2.4 — Costs of Production

ECON 306 • Microeconomic Analysis • Fall 2021

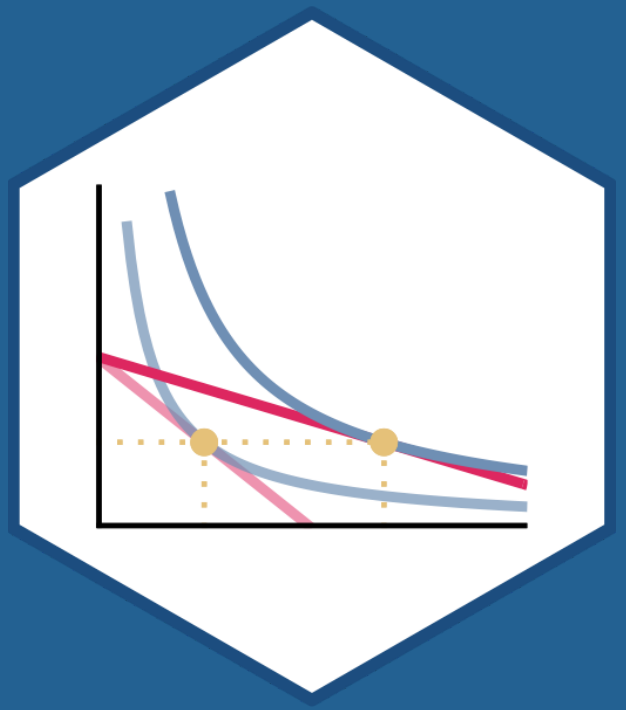
Ryan Safner

Assistant Professor of Economics

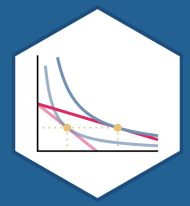
safner@hood.edu

ryansafner/microF21

microF21.classes.ryansafner.com



Outline



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:

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

- We'll first take a closer look at **costs** today

- Next class we'll put costs together with revenues to find optimal q^* that maximizes π (the first stage problem)

Opportunity Costs in Production

Production Costs are Opportunity Costs

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

Production Costs are Opportunity Costs

- This leads to the difference between
  - **Accounting profit**: revenues minus accounting costs
  - **Economic profit**: revenues minus accounting & *opportunity* costs
- A really difficult concept to think about!

Production Costs 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

A Reminder: It's Demand all the Way Down!

- **Supply** is actually **Demand** in disguise!
- The **(opportunity) cost** producers must pay to purchase (scarce) inputs to produce products comes from the fact that **other people demand** those same inputs to consume or produce **other things** for other purposes!
    - You are not paying the price just to buy them, but also to **pull them out of other valuable lines of production** in the economy!

Production Costs 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!

Production Costs are Opportunity Costs

- 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

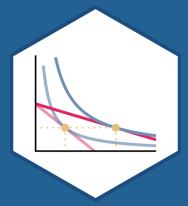
    - i.e. are there higher-valued uses of your resources you are keeping them out of?

The Accounting vs. Economic Point of View II

- **Implications for society**: are consumers *best* off with you using scarce resources (with alternative uses!) to produce your current product?

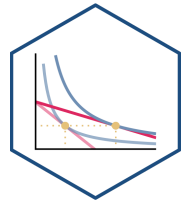
- Remember: **this is an *economics* course, not a *business* course**!

    - **Economists are pro-market, *not* pro-business!**
    - What might be good/bad for **one** business might have bad/good *consequences* for society!



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

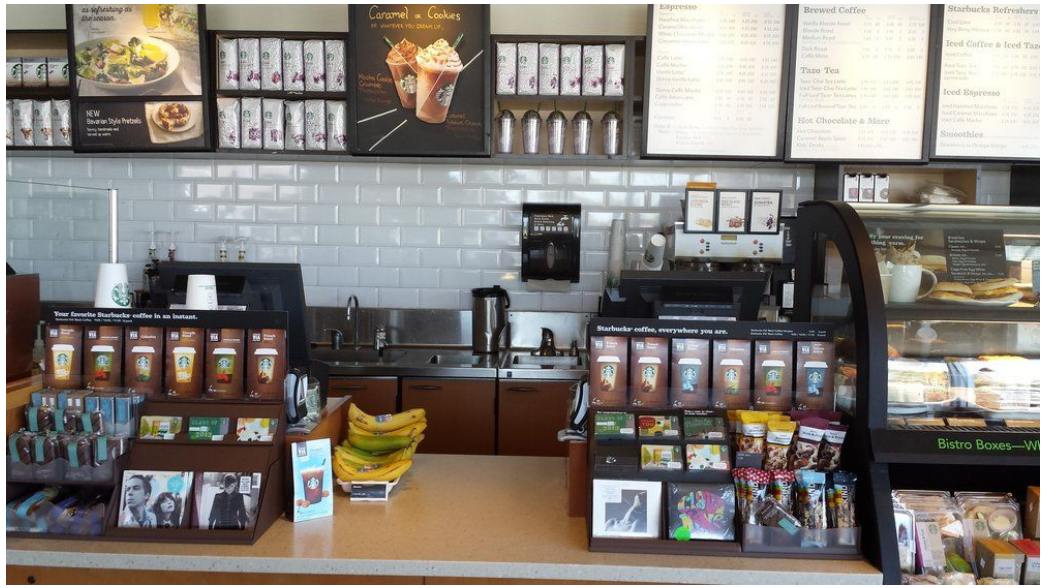
Fixed vs. Variable costs: Examples

Example: Car Factory

Fixed costs: the factory, machines in the factory

Variable costs: producing one more car

Fixed vs. Variable costs: Examples



Example: Starbucks

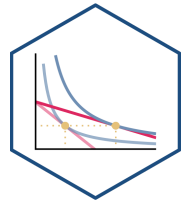
Fixed costs: the retail space

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:

