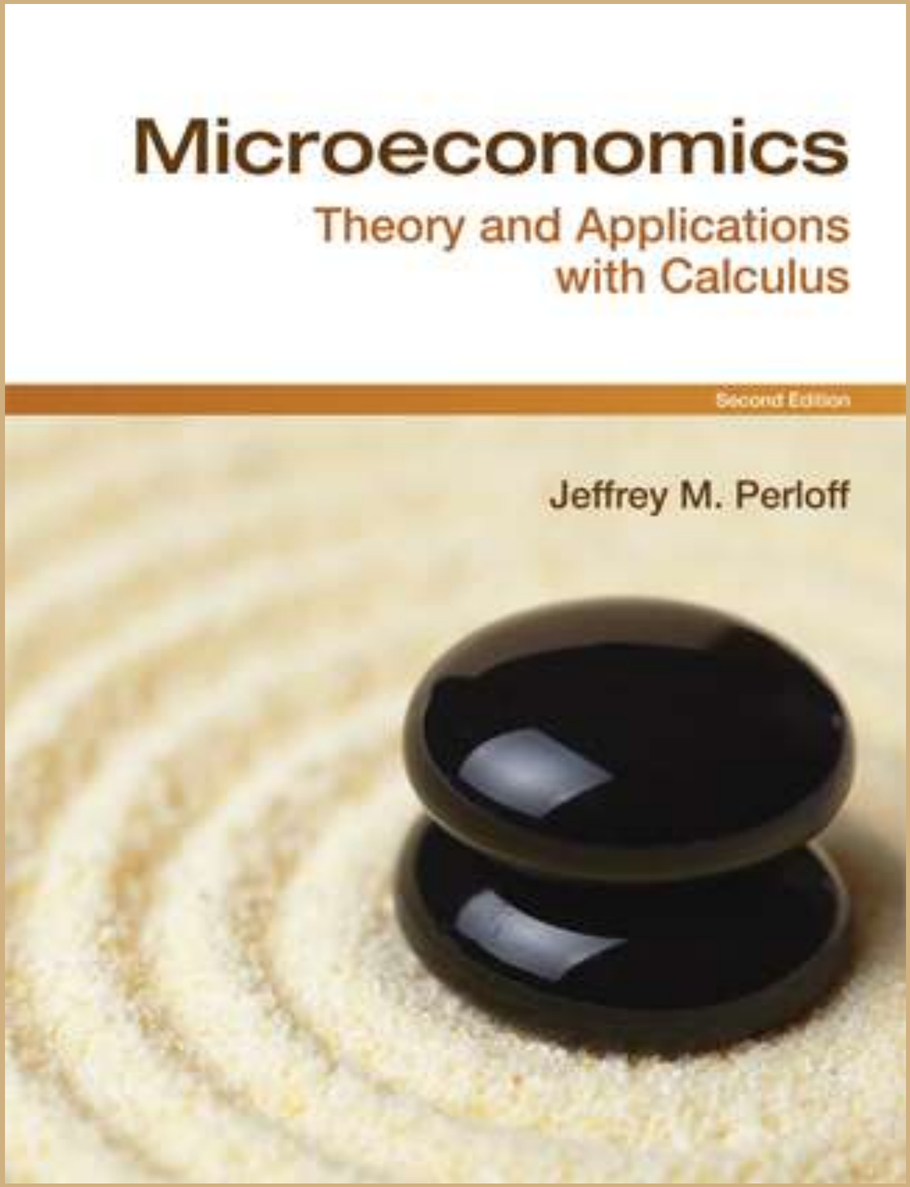
Chapter 2

Supply and Demand

Talk is cheap because supply exceeds demand.



Addison-Wesley is an imprint of PEARSON

Chapter 2 Outline

2.1 Demand
2.2 Supply
2.3 Market Equilibrium
2.4 Shocking the Equilibrium: Comparative Statistics
2.5 Elasticities
2.6 Effects of a Sales Tax
2.7 Quantity Supplied Need Not Equal Quantity Demanded
2.8 When to Use the Supply-and-Demand Model

2.1 Demand

- The quantity of a good or service that consumers demand depends on price and other factors such as consumers' incomes and the prices of related goods.
- The ***demand function*** describes the mathematical relationship between quantity demanded (Q_d), price (p) and other factors that influence purchases:

$$Q = D(p, p_s, p_c, Y)$$

  - p = per unit price of the good or service
  - p_s = per unit price of a substitute good
  - p_c = per unit price of a complementary good
  - Y = consumers' income

2.1 Demand

- We often work with a linear demand function.
- Example: estimated demand function for pork in Canada

$$Q = 171 - 20p + 20p_b + 3p_c + 2Y$$

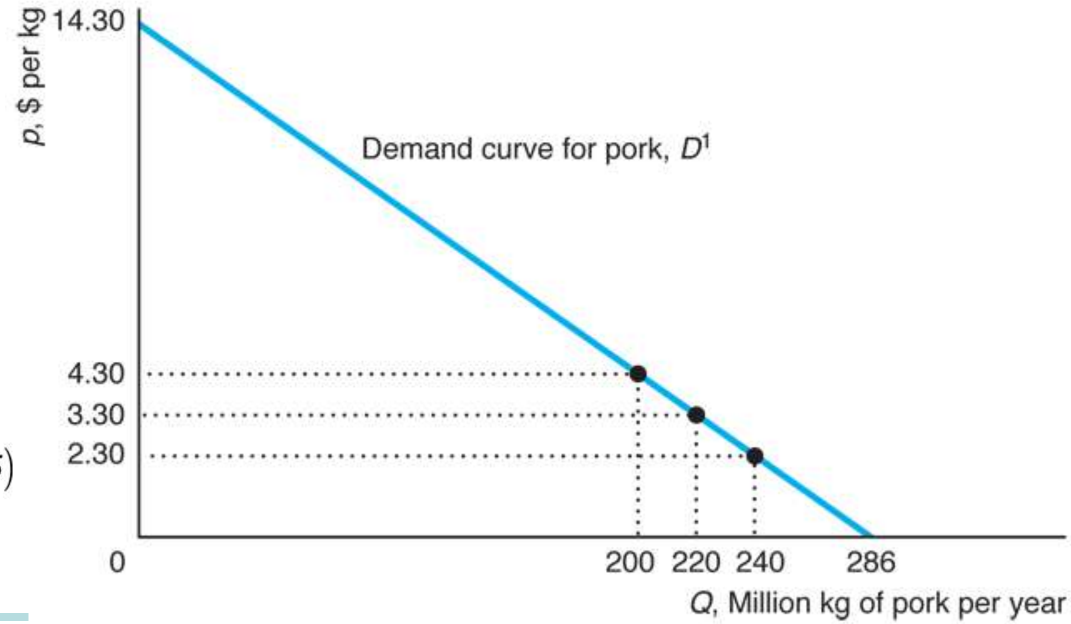
  - Q_d = quantity of pork demanded (million kg per year)
  - p = price of pork (in Canadian dollars per kg)
  - p_b = price of beef, a substitute good (in Canadian dollars per kg)
  - p_c = price of chicken, another substitute (in Canadian dollars per kg)
  - Y = consumers' income (in Canadian dollars per year)
- Graphically, we can only depict the relationship between Q_d and p, so we hold the other factors constant.

