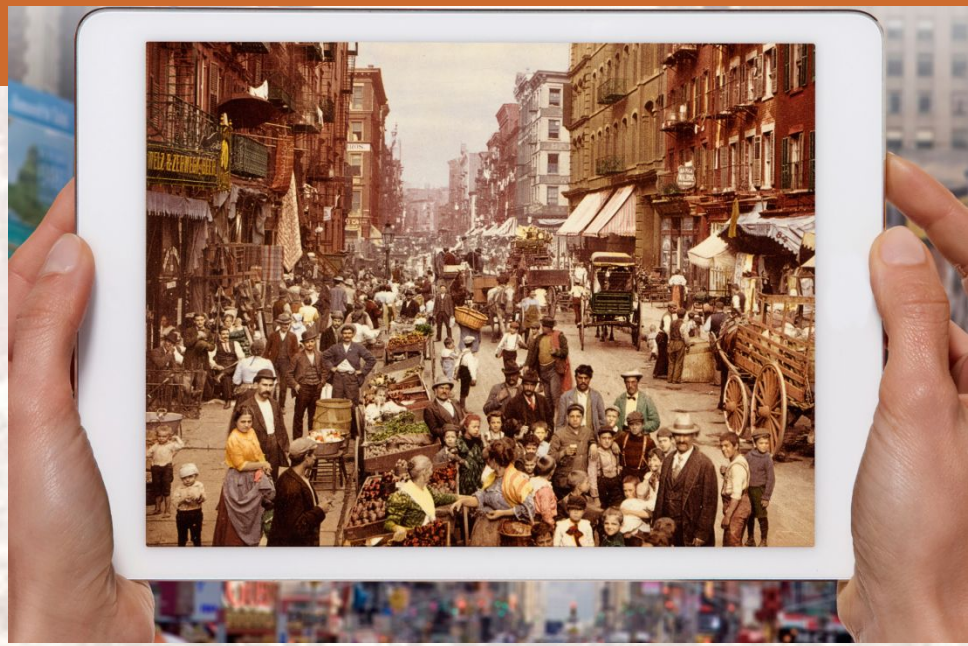
N. GREGORY MANKIW

PRINCIPLES OF

ECONOMICS

Eight Edition



CHAPTER

13

The Costs of Production

Premium PowerPoint Slides by:
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Active Learning 1 Brainstorming costs

You run Ford Motor Company.

- List three different costs you have.
- List three different business decisions that are affected by your costs

Look for the answers to these questions:

- What is a production function? What is marginal product? How are they related?
- What are the various costs? 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"?

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

$TR = P \times Q$

the market value of the inputs a firm uses in production

Costs: Explicit vs. Implicit

- 'The cost of something is what you give up to get it.'
- 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 cost = Explicit + Implicit costs

Explicit vs. Implicit Costs: An Example

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

Example

- 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

Total Cost

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.

Economic Profit is Best

Active Learning 2

Example

Economic profit vs. accounting profit

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

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.

Production Function

- Production function
  - Relationship between
    - Quantity of inputs used to make a good
    - And the quantity of output of that good
  - Gets flatter as production rises

EXAMPLE 1: Farmer Jack

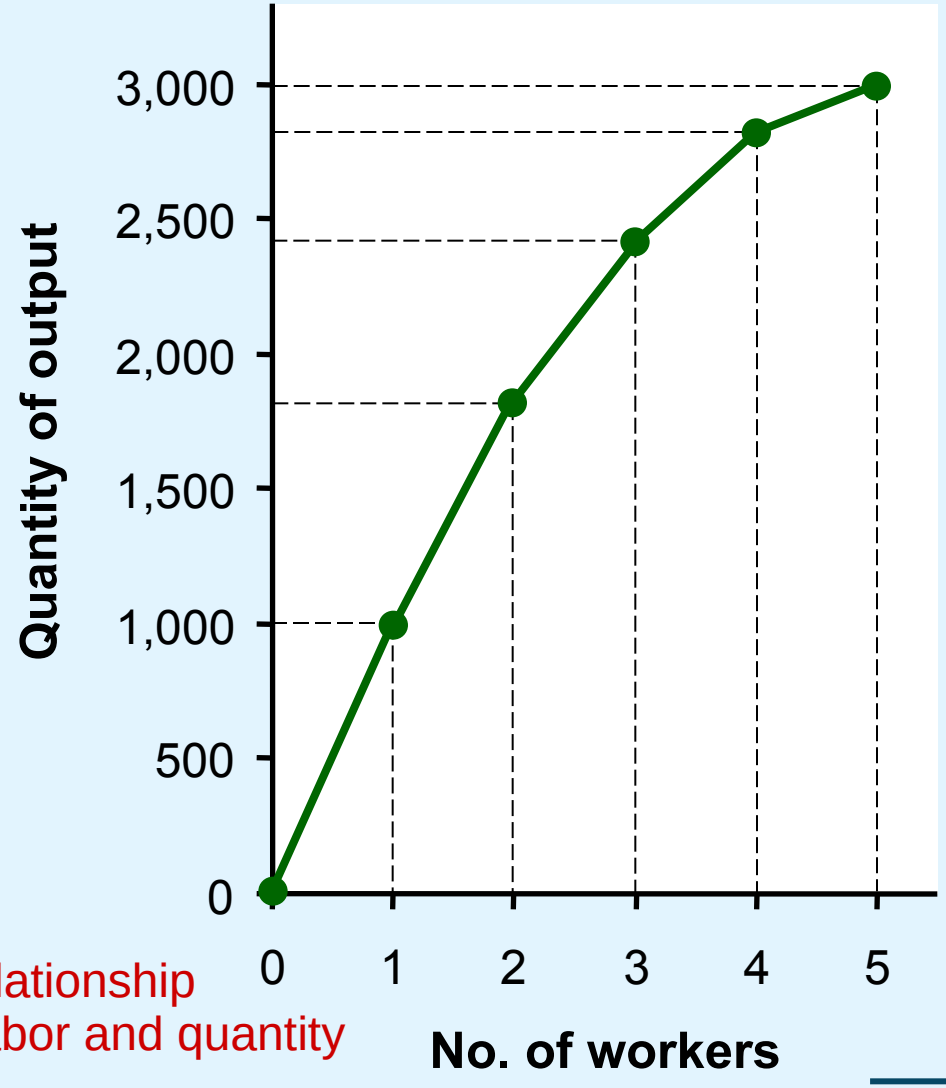
Example 1:

