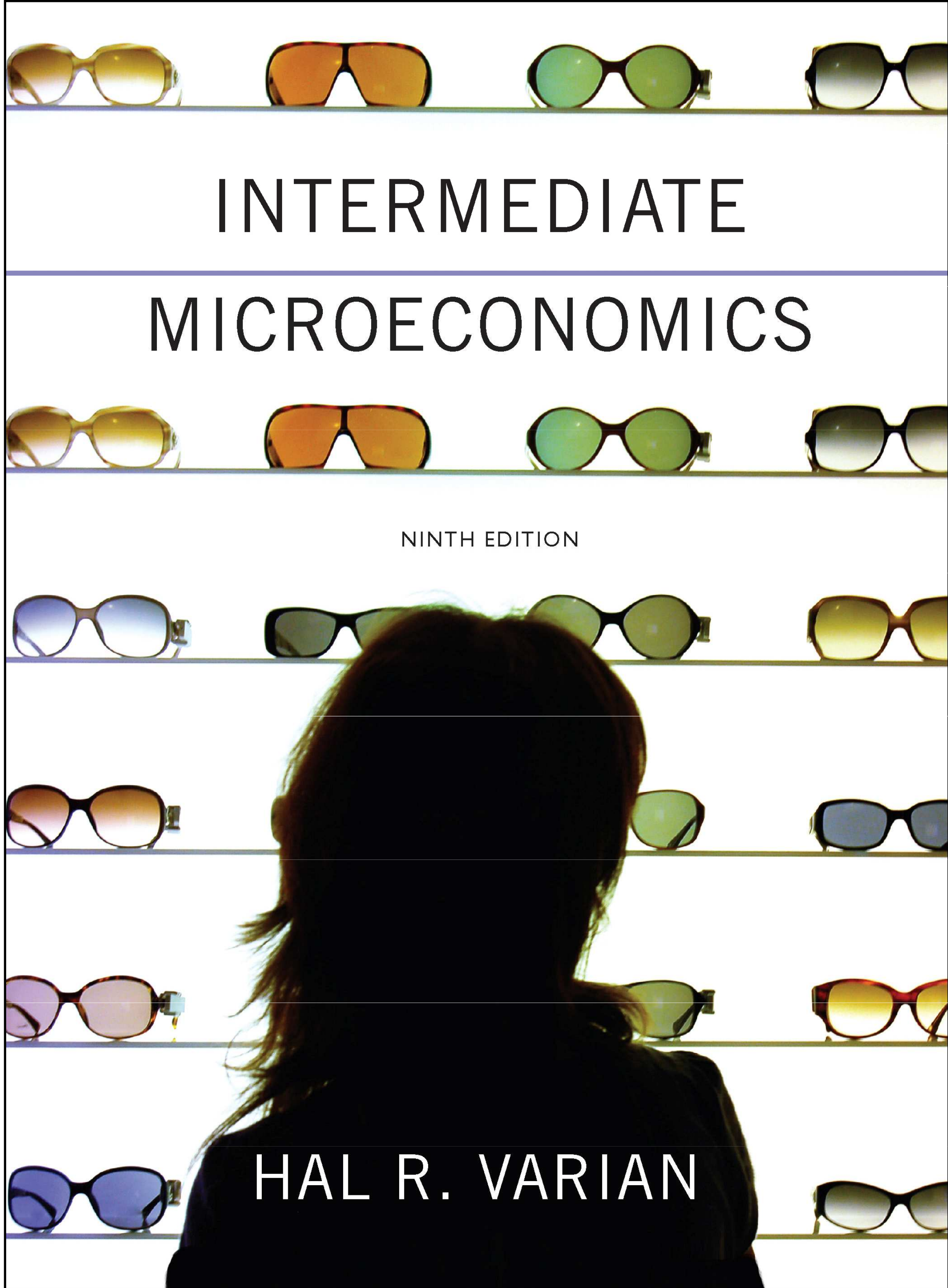


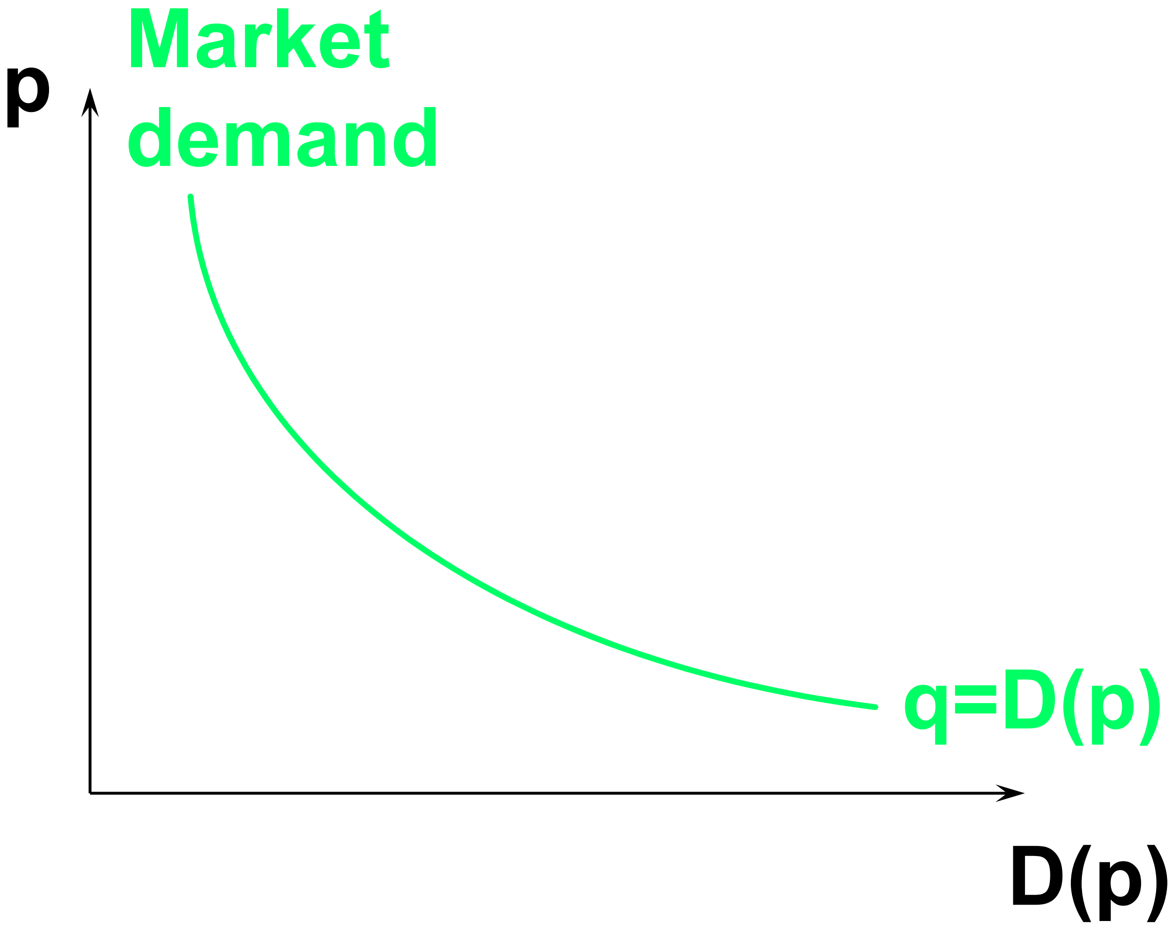
Chapter 16

Equilibrium

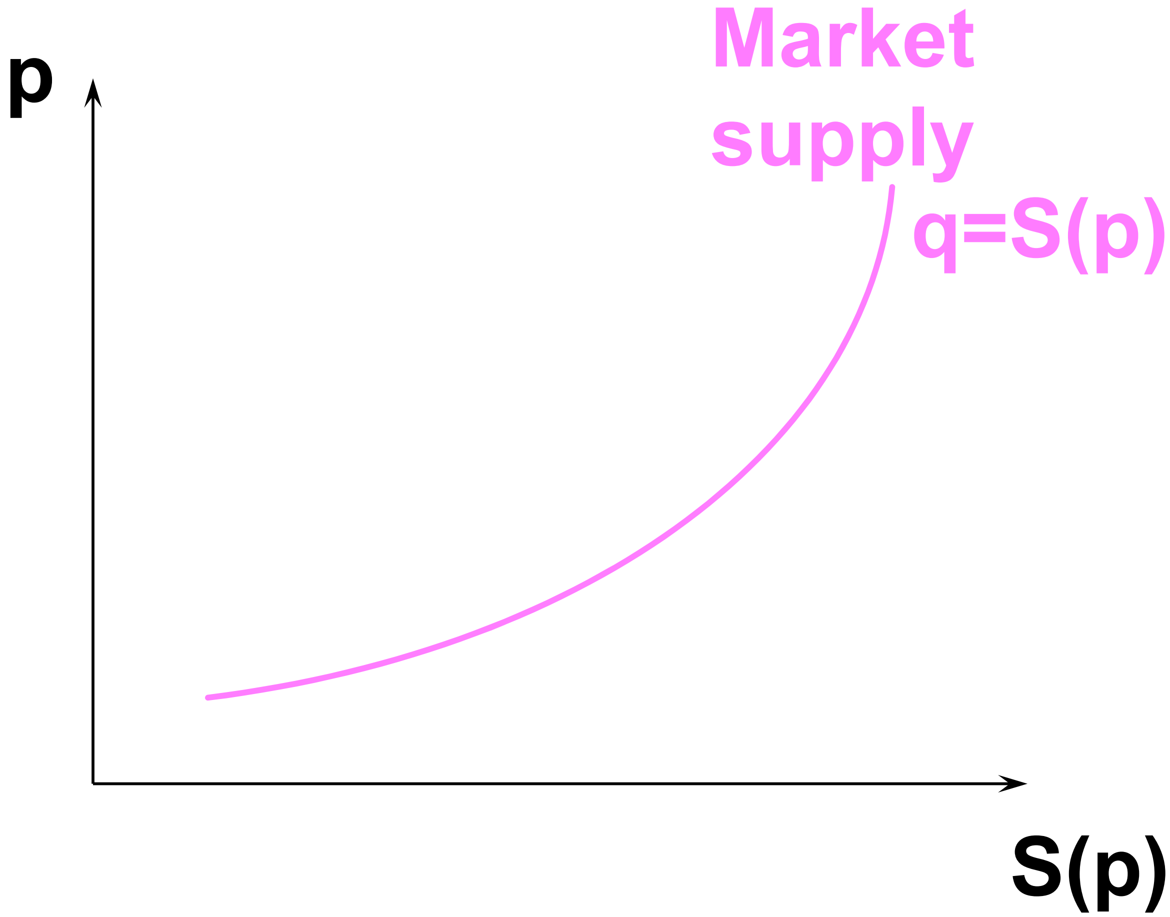
Market Equilibrium

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

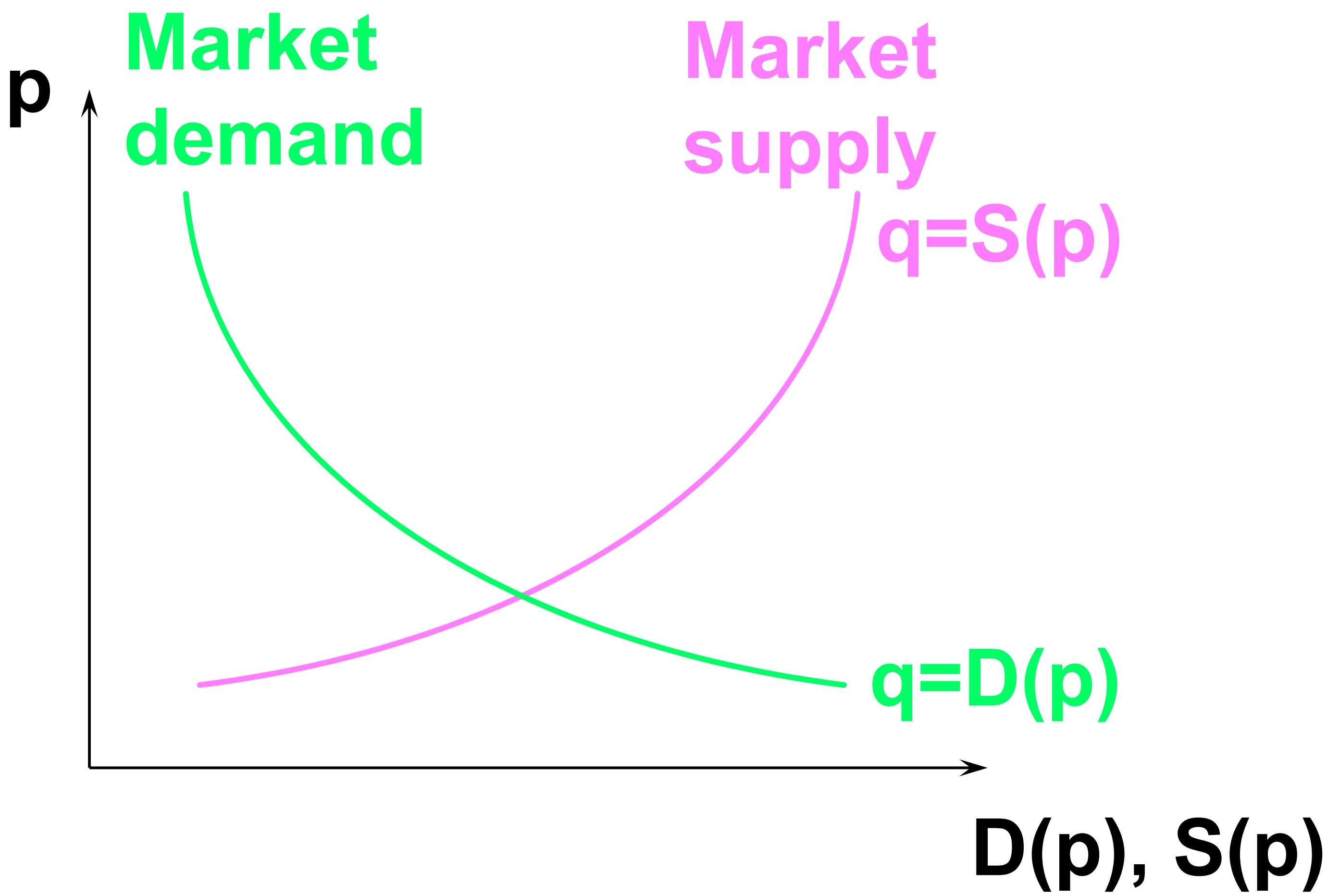
Market Equilibrium



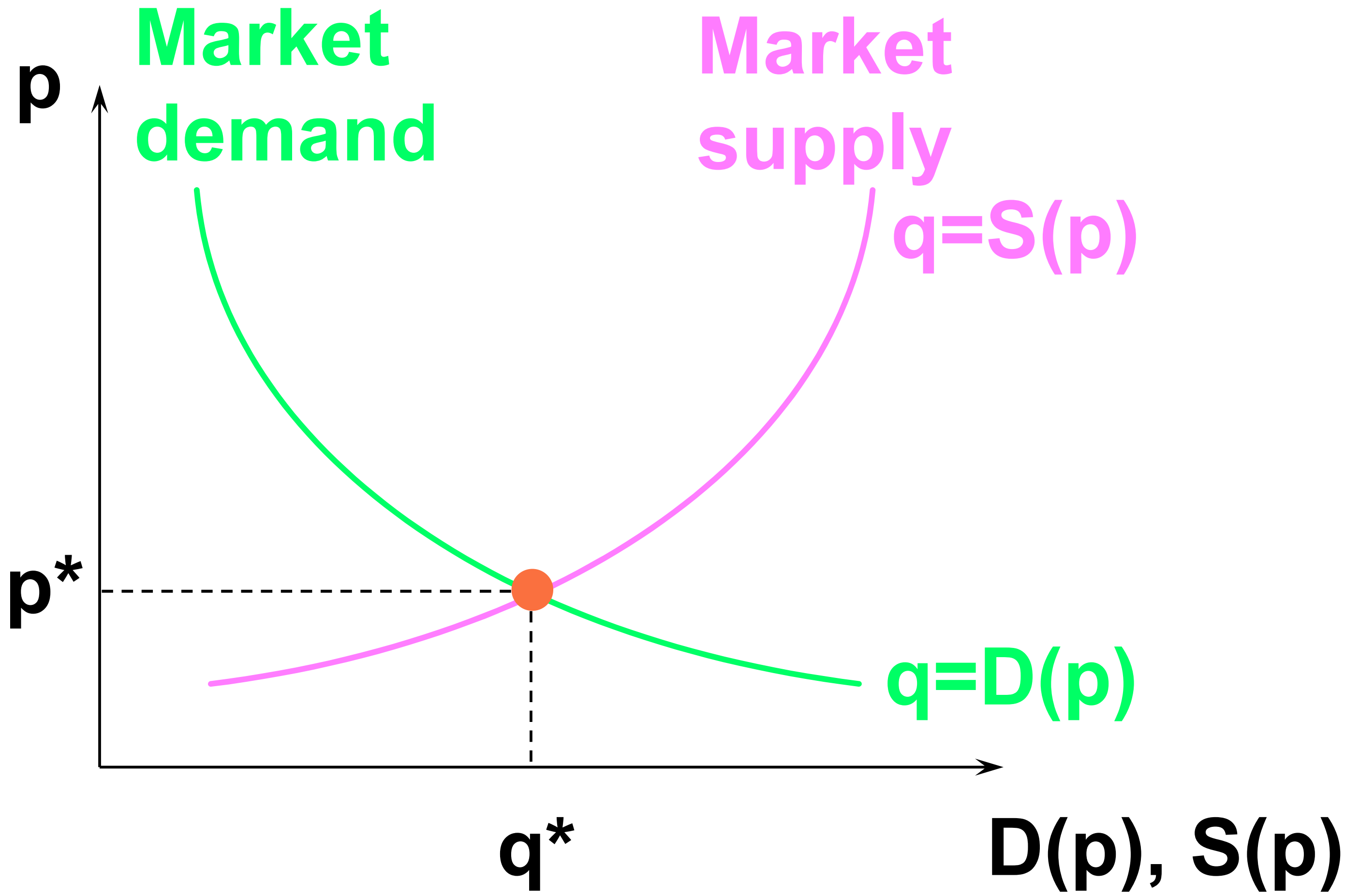
Market Equilibrium



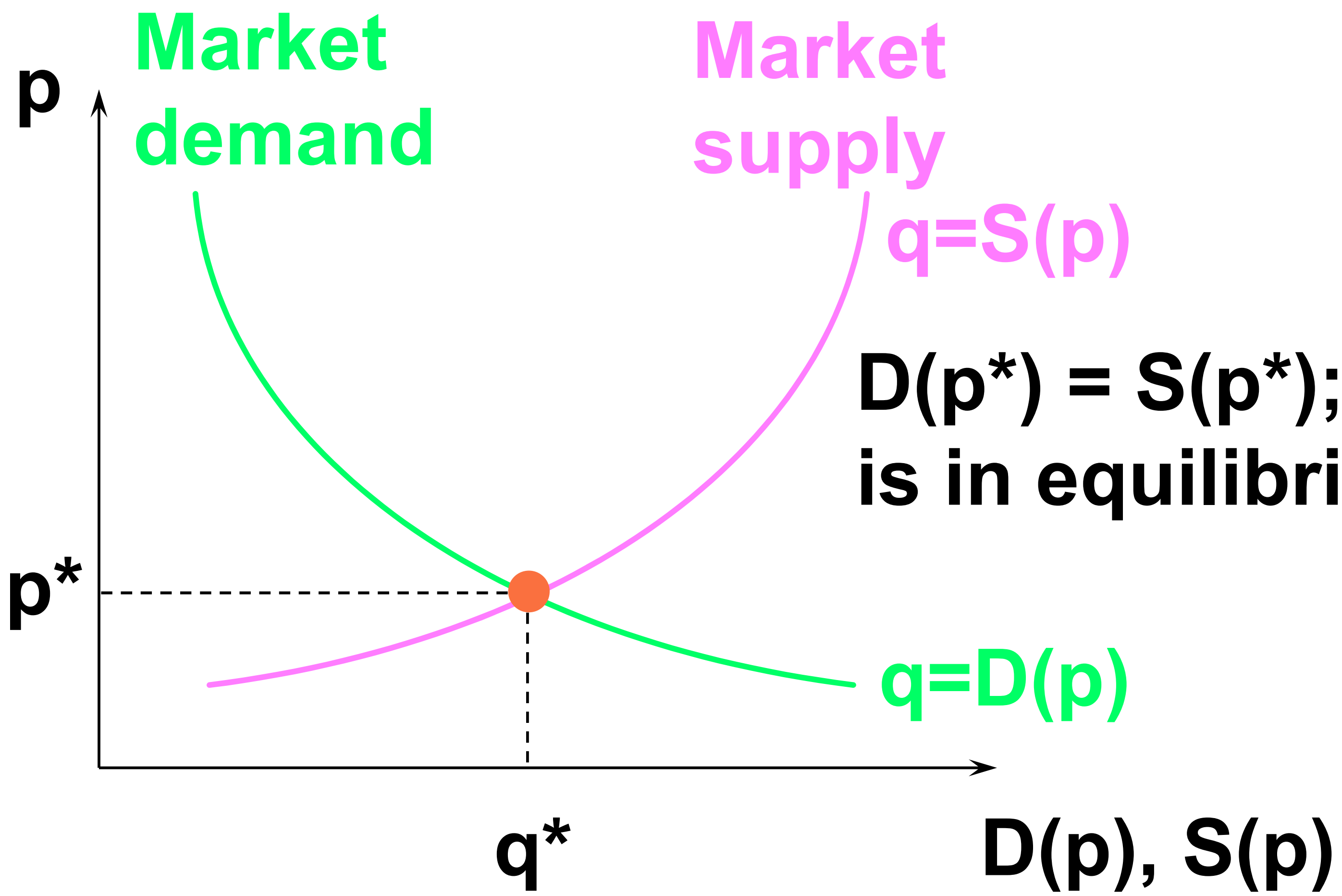
Market Equilibrium



Market Equilibrium

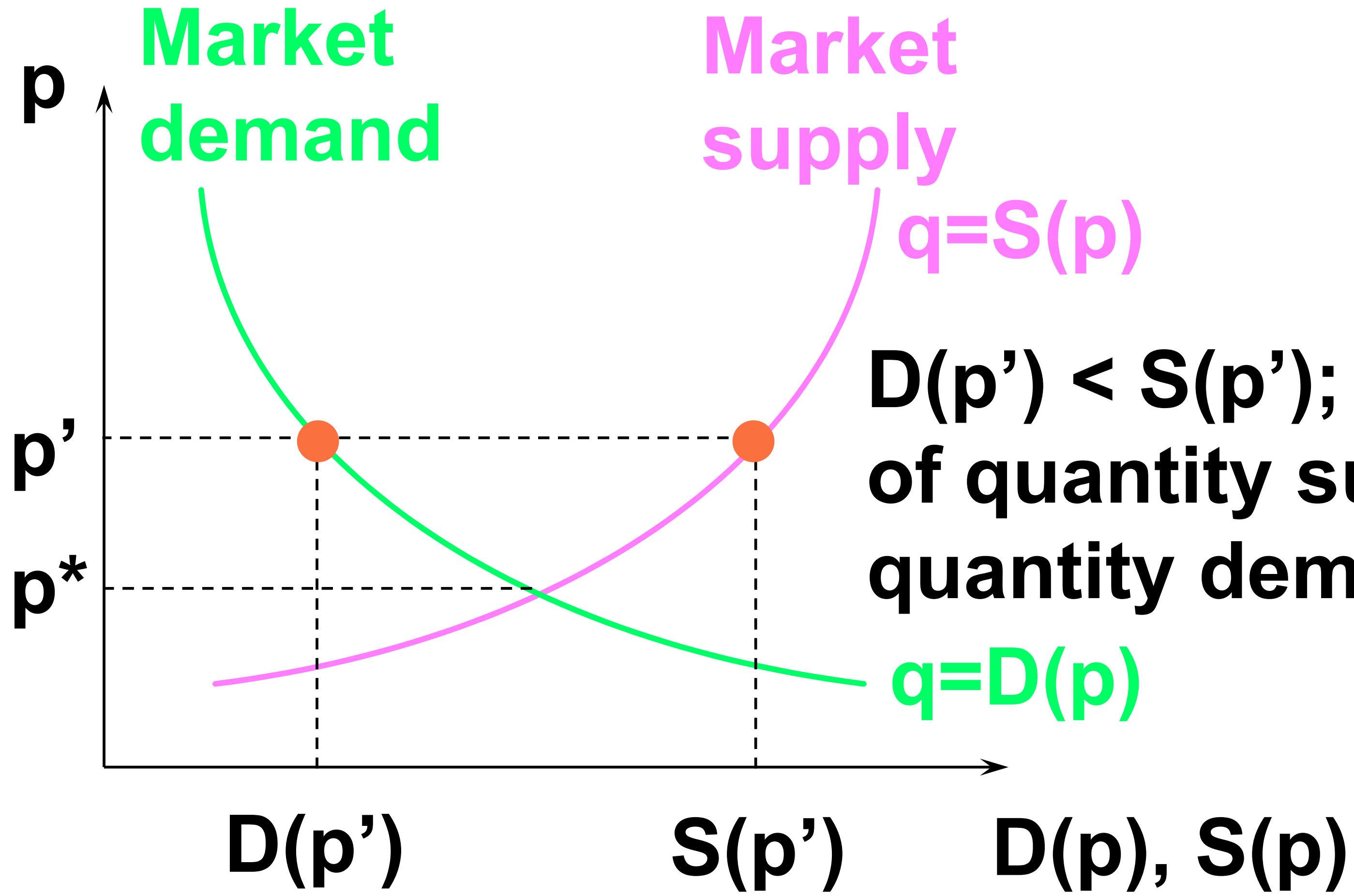


Market Equilibrium



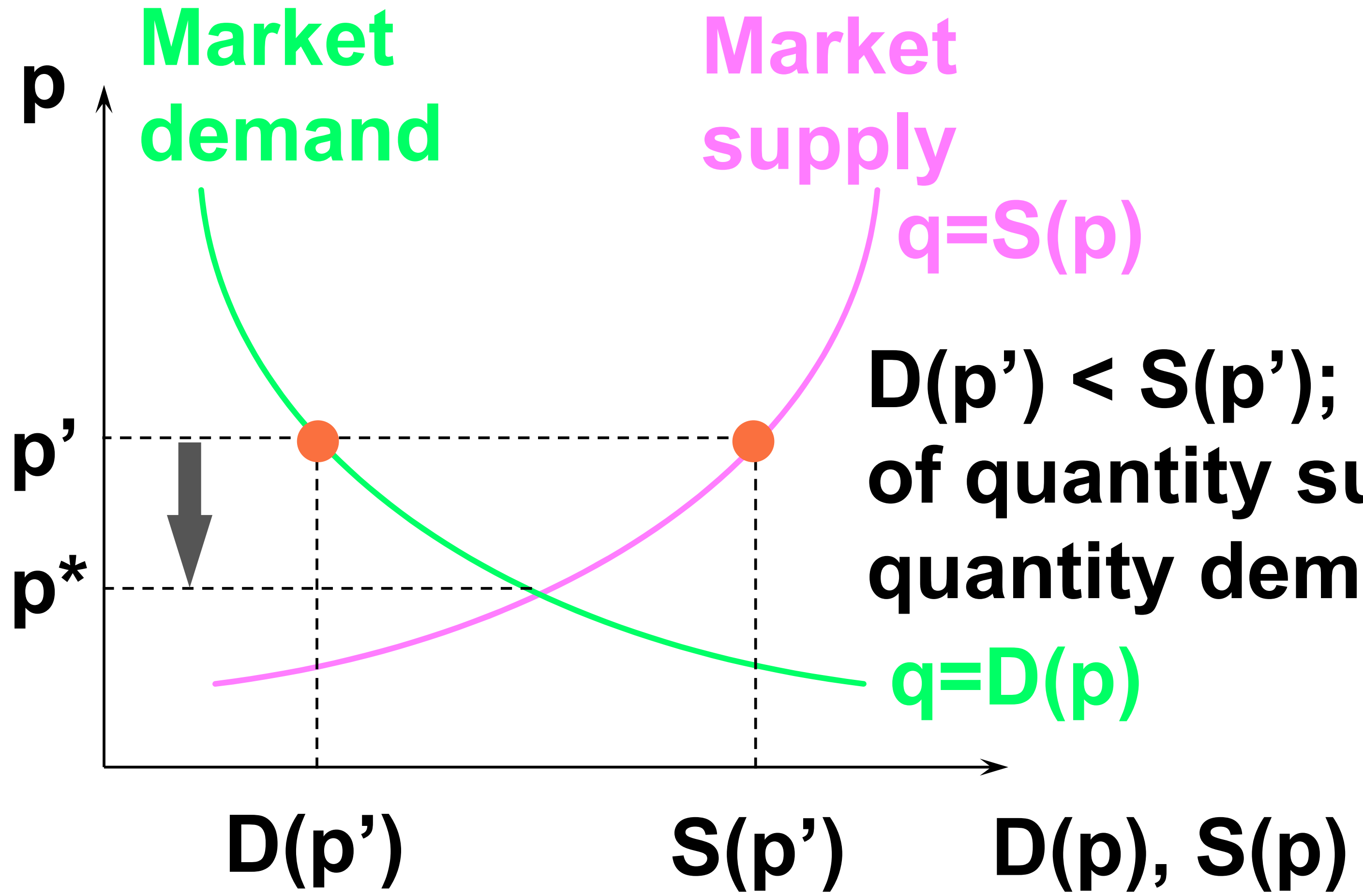
D(p*) = S(p*); the market is in equilibrium.

Market Equilibrium



D(p') < S(p'); an excess of quantity supplied over quantity demanded.

