

# 2.4 – Costs of Production

ECON 306 • Microeconomic Analysis • Spring 2021

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 [ryansafner/microS21](https://github.com/ryansafner/microS21)

 [microS21.classes.ryansafner.com](http://microS21.classes.ryansafner.com)



# Outline

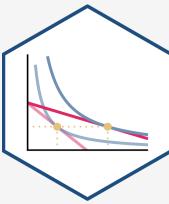


Opportunity Costs in Production

Costs in the Short Run

Costs in the Long Run

# Recall: The Firm's Two Problems



1<sup>st</sup> Stage: **firm's profit maximization problem:**

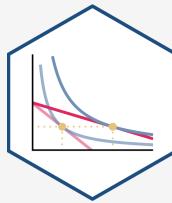
1. **Choose:** < output >
2. **In order to maximize:** < profits >

2<sup>nd</sup> Stage: **firm's cost minimization problem:**

1. **Choose:** < inputs >
2. **In order to minimize:** < cost >
3. **Subject to:** < producing the optimal output >
  - Minimizing costs  $\iff$  maximizing profits



# A Competitive Market

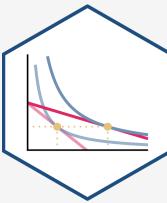


- We assume (for now) the firm is in a **competitive** industry:
  1. Firms' products are **perfect substitutes**
  2. Firms are "**price-takers**", no one firm can affect the *market price*
  3. Market **entry and exit are free<sup>†</sup>**



<sup>†</sup> Remember this feature. It turns out to be the most important feature that distinguishes different types of industries!

# Profit

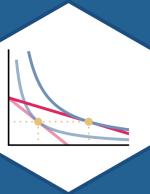


- Recall that profit is:

$$\pi = \underbrace{pq}_{revenues} - \underbrace{(wl + rk)}_{costs}$$

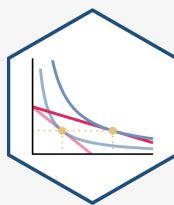
- We'll first take a closer look at costs today, then at revenues
- Next class we'll put them together to find  $q^*$  that maximizes  $\pi$  (the first stage problem)





# Opportunity Costs in Production

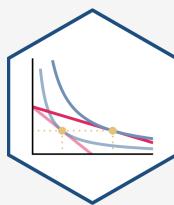
# Costs in Economics are Opportunity Costs



- Remember, **economic costs** are different from common conception of “cost”
  - **Accounting cost**: monetary cost
  - **Economic cost**: value of next best alternative use of resources given up (i.e. **opportunity cost**)



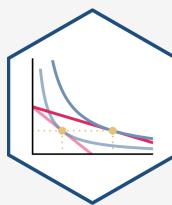
# Costs in Economics are Opportunity Costs



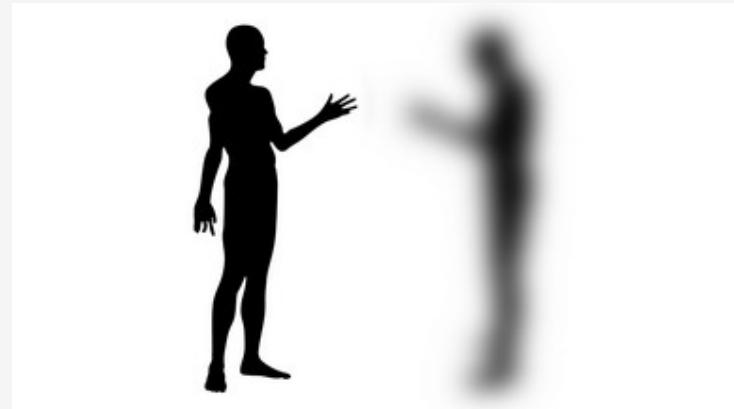
- This leads to the difference between
  - **Accounting profit:** revenues minus accounting costs
  - **Economic profit:** revenues minus *opportunity costs*
- One of the most difficult concepts to think about!



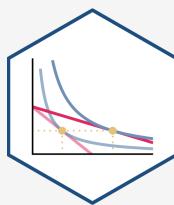
# Costs in Economics are Opportunity Costs



- Another helpful perspective:
- **Accounting cost**: what you **historically** paid for a resource
- **Economic cost**: what you can **currently** get in the market for a selling a resource
  - Resource's value in *alternative* uses



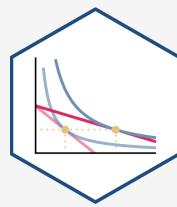
# Costs in Economics are Opportunity Costs



- Because resources are scarce, and have rivalrous uses, **how do we know we are using resources efficiently??**
- In functioning markets, **the market price measures the opportunity cost of using a resource for an alternative use**
- Firms not only pay for direct use of a resource, but also indirectly compensate society for "*pulling the resource out*" of alternate uses in the economy!



# Opportunity Costs in Production

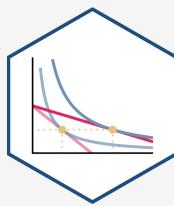


- Every choice incurs an opportunity cost

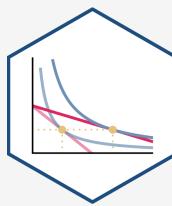
## Examples:

- If you start a business, you may give up your salary at your current job
- If you invest in a factory, you give up other investment opportunities
- If you use an office building you own, you cannot rent it to other people
- If you hire a skilled worker, you must pay them a high enough salary to deter them from working for other firms

# Opportunity Cost is Hard for People



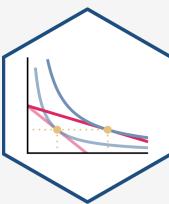
# Opportunity Costs vs. Sunk Costs



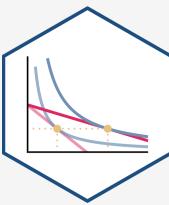
- Opportunity cost is a *forward-looking* concept
- Choices made in the *past* with *non-recoverable* costs are called **sunk costs**
- Sunk costs *should not* enter into future decisions
- Many people have difficulty letting go of unchangeable past decisions: **sunk cost fallacy**



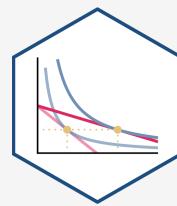
# Sunk Costs: Examples



# Sunks Costs: Examples



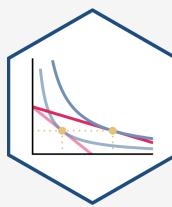
# Common Sunk Costs in Business



- Licensing fees, long-term lease contracts
- Specific capital (with no alternative use): uniforms, menus, signs
- Research & Development spending
- Advertising spending