2.1 Demand Example: Canadian Pork

Assumptions about p_b, p_c, and Y to simplify equation

- p_b = \$4/kg
- p_c = \$3.33/kg
- Y = \$12.5 thousand

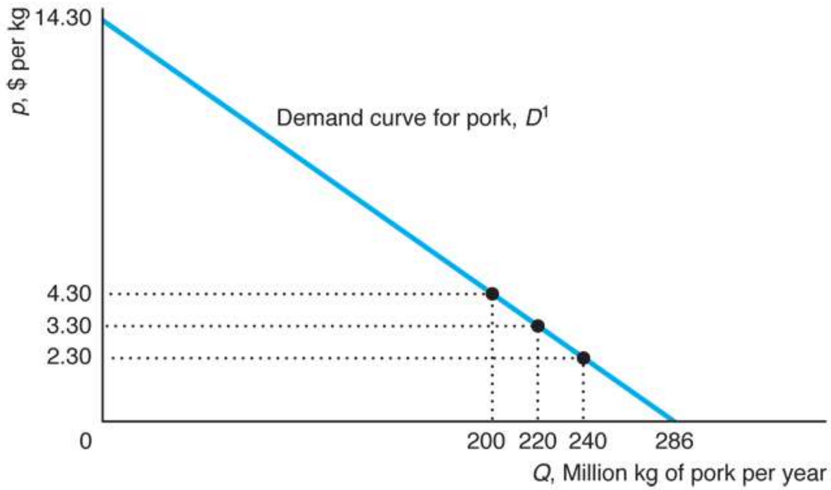
$$Q = 171 - 20p + 20p_b + 3p_c + 2Y$$
$$= 171 - 20p + (20 \times 4) + \left(3 \times 3\frac{1}{3}\right) + (2 \times 12.5)$$
$$= 286 - 20p = D(p)$$



$$\frac{dQ}{dp} = -20 \Longrightarrow \text{slope} = \frac{\text{rise}}{\text{run}} = \frac{\Delta p}{\Delta Q} = \frac{\$1 \text{ per kg}}{-20 \text{ million kg per year}} = -\$0.05 \text{ per million kg per year}$$

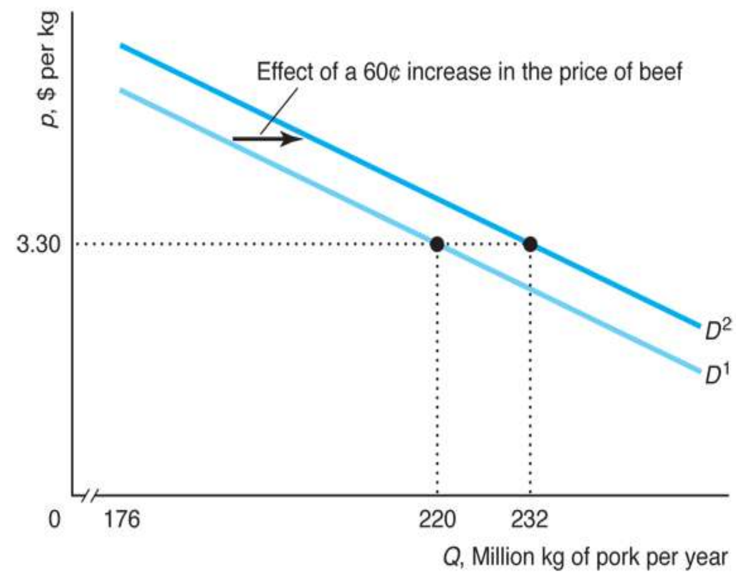
2.1 Demand Example: Canadian Pork

- Changing the own-price of pork simply moves us along an existing demand curve.



$$Q = 298 - 20\,p$$

- Changing one of the things held constant (e.g. p_b, p_c, and Y) shifts the entire demand curve.
- $p_b\uparrow$ to \$4.60 /kg



2.2 Supply

- The quantity of a good or service that firms supply depends on price and other factors such as the cost of inputs that firms use to produce the good or service.
- The ***supply function*** describes the mathematical relationship between quantity supplied (Q_s), price (p) and other factors that influence the number of units offered for sale:

$$Q = S(p, p_h)$$

  - p = per unit price of the good or service
  - p_h = per unit price of other production factors

2.2 Supply

- We often work with a linear supply function.
- Example: estimated supply function for pork in Canada.

$$Q = 178 + 40p - 60p_h$$

  - Q_s = quantity of pork supplied (million kg per year)
  - p = price of pork (in Canadian dollars per kg)
  - p_h = price of hogs, an input (in Canadian dollars per kg)

- Graphically, we can only depict the relationship between Q_s and p, so we hold the other factors constant.

