

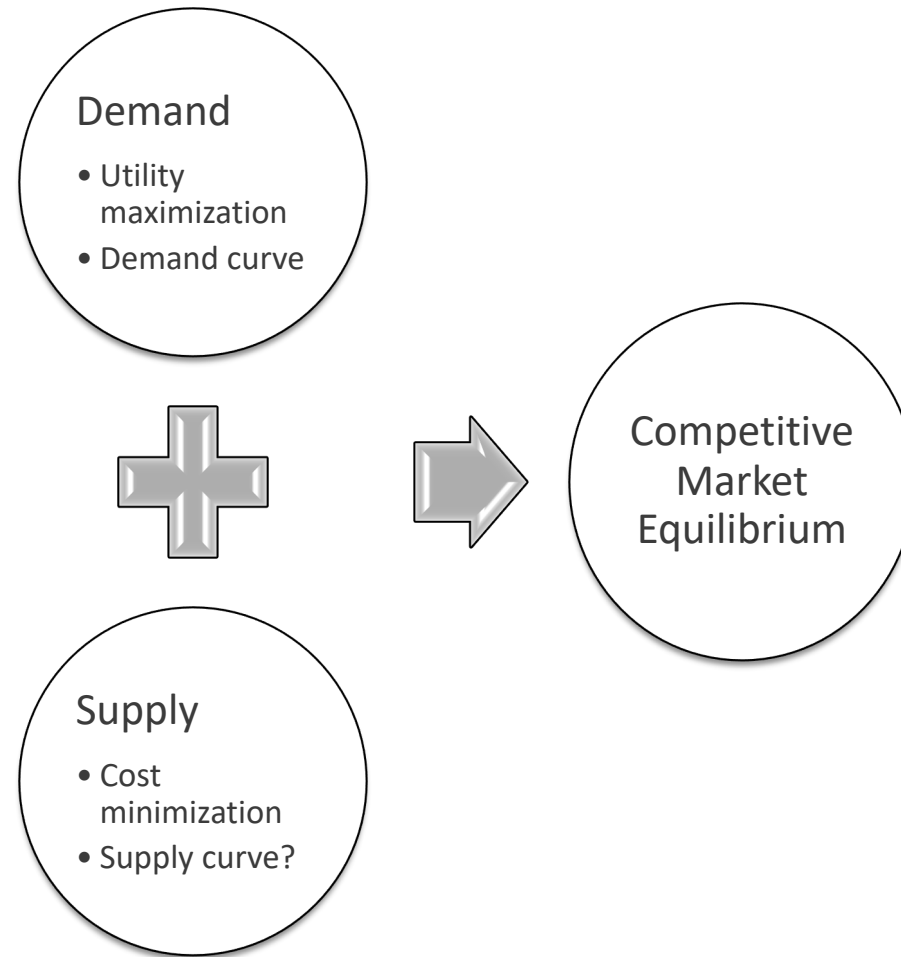
LECTURE 10

PERFECT COMPETITION IN THE SHORT RUN



The Big Picture

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Where are we?

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- 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?

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- 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

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- 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

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- 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

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- 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?

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- To maximize profit, we solve

$$\max_Q TR(Q) - TC(Q)$$

- The first-order condition is

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

- Rearranging, we have

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

Profit-Maximizing Condition in Perfectly Competitive Market

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- 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

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- 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

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- 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

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- 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 than total cost as production level decreases

Intuition: Profit-Maximizing Optimal Output Choice

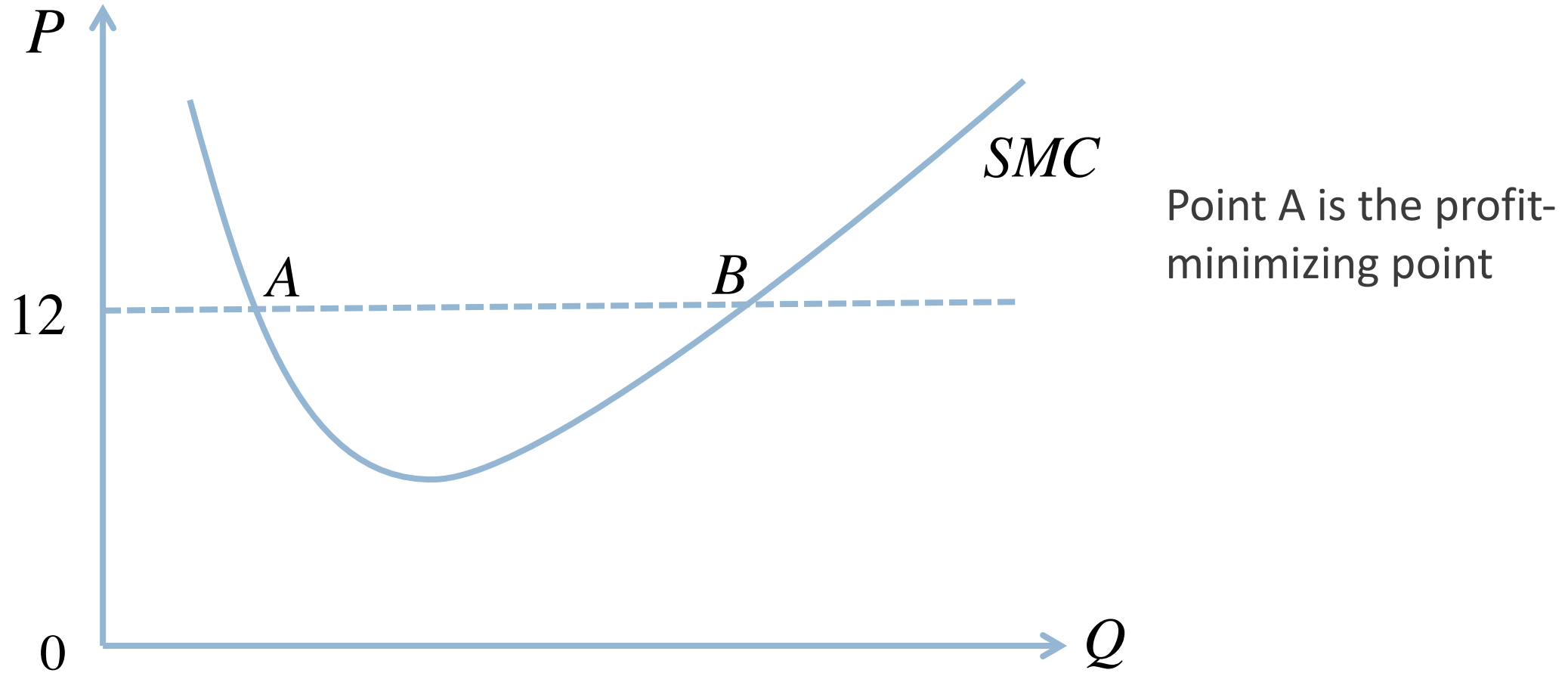
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- If the firm can increase the profit by either producing more when $P > SMC$ or producing less when $P < SMC$
- It must be that the firm is maximizing profit when producing an output level such that $P = SMC$
- When $P = 12$, the optimal output choice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