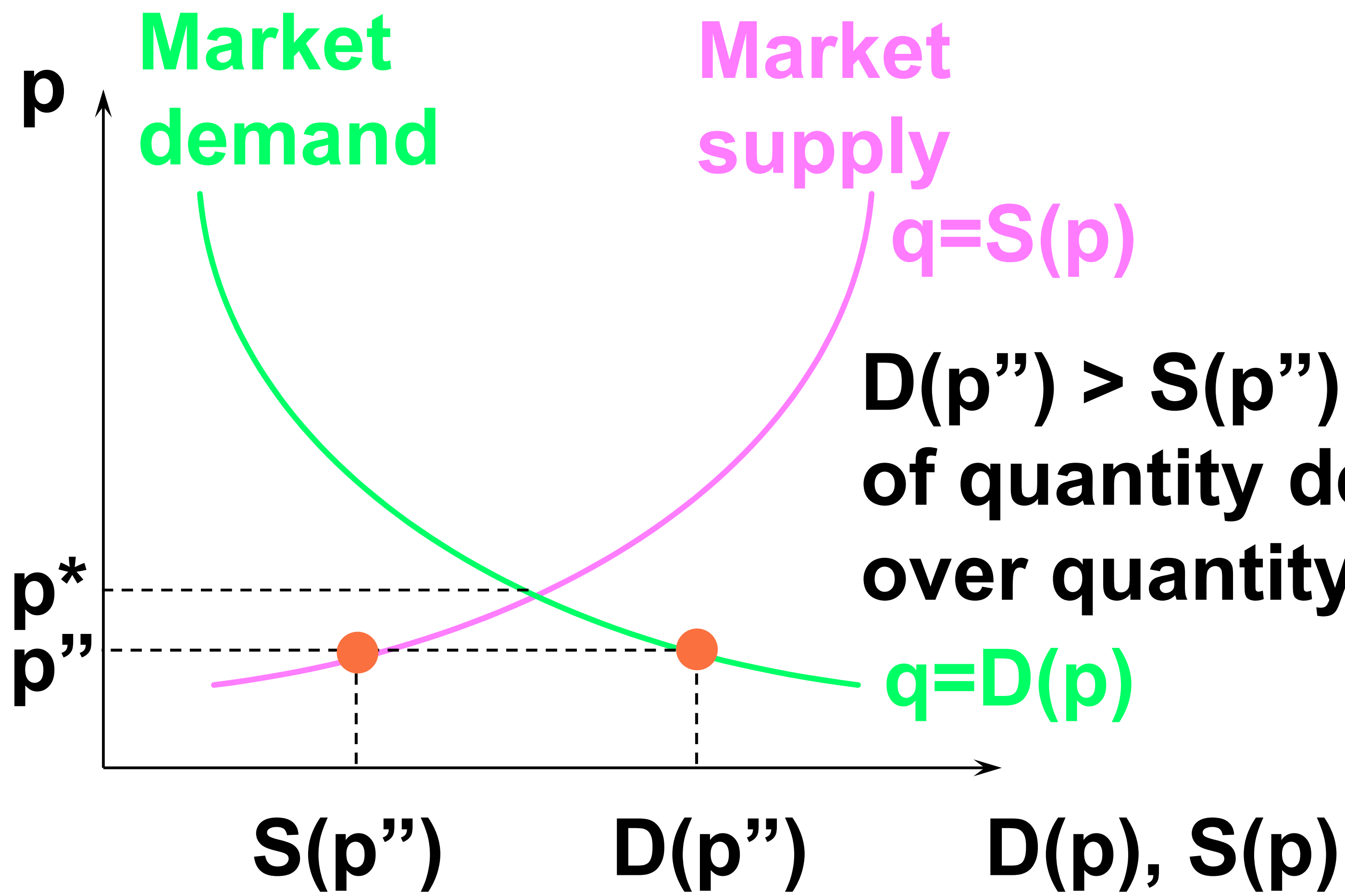
Market Equilibrium



D(p') < S(p'); an excess of quantity supplied over quantity demanded.

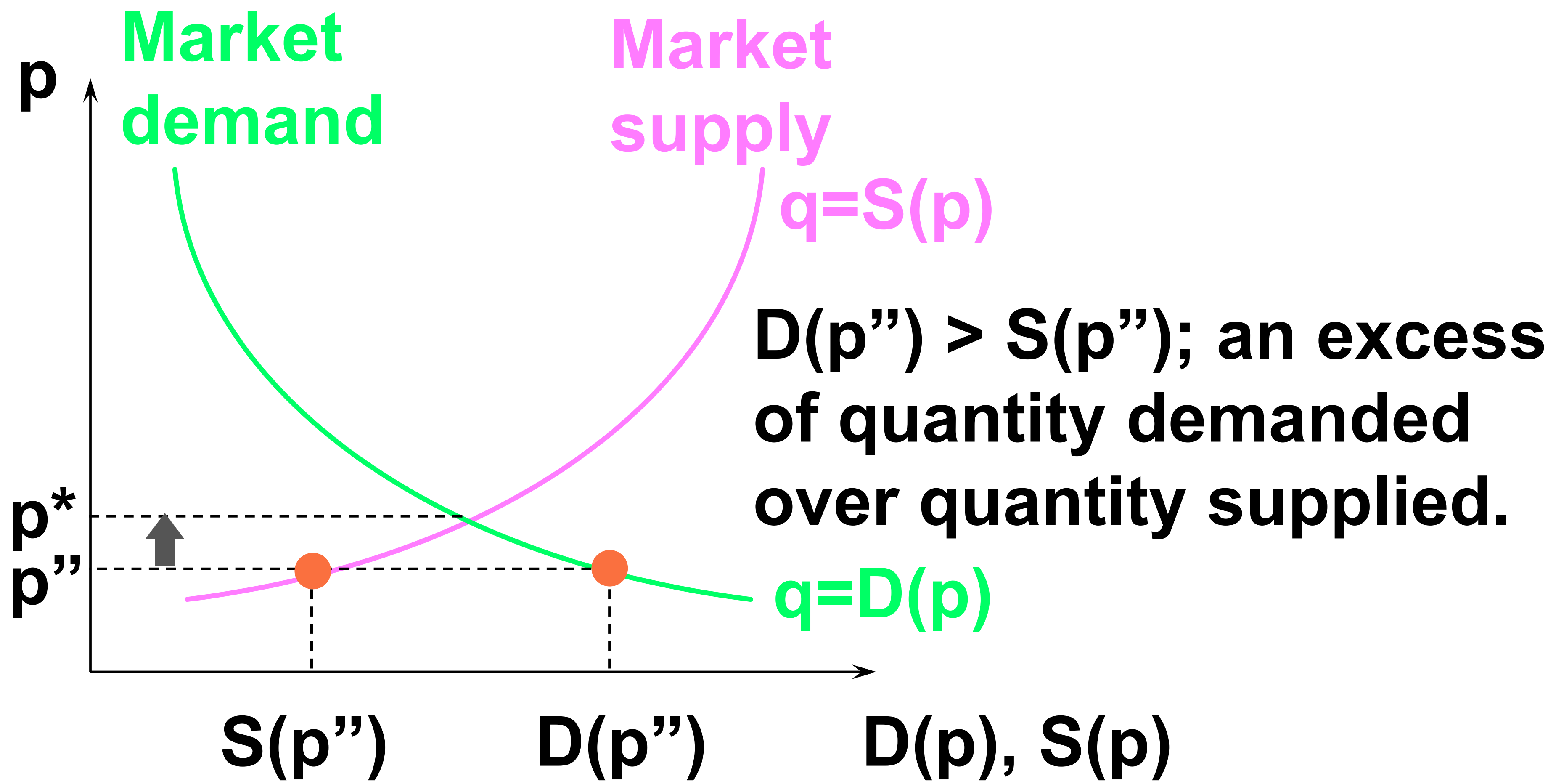
Market price must fall towards p*.

Market Equilibrium



D(p”) > S(p”); an excess of quantity demanded over quantity supplied.

Market Equilibrium



Market price must rise towards p*.

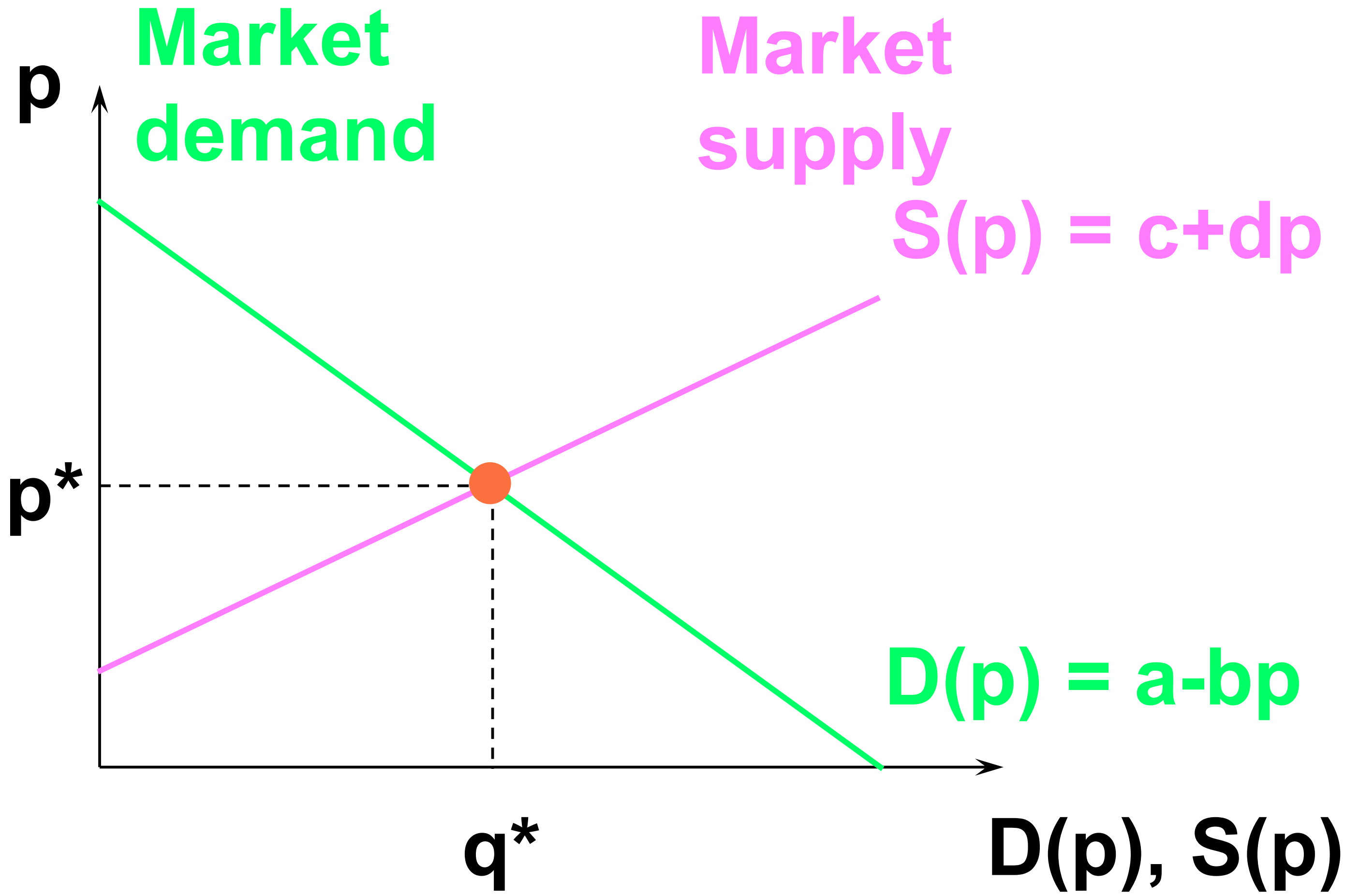
Market Equilibrium

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

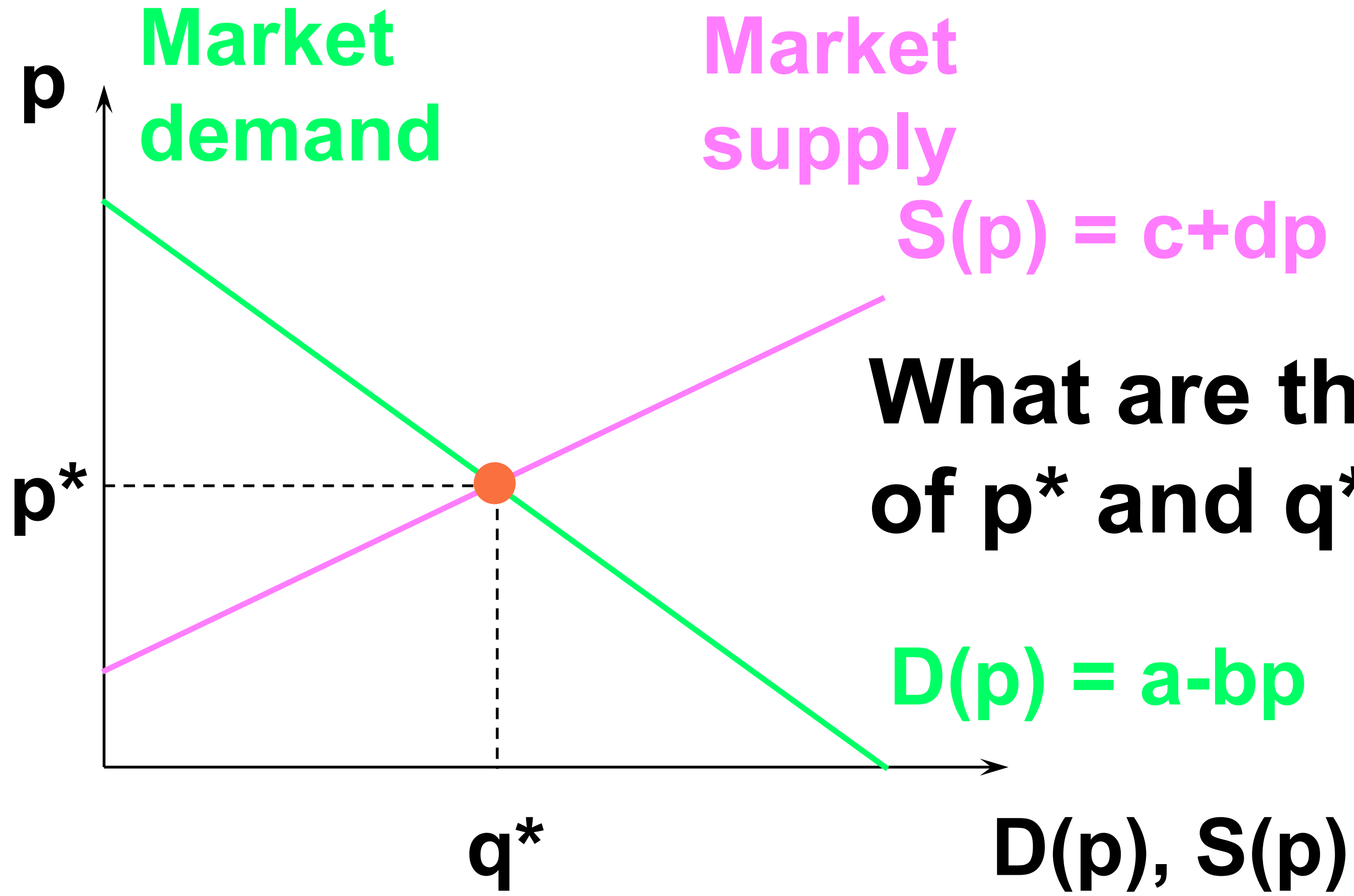
$$D(p) = a - bp$$

$$S(p) = c + dp$$

Market Equilibrium



Market Equilibrium



What are the values of p* and q*?

Market Equilibrium

$$D(p) = a - bp$$

$$S(p) = c + dp$$

At the equilibrium price p*, D(p*) = S(p*).

Market Equilibrium

$$D(p) = a - bp$$

$$S(p) = c + dp$$

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

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

Market Equilibrium

$$D(p) = a - bp$$

$$S(p) = c + dp$$

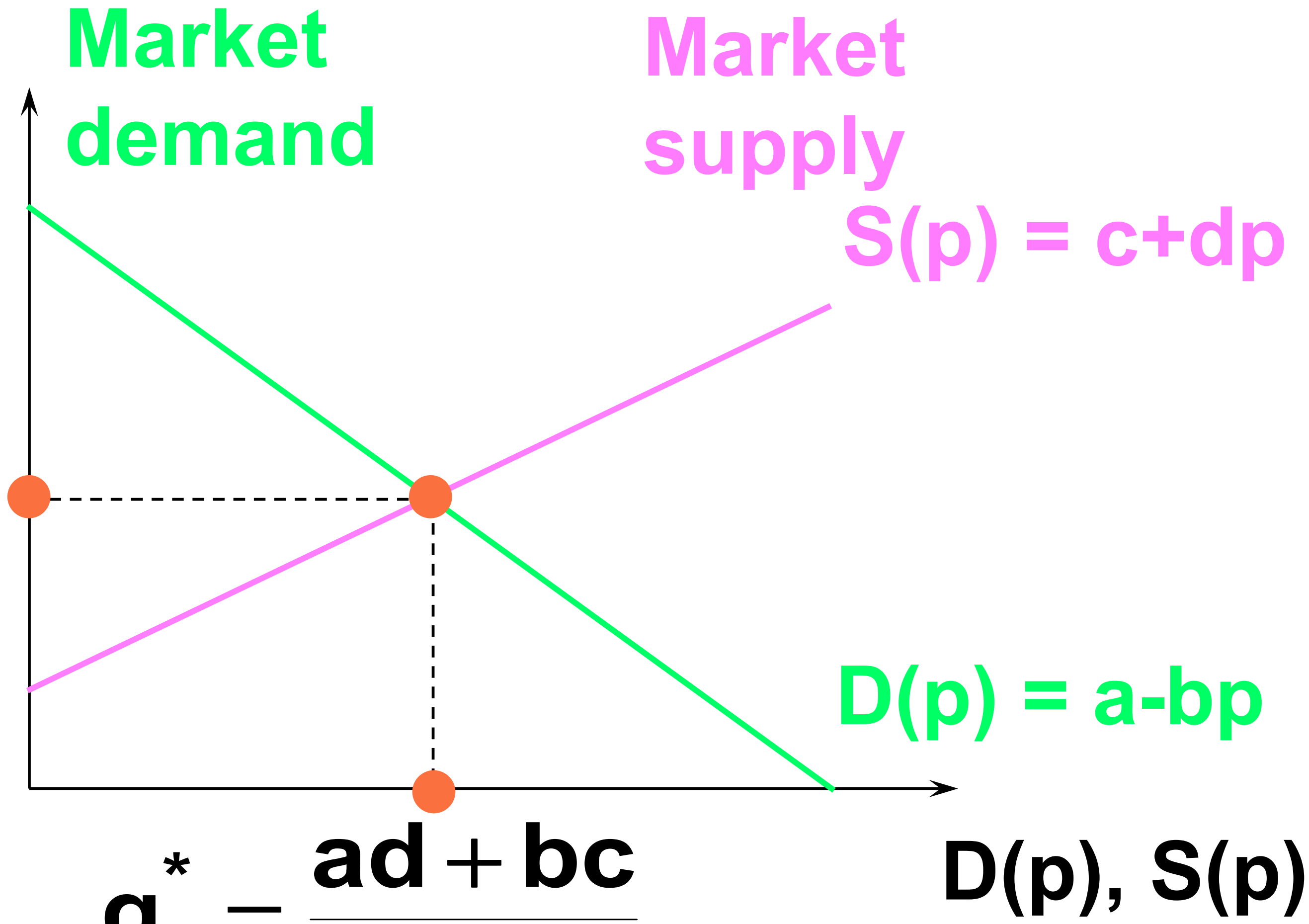
At the equilibrium price p*, D(p*) = S(p*).

That is, $a - bp^* = c + dp^*$

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

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

Market Equilibrium



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

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

Market Equilibrium

- **Can we calculate the market equilibrium using the inverse market demand and supply curves?**

Market Equilibrium

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

Market Equilibrium

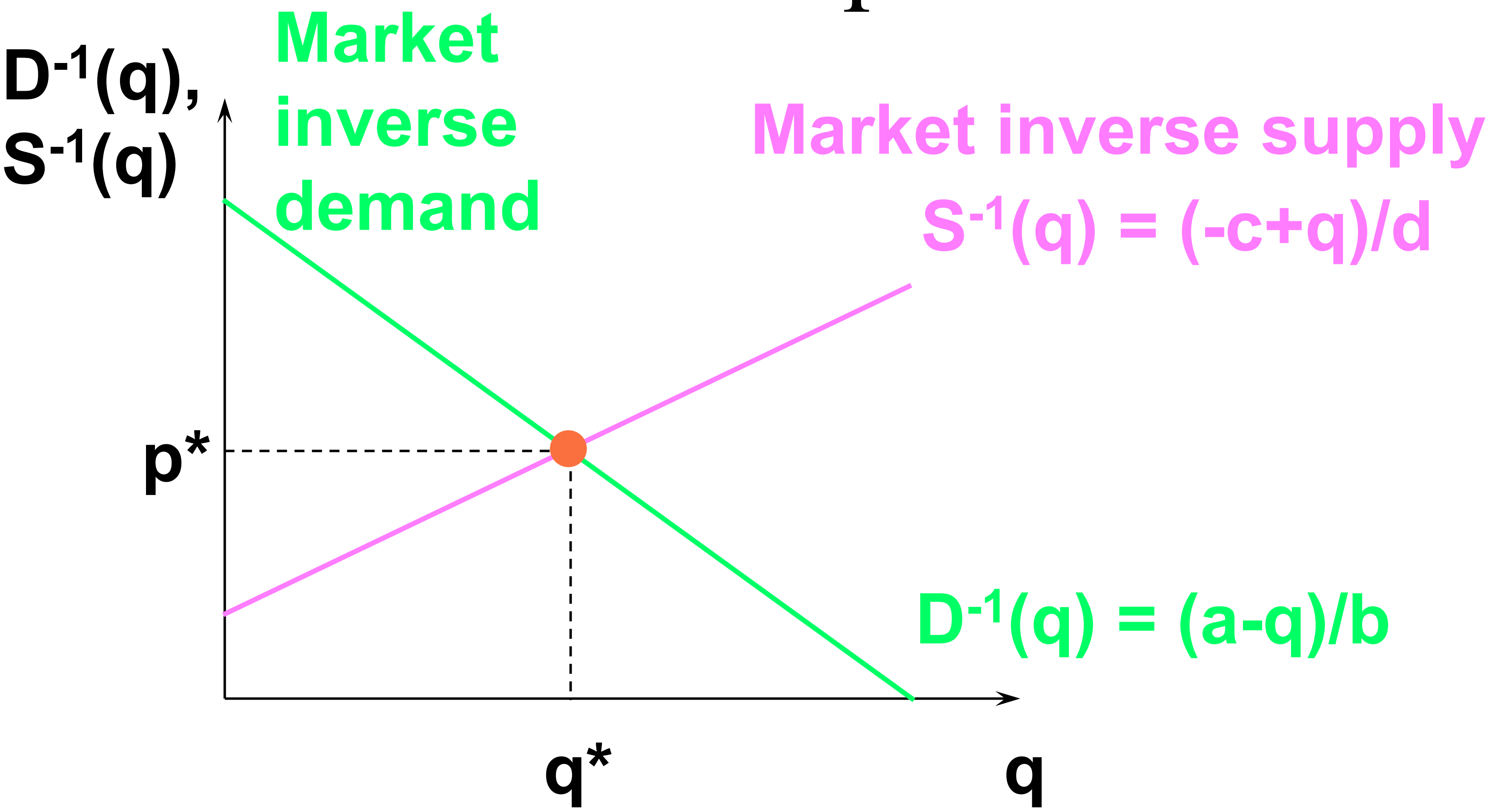
$$q = D(p) = a - bp \Leftrightarrow p = \frac{a-q}{b} = D^{-1}(q),$$

the equation of the inverse market demand curve. And

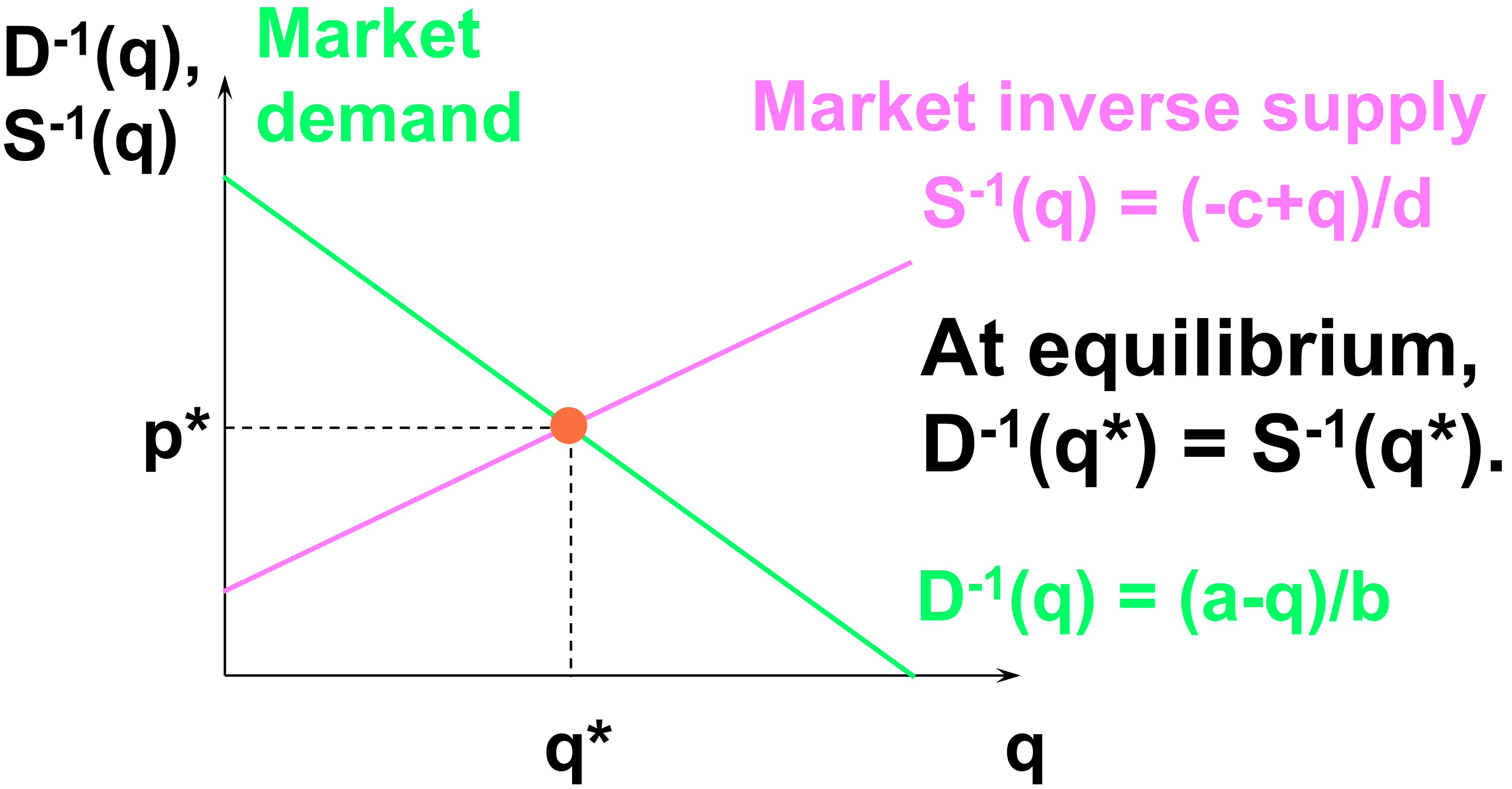
$$q = S(p) = c + dp \Leftrightarrow p = \frac{-c+q}{d} = S^{-1}(q),$$

the equation of the inverse market supply curve.

Market Equilibrium



Market Equilibrium



Market Equilibrium

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

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

Market Equilibrium

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

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

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

Market Equilibrium

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

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

Market Equilibrium

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

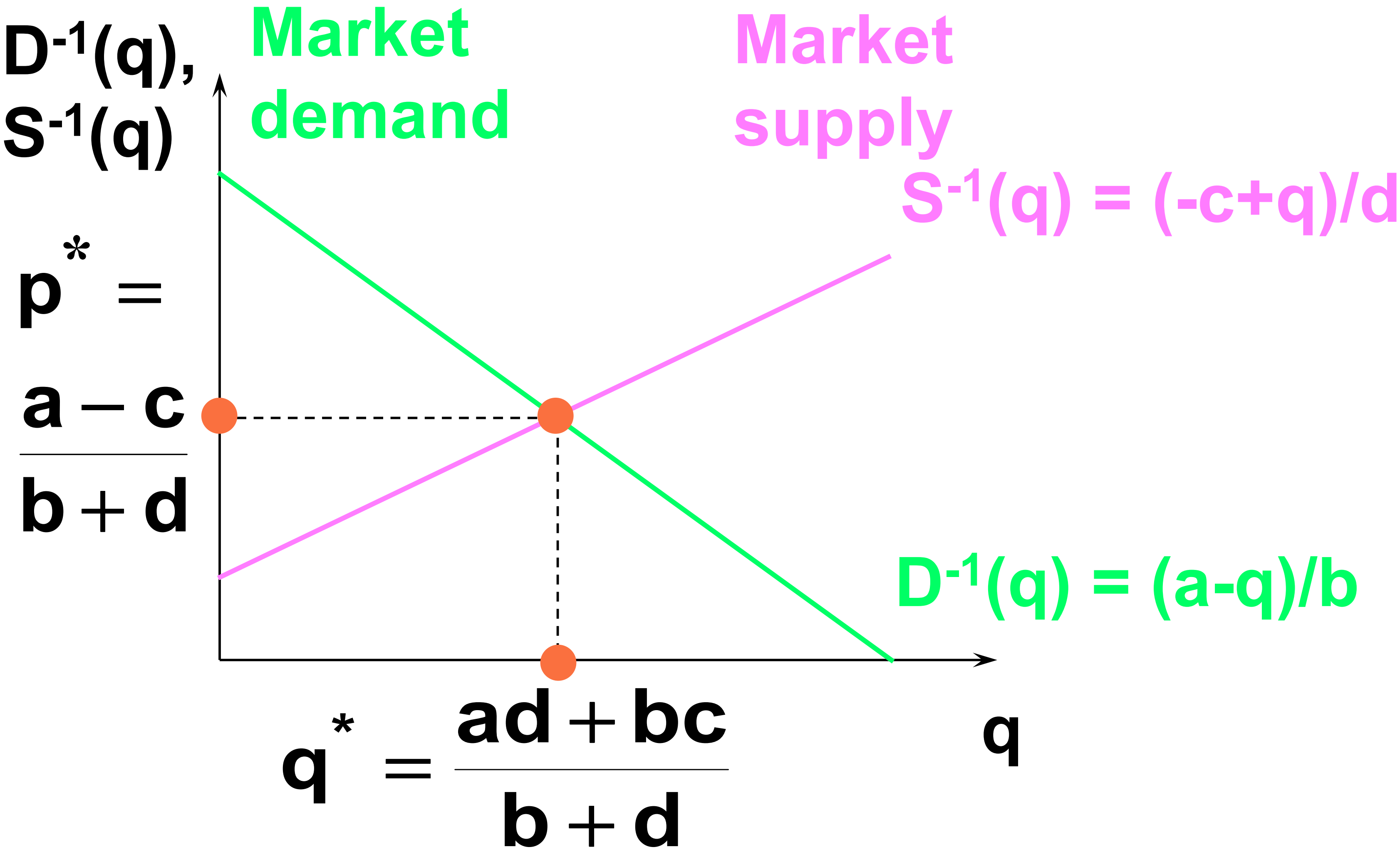
At the equilibrium quantity q*, $D^{-1}(p^*) = S^{-1}(p^*)$.
That is,

