2.5 — Short Run Profit Maximization

ECON 306 • Microeconomic Analysis • Spring 2021

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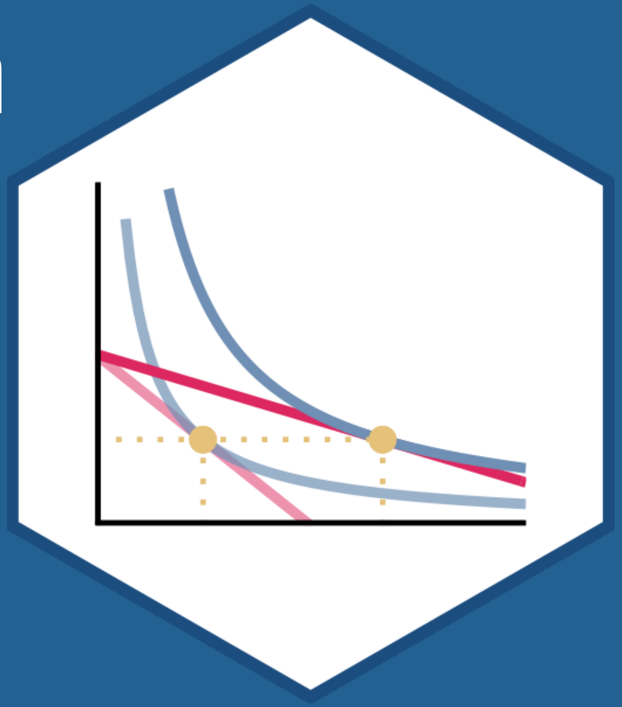
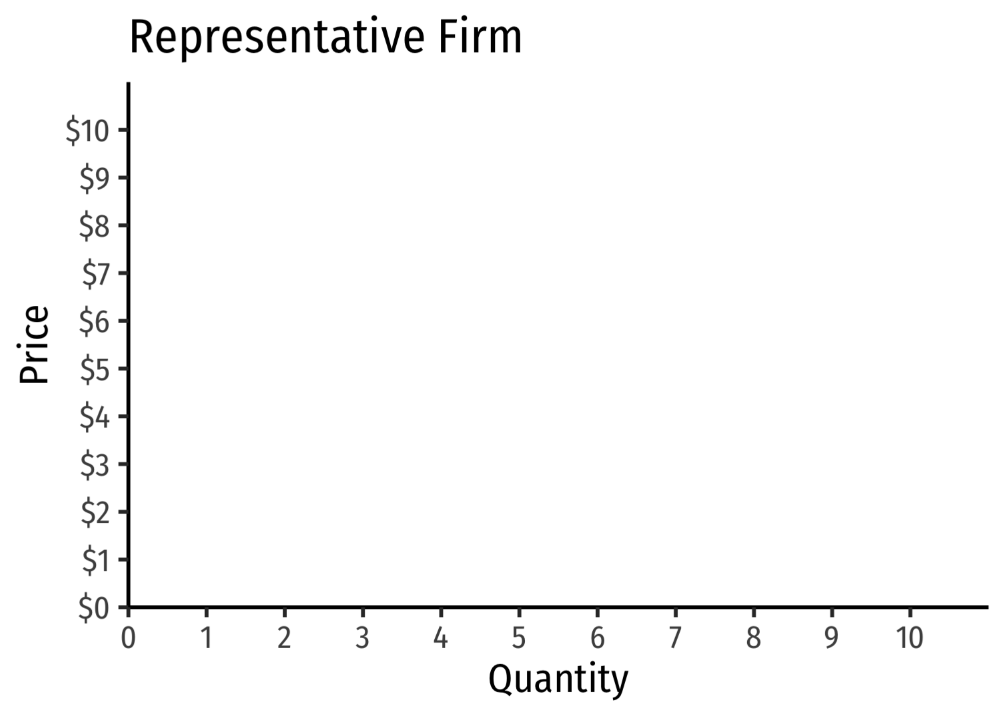
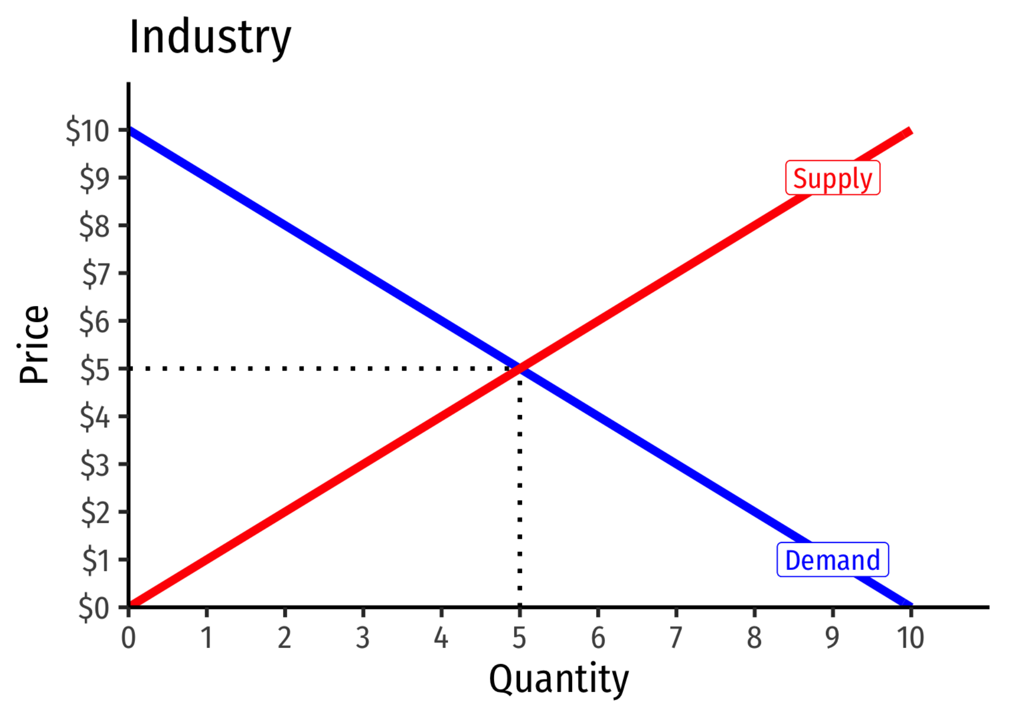


Outline

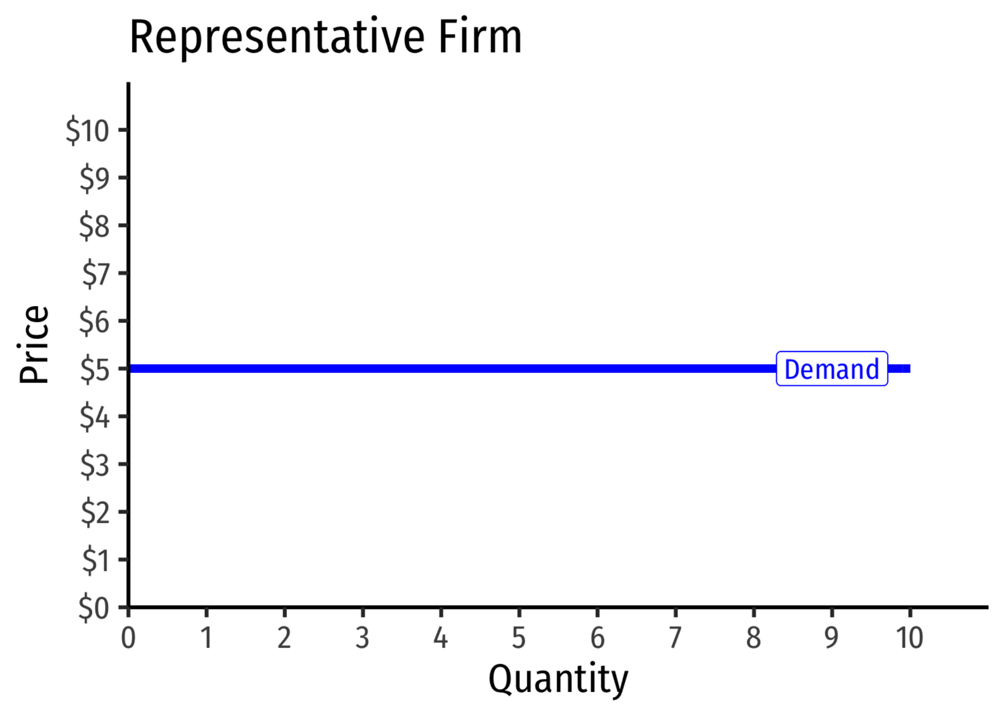
Revenues

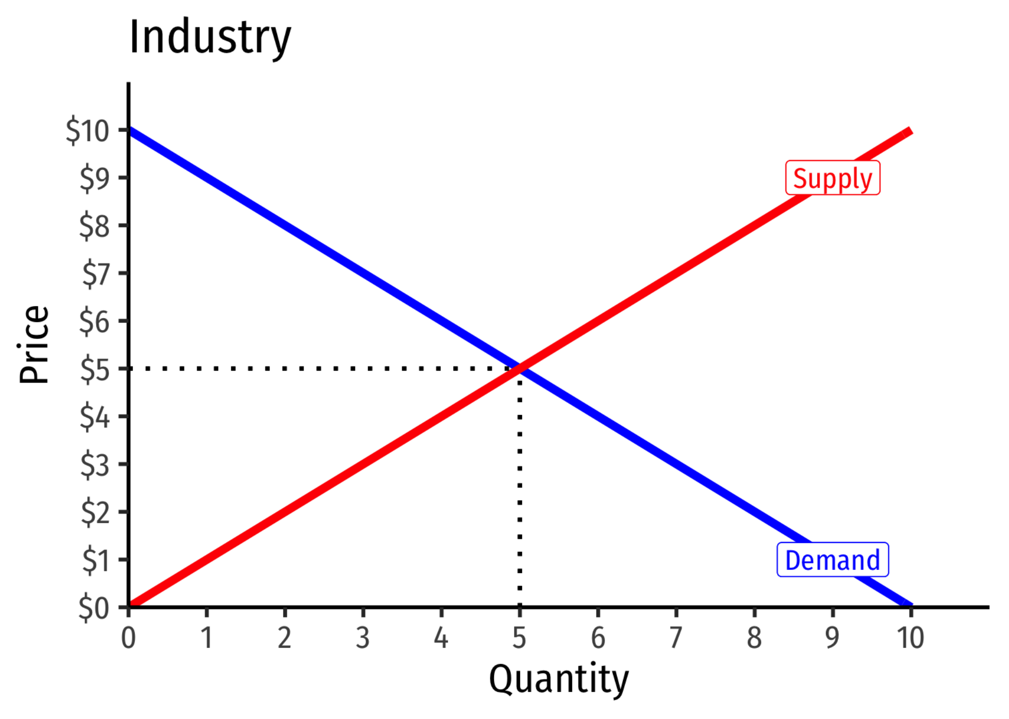
Revenues for Firms in *Competitive* Industries I





Revenues for Firms in *Competitive* Industries I

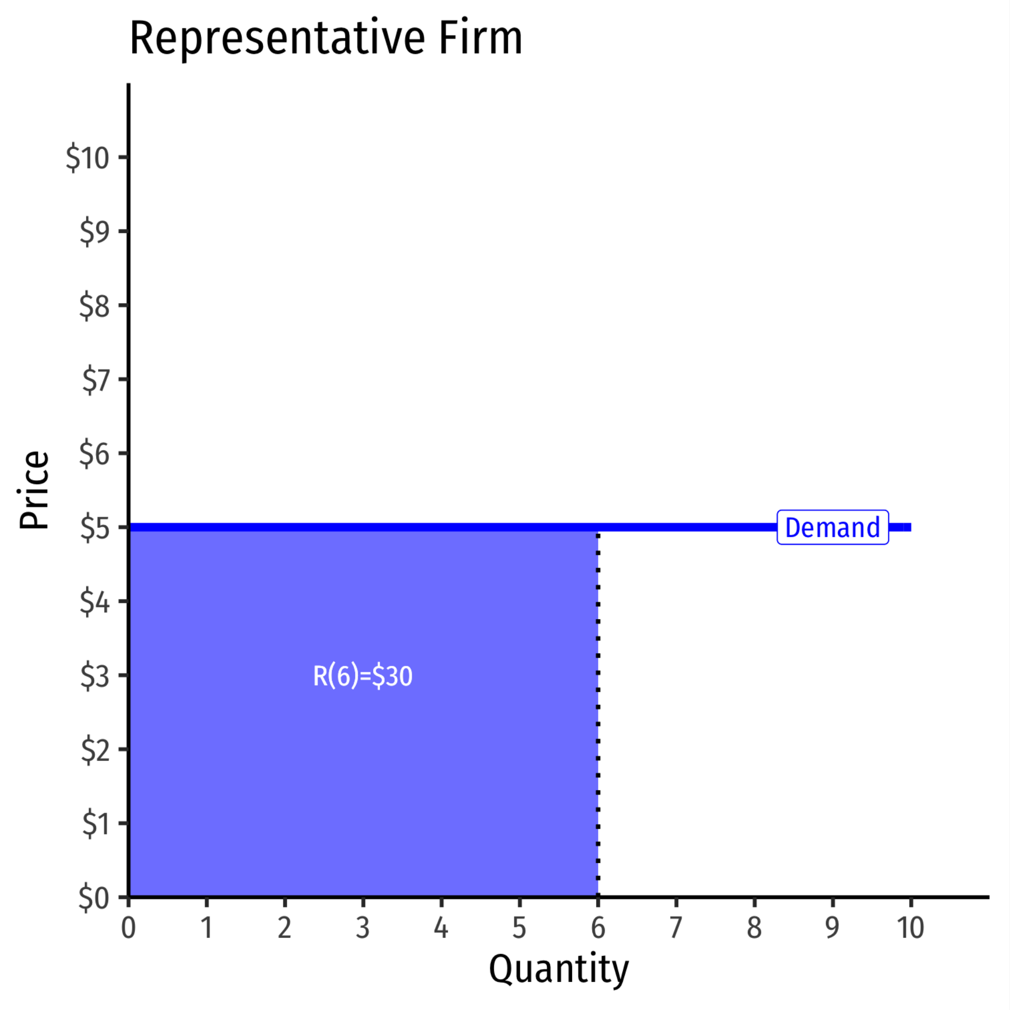




- Demand for a firm's product is **perfectly elastic** at the market price

- Where did the supply curve come from? You'll see

Revenues for Firms in *Competitive* Industries II



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

Average and Marginal Revenues

- **Average Revenue**: revenue per unit of output $$AR(q)=\frac{R}{q}$$
  - Is *always* 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, \(MR(q) = p\), 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:

