Ch 14: The Costs of Production

What it takes to make the thing you sell

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EC 111 Principles of Microeconomics, Bentley University, Fall 2026

From the market to the firm

Chapter 7

The supply curve is the sellers' costs, stacked up

Chapters 14–18

Open the firm and look inside

- what are its costs?
- how do they change with output?
- where does the supply curve come from? (Ch 15)

Question

You need $100,000 to open a shop. The bank charges 5%.

A. Borrow all $100,000.

B. Put in $40,000 of your savings, borrow $60,000.

Which costs you less per year?

Costs are opportunity costs

Total cost

The market value of everything the firm gives up to produce, bought or owner-supplied

Explicit costs: money goes out

- wages, rent, flour, interest

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Implicit costs: no money changes hands

- the owner's time: the salary she gave up
- the owner's money: forgone interest

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The $100,000 shop, per year

	A: borrow	B: own $40k
Interest paid (explicit)	$5,000	$3,000
Interest forgone (implicit)	0	$2,000
Cost of capital	$5,000	$5,000

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Total cost

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Cost of capital	$5,000	$5,000

The accountant sees $5,000 vs $3,000.
The economist sees $5,000 either way.

Two kinds of profit

Maya's cookie shop, one year

Total revenue	$200,000
Ingredients	45,000
Rent	30,000
One employee	35,000
Explicit costs	*110,000*

Profit

Total revenue − total cost

Two kinds of profit

Maya's cookie shop, one year

Total revenue	$200,000
Ingredients	45,000
Rent	30,000
One employee	35,000
Explicit costs	*110,000*
Accounting profit	$90,000

Profit

Total revenue − total cost

Accounting profit = revenue − explicit costs

what the tax return shows

Two kinds of profit

Maya's cookie shop, one year

Total revenue	$200,000
Ingredients	45,000
Rent	30,000
One employee	35,000
Explicit costs	*110,000*
Accounting profit	$90,000
Salary Maya gave up	55,000
5% on her $100,000	5,000
Implicit costs	*60,000*

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what the tax return shows

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5% on her $100,000	5,000
Implicit costs	*60,000*
Economic profit	$30,000

Profit

Total revenue − total cost

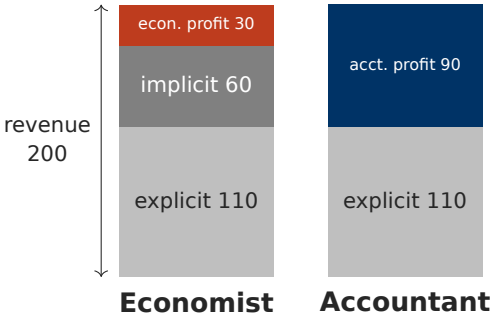
Accounting profit = revenue − explicit costs

what the tax return shows

Economic profit = revenue − explicit − implicit costs

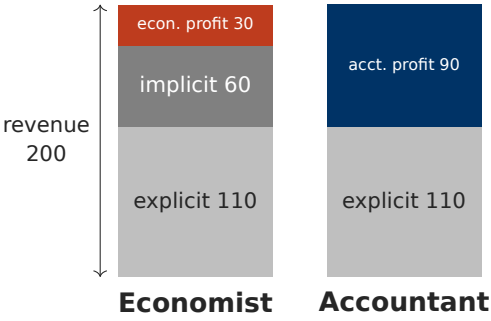
what Maya gains by running the shop instead of taking her next best option

The same firm, seen two ways



The accountant stops at explicit costs:
accounting profit $\geq$ economic profit

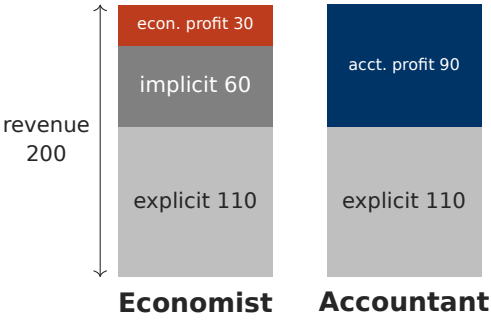
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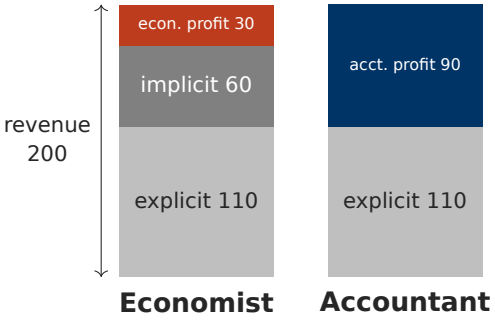


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From here on, cost and profit mean the economist's version

The same firm, seen two ways



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Question

Maya's brother: accounting profit \$40,000, and he gave up a \$55,000 job. Should he stay in business?

