Equilibrium
(Chapter 16)
Today

- Marginal Revenue
- Competitive Equilibrium Intro
- Equilibrium: Comparative Statics
Midterm Next Week

- Covers material up to end of this week: chapters 12, 14, 15, 16
- 10-15 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
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.

$$R = pq \implies MR = \frac{\partial R}{\partial q} = p \cdot 1 + q \frac{\partial p}{\partial q}$$
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
Linear demand: $p(q) = a - bq$ (inverse demand)

$MR = a - 2bq$, so revenue maximizing $(p, q) = \left(\frac{a}{2}, \frac{a}{2b}\right)$. 
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
What is the equilibrium price?
What is the equilibrium price?
What are the sellers’ disequilibrium incentives?
What are the sellers’ disequilibrium incentives?

![Graph showing excess supply and price competition driving the price down.](image-url)
What are the sellers’ disequilibrium incentives?

\[ p < p^* \]
What are the sellers’ disequilibrium incentives?

Greed will drive the price up
Q: What is a competitive equilibrium?

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

$$D(p^\ast) = S(p^\ast) = q^\ast.$$ 

Alternatively, using inverse demand and supply we can write

$$P_D(q^\ast) = P_S(q^\ast) = p^\ast.$$
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 \((p^*, q^*)\)?
A new study reveals health benefits of eating kale.
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](Diagram of supply and demand curves with a point at equilibrium, labeled with price and quantity symbols.)
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*

\[ p_s \]

\[ p_d \]

\[ p^* \]

\[ p_s \]

\[ S(p_s) \]

\[ D(p_s) \]

\[ D(p_s + t) \]

\[ q^t \]

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

Another view: supply shifts \textit{upward}

\begin{align*}
\text{Equilibrium with Quantity Tax: Shifting Supply} \\
\text{Gas} \quad p_d \quad d \quad p_s \\
\text{Supply} \quad S(p_d - t) \\
\text{Demand} \quad D(p_d) \\
\text{Equilibrium Prices} \quad p^* \\
\text{Quantity} \quad q^* \\
\end{align*}
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?

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