Chapter 10

THE PARTIAL EQUILIBRIUM COMPETITIVE MODEL

Market Demand

- Assume that there are only two goods (x and y)
  - An individual's demand for x is

$$\text{Quantity of } x \text{ demanded} = x(p_x, p_y, I)$$

  - If we use i to reflect each individual in the market, then the market demand curve is

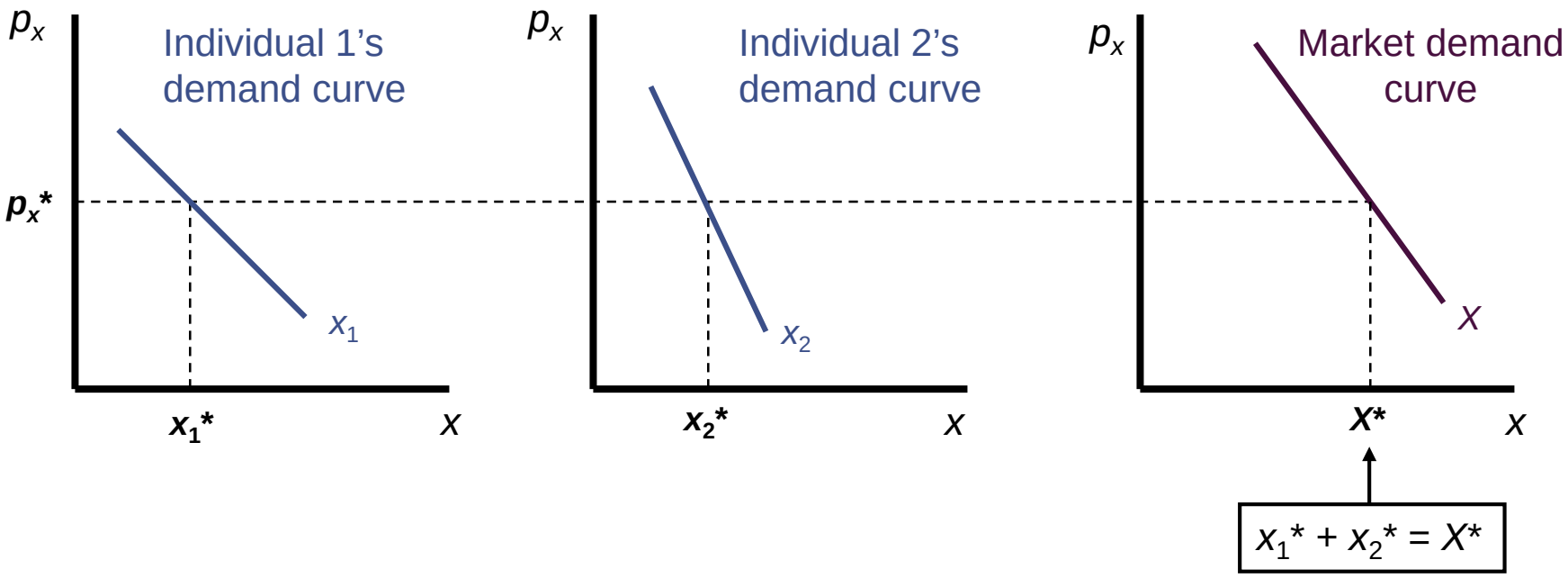
$$\text{Market demand for } X = \sum_{i=1}^{n} x_i(p_x, p_y, I_i)$$

Market Demand

- To construct the market demand curve, P_X is allowed to vary while P_y and the income of each individual are held constant
- If each individual's demand for *x* is downward sloping, the market demand curve will also be downward sloping

Market Demand

To derive the market demand curve, we sum the quantities demanded at every price



Shifts in the Market Demand Curve

- The market demand summarizes the *ceteris paribus* relationship between X and p_x
  - changes in p_x result in movements along the curve (change in quantity demanded)
  - changes in other determinants of the demand for X cause the demand curve to shift to a new position (change in demand)

Shifts in Market Demand

- Suppose that individual 1's demand for oranges is given by

$$x_1 = 10 - 2p_x + 0.1I_1 + 0.5p_y$$

and individual 2's demand is

$$x_2 = 17 - p_x + 0.05I_2 + 0.5p_y$$

- The market demand curve is

$$X = x_1 + x_2 = 27 - 3p_x + 0.1I_1 + 0.05I_2 + p_y$$

Shifts in Market Demand

- To graph the demand curve, we must assume values for p_y, I_1, and I_2
- If $p_y = 4$, $I_1 = 40$, and $I_2 = 20$, the market demand curve becomes

$$X = 27 - 3p_x + 4 + 1 + 4 = 36 - 3p_x$$

Shifts in Market Demand

- If p_y rises to 6, the market demand curve shifts outward to

$$X = 27 - 3p_x + 4 + 1 + 6 = 38 - 3p_x$$

  – note that *X* and *Y* are substitutes

- If I_1 fell to 30 while I_2 rose to 30, the market demand would shift inward to

$$X = 27 - 3p_x + 3 + 1.5 + 4 = 35.5 - 3p_x$$

  – note that *X* is a normal good for both buyers

Generalizations

- Suppose that there are n goods (x_i, $i = 1,n$) with prices p_i, $i = 1,n$.
- Assume that there are m individuals in the economy
- The j th's demand for the i th good will depend on all prices and on I_j

$$x_{ij} = x_{ij}(p_1,\ldots,p_n, I_j)$$

Generalizations

- The market demand function for x_i is the sum of each individual's demand for that good

$$X_i = \sum_{j=1}^{m} x_{ij}(p_1, \ldots, p_n, I_j)$$

- The market demand function depends on the prices of all goods and the incomes and preferences of all buyers

Elasticity of Market Demand

- The price elasticity of market demand is measured by

$$e_{Q,P} = \frac{\partial Q_D(P,P',I)}{\partial P} \cdot \frac{P}{Q_D}$$

- Market demand is characterized by whether demand is elastic ($e_{Q,P}$ <-1) or inelastic (0> $e_{Q,P}$ > -1)

Elasticity of Market Demand

- The cross-price elasticity of market demand is measured by

$$e_{Q,P} = \frac{\partial Q_D(P,P',I)}{\partial P'} \cdot \frac{P'}{Q_D}$$

- The income elasticity of market demand is measured by

$$e_{Q,I} = \frac{\partial Q_D(P,P',I)}{\partial I} \cdot \frac{I}{Q_D}$$

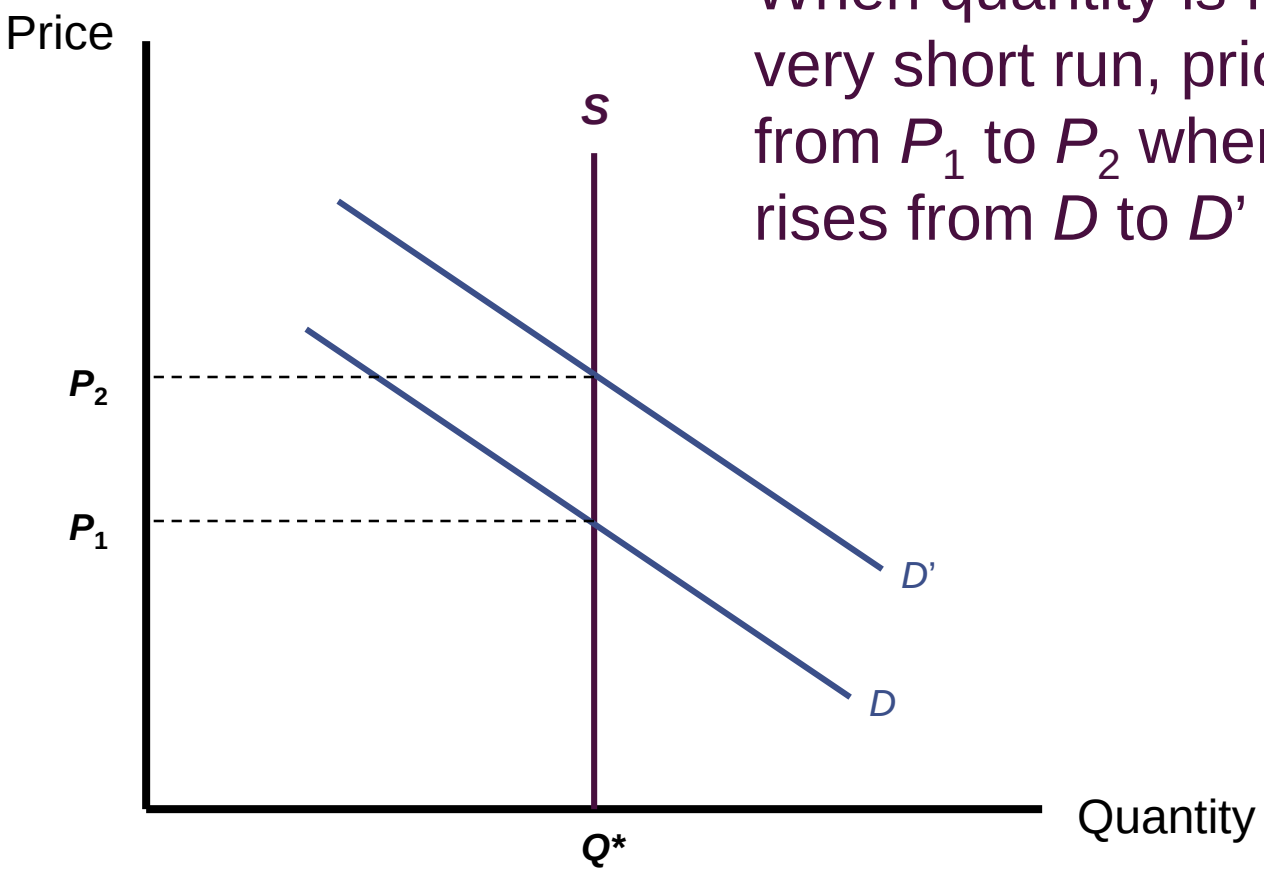
Timing of the Supply Response

- In the analysis of competitive pricing, the time period under consideration is important
  - very short run
    - no supply response (quantity supplied is fixed)
  - short run
    - existing firms can alter their quantity supplied, but no new firms can enter the industry
  - long run
    - new firms may enter an industry

Pricing in the Very Short Run

- In the very short run (or the market period), there is no supply response to changing market conditions
  - price acts only as a device to ration demand
    - price will adjust to clear the market
  - the supply curve is a vertical line

Pricing in the Very Short Run



When quantity is fixed in the very short run, price will rise from P_1 to P_2 when the demand rises from *D* to *D*'

Short-Run Price Determination

- The number of firms in an industry is fixed
- These firms are able to adjust the quantity they are producing
  - they can do this by altering the levels of the variable inputs they employ

Perfect Competition(完全竞争)

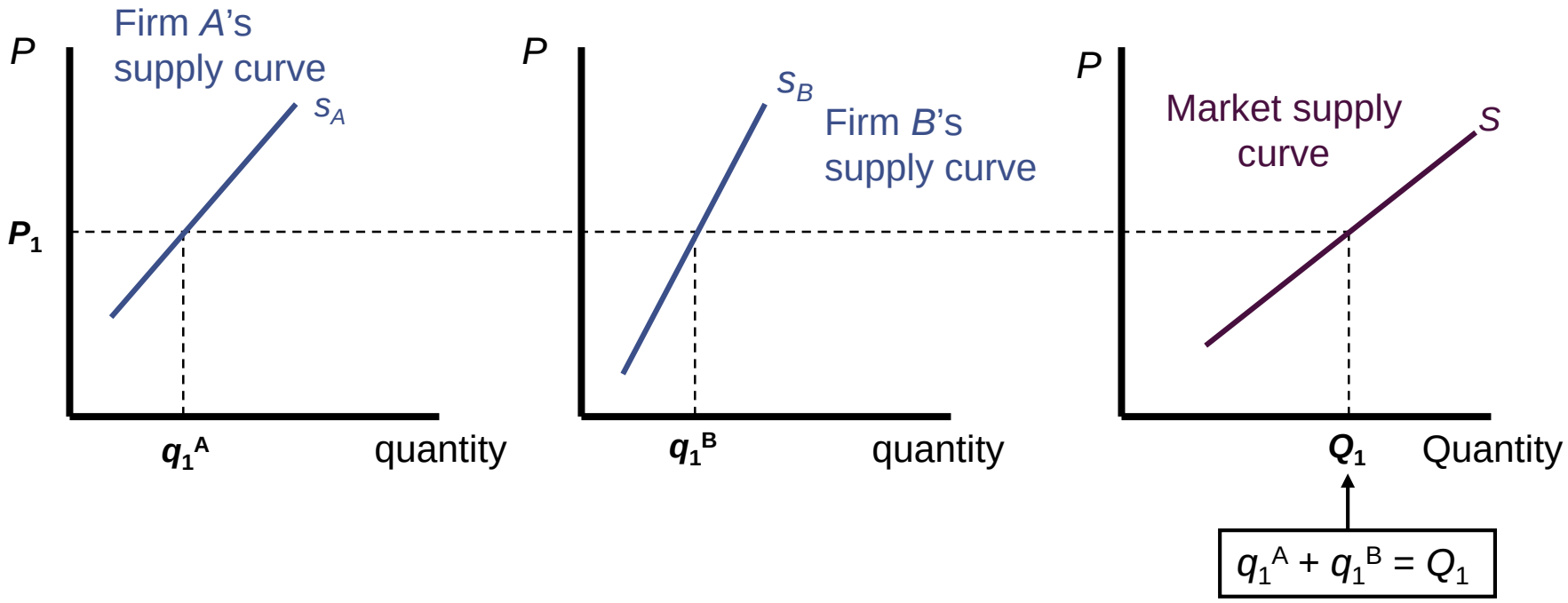
- A perfectly competitive industry is one that obeys the following assumptions:
  - there are a large number of firms, each producing the same homogeneous product
  - each firm attempts to maximize profits
  - each firm is a price taker
    - its actions have no effect on the market price
  - information is perfect
  - transactions are costless