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

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

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

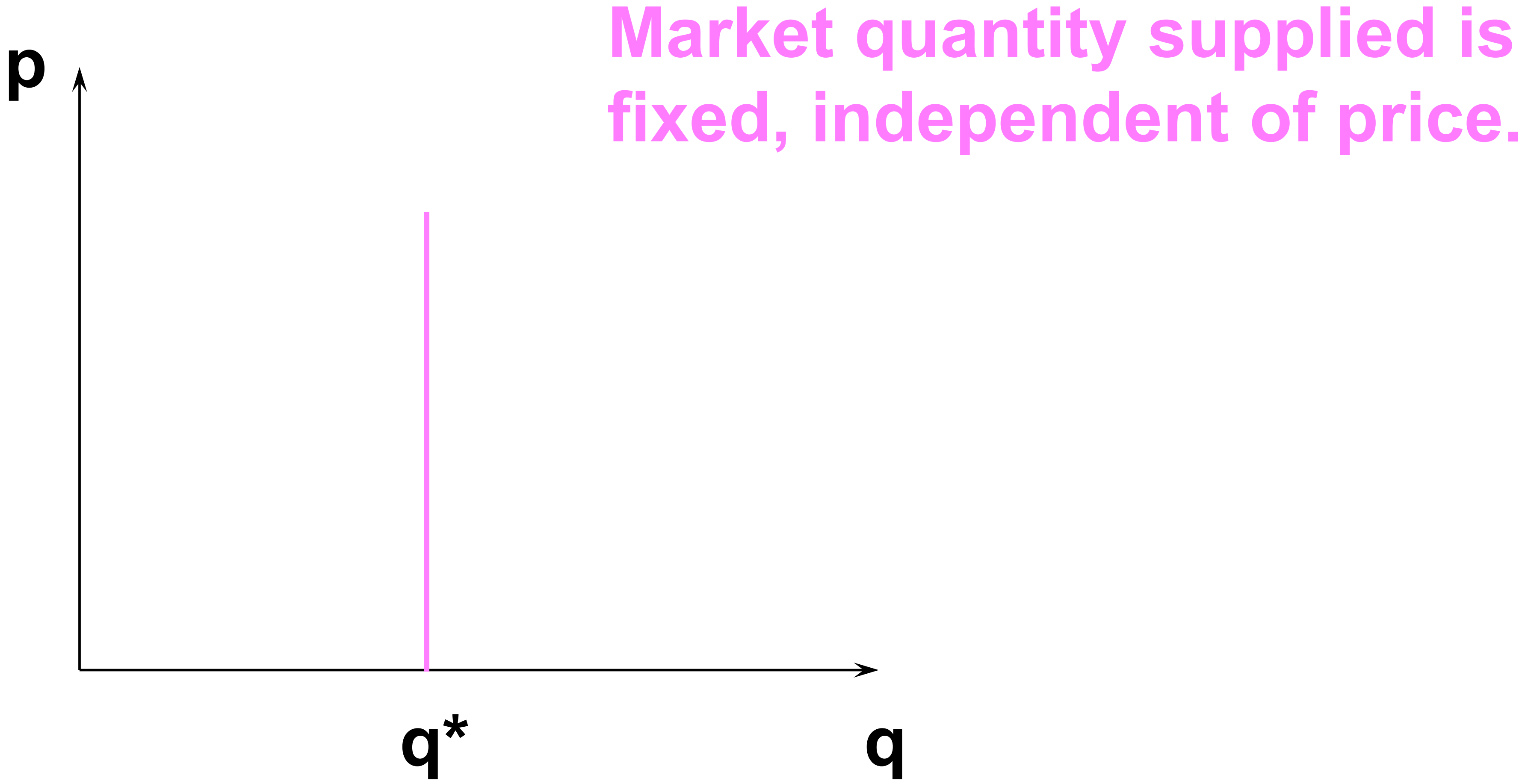
Market Equilibrium



Market Equilibrium

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

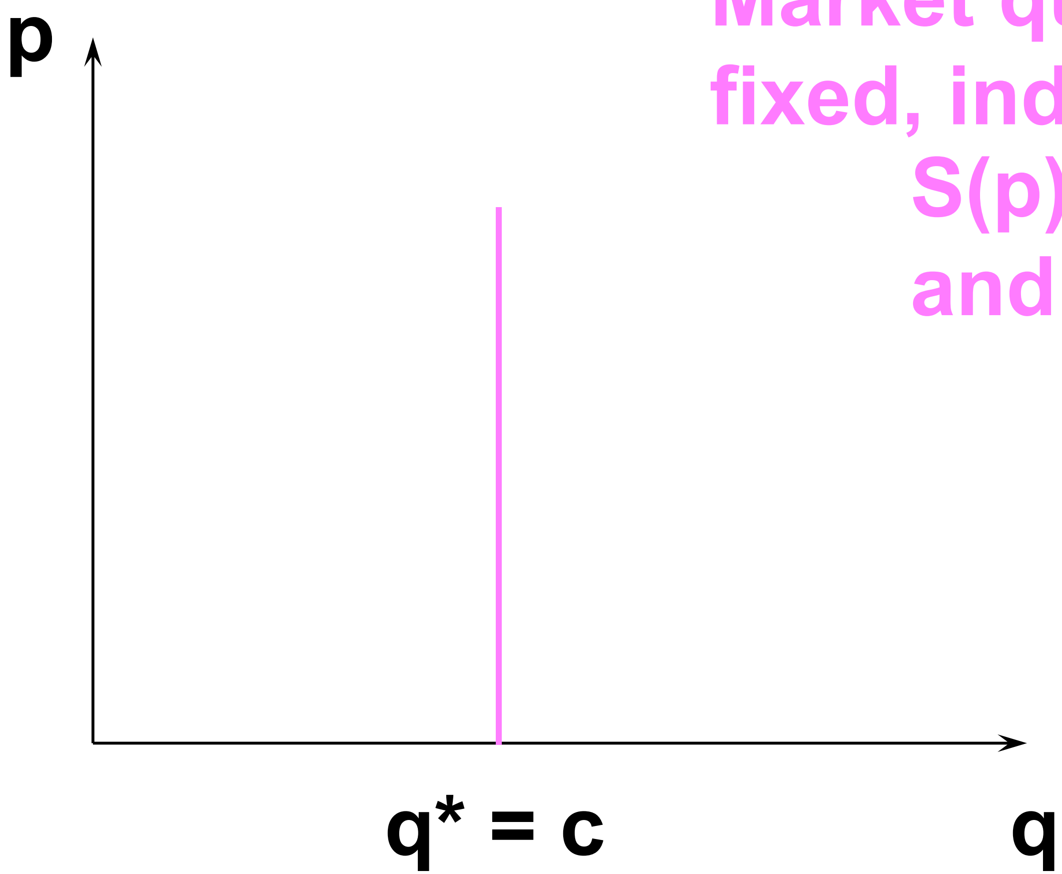
Market Equilibrium



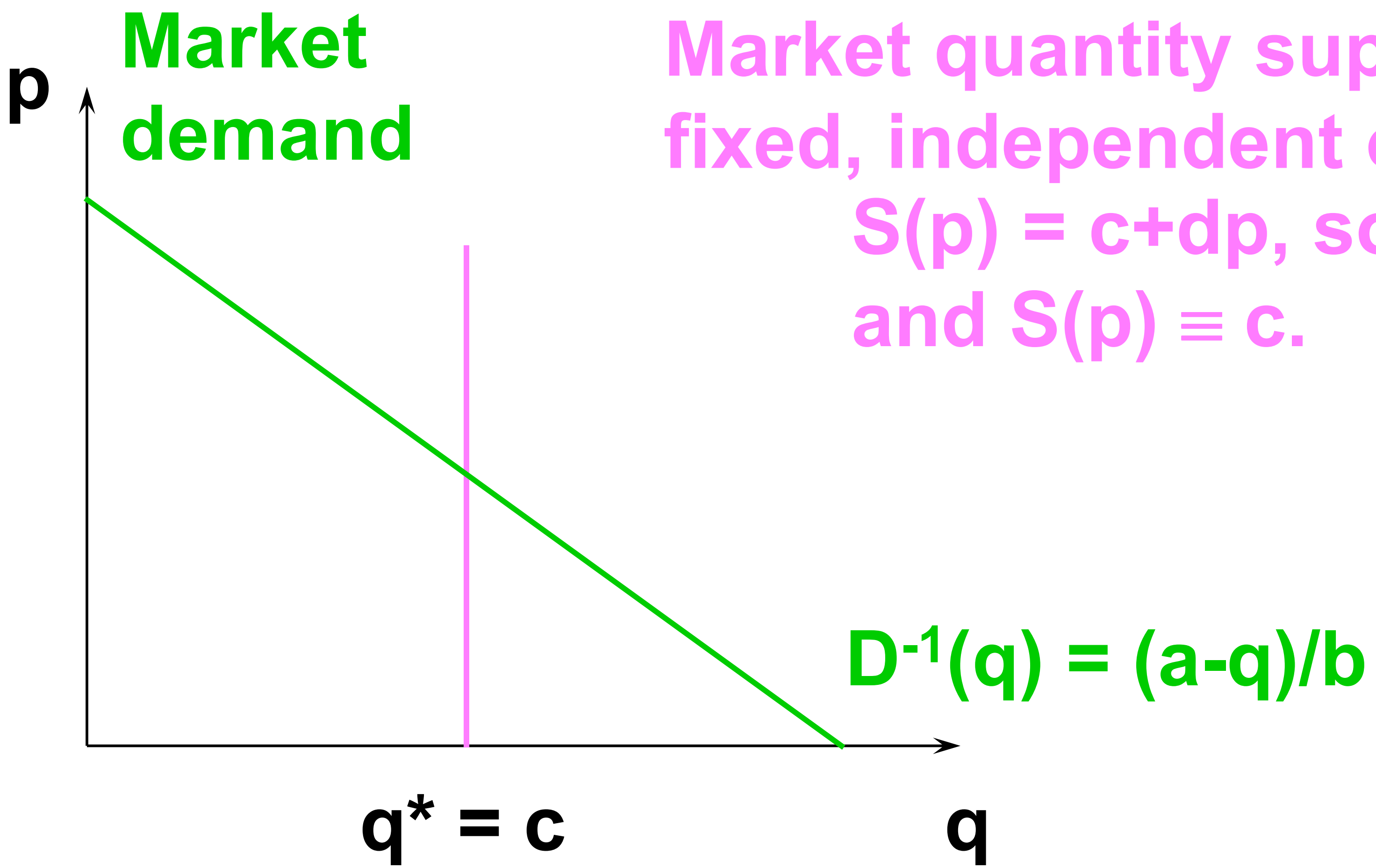
Market Equilibrium

Market quantity supplied is fixed, independent of price.

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



Market Equilibrium



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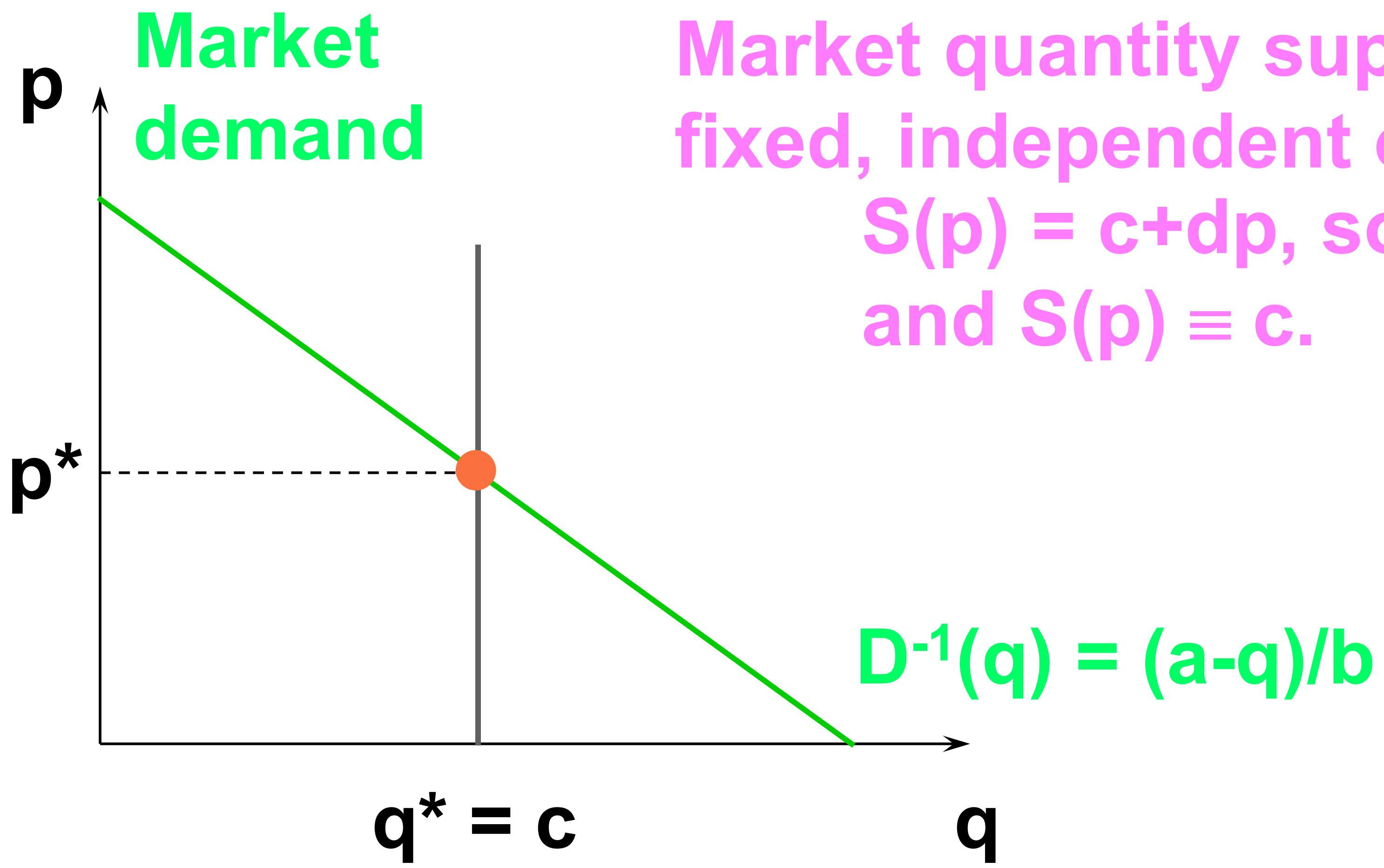
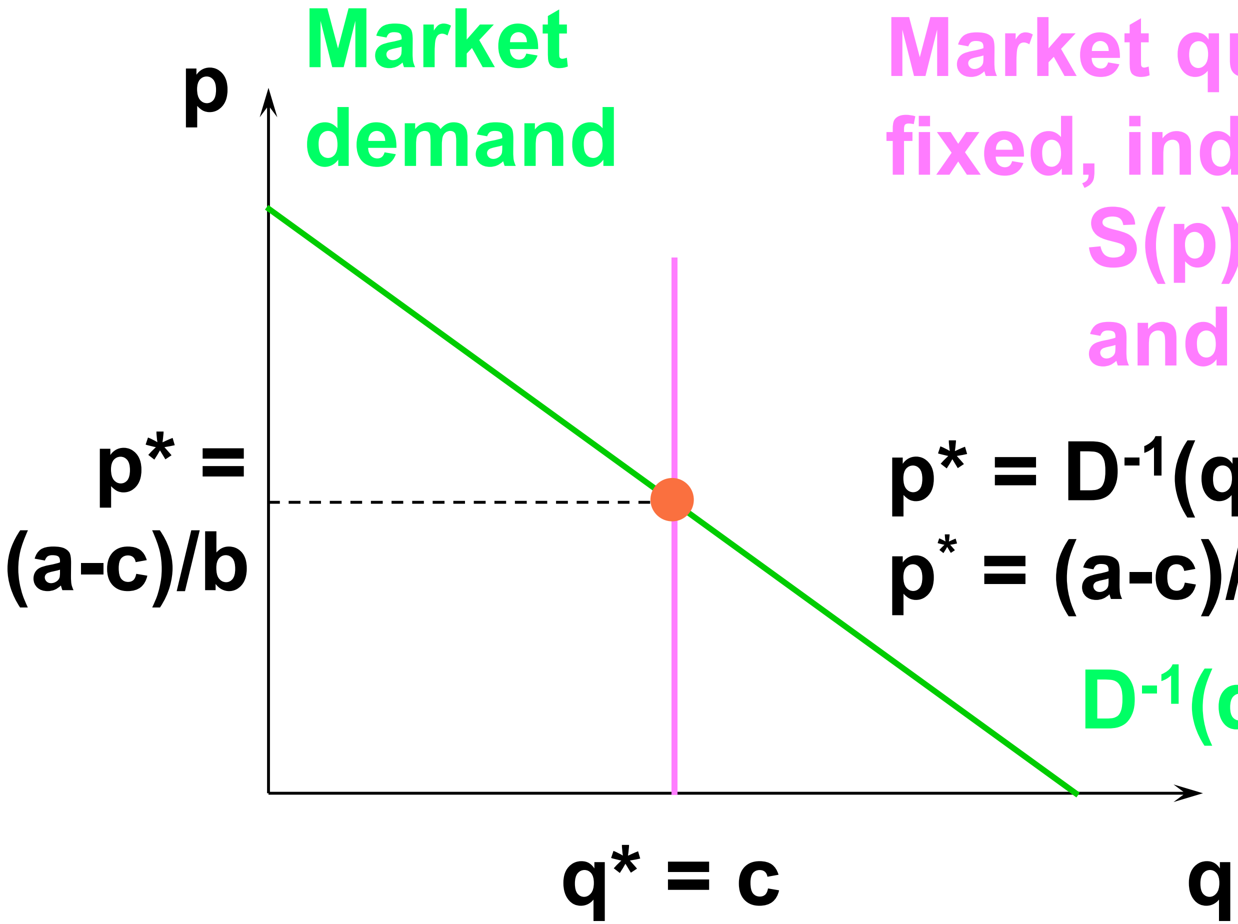
Market Equilibrium



Market quantity supplied is fixed, independent of price. $S(p) = c+dp$, so $d=0$ and $S(p) \equiv c$.

Market Equilibrium



Market quantity supplied is fixed, independent of price.

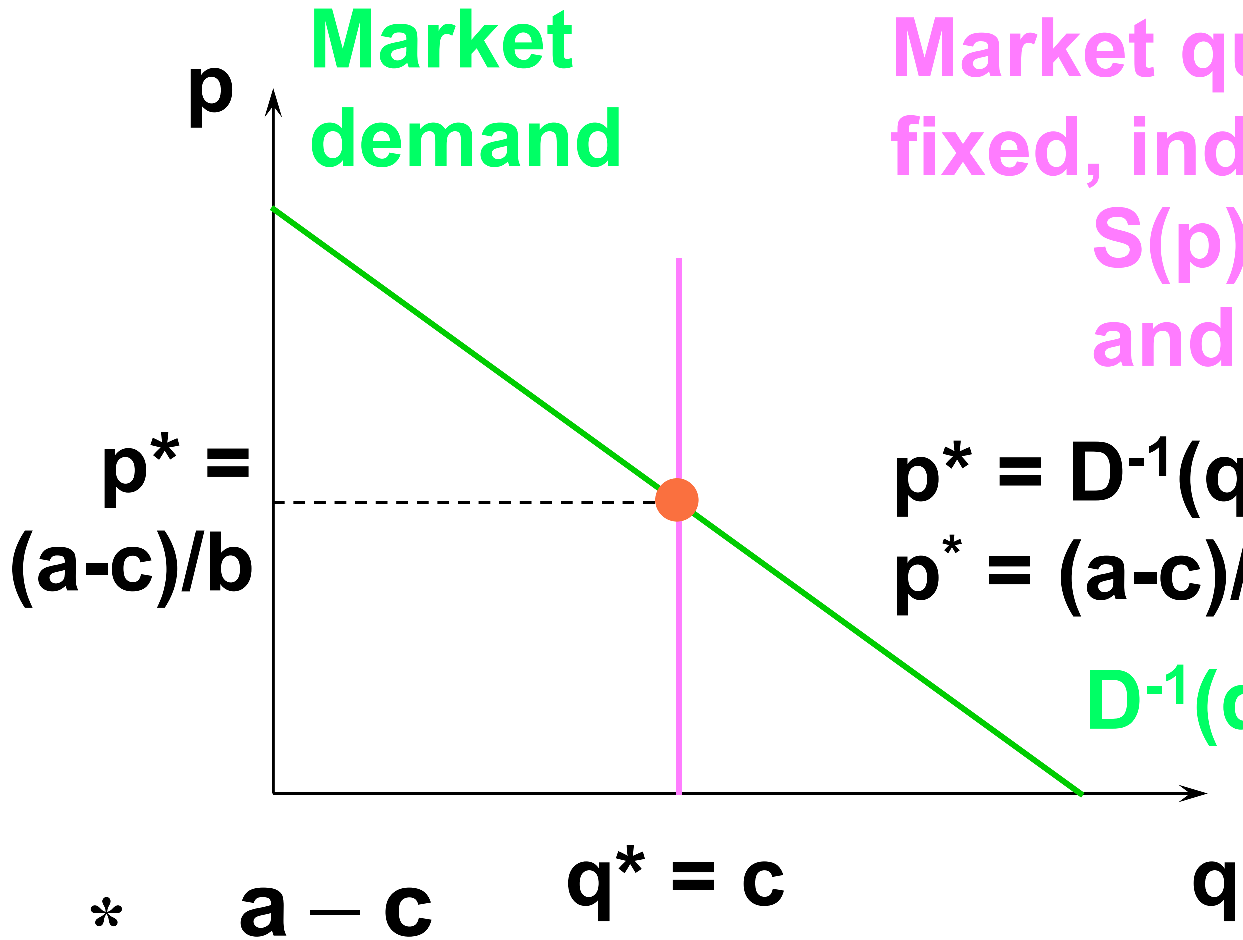
$S(p) = c+dp$, so $d=0$ and $S(p) \equiv c$.

$p^* = D^{-1}(q^*)$; that is,

$p^* = (a-c)/b$.

$D^{-1}(q) = (a-q)/b$

Market Equilibrium



Market quantity supplied is fixed, independent of price.

S(p) = c+dp, so d=0
and S(p) ≡ c.

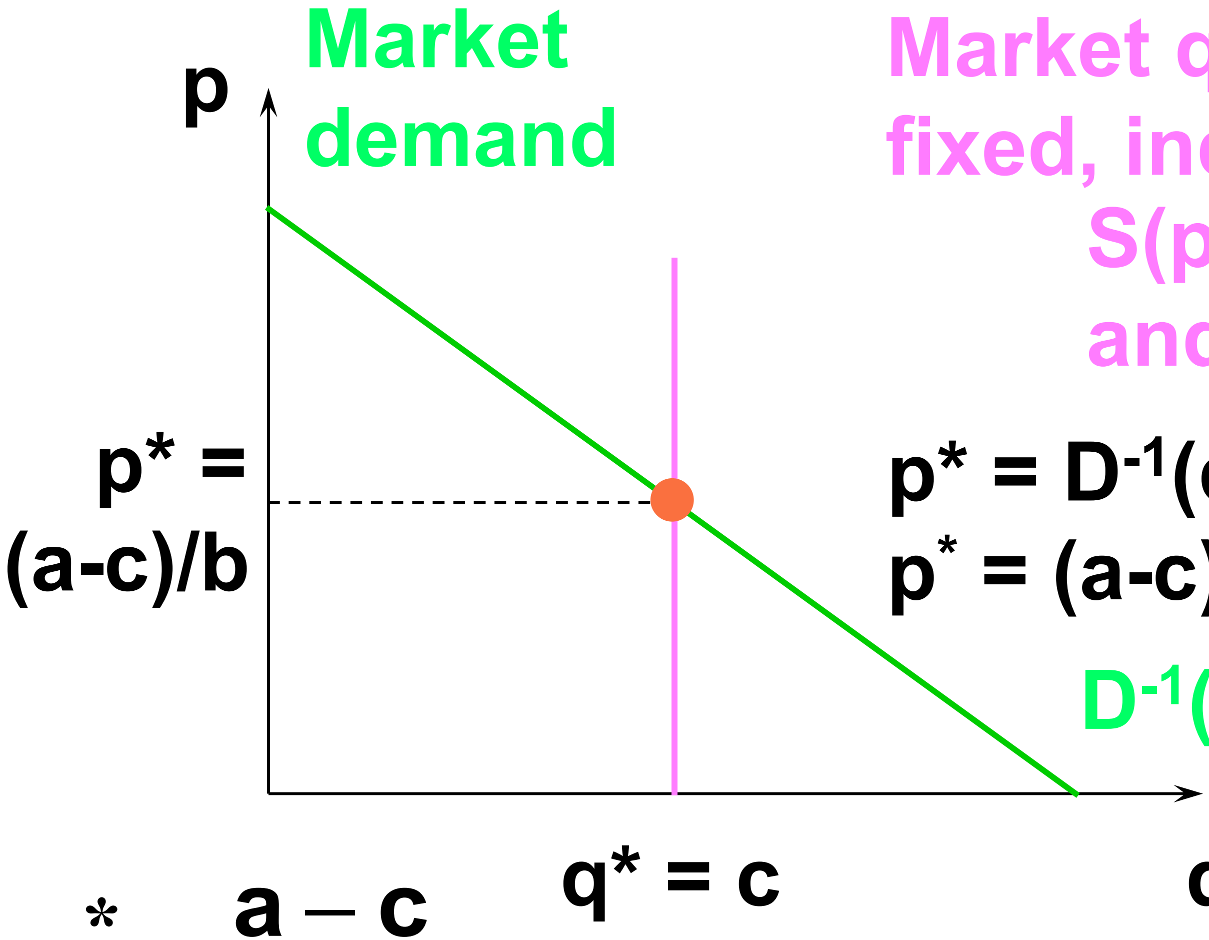
$p^* = D^{-1}(q^*)$; that is,
$p^* = (a-c)/b$.

$D^{-1}(q) = (a-q)/b$

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

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

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,

$p^* = (a-c)/b$.

$D^{-1}(q) = (a-q)/b$

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

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

with d = 0 give

$$p^* = \frac{a-c}{b}$$

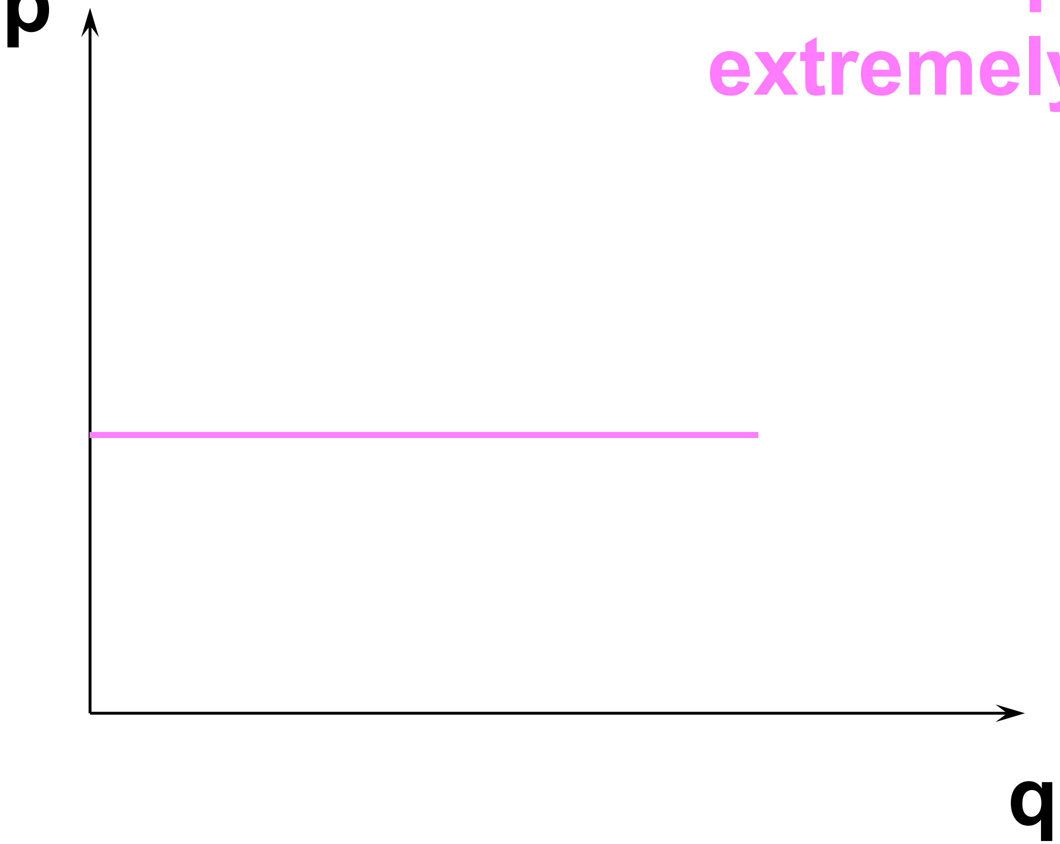
$$q^* = c.$$

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

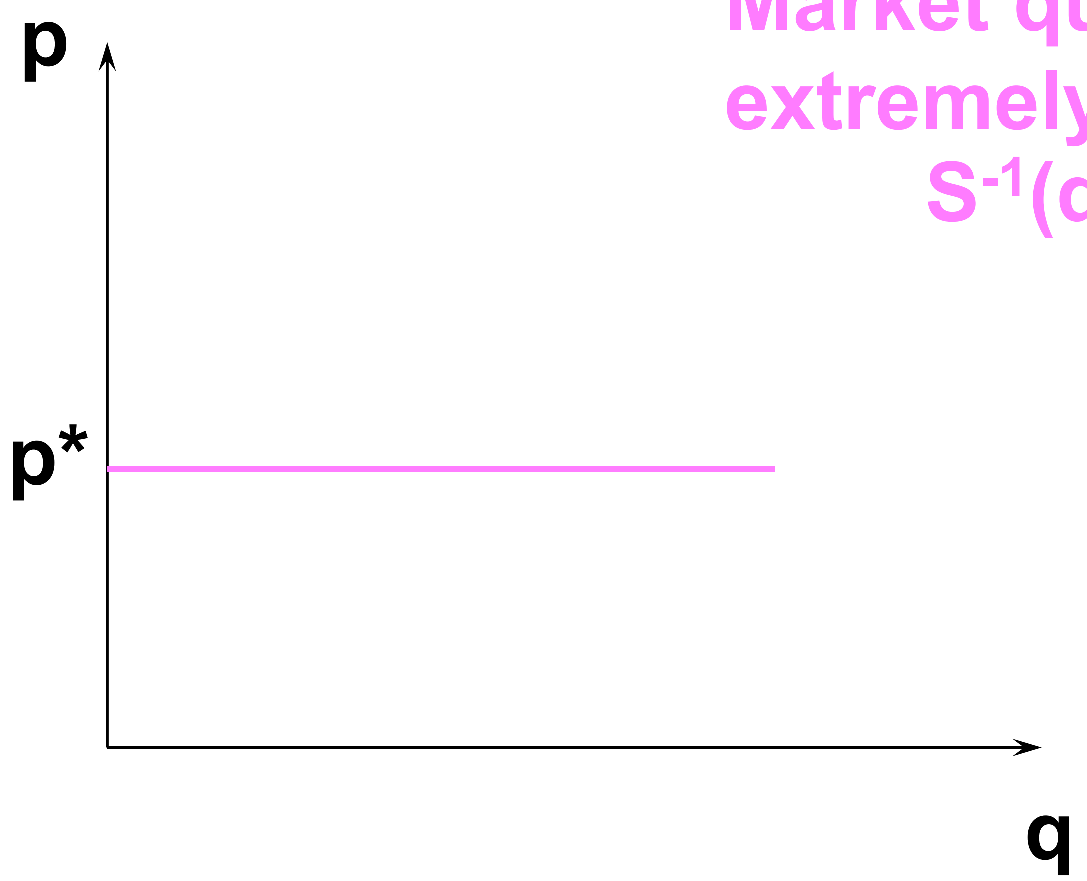
Market quantity supplied is extremely sensitive to price.



