

2.4 — Costs of Production

ECON 306 • Microeconomic Analysis • Spring 2021

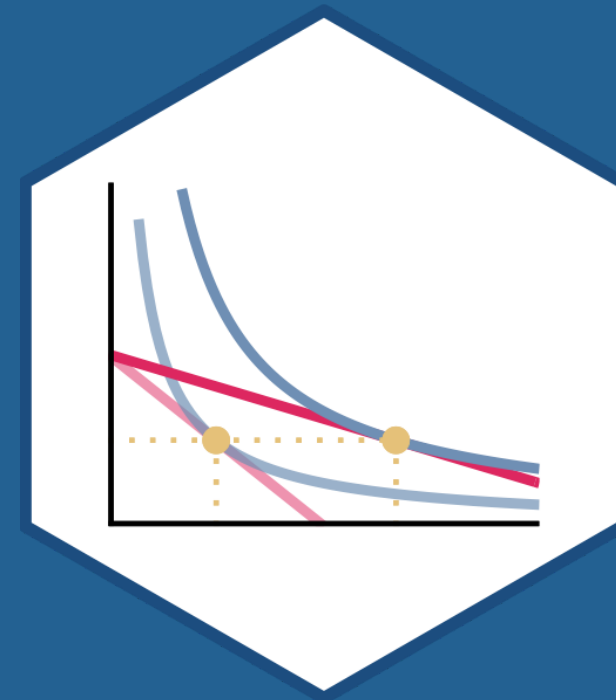
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[🔗 ryansafner/microS21](https://github.com/ryansafner/microS21)

[🌐 microS21.classes.ryansafner.com](https://microS21.classes.ryansafner.com)



Outline

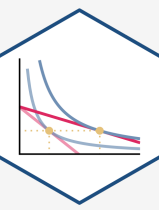


Opportunity Costs in Production

Costs in the Short Run

Costs in the Long Run

Recall: The Firm's Two Problems



1st Stage: **firm's profit maximization problem:**

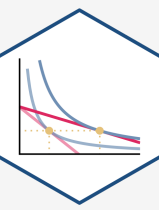
1. **Choose:** < output >
2. **In order to maximize:** < profits >

2nd 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

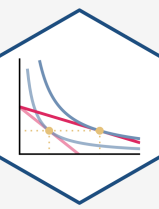


- We assume (for now) the firm is in a **competitive** industry:
 1. Firms' products are **perfect substitutes**
 2. Firms are “**price-takers**”, no one firm can affect the *market price*
 3. Market **entry and exit are free**[†]



[†] Remember this feature. It turns out to be the most important feature that distinguishes different types of industries!

Profit

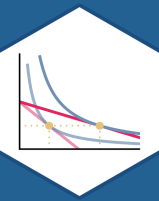


- Recall that profit is is:

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

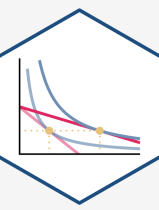
- We'll first take a closer look at costs today, then at revenues
- Next class we'll put them together to find q^* that maximizes π (the first stage problem)





Opportunity Costs in Production

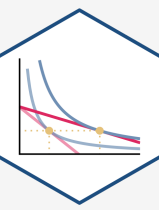
Costs in Economics are Opportunity Costs



- 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**)



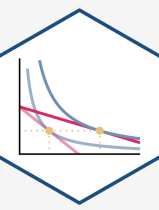
Costs in Economics are Opportunity Costs



- 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!



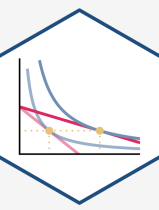
Costs in Economics are Opportunity Costs



- 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*



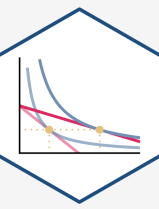
Costs in Economics are Opportunity Costs



- 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

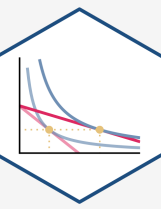


- Every choice incurs an opportunity cost

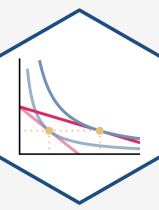
Examples:

- 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



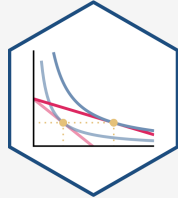
Opportunity Costs vs. Sunk Costs



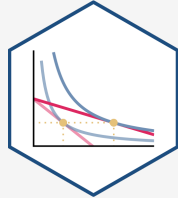
- Opportunity cost is a *forward-looking* concept
- Choices made in the *past* with *non-recoverable* costs are called **sunk costs**
- Sunk costs *should not* enter into future decisions
- Many people have difficulty letting go of unchangeable past decisions: **sunk cost fallacy**



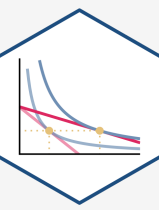
Sunk Costs: Examples



Sunks Costs: Examples



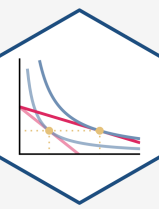
Common Sunk Costs in Business



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



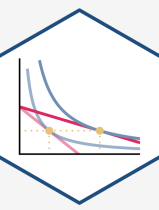
The Accounting vs. Economic Point of View I



- 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?

