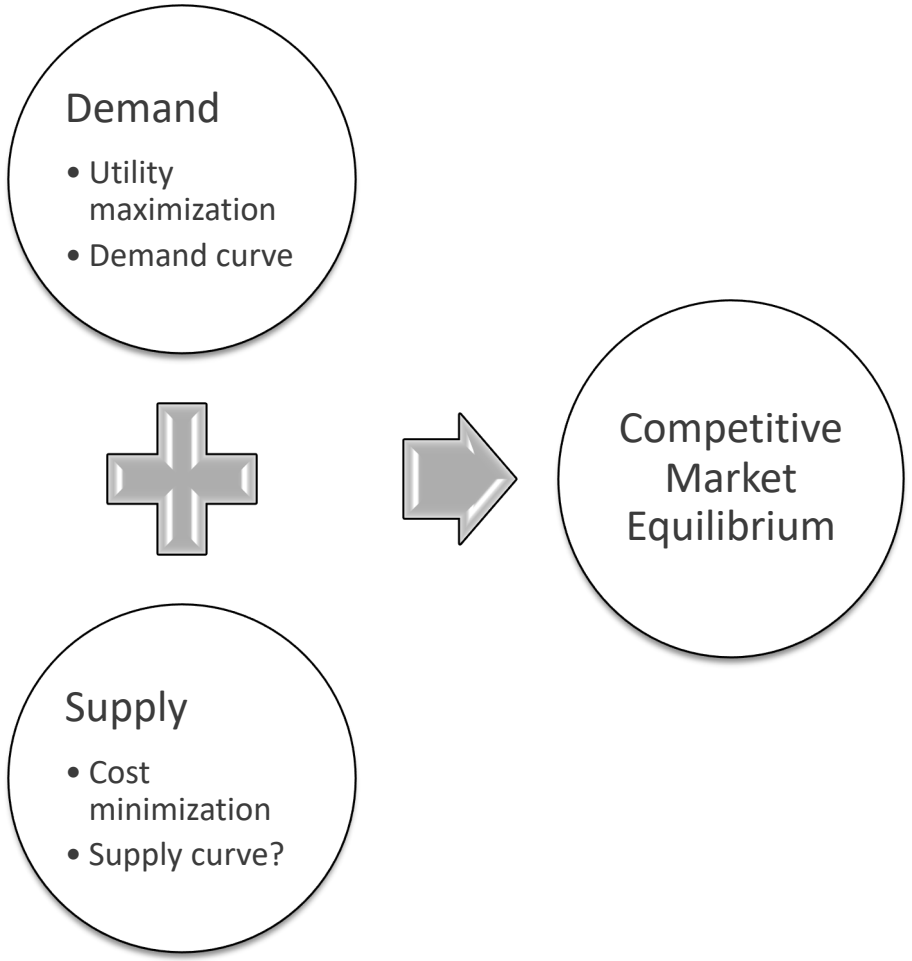
LECTURE 10
PERFECT COMPETITION IN THE SHORT RUN

The Big Picture



Where are we?

- Production function
  - How firms turn *L* and *K* into *Q*
- Cost-minimizing choice of *L* and *K*
  - Cost curves in the short run and long run
- Optimal choice of *Q*
  - At any given price, how much output should the firm produce?
- Firm's supply curve
  - Output *Q* as a function of market price

Part 1

Short-Run Supply Curve

What is a perfectly competitive market?

- The industry is fragmented
  - Thus firms and consumers are *price takers*
- The product is homogeneous
  - Products produced by different firms are the same
- Perfect information about prices
  - Thus there will be a single market price
- Equal access to resources
  - Everyone has access to the same technology and inputs
  - Thus the market is characterized by *free entry*

Example: Catfish Farming Industry in US

- The industry is fragmented
  - There are over 1000 catfish farms
- The product is homogeneous
- Perfect information about prices
- Equal access to resources
  - Production technology is well understood

Short Run vs. Long Run

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

Profit and Revenue

- Firm chooses *Q* to maximize profit
- Profit=total revenue-total cost

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

- Total revenue

$$TR(Q) = P(Q)Q$$

- Definition 10.1 *Marginal revenue*
  - The rate at which total revenue changes with output

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

  - The slope of the total revenue curve

How to maximize profit?

- To maximize profit, we solve

$$\max_{Q} \quad TR(Q) - TC(Q)$$

- The first-order condition is

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

- Rearranging, we have

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

Profit-Maximizing Condition in Perfectly Competitive Market

- Firms take market price *P* as given
- Total revenue is linear in output

$$TR(Q) = PQ$$

- Marginal revenue = price

$$MR(Q) = P$$

- To maximize profit

$$P = MC(Q)$$

Example: Profit Maximization

- Suppose the total cost curve of a firm is

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

- Short-run marginal cost is

$$SMC(Q) = 2Q$$

- To maximize profit, we need

$$P = SMC(Q) = 2Q$$

- The profit-maximizing Q given P is

$$Q = \frac{P}{2}$$

Intuition: Producing Too Little

- Suppose the market price is P=12
- Suppose the firm produces 2 units
- MR=P=12
  - If the firm increases the production level, the total revenue increases at a rate of 12
- SMC=2Q=2*2=4
  - If the firm increases the production level, the total cost increases at a rate of 4
- When P>SMC, total revenue increases than total cost as production level increases

