Chapter 1: Introduction to microeconomics

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Spring 2017

1.1 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:

$$Q = D\left(p, p_s, p_c, Y\right)$$

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

Demand example: Canadian Pork

- **Reference:** Moschini, G. and K.D. Meilke (1992), Production Subsidy and Countervailing Duties in Vertically Related Markets: The Hog-Pork Case Between Canada and the United States, *American Journal of Agricultural Economics*, 74, 951-961.

- Perloff (Exercice 1.1, p. 55) uses a rounded up version of this paper's estimated processed pork demand function in Canada:

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

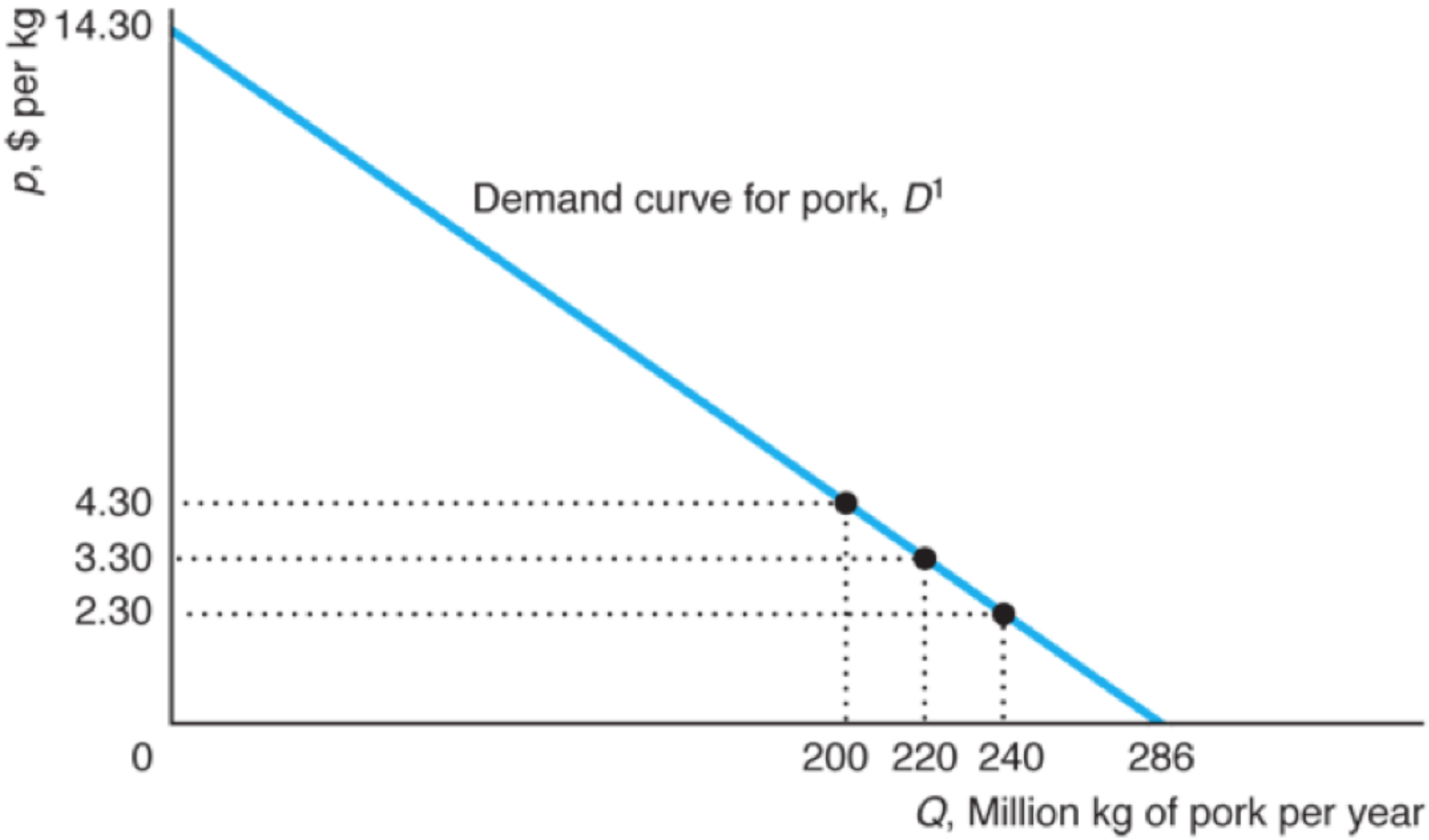
  - Q = quantity of pork demanded (million kg per year)
  - p = price of pork (in Canadian dollars per kg)
  - p_b = price of beef, a substitute good (in Canadian dollars per kg)
  - p_c = price of chicken, another substitute (in Canadian dollars per kg)

Demand example: Canadian Pork

- Graphically, we can only depict the relationship between Q_d and p, so we hold the other factors constant.
  - $p_b =$\$4/kg
  - $p_c =$\$3.33/kg
  - $Y =$\$12.5 thousand
- The demand function becomes

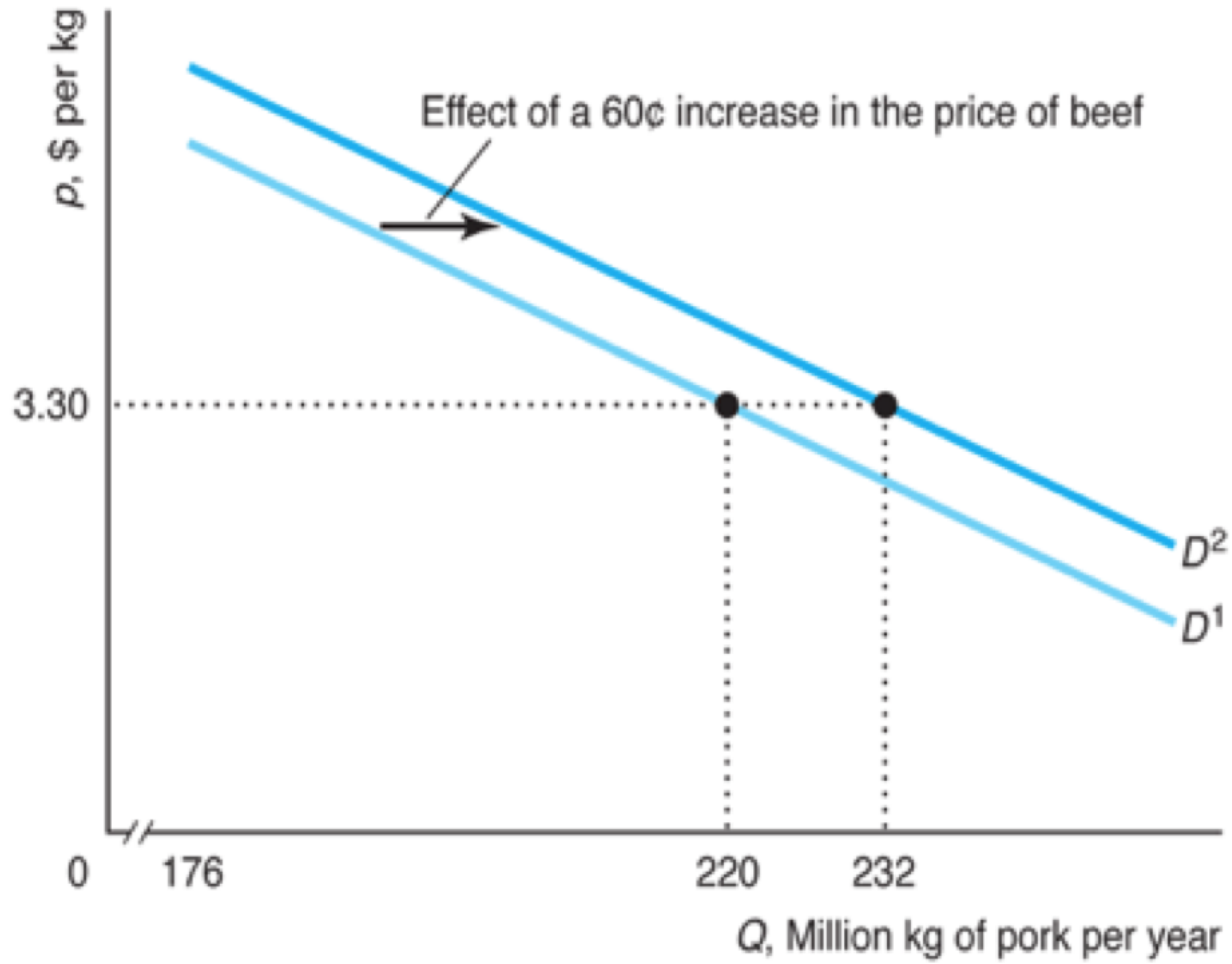
$$Q = 286 - 20p$$

Demand for porc in Canada



Demand for porc in Canada

- Changing one of the things held constant (e.g. p_b, p_c or Y) shifts the entire demand curve
  - e.g. $\uparrow p_b \rightarrow \$4.60/\text{kg} \rightarrow Q = 298 - 20p$.



