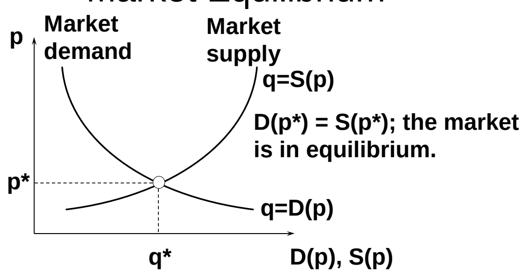
Chapter Sixteen

Equilibrium

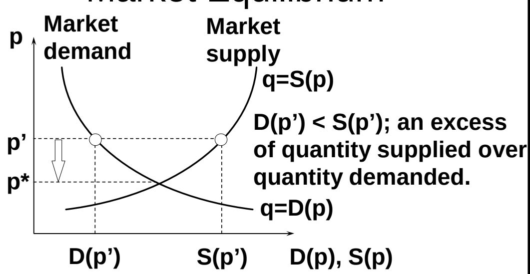
Market Equilibrium

- A market is in equilibrium when total quantity demanded by buyers equals total quantity supplied by sellers.
- Persistence and stability

Market Equilibrium

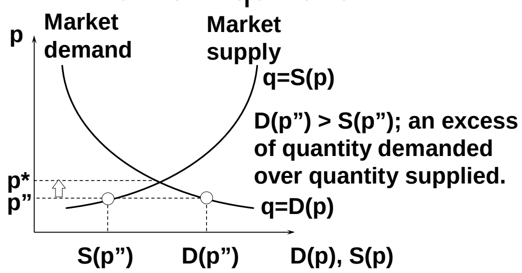


Market Equilibrium



Market price must fall towards p*.

Market Equilibrium



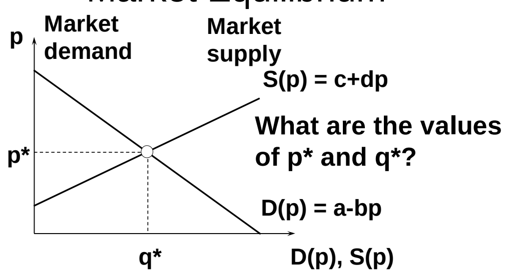
Market price must rise towards p*.

Market Equilibrium

- An example of calculating a market equilibrium when the market demand and supply curves are linear.

$$D(p) = a - bp$$
$$S(p) = c + dp$$

Market Equilibrium



Market Equilibrium

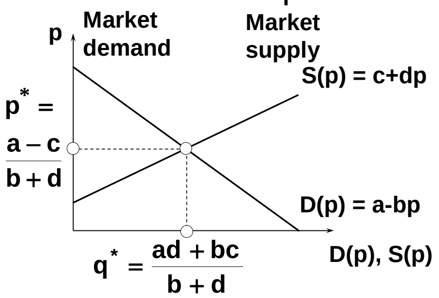
$$D(p) = a - bp$$
$$S(p) = c + dp$$

At the equilibrium price p*, D(p*) = S(p*).
That is, $a - bp^* = c + dp^*$

which gives $p^* = \dfrac{a-c}{b+d}$

and $q^* = D(p^*) = S(p^*) = \dfrac{ad+bc}{b+d}.$

Market Equilibrium



Market Equilibrium

- Can we calculate the market equilibrium using the inverse market demand and supply curves?
- Yes, it is the same calculation.

Market Equilibrium

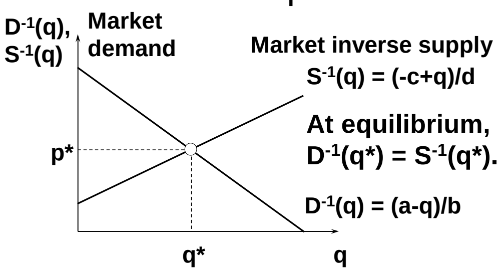
$$q = D(p) = a - bp \Leftrightarrow p = \frac{a-q}{b} = D^{-1}(q),$$

the equation of the inverse market demand curve. And

$$q = S(p) = c + dp \Leftrightarrow p = \frac{-c+q}{d} = S^{-1}(q),$$

the equation of the inverse market supply curve.

Market Equilibrium



Market Equilibrium

$p = D^{-1}(q) = \frac{a-q}{b}$ and $p = S^{-1}(q) = \frac{-c+q}{d}$.

