Using Supply and Demand to Analyze Markets
# Introduction

## Chapter Outline

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Consumer and Producer Surplus: Who Benefits in a Market</td>
</tr>
<tr>
<td>3.2</td>
<td>Price Regulation</td>
</tr>
<tr>
<td>3.3</td>
<td>Quantity Regulations</td>
</tr>
<tr>
<td>3.4</td>
<td>Taxes</td>
</tr>
<tr>
<td>3.5</td>
<td>Subsidies</td>
</tr>
<tr>
<td>3.6</td>
<td>Conclusion</td>
</tr>
</tbody>
</table>
In this chapter, we use the supply and demand model to answer the following questions:

- How do we measure the benefits that accrue to producers and consumers in a market?
- How do government interventions (e.g., taxes) affect markets and the benefits associated with market exchange?
Consumers benefit from market exchange, otherwise they would not participate

- **Consumer surplus**: the difference between the amount consumers would be *willing* to pay for a good or service and the amount they *actually* pay (the market price)

In many cases, this difference is positive, and consumers experience net benefits from market exchange
Figure 3.1  Defining Consumer Surplus

- **Price ($/pound)**: $5.50, $4.50, $3.50, $3.00, $2.00, $1.00, $0.00
- **Demand choke price**: $5.50
- **Total consumer surplus ($CS$)**: Area ABCD
- **Market price**: $3.50
- **Person A's consumer surplus**: $1.50

The consumer at point $E$ will not buy any apples because the market price is too high.
Producers benefit from market exchange, otherwise they would not participate

- **Producer surplus**: the difference between the price producers actually receive (market price) for their goods and the price at which they are willing to sell them.

Producer surplus is *not* the same as profit, as we will see in later chapters.
Figure 3.2  Defining Producer Surplus

Price ($/pound)

Total producer surplus ($PS$)

Market price

The producer at point $Z$ will not produce any apples because the market price is too low.

Seller V’s producer surplus = $1.50

Supply choke price

Quantity of apples (pounds)
The demand and supply curves for newspapers in a Midwestern city are given by:

\[ Q^D = 152 - 20P \]
\[ Q^S = 188P - 4 \]

where \( Q \) is measured in **thousands** of newspapers per day and \( P \) is the price in dollars per newspaper.

**Answer the following questions:**

a. Find the equilibrium price and quantity

b. Calculate consumer and producer surplus at the equilibrium
**figure it out**

**a.** Remember, the equilibrium is characterized by \( Q^D = Q^S \)

\[
152 - 20P = 188P - 4
\]

Combining terms and solving for \( P \) yields

\[
156 = 208P \rightarrow P^* = $0.75
\]

To find the equilibrium quantity, plug the above price into either the supply or demand equation,

\[
Q^D = 152 - 20(0.75) = 137 \text{ newspapers} \quad \text{or} \quad Q^S = 188(0.75) - 4 = 137 \text{ newspapers}
\]

**b.** The easiest way to calculate consumer and producer surplus is with a graph; to do this, we must determine two points for each curve

1. Equilibrium price/quantity
2. Choke prices (where \( Q^D / Q^S \) are equal to zero)
We already know one point for each curve: \( P^* = \$0.75; Q^* = 137 \)

Demand choke price: \( Q^D = 0 = 152 - 20P \rightarrow 20P = 152 \rightarrow P = \$7.6; Q = 0 \)

Supply choke price: \( Q^S = 0 = 188P - 4 \rightarrow 188P = 4 \rightarrow P = \$0.02; Q = 0 \)

**Consumer surplus** is the area below demand but above the price (Area \( A \))

\[
CS = \text{Area } A = \frac{1}{2} \times \text{base} \times \text{height} \\
= \frac{1}{2} \times 137,000 \times (7.6 - 0.75) = \$469,225
\]

**Producer surplus** is the area above supply but below the price (Area \( B \))

\[
PS = \text{Area } B = \frac{1}{2} \times \text{base} \times \text{height} \\
= \frac{1}{2} \times 137,000 \times (0.75 - 0.02) = \$50,005
\]

Surplus is generally measured in dollars
Imagine a pie shop opens up in the same town. What will happen to the demand for cupcakes?