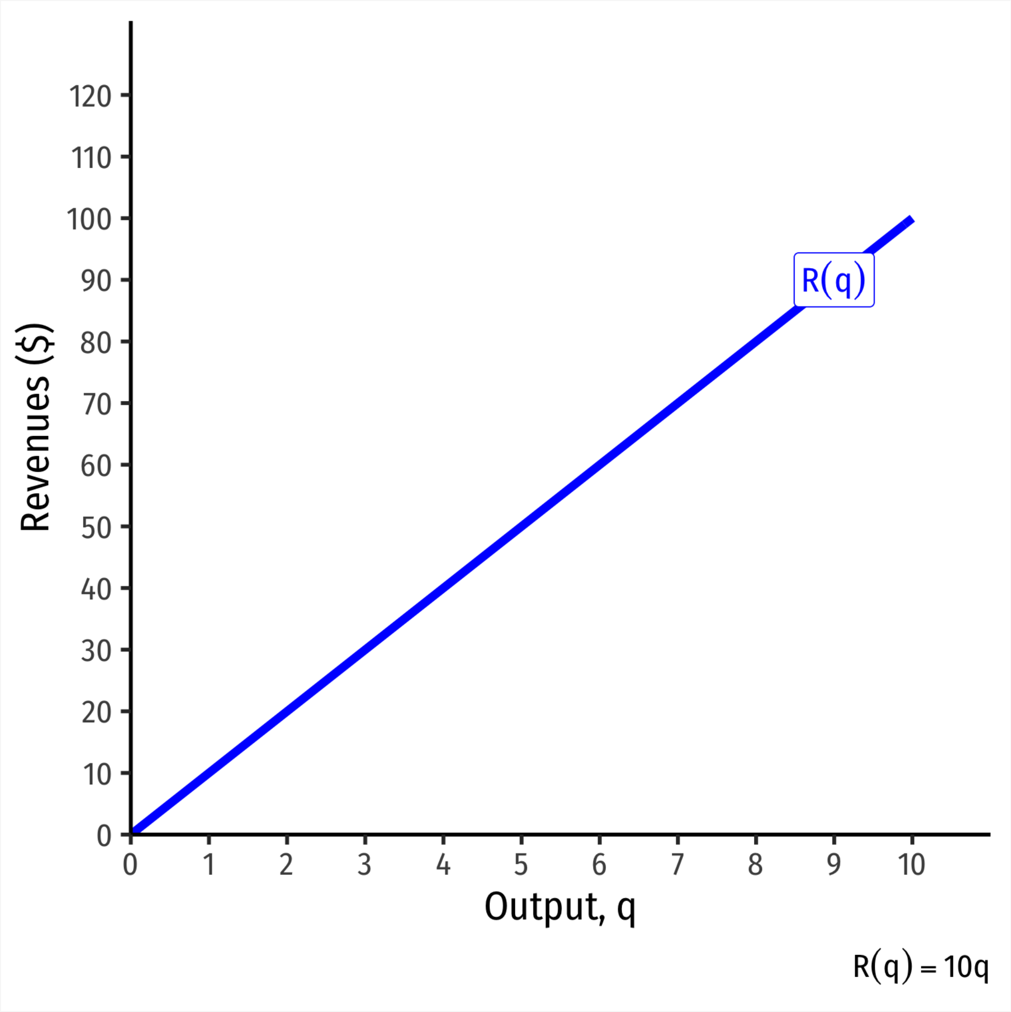
- What is the total revenue?
- What is the average revenue?

For the 2nd bushel sold:

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

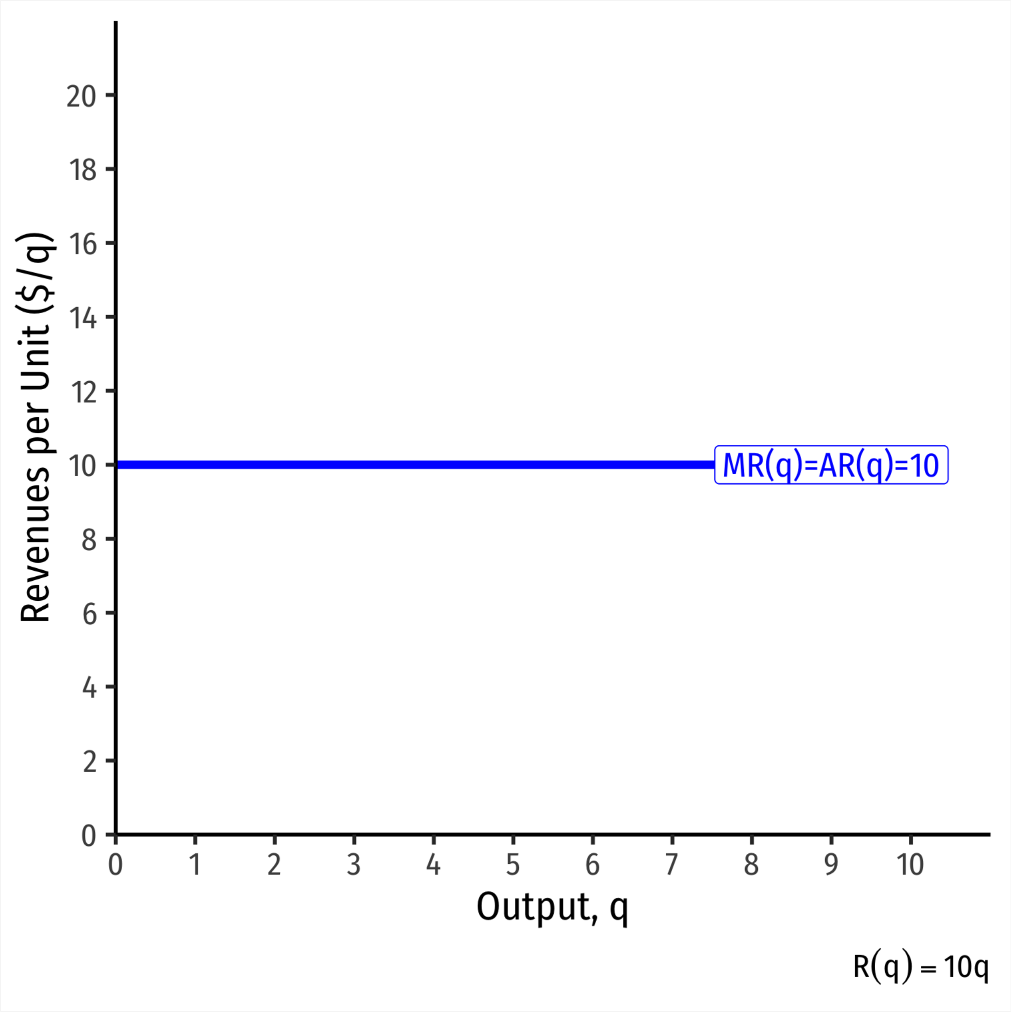
Total Revenue, Example: Visualized

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



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



Profits

Recall: The Firm's Two Problems

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

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

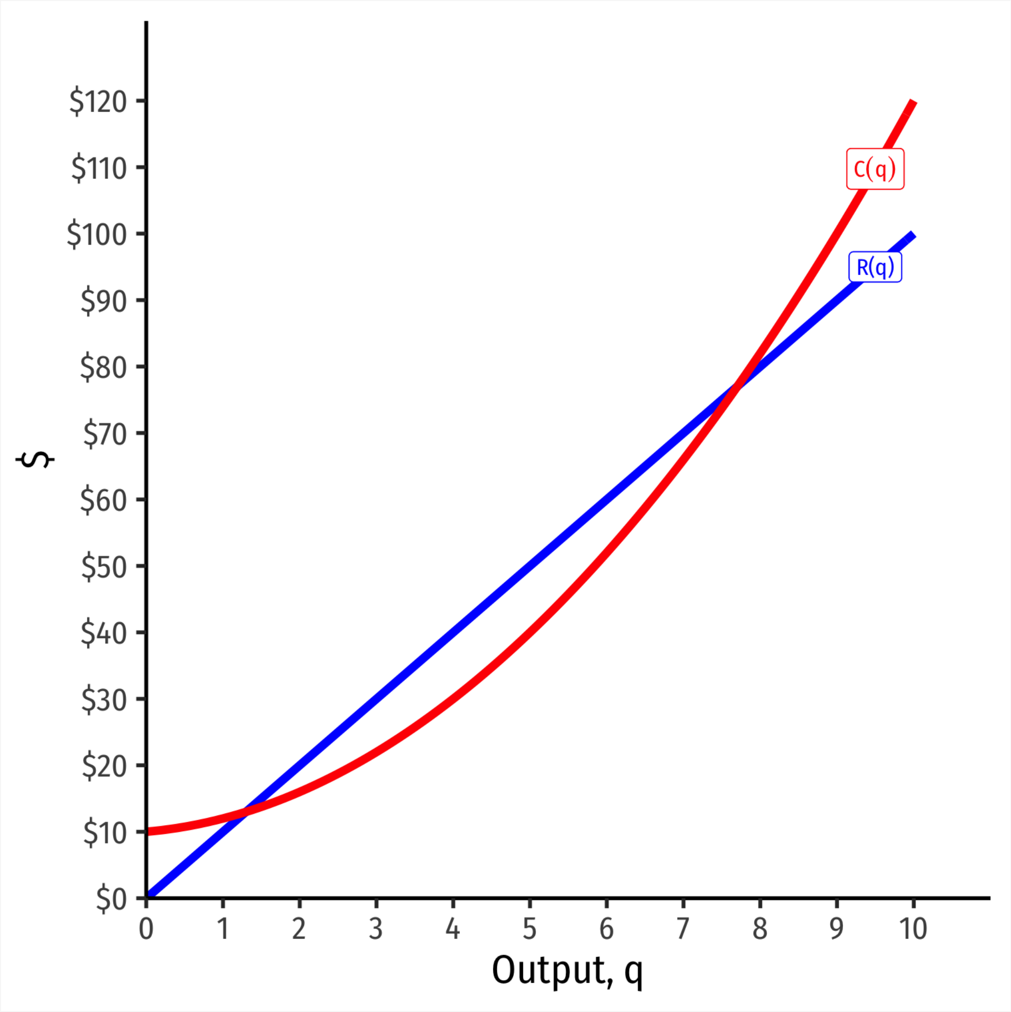
2nd Stage: **firm's cost minimization problem**:

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 $R(q)-C(q)$

- $\color{green}{\pi(q)}=\color{blue}{R(q)}-\color{red}{C(q)}$



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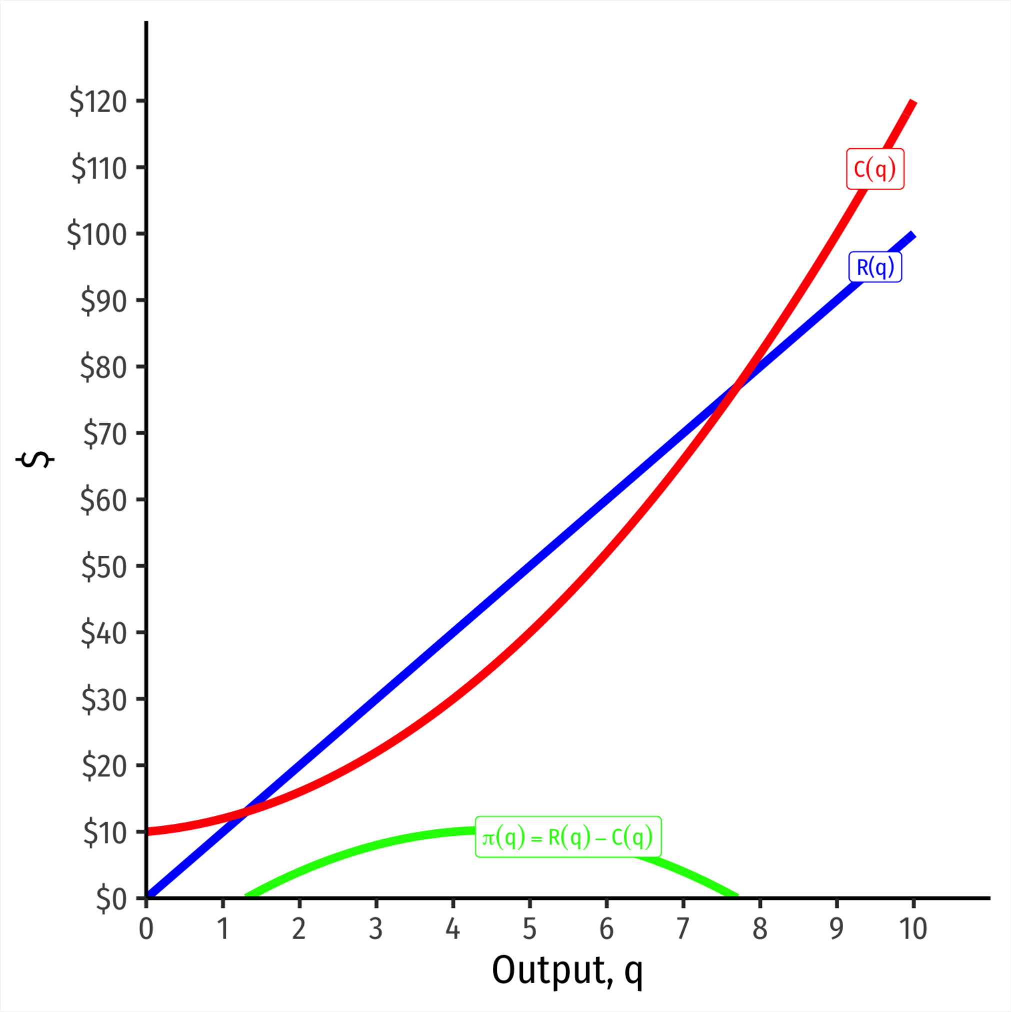
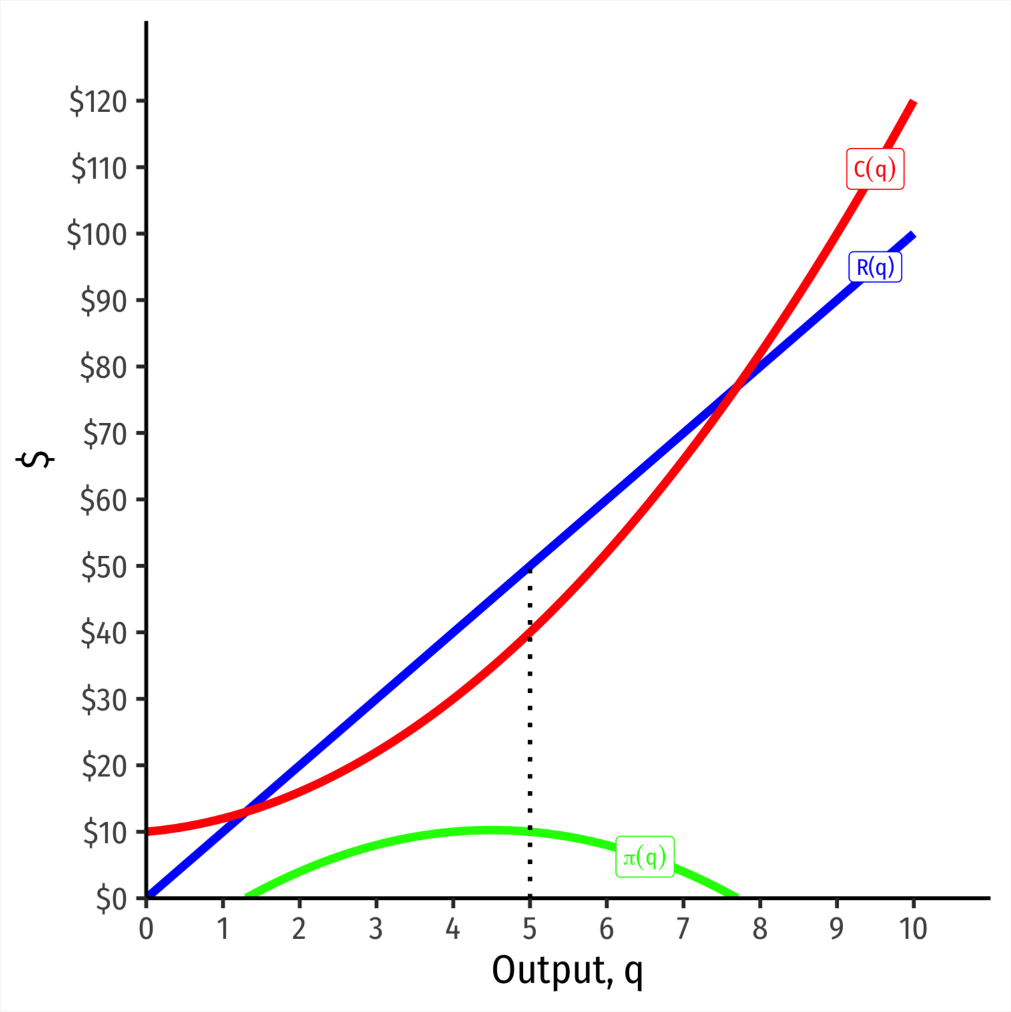