1.2 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 a production factor

Supply example: Canadian Pork

- Perloff (Exercice 2.1, p. 56) uses again a rounded up version of Moschini and Meilke (1992) estimated processed pork supply function in Canada:

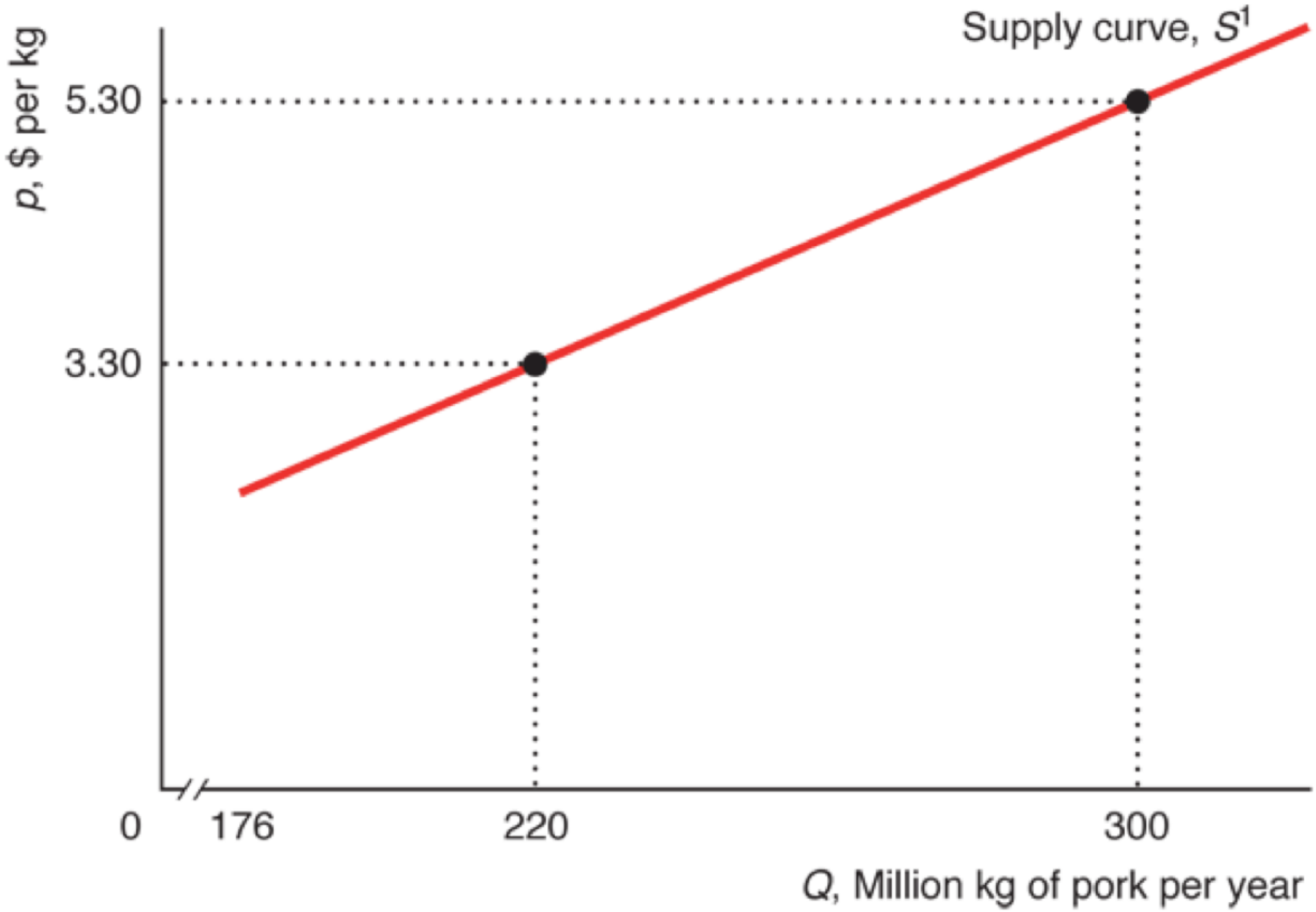
$$Q = 178 + 40p - 60p_h$$

  - Q = 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. Assuming $p_h = \$1.50/\text{kg}$, we get

