Equilibrium
Chapter 16

Competitive Equilibrium: Motivating Questions

- Firms are 'price-takers' in competitive markets, but how is the market price (and quantity) determined? **competitive equilibrium**
- What happens to equilibrium price and quantity when either supply or demand changes? **comparative statics**
- What are the effects of taxes and subsidies on prices and quantities?
- What are the welfare effects of taxes and subsidies? **deadweight loss, tax incidence**

Taxes

- Quantity (or excise) tax
  - Effect on p, q
  - Subsidy
  - Incidence
  - Welfare effects
- Price tax: effect on p, q

Quantity Taxes

- Levied on each unit sold.
- E.g. gasoline tax: seller sets price at \$2.05/gallon and gasoline tax is \$0.35/gallon. Consumer must pay $p_d = 2.05 + 0.35 = 2.40$ dollars/gallon
- Seller gets $p_s = 2.05$
- Like any tax, this creates a wedge between what consumer pays and what producer receives
- The \$0.35 tax, collected by the govt., is the difference between the *consumer price*, p_d, and the *producer price*, p_s:

$$p_d - p_s = 0.35$$

Equilibrium with a Quantity Tax

Suppose gasoline tax is t dollars/gallon.

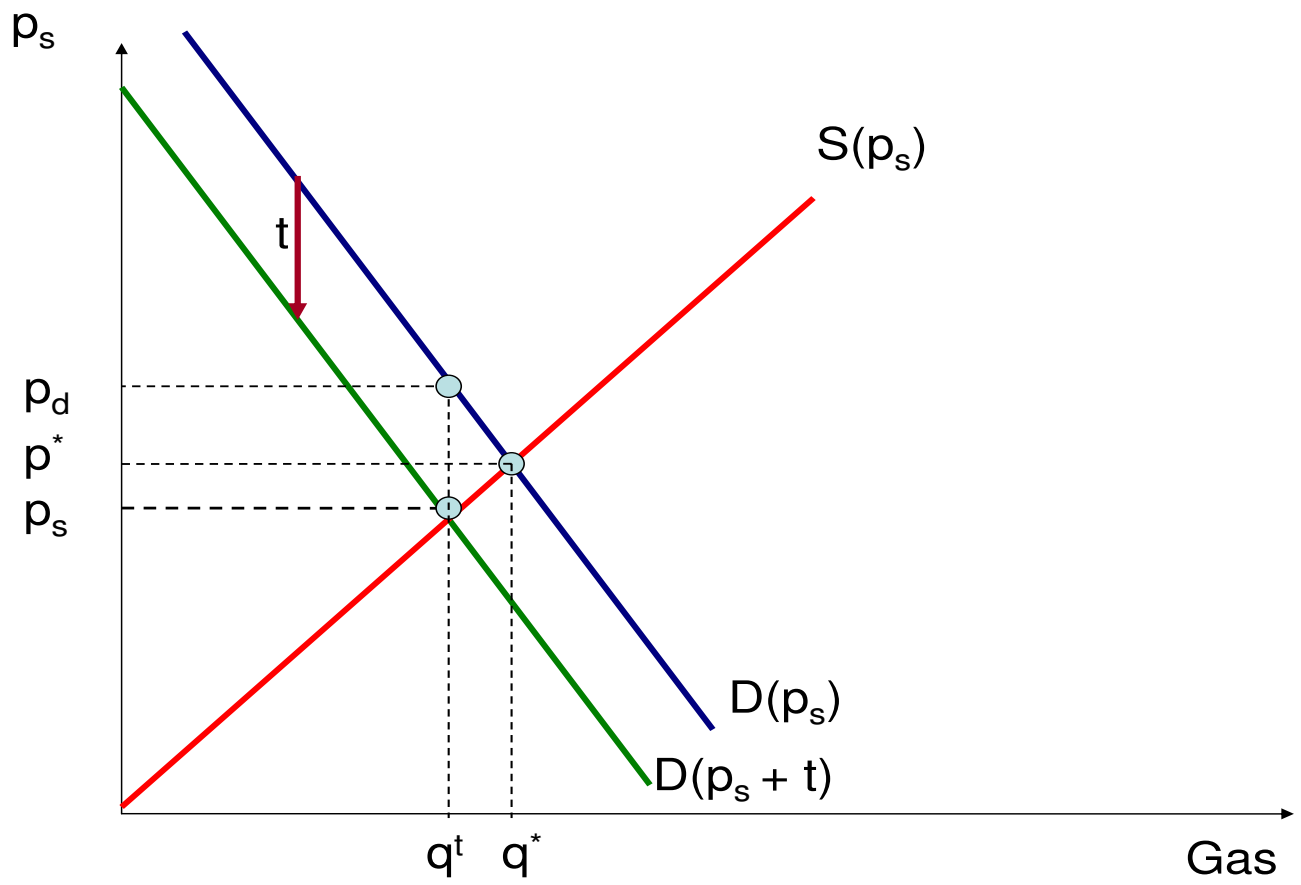
- t as a wedge:

$$p_d - p_s = t \Longrightarrow p_d = p_s + t$$

- How does this affect equilibrium?
- New condition: $D(p_d) = S(p_s)$
- Rewrite as $D(p_s + t) = S(p_s)$ *or* $D(p_d) = S(p_d - t)$
- Can think of this as either shifting D or S

