2.5 — Short Run Profit Maximization

ECON 306 • Microeconomic Analysis • Fall 2022

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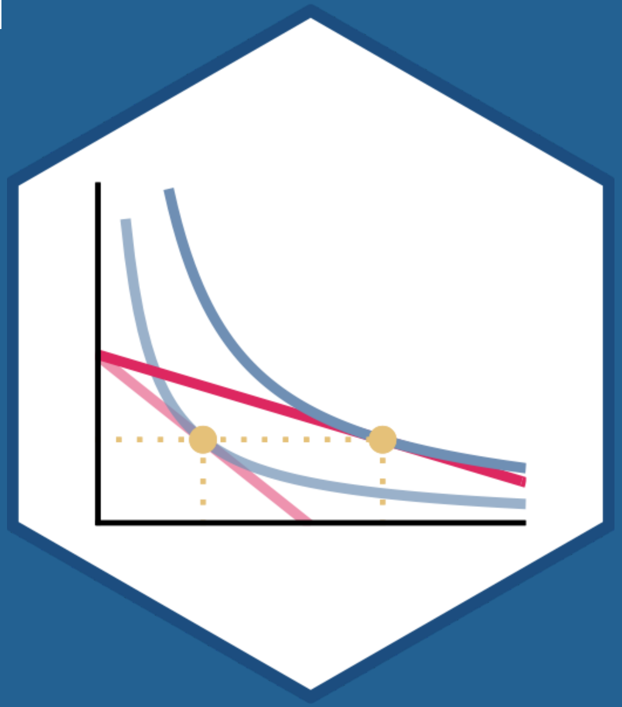
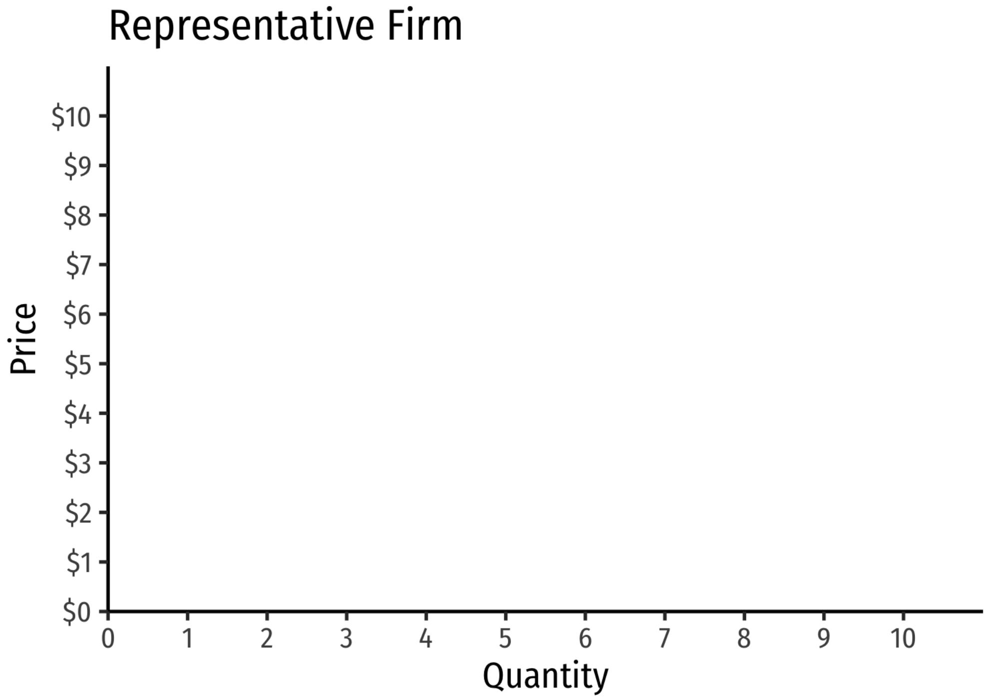
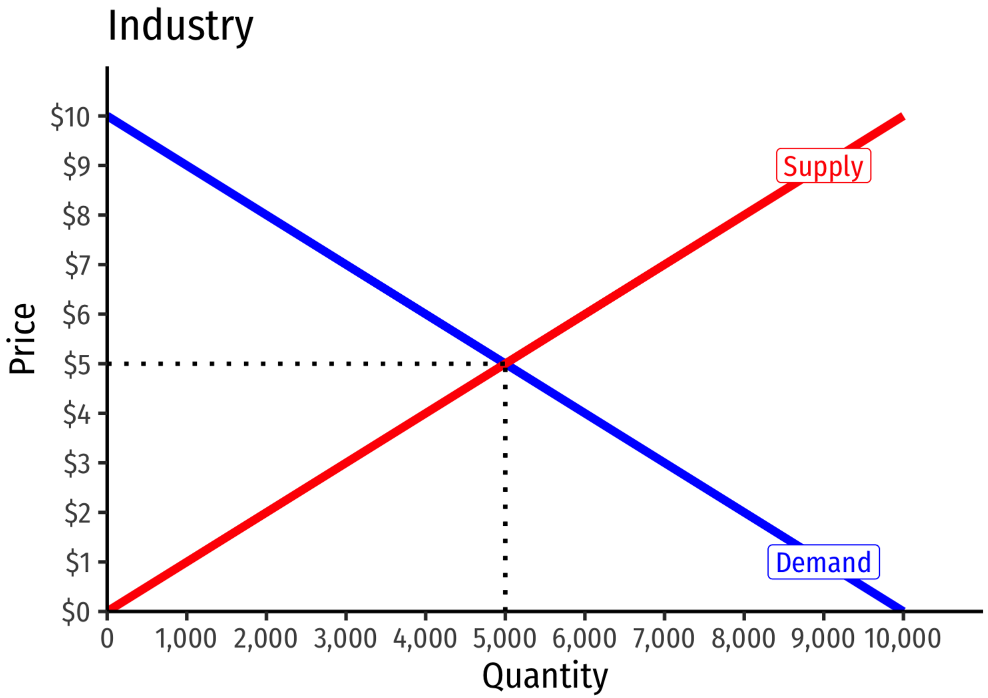


Outline

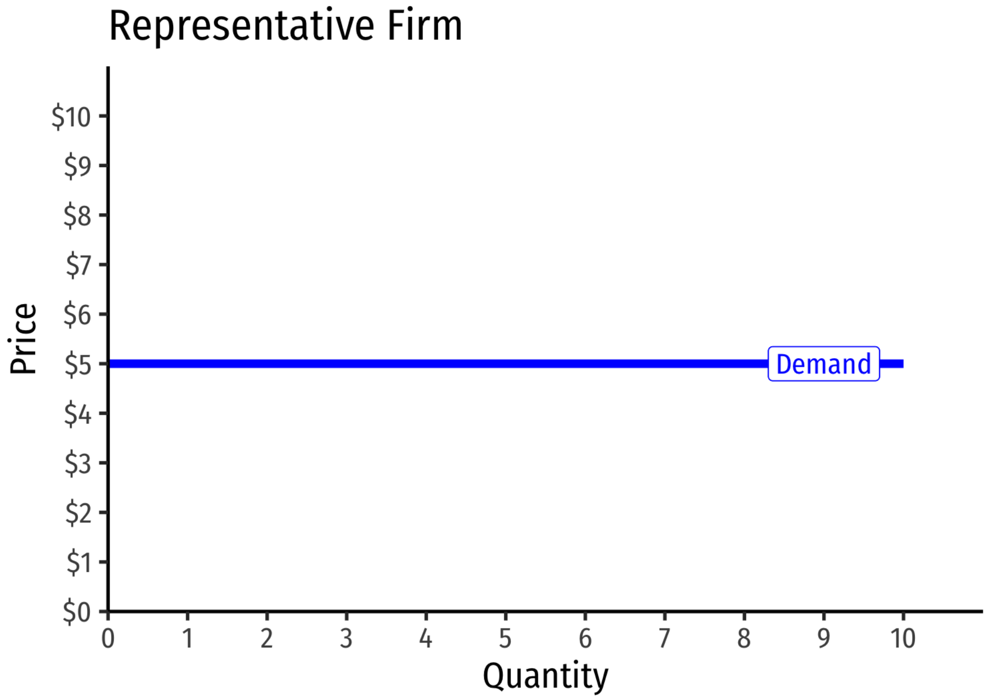
Revenues

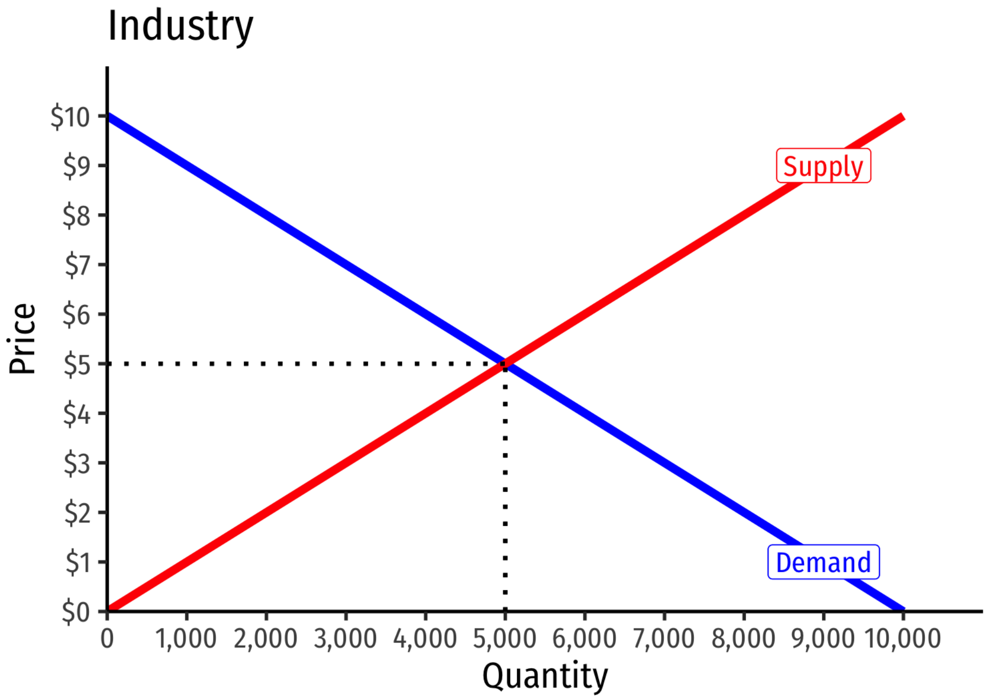
Revenues for Firms in *Competitive* Industries I





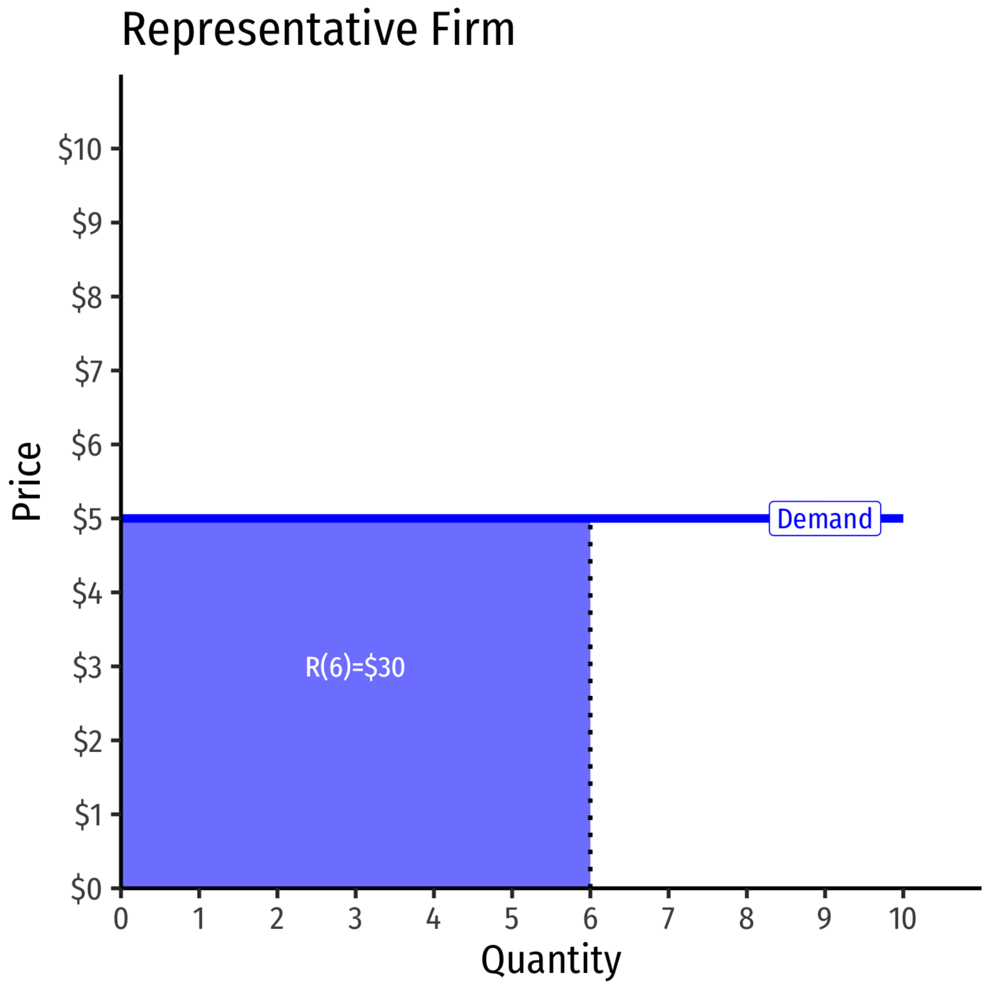
Revenues for Firms in *Competitive* Industries I





- Demand for a firm's product is **perfectly elastic** at the market price
- Where did the supply curve come from? You'll know today

Revenues for Firms in *Competitive* Industries II



- **Total Revenue** $R(q) = pq$

Average and Marginal Revenues

- **Average Revenue**: revenue per unit of output

$$AR(q) = \frac{R}{q}$$

  - $AR(q)$ is **by definition** equal to the price! (Why?)

- **Marginal Revenue**: change in revenues for each additional unit of output sold:

$$MR(q) = \frac{\Delta R(q)}{\Delta q} \approx \frac{R_2 - R_1}{q_2 - q_1}$$

  - Calculus: first derivative of the revenues function
  - **For a *competitive* firm (only), MR(q) = p, i.e. the price!**

Average and Marginal Revenues: Example

Example: A firm sells bushels of wheat in a very competitive market. The current market price is $10/bushel.