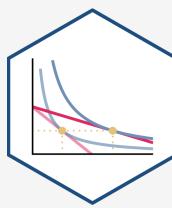
# The Accounting vs. Economic Point of View I



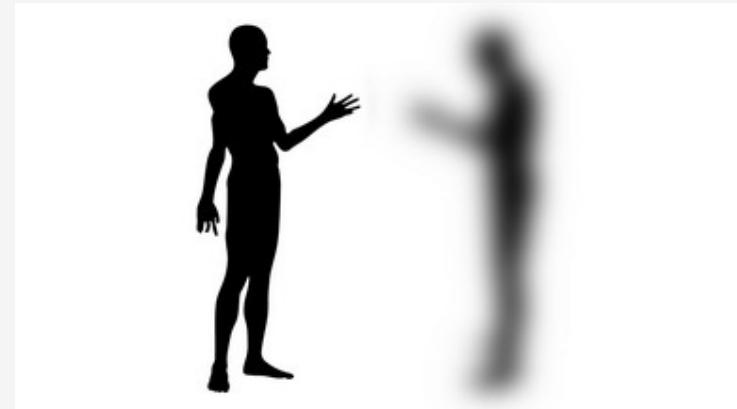
- Helpful to consider two points of view:
  1. **“Accounting point of view”**: are you taking in more cash than you are spending?
  2. **“Economic point of view”**: is your product you making the *best social* use of your resources
    - i.e. are there higher-valued uses of your resources you are keeping them away from?

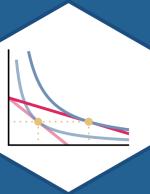


# The Accounting vs. Economic Point of View II



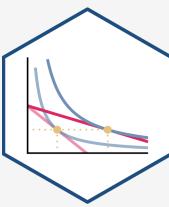
- **Social implications:** are consumers *best off* with you using scarce resources (with alternative uses!) to produce your current product?
- Remember: **this is an *economics* course, not a *business* course!**
  - What might be good/bad for one business might have bad/good *consequences* for society!
  - e.g. monopoly vs. competition





# Costs in the Short Run

# Costs in the Short Run



- **Total cost function,  $C(q)$**  relates output  $q$  to the total cost of production  $C$

$$C(q) = f + VC(q)$$

- Two kinds of short run costs:

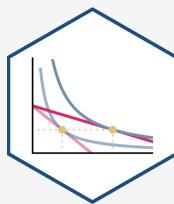
**1. Fixed costs,  $f$**  are costs that do not vary with output

- Only true in the short run! (Consider this the cost of maintaining your capital)

**2. Variable costs,  $VC(q)$**  are costs that vary with output (notice the variable in them!)

- Typically, the more production of  $q$ , the higher the cost
- e.g. firm is hiring *additional* labor

# Fixed vs. Variable costs: Examples

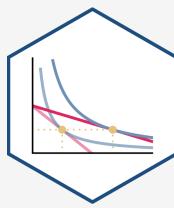


**Example:** Airlines

**Fixed costs:** the aircraft

**Variable costs:** getting one more customer in a seat

# Fixed vs. Variable costs: Examples

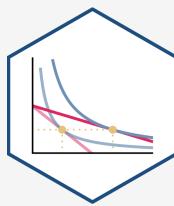


**Example:** Car Factory

**Fixed costs:** the factory, machines in the factory

**Variable costs:** producing one more car

# Fixed vs. Variable costs: Examples

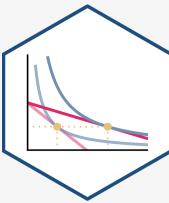


**Example:** Starbucks

**Fixed costs:** the retail space

**Variable costs:** selling one more cup of coffee

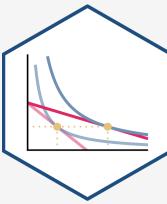
# Fixed vs. Sunk costs



- Diff. between **fixed** vs. **sunk** costs?
- **Sunk costs** are a *type* of **fixed cost** that are *not* avoidable or recoverable
- Many **fixed costs** can be avoided or changed in the long run
- Common **fixed**, but *not* **sunk**, costs:
  - rent for office space, durable equipment, operating permits (that are renewed)
- When deciding to *stay* in business, **fixed costs** matter, **sunk costs** do not!