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

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

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Second-Order Condition

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- 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 $MR(Q)=P$

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

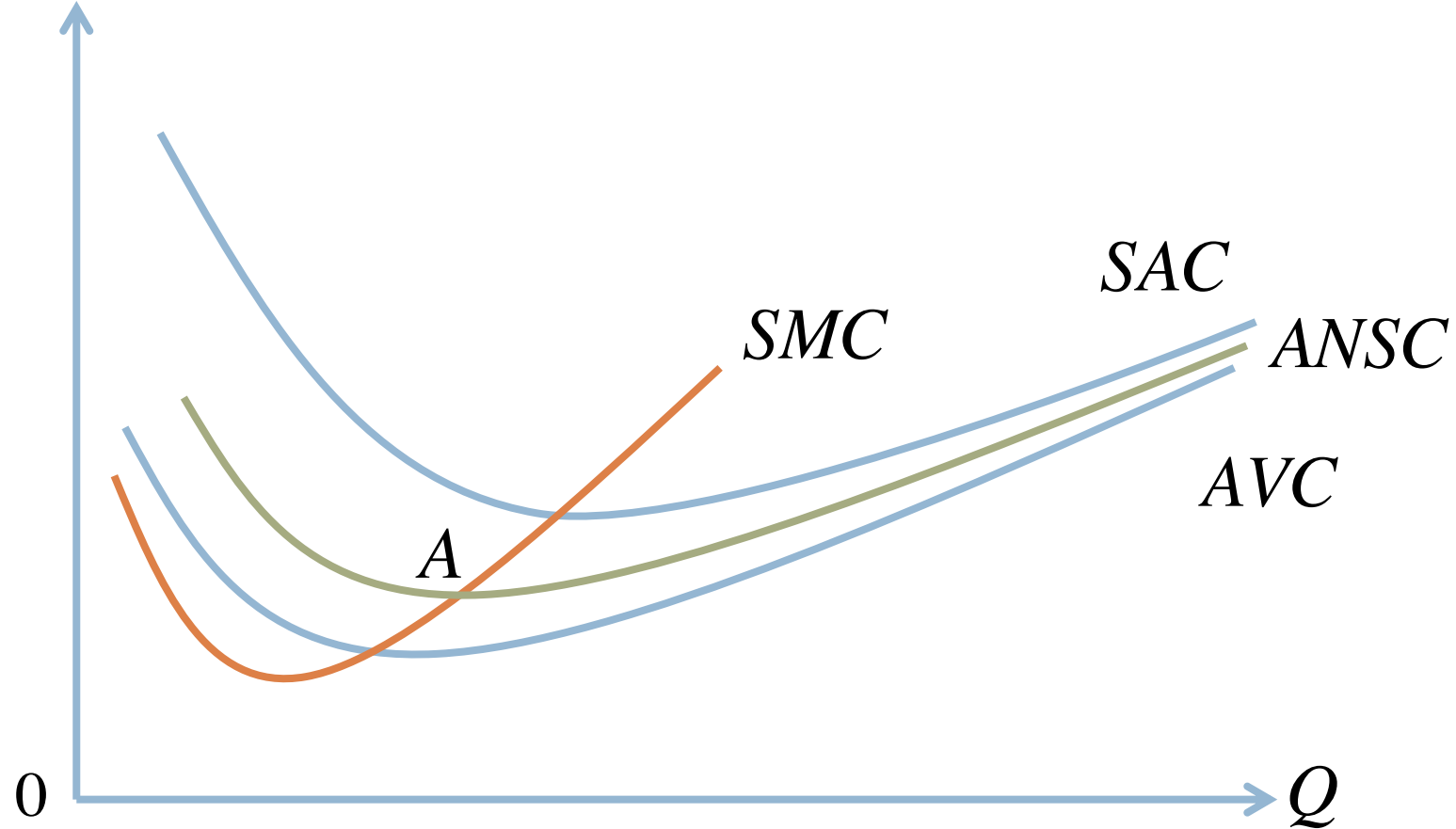
Non-Sunk Cost vs. Sunk Cost

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- 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 $ANSC$

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Should the firm produce at all?