For the 1st bushel sold:

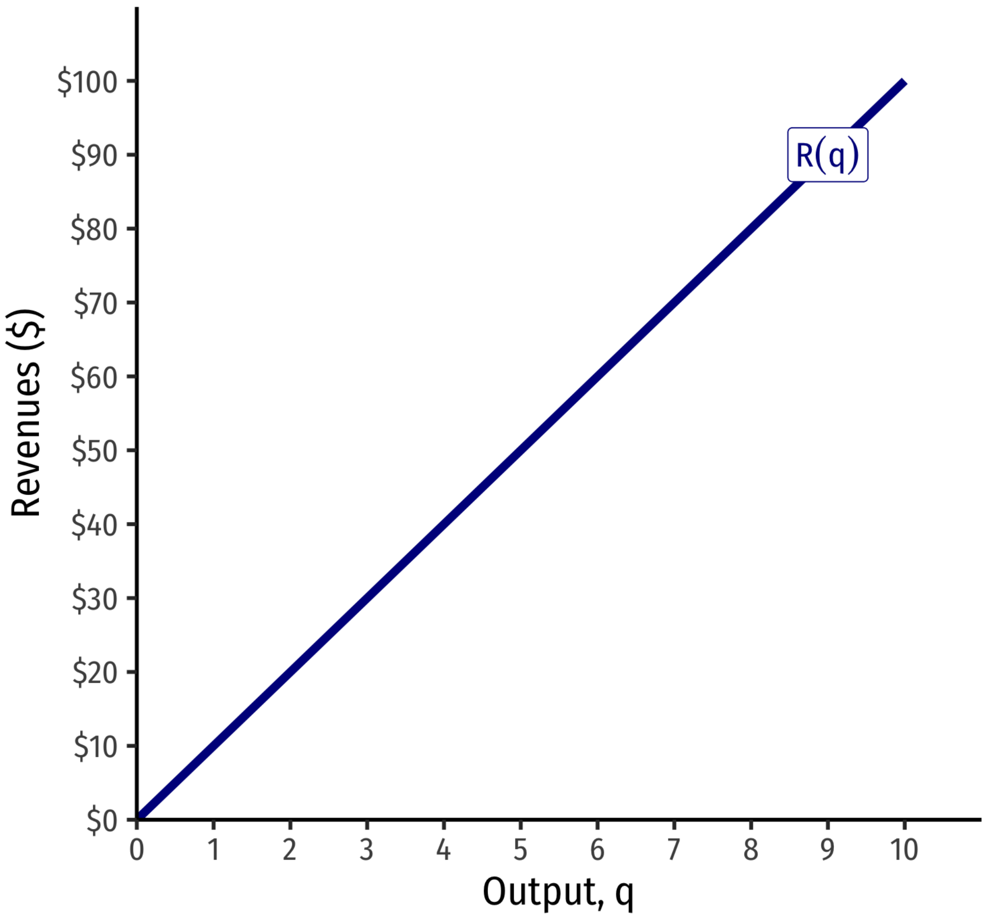
- What is the total revenue?
- What is the average revenue?

For the 2nd bushel sold:

- What is the total revenue?
- What is the average revenue?
- What is the marginal revenue?

Total Revenue, Example: Visualized

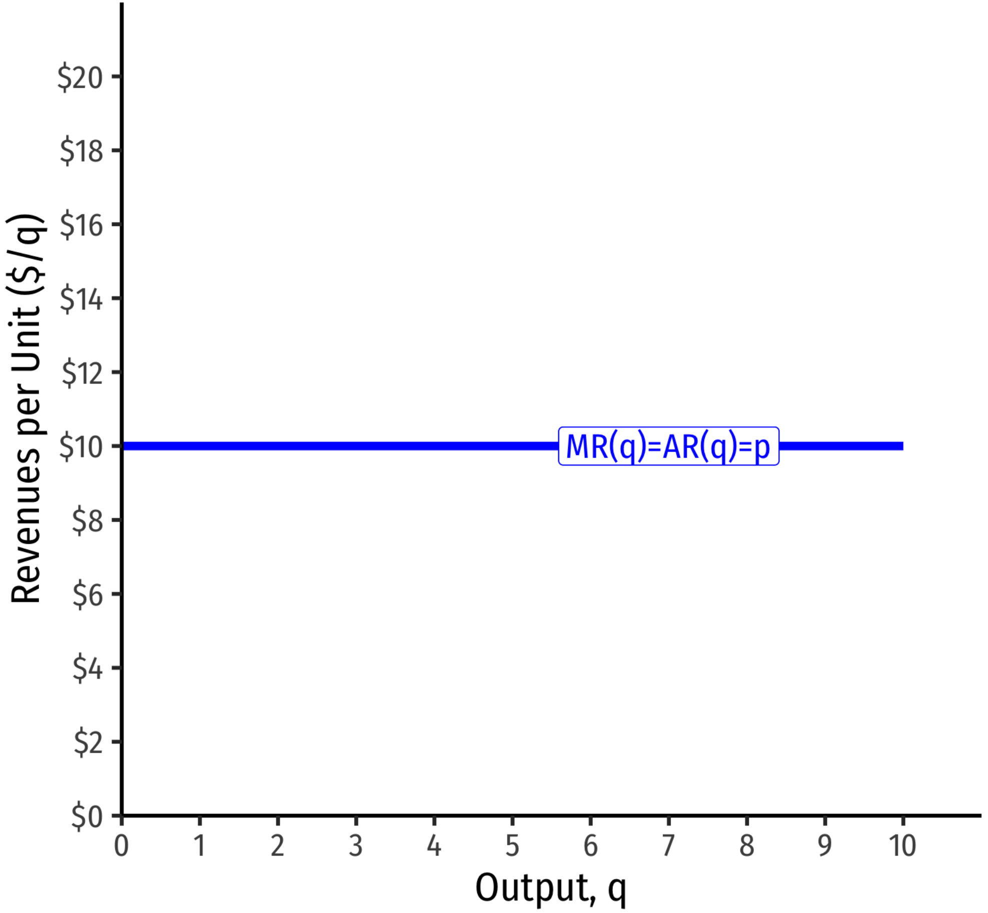
q	$R(q)$
0	0
1	10
2	20
3	30
4	40
5	50
6	60
7	70
8	80
9	90
10	100



$R(q) = 10q$

Average and Marginal Revenue, Example: Visualized

q	$R(q)$	$AR(q)$	$MR(q)$
0	0	–	–
1	10	10	10
2	20	10	10
3	30	10	10
4	40	10	10
5	50	10	10
6	60	10	10
7	70	10	10
8	80	10	10
9	90	10	10
10	100	10	10



R(q) = 10q

Profits

Recall: The Firm's Two Problems

1st Stage: firm's profit maximization problem:

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

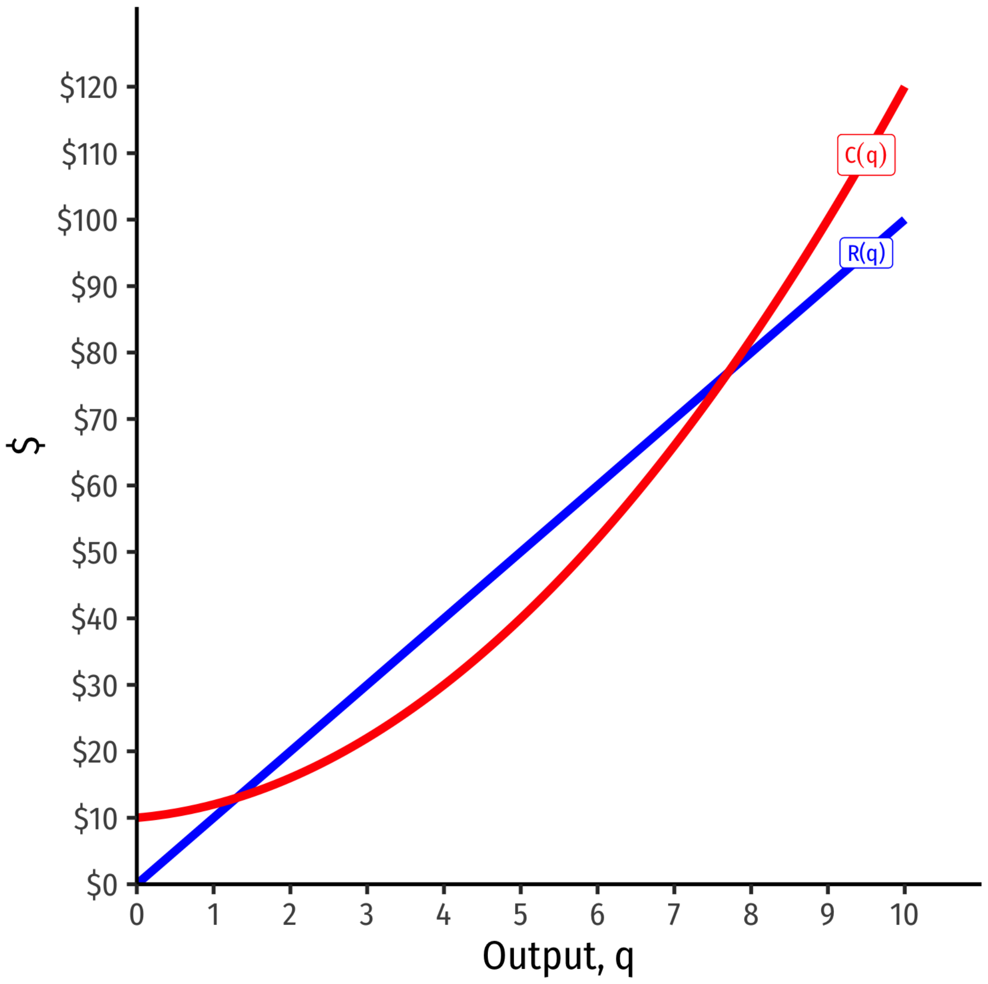
2nd Stage: firm's cost minimization problem:

1. **Choose:** < inputs >
2. **In order to *minimize*:** < cost >
3. **Subject to:** < producing the optimal output >

- Minimizing costs $\iff$ maximizing profits

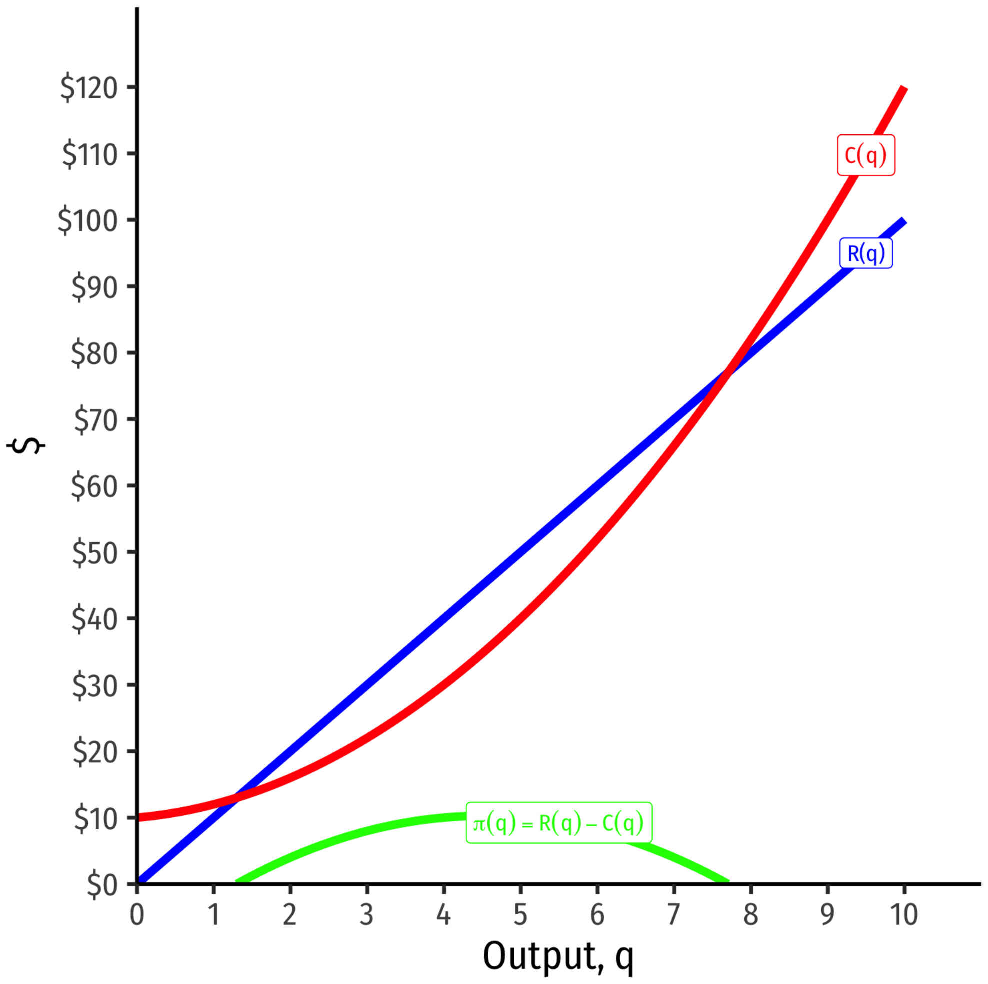
Visualizing Total Profit As $R(q) - C(q)$

- $\pi(q) = R(q) - C(q)$



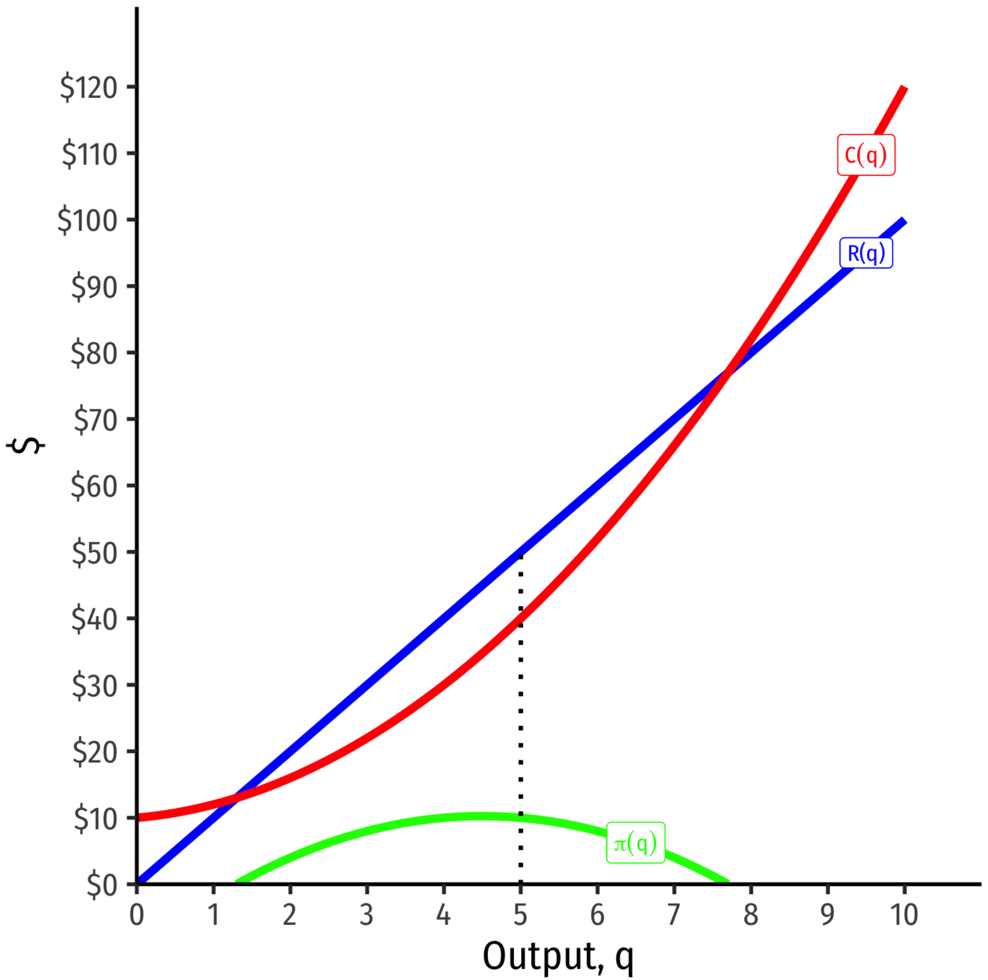
Visualizing Total Profit As $R(q) - C(q)$