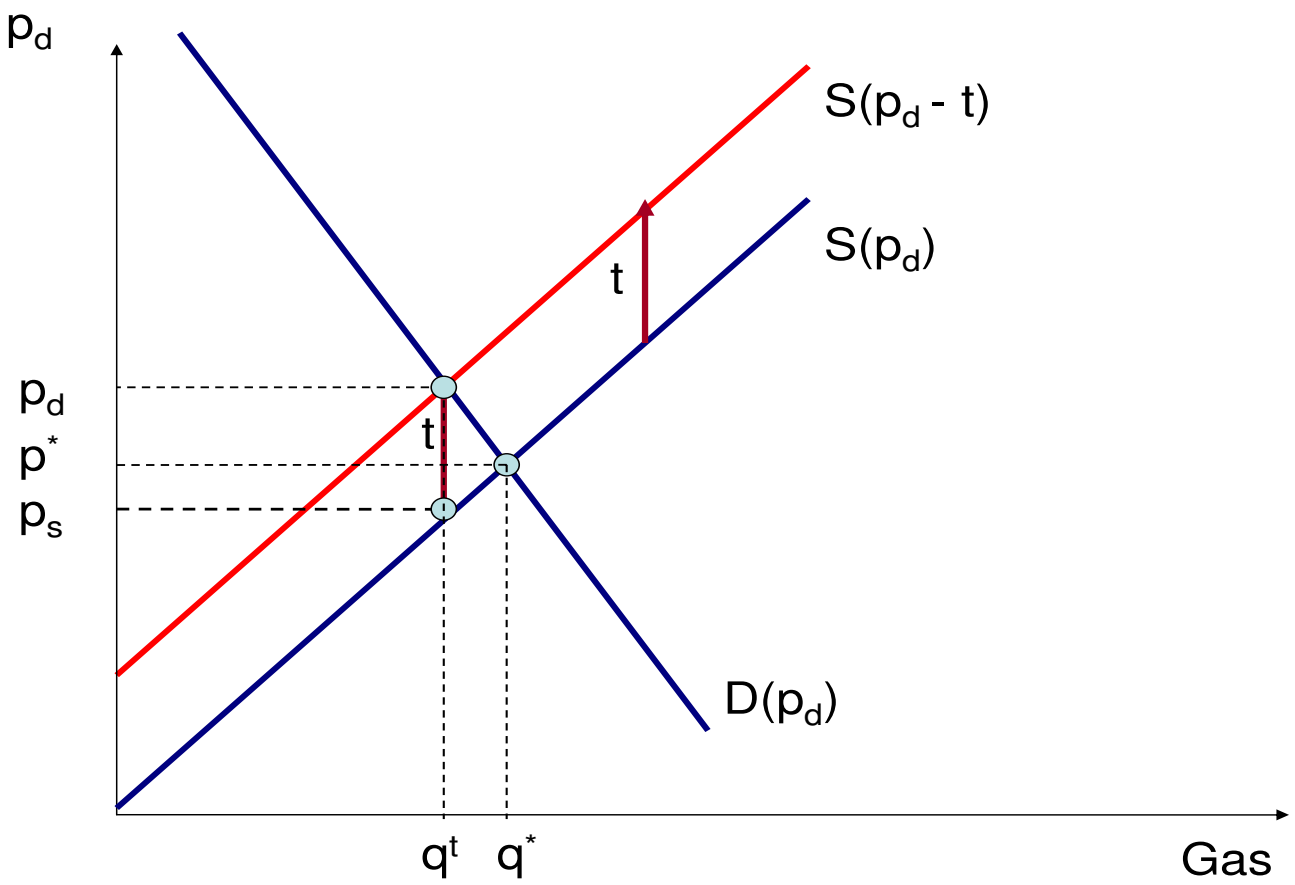
Equilibrium with a Quantity Tax

One view: demand shifts *downward*



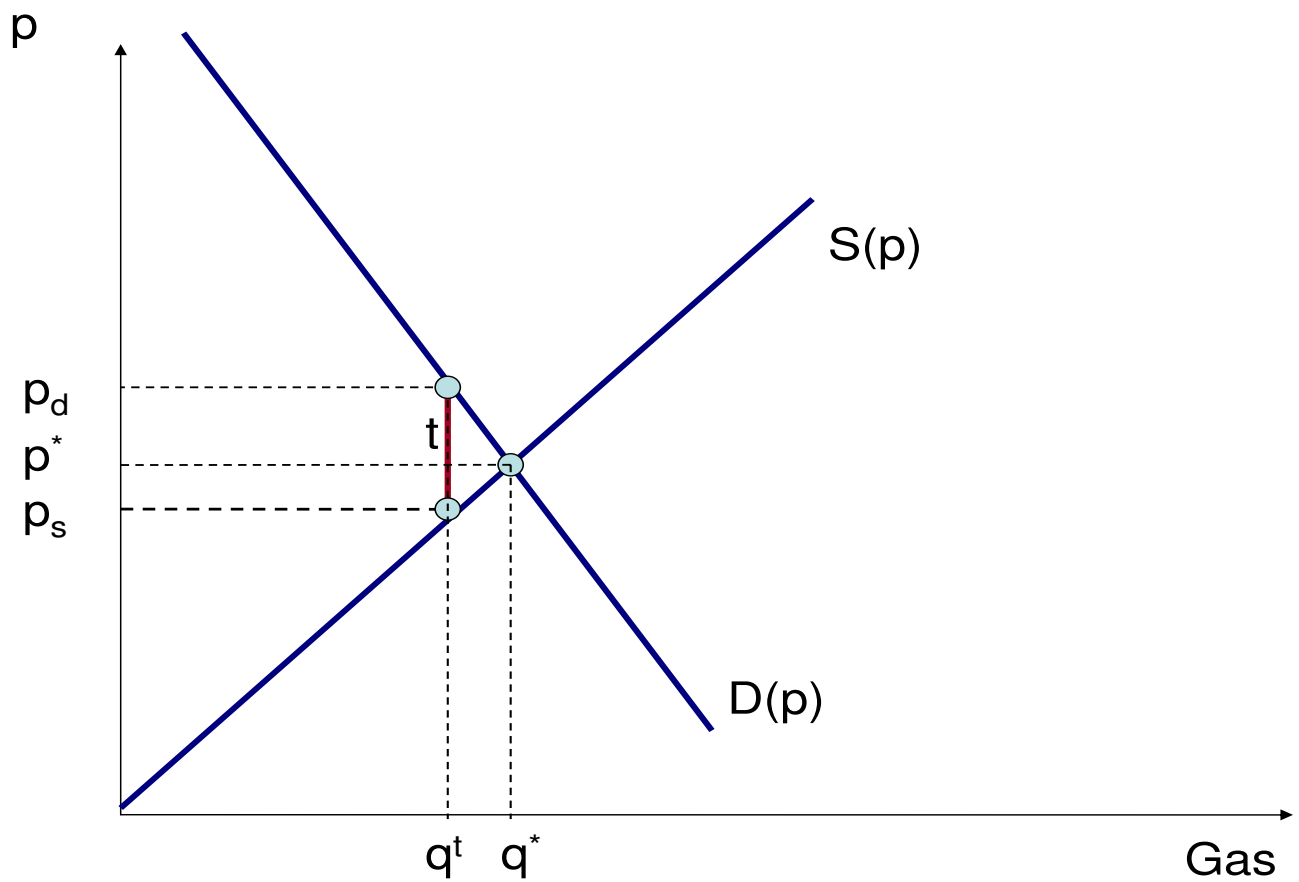
Equilibrium with a Quantity Tax

Another view: supply shifts *upward*



Equilibrium with a Quantity Tax

Either way: $q^t < q^*$ and $p_s < p^* < p_d$



Example

- Inverse Demand: $P_d(q) = 50 + \frac{q}{2}$
- Supply: $S(p) = 10 + 7p$
- Suppose govt. imposes tax $t = 0.90$ per gallon. What is the after-tax equilibrium?
- We need to find $D(p)$ first:

$$p = 50 + \frac{D(p)}{2} \Longrightarrow D(p) = 100 - 2p$$

- Equilibrium condition:

$$\begin{aligned} D(p_s + t) = S(p_s) &\Longrightarrow 100 - 2(p_s + 0.90) = 10 + 7p_s \\ &\Longrightarrow 9p_s = 90 - 2 \times 0.90 \\ &\Longrightarrow p_s = 10 - 0.2 = 9.80 \end{aligned}$$

