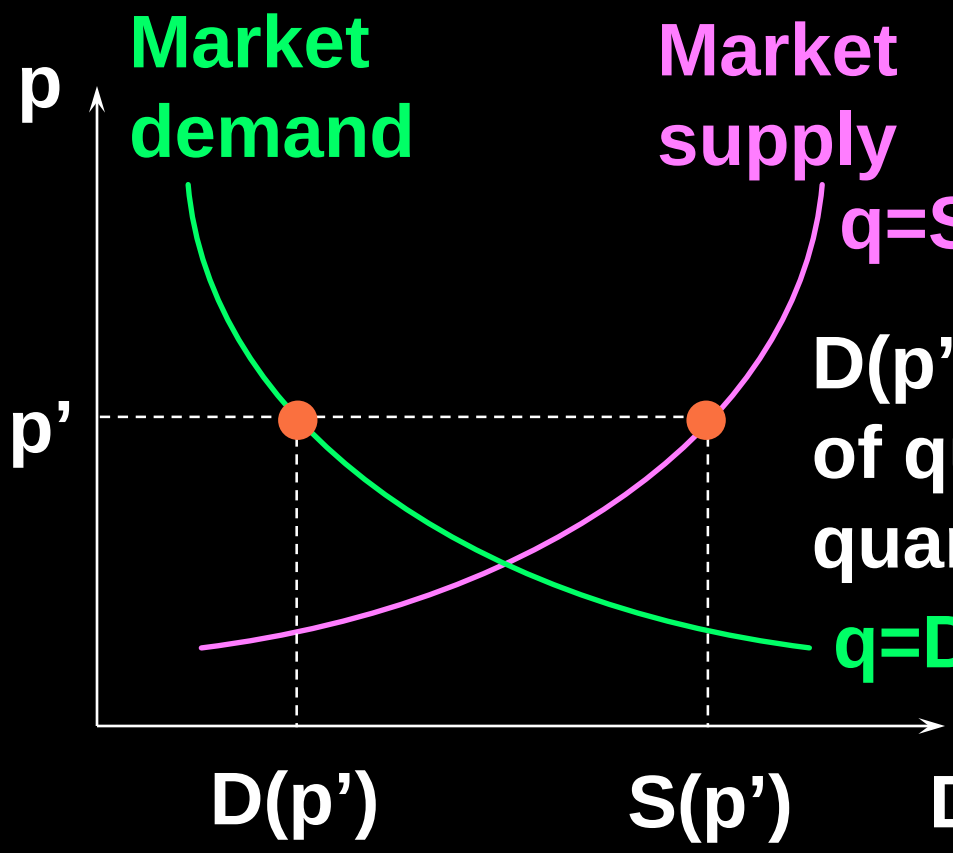
Lecture 9: Part b

Equilibrium

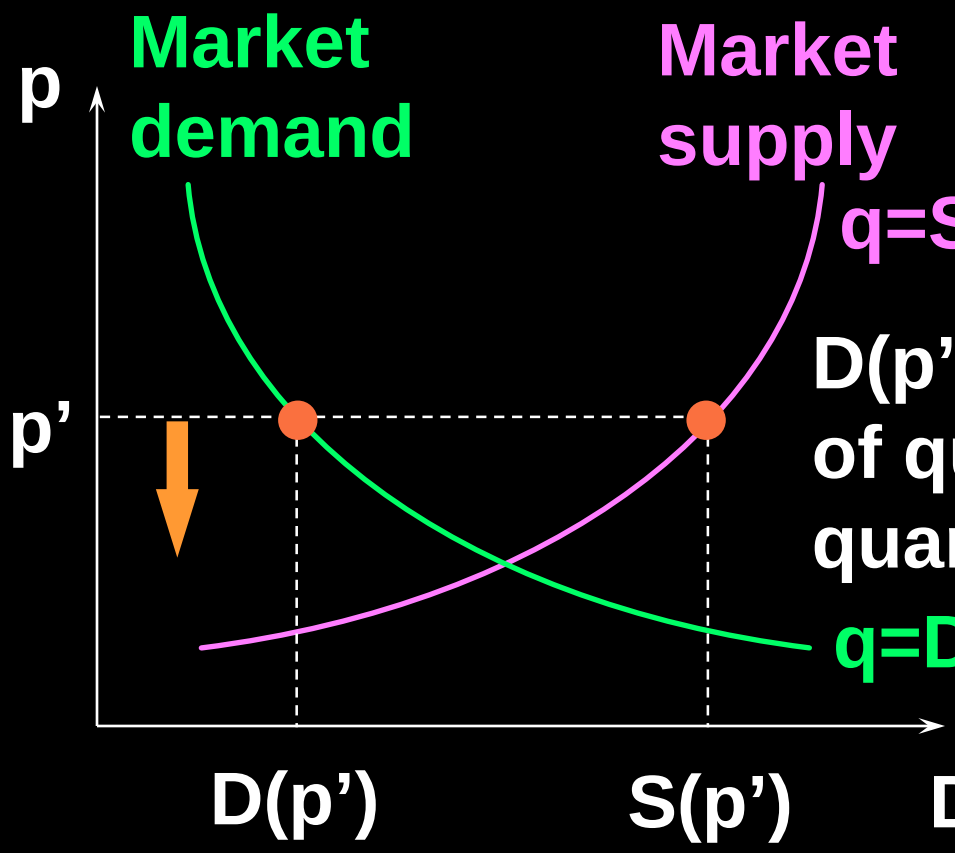
Market Equilibrium

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

Market Equilibrium



Market Equilibrium

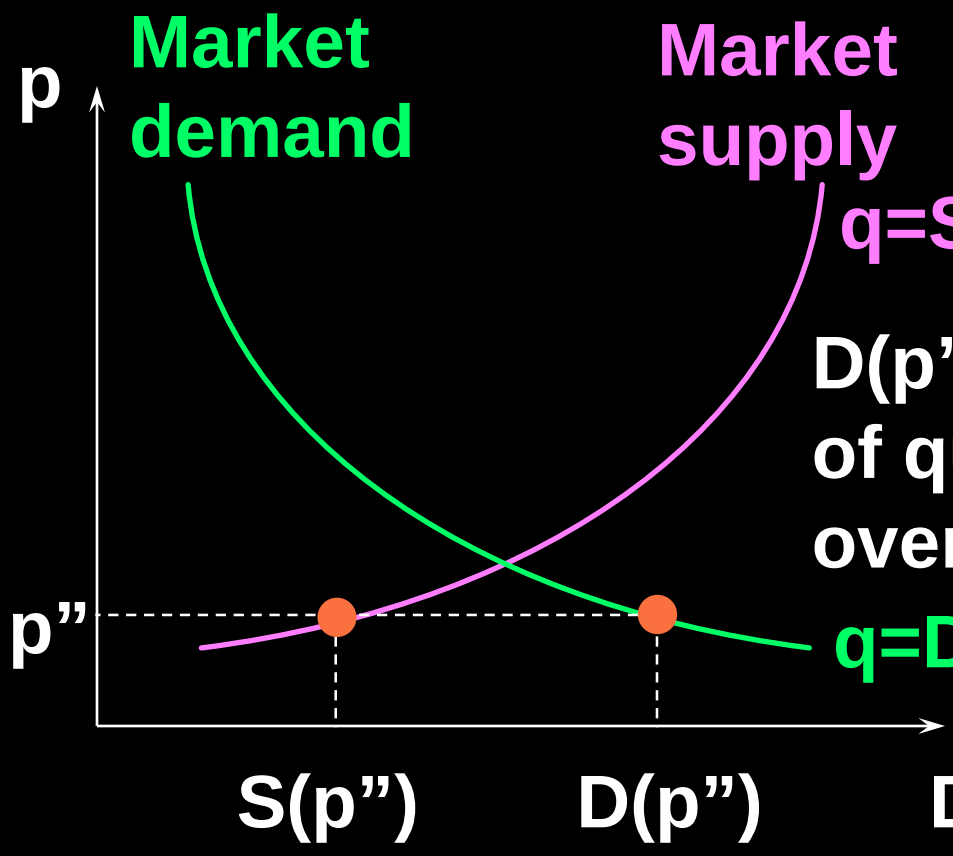


D(p') < S(p'); an excess of quantity supplied over quantity demanded.

q=D(p)

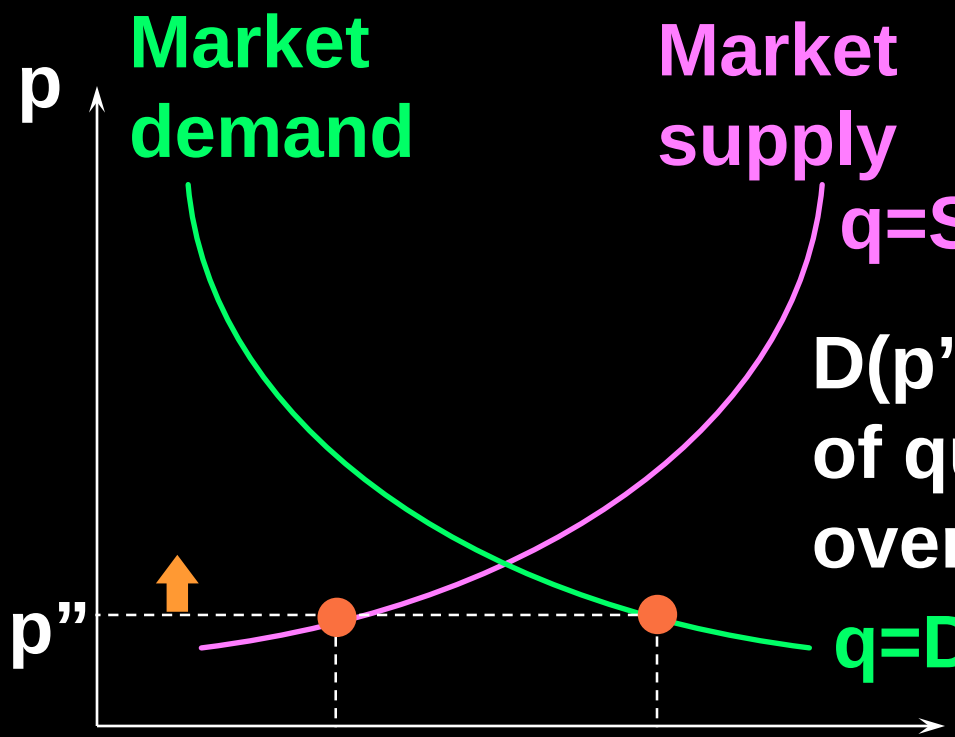
Market price must fall.

Market Equilibrium



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

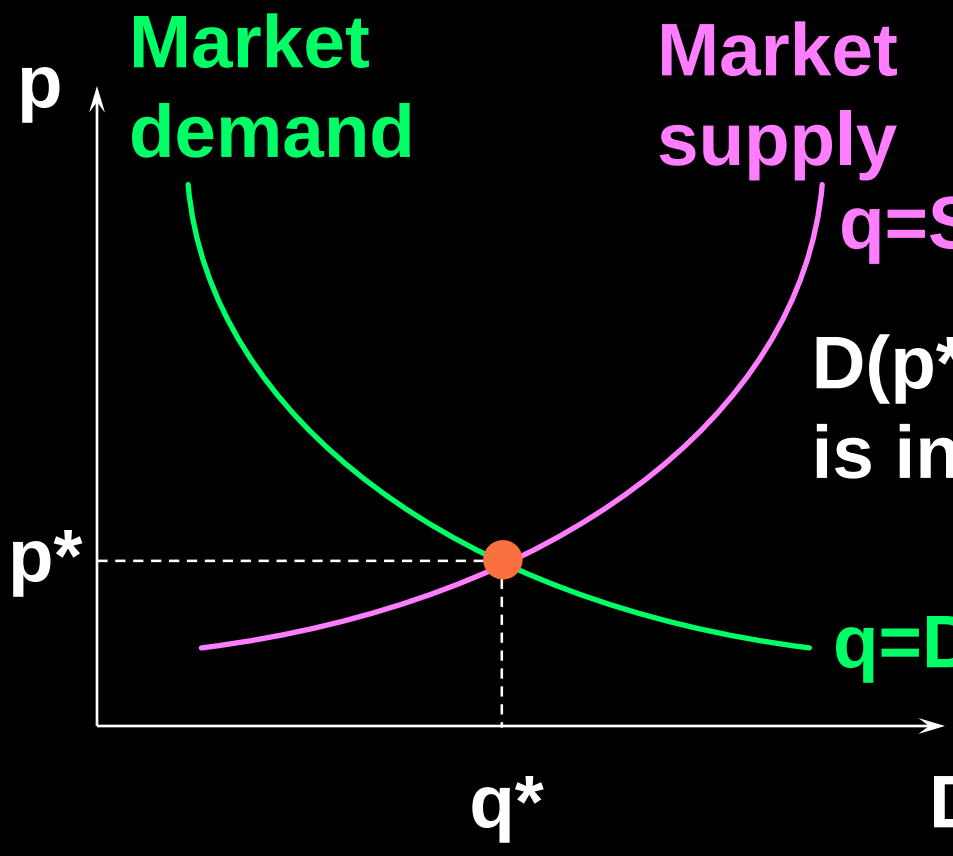
Market Equilibrium



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

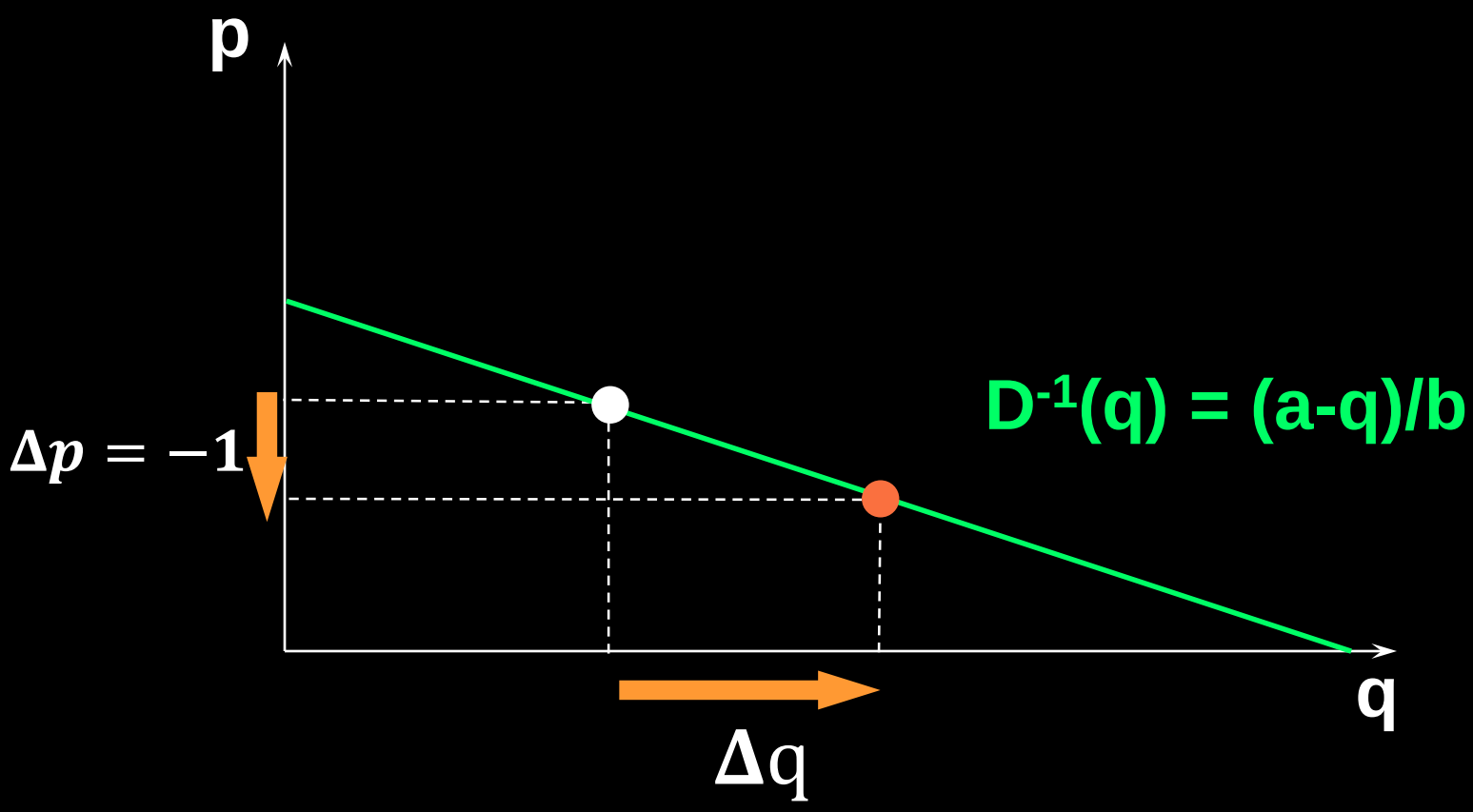
Market price must rise towards p*.

Market Equilibrium

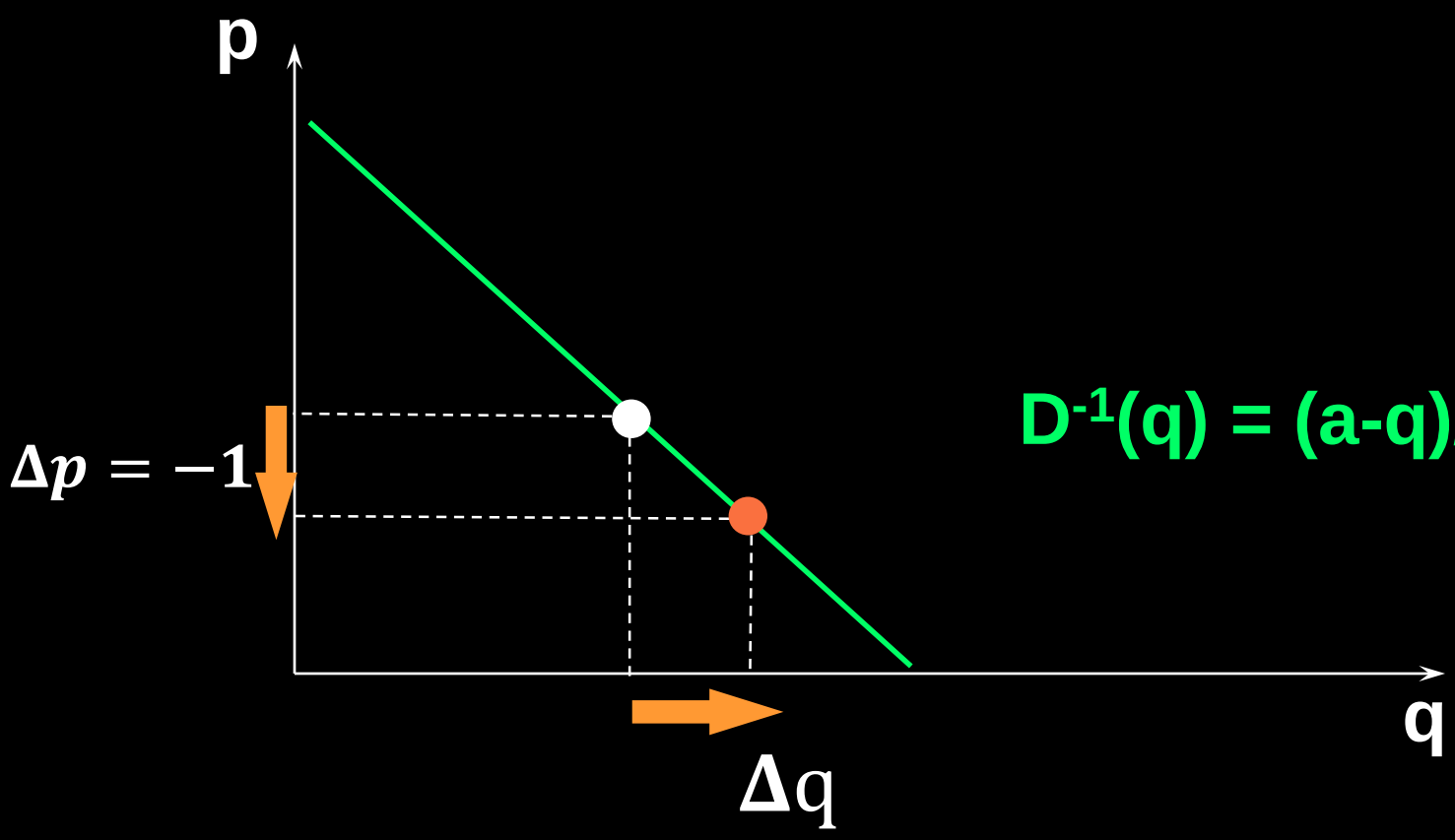


D(p*) = S(p*); the market is in equilibrium.