# Cost Functions: Example

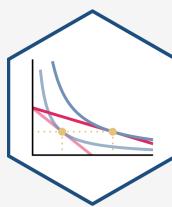


**Example:** Suppose your firm has the following total cost function:

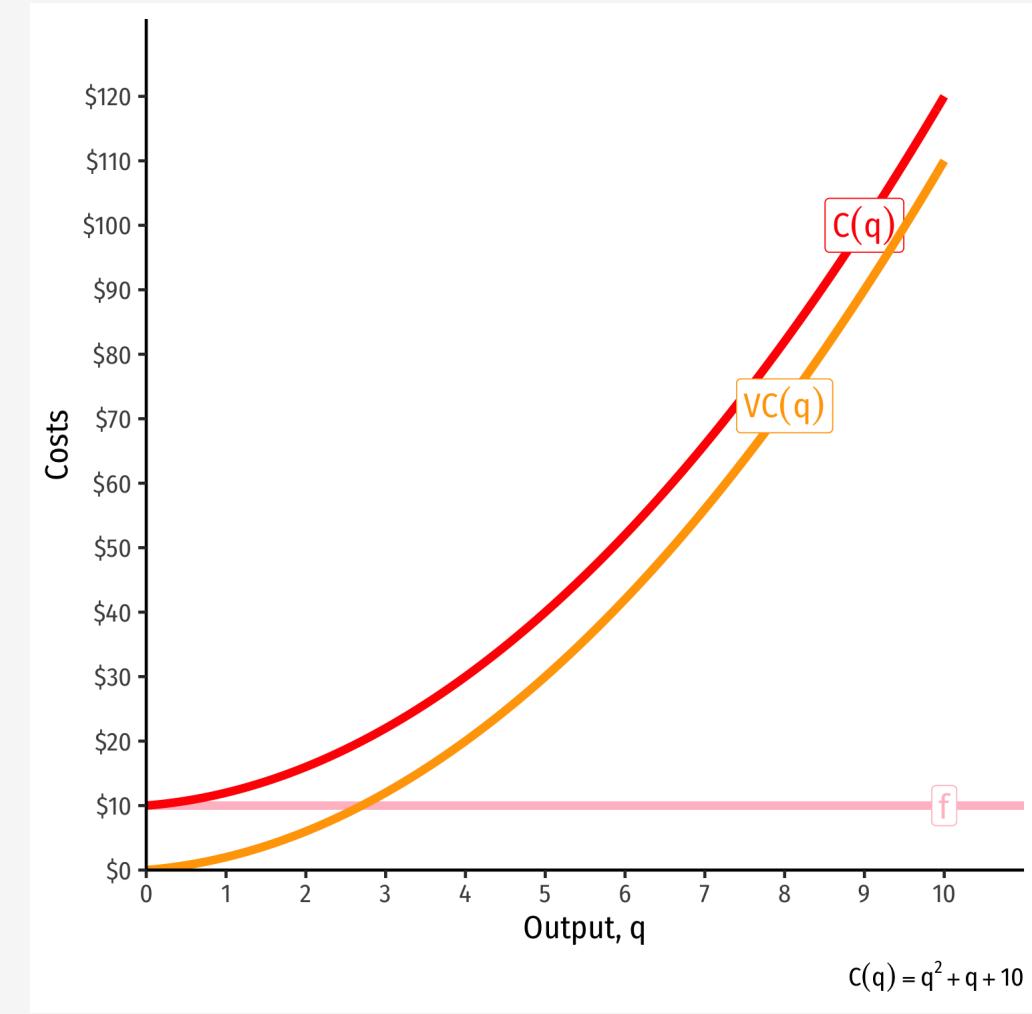
$$C(q) = q^2 + q + 10$$

1. Write a function for the fixed costs,  $f$ .
2. Write a function for the variable costs,  $VC(q)$ .

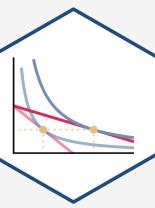
# Cost Functions: Example, Visualized



$q$	$f$	$VC(q)$	$C(q)$
0	10	0	10
1	10	2	12
2	10	6	16
3	10	12	22
4	10	20	30
5	10	30	40
6	10	42	52
7	10	56	66
8	10	72	82
9	10	90	100



# Average Costs



- **Average Fixed Cost:** fixed cost per unit of output:

$$AFC(q) = \frac{f}{q}$$

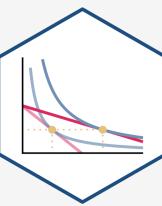
- **Average Variable Cost:** variable cost per unit of output:

$$AVC(q) = \frac{VC(q)}{q}$$

- **Average (Total) Cost:** (total) cost per unit of output:

$$AC(q) = \frac{C(q)}{q}$$

# Marginal Cost

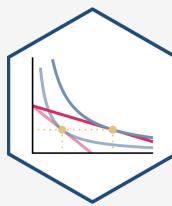


- **Marginal Cost** is the change in cost for each additional unit of output produced:

$$MC(q) = \frac{\Delta C(q)}{\Delta q} \approx \frac{C_2 - C_1}{q_2 - q_1}$$

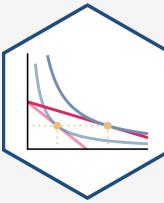
- Calculus: first derivative of the cost function
- **Marginal cost is the *primary* cost that matters in making decisions**
  - All other costs are driven by marginal costs
  - This is the main cost that firms can "see"

# The Importance of Marginal Cost



Dazexiang Rebellion against the Qin Dynasty (209 B.C.)

# Average and Marginal Costs: Example

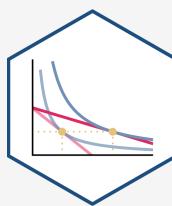


**Example:** A small farm grows strawberries on 5 acres of land that it rents for \$200 a week. The farm can hire workers at a wage of \$250/week for each worker. The table below shows how the output of strawberries (in truckloads) varies with the number of workers hired:

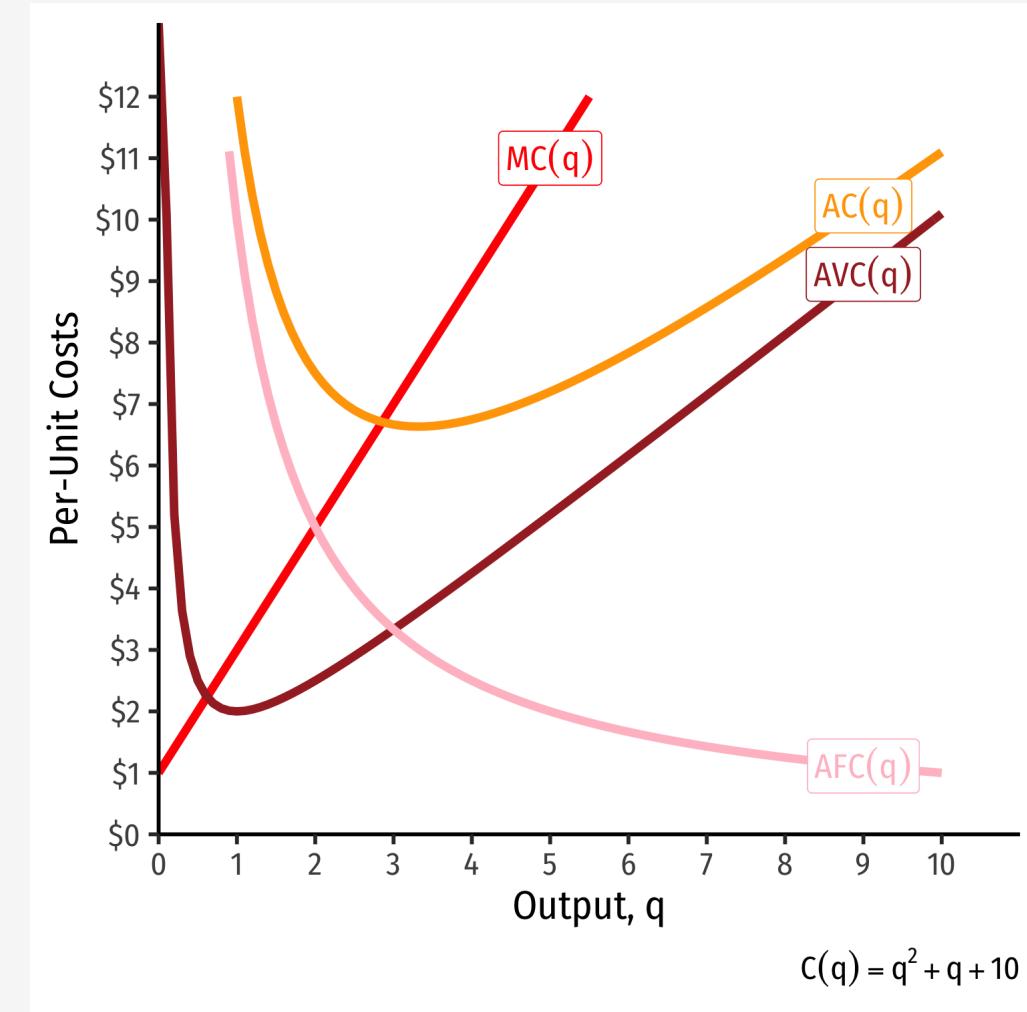
Output	Labor
0	0
1	1
2	3
3	7
4	12
5	18

1. If labor is the only variable cost, calculate the  $MC(q)$  and  $AC(q)$  for each of the first 5 truckloads.

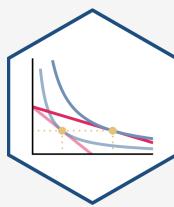
# Average and Marginal Costs: Visualized