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- 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

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

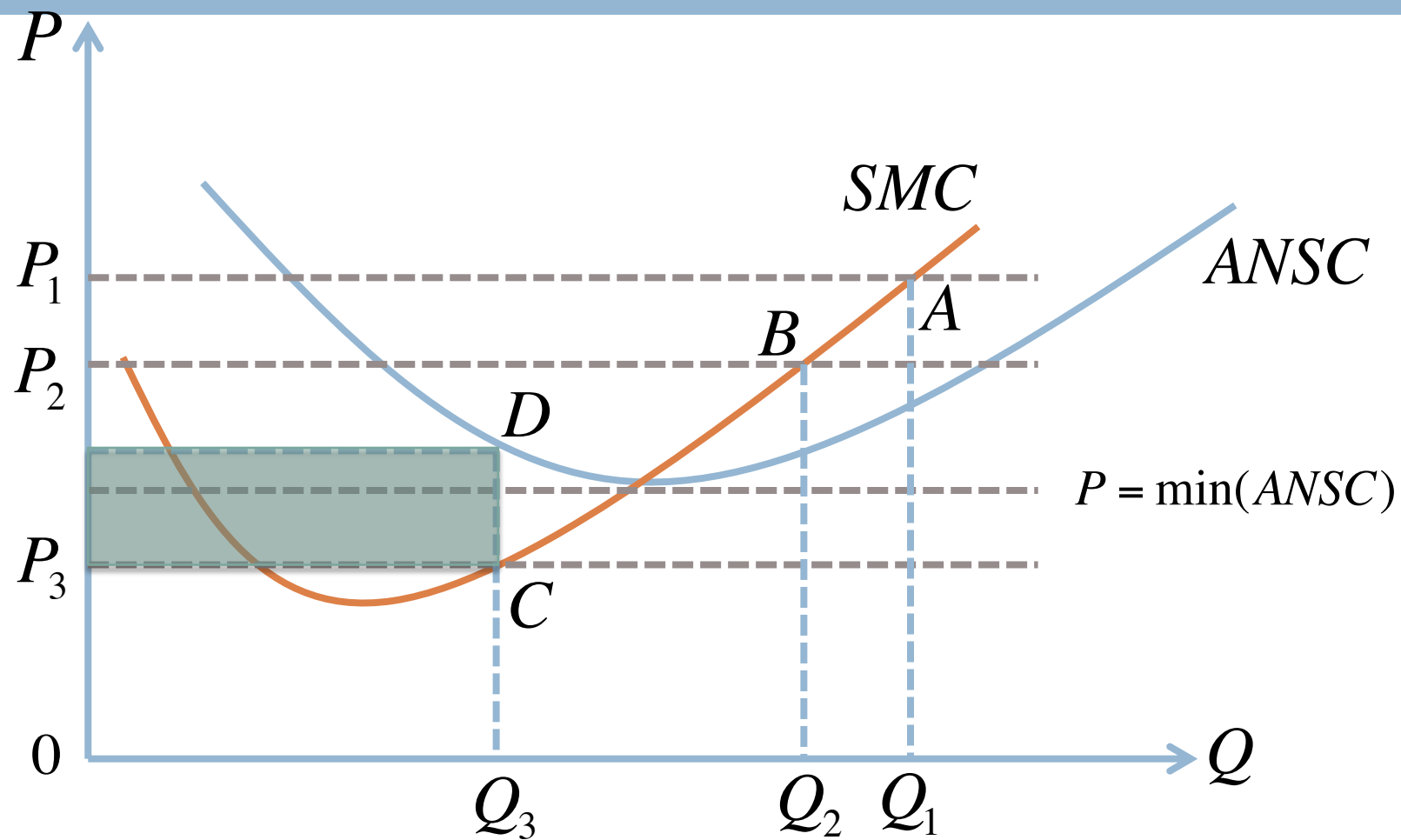
- ▣ Since

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

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

When should the firm stop producing?

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Profit-maximizing conditions in the short run