Visualizing Total Profit As \(R(q)-C(q)\)

- \(\color{green}{\pi(q)}=\color{blue}{R(q)}-\color{red}{C(q)}\)
- Graph: find \(q^*\) to max \(\pi \implies q^*\) where max distance between \(R(q)\) and \(C(q)\)

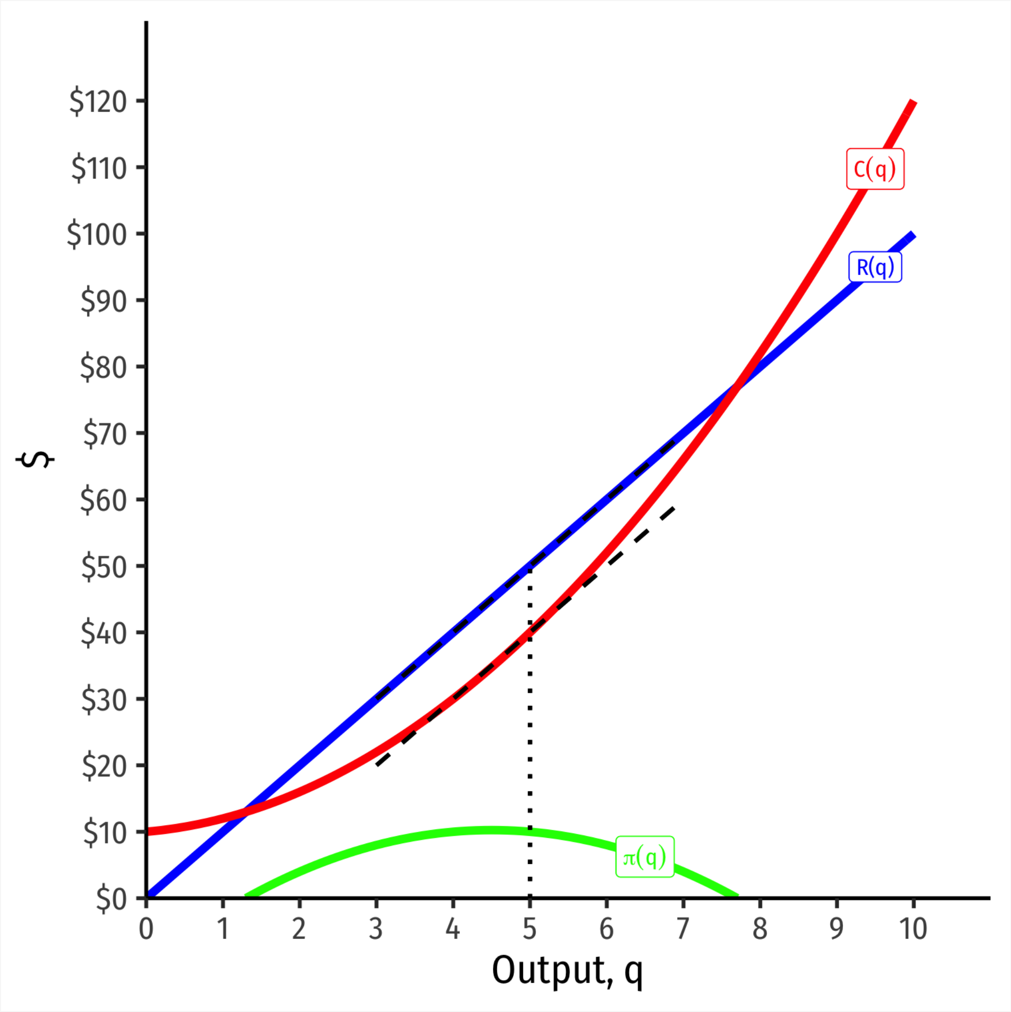


Visualizing Total Profit As $R(q)-C(q)$

- $\color{green}{\pi(q)}=\color{blue}{R(q)}-\color{red}{C(q)}$

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

- Slopes must be equal: $$\color{blue}{MR(q)}=\color{red}{MC(q)}$$



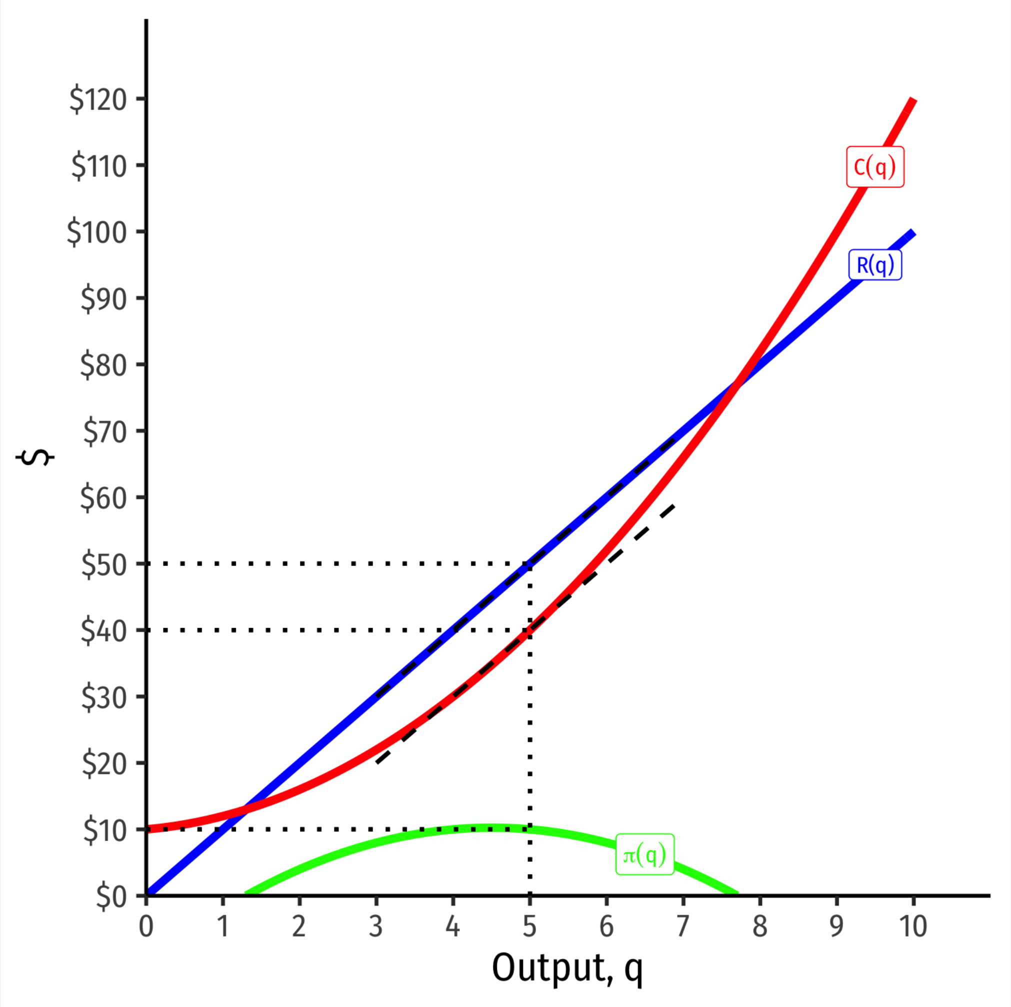
Visualizing Total Profit As \(R(q)-C(q)\)

- \(\color{green}{\pi(q)}=\color{blue}{R(q)}-\color{red}{C(q)}\)

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

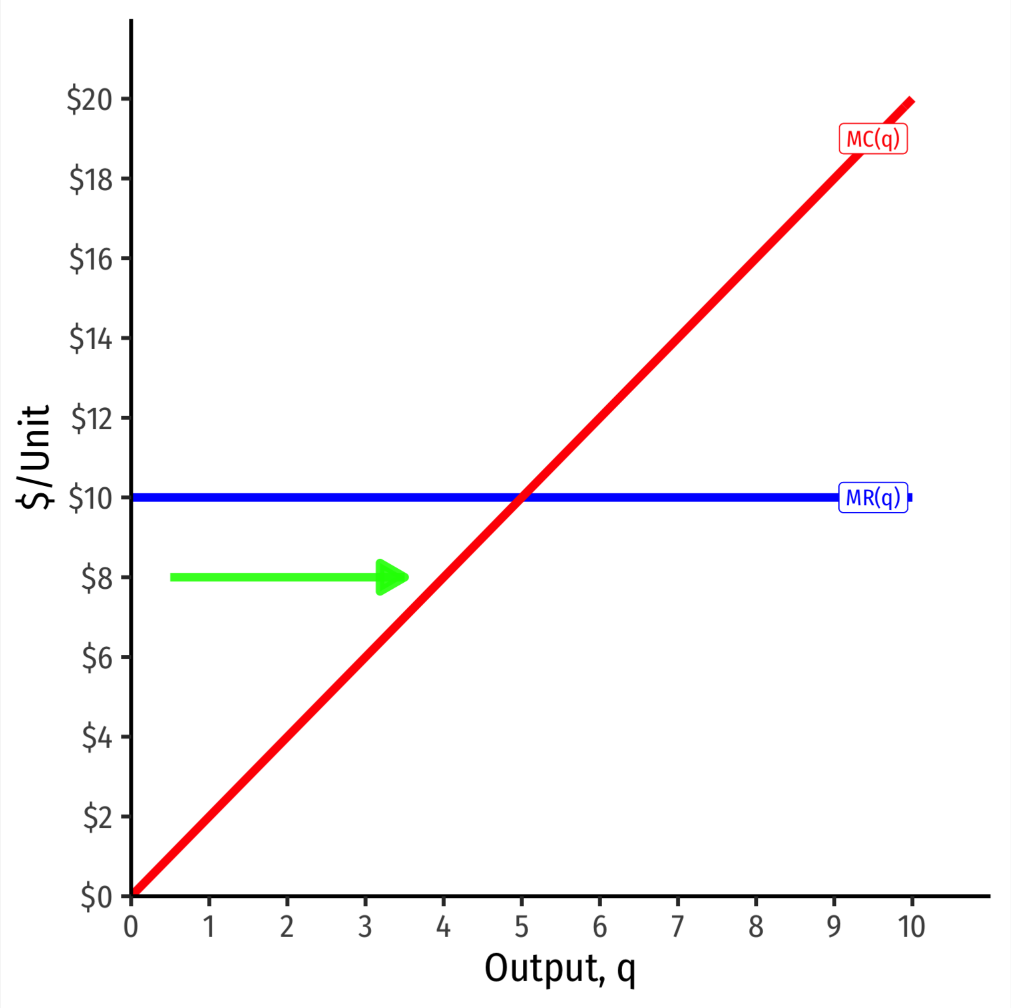
- Slopes must be equal: $$\color{blue}{MR(q)}=\color{red}{MC(q)}$$

- At \(q^*=5\):
  - \(\color{blue}{R(q)=50}\)
  - \(\color{red}{C(q)=40}\)
  - \(\color{green}{\pi(q)=10}\)