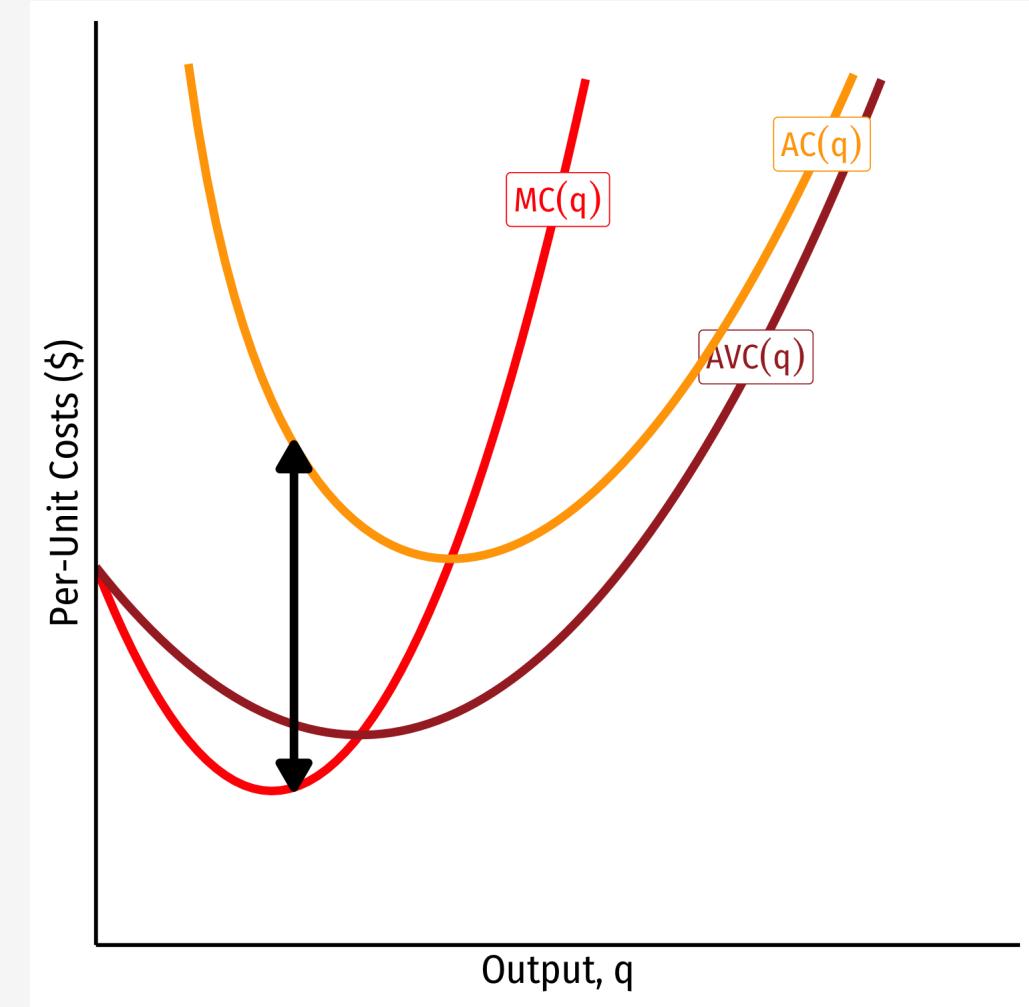
$q$	$C(q)$	$MC(q)$	$AFC(q)$	$AVC(q)$	$AC(q)$
0	10	—	—	—	—
1	12	2	10.00	2	12.00
2	16	4	5.00	3	8.00
3	22	6	3.33	4	7.30
4	30	8	2.50	5	7.50
5	40	10	2.00	6	8.00
6	52	12	1.67	7	8.70
7	66	14	1.43	8	9.40
8	82	16	1.25	9	10.25
9	100	18	1.11	10	11.10



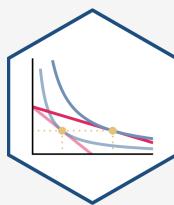
# Relationship Between Marginal and Average