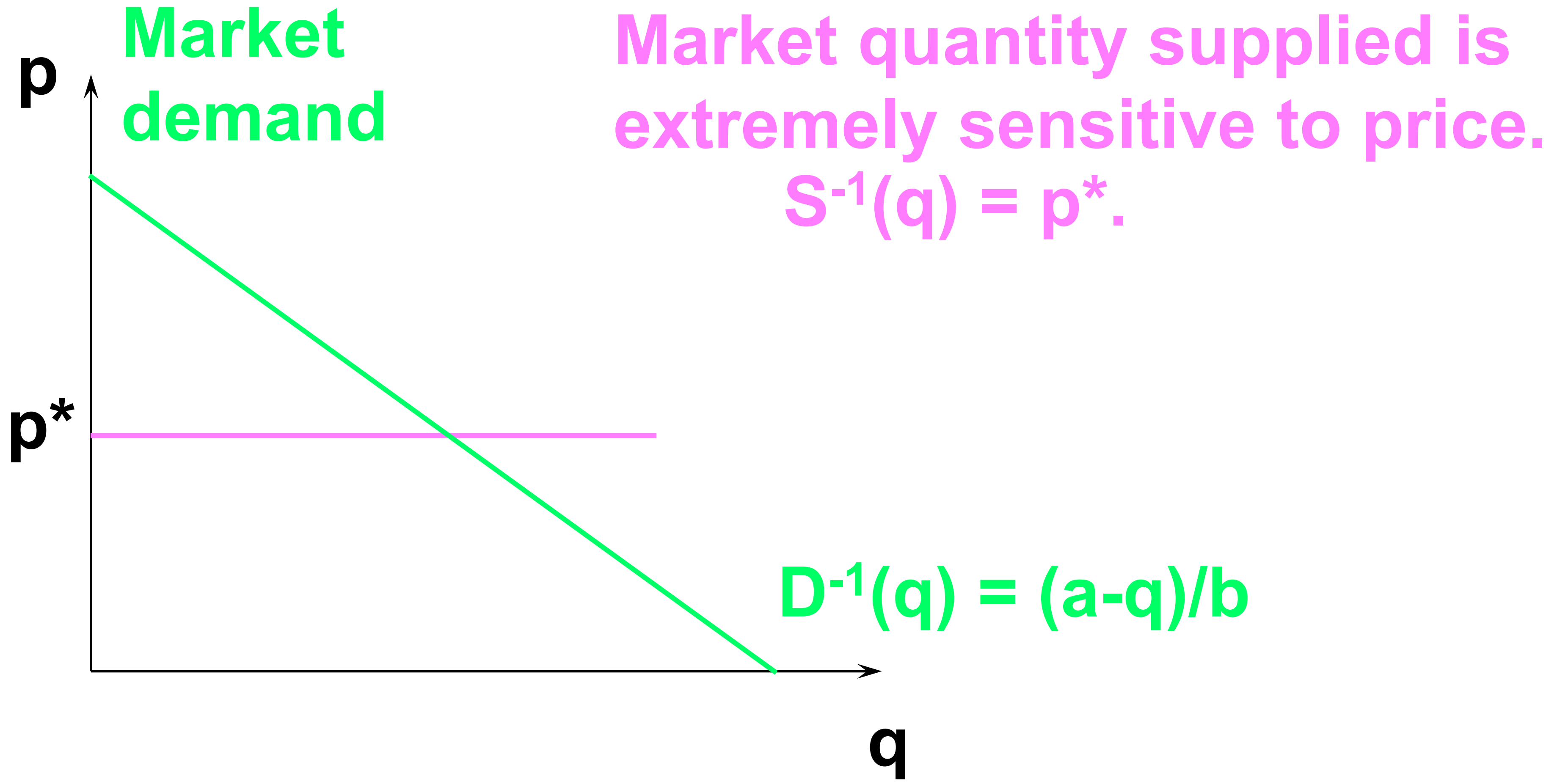
Market Equilibrium

Market quantity supplied is extremely sensitive to price.

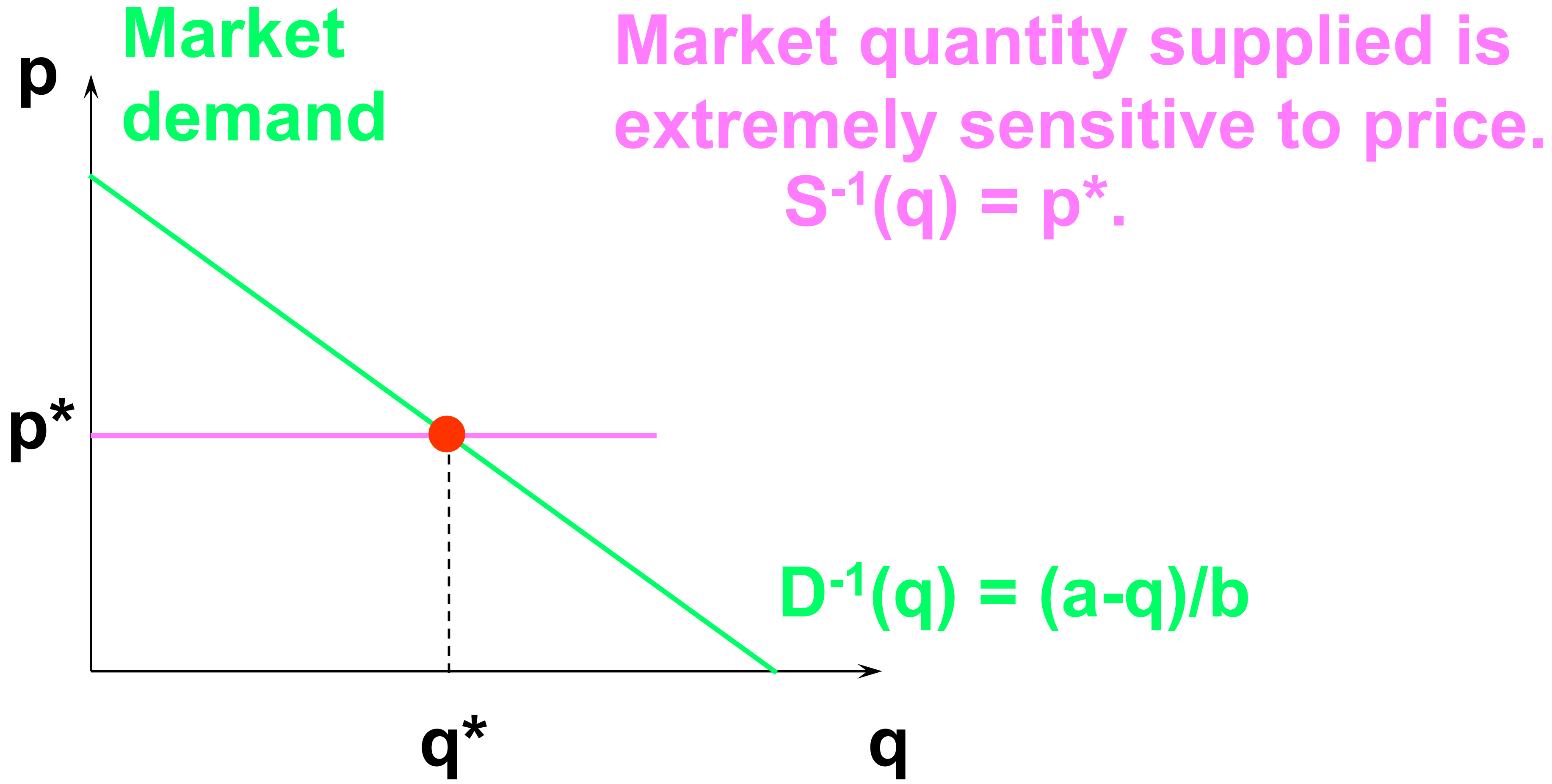
$S^{-1}(q) = p^*$.



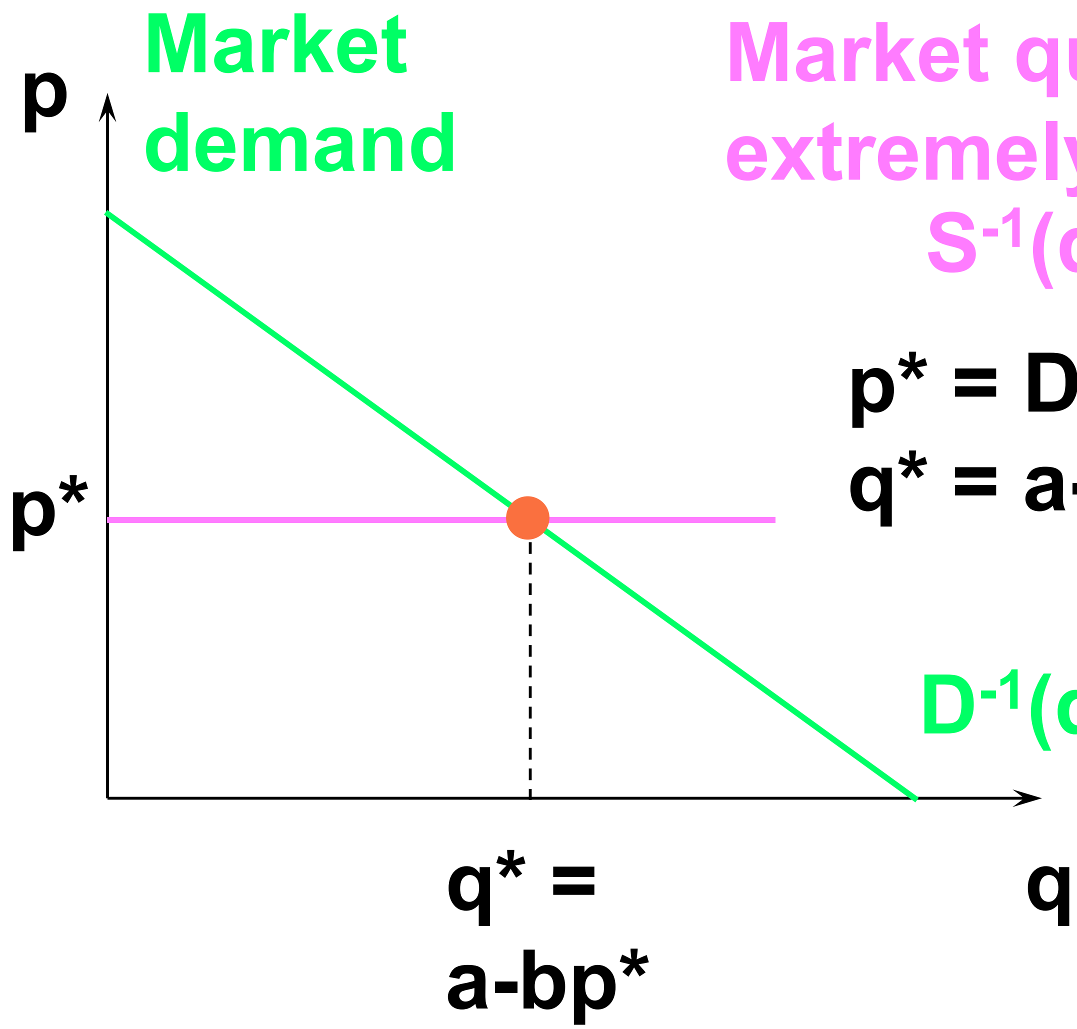
Market Equilibrium



Market Equilibrium



Market Equilibrium



Market quantity supplied is extremely sensitive to price.

$S^{-1}(q) = p^*$.

$p^* = D^{-1}(q^*) = (a-q^*)/b$ so

$q^* = a-bp^*$

$D^{-1}(q) = (a-q)/b$

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

$$p_b - p_s = t \qquad \text{and} \qquad D(p_b) = S(p_s)$$

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

Quantity Taxes

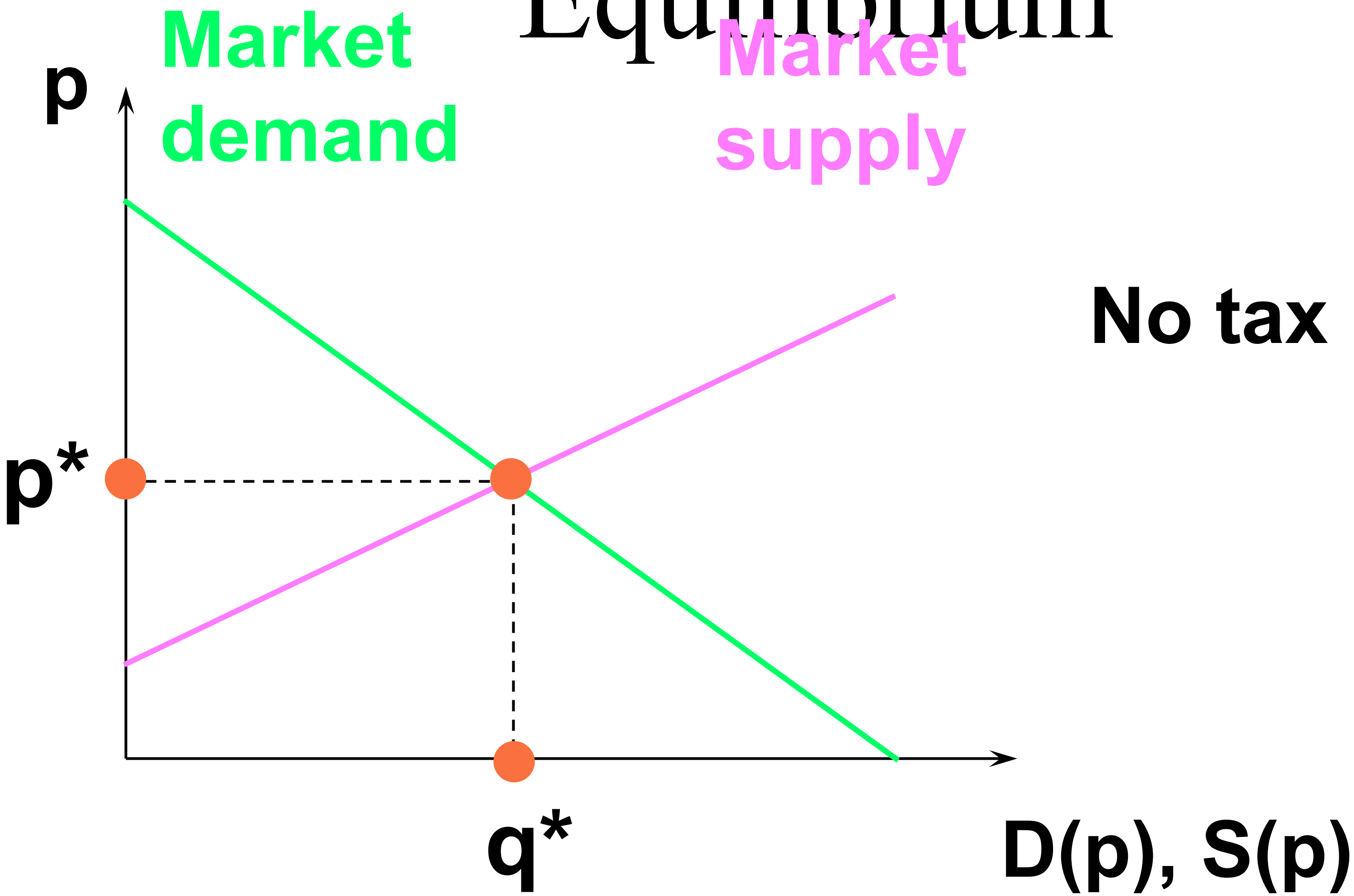
$$p_b - p_s = t \quad \text{and} \quad D(p_b) = S(p_s)$$

describe the market's equilibrium.

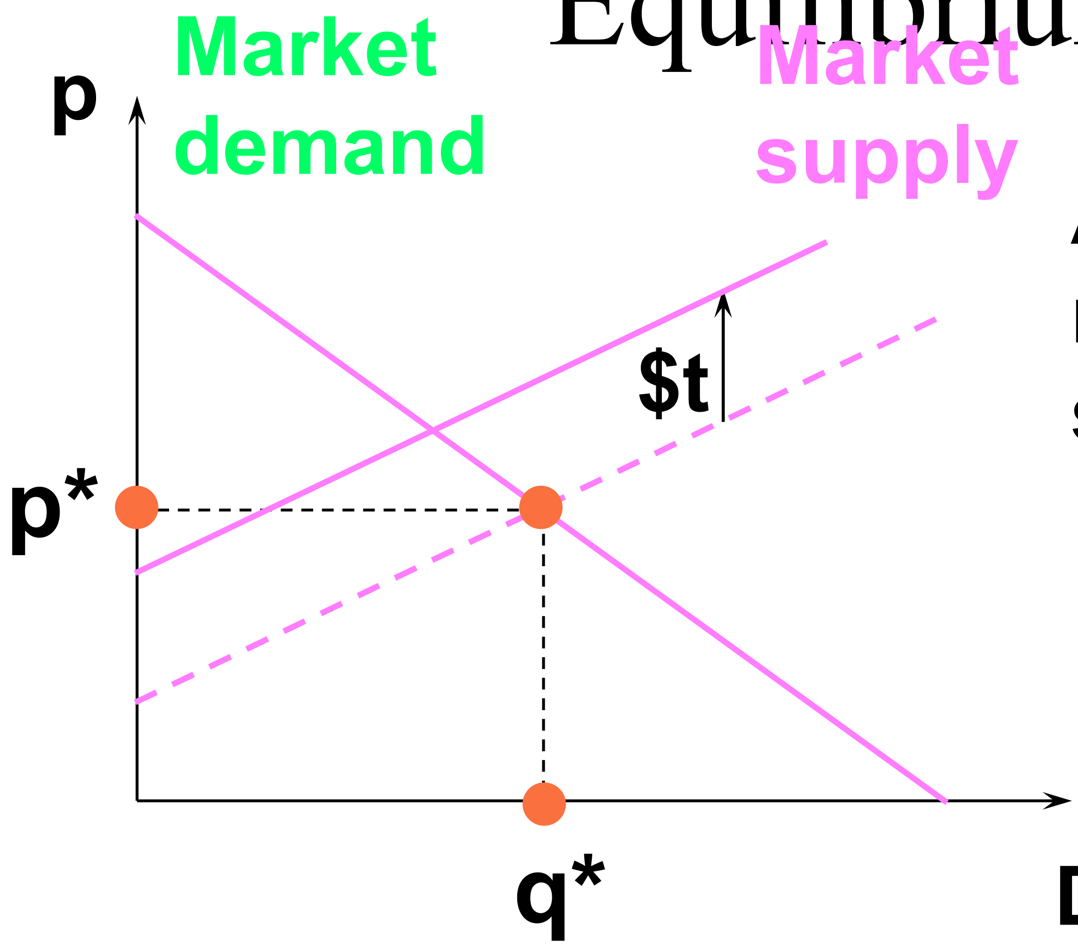
Notice that these two conditions apply no matter if the tax is levied on sellers or on buyers.

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

Quantity Taxes & Market Equilibrium

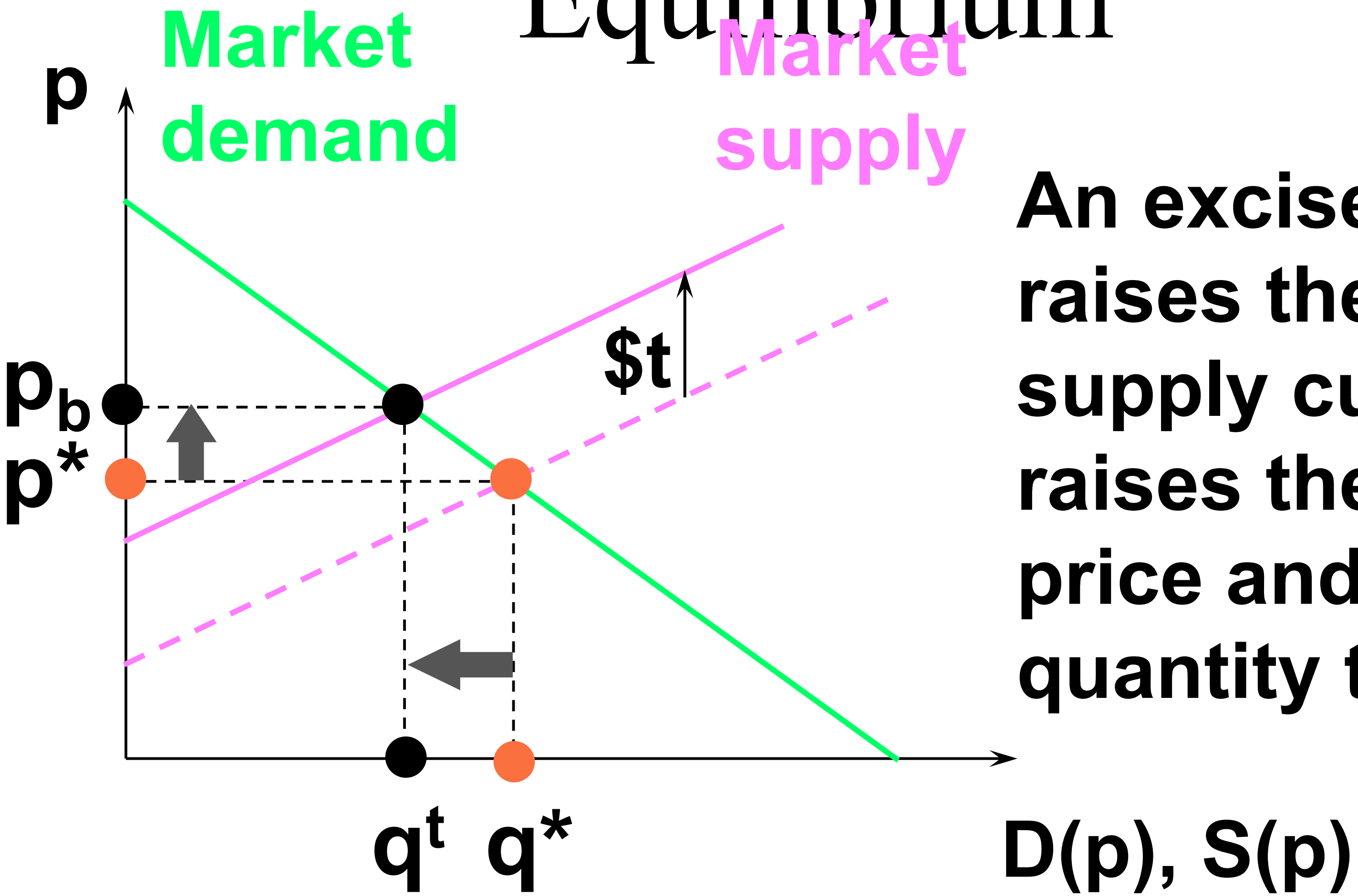


Quantity Taxes & Market Equilibrium



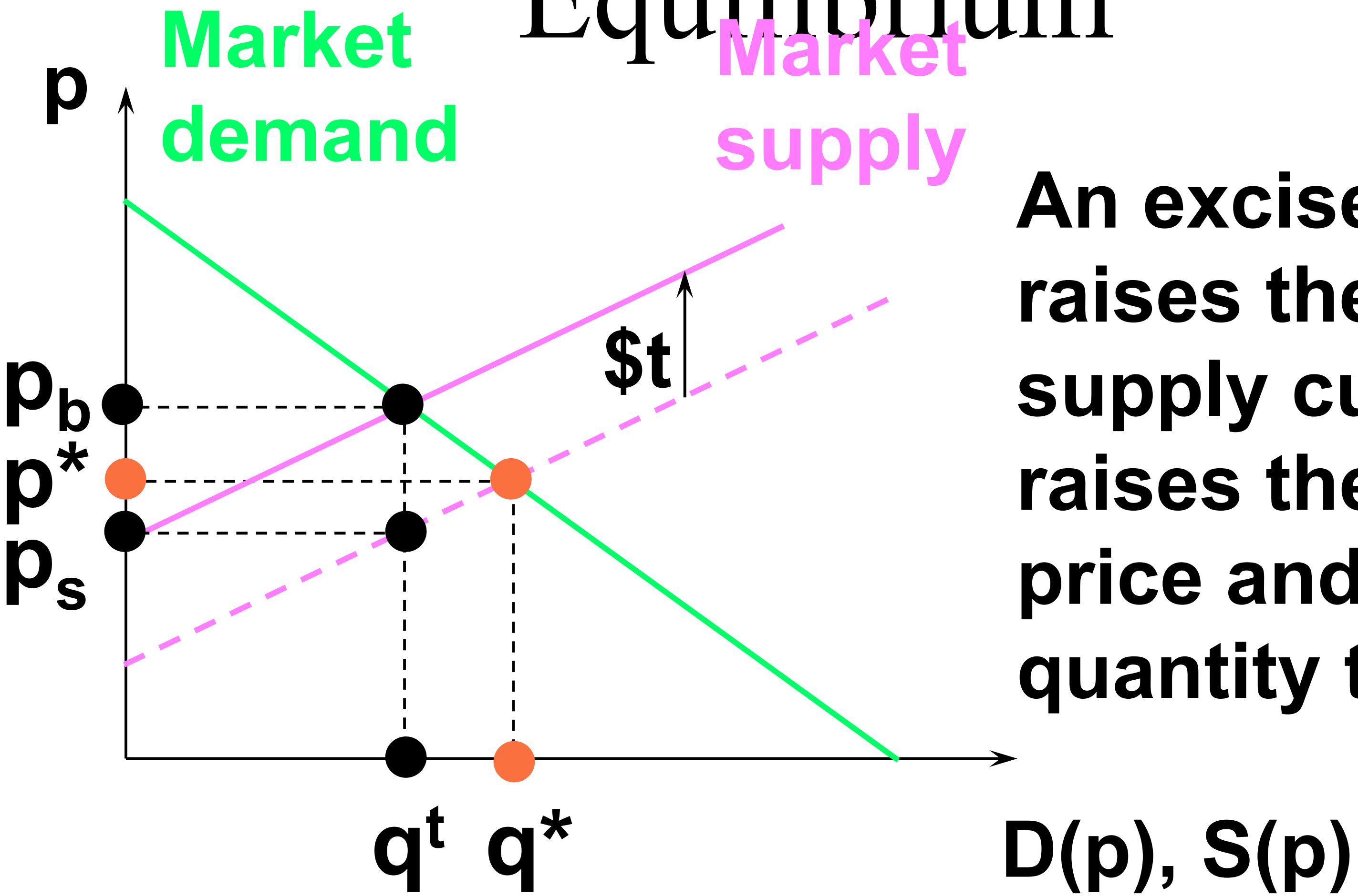
An excise tax raises the market supply curve by $t

Quantity Taxes & Market Equilibrium



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

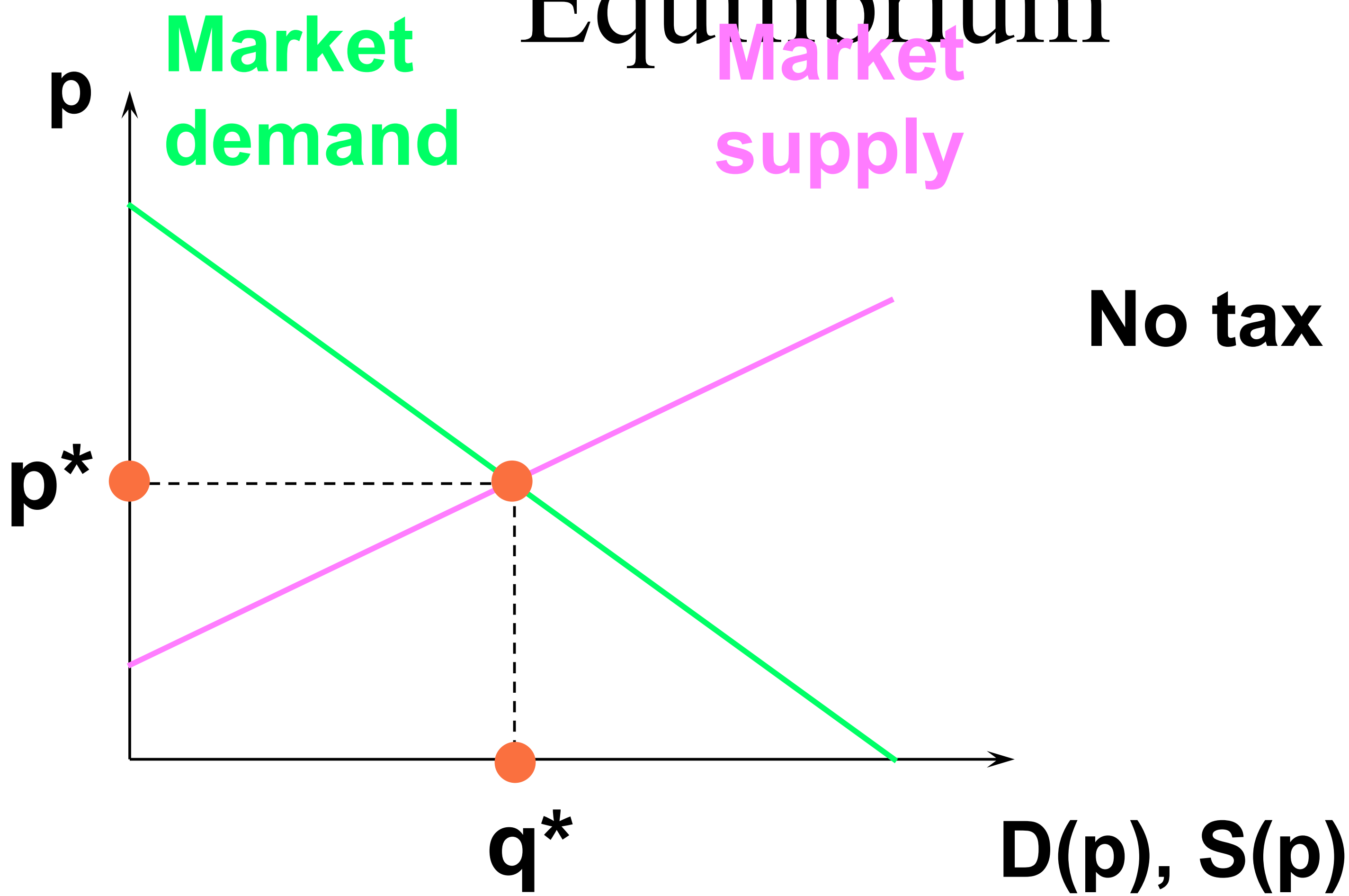
Quantity Taxes & Market Equilibrium



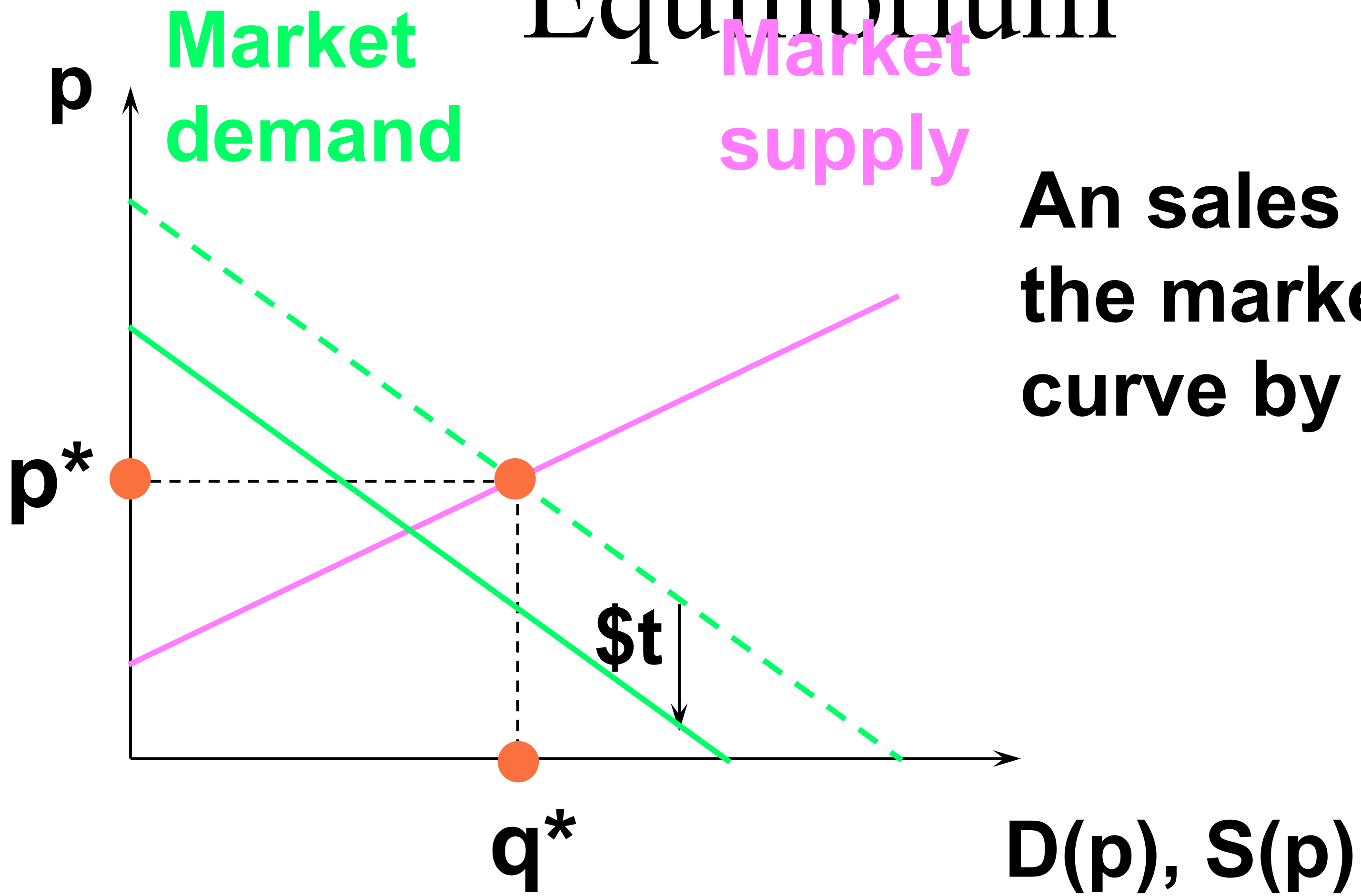
An excise tax raises the market supply curve by \$t, raises the buyers' price and lowers the quantity traded.