- $\pi(q) = R(q) - C(q)$



Visualizing Total Profit As $R(q) - C(q)$

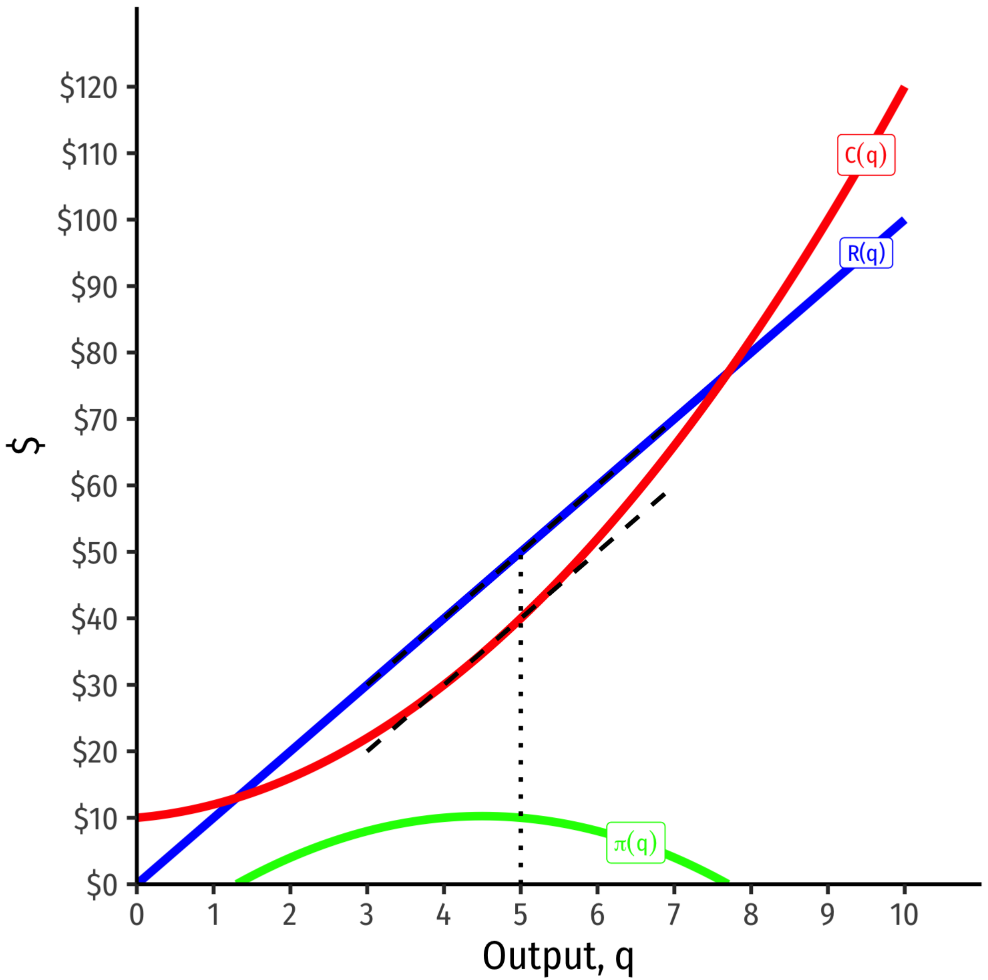
- $\pi(q) = R(q) - C(q)$
- Graph: find q^* to max $\pi \implies q^*$ where max distance between $R(q)$ and $C(q)$



Visualizing Total Profit As $R(q) - C(q)$

- $\pi(q) = R(q) - C(q)$
- Graph: find q^* to max $\pi \implies q^*$ where max distance between $R(q)$ and $C(q)$
- Slopes must be equal:

$$MR(q) = MC(q)$$

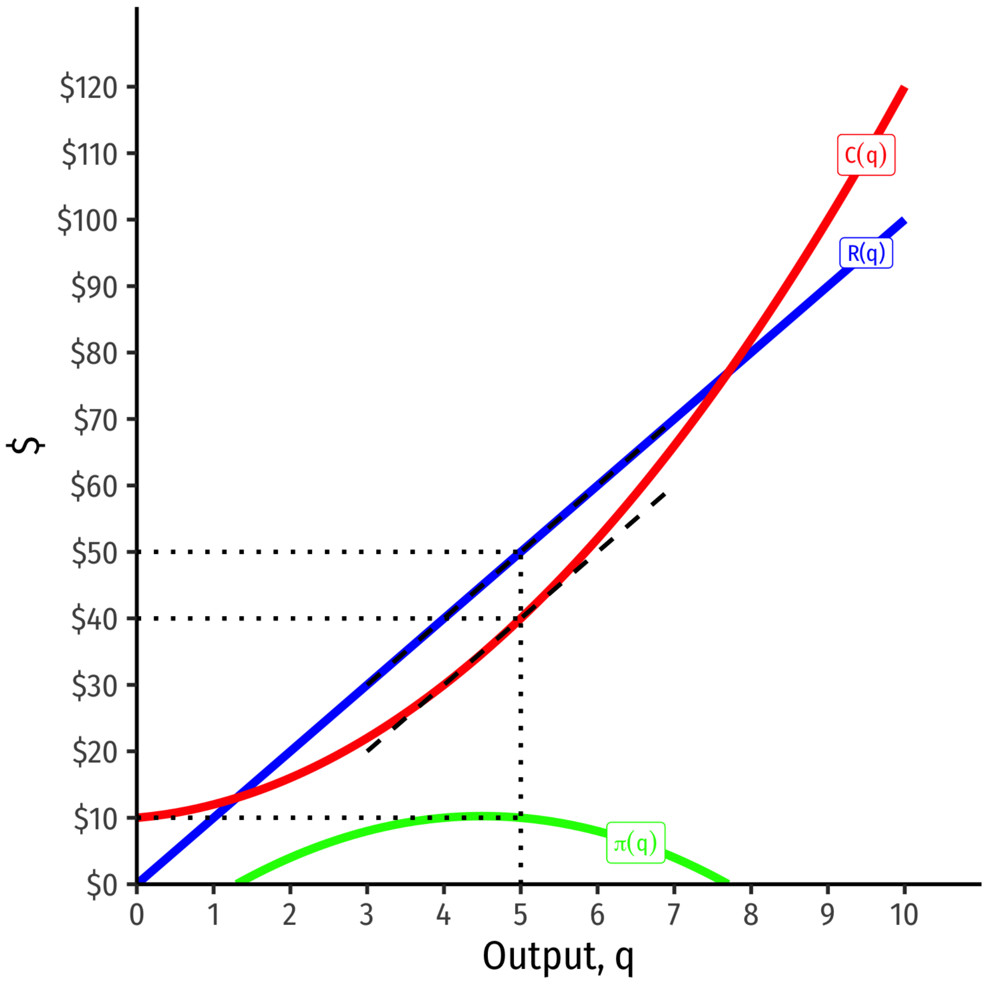


Visualizing Total Profit As $R(q) - C(q)$

- $\pi(q) = R(q) - C(q)$
- Graph: find q^* to max $\pi \implies q^*$ where max distance between $R(q)$ and $C(q)$
- Slopes must be equal:

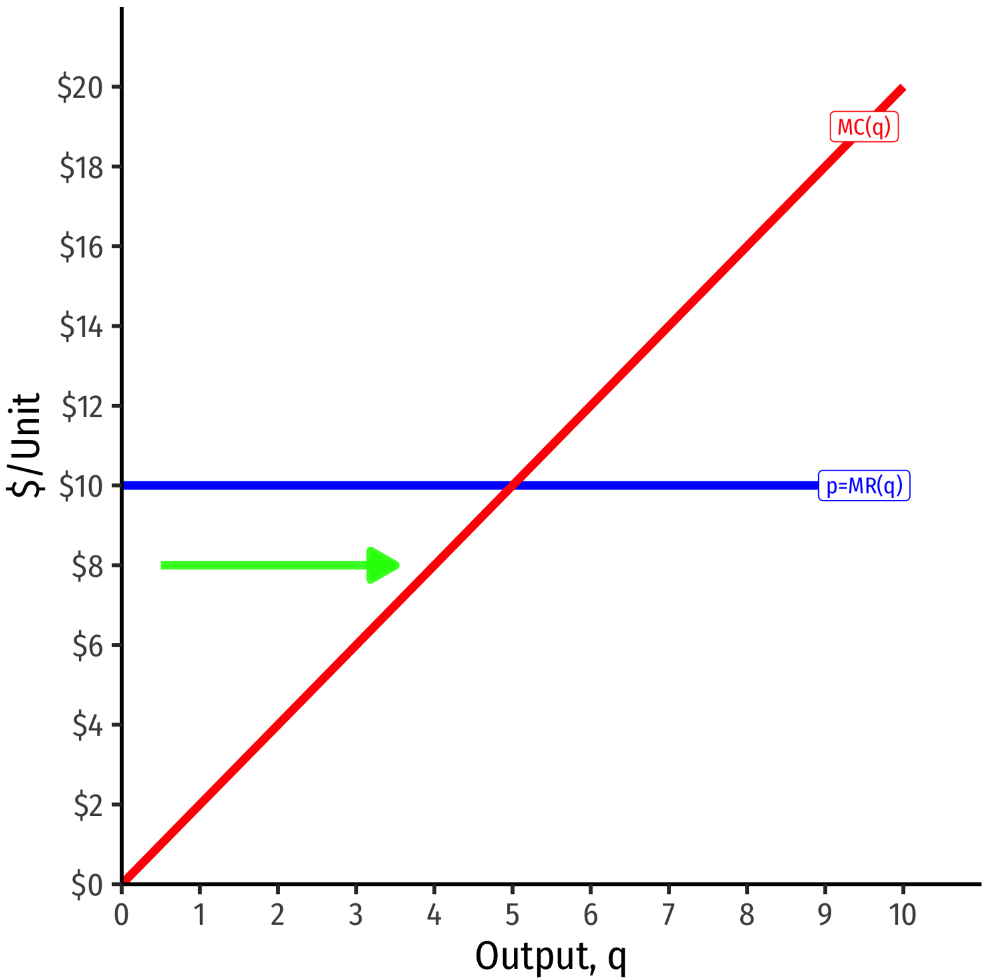
$$MR(q) = MC(q)$$

- At $q^* = 5$:
  - $R(q) = 50$
  - $C(q) = 40$
  - $\pi(q) = 10$



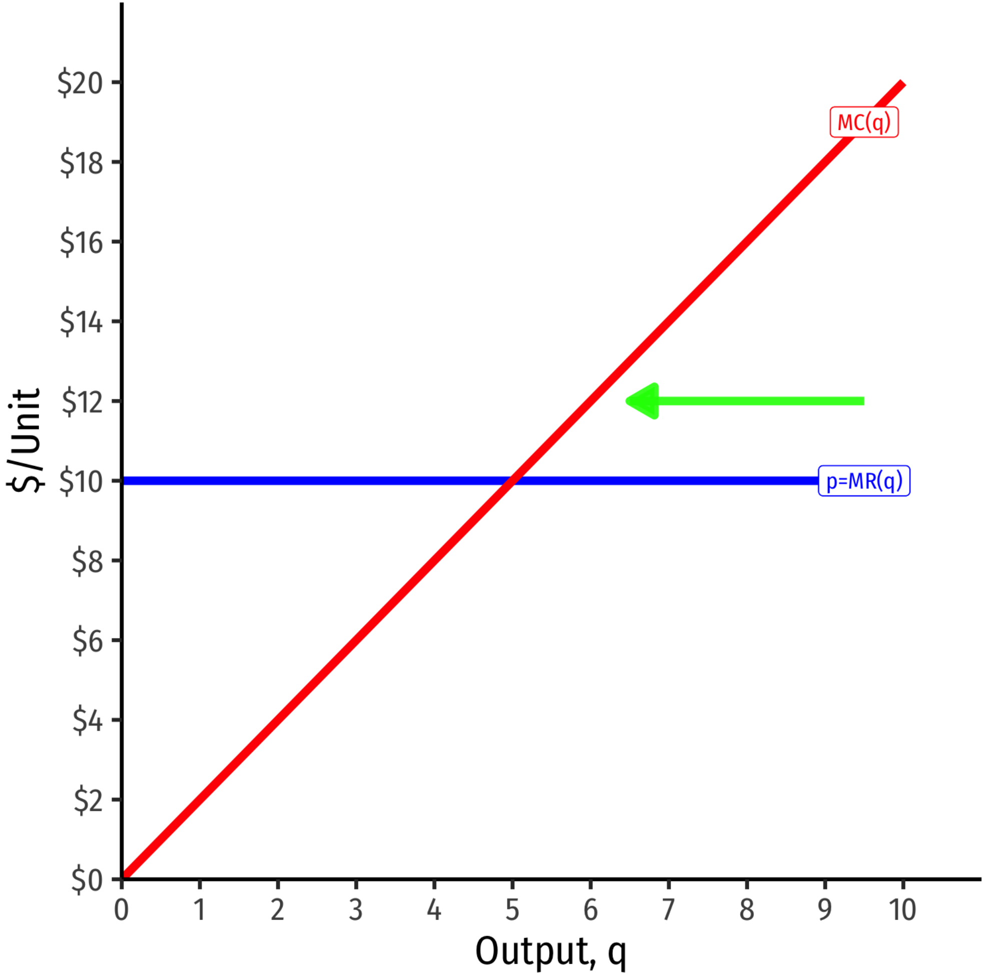
Visualizing Profit Per Unit As $MR(q)$ and $MC(q)$

- At low output $q < q^*$, can increase π by producing *more*: $MR(q) > MC(q)$



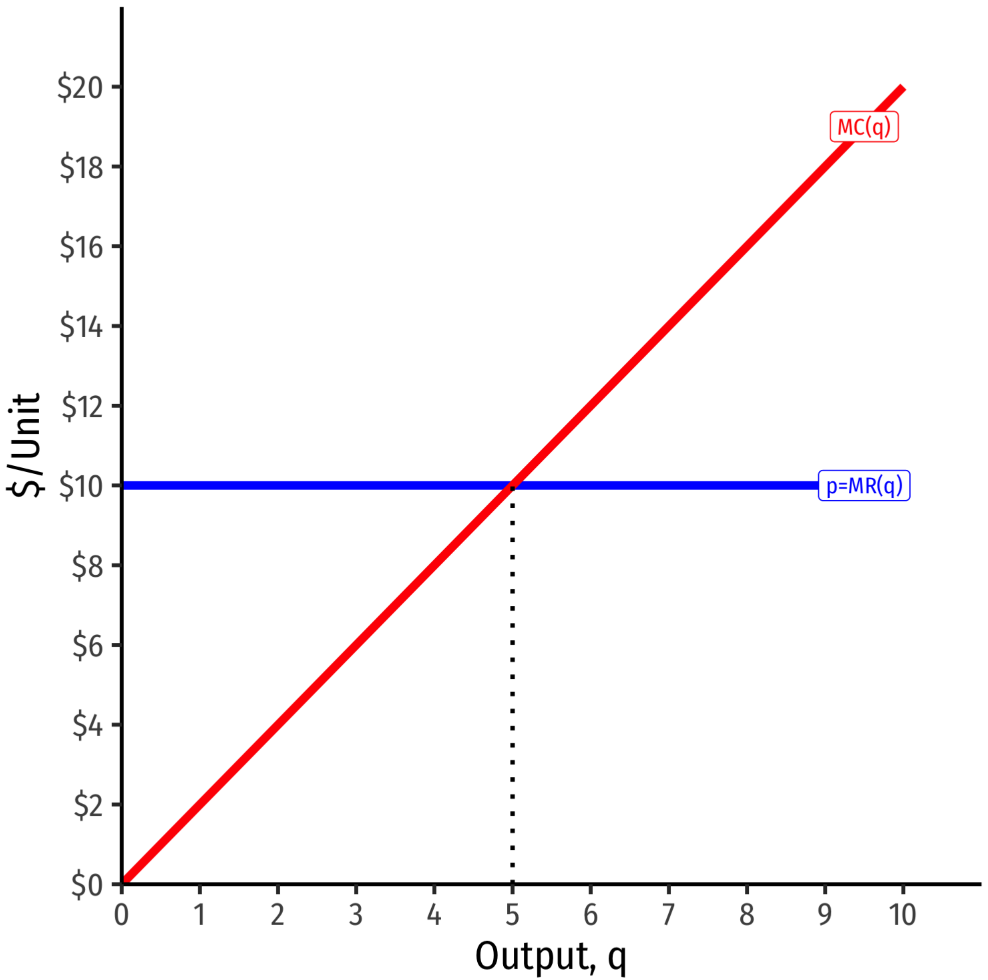
Visualizing Profit Per Unit As $MR(q)$ and $MC(q)$

