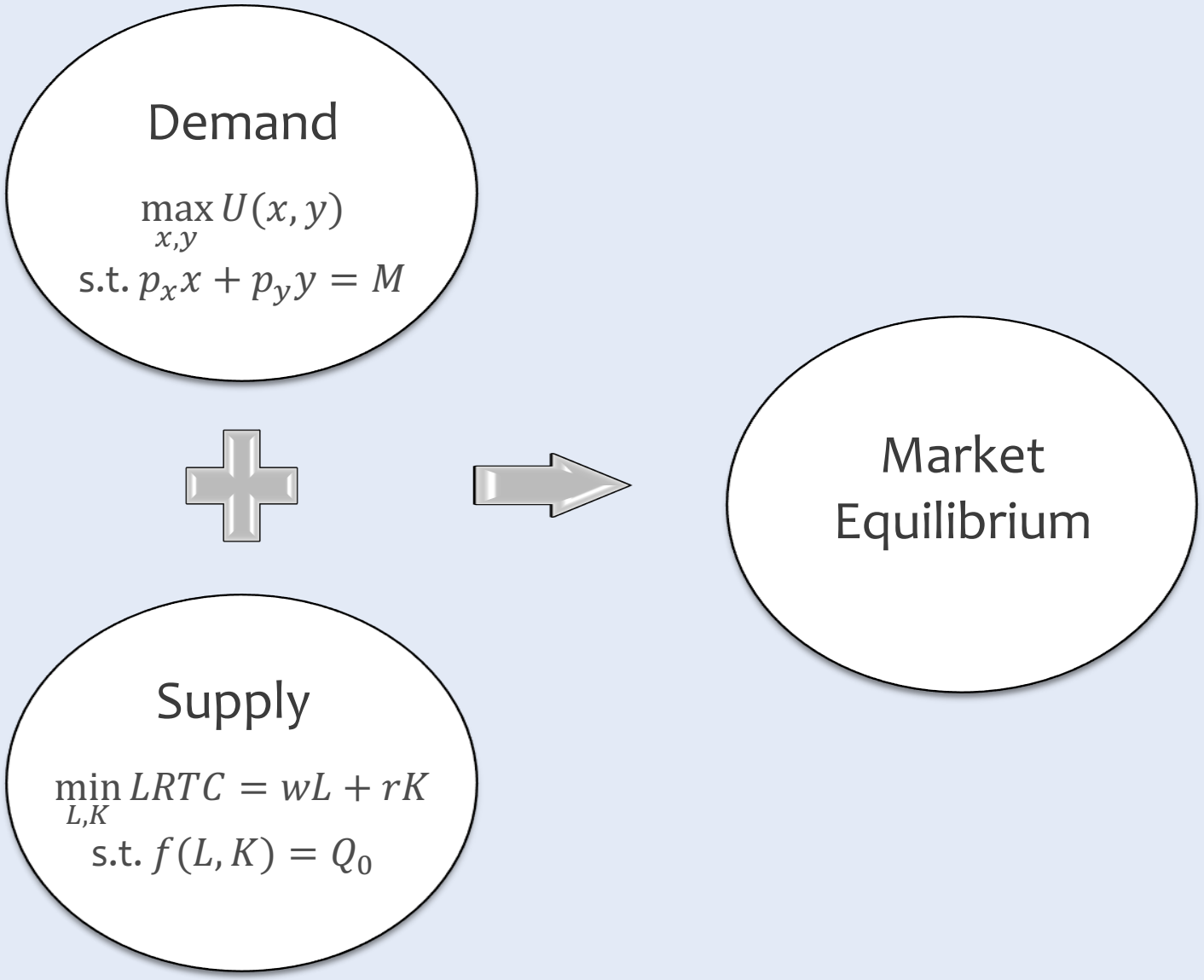
# EC2101: Microeconomic Analysis I

# The Big Picture



# Partial Equilibrium Analysis: Market Structure

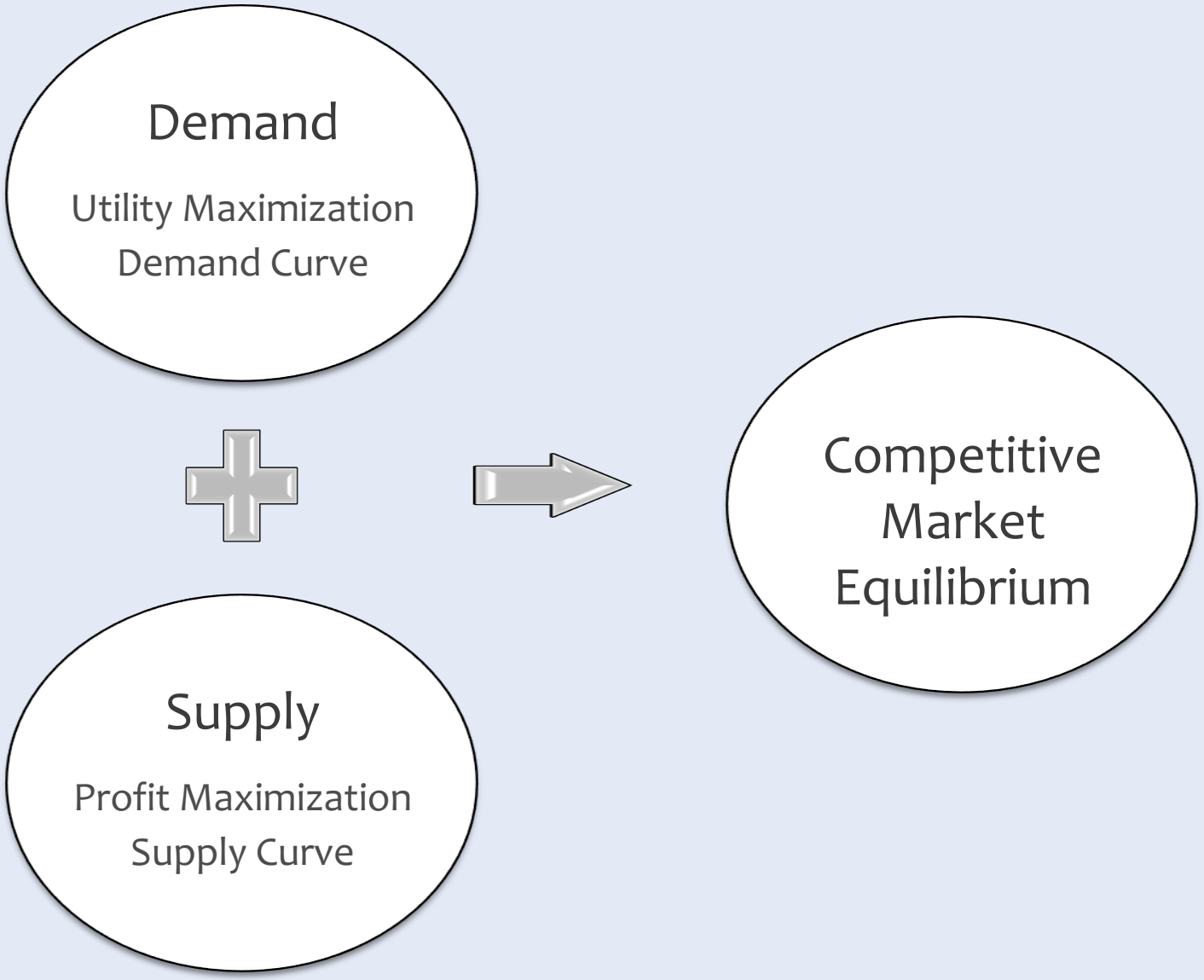
- Perfectly Competitive Markets
- Monopoly
- Monopolistic Competition
- Oligopoly

Lecture 10

# Perfect Competition

- Accounting Profit vs. Economic Profit
- Perfect Competition in the Short Run
  - SR Profit-Maximizing Output Choice
  - SR Supply Curve
  - SR Market Equilibrium
  - Producer Surplus in the SR

# Where are we?


Demand
Utility Maximization
Demand Curve
Supply
Profit Maximization
Supply Curve
Competitive
Market
Equilibrium

# Perfectly Competitive Markets

- The industry is fragmented.
  - Thus firms and consumers are price-takers.
- The product is homogeneous.
  - The products produced by different firms are identical.
- There is perfect information on prices.
  - Thus there is a single market price.
- Every firm has equal access to technology and inputs.
  - Thus the market is characterized by free entry (and exit).

# Example: Catfish Farming Industry in the U.S.

- The industry is fragmented.
  - There are over 1,000 catfish farms.
- The product is homogeneous.
  - The catfish produced by different farms are indistinguishable.
- There is perfect information on prices.
  - All buyers and sellers know the prices charged by all sellers.
- Every firm has access to the same technology and inputs.
  - The production technology is well understood.

# Short Run vs. Long Run

- In the short run:
  - At least one input is fixed.
  - Firms choose the level of output to maximize profit.
- In the long run:
  - All inputs are adjustable.
  - Firms choose the level of output to maximize profit.
  - Firms decide whether to enter or exit the market.

# Accounting Profit vs. Economic Profit

# Accounting Profit vs. Economic Profit

- Accounting Profit
  = Total Revenue – Explicit Costs

- Economic Profit
  = Total Revenue – (Explicit Costs + Implicit Costs)

# Accounting Profit vs. Economic Profit: Example

- Suppose you own and run a small software development firm.
- In 2020, your total revenue was $\$400{,}000.$
- You incurred explicit costs of $\$250{,}000$ for wages, supplies, rent, utilities, etc.
- Your accounting profit is:
  - $\$400{,}000 - \$250{,}000 = \$150{,}000$

# Accounting Profit vs. Economic Profit: Example

- Your best alternative is to work for Google for an annual salary of $\$150{,}000.$
  - I.e., your implicit cost is $\$150{,}000.$
- Your economic cost / opportunity cost is:
  - $\$250{,}000 + \$150{,}000 = \$400{,}000$
- Your economic profit is:
  - $\$400{,}000 - \$400{,}000 = \$0$
- The money you make running your own firm is the same as the money you could have made working for Google.

# Economic Profit

- Zero economic profit
  - All resources (entrepreneur's time, assets, capital) are getting returns that are equivalent to the returns from the best alternative.
- Positive economic profit
  - The business is delivering returns that are higher than the returns from the best alternative.
- Negative economic profit
  - The resources could be used somewhere else to generate higher returns.

*Exercise 10.1*

# Accounting Profit vs. Economic Profit

The rent on office space has just decreased by $\$500$ a month. How does accounting profit change? How does economic profit change?

(a) You rent your office space.

(b) You own your office space.