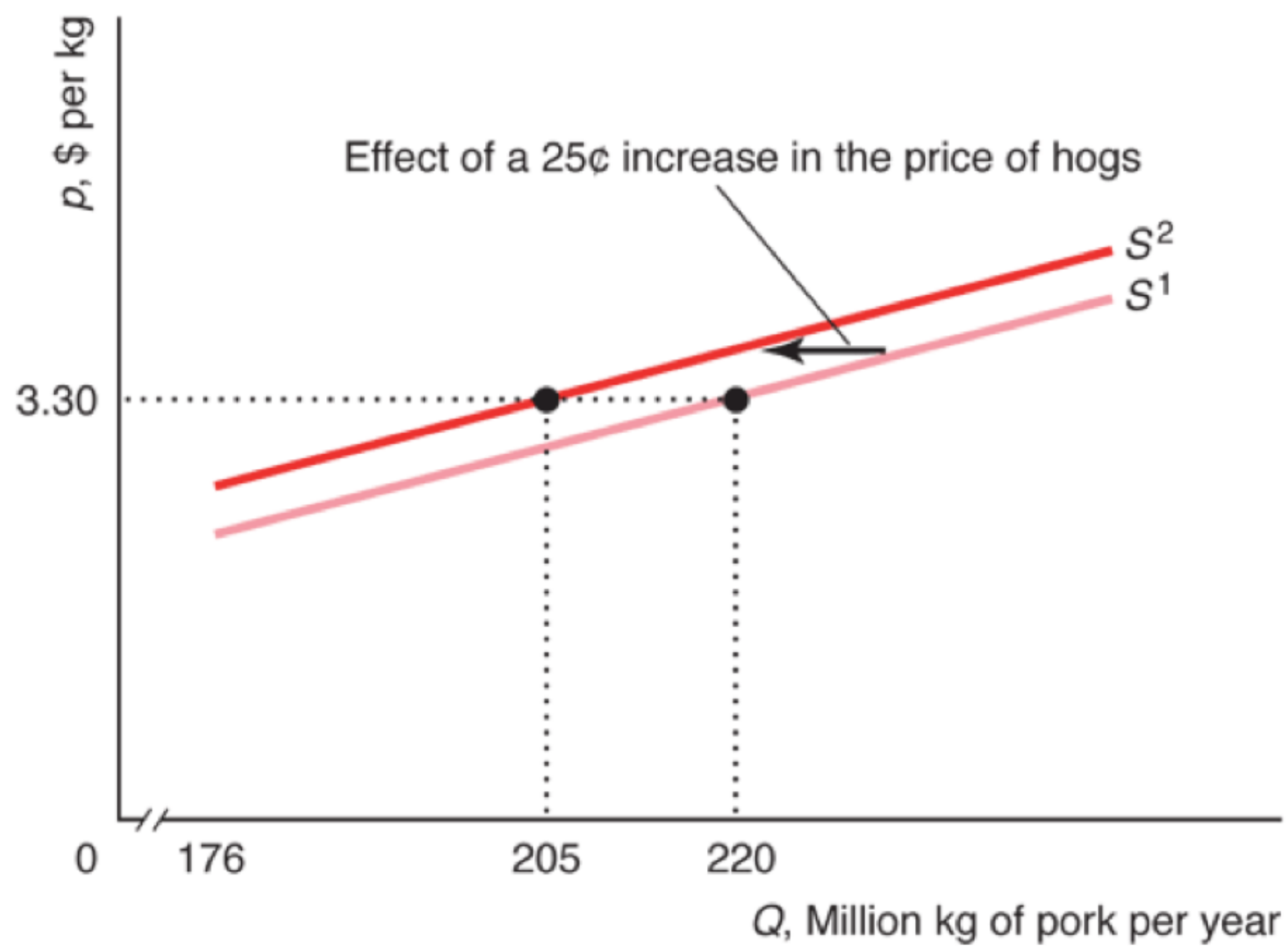
$$Q = 88 + 40p$$

Supply of porc in Canada

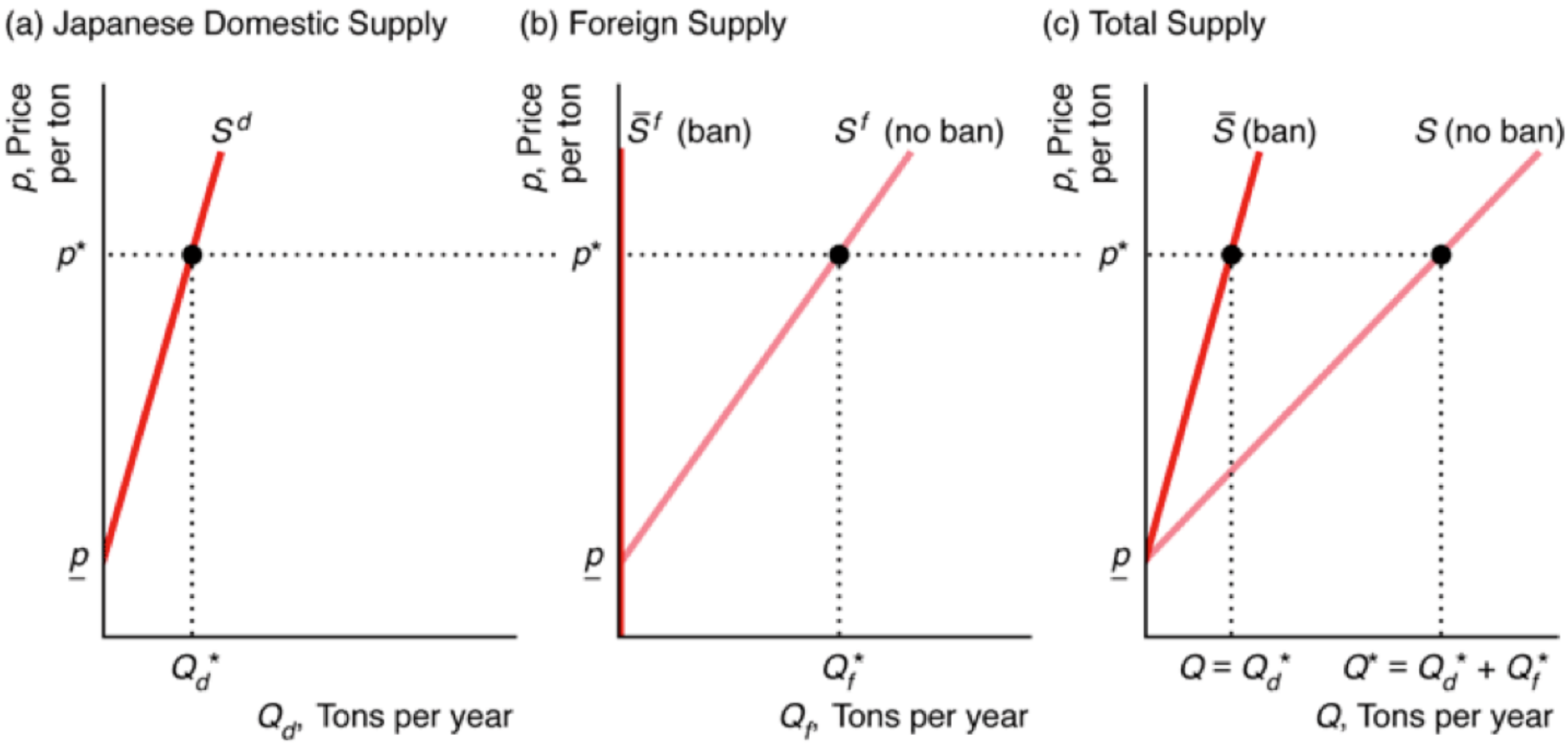


Supply of porc in Canada

- Changing one of the things held constant (p_h in this example) shifts the entire supply curve.
  - e.g. $\uparrow p_h \rightarrow \$1.75/\text{kg} \rightarrow Q = 73 + 40p$.



Supply example 2: Domestic and foreign supply of rice



1.3 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. Assume that we have the following supply and demand functions for pork:

$$\begin{aligned} Q_d &= 286 - 20p \\ Q_s &= 88 + 40p \end{aligned}$$

  The equilibrium price and quantity are:

  - $p^* = \$3.30/\text{kg}$
  - $Q^* = 220$ million kg.

$$Q_d = 286 - 20p$$

$$Q_s = 88 + 40p$$

$$286 - 20p = 88 + 40p$$

~~$60p = 374$~~

$$60p = 198$$

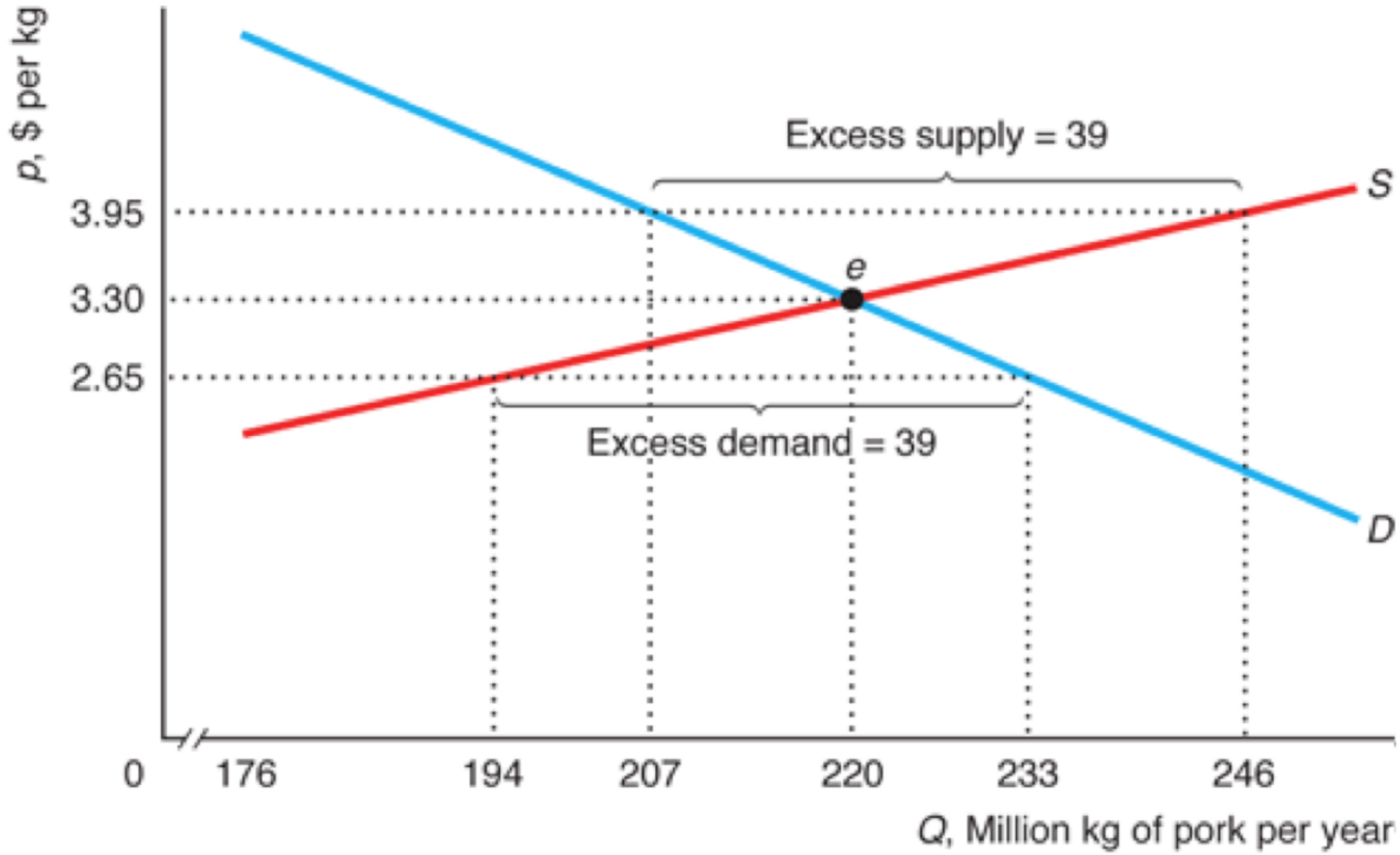
$$p = 3.30\ \$$$

$$Q = 88 + 40(3.3) = 220$$

$$Q = 286 - 20(3) = 220$$

Market equilibrium

- Graphically, market equilibrium occurs where the demand and supply curves intersect.