Elastic Demand



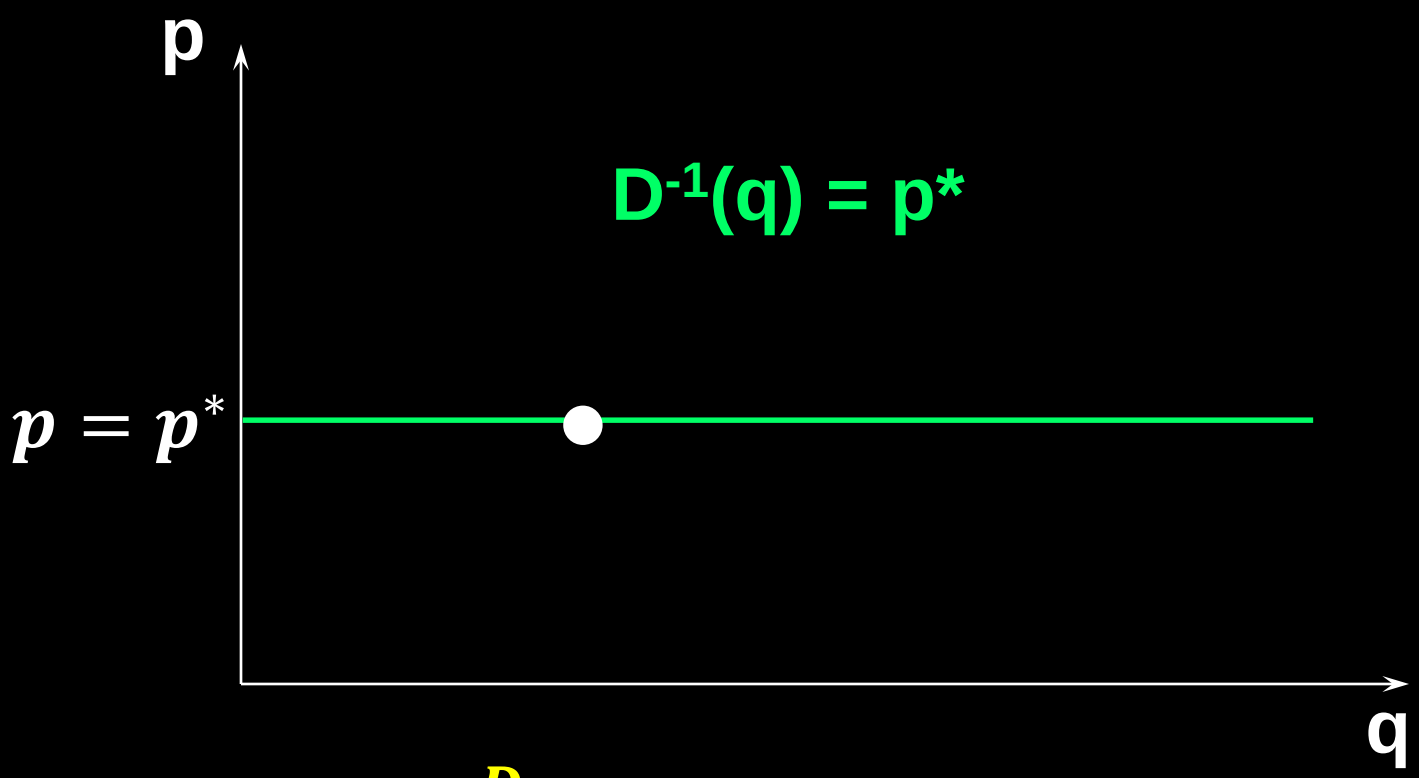
Inelastic Demand



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

初始价格处的弹性(绝对值)减小

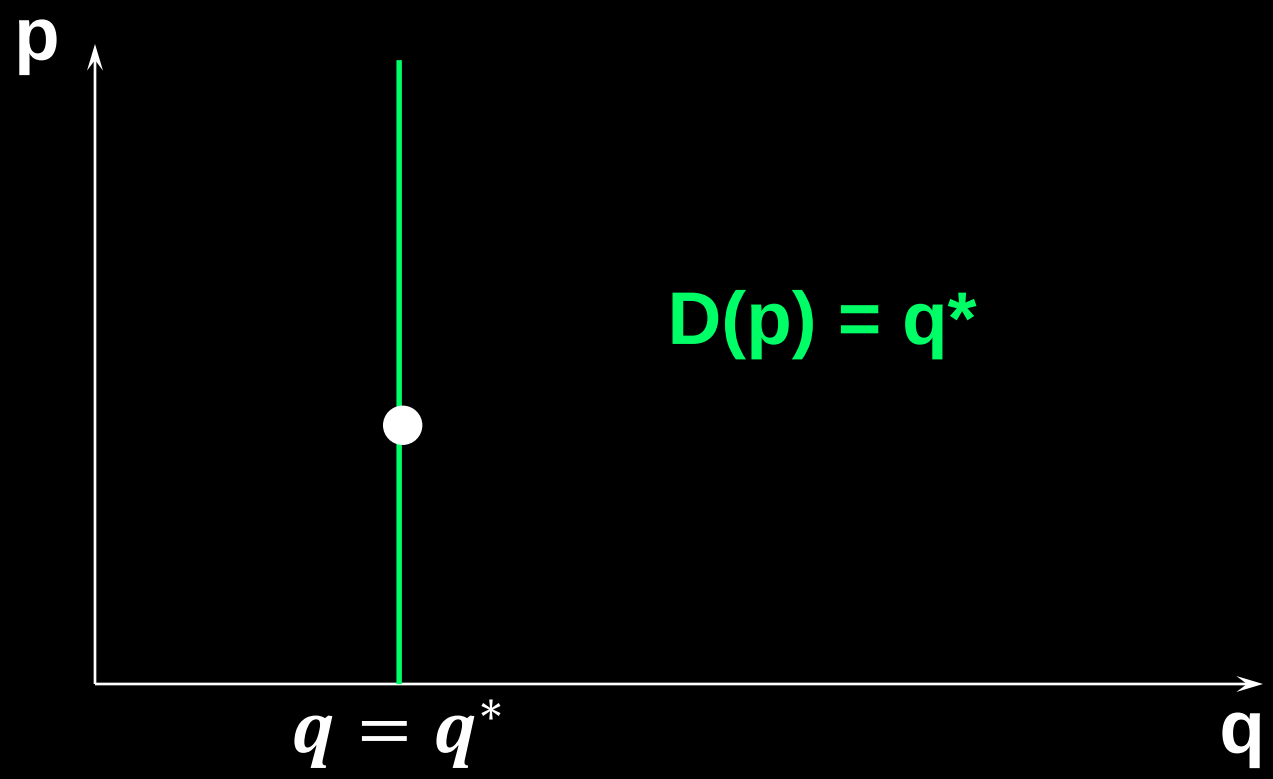
Elastic Demand: an extreme case



$\varepsilon^D = -\infty$

quantity demanded is extremely sensitive to the market price

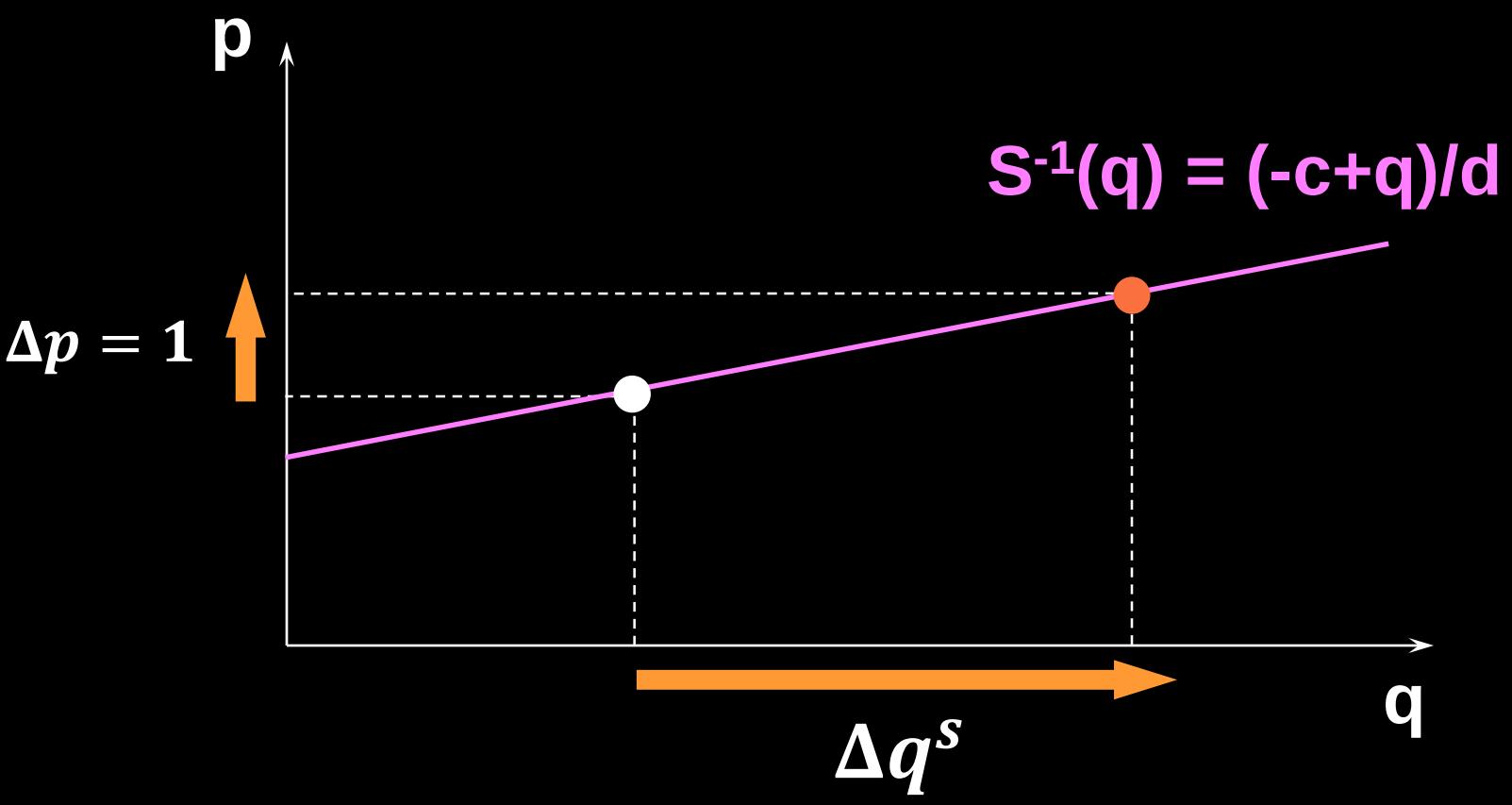
Inelastic Demand: an extreme case



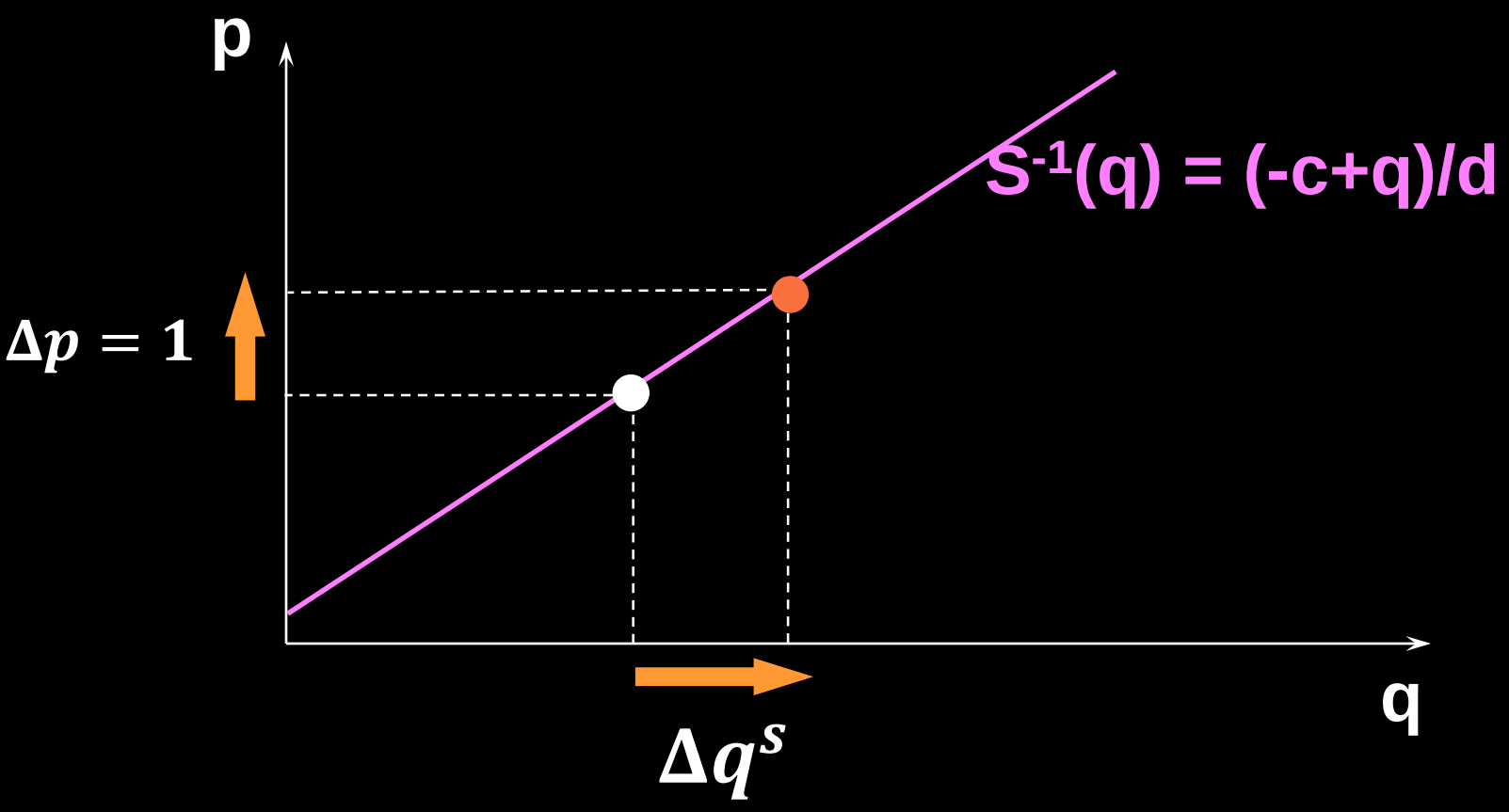
$\varepsilon^D = 0$

quantity demanded is fixed, independent of the market price

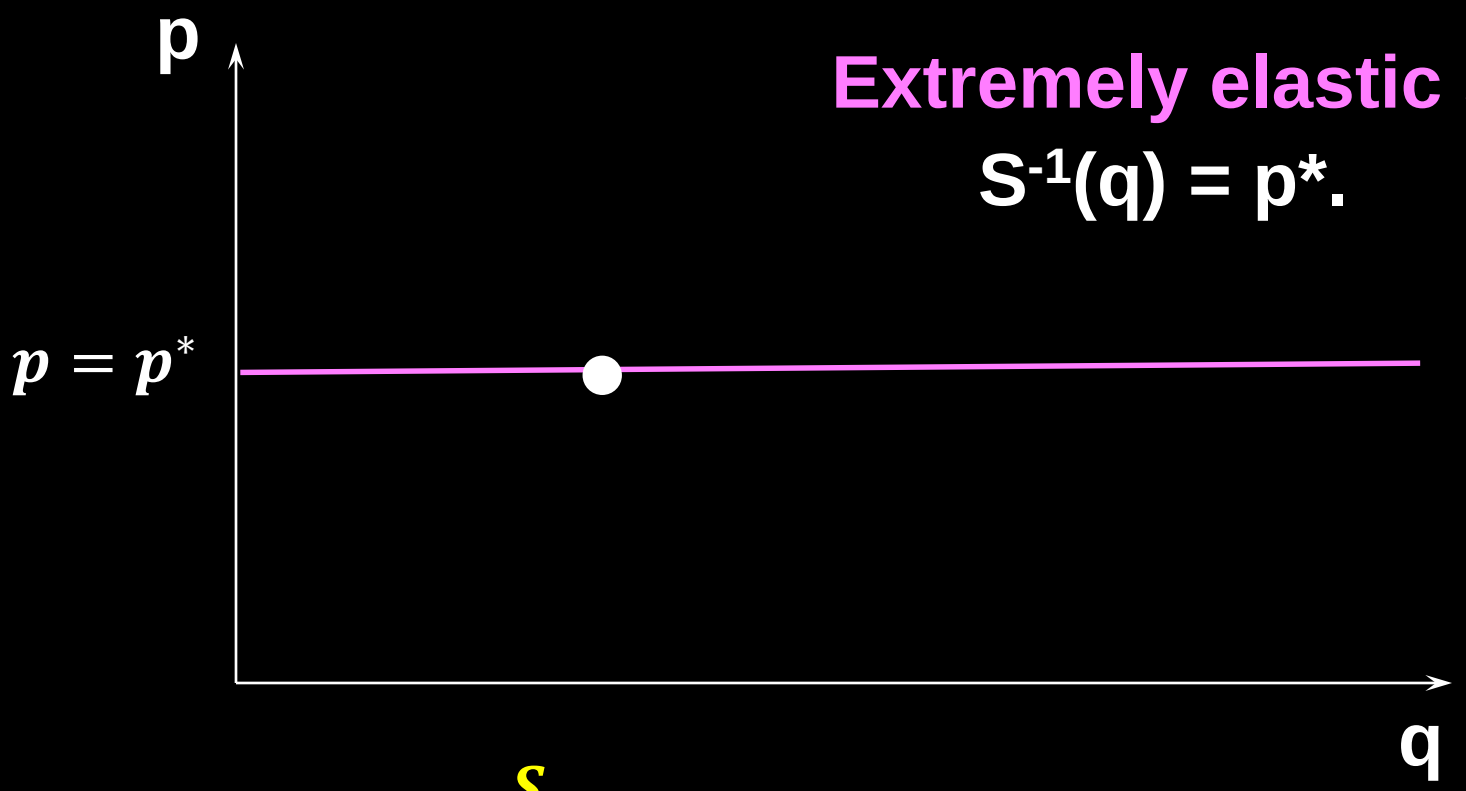
Elastic Supply



Elastic Supply



Elastic Supply: an extreme case



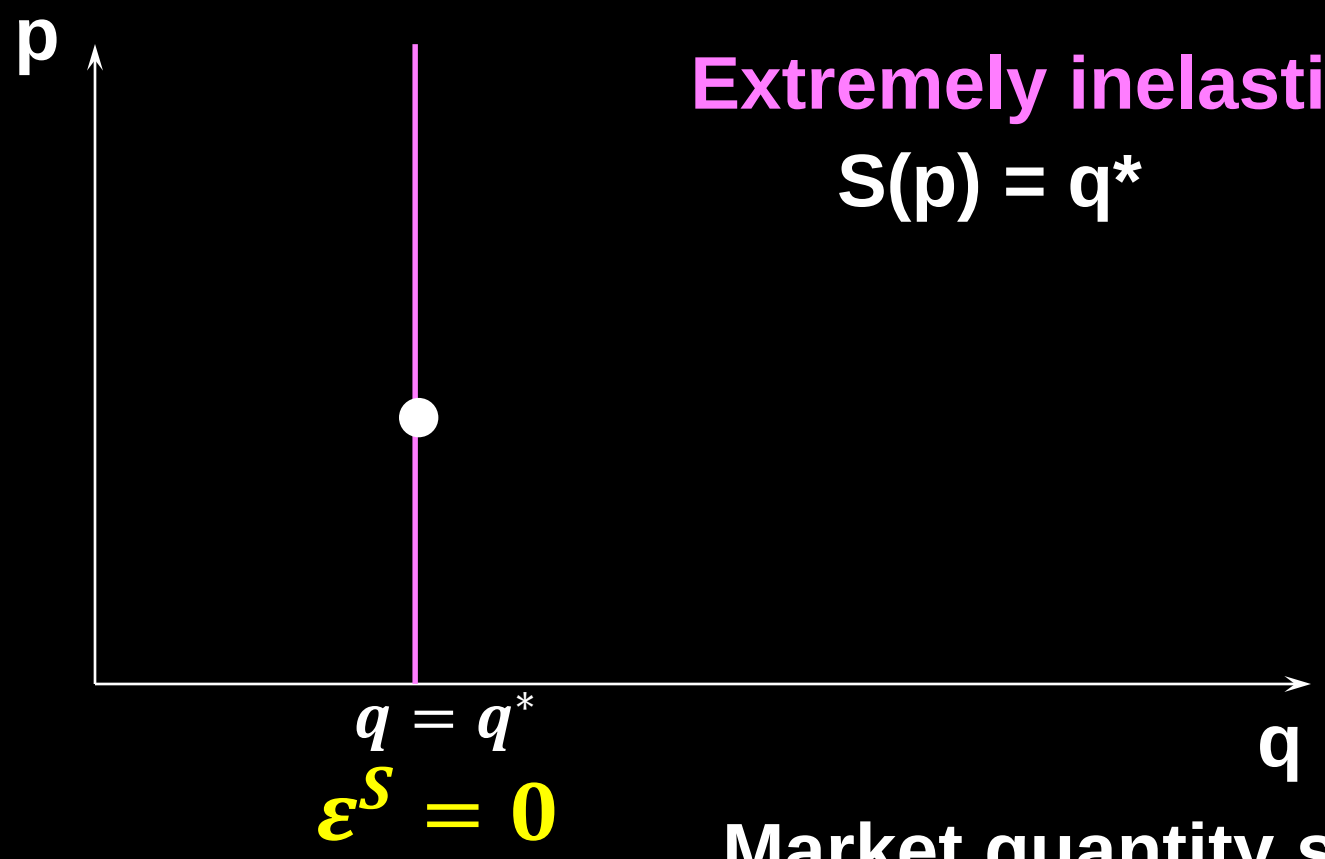
Extremely elastic supply

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

$\varepsilon^S = \infty$

Market quantity supplied is extremely sensitive to the market price

Inelastic Supply: an extreme case



Extremely inelastic supply

S(p) = q*

Market quantity supplied is fixed, independent of price.