Short-Run Market Supply

- The quantity of output supplied to the entire market in the short run is the sum of the quantities supplied by each firm
  - the amount supplied by each firm depends on price
- The short-run market supply curve will be upward-sloping because each firm's short-run supply curve has a positive slope

Short-Run Market Supply Curve

To derive the market supply curve, we sum the quantities supplied at every price



Short-Run Market Supply Function

- The short-run market supply function shows total quantity supplied by each firm to a market

$$Q_s(P,v,w) = \sum_{i=1}^{n} q_i(P,v,w)$$

- Firms are assumed to face the same market price and the same prices for inputs

Short-Run Supply Elasticity

- The short-run supply elasticity describes the responsiveness of quantity supplied to changes in market price

$$e_{S,P} = \frac{\%\ \text{change in}\ Q\ \text{supplied}}{\%\ \text{change in}\ P} = \frac{\partial Q_S}{\partial P} \cdot \frac{P}{Q_S}$$

- Because price and quantity supplied are positively related, $e_{S,P} > 0$

A Short-Run Supply Function

- Suppose that there are 100 identical firms each with the following short-run supply curve

$$q_i(P,v,w) = 10P/3 \qquad (i = 1,2,\ldots,100)$$

- This means that the market supply function is given by

$$Q_s = \sum_{i=1}^{100} q_i = \sum_{i=1}^{100} \frac{10P}{3} = \frac{1000P}{3}$$

A Short-Run Supply Function

- In this case, computation of the elasticity of supply shows that it is unit elastic

$$e_{S,P} = \frac{\partial Q_S(P,v,w)}{\partial P} \cdot \frac{P}{Q_S} = \frac{1000}{3} \cdot \frac{P}{1000P/3} = 1$$

Equilibrium Price Determination

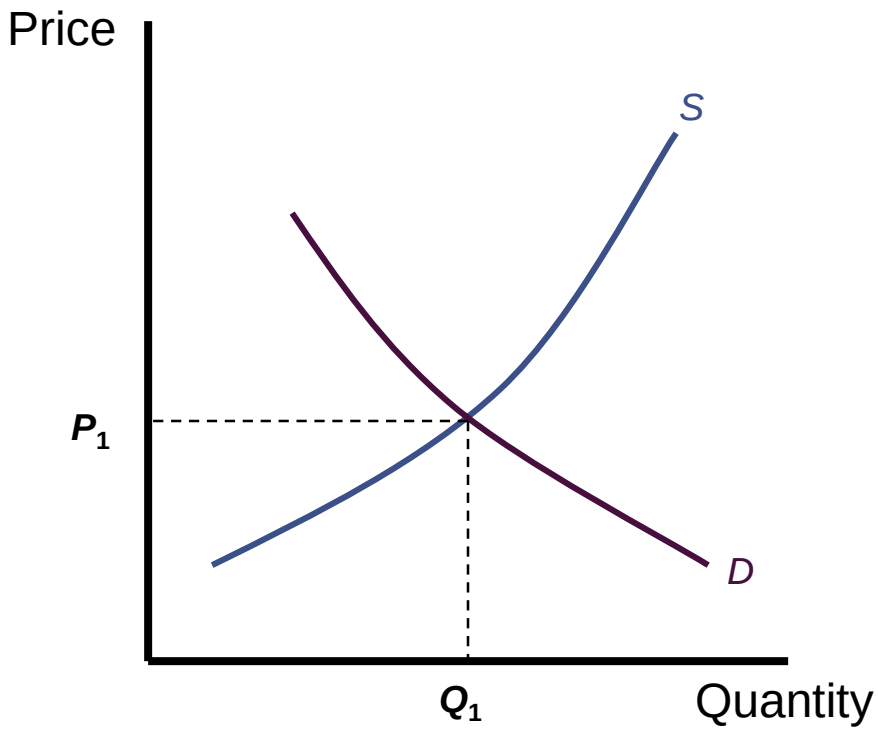
- An equilibrium price is one at which quantity demanded is equal to quantity supplied
  - neither suppliers nor demanders have an incentive to alter their economic decisions
- An equilibrium price (P^*) solves the equation:

$$Q_D(P^*, P', I) = Q_S(P^*, v, w)$$

Equilibrium Price Determination

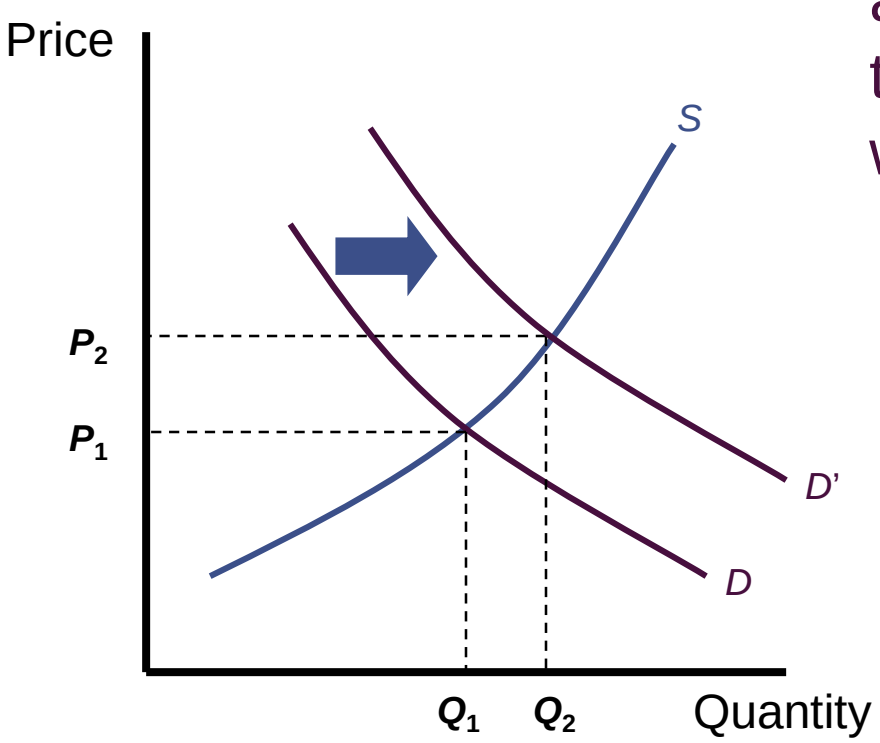
- The equilibrium price depends on many exogenous factors
  - changes in any of these factors will likely result in a new equilibrium price

Equilibrium Price Determination



The interaction between market demand and market supply determines the equilibrium price

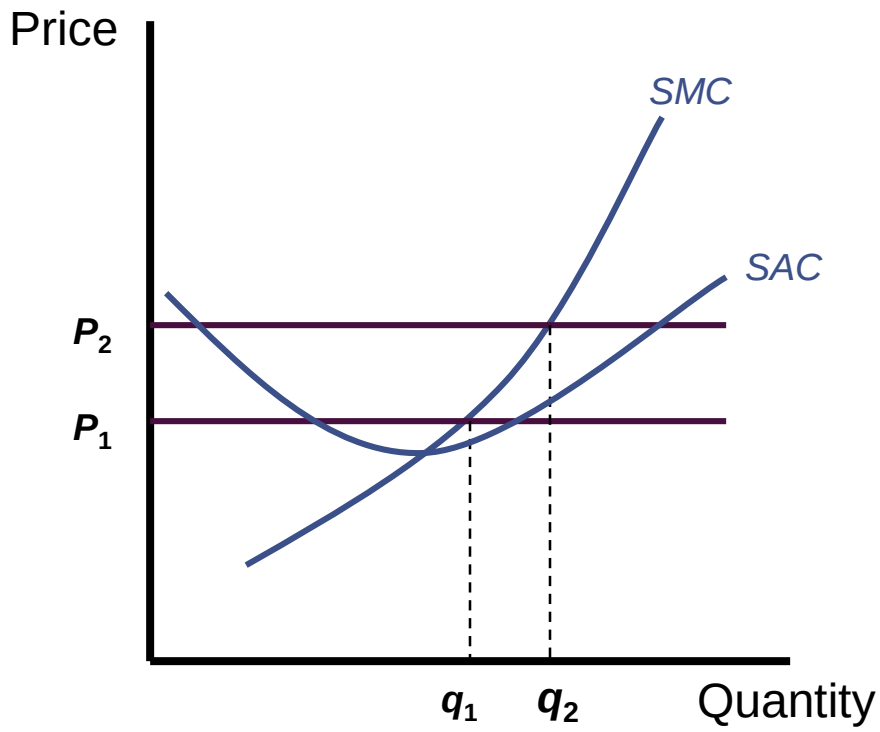
Market Reaction to a Shift in Demand



If many buyers experience an increase in their demands, the market demand curve will shift to the right

Equilibrium price and equilibrium quantity will both rise

Market Reaction to a Shift in Demand



If the market price rises, firms will increase their level of output

This is the short-run supply response to an increase in market price

Shifts in Supply and Demand Curves

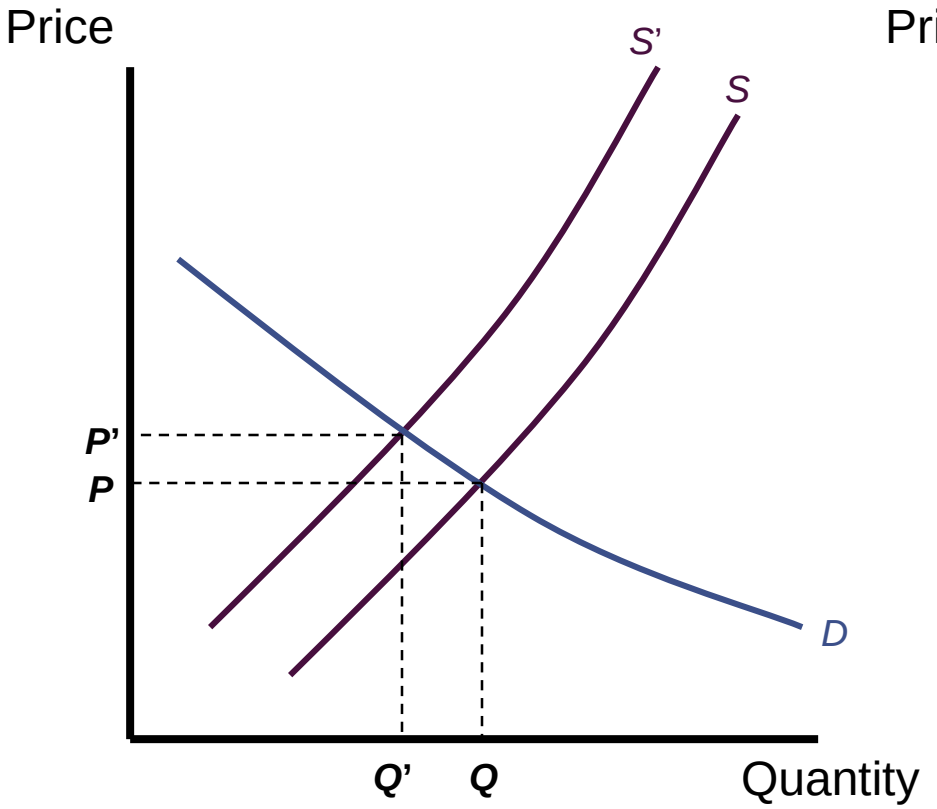
- Demand curves shift because
  - incomes change
  - prices of substitutes or complements change
  - preferences change
- Supply curves shift because
  - input prices change
  - technology changes
  - number of producers change

Shifts in Supply and Demand Curves

- When either a supply curve or a demand curve shift, equilibrium price and quantity will change
- The relative magnitudes of these changes depends on the shapes of the supply and demand curves