Demand will shift left, resulting in a new equilibrium of $P_2$ and $Q_2$

What happens to consumer surplus?
- Old consumer surplus: $A + B + F$
- New consumer surplus: $B + C$

What happens to producer surplus?
- Old producer surplus: $C + D + E + G$
- New producer surplus: $D$

$C$ has transferred from producers to consumers
$A + E + F + G$ has disappeared from this market
Figure 3.5 Changes in Surplus from a Supply Shift

Consumer surplus before: \( A + B + C + D \)
Consumer surplus after: \( A \)
Producer surplus before: \( E + F + G \)
Producer surplus after: \( B + E \)
Politicians often call for the direct regulation of prices on products and services

- **Price ceiling**: a regulation that sets the maximum price that can be legally paid for a good or service
  - Binding only when set below the equilibrium price

- **Price floor**: a regulation that sets the minimum price that can be legally paid for a good or service (often called a *price support*)
  - Binding only when set above the equilibrium price

What are the effects of price ceilings/floors on markets?
Some important terminology

**Transfer**: surplus that moves from producers to consumers, or vice versa, as a result of a regulation

**Deadweight loss (DWL)**: the reduction in total surplus that occurs as a result of a market inefficiency

- Remember the cupcake example of changing demand due to a pie shop

**Nonbinding price ceiling**: a price ceiling set at a level above the equilibrium market price

**Nonbinding price floor**: a price floor set at a level below the equilibrium market price
Figure 3.7 The Effects of a Binding Price Ceiling

- Consumer surplus before: \( A + B + C \)
- Consumer surplus after: \( A + B + D \)
- Producer surplus before: \( D + E + F \)
- Producer surplus after: \( F \)

Price Regulation

Price ($/pizza)

Price Ceiling: $8

Transfer of PS to CS

Demand

Supply

DWL = C + E

Quantity of pizzas (thousands)/month

Shortage

6 10 12

20

0 5 8 10 14 $20
3.8 Deadweight Loss and Elasticities

(a) Transfer of PS to CS

Price ($/pizza)

$10

Equilibrium

Price ceiling

Quantity of pizzas (thousands)/month

8

0

D_{inelastic}

S_{inelastic}

DWL

(b) Transfer of PS to CS

Price ($/pizza)

$10

Price ceiling

Quantity of pizzas (thousands)/month

8

0

D_{elastic}

S_{elastic}

DWL
Figure 3.9 The Effects of Binding a Price Floor

- Consumer surplus before: $A + B + C$
- Consumer surplus after: $A$
- Producer surplus before: $D + E + F$
- Producer surplus after: $B + D + F$
Like price regulations, quantity regulations restrict the amount of a good or service provided to a market.

**Quota:** a regulation that sets the quantity of a good or service provided

- Often used to limit imports of certain goods
  - Why might a government pursue an import quota?
- Sometimes used to limit exports (e.g., China and rare earths)

**What are the effects of quotas on markets?**
Figure 3.10 The Effects of a Quota

- Consumer surplus before: $A + B + C$
- Consumer surplus after: $A$
- Producer surplus before: $D + E + F$
- Producer surplus after: $B + D + F$

Transfer of CS to PS

Price ($/tattoo)$

- $P_{quota} = 100$
- $P = 50$

Quantity of tattoos/year

- 500 (Quota)
- 1,500

$A$, $B$, $C$, $D$, $E$, $F$, $S_1$, $S_2$, $Z$, $X$, $Y$, $X$
Taxes are very prevalent in societies

Examples:
1. Product markets (VAT; sales taxes)
2. Labor markets (income taxes; payroll taxes)
3. Capital markets (capital gains taxes)

How do taxes impact markets?
• Some taxes are imposed to correct market failures (see Chapter 16)
• In general, taxes distort market outcomes