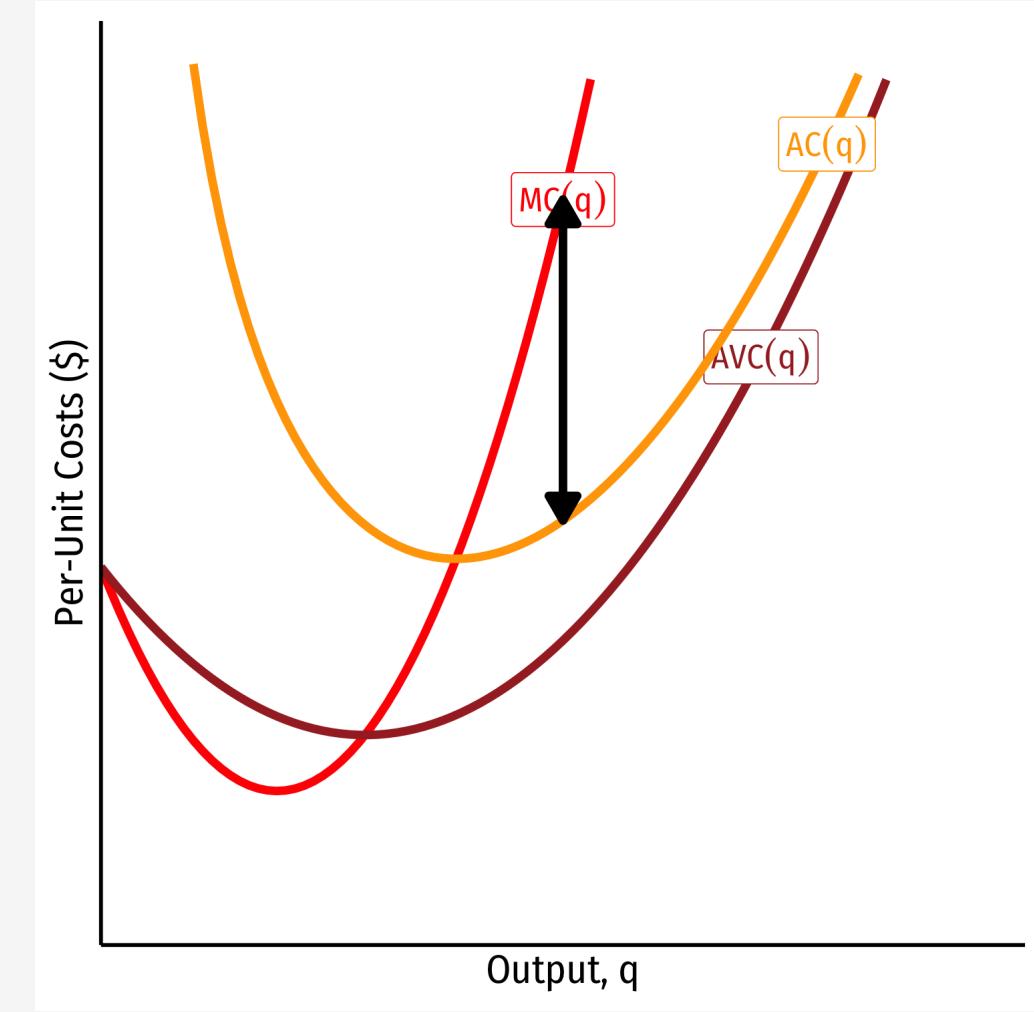
- Relationship between a marginal and an average value:
- marginal < average, average ↓



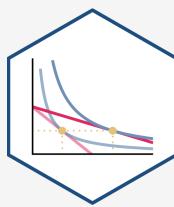
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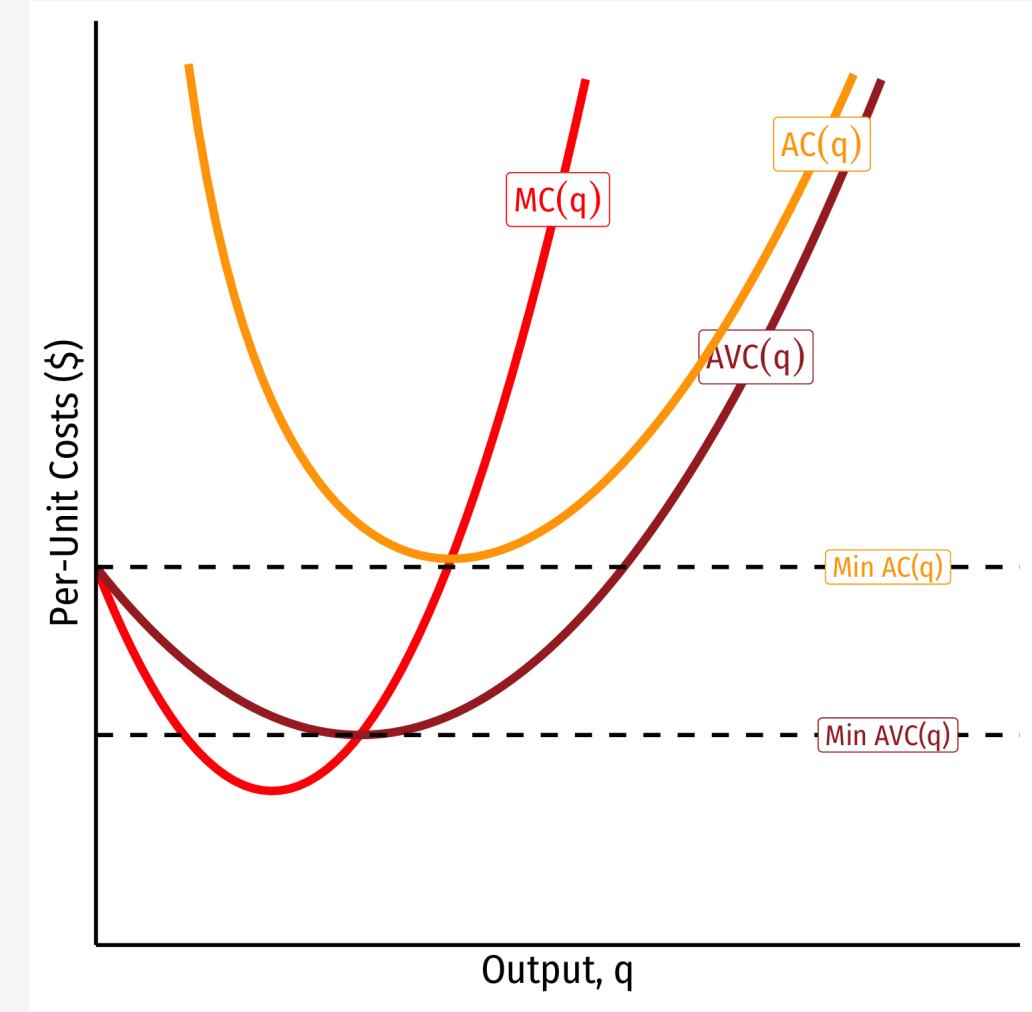
- Relationship between a marginal and an average value:
- marginal < average, average ↓
- marginal > average, average ↑



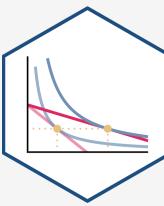
# Relationship Between Marginal and Average



- Relationship between a marginal and an average value:
- marginal < average, average ↓
- marginal > average, average ↑
- When marginal = average, average is **maximized/minimized**
- When  $MC = AC$ ,  $AC$  is at a *minimum*
- When  $MC = AVC$ ,  $AVC$  is at a *minimum*
- Economic importance (later): Break-even price and shut-down price



