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
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
  \[ p_d = 2.05 + 0.35 = 2.40 \text{ dollars/gallon} \]
- 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:

\[ p_d - p_s = t \implies p_d = p_s + t \]

- 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 \( S \)
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:

\[
p = 50 + \frac{D(p)}{2} \implies D(p) = 100 - 2p
\]

- Equilibrium condition:

\[
D(p_s + t) = S(p_s) \implies 100 - 2(p_s + 0.90) = 10 + 7p_s
\]
\[
\implies 9p_s = 90 - 2 \times 0.90
\]
\[
\implies p_s = 10 - 0.2 = 9.80
\]
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?

\[ R_t = tq^t = 0.90 \times 78.6 \approx 70.74 \]
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.

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.
Equilibrium with a Subsidy

Example

• What if govt. wants to keep gas prices low, e.g. $p = 8$? A price ceiling will lead 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

\[
D(p_d) = S(p_s) \implies D(8) = S(8 + s)
\]

\[
\implies 100 - 2 \times 8 = 10 + 7 \times (8 + s)
\]

\[
\implies s = \frac{18}{7}
\]
Equilibrium with a Subsidy

Example

\[ p_s = 8 + s \]
\[ s = \frac{18}{7} \]
\[ q^t = 100 - 2 \times 8 = 84 \]
Equilibrium with a Subsidy

Just a negative tax: \( q^t > q^* \) and \( p_d < p^* < p_s \)
Total Surplus

CS = A + B + E
PS = C + D + F
Total surplus = A + B + C + D + E + F
Deadweight Loss (DWL)

CS = A, PS = D, Gov’t = B+C
Total surplus with Tax = A+B+C+D
DWL = E+F

Price

Gas

CS = A, PS = D, Gov’t = B+C
Total surplus with Tax = A+B+C+D
DWL = E+F

A
B
C
D

S(p)

D(p)
Deadweight Loss (DWL)

Tax example: recall that \( p^* = 10 \), \( q^* = 80 \), \( p^t = 10.7 \), \( p_s = 9.8 \), \( q^t = 78.6 \).

\[
\text{DWL} = \frac{1}{2} \times (10.7 - 9.8) \times (80 - 78.6) \\
= 0.63
\]
Deadweight Loss (DWL)

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

\[
\text{DWL} = \frac{1}{2} \times (10.57 - 8) \times (84 - 80) = 5.14
\]