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

Quantity Taxes & Market Equilibrium

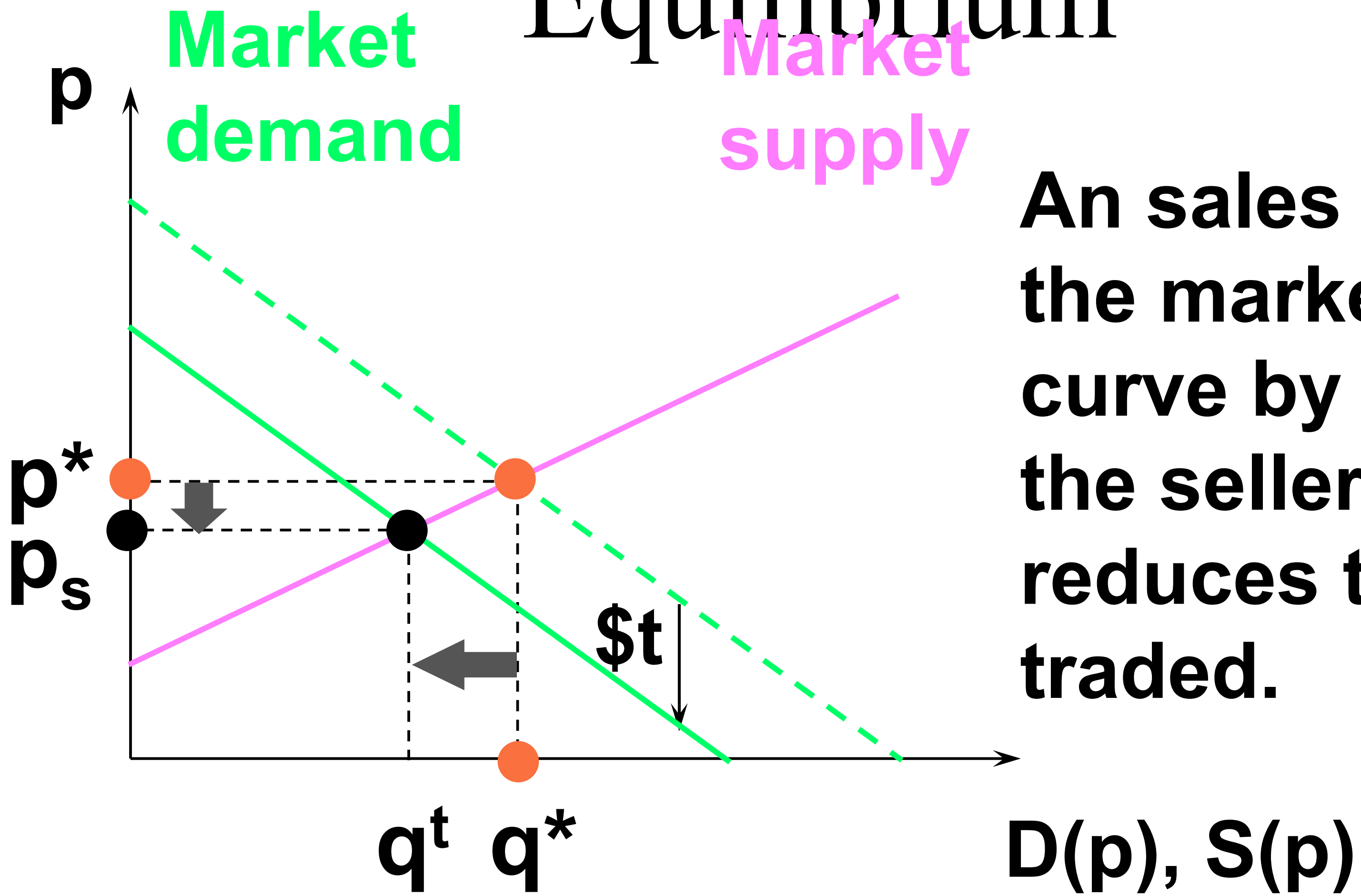


Quantity Taxes & Market Equilibrium



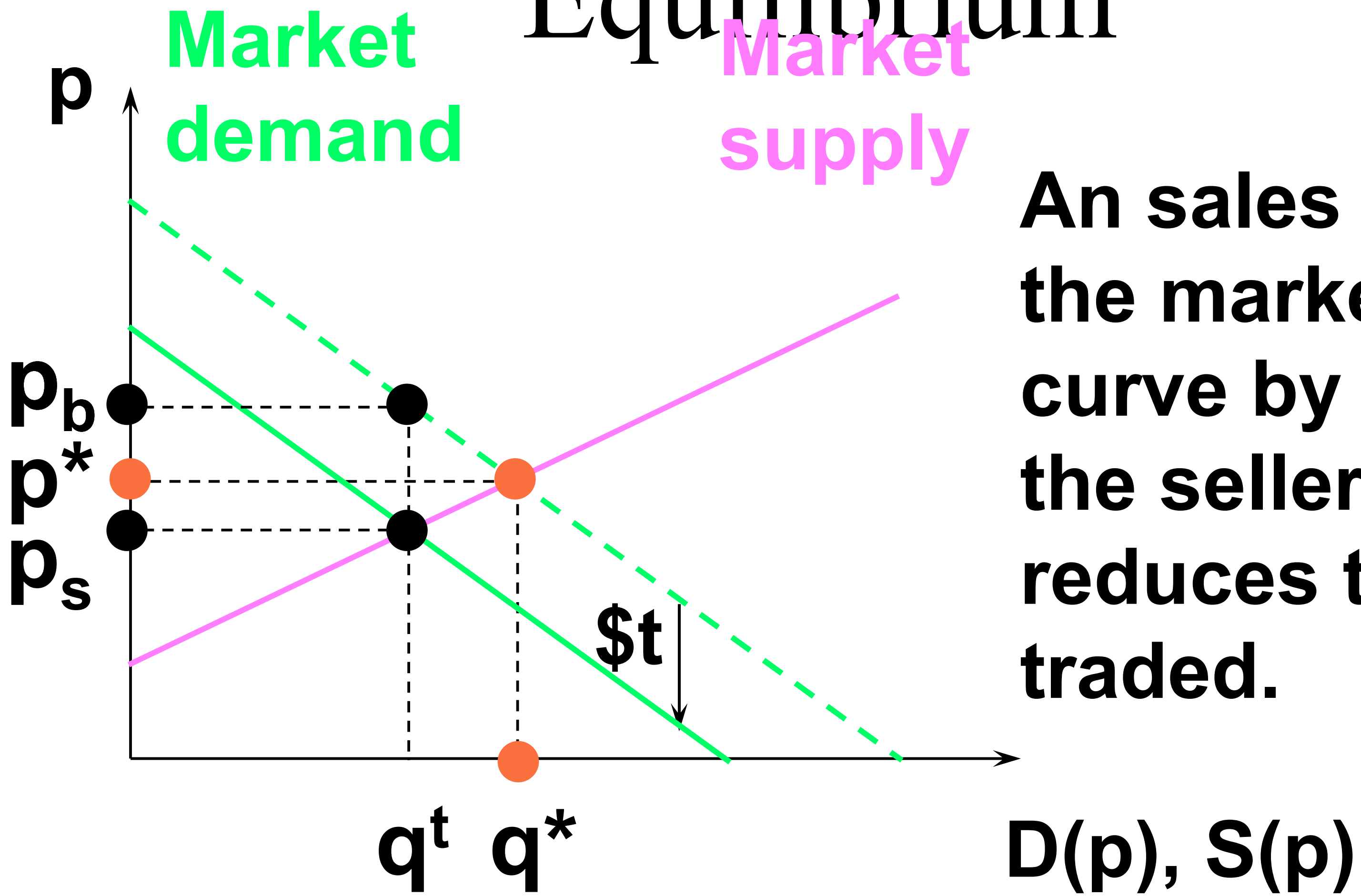
An sales tax lowers the market demand curve by $t

Quantity Taxes & Market Equilibrium



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

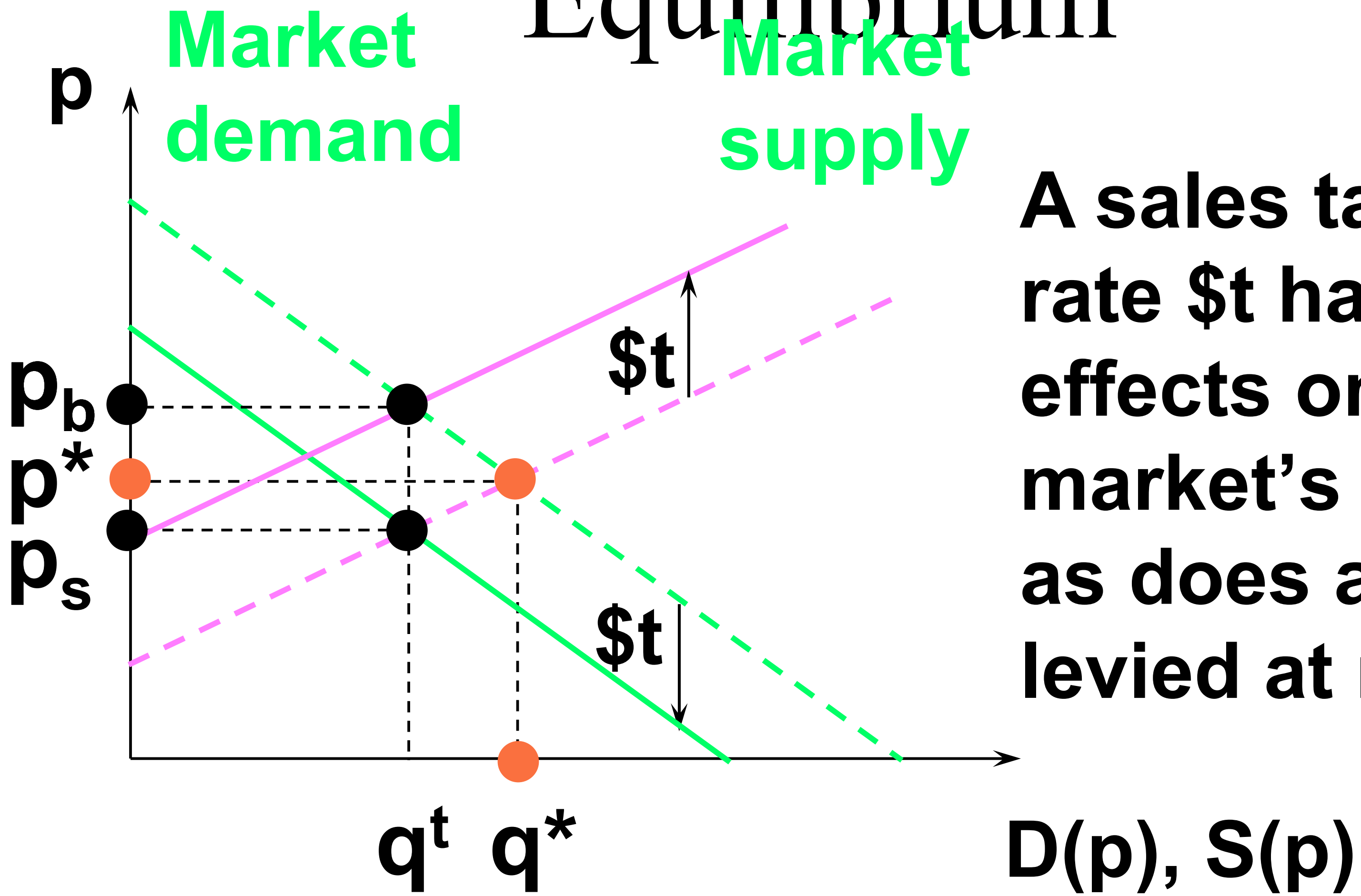
Quantity Taxes & Market Equilibrium



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

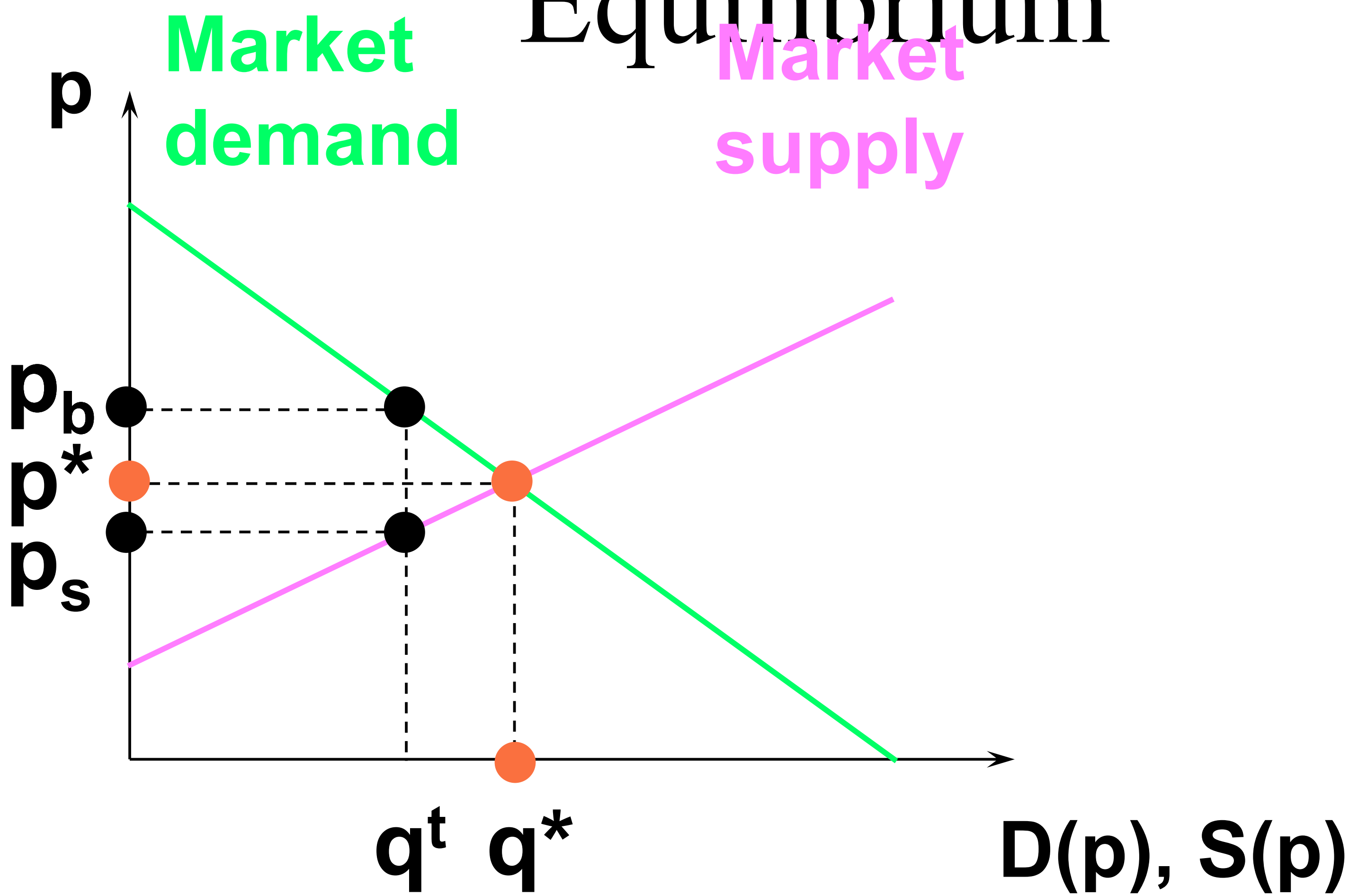


A sales tax levied at rate $t has the same effects on the market's equilibrium as does an excise tax levied at rate $t.

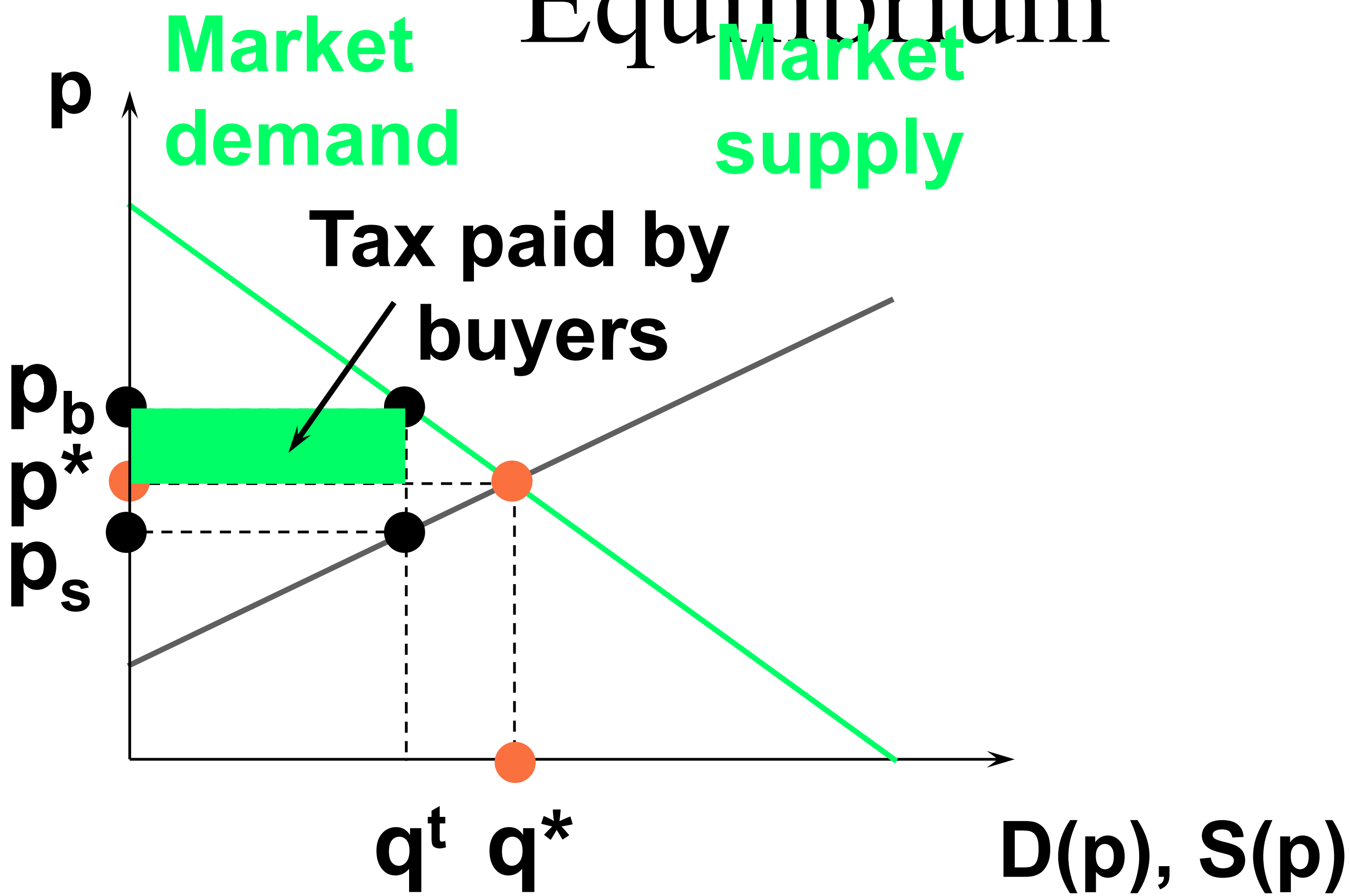
Quantity Taxes & Market Equilibrium

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

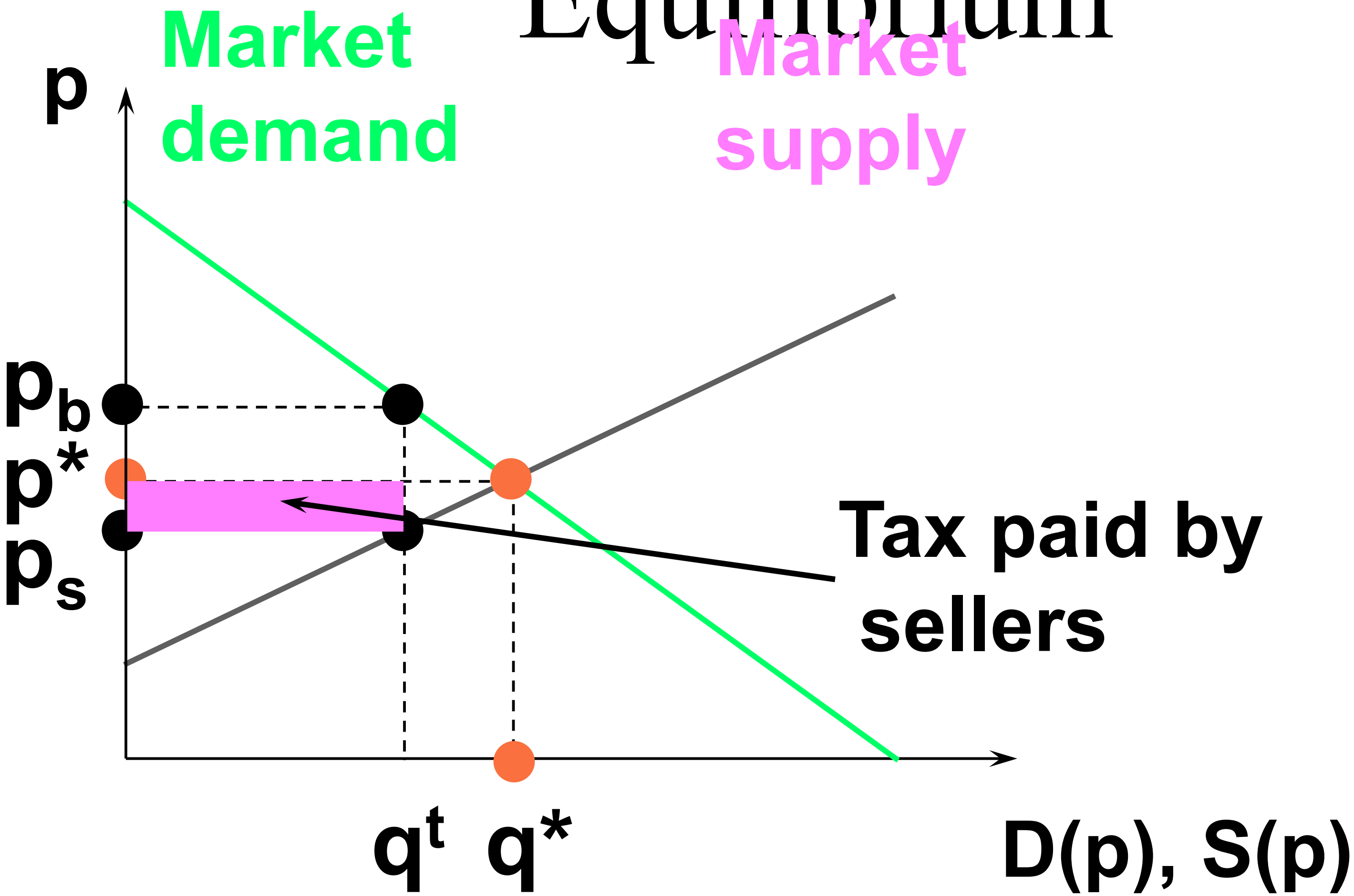
Quantity Taxes & Market Equilibrium



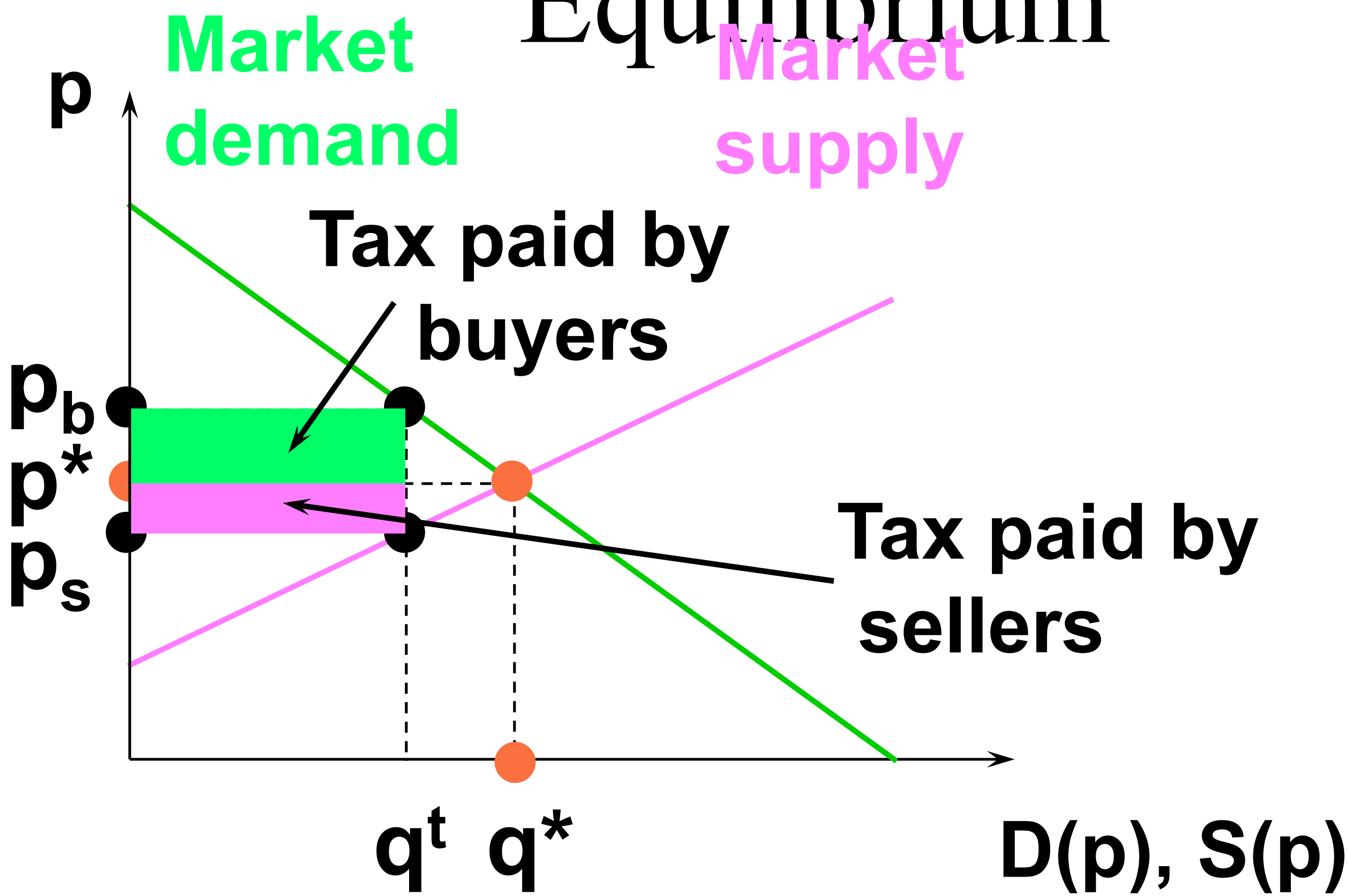
Quantity Taxes & Market Equilibrium



Quantity Taxes & Market Equilibrium



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

$$D(p_b) = a - bp_b \text{ and } S(p_s) = c + dp_s.$$

Quantity Taxes & Market Equilibrium

$$D(p_b) = a - bp_b \text{ and } S(p_s) = c + dp_s.$$

With the tax, the market equilibrium satisfies

$$p_b = p_s + t \quad \text{and} \quad D(p_b) = S(p_s) \quad \text{so}$$

$$p_b = p_s + t \quad \text{and} \quad a - bp_b = c + dp_s.$$

Quantity Taxes & Market Equilibrium

$$D(p_b) = a - bp_b \text{ and } S(p_s) = c + dp_s.$$

With the tax, the market equilibrium satisfies

$$p_b = p_s + t \quad \text{and} \quad D(p_b) = S(p_s) \quad \text{so}$$

$$p_b = p_s + t \quad \text{and} \quad a - bp_b = c + dp_s.$$

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

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

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

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

$$p_s = \frac{a - c - bt}{b + d}$$

$$q^t = \frac{ad + bc - bdt}{b + d}$$

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

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

Quantity Taxes & Market Equilibrium

$$p_s = \frac{a - c - bt}{b + d}$$

$$q^t = \frac{ad + bc - bdt}{b + d}$$

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

As t increases, **p_s falls,**

p_b rises,

and **q^t falls.**

Quantity Taxes & Market Equilibrium

$$p_s = \frac{a - c - bt}{b + d}$$

$$q^t = \frac{ad + bc - bdt}{b + d}$$

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

The tax paid per unit by the buyer is

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

Quantity Taxes & Market Equilibrium

$$p_s = \frac{a - c - bt}{b + d}$$

$$q^t = \frac{ad + bc - bdt}{b + d}$$

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

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

$$p_s = \frac{a - c - bt}{b + d}$$

$$q^t = \frac{ad + bc - bdt}{b + d}$$

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

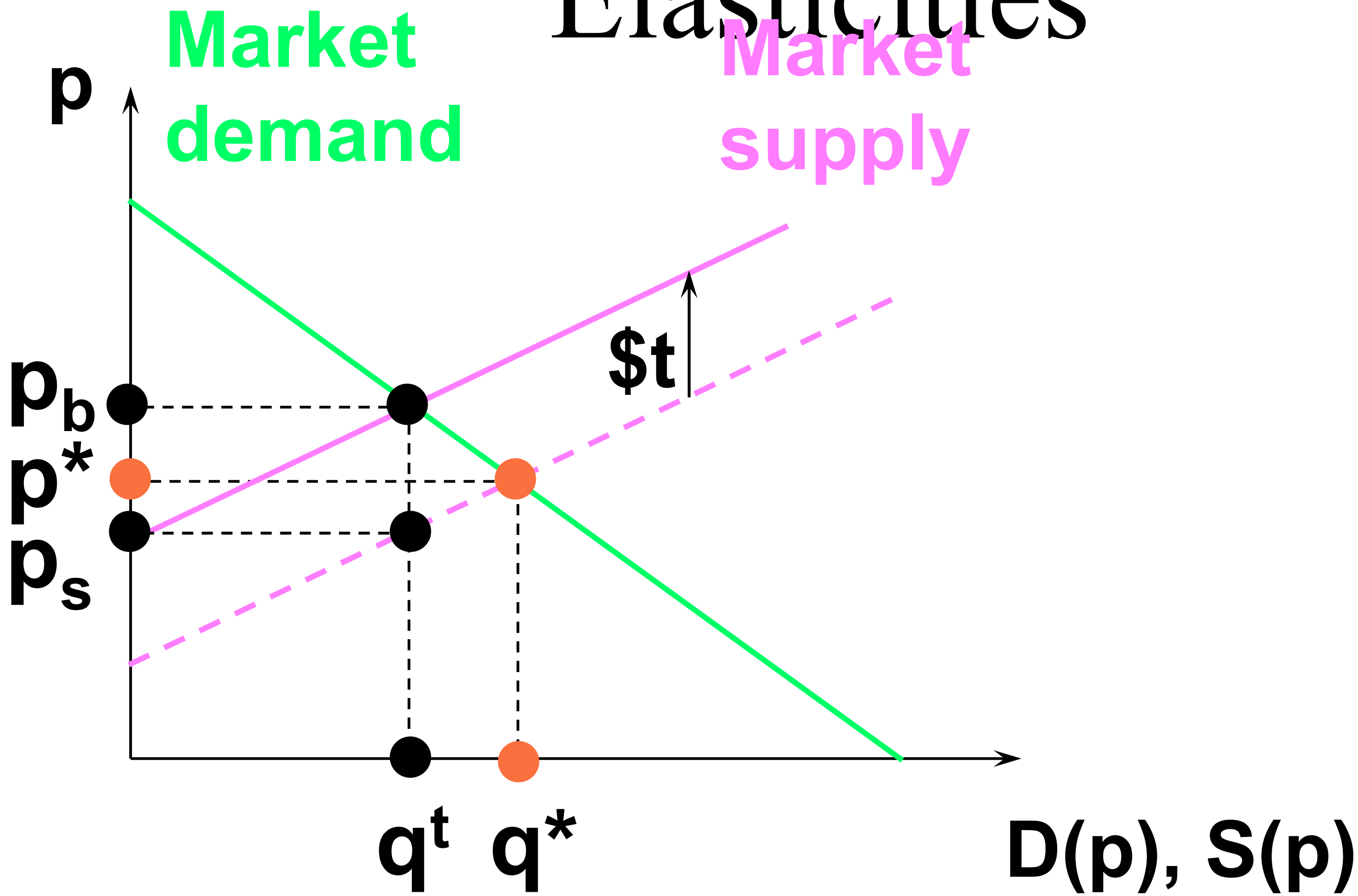
The total tax paid (by buyers and sellers combined) is