- Farmer Jack grows wheat.
- He has 5 acres of land (fixed resource).
- He can hire as many workers as he wants.
  - The quantity of output produced varies with the number of workers hired

EXAMPLE 1: Farmer Jack's Production Function

Example

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



Positive relationship between labor and quantity

Marginal Product

- Marginal product
  - Increase in output that arises from an additional unit of input
    - Other inputs constant
  - Slope of the production function
- Marginal product of labor, MPL
  - $MPL = \Delta Q/\Delta L$
  - If Jack hires one more worker, his output rises by the marginal product of labor.

EXAMPLE 1: Total & Marginal Product

	L (no. of workers)	***Q*** (bushels of wheat)		*MPL*
	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		

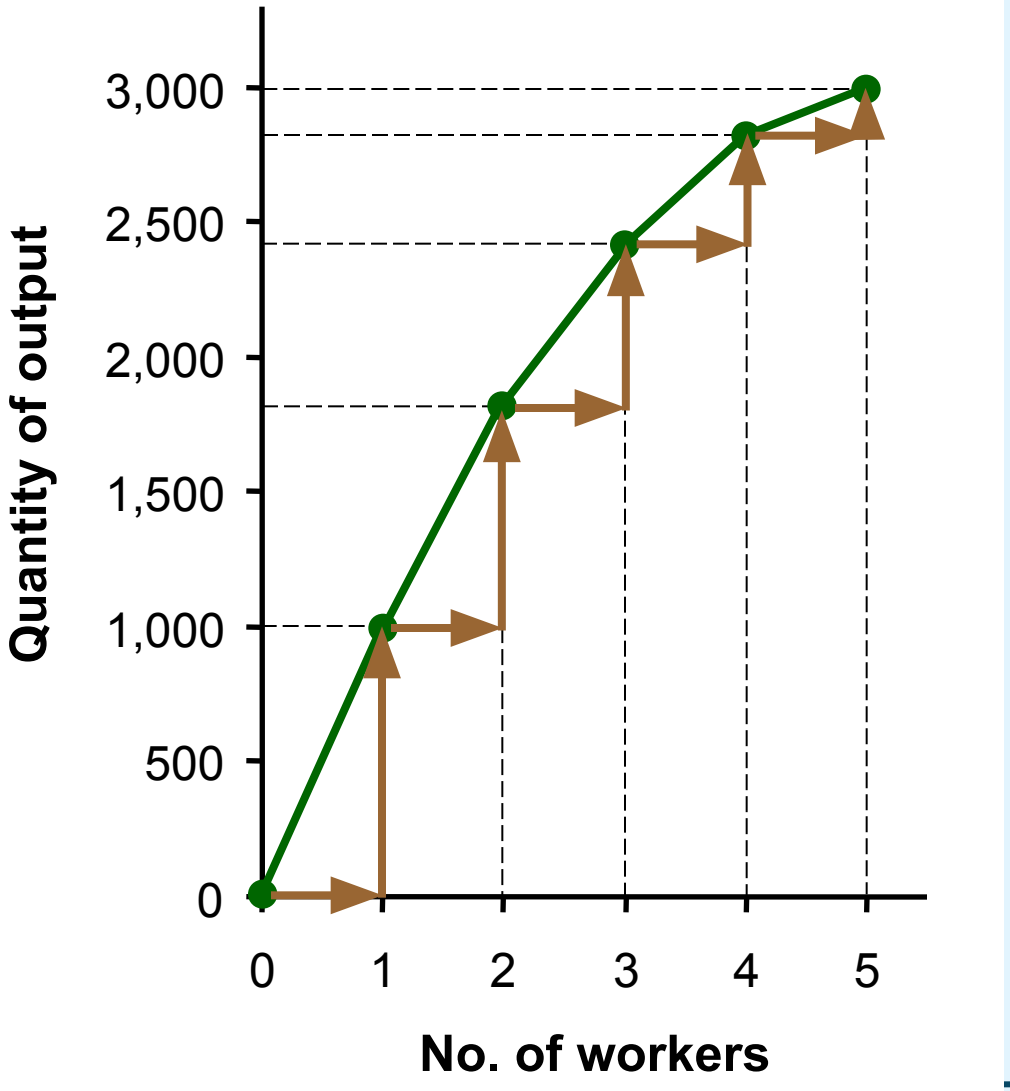
$\frac{\Delta 1000}{\Delta 1}$

Diminishing MPL

- Diminishing marginal product
  - Marginal product of an input declines as the quantity of the input increases
  - Production function gets flatter as more inputs are being used:
    - The slope of the production function decreases

EXAMPLE 1: MPL = Slope of Prod 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	



Why MPL Is Important

- '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.

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.).

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.