Example: In 2003, Boston’s Mayor Tom Menino proposed a $0.50 tax on movie tickets
  – How should this tax (which was ultimately not adopted by the legislature) affect the market for movie tickets?
Figure 3.11 The Effects of a Tax on Boston Movie Tickets

Price ($/ticket)

$10

$6.67

Quantity of tickets (100,000s)

$P_b = 8.30$

$P_1 = 8.00$

$P_s = 7.80$

$Q_2 = 3.4$

$Q_1 = 4$

Transfer from CS and PS to government

$A$

$B$

$C$

$D$

$E$

$F$

Consumer surplus (CS) before $A + B + C$

Consumer surplus (CS) after $A$

Producer surplus (PS) before $D + E + F$

Producer surplus (PS) after $F$

Government revenue $B + D$

$S_2 = S_1 + \text{tax}$

Government revenue $B + D$

Quantity of tickets (100,000s)
We can also describe the effect of a tax on consumer and producer surplus with equations. Demand and supply for tickets are given by

\[ Q^D = 20 - 2P; \quad Q^S = 3P - 20 \]

where prices are measured in dollars and quantity in hundreds of thousands of tickets. Equilibrium occurs when \( Q^D = Q^S \),

\[ 20 - 2P = 3P - 20 \rightarrow 5P = 40 \]

Before the tax, tickets are $8 and 400,000 tickets are sold in Boston.

**Pre-tax consumer surplus**

\[ CS = \frac{1}{2} \times Q^E \times (P_{D\text{Choke}} - P_1) \]

where the demand choke price is found by solving

\[ Q^D = 0 = 20 - 2P_{D\text{Choke}} \rightarrow P_{D\text{Choke}} = $10 \]

and consumer surplus is equal to

\[ CS = \frac{1}{2} \times (400,000) \times ($10 - $8) = $400,000 \]
Pre-tax producer surplus

\[ PS = \frac{1}{2} \times Q^E \times (P_1 - P_{SC}^{Choke}) \]

where the supply choke price is found by solving,

\[ Q^S = 0 = 3P_{SC}^{Choke} - 20 \rightarrow P_{SC}^{Choke} = $6.67 \]

Solving for producer surplus yields

\[ PS = \frac{1}{2} \times (400,000) \times ($8 - $6.67) = $266,667 \]

And Total Surplus \( PS + CS = $666,667 \)

What happens after the tax?
Define the **after-tax price** as

$$P_b = P_S + \$0.50$$

The market price (the price buyers pay), $P_b$, is equal to the price the producer receives, $P_S$, plus the tax. To find the new equilibrium, substitute this expression into the demand equation

$$Q^D = Q^S \rightarrow 20 - 2P_b = 3P_S - 20 \rightarrow 20 - 2(P_S + 0.50) = 3P_S - 20$$

Solving for $P_S$: $20 - 1 + 20 = 5P_S$

The price sellers receive after the tax is $P_S = $7.80

The price the buyers pay in the market is $P_b = P_S + $0.50 = $8.30

and quantity sold is (substitute buyer price into demand function)

$$Q_2 = 20 - 2(8.30) = 340,000$$
Taxes

Post-tax consumer surplus

\[ CS = \frac{1}{2} \times (340,000) \times (10 - 8.30) = 289,000 \]

Post-tax producer surplus

\[ PS = \frac{1}{2} \times (340,000) \times (7.80 - 6.67) = 192,100 \]

How much revenue has been generated by the tax?

Revenue = \(0.50Q_2 = 0.50 \times 340,000 = 170,000\)

And the deadweight loss associated with this distortion is

\[ DWL = \frac{1}{2} \times (Q_1 - Q_2) \times (P_b - P_s) = \frac{1}{2} \times (400,000 - 340,000) \times (0.50) = 15,000 \]
Deadweight loss (DWL) is the loss in total surplus generated any time a policy creates a market distortion

- DWL associated with taxes is often referred to as “excess burden”
- The size of DWL increases at an increasing rate with the difference between the pre- and post-policy equilibrium quantities
  - i.e. Big taxes create more DWL than little taxes

