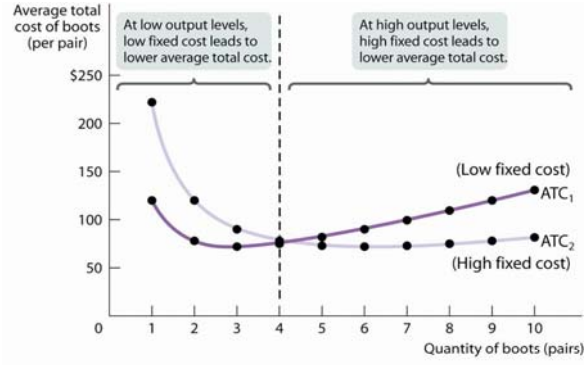


Where does Long run average cost (LAC) come from?

Short-Run versus Long-Run Costs

In the short run, fixed cost is completely outside the control of a firm. But all inputs are variable in the long run: This means that in the long run fixed cost may also be varied. In the long run, in other words, a firm's fixed cost becomes a variable it can choose!

The firm will choose its fixed cost in the long run based on the level of output it expects to produce.



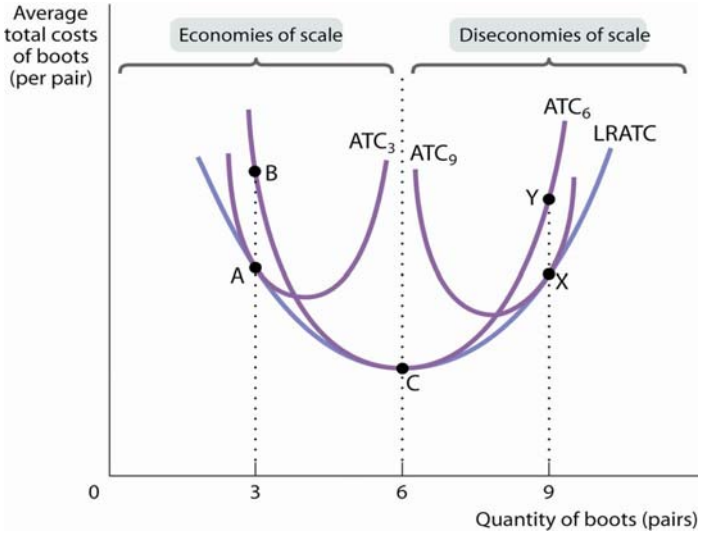
	Low fixed cost (FC = $108)			High fixed cost (FC = $216)		
Quantity of boots (pairs)	Variable cost	Total cost	Average total cost of boots ATC_1 (per pair)	Variable cost	Total cost	Average total cost of boots ATC_2 (per pair)
1	$12	$120	$120	$6	$222	$222
2	48	156	78	24	240	120
3	108	216	72	54	270	90
4	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

Choosing the Level of Fixed Cost for Ben's Boots

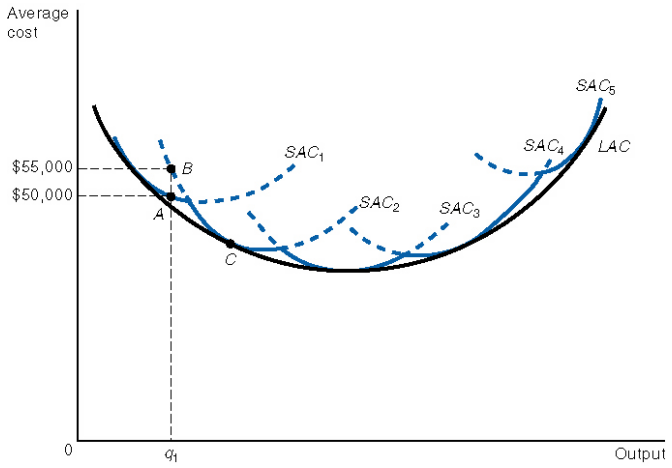
There is a trade-off between higher fixed cost and lower variable cost for any given output level, and vice versa.
But as output goes up, average total cost is lower with the higher amount of fixed cost.

The **long-run average total cost curve** shows the relationship between output and average total cost when fixed cost has been chosen to minimize average total cost for each level of output.

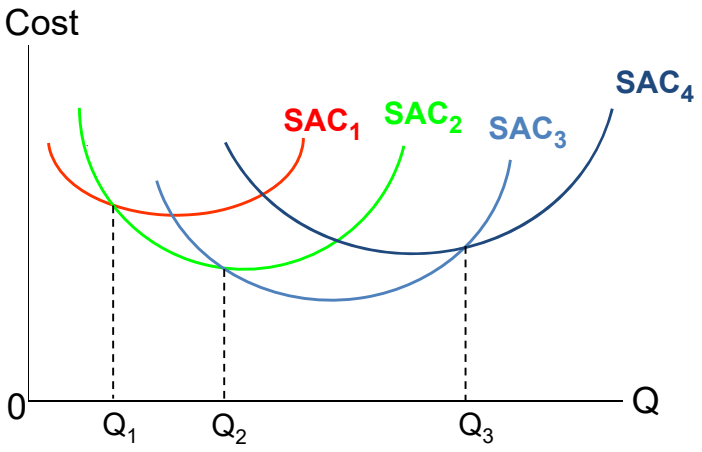
Short-Run and Long-Run Average Total Cost Curves



Long-Run Cost Curves



LAC



- Economies of scale
  - Long-run average total cost falls as the quantity of output increases
  - Increasing specialization among workers
- Constant returns to scale
  - Long-run average total cost stays the same as the quantity of output changes
- Diseconomies of scale
  - Long-run average total cost rises as the quantity of output increases
  - Increasing coordination problems

Long run equilibrium for perfectly competitive market

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.

Men's restroom @Changi Airport Singapore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