# Short-Run Profit-Maximizing Output Choice

# Profit and Revenue

- The firm chooses $Q$ to maximize profit.

$$Profit = Total\ Revenue - Total\ Cost$$

$$\pi(Q) = TR(Q) - TC(Q)$$

- Total Revenue:

$$TR(Q) = P(Q) \cdot Q$$

- Marginal Revenue:

$$MR(Q) = \frac{dTR(Q)}{dQ}$$

  - The rate at which total revenue changes with output.
  - The slope of the total revenue curve.

# Profit Maximization

- To maximize profit, we solve:

$$\max_{Q} \pi(Q) = TR(Q) - TC(Q)$$

- First-order condition:

$$\pi'(Q) = 0$$

$$\frac{d\pi(Q)}{dQ} = 0$$

$$MR(Q) - MC(Q) = 0$$

- Rearranging, we have:

$$MR(Q) = MC(Q)$$

# Profit-Maximizing Condition in a Perfectly Competitive Market

- Firms take the market price $p$ as given.
- Total revenue is linear in output:

$$TR(Q) = pQ$$

- The firm can sell as many units as it wants at the market price.
  - Thus marginal revenue equals price:

$$MR(Q) = p$$

- To maximize profit:

$$MR(Q) = MC(Q)$$

$$p = MC(Q)$$

# Profit Maximization: Example

- Suppose the firm's short-run total cost curve is:

$$SRTC(Q) = 25 + Q^2$$

- Therefore, the short-run marginal cost is:

$$SRMC(Q) = 2Q$$

- To maximize profit,

$$p = SRMC(Q)$$

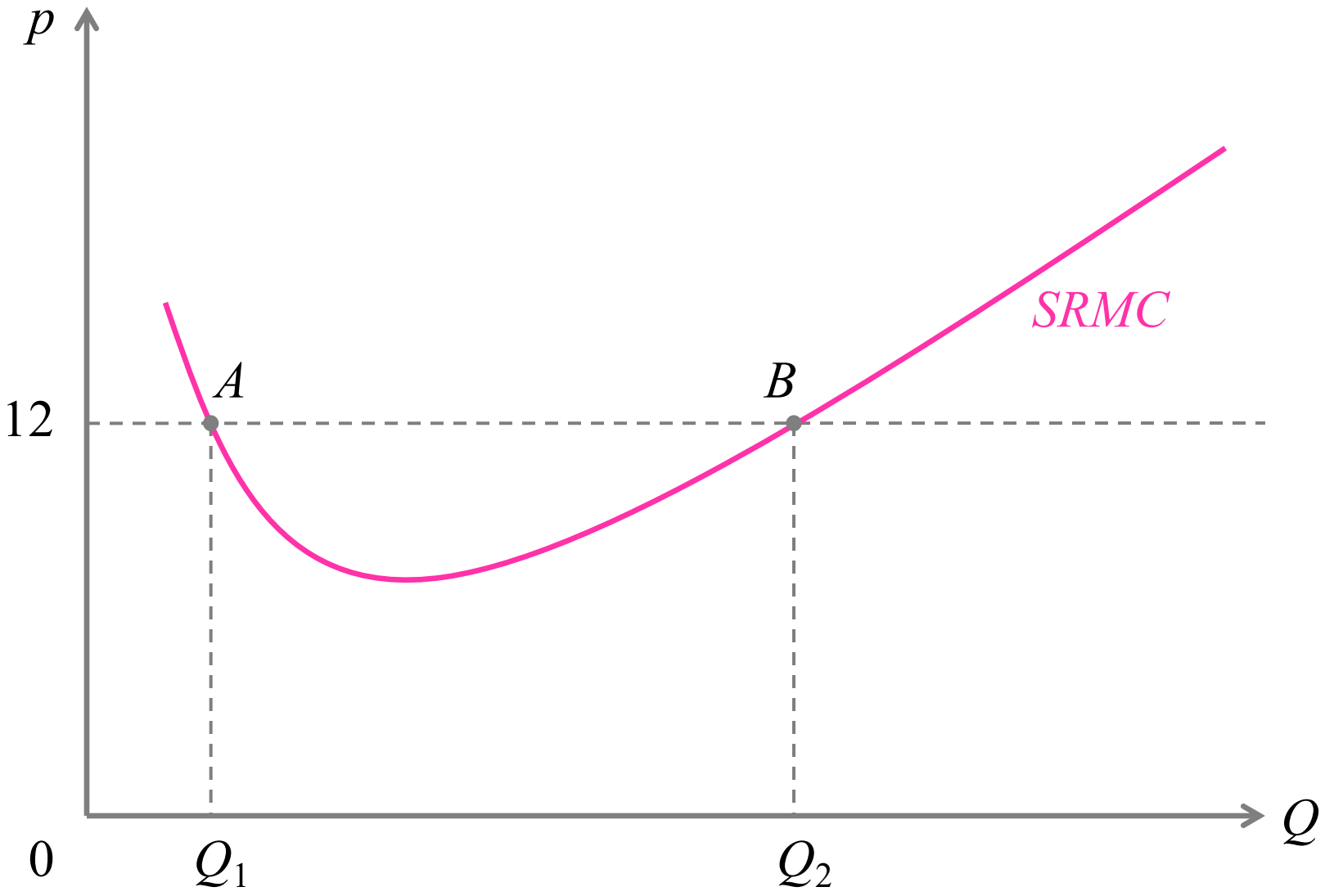
$$p = 2Q$$

- If $p = 12$, the profit-maximizing $Q$ is:

$$12 = 2Q$$

$$Q = 6$$

There may be more than one output level at which $p = SRMC$



# Second-Order Condition

- To ensure that we are indeed maximizing profit, we need the second-order condition:

$$\pi''(Q) \leq 0$$

$$\frac{d\left(\frac{d\pi(Q)}{dQ}\right)}{dQ} \leq 0$$

$$\frac{d(MR(Q) - MC(Q))}{dQ} \leq 0$$

$$\frac{dMR(Q)}{dQ} - \frac{dMC(Q)}{dQ} \leq 0$$

# Second-Order Condition

- Second-order condition:

$$\frac{dMR(Q)}{dQ} - \frac{dMC(Q)}{dQ} \leq 0$$

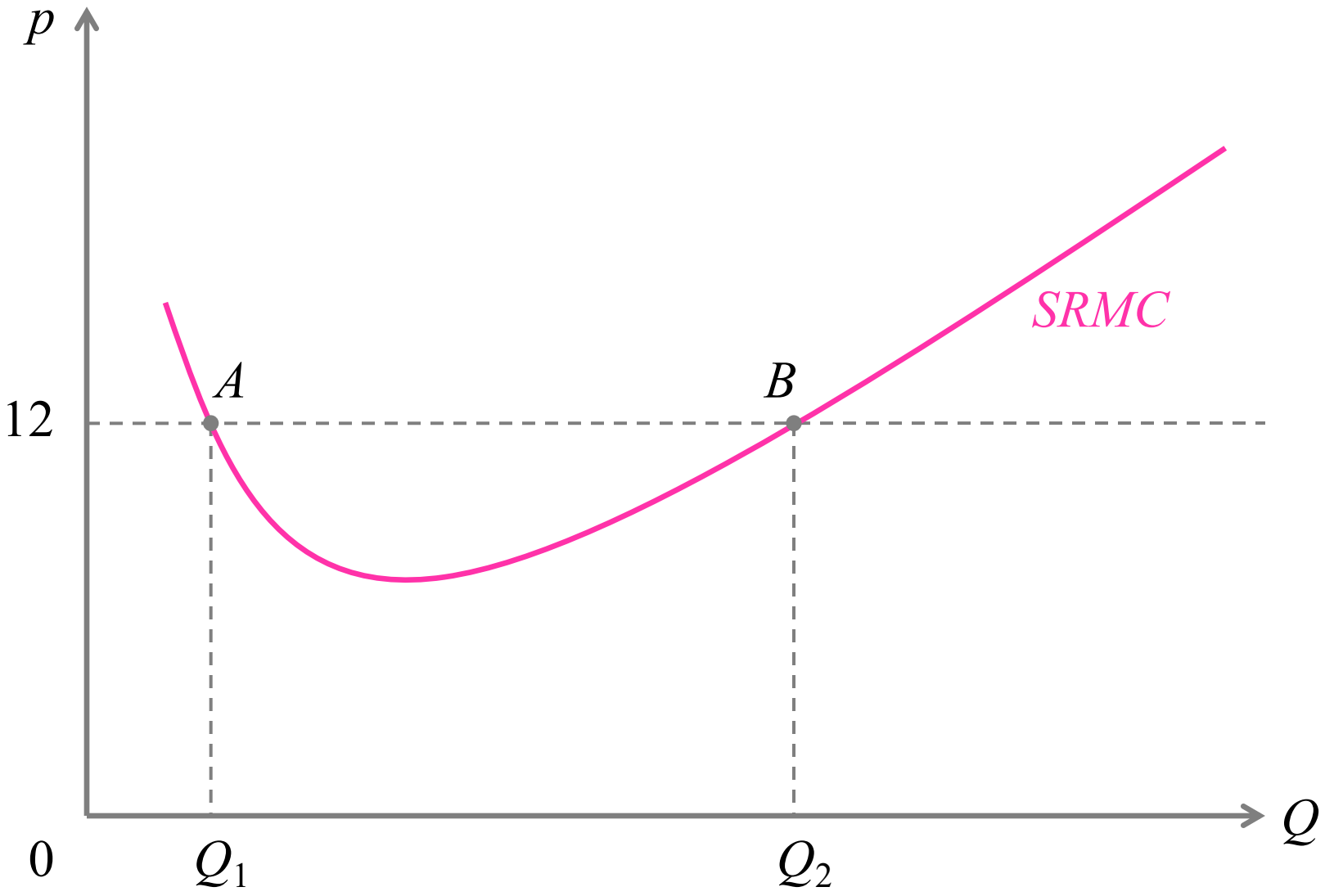
- Since $MR(Q) = p$,

$$\frac{dMR(Q)}{dQ} = 0$$

- Therefore,

$$\frac{dMC(Q)}{dQ} \geq 0$$

There may be more than one output level at which $p = SRMC$



# Profit Maximization: When $p > SRMC$

- Suppose $p = 12$, and the firm produces $Q = 2$.
- $MR = p = 12$
  - If the firm increases the production level, total revenue increases at a rate of $12$.
- $SRMC = 2Q = 2 \cdot 2 = 4$
  - If the firm increases the production level, total cost increases at a rate of $4$.
- When $p > SRMC$, total revenue increases faster than total cost as the production level increases.