Intuition: Producing Too Much

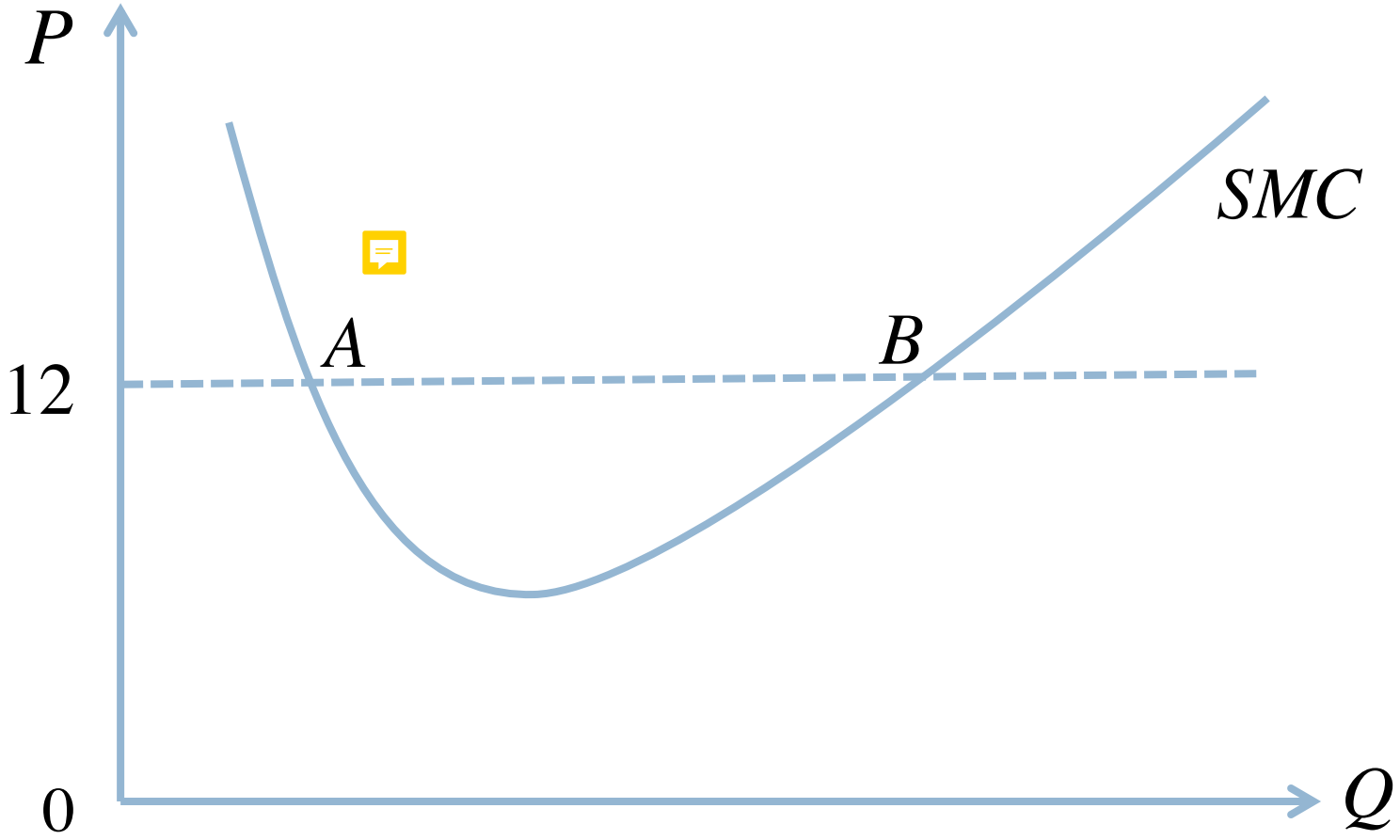
- Suppose the firm produces 8 units when the market price is P=12
- MR=P=12
  - If the firm decreases the production level, the total revenue decreases at a rate of 12
- SMC=2Q=2*8=16
  - If the firm decreases the production level, the total cost decreases at a rate of 16
- When P<SMC, total revenue decreases [redacted] than total cost as production level decreases

Intuition: Profit-Maximizing Optimal Output Choice

- If the firm can increase the profit by either producing more when $P>SMC$ or producing less when $P<SMC$
- It must be that the firm is maximizing profit when producing an output level such that $P=SMC$
- When $P=12$, the optimal output choice is