# Short Run Costs: Example



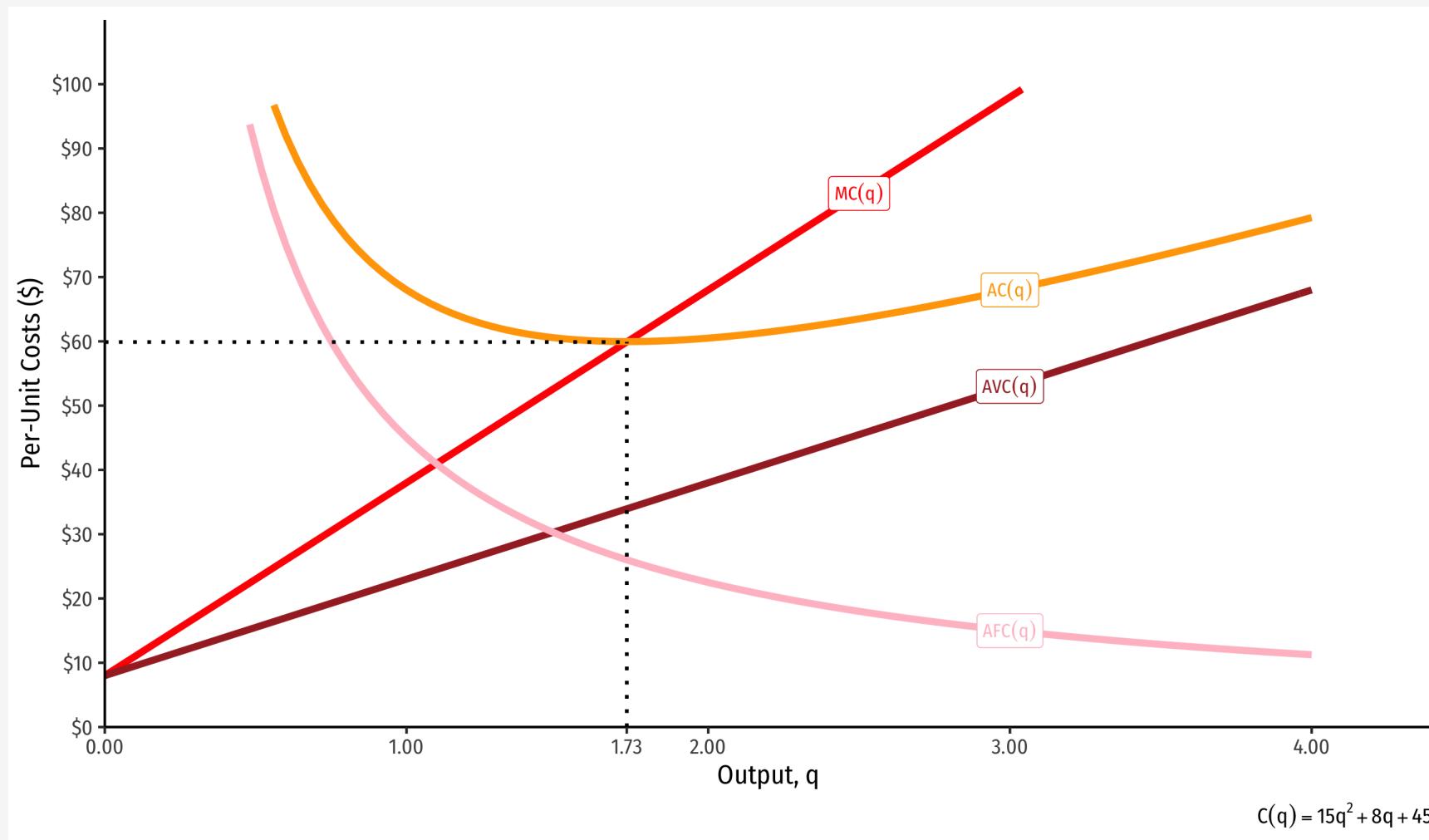
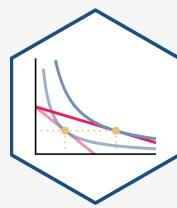
**Example:** Suppose a firm's cost structure is described by:

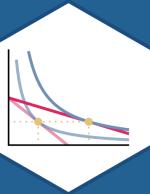
$$C(q) = 15q^2 + 8q + 45$$

$$MC(q) = 30q + 8$$

1. Write expressions for the firm's **fixed costs**, **variable costs**, **average fixed costs**, **average variable costs**, and **average (total) costs**.
2. Find the minimum average (total) cost.
3. Find the minimum average variable cost.

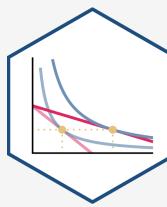
# Costs: Example: Visualized





# Costs in the Long Run

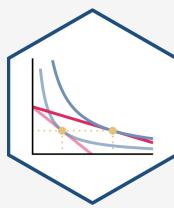
# Costs in the Long Run



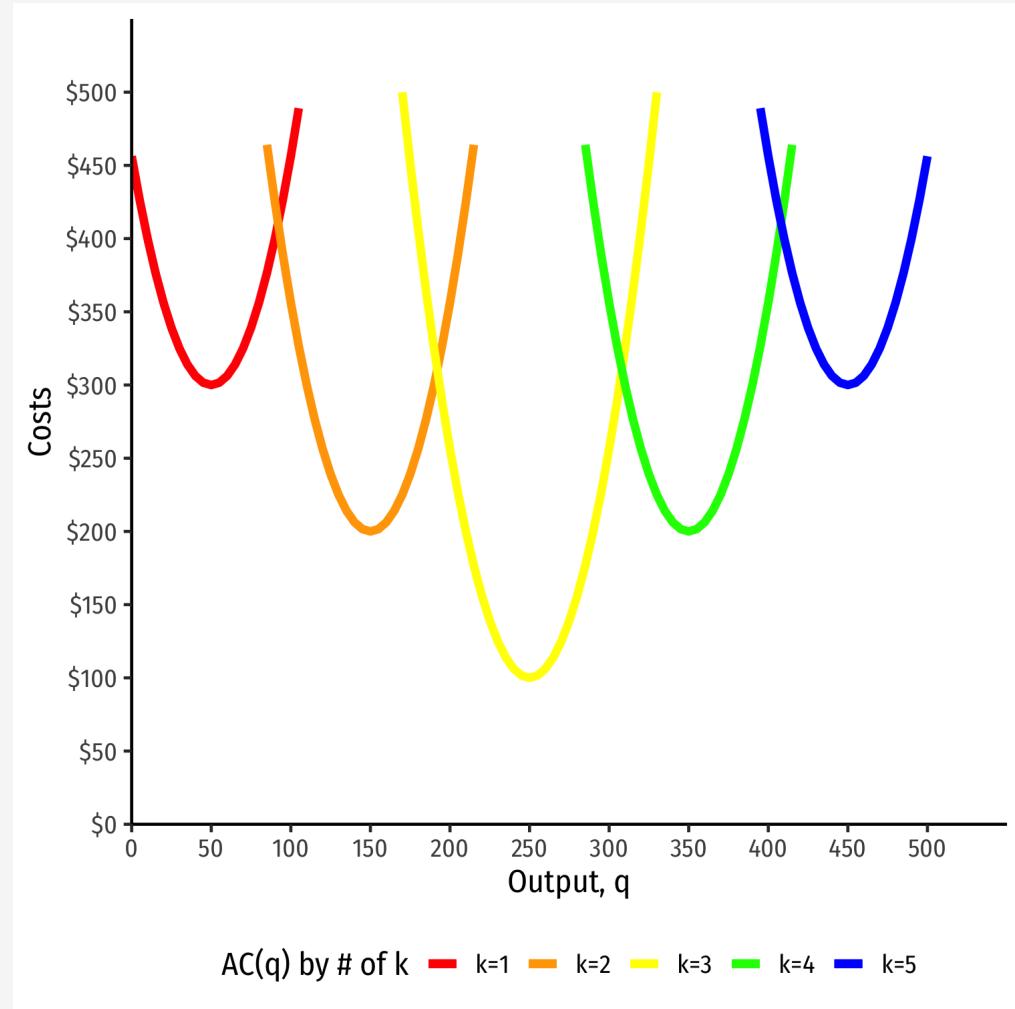
- **Long run:** firm can change all factors of production & vary scale of production
- **Long run average cost,  $LRAC(q)$ :** cost per unit of output when the firm can change *both*  $l$  and  $k$  to make more  $q$
- **Long run marginal cost,  $LRMC(q)$ :** change in long run total cost as the firm produce an additional unit of  $q$  (by changing *both*  $l$  and/or  $k$ )