# Profit Maximization: When $p < SRMC$

- Suppose $p = 12$, and the firm produces $Q = 8$.
- $MR = p = 12$
  - If the firm decreases the production level, total revenue decreases at a rate of $12$.
- $SRMC = 2Q = 2 \cdot 8 = 16$
  - If the firm decreases the production level, total cost decreases at a rate of $16$.
- When $p < SRMC$, total revenue decreases slower than total cost as the production level decreases.

# Profit Maximization

- If the firm can increase profit by either:
  - producing more when $p > SRMC$

    or
  - producing less when $p < SRMC$
- Then the firm must be maximizing profit
  when producing at an output level such that $p = SRMC.$

*Exercise 10.2*

# Short-Run Profit-Maximizing Output Choice

Suppose a firm in a perfectly competitive market has a short-run total cost curve of $SRTC(Q) = \frac{1}{2}Q^2 - 10Q + 800.$ The market price of the output is $p = 20.$

(a) Write down the firm's profit-maximization problem.

(b) What is the firm's optimal level of output?

(c) Verify that your answer in (b) is indeed profit maximizing.

(d) Calculate the firm's profit.

*Exercise 10.2*

# Short-Run Profit-Maximizing Output Choice

# Short-Run Supply Curve

# Non-Sunk Cost vs. Sunk Cost

- The fixed cost may or may not be sunk.
- Total Non-Sunk Cost ($TNSC$):
  - Variable Cost + Non-Sunk Fixed Cost
- Total Sunk Cost ($TSC$):
  - Sunk Fixed Cost
- If all of the fixed cost is non-sunk,

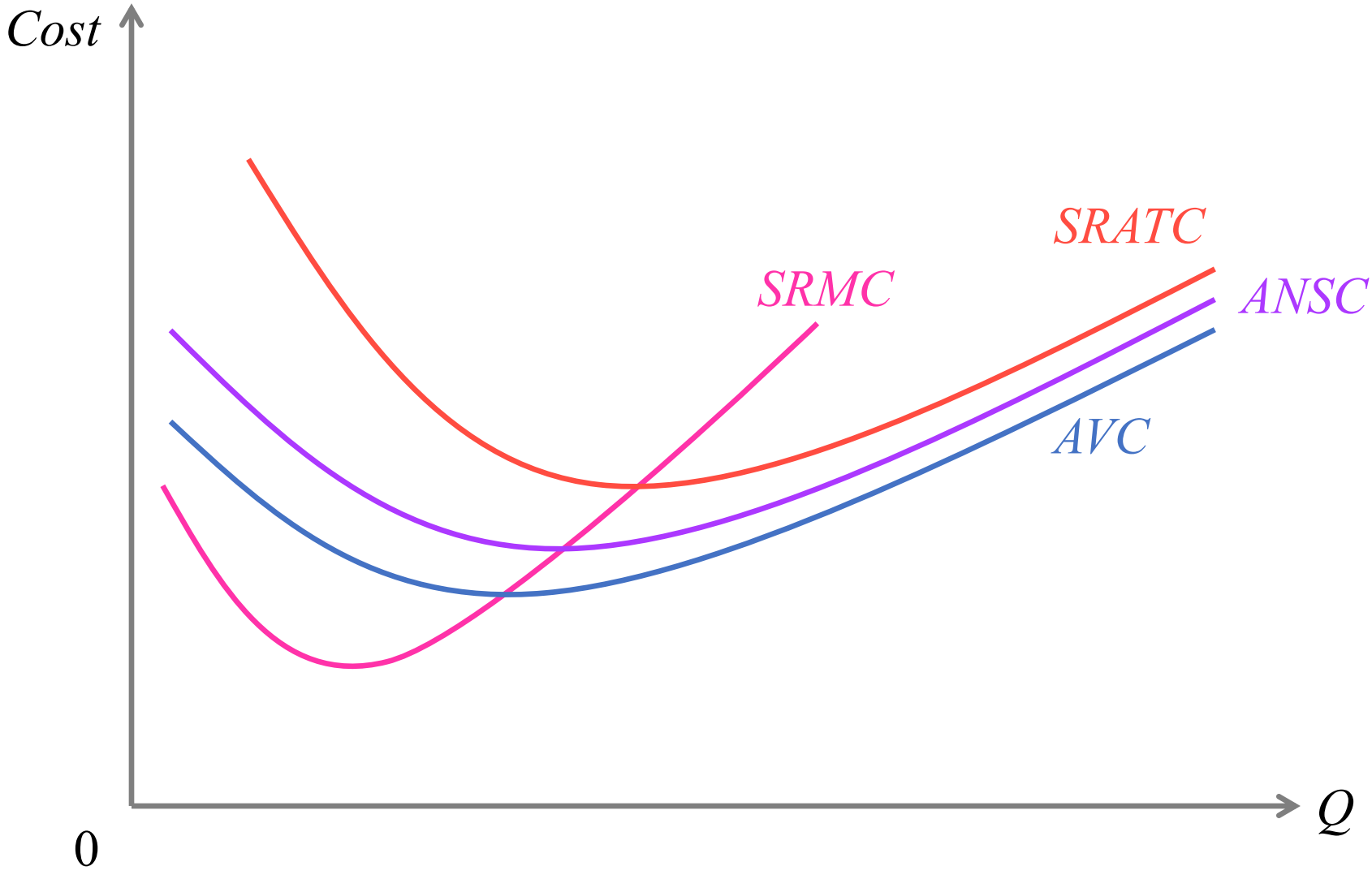
$$TNSC = VC + FC = SRTC$$

- If all of the fixed cost is sunk,

$$TNSC = VC$$

$SRMC$ intersects $ANSC$

at the minimum point of $ANSC$



# Should the firm produce at all?

- If the firm does not produce any output,
  - $\pi(Q = 0) = 0 - TSC$
- If the firm produces output,
  - $\pi(Q > 0) = TR(Q) - TNSC(Q) - TSC$
- The firm produces output only if

$$TR(Q) - TNSC(Q) - TSC \geq -TSC$$

$$TR(Q) \geq TNSC(Q)$$

# Should the firm produce at all?

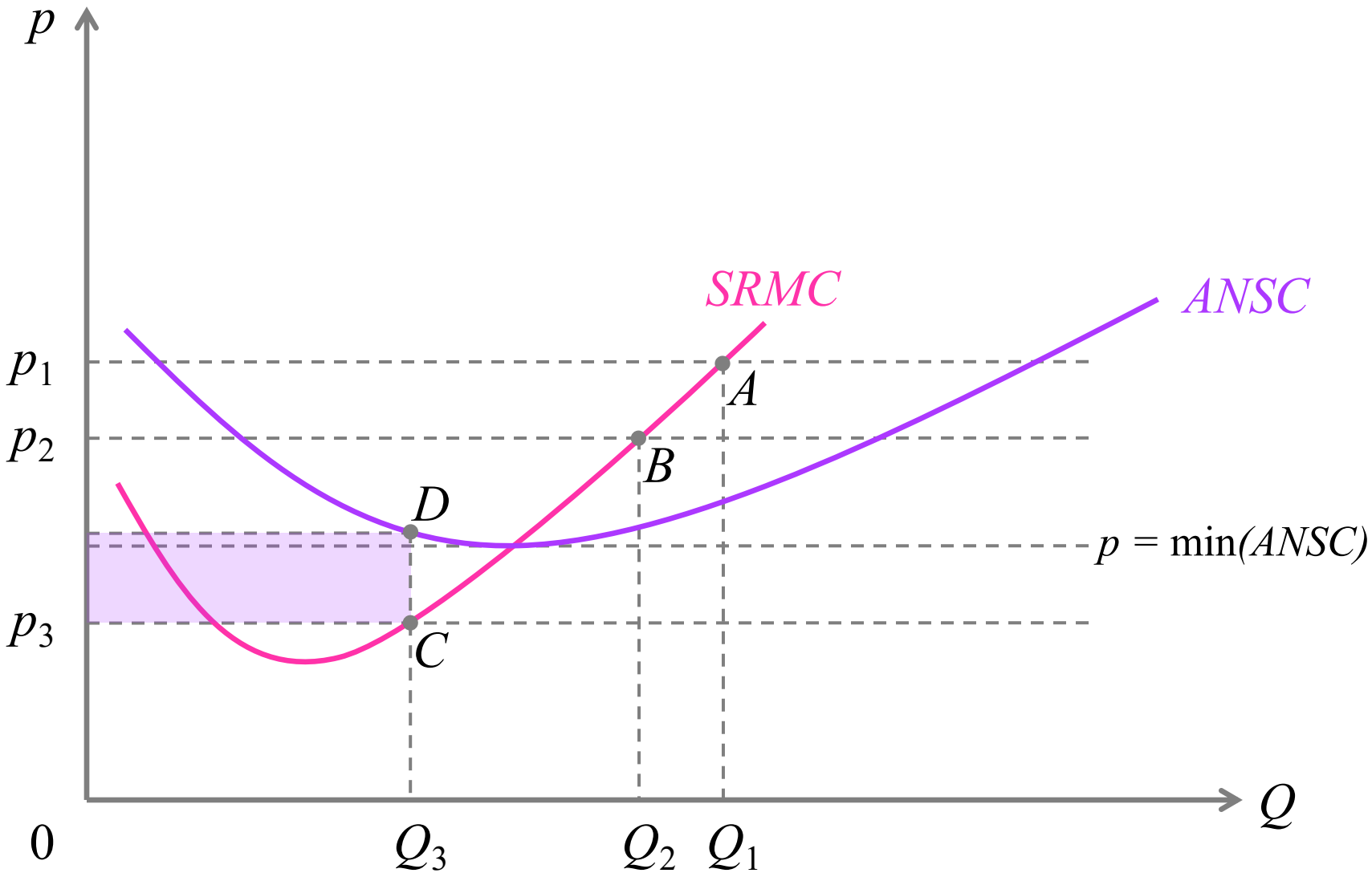
- Recall that:
  - $TR(Q) = pQ$
  - $TNSC(Q) = ANSC(Q) \times Q$
- The firm produces output only if