$$P = SMC \Rightarrow 12 = 2Q \Rightarrow Q = 6$$

Caveat: there may be more than one output level at which *P=SMC*



Point A is the profit-minimizing point

Second-Order Condition

- To make sure we are maximizing profit, it must be that

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

- This implies

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

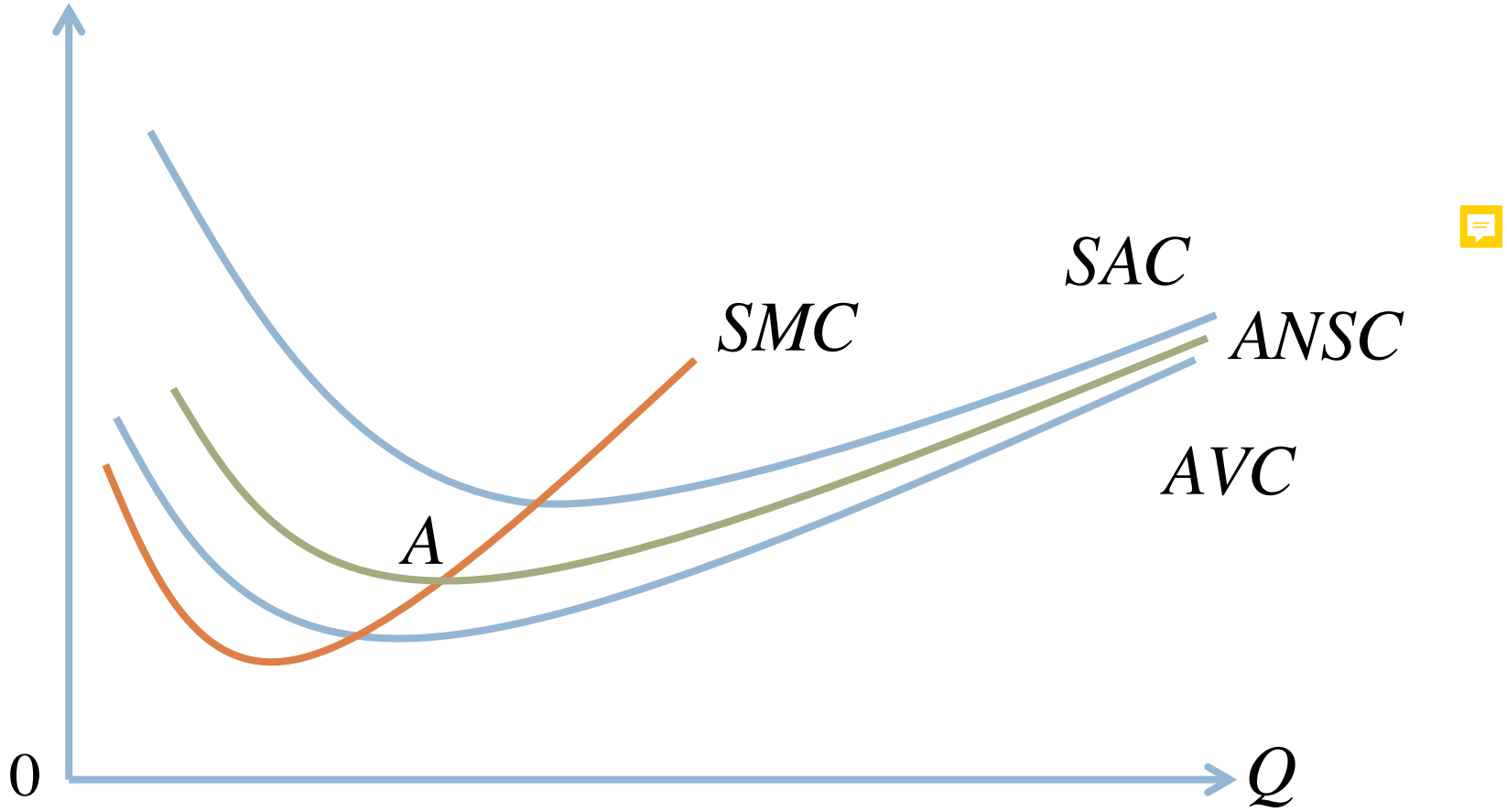
- Since $MR(Q)=P$

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

Non-Sunk Cost vs. Sunk Cost

- Fixed cost may or may not be sunk
- Definition 10.2 *Total non-sunk cost* (*TNSC*) is
  - Total variable cost + total non-sunk fixed cost
- Definition 10.3 *Total sunk cost* (*TSC*) is
  - Total sunk fixed cost
- If all fixed cost is non-sunk
  - *TNSC*=
- If all fixed cost is sunk
  - *TNSC*=

SMC crosses *ANSC* at the minimum point of *ANSC*



Should the firm produce at all?

- If the firm does not produce
  - Its profit is -*TSC*
- If the firm produces
  - Its profit is *TR*(*Q*)-*TNSC*(*Q*)-*TSC*
- Firm only produces when

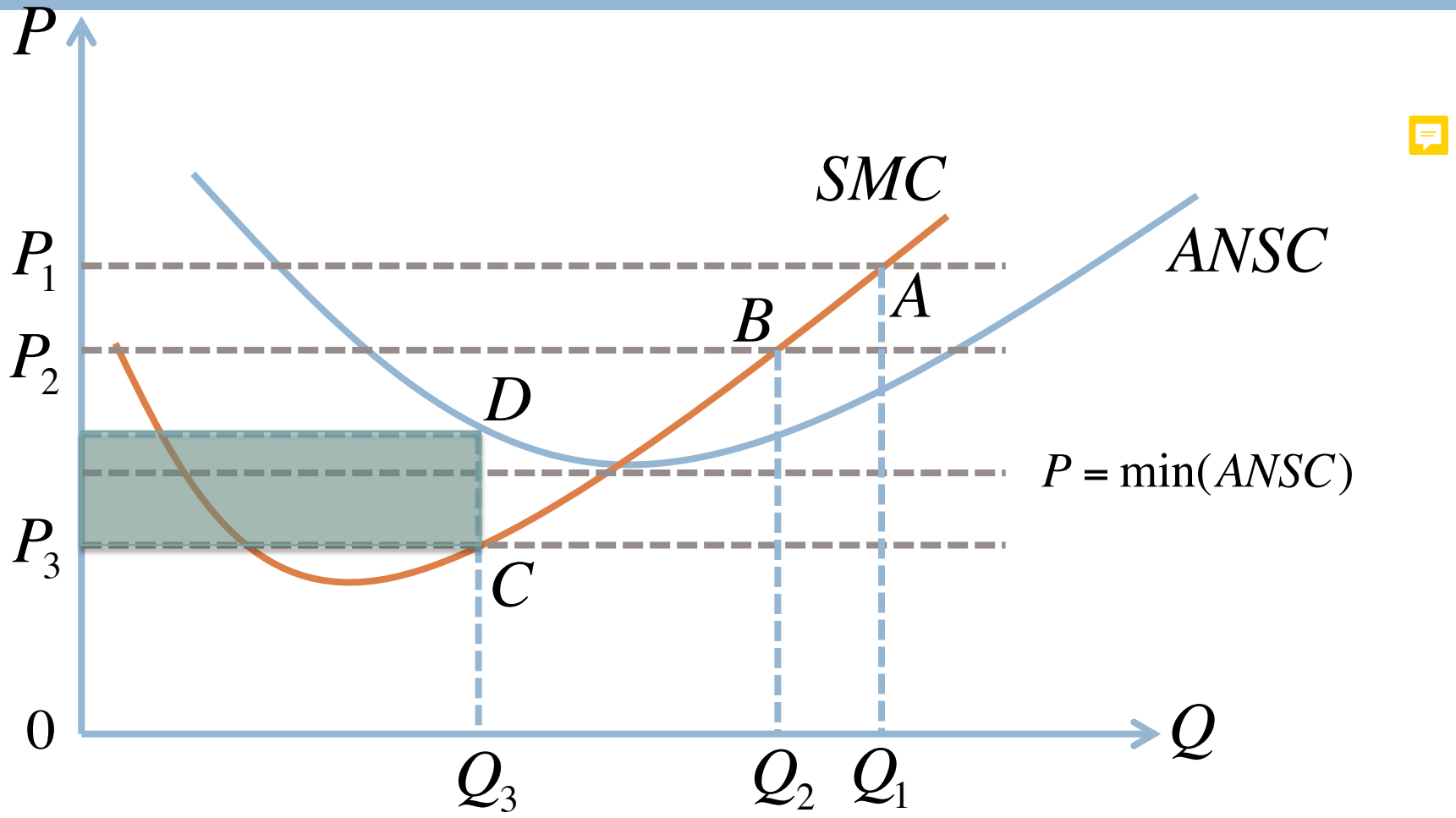
$$TR(Q) \geq TNSC(Q)$$

  - Since

$$TR(Q) = PQ, \quad TNSC(Q) = ANSC(Q) \times Q$$

  - Firm only produces when $P \geq ANSC(Q)$

When should the firm stop producing?



