Economics 1
Principles of Economics

Costs and Profit Maximization Under Competition

(Chapters 13 and 14)

Dr. Randall R. Rojas

Look for the Answers to These Questions 1 of 2

- What is a production function? What is marginal product? How are they related?
- What are the various costs, and how are they related to each other and to output?
- How are costs different in the short run vs. the long run?
- What are “economies of scale”?

Look for the Answers to These Questions 2 of 2

- What is a perfectly competitive market?
- What is marginal revenue? How is it related to total and average revenue?
- How does a competitive firm determine the quantity that maximizes profits?
- When might a competitive firm shut down in the short run? Exit the market in the long run?
- What does the market supply curve look like in the short run? In the long run?

I. Introduction

A Scenario

- You run Ford Motor Company.
- List three different costs you have.
- List three different business decisions that are affected by your costs.

II. What are Costs? 1 of 6

Total Revenue, Total Cost, Profit

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

Profit = Total revenue − Total cost

The amount a firm receives from the sale of its output.

The market value of the inputs a firm uses in production.

II. What are Costs? 2 of 6

Costs: Explicit vs. Implicit

- Def: Explicit costs require an outlay of money, e.g., paying wages to workers.
- Def: Implicit costs do not require a cash outlay, e.g., the opportunity cost of the owner's time.
- 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.

II. What are Costs? 3 of 6

Costs: Explicit vs. Implicit (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. Assume your savings account pays 5% interest.
- 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 (explicit + implicit) costs are $5000.

II. What are Costs? 4 of 6

Economic Profit vs. Accounting Profit

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

II. What are Costs?

Economic Profit vs. Accounting Profit (Example)

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

Determine the effects on accounting profit and economic profit if

a. you rent your office space.

b. you own your office space.

II. What are Costs? 6 of 6

Economic Profit vs. Accounting Profit (Example)

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.

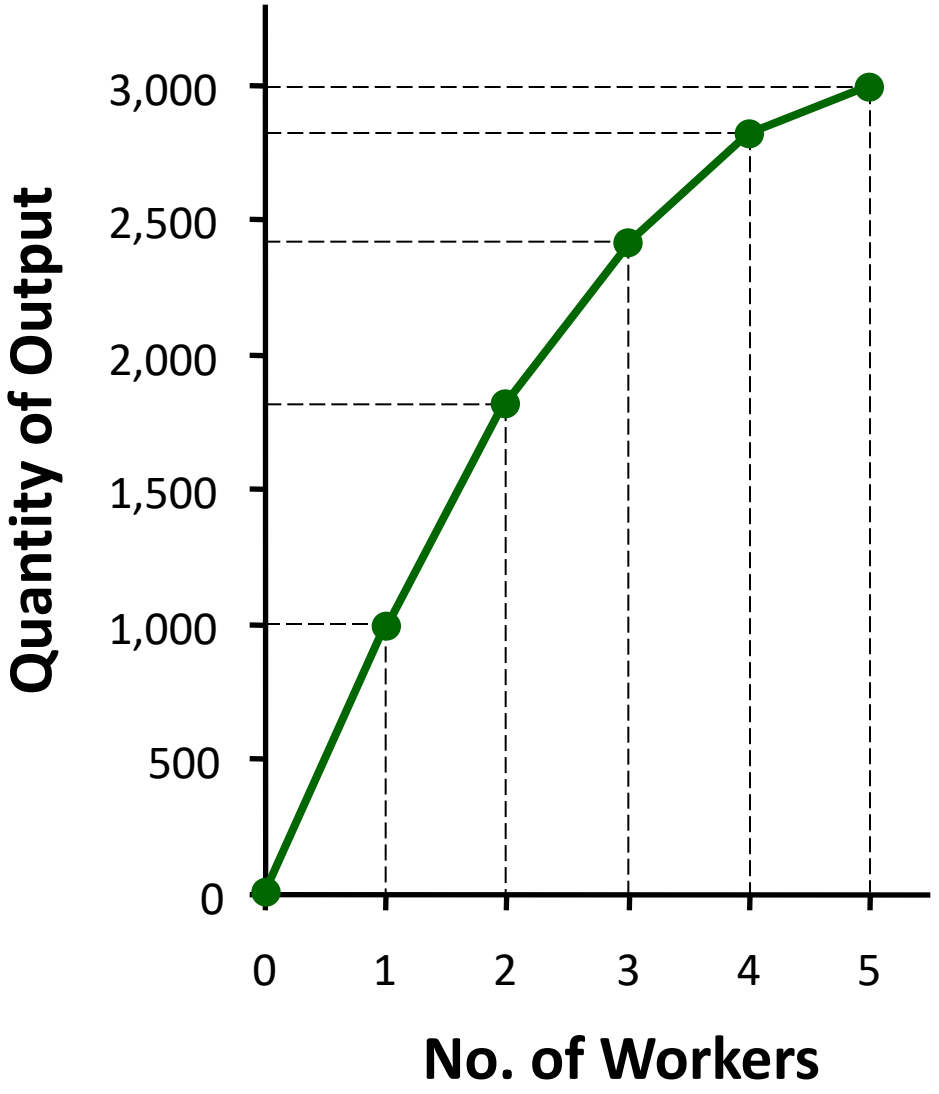
- Explicit costs do not change, so accounting profit does not change.
- Implicit costs increase $500/month (opportunity cost of using your space instead of renting it), so economic profit falls by $500/month.

III. The Production Function

- Def: 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 a graph.
- Example 1
  - Farmer Jack grows wheat.
  - He has 5 acres of land.
  - He can hire as many workers as he wants.

Example 1: Farmer Jack's Production Function

L (No. of workers)	*Q* (Bushels of wheat)
0	0
1	1000
2	1800
3	2400
4	2800
5	3000



IV. The Various Measures of Cost

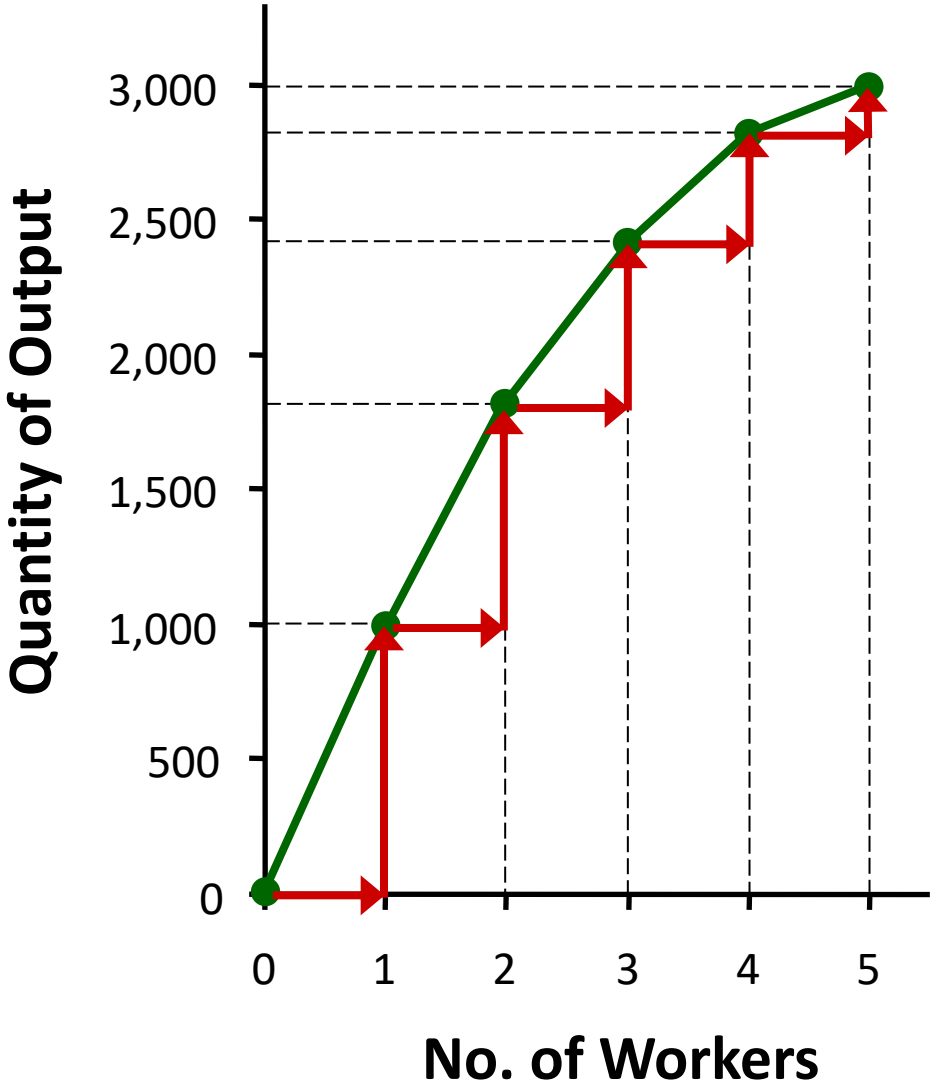
- If Jack hires one more worker, his output rises by the marginal product of labor.
- Def: The Marginal Product of any input is the increase in output arising from an additional unit of that input, holding all other inputs constant.
- Notation:
  Δ (delta) = "change in…"
- Examples:
  ΔQ = change in output, ΔL = change in labor
- Marginal Product of Labor (MPL) = $\frac{\Delta Q}{\Delta L}$

Example 1: Total and Marginal Product

	L (No. of workers)	*Q* (Bushels of wheat)	$MPL = \frac{\Delta Q}{\Delta L}$
	0	0	
$\Delta L = 1$			$\Delta Q = 1000$ → 1000
	1	1000	
$\Delta L = 1$			$\Delta Q = 800$ → 800
	2	1800	
$\Delta L = 1$			$\Delta Q = 600$ → 600
	3	2400	
$\Delta L = 1$			$\Delta Q = 400$ → 400
	4	2800	
$\Delta L = 1$			$\Delta Q = 200$ → 200
	5	3000	

Example 1: MPL = Slope of the Production Function

L (No. of workers)	*Q* (Bushels of wheat)	*MPL*
0	0	
		1000
1	1000	
		800
2	1800	
		600
3	2400	
		400
4	2800	
		200
5	3000	



IV. The Various Measures of Cost

Why MPL is Important

- Recall one of the Ten Principles:
  - Rational people think at the margin.
- When Farmer Jack hires an extra worker,
  - his costs rise by the wage he pays the worker.
  - his output rises by MPL.
- Comparing them helps Jack decide whether he should hire the worker.

IV. The Various Measures of Cost

Why MPL Diminishes

- Farmer Jack's output rises by a smaller and smaller amount for each additional worker. Why?
- As Jack adds workers, the average worker has less land to work with and will be less productive.
- In general, MPL diminishes as L rises whether the fixed input is land or capital (equipment, machines, etc.).
- Def: Diminishing Marginal Product

  The marginal product of an input declines as the quantity of the input increases (other things equal).

IV. The Various Measures of Cost

Example 1: Farmer Jack's Costs

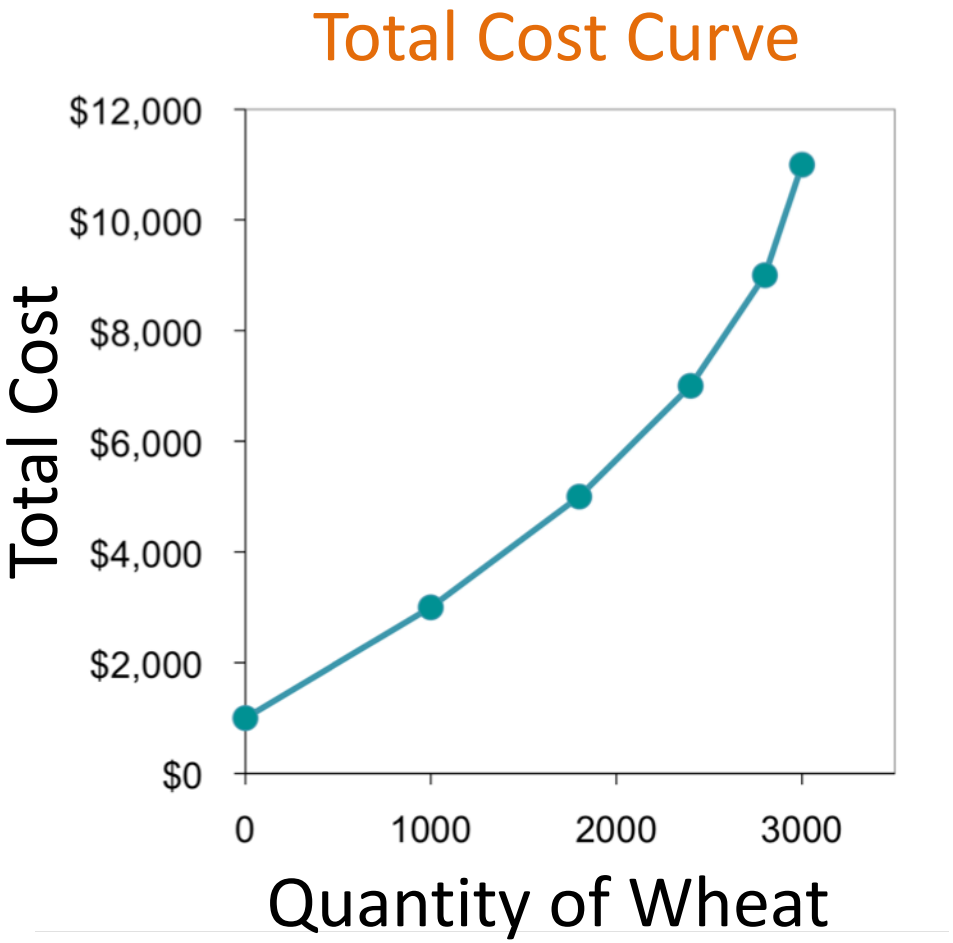
- Farmer Jack must pay $1000 per month for the land, regardless of how much wheat he grows.
- The market wage for a farm worker is $2000 per month.
- So Farmer Jack's costs are related to how much wheat he produces….