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

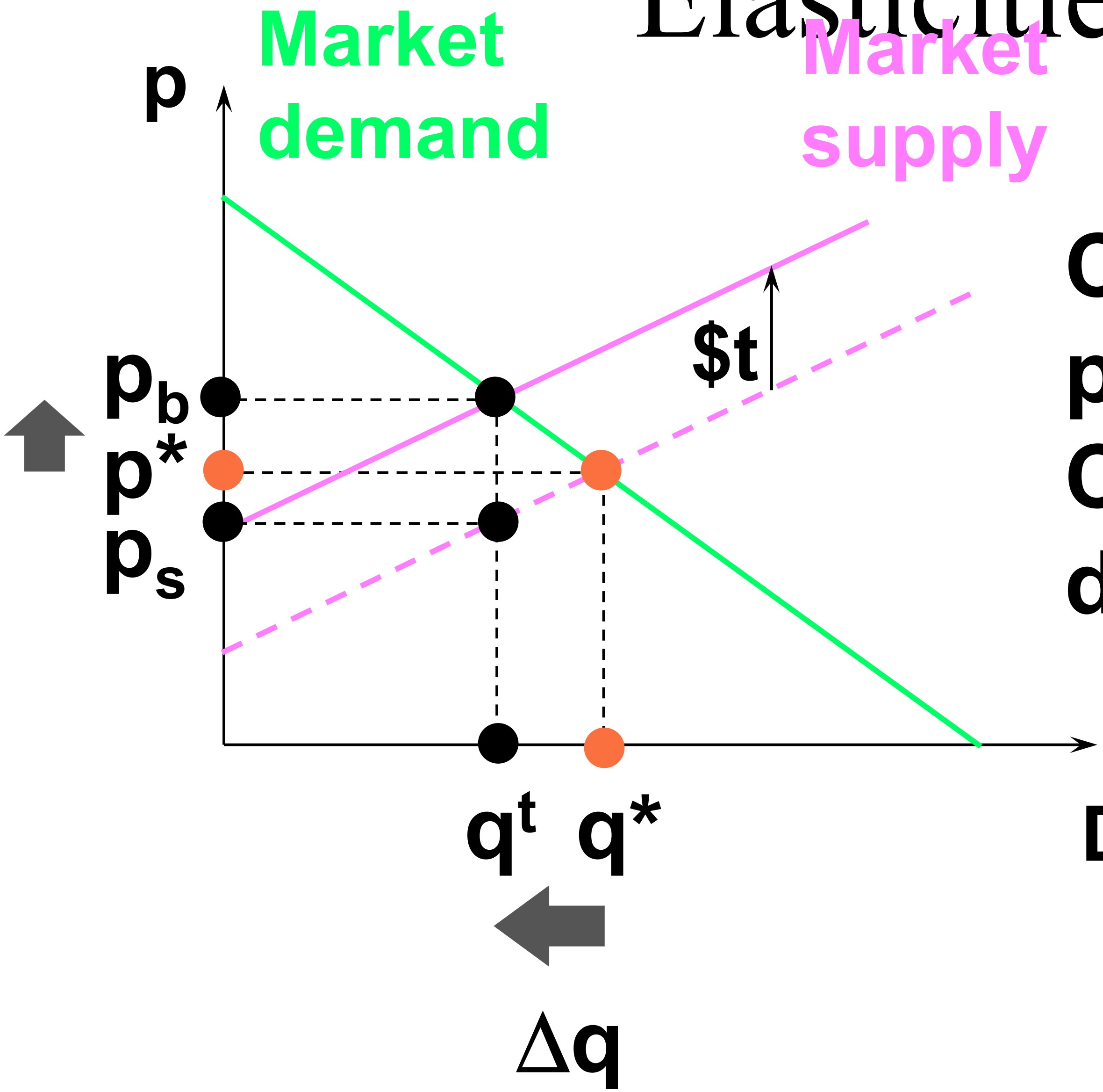
Tax Incidence and Own-Price Elasticities

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

Tax Incidence and Own-Price Elasticities



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

$$\varepsilon_D \approx \frac{\dfrac{\Delta q}{q^*}}{\dfrac{p_b - p^*}{p^*}}$$

Tax Incidence and Own-Price Elasticities

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

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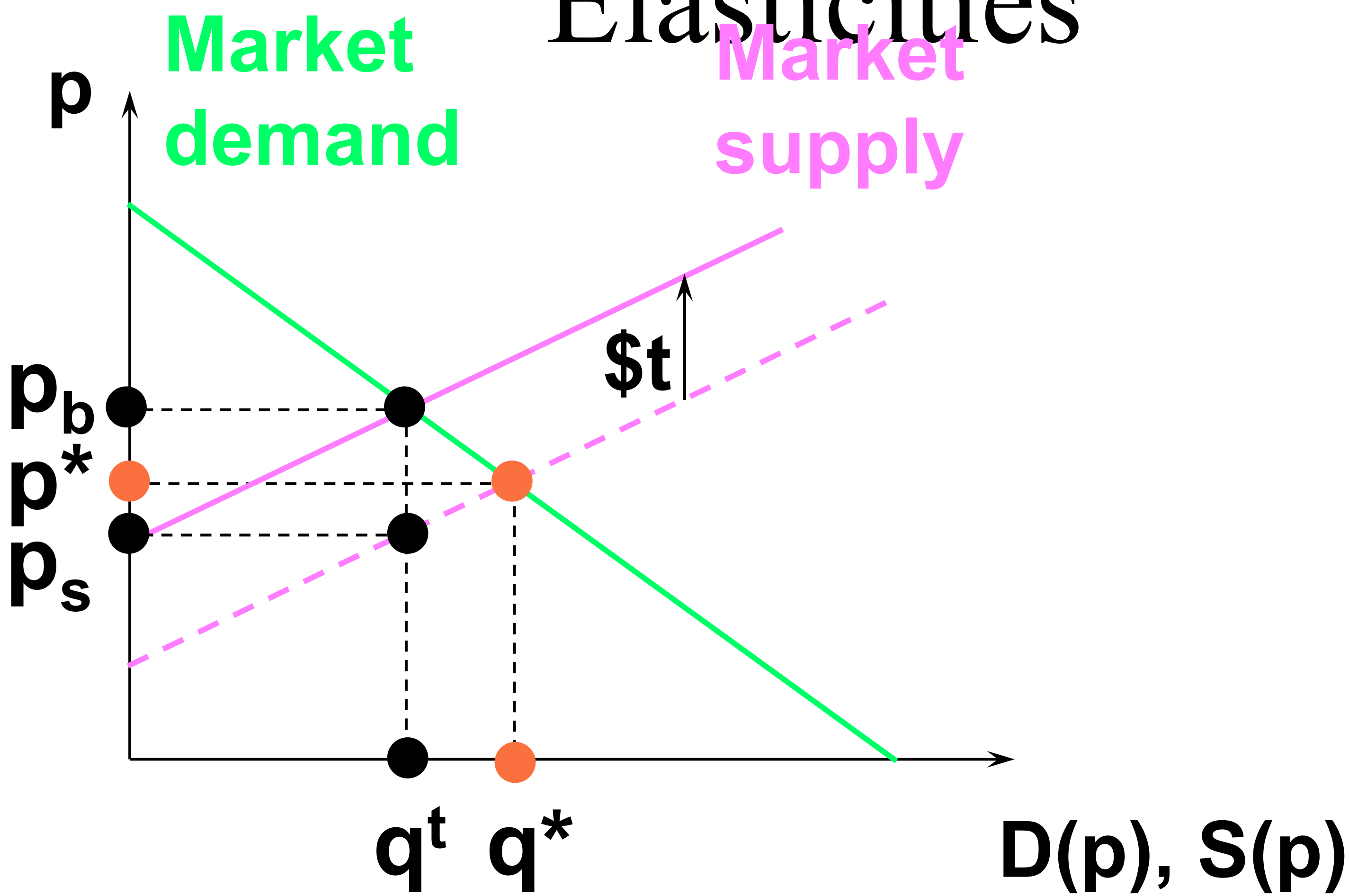
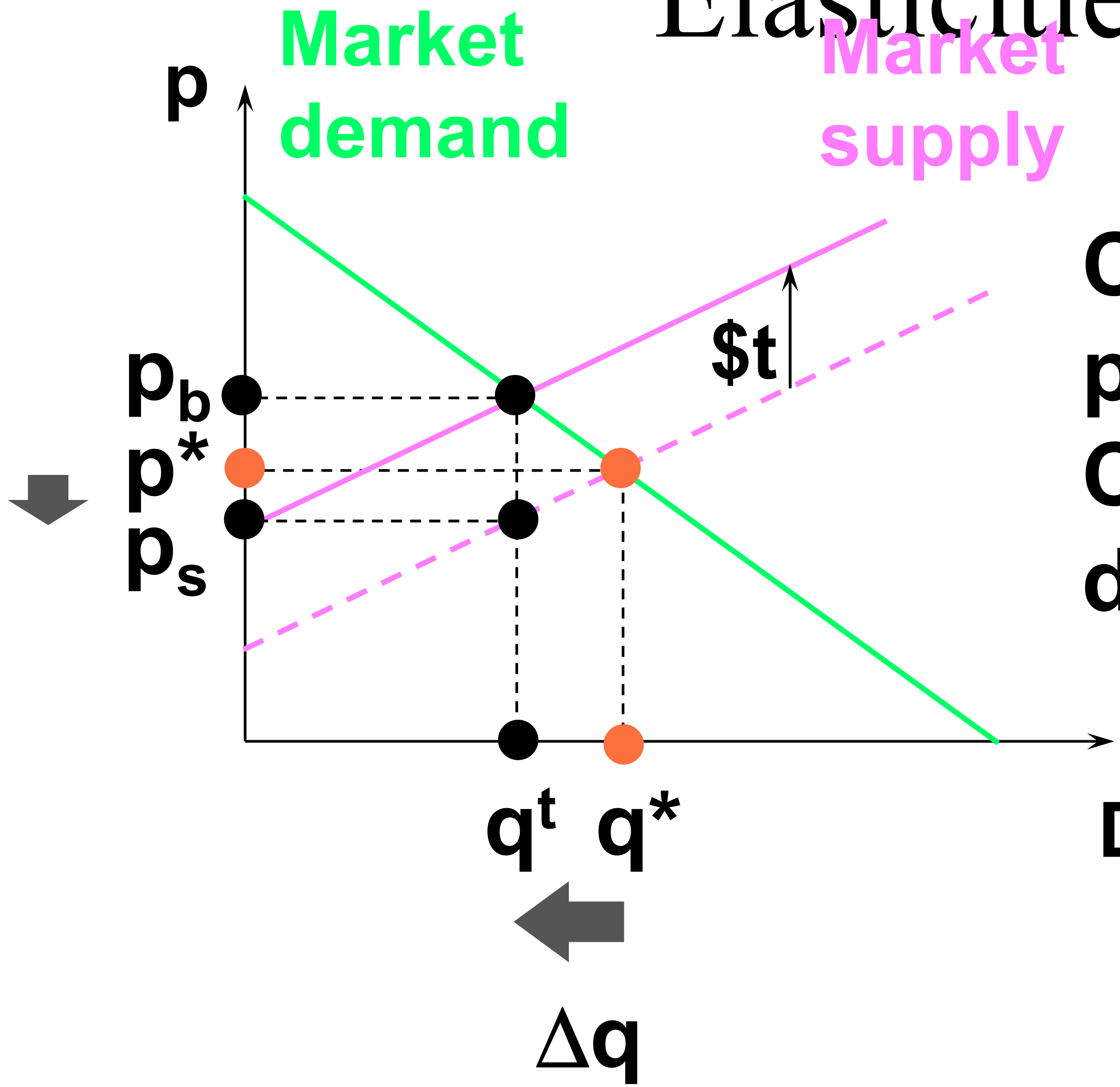
Tax Incidence and Own-Price Elasticities



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

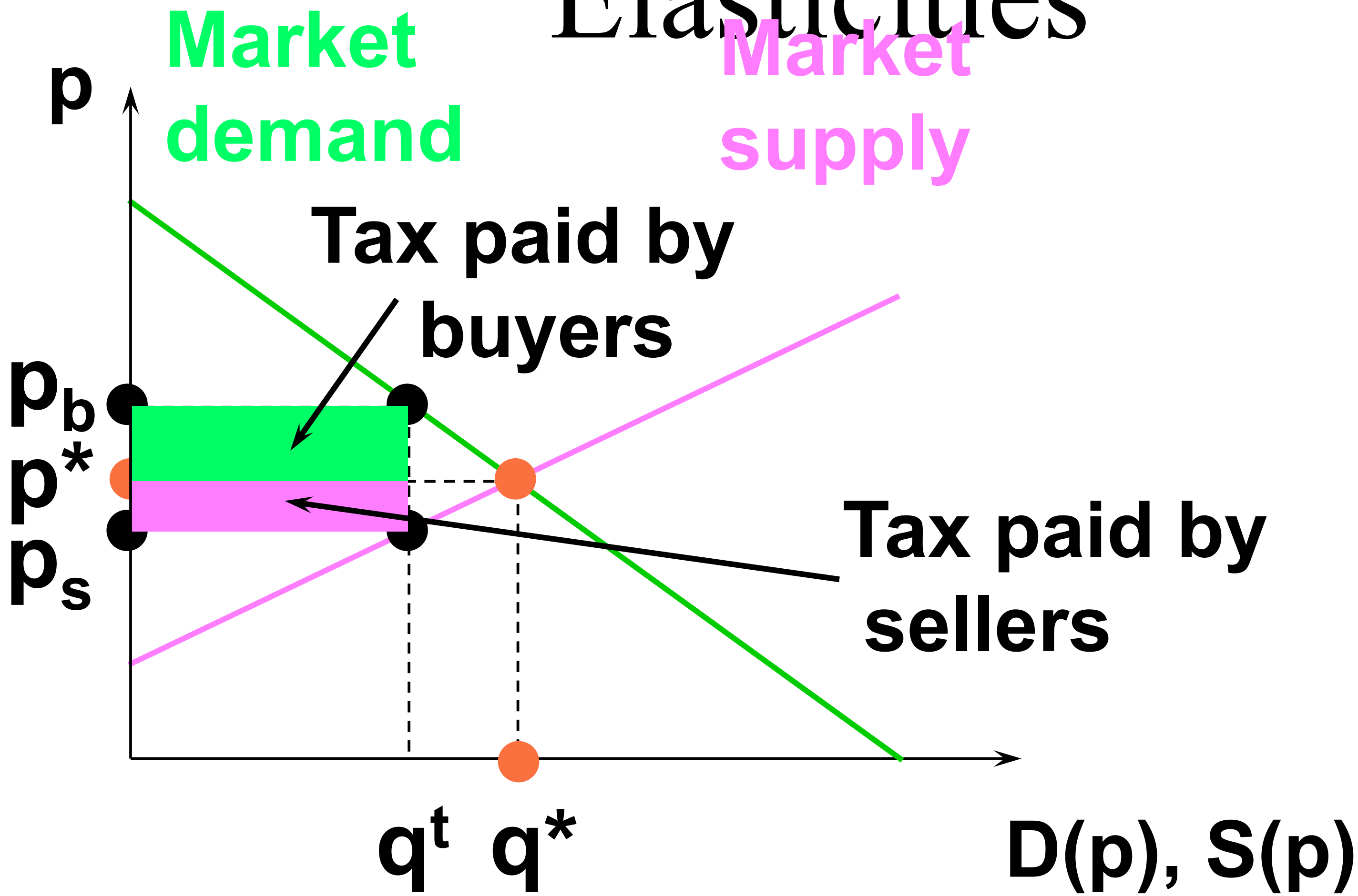
$$\varepsilon_S \approx \frac{\dfrac{\Delta q}{q^*}}{\dfrac{p_s - p^*}{p^*}}$$

Tax Incidence and Own-Price Elasticities

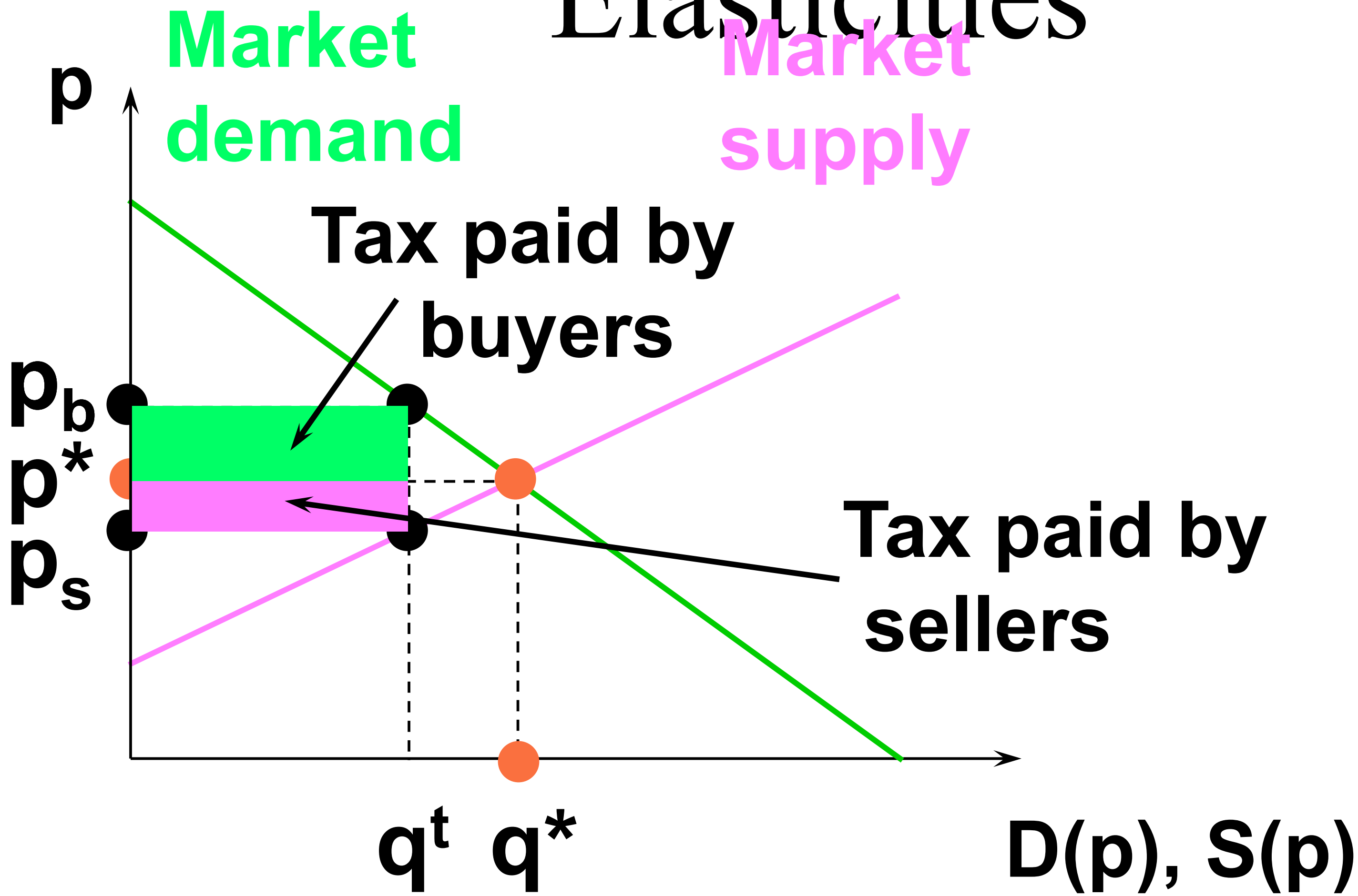
Around p = p* the own-price elasticity of supply is approximately

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

Tax Incidence and Own-Price Elasticities



Tax Incidence and Own-Price Elasticities



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

Tax Incidence and Own-Price Elasticities

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

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

Tax Incidence and Own-Price Elasticities

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

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

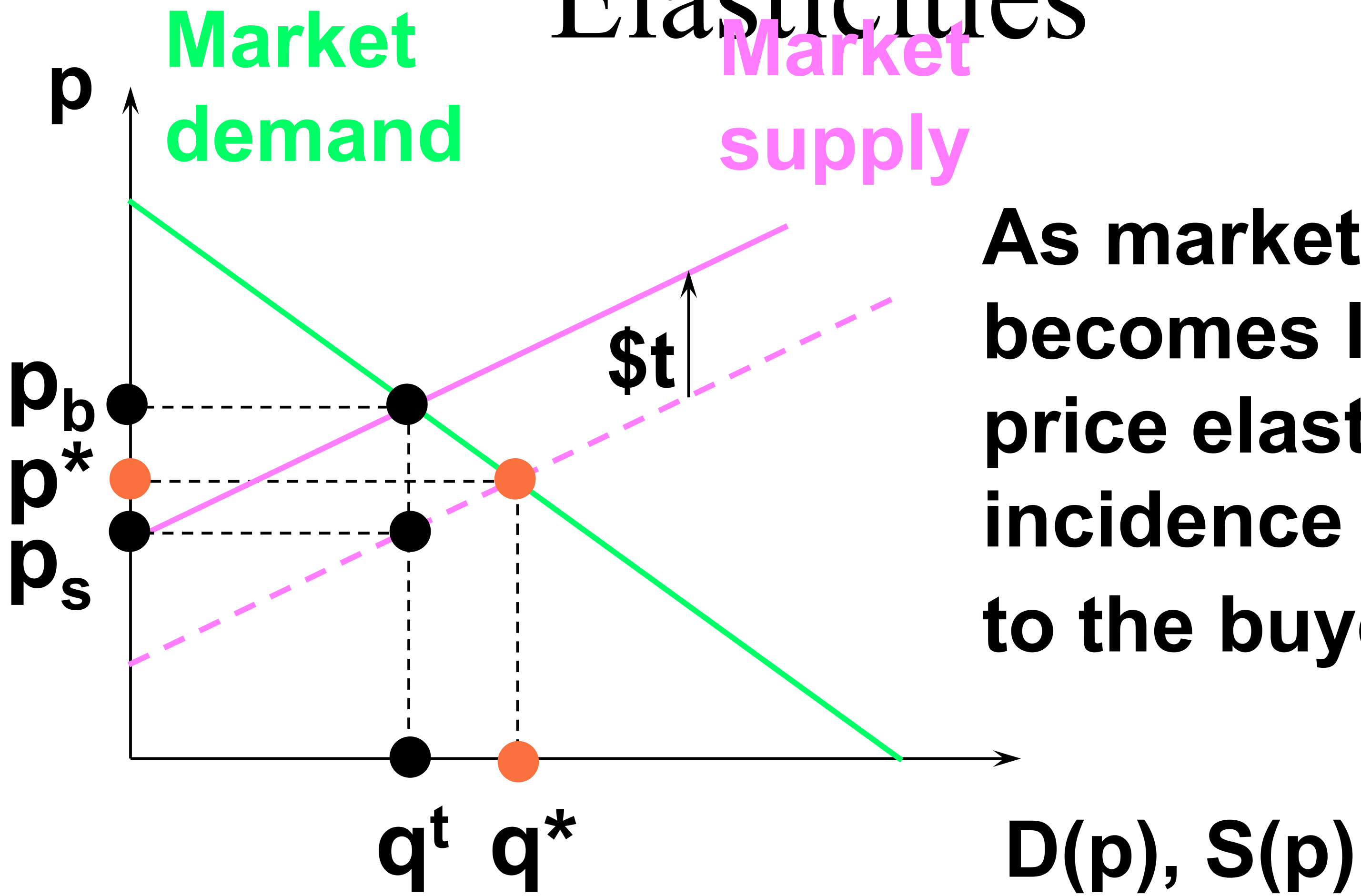
So $$\frac{p_b - p^*}{p^* - p_s} \approx -\frac{\varepsilon_S}{\varepsilon_D}.$$

Tax Incidence and Own-Price Elasticities

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

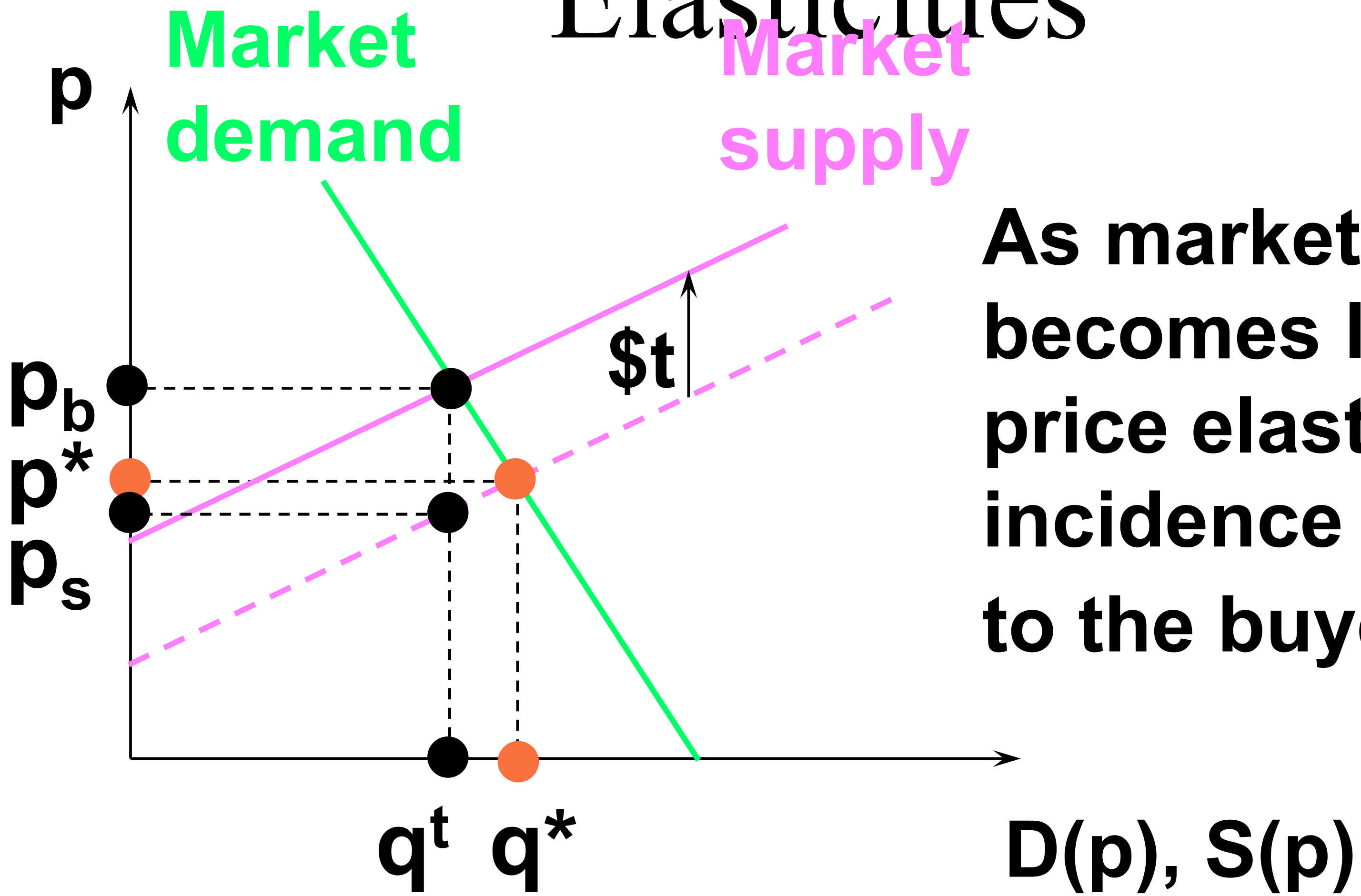
The fraction of a $t quantity tax paid by buyers rises as supply becomes more own-price elastic or as demand becomes less own-price elastic.