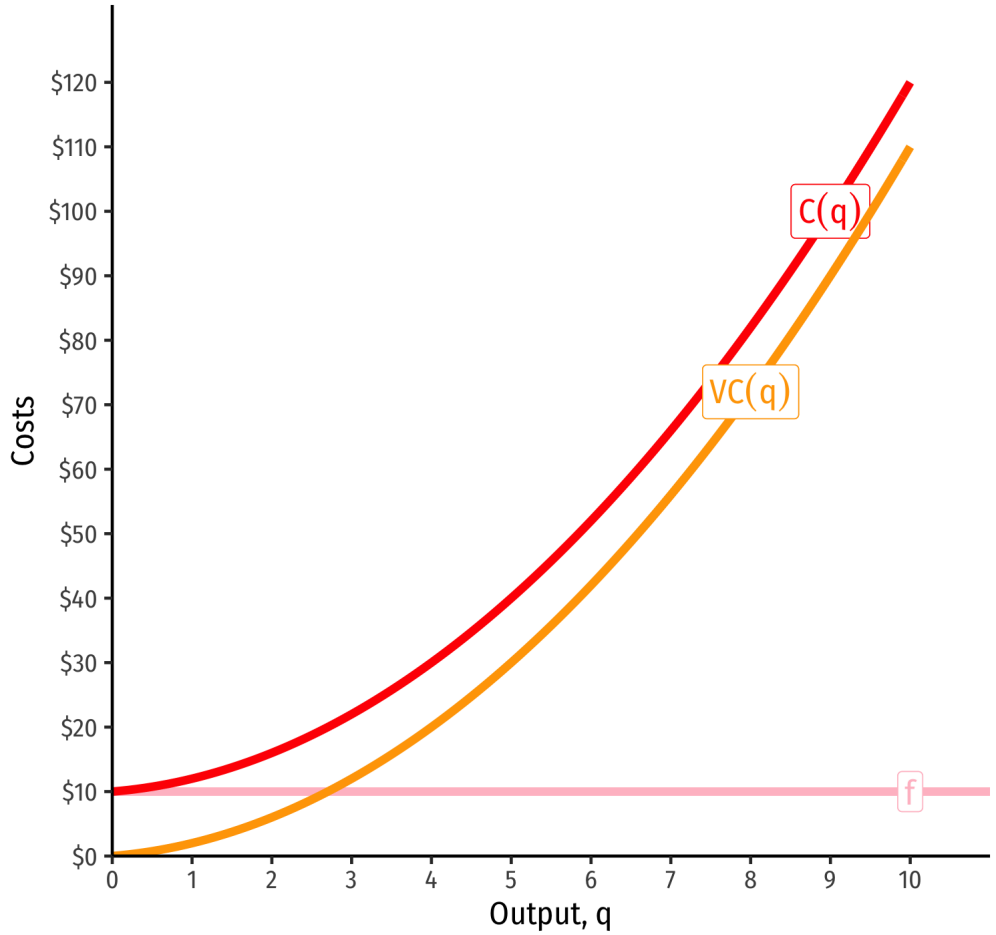
$$C(q) = q^2 + q + 10$$

1. Write a function for the fixed costs, f.

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

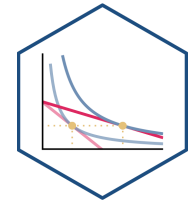
Cost Functions: Example, Visualized

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
10	10	110	120



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

Average Costs



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

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

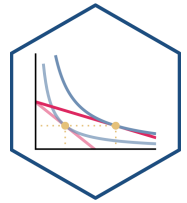
- **Average Variable Cost**: variable cost per unit of output:

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

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

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

Marginal Cost



- **Marginal Cost** is the change in total 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

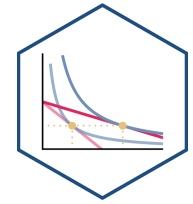
- **Marginal cost is the *primary* cost that matters in making decisions**