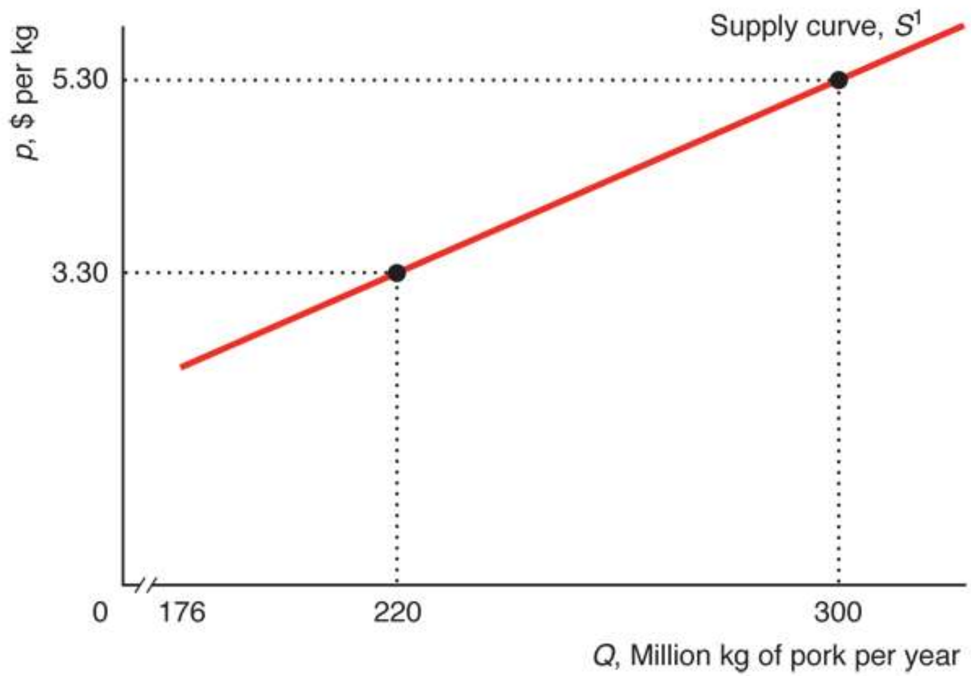
2.2 Supply Example: Canadian Pork

- Assumption about p_h to simplify equation
- p_h = \$1.50/kg

$$Q = 178 + 40p - 60p_h$$

$$\downarrow$$

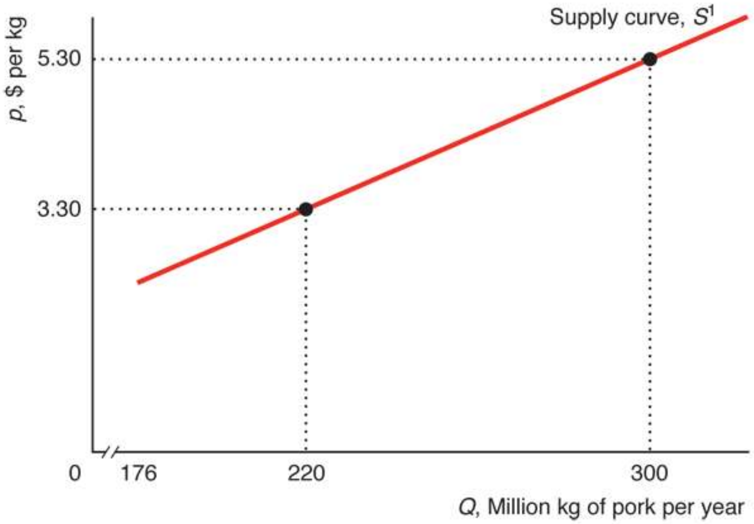
$$Q = 88 + 40p$$



$$\frac{dQ_s}{dp} = 40 \Longrightarrow \frac{dp}{dQ_s} = \frac{1}{40} = slope$$

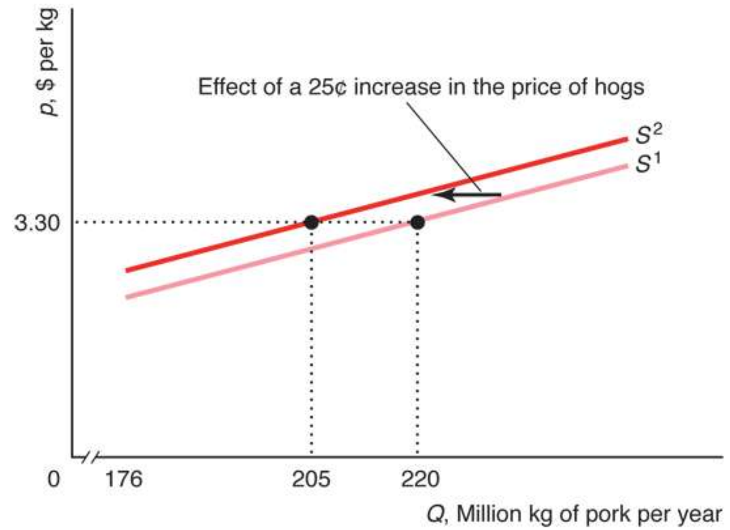
2.2 Supply Example: Canadian Pork

- Changing the own-price of pork simply moves us along an existing supply curve.



- Changing one of the things held constant (e.g. p_h) shifts the entire supply curve.
- p_h ↑ to \$4.60 /kg

$$Q = 73 + 40p$$



2.3 Market Equilibrium

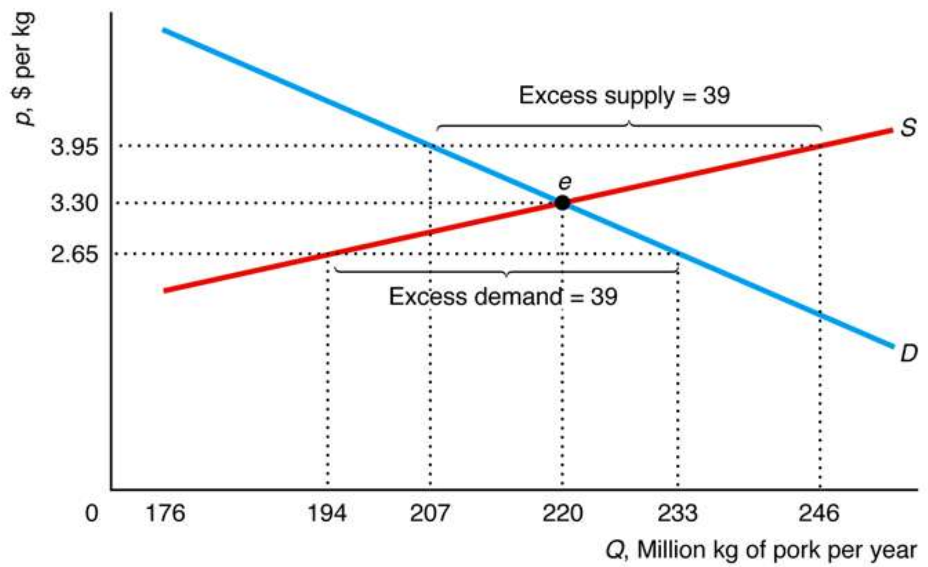
- The interaction between consumers' demand curve and firms' supply curve determines the market price and quantity of a good or service that is bought and sold.
- Mathematically, we find the price that equates the quantity demanded, Q_d, and the quantity supplied, Q_s:
  - Given $Q_d = 286 - 20p$ and $Q_s = 88 + 40p$, find p such that $Q_d = Q_s$: $286 - 20p = 88 + 40p$

$$p = \$3.30$$

$$Q_d = Q_s$$
$$286 - (20 \times 3.30) = 88 + (40 \times 3.30)$$
$$220 = 220$$

2.3 Market Equilibrium

- Graphically, market equilibrium occurs where the demand and supply curves intersect.
  - At any other price, excess supply or excess demand results.
  - Natural market forces push toward equilibrium Q and p.