- At high output $q > q^*$, can increase π by producing *less*: $MR(q) < MC(q)$



Visualizing Profit Per Unit As $MR(q)$ and $MC(q)$

- π is *maximized* where $MR(q) = MC(q)$

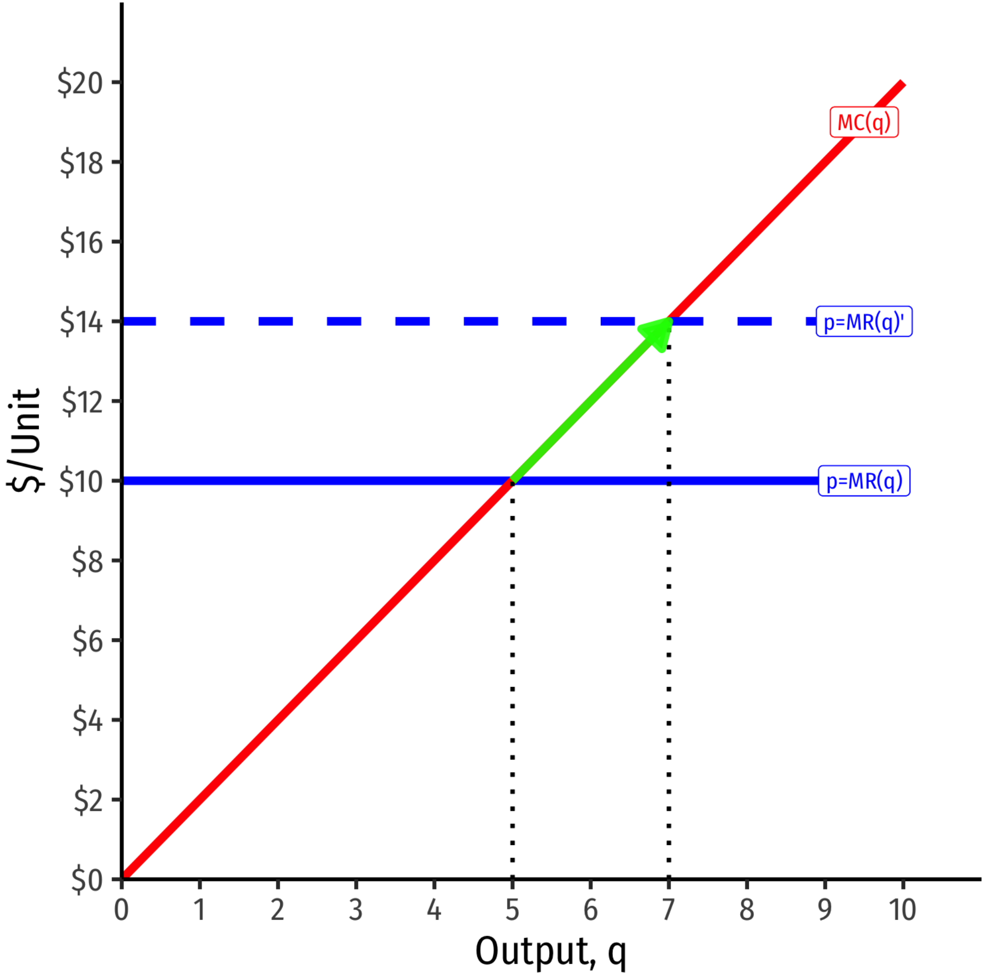


Comparative Statics

If Market Price Changes I

- Suppose the market price **increases**

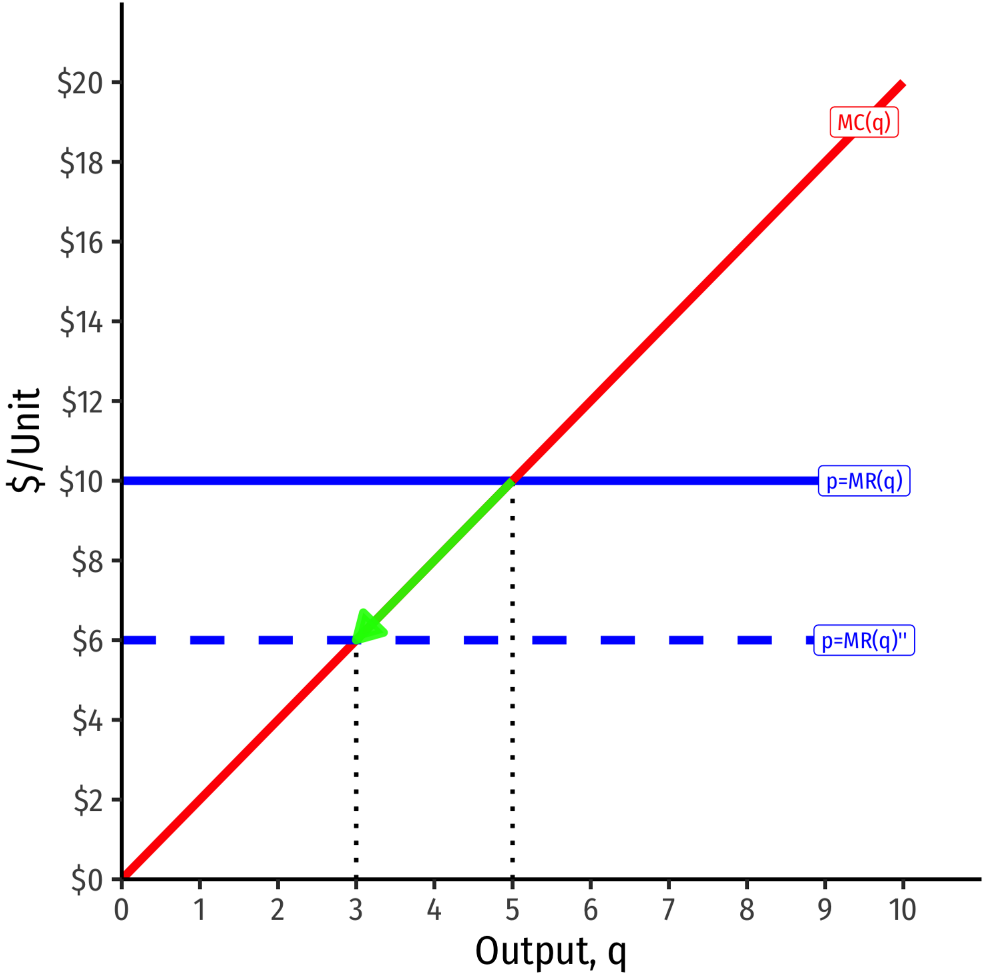
- Firm (always setting MR=MC) will respond by **producing more**



If Market Price Changes II

- Suppose the market price **decreases**

- Firm (always setting MR=MC) will respond by **producing less**



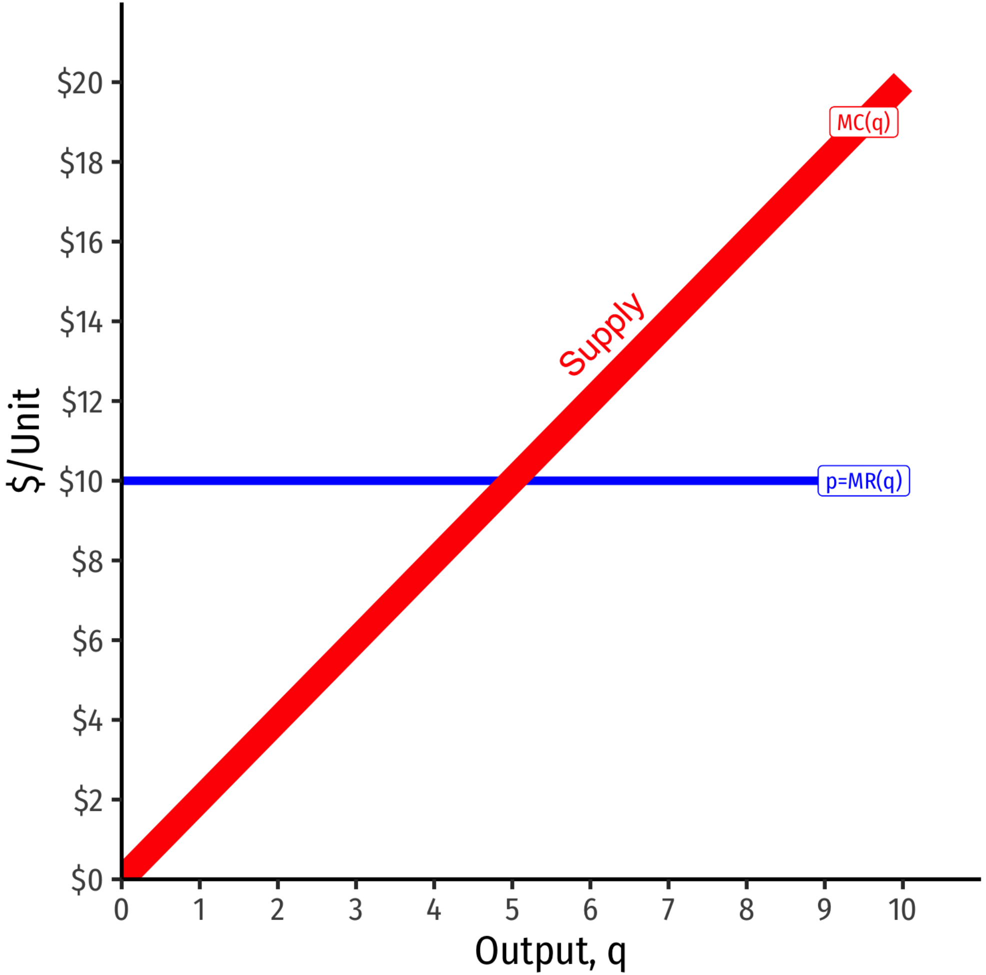
The Firm's Supply Curve

- **The firm's marginal cost curve is its supply curve**‡

$$p = MC(q)$$

  - How it will supply the optimal amount of output in response to the market price
  - **Firm always sets its price equal to its marginal cost**

‡ Mostly...there is an important **exception** we will see shortly!

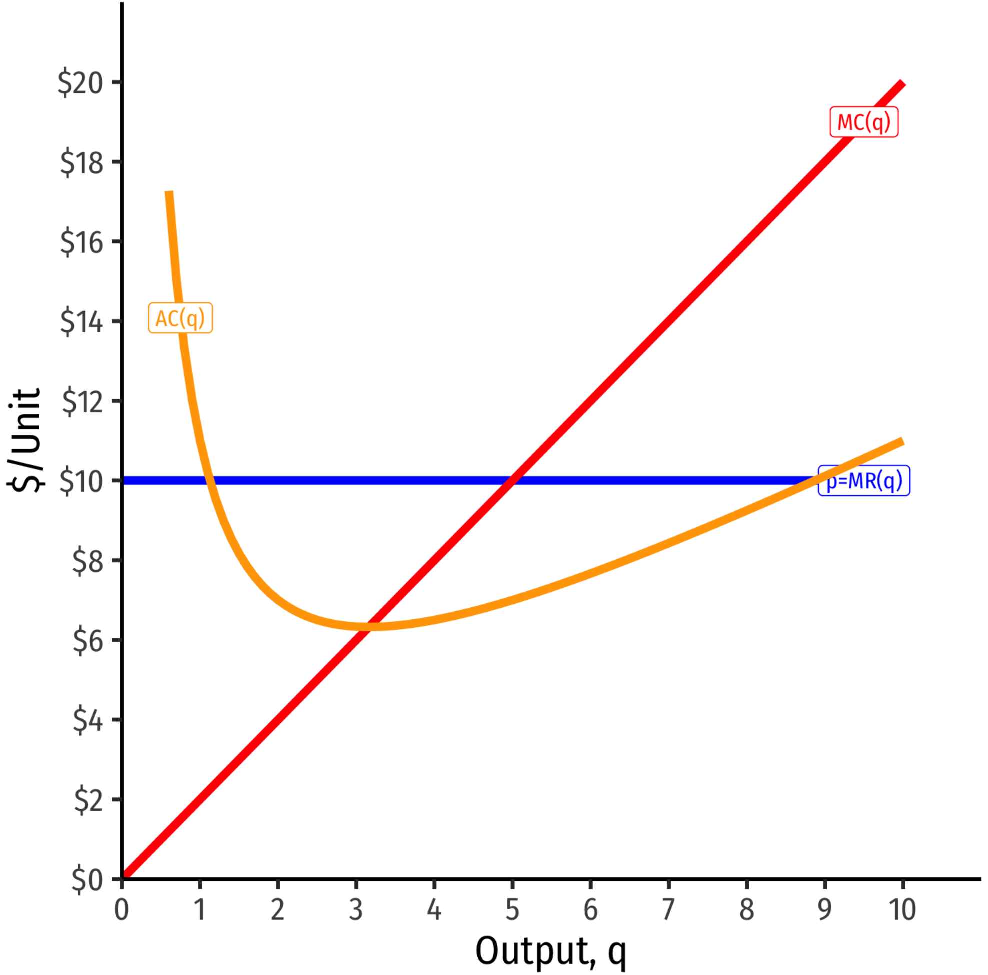


Calculating Profit

Calculating (Average) Profit as AR(q)-AC(q)