  - 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



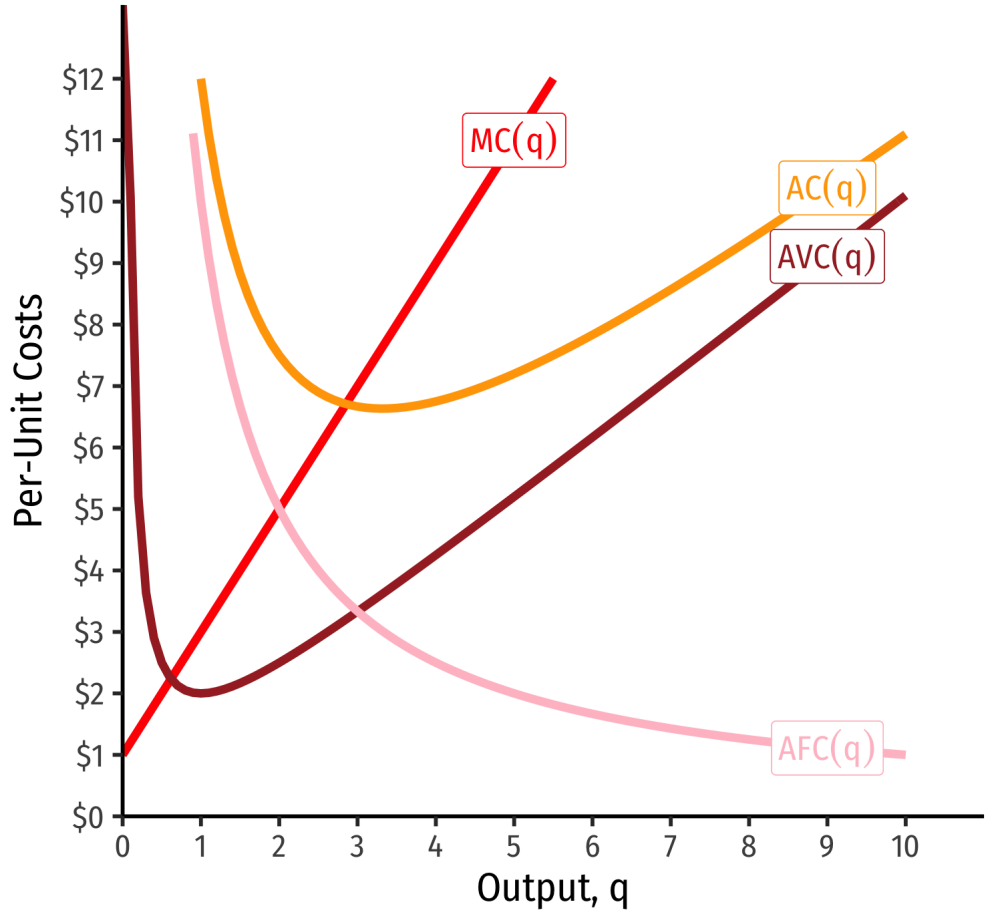
Example: A small farm grows strawberries on 5 acres of land that it rents for $200 a week. The farm can hire workers at a wage of $250/week for each worker. The table below shows how the output of strawberries (in truckloads) varies with the number of workers hired:

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

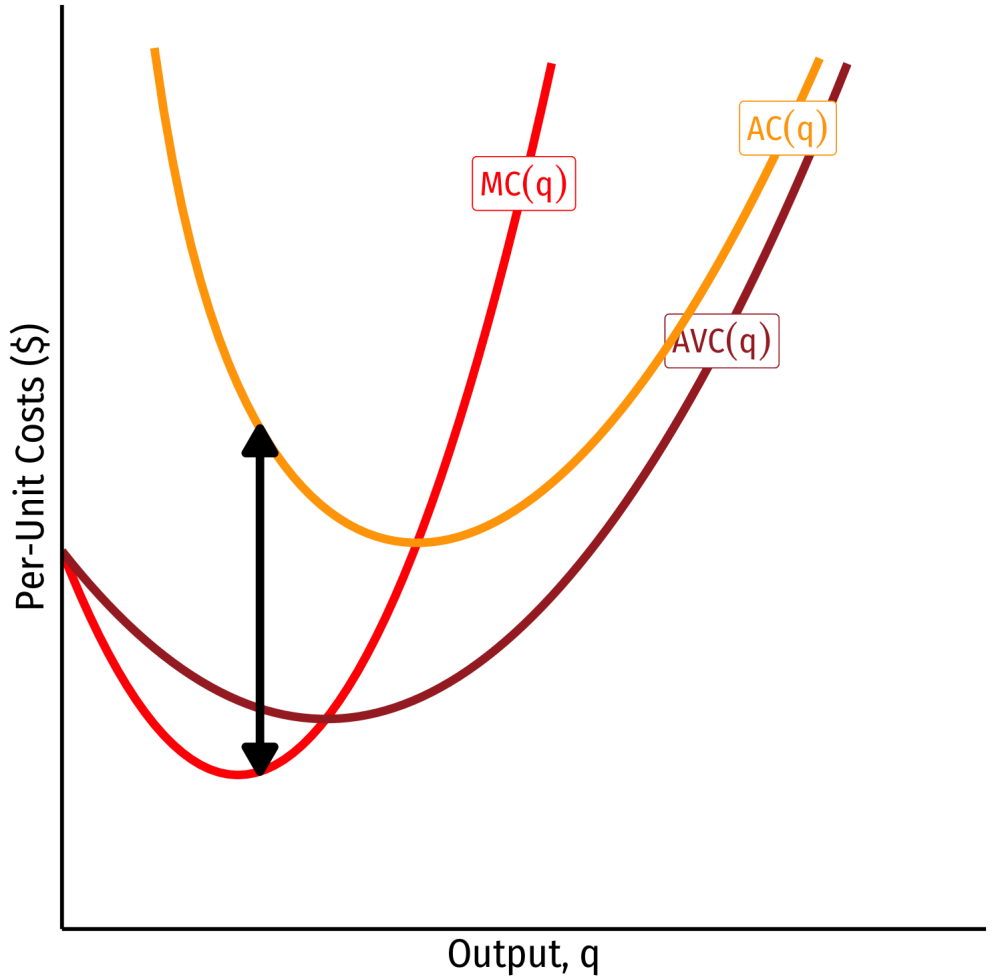
q	$C(q)$	$MC(q)$	$AFC(q)$	$AVC(q)$	$AC(q)$
0	10	–	–	–	–
1	12	2	10.00	2	12.00
2	16	4	5.00	3	8.00
3	22	6	3.33	4	7.30
4	30	8	2.50	5	7.50
5	40	10	2.00	6	8.00
6	52	12	1.67	7	8.70
7	66	14	1.43	8	9.40
8	82	16	1.25	9	10.25
9	100	18	1.11	10	11.10
10	120	20	1.00	11	12.00