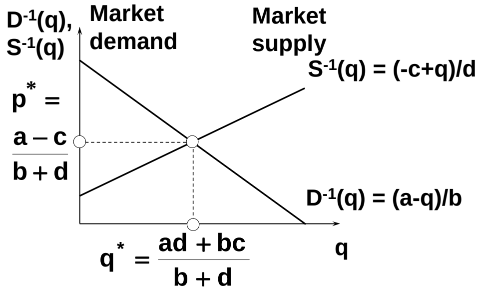
At the equilibrium quantity q*, $D^{-1}(p^*) = S^{-1}(p^*)$. That is,

$$\frac{a-q^*}{b} = \frac{-c+q^*}{d}$$

which gives $q^* = \frac{ad+bc}{b+d}$

and $p^* = D^{-1}(q^*) = S^{-1}(q^*) = \frac{a-c}{b+d}$.

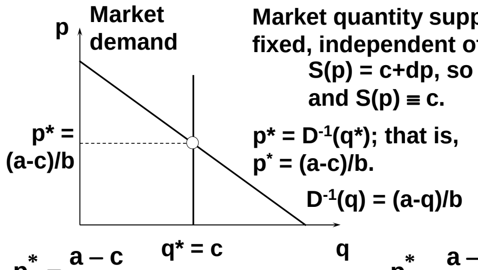
Market Equilibrium



Market Equilibrium

- Two special cases:
  - quantity supplied is fixed, independent of the market price, and
  - quantity supplied is extremely sensitive to the market price.

Market Equilibrium



Market quantity supplied is fixed, independent of price.

$S(p) = c+dp$, so $d=0$ and $S(p) \equiv c$.

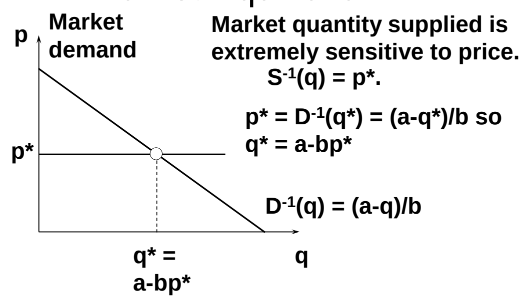
$p^* = D^{-1}(q^*)$; that is, $p^* = (a-c)/b$.

$p^* = \frac{a-c}{b+d}$, $q^* = \frac{ad+bc}{b+d}$ **with d = 0 give** $p^* = \frac{a-c}{b}$, $q^* = c$.

Market Equilibrium

- Two special cases are
  - when quantity supplied is fixed, independent of the market price, and
  - ✓ when quantity supplied is extremely sensitive to the market price.

Market Equilibrium



Quantity Taxes

- A quantity tax levied at a rate of \$t is a tax of \$t paid on each unit traded.
- If the tax is levied on sellers then it is an excise tax.
- If the tax is levied on buyers then it is a sales tax.

Quantity Taxes

- What is the effect of a quantity tax on a market's equilibrium?
- How are prices affected?
- How is the quantity traded affected?
- Who pays the tax?
- How are gains-to-trade altered?

Quantity Taxes

- A tax rate t makes the price paid by buyers, p_b, higher by t from the price received by sellers, p_s.

$$p_b - p_s = t$$

Quantity Taxes

- Even with a tax the market must clear.
- I.e. quantity demanded by buyers at price p_b must equal quantity supplied by sellers at price p_s.

$$D(p_b) = S(p_s)$$

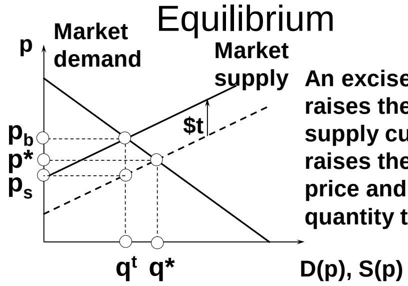
Quantity Taxes

$p_b - p_s = t$ **and** $D(p_b) = S(p_s)$

describe the market's equilibrium.
Notice that these two conditions apply no matter if the tax is levied on sellers or on buyers.

Hence, a sales tax rate \$t has the same effect as an excise tax rate \$t.

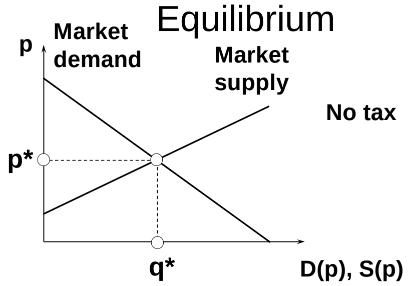
Quantity Taxes & Market Equilibrium



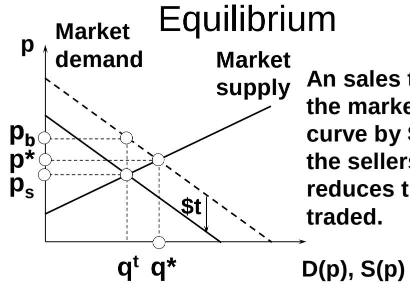
An excise tax raises the market supply curve by \$t, raises the buyers' price and lowers the quantity traded.