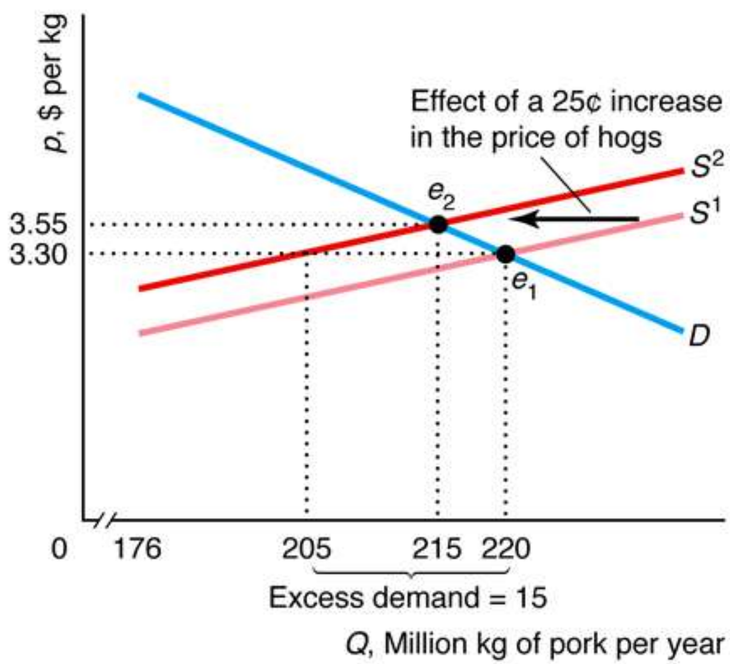


2.4 Shocking the Equilibrium: Comparative Statics

- Changes in a factor that affects demand, supply, or a new government policy alters the market price and quantity of a good or service.
- Changes in demand and supply factors can be analyzed graphically and/or mathematically.
  - Graphical analysis should be familiar from your introductory microeconomics course.
  - Mathematical analysis simply utilizes demand and supply functions to solve for a new market equilibrium.
- Changes in demand and supply factors can be large or small.
  - Small changes are analyzed with Calculus.

2.4 Shocking the Equilibrium: Comparative Statics with Discrete (large) Changes

- Graphically analyzing the effect of an increase in the price of hogs
  - When an input gets more expensive, producers supply less pork at every price.



2.4 Shocking the Equilibrium: Comparative Statics with Discrete (large) Changes

- Mathematically analyzing the effect of an increase in the price of hogs $Q_s = 73 + 40p$
  - If p_h increases by $0.25, new p_h = $1.75 and

$$Q_d = Q_s$$
$$286 - 20p = 73 + 40p$$
$$p = \$3.55$$

$\Rightarrow$

$$Q_d = 286 - 20(3.55) = 215$$
$$Q_s = 73 + 40(3.55) = 215$$

2.4 Shocking the Equilibrium: Comparative Statics with Small Changes

- Demand and supply functions are written as general functions of the price of the good, holding all else constant. $Q = D(p)$
  - Supply is also a function of some exogenous (not in firms' control) variable, *a*. $Q = S(p, a)$
- Because the intersection of demand and supply determines the price, *p*, we can write the price as an implicit function of the supply-shifter, *a*: $Q = D(p(a))$ $Q_s = S\left(p(a), a\right)$
- In equilibrium: $D(p(a)) = S(p(a), a)$

2.4 Shocking the Equilibrium: Comparative Statics with Small Changes

- Given the equilibrium condition $D(p(a)) = S(p(a), a)$, we differentiate with respect to *a* using the chain rule to determine how equilibrium is affected by a small change in *a*:

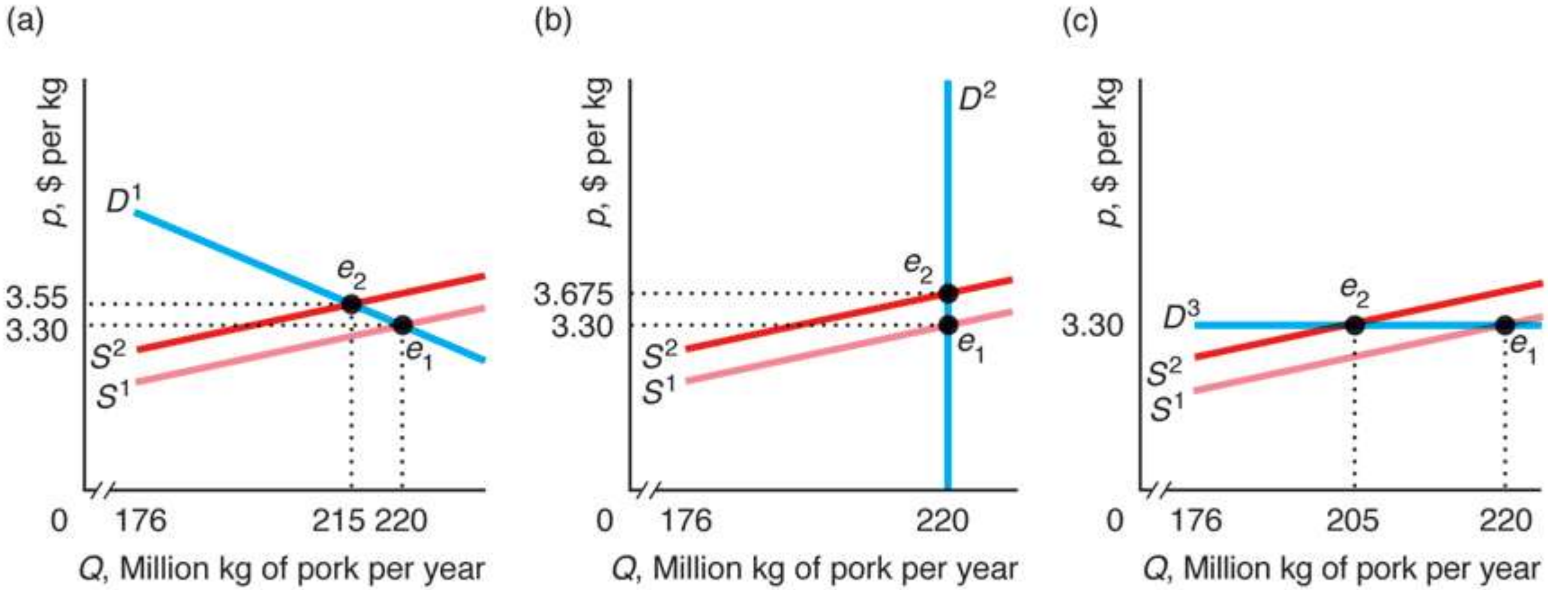
$$\frac{\mathrm{d}D\big(p(a)\big)}{\mathrm{d}p}\frac{\mathrm{d}p}{\mathrm{d}a} = \frac{\partial S\big(p(a), a\big)}{\partial p}\frac{\mathrm{d}p}{\mathrm{d}a} + \frac{\partial S\big(p(a), a\big)}{\partial a}$$

- Rearranging:

$$\frac{\mathrm{d}p}{\mathrm{d}a} = \frac{\dfrac{\partial S}{\partial a}}{\dfrac{\mathrm{d}D}{\mathrm{d}p} - \dfrac{\partial S}{\partial p}}$$

2.5 Elasticities

- The shape of demand and supply curves influence how much shifts in demand or supply affect market equilibrium.
  - Shape is best summarized by elasticity.