1.4 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.

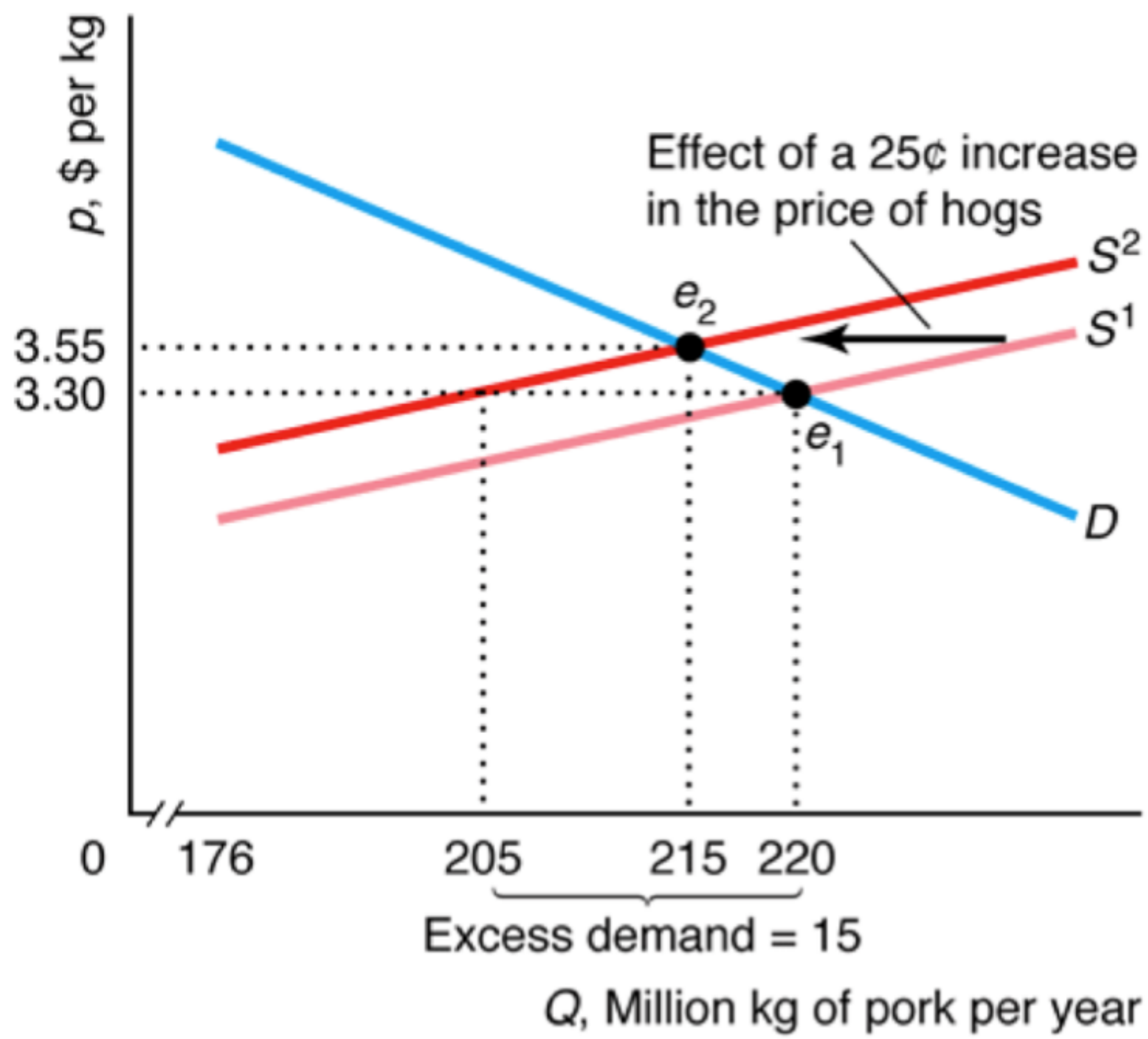
- Changes in demand and supply factors can be analyzed graphically and/or mathematically.
  - Graphical analysis should be familiar from your introductory microeconomics course.
  - Mathematical analysis simply utilizes demand and supply functions to solve for a new market equilibrium.

- Changes in demand and supply factors can be large or small.
  - Small changes are analyzed with calculus.

Example of porc in Canada

- $\uparrow p_h \rightarrow \$1.75/\text{kg} \rightarrow Q_s = 73 + 40p$. The demand remains the same $Q_d = 286 - 20p$.
  - New equilibrium price $p^* = 3.55\$/\text{kg}$
  - New equilibrium quantity $Q^* = 215$ million kg.