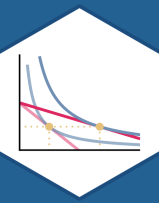


The Accounting vs. Economic Point of View II



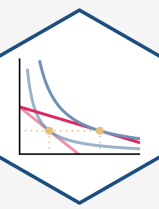
- **Social implications:** are consumers *best* off with you using scarce resources (with alternative uses!) to produce your current product?
- Remember: **this is an *economics* course, not a *business* course!**
 - What might be good/bad for one business might have bad/good *consequences* for society!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

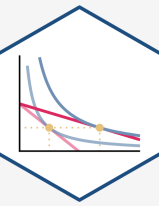
1. Fixed costs, f are costs that do not vary with output

- 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

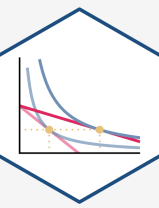


Example: Airlines

Fixed costs: the aircraft

Variable costs: getting one more customer in a seat

Fixed vs. Variable costs: Examples

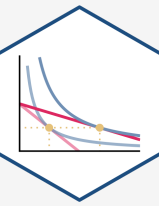


Example: Car Factory

Fixed costs: the factory, machines in the factory

Variable costs: producing one more car

Fixed vs. Variable costs: Examples

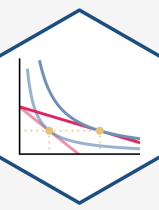


Example: Starbucks

Fixed costs: the retail space

Variable costs: selling one more cup of coffee

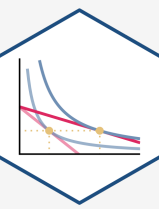
Fixed vs. Sunk costs



- 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

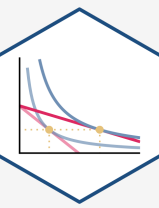


Example: Suppose your firm has the following total cost function:

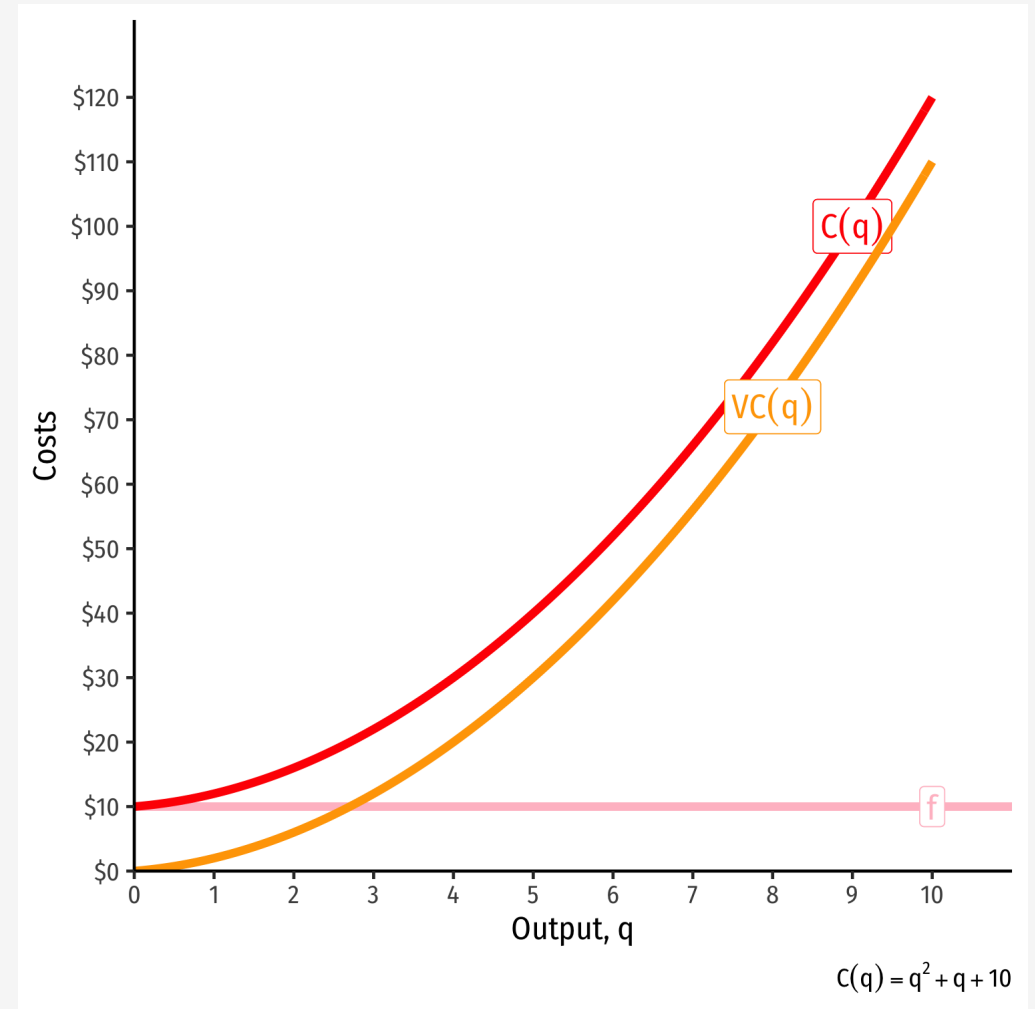
$$C(q) = q^2 + q + 10$$

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

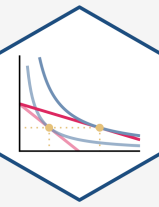
Cost Functions: Example, Visualized



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:

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

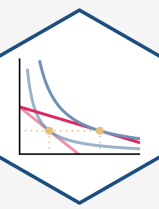
- **Average Variable Cost:** variable cost per unit of output:

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

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

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

Marginal Cost

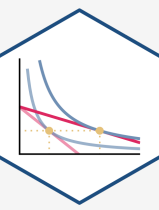


- **Marginal Cost** is the change in cost for each additional unit of output produced:

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

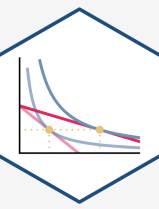
- Calculus: first derivative of the cost function
- **Marginal cost is the *primary* cost that matters in making decisions**
 - All other costs are driven by marginal costs
 - This is the main cost that firms can "see"