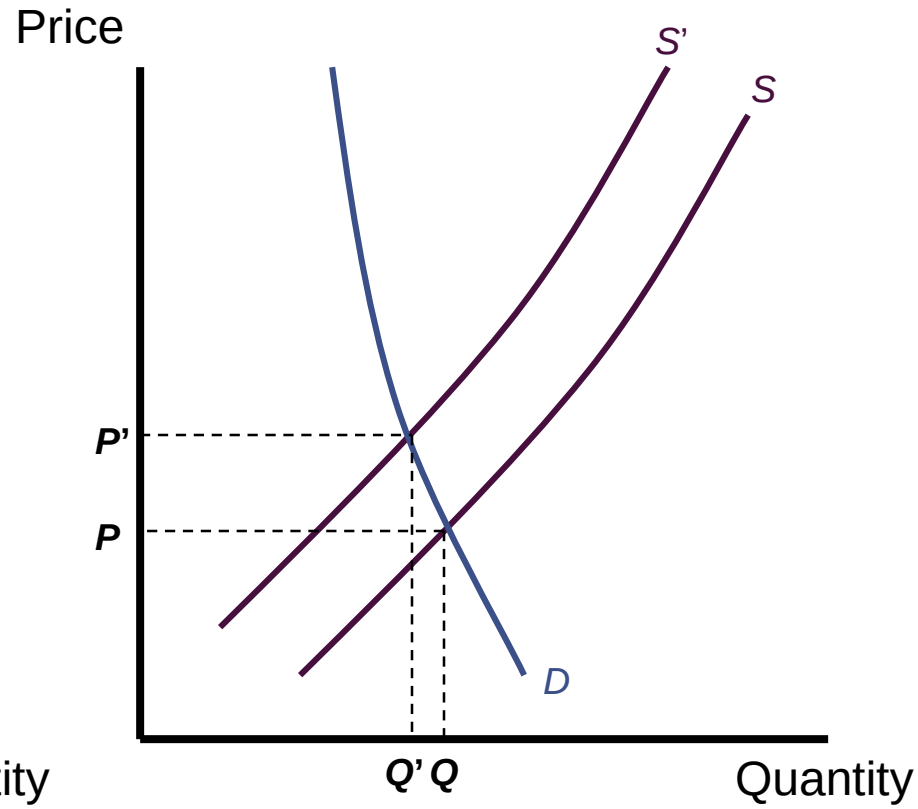
Shifts in Supply

Small increase in price, large drop in quantity



Elastic Demand

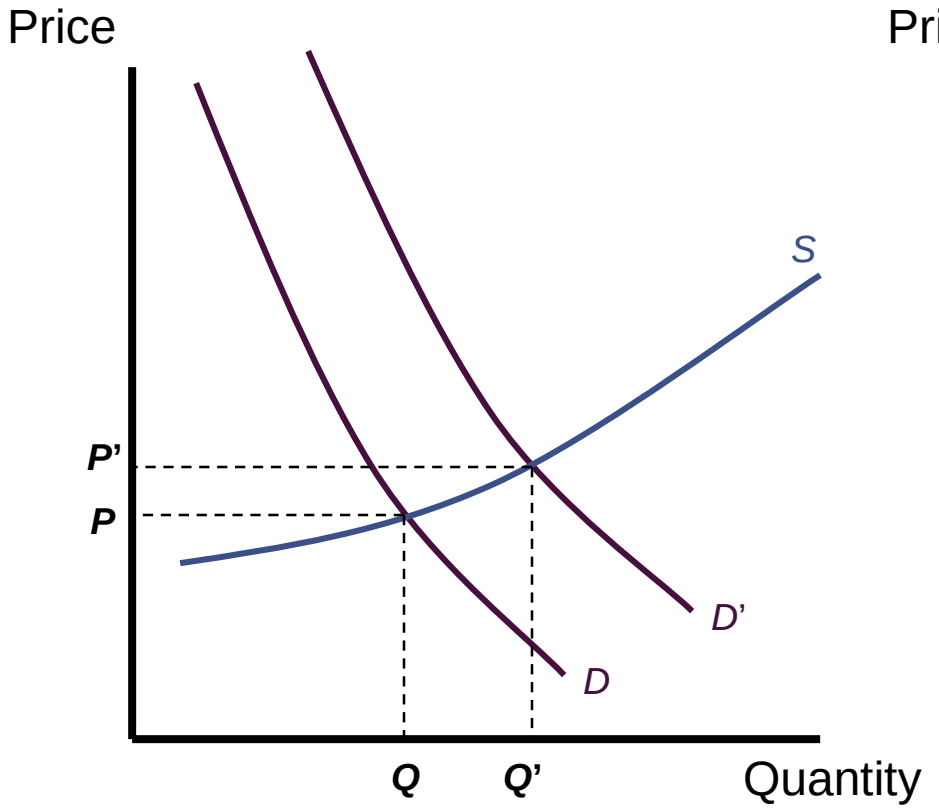
Large increase in price, small drop in quantity



Inelastic Demand

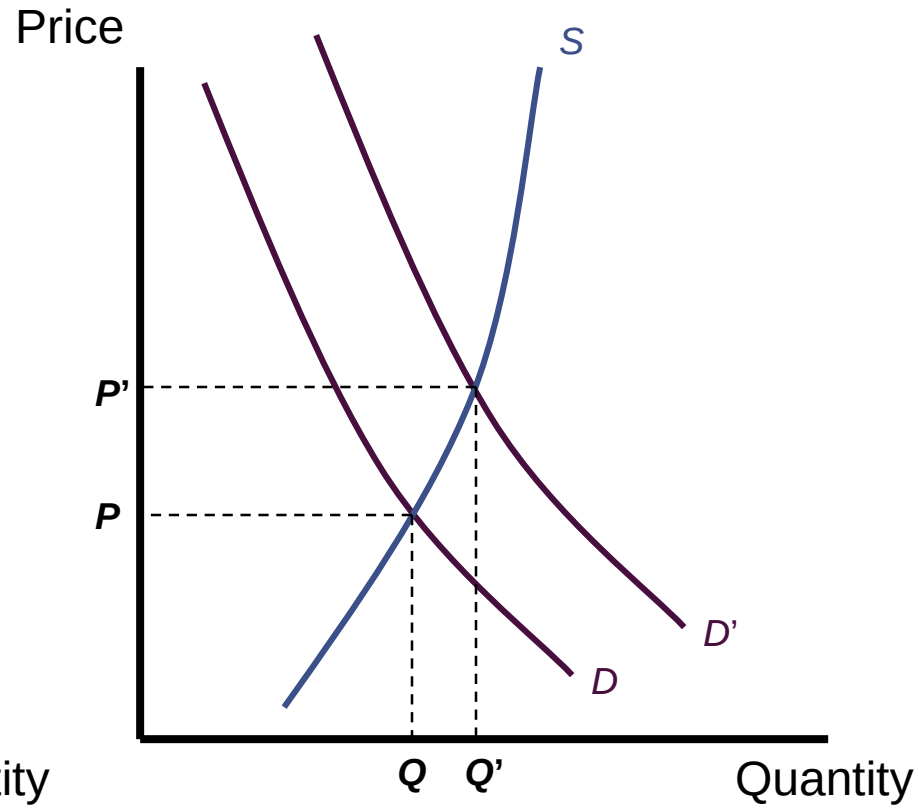
Shifts in Demand

Small increase in price, large rise in quantity



Elastic Supply

Large increase in price, small rise in quantity



Inelastic Supply

Changing Short-Run Equilibria

- Suppose that the market demand for luxury beach towels is

$$Q_D = 10{,}000 - 500P$$

and the short-run market supply is

$$Q_S = 1{,}000P/3$$

- Setting these equal, we find

$$P^* = \$12$$

$$Q^* = 4{,}000$$

Changing Short-Run Equilibria

- Suppose instead that the demand for luxury towels rises to

$$Q_D = 12{,}500 - 500P$$

- Solving for the new equilibrium, we find

$$P^* = \$15$$

$$Q^* = 5{,}000$$

- Equilibrium price and quantity both rise

Changing Short-Run Equilibria

- Suppose that the wage of towel cutters rises so that the short-run market supply becomes

$$Q_S = 800P/3$$

- Solving for the new equilibrium, we find

$$P^* = \$13.04$$

$$Q^* = 3{,}480$$

- Equilibrium price rises and quantity falls

Mathematical Model of Supply and Demand

- Suppose that the demand function is represented by

$$Q_D = D(P,\alpha)$$

  - α is a parameter that shifts the demand curve
    - $\partial D/\partial\alpha = D_\alpha$ can have any sign
  - $\partial D/\partial P = D_P < 0$

Mathematical Model of Supply and Demand

- The supply relationship can be shown as

$$Q_S = S(P,\beta)$$

  - β is a parameter that shifts the supply curve
    - $\partial S/\partial\beta = S_\beta$ can have any sign
  - $\partial S/\partial P = S_P > 0$

- Equilibrium requires that $Q_D = Q_S$

Mathematical Model of Supply and Demand

- To analyze the comparative statics of this model, we need to use the total differentials of the supply and demand functions:

$$dQ_D = D_P dP + D_\alpha d\alpha$$

$$dQ_S = S_P dP + S_\beta d\beta$$

- Maintenance of equilibrium requires that

$$dQ_D = dQ_S$$

Mathematical Model of Supply and Demand

- Suppose that the demand parameter (α) changed while β remains constant
- The equilibrium condition requires that

$$D_P dP + D_\alpha d\alpha = S_P dP$$

$$\frac{\partial P}{\partial \alpha} = \frac{D_\alpha}{S_P - D_P}$$

- Because $S_P - D_P > 0$, $\partial P/\partial \alpha$ will have the same sign as D_α

Mathematical Model of Supply and Demand

- We can convert our analysis to elasticities

$$e_{P,\alpha} = \frac{\partial P}{\partial \alpha} \cdot \frac{\alpha}{P} = \frac{D_\alpha}{S_P - D_P} \cdot \frac{\alpha}{P}$$

$$e_{P,\alpha} = \frac{D_\alpha \dfrac{\alpha}{Q}}{(S_P - D_P) \cdot \dfrac{P}{Q}} = \frac{e_{Q,\alpha}}{e_{S,P} - e_{Q,P}}$$

Long-Run Analysis

- In the long run, a firm may adapt all of its inputs to fit market conditions
  - profit-maximization for a price-taking firm implies that price is equal to long-run *MC*
- Firms can also enter and exit an industry in the long run
  - perfect competition assumes that there are no special costs of entering or exiting an industry

Long-Run Analysis

- New firms will be lured into any market for which economic profits are greater than zero
  - entry of firms will cause the short-run industry supply curve to shift outward
  - market price and profits will fall
  - the process will continue until economic profits are zero

Long-Run Analysis

- Existing firms will leave any industry for which economic profits are negative
  - exit of firms will cause the short-run industry supply curve to shift inward
  - market price will rise and losses will fall
  - the process will continue until economic profits are zero

Long-Run Competitive Equilibrium

- A perfectly competitive industry is in long-run equilibrium if there are no incentives for profit-maximizing firms to enter or to leave the industry
  - this will occur when the number of firms is such that $P = MC = AC$ and each firm operates at minimum AC

Long-Run Competitive Equilibrium

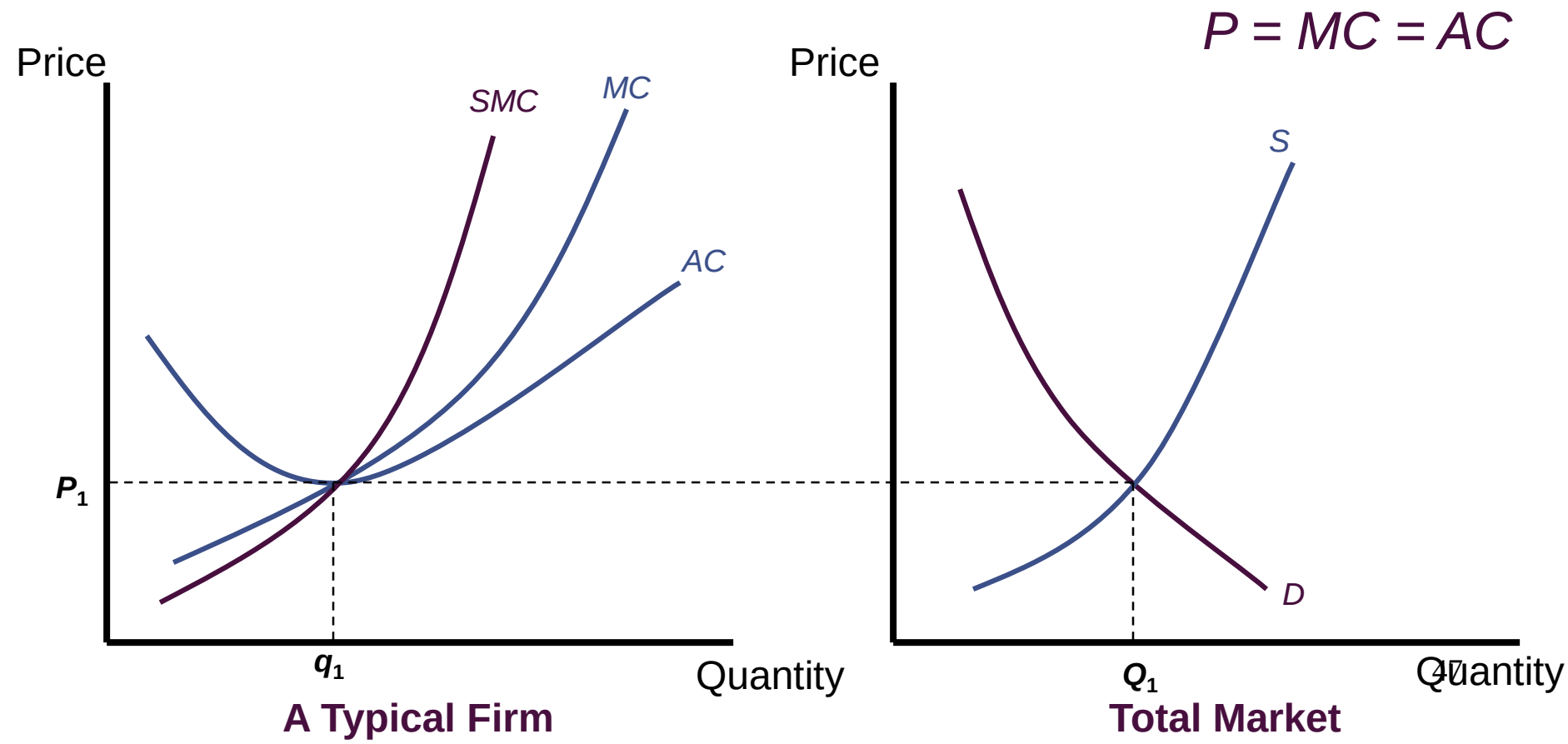
- We will assume that all firms in an industry have identical cost curves
  - no firm controls any special resources or technology
- The equilibrium long-run position requires that each firm earn zero economic profit

Long-Run Equilibrium: Constant-Cost Case

- Assume that the entry of new firms in an industry has no effect on the cost of inputs
  - no matter how many firms enter or leave an industry, a firm's cost curves will remain unchanged
- This is referred to as a constant-cost industry