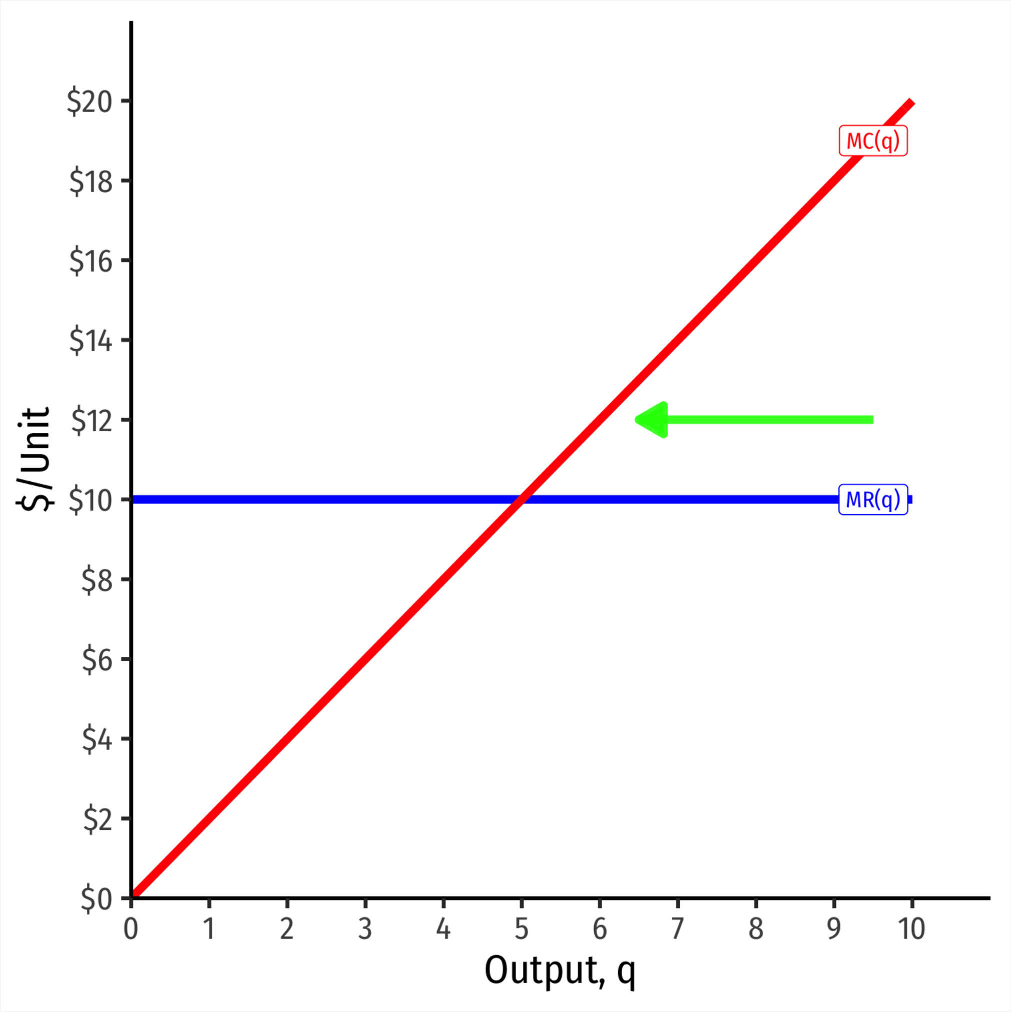
Visualizing Profit Per Unit As \(MR(q)\) and \(MC(q)\)

- At low output \(q<q^*\), can increase \(\pi\) by producing *more*: \(\color{blue}{MR(q)}>\color{red}{MC(q)}\)



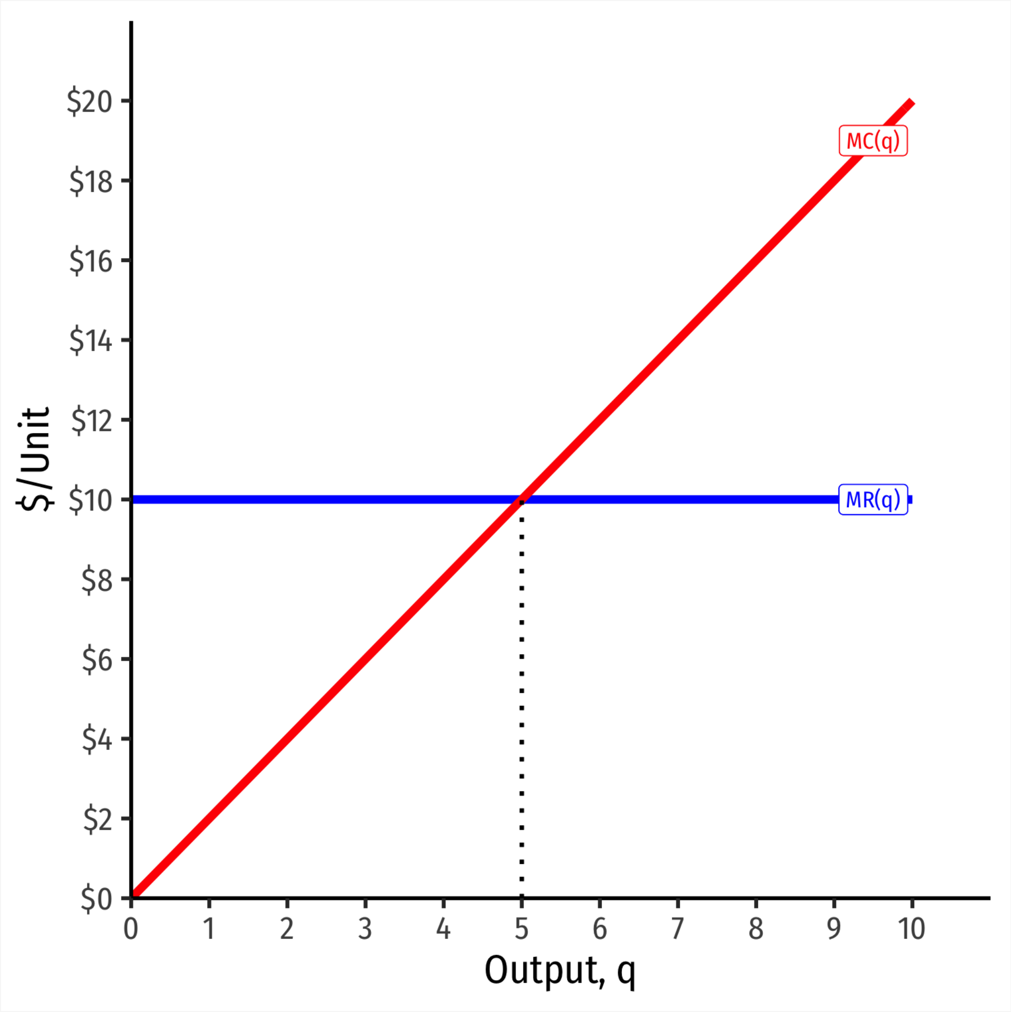
Visualizing Profit Per Unit As $MR(q)$ and $MC(q)$

- At high output $q>q^*$, can increase π by producing *less*: $\color{blue}{MR(q)}<\color{red}{MC(q)}$



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

- \(\pi\) is *maximized* where \(\color{blue}{MR(q)}=\color{red}{MC(q)}\)

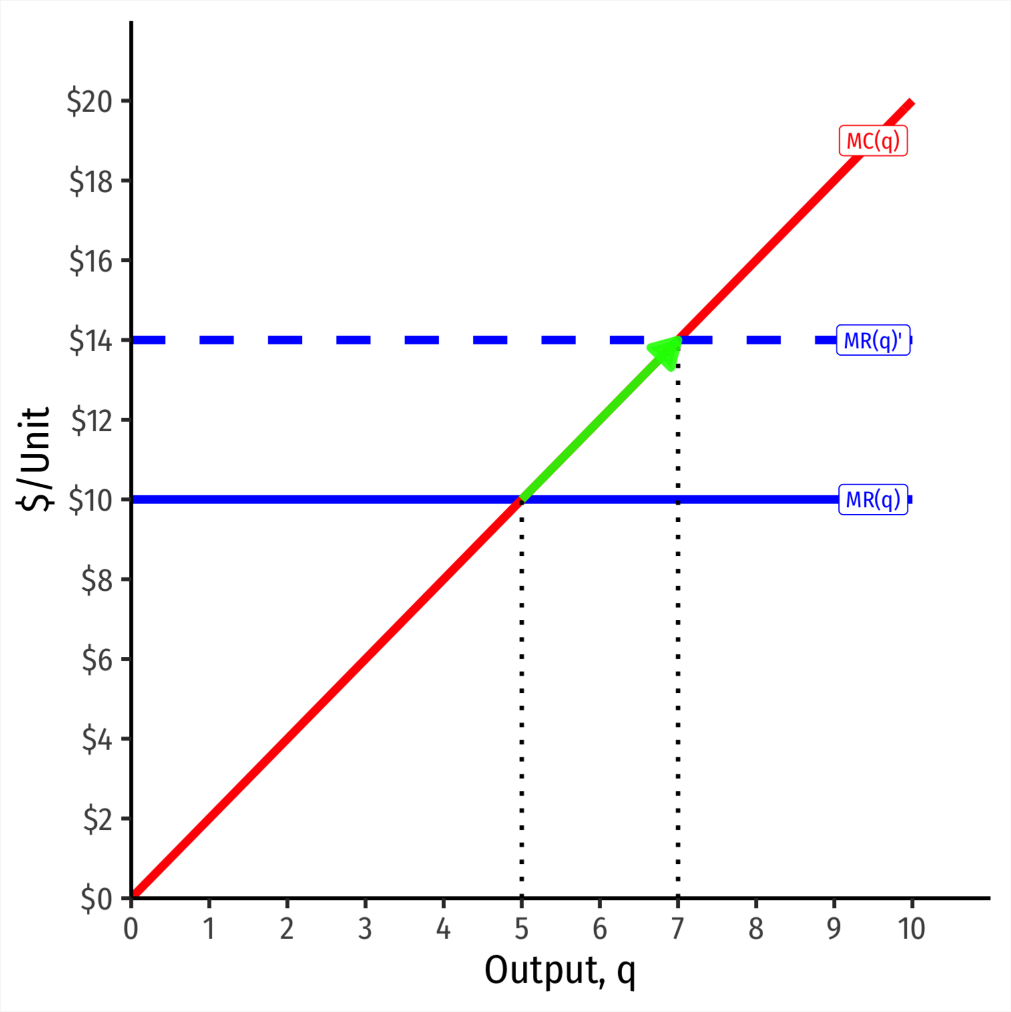


Comparative Statics

If Market Price Changes I

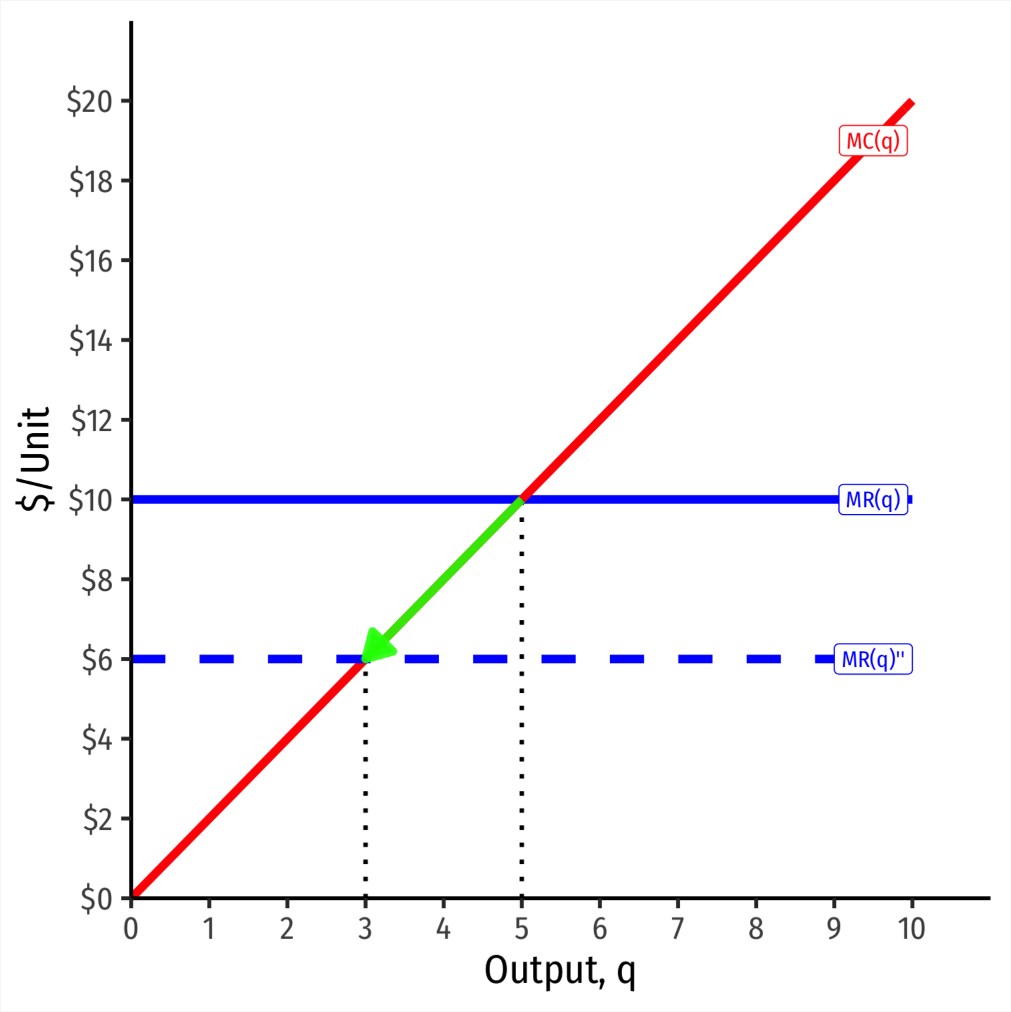
- Suppose the market price *increases*

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



If Market Price Changes II

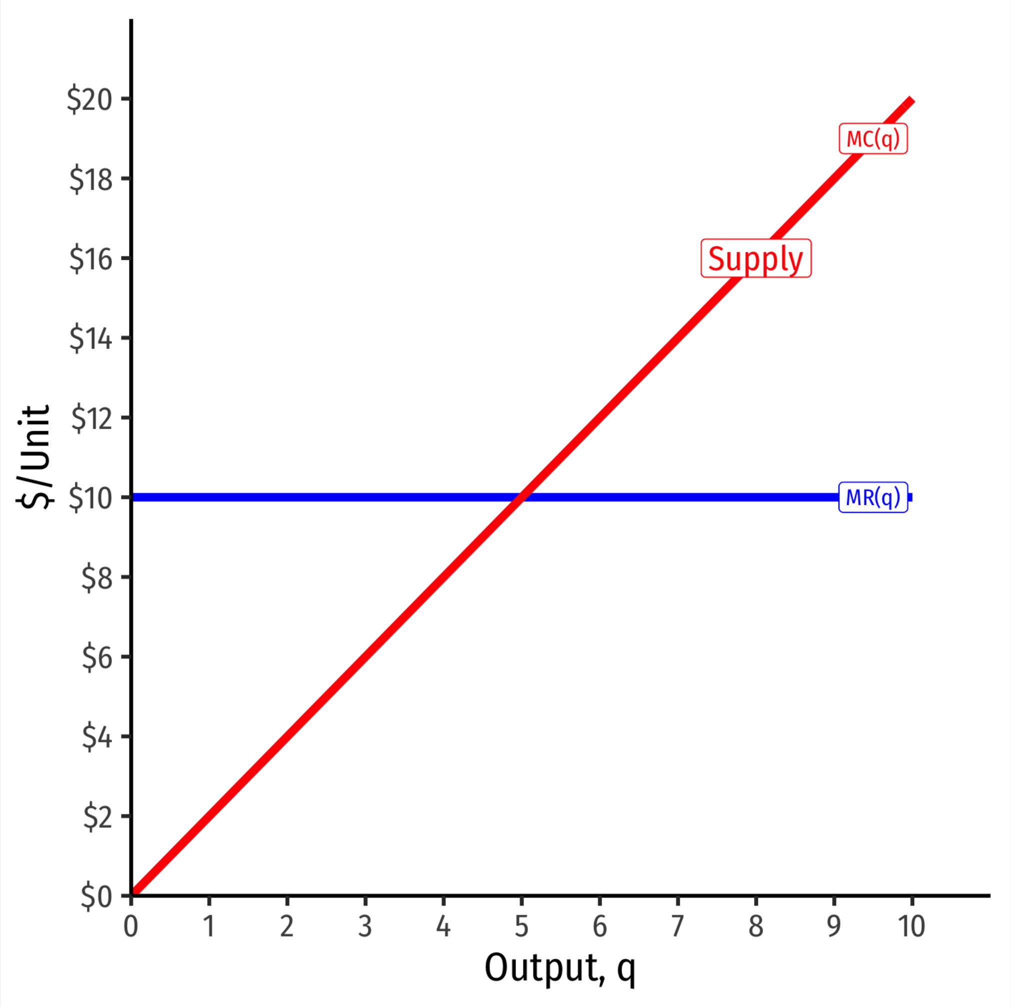
- Suppose the market price *decreases*
- Firm (always setting \(MR=MC)\) will respond by *producing more*



If Market Price Changes II

- **The firm's marginal cost curve is its (inverse) supply curve**†
  $$Supply=MC(q)$$
  - How it will supply the optimal amount of output in response to the market price
- There is an exception to this! We will see shortly!