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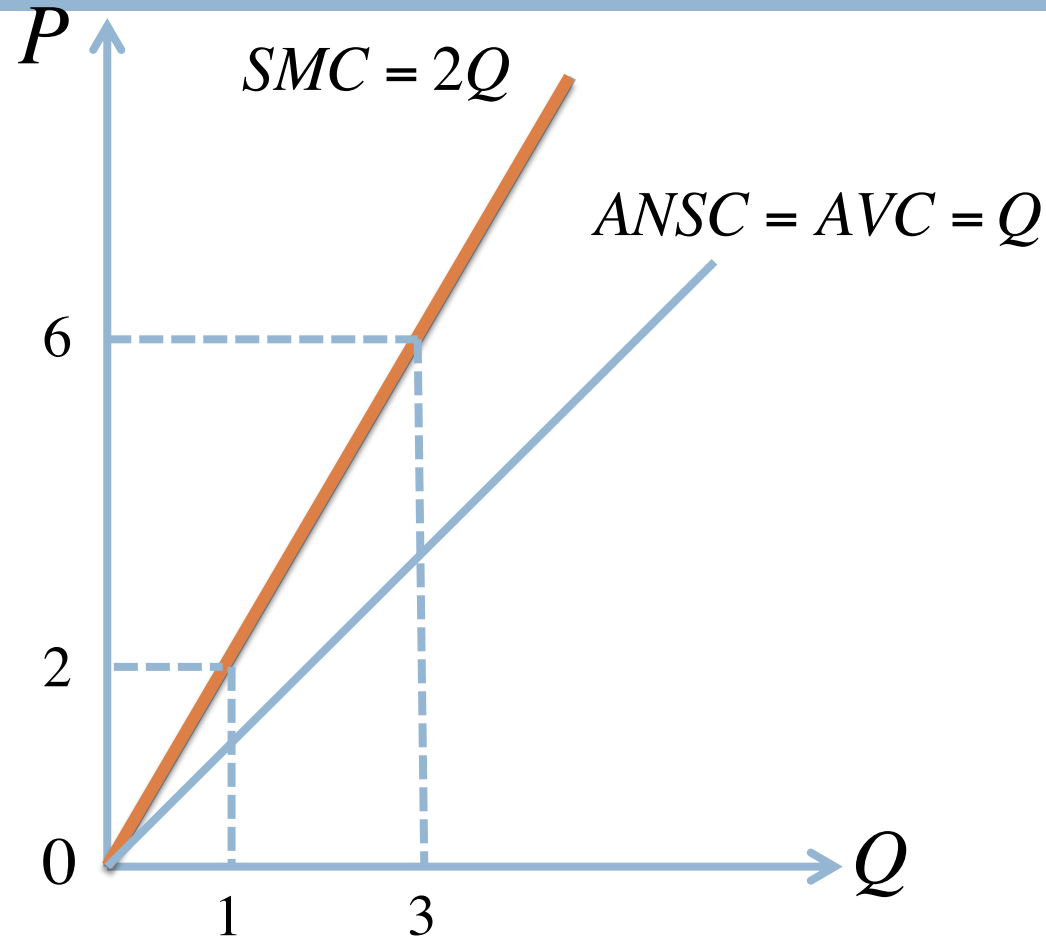
When $P \geq \min(ANSC)$, each firm should choose a level of Q such that

- 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

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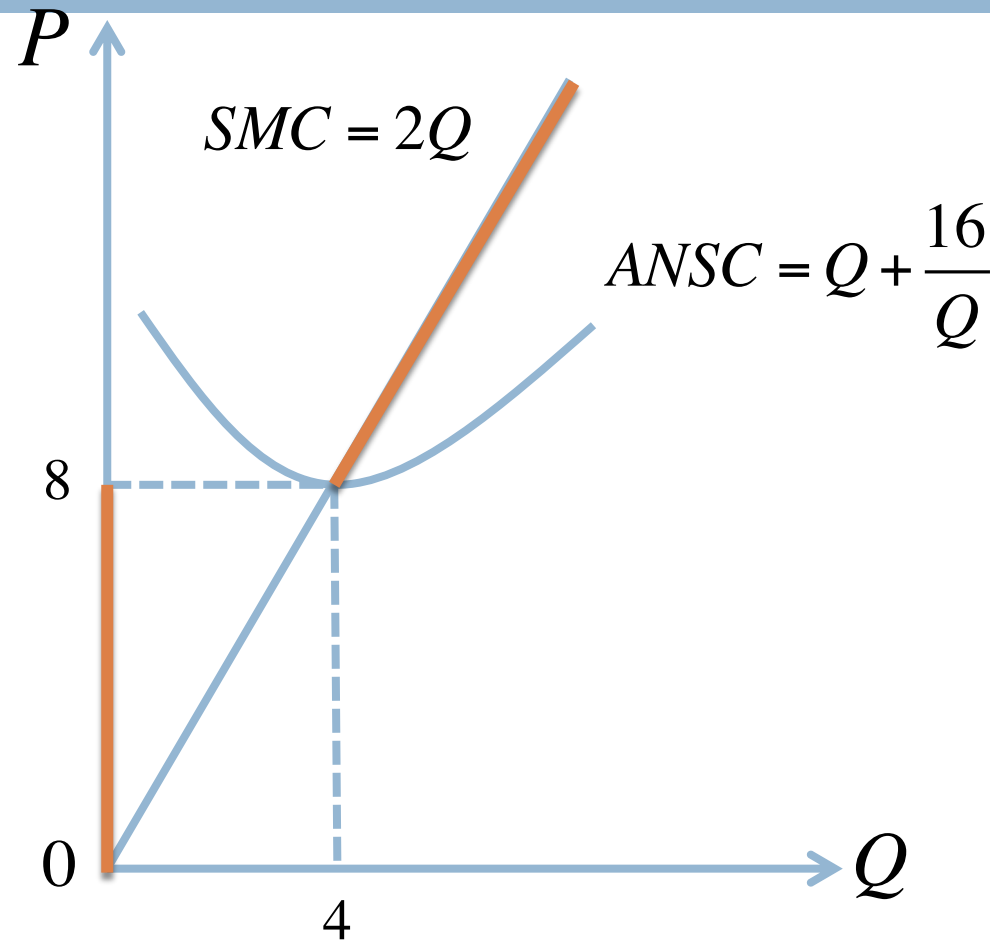
$$STC(Q) = Q^2 + 25$$

$$P = SMC = 2Q$$

thus the supply curve is
 $Q = P/2$

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

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Suppose the non-sunk
fixed cost is 16