$286 - 20p = 73 + 40p$
$60p = 213$
$p = 3.55$
$Q = 216$

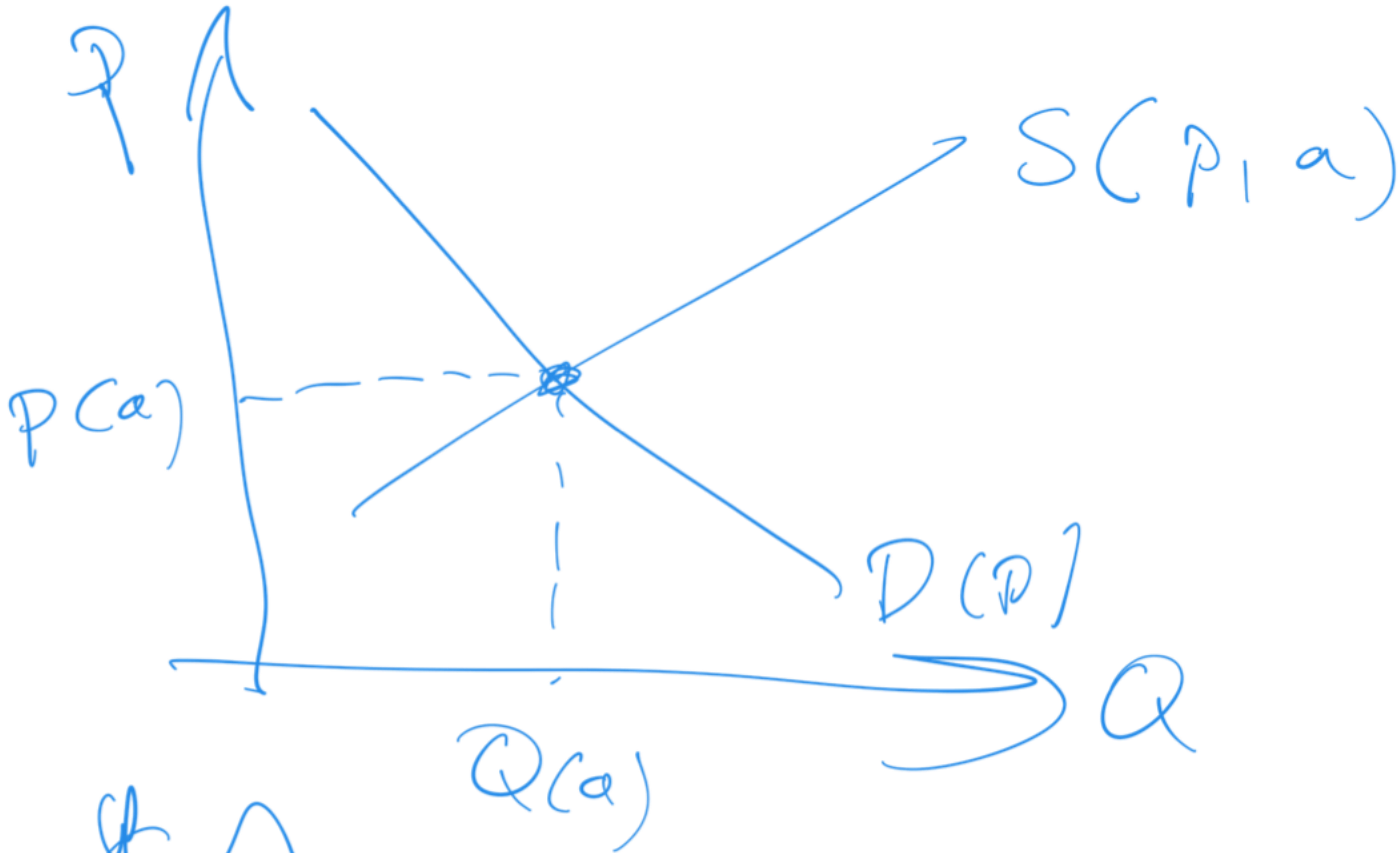


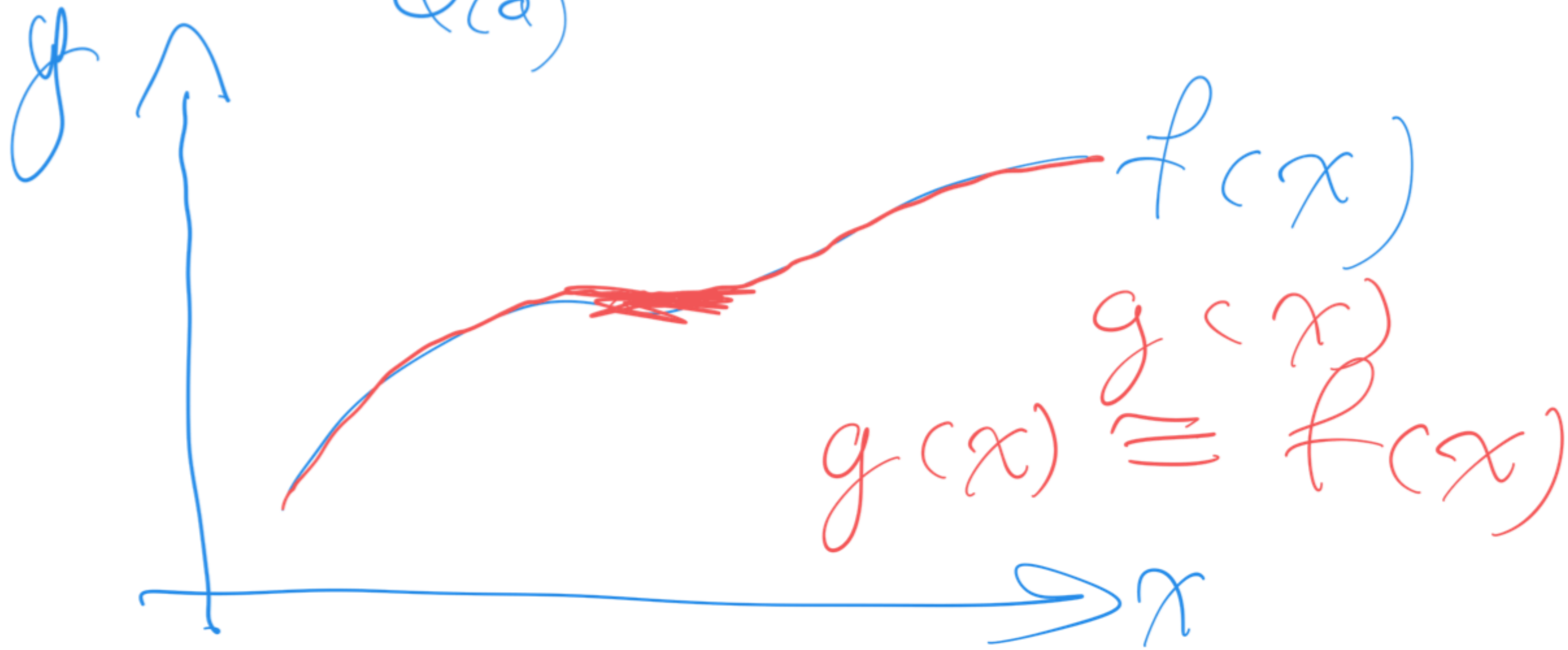
Comparative statics with small changes

- 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:

$$\begin{aligned} Q &= D(p(a)) \\ Q &= S(p(a), a) \end{aligned}$$

- In equilibrium, $D(p(a)) \equiv S(p(a), a)$.


P
S(p, a)
P(a)
D(p)
Q
Q(a)


y
f(x)
g(x)
g(x) ≅ f(x)
x

$$f(x) = g(x)$$

Can I do this $\Rightarrow$

$$f'(x) = g'(x)$$

Comparative statics with small changes

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

$$\frac{dD(p(a))}{dp}\frac{dp(a)}{da} = \frac{\partial S(p(a), a)}{\partial p}\frac{dp(a)}{da} + \frac{\partial S(p(a), a)}{\partial a}$$

- Rearranging:

$$\frac{dp(a)}{da} = \frac{\frac{\partial S(p(a),a)}{\partial a}}{\frac{dD(p(a))}{dp} - \frac{\partial S(p(a),a)}{\partial p}}$$

Example

- How do the equilibrium price and quantity of pork vary as the price of hogs changes if the variables that affect demand are held constant at their typical values? Answer this comparative statics question using calculus. $\Rightarrow \frac{dP}{dp_h} = 1$

- The estimated processed pork demand function in Canada is

  $Q_d = 288 - 20P$

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

  The typical values of the variables affecting demand are

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

  $Q_s = 178 + 40 - 60p_h$

- The estimated processed pork supply function in Canada is

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

$$Q_d = D(p) = 288 - 20p$$

$$Q_s = S(p, p_h) = 178 + 40p - 60p_h$$

$$\Rightarrow \frac{dp}{dp_h}$$

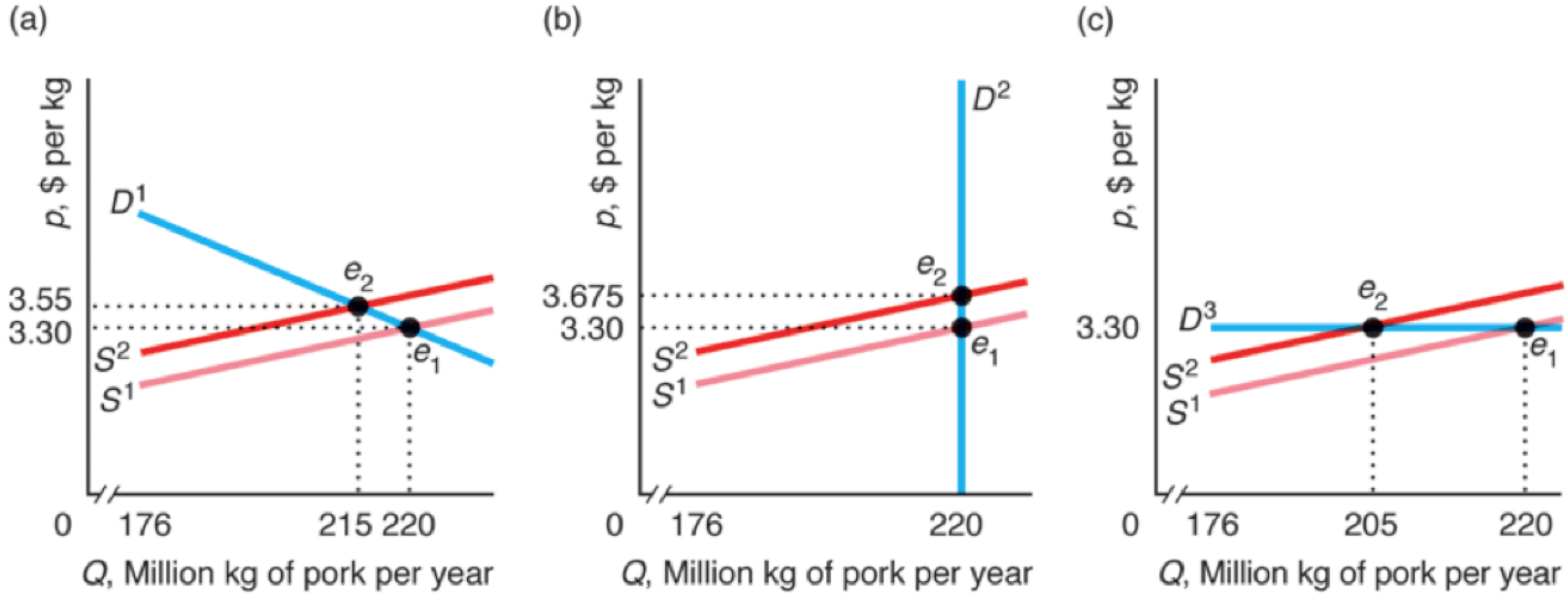
$$288 - 20p = 178 + 40p - 60p_h$$

$$60p = 110 + 60p_h$$

$$p = 1.83 + p_h$$

$$\frac{dp}{dp_h} = 1$$

- The shape of demand and supply curves influence how much shifts in demand or supply affect market equilibrium.