The Importance of Marginal Cost



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

Average and Marginal Costs: Example

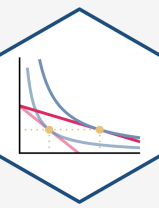


Example: A small farm grows strawberries on 5 acres of land that it rents for \$200 a week. The farm can hire workers at a wage of \$250/week for each worker. The table below shows how the output of strawberries (in truckloads) varies with the number of workers hired:

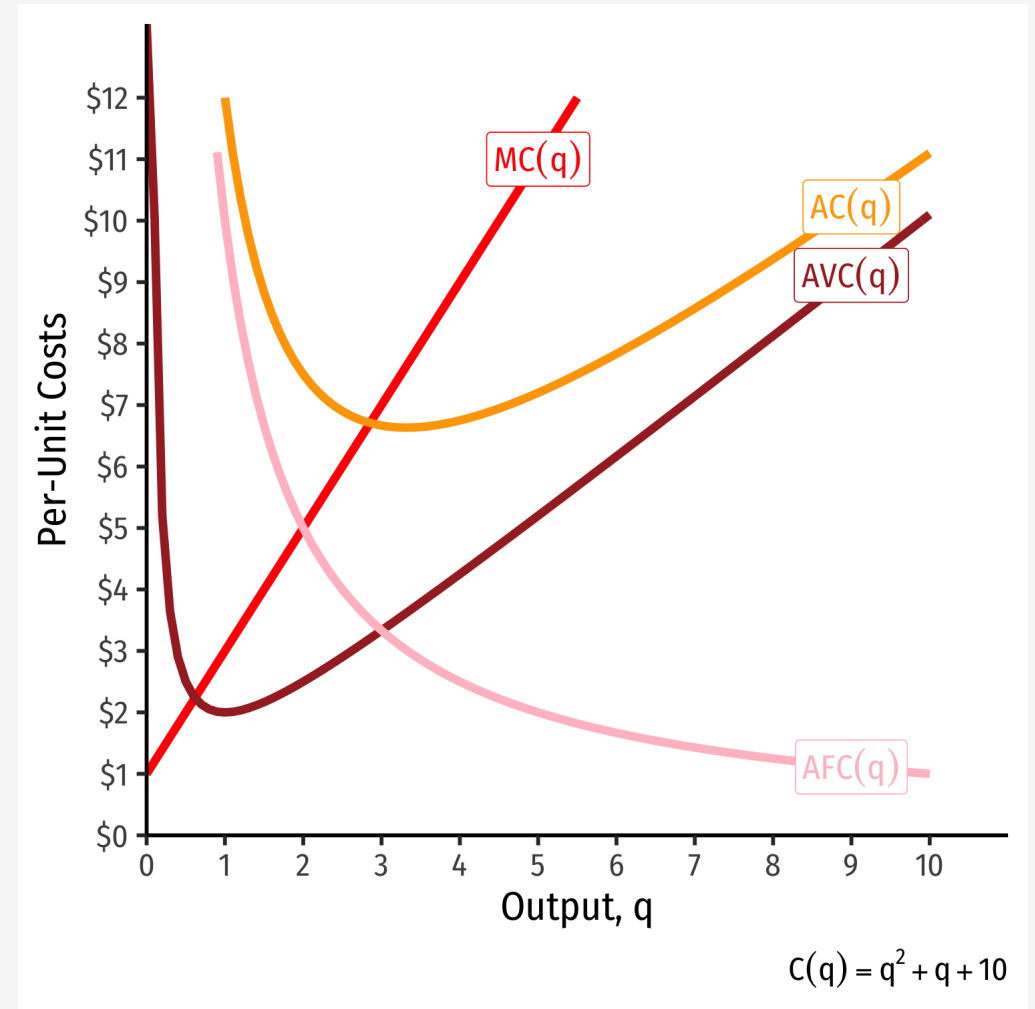
Output	Labor
0	0
1	1
2	3
3	7
4	12
5	18

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