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

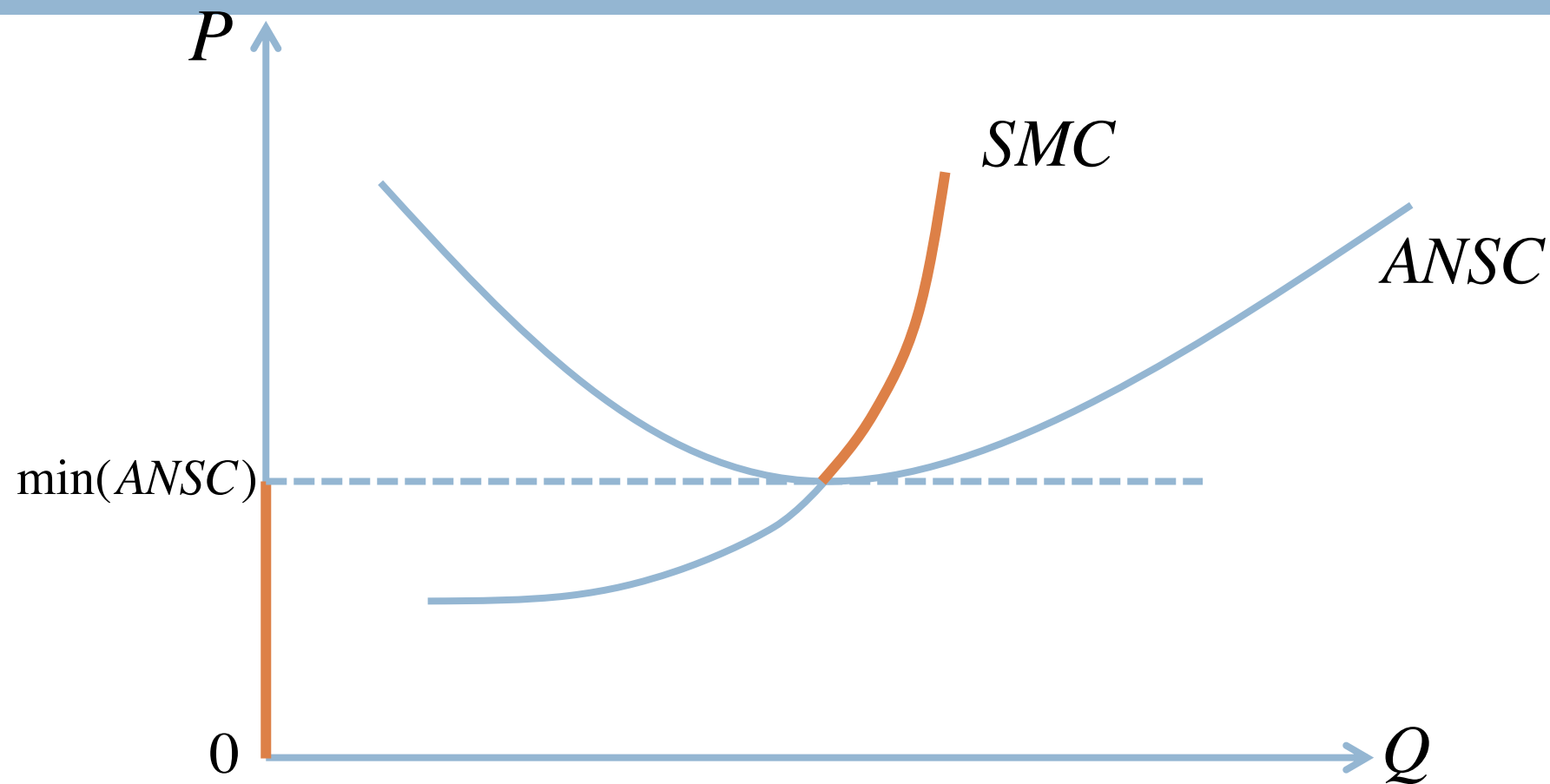
Individual Firm's Supply Curve

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- 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 $P \geq \min(ANSC)$
 - ▣ Firm chooses Q such that $SMC(Q)=P$
 - ▣ Supply curve is the marginal cost curve

Firm's Short-run Supply Curve in General

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Short-Run Market Supply Curve

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- 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

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- 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

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- 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 $50 \times 8 = 400$
- Each firm produces $8/2 = 4$ units

Relationship between Profit and SAC

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- 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

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- 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

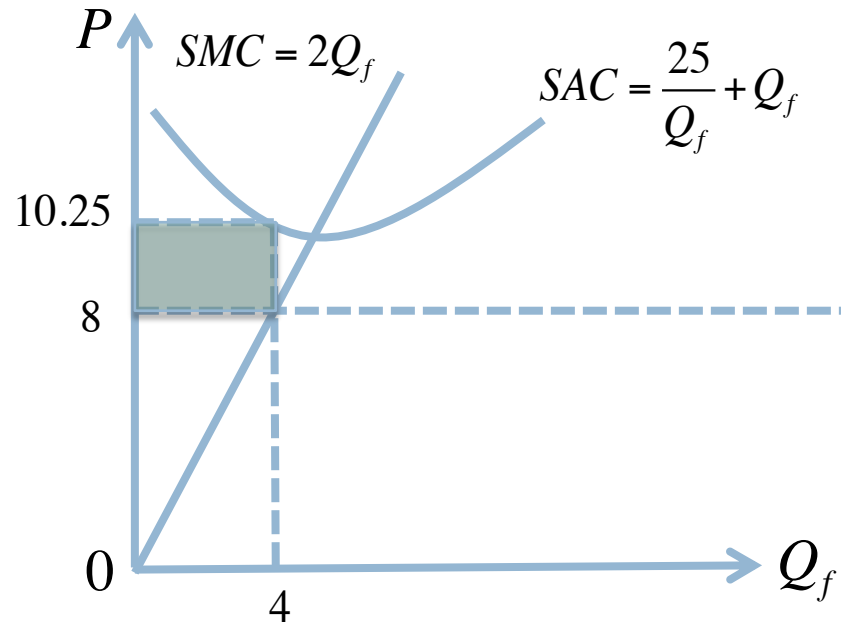
$$SAC(Q_f) = \frac{STC(Q_f)}{Q_f} = \frac{25 + Q_f^2}{Q_f} \Rightarrow SAC(4) = \frac{25 + 16}{4} = 10.25$$

