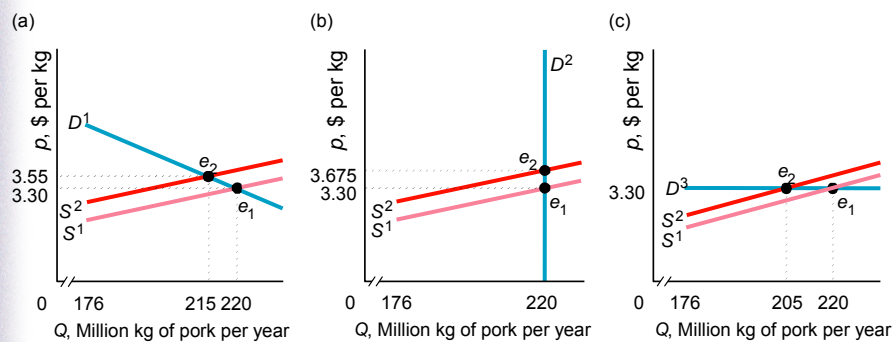**Chapter 3**

Applying the
Supply-and-Demand
Model

Applying supply and demand model

1. shapes matter
2. sensitivity of quantity demanded to price
3. sensitivity of quantity supplied to price
4. sensitivity is different in long run than in the short run
5. effects of a sales tax

What-if questions

- how do equilibrium price and quantity change when an underlying factor changes?
- use graphs to predict *qualitative* effects of changes: The direction of change
- need to know shape of demand and supply curves to determine *quantitative* change: amount equilibrium quantity and price change

Figure 3.1 How the Effect of a Supply Shock Depends on the Shape of the Demand Curve

(a)

p, \$ per kg

D^1

e_2

e_1

3.55
3.30

S^2
S^1

0   176   215 220

Q, Million kg of pork per year

(b)

p, \$ per kg

D^2

e_2

e_1

3.675
3.30

S^2
S^1

0   176   220

Q, Million kg of pork per year

(c)

p, \$ per kg

e_2

e_1

3.30 D^3

S^2
S^1

0   176   205 220

Q, Million kg of pork per year

Elasticity of demand

- summarize sensitivity of the quantity demanded to price in a single statistic: *price elasticity of demand*:

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

$$\varepsilon = \frac{\Delta Q/Q}{\Delta p/p} = \frac{\Delta Q}{\Delta p}\frac{p}{Q}$$

Linear demand curve

- linear demand: $Q = a - bp$
- elasticity of demand:

$$\varepsilon = \frac{\Delta Q}{\Delta p}\frac{p}{Q} = -b\frac{p}{Q}$$

- pork demand curve: $Q = 286 - 20p$

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

Interpretation of pork demand elasticity

- 1% increase in price of pork leads to an ε% = -0.3% change in the quantity demanded
- quantity falls less than in proportion to price
- negative price elasticity, -0.3, is consistent with Law of Demand

Types of elasticities

- *elastic*: the quantity demanded changes more than in proportion to a change in price
- *inelastic*: the quantity demanded changes less than in proportion to a change in price
- *elasticity of demand varies along most linear demand curves*