Example 1: Farmer Jack's Costs

L (No. of workers)	*Q* (Bushels of wheat)	Cost of land	Cost of labor	Total Cost
0	0	$1,000	$0	$1,000
1	1000	$1,000	$2,000	$3,000
2	1800	$1,000	$4,000	$5,000
3	2400	$1,000	$6,000	$7,000
4	2800	$1,000	$8,000	$9,000
5	3000	$1,000	$10,000	$11,000

Example 1: Farmer Jack's Total Cost Curve

Q (bushels of wheat)	Total Cost
0	$1,000
1000	$3,000
1800	$5,000
2400	$7,000
2800	$9,000
3000	$11,000



IV. The Various Measures of Cost

- Def: Marginal Cost (MC) = The increase in Total Cost from producing one more unit:

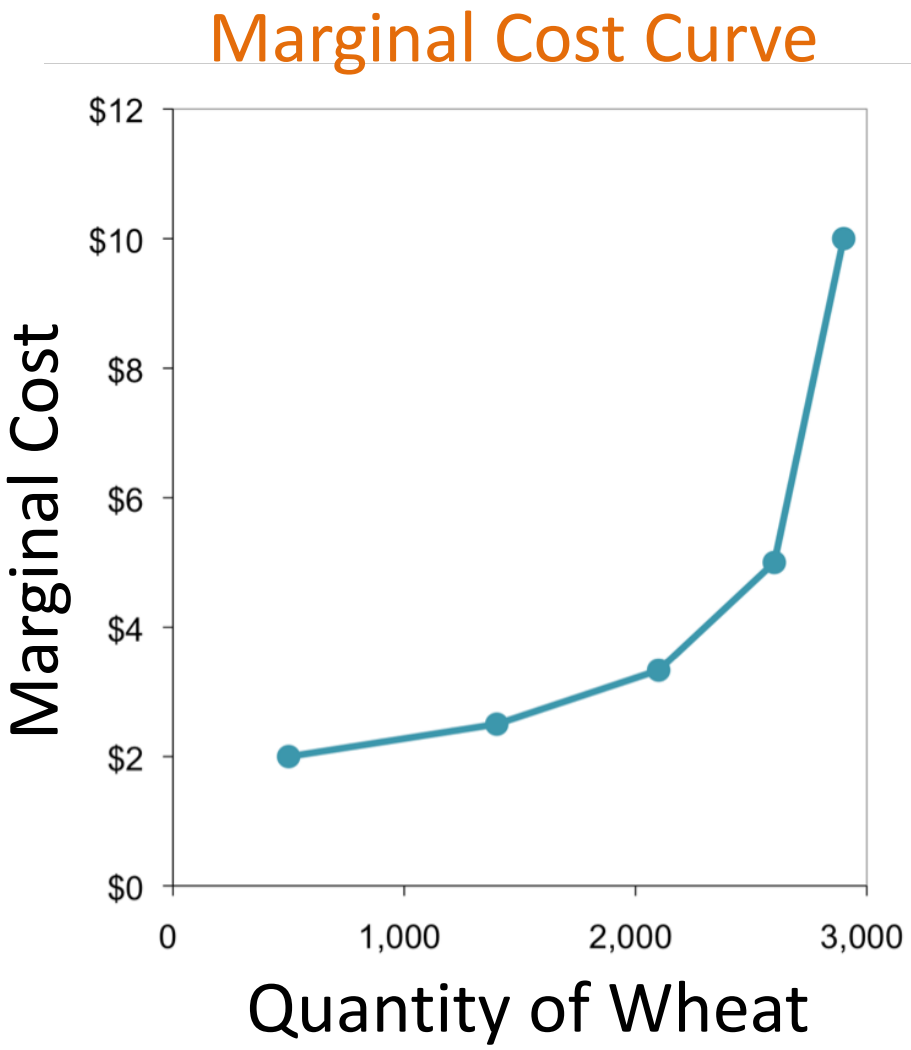
$$MC = \frac{\Delta TC}{\Delta Q}$$

Example 1: Total and Marginal Cost

	Q (bushels of wheat)	Total Cost		Marginal Cost (*MC*)
	0	$1,000		
$\Delta Q = 1000$			$\Delta TC = \$2000$	$2.00
	1000	$3,000		
$\Delta Q = 800$			$\Delta TC = \$2000$	$2.50
	1800	$5,000		
$\Delta Q = 600$			$\Delta TC = \$2000$	$3.33
	2400	$7,000		
$\Delta Q = 400$			$\Delta TC = \$2000$	$5.00
	2800	$9,000		
$\Delta Q = 200$			$\Delta TC = \$2000$	$10.00
	3000	$11,000		

Example 1: Farmer Jack's Marginal Cost Curve

Q (bushels of wheat)	*TC*	*MC*
0	$1,000	
		$2.00
1000	$3,000	
		$2.50
1800	$5,000	
		$3.33
2400	$7,000	
		$5.00
2800	$9,000	
		$10.00
3000	$11,000	



IV. The Various Measures of Cost

Why MC is Important

- Farmer Jack is rational and wants to maximize his profit. To increase profit, should he produce more or less wheat?
- To find the answer, Farmer Jack needs to "think at the margin."
- If the cost of additional wheat (MC) is less than the revenue he would get from selling it, then Jack's profits rise if he produces more.

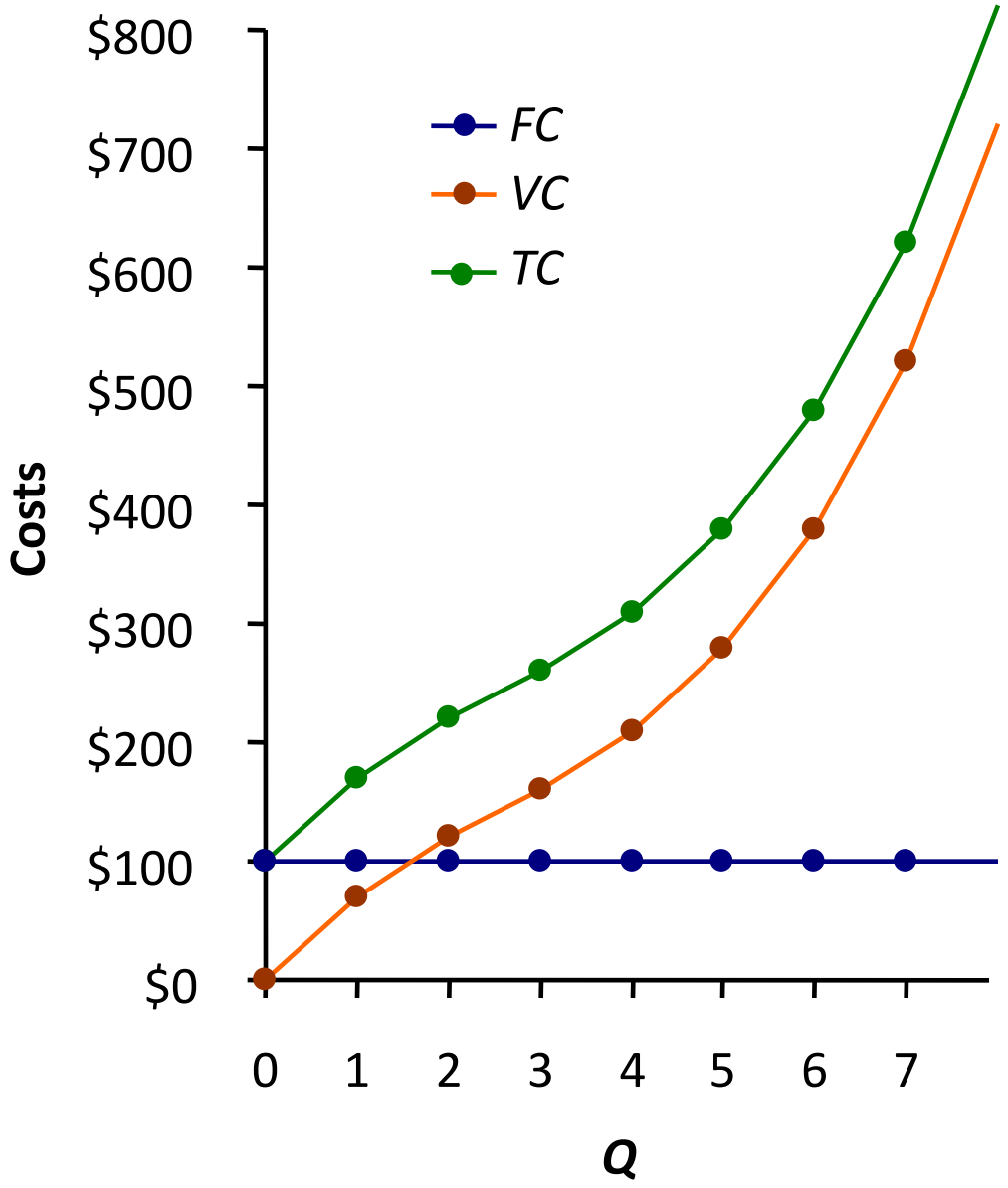
IV. The Various Measures of Cost

Fixed and Variable Costs

- Def: Fixed Costs (FC) do not vary with the quantity of output produced.
  - For Farmer Jack, FC = $1000 for his land
  - Other examples:
    cost of equipment, loan payments, rent, etc.
- Def: Variable Costs (VC) vary with the quantity produced.
  - For Farmer Jack, VC = wages he pays workers
  - Other example: cost of materials
- Def: Total cost (TC) = FC + VC