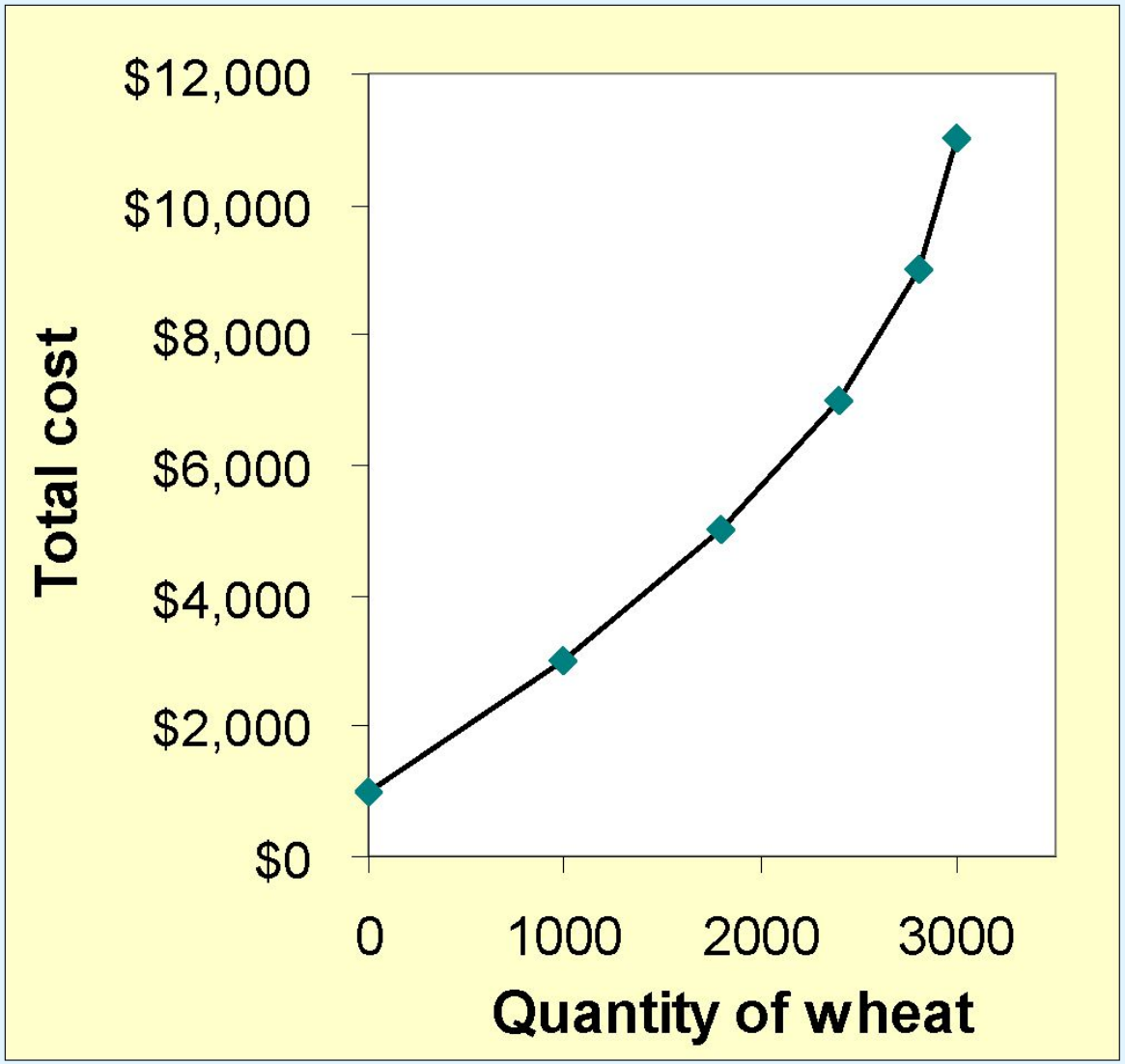
- So Farmer Jack's costs are related to how much wheat he produces….

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



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Marginal Cost

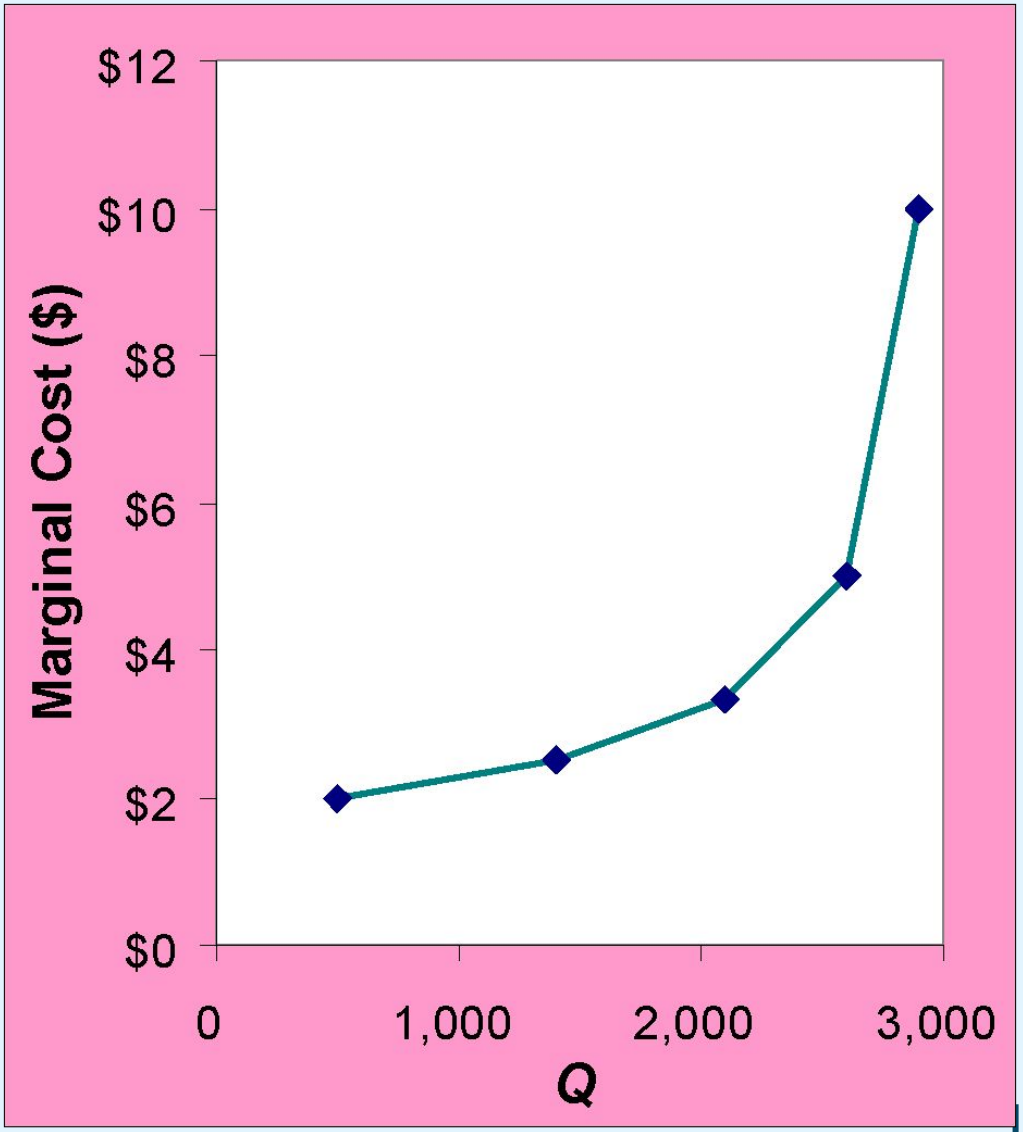
- Marginal cost, MC
  - Increase in total cost arising from an extra unit of production
  - Marginal cost = Change in total cost / Change in quantity
  - $MC = \Delta TC / \Delta Q$
  - Increase in total cost
    - From producing an additional unit of output