The production function: Jack's wheat farm

5 acres of land, fixed: \$1,000 a month

Workers, as many as he wants: \$2,000 a month each

Workers L	Bushels Q
0	0
1	1,000
2	1,800
3	2,400
4	2,800
5	3,000

Production function

How much output comes out of each quantity of inputs: $Q = F(\text{land}, L)$

The production function: Jack's wheat farm

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3	2,400	600
4	2,800	400
5	3,000	200

Production function

How much output comes out of each quantity of inputs: $Q = F(\text{land}, L)$

Marginal product

The extra output from one more unit of an input: $MP_L = \Delta Q / \Delta L$

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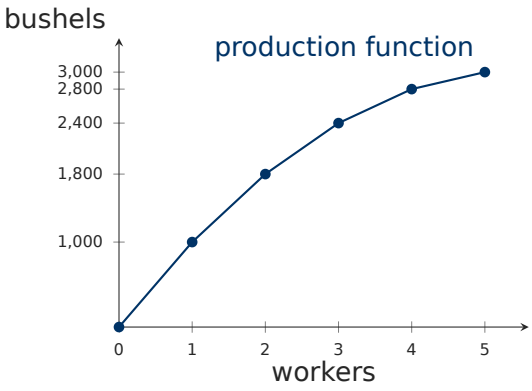
Marginal product

The extra output from one more unit of an input: $MP_L = \Delta Q / \Delta L$

Question

Each worker adds less than the one before. Why, if they are all equally good?

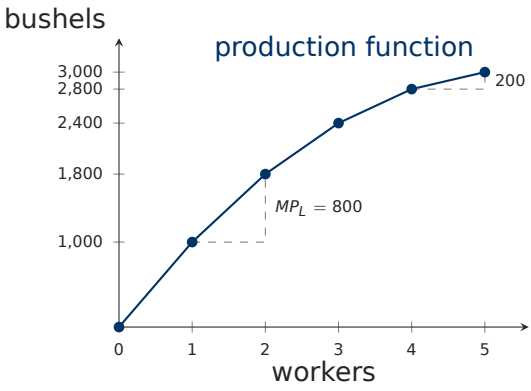
Diminishing marginal product



Diminishing marginal product

The marginal product of an input falls as more of it is used, the other inputs held fixed

Diminishing marginal product

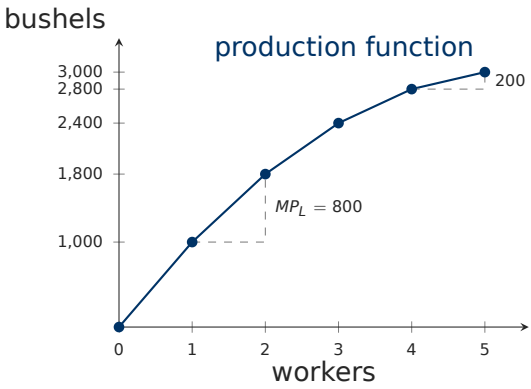


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The slope of the production function is MP_L: steep at first, then flatter

Diminishing marginal product



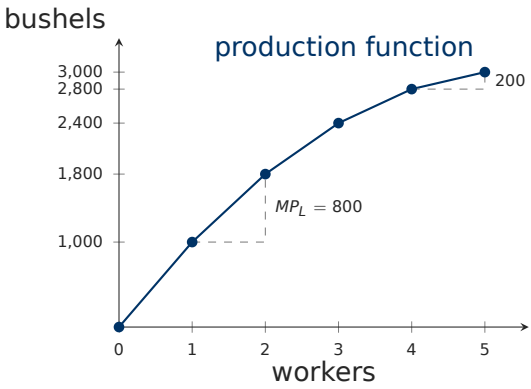
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Why: the 5 acres do not grow. The first worker has the whole field; the fifth waits for the tractor