$$TR(Q) \geq TNSC(Q)$$

$$pQ \geq ANSC(Q) \times Q$$

$$p \geq ANSC(Q)$$

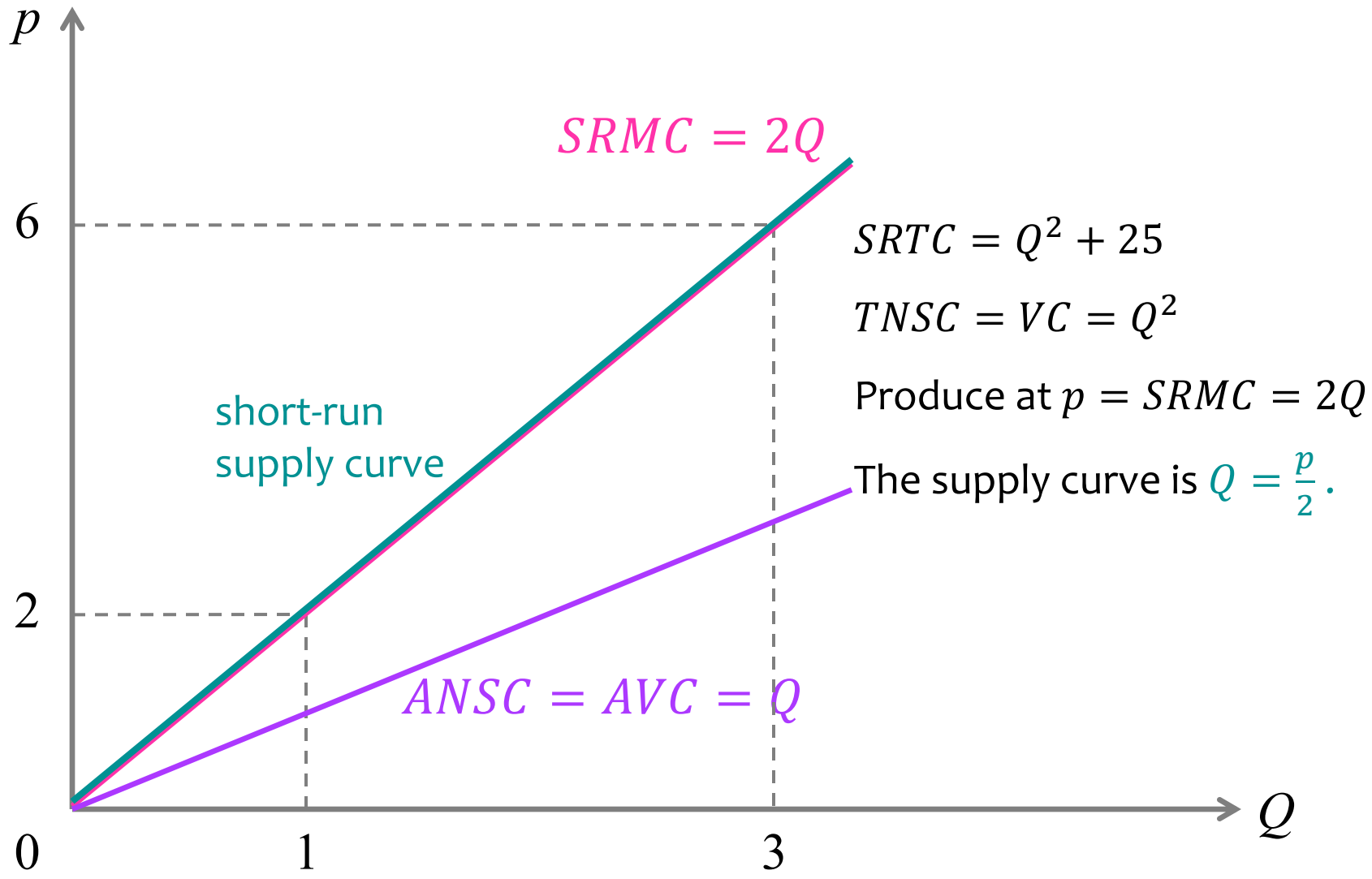
# When should the firm stop producing?



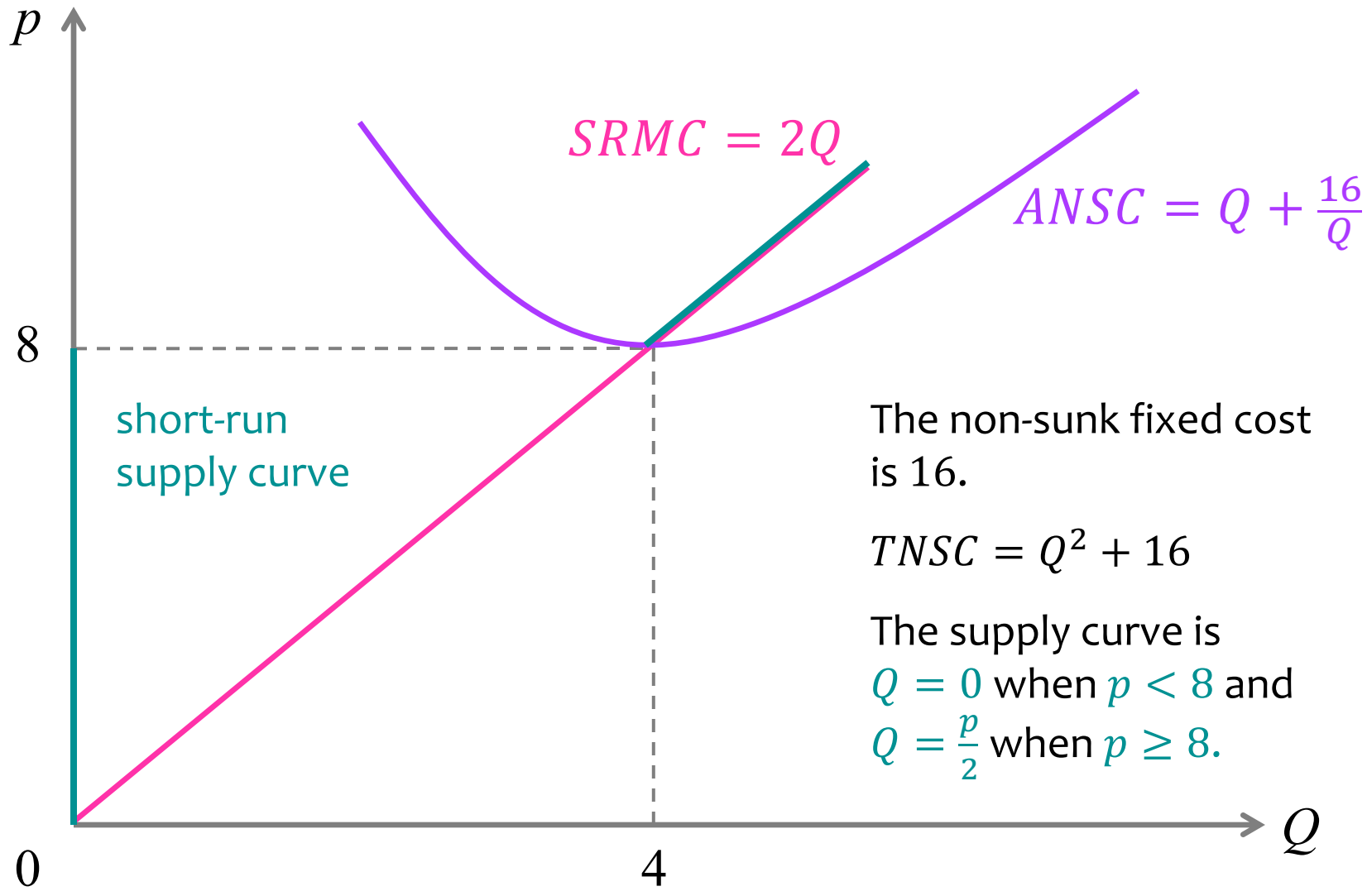
# Profit-Maximizing Conditions in the Short Run

- When $p \geq \min(ANSC)$, the firm should choose $Q$ such that:
  - At that output level, $p = SRMC(Q)$.
  - $SRMC$ is non-decreasing in $Q$.
- When $p < \min(ANSC)$, the firm should choose $Q = 0$.

# The Firm's Supply Curve
## when All of the Fixed Cost is Sunk



# The Firm's Supply Curve
## when Part of the Fixed Cost is Non-Sunk




The non-sunk fixed cost is 16.

$TNSC = Q^2 + 16$

The supply curve is
$Q = 0$ when $p < 8$ and
$Q = \frac{p}{2}$ when $p \geq 8$.

*Exercise 10.3*

# Deriving $ANSC(Q)$ and Finding the Minimum

Refer to the graph on the previous slide. The short-run total cost curve is $SRTC(Q) = Q^2 + 25$ and the non-sunk fixed cost is $16$.

(a) Verify that $ANSC(Q) = Q + \frac{16}{Q}$.

(b) Verify that at the minimum of $ANSC(Q)$, $Q = 4$ and $ANSC = 8$.