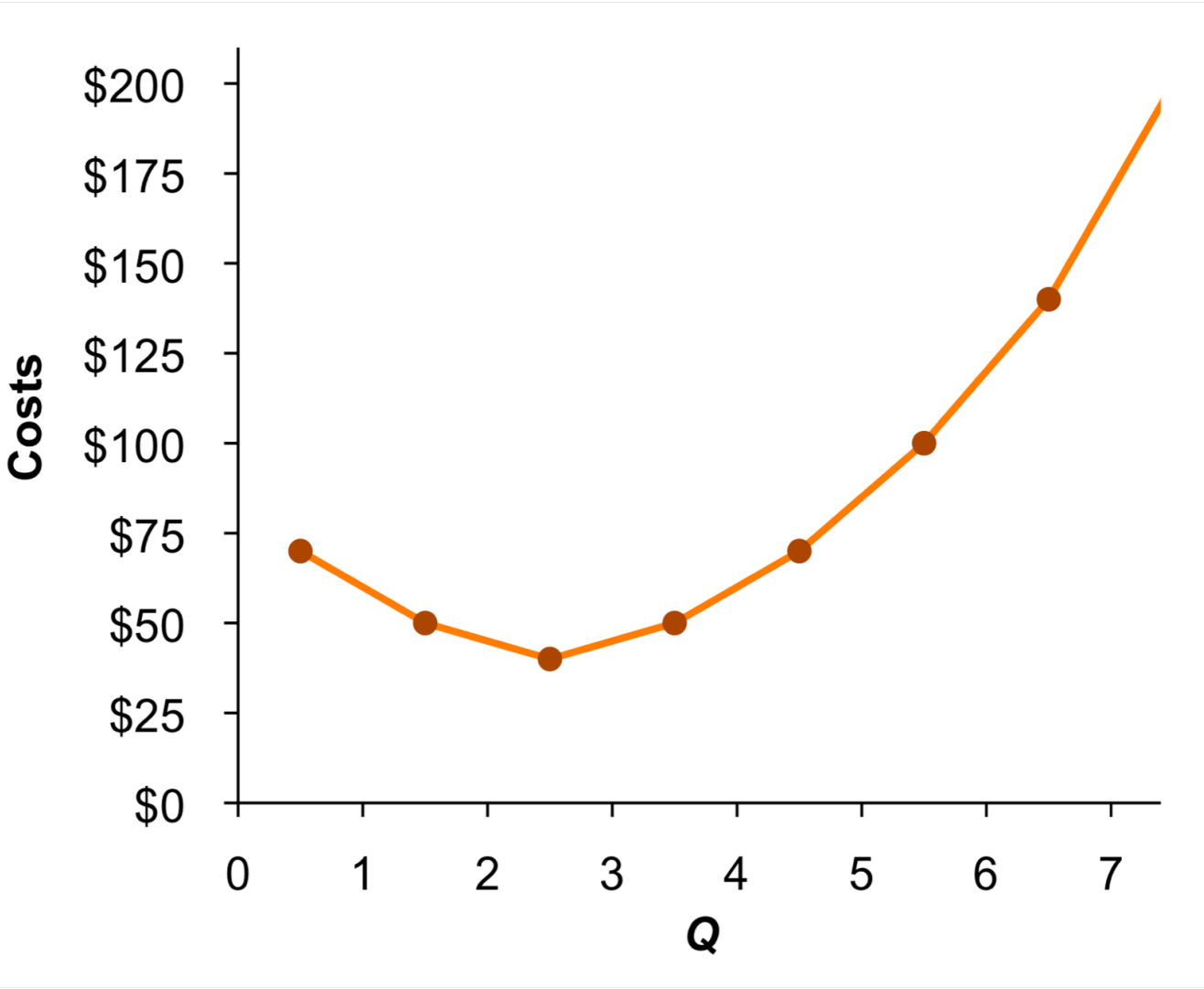
Example 2: Costs

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



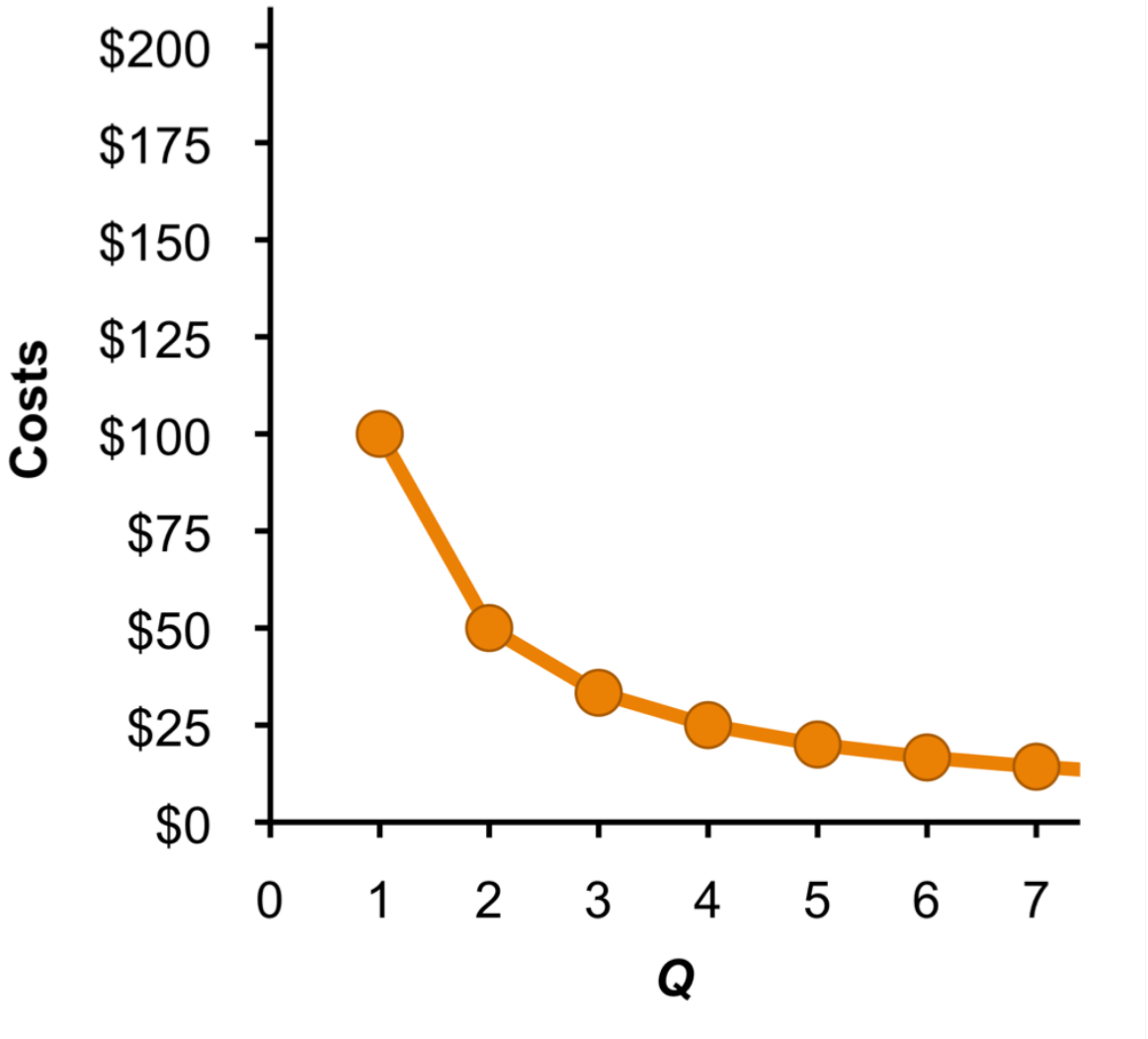
Example 2: Marginal Cost

Q	TC	MC
0	$100	
		$70
1	170	
		50
2	220	
		40
3	260	
		50
4	310	
		70
5	380	
		100
6	480	
		140
7	620	



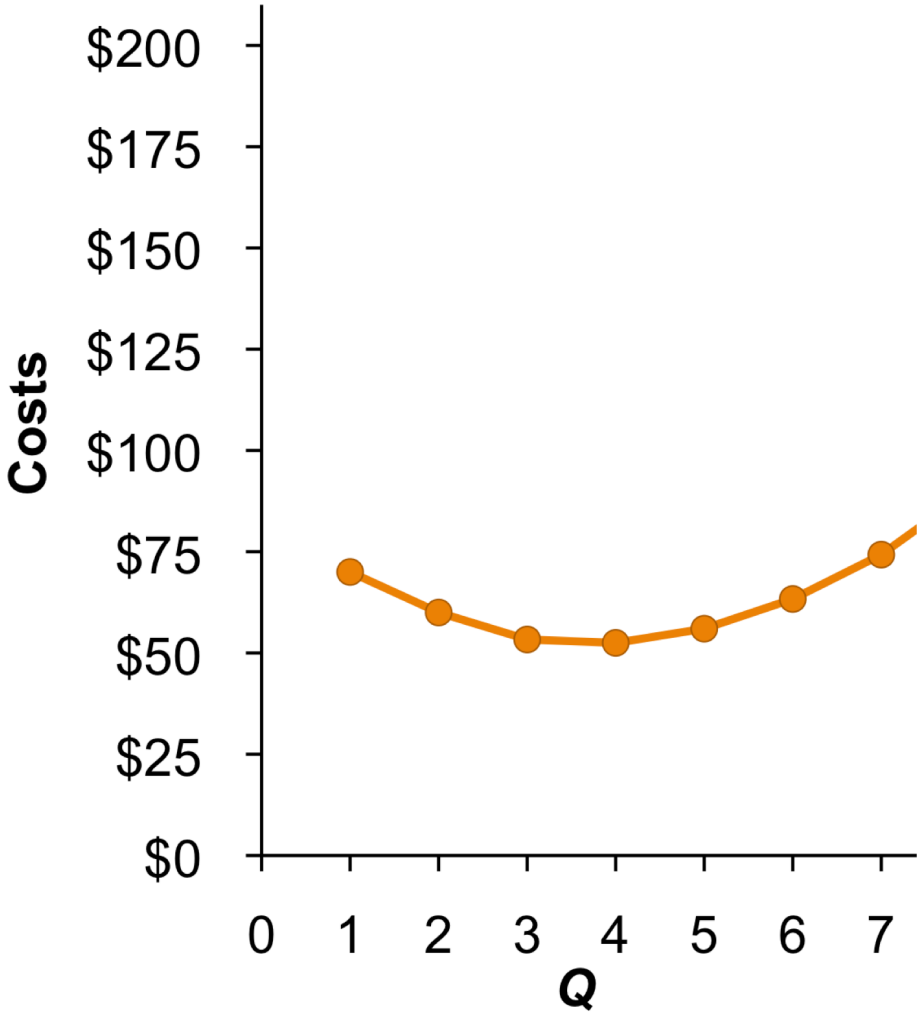
Example 2: Average Fixed Cost

Q	*FC*	*AFC*
0	$100	n/a
1	100	$100
2	100	50
3	100	33.33
4	100	25
5	100	20
6	100	16.67
7	100	14.29



Example 2: Average Variable Cost

Q	*VC*	*AVC*
0	$0	n/a
1	70	$70
2	120	60
3	160	53.33
4	210	52.50
5	280	56.00
6	380	63.33
7	520	74.29



Example 2: Average Total Cost

Q	*TC*	*ATC*	*AFC*	*AVC*
0	$100	n/a	n/a	n/a
1	170	$170	$100	$70
2	220	110	50	60
3	260	86.67	33.33	53.33
4	310	77.50	25	52.50
5	380	76	20	56.00
6	480	80	16.67	63.33
7	620	88.57	14.29	74.29

Average total cost (*ATC*) equals total cost divided by the quantity of output:

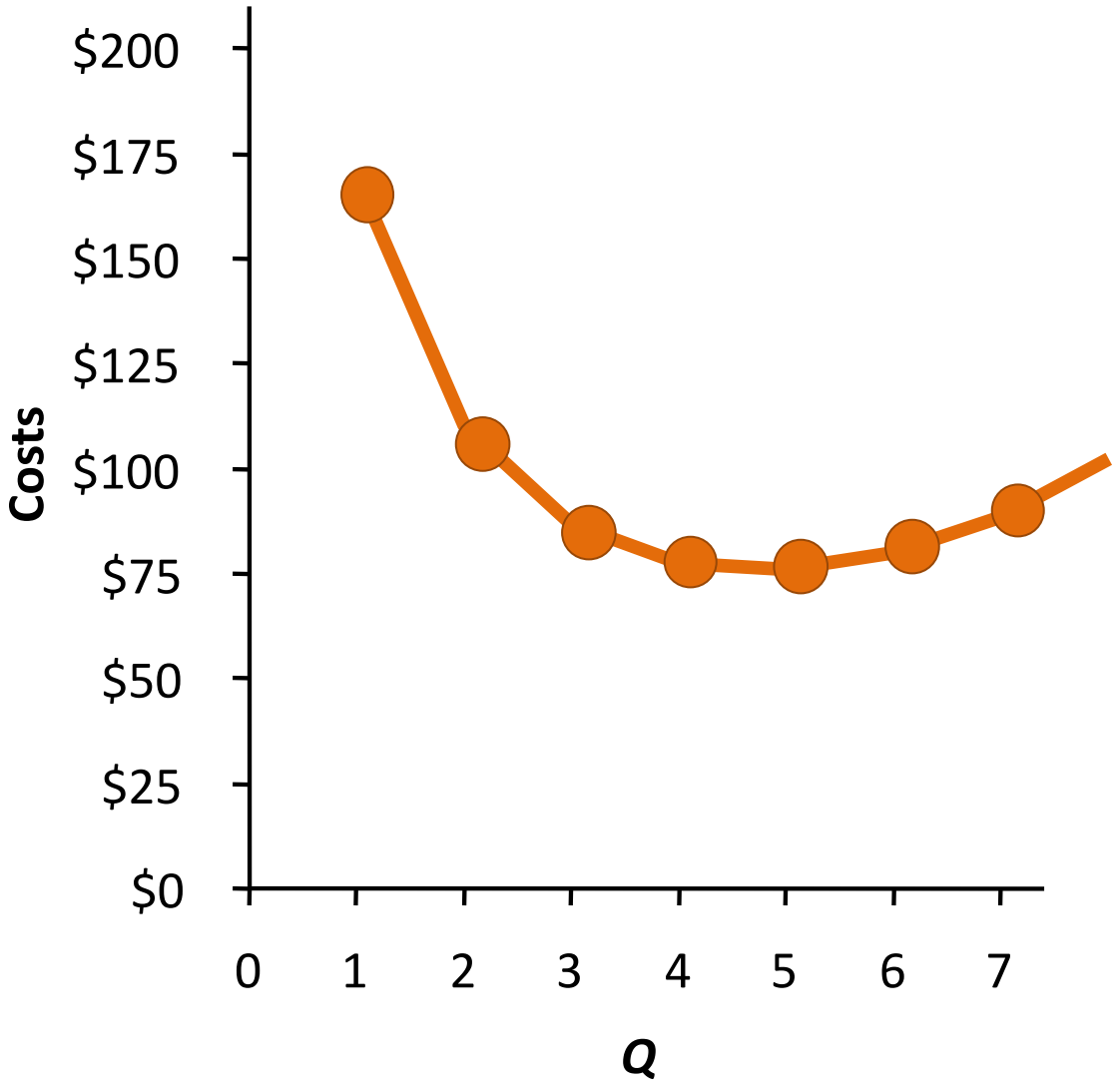
$$ATC = TC/Q$$

Also,

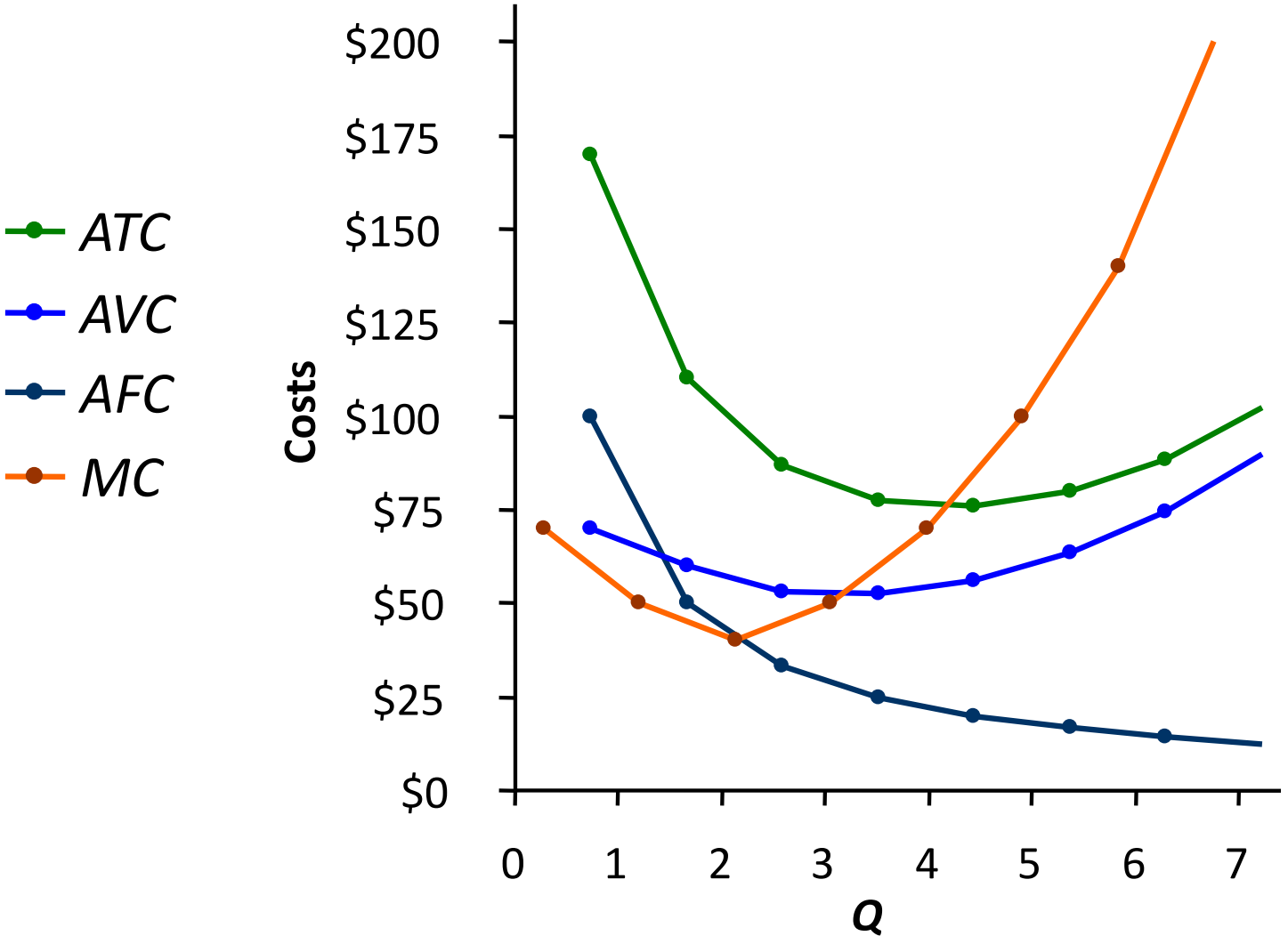
$$ATC = AFC + AVC$$

Example 2: Average Total Cost

Q	TC	ATC
0	$100	n/a
1	170	$170
2	220	110
3	260	86.67
4	310	77.50
5	380	76
6	480	80
7	620	88.57