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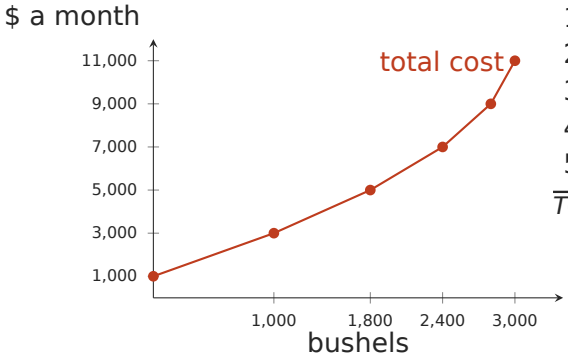
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Same in a kitchen or a factory: more people on a fixed space

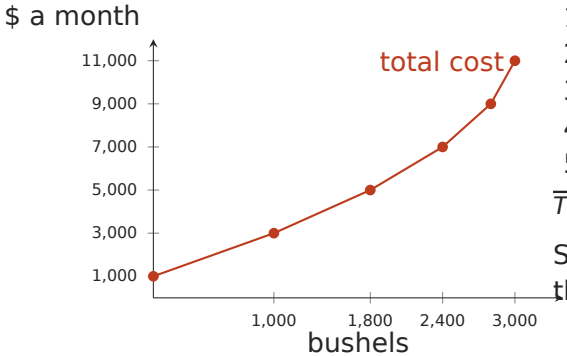
From the production function to the total-cost curve



L	Q	Total cost
0	0	\$1,000
1	1,000	3,000
2	1,800	5,000
3	2,400	7,000
4	2,800	9,000
5	3,000	11,000

$TC = \$1{,}000 + \$2{,}000 \times L$

From the production function to the total-cost curve

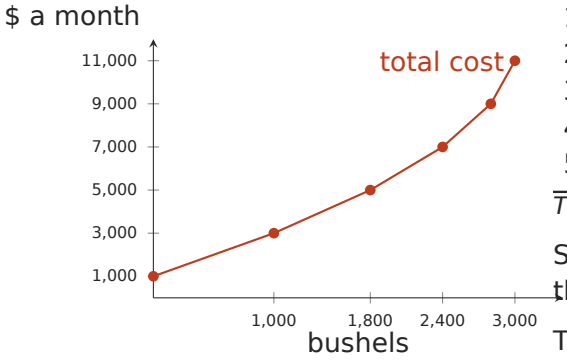


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Same table, axes swapped: output along the bottom, cost up the side

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Same table, axes swapped: output along the bottom, cost up the side

The curve gets steeper: each extra 1,000 bushels takes more workers than the last. Diminishing marginal product, in dollars

Marginal cost

Marginal cost

The increase in total cost from one more unit of output:

$MC = \Delta TC / \Delta Q$

L	Q	TC	MC per bushel
0	0	\$1,000	
1	1,000	3,000	\$2.00
2	1,800	5,000	
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Worker 1: \$2,000 buys 1,000 bushels

$MC = 2{,}000/1{,}000 = \$2.00$

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1	1,000	3,000	\$2.00
2	1,800	5,000	2.50
3	2,400	7,000	3.33
4	2,800	9,000	5.00
5	3,000	11,000	10.00

Worker 1: \$2,000 buys 1,000 bushels

$$MC = 2{,}000/1{,}000 = \$2.00$$

Worker 2: \$2,000 buys 800 bushels

$$MC = 2{,}000/800 = \$2.50$$

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In general: $MC = \dfrac{\text{wage}}{MP_L}$

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In general: $MC = \dfrac{\text{wage}}{MP_L}$

Rising marginal cost is diminishing marginal product, priced in dollars

Average total cost

Average total cost

Total cost divided by output:
$ATC = TC/Q$

L	Q	TC	MC	ATC
1	1,000	$3,000	$2.00	$3.00
2	1,800	5,000	2.50	
3	2,400	7,000	3.33	
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Marginal: the last bushel.
Average: the typical bushel

Average total cost

Average total cost

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L	Q	TC	MC	ATC
1	1,000	$3,000	$2.00	$3.00
2	1,800	5,000	2.50	2.78
3	2,400	7,000	3.33	2.92
4	2,800	9,000	5.00	3.21
5	3,000	11,000	10.00	3.67

Marginal: the last bushel.
Average: the typical bushel

Question

The average falls, then rises.
Why?