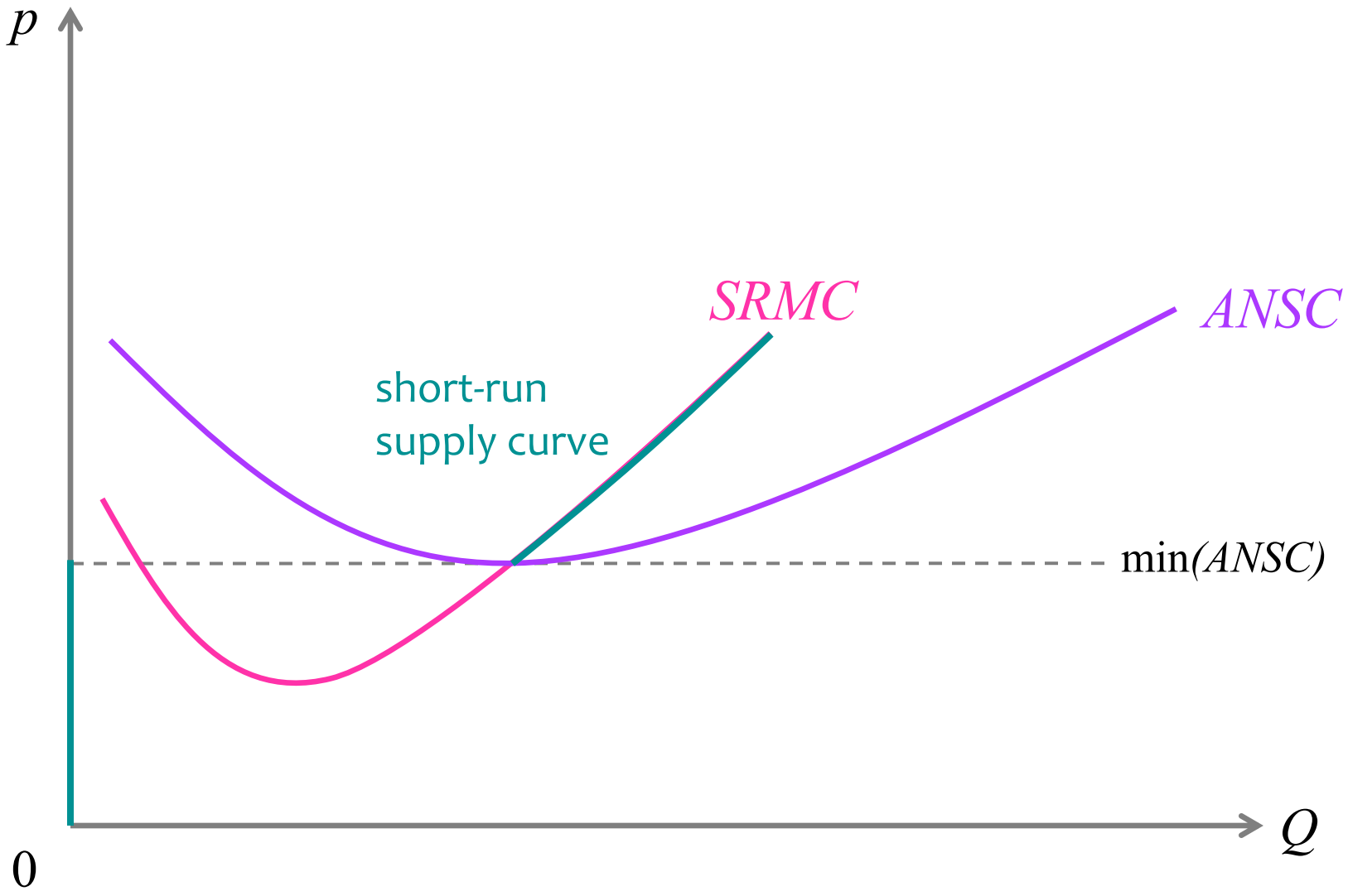
*Exercise 10.3*

# Deriving $ANSC(Q)$ and Finding the Minimum

# The Individual Firm's Supply Curve

- The short-run supply curve for an individual firm is the profit-maximizing quantity for the firm as a function of the market price.
  - $Q_f(p)$
- When $p < \min(ANSC)$:
  - The firm chooses $Q = 0$.
  - The supply curve is the vertical axis.
- When $p \geq \min(ANSC)$:
  - The firm chooses $Q$ such that $p = SRMC(Q)$.
  - The supply curve is the marginal cost curve.

# The Firm's Short-Run Supply Curve in General



# Short-Run Market Supply Curve

- The short-run market supply curve is the horizontal sum of all individual firms' supply curves.
- Suppose there are 100 identical firms in the market.
- Assuming all of the fixed cost is sunk, each firm has a supply curve:

$$Q_f = \frac{p}{2}$$

- The market supply curve is:

$$S(p) = 100 \times \frac{p}{2} = 50p$$

# Short-Run Market Equilibrium

# Short-Run Market Equilibrium

- At the short-run market equilibrium price:
  - Total quantity demanded equals total quantity supplied.
  - Each firm produces at the profit-maximizing output level given the equilibrium market price.
  - Each consumer buys the utility-maximizing quantity given the equilibrium market price.

# Short-Run Market Equilibrium: Example

- Recall that each firm's supply curve is $Q_f = \frac{p}{2}$ and that the market supply curve is $S(p) = 50p.$
- Suppose the market demand curve is:

$$D(p) = 560 - 20p$$

- Therefore, the short-run equilibrium price is:

$$S(p) = D(p)$$

$$50p = 560 - 20p$$

$$p = 8$$

# Short-Run Market Equilibrium: Example

- Recall that each firm's supply curve is $Q_f = \frac{p}{2}$ and that the market supply curve is $S(p) = 50p.$
- The short-run equilibrium price is $p = 8.$
- In equilibrium, the total quantity of output produced is:

$$S = 50p = 50 \cdot 8 = 400$$

- Each firm produces:

$$Q_f = \frac{p}{2} = \frac{8}{2} = 4$$

# Relationship between Profit and $SRATC$

- Suppose the market price is $p$,
  and at this price, the firm's optimal output level is $Q_f$.

- The firm's profit is:

$$TR - SRTC = pQ_f - \left(SRATC(Q_f) \times Q_f\right)$$
$$= \left(p - SRATC(Q_f)\right) Q_f$$

- If $p > SRATC(Q)$:
  - The firm's profit is positive at the output level $Q_f$.

- If $p < SRATC(Q)$:
  - The firm's profit is negative at the output level $Q_f$.

# Profit in the Short-Run Market Equilibrium

- Recall that:
  - The short-run equilibrium price is $p = 8.$
  - Each firm produces $Q_f = 4.$
  - Each firm's short-run total cost is $SRTC(Q_f) = 25 + (Q_f)^2.$
- Each firm's profit is:

$$\begin{aligned} TR - SRTC &= pQ_f - SRTC(Q_f) \\ &= 8 \cdot 4 - (25 + 4^2) \\ &= -9 \end{aligned}$$

# Profit in the Short-Run Market Equilibrium

- Each firm's short-run average total cost is:

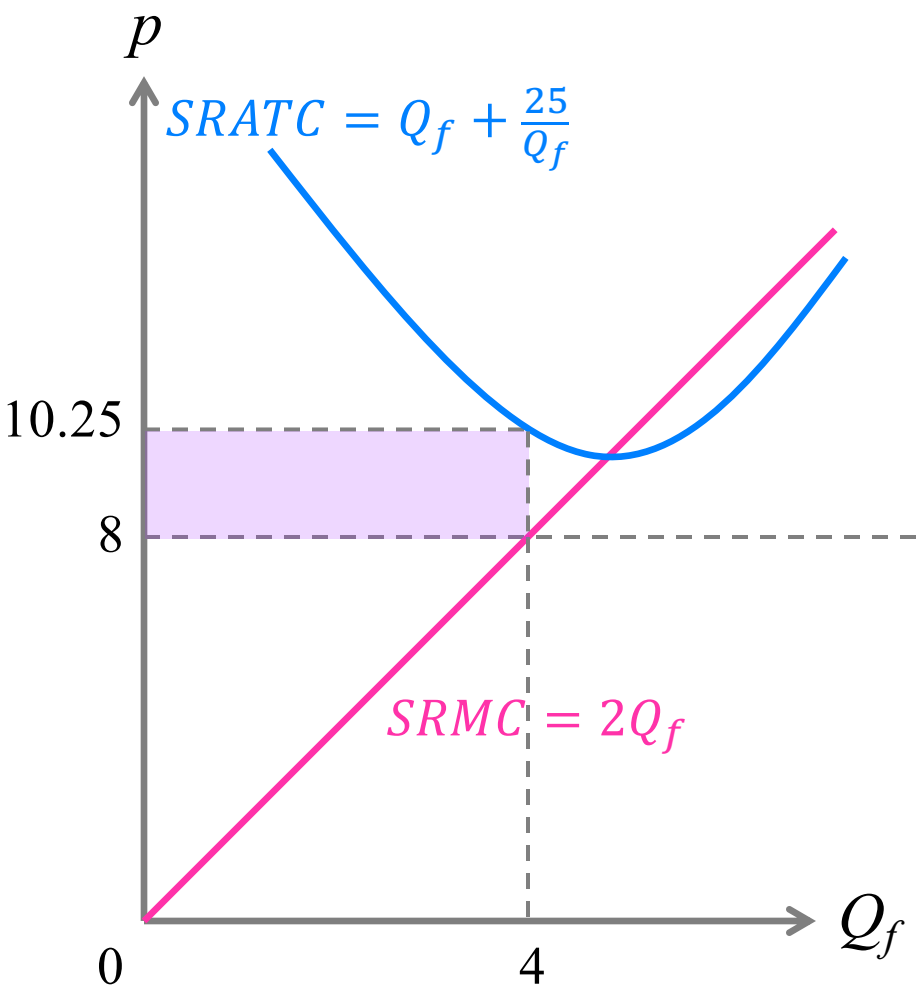
$$SRATC(Q_f) = \frac{SRTC(Q_f)}{Q} = \frac{25 + (Q_f)^2}{Q}$$

- At $Q_f = 4$ :

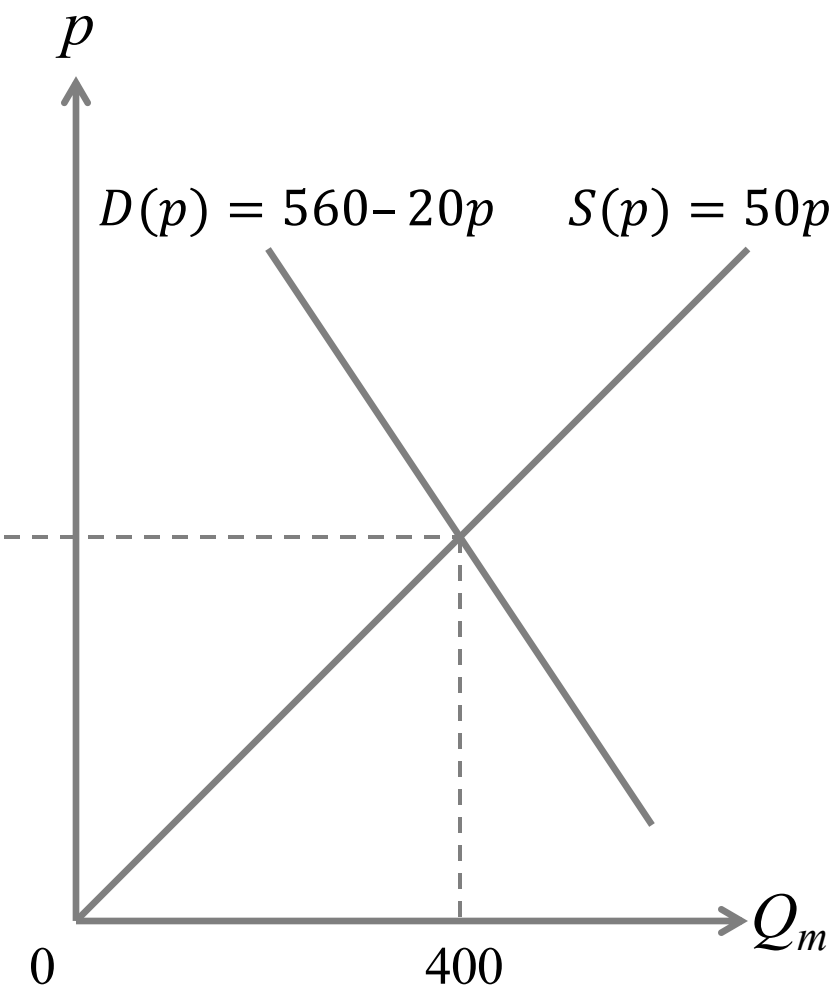
$$SRATC(4) = \frac{25 + 4^2}{4} = 10.25$$

- Negative profit is possible in the short-run market equilibrium.
  - Firms do not consider sunk cost when deciding how many units of output to produce.