Example 2: The Various Cost Curves Together



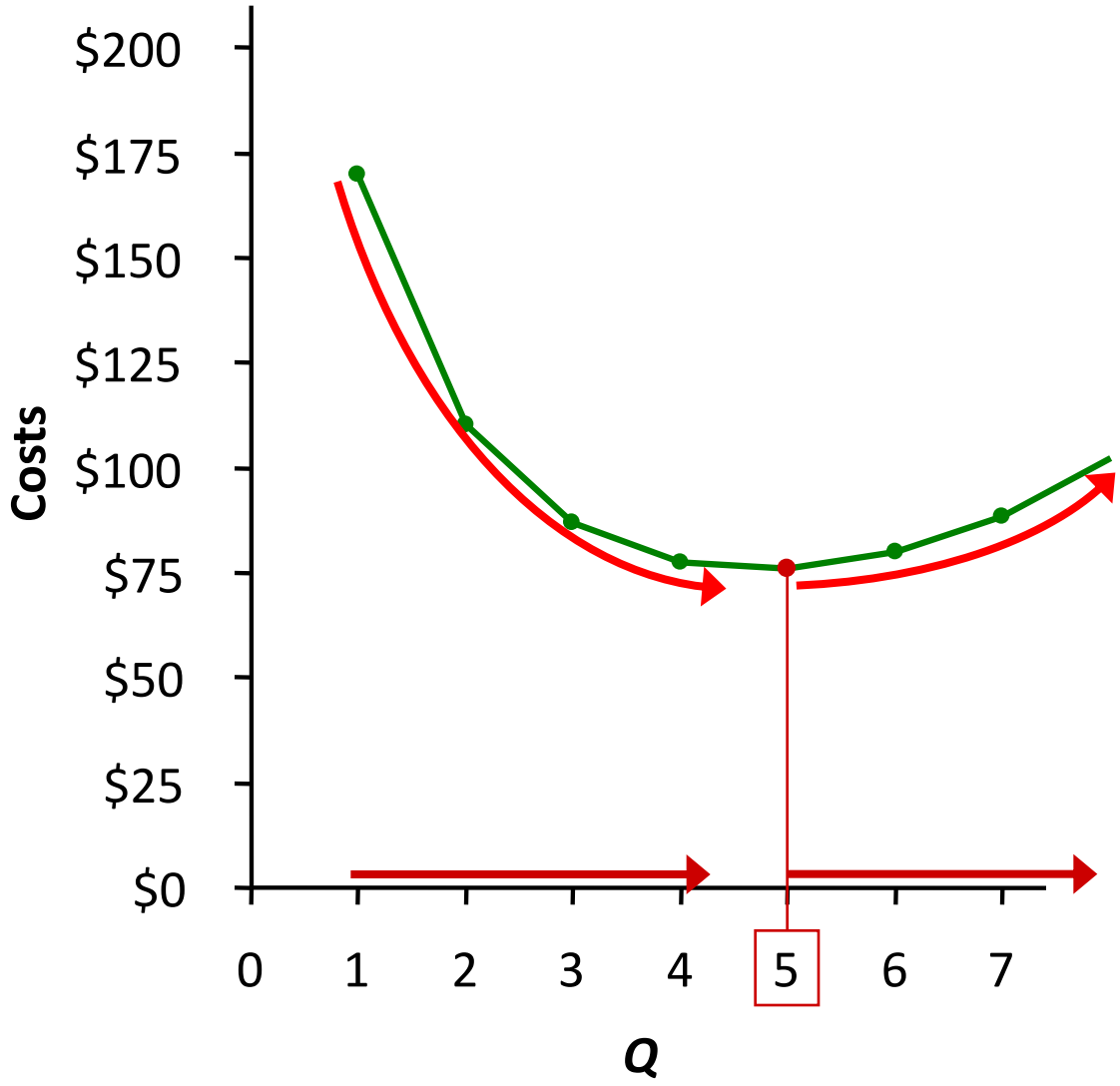
Example 2: Why ATC is Usually U-Shaped

As *Q* rises:

Initially,
falling *AFC*
pulls *ATC* down.

Eventually,
rising *AVC*
pulls *ATC* up.

Efficient scale:
The quantity that
minimizes ATC.

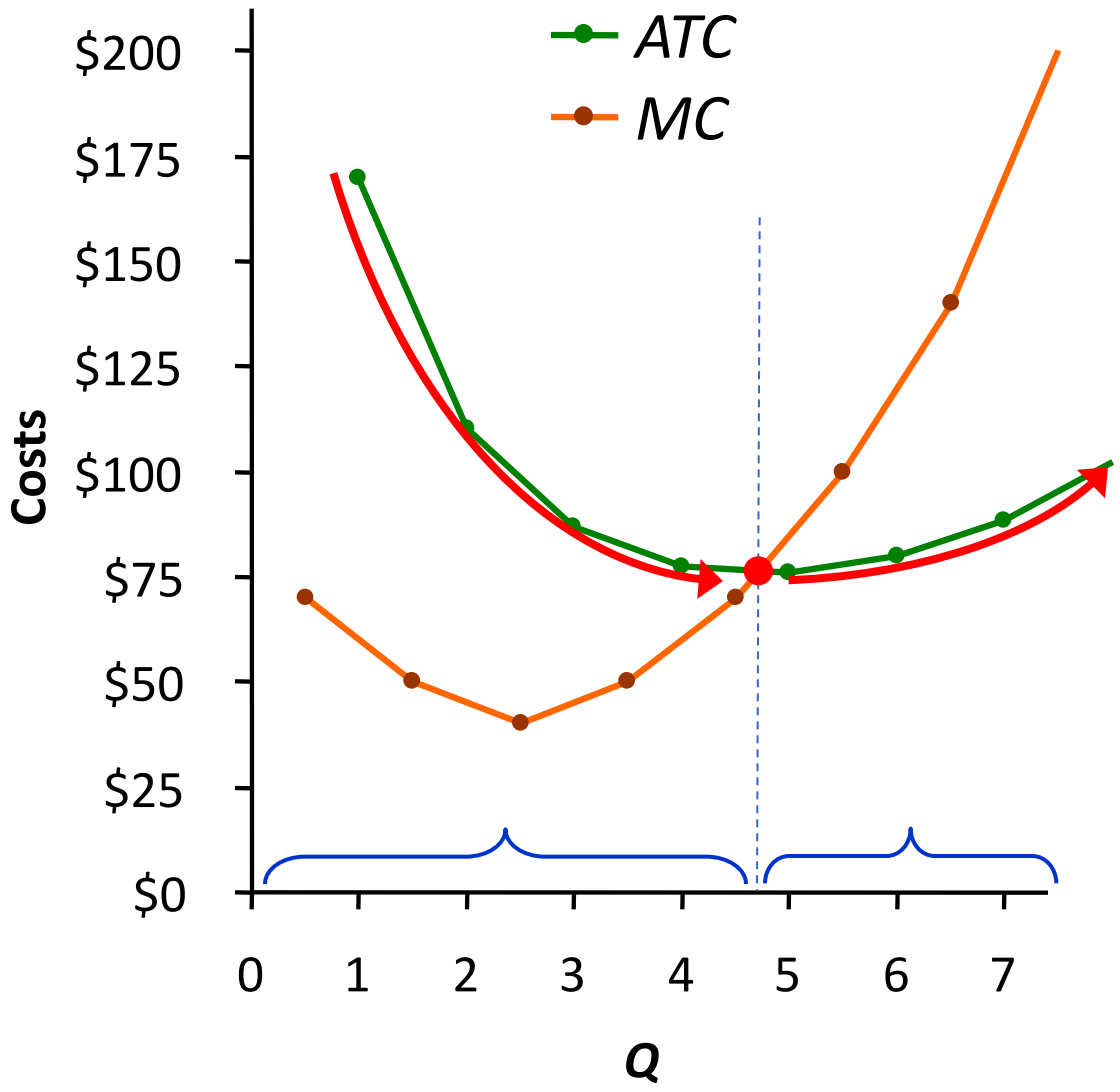


Example 2: ATC and MC

When *MC* < *ATC*, *ATC* is falling.

When *MC* > *ATC*, *ATC* is rising.

The *MC* curve crosses the *ATC* curve at the *ATC* curve's minimum.



V. Costs in the Short Run and in the Long Run

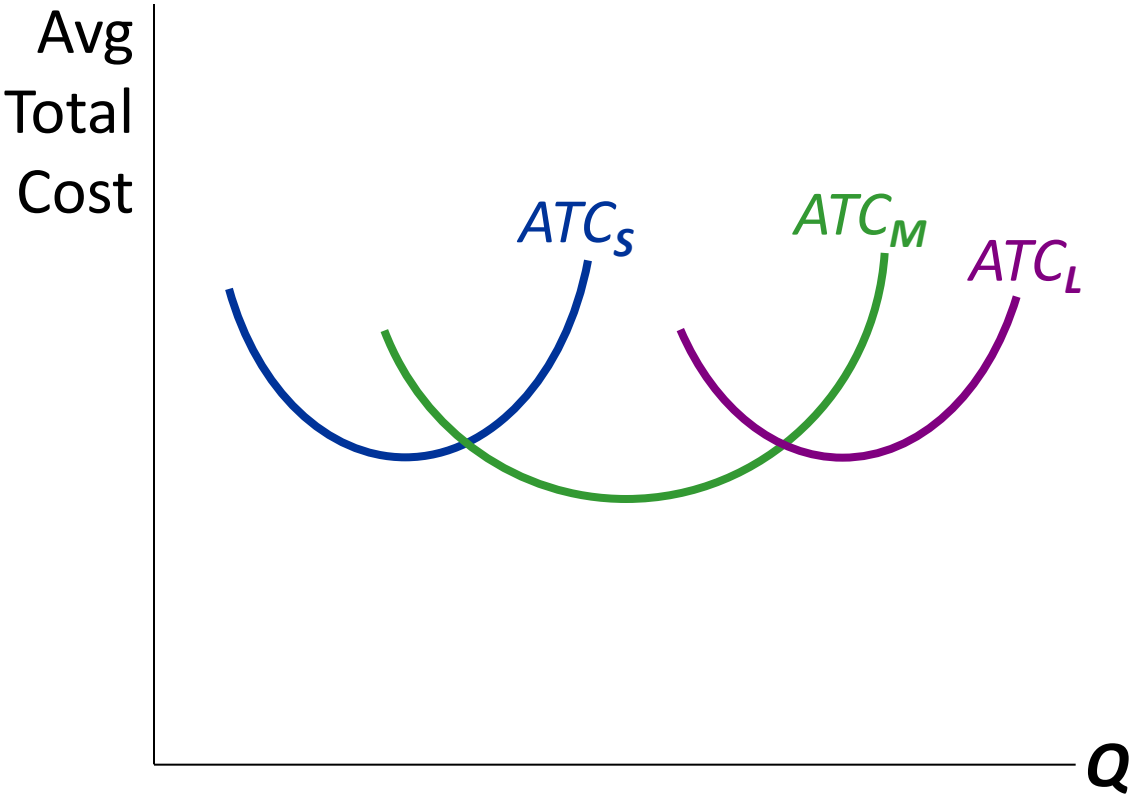
- Short run:
  Some inputs are fixed (e.g., factories, land).
  - The costs of these inputs are FC.
- Long run:
  All inputs are variable (e.g., firms can build more factories, or sell existing ones).

Example 3: Long-Run ATC with 3 Factory Sizes

Firm can choose from three factory sizes: **S**, **M**, **L**.

Each size has its own *Short-run ATC* (SRATC) curve.

The firm can change to a different factory size in the long run, but not in the short run.