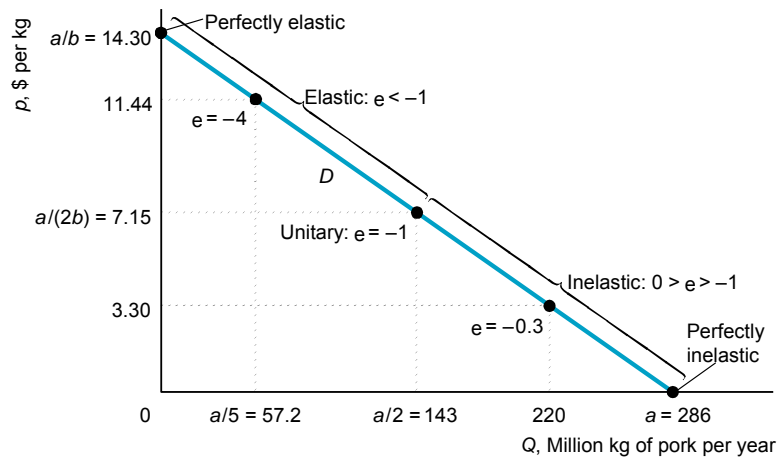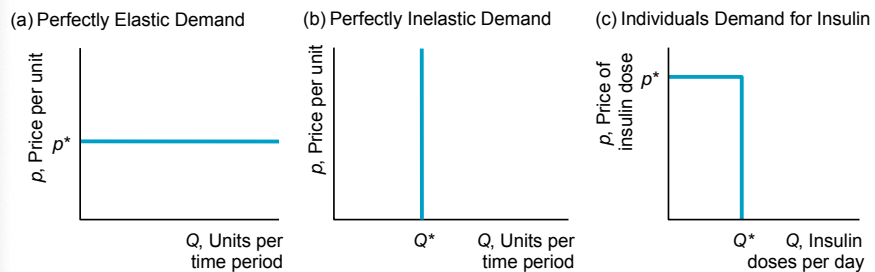# Figure 3.2 Elasticity Along the Pork Demand Curve

p, \$ per kg

$a/b = 14.30$ — Perfectly elastic

11.44 — Elastic: $e < -1$

$e = -4$

D

$a/(2b) = 7.15$

Unitary: $e = -1$

Inelastic: $0 > e > -1$

3.30

$e = -0.3$

Perfectly inelastic

0   $a/5 = 57.2$ $a/2 = 143$ 220 $a = 286$

Q, Million kg of pork per year

Figure 3.3 Vertical and Horizontal Demand Curves

(a) Perfectly Elastic Demand

p, Price per unit

p^*

Q, Units per time period

(b) Perfectly Inelastic Demand

p, Price per unit

Q^*

Q, Units per time period

(c) Individuals Demand for Insulin

p, Price of insulin dose

p^*

Q^* Q, Insulin doses per day

Pork income elasticity of demand

pork demand function is
$$Q = 171 - 20p + 20p_b + 3p_c + 2Y$$
so pork income elasticity is

$$\xi = \frac{\Delta Q}{\Delta Y}\frac{Y}{Q} = 2\frac{Y}{Q}$$

at $Q = 220$ and $Y = 12.5$
$$\xi = 2 \text{ x } 12.5/220 = 0.114$$

Cross-price elasticity of demand

- how quantity of one good changes as price of another good increases

$$\frac{\%\text{change in quantity demanded}}{\%\text{change in price of another good}}$$

$$= \frac{\Delta Q / Q}{\Delta p_o / p_o} = \frac{\Delta Q}{\Delta p_o}\frac{p_o}{Q}$$

Negative cross-price elasticity

- When the cross price elasticity is negative between two goods, the goods are *complements.*
- as the other good's price increases, people buy less of this good
- demand curve shifts to the left
- examples
  - as price of cream rises, people consume less coffee (cross-price elasticity is negative)
  - Ford wants to know how much a change in the price of a Camry affects the demand for a Taurus

Positive cross-price elasticity

- When the cross price elasticity is positive between two goods, the goods are *substitutes.*
- as the price of the other good increases, people buy more of this good
- demand curve shifts to the right
- example: cross-price elasticity of pork with respect to the price of beef is positive