# Short-Run Equilibrium

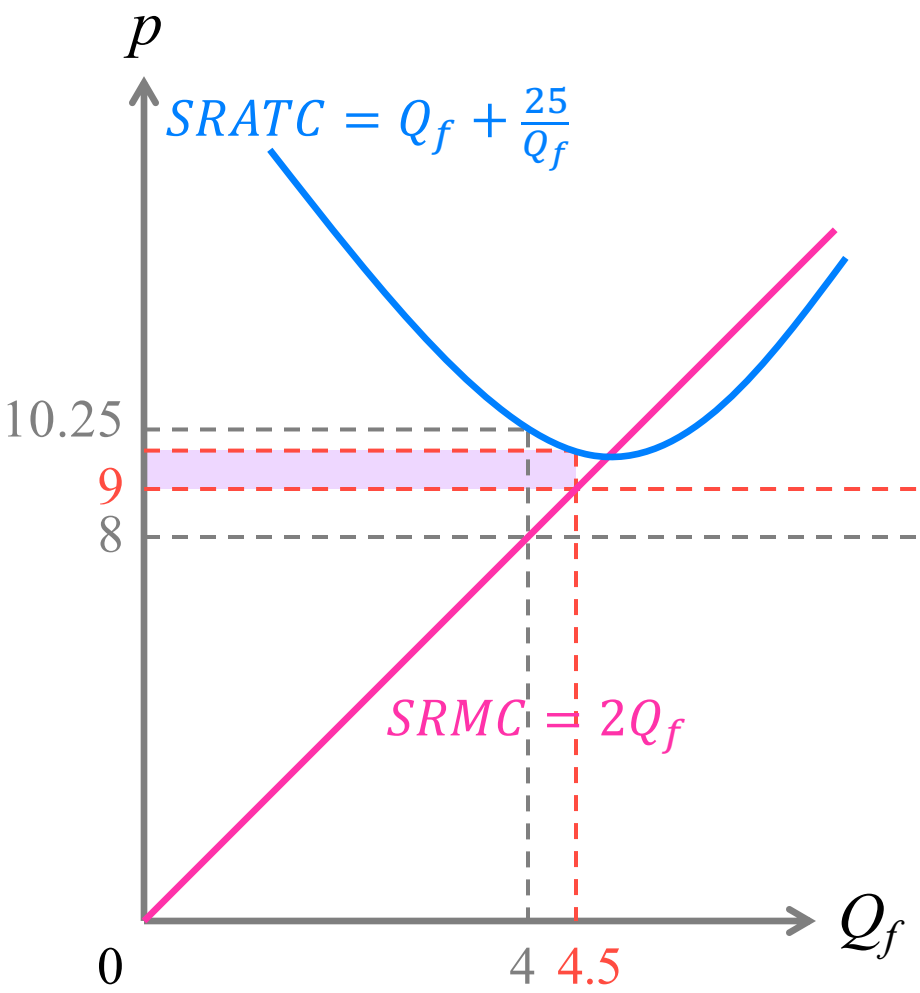



Typical firm's
cost and supply




Market equilibrium
with 100 identical firms

# Comparative Statics: Increase in Demand




Typical firm's
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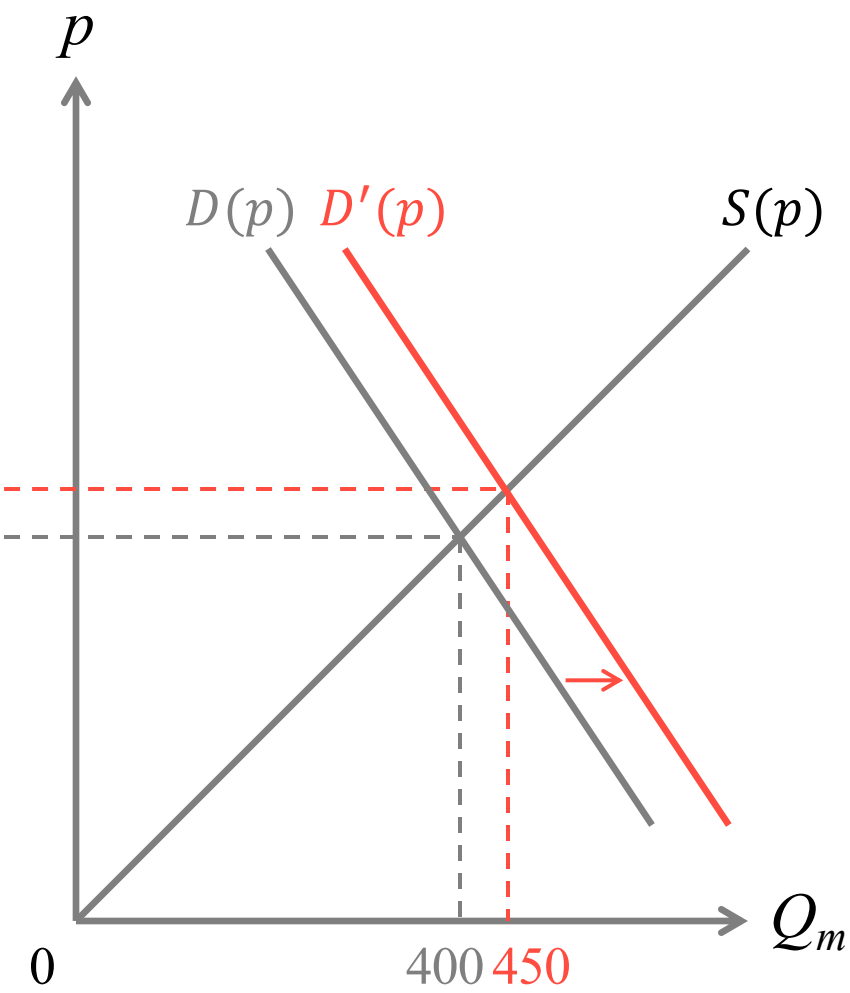
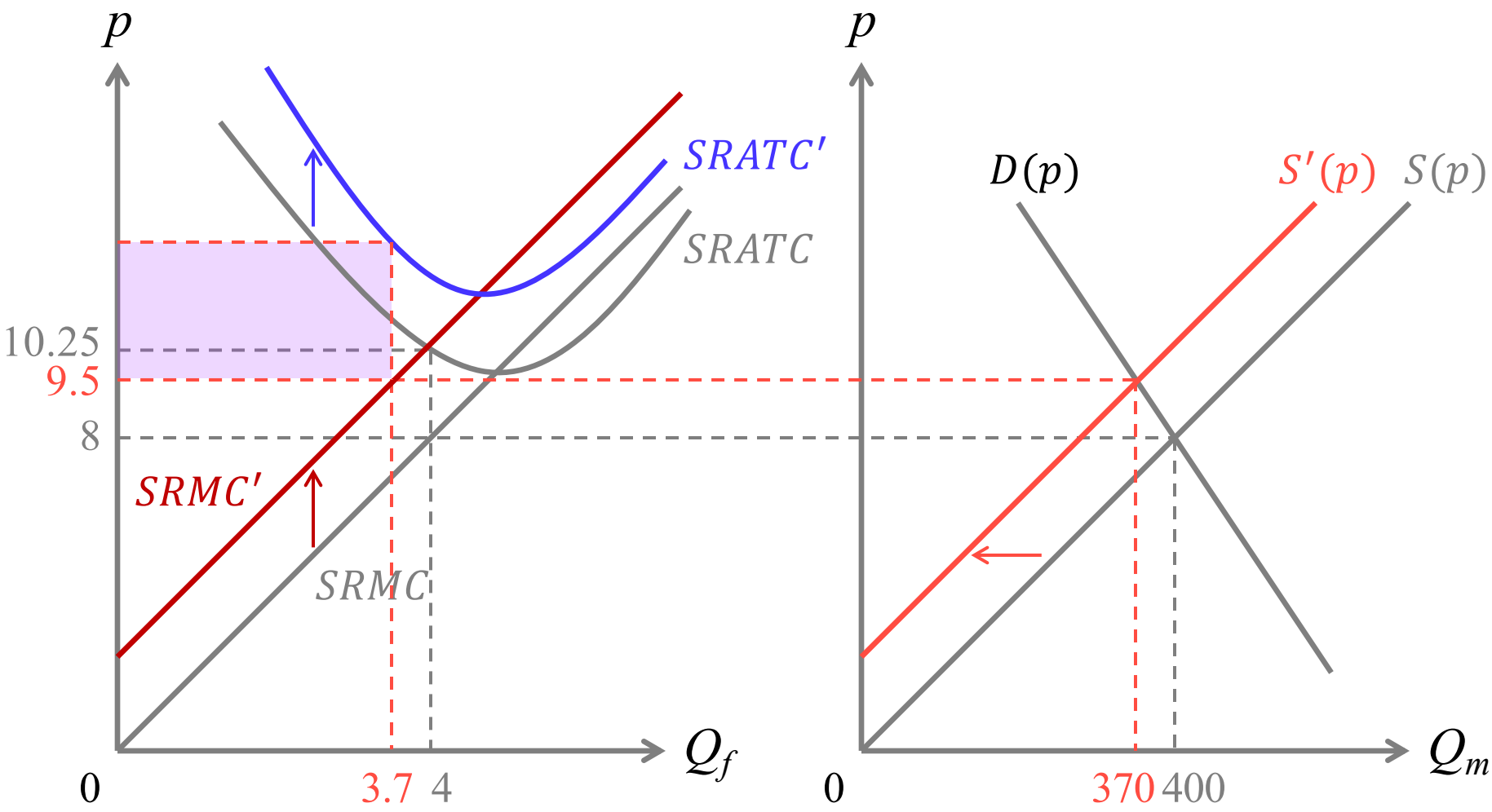



Market equilibrium
with 100 identical firms

# Comparative Statics: Increase in Wage




Typical firm's cost and supply

Market equilibrium with 100 identical firms

*Summary*

# $SRATC, SRMC, ANSC$

When does the firm consider:

- short-run average total cost $(SRATC)$
- short-run marginal cost $(SRMC)$
- average non-sunk cost $(ANSC)$