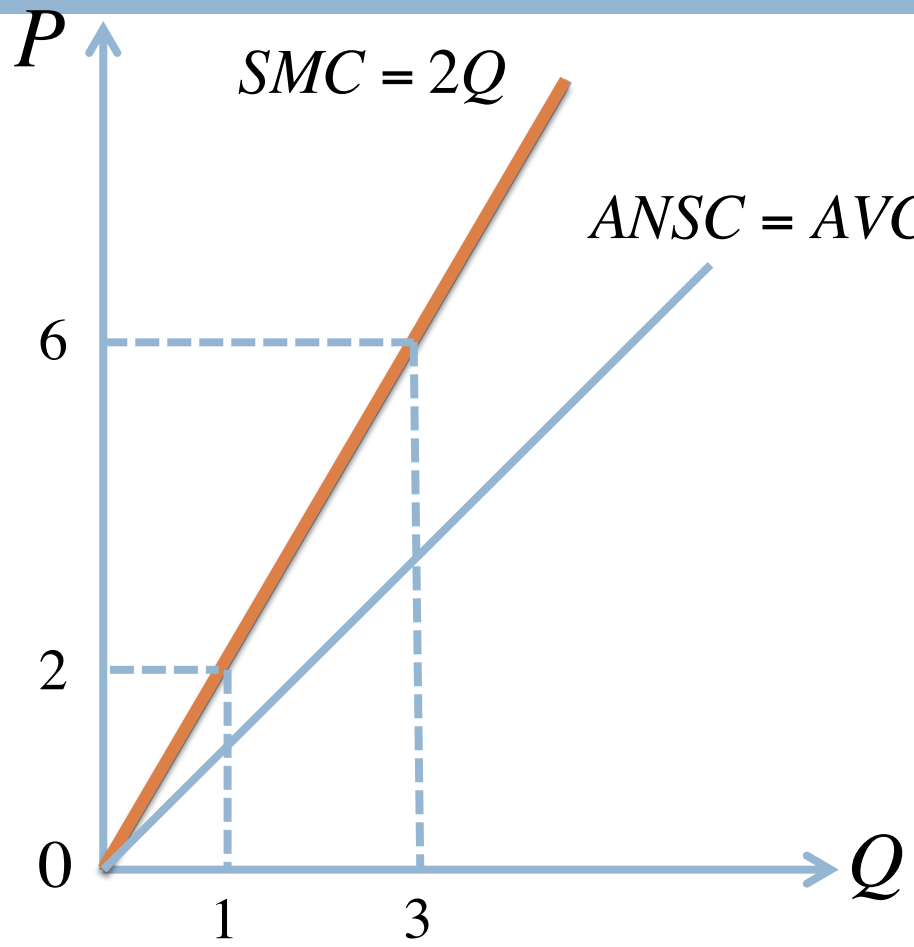
Profit-maximizing conditions in the short run

When P>=min$(ANSC)$, each firm should choose a level of Q such that

- At that output level, P=SMC
- SMC is non-decreasing in Q

When P<min$(ANSC)$, each firm should set Q=0

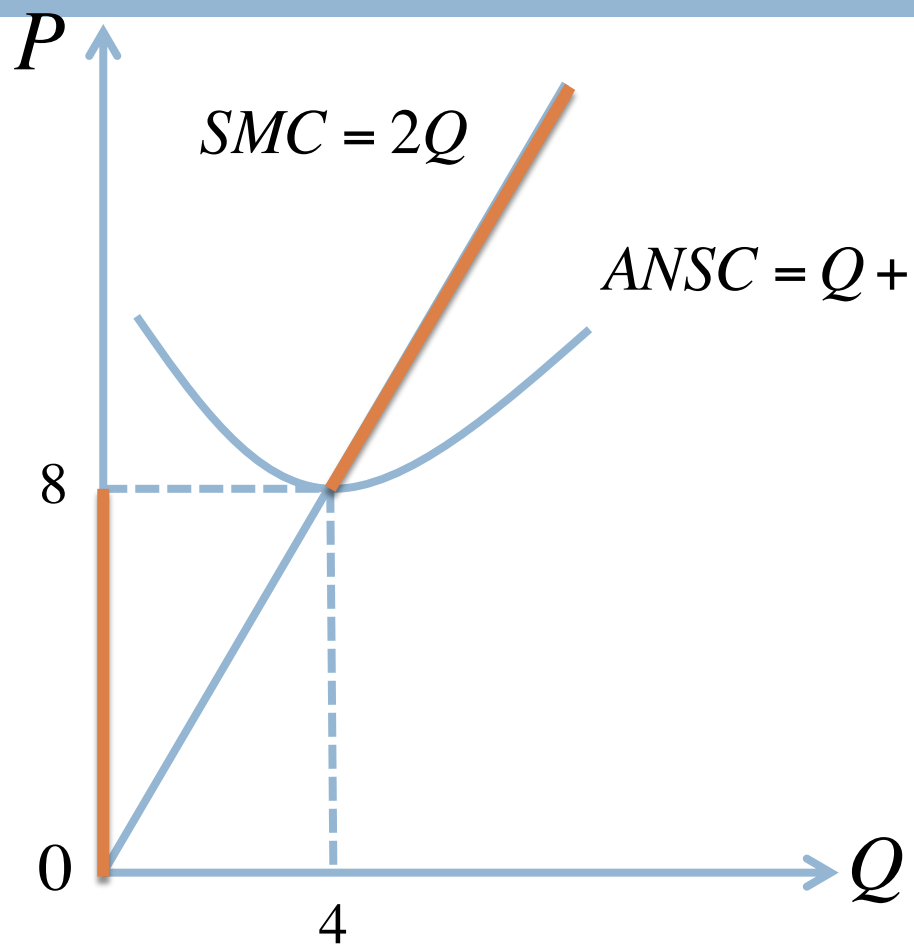
Example: Firm's Supply Curve When All Fixed Cost is Sunk



