Equilibrium
(Chapter 16)
Today

- Marginal Revenue
- Competitive Equilibrium
- Comparative Statics
- Quantity Tax
Midterm Next Week

- Covers material up to end of this week: chapters 12, 14, 15, 16
- Approx. 8 multiple choice, 2 blue-book
- In class on Tuesday
- Bring scrantron, bluebook, pencil (and pen)
- Returned in section (or OH) following week
- See syllabus, FAQ for more details, policies
Marginal Revenue

Q: Why is the $MR$ curve always below $D$?

A: Lower price to sell additional unit; earn extra $p$ on additional unit, but lose revenue with lower price on all previous units.

\[ R = pq \implies MR = \frac{dR}{dq} = p \cdot 1 + q \frac{dp}{dq} \]
Marginal Revenue

Linear demand: \( p(q) = a - bq \) (inverse demand)

\[
MR = a - 2bq, \text{ so revenue maximizing } (p, q) = \left(\frac{a}{2}, \frac{a}{2b}\right).
\]
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**
Competitive Equilibrium

Market Basics:

- How do we determine what to produce, how to do so, how to allocate produced goods, and to whom?
- One method: central planning
- Market system = decentralized alternative: each person/firm decides what/how to produce, individuals decide what to buy
- Market = meeting of buyers and sellers; many different formats/institutions
- How is price/quantity determined? Depends on institutional rules, individuals but...
- By understanding incentives, we arrive at the concept of equilibrium as a predictor of long-term behavior
- In equilibrium, no one has any reason to change behavior; disequilibrium incentive push people back towards equilibrium
Market Forces

What is the equilibrium price?
Market Forces

What is the equilibrium price?

\[ p^* \]
Market Forces

What are the sellers’ disequilibrium incentives?

\[ p > p^* \]

\[ p^* \]
Market Forces

What are the sellers’ disequilibrium incentives?

$p > p^*$

Excess Supply

$\text{Competition will drive the price down}$

Kale

Price

Supply

Demand
Market Forces

What are the sellers’ disequilibrium incentives?

![Graph showing supply and demand with price and kale on axes.](image)
Market Forces

What are the sellers’ disequilibrium incentives?

\[
p < p^* \quad \text{Excess Demand} \quad \text{Greed will drive the price up}
\]

\[
p^* \quad \text{Supply}
\]

\[
demand \quad supply
\]

Kale

Price

Supply

Demand

Greed will drive the price up

Excess Demand

\[ p < p^* \]

\[ p^* \]
Q: What is a competitive equilibrium?

A: The price $p^*$ and quantity $q^*$ such that

$$D(p^*) = S(p^*) = q^*.$$  

Alternatively, using inverse demand and supply we can write

$$P_D(q^*) = P_S(q^*) = p^*.$$
Example

Market for kale

- Demand for kale: \( D(p) = 100 - 2p \)
- Supply of kale: \( S(p) = 10 + 7p \)
- Equilibrium condition:

\[
D(p^*) = S(p^*) \implies 100 - 2p^* = 10 + 7p^* \implies 9p^* = 90 \\
\implies p^* = 10
\]

- So equilibrium \( q \) is

\[
q^* = D(10) = 100 - 2 \times 10 = 80 = S(10)
\]
A new study reveals health benefits of eating kale. How does this affect \((p^*, q^*)\)?
Comparative Statics: Shifting Demand

A new study reveals health benefits of eating kale.
Comparative Statics: Shifting Demand

An *E. coli* outbreak is traced to a kale farm.
Comparative Statics: Shifting Supply

Kale-weevils decimate crop

![Diagram showing the effect of kale-weevils decimating crop on the market for kale. The supply curve shifts from S to S', resulting in a decrease in quantity from q* to q' and an increase in price from p* to p'.]
Comparative Statics: Shifting Both Curves

The effect on \((p^*, q^*)\) of shifting both curves: ambiguous for one, unambiguous for the other.
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:
  
  \[ p_d - p_s = t \implies p_d = p_s + t \]

- 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 \( S \)
Equilibrium with a Quantity Tax

One view: demand shifts *downward*

\[
D(p_s + t) \quad S(p_s)
\]

\[
D(p_s) \quad S(p_s)
\]

\[
p_s \quad p_d \quad p^* \quad q^* \quad q^t
\]

\[
p^* \quad q^*
\]
Equilibrium with a Quantity Tax

Another view: supply shifts *upward*

\[
S(p_d) \quad D(p_d) \\
S(p_d - t) \quad D(p_d) \\
\]

\[
p_d \quad p^* \\
p_d \quad p^* \\
p_s \quad q^t \quad q^* \\
\]

Marginal Revenue
Competitive Equilibrium
Comparative Statics
Quantity Tax
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:

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

- 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?

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