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

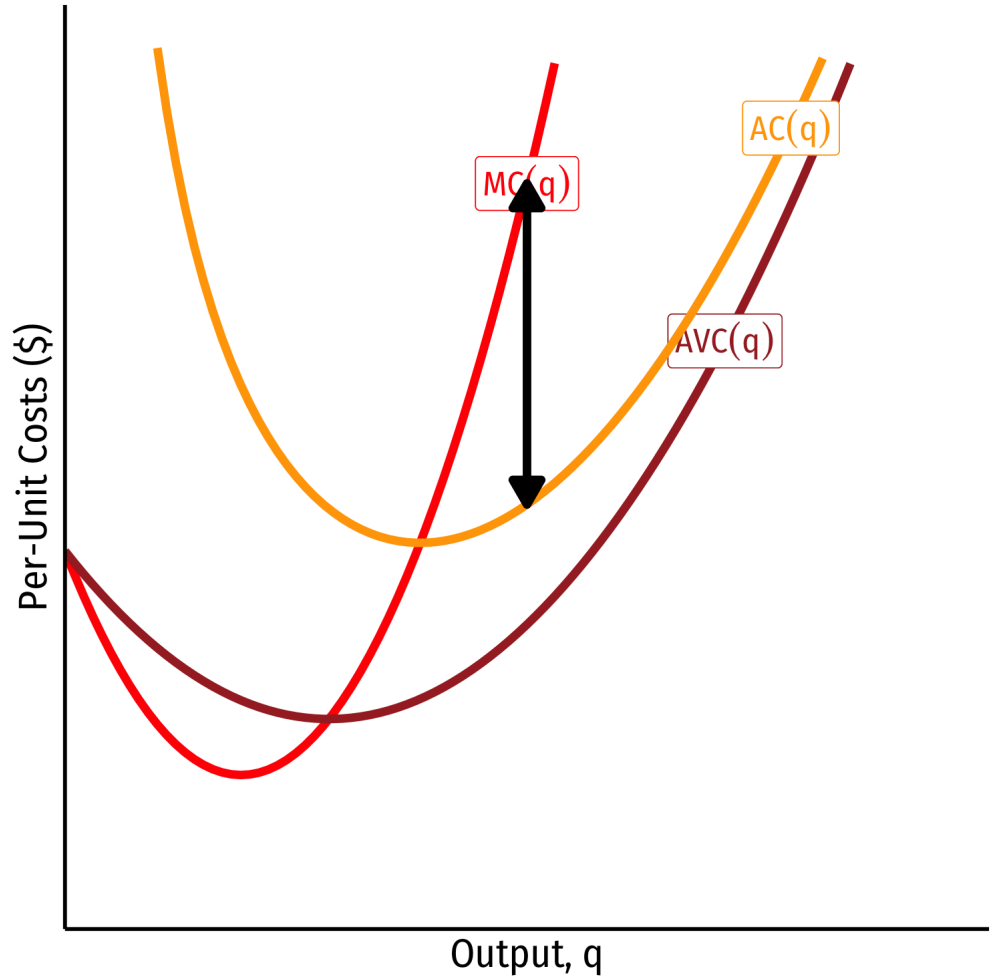
Relationship Between Marginal and Average

- Mathematical relationship between a marginal & an average value
- If marginal $<$ average, then average $\downarrow$