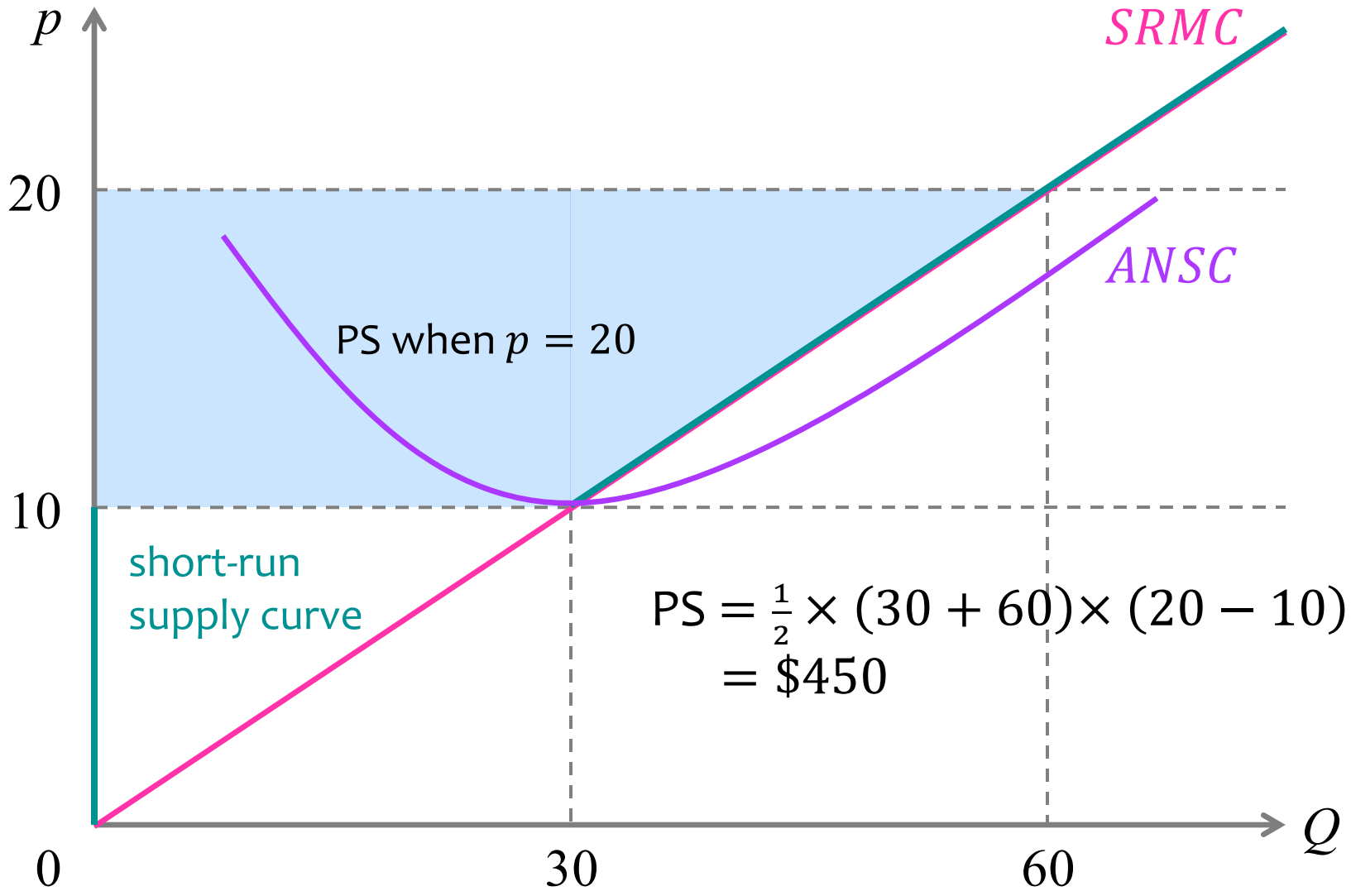
# Producer Surplus in the Short Run

# Producer Surplus

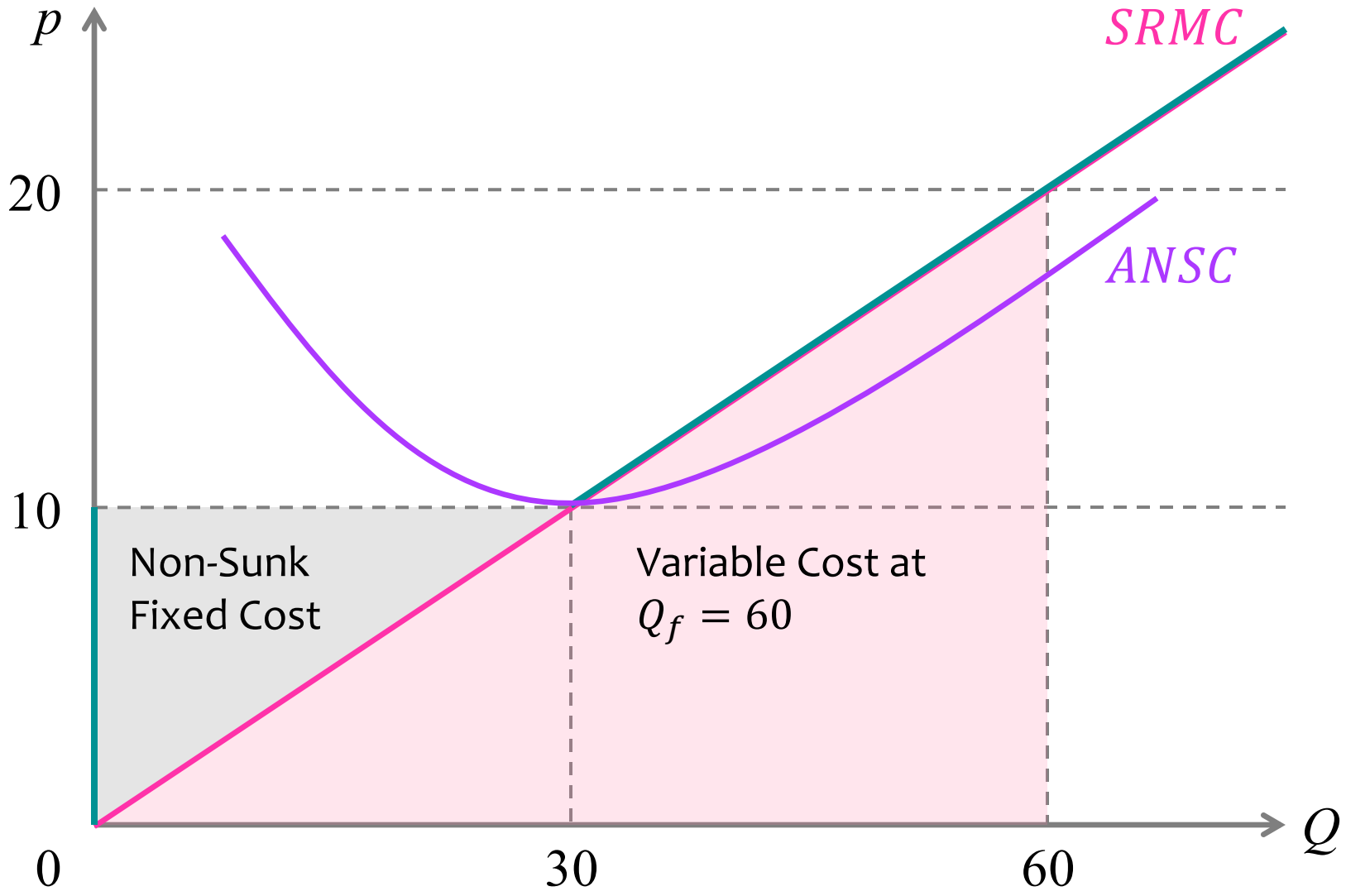
- Producer Surplus (PS) — individual firm:
  - The difference between
    the amount that the firm receives
      for producing a certain quantity of output and
    the amount the firm has to receive
      in order to produce that quantity of output.
  - PS = Total Revenue – Total Non-Sunk Cost
  - Graphically, the area below the price
    and above the supply curve.

- Producer Surplus (PS) — market:
  - The sum of all individual firms' producer surplus.