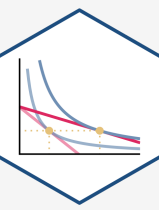
Average and Marginal Costs: Visualized



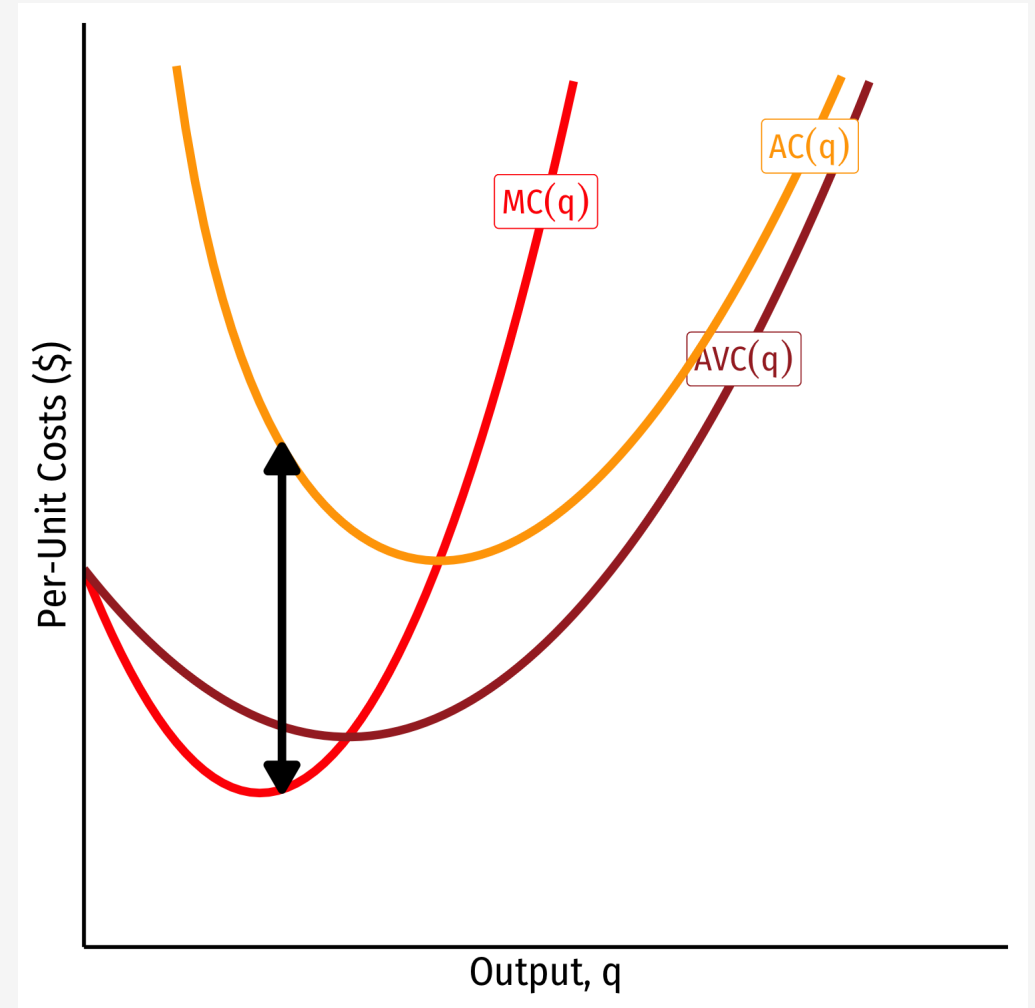
q	$C(q)$	$MC(q)$	$AFC(q)$	$AVC(q)$	$AC(q)$
0	10	—	—	—	—
1	12	2	10.00	2	12.00
2	16	4	5.00	3	8.00
3	22	6	3.33	4	7.30
4	30	8	2.50	5	7.50
5	40	10	2.00	6	8.00
6	52	12	1.67	7	8.70
7	66	14	1.43	8	9.40
8	82	16	1.25	9	10.25
9	100	18	1.11	10	11.10



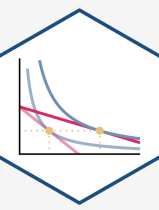
Relationship Between Marginal and Average



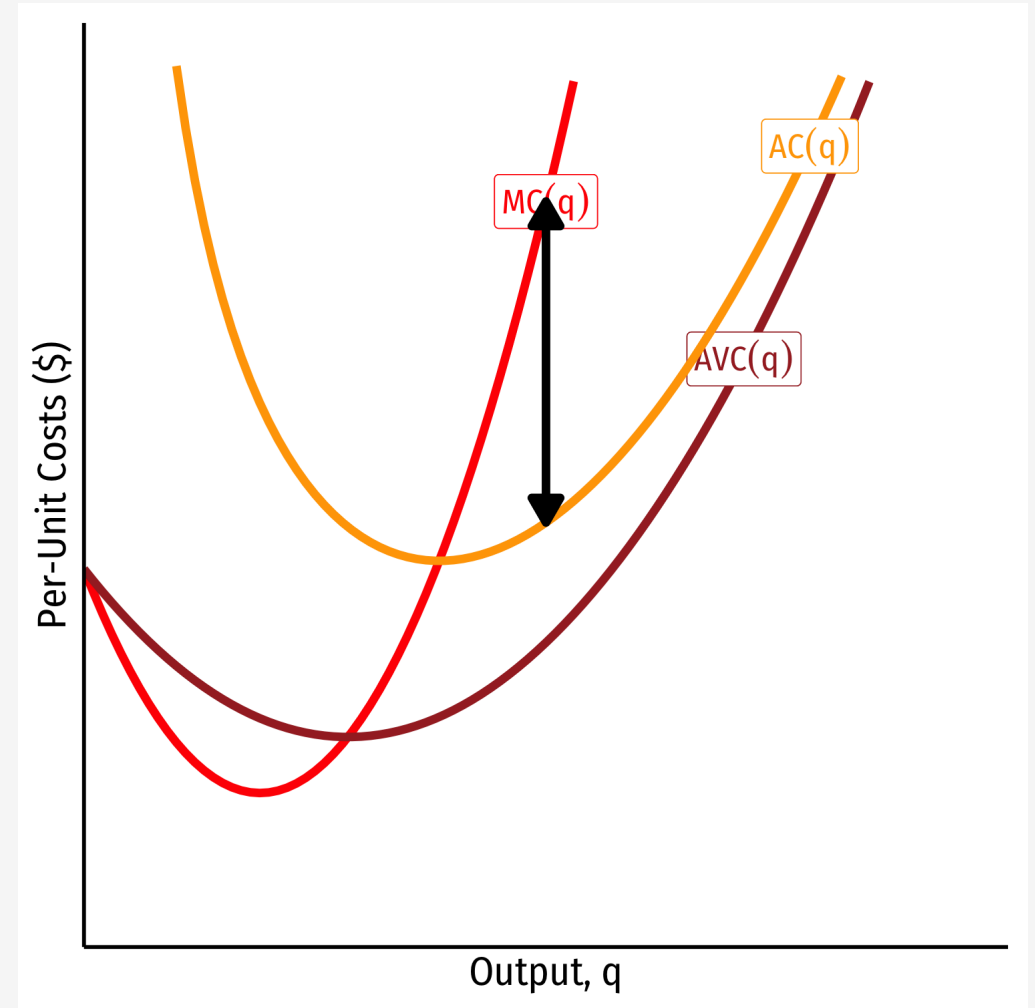
- Relationship between a marginal and an average value:
- $\text{marginal} < \text{average}$, average \downarrow