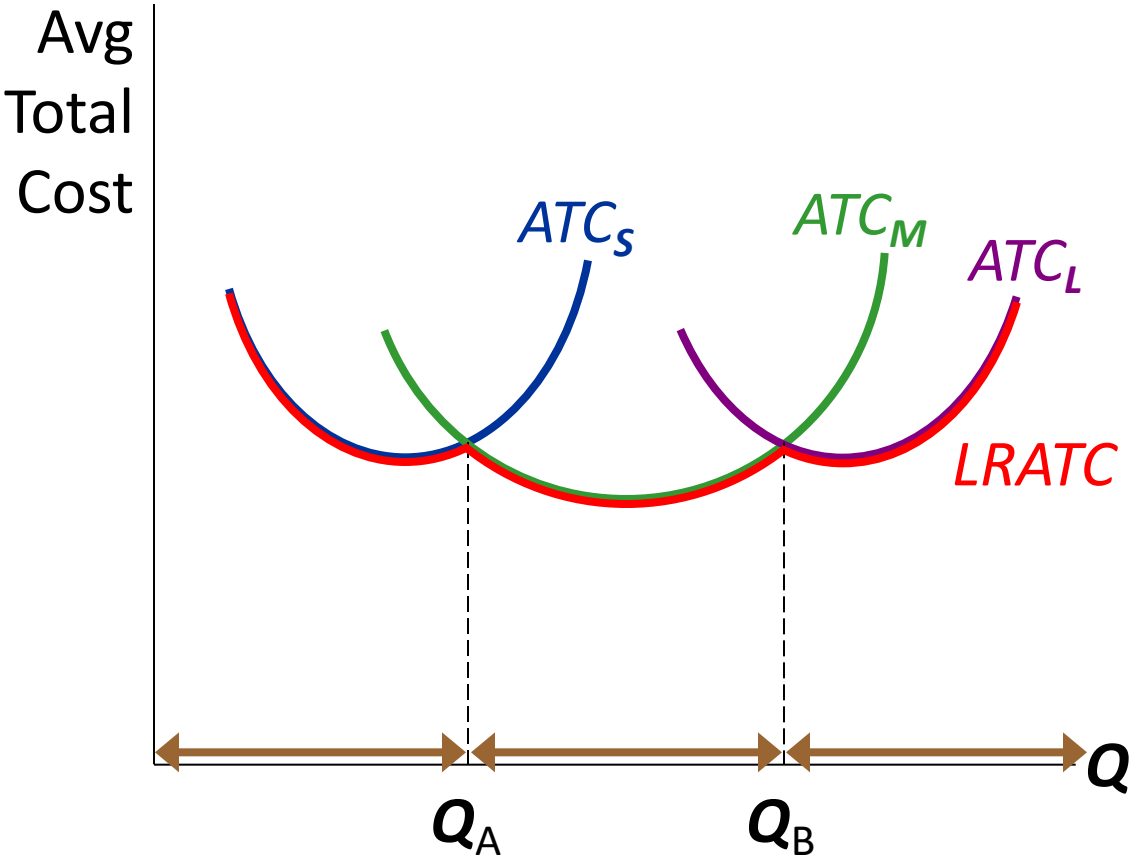


Example 3: Long-Run ATC with 3 Factory Sizes

To produce less than Q_A, firm will choose size **S** in the long run.

To produce between Q_A and Q_B, firm will choose size **M** in the long run.

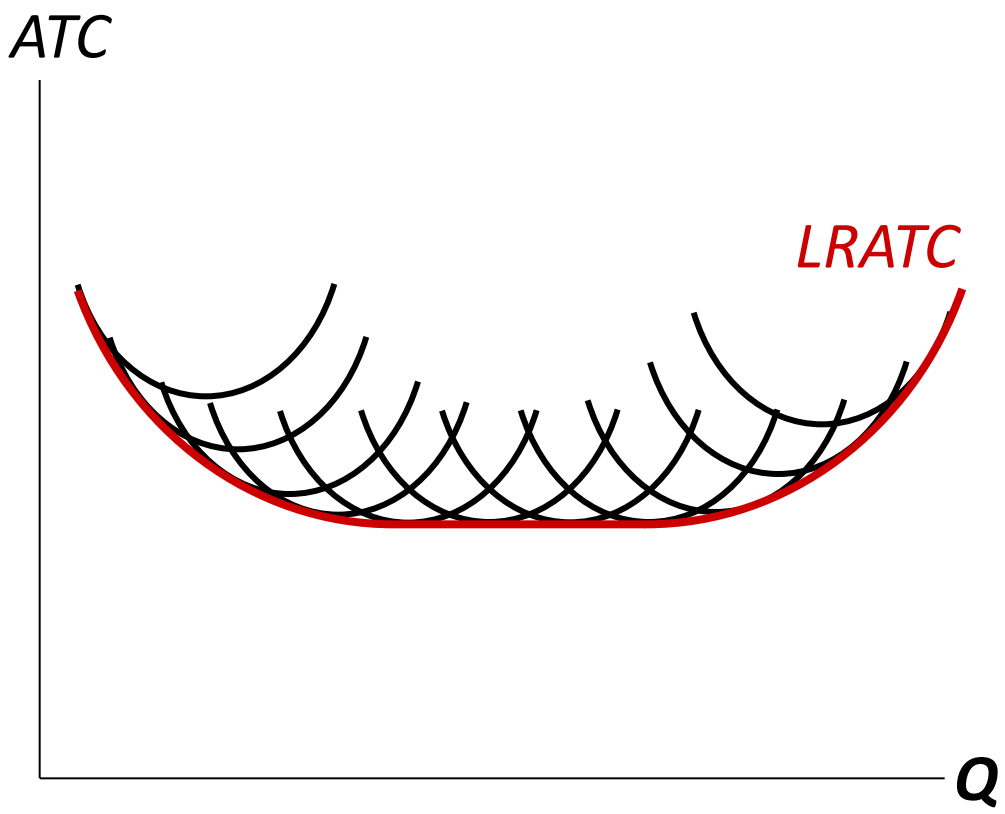
To produce more than Q_B, firm will choose size **L** in the long run.



A Typical Long-Run ATC (LRATC) Curve

In the real world, factories come in many sizes, each with its own *SRATC* curve.

So a typical *LRATC* curve looks like this:

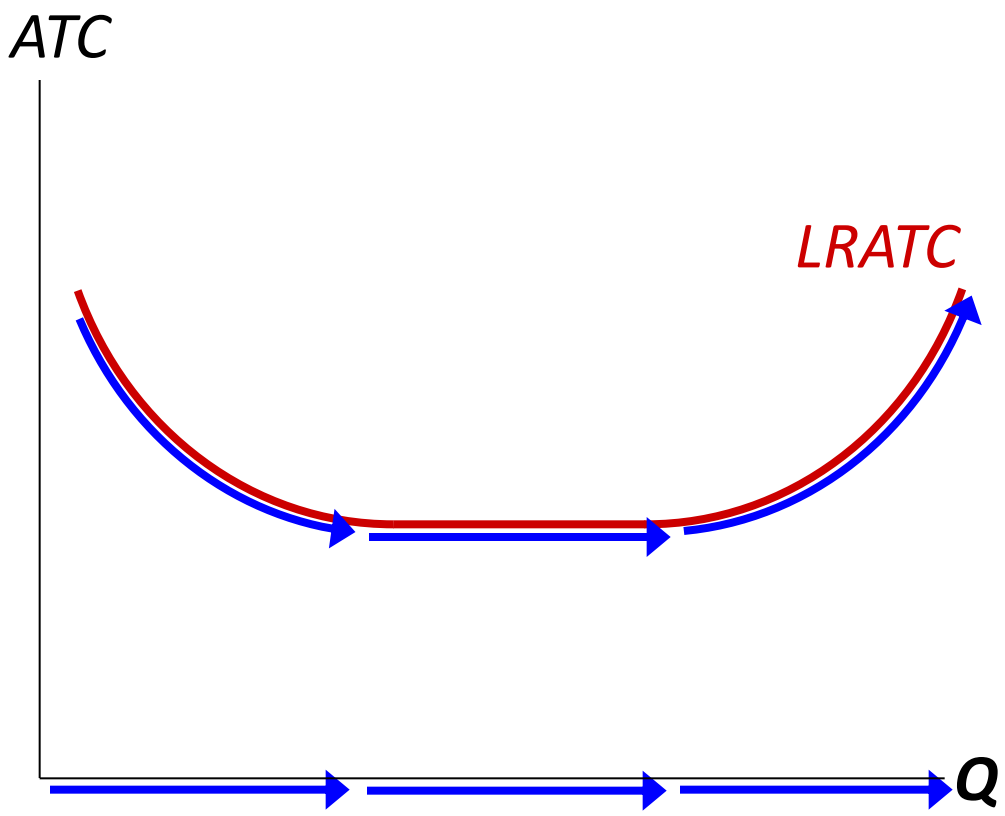


VI. How ATC Changes as the Scale of Production Changes

Economies of scale: *ATC* falls as ***Q*** increases.

Constant returns to scale: *ATC* stays the same as ***Q*** increases.

Diseconomies of scale: *ATC* rises as ***Q*** increases.



VI. How ATC Changes as the Scale of Production Changes

- Economies of scale occur when increasing production allows greater specialization: workers more efficient when focusing on a narrow task.
  - More common when Q is low.
- Diseconomies of scale are due to coordination problems in large organizations.
  E.g., management becomes stretched, can not control costs.
  - More common when Q is high.

The Complete Data for Example 2

Q	*FC*	*VC*	*TC*	*AFC*	*AVC*	*ATC*	*MC*
0	$100	$0	$100	n/a	n/a	n/a	
							$70
1	100	70	170	$100	$70	$170	
							50
2	100	120	220	50	60	110	
							40
3	100	160	260	33.33	53.33	86.67	
							50
4	100	210	310	25	52.50	77.50	
							70
5	100	280	380	20	56.00	76	
							100
6	100	380	480	16.67	63.33	80	
							140
7	100	520	620	14.29	74.29	88.57	
							200
8	100	720	820	12.50	90	102.50	

VII. Introduction to Competition

A Scenario

- Three years after graduating, you run your own business.
- You must decide how much to produce, what price to charge, how many workers to hire, etc.
- What factors should affect these decisions?
  - Your costs (studied in preceding chapter).
  - How much competition you face.
- We begin by studying the behavior of firms in perfectly competitive markets.

VIII. Characteristics of Perfect Competition 1 of 2

1. Many buyers and many sellers.
2. The goods offered for sale are largely the same.
3. Firms can freely enter or exit the market.

- Because of 1 & 2, each buyer and seller is a “price taker” – takes the price as given.

VIII. Characteristics of Perfect Competition 2 of 2

The Revenue of a Competitive Firm

- Total revenue (TR): $TR = P \times Q$
- Average revenue (AR): $AR = \frac{TR}{Q} = P$
- Marginal revenue (MR): The change in TR from selling one more unit. $MR = \frac{\Delta TR}{\Delta Q}$

Example: Calculating TR, AR, MR

Fill in the empty spaces of the table.

Q	***P***	*TR*	*AR*	*MR*
0	$10		n/a	
1	$10		$10	
2	$10			
3	$10			
4	$10	$40		$10
5	$10	$50		

Example: Calculating TR, AR, MR

Fill in the empty spaces of the table.

Q	P	$TR = P \times Q$	$AR = \frac{TR}{Q}$	$MR = \frac{\Delta TR}{\Delta Q}$
0	\$10	\$0	n/a	
1	\$10	\$10	\$10	\$10
2	\$10			\$10
3	\$10	\$30	\$10	\$10
4	\$10	\$40	\$10	\$10
5	\$10	\$50	\$10	\$10

Notice that $MR = P$

IX. Characteristics of Perfect Competition

MR = P for a Competitive Firm

- A competitive firm can keep increasing its output without affecting the market price.
- So, each one-unit increase in Q causes revenue to rise by P, i.e., MR = P.

MR = *P* is only true for firms in competitive markets.

X. Profit Maximization

- What Q maximizes the firm's profit?
- To find the answer, "think at the margin."
  - If increase Q by one unit, revenue rises by MR, cost rises by MC.
- If MR > MC, then increase Q to raise profit.
- If MR < MC, then reduce Q to raise profit.

X. Profit Maximization

(continued from earlier exercise)

At any ***Q*** with *MR* > *MC*, increasing ***Q*** raises profit.

At any ***Q*** with *MR* < *MC*, reducing ***Q*** raises profit.

Q	*TR*	*TC*	Profit	*MR*	*MC*	ΔProfit = *MR* – *MC*
0	$0	$5	–$5			
				$10	$4	$6
1	10	9	1			
				10	6	4
2	20	15	5			
				10	8	2
3	30	23	7			
				10	10	0
4	40	33	7			
				10	12	–2
5	50	45	5			

MC and the Firm's Supply Decision

Rule: *MR* = *MC* at the profit-maximizing ***Q***.

At Q_a, *MC* < *MR*.

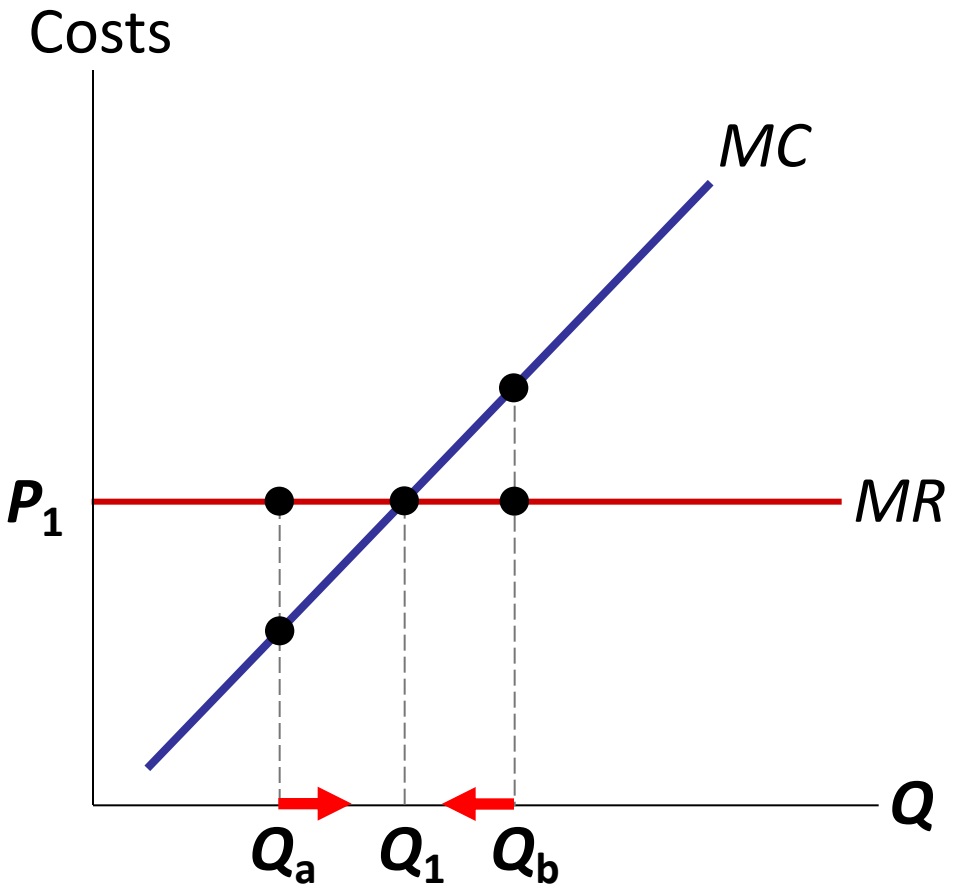
So, increase ***Q*** to raise profit.