2.5 Elasticities

- Elasticity indicates how responsive one variable is to a change in another variable.
- The price elasticity of demand measures how sensitive the quantity demanded of a good, Q_d, is to changes in the price of that good, p.

$$\varepsilon = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}} = \frac{\Delta Q / Q}{\Delta p / p} = \frac{\partial Q}{\partial p} \frac{p}{Q}$$

- If $Q_d = a - bp$, then $\varepsilon = \frac{dQ}{dp} \frac{p}{Q} = -b \frac{p}{Q}$ and elasticity can be evaluated at any point on the demand curve.

2.5 Example: Elasticity of Demand

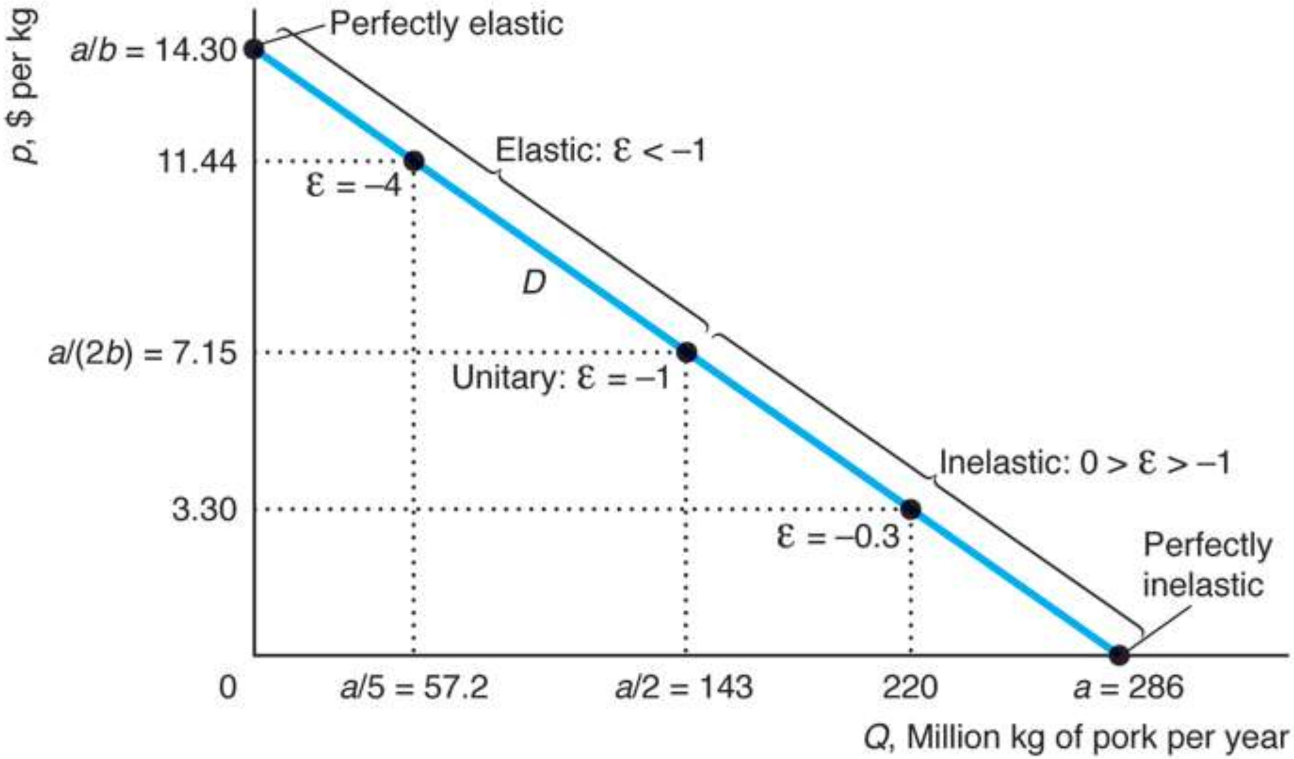
- Previous pork demand was $Q_d = 286 - 20p$
- Calculating price elasticity of demand at equilibrium (p=\$3.30 and Q=220):

$$\varepsilon = b\frac{p}{Q} = -20 \times \frac{3.30}{220} = -0.3$$

- Interpretation:
  - negative sign consistent with downward-sloping demand
  - a 1% increase in the price of pork leads to a 0.3% decrease in quantity of pork demanded

2.5 Elasticity of Demand

- Elasticity of demand varies along a linear demand curve



2.5 Elasticities

- There are other common elasticities that are used to gauge responsiveness.
  - income elasticity of demand

$$\xi = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}} = \frac{\Delta Q / Q}{\Delta Y / Y} = \frac{\partial Q}{\partial Y}\frac{Y}{Q}$$

  - cross-price elasticity of demand

$$\frac{\text{percentage change in quantity demanded}}{\text{percentage change in price of another good}} = \frac{\Delta Q / Q}{\Delta p_o / p_o} = \frac{\partial Q}{\partial p_o}\frac{p_o}{Q}$$

  - elasticity of supply

$$\eta = \frac{\text{percentage change in quantity supplied}}{\text{percentage change in price}} = \frac{\Delta Q / Q}{\Delta p / p} = \frac{\partial Q}{\partial p}\frac{p}{Q}$$