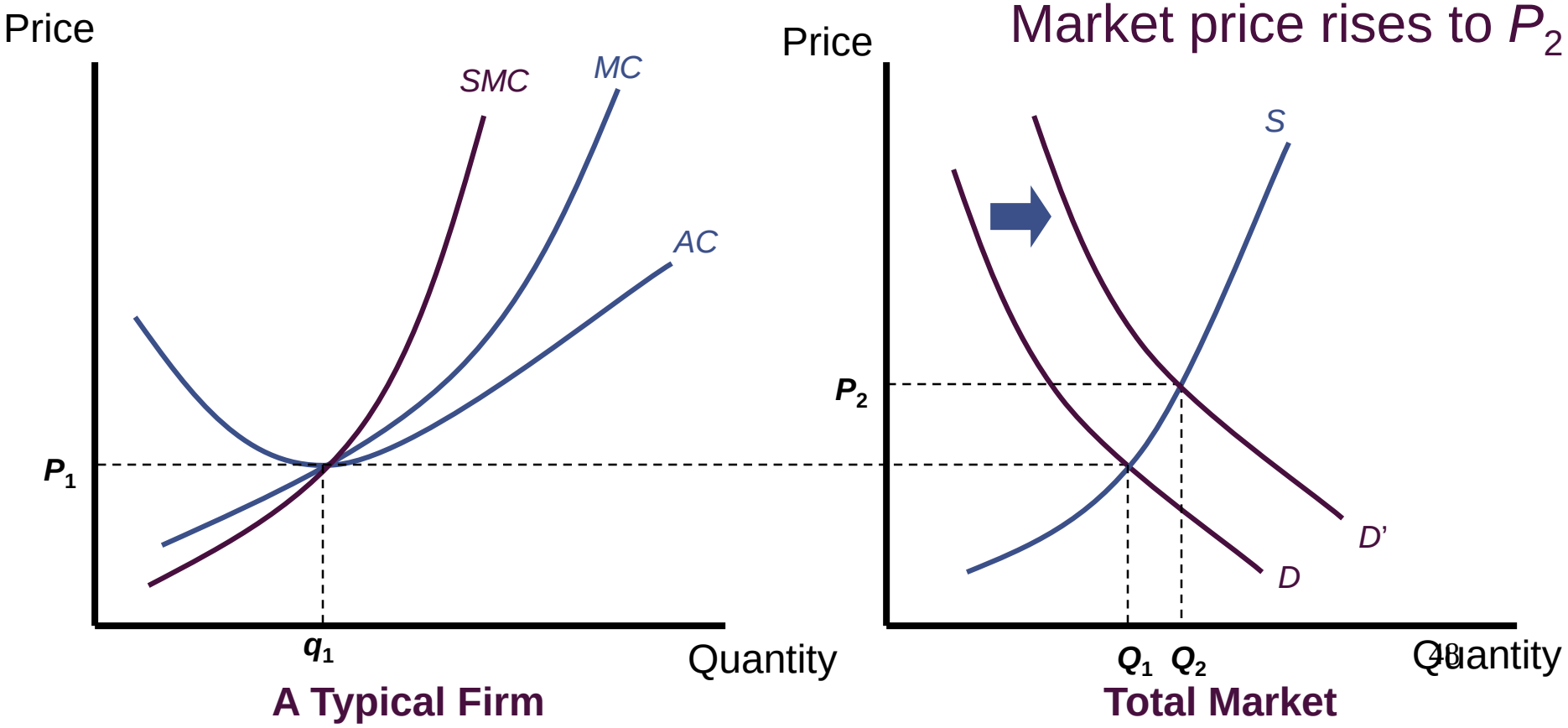
Long-Run Equilibrium: Constant-Cost Case

This is a long-run equilibrium for this industry



Long-Run Equilibrium: Constant-Cost Case

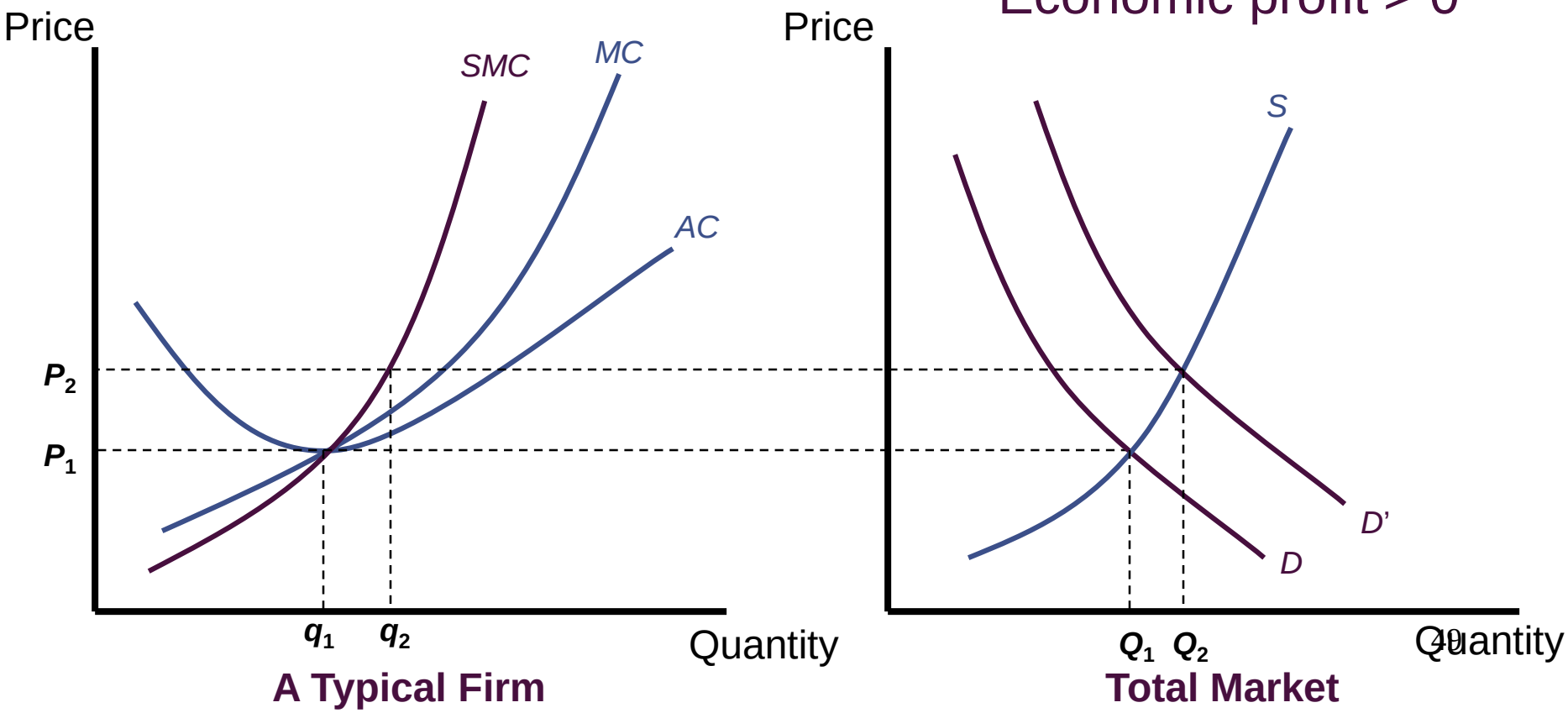
Suppose that market demand rises to *D*'



Long-Run Equilibrium: Constant-Cost Case

In the short run, each firm increases output to q_2

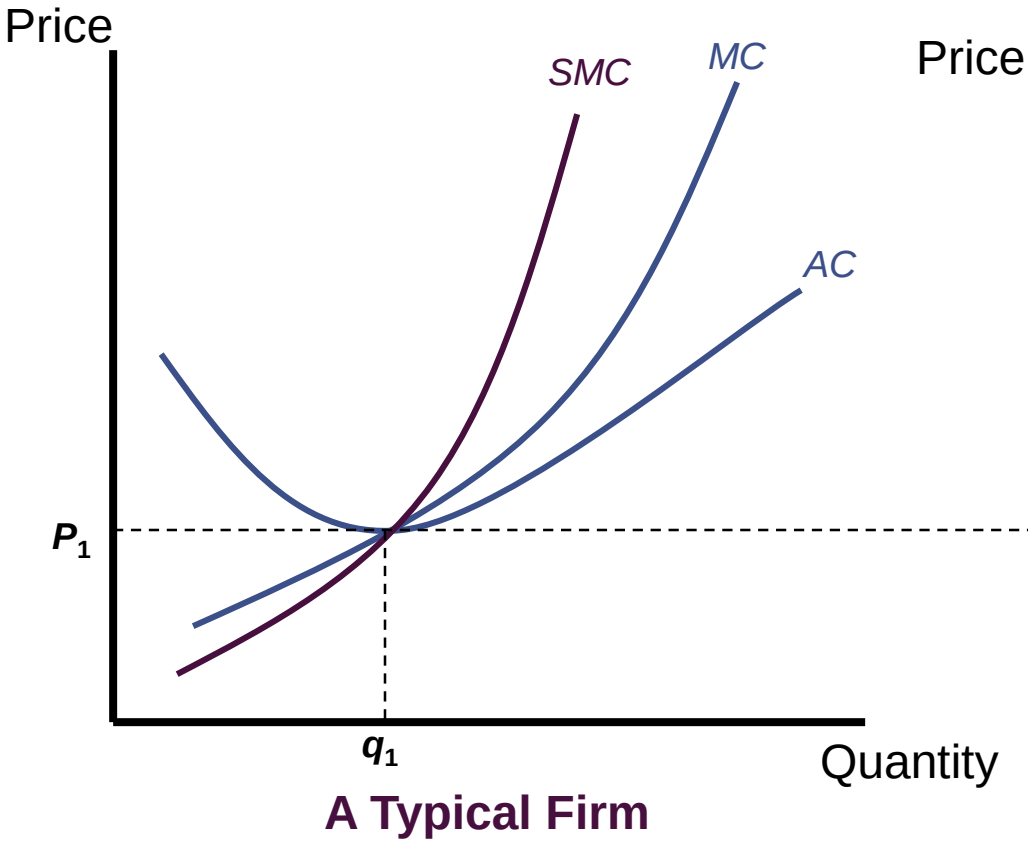
Economic profit > 0

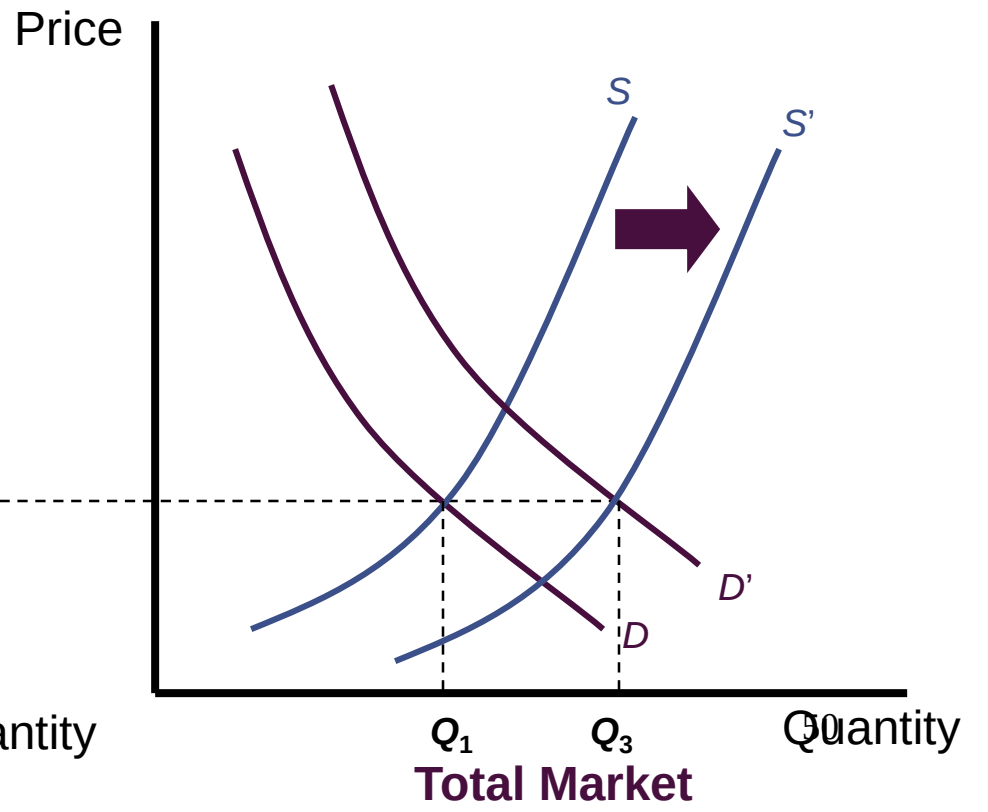


Long-Run Equilibrium: Constant-Cost Case

In the long run, new firms will enter the industry

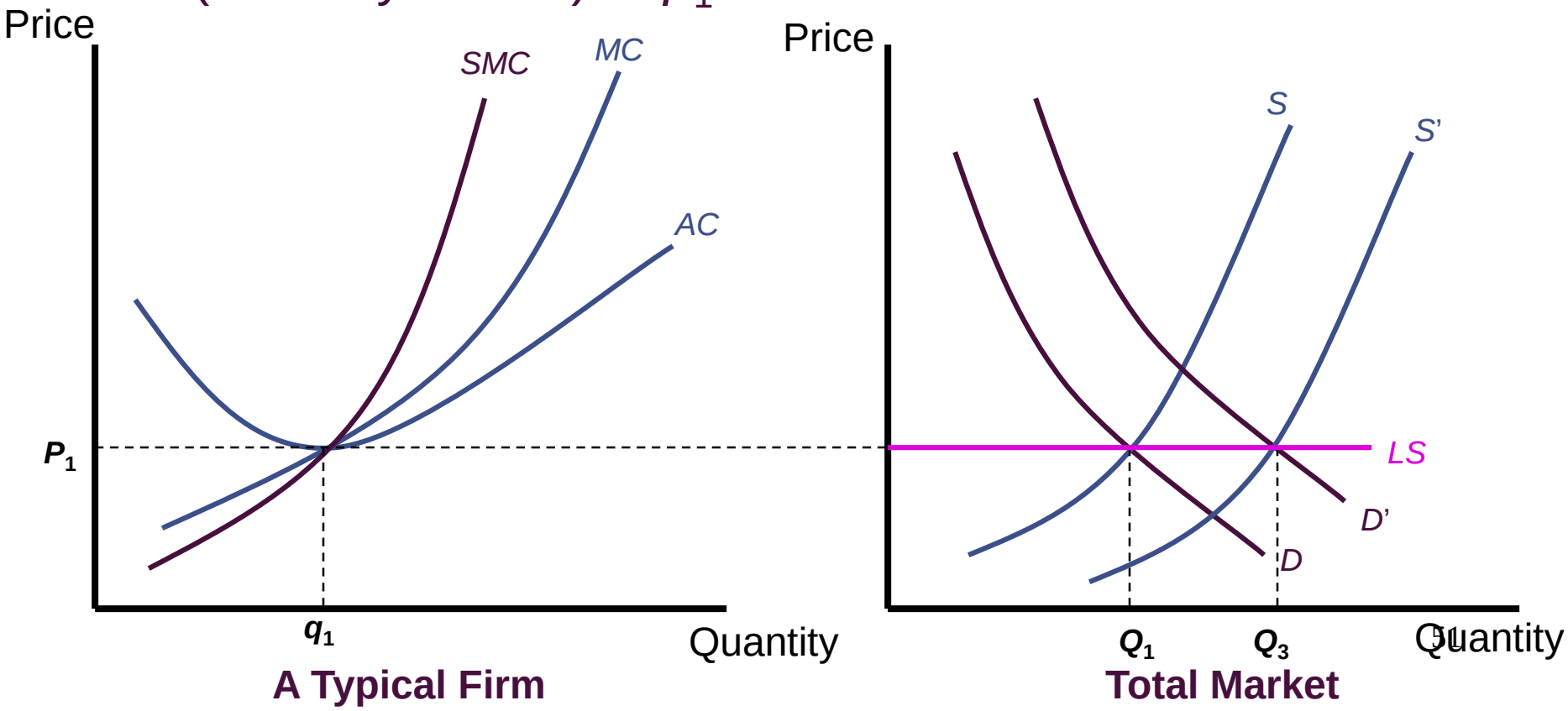
Economic profit will return to 0





Long-Run Equilibrium: Constant-Cost Case

The long-run supply curve will be a horizontal line (infinitely elastic) at p_1



Infinitely Elastic Long-Run Supply

- Suppose that the total cost curve for a typical firm in the bicycle industry is

$$TC = q^3 - 20q^2 + 100q + 8{,}000$$

- Demand for bicycles is given by

$$Q_D = 2{,}500 - 3P$$

Infinitely Elastic Long-Run Supply

- To find the long-run equilibrium for this market, we must find the low point on the typical firm's average cost curve
  - where $AC = MC$

$$AC = q^2 - 20q + 100 + 8{,}000/q$$

$$MC = 3q^2 - 40q + 100$$

  - this occurs where $q = 20$
- If $q = 20$, $AC = MC = \$500$
  - this will be the long-run equilibrium price