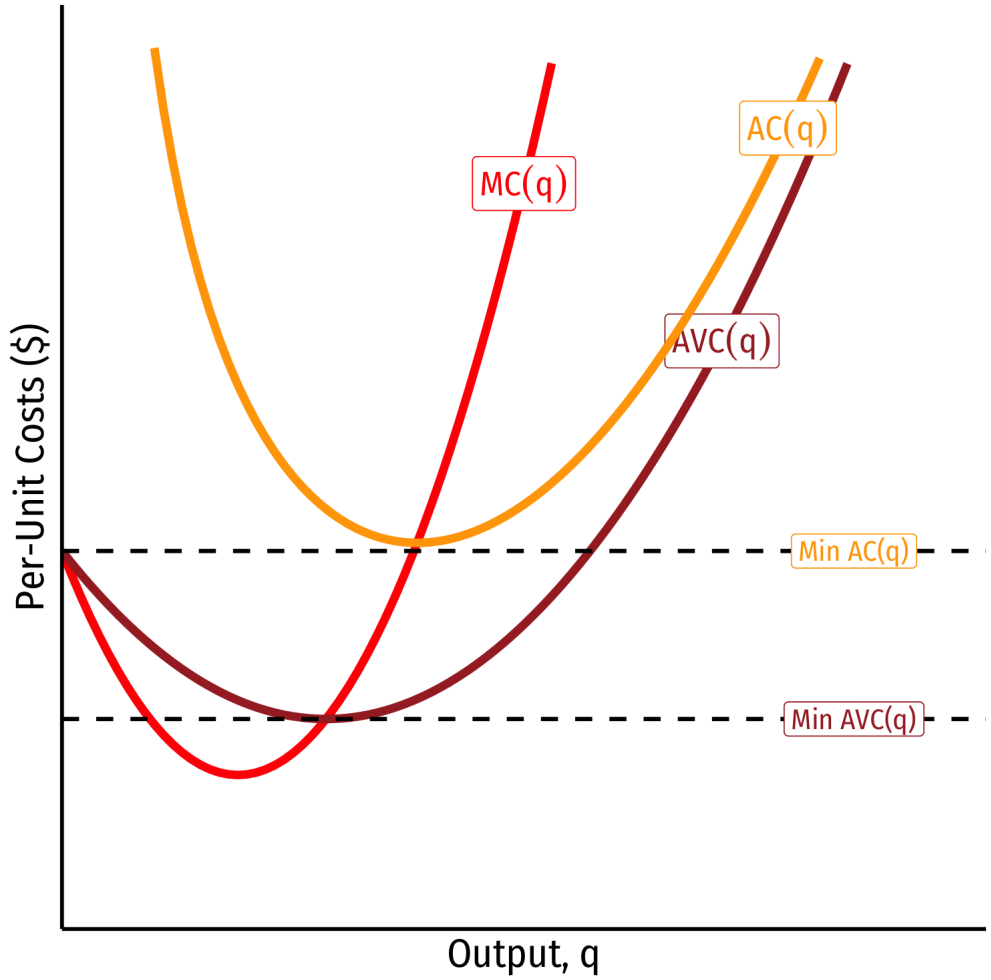
Relationship Between Marginal and Average

- Mathematical relationship between a marginal & an average value
- If marginal $<$ average, then average $\downarrow$
- If marginal $>$ average, then average $\uparrow$

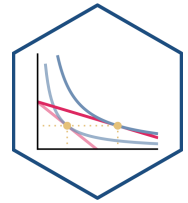


Relationship Between Marginal and Average

- Mathematical relationship between a marginal & an average value
- If marginal $<$ average, then average $\downarrow$
- If marginal $>$ average, then average $\uparrow$
- 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 & shut-down price



Short Run Costs: Example



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

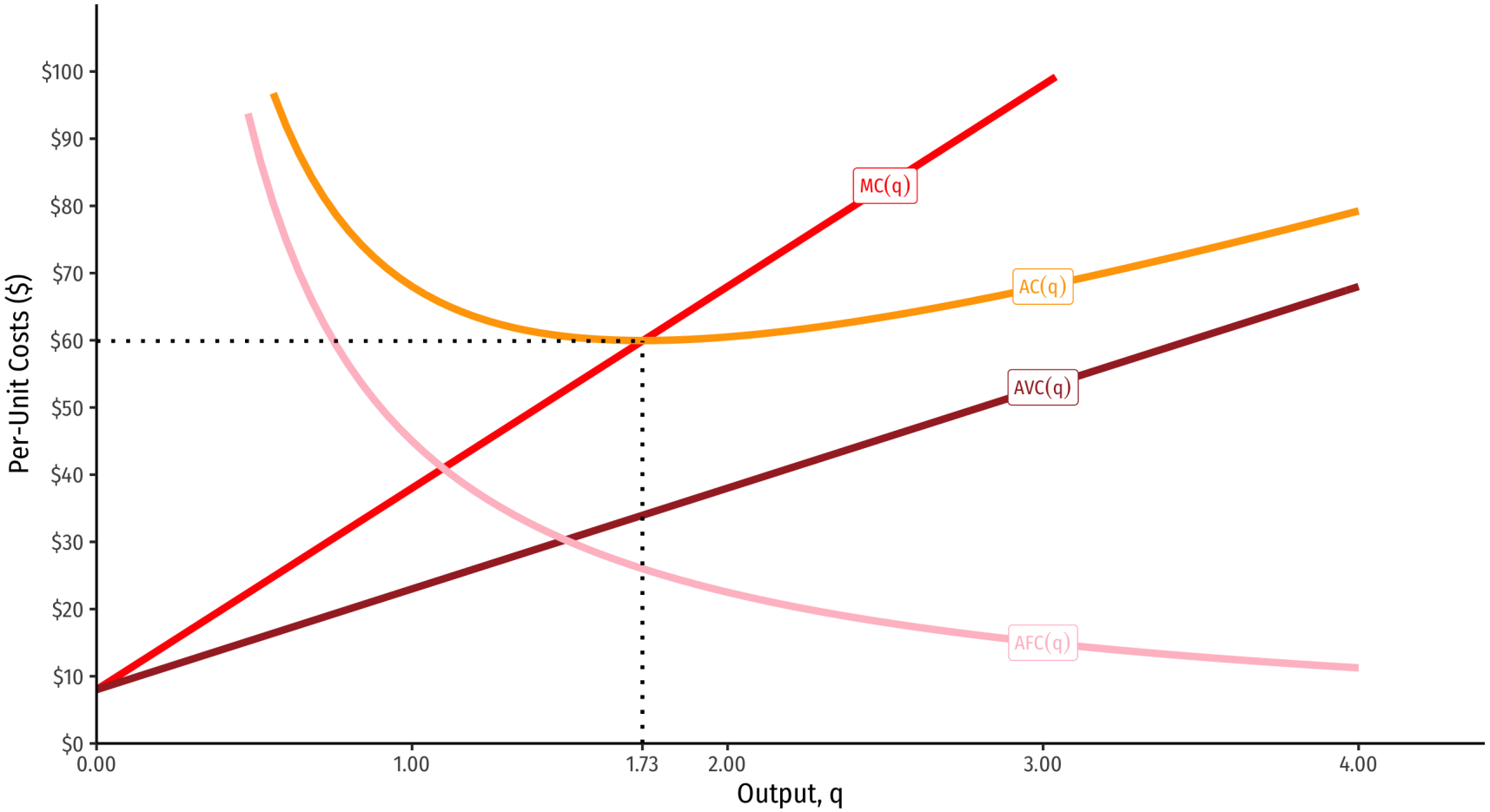
$$C(q) = 15q^2 + 8q + 45$$
$$MC(q) = 30q + 8$$