Example

- Consumer price:

$$p_d = p_s + t = 9.80 + 0.90 = 10.70$$

- So the equilibrium quantity is

$$q^t = S(p_s) = 10 + 7p_s = 10 + 7 \times 9.80 = 78.6$$

- How much tax revenue does the government collect?

$$R_t = tq^t = 0.90 \times 78.6 \approx 70.74$$

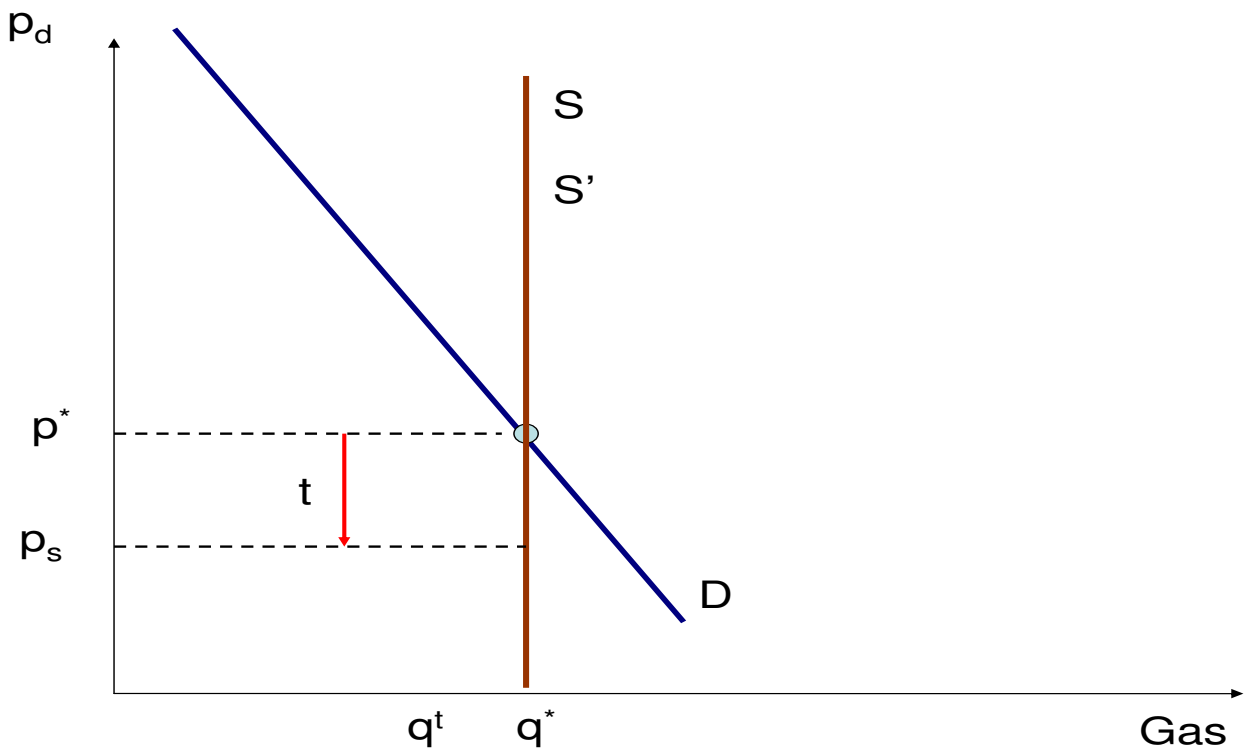
Example

Who really pays this tax?

- The division of t between the buyers and sellers is the *incidence* of the tax.
- Compare pre-tax equilibrium price, p^*, with consumer price, p_d, and producer price, p_s.
- $p^* = 10$, $p_d = 10.70$, and $p_s = 9.80$
- So consumer 'pays' $10.70 - 10 = 0.70$ per gallon and the producer 'pays' $10 - 9.80 = 0.20$ per gallon.