At Q_b, *MC* > *MR*.

So, reduce ***Q*** to raise profit.

At Q_1, *MC* = *MR*.

Changing ***Q*** would lower profit.



MC and the Firm's Supply Decision

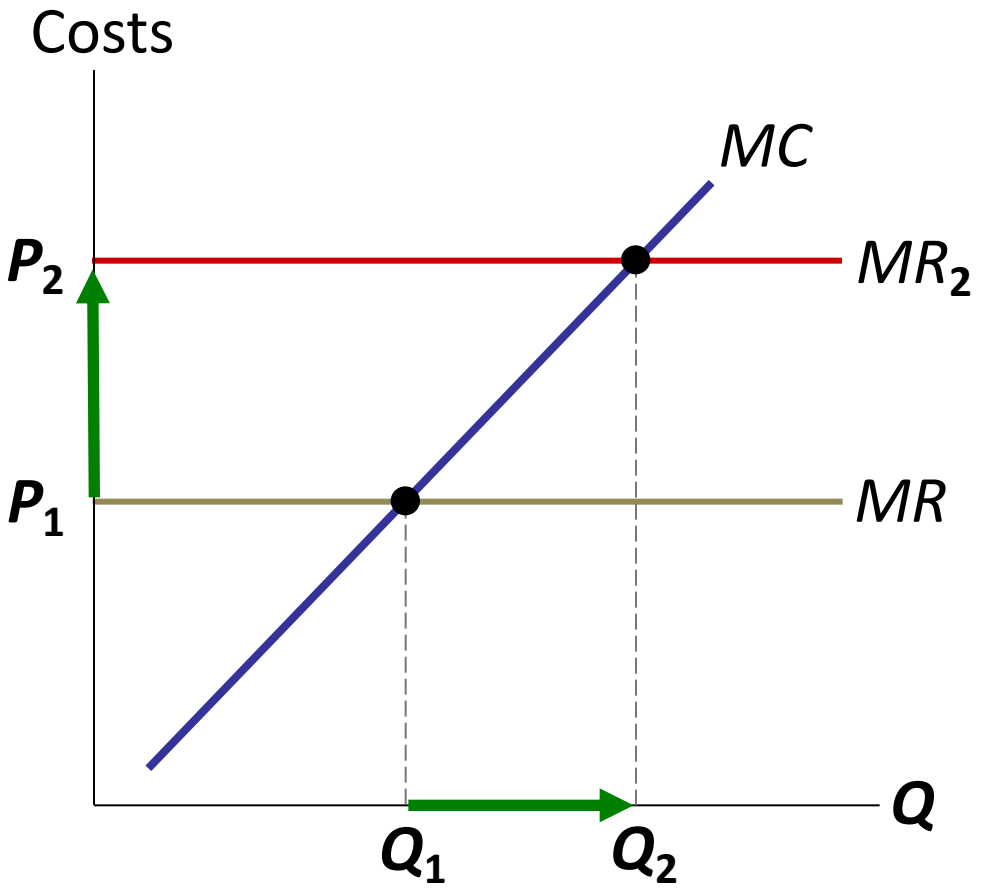
If price rises to P_2,

then the profit-maximizing quantity rises to Q_2.

The *MC* curve determines the firm's **Q** at any price.

Hence,

the *MC* curve is the firm's supply curve.



X. Profit Maximization

Shutdown vs. Exit

- Shutdown:
  A short-run (SR) decision not to produce anything because of market conditions.
- Exit:
  A long-run (LR) decision to leave the market.
- A key difference:
  - If shut down in SR, must still pay FC.
  - If exit in LR, zero costs.

X. Profit Maximization

A Firm's Short-run Decision to Shut Down

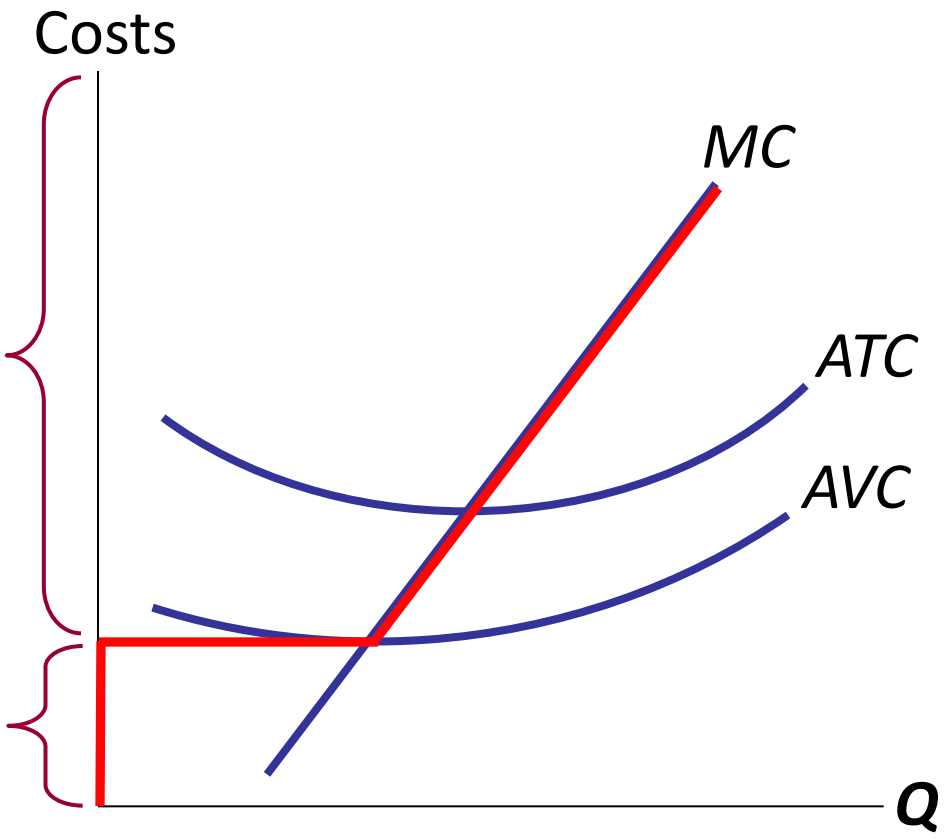
- Cost of shutting down: Revenue loss = TR
- Benefit of shutting down: Cost savings = VC (firm must still pay FC)
- So, shut down if TR < VC
- Divide both sides by Q: TR/Q < VC/Q
- So, firm's decision rule is: Shut down if P < AVC

A Competitive Firm's SR Supply Curve

The firm's SR supply curve is the portion of its *MC* curve abov

If ***P*** > *AVC*, then firm produces ***Q*** where ***P*** = *MC*.

If ***P*** < *AVC*, then firm shuts down (produces ***Q*** = 0).



X. Profit Maximization

The Irrelevance of Sunk Costs

- Def: Sunk Cost = A cost that has already been committed and cannot be recovered
- Sunk costs should be irrelevant to decisions; you must pay them regardless of your choice.
- FC is a sunk cost: The firm must pay its fixed costs whether it produces or shuts down.
- So, FC should not matter in the decision to shut down.

X. Profit Maximization

A Firm's Long-Run Decision to Exit

- Cost of exiting the market: Revenue loss = TR
- Benefit of exiting the market: Cost savings = TC
  (zero FC in the long run)
- So, firm exits if TR < TC
- Divide both sides by Q to write the firm's decision rule as: Exit if P < ATC

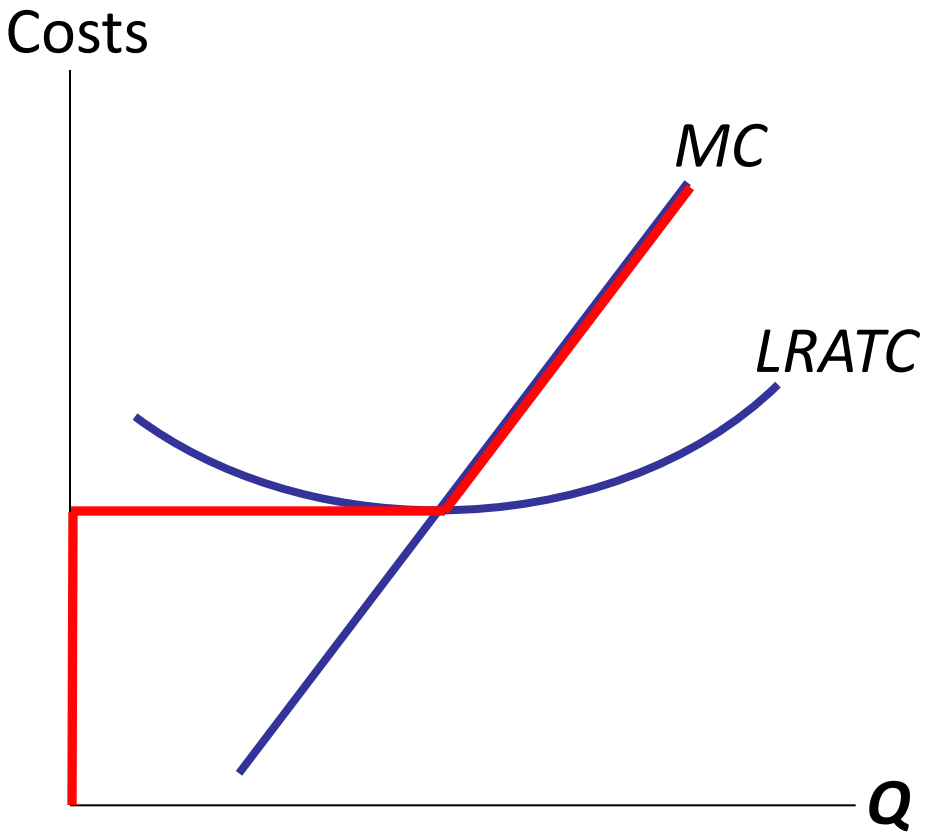
X. Profit Maximization

A New Firm's Decision to Enter Market

- In the long run, a new firm will enter the market if it is profitable to do so: if TR > TC.
- Divide both sides by Q to express the firm's entry decision as: Enter if P > ATC

The Competitive Firm's Supply Curve

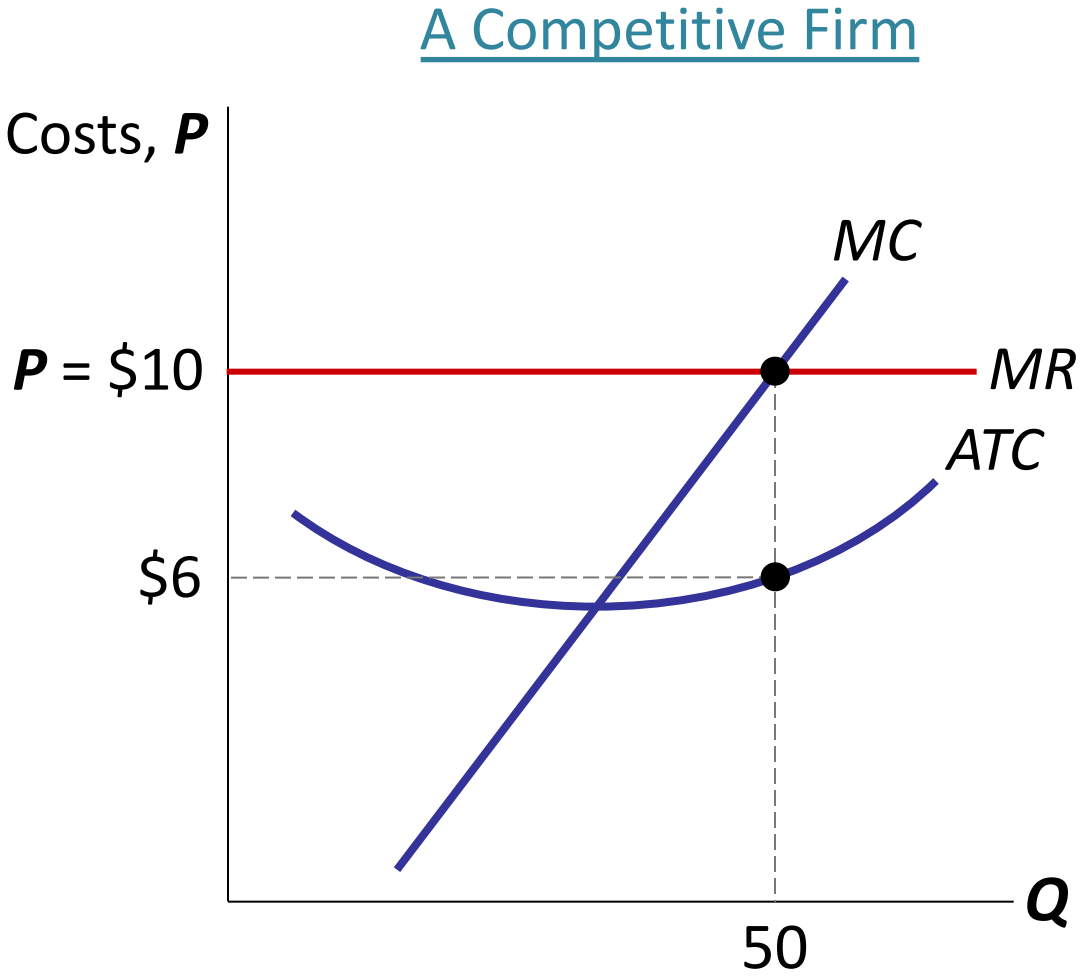
The firm's
LR supply curve is
the portion of
its *MC* curve
above *LRATC*.