1. Write expressions for the firm's **fixed costs**, **variable costs**, **average fixed costs**, **average variable costs**, and **average (total) costs**.

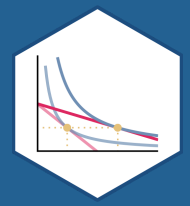
2. Find the minimum average (total) cost.

3. Find the minimum average variable cost.

Costs: Example: Visualized



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



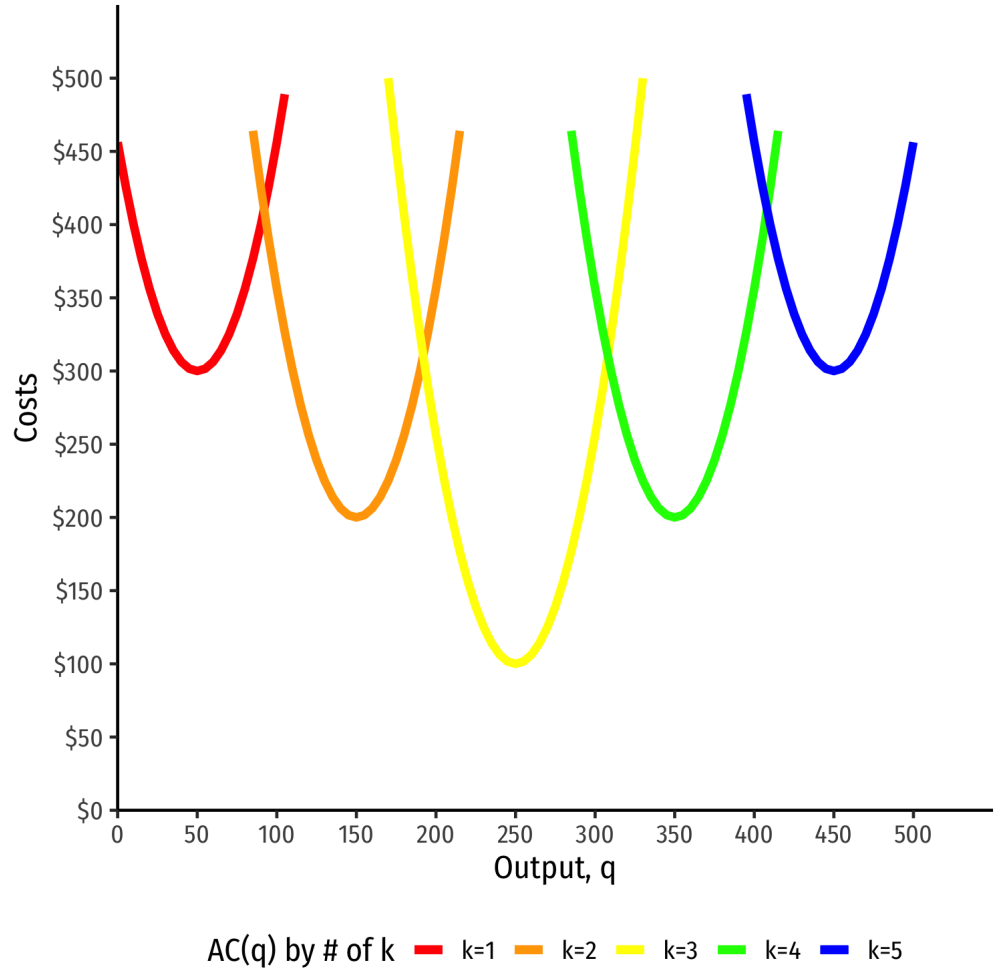
Costs in the Long Run

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

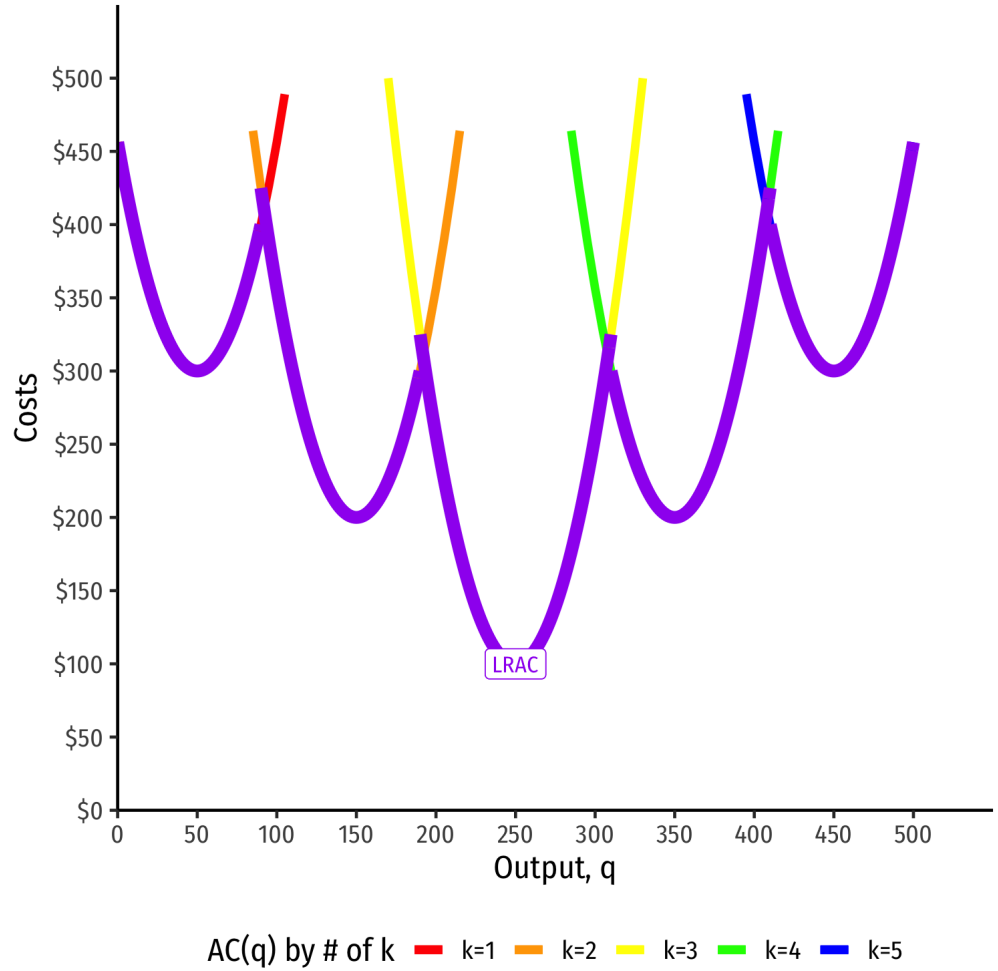
- **Long run**: firm can choose k (factories, locations, etc)
- Separate short run average cost (SRAC) curves for each amount of k potentially chosen