Consider the movie example, but with a $1.00 tax

\[ P_b = P_S + $1.00 \]

\[ Q^D = Q^S \rightarrow 20 - 2P_b = 3P_S - 20 \rightarrow 20 - 2(P_S + 1.00) = 3P_S - 20 \]

Solving for \( P_S \), \( P_b \), and \( Q_2 \)

\[ 20 - 2P_S - 2 = 3P_S - 20 \rightarrow P_S = $7.60; \ P_b = $8.60 \]

\[ Q_2 = 20 - 2(8.60) = 2.8 \]
Taxes

Post-tax consumer surplus
\[ CS = \frac{1}{2} \times (280,000) \times ($10 - $8.60) = $196,000 \]

Post-tax producer surplus
\[ PS = \frac{1}{2} \times (280,000) \times ($7.60 - $6.67) = $130,200 \]

How much revenue has been generated by the tax?
Revenue \[= 1.00Q_2 = $1.00 \times 280,000 = $280,000 \]

And the deadweight loss associated with this distortion is
\[ DWL = \frac{1}{2} \times (Q_1 - Q_2) \times (P_b - P_s) = \frac{1}{2} \times (400,000 - 280,000) \times ($1.00) = $60,000 \]

So, while the tax has doubled, deadweight loss has quadrupled from $15,000 to $60,000, and tax revenues have only increased by 78.5% (from $170,000 to $280,000)
Figure 3.12 The Effect of a Larger Tax on Boston Movie Tickets
**Tax incidence** is a term describing who actually bears the burden of a tax

- In the supply and demand model, it *does not matter* who is required to pay the tax (e.g., a sales tax vs. a production tax)
  - Tax incidence will be the same in each case!

**Tax incidence and elasticities**

- Elasticities of supply and demand are the major determinants of incidence
- In general, when demand is relatively *more elastic*, consumers will experience *less burden*, and vice versa
  - **Rule:** The more elastic curve (supply or demand) bares the least burden (producer or consumer)
Figure 3.13 Tax Incidence

(a) Seller Taxed

Price ($)

\[ P_b \]

\[ P_1 \]

\[ P_s \]

Tax = \( P_b - P_s \)

0

Q2

Q1

Quantity

(b) Buyer Taxed

Price ($)

\[ P_b \]

\[ P_1 \]

\[ P_s \]

Tax = \( P_b - P_s \)

0

Q2

Q1

Quantity
A TAX ON GASOLINE

\[ Q^D = 150 - 25P_b \]  \hspace{1cm} \text{(Demand)}

\[ Q^S = 60 + 20P_s \]  \hspace{1cm} \text{(Supply)}

\[ Q^D = Q^S \]  \hspace{1cm} \text{(Supply must equal demand)}

\[ P_b - P_s = 1.00 \]  \hspace{1cm} \text{(Government must receive $1.00/gallon)}

\[
150 - 25P_b = 60 + 20P_s \\
150 - 25P_b = 60 + 20P_s \\
20P_s + 25P_s = 150 - 25 - 60 \\
45P_s = 65, \text{ or } P_s = 1.44 \\
Q^D = 150 - (25)(2.44) = 150 - 61, \text{ or } Q = 89 \text{ bg/yr}
\]

Annual revenue from the tax \( tQ = (1.00)(89) = $89 \text{ billion per year} \)

Deadweight loss: \( \frac{1}{2} \times ($1.00/gallon) \times (11 \text{ billion gallons/year}) = $5.5 \text{ billion per year} \)
A TAX ON GASOLINE

**Figure 9.20**
**IMPACT OF $1 GASOLINE TAX**

The price of gasoline at the pump increases from $2.00 per gallon to $2.44, and the quantity sold falls from 100 to 89 bg/yr.

Annual revenue from the tax is $(1.00)(89) = $89 billion (areas $A + D$).