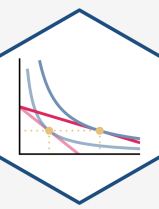
Relationship Between Marginal and Average



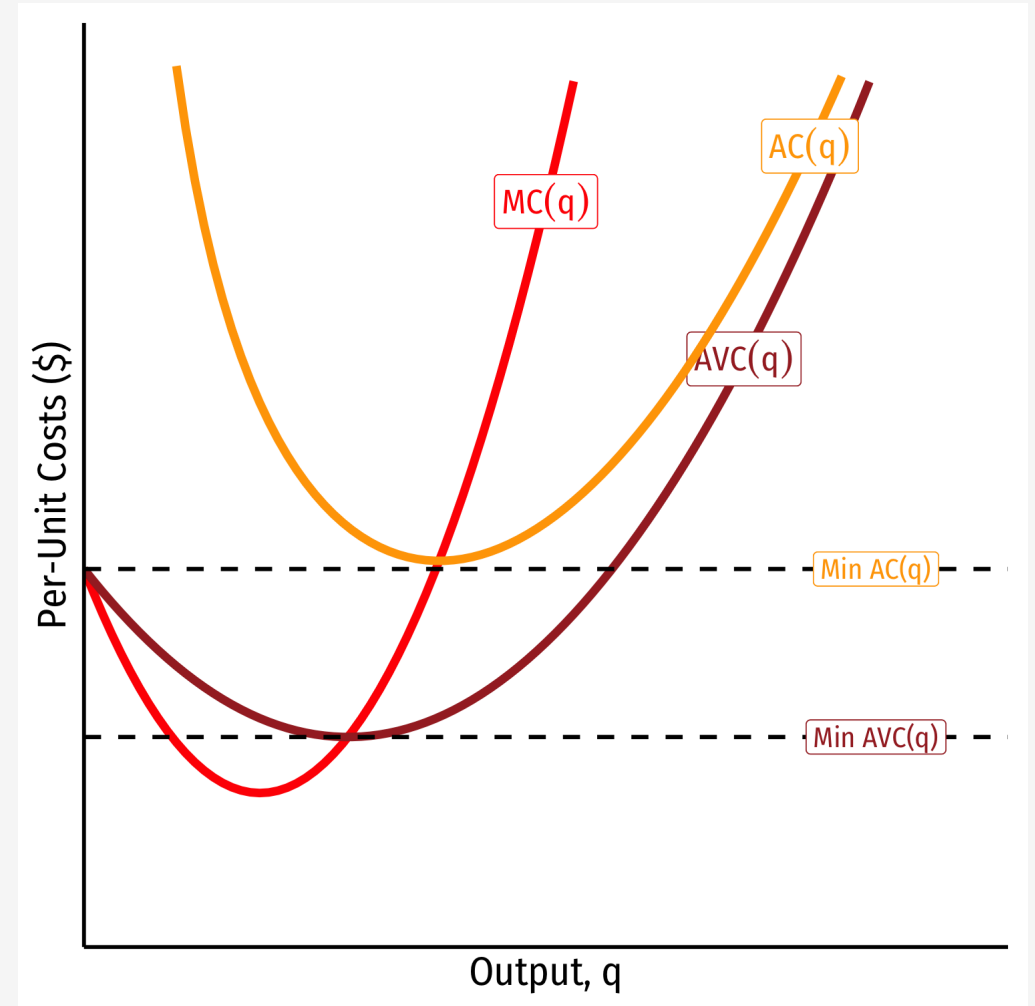
- Relationship between a marginal and an average value:
- $\text{marginal} < \text{average}$, average \downarrow
- $\text{marginal} > \text{average}$, average \uparrow



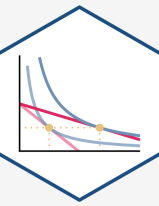
Relationship Between Marginal and Average



- Relationship between a marginal and an average value:
- $\text{marginal} < \text{average}$, average \downarrow
- $\text{marginal} > \text{average}$, average \uparrow
- When $\text{marginal} = \text{average}$, 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