Pork-beef example
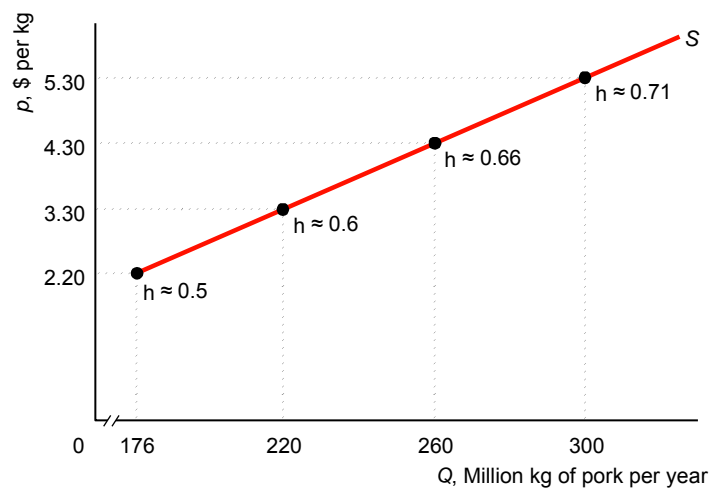
- pork demand function is
$$Q = 171 - 20p + 20p_b + 3p_c + 2Y$$
- so cross-price elasticity of demand for pork and the price of beef is

$$\frac{\Delta Q}{\Delta p_o} \frac{p_o}{Q} = 20\frac{p_b}{Q}$$

- at $Q = 220$ and $p_b = \$4$ per kg, cross-price elasticity is 20 x 4/220 = 0.364

Figure 3.4 Elasticity Along the Pork Supply Curve

Burden of Tax: Predictions based on elasticities

knowing only the elasticities of demand and supply, we can make accurate predictions about the effects of a new tax and determine how much of the tax falls on consumers

Two types of sales taxes

- *ad valorem* tax (*the* sales tax): for every dollar the consumer spends, the government keeps a fraction, α
- *specific* (*unit*) tax: a specified amount, τ, is collected per unit of output

4 Questions about sales taxes

- What effect does a specific sales tax have on equilibrium prices and quantity?
- Are sales taxes assessed on producers "passed along" to consumers? (do consumers pay entire tax?)
- Do equilibrium price and quantity depend on whether the consumers or producers are taxed?
- Do both types of sales taxes have the same effect on equilibrium?

Specific tax

- assume the specific tax is assessed on firms at the time of sale
- consumer pays p
- government takes τ
- seller receives $p - \tau$

Tax on consumer

Per unit tax	Total tax revenue	Firms' after-tax revenue
ad valorem tax αp	$T = \alpha p Q$	$(1 - \alpha) p Q$
specific tax τ	$T = \tau Q$	$p Q - \tau Q$

An animated illustration

- In this animated slide, we see that in a competitive market a sales tax or an equivalent consumption tax have the same effect on the equilibrium.

- The effects on quantity, price and the incidence of tax that falls on consumers depend on the demand and supply elasticities.

- In a competitive market, whether the tax is collected from consumers or from producers has the same effects on quantity, price and the incidence of tax that falls on consumers and producers.

Animated Graph 3.6

- After the illustration using the animated graph, I will explain each of them step by step.
- Animated Example:

Figure 3.5 Effect of a $1.05 Specific Tax on the Pork Market Collected from Producers
Consumer pays p, government collects from producer τ, producer gets p-t, how many units producer will supply after tax imposed when consumer pays p? What he would like to supply when he receives price p-τ. To trace after tax supply amount at price p, link it to his supply at p-τ. Do it for various p's, and you figure out which way the supply curve shifts. (Japan follows this tax scheme)