Quantity Taxes

- **A quantity tax (从量税) levied at a rate of t is a tax of $t paid on each unit traded.**
  - **A quantity tax levied at the rate of *t* increases the price from p to p+t.**

基于商品数量征收的税负叫做从量税；如：对每单位销售的商品征税t元

Ad Valorem Taxes

- **An *ad valorem* tax (从价税) levied at a rate of *t* is a tax of $t paid on each dollar traded.**
  - **An *ad valorem* sales tax levied at a rate of *t* increases the price from p to (1+*t*)p.**

基于商品价格征收的税负叫做从价税；如：对每单位销售额征税t元

Quantity Taxes

- This lecture focuses on quantity taxes.

- If the tax is levied on **sellers** then it is an **excise tax (货物税)**.
- If the tax is levied on **buyers** then it is a **sales tax (销售税)**.

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

- The **real** price paid by buyers, p_b, is the nominal price + quantity taxes paid by the consumer if any

  消费者实际支付的税后价格=名义价格+消费税

- The **real** price received by sellers, p_s, is the nominal price − quantity taxes paid by the sellers if any

  供给者实际收到的税后价格=名义价格−货物税

Quantity Taxes

- Suppose **t** is imposed on the **buyers** (sales tax,销售税), and **p** is the nominal price (名义价格), then

$$p_b = p + t$$

$$p_s = p$$

$$p_b - p_s = t$$

Quantity Taxes

- If **t** is imposed on the **sellers** (excise tax), and **p** is the nominal price, then

$$p_b = p$$

$$p_s = p - t$$

$$p_b - p_s = t$$

Quantity Taxes

- **In either case, a tax rate t makes the real price paid by buyers, p_b, higher by t from the real price received by sellers, p_s.**

$$p_b - p_s = t$$

无论税负向谁征收，实际价格之间的关系不发生改变

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

Two unknown parameters, p_b, p_s, two equilibrium conditions:

$$\begin{cases} \mathbf{p_b - p_s = t} \\ \mathbf{D(p_b) = S(p_s)} \end{cases}$$

Solving the system of equations gives p_b^* and p_s^*.

Note that a **sales** tax rate $t has the **same** effect as an **excise** tax rate $t.

对消费者征税t和对生产者征税t的均衡相同。

Example

The demand function is given by:

$$D(p_b) = 1000 - 60p_b$$

The supply function is given by:

$$S(p_s) = 40p_s$$

Q1: What are the equilibrium p and q when there is no tax?

Example

The demand function is given by:

$$D(p_b) = 1000 - 60p_b$$

The supply function is given by:

$$S(p_s) = 40p_s$$

Q1: What are the equilibrium p and q when there is no tax?

$$p_s = p_b$$

$$1000 - 60p_b = 40p_s = 40p_b$$

$$p_s^* = p_b^* = 10,\ q^* = 1000 - 60p_b = 400$$

Example

The demand function is given by:

$$D(p_b) = 1000 - 60p_b$$

The supply function is given by:

$$S(p_s) = 40p_s$$

Q2: What are the equilibrium p and q when buyers pay a sales tax of rate $5?

Example

The demand function is given by:

$$D(p_b) = 1000 - 60p_b$$

The supply function is given by:

$$S(p_s) = 40p_s$$

Q2: What are the equilibrium p and q when buyers pay a sales tax of rate $5?

$$p_b = p_s + 5$$

$$1000 - 60p_b = 40p_s = 40(p_b - 5)$$

$$p_b^* = 12, p_s^* = 7, \mathrm{q}^* = 1000 - 60p_b = 280$$

Example

The demand function is given by:

$$D(p_b) = 1000 - 60p_b$$

The supply function is given by:

$$S(p_s) = 40p_s$$

Q3: What are the equilibrium p and q when sellers pay an excise tax of rate $5?

Example

The demand function is given by:

$$D(p_b) = 1000 - 60p_b$$

The supply function is given by:

$$S(p_s) = 40p_s$$

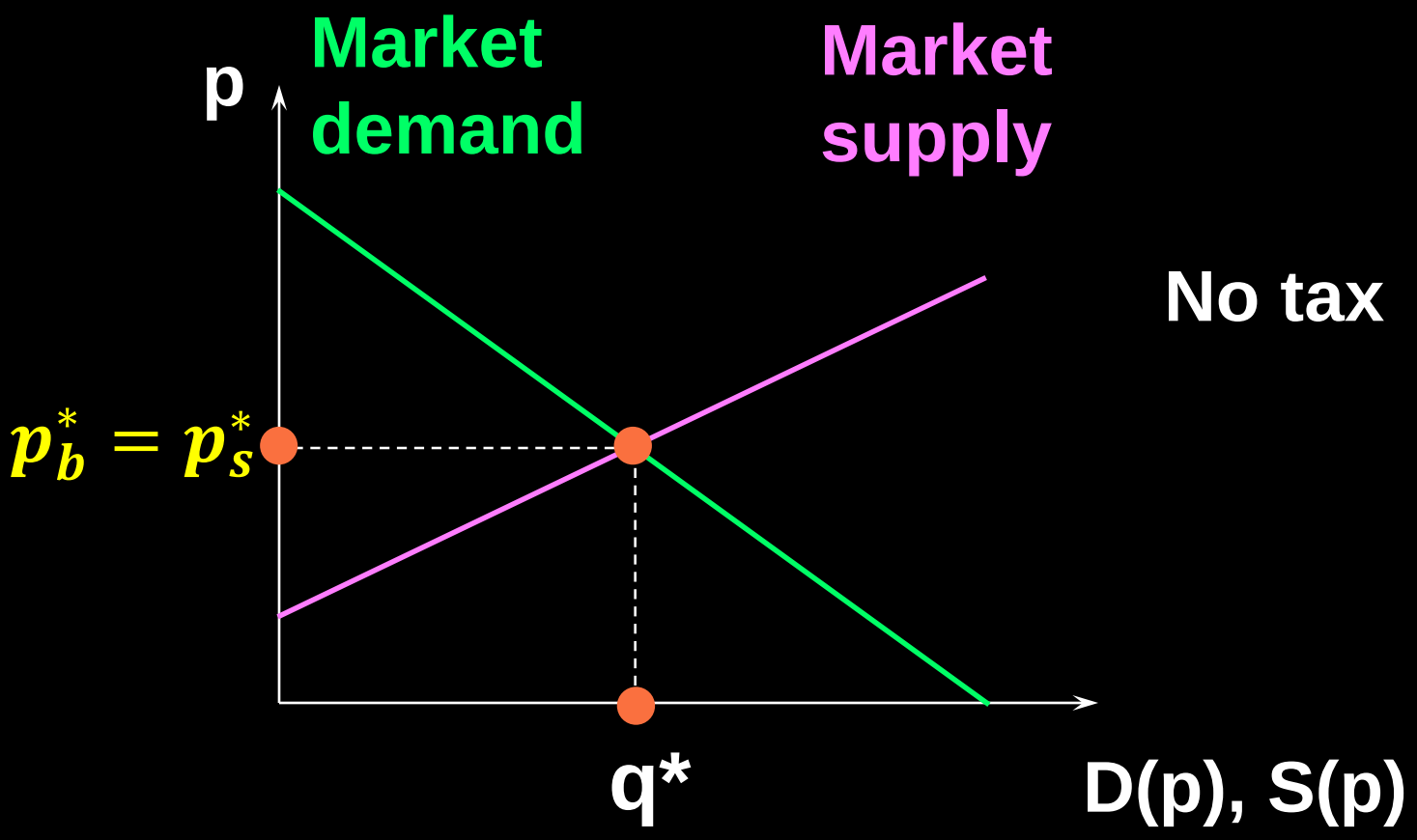
Q3: What are the equilibrium p and q when sellers pay an excise tax of rate $5?

$$p_s = p_b - 5$$

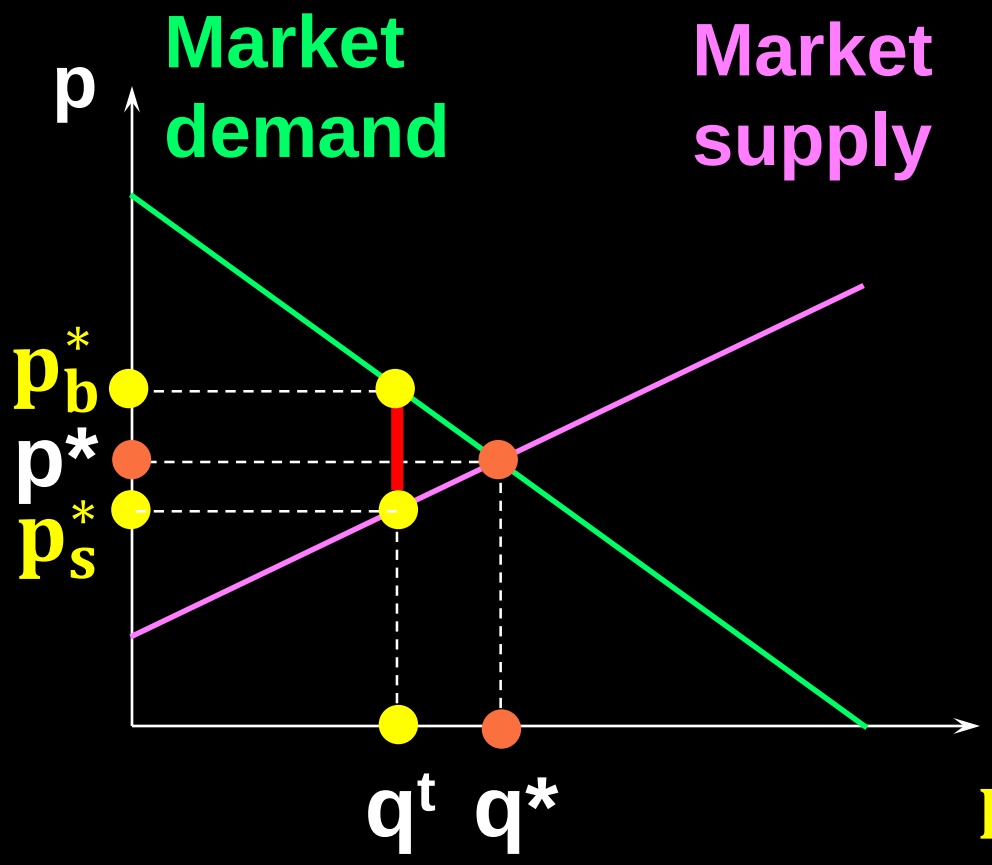
$$1000 - 60p_b = 40p_s = 40(p_b - 5)$$

$$p_b^* = 12,\ p_s^* = 7,\ \mathrm{q}^* = 1000 - 60p_b = 280$$

Quantity Taxes & Market Equilibrium



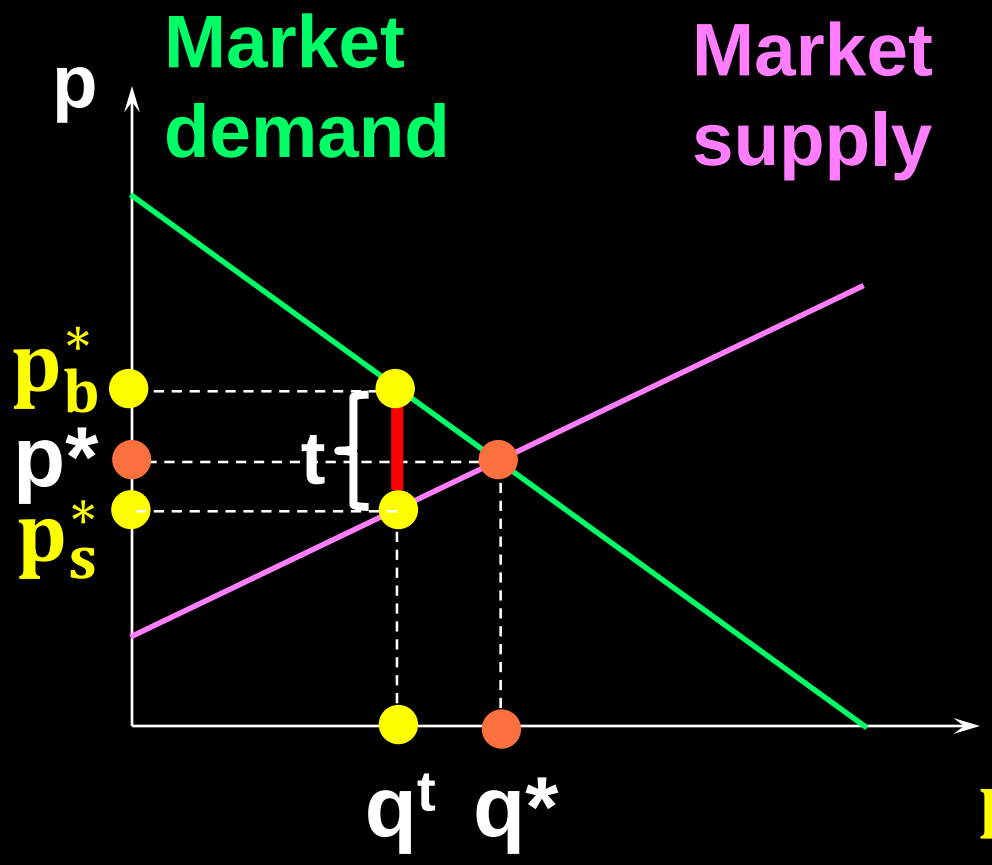
Quantity Taxes & Market Equilibrium



sales tax = t

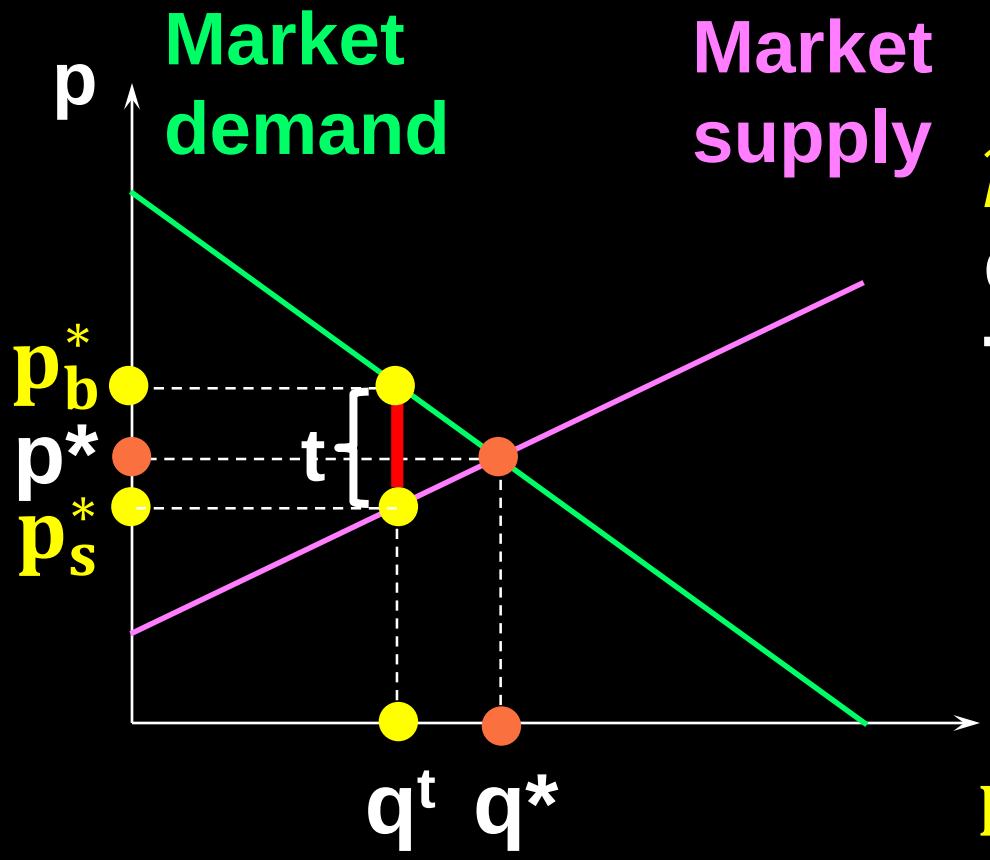
$D(p_b), S(p_s)$

Quantity Taxes & Market Equilibrium



sales tax = t

Quantity Taxes & Market Equilibrium

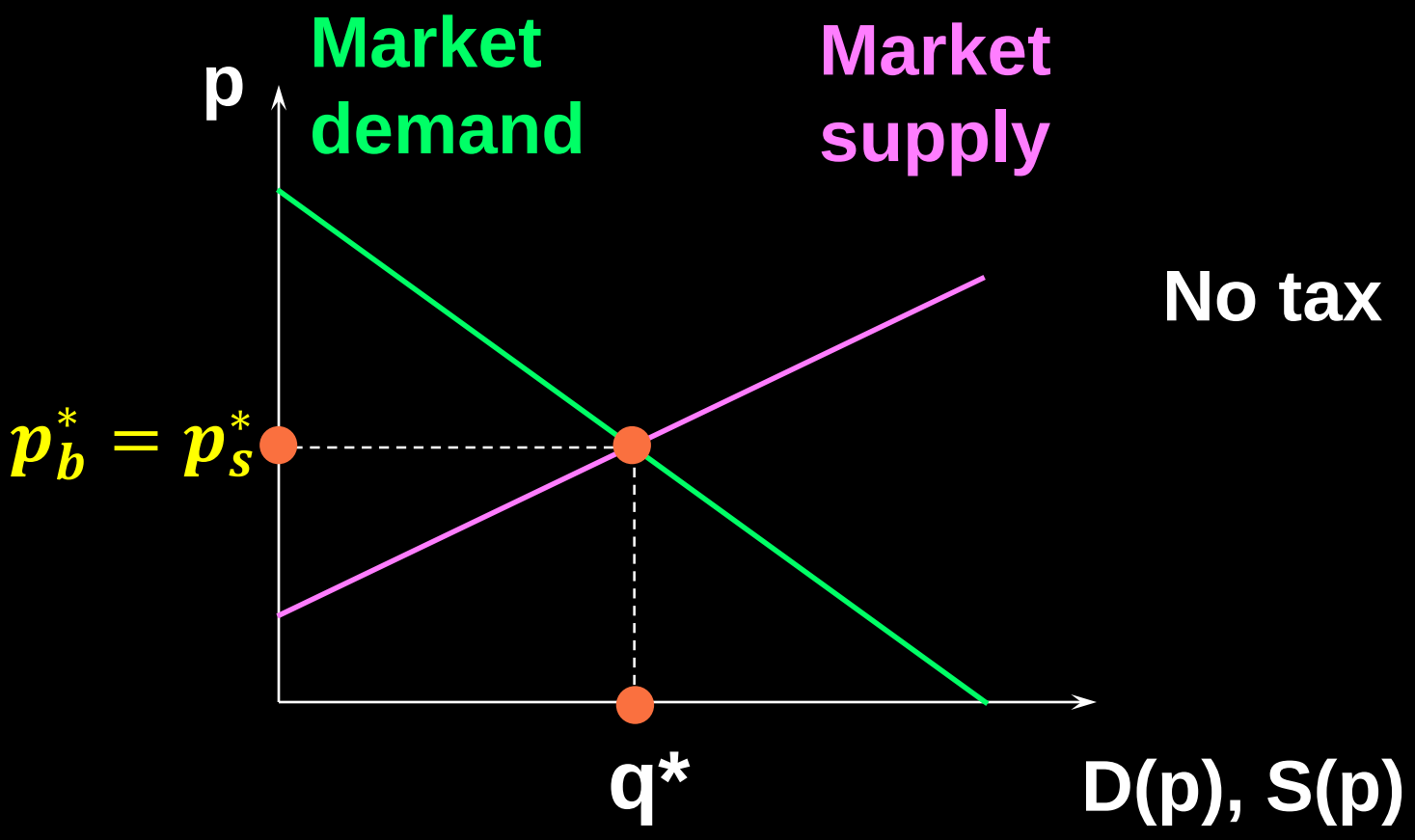


p_b^*, p_s^* are the equilibrium prices. They satisfy:

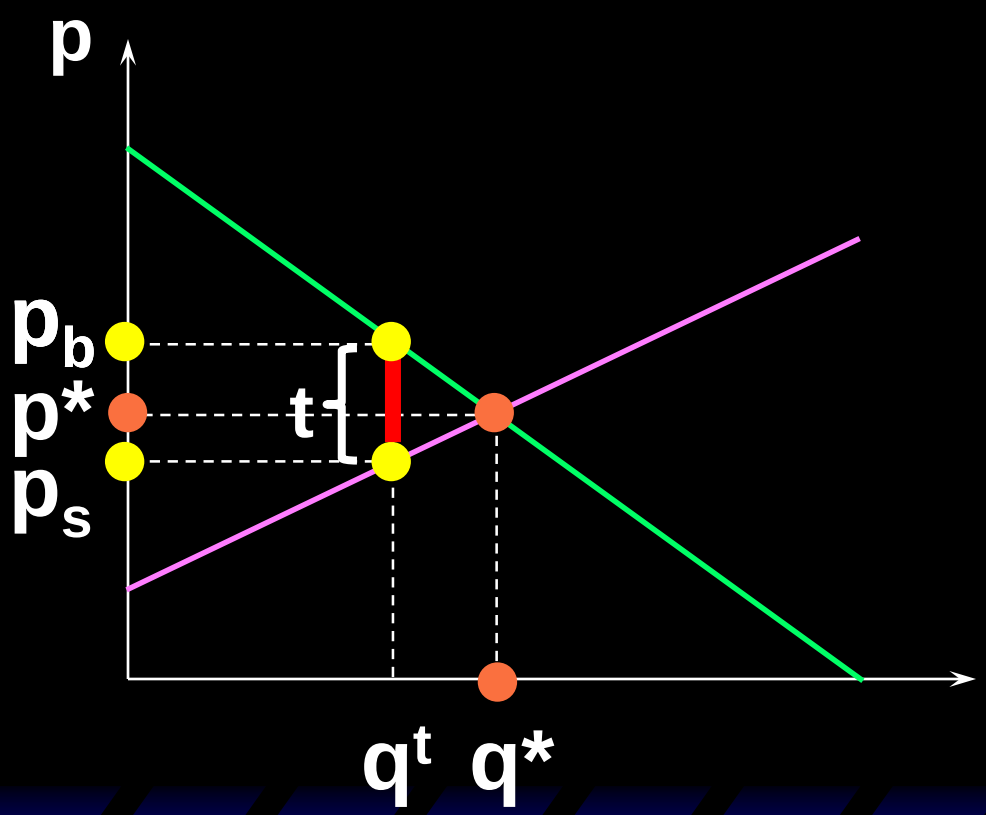
$$\begin{cases} p_b^* - p_s^* = t \\ D(p_b^*) = S(p_s^*) \end{cases}$$