The two triangles show the deadweight loss of $5.5 billion per year.
Tax incidence and elasticities

A general formula(s) for incidence as a function of elasticities

Share born by consumer = \( \frac{E^S}{E^S + |E^D|} \)  
Share born by producer = \( \frac{|E^D|}{E^S + |E^D|} \)

- Notice, the share born by the consumer relies primarily on the elasticity of the supplier/producer, and vice versa
Taxes

3.4

Figure 3.14 Tax Incidence and Elasticities

(a) Demand More Elastic, Consumer Bares Less Burden

(b) Supply More Elastic, Supplier Bares Less Burden
Subsidies

**Subsidy:** a payment by the government to a buyer or seller of a good or service

- Subsidies are simply the opposite of a tax

\[ P_b + \text{subsidy} = P_s \]

Governments subsidize many products and production processes

**Examples:**

- **Producer subsidies:** ethanol production, research and development
- **Consumer subsidies:** education, public transportation
Figure 3.15 The Impact of a Producer Subsidy

Subsidies

Per unit subsidy = \( P_s - P_b \)

Cost to government

\[ CS_{\text{before}} = A + B + C \]
\[ CS_{\text{after}} = A + B + C + F + G + H \]
\[ PS_{\text{before}} = F + G + J \]
\[ PS_{\text{after}} = F + G + J + B + C + D \]
Cost = \( B + C + D + E + F + G + H + I \)
\[ DWL = E + I \]
This chapter examined the supply and demand model in more detail, and analyzed how government policies affect markets.

In the next few chapters, we examine the microeconomic underpinnings of demand and supply.

In Chapter 4, we introduce the concept of utility, which provides context for understanding how consumers make consumption decisions.
The weekly supply and demand for cupcakes in a small town are given as

\[ Q^D = 124 - 18P \]
\[ Q^S = 30P - 20 \]

where \( P \) is the price, in dollars, and quantity is measured in thousands of cupcakes per week.

**Answer the following questions:**

a. Find the equilibrium price and quantity

b. Calculate consumer and producer surplus at the equilibrium
a. Remember, the equilibrium is characterized by \( Q^s = Q^d \)

\[
30P - 20 = 124 - 18P
\]

Combining terms and solving for \( P \) yields

\[
48P = 144 \rightarrow P^* = $3
\]

To find the equilibrium quantity, plug the above price into either the supply or demand equation,

\[
Q^d = 124 - 18(3) = 70 \text{ cupcakes} \quad \text{or} \quad Q^s = 30(3) - 20 = 70 \text{ cupcakes}
\]

b. The easiest way to calculate consumer and producer surplus is with a graph; to do this, we must determine two points for each curve

1. Equilibrium price/quantity
2. Choke prices (where \( Q^d/Q^s \) are equal to zero)
We already know one point for each curve: \( P^* = $3.00 \); \( Q^* = 70 \)

Demand choke price: \( Q^D = 0 = 124 - 18P \rightarrow P = $6.89; Q = 0 \)

Supply choke price: \( Q^S = 0 = 30P - 20 \rightarrow P = $0.67; Q = 0 \)

**Consumer surplus** is the area below demand but above the price (Area A)

\[
CS = \text{Area } A = \frac{1}{2} \times \text{base} \times \text{height}
= \frac{1}{2} \times 70,000 \times (6.89 - 3) = $136,150
\]

**Producer surplus** is the area above supply but below the price (Area B)

\[
PS = \text{Area } B = \frac{1}{2} \times \text{base} \times \text{height}
= \frac{1}{2} \times 70,000 \times (3 - 0.67) = $81,550
\]

Surplus is generally measured in dollars.
The supply and demand for tires in a local tire market are given as

\[ Q^D = 3,200 - 25P \]

\[ Q^S = 15P - 800 \]

Where \( Q \) is the number of tires sold weekly and \( P \) is the price, in dollars, per tire. The equilibrium price is $100 per tire, and 700 tires are sold each week.

Suppose an improvement in technology of tire production makes them cheaper to produce; specifically, suppose the quantity supplied rises by 200 at every price.