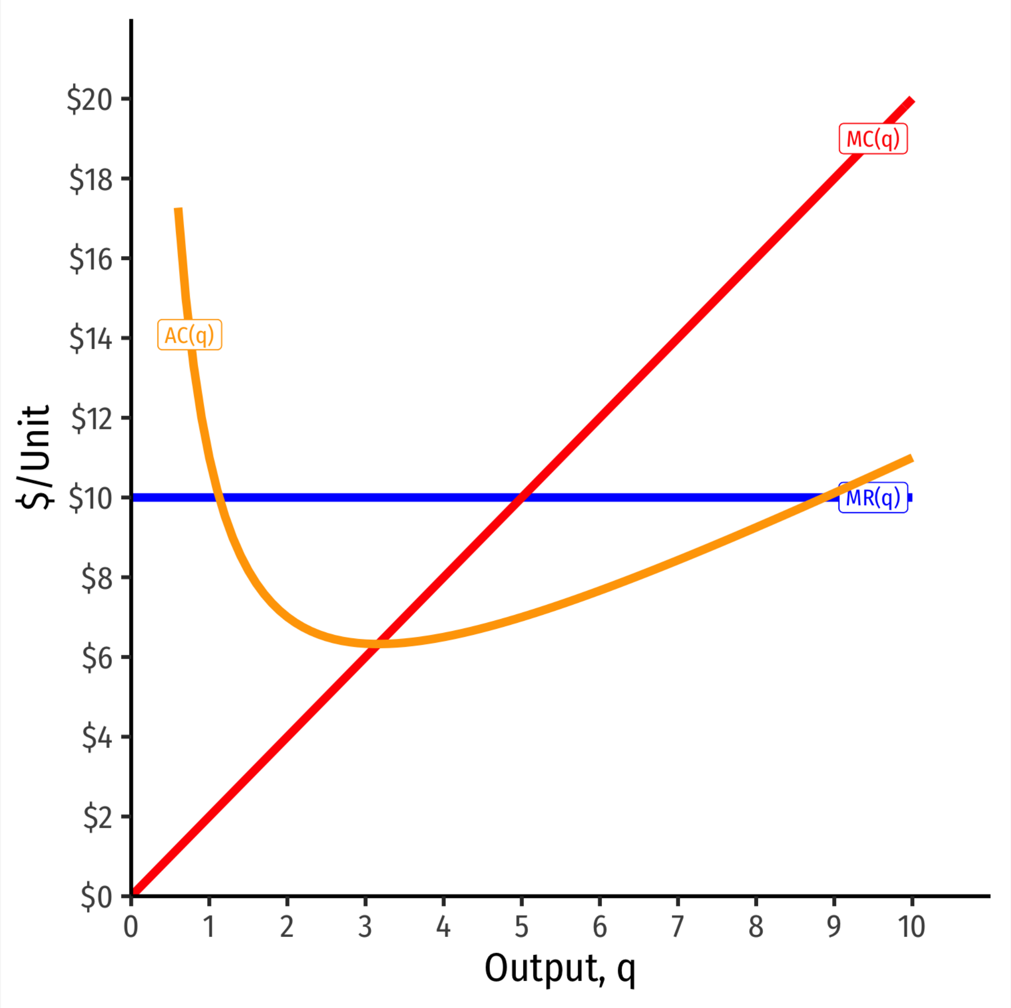
† Mostly...there is an exception we will see shortly!



Calculating Profit

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

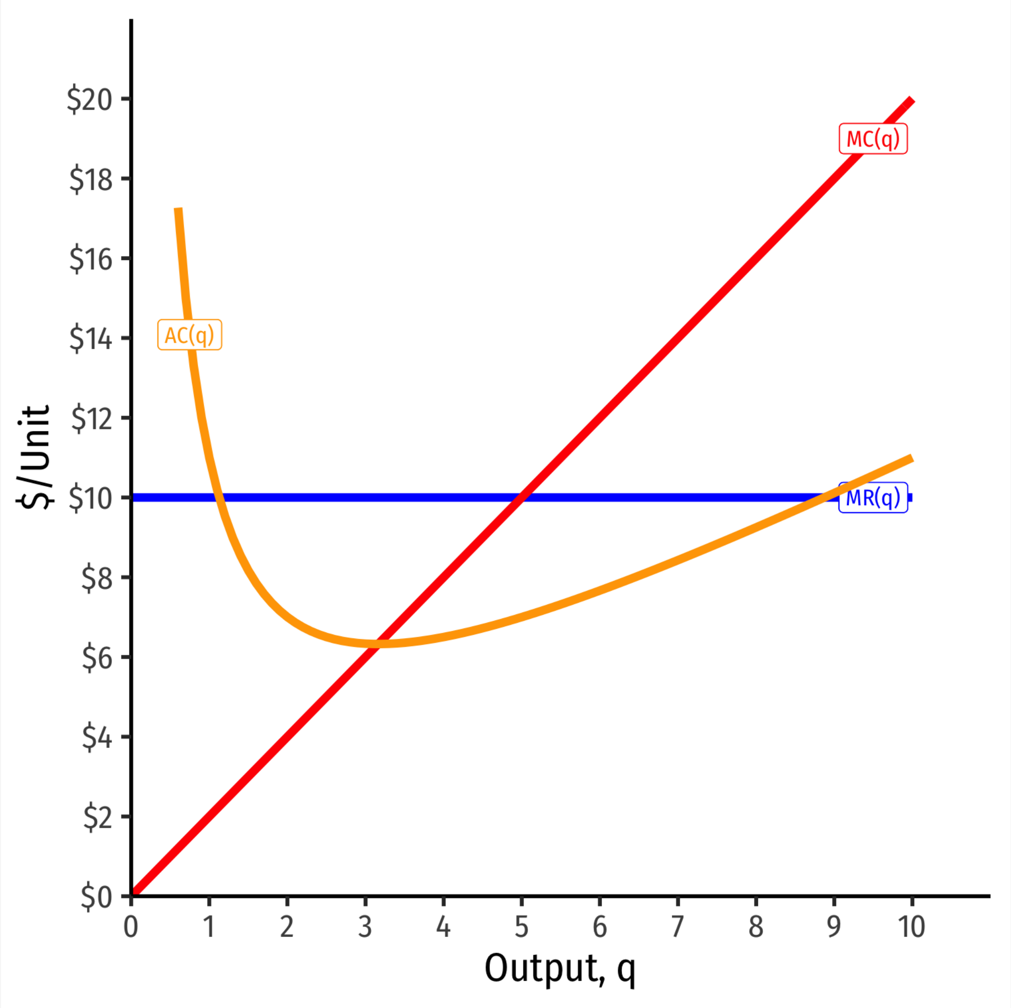
- Profit is $$\pi(q)=R(q)-C(q)$$



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

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

- Profit per unit can be calculated as: $$\begin{align*} \frac{\pi(q)}{q}&=\color{blue}{AR(q)}-\color{orange}{AC(q)}\\ &=\color{blue}{p}-\color{orange}{AC(q)}\\ \end{align*}$$



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

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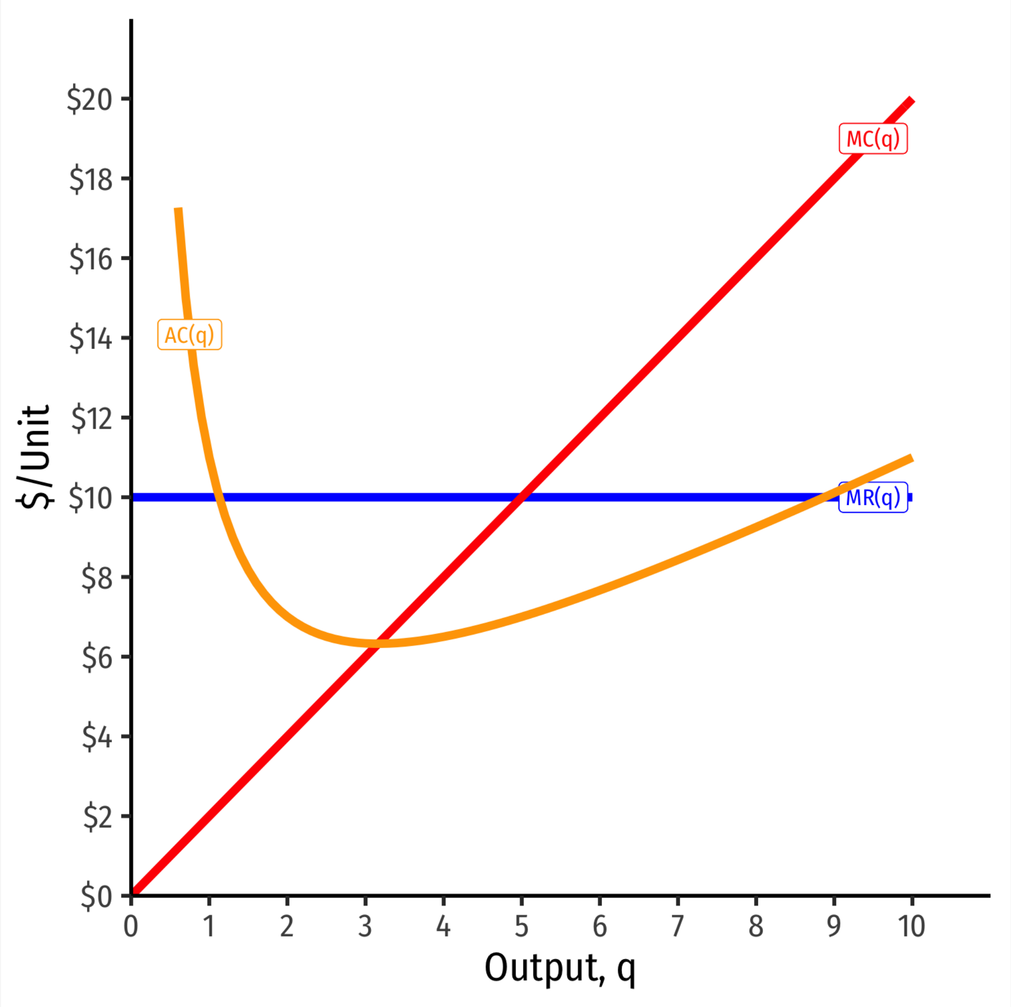
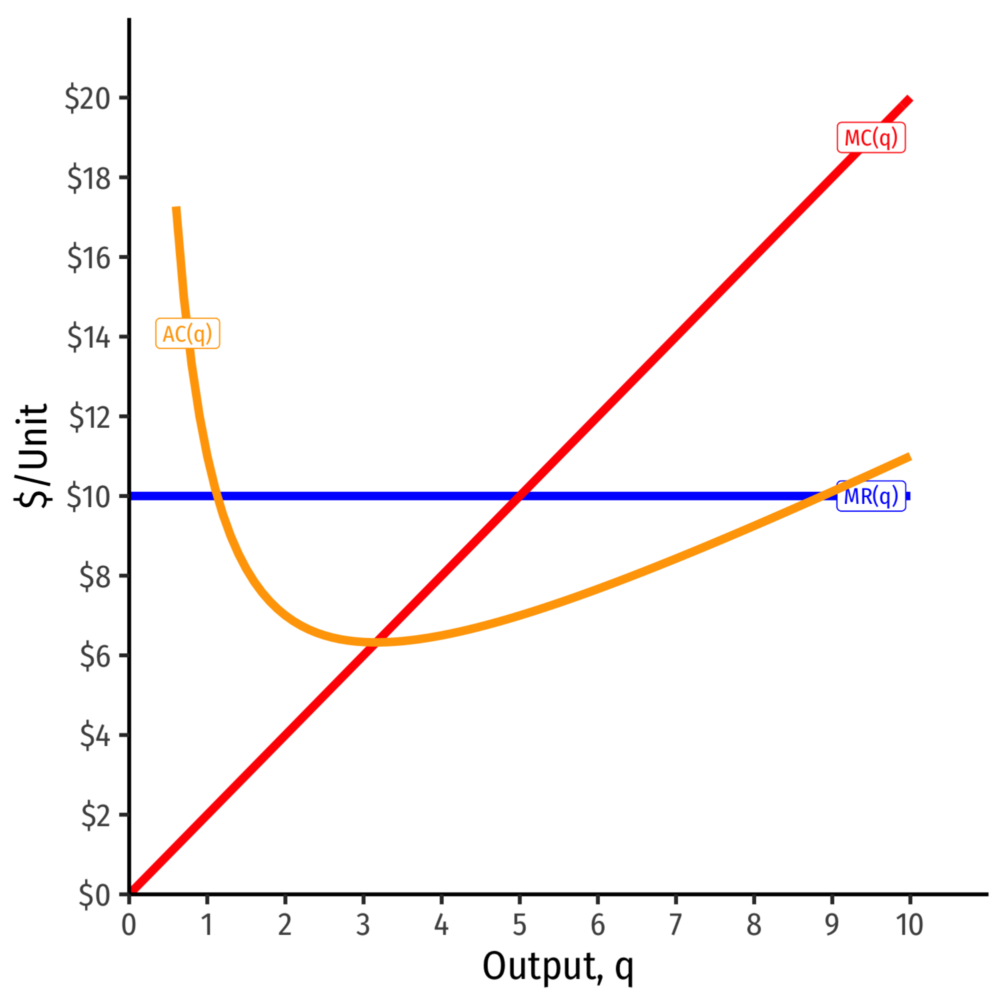
- Profit per unit can be calculated as: $$\begin{align*} \frac{\pi(q)}{q}&=\color{blue}{AR(q)}-\color{orange}{AC(q)}\\ &=\color{blue}{p}-\color{orange}{AC(q)}\\ \end{align*}$$