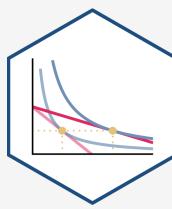
# Average Cost in the Long Run



- **Long run:** firm can choose  $k$  (factories, locations, etc)
- Separate short run average cost (SRAC) curves for each amount of  $k$  potentially chosen

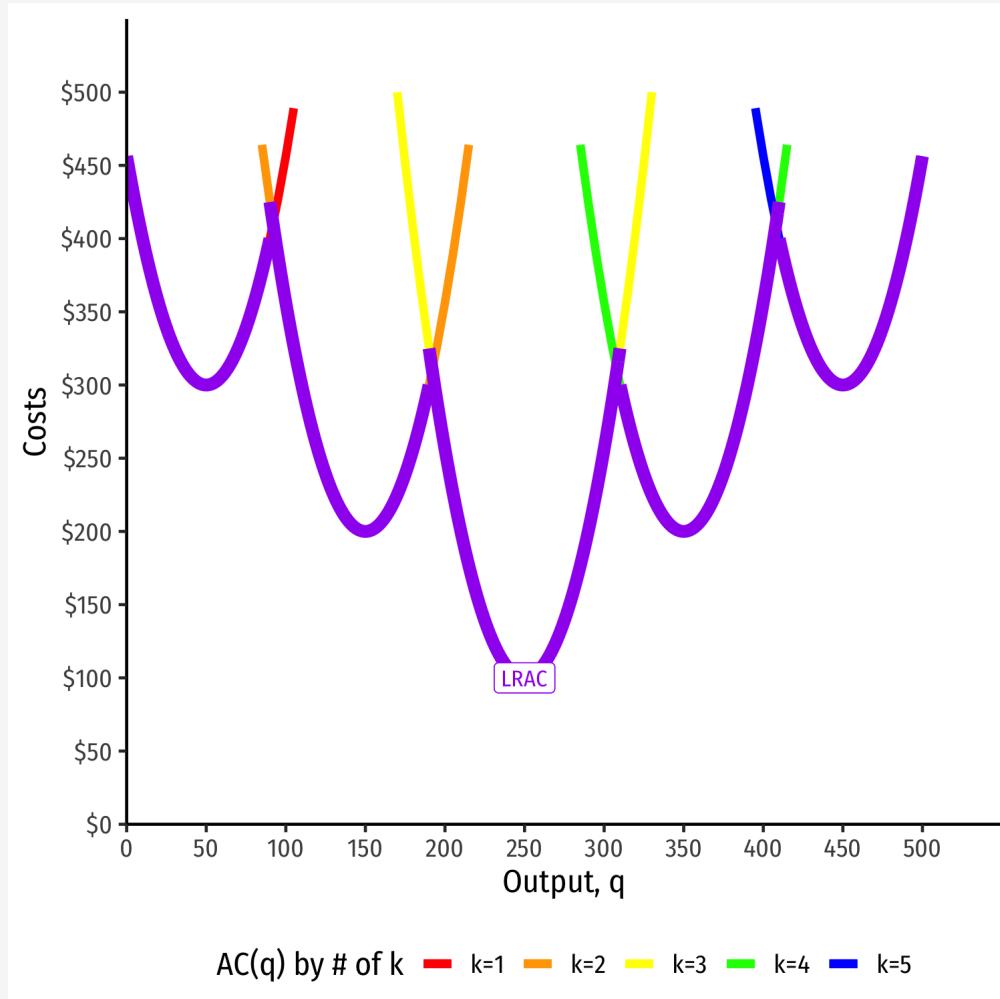


# Average Cost in the Long Run

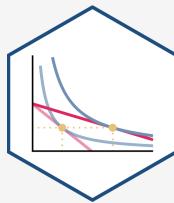


- **Long run:** firm can choose  $k$  (factories, locations, etc)
- Separate short run average cost (SRAC) curves for each amount of  $k$  potentially chosen
- **Long run average cost (LRAC)** curve "envelopes" the lowest (optimal) parts of all the SRAC curves!