Average total cost

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Total cost divided by output:
$ATC = TC/Q$

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4	2,800	9,000	5.00	3.21
5	3,000	11,000	10.00	3.67

Marginal: the last bushel.
Average: the typical bushel

Question

The average falls, then rises. Why?

Falls: the \$1,000 for land is spread over more bushels

Rises: each worker adds fewer bushels, so labor cost per bushel climbs

Lowest at $Q = 1{,}800$: the efficient scale

Fixed and variable costs

Fixed costs

Do not change with output: Jack's land, a lease, a license

Variable costs

Change with output: workers, flour, electricity. $TC = FC + VC$

Fixed and variable costs

Fixed costs

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Variable costs

Change with output: workers, flour, electricity. $TC = FC + VC$

Lena's bagel cart, per day; Q in hundreds of bagels. The cart costs $100 a day whether she bakes or not

Q	FC	VC	TC
0	$100	$0	$100
1	100	70	170
2	100	120	220
3	100	160	260
4	100	210	310
5	100	280	380
6	100	380	480
7	100	520	620

Fixed and variable costs

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7	100	520	620

Question

Her lease runs five more years. Is the $100 fixed? For how long?

The whole cost table

Q	*FC*	*VC*	*TC*
0	$100	$0	$100
1	100	70	170
2	100	120	220
3	100	160	260
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The whole cost table

Q	FC	VC	TC	AFC
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1	100	70	170	\$100.00
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3	100	160	260	33.33
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5	100	280	380	20.00
6	100	380	480	16.67
7	100	520	620	14.29

$AFC = FC/Q$
always falls

The whole cost table

Q	FC	VC	TC	AFC	AVC
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5	100	280	380	20.00	56.00
6	100	380	480	16.67	63.33
7	100	520	620	14.29	74.29

$AFC = FC/Q$ always falls

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The whole cost table

Q	FC	VC	TC	AFC	AVC	ATC
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1	100	70	170	\$100.00	\$70.00	\$170.00
2	100	120	220	50.00	60.00	110.00
3	100	160	260	33.33	53.33	86.67
4	100	210	310	25.00	52.50	77.50
5	100	280	380	20.00	56.00	76.00
6	100	380	480	16.67	63.33	80.00
7	100	520	620	14.29	74.29	88.57

$AFC = FC/Q$
always falls

$AVC = VC/Q$
falls, then rises

$ATC = AFC + AVC$
U-shaped, lowest at $Q = 5$

The whole cost table

Q	FC	VC	TC	AFC	AVC	ATC	MC
0	\$100	\$0	\$100				
1	100	70	170	\$100.00	\$70.00	\$170.00	\$70
2	100	120	220	50.00	60.00	110.00	50
3	100	160	260	33.33	53.33	86.67	40
4	100	210	310	25.00	52.50	77.50	50
5	100	280	380	20.00	56.00	76.00	70
6	100	380	480	16.67	63.33	80.00	100
7	100	520	620	14.29	74.29	88.57	140

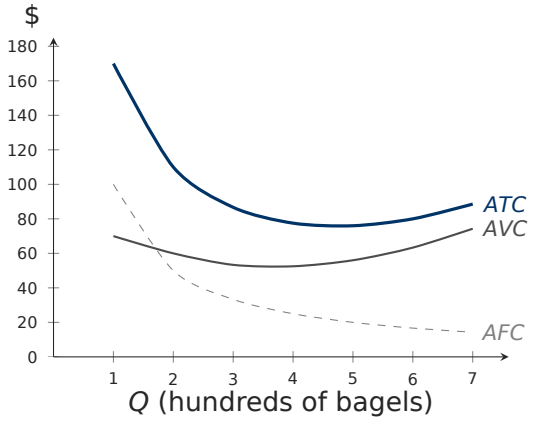
$AFC = FC/Q$ always falls

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$ATC = AFC + AVC$ U-shaped, lowest at $Q = 5$

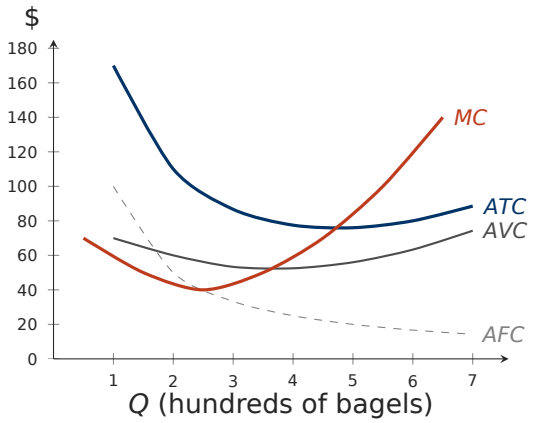
$MC = \Delta TC/\Delta Q$ falls at first, then rises