- Multiply by \(q\) to get total profit: $$\pi(q)=q\left[\color{blue}{p}-\color{orange}{AC(q)} \right]$$



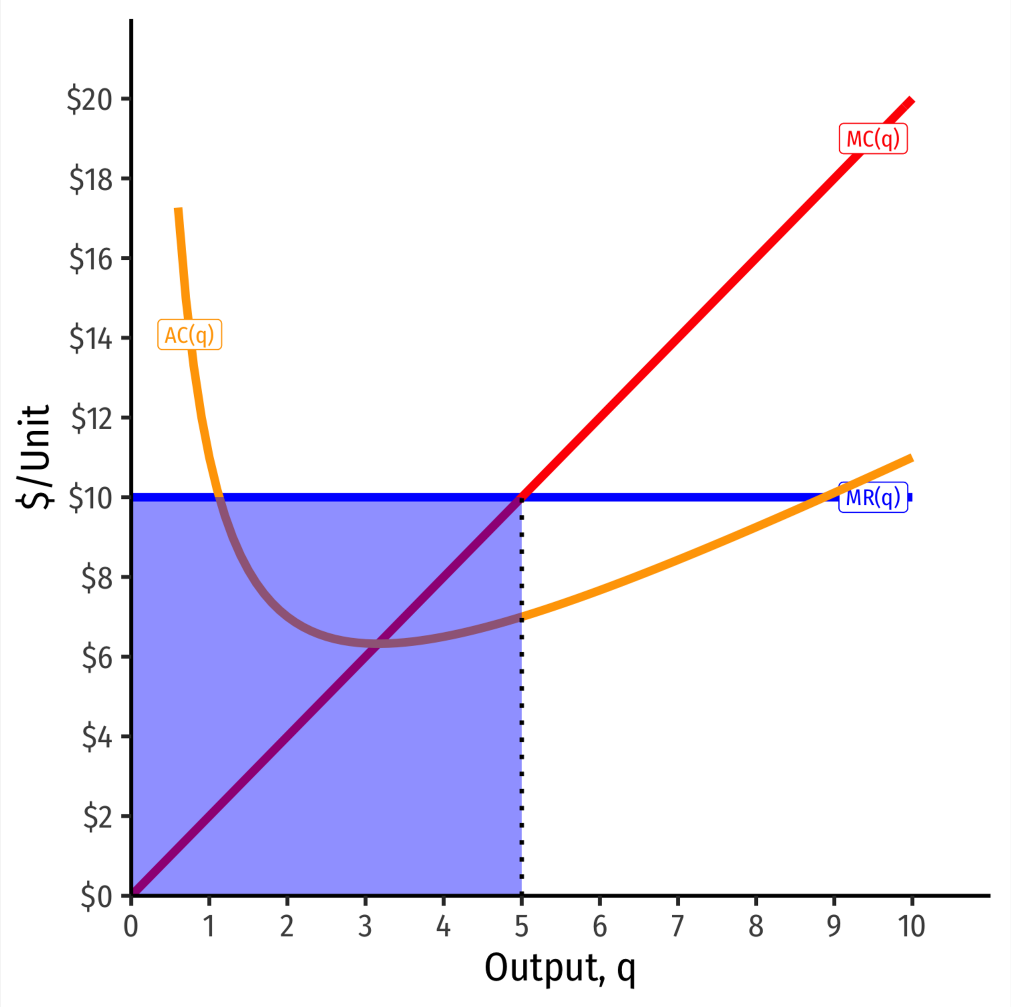
Calculating Average Profit as $AR(q)-AC(q)$

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



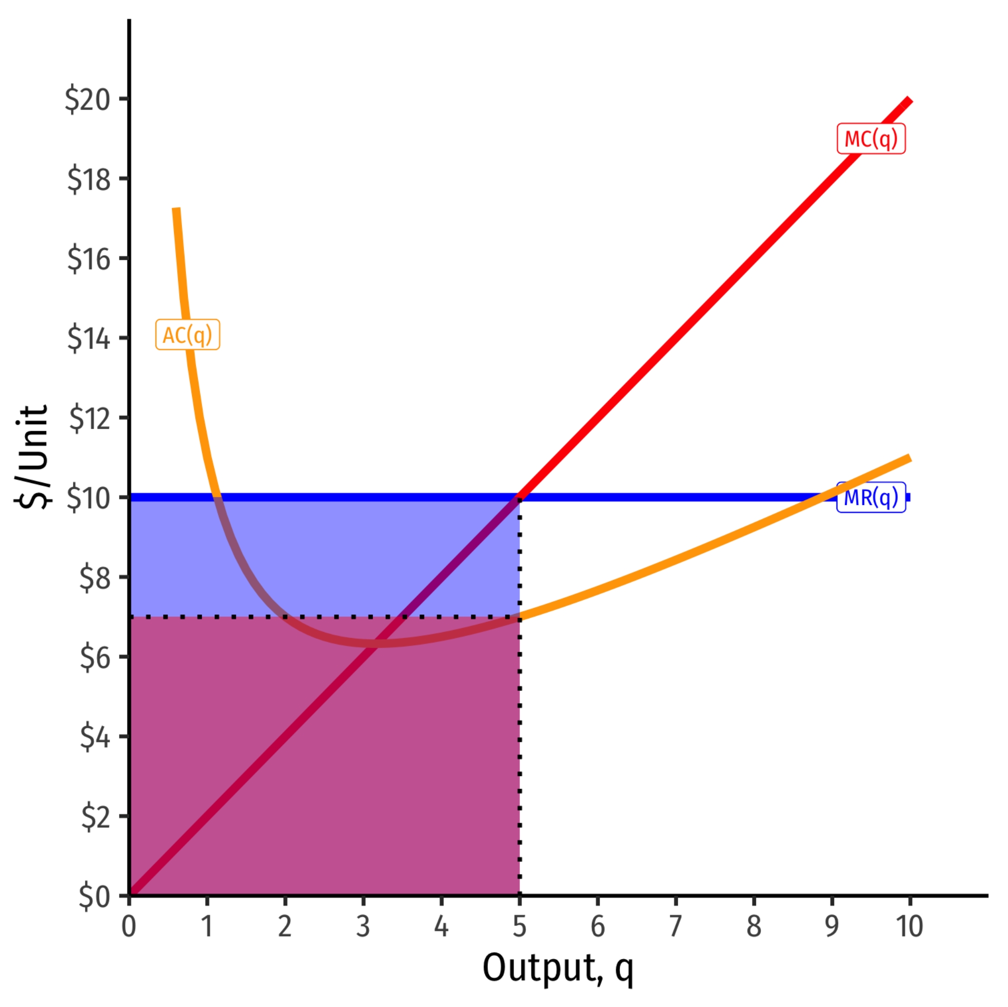
Calculating Average Profit as \(AR(q)-AC(q)\)

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



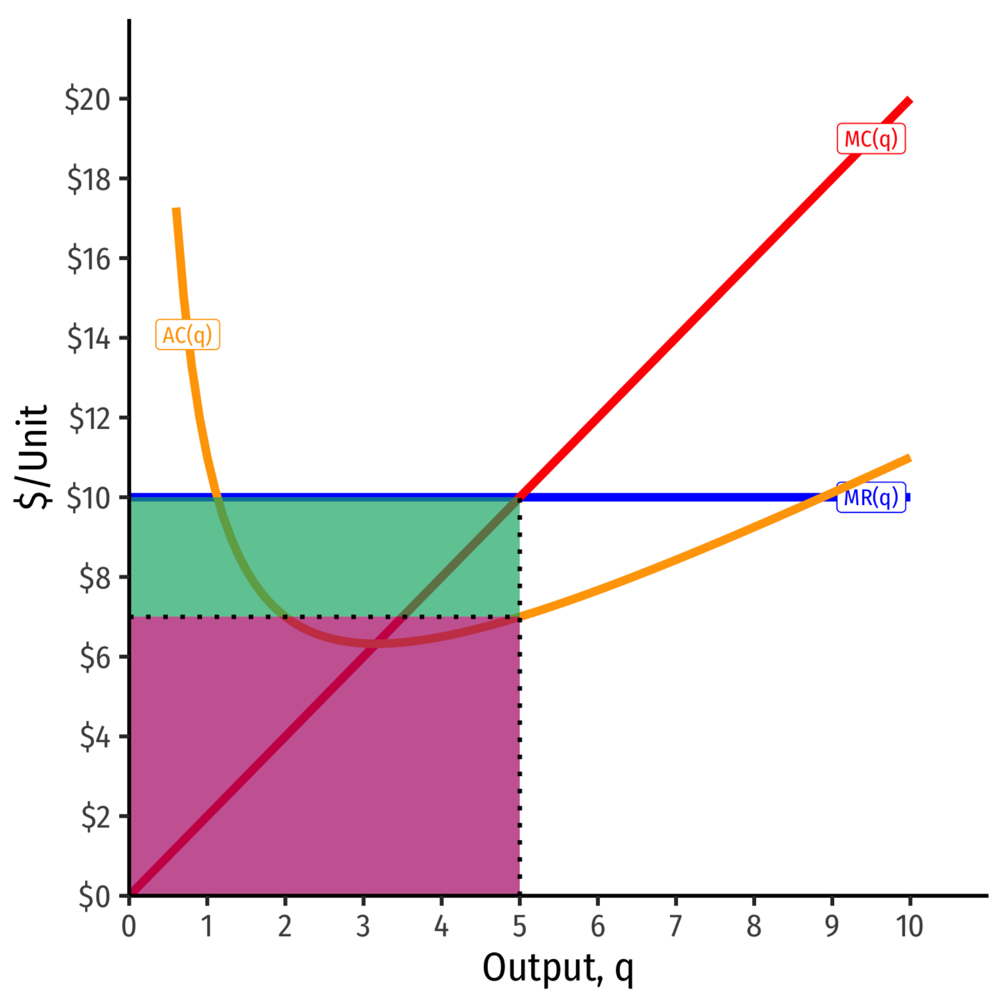
Calculating Average Profit as $AR(q)-AC(q)$

- 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



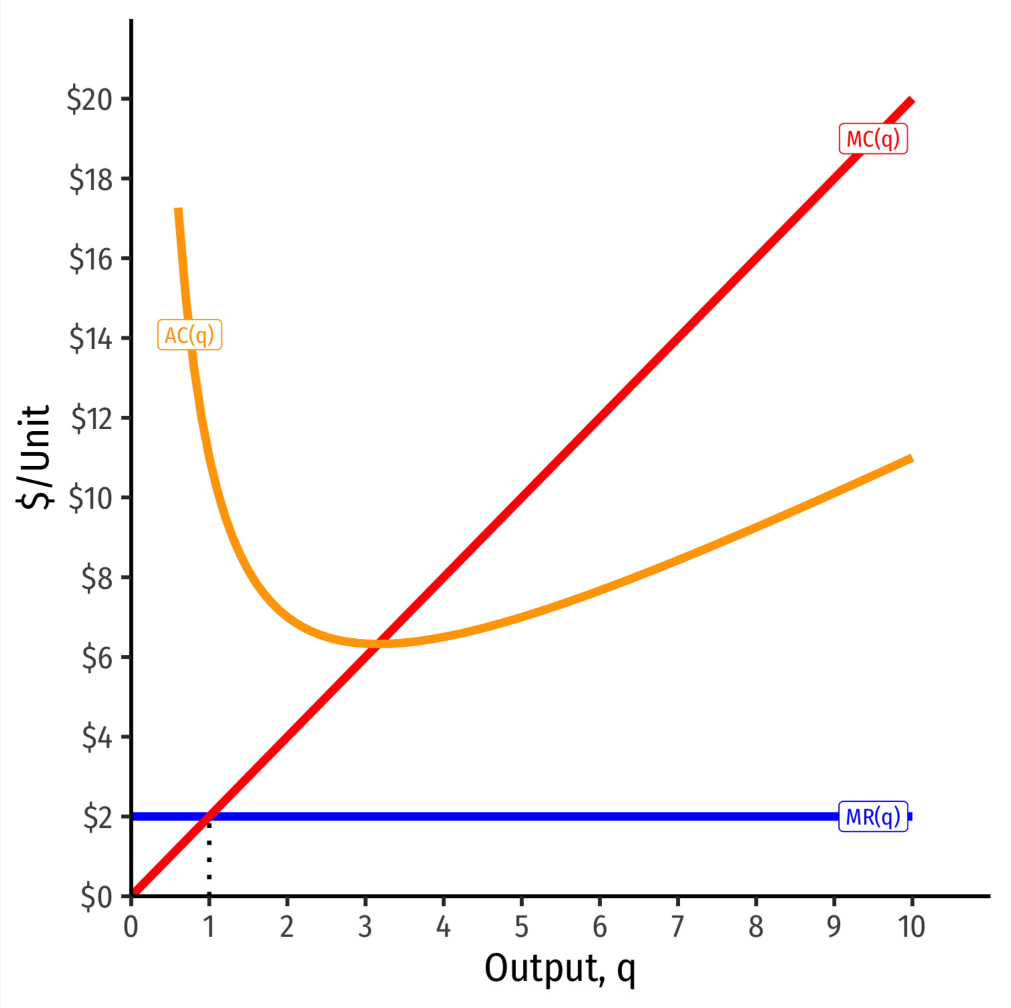
Calculating Average Profit as $AR(q)-AC(q)$

- 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):
  - $R(5) = \$50$
  - $C(5) = \$35$
  - $\pi = \$15$