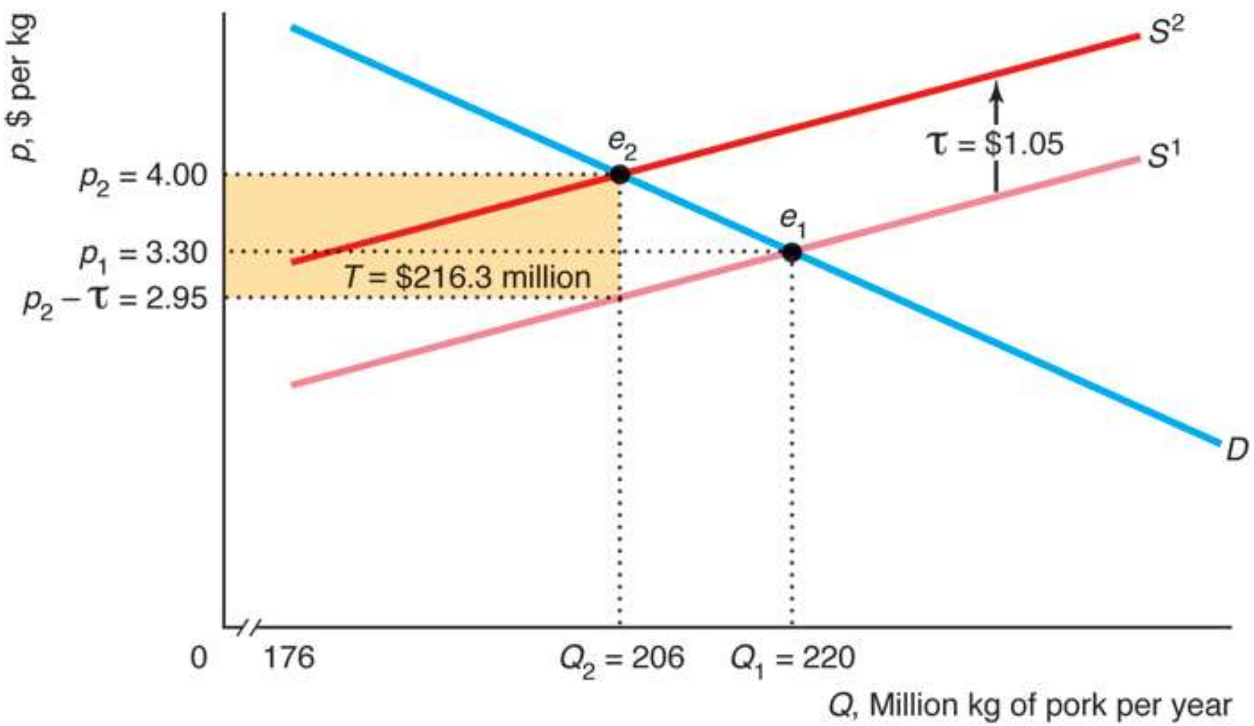
2.6 Effects of a Sales Tax

- Two types of sales taxes:
  - ***Ad valorem tax*** is in percentage terms
    - California's state tax rate is 8.25%, so a $100 purchase generates $8.25 in tax revenue
  - ***Specific (or unit) tax*** is in dollar terms
    - U.S. gasoline tax is $0.18 per gallon
  - Ad valorem taxes are much more common.

- The effect of a sales tax on equilibrium price and quantity depends on elasticities of demand and supply.

2.6 Equilibrium Effects of a Sales Tax

- Consider the effect of a $1.05 per unit (specific) sales tax on the pork market that is collected from pork producers.



2.6 How Specific Tax Effects Depend on Elasticities

- If a unit tax, τ, is collected from pork producers, the price received by pork producers is reduced by this amount and our equilibrium condition becomes:

$$D(p(\tau) = S(p(\tau) - \tau)$$

- Differentiating with respect to τ:

$$\frac{\mathrm{d}D}{\mathrm{d}p}\,\frac{\mathrm{d}p}{\mathrm{d}\tau} = \frac{\mathrm{d}S}{\mathrm{d}p}\,\frac{\mathrm{d}\big(p(\tau) - \tau\big)}{\mathrm{d}\tau} = \frac{\mathrm{d}S}{\mathrm{d}p}\left(\frac{\mathrm{d}p}{\mathrm{d}\tau} - 1\right)$$

- Rearranging indicates how the tax changes the price consumers pay:

$$\frac{\mathrm{d}p}{\mathrm{d}\tau} = \frac{\dfrac{\mathrm{d}S}{\mathrm{d}p}}{\dfrac{\mathrm{d}S}{\mathrm{d}p} - \dfrac{\mathrm{d}D}{\mathrm{d}p}}$$

2.6 How Specific Tax Effects Depend on Elasticities

- The equation $\frac{dp}{d\tau} = \frac{\frac{dS}{dp}}{\frac{dS}{dp} - \frac{dD}{dp}}$ can be expressed in terms of elasticities by multiplying through by *p/Q*:

$$\frac{dp}{d\tau} = \frac{\frac{dS}{dp}\frac{p}{Q}}{\frac{dS}{dp}\frac{p}{Q} - \frac{dD}{dp}\frac{p}{Q}} = \frac{\eta}{\eta - \varepsilon}$$

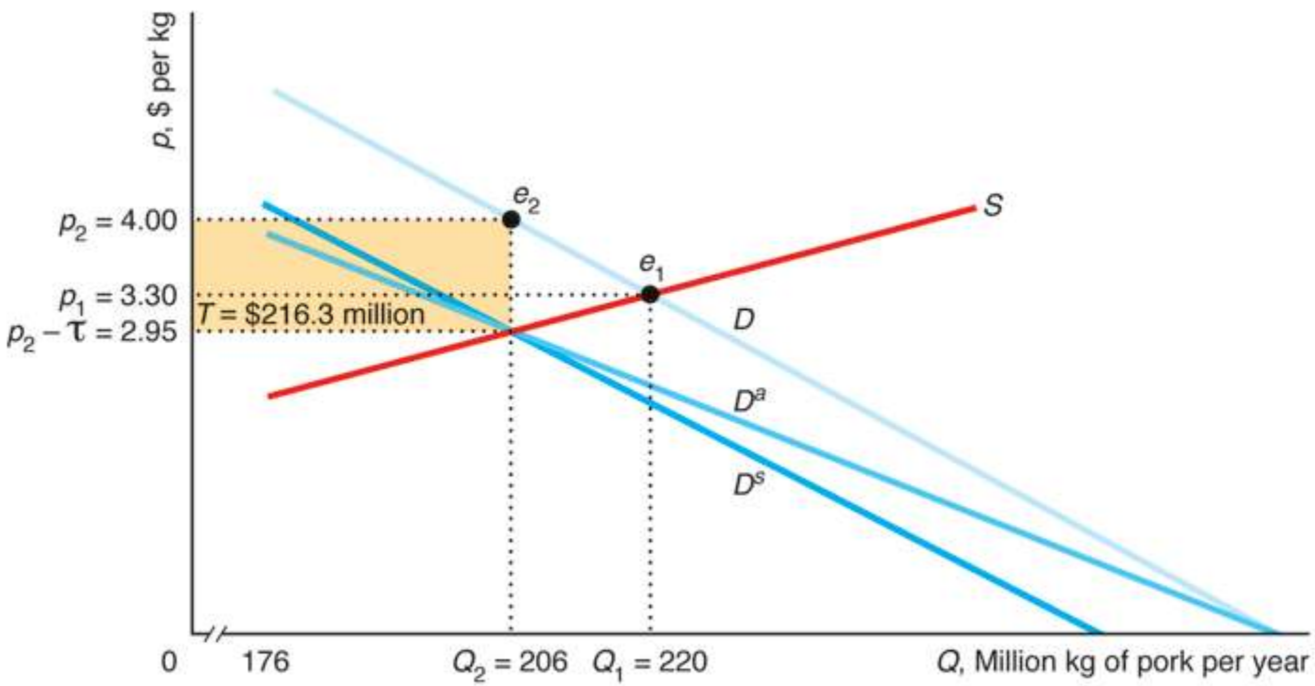
- *Tax incidence on consumers*, the amount by which the price to consumers rises as a fraction of the amount of the tax, is now easy to calculate given elasticities of demand and supply.
- *Tax incidence on firms*, the amount by which the price paid to firms rises, is simply 1 – d*p*/d τ