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

P=*SMC*=2*Q*
thus the supply curve is
Q=*P*/2

Example: Firm's Supply Curve When Part of the Fixed Cost is Non-Sunk



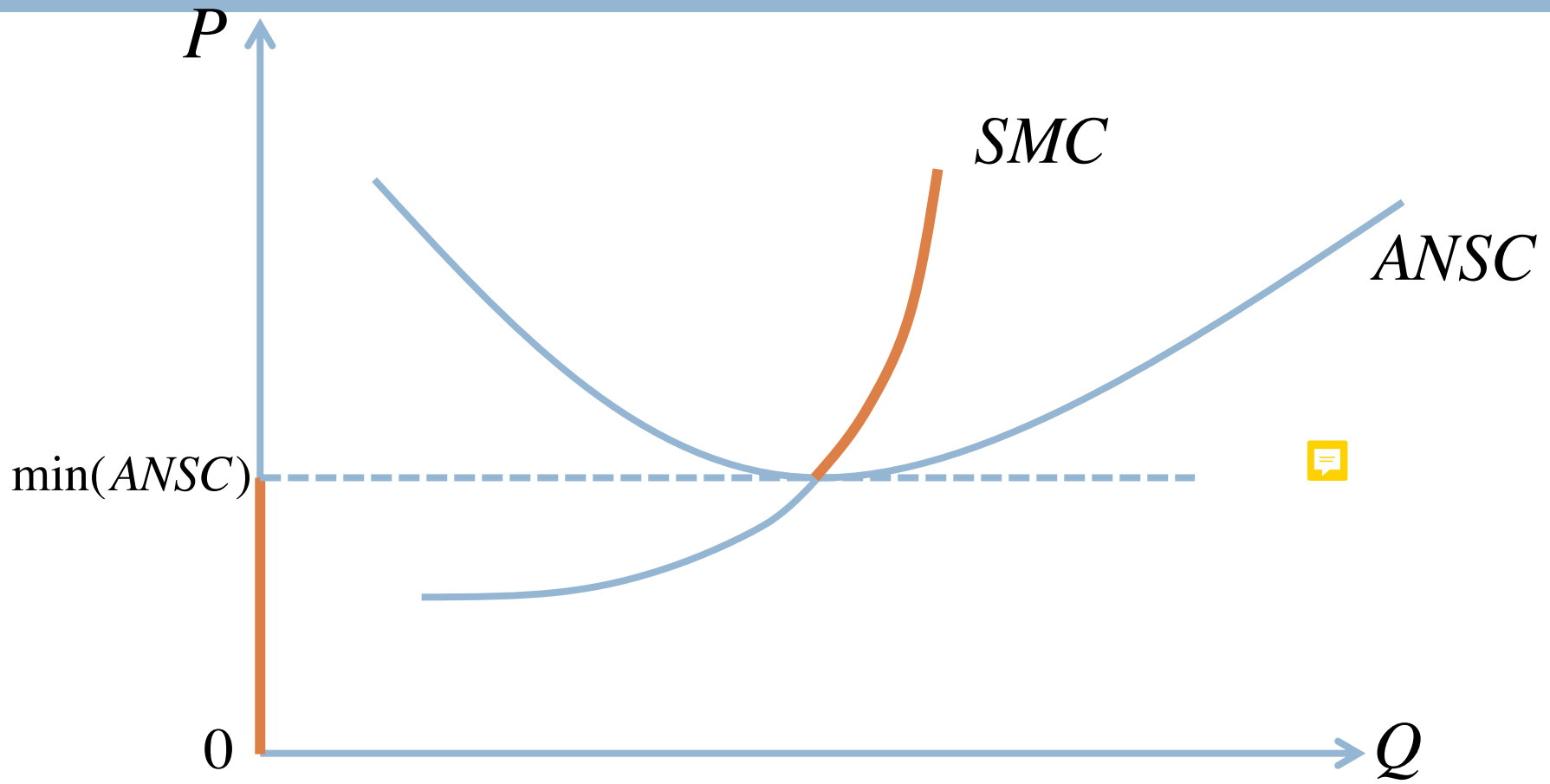
Suppose the non-sunk fixed cost is 16

The supply curve is $Q=P/2$ when $P>=8$ and $Q=0$ when $P<8$

Individual Firm's Supply Curve

- Definition 10.4 The *short-run supply curve for an individual firm* is the profit-maximizing quantity for the firm as a function of the market price
- If $P<\min(ANSC)$
  - $Q=0$
  - Supply curve is the vertical axis
- If $P>=\min(ANSC)$
  - Firm chooses Q such that $SMC(Q)=P$
  - Supply curve is the marginal cost curve

Firm's Short-run Supply Curve in General



Short-Run Market Supply Curve

- Definition 10.5 *Short-run market supply curve* is the horizontal sum of all individual firm's supply curve
- Suppose there are 100 identical firms in the market
- Assuming all fixed cost is sunk, each firm has a supply curve

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

- The market supply curve is

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

Part 2

Short-Run Market Equilibrium

Short-run Market Equilibrium

- Definition 10.6 At the *short-run market equilibrium* in a competitive market
  - Total quantity demanded equals total quantity supplied
  - Each firm produces at the profit-maximizing output level given the equilibrium price
  - Each consumer buys the utility-maximizing quantity given the equilibrium price

Example: Short-run Market Equilibrium

- Suppose the demand curve is

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

- Short-run equilibrium price is thus

$$S(P) = D(P) \Rightarrow 50P = 560 - 20P \Rightarrow P = 8$$

- Total quantity produced in the equilibrium is 50*8=400
- Each firm produces 8/2=4 units

Relationship between Profit and *SAC*

- Suppose the market price is P
- At this price, a firm's optimal output level is Q_f
- Firm's profit is

$$TR - STC = P \times Q_f - SAC(Q_f) \times Q_f = [P - SAC(Q_f)]Q_f$$

- $P>SAC(Q_f)$
  - Firm's profit is at the output level Q_f
- $P<SAC(Q_f)$
  - Firm's profit is at the output level Q_f