- Profit is

$$\pi(q) = R(q) - C(q)$$



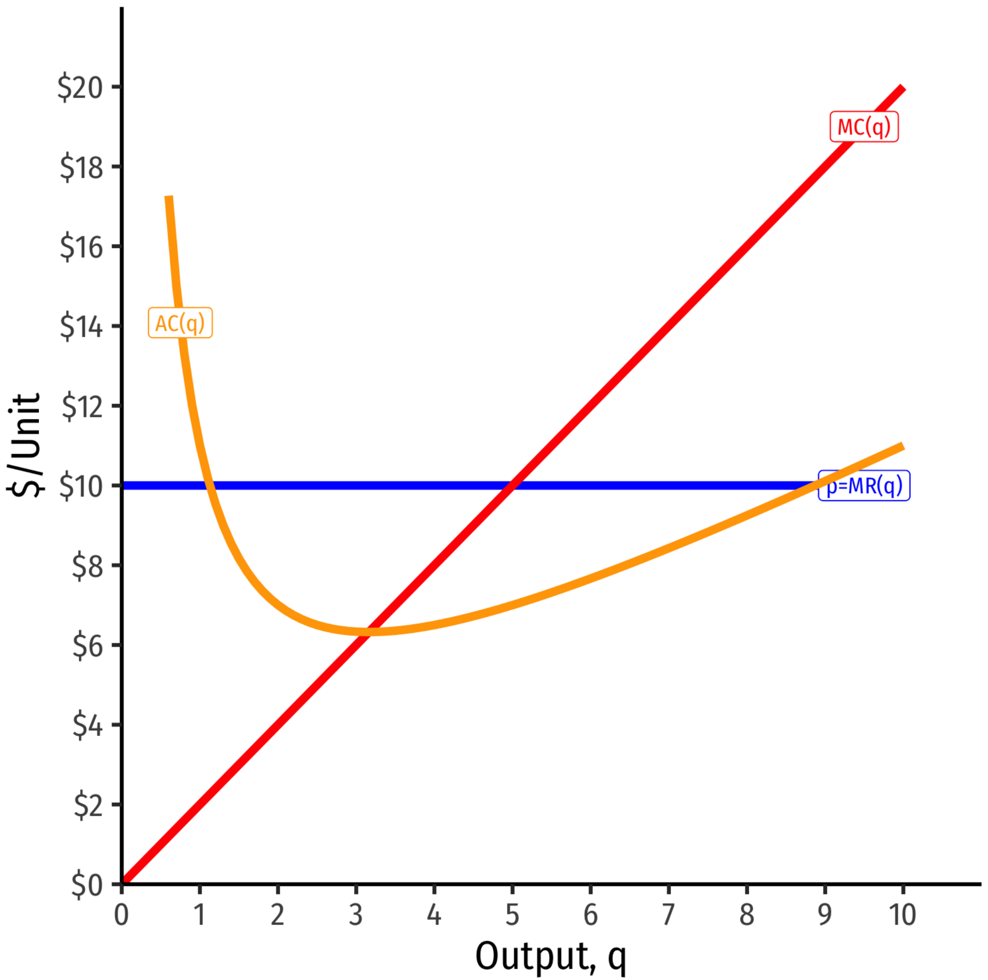
Calculating (Average) Profit as AR(q)-AC(q)

- Profit is

$$\pi(q) = R(q) - C(q)$$

- Profit per unit can be calculated as:

$$\frac{\pi(q)}{q} = AR(q) - AC(q)$$
$$= p - AC(q)$$



Calculating (Average) Profit as AR(q)-AC(q)

- Profit is

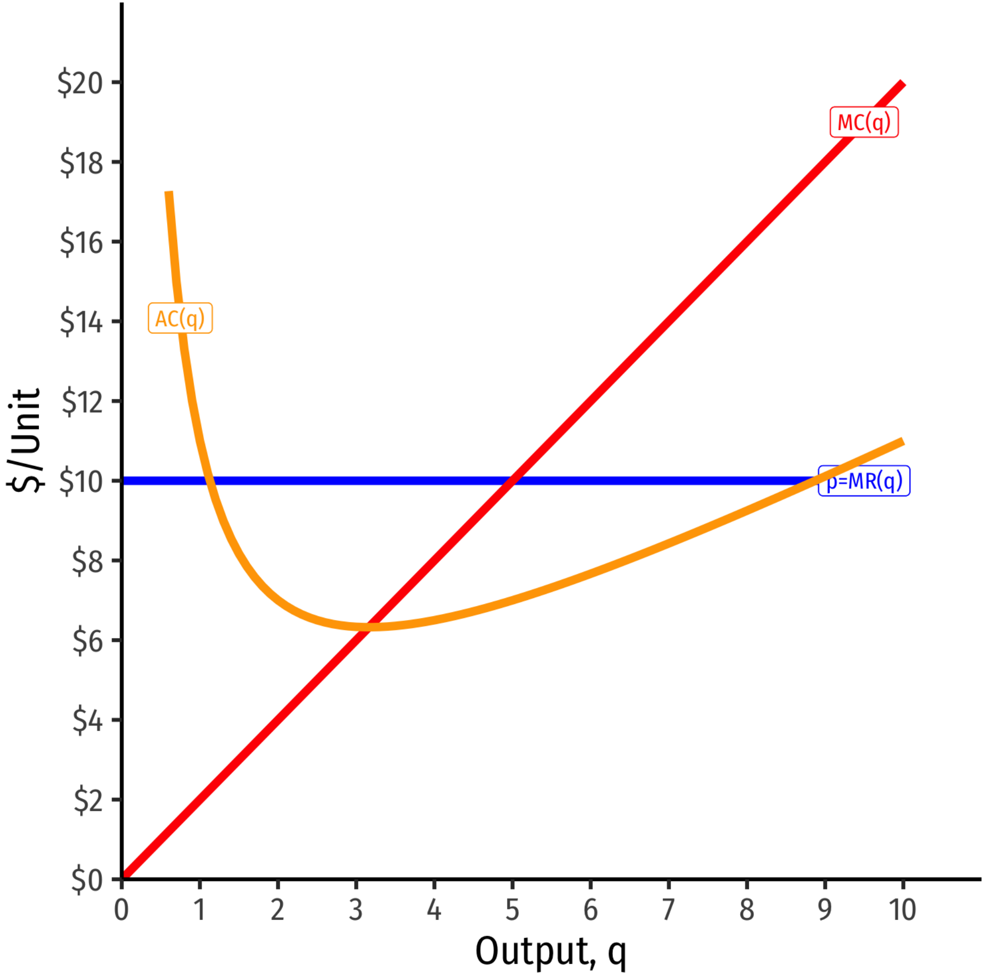
$$\pi(q) = R(q) - C(q)$$

- Profit per unit can be calculated as:

$$\begin{aligned}\frac{\pi(q)}{q} &= {\color{blue}AR(q)} - {\color{orange}AC(q)}\\ &= {\color{blue}p} - {\color{orange}AC(q)}\end{aligned}$$

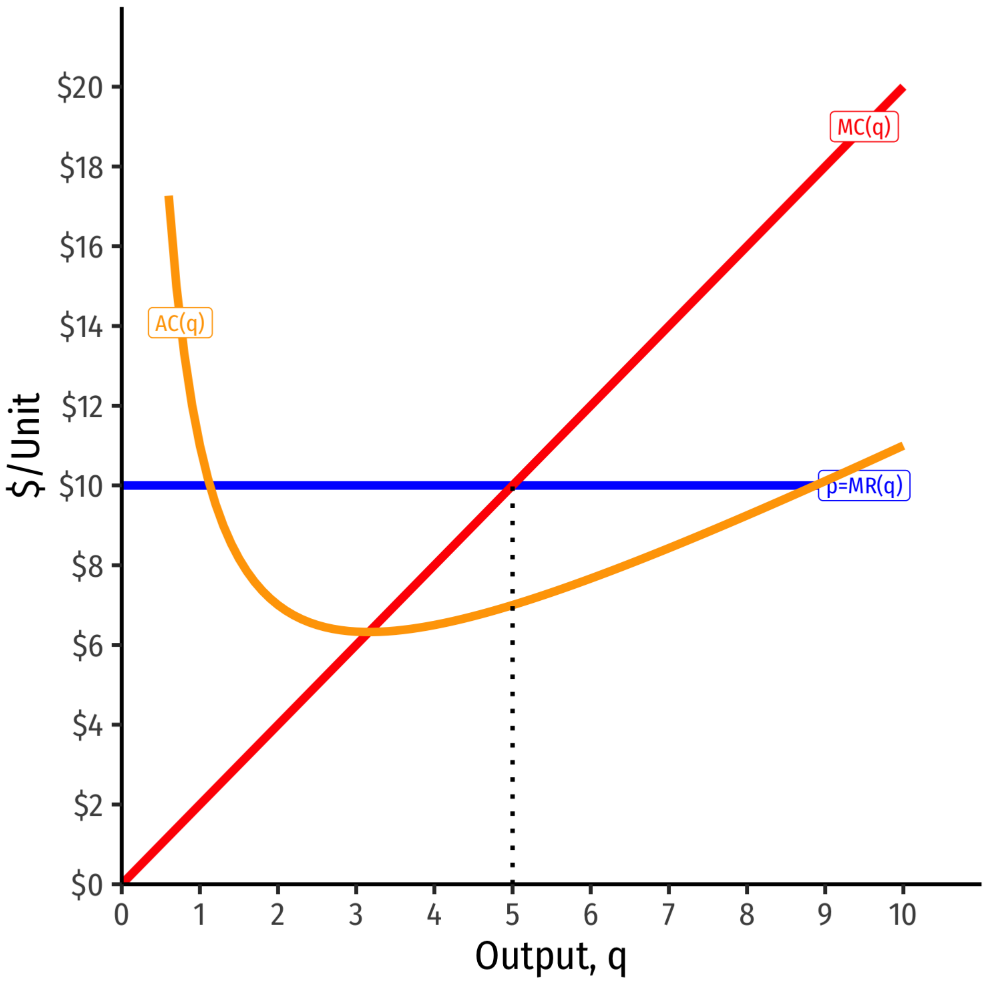
- Multiply by q to get total profit:

$$\pi(q) = q\left[{\color{blue}p} - {\color{orange}AC(q)}\right]$$



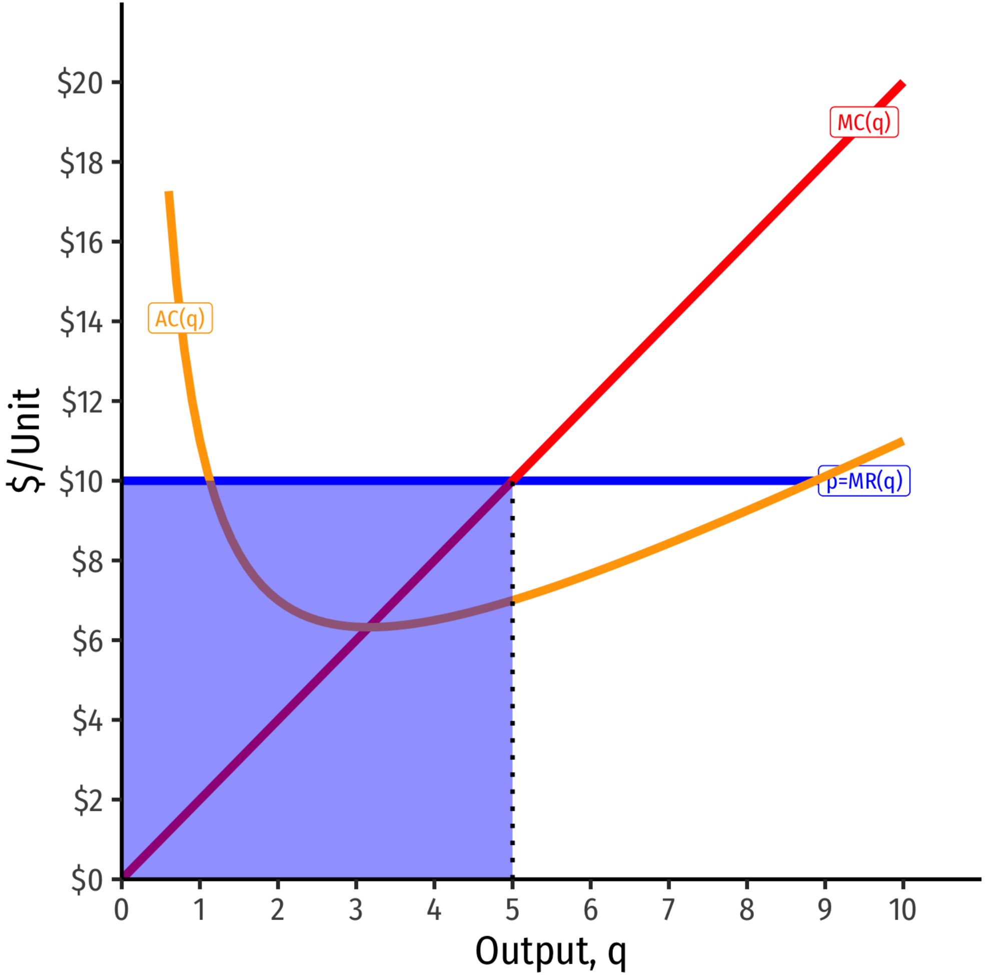
Calculating (Average) Profit as AR(q)-AC(q)

- At market price of p* = $10
- At q* = 5 (per unit):
- At q* = 5 (totals):



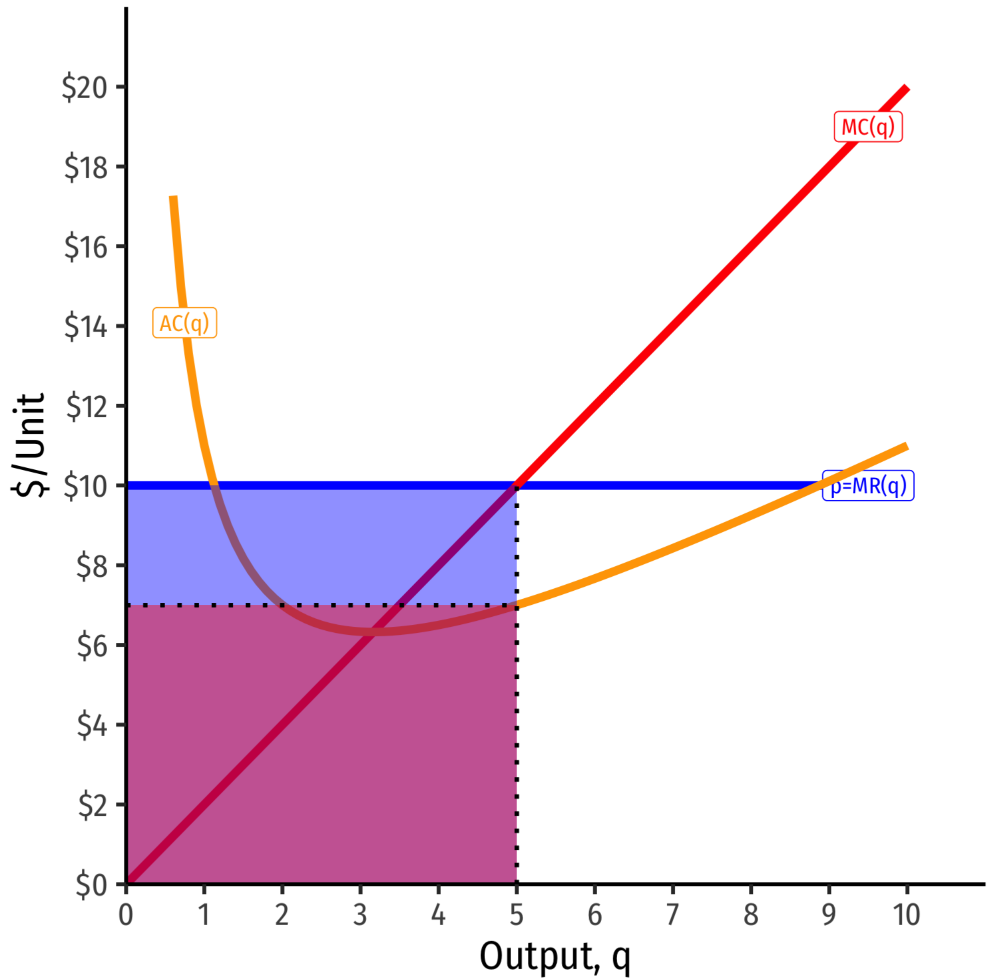
Calculating (Average) Profit as AR(q)-AC(q)