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.

$$\varepsilon = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}}$$

$$\varepsilon = \frac{\partial Q_d}{\partial p} \cdot \frac{p}{Q}$$

$$\frac{\partial Q_d}{\partial P} = -b$$

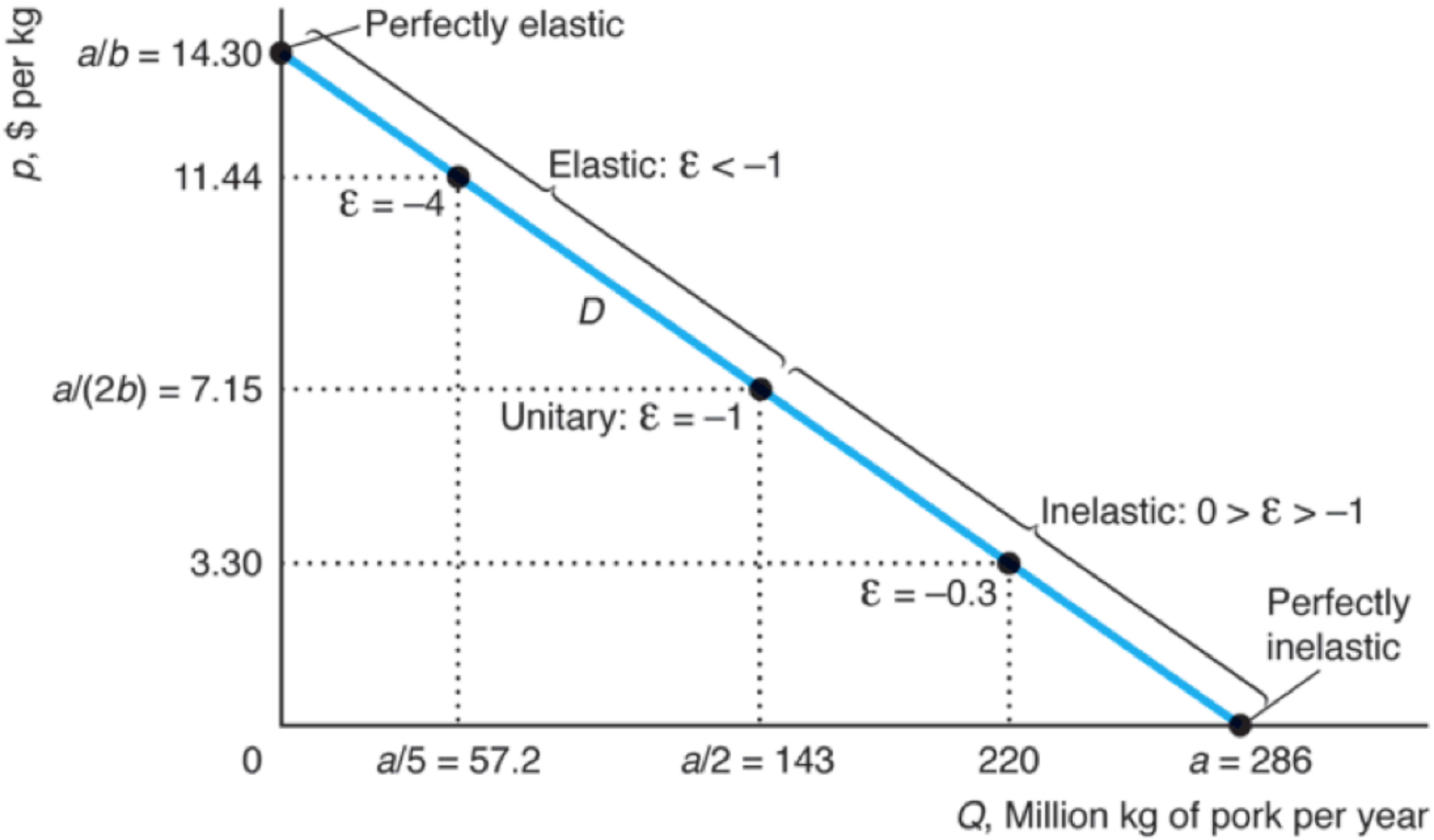
$$\varepsilon = -b \frac{P}{Q}$$

- **Example:** If $Q_d = a - bp$, $\varepsilon = -b\frac{p}{Q}$.

Example: Elasticity of the demand for porc in Canada

- Demand for porc: $Q_d = 286 - 20p$. The elasticity when $p = \$3.30$ and $Q = 220$ is $\varepsilon = -0.3$.

- Note that the elasticity of demand varies along a linear demand curve.

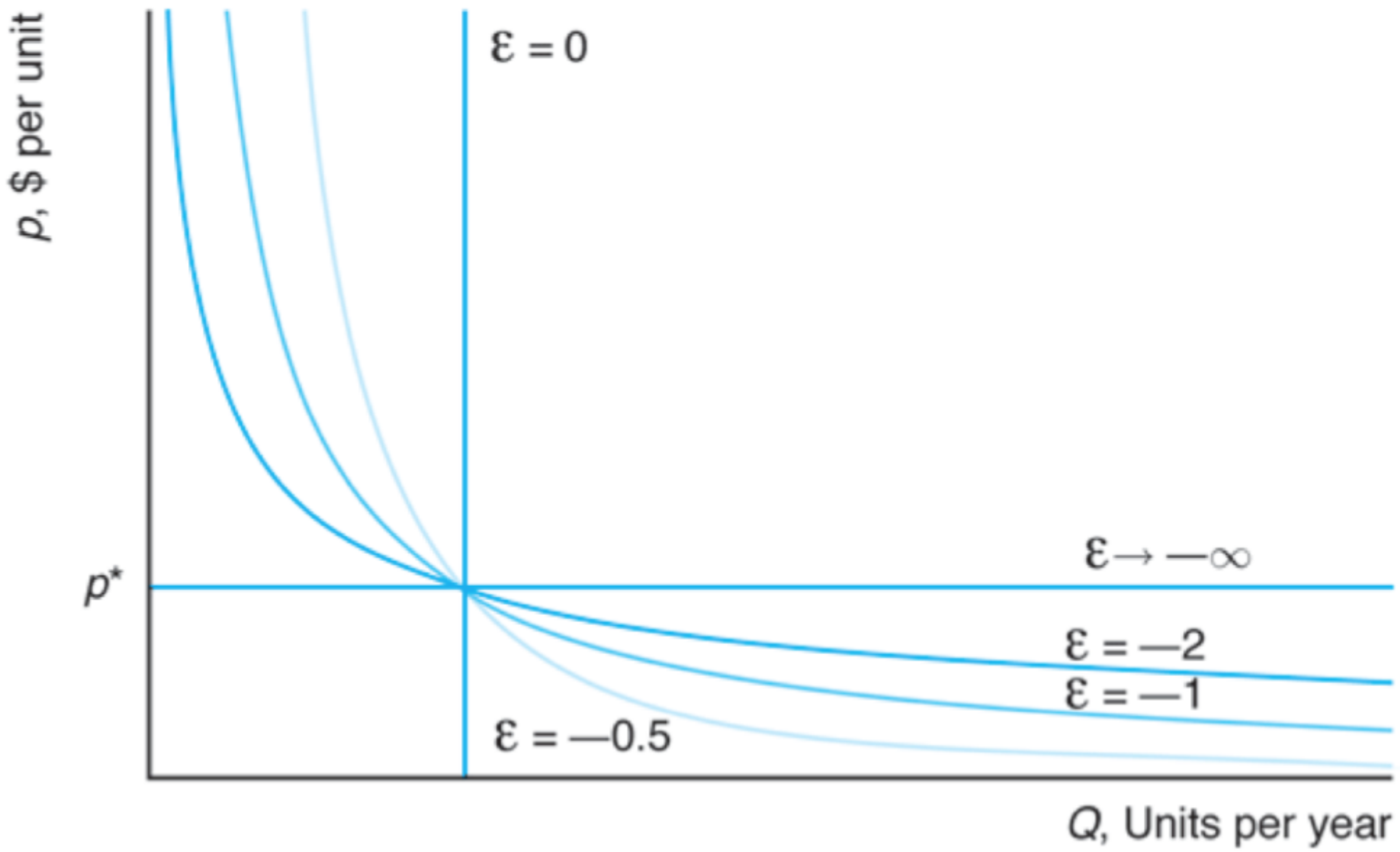


Isoelastic demand

- An isoelastic demand takes the following form:

$$\begin{aligned} Q_d &= Ap^{\varepsilon} \\ \ln Q_d &= \ln A + \varepsilon \ln p \end{aligned}$$