Shape of the Long-Run Supply Curve

- The zero-profit condition is the factor that determines the shape of the long-run cost curve
  - if average costs are constant as firms enter, long-run supply will be horizontal
  - if average costs rise as firms enter, long-run supply will have an upward slope
  - if average costs fall as firms enter, long-run supply will be negatively sloped

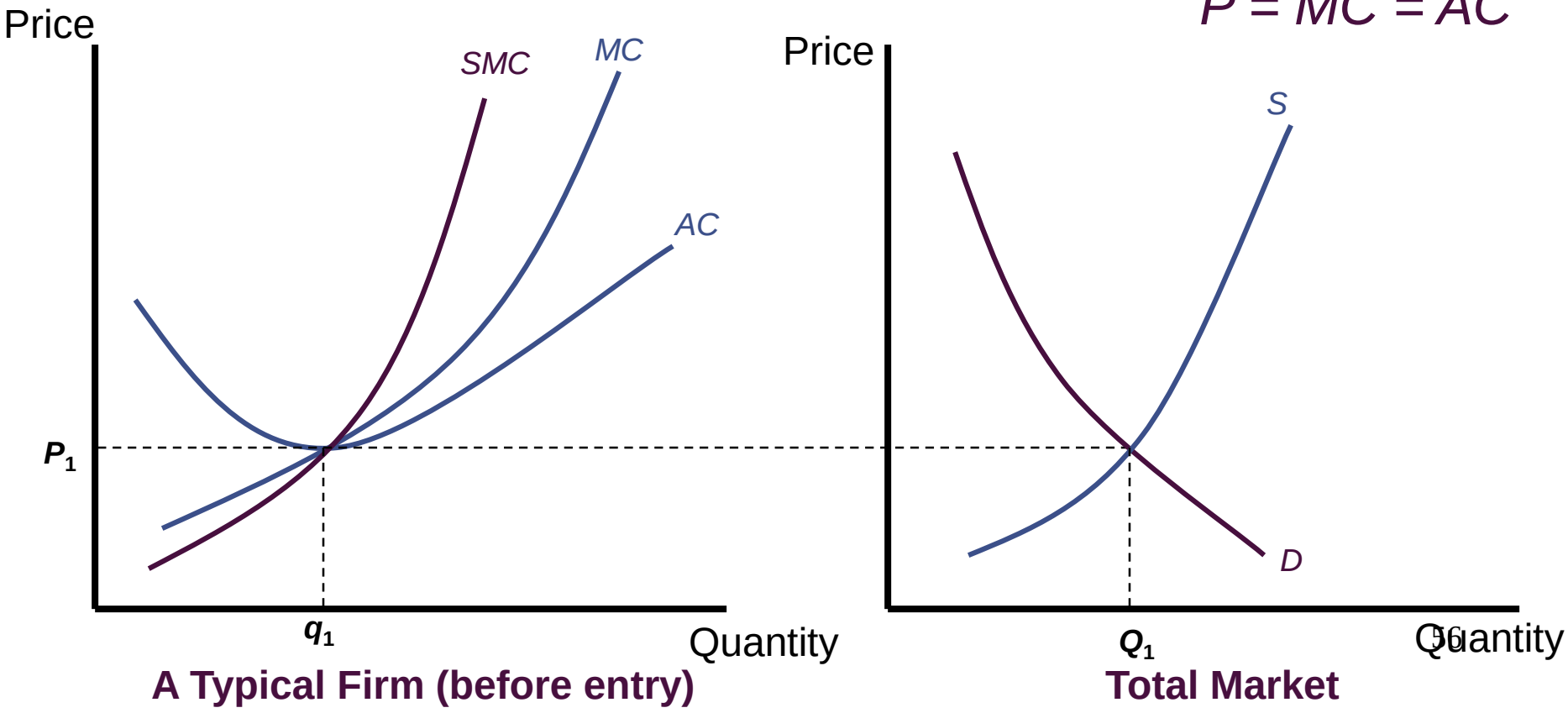
Long-Run Equilibrium: Increasing-Cost Industry

- The entry of new firms may cause the average costs of all firms to rise
  - prices of scarce inputs may rise
  - new firms may impose “external” costs on existing firms
  - new firms may increase the demand for tax-financed services

Long-Run Equilibrium: Increasing-Cost Industry

Suppose that we are in long-run equilibrium in this industry

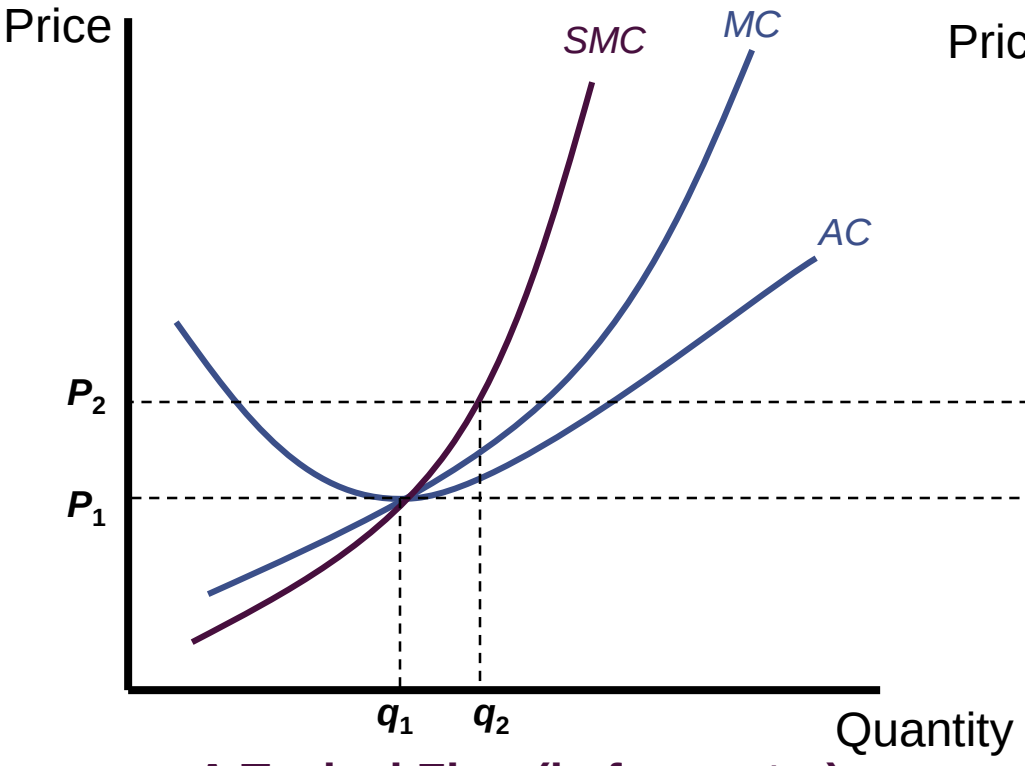
$P = MC = AC$



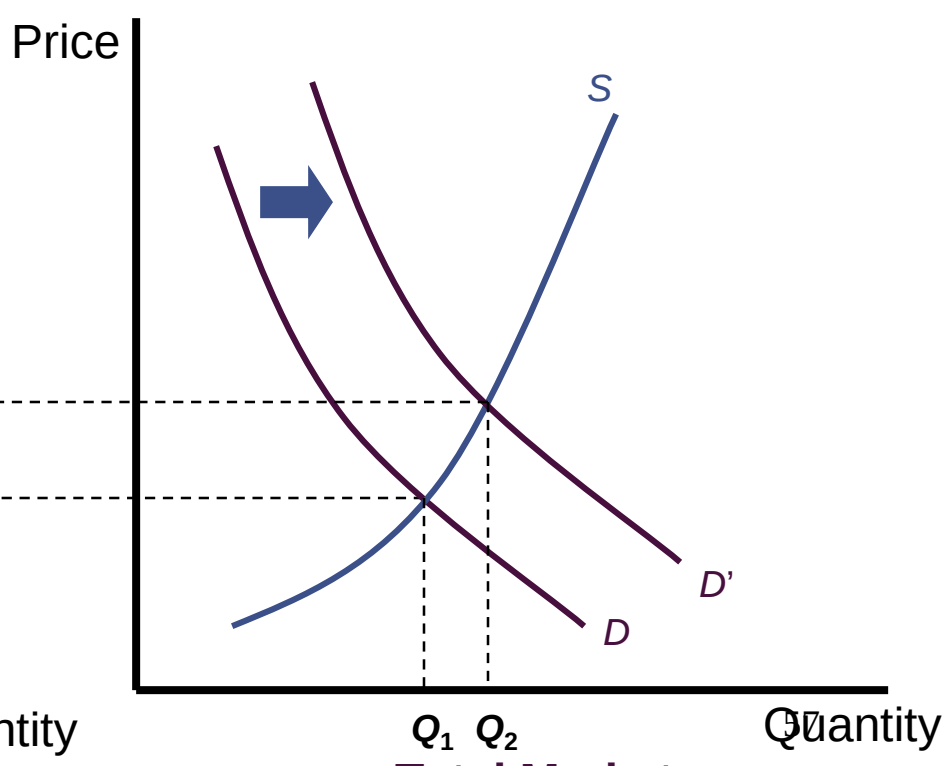
Long-Run Equilibrium: Increasing-Cost Industry

Suppose that market demand rises to *D*'

Market price rises to P_2 and firms increase output to q_2



A Typical Firm (before entry)

