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: Clicker Vote 1

Q: For a given quantity, how does $MR(q)$ relate to $P(q)$?

A) Above  
B) Equal  
C) Below  Correct!  (Why?)  
D) Depends
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 w/ lower price on all previous units.

\[ R = pq \implies MR = \frac{dR}{dq} = p \cdot 1 + q \frac{dp}{dq} \]
Marginal Revenue: Clicker Vote 2

How elastic is demand at the quantity at which $MR = 0$?

A) Elastic  
B) Unit Elastic  
C) Inelastic  
D) Not enough info
Marginal Revenue: Clicker Vote 1

How elastic is demand at the quantity at which $MR = 0$?

A) Elastic
B) Unit Elastic
C) Inelastic
D) Not enough info

\[ \varepsilon = -1 \]
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

Competition will drive the price down

Kale

Price

Supply

Demand

\[ p^* \]
Market Forces

What are the sellers’ disequilibrium incentives?

![Graph showing supply and demand curves with prices $p^*$ and $p < p^*$]
Market Forces

What are the sellers’ disequilibrium incentives?

Price

Supply

Demand

Kale

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

\[ q^* = D(10) = 100 - 2 \times 10 = 80 = S(10) \]
Comparative Statics: Shifting Demand

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

Clicker Vote: Which way does supply shift?
- Up
- Down
- Left
- Right

![Supply and Demand Diagram]

Price

\( p^* \)

Kale

\( q^* \)
Comparative Statics: Shifting Supply

Kale-weevils decimate crop

**Clicker Vote:** Which way does supply shift?

- Up
- Down
- Left
- Right

![Diagram](image-url)
Comparative Statics: Shifting Supply

Kale-weevils decimate crop
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, $p_s$:

  $$p_d - p_s = 0.35$$
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*

\[ q_t, q^* \]

\[ p_d, p_s, p^* \]

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

\[ t \]
Equilibrium with a Quantity Tax

Another view: supply shifts *upward*

![Graph showing Equilibrium with a 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?
  \[ R_t = tq^t = 0.90 \times 78.6 \approx 70.74 \]