And sellers receive only $p_s = p_b - t$.

Quantity Taxes & Market Equilibrium



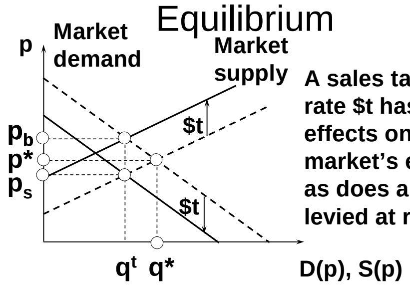
Quantity Taxes & Market Equilibrium



An sales tax lowers the market demand curve by \$t, lowers the sellers' price and reduces the quantity traded.

And buyers pay $p_b = p_s + t$.

Quantity Taxes & Market Equilibrium

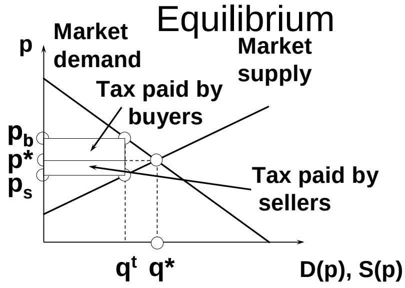


A sales tax levied at rate \$t has the same effects on the market's equilibrium as does an excise tax levied at rate \$t.

Quantity Taxes & Market Equilibrium

- Who pays the tax of \$t per unit traded?
- The division of the \$t between buyers and sellers is the incidence(歸宿) of the tax.

Quantity Taxes & Market Equilibrium



Quantity Taxes & Market Equilibrium

- E.g. suppose the market demand and supply curves are linear.

$$D(p_b) = a - bp_b$$
$$S(p_s) = c + dp_s$$

Quantity Taxes & Market Equilibrium

$D(p_b) = a - bp_b$ **and** $S(p_s) = c + dp_s$.

With the tax, the market equilibrium satisfies

$p_b = p_s + t$ **and** $D(p_b) = S(p_s)$ **so**

$p_b = p_s + t$ **and** $a - bp_b = c + dp_s$.

Substituting for p_b gives

$$a - b(p_s + t) = c + dp_s \Rightarrow p_s = \frac{a - c - bt}{b + d}.$$

Quantity Taxes & Market Equilibrium

$p_s = \dfrac{a - c - bt}{b + d}$ **and** $p_b = p_s + t$ **give**

$$p_b = \frac{a - c + dt}{b + d}$$

The quantity traded at equilibrium is

$$q^t = D(p_b) = S(p_s)$$
$$= a + bp_b = \frac{ad + bc - bdt}{b + d}.$$

Quantity Taxes & Market Equilibrium

$$p_s = \frac{a - c - bt}{b + d} \qquad q^t = \frac{ad + bc - bdt}{b + d}$$

$$p_b = \frac{a - c + dt}{b + d}$$

As $t \to 0$, p_s and $p_b \to \frac{a-c}{b+d} = p^*$, the equilibrium price if there is no tax ($t = 0$) and $q^t \to \frac{ad + bc}{b + d}$, the quantity traded at equilibrium when there is no tax.

Quantity Taxes & Market Equilibrium

$$p_s = \frac{a - c - bt}{b + d} \qquad q^t = \frac{ad + bc - bdt}{b + d}$$

$$p_b = \frac{a - c + dt}{b + d}$$

As t increases, p_s falls, p_b rises, and q^t falls.

Quantity Taxes & Market Equilibrium

$$p_s = \frac{a - c - bt}{b + d} \qquad q^t = \frac{ad + bc - bdt}{b + d}$$

$$p_b = \frac{a - c + dt}{b + d}$$

The tax paid per unit by the buyer is

$$p_b - p^* = \frac{a - c + dt}{b + d} - \frac{a - c}{b + d} = \frac{dt}{b + d}.$$

The tax paid per unit by the seller is

$$p^* - p_s = \frac{a - c}{b + d} - \frac{a - c - bt}{b + d} = \frac{bt}{b + d}.$$