2.6 Important Questions About Tax Effects

- Does it matter whether the tax is collected from producers or consumers?
  - Tax incidence is not sensitive to *who* is actually taxed.
  - A tax collected from producers shifts the supply curve back.
  - A tax collected from consumers shifts the demand curve back.
  - Under either scenario, a tax-sized wedge opens up between demand and supply and the incidence analysis is identical.
- Does it matter whether the tax is a unit tax or an ad valorem tax?
  - If the ad valorem tax rate is chosen to match the per unit tax divided by equilibrium price, the effects are the same.

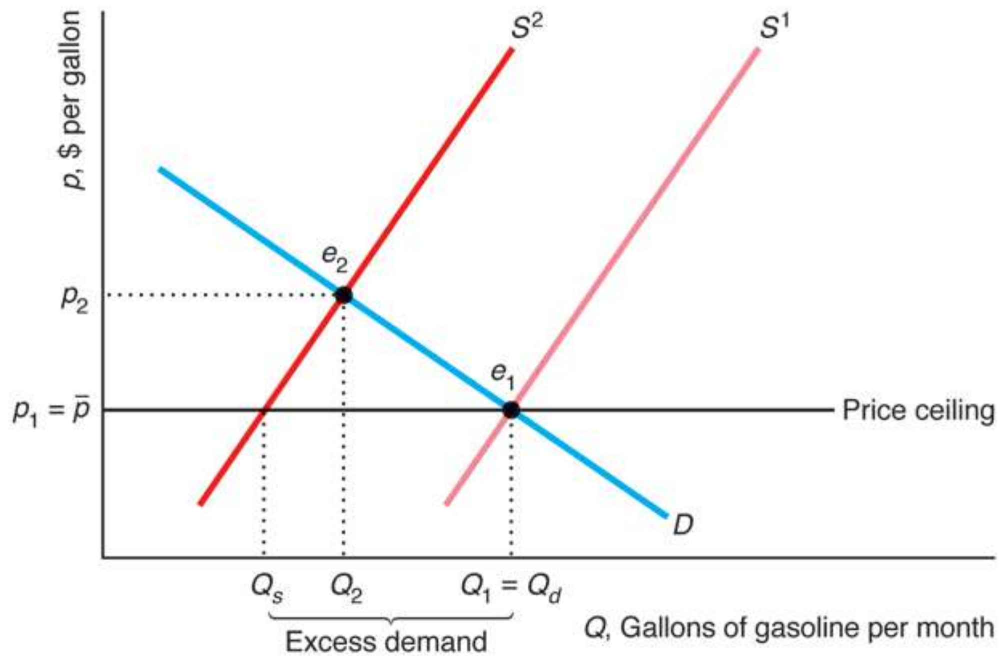
2.6 Important Questions About Tax Effects

- Does it matter whether the tax is a unit tax or an ad valorem tax?



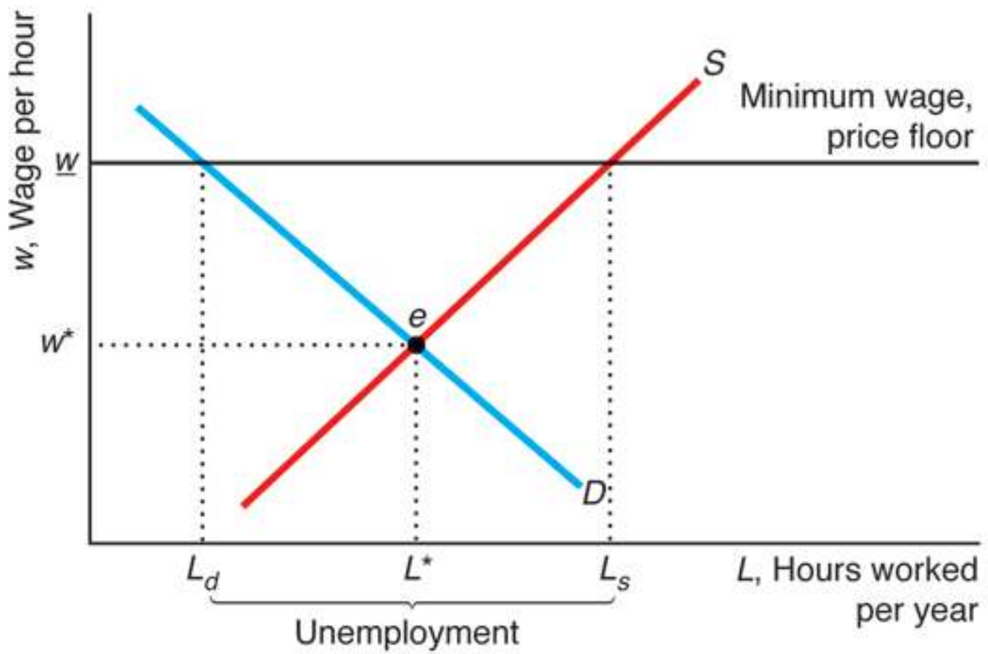
2.7 Quantity Supplied Need Not Equal Quantity Demanded

- Price determines whether $Q_s = Q_d$
- A ***price ceiling*** legally limits the amount that can be charged for a product.
  - Effective ceilings force the price below equilibrium price.



2.7 Quantity Supplied Need Not Equal Quantity Demanded

- Price determines whether $Q_s = Q_d$
- A ***price floor*** legally inflates the price of a product above some level.
  - Effective floor forces the price above equilibrium price.



2.8 When to Use the Supply-and-Demand Model

- This model is appropriate in markets that are perfectly competitive:
  1. There are a large number of buyers and sellers.
  2. All firms produce identical products.
  3. All market participants have full information about prices and product characteristics.
  4. Transaction costs are negligible.
  5. Firms can easily enter and exit the market.

- We will talk more about the perfectly competitive market in Chapter 8.