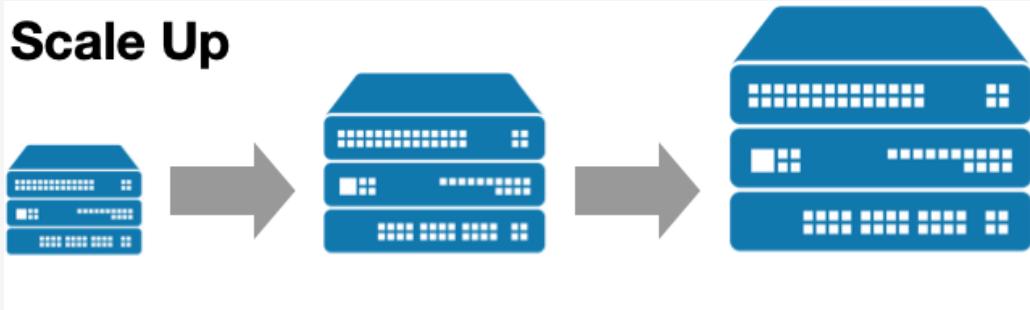
"Subject to producing the optimal amount of output, choose  $l$  and  $k$  to minimize cost"



# Long Run Costs & Scale Economies I

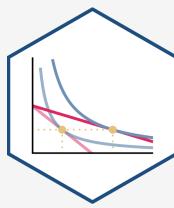


## Scale Up

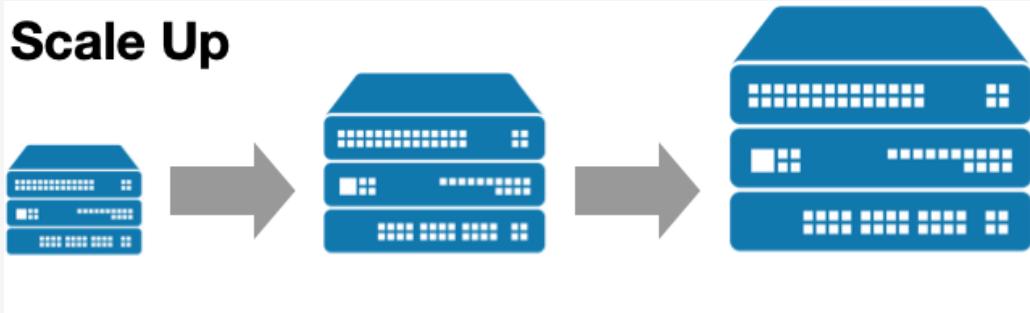


- Further properties about costs based on **scale economies** of production:
- **Economies of scale**: costs fall with output
  - $AFC > AVC(q)$
- **Diseconomies of scale**: costs rise with output
  - $AFC < AVC(q)$
- **Constant economies of scale**: costs don't change with output

# Long Run Costs & Scale Economies I

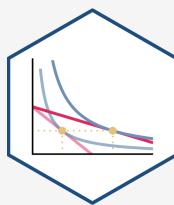


## Scale Up

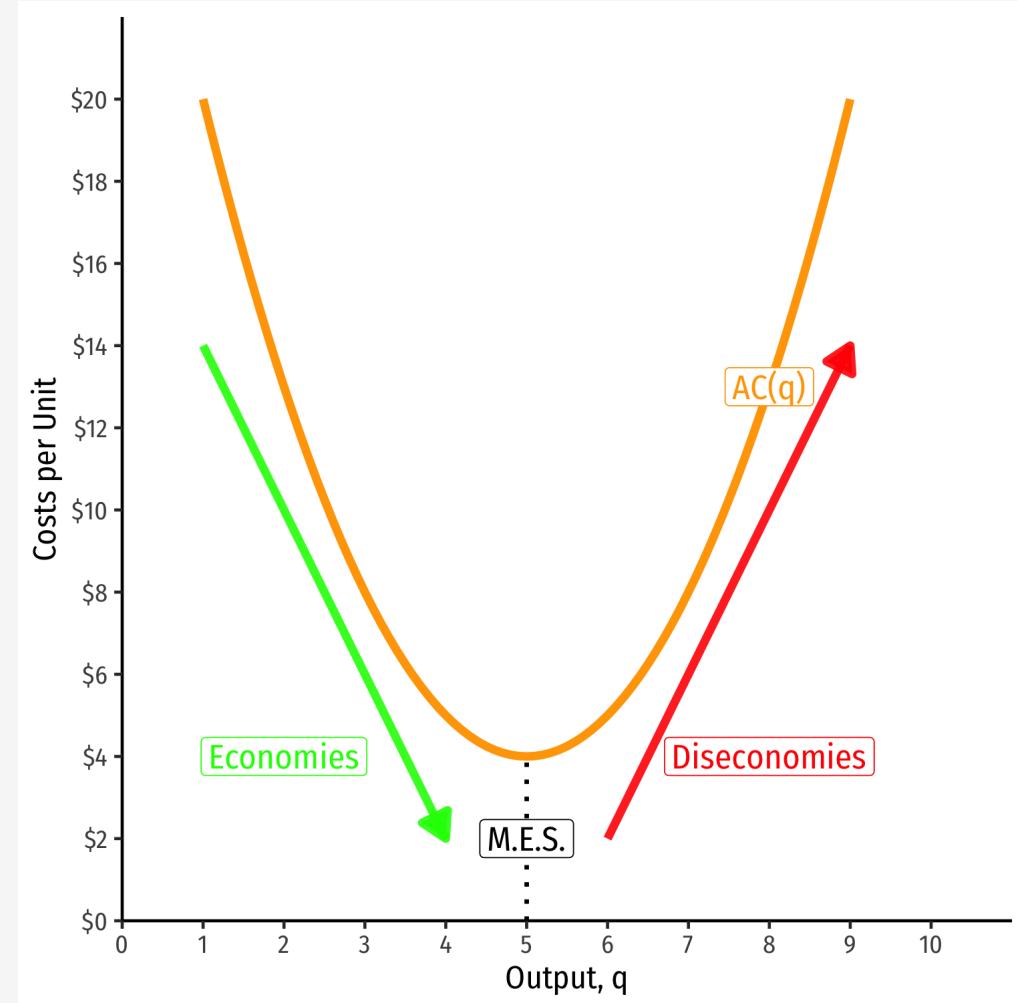


- Note **economies of scale**  $\neq$  **returns to scale**!
- **Returns to Scale** (last class): a **technological** relationship between inputs & output
- **Economies of Scale** (this class): an **economic** relationship between output and average costs

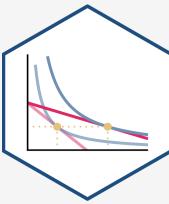
# Long Run Costs & Scale Economies II



- **Minimum Efficient Scale:**  $q$  with the lowest  $AC(q)$
- **Economies of Scale:**  $\uparrow q, \downarrow AC(q)$
- **Diseconomies of Scale:**  $\uparrow q, \uparrow AC(q)$



# Long Run Costs and Scale Economies: Example



**Example:** A firm's long run cost structure is as follows:

$$LRC(q) = 32000q - 250q^2 + q^3$$

$$LRMC(q) = 32000 - 500q + 3q^2$$

1. At what levels of output will the firm face economies of scale and diseconomies of scale?  
(Hint: This firm has a *U*-shaped LRAC.)

# Long Run Costs and Scale Economies: Example