Tax Incidence and Elasticity

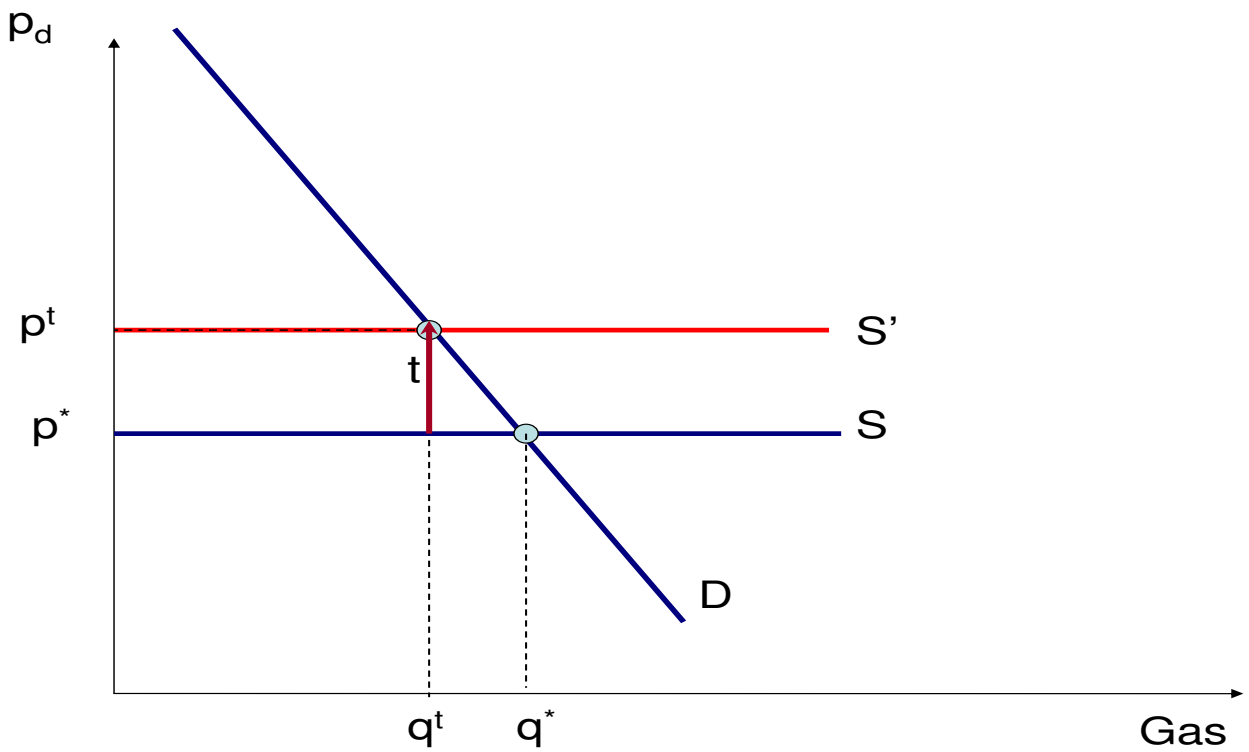
The incidence of a quantity tax depends upon the price-elasticities of demand and supply.



The producers pay all the tax when supply is perfectly inelastic.

Tax Incidence and Elasticity

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



The consumers pay all the tax when supply is perfectly elastic.