$D(p_b), S(p_s)$

Quantity Taxes & Market Equilibrium



Quantity Taxes & Market Equilibrium



和无税收情况相比，

$$p_b > p^*$$

税收导致消费者实际支付价格上升

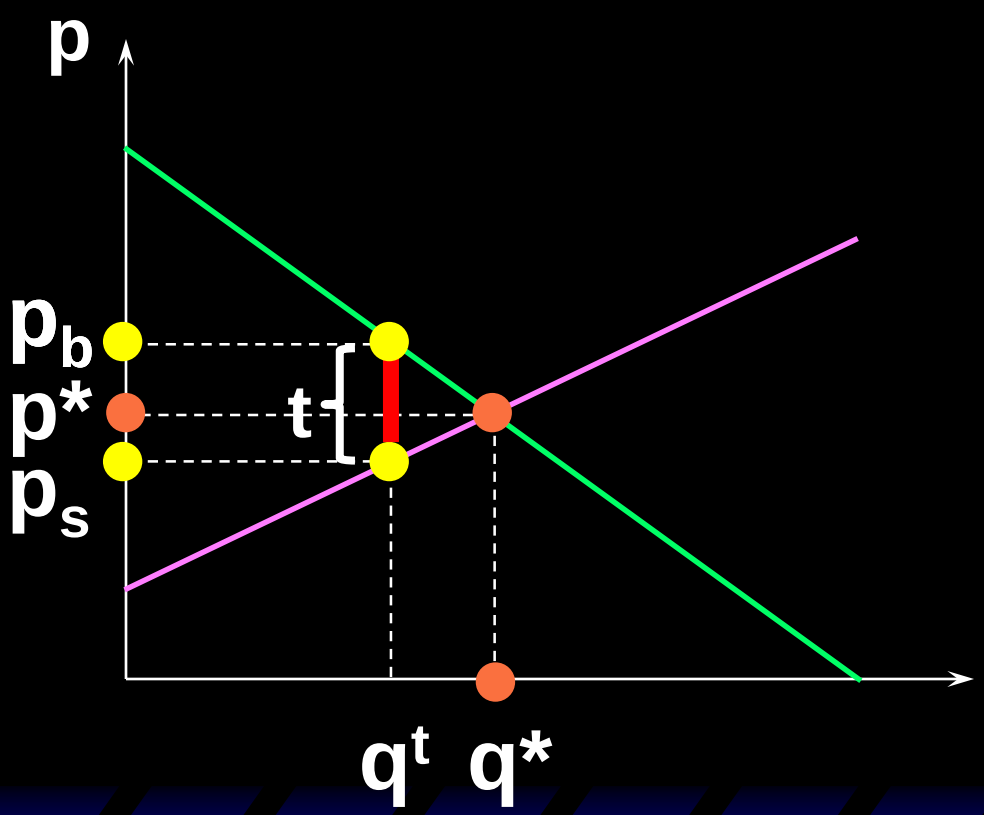
$$p_s < p^*$$

生产者实际销售价格下降

$$q_t < q^*$$

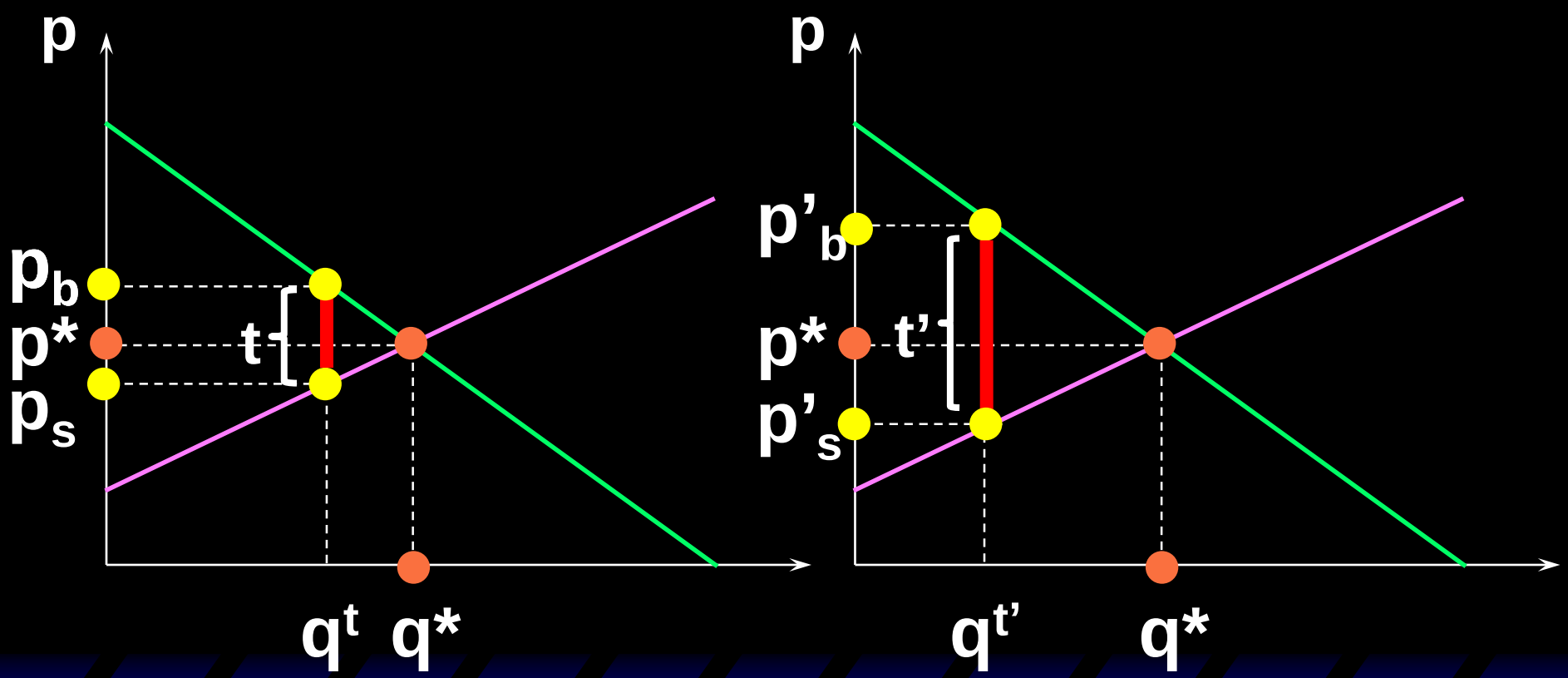
市场均衡交易数量下降

Quantity Taxes & Market Equilibrium



Quantity Taxes & Market Equilibrium

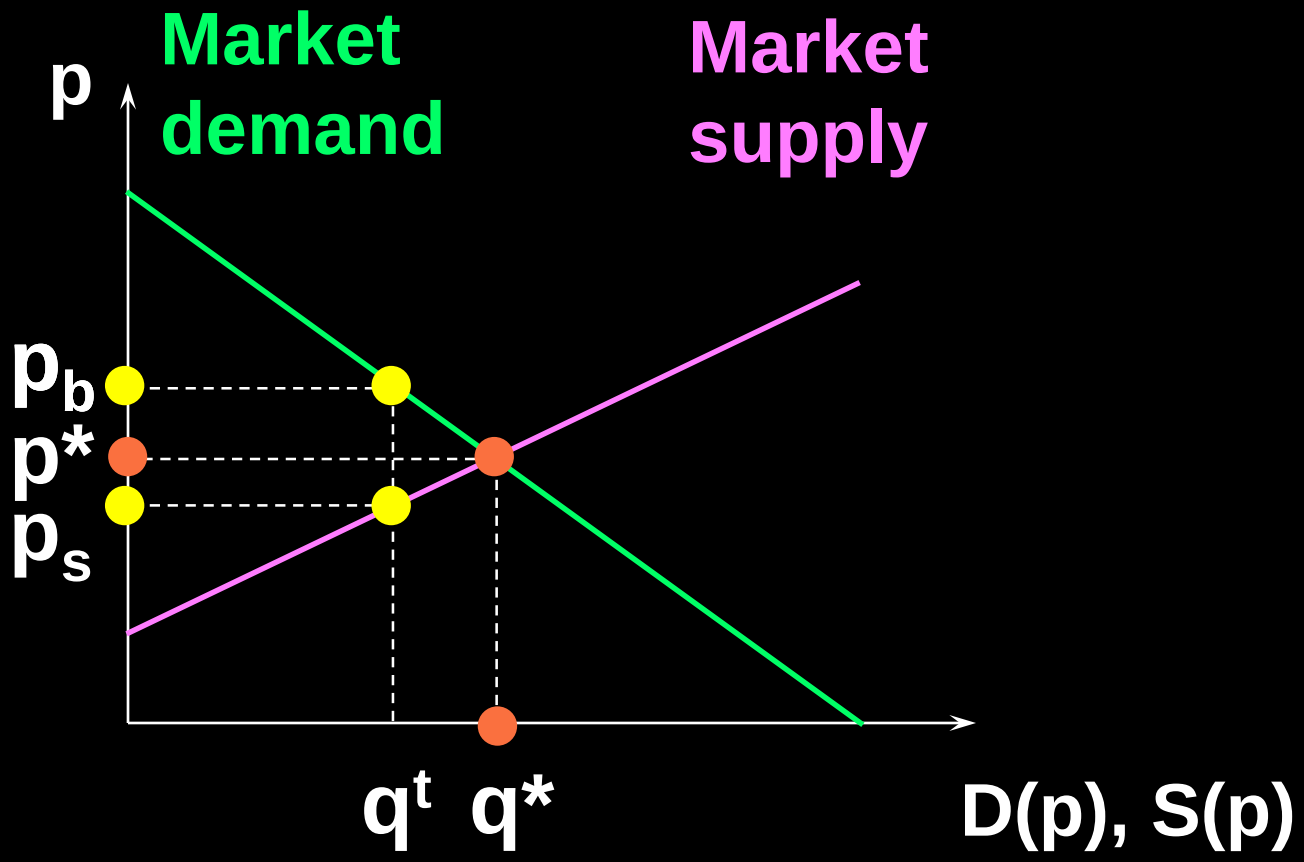
税收t升高，导致p_b上升，p_s下降，q下降



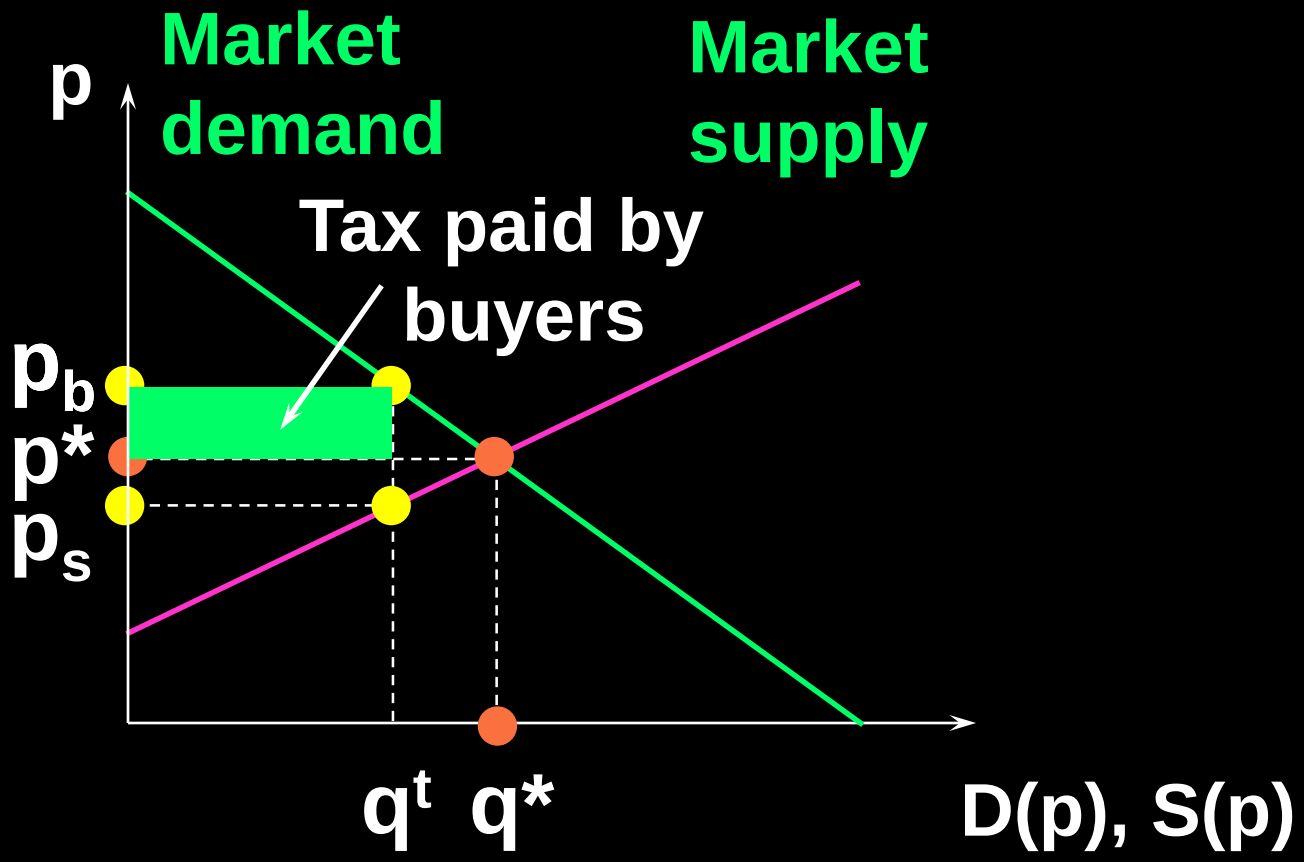
Quantity Taxes & Market Equilibrium

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

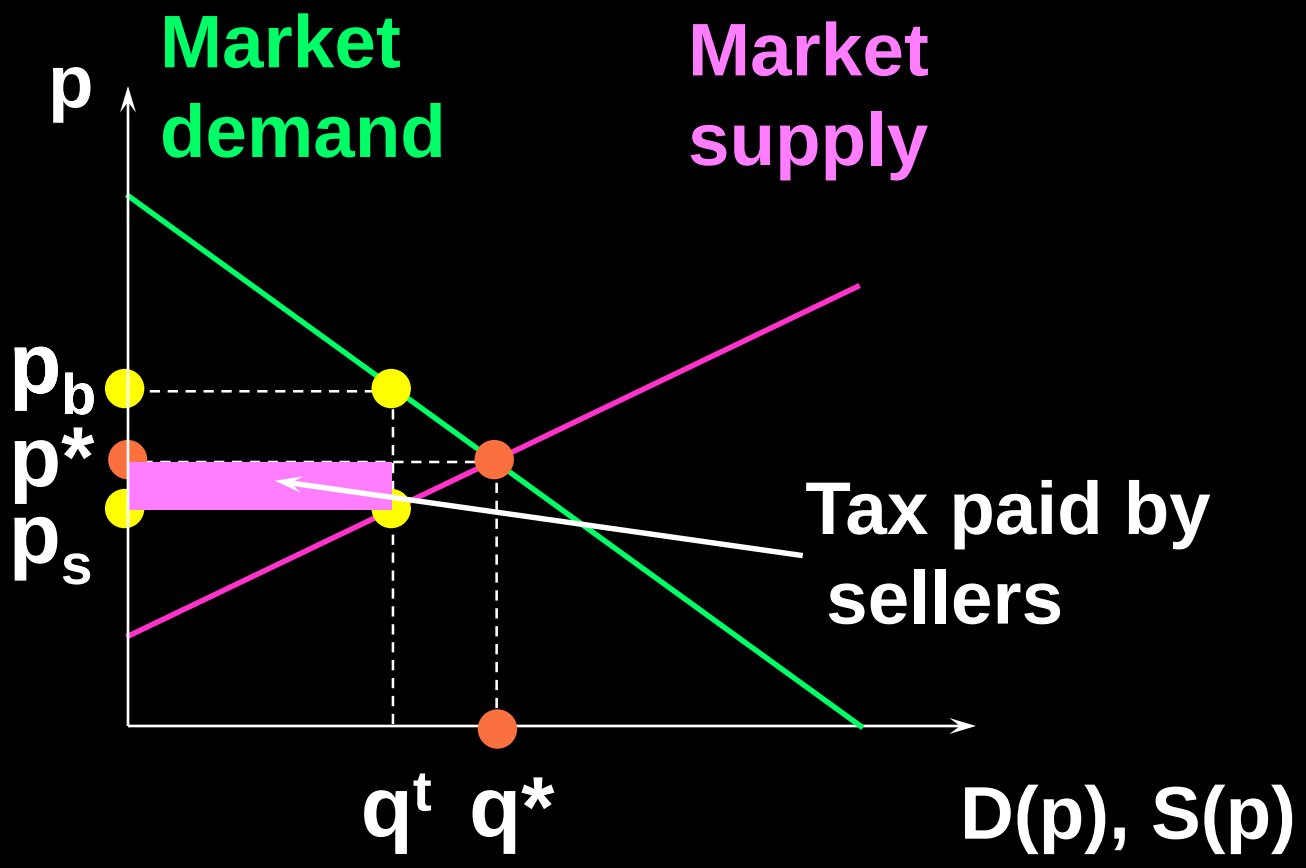
Quantity Taxes & Market Equilibrium



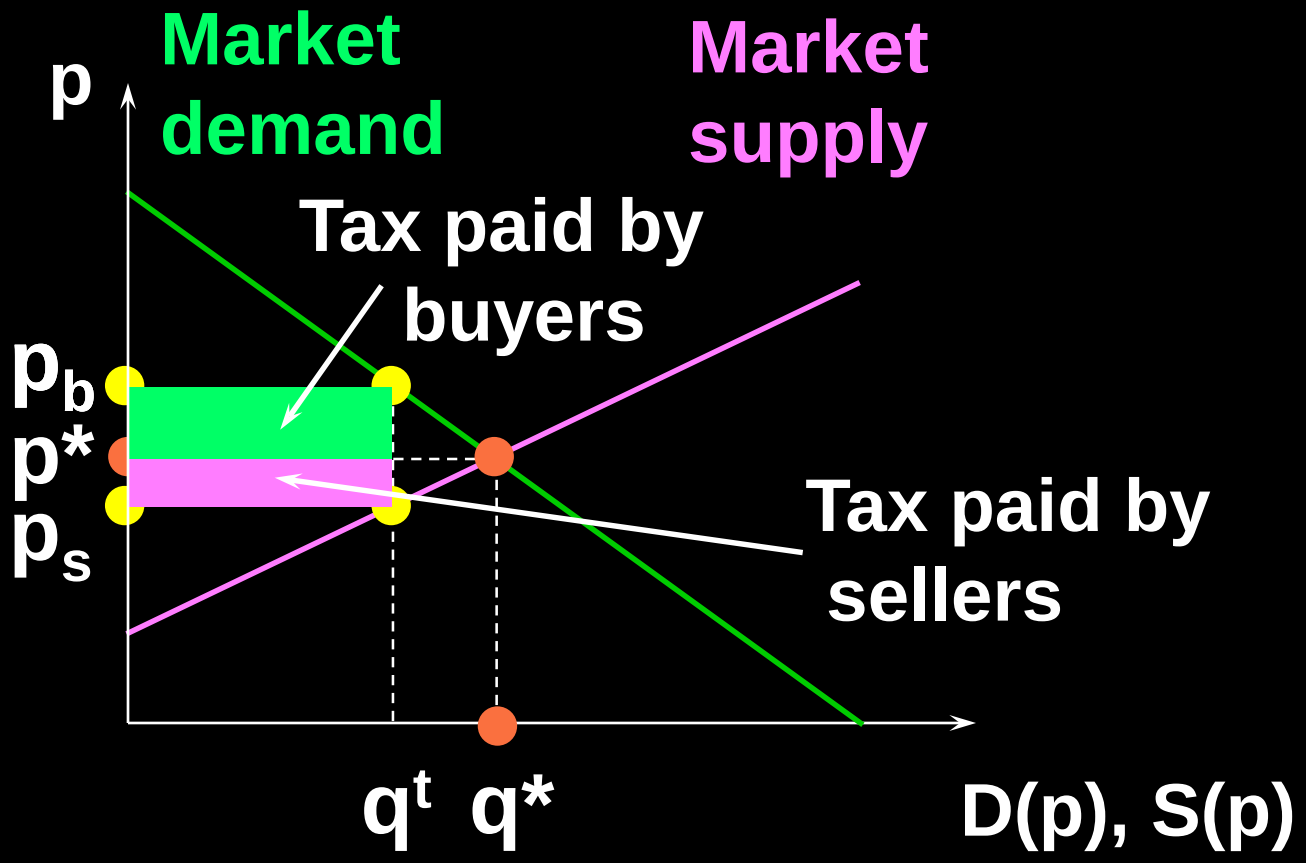
Quantity Taxes & Market Equilibrium



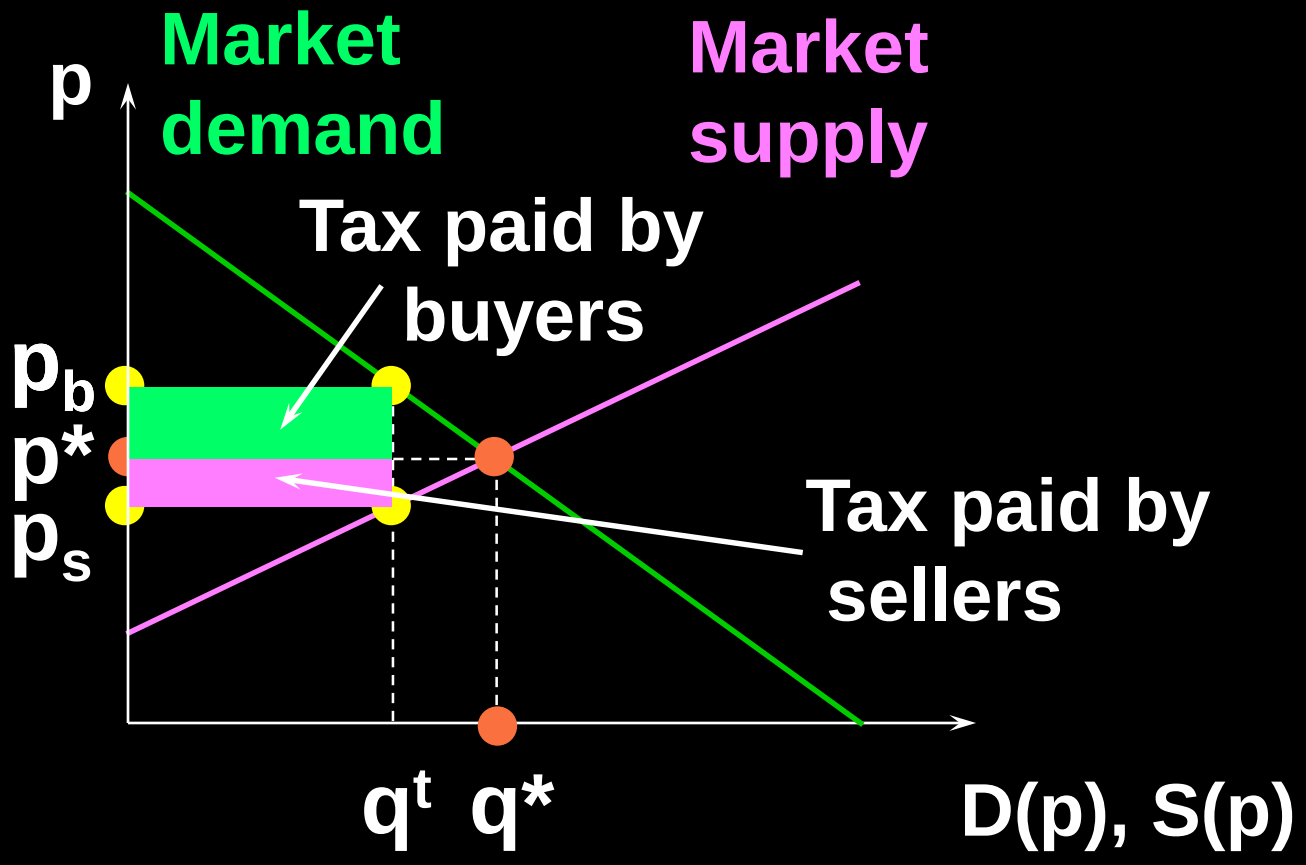
Quantity Taxes & Market Equilibrium



Quantity Taxes & Market Equilibrium



Quantity Taxes & Market Equilibrium



Tax Incidence = $\frac{p_b - p^*}{p^* - p_s}$

Example

The demand function is given by:

$$D(p_b) = 1000 - 60p_b$$

The supply function is given by:

$$S(p_s) = 40p_s$$

Q: What is the tax incidence when sellers pay an excise tax of rate $5?

Example

Q: What is the tax incidence when sellers pay an excise tax of rate $5?

When there is no tax:

$$1000 - 60p = 40p$$

$$p^* = 10$$

When sellers pay an excise tax of $5,

$$p_s = p_b - 5$$

$$1000 - 60p_b = 40p_s = 40(p_b - 5)$$

$$p_b^* = 12, p_s^* = 7$$

Example

Q: What is the tax incidence when sellers pay an excise tax of rate $5?

When there is no tax:

$$p^* = 10$$

When sellers pay an excise tax of $5,

$$p_b^* = 12, p_s^* = 7$$

Buyers pay $p_b^* - p^* = \$2$ of the tax

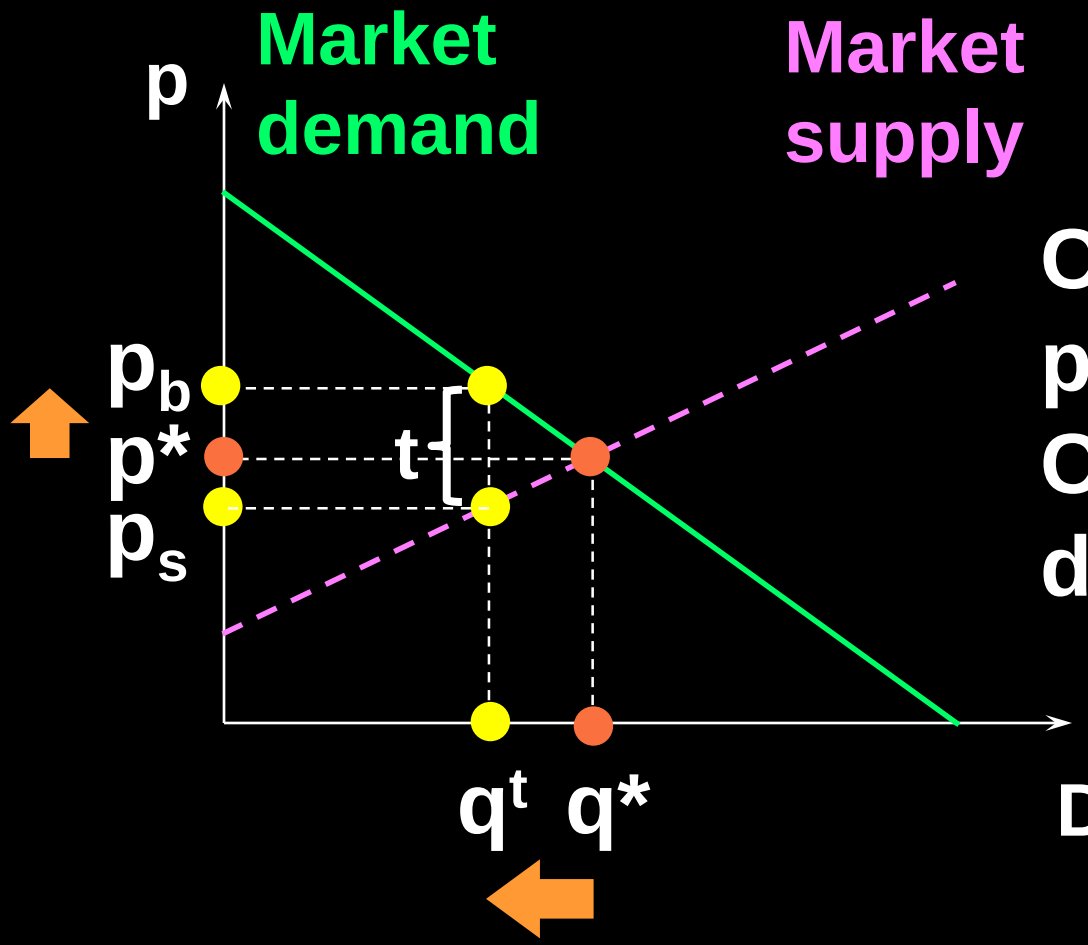
Sellers pay $p^* - p_s^* = \$3$ of the tax

Tax Incidence = $\frac{p_b - p^*}{p^* - p_s} = \frac{2}{3}$

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

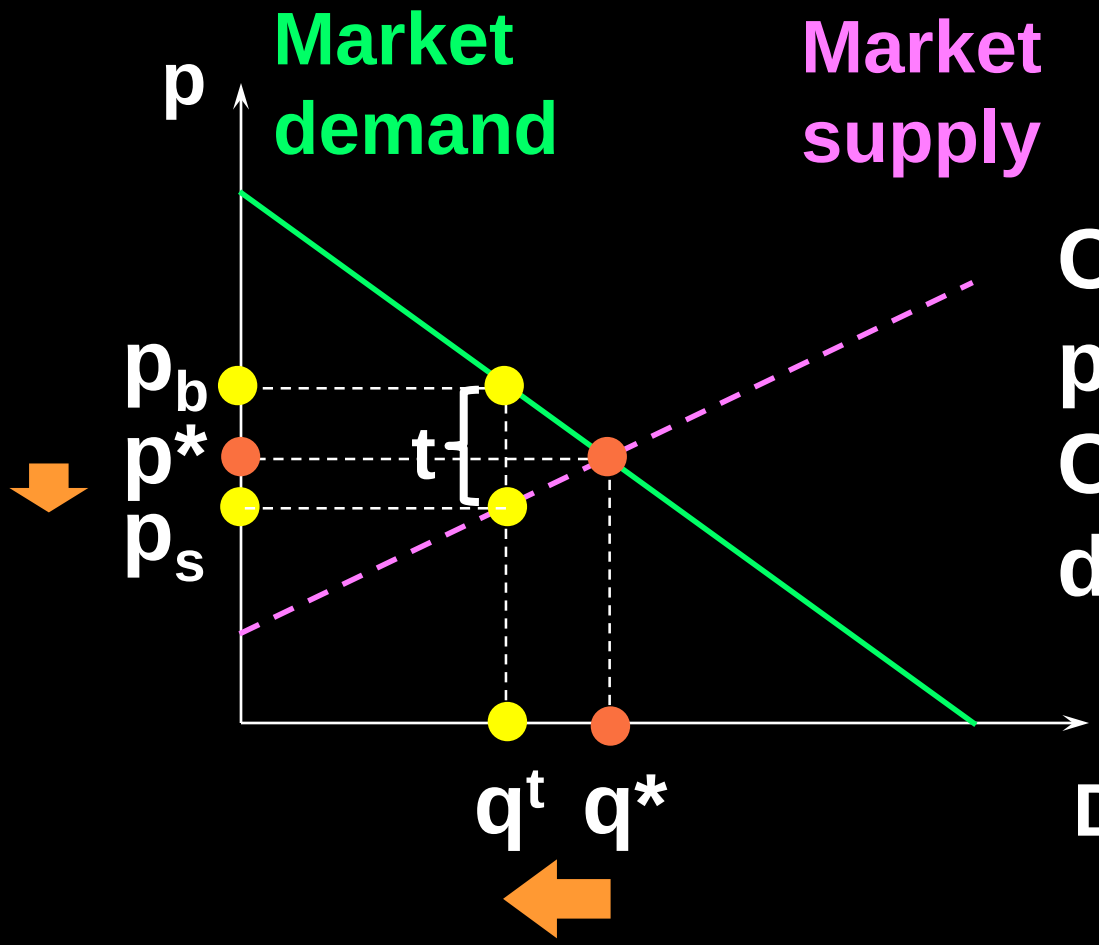
$$\varepsilon_D \approx \frac{\frac{\Delta q}{q^*}}{\frac{p_b - p^*}{p^*}}$$

Tax Incidence and Own-Price Elasticities

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

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

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

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

Tax Incidence and Own-Price Elasticities

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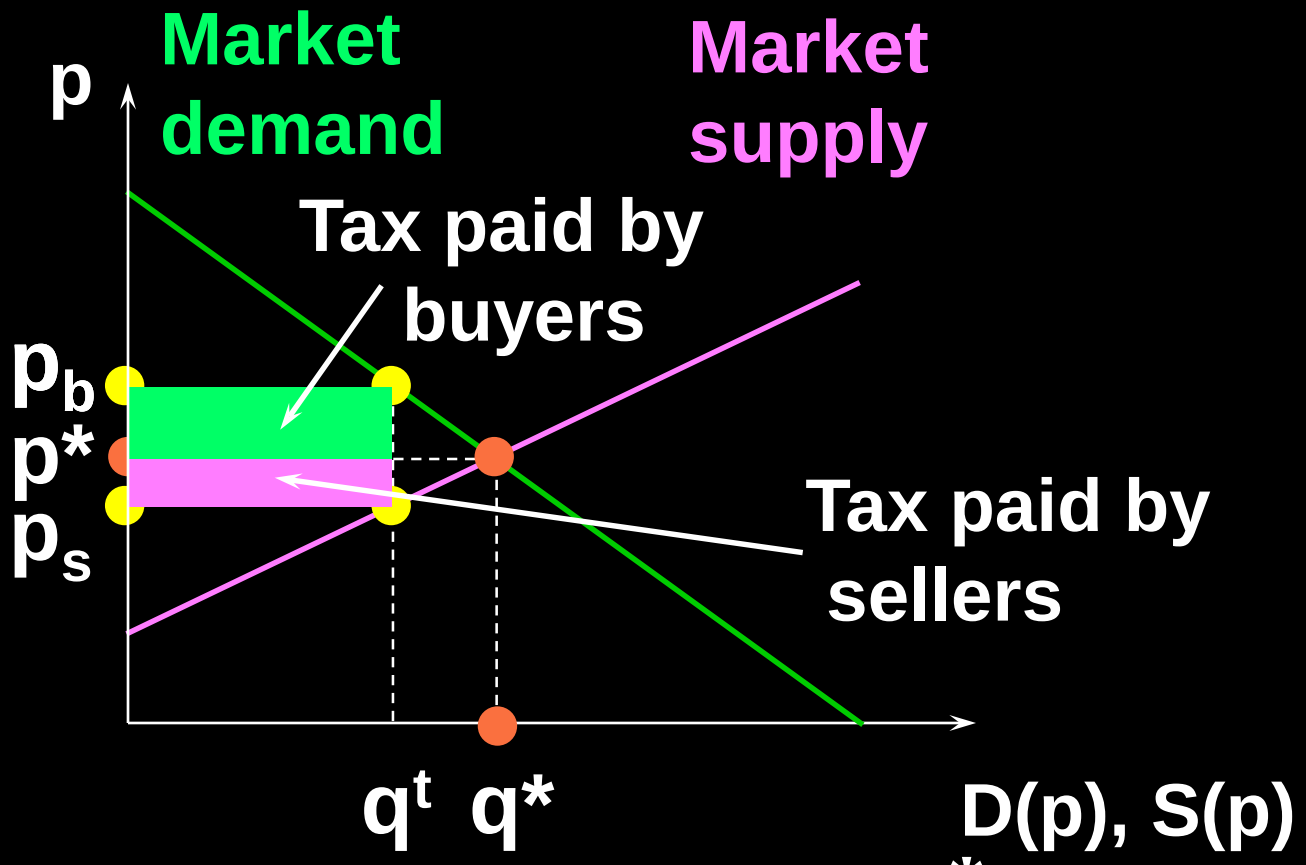
$$\varepsilon_S \approx \frac{\frac{\Delta q}{q^*}}{\frac{p_S - p^*}{p^*}} \quad \Rightarrow \quad p_S - p^* \approx \frac{\Delta q \times p^*}{\varepsilon_S \times q^*}.$$