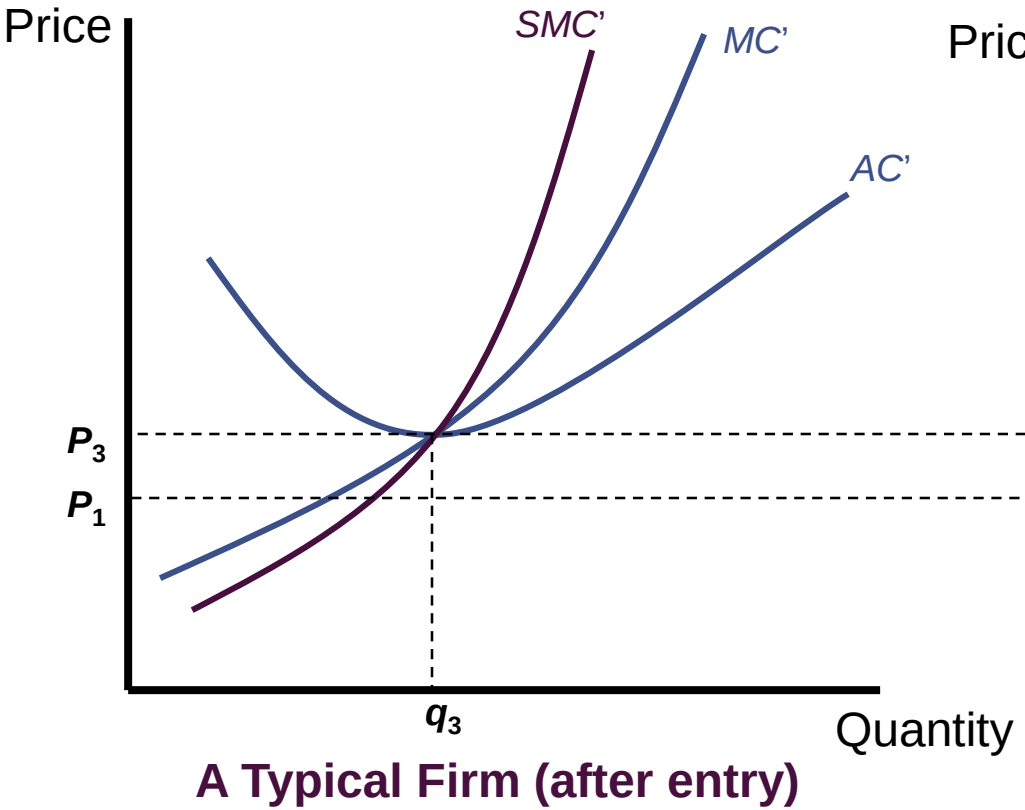


Total Market

Long-Run Equilibrium: Increasing-Cost Industry

Positive profits attract new firms and supply shifts out

Entry of firms causes costs for each firm to rise



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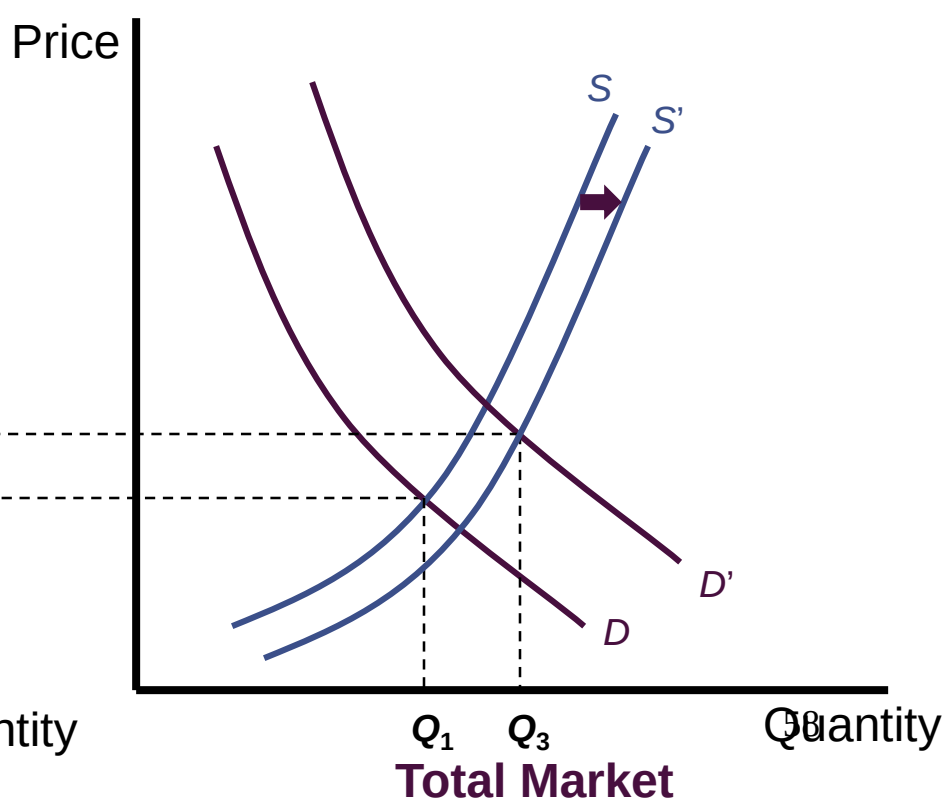
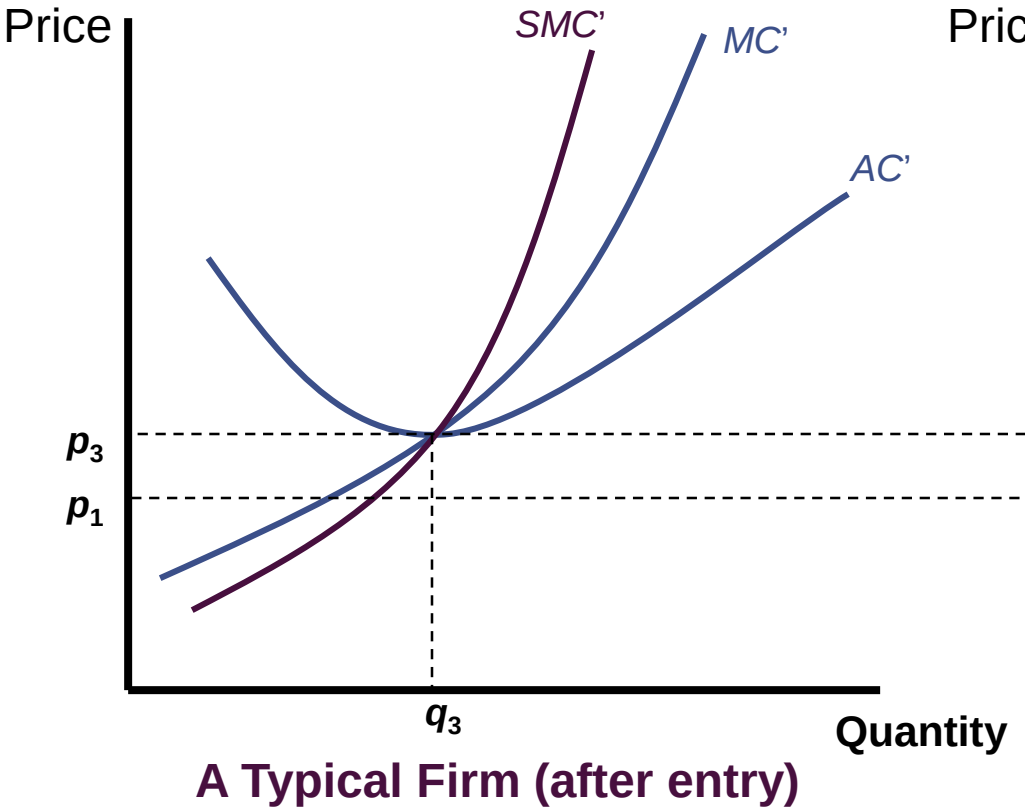


Total Market

Long-Run Equilibrium: Increasing-Cost Industry

The long-run supply curve will be upward-sloping



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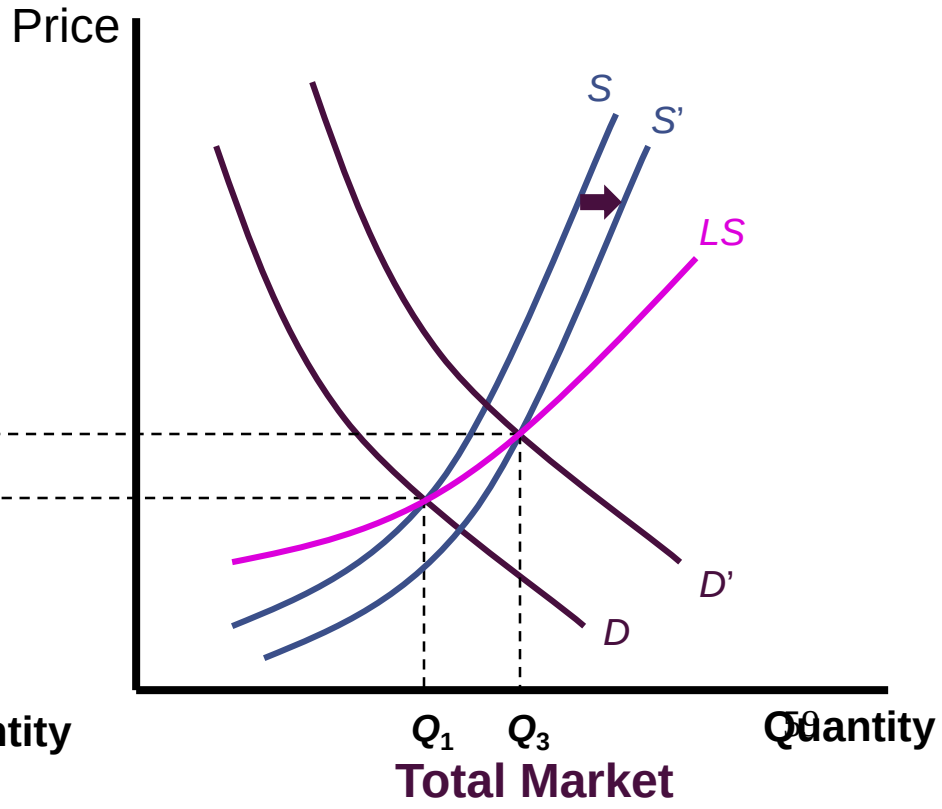


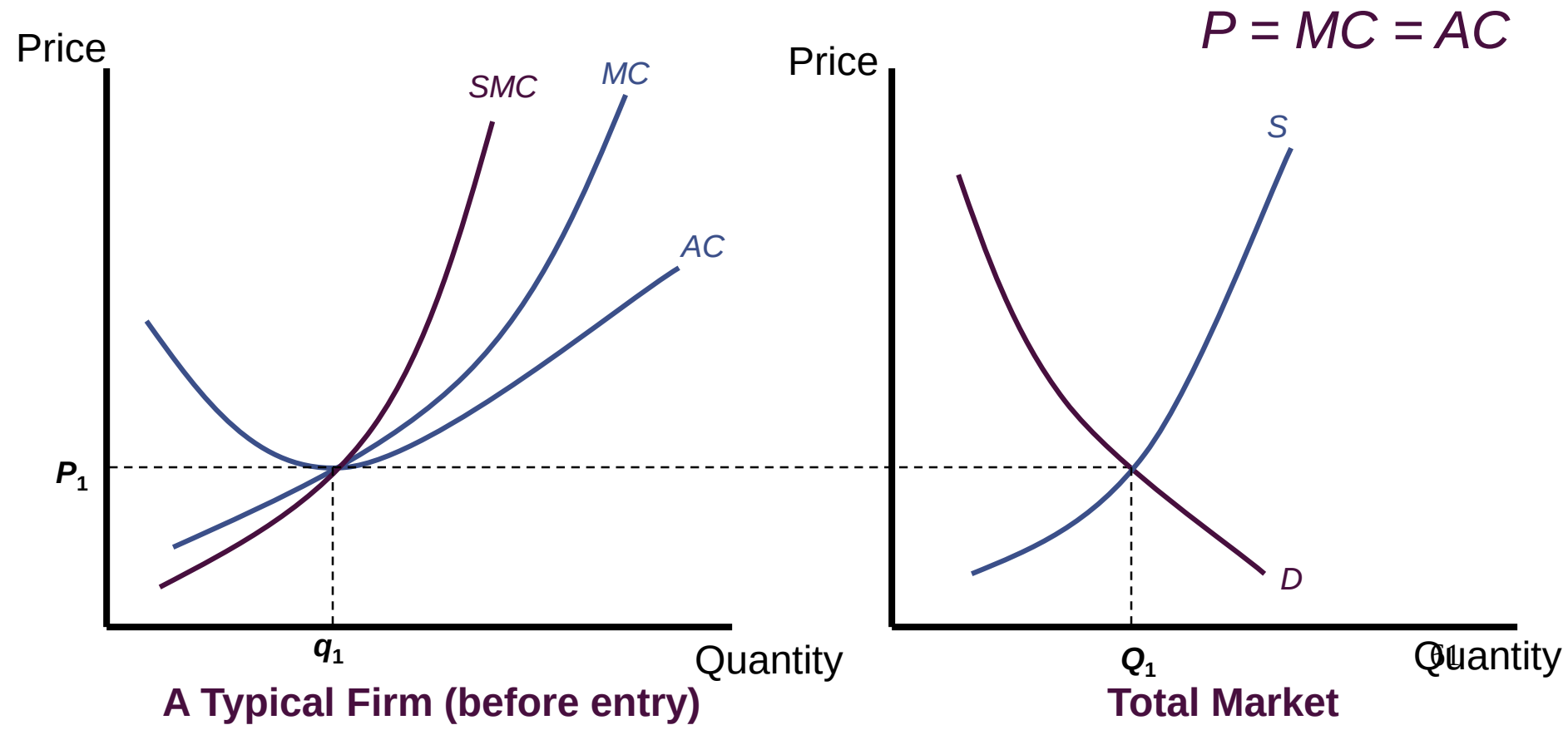
Total Market

Long-Run Equilibrium: Decreasing-Cost Industry

- The entry of new firms may cause the average costs of all firms to fall
  - new firms may attract a larger pool of trained labor
  - entry of new firms may provide a “critical mass” of industrialization
    - permits the development of more efficient transportation and communications networks

Long-Run Equilibrium: Decreasing-Cost Case

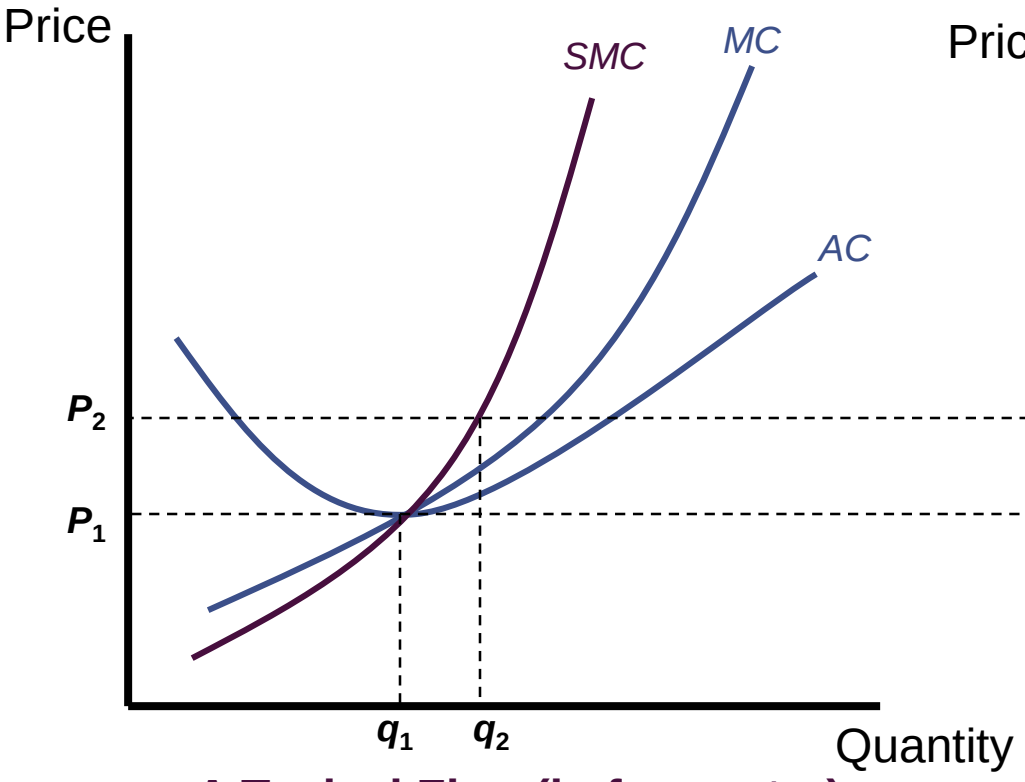
Suppose that we are in long-run equilibrium in this industry