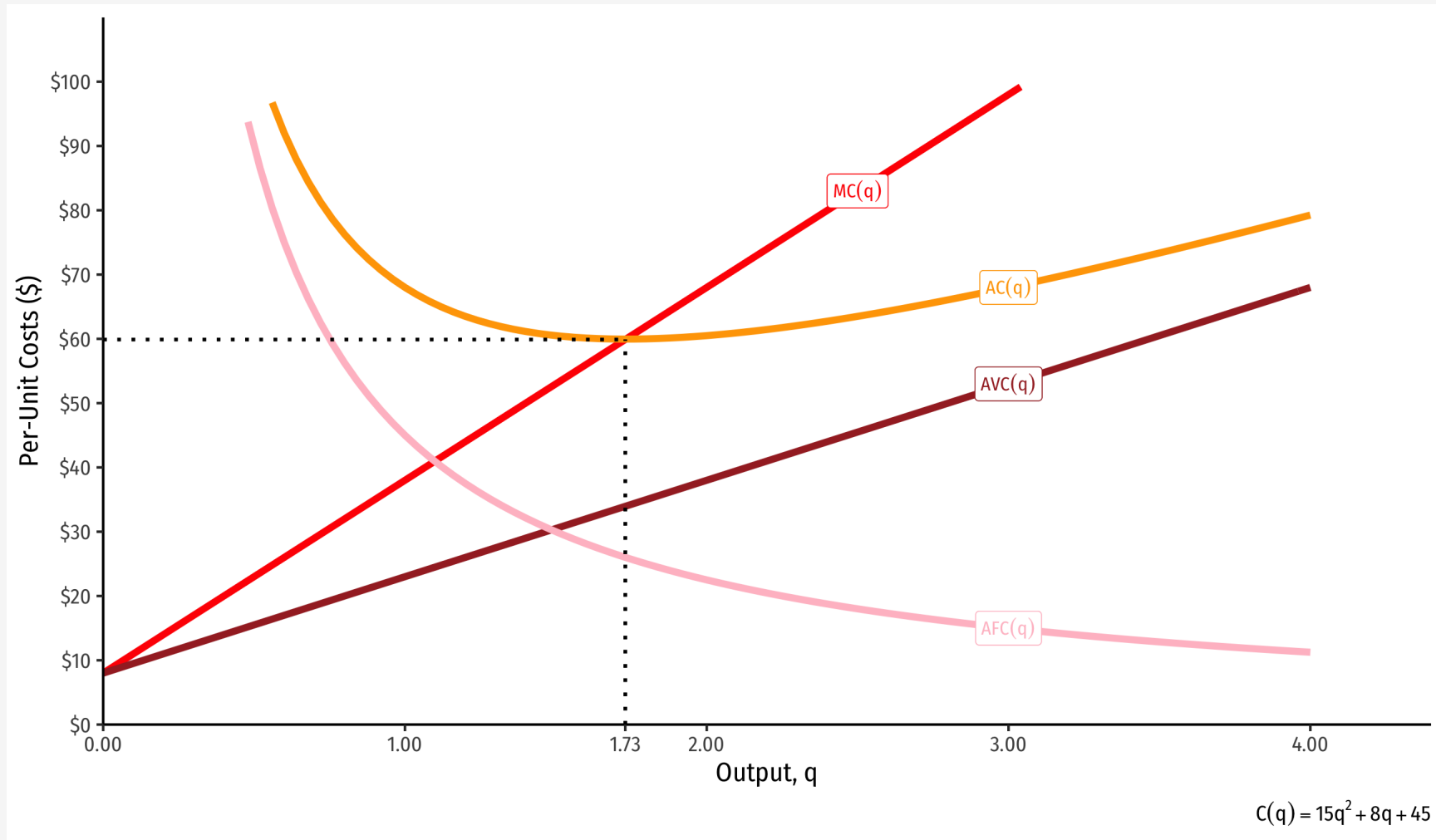
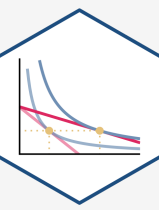


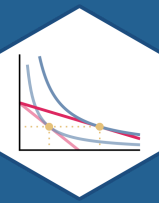
Example: Suppose a firm's cost structure is described by:

$$C(q) = 15q^2 + 8q + 45$$
$$MC(q) = 30q + 8$$

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.

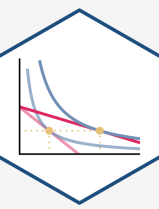
Costs: Example: Visualized





Costs in the Long Run

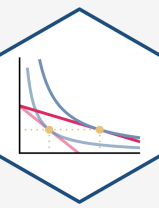
Costs in the Long Run



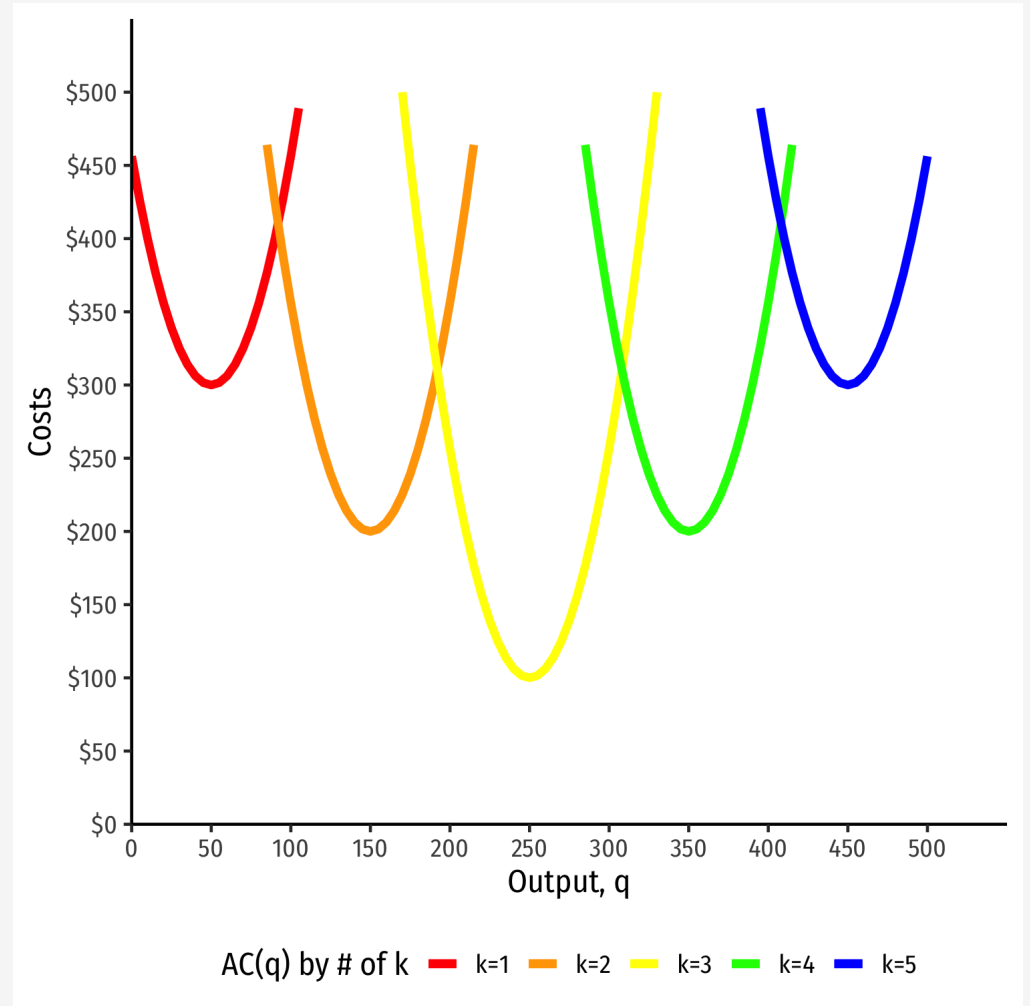
- **Long run:** firm can change all factors of production & vary scale of production
- **Long run average cost, LRAC(q):** cost per unit of output when the firm can change *both* l and k to make more q
- **Long run marginal cost, LRMC(q):** change in long run total cost as the firm produce an additional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