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



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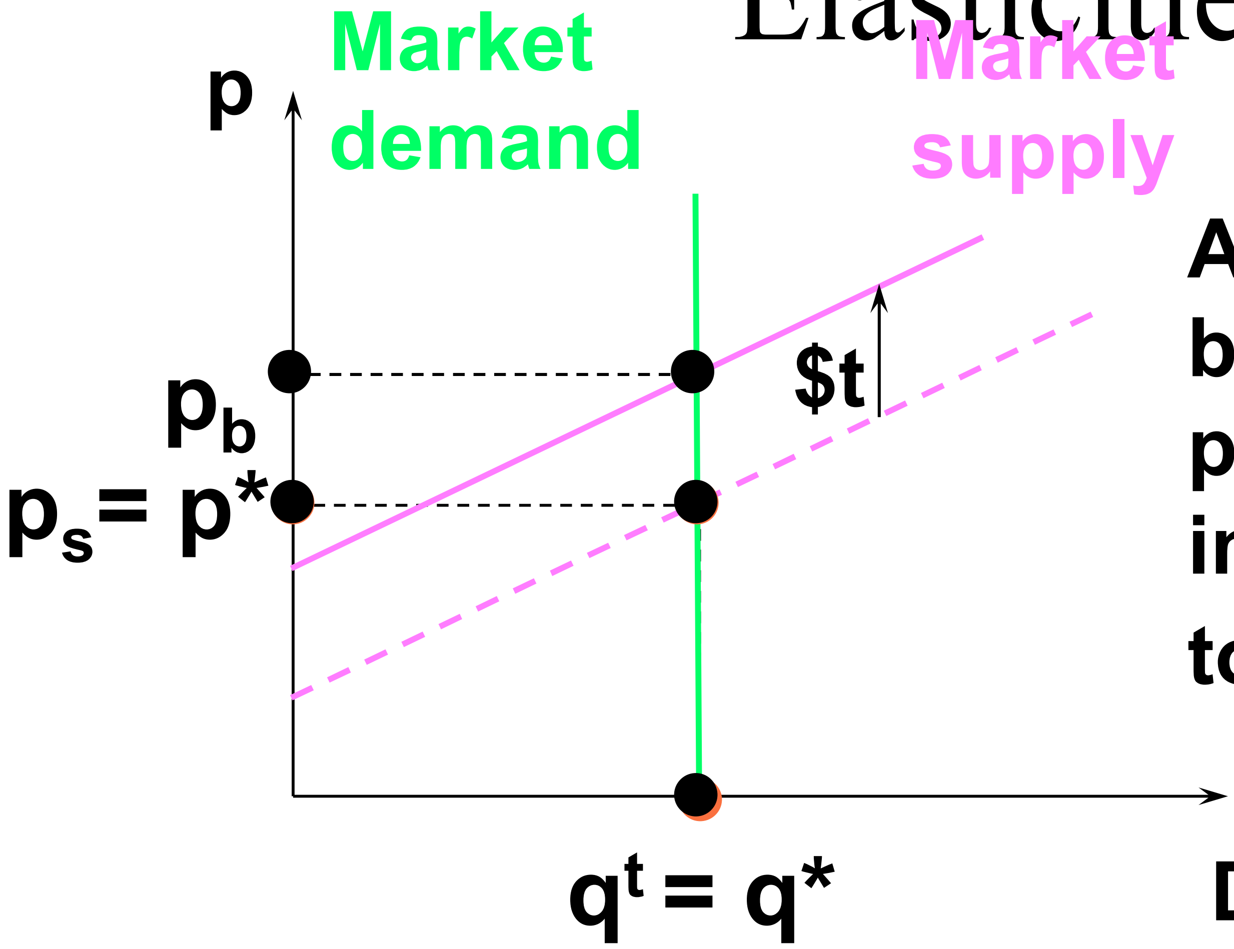
Tax Incidence and Own-Price Elasticities



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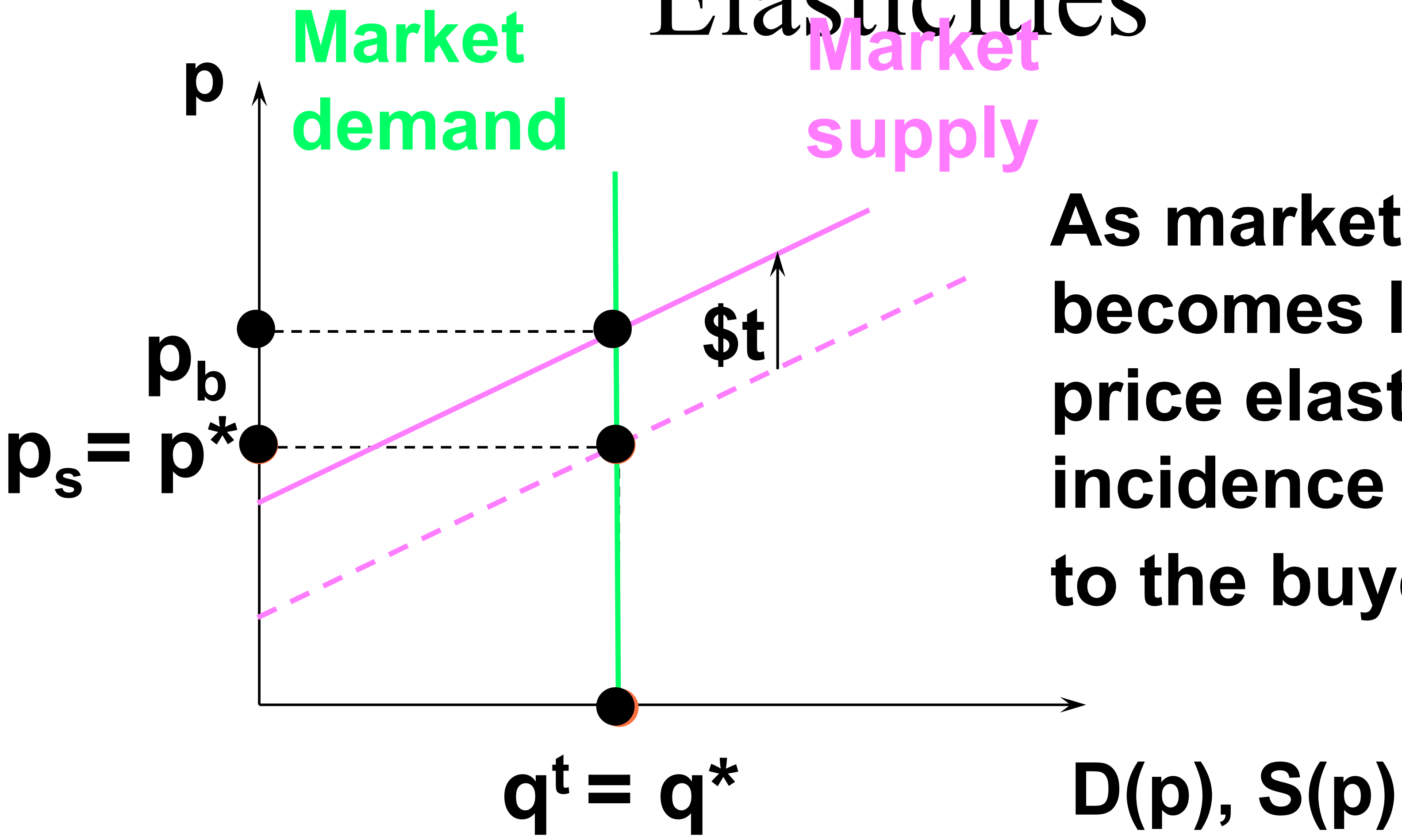
Tax Incidence and Own-Price Elasticities



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

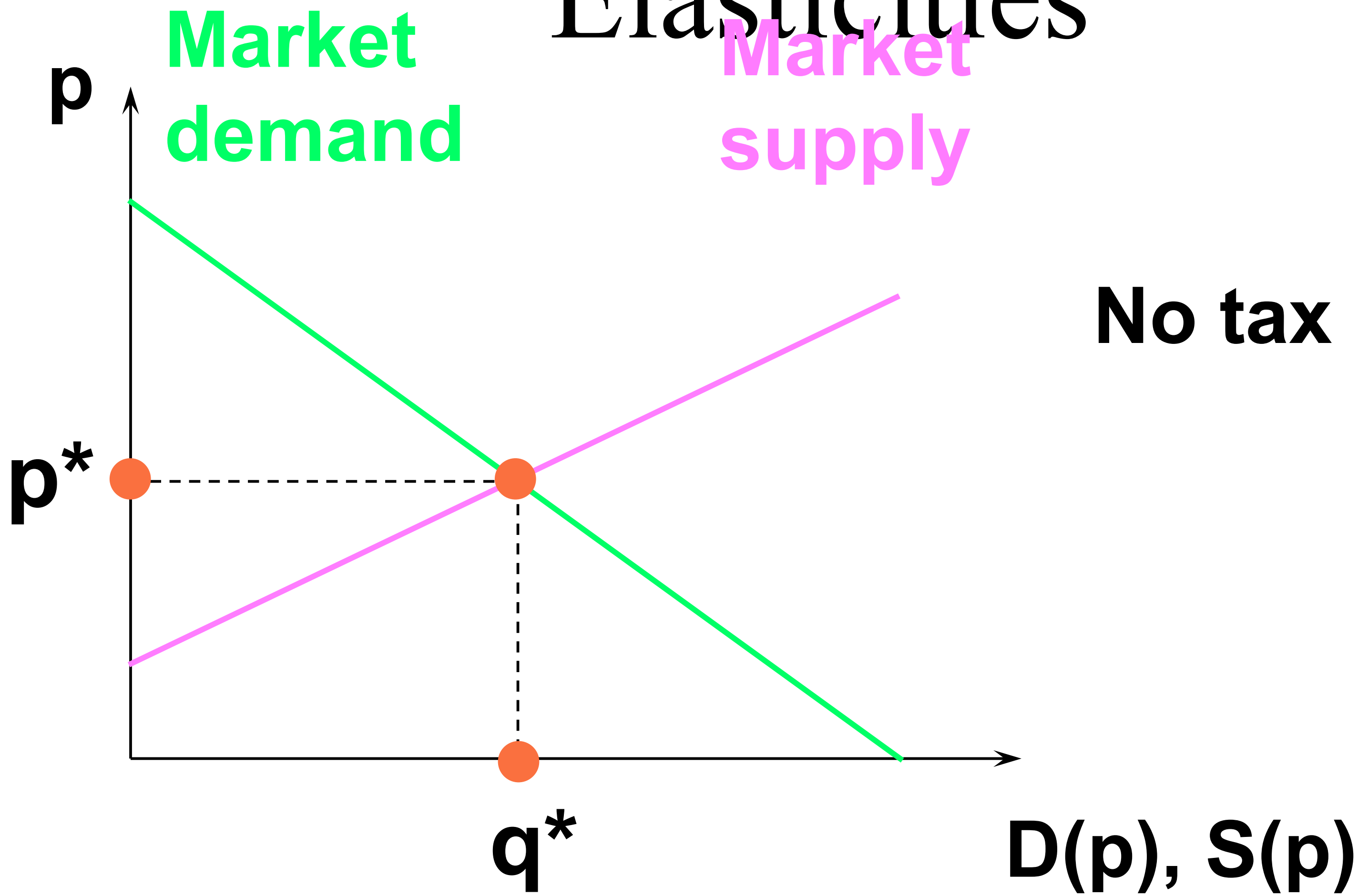
Tax incidence is $$\frac{p_b - p^*}{p^* - p_s} \approx -\frac{\varepsilon_S}{\varepsilon_D}.$$

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.

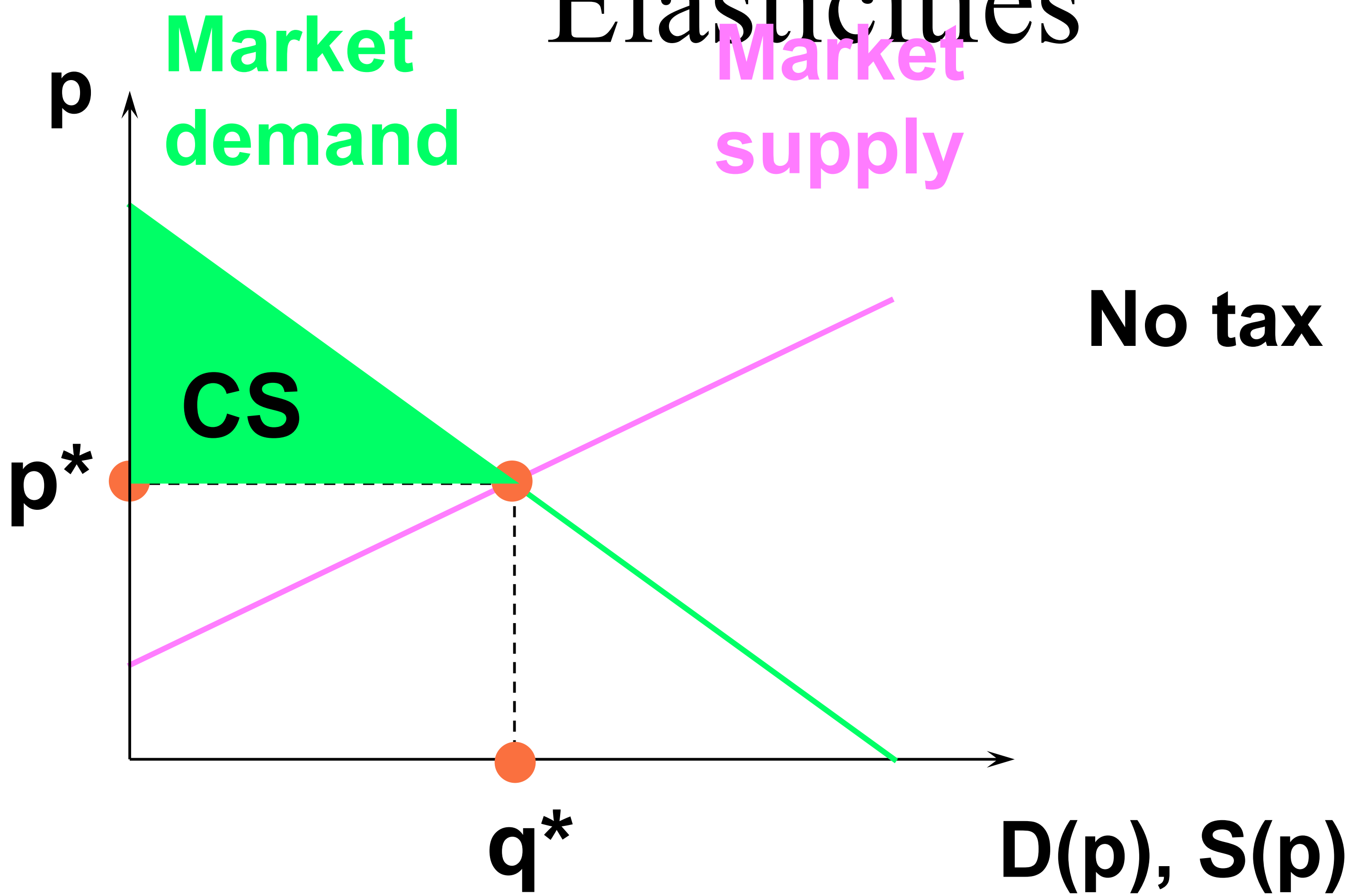
Deadweight Loss and Own-Price Elasticities

- **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



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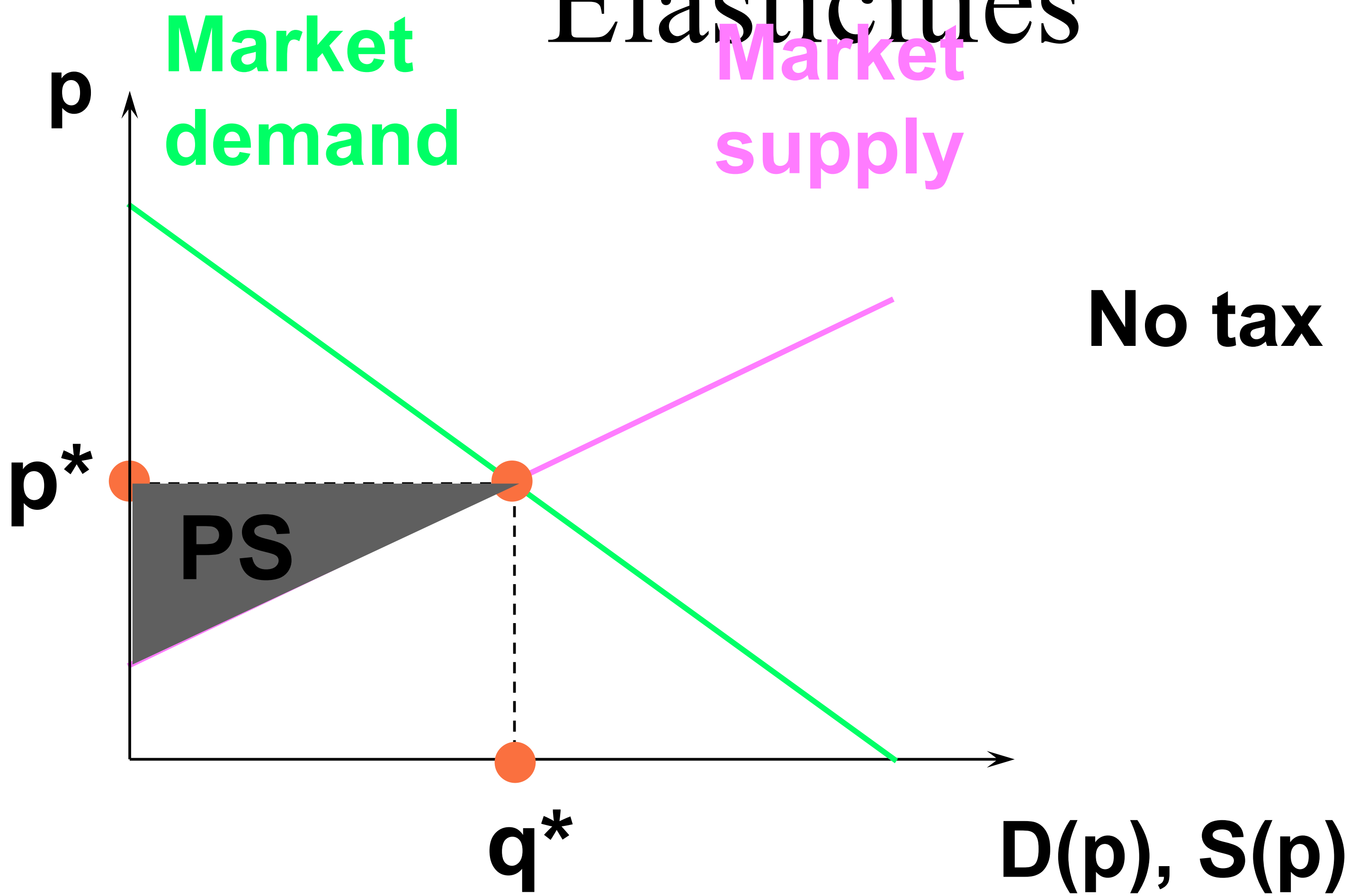

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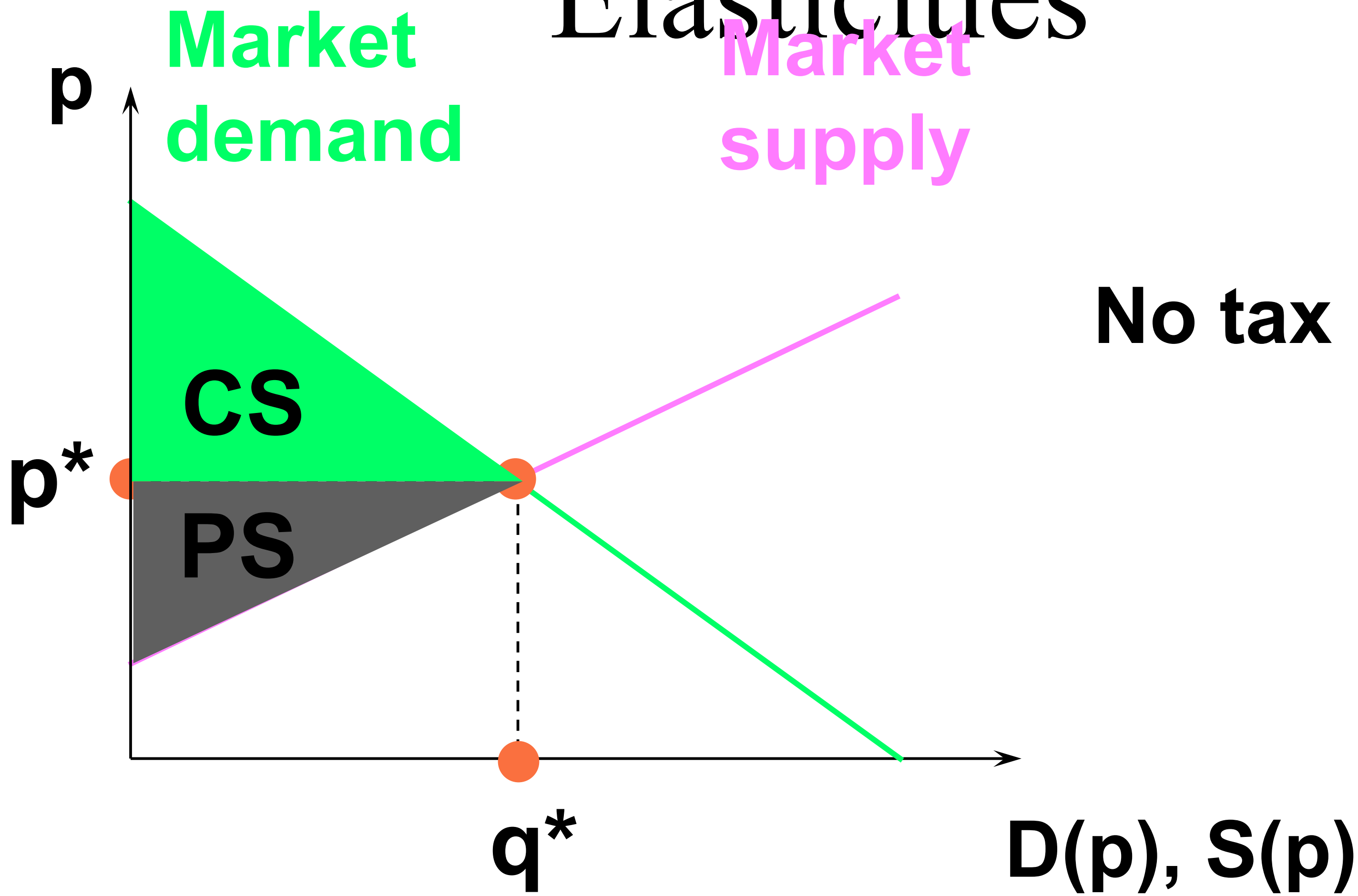

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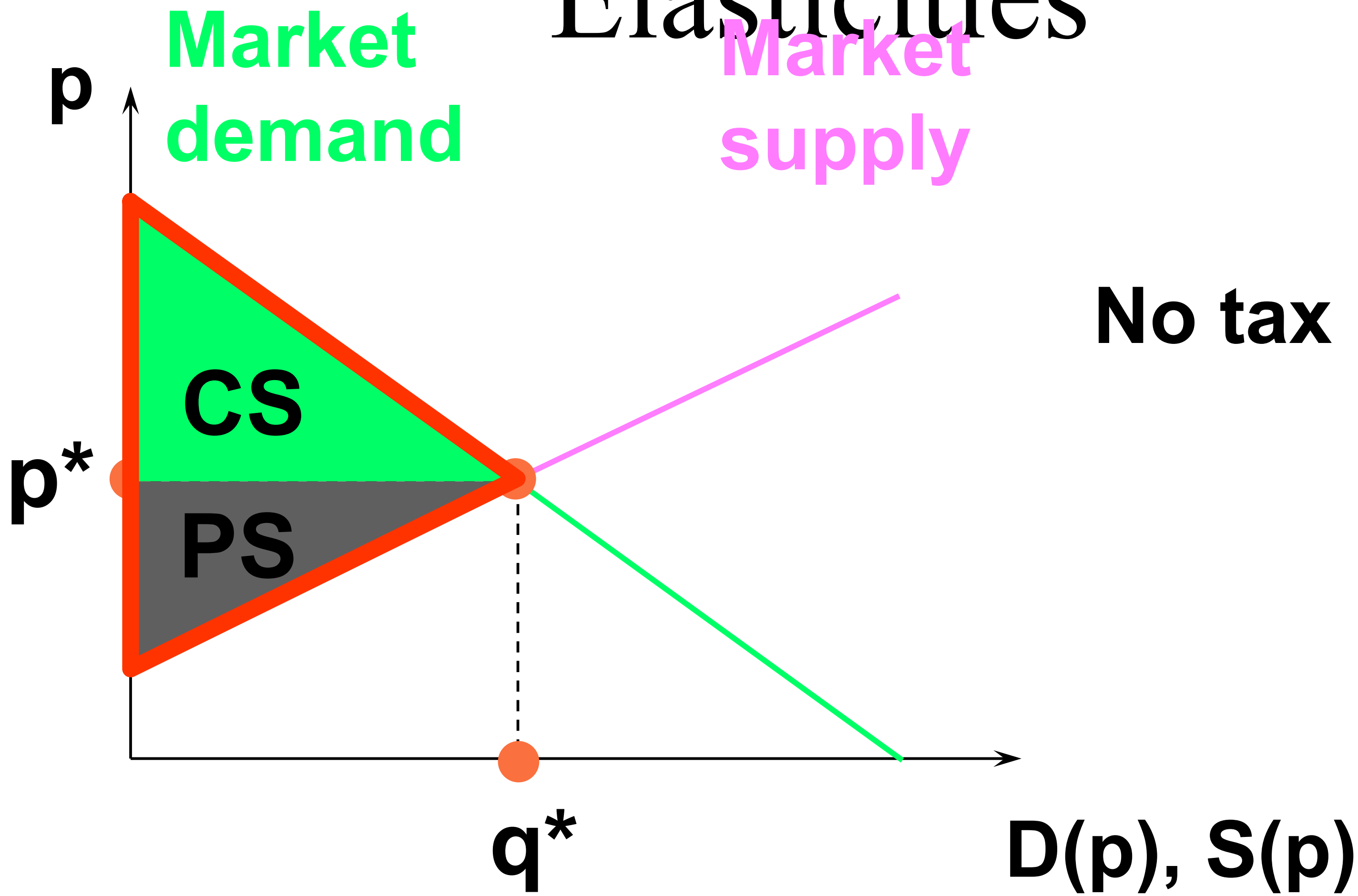

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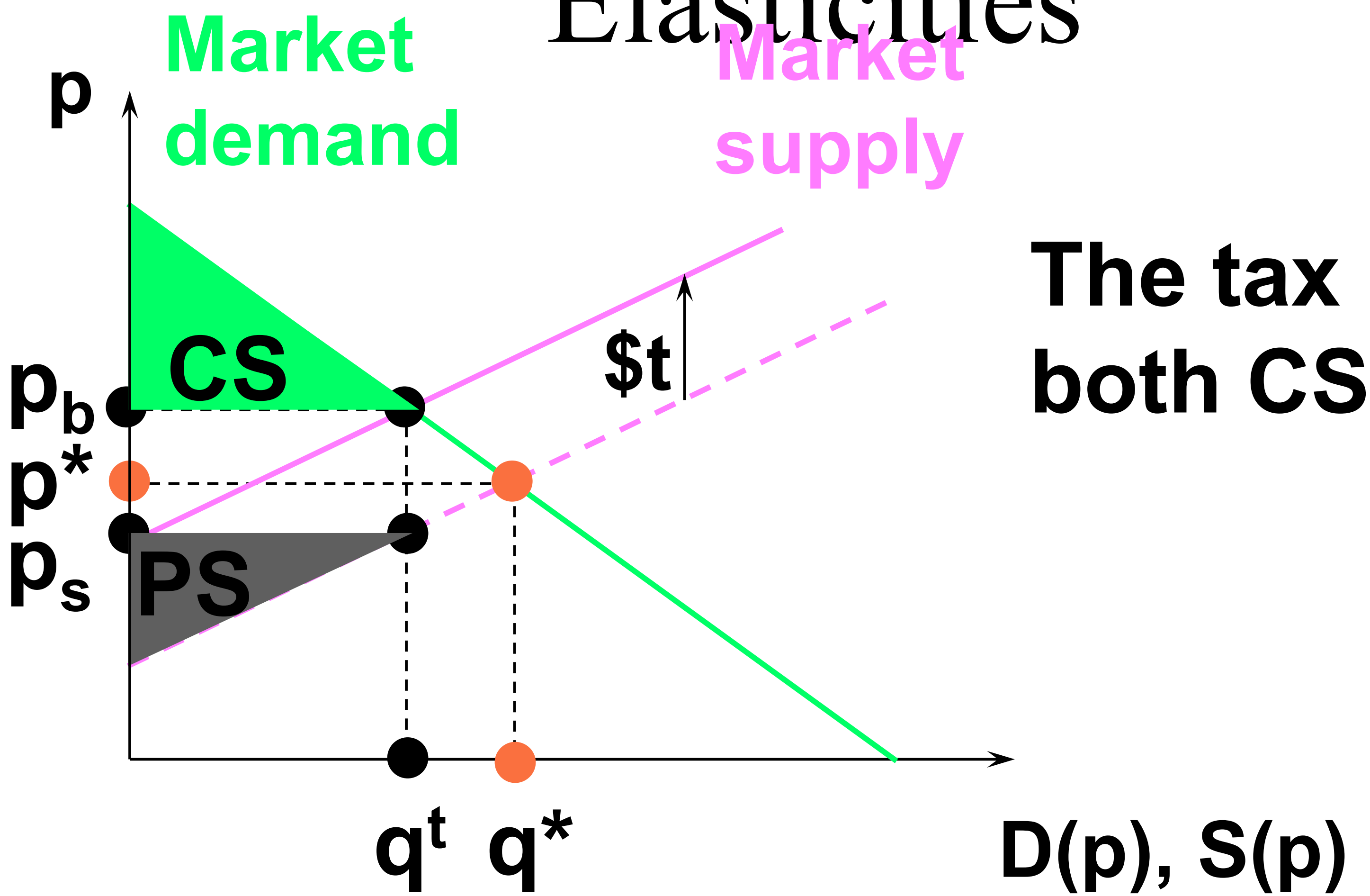
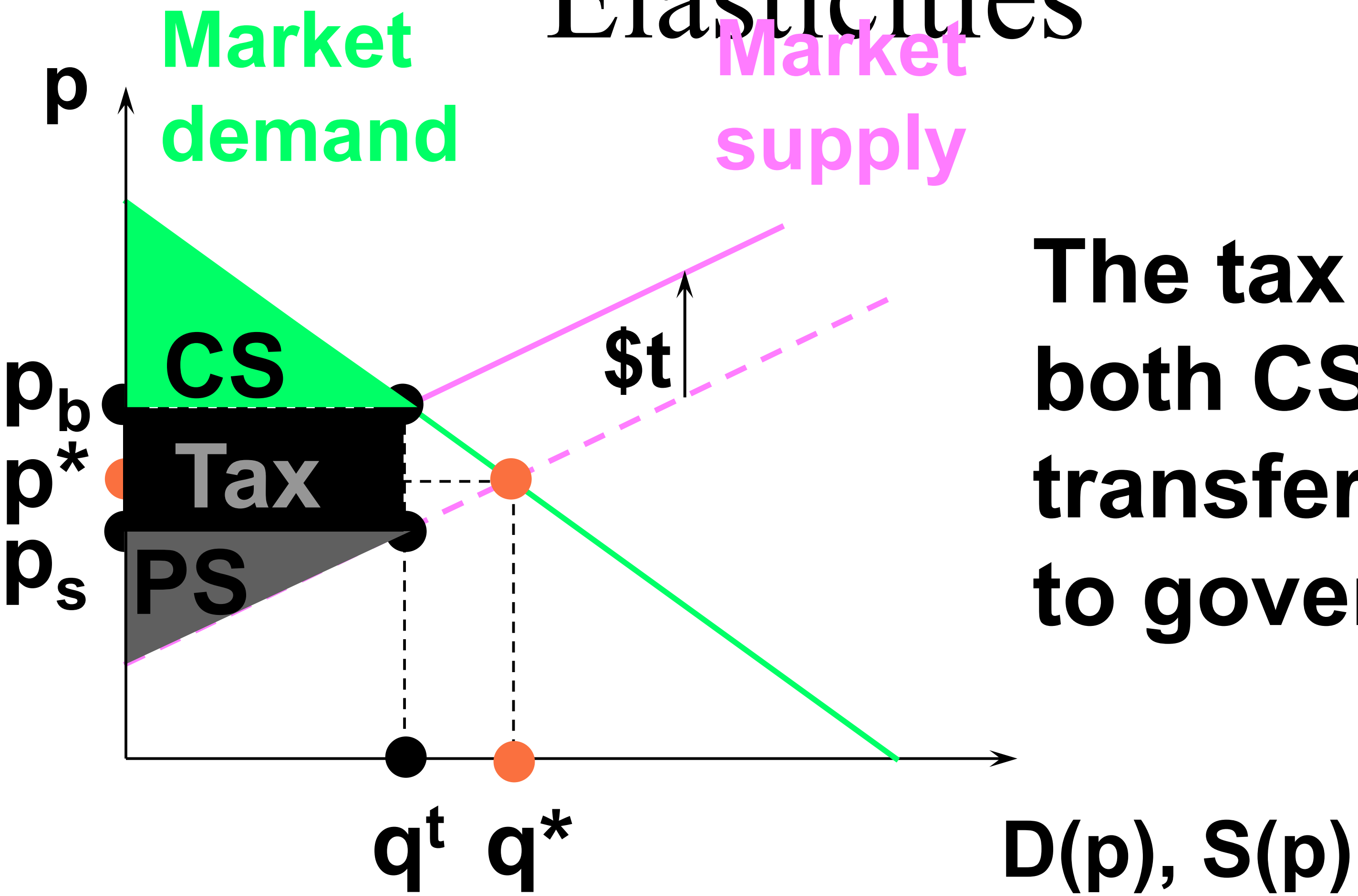