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: The 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	



Why MC Is Important

- Farmer Jack is rational and wants to maximize his profit
  - To increase profit, should he produce more or less wheat?
    - 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.

Fixed and Variable Costs

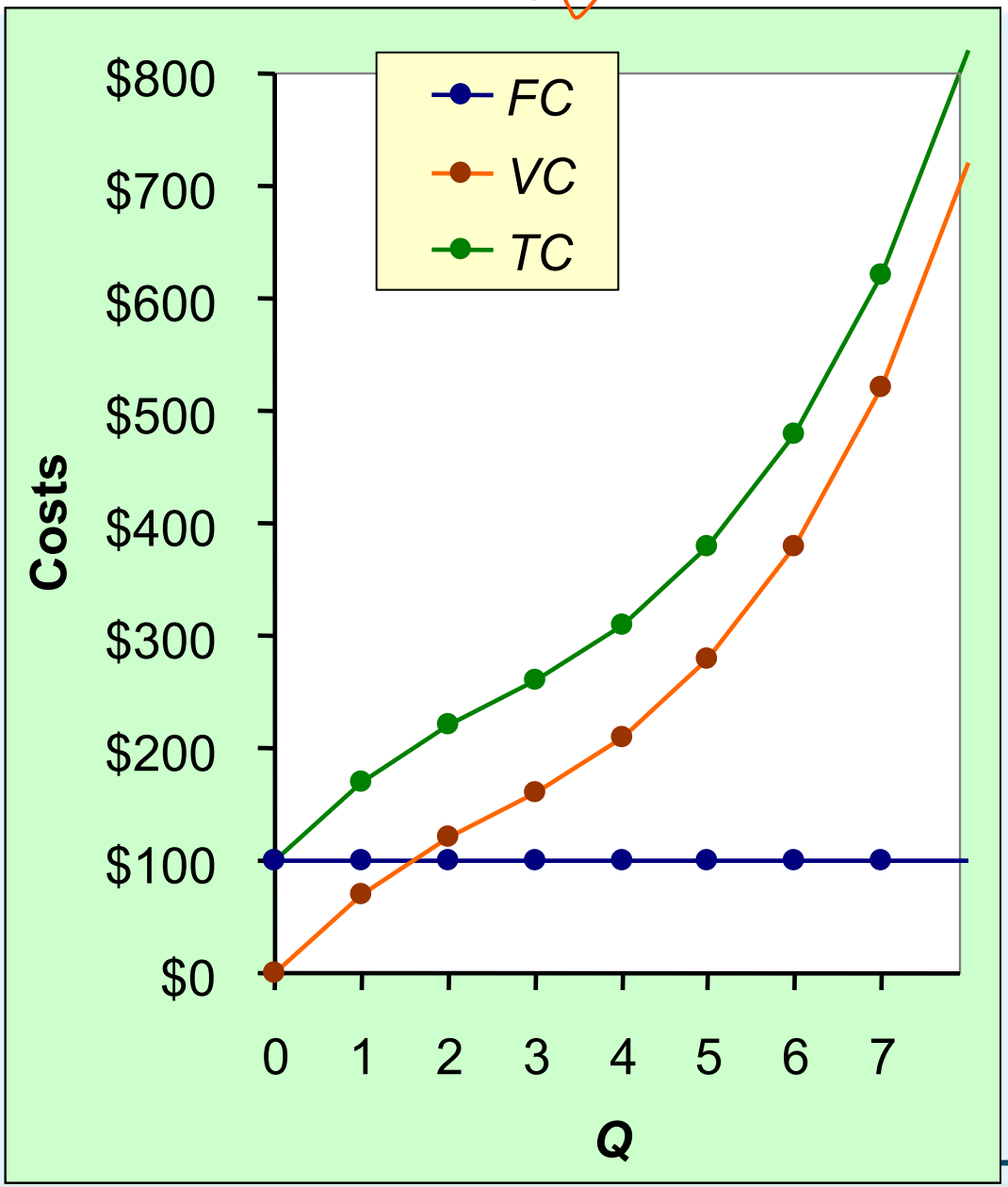
- Fixed costs, FC, do not vary with the quantity of output produced
  - For Farmer Jack, FC = $1000 for his land
  - Other examples: cost of equipment, loan payments, rent
- Variable costs, VC, vary with the quantity of output produced
  - For Farmer Jack, VC = wages he pays workers
  - Other example: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

EXAMPLE 2: Production Costs

- Our second example is more general, applies to any type of firm producing any good with any types of inputs.
  - Calculate and graph TC knowing FC and VC
  - Calculate and graph marginal and average costs
  - Understand the relationship between marginal cost and average cost