Tax Incidence and Own-Price Elasticities



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

Tax Incidence and Own-Price Elasticities

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

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

Tax Incidence and Own-Price Elasticities

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

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

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

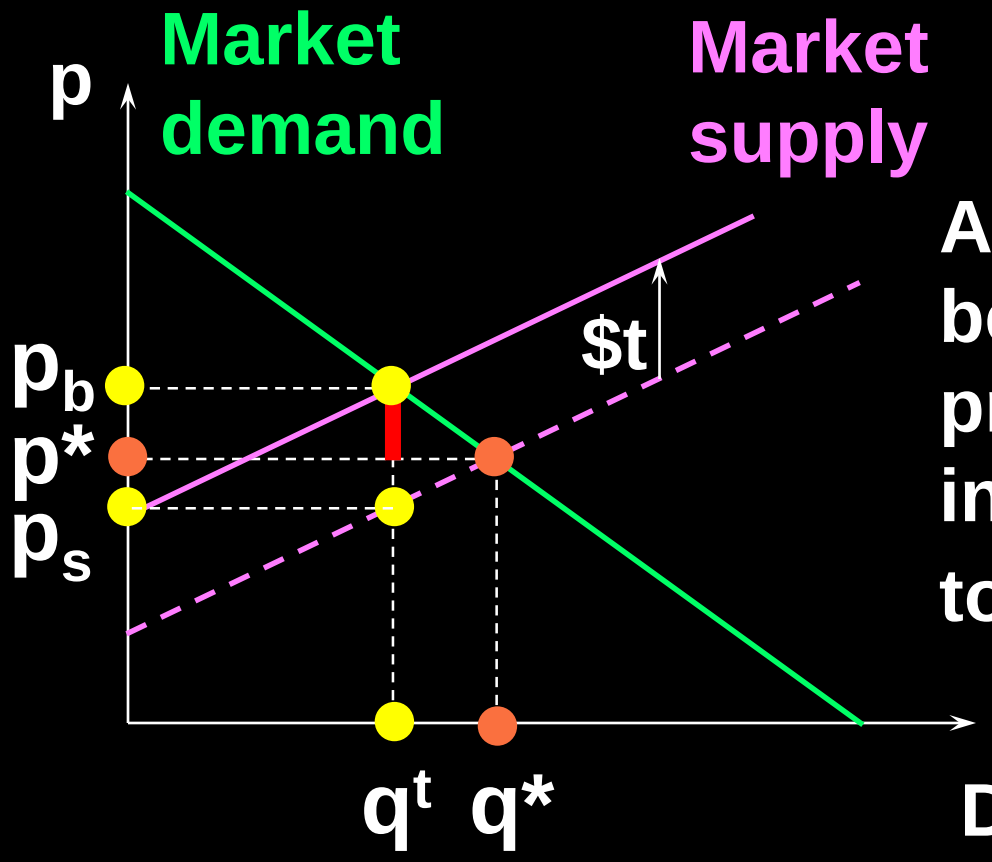
Tax Incidence and Own-Price Elasticities

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

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.

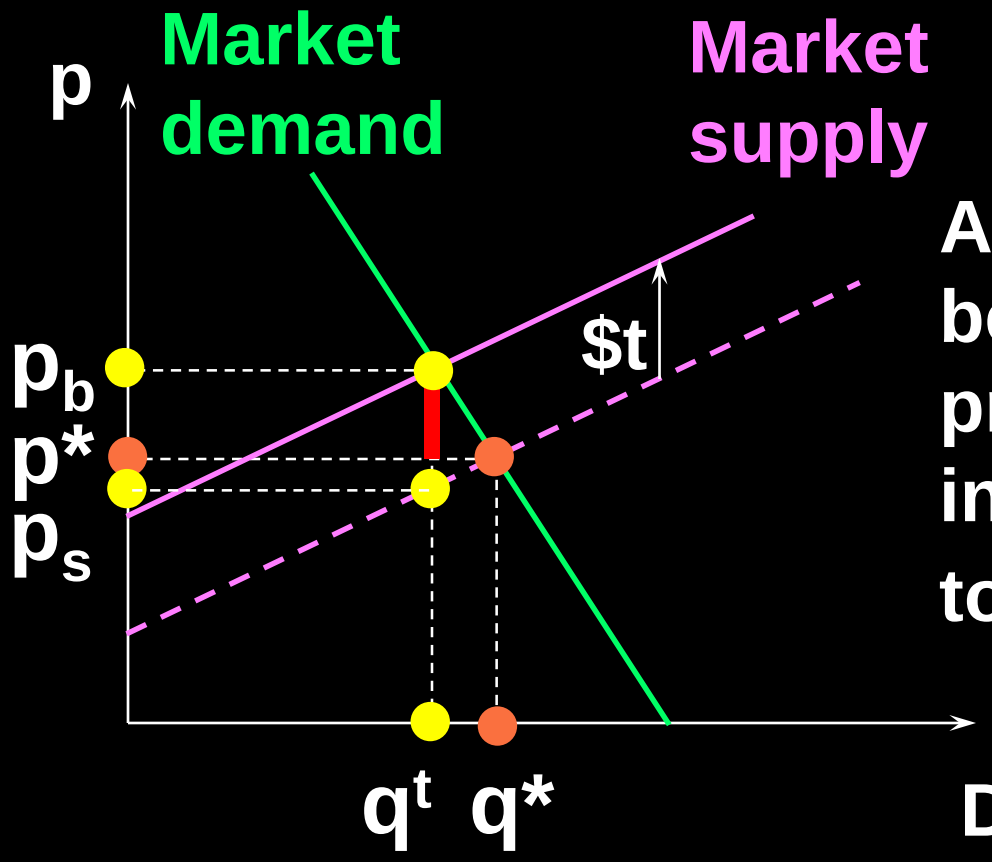
由消费者负担的税收比例随需求价格弹性绝对值的上升而下降，随供给价格弹性的上升而上升。

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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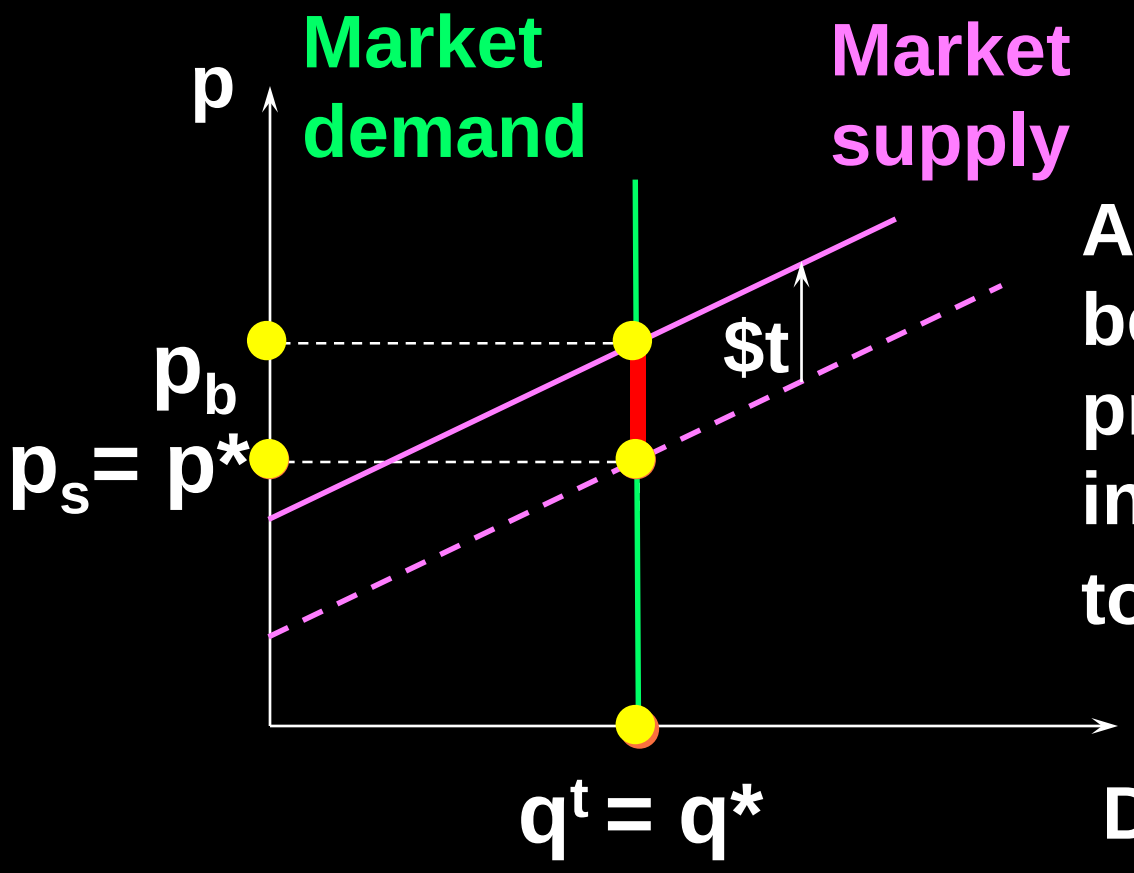

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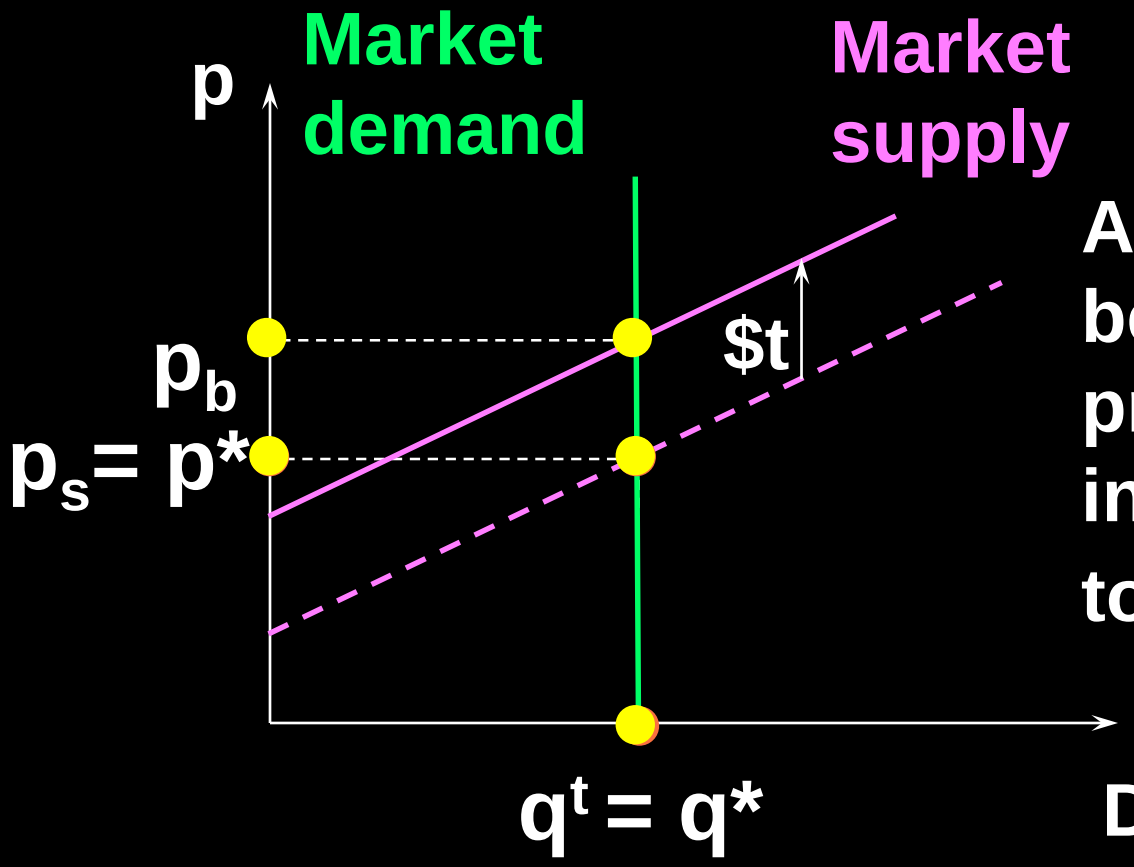
Tax Incidence and Own-Price Elasticities



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

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.

由生产者负担的税收比例随需求价格弹性绝对值的上升而上升，随供给价格弹性的上升而下降。

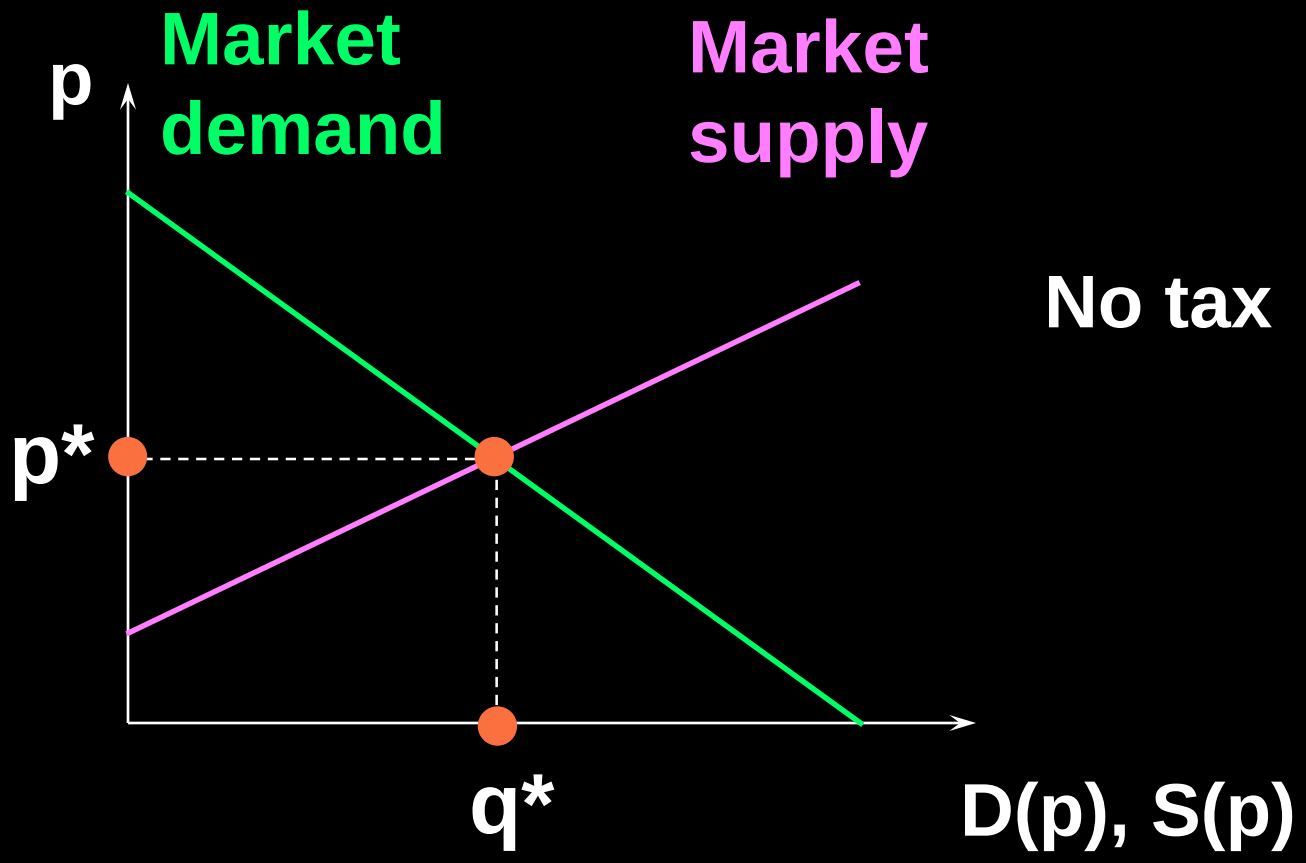
“弹性大的税负比例小”

Deadweight Loss and Own-Price Elasticities

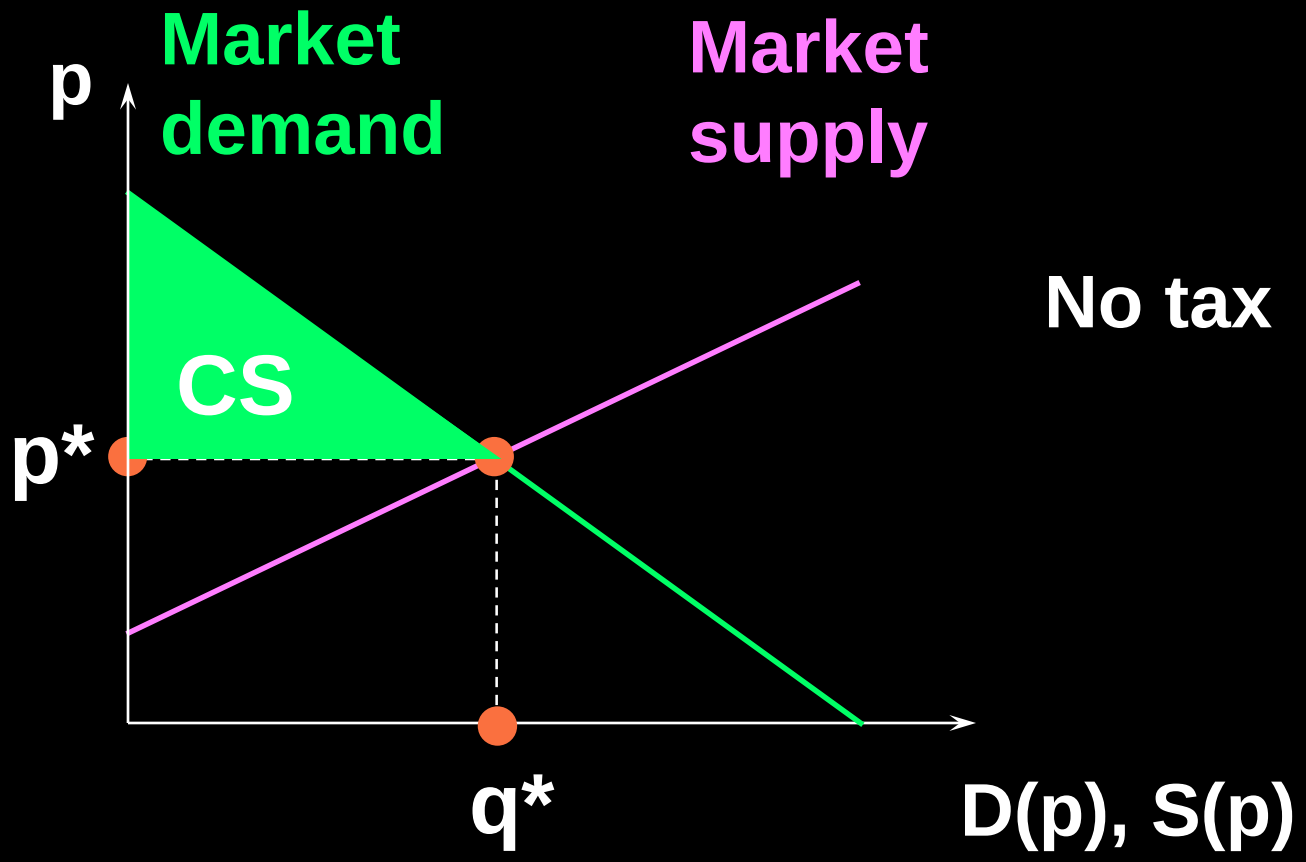
- **A quantity tax imposed on a competitive market reduces the quantity traded and so reduces gains-to-trade (*i.e.* the sum of Consumers' and Producers' Surpluses).**
- **The lost total surplus is the tax's deadweight loss, or excess burden.**