The cost curves



Three facts for every later chapter

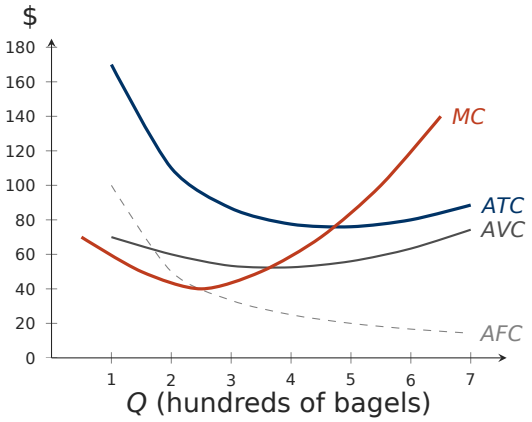
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Three facts for every later chapter

1. **Marginal cost eventually rises**
   diminishing marginal product; it can fall at very low output while a small team splits tasks

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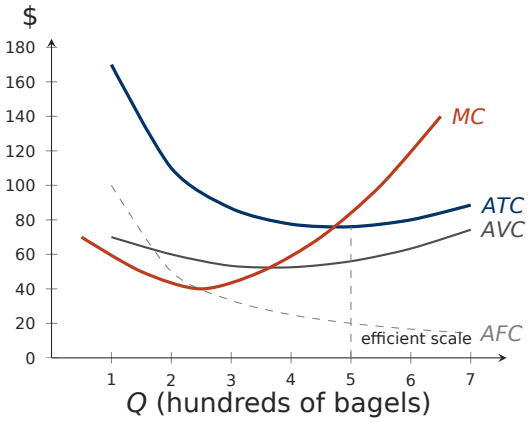


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   AFC pulls it down, rising *AVC* pulls it up

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   diminishing marginal product; it can fall at very low output while a small team splits tasks
2. **Average total cost is U-shaped**
   AFC pulls it down, rising *AVC* pulls it up
3. ***MC* crosses *ATC* at its minimum**
   the efficient scale: $Q = 5$, $ATC = \$76$
   it also crosses *AVC* at its minimum

Why marginal cost crosses average cost at the bottom

Question

Your GPA is 3.4. This term you earn a 3.0 average. What happens to your GPA?

Why marginal cost crosses average cost at the bottom

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It falls. The marginal term pulled the average toward it

Earn a 3.8 next term and the GPA rises

It stops moving only when the new term equals it

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Costs work the same way

$MC < ATC$: the last unit was cheaper than average, so the average falls

$MC > ATC$: the last unit was dearer than average, so the average rises

$MC = ATC$: the average is at its minimum

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Efficient scale

The output that minimizes average total cost

Try it: the pizzeria

Question

A pizzeria's costs per hour; Q in dozens of pizzas.

Q	0	1	2	3	4	5	6
TC	\$280	320	350	380	420	470	530
VC	0	40	70	100	140	190	250

(a) Fixed cost? (b) MC of each dozen from TC. (c) MC from VC.

(d) True or false: it doesn't matter which column you use.

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(a) $FC = TC$ at $Q = 0$, or $TC - VC$ at any Q: \$280.

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(b) From TC: $320 - 280 = 40$, then $30, 30, 40, 50, 60$.

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Question

A pizzeria's costs per hour; Q in dozens of pizzas.

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(d) True. Fixed cost sits in both TC numbers and cancels in the difference. Marginal cost is only ever about variable cost.