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

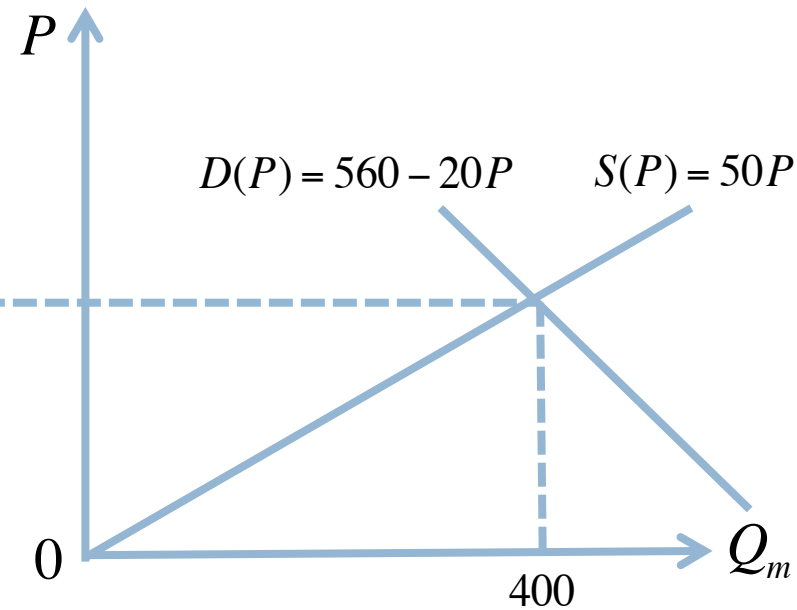
Short-Run Equilibrium in Graph

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Typical Firm's Cost and Supply



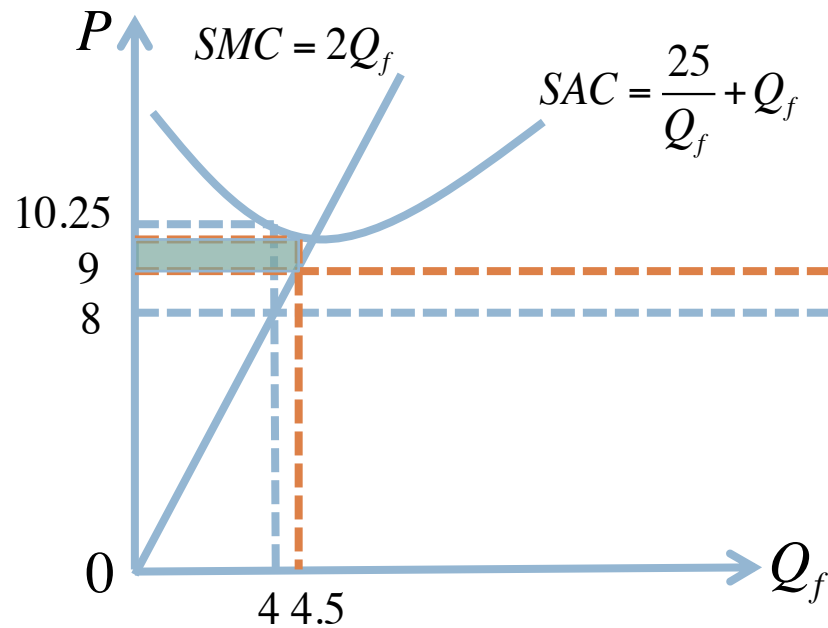
Market Equilibrium with 100 Identical Firms



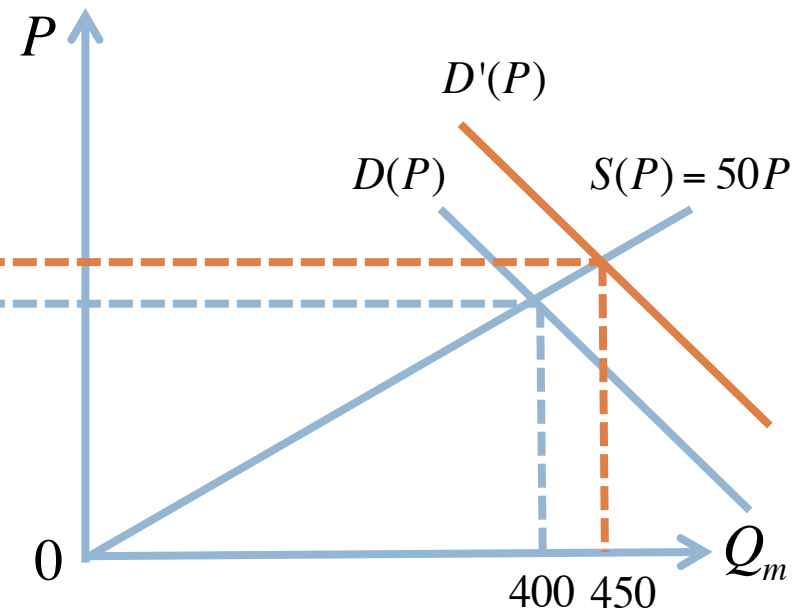
Comparative Statics: What if demand increases?