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

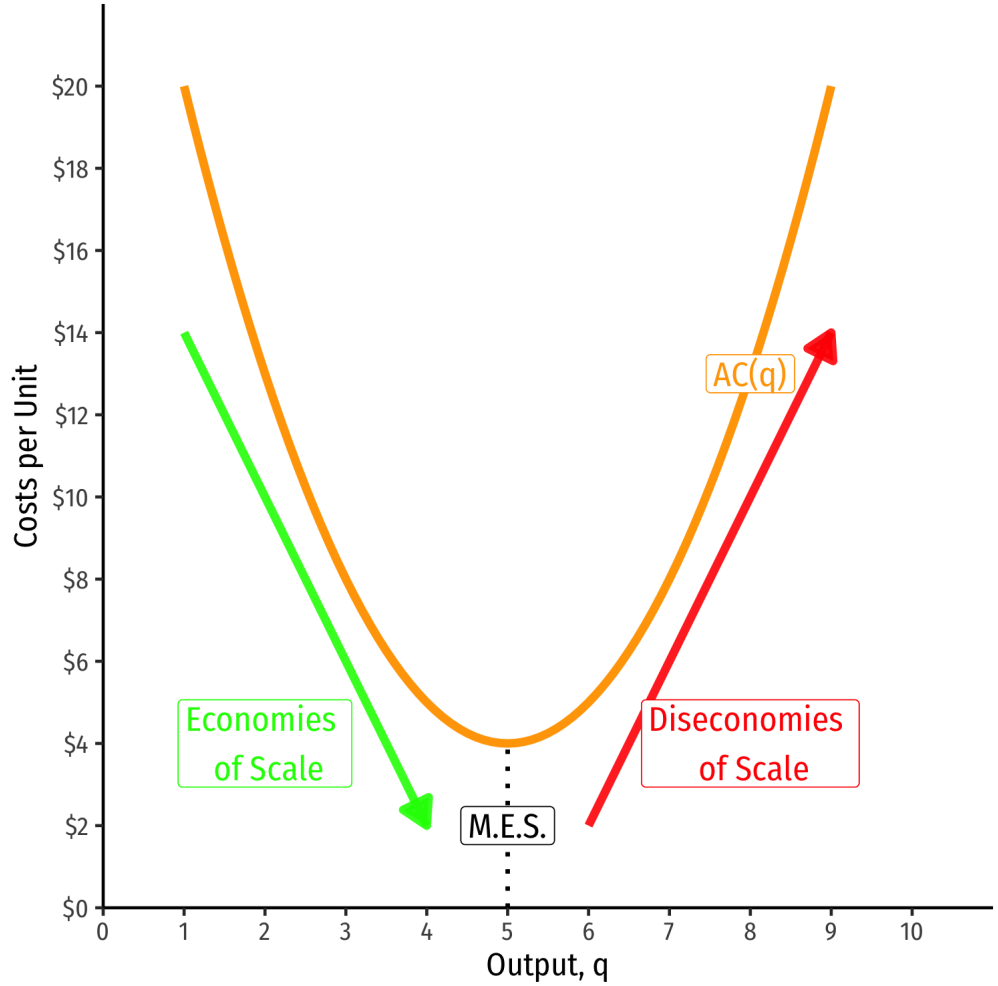
- Further important properties about costs based on **scale economies** of production: change in **average costs** when output is increased (scaled)
- **Economies of scale**: average costs **fall** with more output
  - High fixed costs $AFC > AVC(q)$ low variable costs
- **Diseconomies of scale**: average costs **rise** with more output
  - Low fixed costs $AFC < AVC(q)$ high variable costs
- **Constant economies of scale**: average costs **don't change** with more output
  - Firm at minimum average cost (optimal plant size), called **minimum efficient scale (MES)**