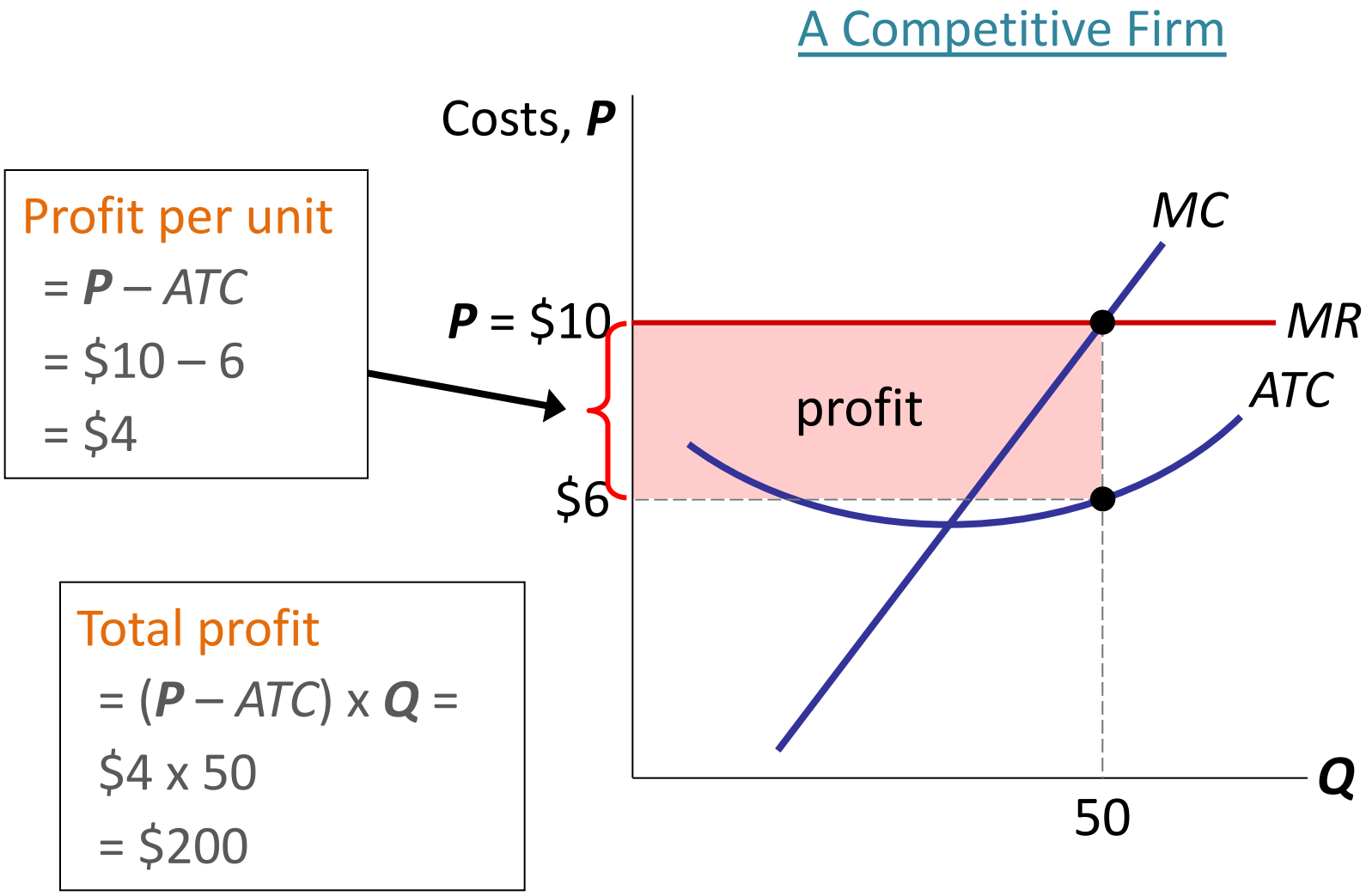
Example: Identifying a Firm's Profit

Determine this firm's total profit.

Identify the area on the graph that represents the firm's profit.



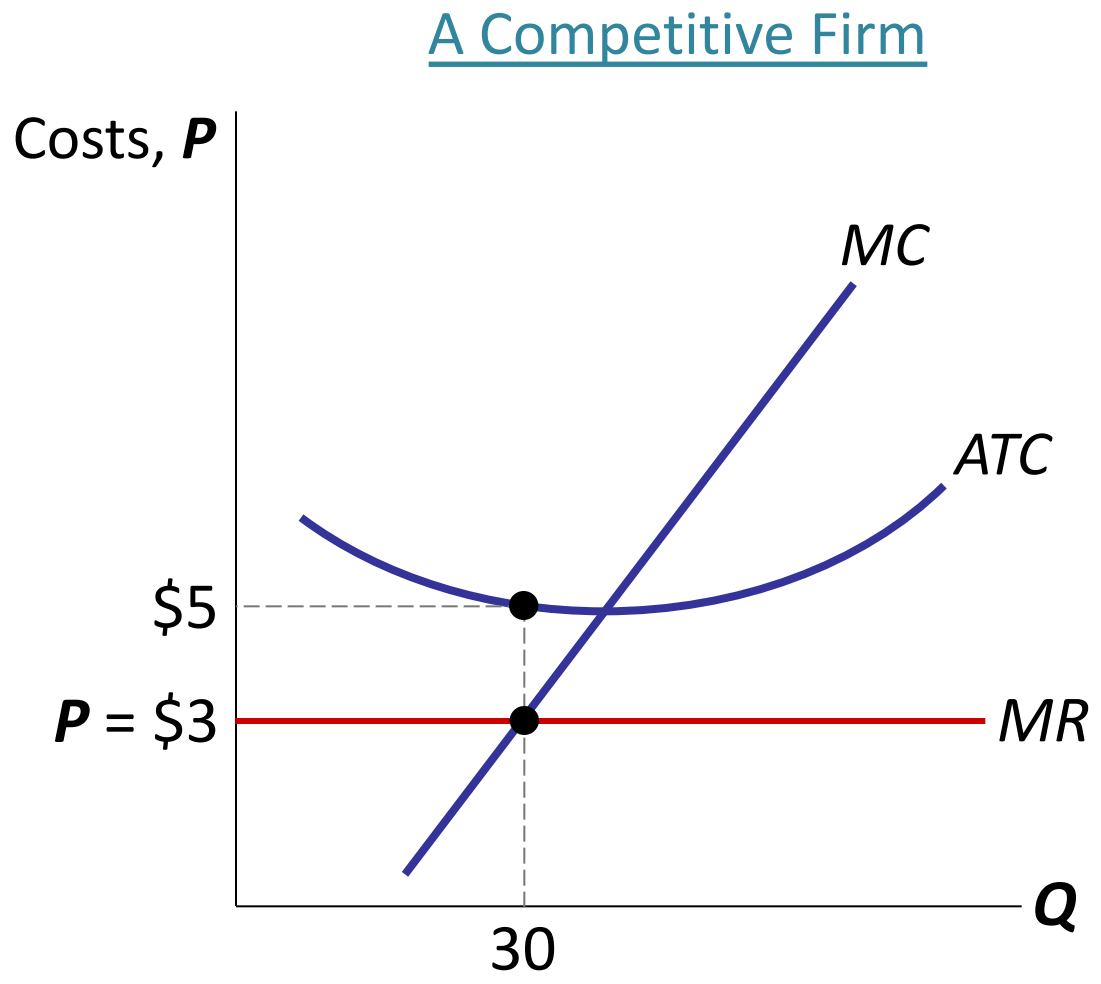
Example: Identifying a Firm's Profit



Example: Identifying a Firm's Loss

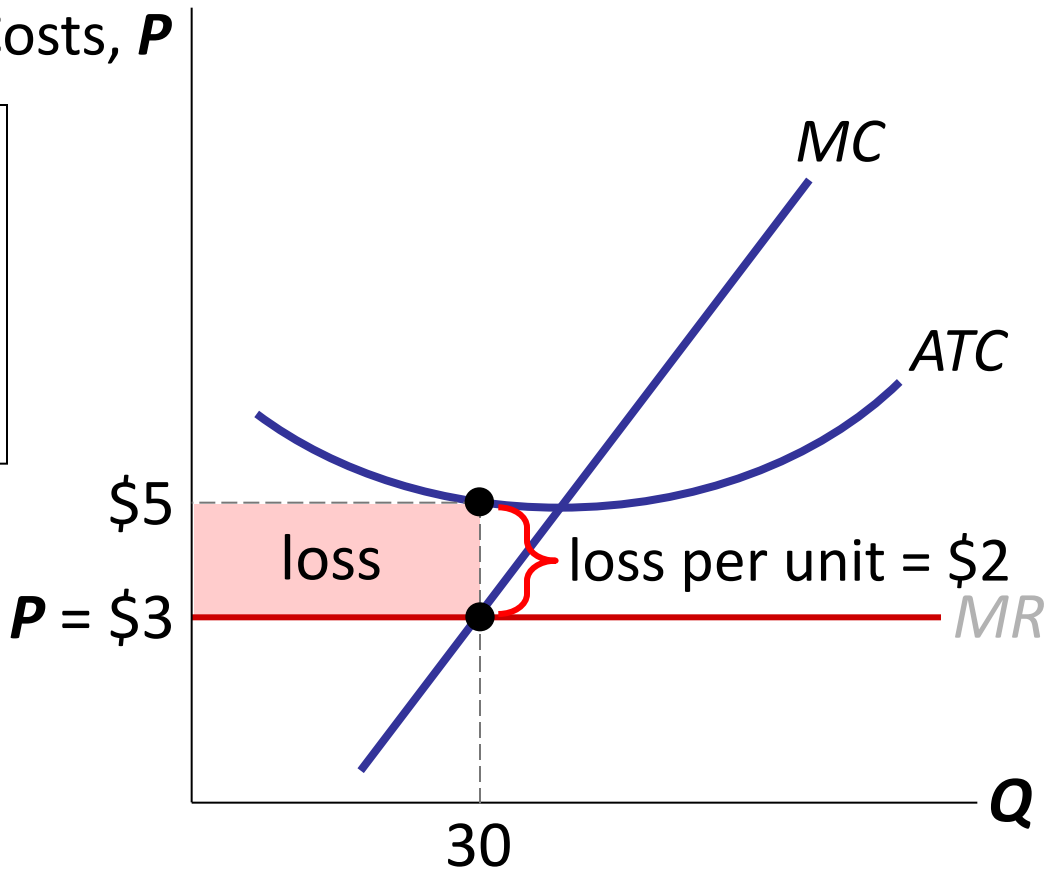
Determine this firm's total loss, assuming *AVC* < $3.

Identify the area on the graph that represents the firm's loss.



Example: Identifying a Firm's Loss

Total loss
= (*ATC* – ***P***) x ***Q*** =
$2 x 30
= $60



XI. The Supply Curve in a Competitive Market

Market Supply: Assumptions

1. All existing firms and potential entrants have identical costs.
2. Each firm's costs do not change as other firms enter or exit the market.
3. The number of firms in the market is
   - fixed in the short run (due to fixed costs).
   - variable in the long run (due to free entry and exit).