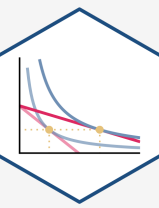
Average Cost in the Long Run



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

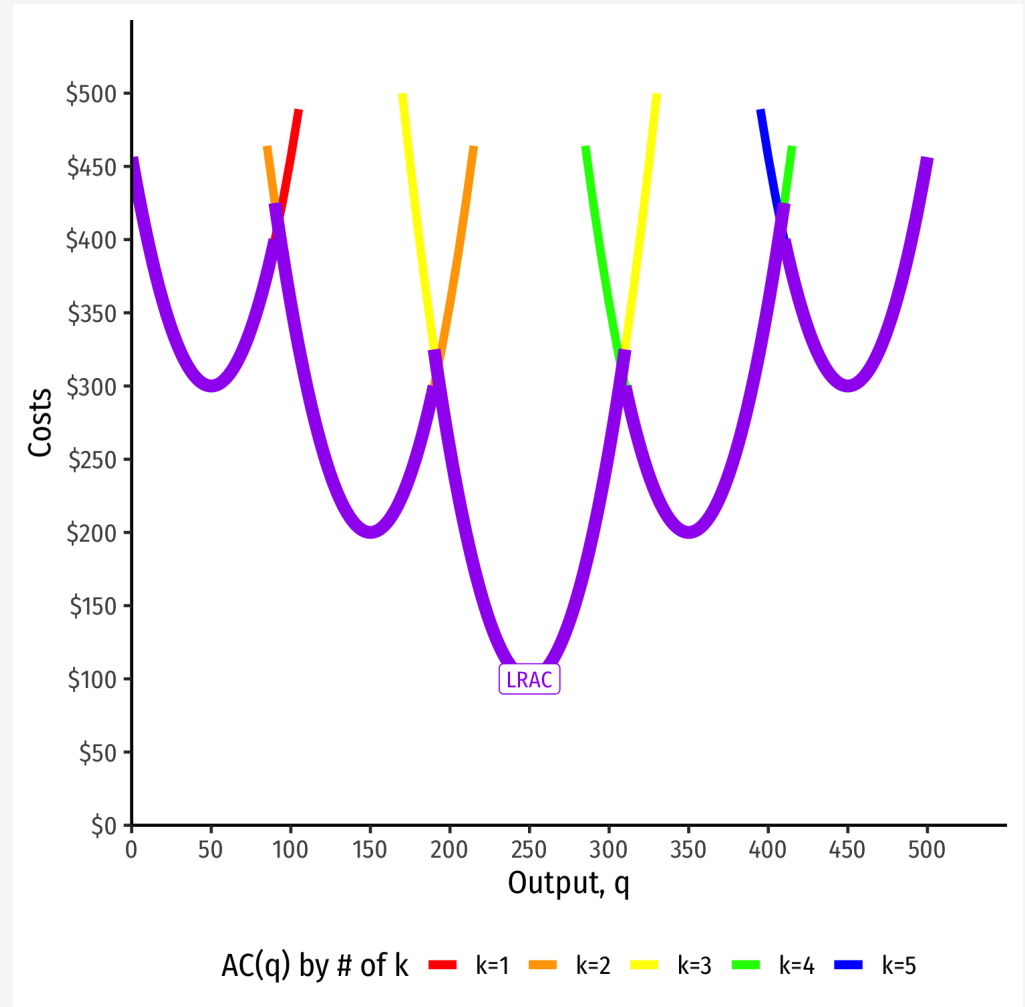


Average Cost in the Long Run

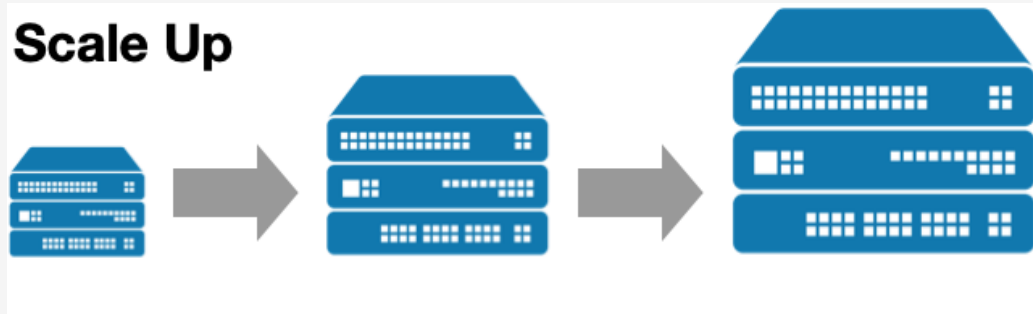
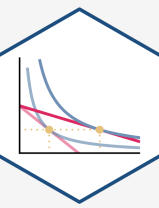


- **Long run:** firm can choose k (factories, locations, etc)
- Separate short run average cost (SRAC) curves for each amount of k potentially chosen
- **Long run average cost (LRAC)** curve "envelopes" the lowest (optimal) parts of all the SRAC curves!