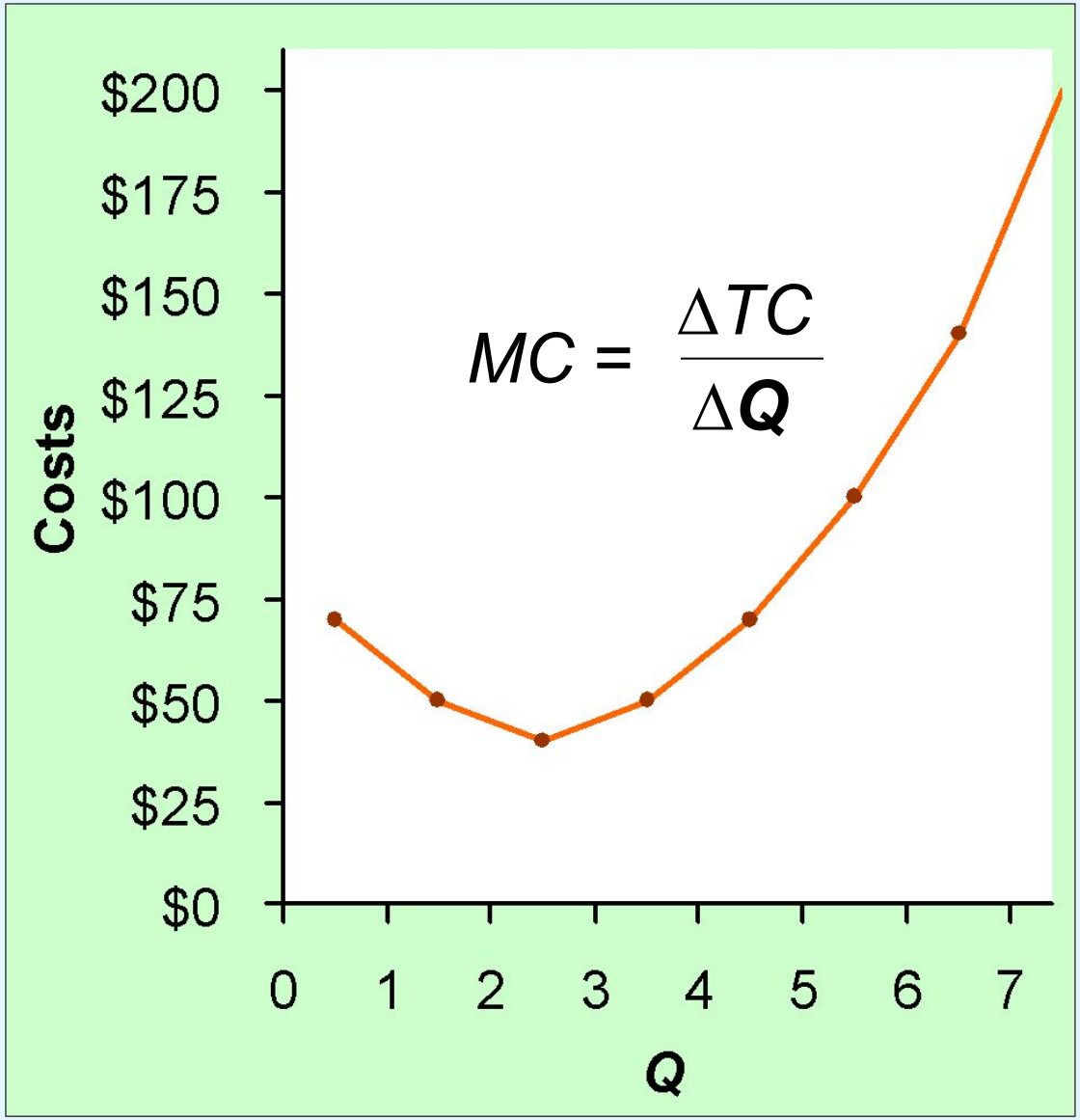
EXAMPLE 2: Costs: TC = FC + VC

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



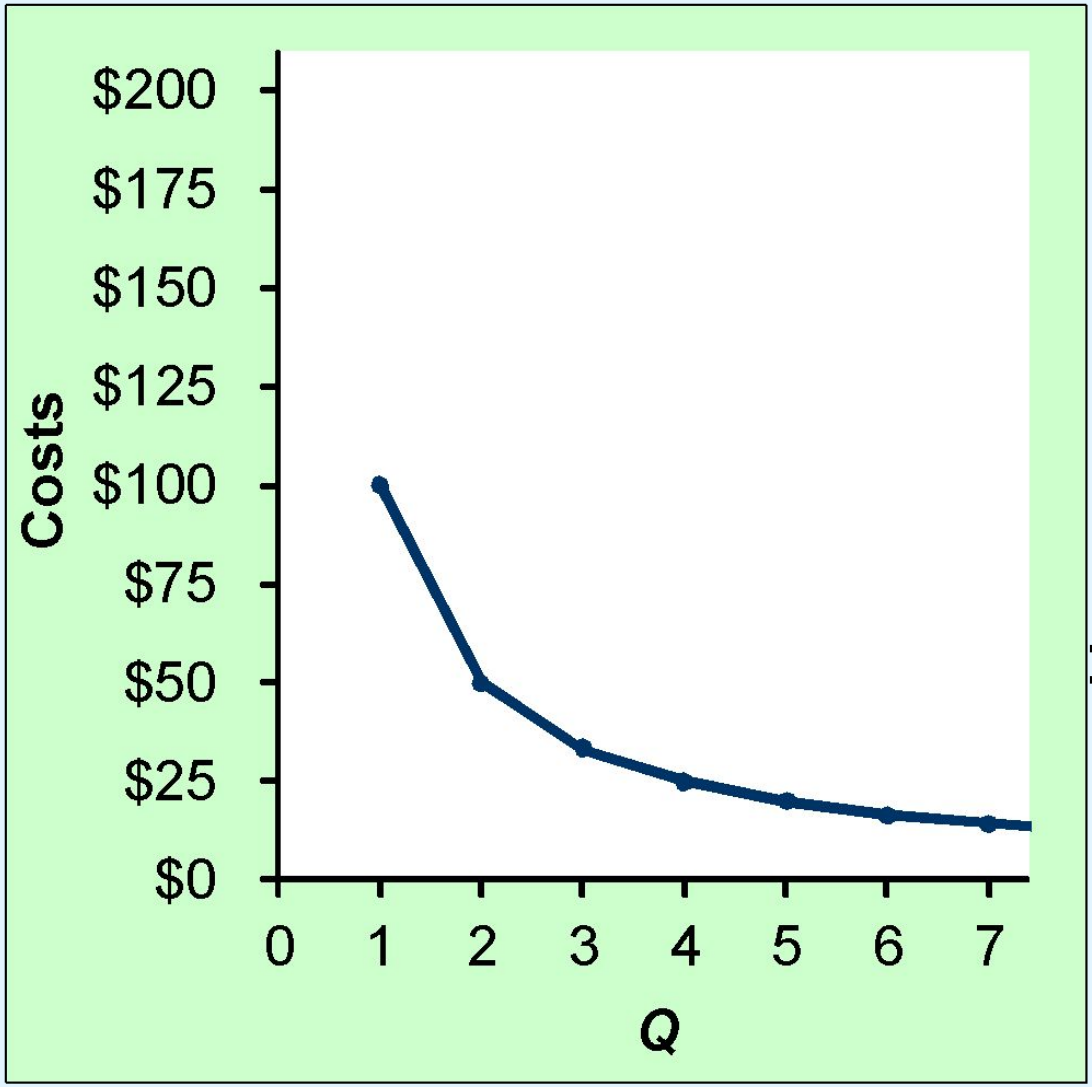
EXAMPLE 2: Marginal Cost