Long Run Costs & Scale Economies I

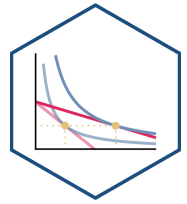
- Note **economies of scale** ≠ **returns to scale**!
- **Returns to Scale** (last class): a **technological** relationship between *inputs* & *output*
- **Economies of Scale** (this class): an **economic** relationship between *output* and *average costs*

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

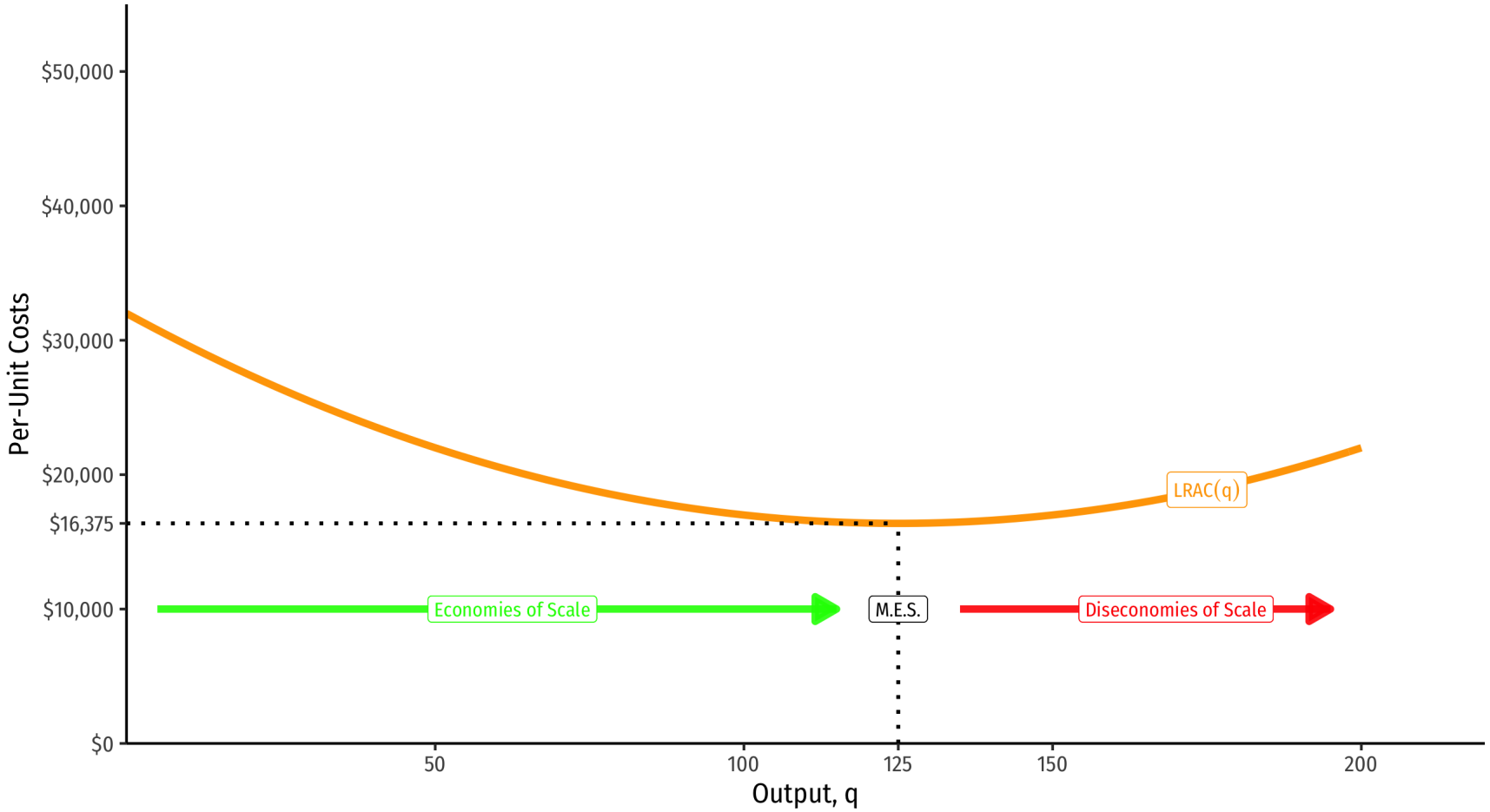


Example: A firm's long run cost structure is as follows:

$$LRC(q) = 32000q - 250q^2 + q^3$$
$$LRMC(q) = 32000 - 500q + 3q^2$$

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



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