Quantity Taxes & Market Equilibrium

$$p_s = \frac{a - c - bt}{b + d} \qquad q^t = \frac{ad + bc - bdt}{b + d}$$

$$p_b = \frac{a - c + dt}{b + d}$$

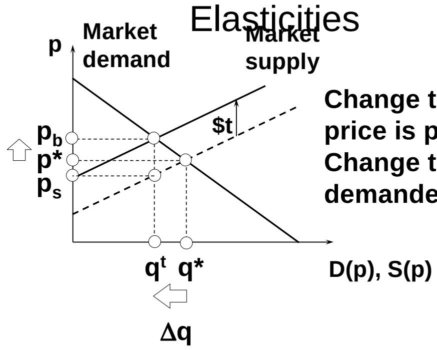
The total tax paid (by buyers and sellers combined) is

$$T = tq^t = t\frac{ad + bc - bdt}{b + d}.$$

Tax Incidence and Own-Price Elasticities

- The incidence of a quantity tax depends upon the own-price elasticities of demand and supply.

Tax Incidence and Own-Price Elasticities



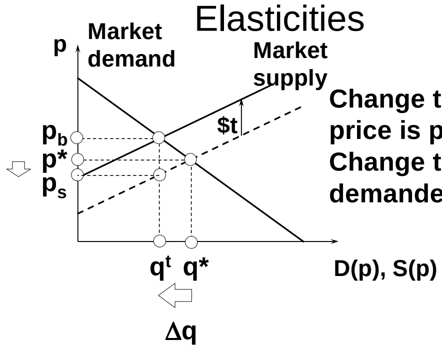
Change to buyers' price is p_b - p*. Change to quantity demanded is Δq.

Tax Incidence and Own-Price Elasticities

Around p = p* the own-price elasticity of demand is approximately

$$\varepsilon_D \approx \frac{\frac{\Delta q}{q^*}}{\frac{p_b - p^*}{p^*}} \Rightarrow p_b - p^* \approx \frac{\Delta q \times p^*}{\varepsilon_D \times q^*}.$$

Tax Incidence and Own-Price Elasticities



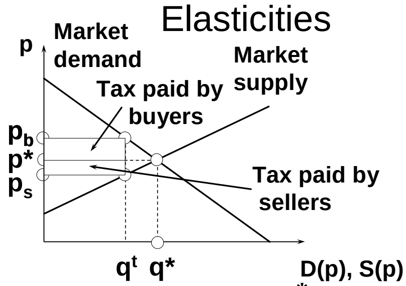
Change to sellers' price is p_s - p*. Change to quantity demanded is Δq.

Tax Incidence and Own-Price Elasticities

Around p = p* the own-price elasticity of supply is approximately

$$\varepsilon_S \approx \frac{\dfrac{\Delta q}{q^*}}{\dfrac{p_s - p^*}{p^*}} \quad \Rightarrow \quad p_s - p^* \approx \frac{\Delta q \times p^*}{\varepsilon_S \times q^*}.$$

Tax Incidence and Own-Price Elasticities



Tax incidence = $\dfrac{p_b - p^*}{p^* - p_s}.$

Tax Incidence and Own-Price Elasticities

Tax incidence = $\dfrac{p_b - p^*}{p^* - p_s}.$

$$p_b - p^* \approx \frac{\Delta q \times p^*}{\varepsilon_D \times q^*}. \qquad p_s - p^* \approx \frac{\Delta q \times p^*}{\varepsilon_S \times q^*}.$$

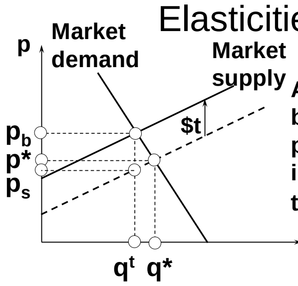
So $$\frac{p_b - p^*}{p^* - p_s} \approx -\frac{\varepsilon_S}{\varepsilon_D}.$$

Tax Incidence and Own-Price Elasticities

Tax incidence is $$\frac{p_b - p^*}{p^* - p_s} \approx -\frac{\varepsilon_S}{\varepsilon_D}.$$

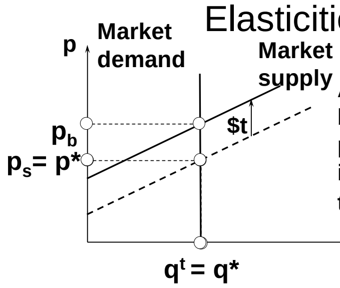
The fraction of a $t quantity tax paid by buyers rises as supply becomes more own-price elastic or as demand becomes less own-price elastic.