- At market price of $p^* = \$10$
- At $q^* = 5$ (per unit):
  - $AR(5) = \$10/\text{unit}$
- At $q^* = 5$ (totals):
  - $R(5) = \$50$



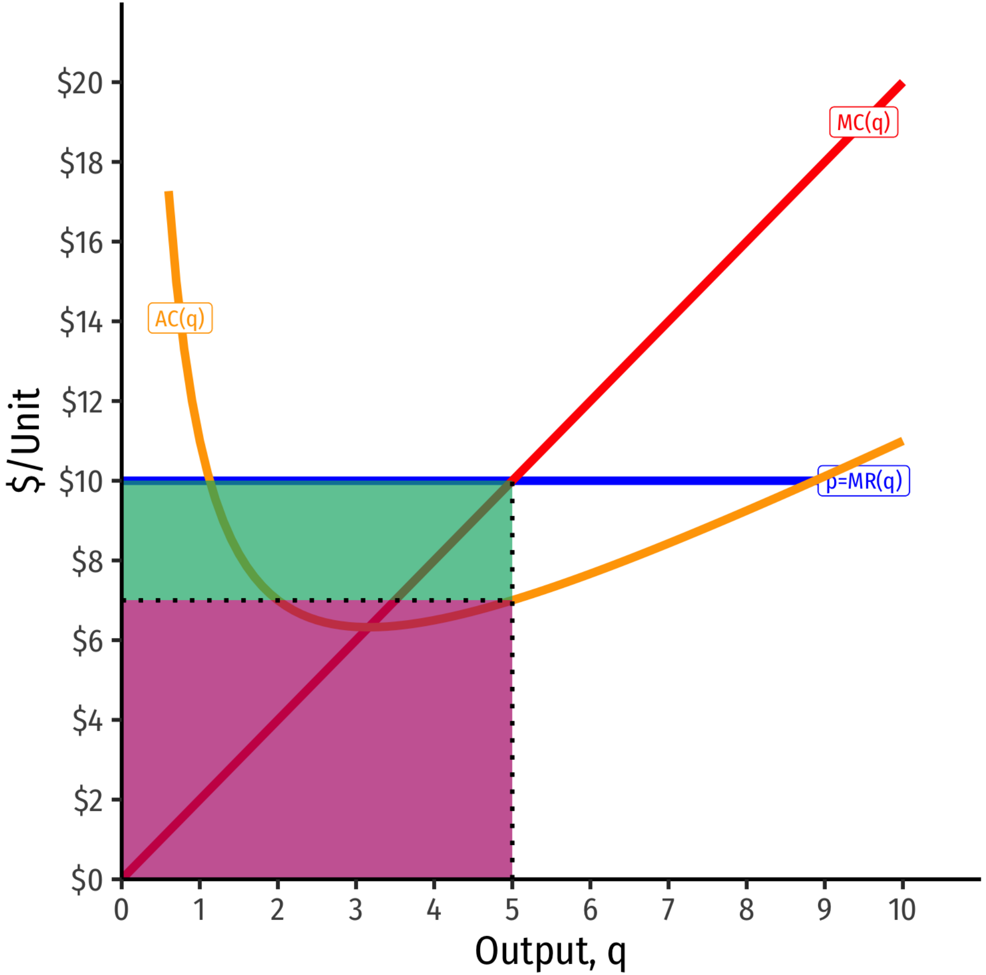
Calculating (Average) Profit as AR(q)-AC(q)

- At market price of p* = $10
- At q* = 5 (per unit):
  - AR(5) = $10/unit
  - AC(5) = $7/unit
- At q* = 5 (totals):
  - R(5) = $50
  - C(5) = $35



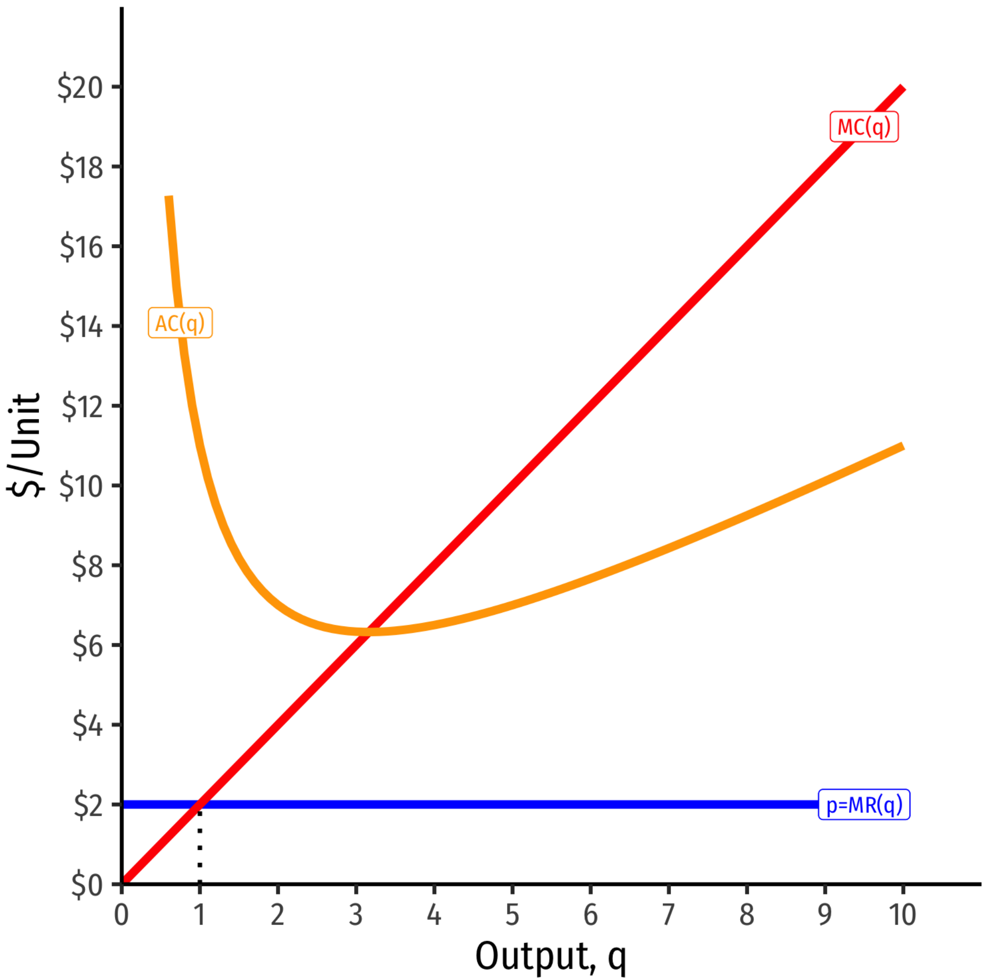
Calculating (Average) Profit as AR(q)-AC(q)

- At market price of $p^* = \$10$
- At $q^* = 5$ (per unit):
  - $AR(5) = \$10/\text{unit}$
  - $AC(5) = \$7/\text{unit}$
  - $A\pi(5) = \$3/\text{unit}$
- At $q^* = 5$ (totals):
  - $R(5) = \$50$
  - $C(5) = \$35$
  - $\pi = \$15$



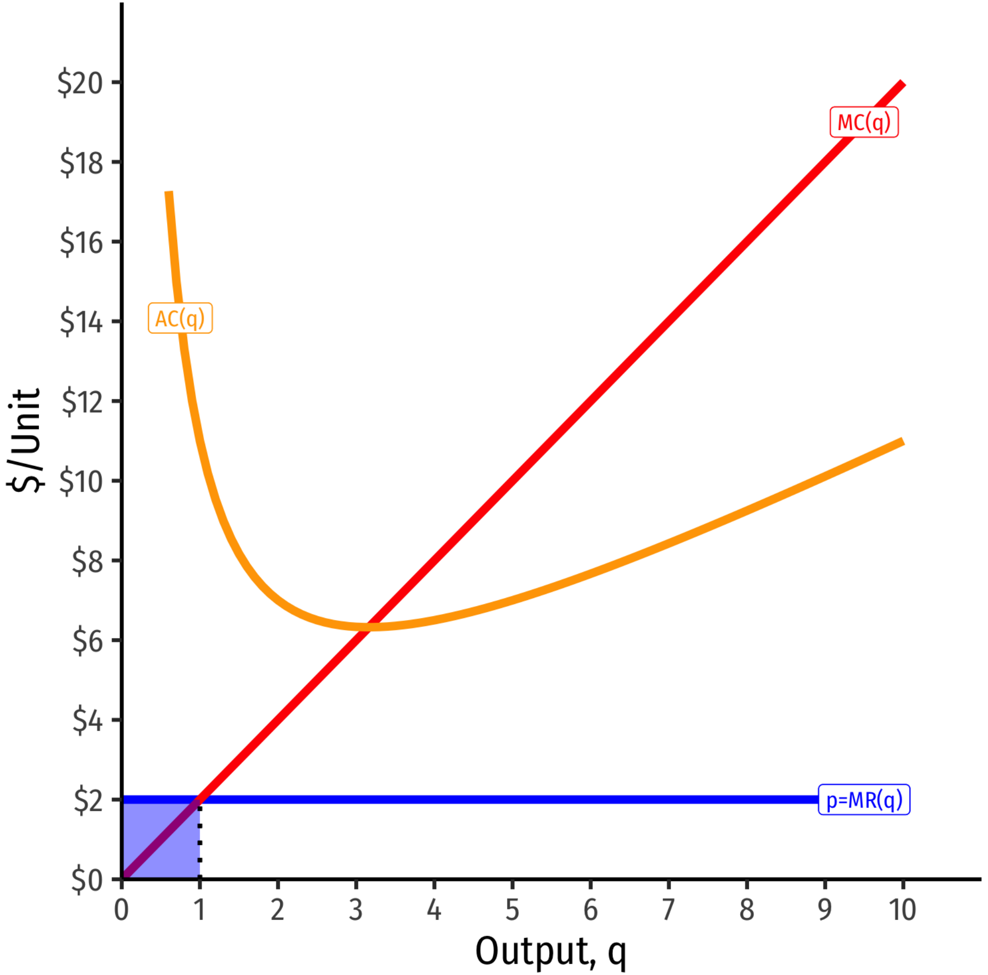
Calculating (Average) Profit as AR(q)-AC(q)

- At market price of p* = $2
- At q* = 1 (per unit):
- At q* = 1 (totals):



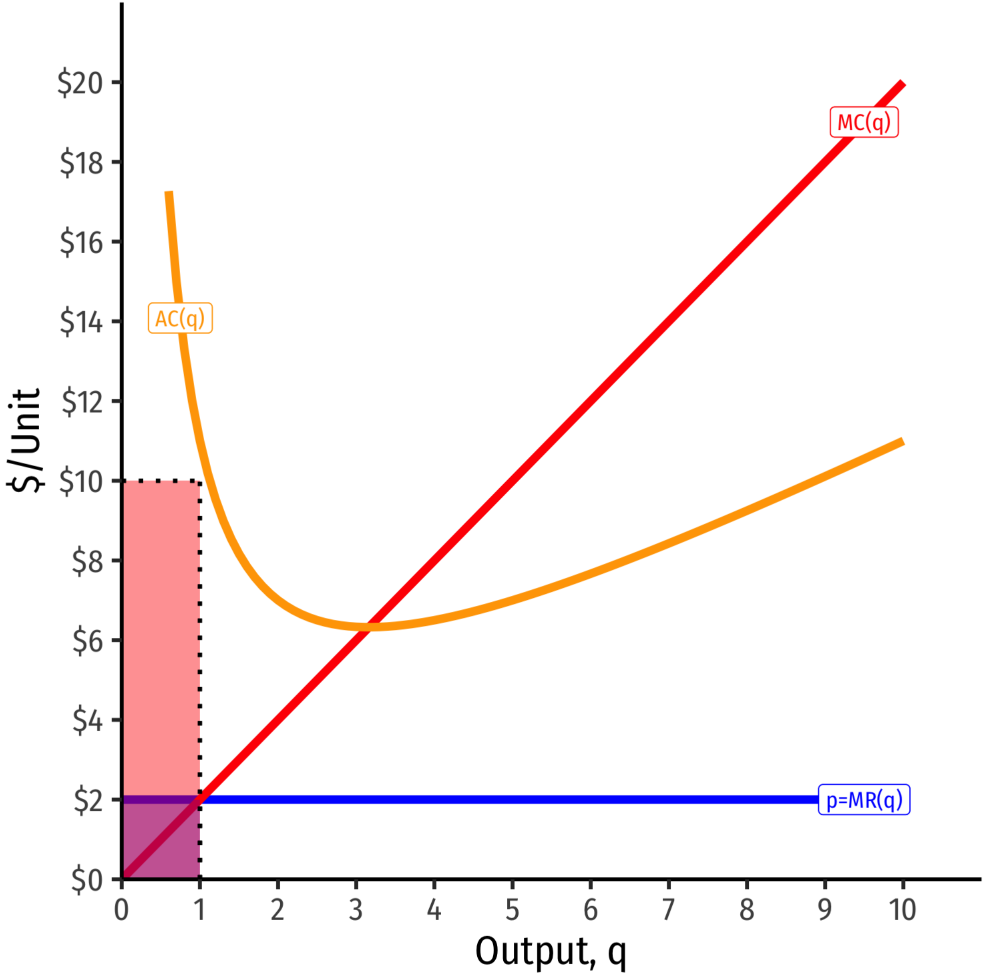
Calculating (Average) Profit as AR(q)-AC(q)

- At market price of $p^* = \$2$
- At $q^* = 1$ (per unit):
  - AR(1) = \$2/unit
- At $q^* = 1$ (totals):
  - R(1) = \$2



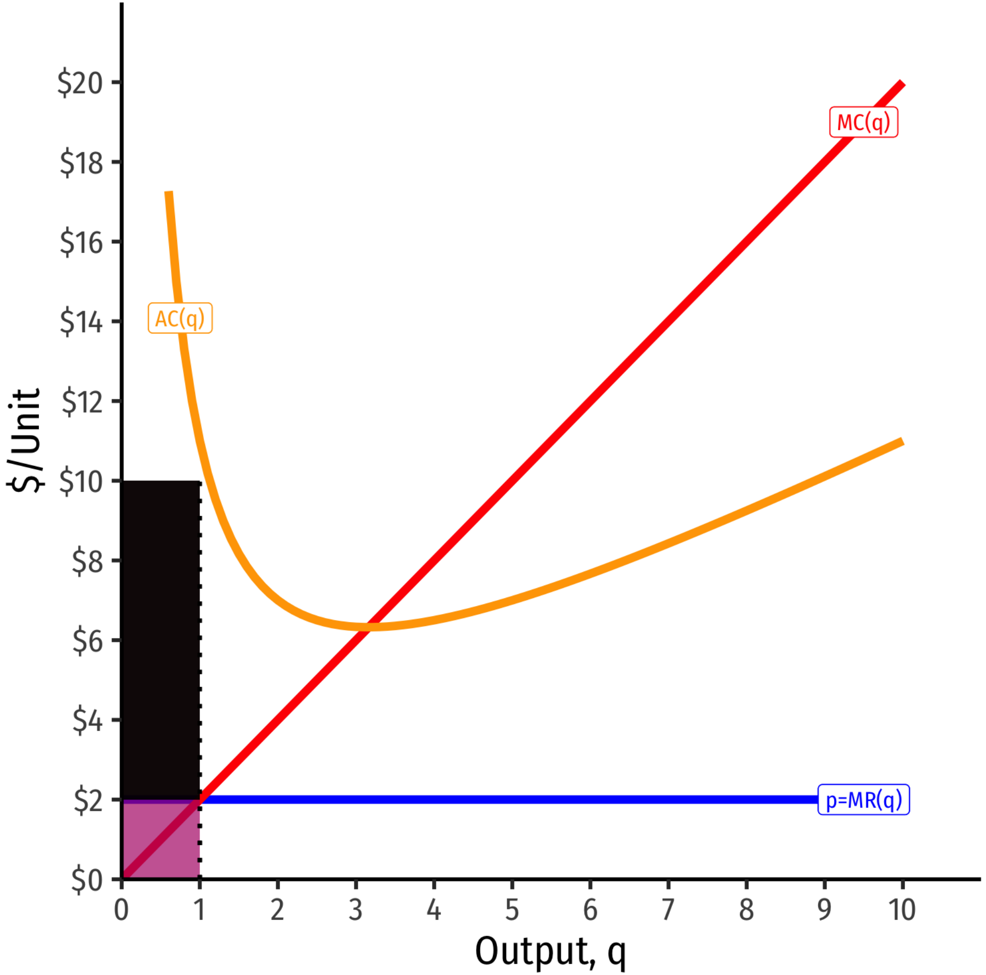
Calculating (Average) Profit as AR(q)-AC(q)

- At market price of p* = $2
- At q* = 1 (per unit):
  - AR(1) = $2/unit
  - AC(1) = $10/unit
- At q* = 1 (totals):
  - R(1) = $2
  - C(1) = $10



Calculating (Average) Profit as AR(q)-AC(q)

- At market price of $p^* = \$2$
- At $q^* = 1$ (per unit):
  - $AR(1) = \$2/\text{unit}$
  - $AC(1) = \$10/\text{unit}$
  - $A\pi(1) = -\$8/\text{unit}$
- At $q^* = 1$ (totals):
  - $R(1) = \$2$
  - $C(1) = \$10$
  - $\pi(1) = -\$8$



Short-Run Shut-Down Decisions

Short-Run Shut-Down Decisions

- What if a firm's profits at q^* are **negative** (i.e. it earns **losses**)?