Profit at Short-Run Market Equilibrium

- What is the profit for each firm?

$$TR - STC = PQ_f - STC(Q_f) = 8 \times 4 - 4 \times 4 - 25 = -9$$

  - The short-run average total cost is

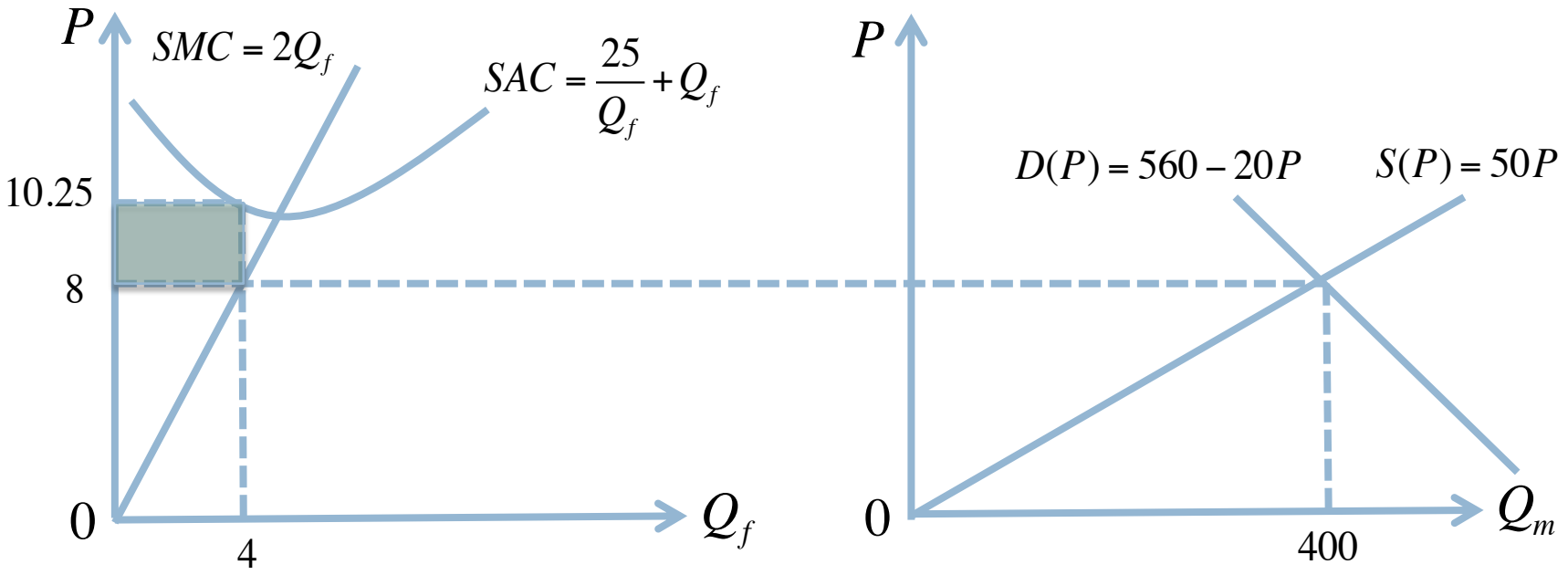
$$SAC(Q_f) = \frac{STC(Q_f)}{Q_f} = \frac{25 + Q_f^2}{Q_f} \Rightarrow SAC(4) = \frac{25 + 16}{4} = 10.25$$

- Negative profit is possible in short-run market equilibrium
  - Firms do not take sunk cost into consideration when deciding how much to produce

Short-Run Equilibrium in Graph

Typical Firm's Cost and Supply

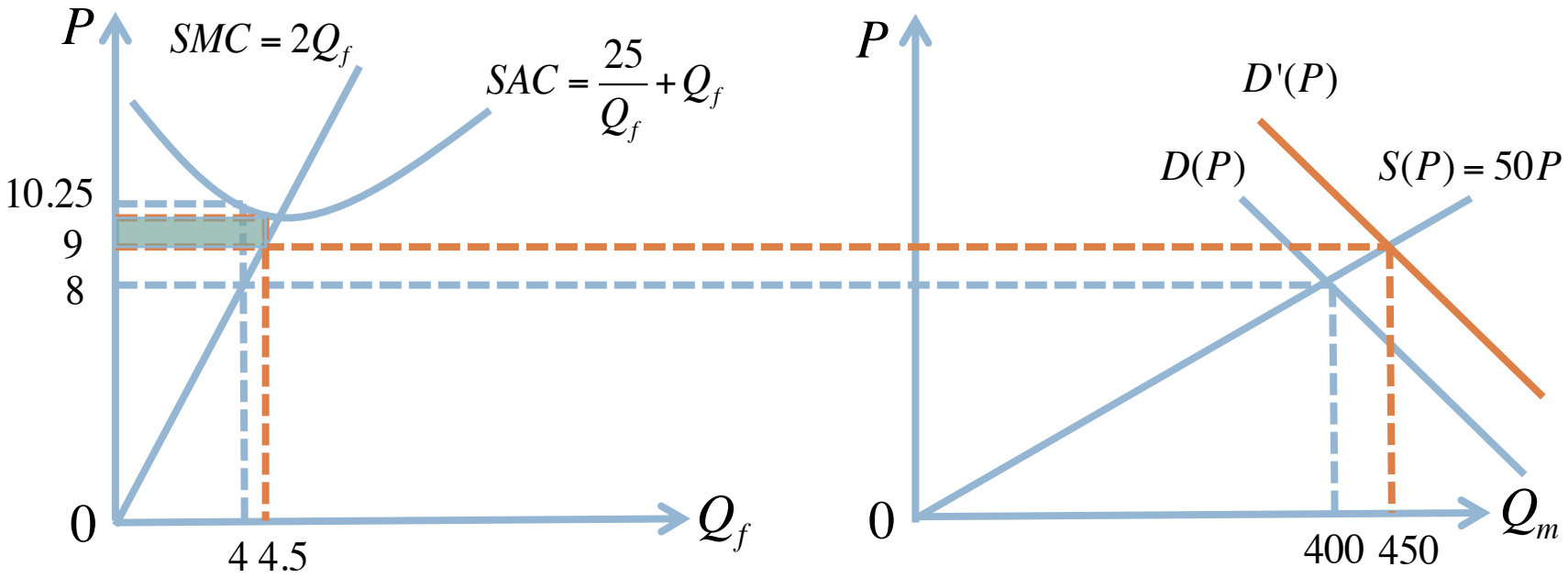
Market Equilibrium with 100 Identical Firms



Comparative Statics: What if demand increases?