Figure 2.5 Total Supply: The Sum of Domestic and Foreign Supply

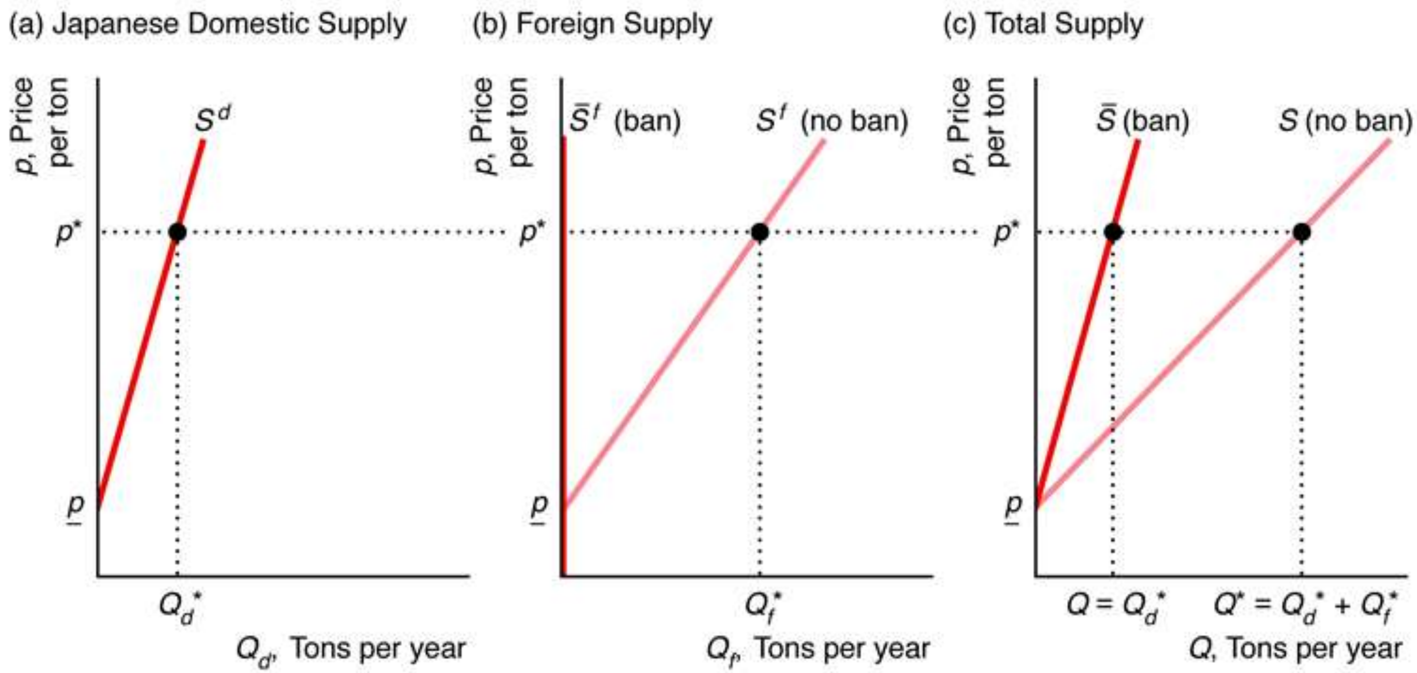


Figure 2.10 Constant-Elasticity Demand Curves

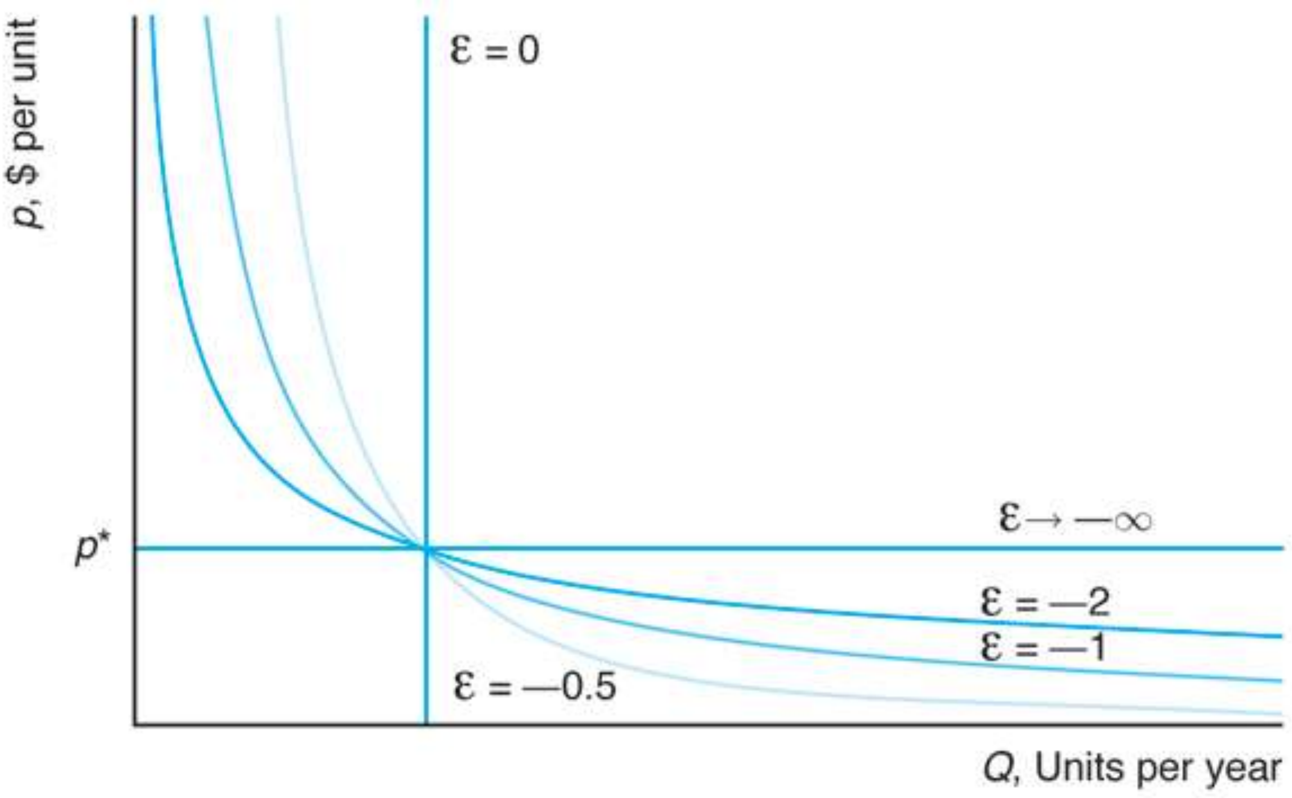


Figure 2.11 Constant-Elasticity Supply Curves