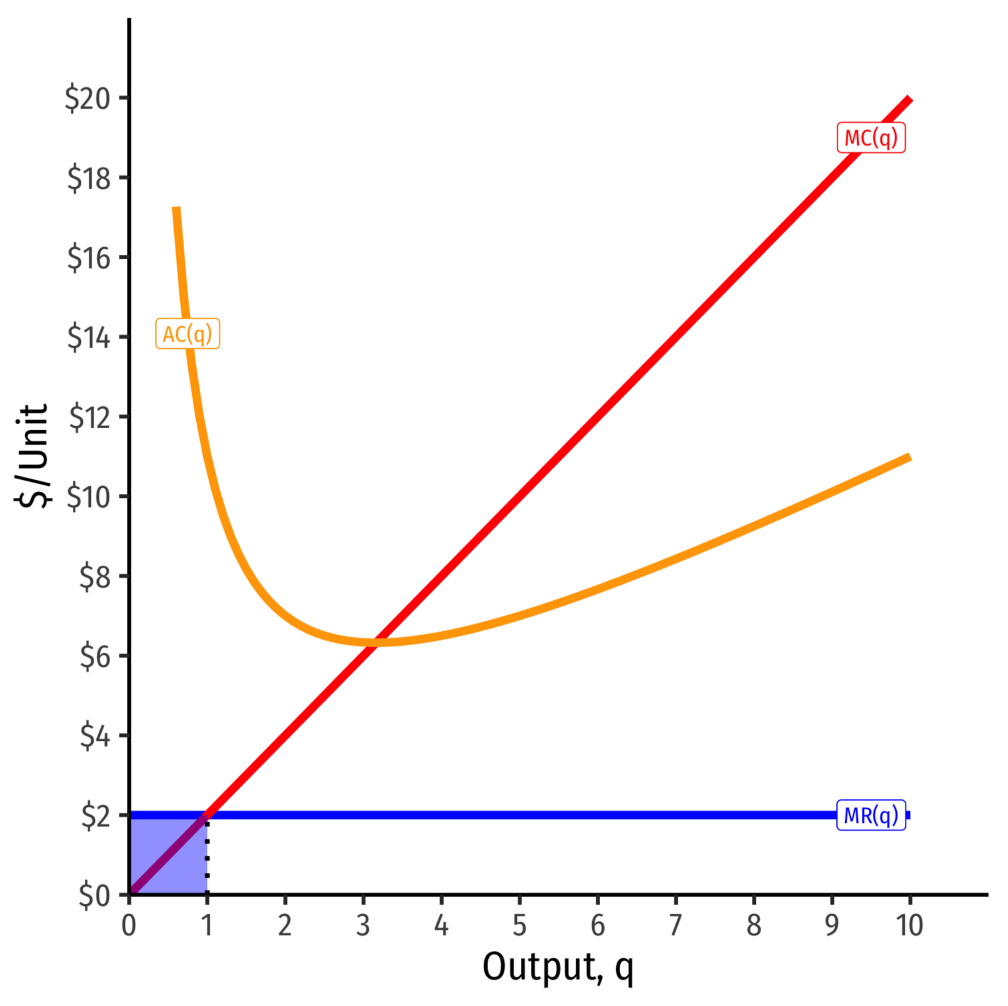
Calculating Average Profit as \(AR(q)-AC(q)\)

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



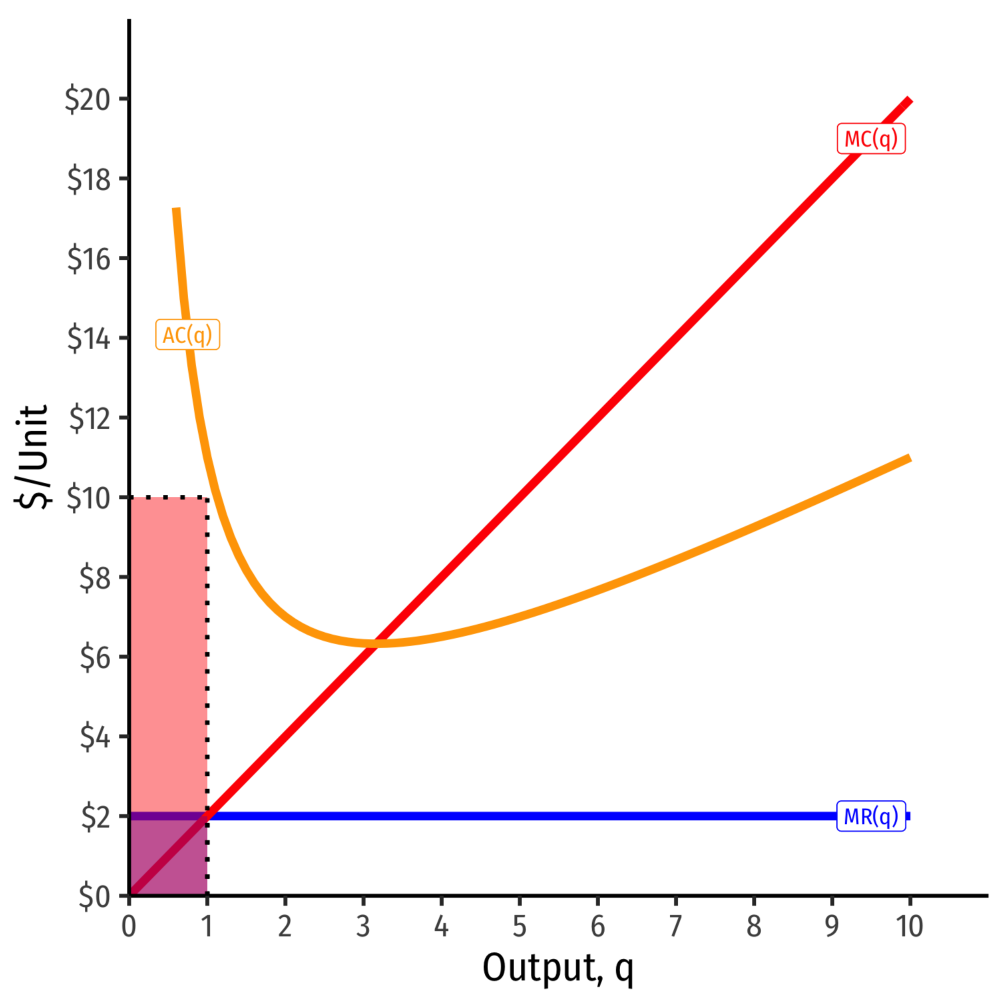
Calculating Average Profit as \(AR(q)-AC(q)\)

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



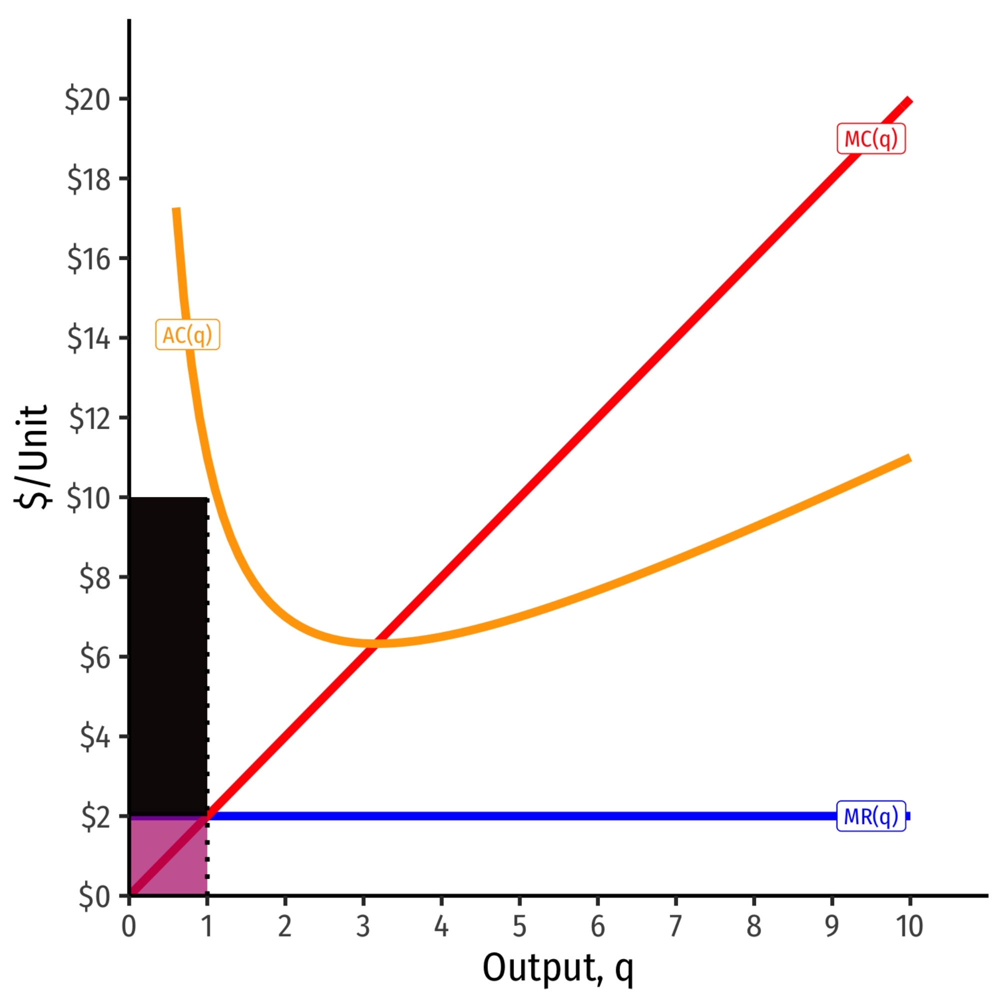
Calculating Average Profit as $AR(q)-AC(q)$

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

$$\begin{align*} \pi(q)&=pq-C(q)\\ \end{align*}$$

Short-Run Shut-Down Decisions

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

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

Short-Run Shut-Down Decisions

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

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

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

Short-Run Shut-Down Decisions

- A firm should choose to produce nothing \((q=0)\) only when:

$$\begin{align*} \pi \text{ from producing} &< \pi \text{ from not producing}\\ \end{align*}$$

Short-Run Shut-Down Decisions

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Short-Run Shut-Down Decisions

- A firm should choose to produce nothing $(q=0)$ only when:

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

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Short-Run Shut-Down Decisions

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

Short-Run Shut-Down Decisions

- **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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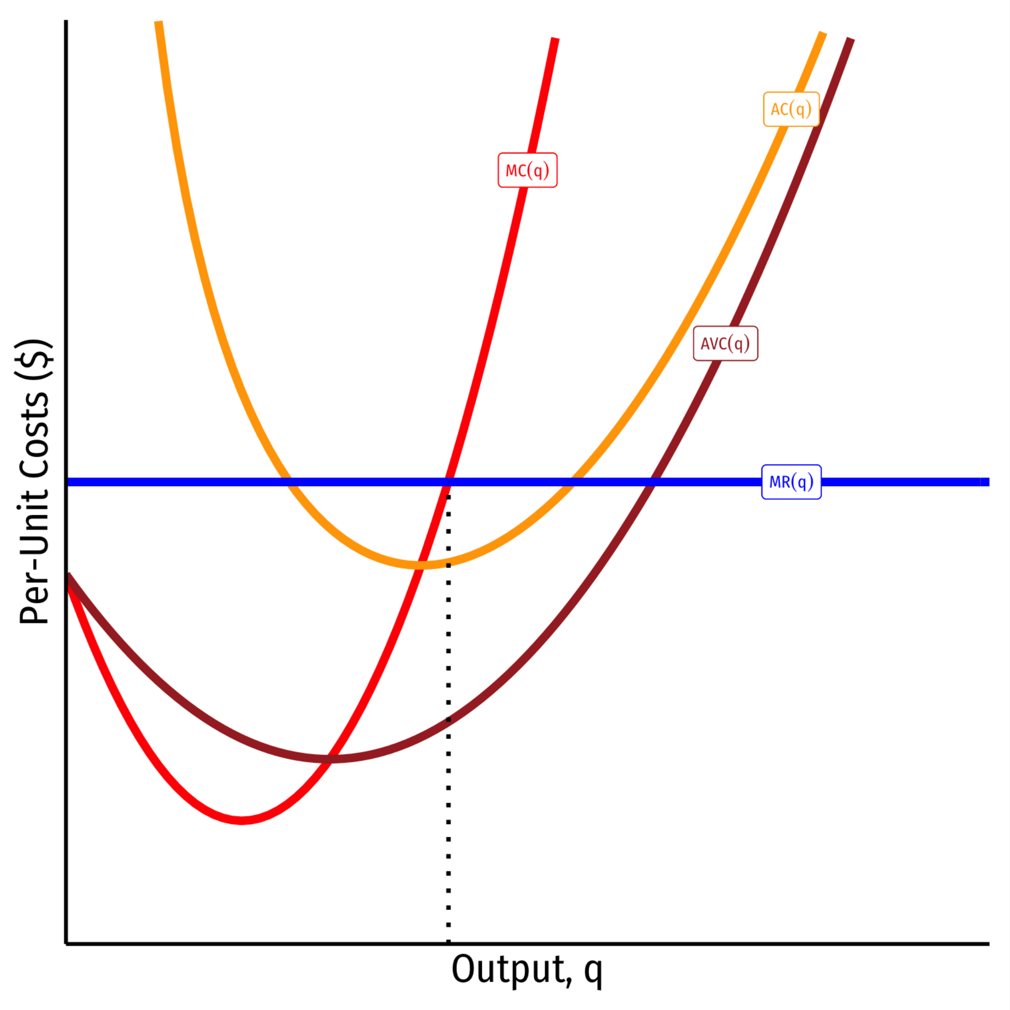
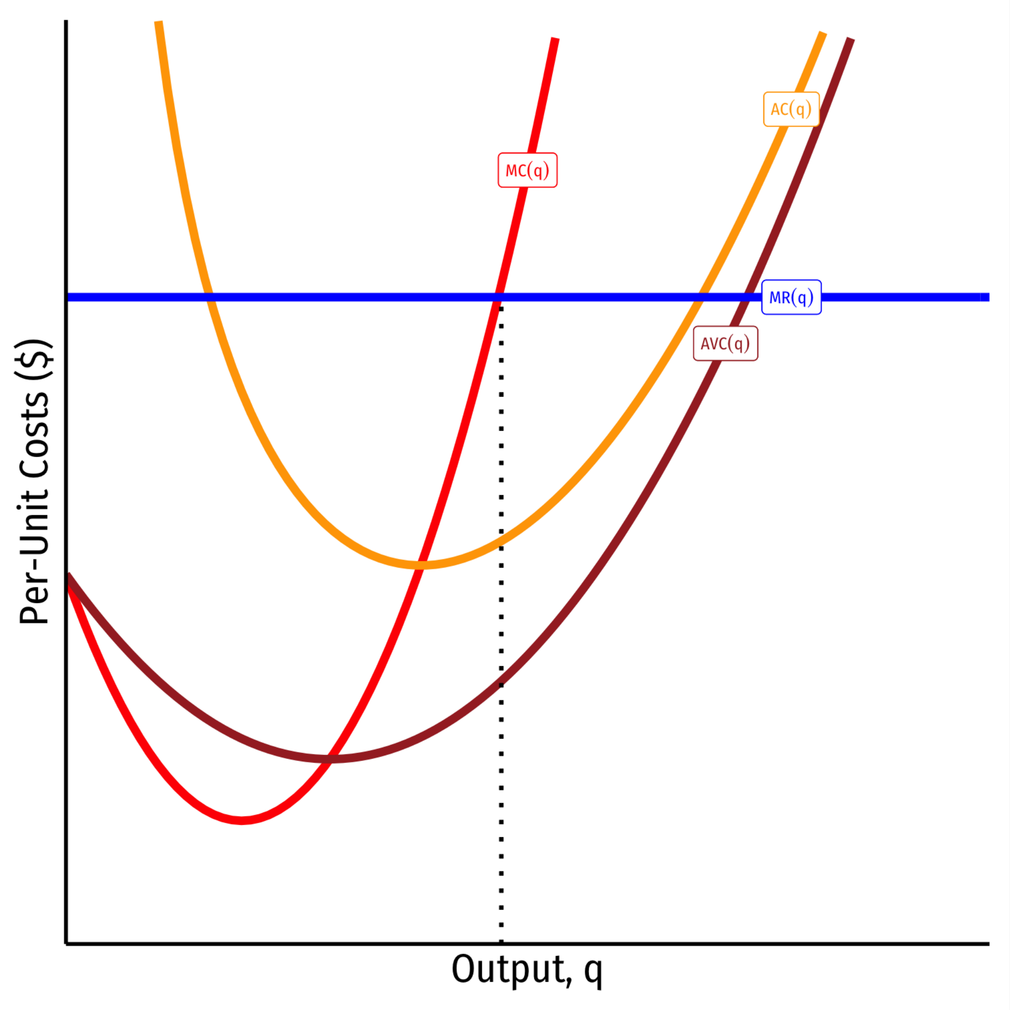