p, $ per kg

S^2

e_2

$\tau = \$1.05$

S^1

$p_2 = 4.00$

e_1

$p_1 = 3.30$

$T = \$216.3$ million

$p_2 - \tau = 2.95$

D

0   176 $Q_2 = 206$ $Q_1 = 220$
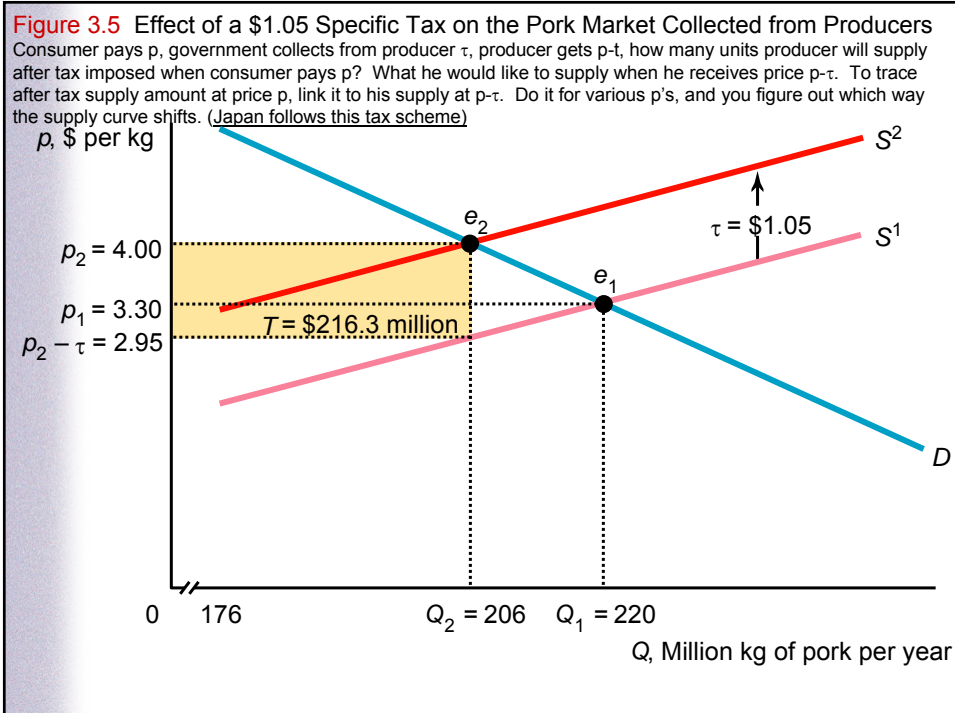
Q, Million kg of pork per year

Figure 3.6 Effect of a $1.05 Specific Tax on Pork Collected from Consumers.

In this case demand curve will shift. To figure out how it shifts, we want to find the relationship between the in-store price (i.e, without taxes included) which is what also producer receives, and the amount he will demand at that price. If the in-store price is $2.95, he figures that he is actually paying 2.95+1.05 = 4.00 and so he will see how many units he would buy when he is actually paying $4 per unit.
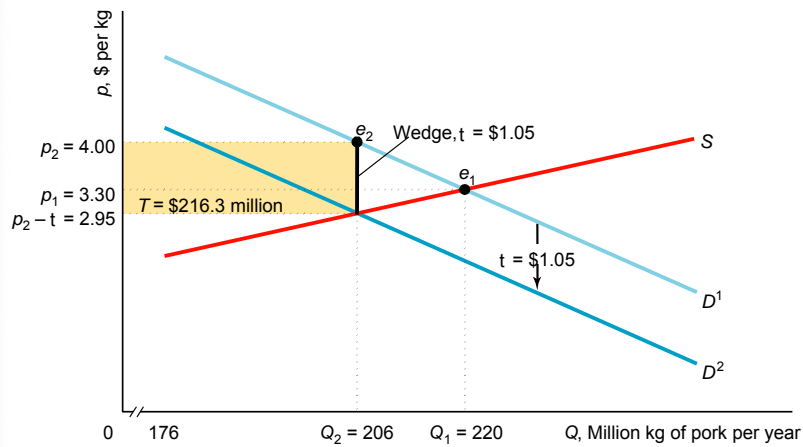
Summary on equivalence of two taxes

- We see that the outcomes are exactly the same in either type of taxes.
- What are those outcomes once again?

Equilibrium Effects of Specific Tax (Analytically), pp. 59-63.