Tax Incidence and Own-Price Elasticities



As market demand becomes less own-price elastic, tax incidence shifts more to the buyers.

Tax Incidence and Own-Price Elasticities



As market demand becomes less own-price elastic, tax incidence shifts more to the buyers.

When $\varepsilon_D = 0$, buyers pay the entire tax, even though it is levied on the sellers.

Tax Incidence and Own-Price Elasticities

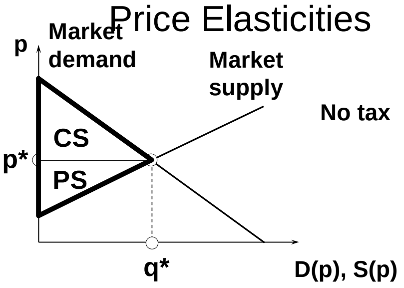
Tax incidence is $\dfrac{p_b - p^*}{p^* - p_s} \approx -\dfrac{\varepsilon_S}{\varepsilon_D}.$

Similarly, the fraction of a $t quantity tax paid by sellers rises as supply becomes less own-price elastic or as demand becomes more own-price elastic.

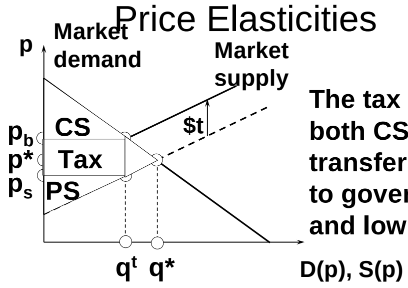
Deadweight Loss and Own-Price Elasticities

- A quantity tax imposed on a competitive market reduces the quantity traded and so reduces gains-to-trade (*i.e.* the sum of Consumers' and Producers' Surpluses).
- The lost total surplus is the tax's deadweight loss, or excess burden.

Deadweight Loss and Own-Price Elasticities

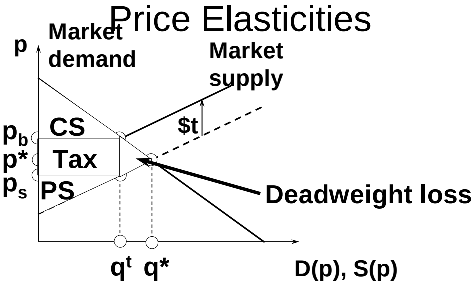


Deadweight Loss and Own-Price Elasticities

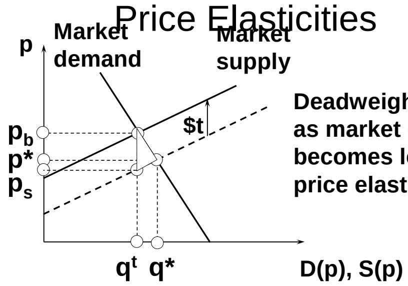


The tax reduces both CS and PS, transfers surplus to government, and lowers total surplus.

Deadweight Loss and Own-Price Elasticities

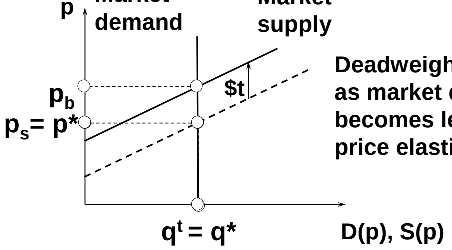


Deadweight Loss and Own-Price Elasticities



Deadweight loss falls as market demand becomes less own-price elastic.

Deadweight Loss and Own-Price Elasticities



Deadweight loss falls as market demand becomes less own-price elastic.

When ε_D = 0, the tax causes no deadweight loss.

Deadweight Loss and Own-Price Elasticities

- Deadweight loss due to a quantity tax rises as either market demand or market supply becomes more own-price elastic.
- If either ε_D = 0 or ε_S = 0 then the deadweight loss is zero.

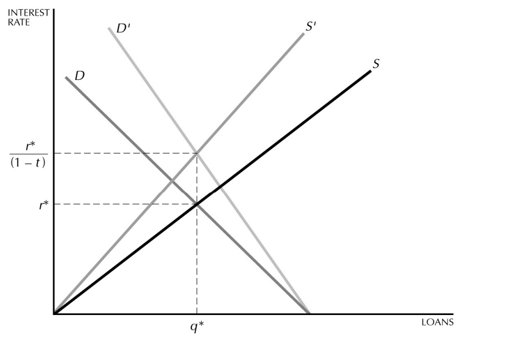


FIGURE 16.8 **Equilibrium in the loan market**