The Firm's Short Run Supply Decision



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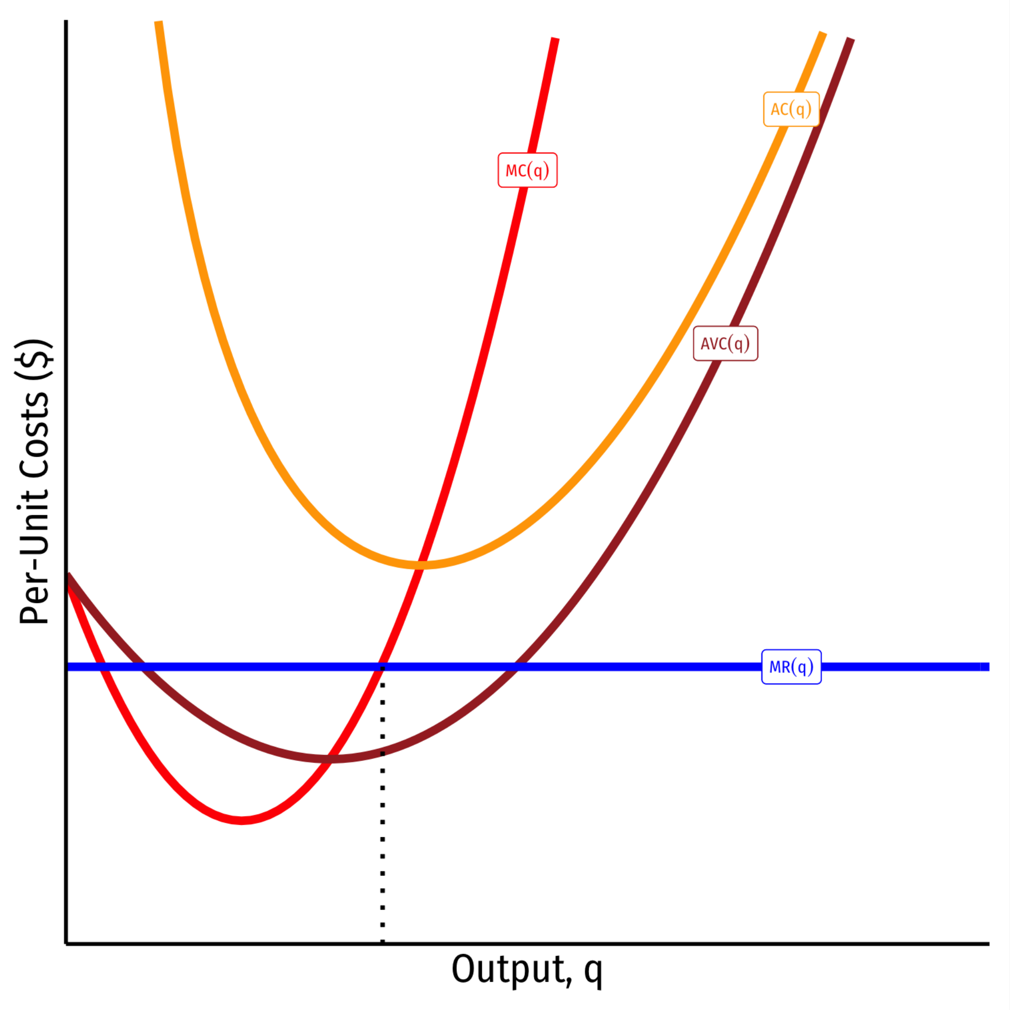

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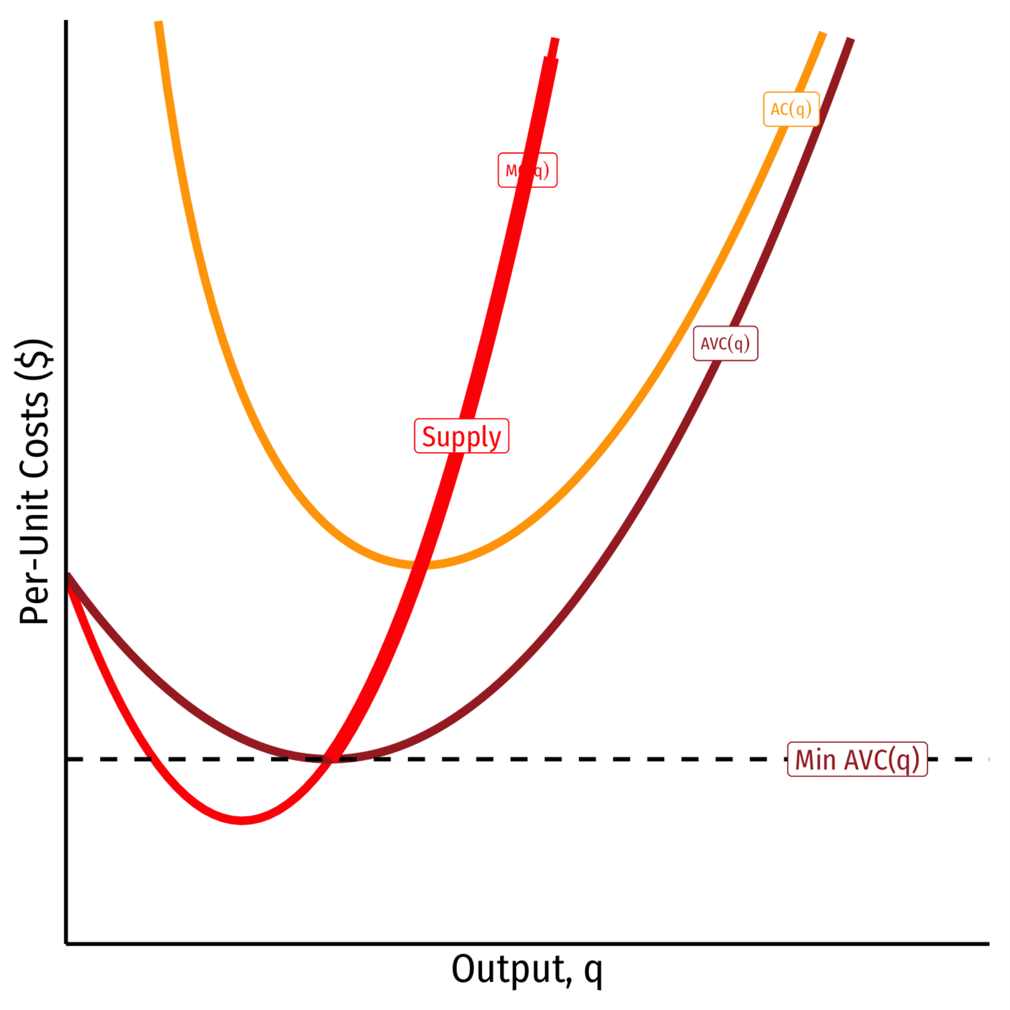
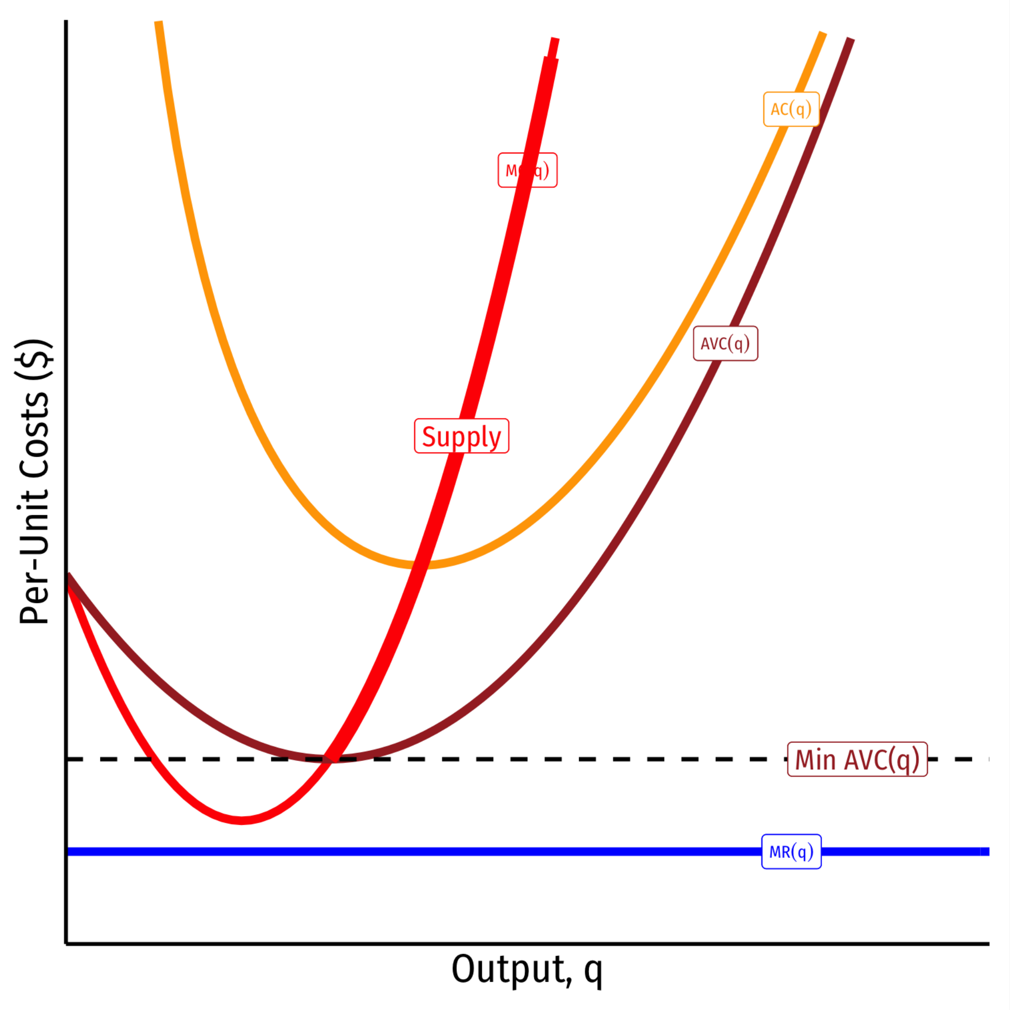
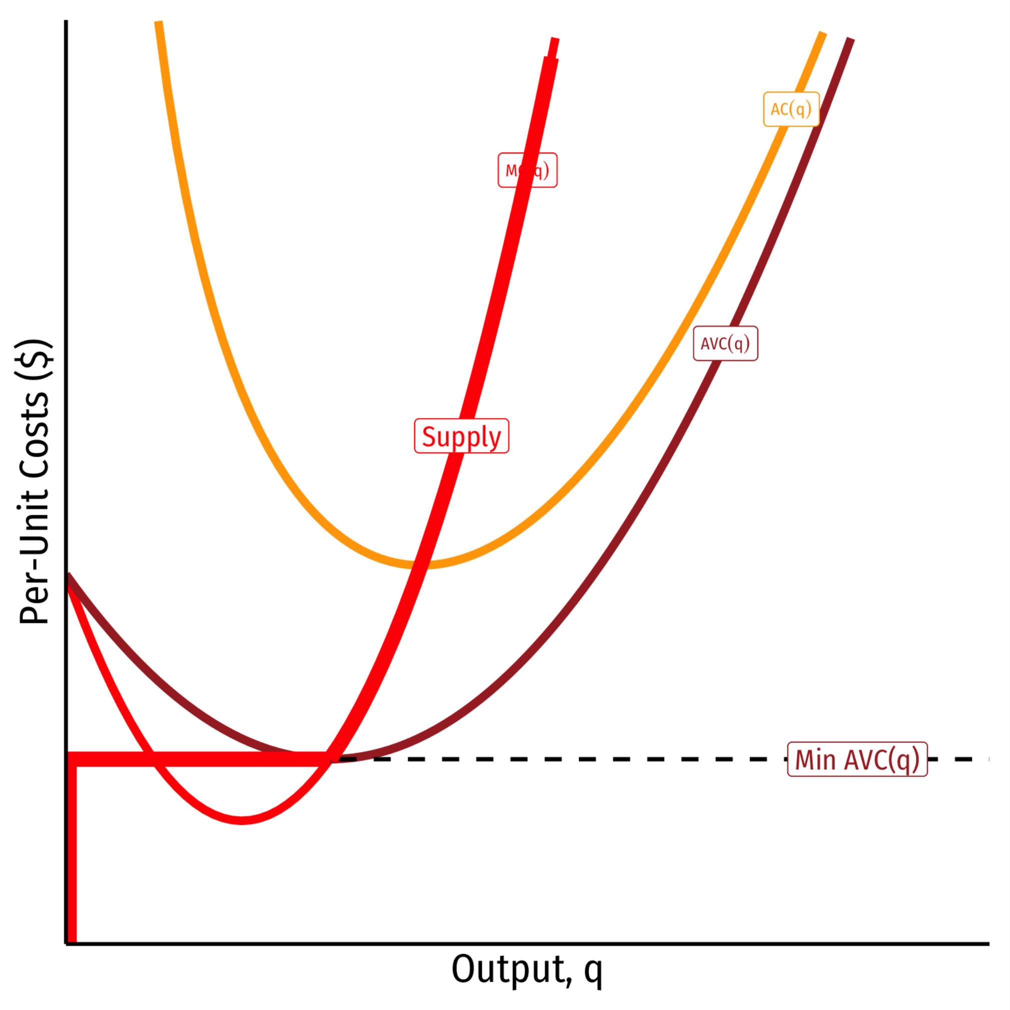


The Firm's Short Run Supply Decision



The Firm's Short Run Supply Decision



Firm's short run (inverse) supply:

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

The Firm's Short Run Supply Decision

Firm's short run (inverse) supply:

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

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:

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

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.