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Short run: some inputs are fixed

Jack's 5 acres, Lena's cart, Ford's factory

fixed costs exist; the firm adjusts labor and materials

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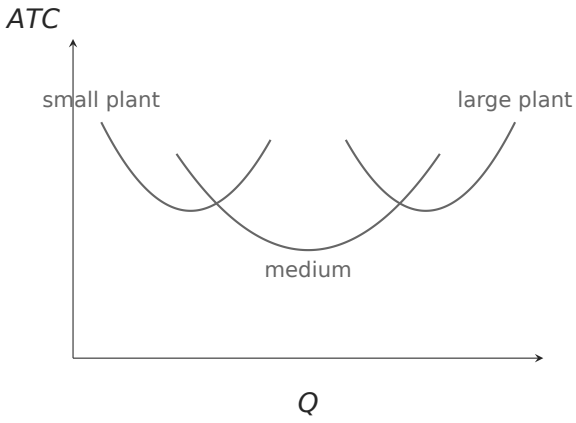
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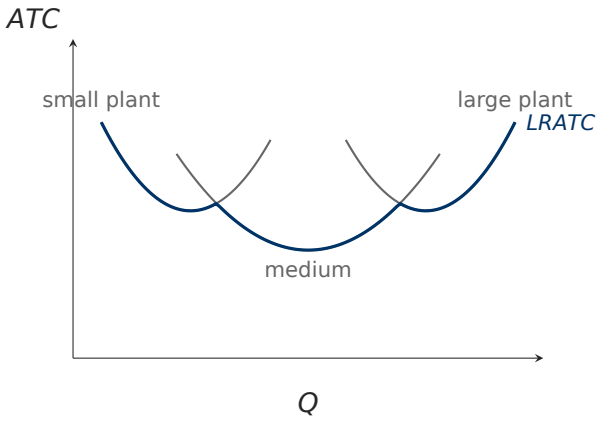
A car maker sells more cars than its one plant can build. What can it do this month? In five years?

Long-run average total cost



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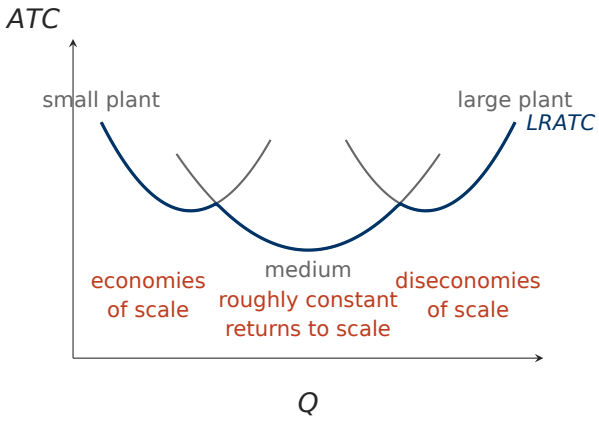
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Flatter than any short-run curve: more ways to adjust

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Why: specialization (Smith's pin factory: ten workers, 48,000 pins a day) and spreading a one-time cost (a car design, a chip, software)

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Ford builds cars in plants with 5,000 workers. Law firms have 10 lawyers. Hair salons have 3 chairs. What is different about their cost curves?

Try it: three firms' long-run costs

Question

Long-run total cost for three firms. Where does each have economies or diseconomies of scale?

Q	1	2	3	4	5	6	7
Firm A	$60	70	80	90	100	110	120
Firm B	11	24	39	56	75	96	119
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ATC, A	60.00	35.00	26.67	22.50	20.00	18.33	17.14
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A: economies throughout. B: diseconomies throughout. C: economies to $Q = 3$, then diseconomies.

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A: a utility or a software firm. B: a business that only works small. C: most firms.

Exam-style: from average to marginal

Question

A firm's average total cost is \$20.00 when it makes 100 units and \$20.20 when it makes 101.

(a) Total cost at each output? (b) Marginal cost of the 101st unit?
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(d) No: it brings in \$30 and costs \$40.20. Comparing *P* to *ATC* misleads; Chapter 15 is about this.

Summary

What costs are

- Cost is opportunity cost: explicit (money out) plus implicit (owner's time and money)
- Economic profit = revenue − all costs; accounting profit ignores implicit costs
- Production function: output from inputs; marginal product diminishes as a fixed input is crowded
- Total cost rises with output and gets steeper: the production function flipped

The cost curves

- $TC = FC + VC$; $ATC = AFC + AVC$; $MC = \Delta TC / \Delta Q$
- MC eventually rises ($MC = \text{wage}/MP_L$); ATC is U-shaped
- MC crosses ATC and AVC at their minimums; min ATC is the efficient scale
- Short run: some inputs fixed. Long run: none; $LRATC$ is flatter
- Economies of scale (specialization), diseconomies (coordination), constant returns

Next: Ch 15, firms in competitive markets.