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Typical Firm's Cost and Supply

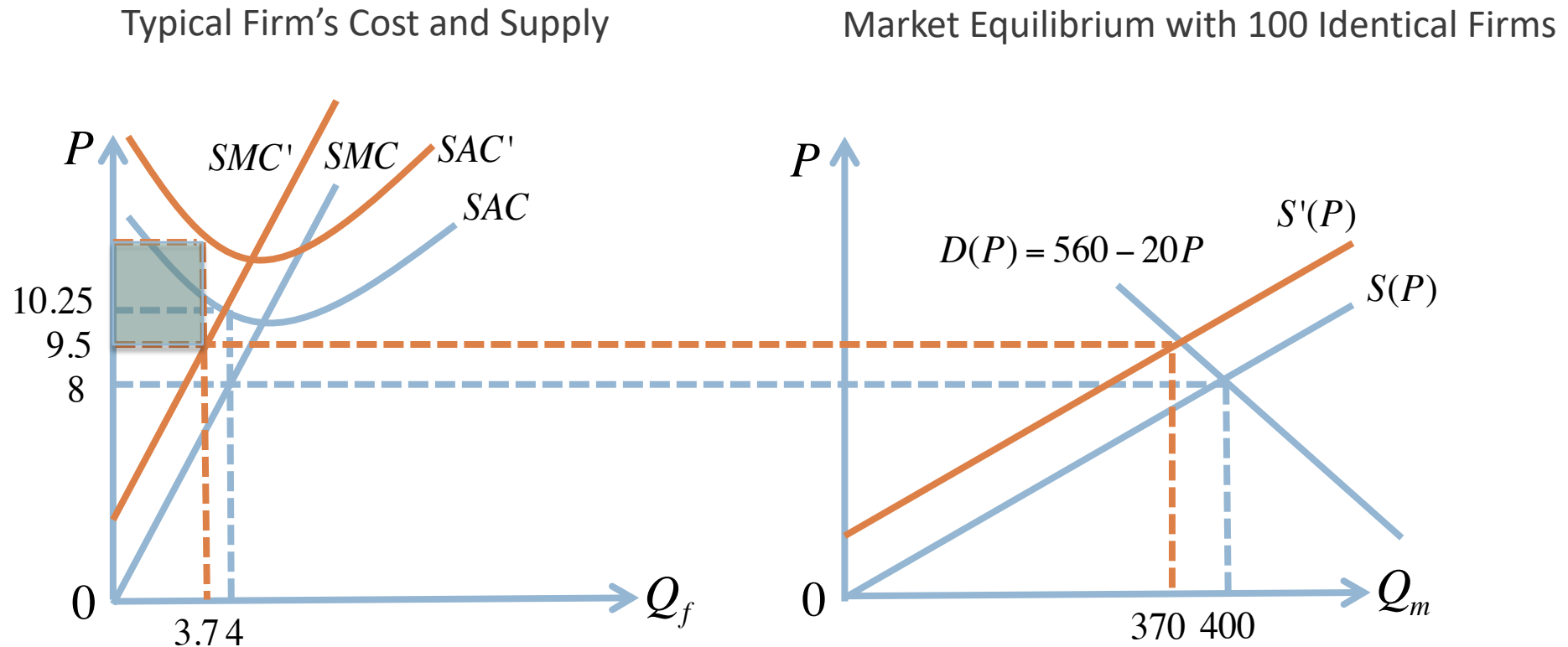


Market Equilibrium with 100 Identical Firms



Comparative Statics: What if input prices increase?