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	



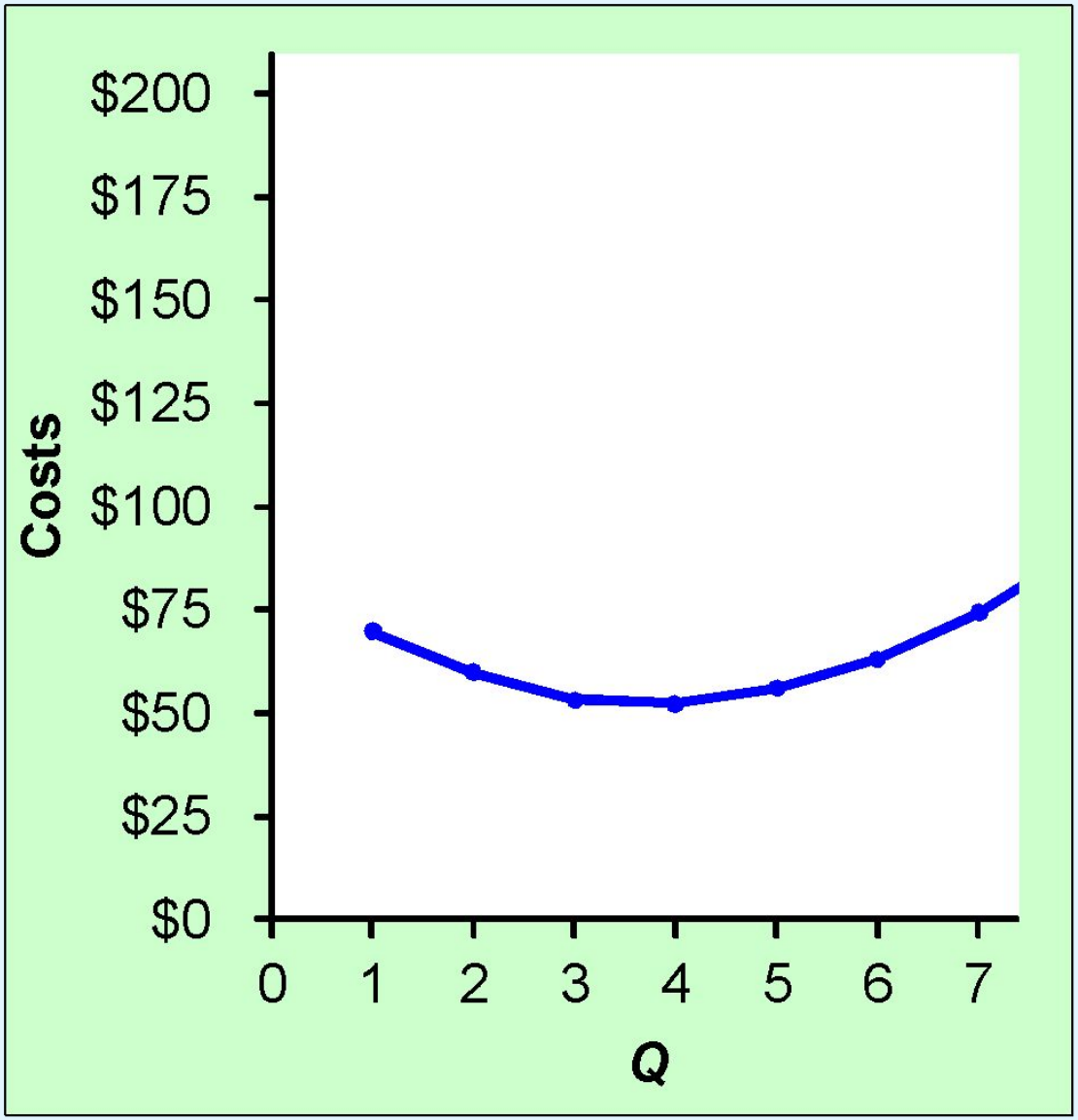
EXAMPLE 2: Average Fixed Cost, AFC

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, AVC

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:

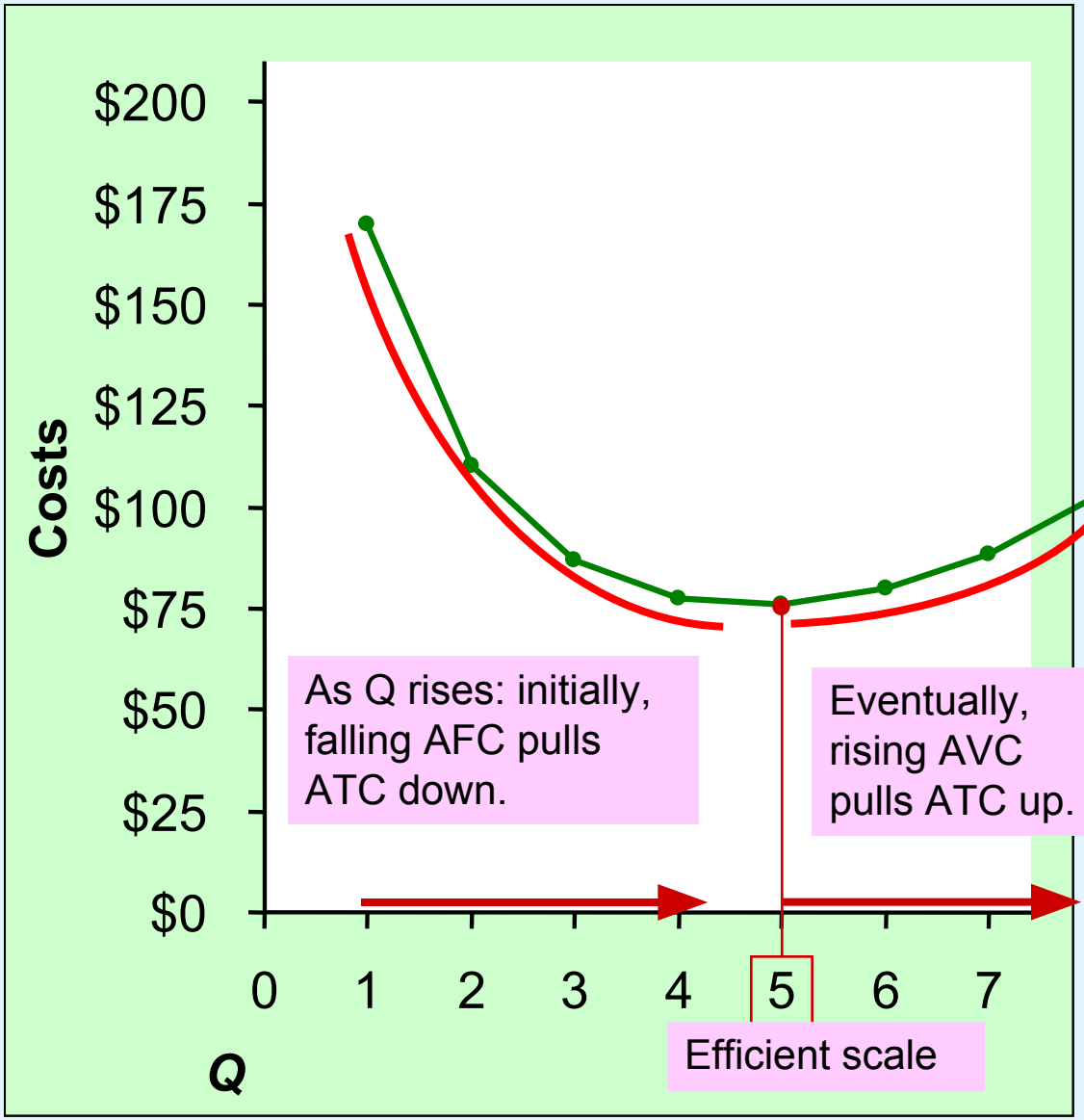
$$ATC = TC/Q$$

Also,

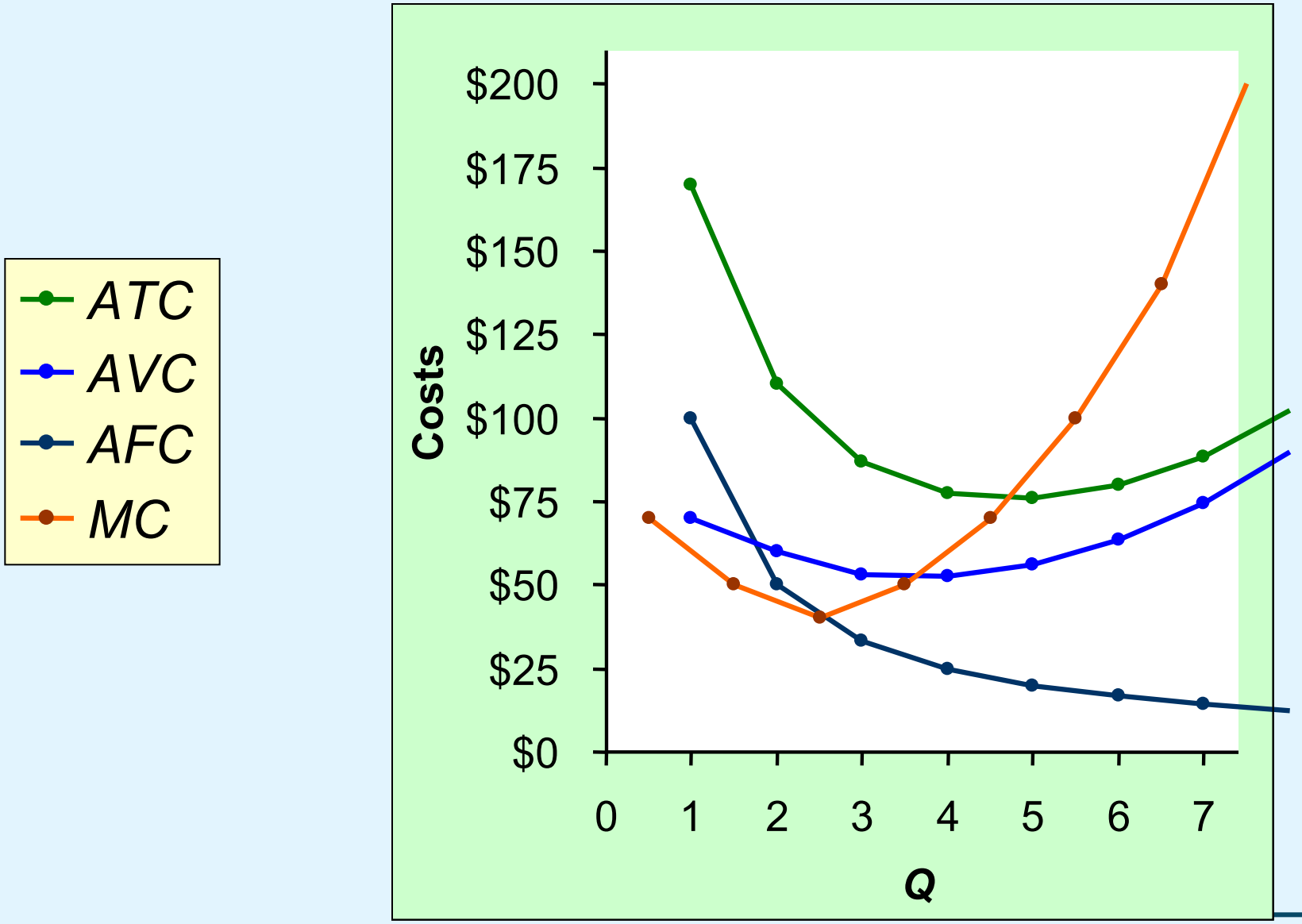
$$ATC = AFC + AVC$$

EXAMPLE 2: Average Total Cost, usually U-shaped

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

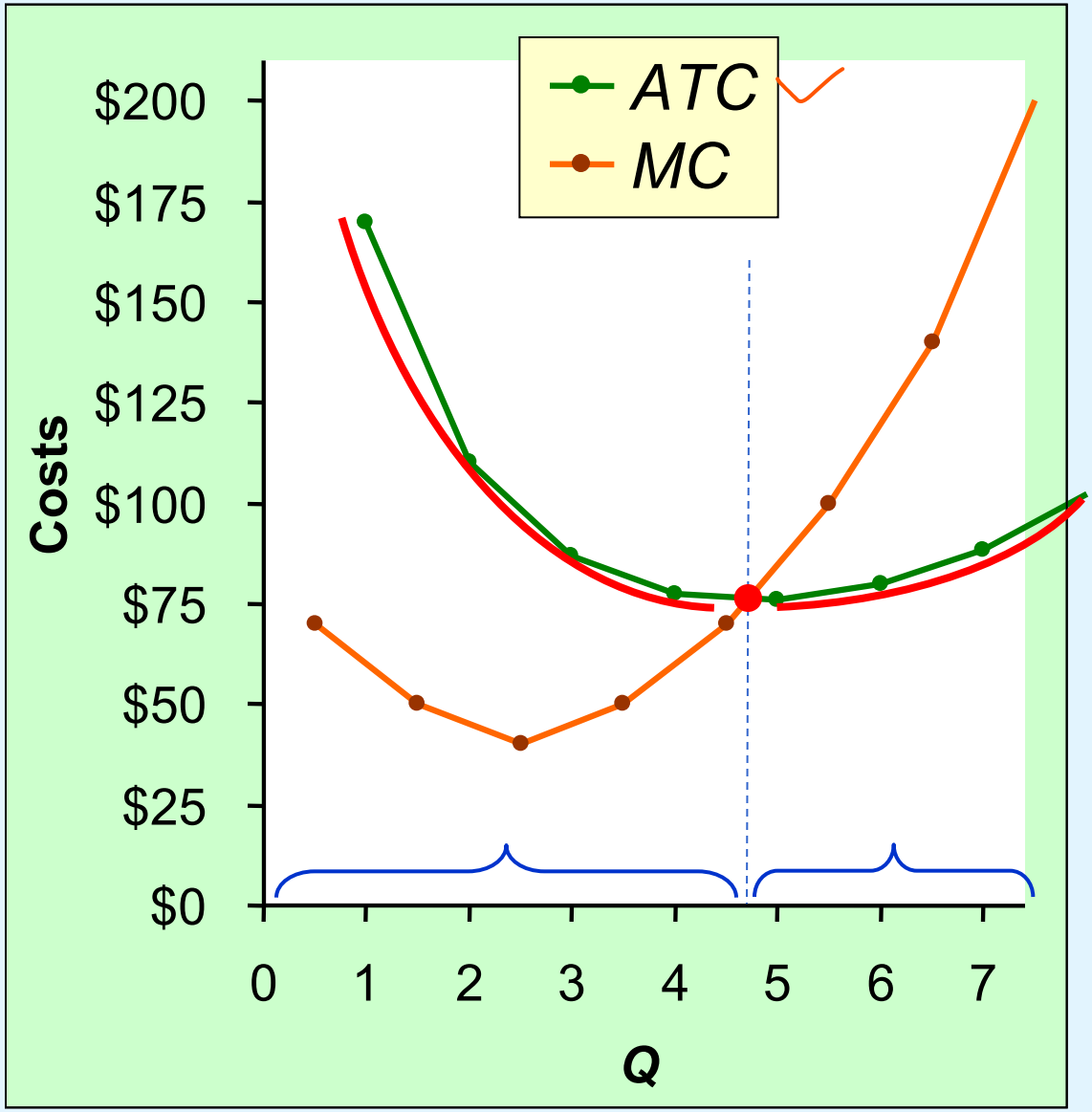


EXAMPLE 2: ATC and MC

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.



Active Learning 3 Calculating costs

FC = 50

Fill in the blank spaces of this table.

Q	VC	TC	AFC	AVC	ATC	MC
0	0	$50	*n/a*	*n/a*	*n/a*	
1	10	60	50	$10	$60.00	$10
2	30	80	25	15	40	20
3	60	110	16.67	20	36.67	30
4	100	150	12.50	25	37.50	40
5	150	200	10	30	40	50
6	210	260	8.33	35	43.33	60