- **Should it produce at all?**

Short-Run Shut-Down Decisions

- Suppose firm chooses to produce **nothing** $(q = 0)$:

- If it has **fixed costs** $(f > 0)$, its profits are:

$$\pi(q) = pq - C(q)$$

Short-Run Shut-Down Decisions

- Suppose firm chooses to produce **nothing** $(q=0)$:

- If it has **fixed costs** $(f>0)$, its profits are:

$$\pi(q) = pq - \color{red}{C(q)}$$
$$\pi(q) = pq - \color{red}{f - VC(q)}$$

Short-Run Shut-Down Decisions

- Suppose firm chooses to produce **nothing** $(q=0)$:
- If it has **fixed costs** $(f>0)$, its profits are:

$$
\begin{aligned}
\pi(q) &= pq - C(q) \\
\pi(q) &= pq - f - VC(q) \\
\pi(0) &= -f
\end{aligned}
$$

i.e. it (still) pays its fixed costs

Short-Run Shut-Down Decisions

- A firm should choose to produce **no output** $(q = 0)$ only when:

$$\pi \text{ from producing} < \pi \text{ from not producing}$$

Short-Run Shut-Down Decisions

- A firm should choose to produce **no output** $(q=0)$ only when:

$$\pi \text{ from producing} < \pi \text{ from not producing}$$
$$\pi(q) < -f$$

Short-Run Shut-Down Decisions

- A firm should choose to produce **no output** $(q=0)$ only when:

$$\begin{aligned} \pi \text{ from producing} &< \pi \text{ from not producing} \\ \pi(q) &< -f \\ pq - VC(q) - f &< -f \end{aligned}$$

Short-Run Shut-Down Decisions

- A firm should choose to produce **no output** $(q=0)$ only when:

$$
\begin{aligned}
\pi \text{ from producing} &< \pi \text{ from not producing}\\
\pi(q) &< -f\\
pq - VC(q) - f &< -f\\
pq - VC(q) &< 0
\end{aligned}
$$

Short-Run Shut-Down Decisions

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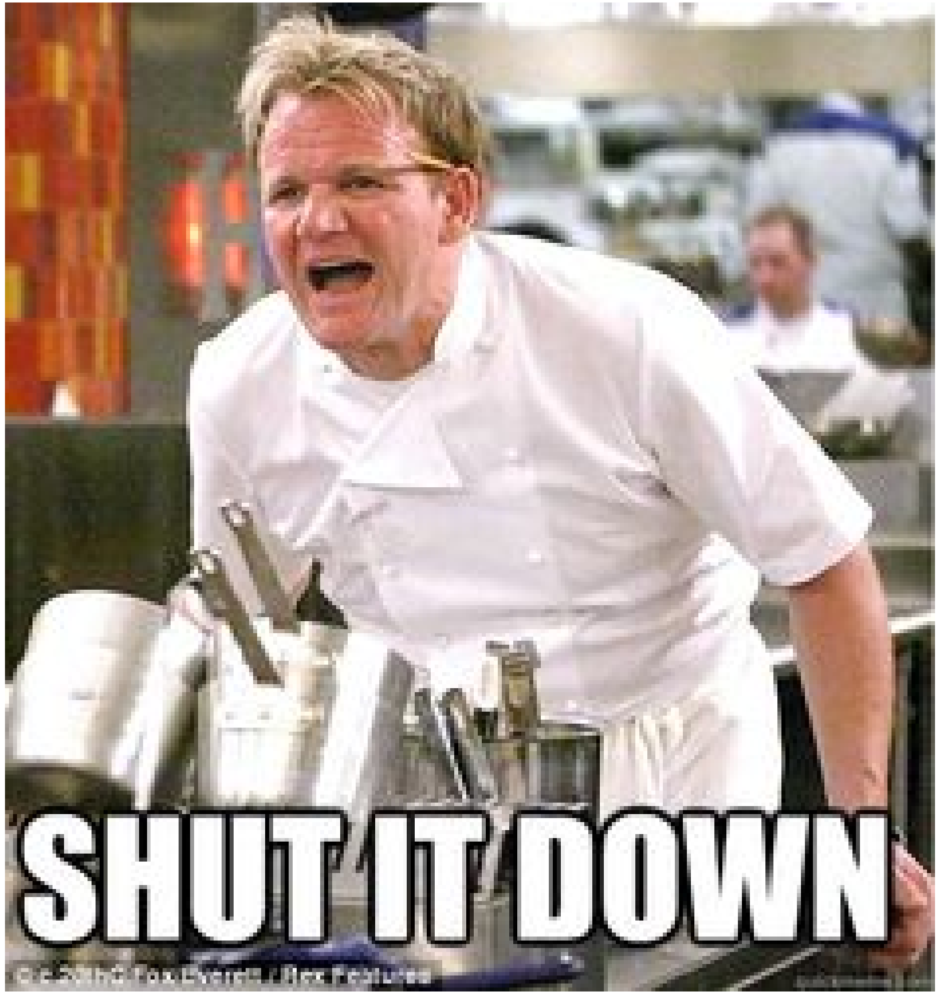
\begin{aligned}
\pi \text{ from producing} &< \pi \text{ from not producing} \\
\pi(q) &< -f \\
pq - VC(q) - f &< -f \\
pq - VC(q) &< 0 \\
pq &< VC(q)
\end{aligned}
$$

Short-Run Shut-Down Decisions

- A firm should choose to produce **no output** $(q = 0)$ only when:

$$\begin{aligned} \pi \text{ from producing} &< \pi \text{ from not producing} \\ \pi(q) &< -f \\ pq - VC(q) - f &< -f \\ pq - VC(q) &< 0 \\ pq &< VC(q) \\ p &< AVC(q) \end{aligned}$$

- **Shut down price**: firm will shut down production *in the short run* when $p < AVC(q)$



The Firm's Short Run Supply Decision

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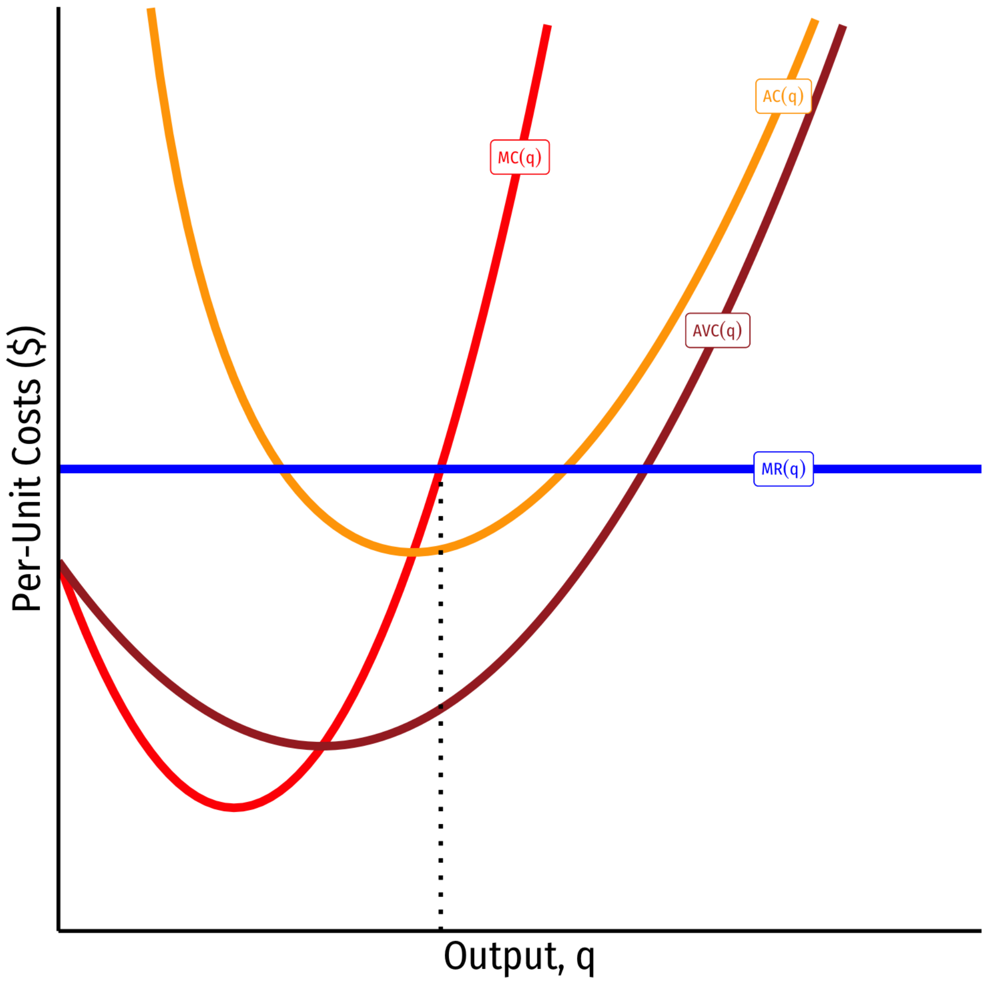
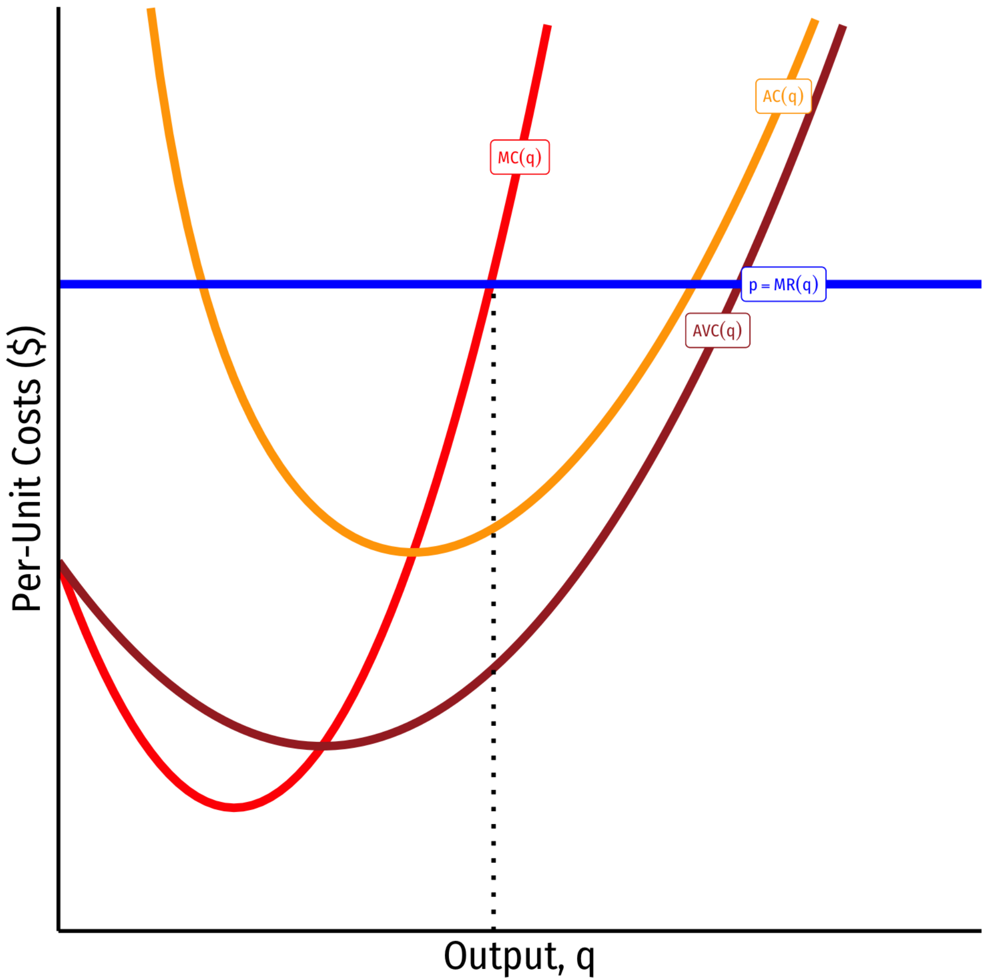