- The elasticity of this demand, ε, is constant.



$$Q_d = Ap^{\varepsilon}$$

$$\varepsilon = \frac{\partial Q_d}{\partial p} \frac{P}{Q}$$

$$= \varepsilon A p^{\varepsilon - 1} \frac{P}{A p^{\varepsilon}}$$

$$= \varepsilon$$

$$\ln Q_d = \ln (Ap^{\varepsilon})$$

$$= \ln A + \varepsilon \ln p$$

$$\ln(AB) = \ln A + \ln B$$

$$\ln(A^b) = b \ln A$$

$$\ln Qd = \ln A + \varepsilon \ln P$$

$$\varepsilon = \frac{\partial Qd}{\partial P} \frac{P}{Q} = \frac{\partial \ln Qd}{\partial \ln P}$$

$$\frac{\partial \ln Qd}{\partial Qd} = \frac{1}{Qd} \Rightarrow \partial \ln Qd = \frac{\partial Qd}{Qd}$$

$$\frac{\partial \ln Q_d}{\partial \ln P} = \frac{\partial Q_d / Q}{\partial P / P}$$

$$= \frac{\partial Q_d}{\partial P} \frac{P}{Q} = \varepsilon$$

Other elasticities

- Income elasticity of demand

$$\xi = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$$

$$\xi = \frac{\partial Q_d}{\partial Y} \cdot \frac{Y}{Q}$$

- Cross-price elasticity

$$\varepsilon_o = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in the price of another good}}$$

$$\varepsilon_o = \frac{\partial Q_d}{\partial p_o} \cdot \frac{p_o}{Q}$$

Other elasticities

- Supply elasticity

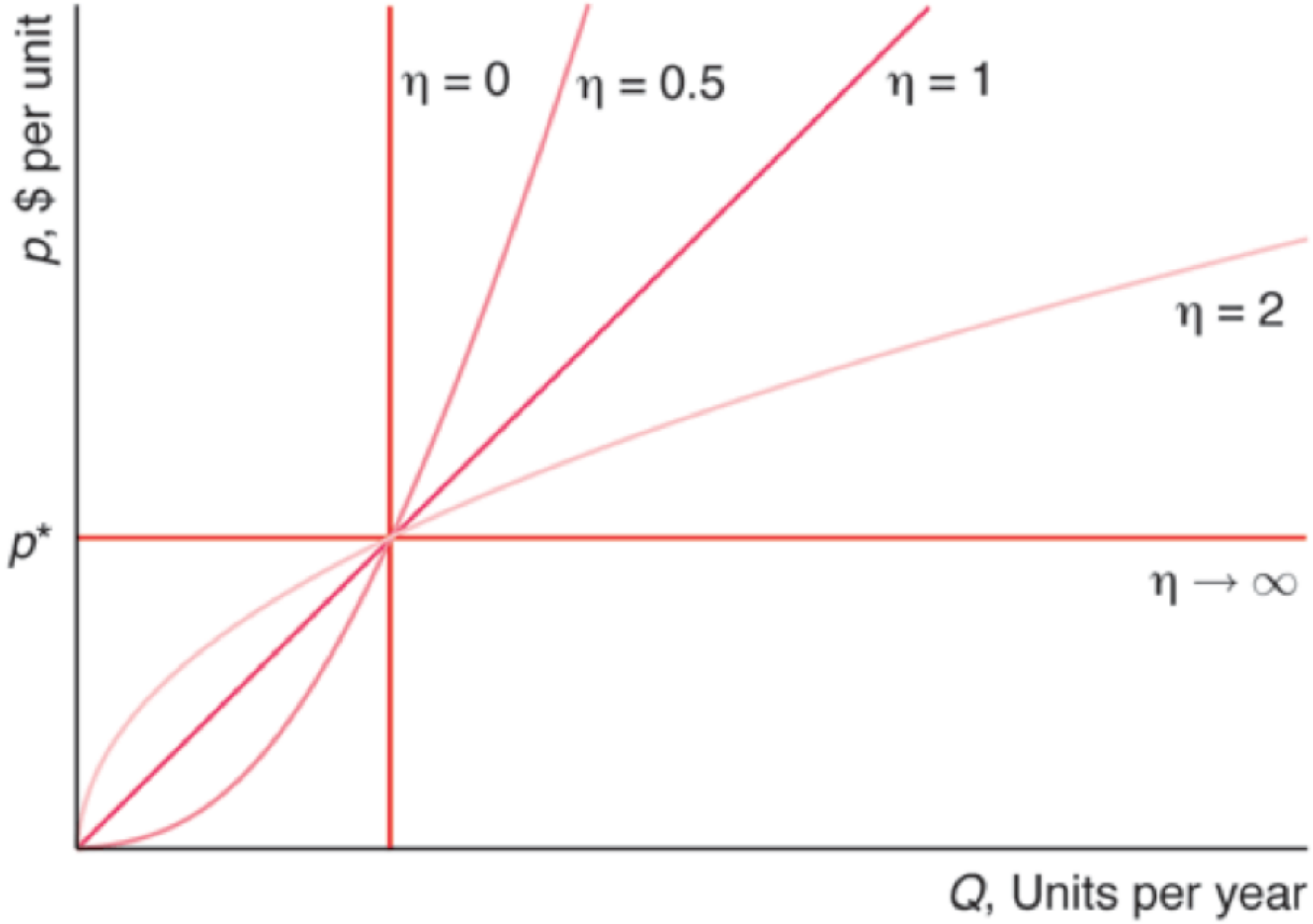
$$\eta = \frac{\text{percentage change in quantity supplied}}{\text{percentage change in price}}$$

$$\eta = \frac{\partial Q_s}{\partial p} \cdot \frac{p}{Q}$$

- A supply function is isoelastic if it takes the following form: $Q_s = Bp^\eta$
  - if $\eta = 1$ it gives a linear demand that starts from the origin.