# Producer Surplus



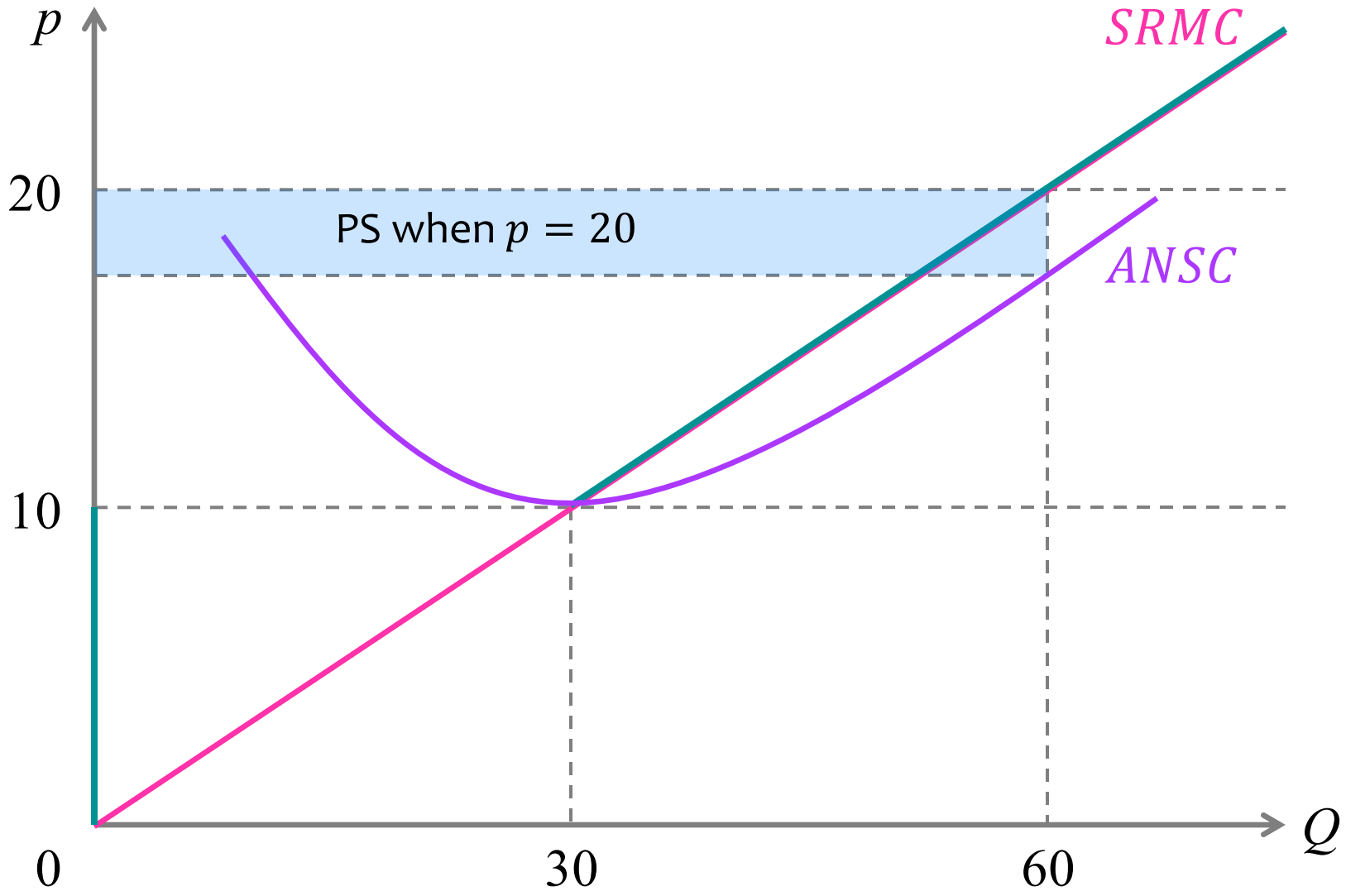
# Producer Surplus



# Producer Surplus

- Total Revenue $(TR) = 20 \cdot 60 = 1{,}200$
- Total Non-Sunk Cost $(TNSC)$:
  - $VC$ when $Q_f = 60$ is $\frac{1}{2} \cdot 60 \cdot 20 = 600.$
    - $VC$ is the area below the $SRMC$ curve.
  - Non-Sunk Fixed Cost is $150.$
    - $TNSC$ for the first 30 units is $ANSC(30) \cdot 30 = 10 \cdot 30 = 300.$
    - But $VC$ for the first 30 units is $\frac{1}{2} \cdot 30 \cdot 10 = 150.$
  - Therefore $TNSC = 600 + 150 = 750$
- $PS = TR - TNSC = 1{,}200 - 750 = 450$
  - The area below the price and above the supply curve.

# Producer Surplus



*Exercise 10.4*

# Part of the Fixed Cost is Non-Sunk ($ANSC$)

Refer to the graph on the next slide. The short-run total cost curve is $SRTC = Q^2 + 25$. Part of the fixed cost is non-sunk. Suppose $p = 12$.

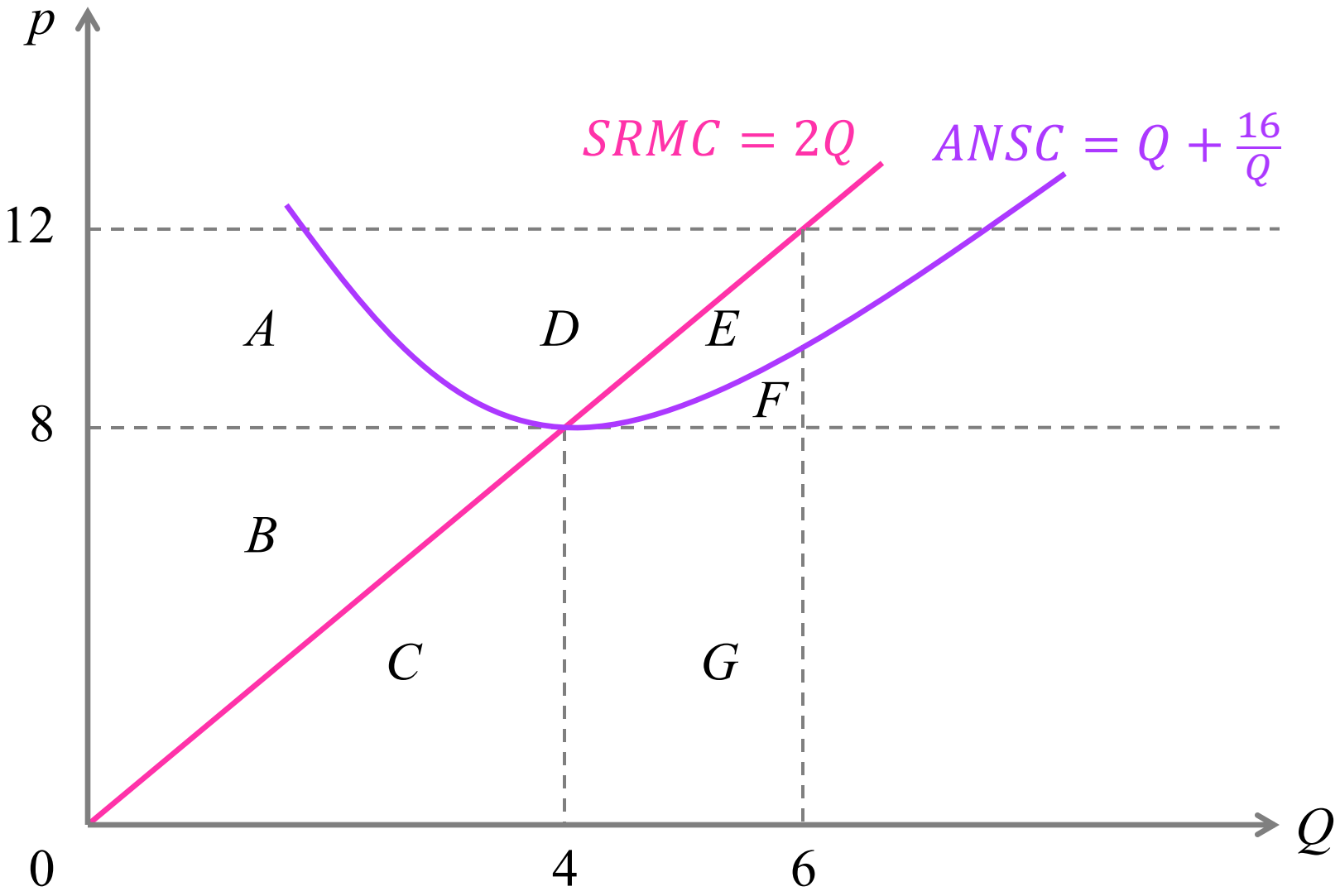
(a) Indicate the variable cost ($VC$) on the graph. Calculate $VC$.

(b) Indicate the non-sunk fixed cost ($NSFC$) on the graph. Calculate $NSFC$.

(c) Indicate the sunk fixed cost ($SFC$) on the graph. Calculate $SFC$.

*Exercise 10.4*

# Part of the Fixed Cost is Non-Sunk ($ANSC$)



*Exercise 10.5*

# All of the Fixed Cost is Sunk ($ANSC$)

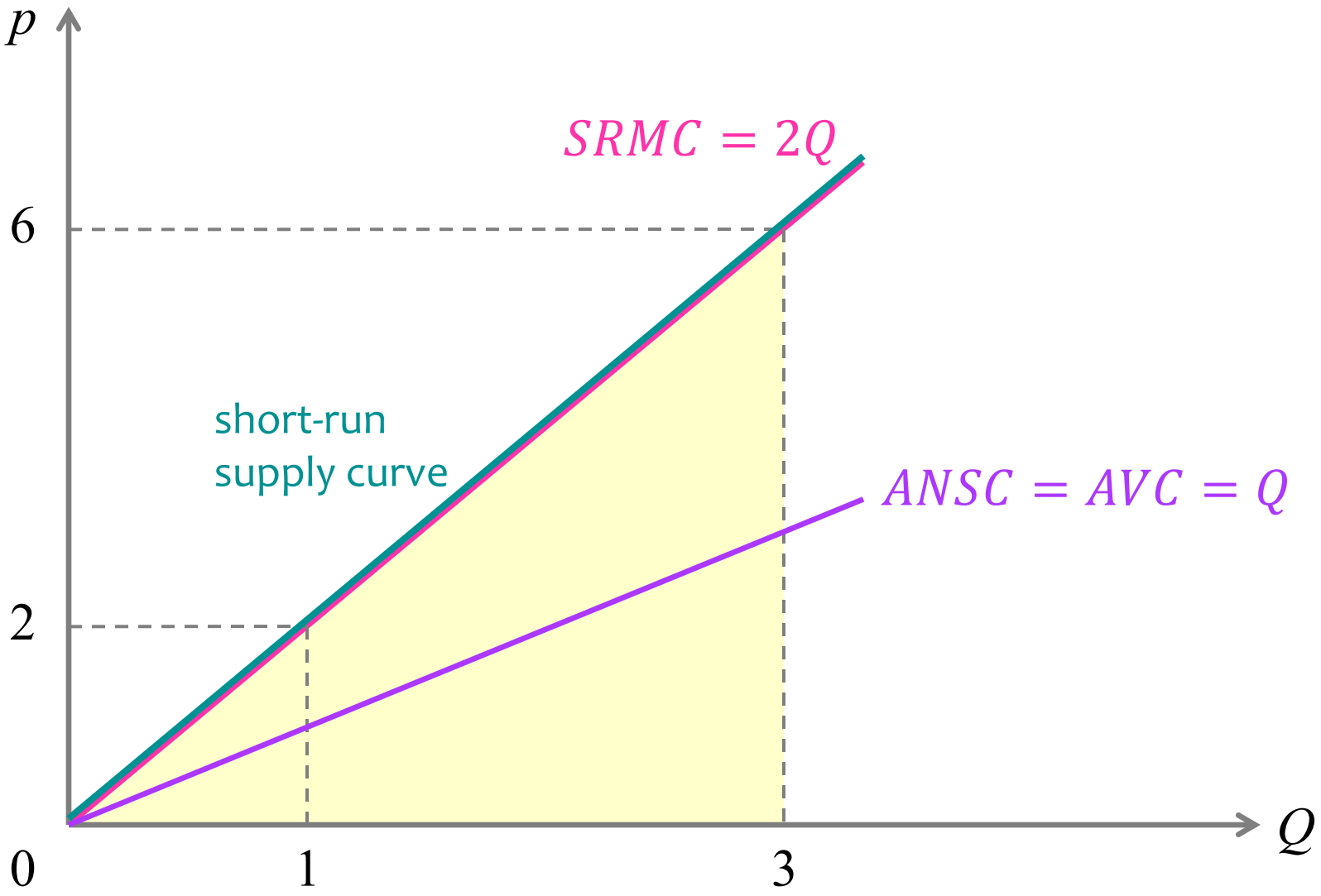
Refer to the graph on the next slide. The short-run total cost curve is $SRTC = Q^2 + 25$. All of the fixed cost is sunk. Suppose $p = 6$.

(a) Show that the short-run supply curve is $Q = p/2$.

(b) What is the shaded area?

*Exercise 10.5*

# All of the Fixed Cost is Sunk ($ANSC$)



*Exercise 10.6*

# All of the Fixed Cost is Sunk ($SRATC$)

Refer to the graph on the next slide. The short-run total cost curve is $SRTC = Q^2 + 25$. All of the fixed cost is sunk. The short-run supply curve is $Q = p/2$.

What is the shaded area?

*Exercise 10.6*

# All of the Fixed Cost is Sunk ($SRATC$)