- *Who is hurt by the tax?*
- *What is the incidence of the tax?*
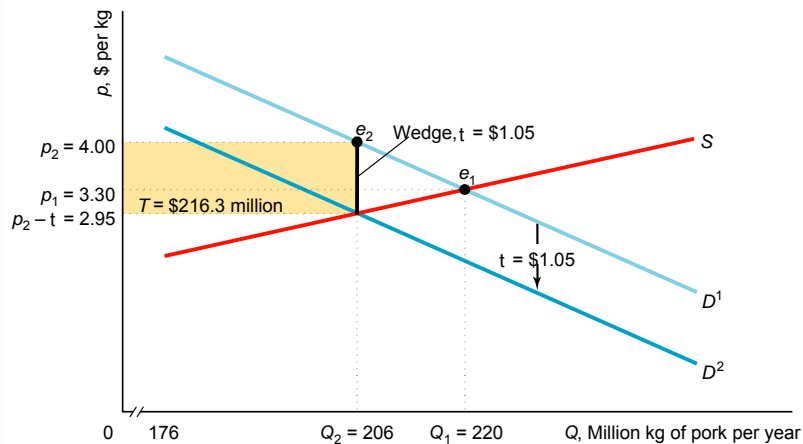- Incidence of a tax on consumers is share of tax that consumers pay

$$\frac{\Delta p}{\Delta \tau} = \frac{\eta}{\eta - \varepsilon}$$

Incidence of a tax on pork (from figure 3.6 and analytically using the above formula)

- Figure 3.6 (next slide) shows incidence of tax on consumers is
  $$\Delta p / \Delta \tau = \$0.70/\$1.05 = 2/3$$
- Analytically using elasticities: Recall
  - Pork demand curve: $Q^D = 286 - 20p$
  - Pork supply curve : $QS = 88 + 40p$
  - Equilibrium: p=3.30 and Q= 220.
- In this example, demand elasticity $\varepsilon = -0.3$, supply elasticity, η = 0.6. The incidence of tax on consumer is then
  $$\eta/(\eta - \varepsilon) = 0.6/(0.6 - [-0.3]) = 2/3$$

Notice that more elastic the demand is say $\varepsilon = -2.4$, i.e., less steep the demand curve is, incidence is $0.21 instead of $0.70 earlier. i.e., lower is the incidence. (Using graphs, next)

**Figure 3.6** Effect of a $1.05 Specific Tax on Pork Collected from Consumers

p, $ per kg

$p_2 = 4.00$

e_2 Wedge, $t = \$1.05$

S

$p_1 = 3.30$
$p_2 - t = 2.95$

$T = \$216.3$ million

e_1

$t = \$1.05$

D^1

D^2

0   176 $Q_2 = 206$ $Q_1 = 220$ Q, Million kg of pork per year

Solved Problem: 3.1

- If the supply curve is perfectly elastic and demand is linear and downward slopping, what is the effect of a $1 specific tax collected from producers on equilibrium price and quantity, and what is the incidence on consumers? **Why?**

Page 64 Solved Problem 3.1
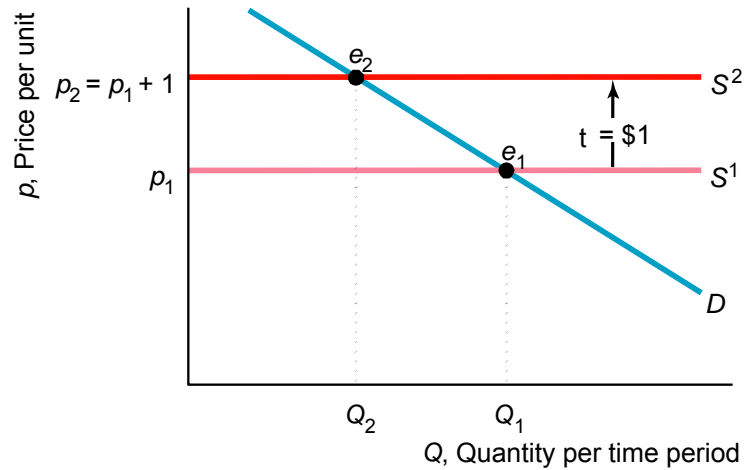
Solved Problem fig 3.2, p. 68

- If the supply curve for fresh fruit is perfectly inelastic and the demand curve is downward slopping straight line, what is the effect of an ad valorem tax on equilibrium price and quantitiy, and what is the incidence on consumers? **Why?**