税收减少了市场中的交易数量，因此造成了总剩余的下降。

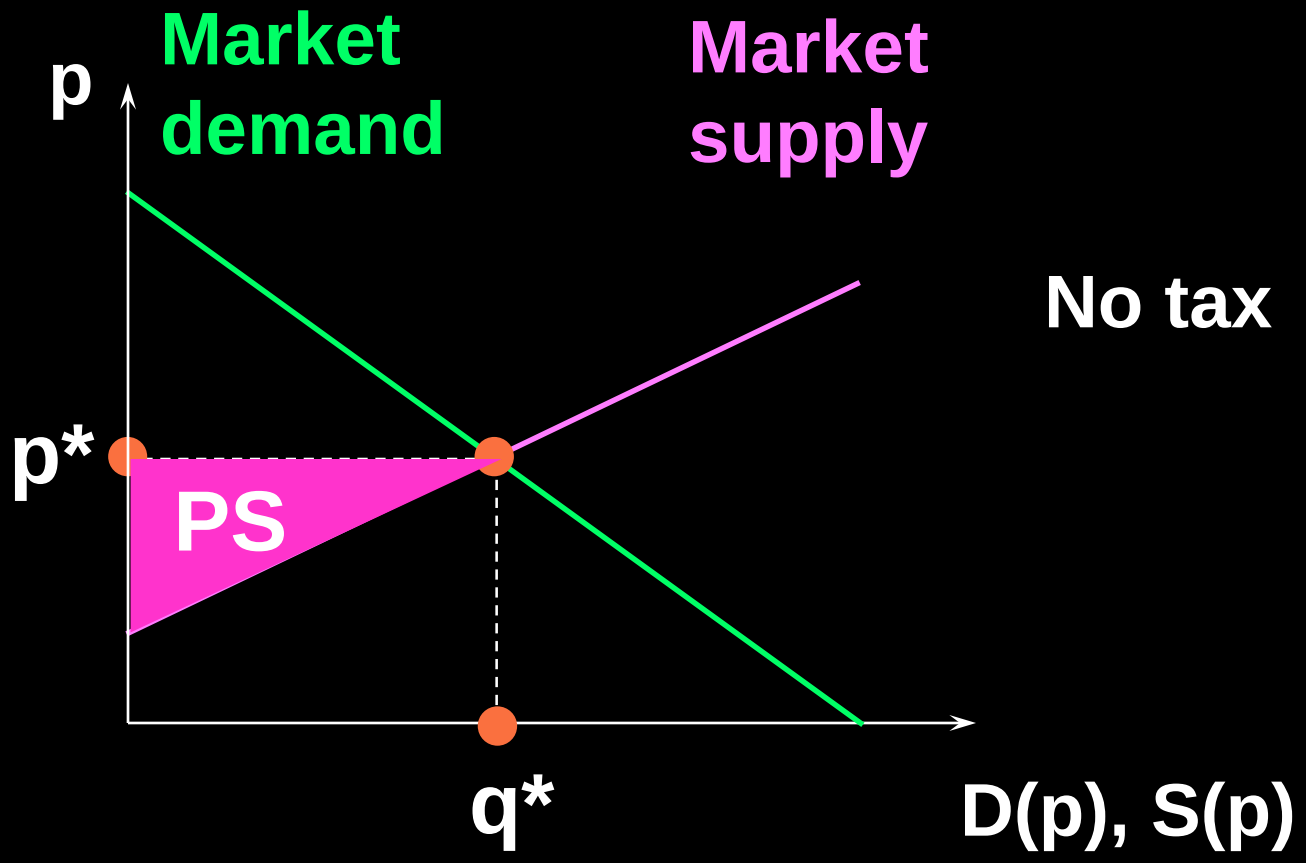
Deadweight Loss and Own-Price Elasticities



Deadweight Loss and Own-Price Elasticities



Deadweight Loss and Own-Price Elasticities



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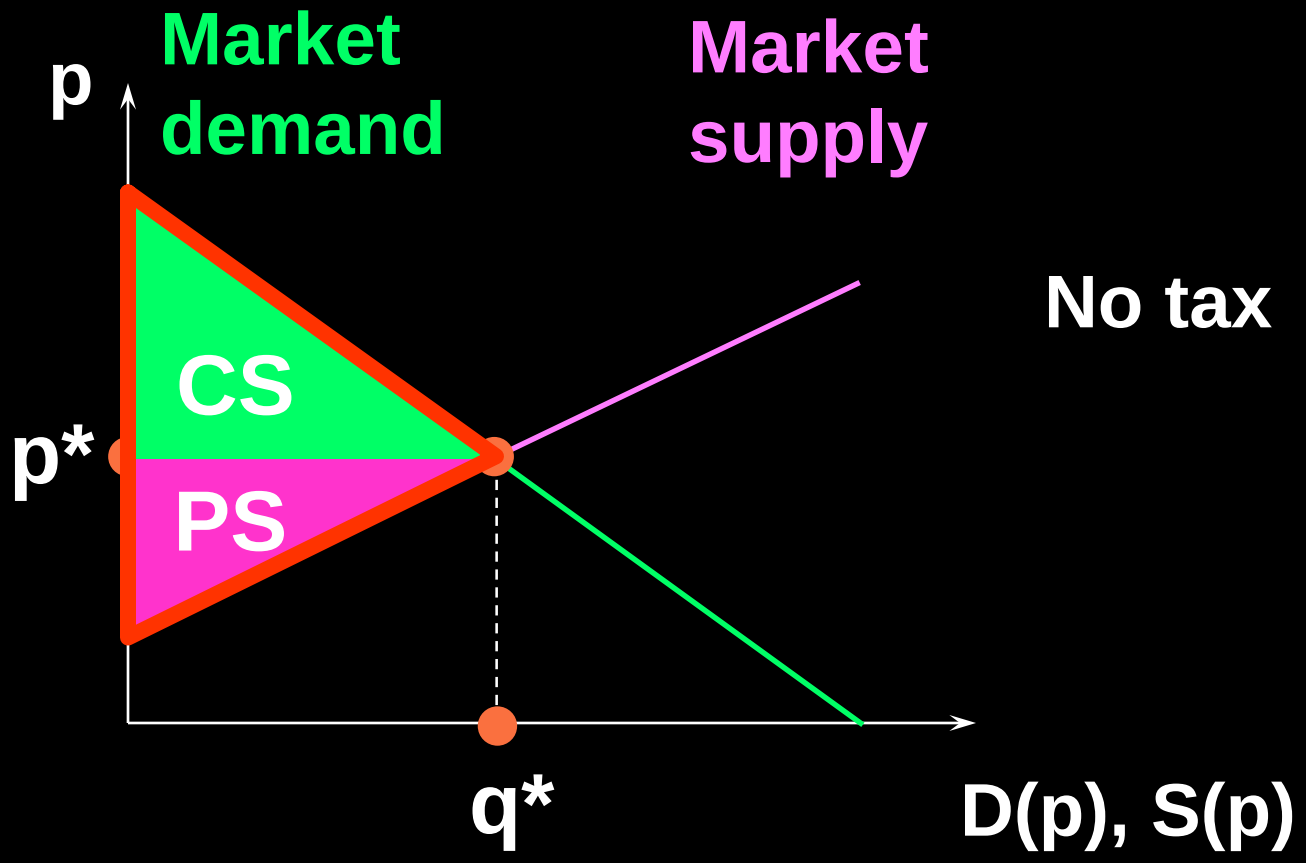
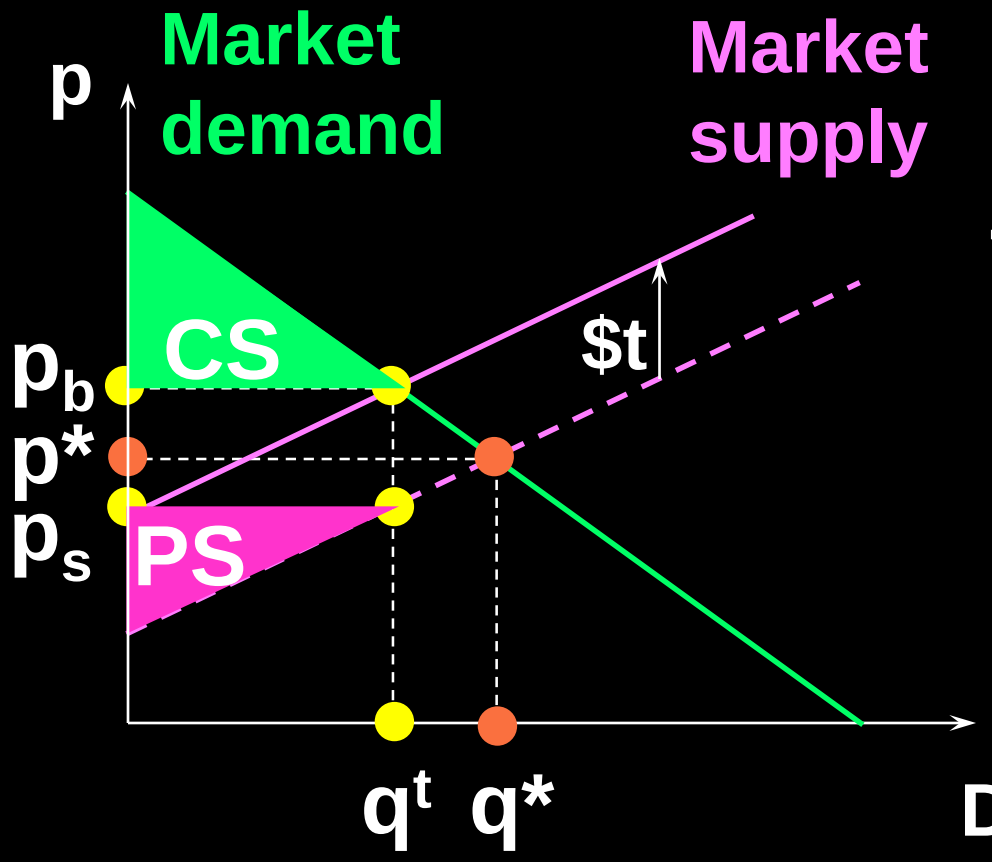
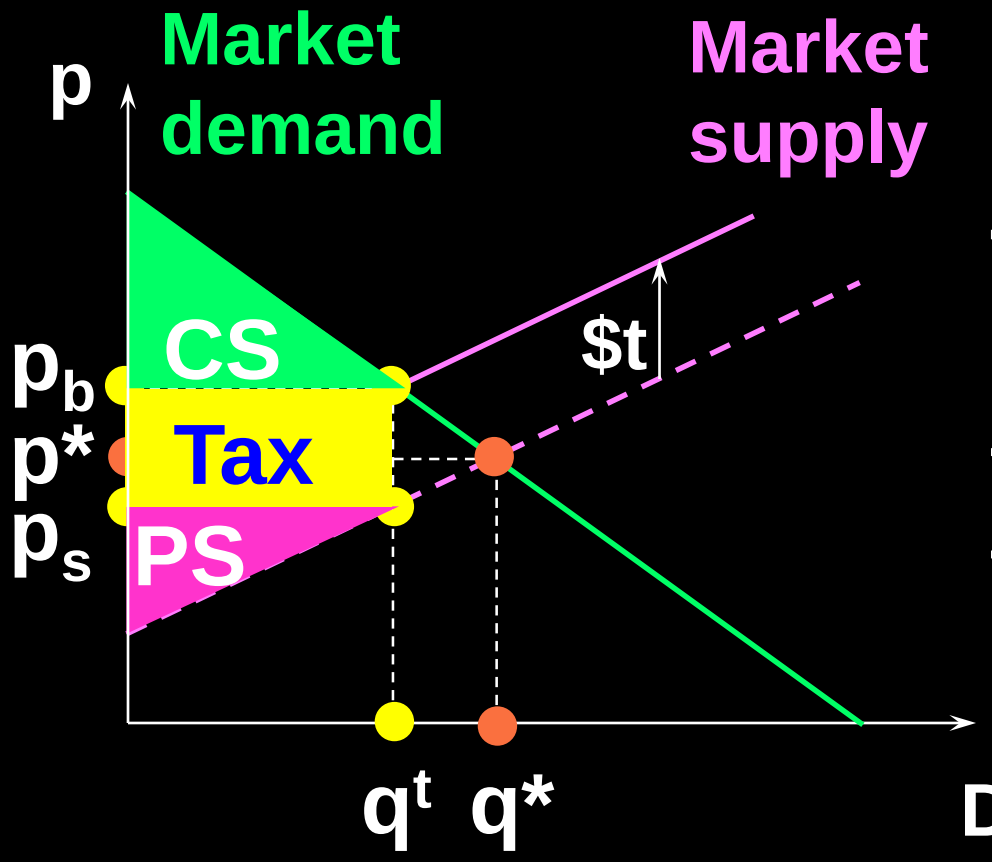


Deadweight Loss and Own-Price Elasticities



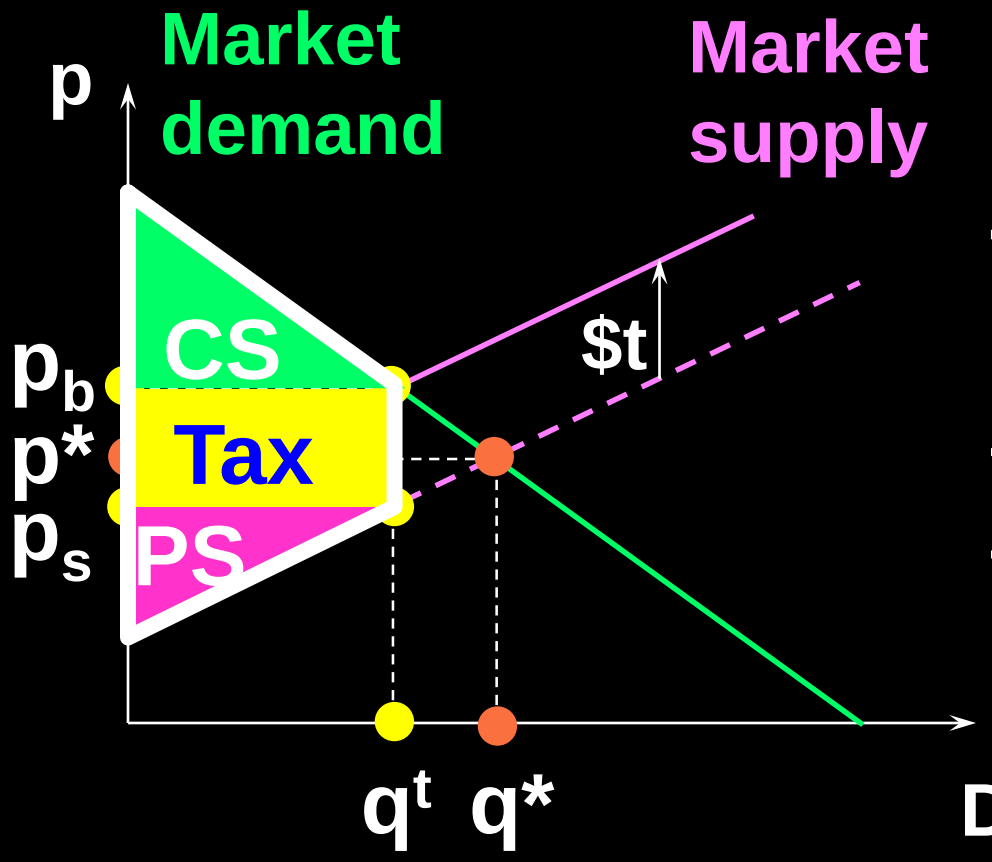
The tax reduces both CS and PS

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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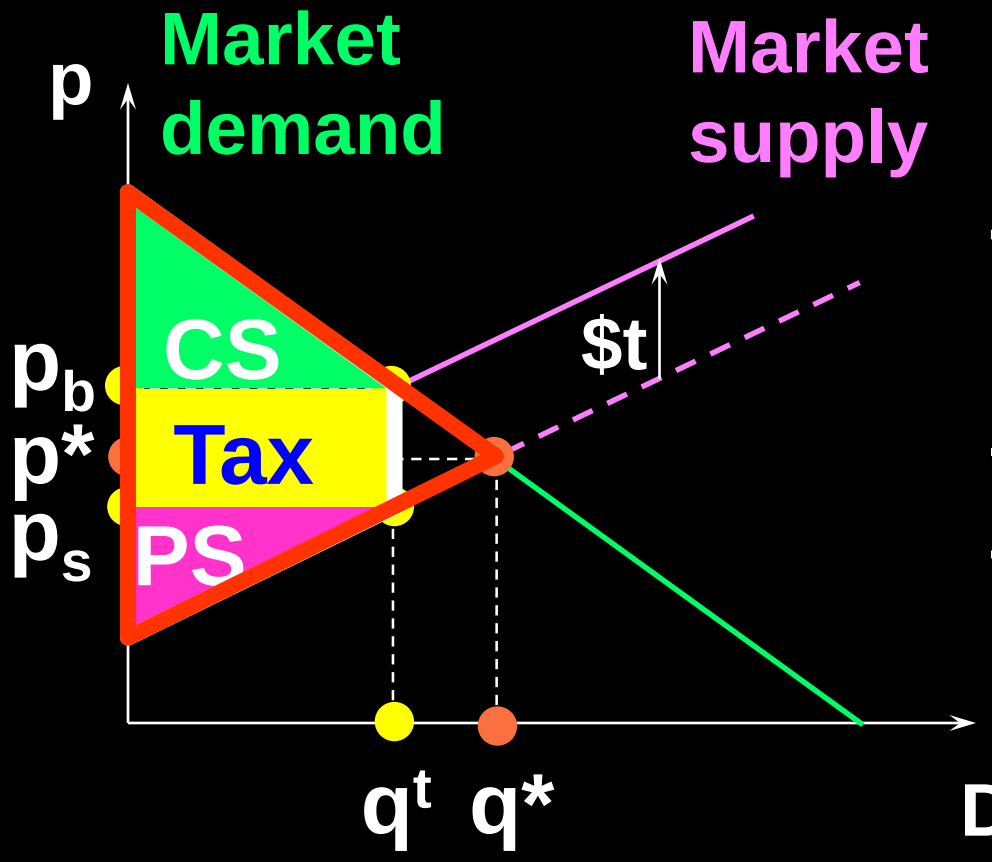