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

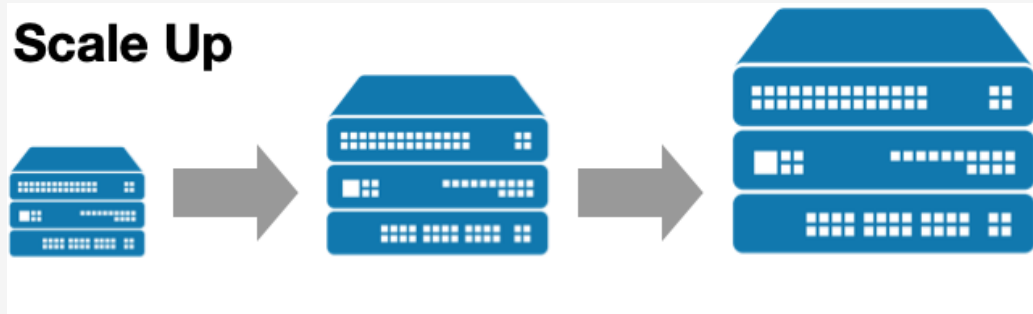
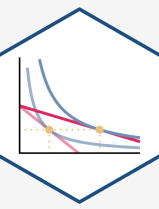


Long Run Costs & Scale Economies I



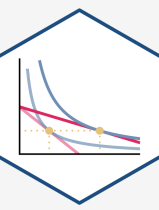
- Further properties about costs based on **scale economies** of production:
- **Economies of scale**: costs fall with output
 - $AFC > AVC(q)$
- **Diseconomies of scale**: costs rise with output
 - $AFC < AVC(q)$
- **Constant economies of scale**: costs don't change with output

Long Run Costs & Scale Economies I

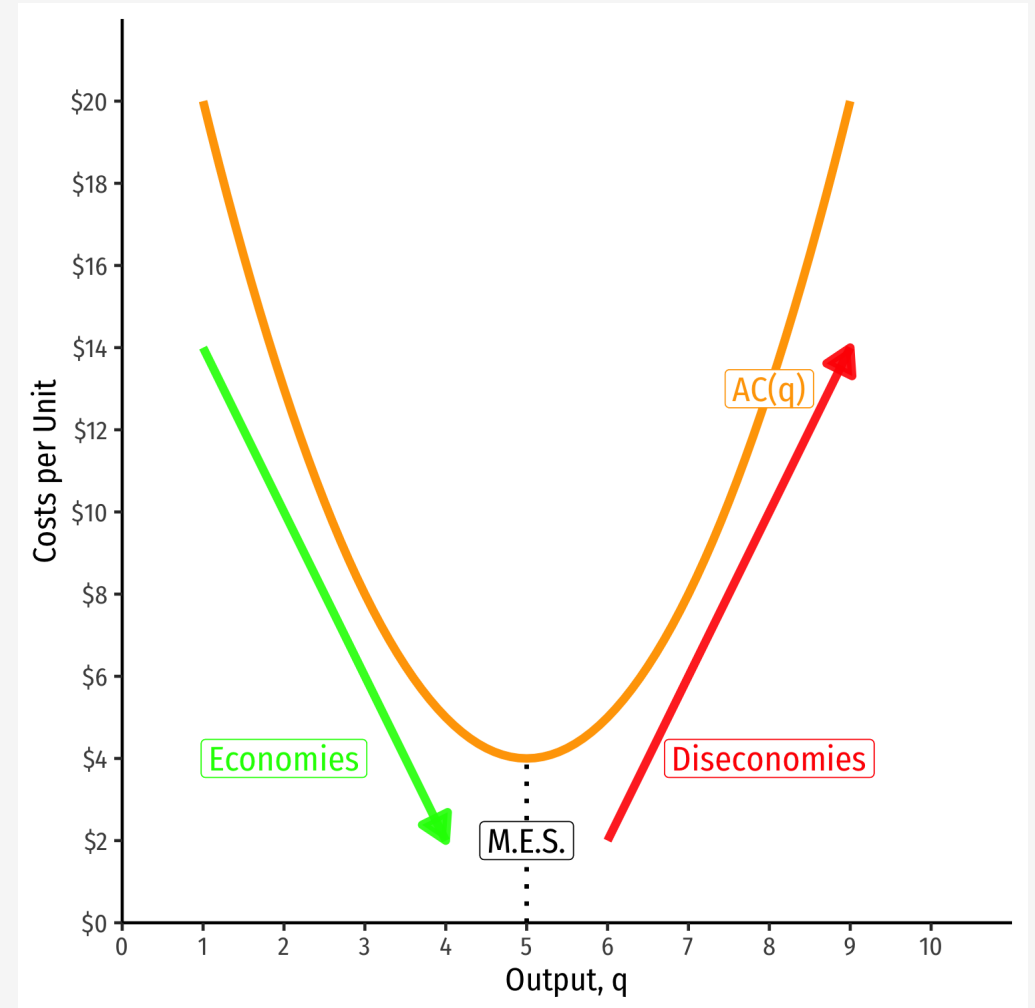


- Note **economies of scale** \neq **returns to scale**!
- **Returns to Scale** (last class): a **technological** relationship between inputs & output
- **Economies of Scale** (this class): an **economic** relationship between output and average costs

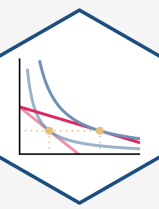
Long Run Costs & Scale Economies II



- **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