Typical Firm's Cost and Supply

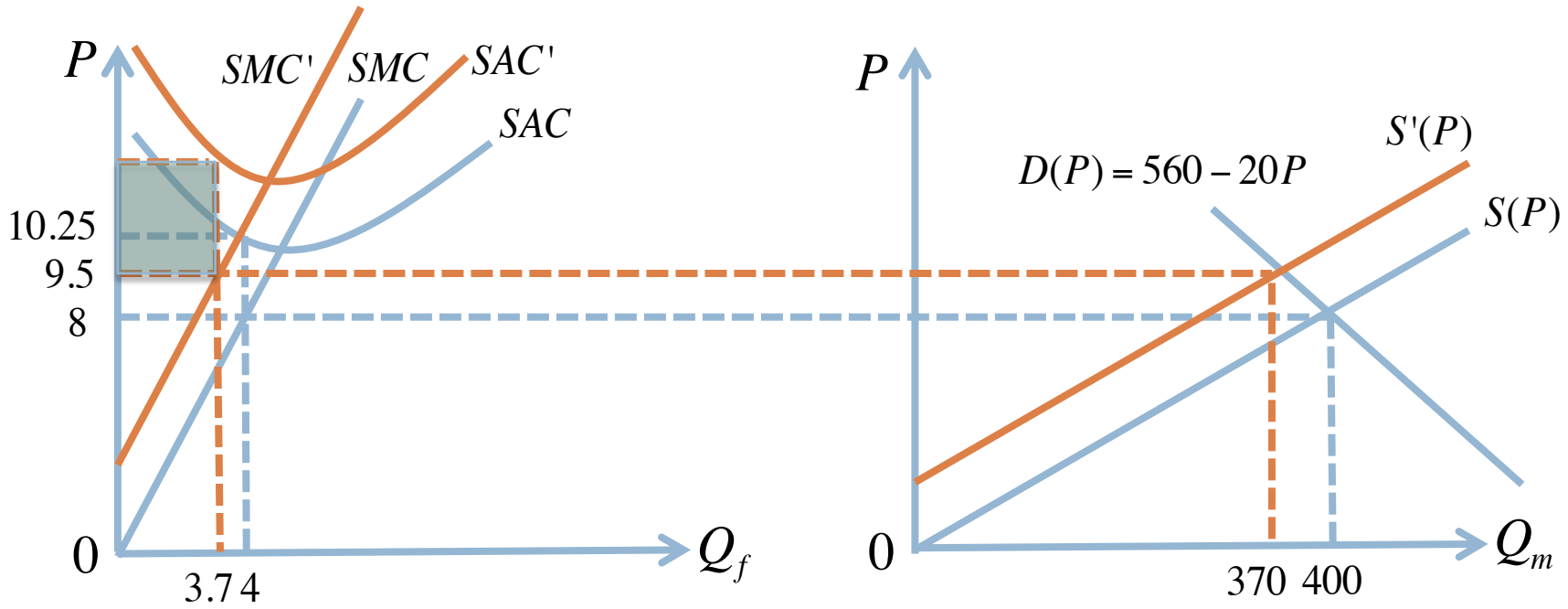
Market Equilibrium with 100 Identical Firms



Comparative Statics: What if input prices increase?