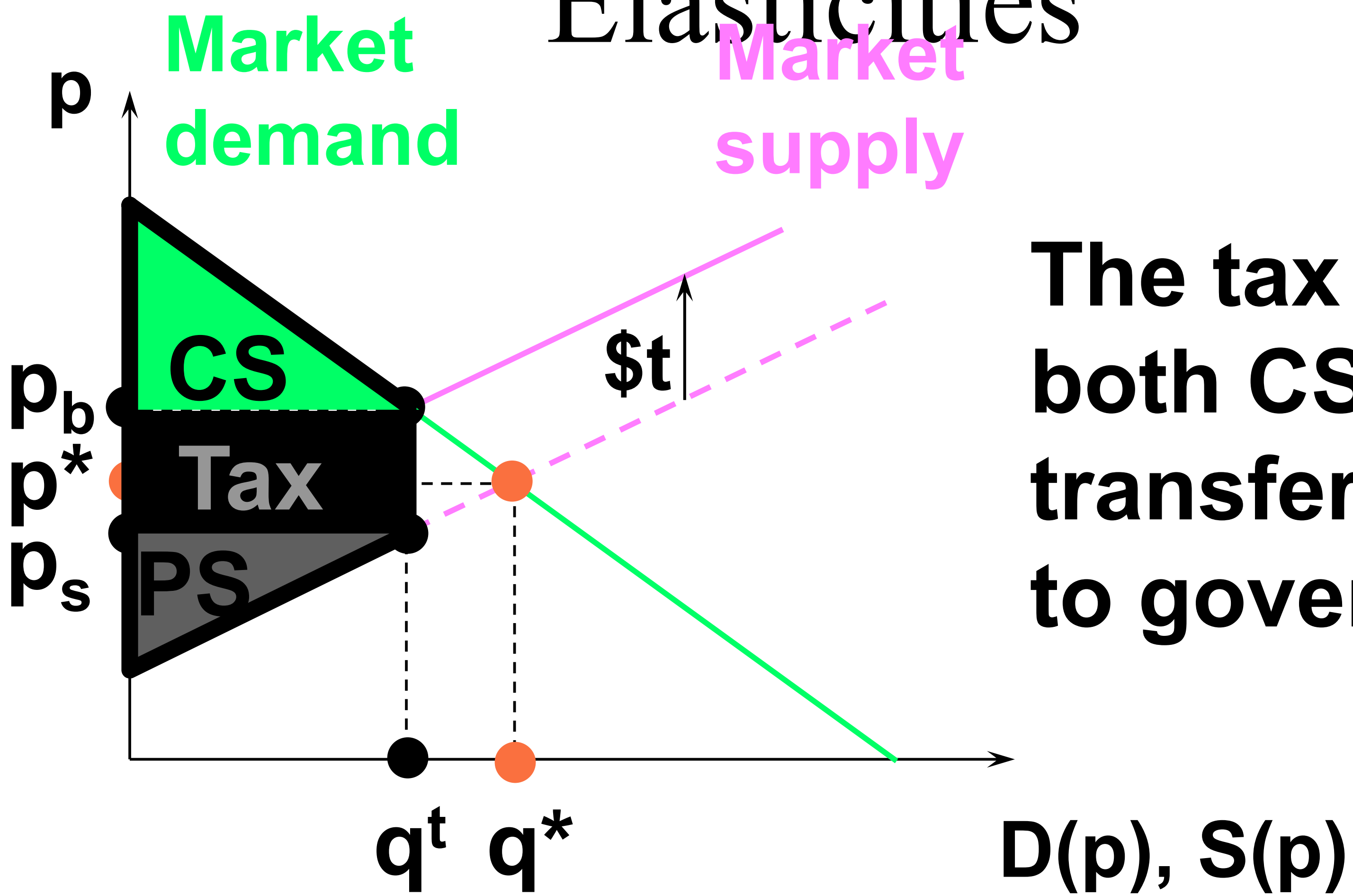
The tax reduces both CS and PS

Deadweight Loss and Own-Price Elasticities



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

Deadweight Loss and Own-Price Elasticities



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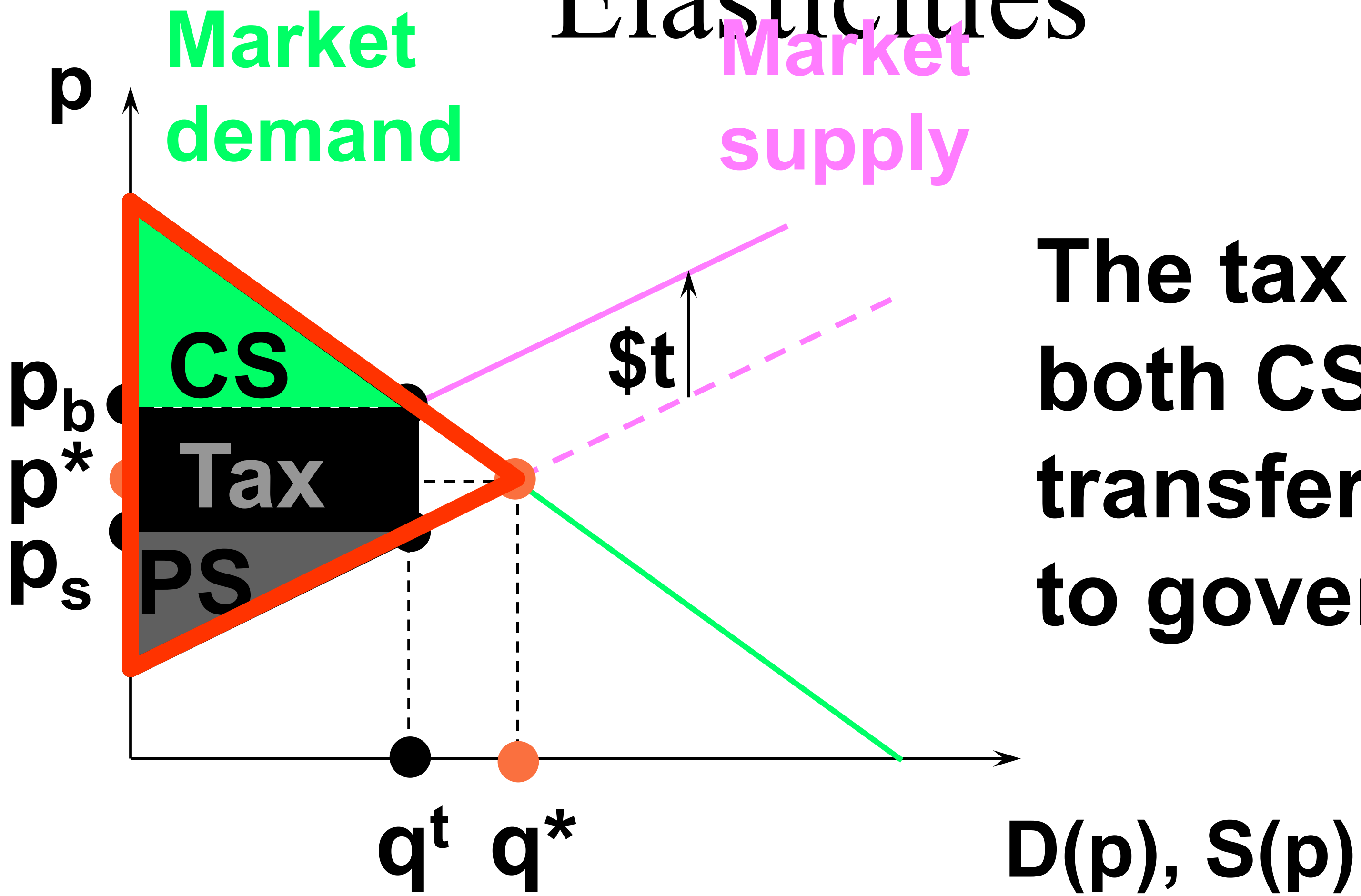

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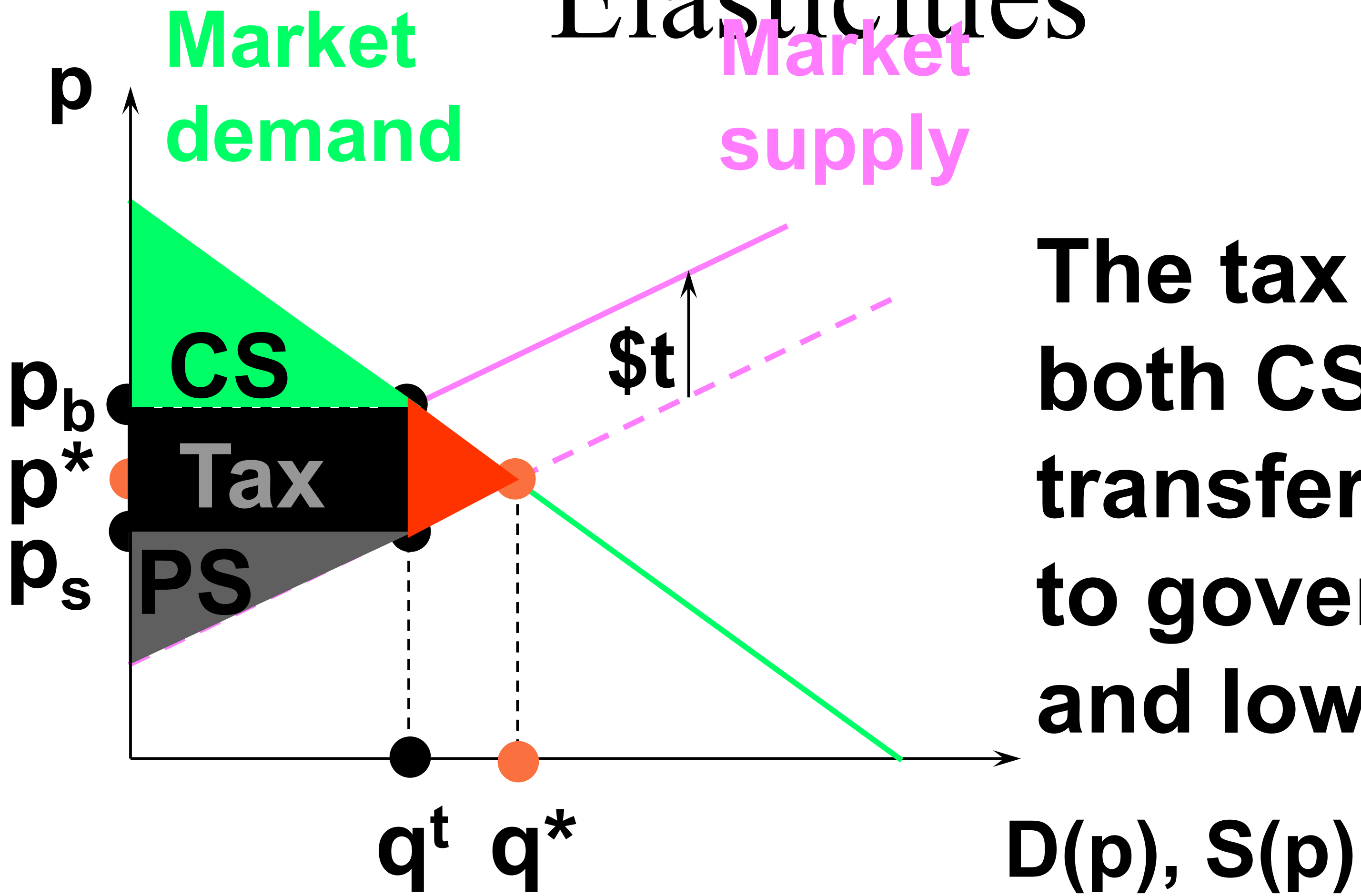
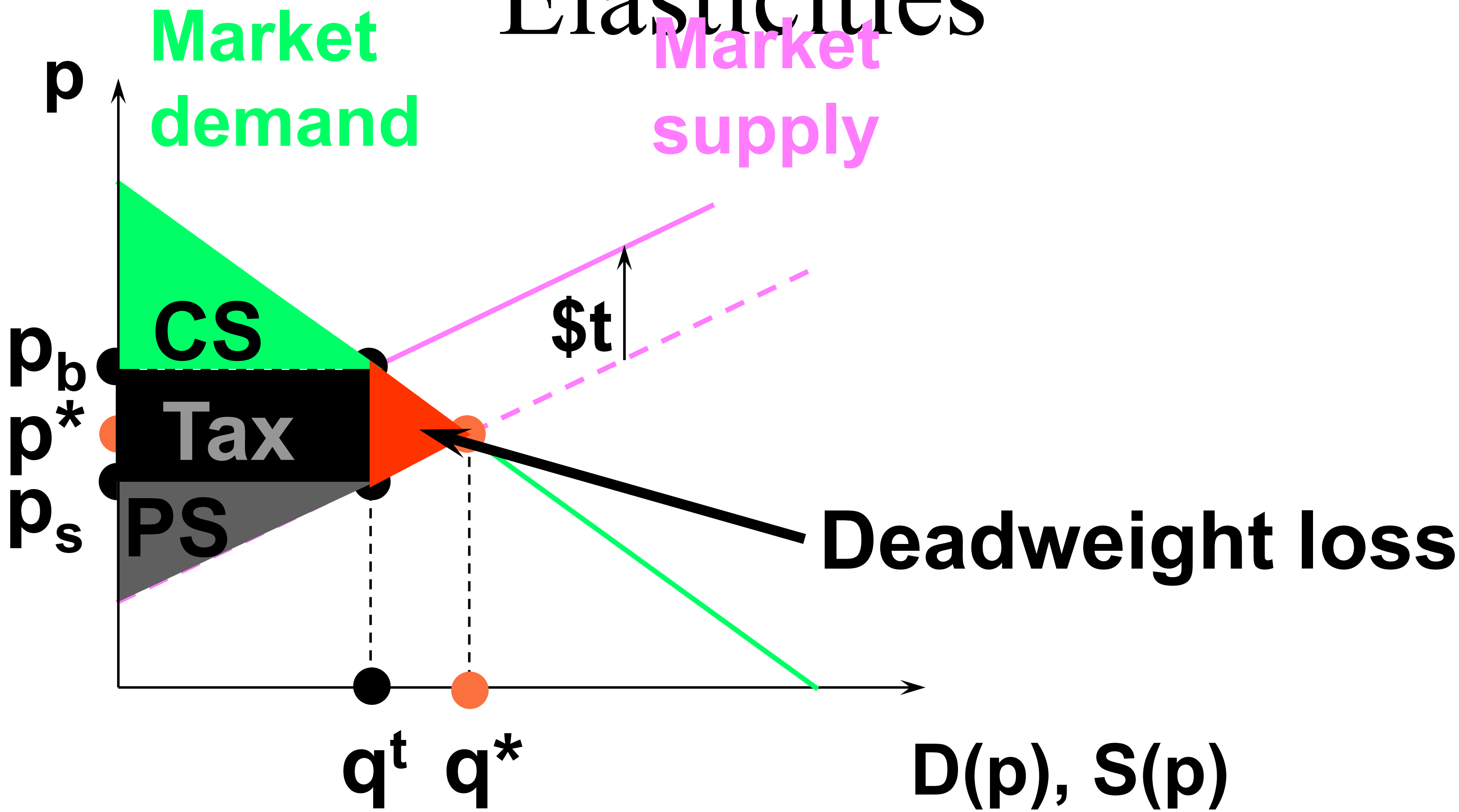


The tax reduces both CS and PS, transfers surplus to government, and lowers total surplus.

Deadweight Loss and Own-Price Elasticities



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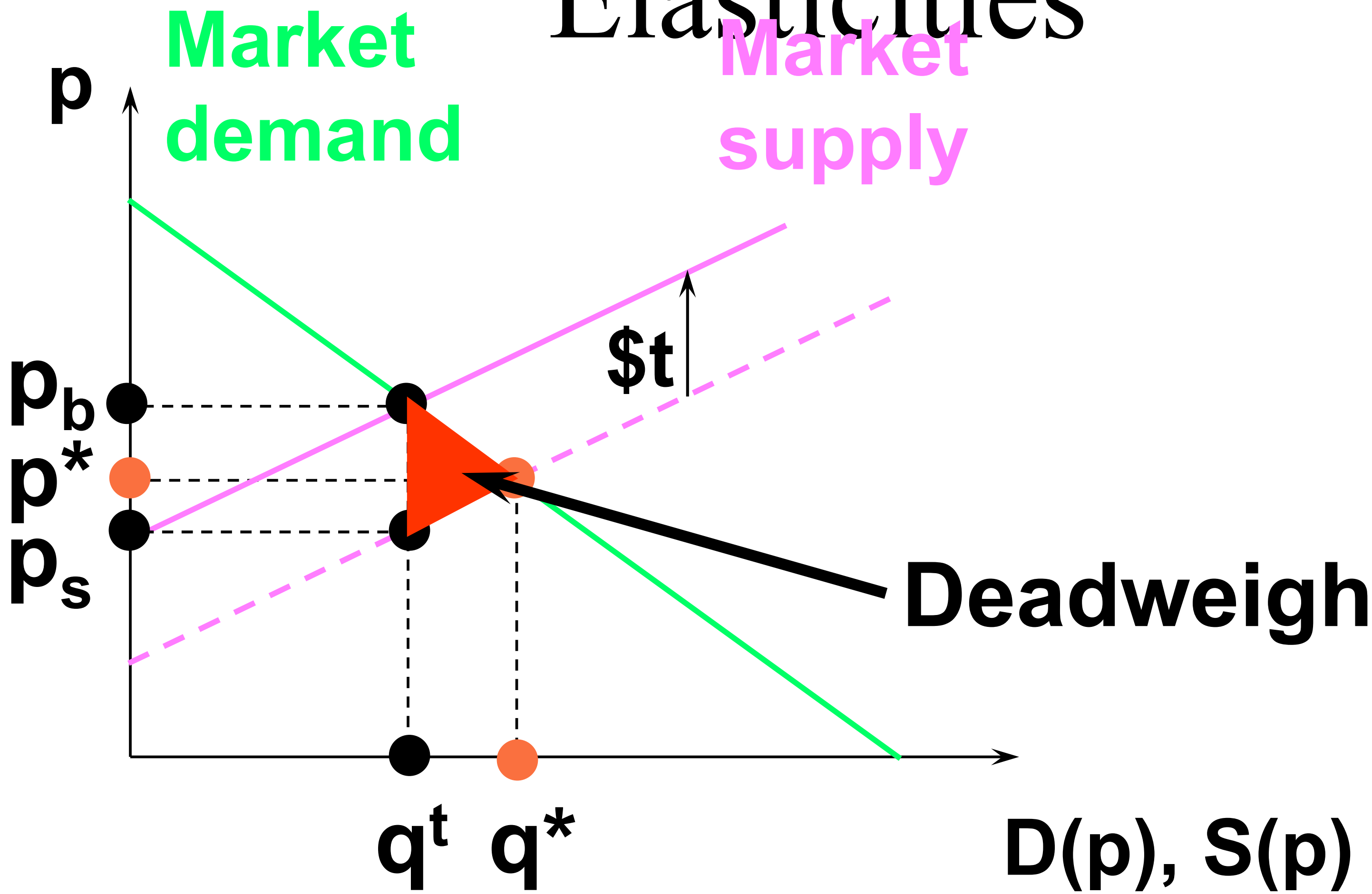

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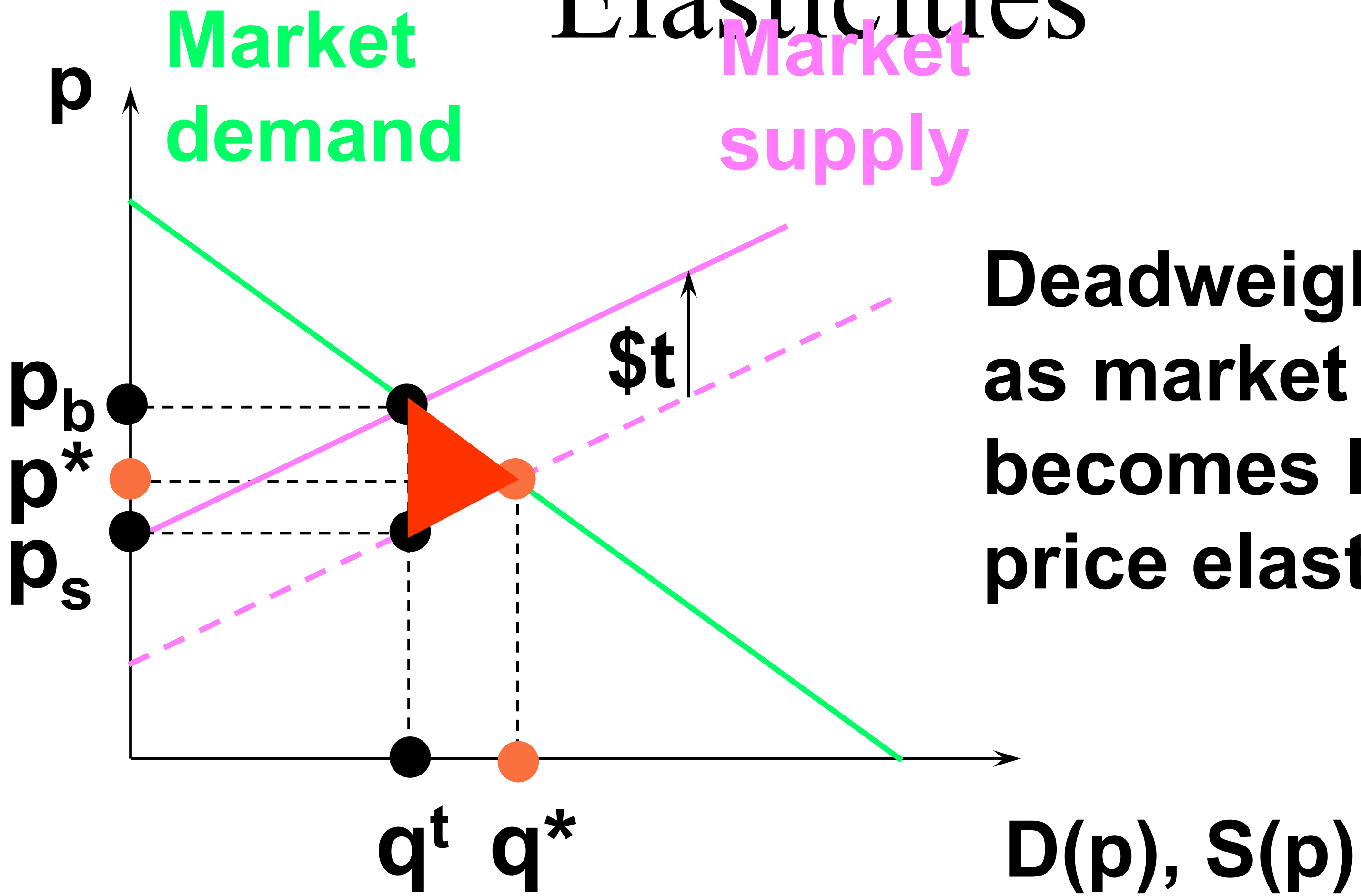
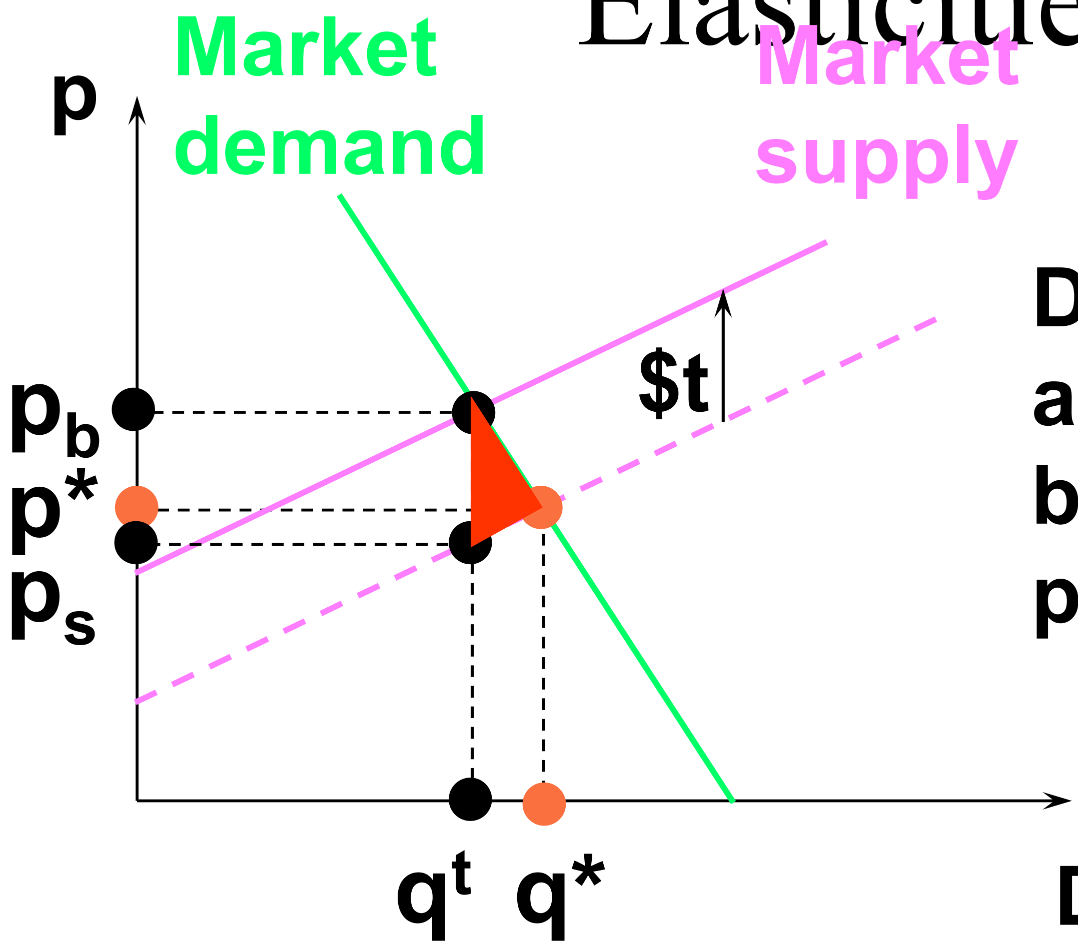


Deadweight loss falls as market demand becomes less own-price elastic.

Deadweight Loss and Own-Price Elasticities



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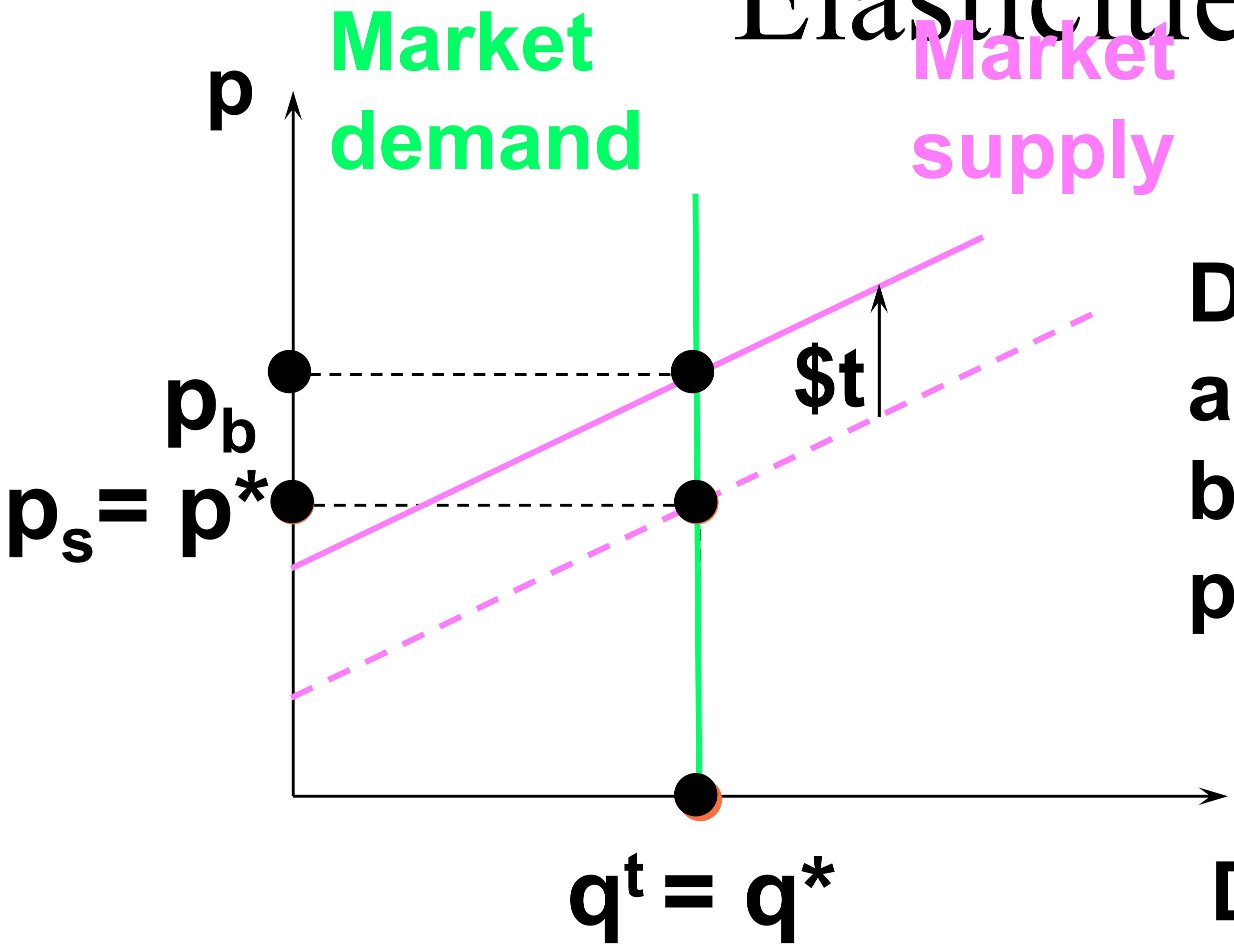

Deadweight loss falls as market demand becomes less own-price elastic.

When $\varepsilon_D = 0$, 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 $\varepsilon_D = 0$ or $\varepsilon_S = 0$ then the deadweight loss is zero.**