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Part 3

Producer Surplus in the Short Run

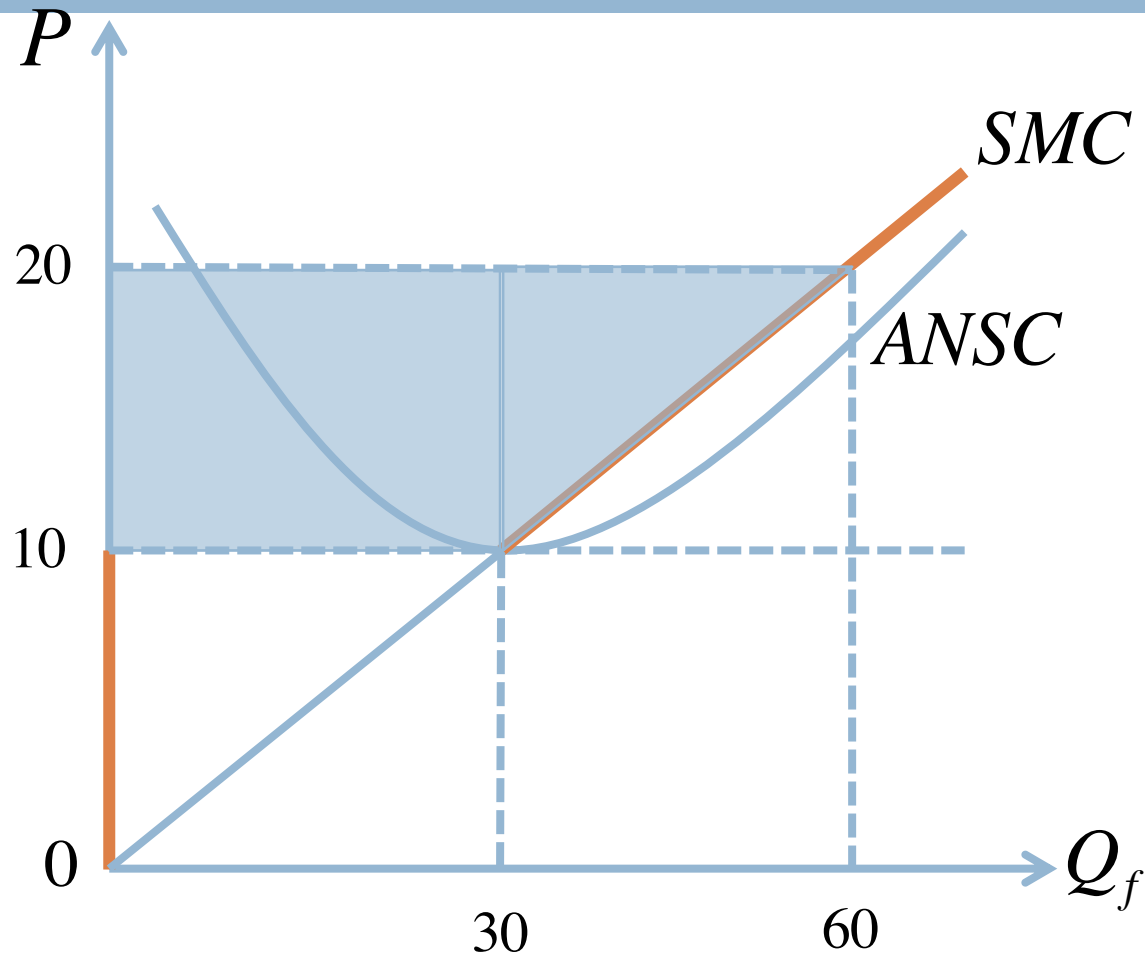
Definition of Producer Surplus

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- 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
- $PS = \text{total revenue} - \text{total non-sunk cost}$
- PS is the area below the price and above the supply curve

Producer Surplus in Graph

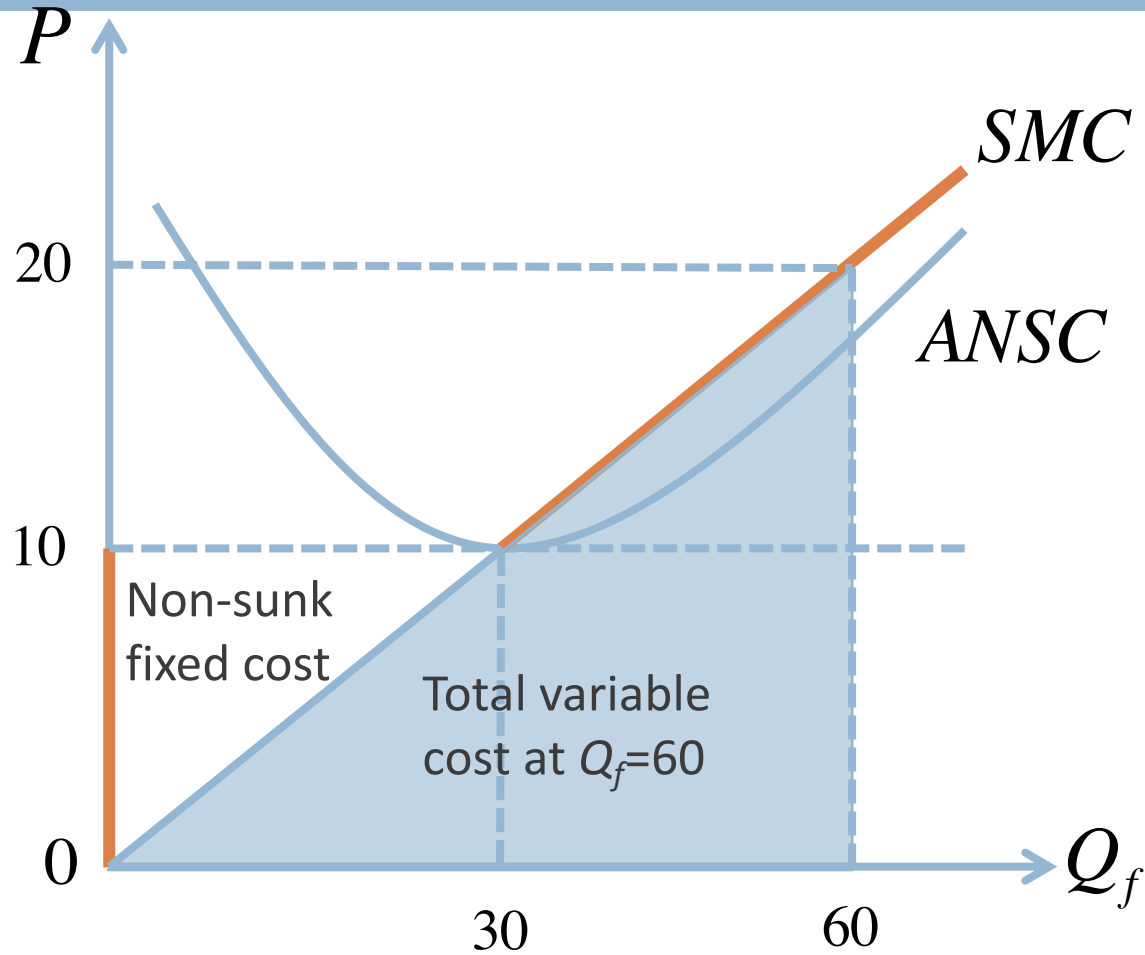
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$$PS = 0.5 * (30 + 60) * (20 - 10) = 450$$

Producer Surplus in Graph Cont'

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Calculating Producer Surplus from the Graph

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