Typical Firm's Cost and Supply

Market Equilibrium with 100 Identical Firms



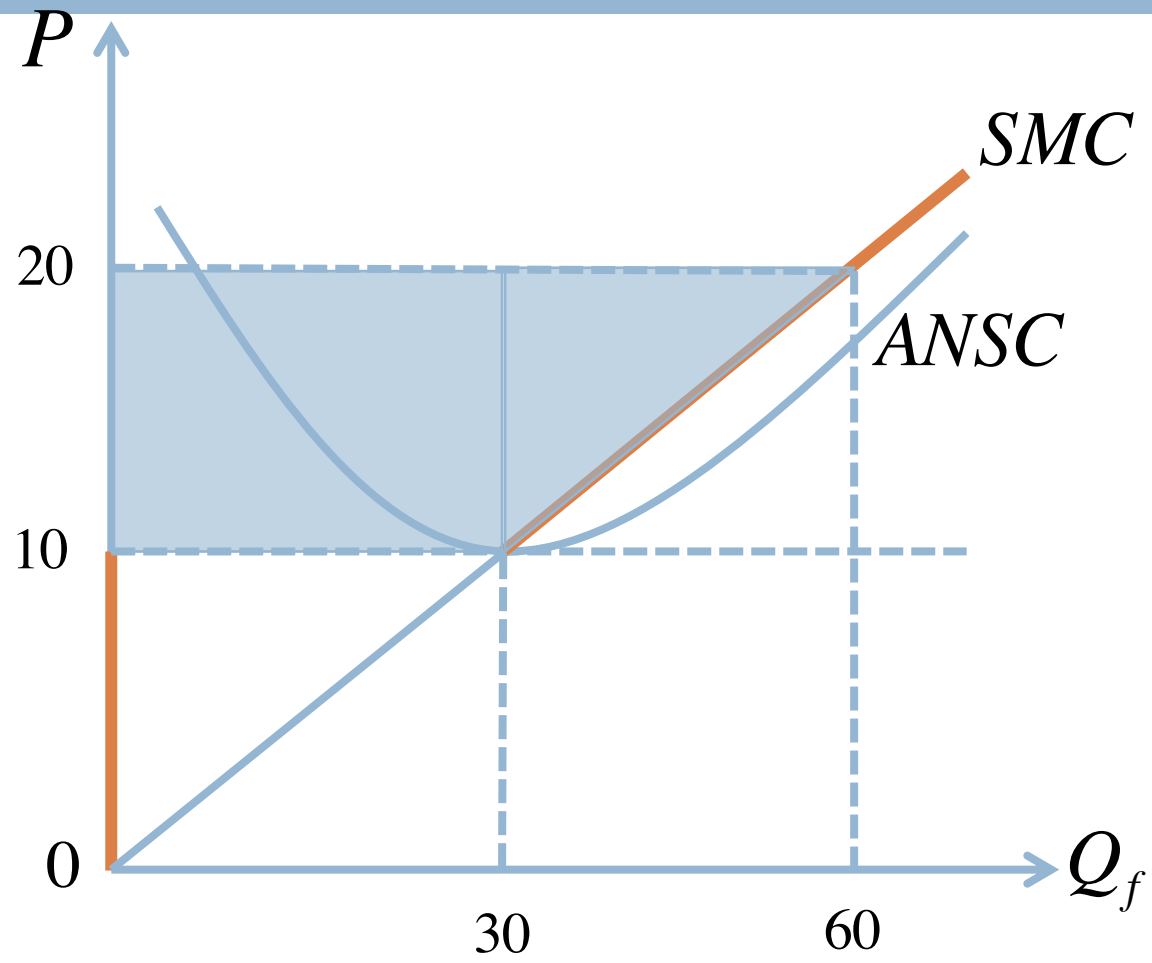
Part 3

Producer Surplus in the Short Run

Definition of Producer Surplus

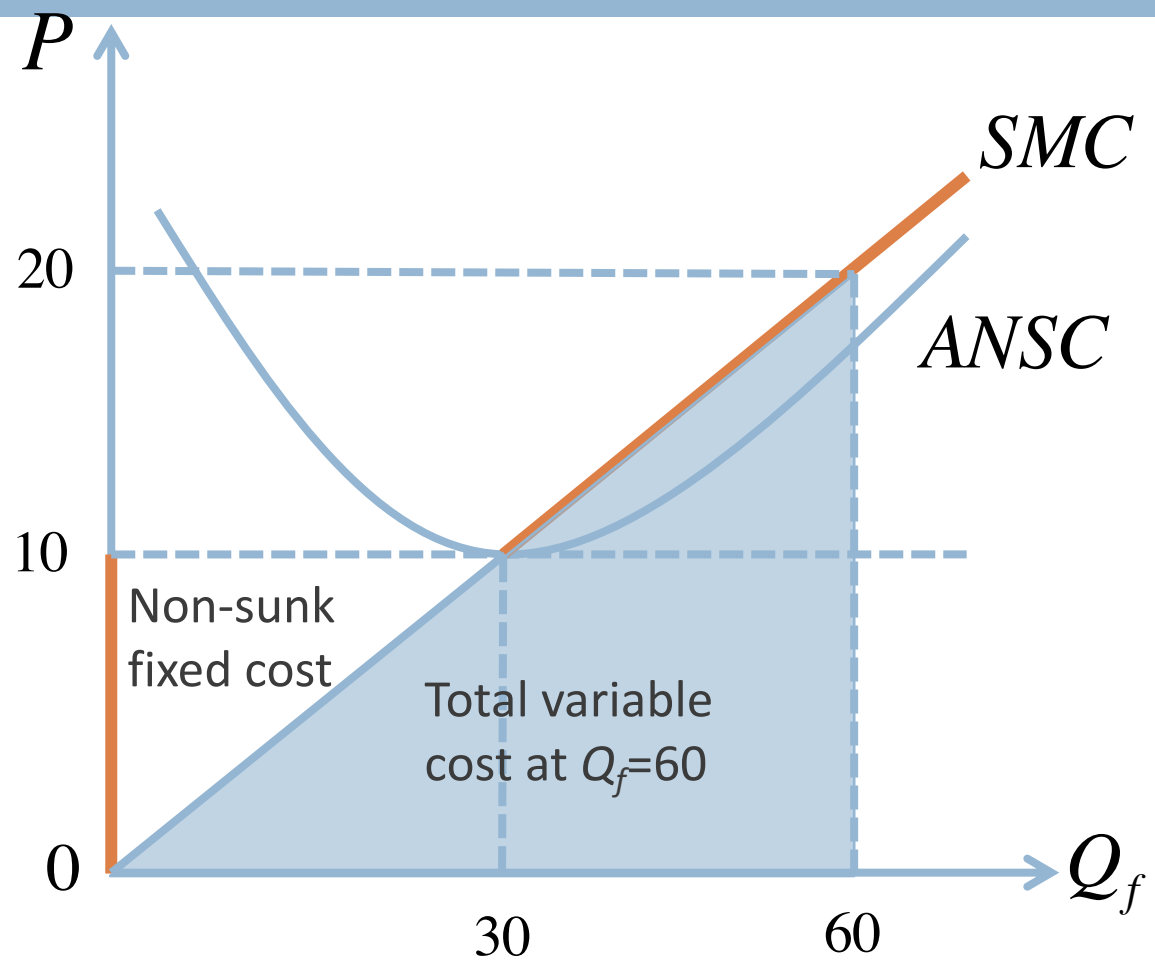
- Definition 10.7 *Producer surplus* (PS) is the difference between the amount producers actually receive by producing and selling a certain units and the amount producers have to receive to produce a certain units
- PS = total revenue - total non-sunk cost
- PS is the area below the price and above the supply curve

Producer Surplus in Graph



PS=0.5*(30+60)*(20-10)=450

Producer Surplus in Graph Cont'



Calculating Producer Surplus from the Graph

- Total revenue
  - 20*60=1200
- Total non-sunk cost
  - *VC* is 0.5*60*20=600
    - The area under the *SMC* curve
  - Non-sunk fixed cost is 150
    - *TNSC* for the first 30 units is *ANSC*(30)*30=10*30=300
    - But *VC* for the first 30 units is 0.5*30*10=150
  - *TNSC*=600+150=750
- PS=1200-750=450
  - The area under the price and above the supply curve