The Firm's Short Run Supply Decision



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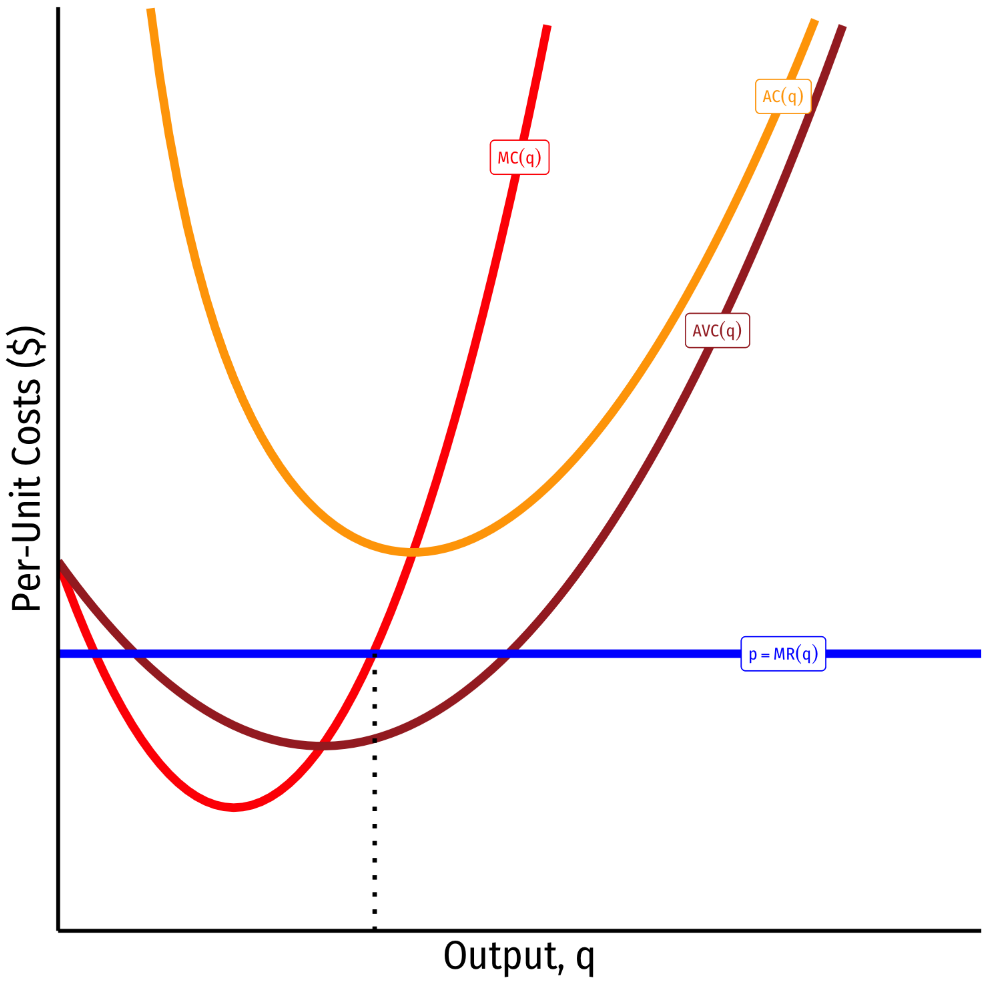
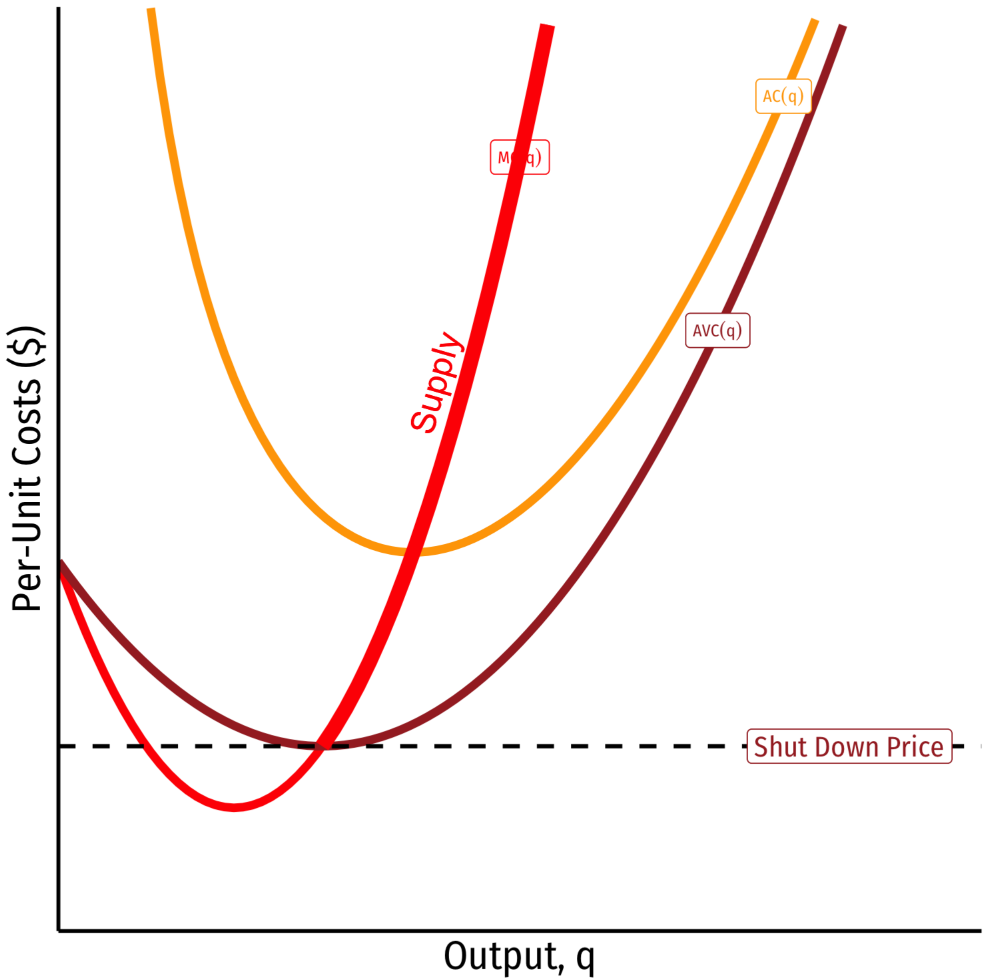


The Firm's Short Run Supply Decision



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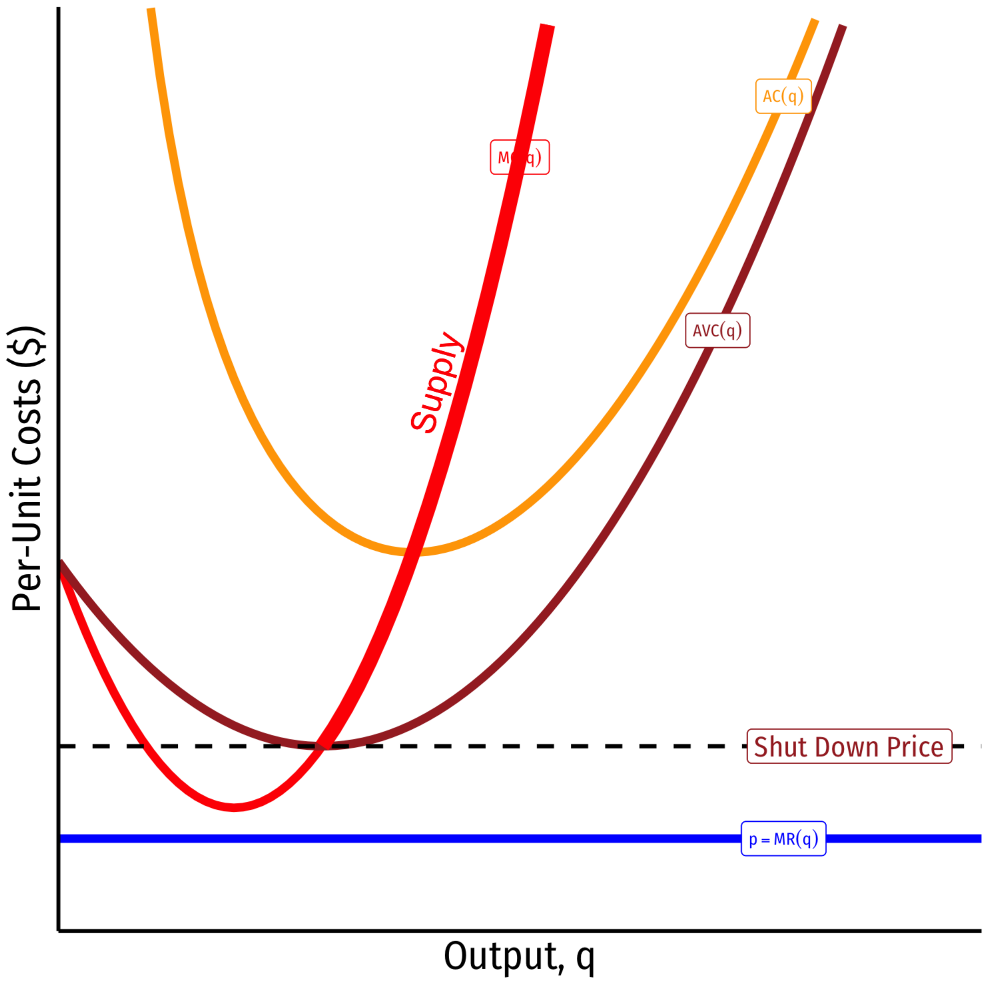
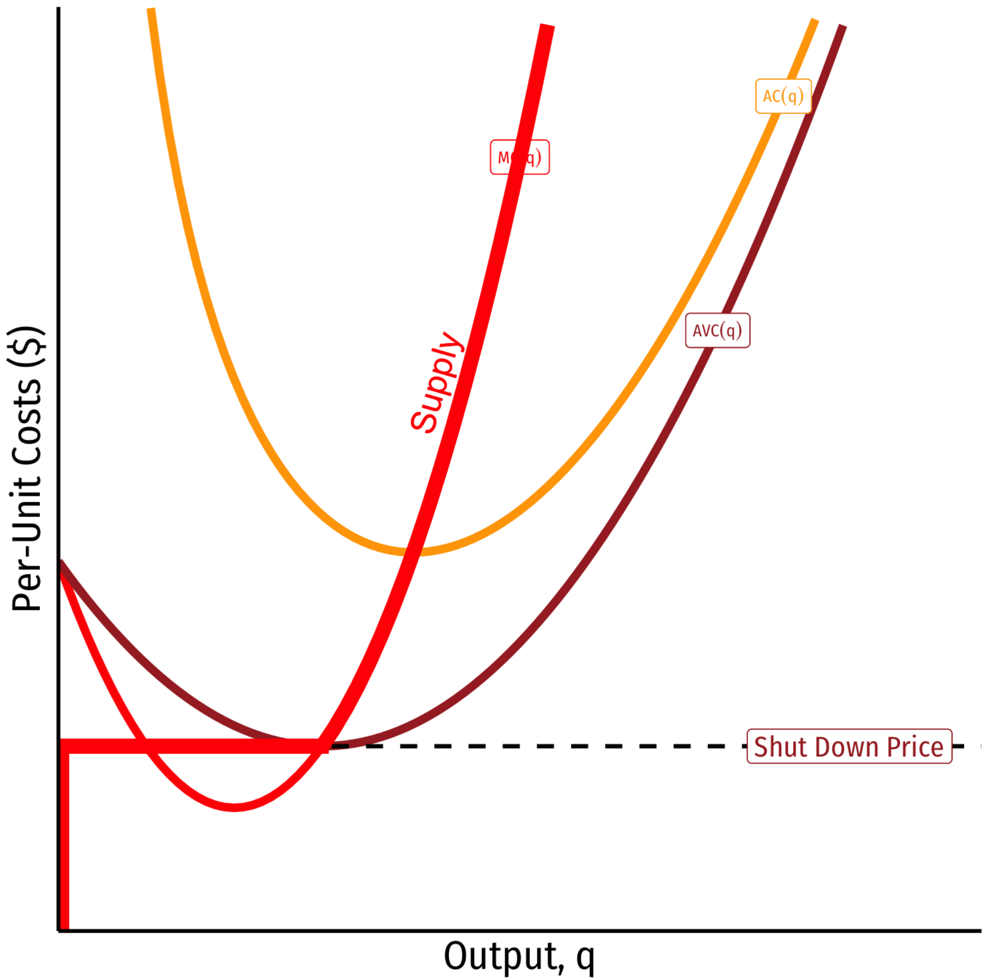


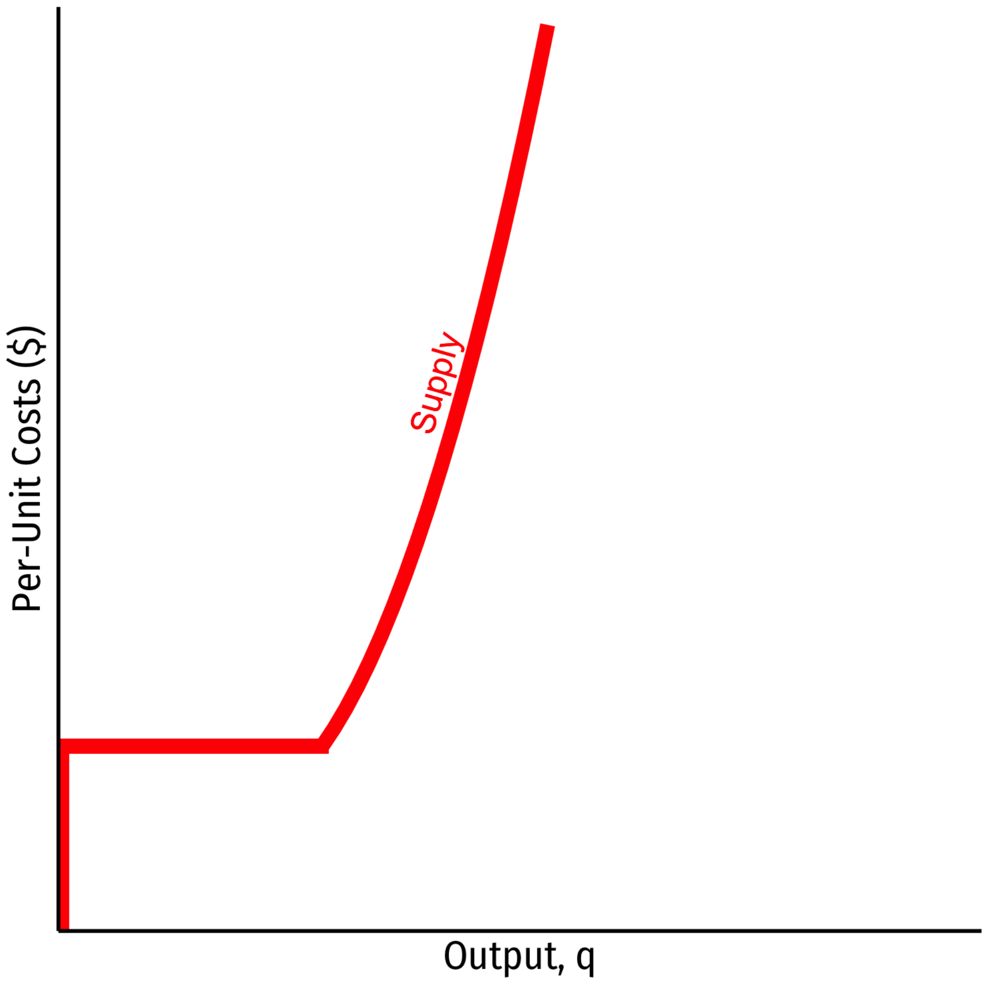
The Firm's Short Run Supply Decision



Firm's short run supply curve:

$$\begin{cases} p = MC(q) & \text{if } p \geq AVC \\ q = 0 & \text{If } p < AVC \end{cases}$$

The Firm's Short Run Supply Decision



Firm's short run supply curve:

$$\begin{cases} p = MC(q) & \text{if } p \geq AVC \\ q = 0 & \text{If } p < AVC \end{cases}$$

Summary:

1. Choose q^* **such that** $MR(q) = MC(q)$

2. Profit $\pi = q[p - AC(q)]$

3. Shut down if $p < AVC(q)$

Firm's short run (inverse) supply:

$$\begin{cases} p = MC(q) & \text{if } p \geq AVC \\ q = 0 & \text{If } p < AVC \end{cases}$$

Choosing the Profit-Maximizing Output q^*: Example

Example: Bob's barbershop gives haircuts in a very competitive market, where barbers cannot differentiate their haircuts. The current market price of a haircut is $15. Bob's daily short run costs are given by:

$$
\begin{aligned}
C(q) &= 0.5q^2 \\
MC(q) &= q
\end{aligned}
$$

1. How many haircuts per day would maximize Bob's profits?

2. How much profit will Bob earn per day?

3. Find Bob's shut down price.