Tax Revenue and Elasticity

Clicker Vote: Govt will raise the most revenue when demand is

A) Elastic
B) Inelastic
C) Unit elastic
D) Elasticity doesn't matter

Equilibrium with a Subsidy

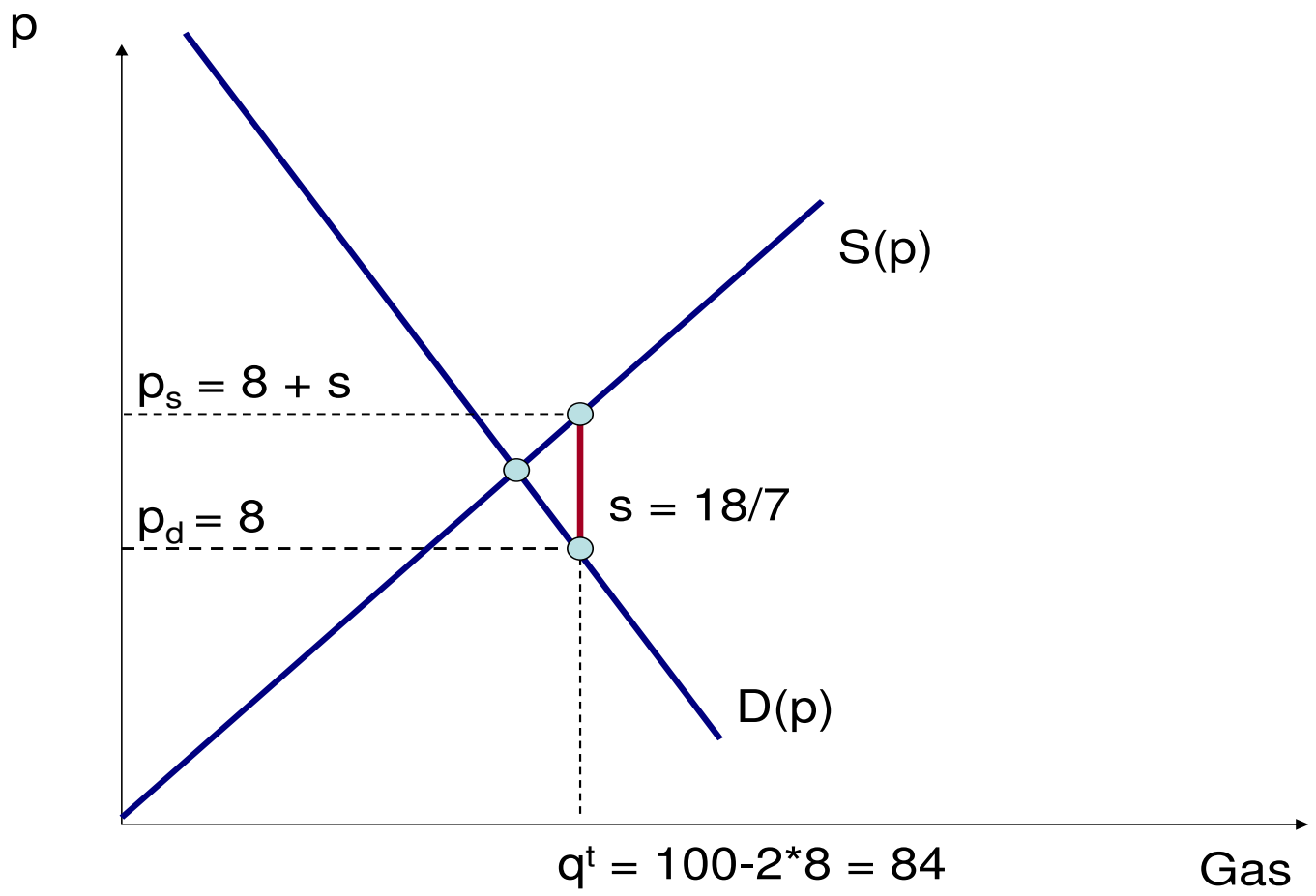
Example

- What if govt. wants to keep gas prices low, e.g. $p = 8$? A price ceiling will leads to shortages.
- An alternative is to subsidize gasoline by paying sellers $\$s$ per gallon.
- How large must s be? Well, $p_d + s = p_s$ so

$$\begin{aligned} D(p_d) = S(p_s) &\implies D(8) = S(8+s) \\ &\implies 100 - 2 \times 8 = 10 + 7 \times (8+s) \\ &\implies s = \frac{18}{7} \end{aligned}$$