Long-Run Equilibrium: Decreasing-Cost Industry

Suppose that market demand rises to *D*'

Market price rises to P_2 and firms increase output to q_2



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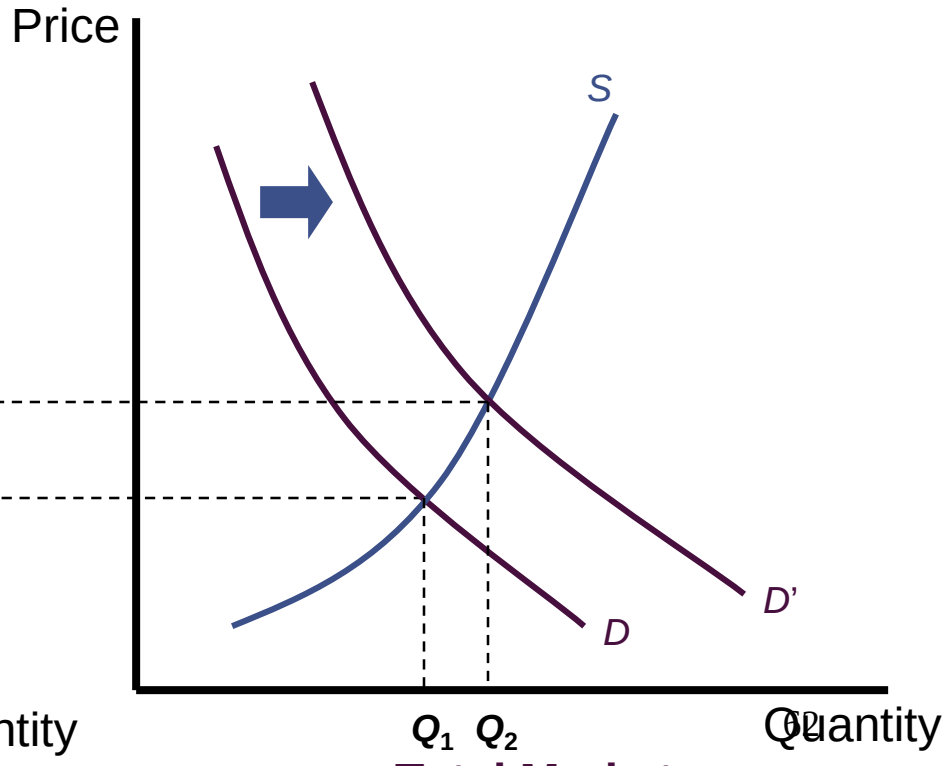
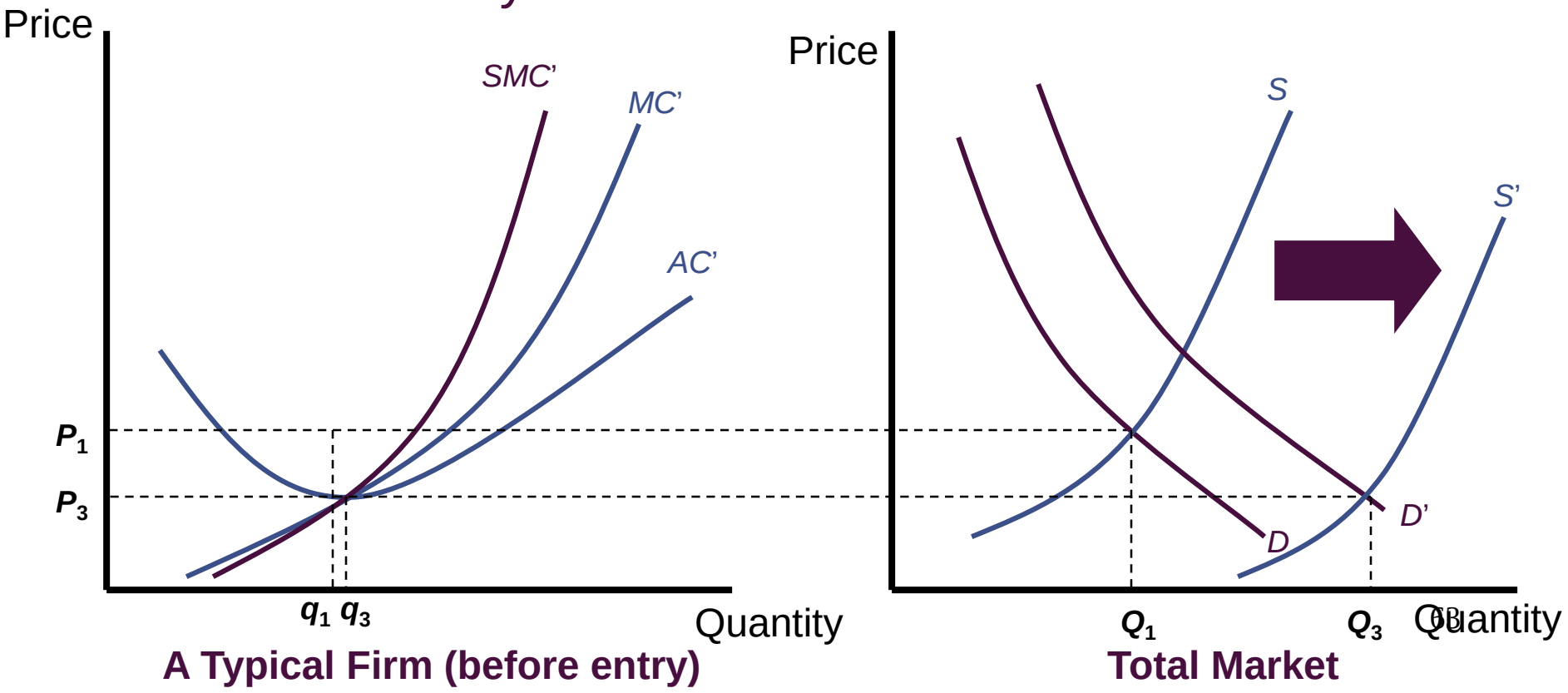


Total Market

Long-Run Equilibrium: Decreasing-Cost Industry

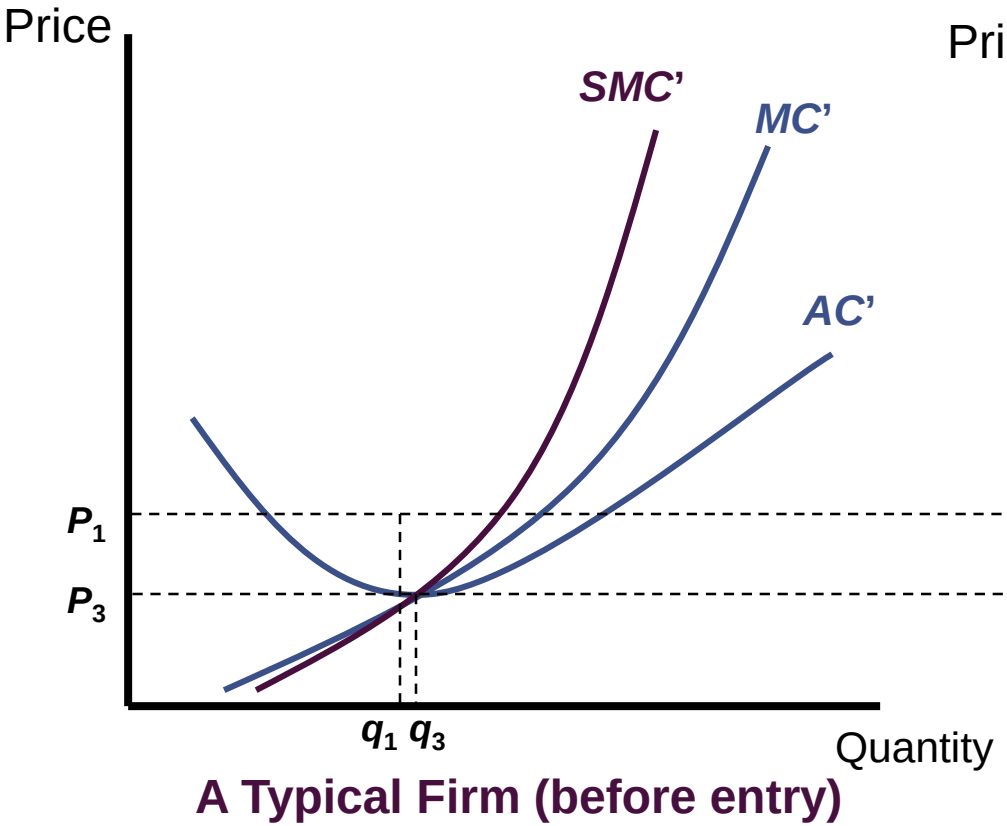
Positive profits attract new firms and supply shifts out

Entry of firms causes costs for each firm to fall

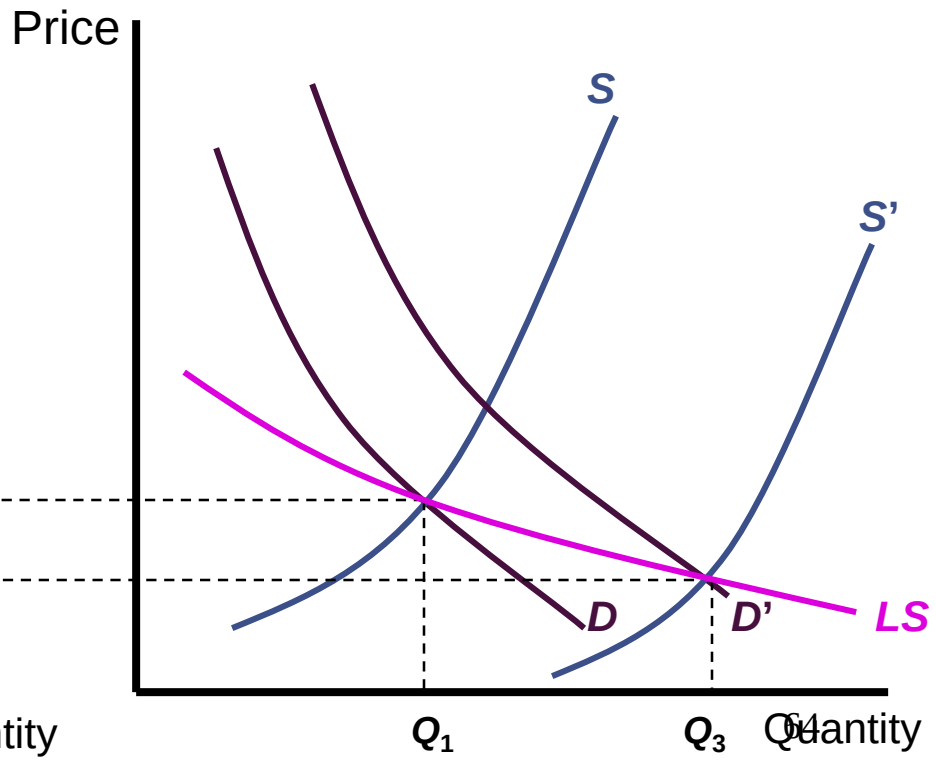


Long-Run Equilibrium: Decreasing-Cost Industry

The long-run industry supply curve will be downward-sloping



A Typical Firm (before entry)



Total Market

Classification of Long-Run Supply Curves

- Constant Cost
  - entry does not affect input costs
  - the long-run supply curve is horizontal at the long-run equilibrium price
- Increasing Cost
  - entry increases inputs costs
  - the long-run supply curve is positively sloped

Classification of Long-Run Supply Curves

- Decreasing Cost
  - entry reduces input costs
  - the long-run supply curve is negatively sloped

Long-Run Elasticity of Supply

- The long-run elasticity of supply ($e_{LS,P}$) records the proportionate change in long-run industry output to a proportionate change in price

$$e_{LS,P} = \frac{\%\text{ change in } Q}{\%\text{ change in } P} = \frac{\partial Q_{LS}}{\partial P} \cdot \frac{P}{Q_{LS}}$$

- $e_{LS,P}$ can be positive or negative
  - the sign depends on whether the industry exhibits increasing or decreasing costs

Comparative Statics Analysis of Long-Run Equilibrium

- Comparative statics analysis of long-run equilibria can be conducted using estimates of long-run elasticities of supply and demand
- Remember that, in the long run, the number of firms in the industry will vary from one long-run equilibrium to another

Comparative Statics Analysis of Long-Run Equilibrium

- Assume that we are examining a constant-cost industry
- Suppose that the initial long-run equilibrium industry output is Q_0 and the typical firm's output is q^* (where AC is minimized)
- The equilibrium number of firms in the industry (n_0) is Q_0/q^*

Comparative Statics Analysis of Long-Run Equilibrium

- A shift in demand that changes the equilibrium industry output to Q_1 will change the equilibrium number of firms to

$$n_1 = Q_1/q^*$$

- The change in the number of firms is

$$n_1 - n_0 = \frac{Q_1 - Q_0}{q^*}$$

  - completely determined by the extent of the demand shift and the optimal output level for the typical firm

Comparative Statics Analysis of Long-Run Equilibrium

- The effect of a change in input prices is more complicated
  - we need to know how much minimum average cost is affected
  - we need to know how an increase in long-run equilibrium price will affect quantity demanded

Comparative Statics Analysis of Long-Run Equilibrium

- The optimal level of output for each firm may also be affected
- Therefore, the change in the number of firms becomes

$$n_1 - n_0 = \frac{Q_1}{q_1^*} - \frac{Q_0}{q_0^*}$$

Rising Input Costs and Industry Structure

- Suppose that the total cost curve for a typical firm in the bicycle industry is

$$TC = q^3 - 20q^2 + 100q + 8{,}000$$

and then rises to

$$TC = q^3 - 20q^2 + 100q + 11{,}616$$

- The optimal scale of each firm rises from 20 to 22 (where $MC = AC$)