supply

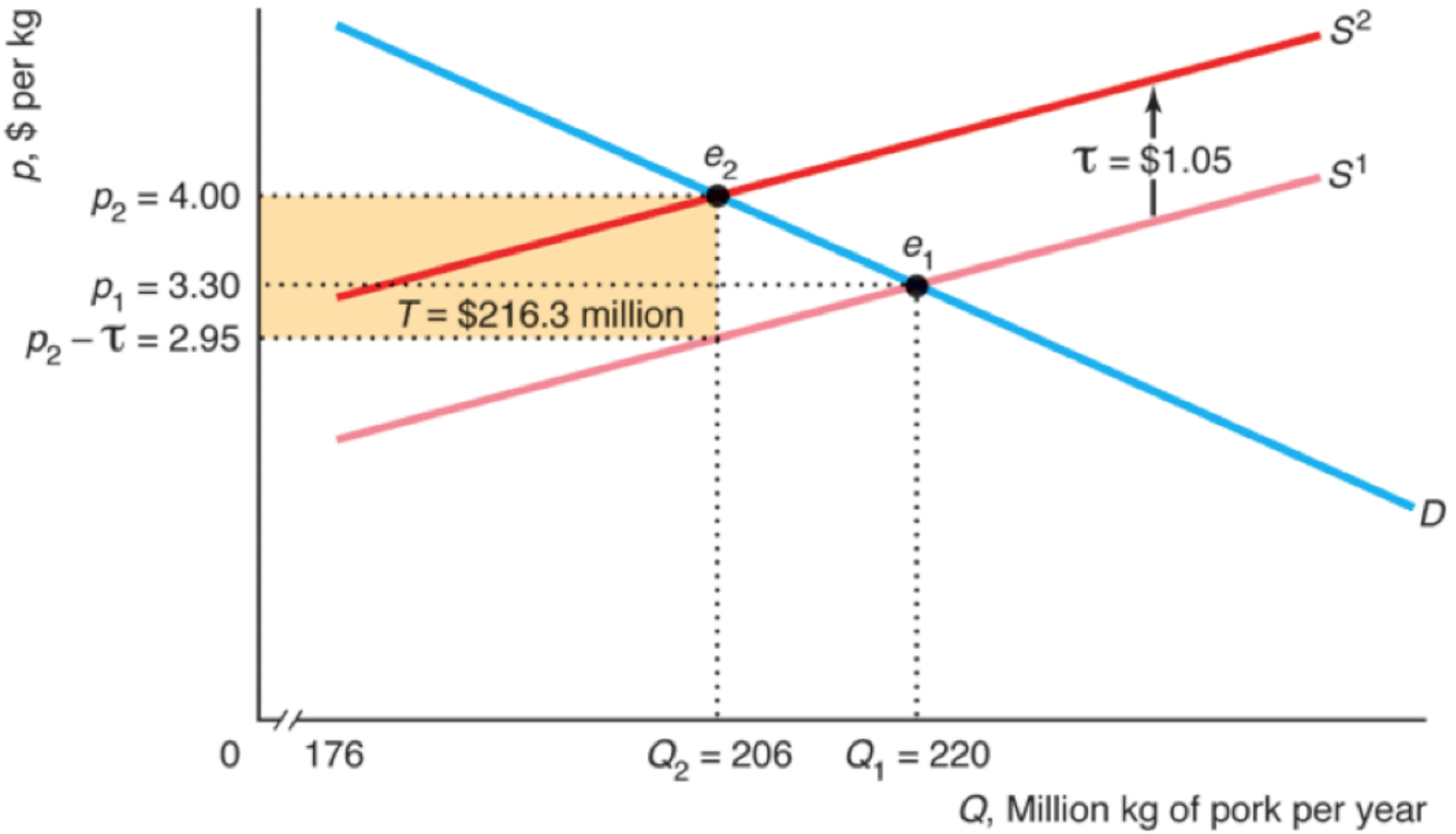
Isoelastic supply function

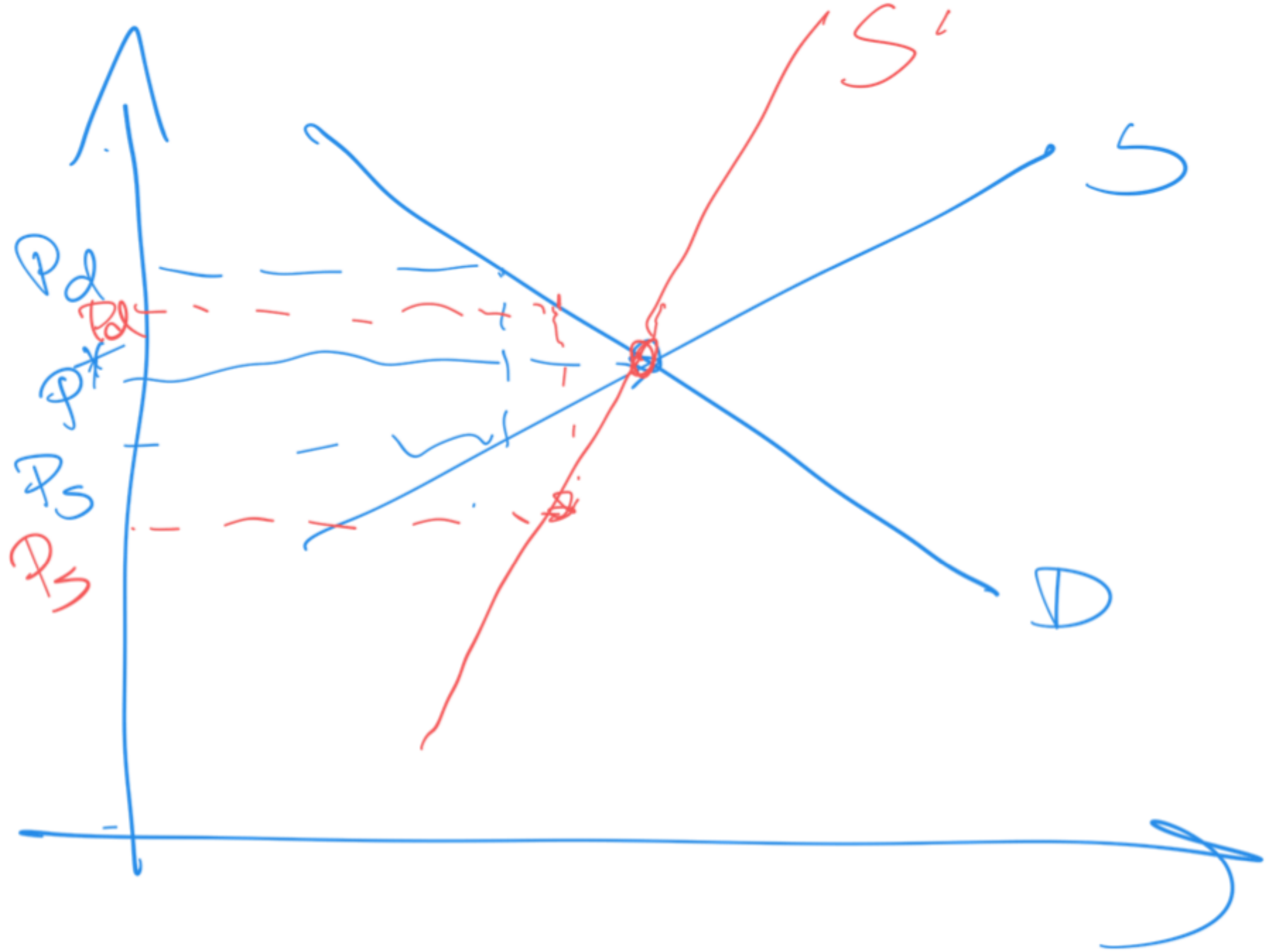


1.6 Effect of a sales tax

- Two types of sales taxes:
  - An **ad valorem tax** is in percentage terms.
    - In most countries, the ad valorem tax α is included in the tag price. If the price of a good is p, the amount of tax paid to the government is $\alpha \times p$ and the price received by the seller is $(1 - \alpha) \times p$.
    - In some countries (like the US and Canada), the ad valorem tax β is not included in the tag price. If the price of a good is p, the amount of tax paid to the government is $\beta \times p$ and the price paid by the buyer is $p_d = (1 + \beta) \times p$.
    - The two systems are equivalent if $(1 - \alpha) = \frac{1}{1+\beta}$.
  - A **specific (or unit) tax** is in dollar terms.
    - If the tax is τ and the price of a good is p, the amount of tax paid to the government is τ, the price paid by consumer is p and the price received by the seller is $p - \tau$.
- The effect of a sales tax on equilibrium price and quantity depends on elasticities of demand and supply.

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





S'
S
Pd
Pd
P*
Ps
Ps
D

Tax incidence and elasticities

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

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

- Differentiating and rearranging yields

$$\frac{dp}{d\tau} = \frac{\eta}{\eta - \varepsilon}$$

- *Tax incidence on consumers* is given by the above expression.
- *Tax incidence on producers* is

$$\frac{dp}{d\tau} - 1$$

$$= \frac{\eta}{\eta - \varepsilon} - 1 = \frac{\eta - \eta + \varepsilon}{\eta - \varepsilon}$$

$$\text{prod} = \frac{\varepsilon}{\eta - \varepsilon}$$

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

$$\frac{dD}{dp} \cdot \frac{dp(\tau)}{d\tau} = \frac{dS}{dp}\left[\frac{d(p(\tau) - \tau)}{d\tau}\right]$$

$$= \frac{dS}{dp}\left[\frac{dp(\tau)}{d\tau} - 1\right]$$

$$\frac{dD}{dP} \cdot \frac{dp(\tau)}{d\tau} = \frac{dS}{dP}\frac{dp(\tau)}{d\tau} - \frac{dS}{dP}$$

$$\frac{dD}{dp}\frac{dp(\tau)}{d\tau} = \frac{dS}{dp}\frac{dp(\tau)}{d\tau} - \frac{dS}{dp}$$

$$\frac{dD}{dp}\frac{P}{Q}\frac{dp(\tau)}{d\tau} = \frac{dS}{dp}\frac{P}{Q}\frac{dp(\tau)}{d\tau} - \frac{dS}{dp}\frac{P}{Q}$$

$$\varepsilon\frac{dp(\tau)}{d\tau} = \eta\frac{dp(\tau)}{d\tau} - \eta$$

$$(\eta - \varepsilon)\frac{dP(\tau)}{d\tau} = \eta$$

$$\frac{dP}{d\tau} = \frac{\eta}{\eta - \varepsilon}$$

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.