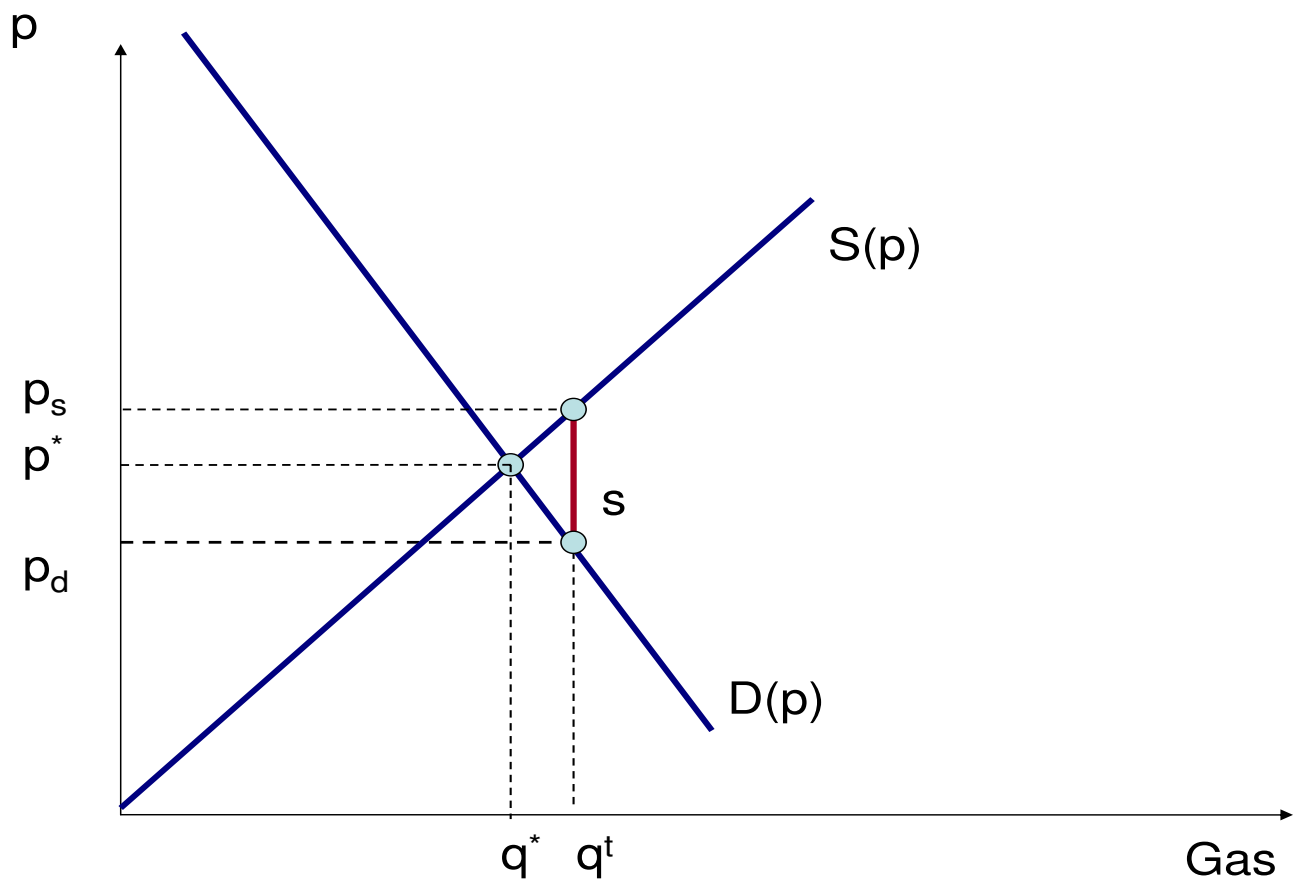
Equilibrium with a Subsidy

Example

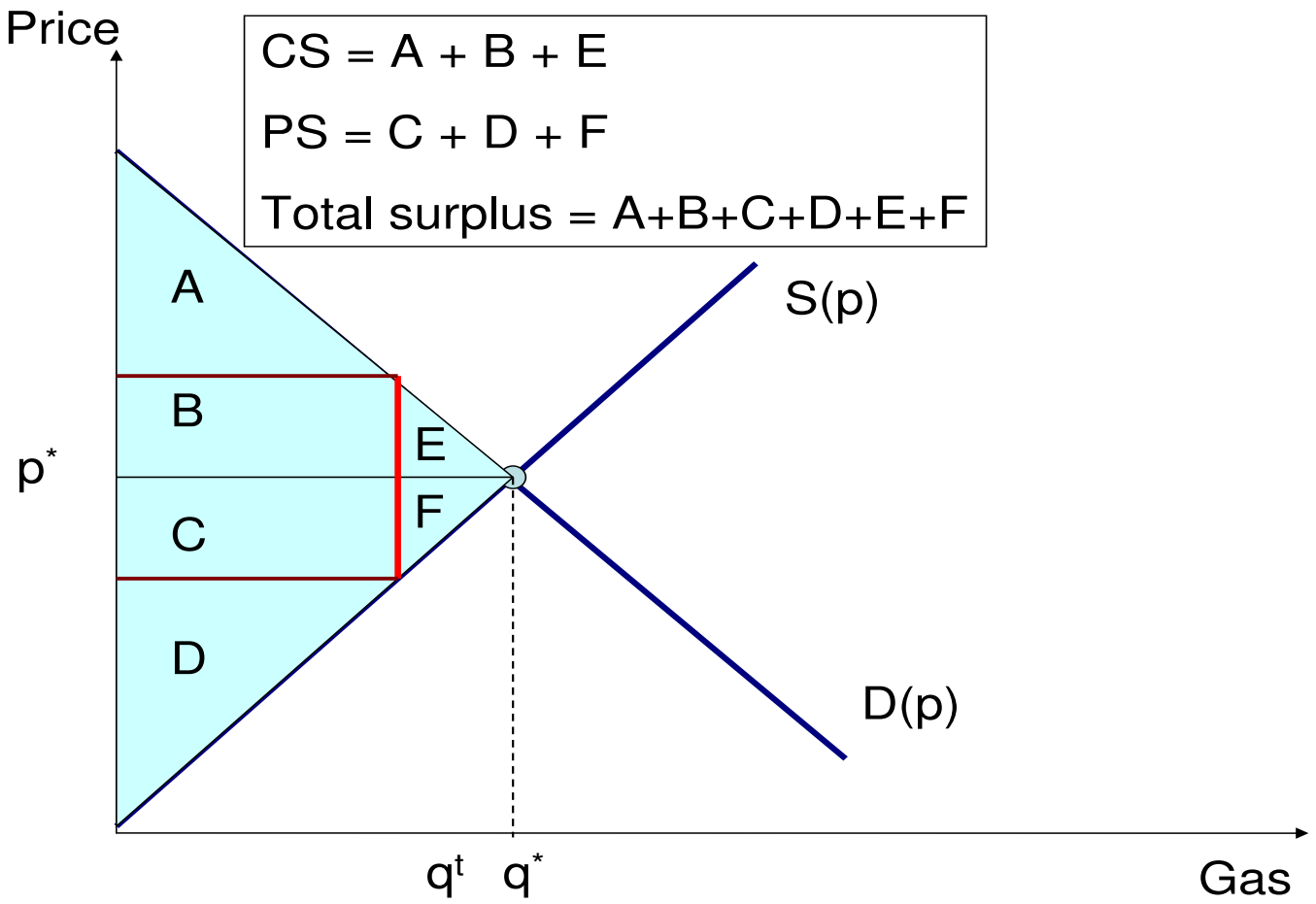


Equilibrium with a Subsidy

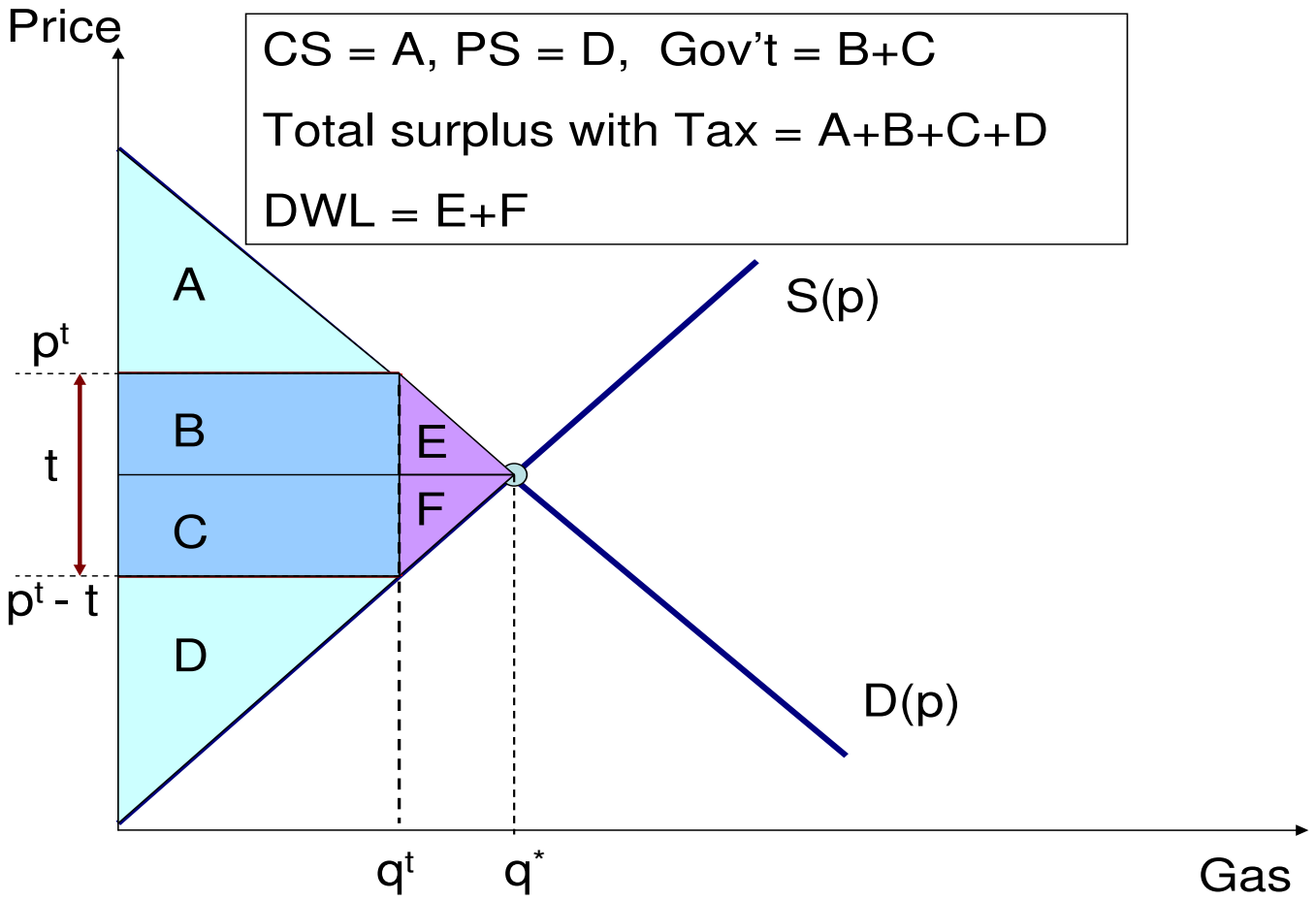
Just a *negative* tax: $q^t > q^*$ and $p_d < p^* < p_s$