Rising Input Costs and Industry Structure

- At $q = 22$, $MC = AC = \$672$ so the long-run equilibrium price will be \$672
- If demand can be represented by

$$Q_D = 2{,}500 - 3P$$

  then $Q_D = 484$
- This means that the industry will have 22 firms ($484 \div 22$)

Producer Surplus in the Long Run

- Short-run producer surplus represents the return to a firm's owners in excess of what would be earned if output was zero
  - the sum of short-run profits and fixed costs

Producer Surplus in the Long Run

- In the long-run, all profits are zero and there are no fixed costs
  - owners are indifferent about whether they are in a particular market
    - they could earn identical returns on their investments elsewhere
- Suppliers of inputs may not be indifferent about the level of production in an industry

Producer Surplus in the Long Run

- In the constant-cost case, input prices are assumed to be independent of the level of production
  - inputs can earn the same amount in alternative occupations
- In the increasing-cost case, entry will bid up some input prices
  - suppliers of these inputs will be made better off

Producer Surplus in the Long Run （skipped）

- Long-run producer surplus represents the additional returns to the inputs in an industry in excess of what these inputs would earn if industry output was zero
  - the area above the long-run supply curve and below the market price
    - this would equal zero in the case of constant costs

Ricardian Rent

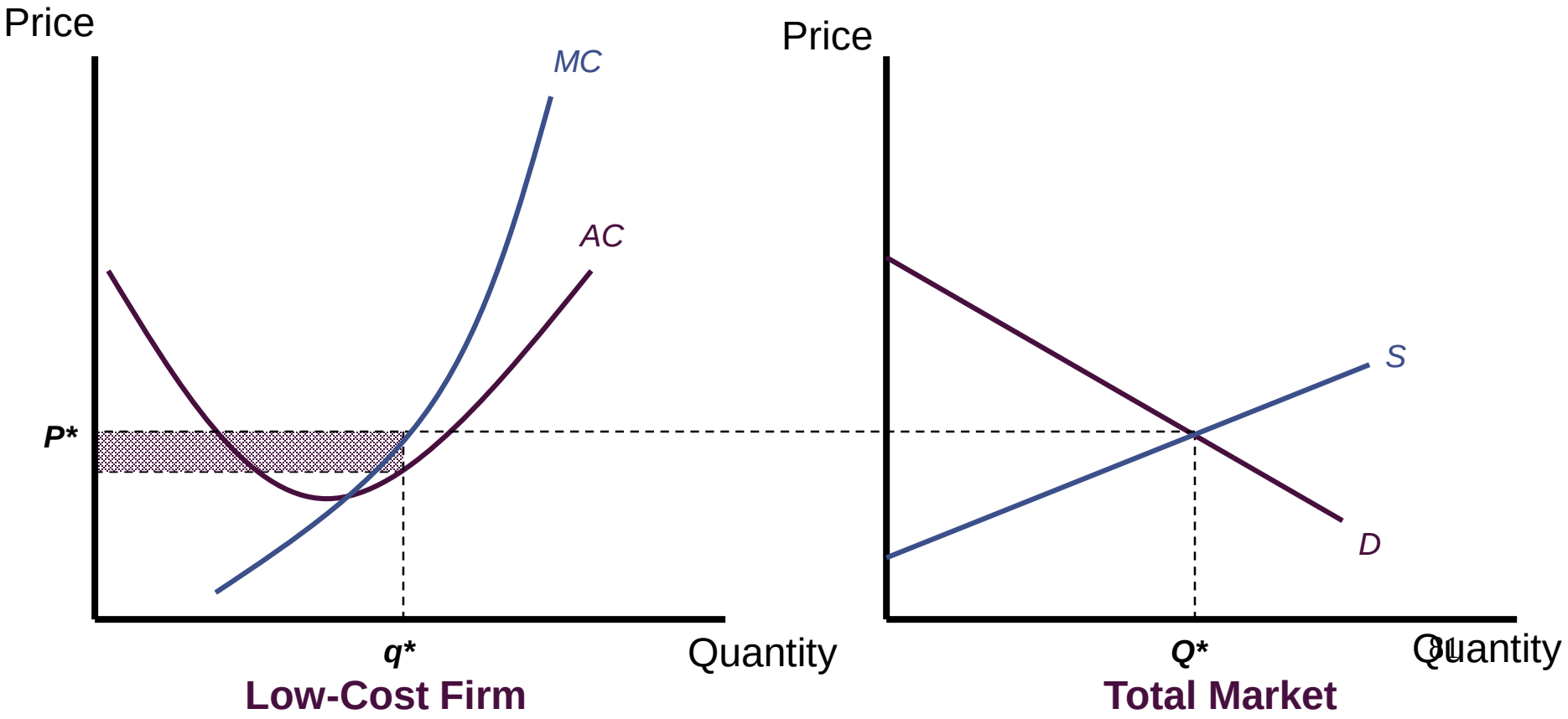
- Long-run producer surplus can be most easily illustrated with a situation first described by economist David Ricardo
  - assume that there are many parcels of land on which a particular crop may be grown
    - the land ranges from very fertile land (low costs of production) to very poor, dry land (high costs of production)

Ricardian Rent

- At low prices only the best land is used
- Higher prices lead to an increase in output through the use of higher-cost land
  - the long-run supply curve is upward-sloping because of the increased costs of using less fertile land

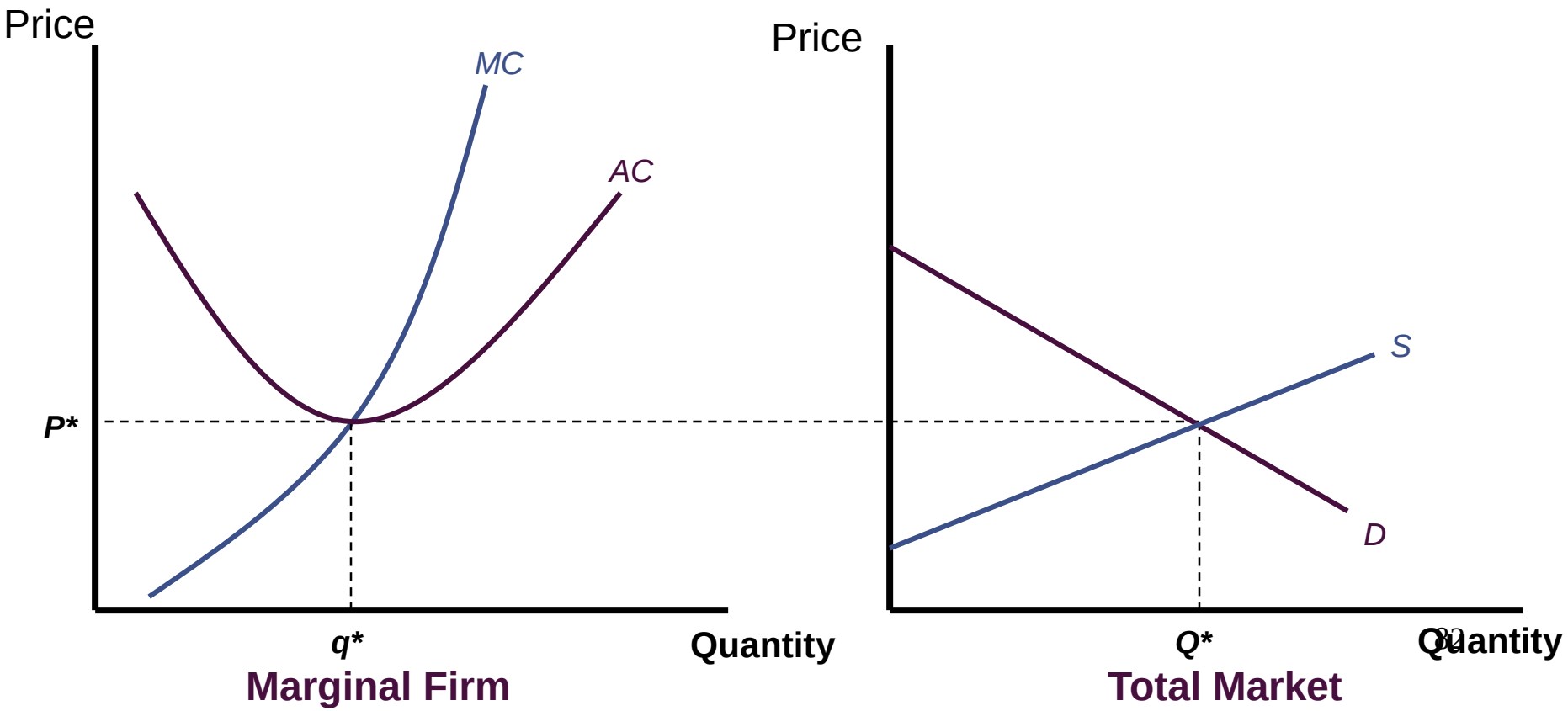
Ricardian Rent

The owners of low-cost firms will earn positive profits



Ricardian Rent

The owners of the marginal firm will earn zero profit

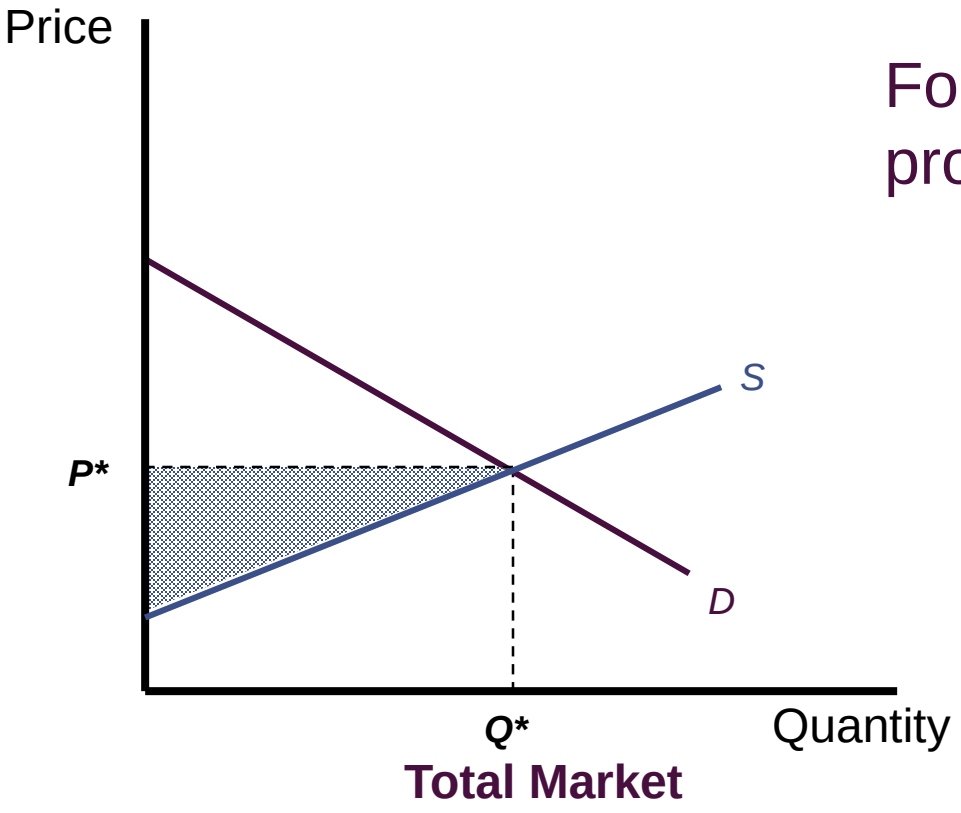


Ricardian Rent

- Firms with higher costs (than the marginal firm) will stay out of the market
  - would incur losses at a price of P^*
- Profits earned by intramarginal firms can persist in the long run
  - they reflect a return to a unique resource
- The sum of these long-run profits constitutes long-run producer surplus

Ricardian Rent

Each point on the supply curve represents minimum average cost for some firm



For each firm, $P - AC$ represents profit per unit of output

Total long-run profits can be computed by summing over all units of output

Ricardian Rent

- The long-run profits for the low-cost firms will often be reflected in the prices of the unique resources owned by those firms
  - the more fertile the land is, the higher its price
- Thus, profits are said to be capitalized inputs' prices
  - reflect the present value of all future profits

Ricardian Rent

- It is the scarcity of low-cost inputs that creates the possibility of Ricardian rent
- In industries with upward-sloping long-run supply curves, increases in output not only raise firms' costs but also generate factor rents for inputs

Important Points to Note:

- In the short run, equilibrium prices are established by the intersection of what demanders are willing to pay (as reflected by the demand curve) and what firms are willing to produce (as reflected by the short-run supply curve)
  - these prices are treated as fixed in both demanders' and suppliers' decision-making processes

Important Points to Note:

- A shift in either demand or supply will cause the equilibrium price to change
  - the extent of such a change will depend on the slopes of the various curves
- Firms may earn positive profits in the short run
  - because fixed costs must always be paid, firms will choose a positive output as long as revenues exceed variable costs

Important Points to Note:

- In the long run, the number of firms is variable in response to profit opportunities
  - the assumption of free entry and exit implies that firms in a competitive industry will earn zero economic profits in the long run ($P = AC$)
  - because firms also seek maximum profits, the equality $P = AC = MC$ implies that firms will operate at the low points of their long-run average cost curves

Important Points to Note:

- The shape of the long-run supply curve depends on how entry and exit affect firms' input costs
  - in the constant-cost case, input prices do not change and the long-run supply curve is horizontal
  - if entry raises input costs, the long-run supply curve will have a positive slope

Important Points to Note:

- Changes in long-run market equilibrium will also change the number of firms
  - precise predictions about the extent of these changes is made difficult by the possibility that the minimum average cost level of output may be affected by changes in input costs or by technical progress

Important Points to Note:

- If changes in the long-run equilibrium in a market change the prices of inputs to that market, the welfare of the suppliers of these inputs will be affected
  - such changes can be measured by changes in the value of long-run producer surplus