XI. The Supply Curve in a Competitive Market

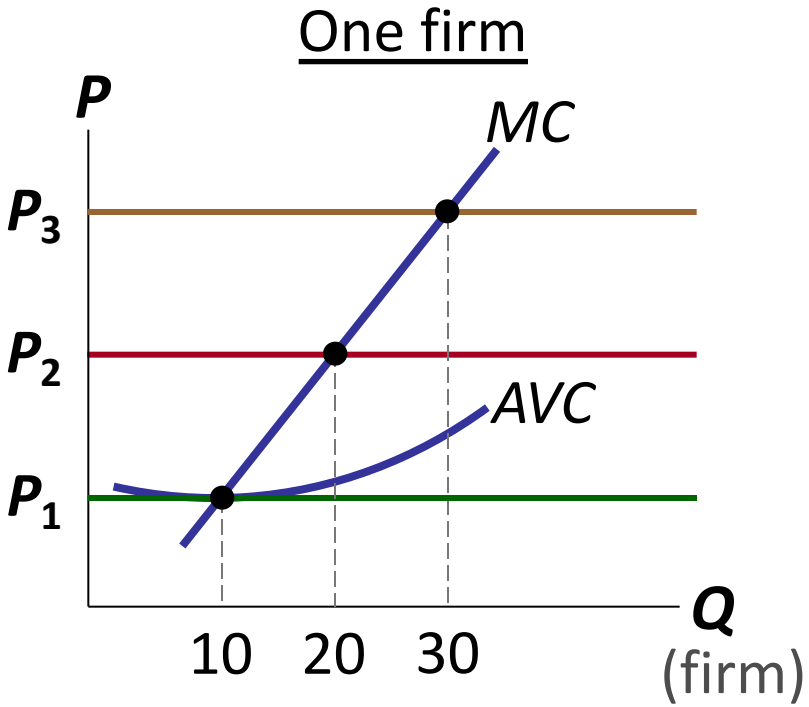
The SR Market Supply Curve

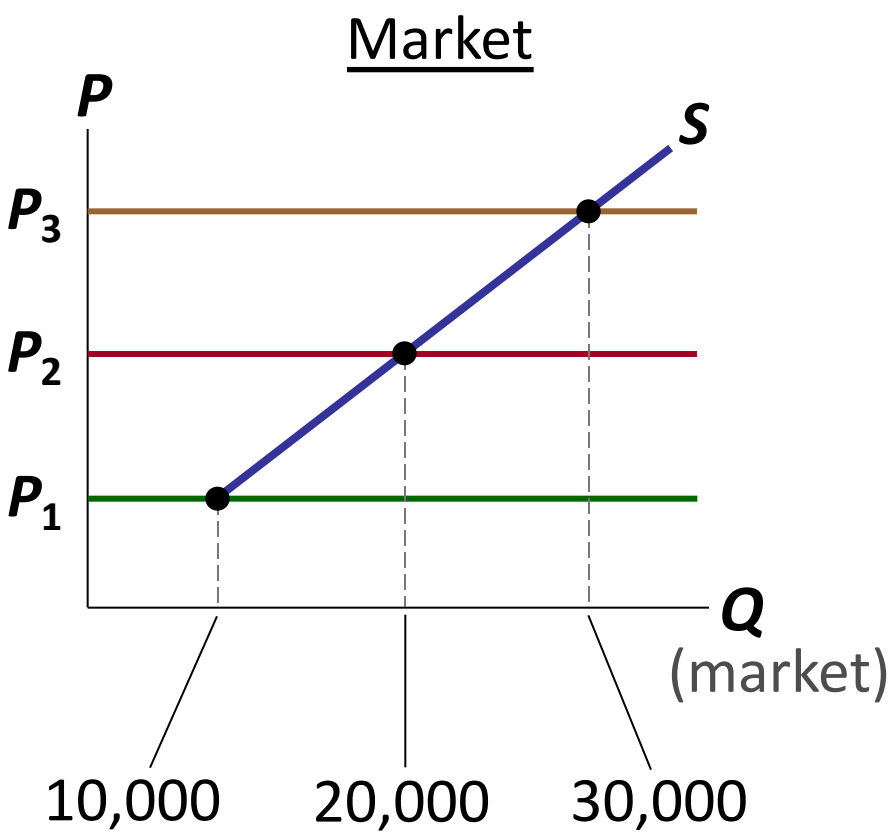
- As long as $P \geq AVC$, each firm will produce its profit-maximizing quantity, where MR = MC.
- Recall from Chapter 4:
  At each price, the market quantity supplied is the sum of quantities supplied by all firms.

The SR Market Supply Curve

Example: 1000 identical firms

At each ***P***, market Q^s = 1000 x (one firm's Q^s)





XI. The Supply Curve in a Competitive Market

Entry & Exit in the Long Run

- In the LR, the number of firms can change due to entry & exit.
- If existing firms earn positive economic profit,
  - new firms enter, SR market supply shifts right.
  - P falls, reducing profits and slowing entry.
- If existing firms incur losses,
  - some firms exit, SR market supply shifts left.
  - P rises, reducing remaining firms' losses.

XI. The Supply Curve in a Competitive Market

The Zero-Profit Condition

- Def: Long-run Equilibrium =The process of entry or exit is complete—remaining firms earn zero economic profit.
- Zero economic profit occurs when P = ATC.
- Since firms produce where P = MR = MC, the zero-profit condition is P = MC = ATC.
- Recall that MC intersects ATC at minimum ATC.
- Hence, in the long run, P = minimum ATC.

XI. The Supply Curve in a Competitive Market

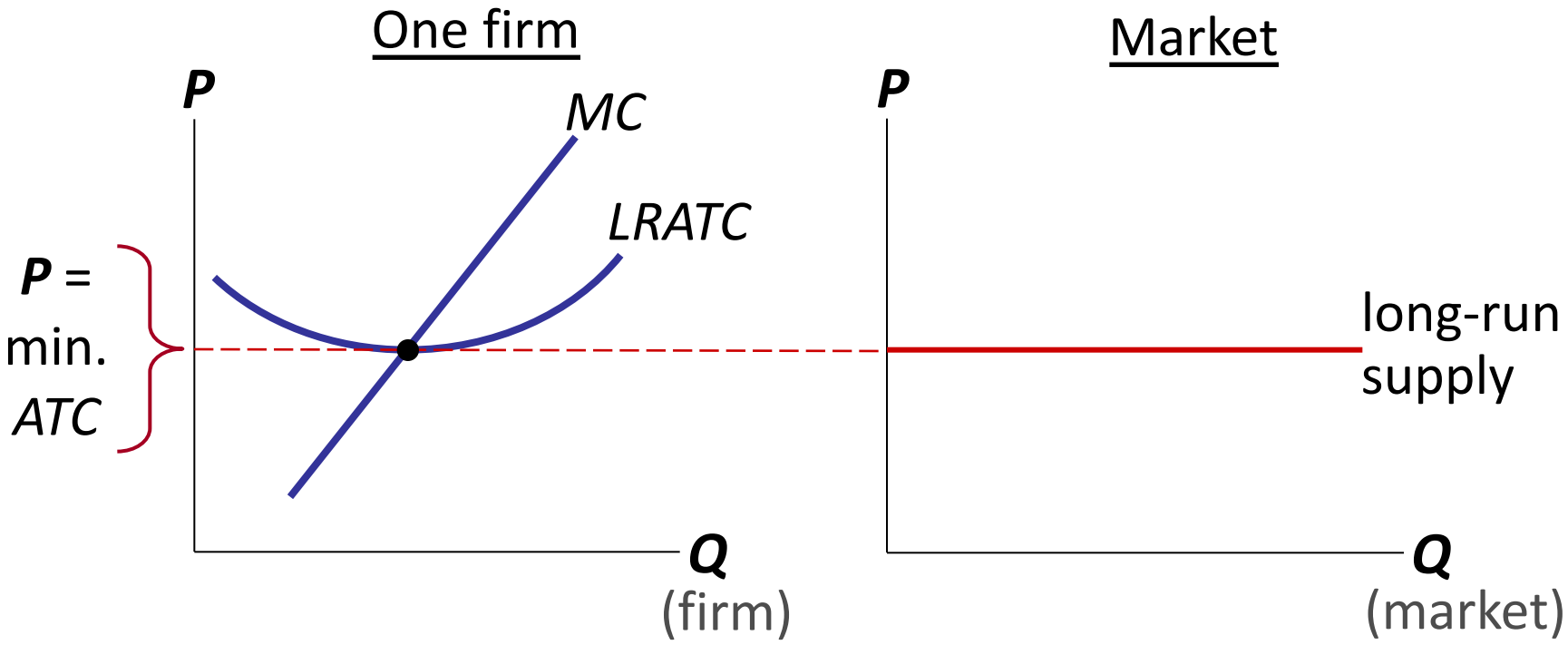
Why Do Firms Stay in Business if Profit = 0?

- Recall, economic profit is revenue minus all costs, including implicit costs like the opportunity cost of the owner's time and money.
- In the zero-profit equilibrium,
  - firms earn enough revenue to cover these costs.
  - accounting profit is positive.

The LR Market Supply Curve

In the long run, the typical firm earns zero profit.

The LR market supply curve is horizontal at ***P*** = minimum *ATC*.



SR & LR Effects of an Increase in Demand

A firm begins in long-

…leading to

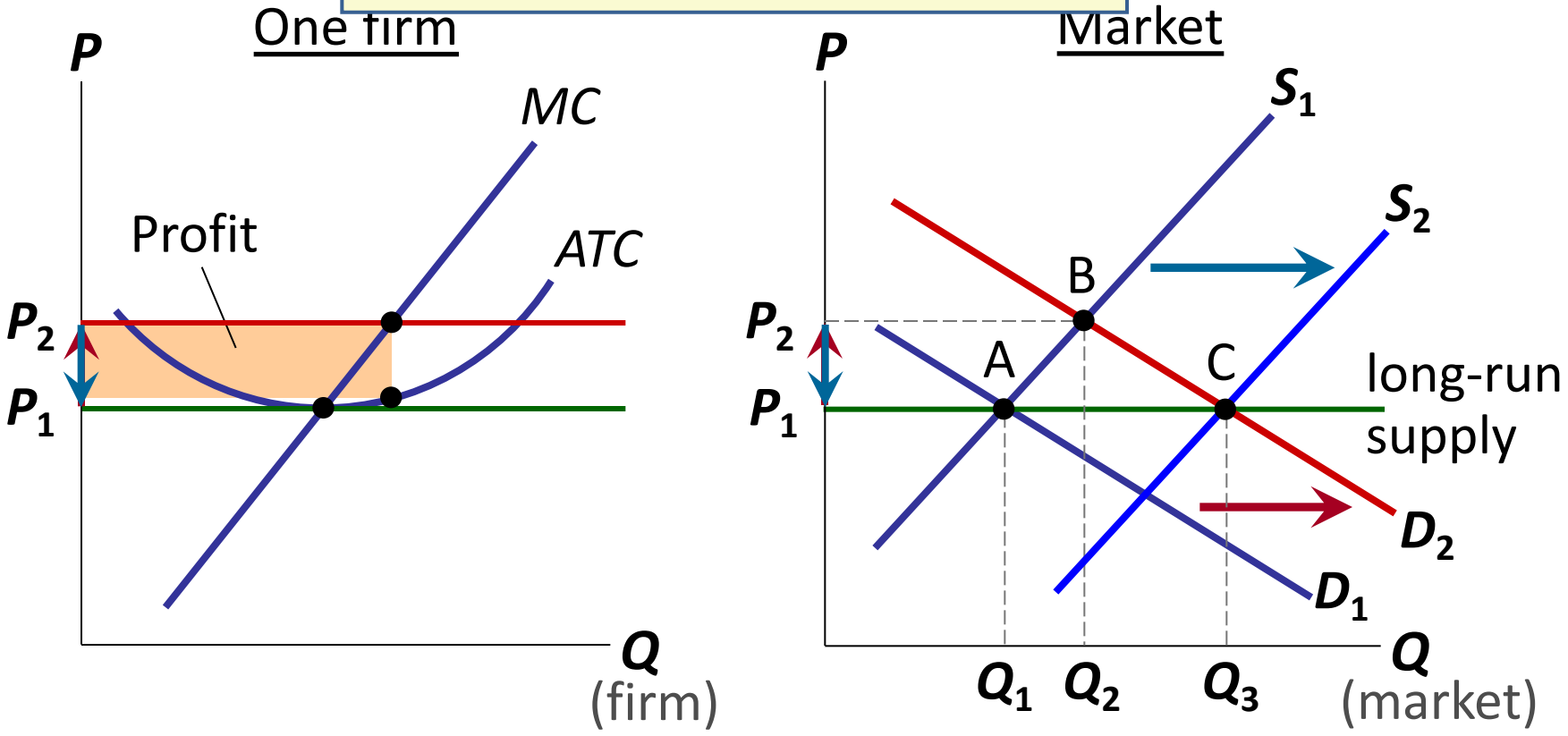
profits for t

but then an increase in

uce entry,

reducing *P*…

…driving profits to zero and restoring long-run equilibrium.



XI. The Supply Curve in a Competitive Market

Why the LR Supply Curve Might Slope Upward

- The LR market supply curve is horizontal if
  - all firms have identical costs, and
  - costs do not change as other firms enter or exit the market.
- If either of these assumptions is not true, then LR supply curve slopes upward.

XI. The Supply Curve in a Competitive Market

(1) Firms Have Different Costs

- As P rises, firms with lower costs enter the market before those with higher costs.
- Further increases in P make it worthwhile for higher-cost firms to enter the market, which increases market quantity supplied.
- Hence, LR market supply curve slopes upward.
- At any P,
  - For the marginal firm, P = minimum ATC and profit = 0.
  - For lower-cost firms, profit > 0.

XI. The Supply Curve in a Competitive Market

(2) Costs Rise as Firms Enter the Market

- In some industries, the supply of a key input is limited (e.g., amount of land suitable for farming is fixed).
- The entry of new firms increases demand for this input, causing its price to rise.
- This increases all firms' costs.
- Hence, an increase in P is required to increase the market quantity supplied, so the supply curve is upward-sloping.

XII. Conclusion: The Efficiency of a Competitive Market

- Profit-maximization: MC = MR
- Perfect competition: P = MR
- So, in the competitive equilibrium: P = MC
- Recall, MC is cost of producing the marginal unit. P is the value to buyers of the marginal unit.
- So, the competitive equilibrium is efficient, maximizes total surplus.

XIII. Summary 1 of 3

- Marginal cost is the increase in total cost from an extra unit of production. The MC curve is usually upward-sloping.
- Average variable cost is variable cost divided by output.
- Average fixed cost is fixed cost divided by output. AFC always falls as output increases.
- Average total cost (sometimes called “cost per unit”) is total cost divided by the quantity of output. The ATC curve is usually U-shaped.

XIII. Summary 2 of 3

- The MC curve intersects the ATC curve at minimum average total cost.
  When MC < ATC, ATC falls as Q rises.
  When MC > ATC, ATC rises as Q rises.
- In the long run, all costs are variable.
- Economies of scale: ATC falls as Q rises.
  Diseconomies of scale: ATC rises as Q rises.
  Constant returns to scale: ATC remains constant as Q rises.

XIII. Summary 3 of 3

- For a firm in a perfectly competitive market, price = marginal revenue = average revenue.
- If P > AVC, a firm maximizes profit by producing the quantity where MR = MC. If P < AVC, a firm will shut down in the short run.
- If P < ATC, a firm will exit in the long run.
- In the short run, entry is not possible, and an increase in demand increases firms' profits.
- With free entry and exit, profits = 0 in the long run, and P = minimum ATC.