Total Surplus

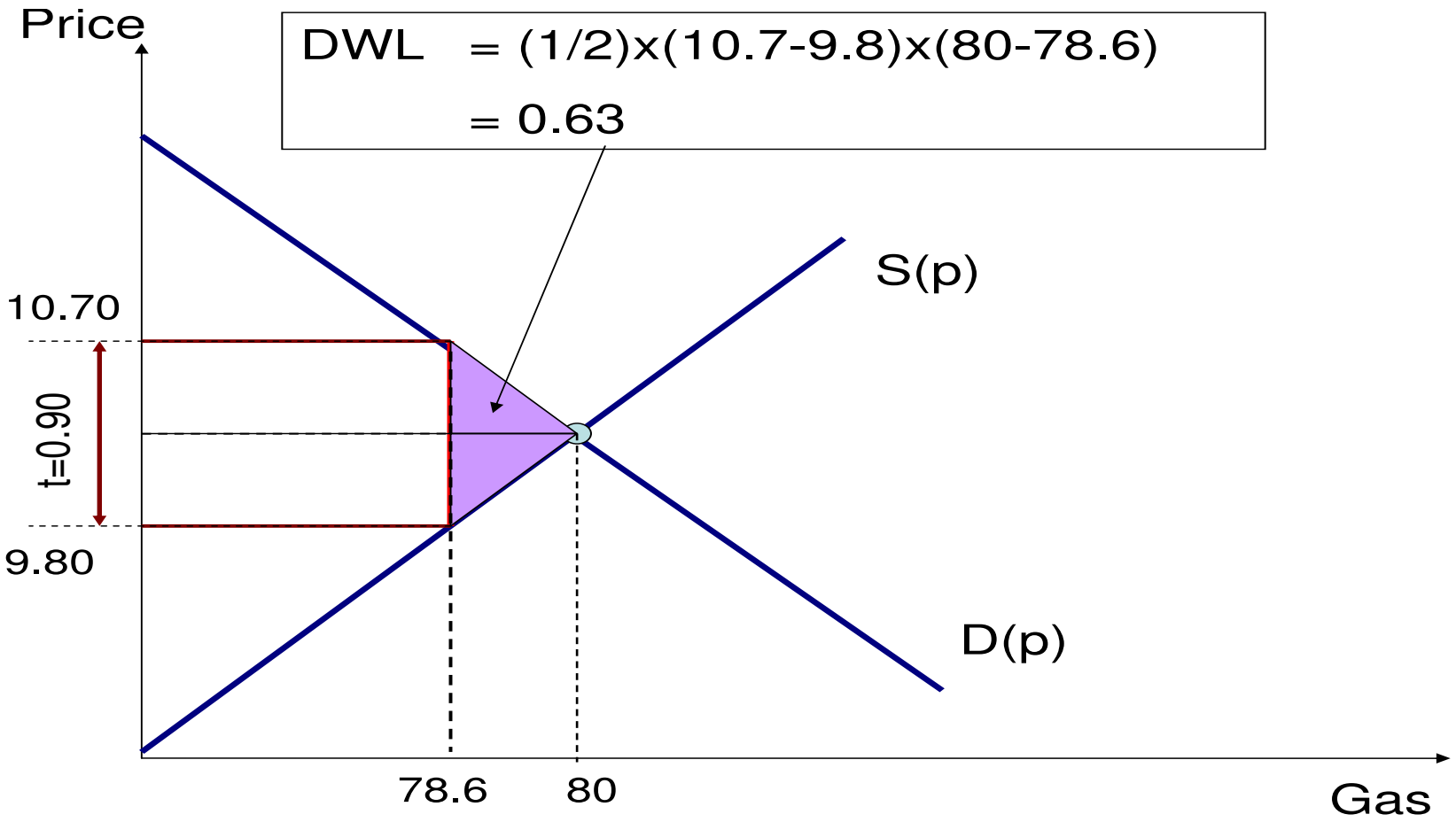


Deadweight Loss (DWL)