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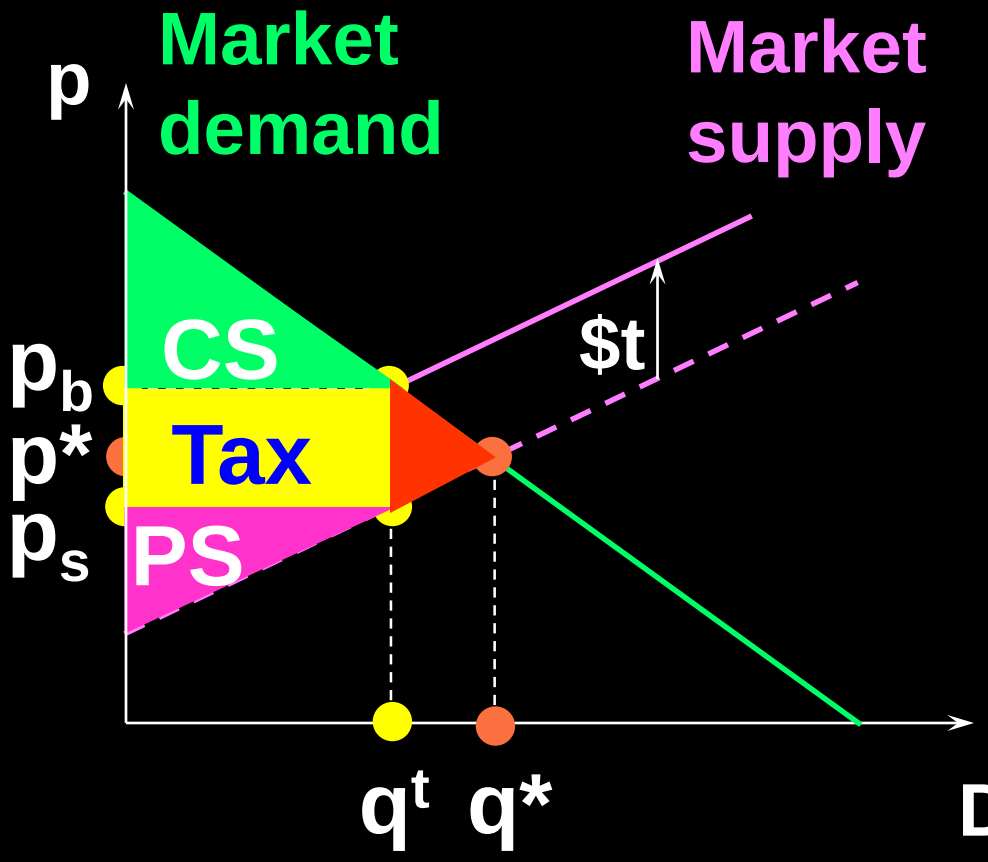
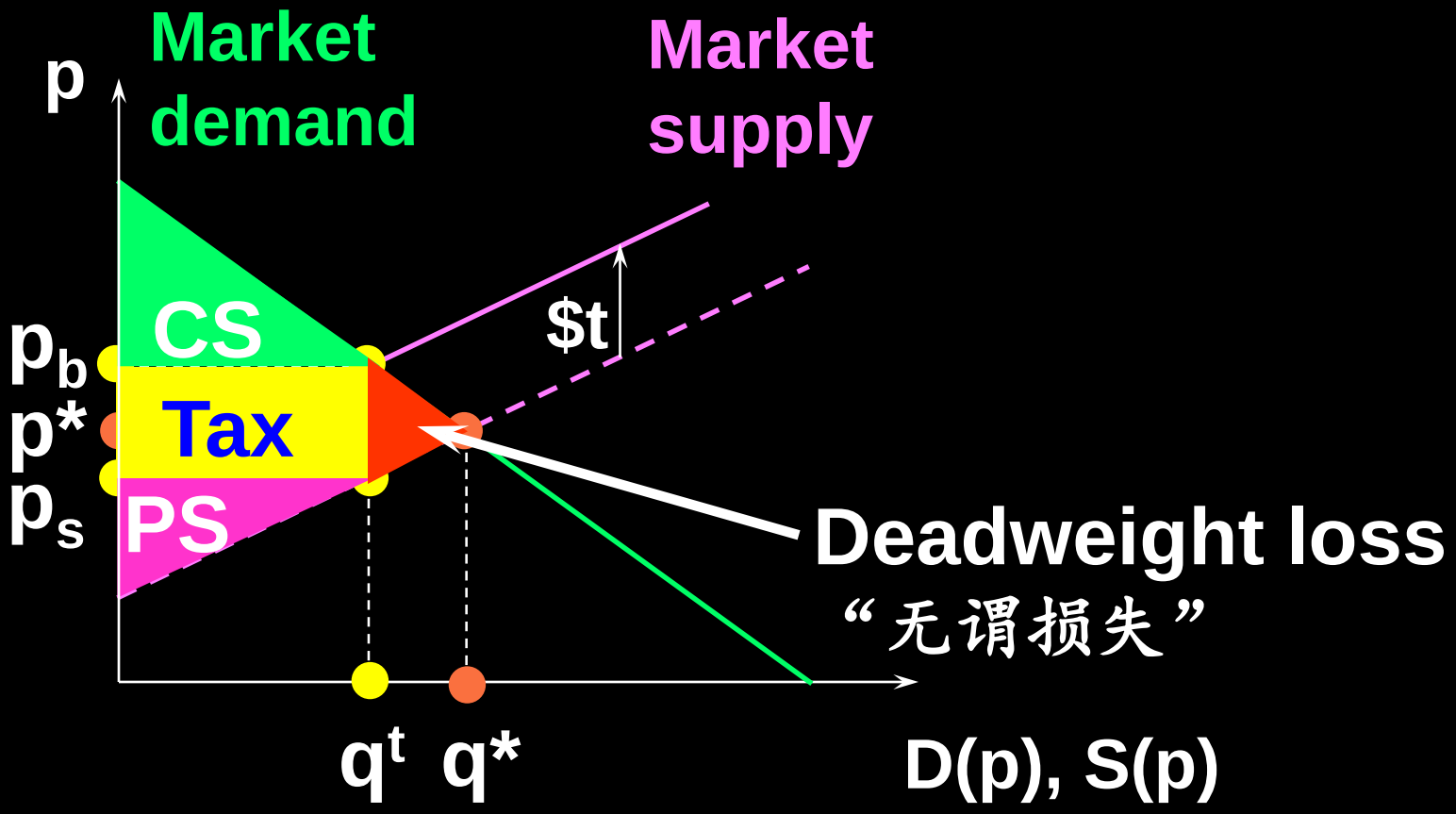
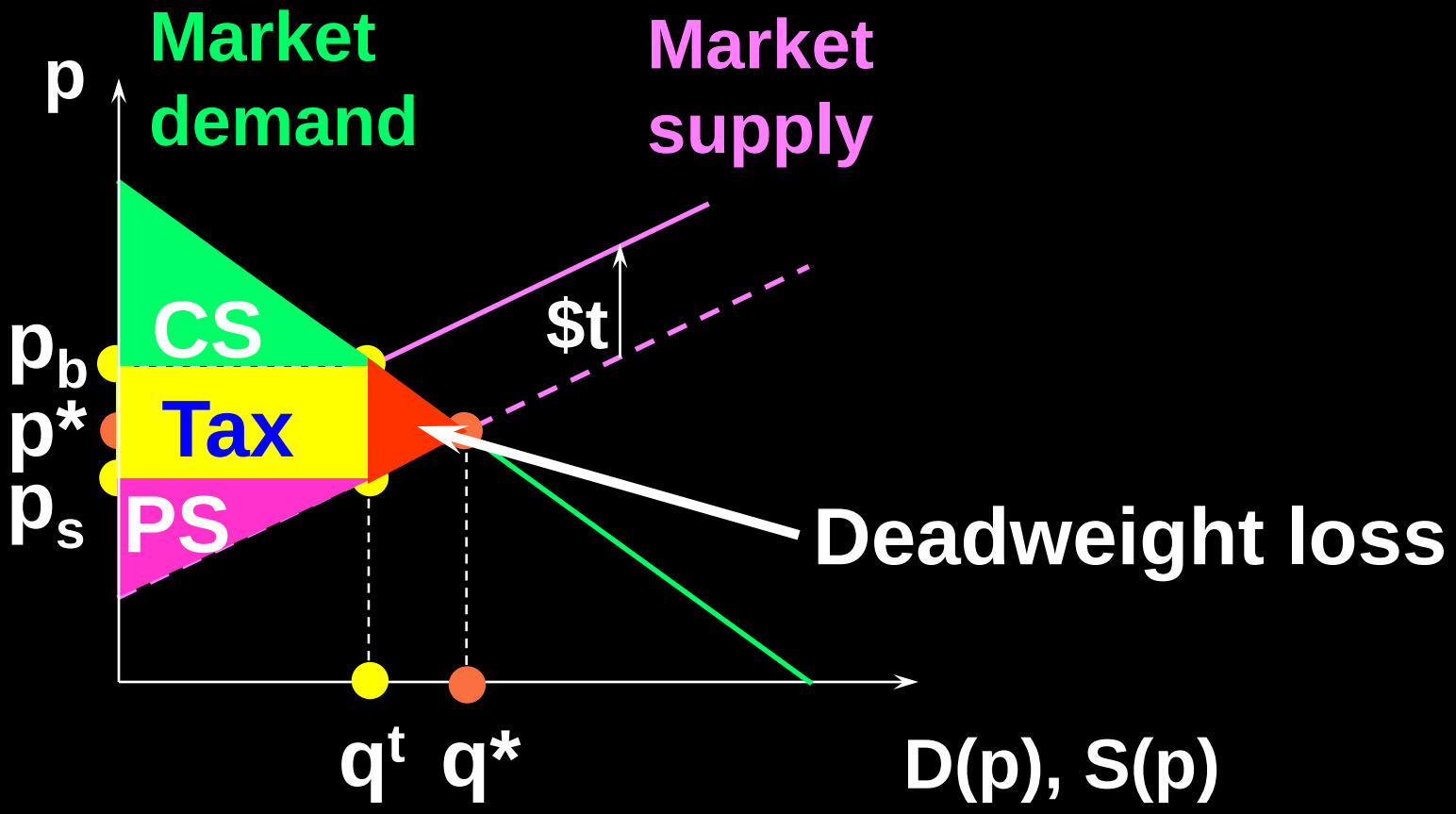


The tax reduces both CS and PS, transfers surplus to government, and lowers total surplus.

Deadweight Loss and Own-Price Elasticities



Deadweight Loss and Own-Price Elasticities



$$\mathbf{DWL} = \frac{1}{2} \times \mathbf{t} \times (\mathbf{q}^* - \mathbf{q}^t)$$

Example

The demand function is given by:

$$D(p_b) = 1000 - 60p_b$$

The supply function is given by:

$$S(p_s) = 40p_s$$

Q: What is the deadweight loss when sellers pay an excise tax of rate $5?

Example

Q: What is the tax incidence when sellers pay an excise tax of rate $5?

When there is no tax:

$$1000 - 60p = 40p$$

$$p^* = 10,\ q^* = 400,$$

When sellers pay an excise tax of $5,

$$p_s = p_b - 5$$

$$1000 - 60p_b = 40p_s = 40(p_b - 5)$$

$$p_b^* = 12,\ p_s^* = 7,\ q_t^* = 280$$

Example

Q: What is the tax incidence when sellers pay an excise tax of rate $5?

When there is no tax:

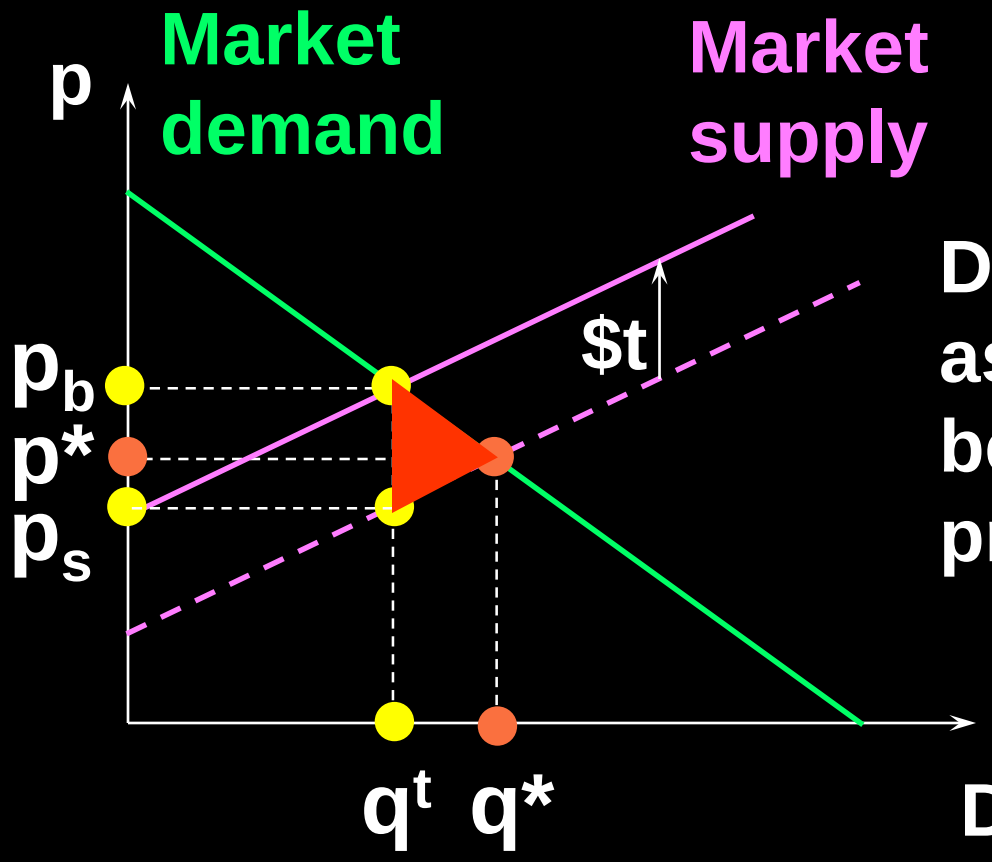
$$q^* = 400,$$

When sellers pay an excise tax of $5,

$$q_t^* = 280$$

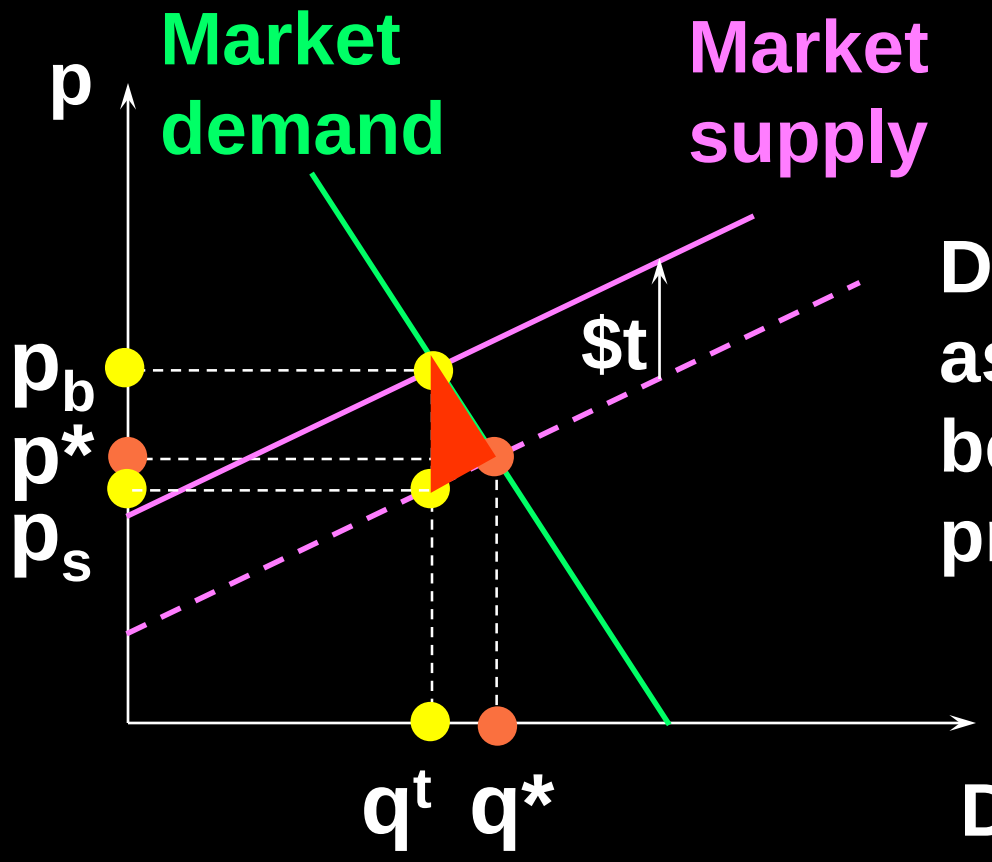
$$\mathbf{DWL} = \frac{1}{2} \times \mathbf{t} \times (\mathbf{q}^* - \mathbf{q}^{\mathbf{t}}) = \frac{1}{2} * 5 * 120 = \$300$$

Deadweight Loss and Own-Price Elasticities



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

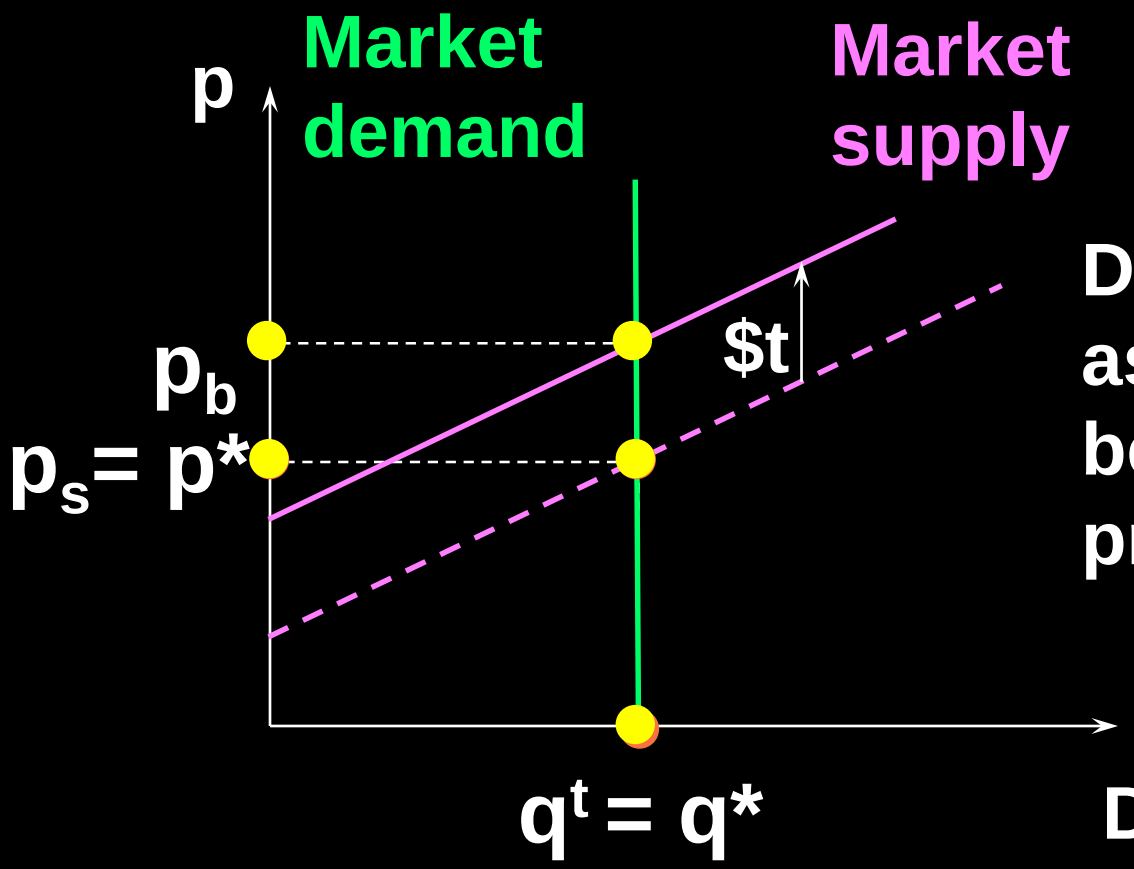
Deadweight Loss and Own-Price Elasticities



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

需求或供给对价格的弹性越小，税收造成的无谓损失越小。

Deadweight Loss and Own-Price Elasticities



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.**