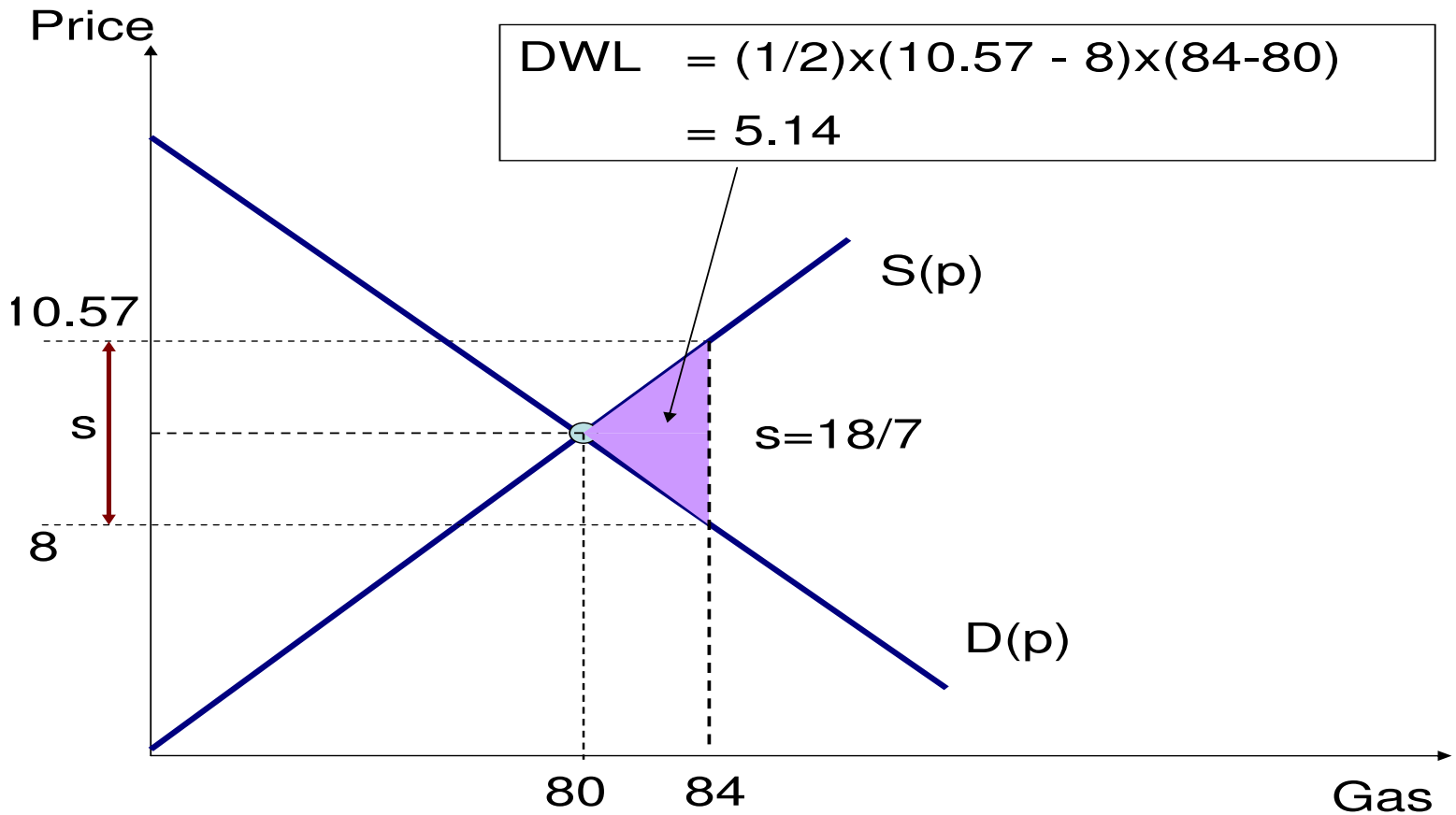
Deadweight Loss (DWL)

Tax example: recall that $p^* = 10$, $q^* = 80$, $p^t = 10.70$, $p_s = 9.80$, $q^t = 78.6$.



Deadweight Loss (DWL)

Subsidy example: recall that $p^* = 10$, $q^* = 80$, $p_s = 8 + \frac{18}{7} = 10.57$, $p_d = 8$, $q^t = 84$.



Price Tax

- A price tax is a per-dollar (as opposed to per-unit) tax.
- Also known as *ad valorem* tax
- Examples: sales tax, interest tax, value-added tax (VAT)

Example: Value-added Tax

- Demand: $D(p) = 100 - 2p$, supply $S(p) = 10 + 7p$ (borrowed from above)
- Suppose government imposes a VAT of $t = .10 = 10\%$.
- With VAT t, consumer pays p_d, but producer only gets $(1 - t)p_d$. So

$$p_s = (1 - t)p_d$$

- What is the after-tax equilibrium?

Example: Value-added Tax

The equilibrium condition:

$$
\begin{aligned}
D(p_d) = S((1-t)p_d) &\implies 100 - 2(p_d) = 10 + 7(1-t)p_d \\
&\implies 7(1-t)p_d + 2p_d = 100 - 10 \\
&\implies (9 - 7t)p_d = 90 \\
&\implies p_d = \frac{90}{9 - 7t} \\
&\implies p_d = \frac{90}{9 - 7 * 0.10} = 10.84
\end{aligned}
$$

The producer price is

$$p_s = (1-t)p_d = .9(10.84) = 9.76$$

Example: Value-added Tax

- After-tax equilibrium quantity:

$$q^t = D(p_d) = 100 - 2p_d = 100 - 2 * 10.84 = 78.31$$

- Government revenue?
- Government is paid tp_d for every unit sold, revenue is

$$tp_d q^t = 0.1 * 10.84 * 78.31 = 84.89.$$

Example: Value-added Tax

What is the deadweight loss with a VAT?