**Answer the following questions:**

a. What is the new supply curve?

b. What are the new equilibrium price and quantity?

c. What happens to consumer and producer surplus?
a. Quantity supplied rises by 200, so we simply add it to the equation for $Q_S$:

$$Q_S^2 = 15P - 800 + 200 = 15P - 600$$

b. The new equilibrium occurs where $Q_D = Q_S^2$

$$3,200 - 25P = 15P - 600$$

$$3,800 = 40P$$

$$P^* = $95$$

Plugging this into either the demand or supply equation:

**Demand:** $Q^* = 3,200 - 25(95) = 825$ tires

**Supply:** $Q^* = 15(95) - 600 = 825$ tires

The new equilibrium price is $95 and the new equilibrium quantity is 825 tires per week.
c. We need to calculate the consumer and producer surplus both before and after the shift then compare the two

**Before the Supply Shift:**

i. **Equilibrium:** \( P^E = 100; \ Q^E = 700 \)

ii. **Demand Choke Price:** \( Q^D = 0 \)

\[ Q^D = 0 = 3,200 - 25P \rightarrow P^D_{\text{choke}} = $128 \]

iii. **Supply Choke Price:** \( Q^S_1 = 0 \)

\[ Q^S_1 = 0 = 15P - 800 \rightarrow P^S_{\text{choke}} = $53.33 \]

**Consumer Surplus:**

\[
CS = \frac{1}{2} \times Q^E \times (P^D_{\text{choke}} - P^E)
\]

\[
CS = \frac{1}{2} \times 700 \times (128 - 100)
\]

\[
CS_{\text{initial}} = $9,800.00
\]

**Producer Surplus:**

\[
PS = \frac{1}{2} \times Q^E \times (P^E - P^S_{\text{choke}})
\]

\[
PS = \frac{1}{2} \times 700 \times (100 - 53.33)
\]

\[
PS_{\text{initial}} = $16,334.50
\]
c. We need to calculate the consumer and producer surplus both before and after the shift then compare the two.

**After the Supply Shift:**

i. Equilibrium: $P^E = 95; \quad Q^E = 825$ (found in b)

ii. Demand Choke Price: $Q^D = 0; \quad P^D_{\text{choke}} = $128
   - Unchanged because the demand curve has not shifted

iii. Supply Choke Price: $Q^S_2 = 0$
   $Q^S_2 = 0 = 15P - 600 \Rightarrow P^S_{\text{choke}} = $40

**Consumer Surplus:**

\[
CS = \frac{1}{2} \times Q^E \times (P^D_{\text{choke}} - P^E)
\]
\[
CS = \frac{1}{2} \times 825 \times (128 - 95) = $16,612.50
\]

**Producer Surplus:**

\[
PS = \frac{1}{2} \times Q^E \times (P^E - P^S_{\text{choke}})
\]
\[
PS = \frac{1}{2} \times 825 \times (95 - 40) = $22,687.50
\]
c. Comparing the initial and the new values:

**Before the Supply Shift:**
i. **Consumer Surplus:** \(CS_{\text{initial}} = \$9,800\)
ii. **Producer Surplus:** \(PS_{\text{initial}} = \$16,334.50\)

**After the Supply Shift:**

i. **Consumer Surplus:** \(CS_{\text{new}} = \$16,612.50\)
ii. **Producer Surplus:** \(PS_{\text{new}} = \$22,687.50\)

**Change in Consumer Surplus**
\[
CS_{\text{new}} - CS_{\text{initial}} = \$16,612.50 - \$9,800
\]
• **Consumer surplus has increased by** \(\$3,812.50\)

**Change in Producer Surplus**
\[
PS_{\text{new}} - PS_{\text{initial}} = \$22,687.50 - \$16,334.50
\]
• **Producer surplus has increased by** \(\$6,353\)
The weekly supply and demand for tires in a small town are given as

\[ Q^S = 15P - 400; \quad Q^D = 2800 - 25P \]

where \( P \) is the price, in dollars, and quantity is the number of tires sold weekly. The equilibrium price is $80 per tire, and 800 tires are sold each week.

Suppose an improvement in technology makes tires cheaper to produce; specifically, suppose the quantity supplied rises by 200 at every price.

**Answer the following questions:**

a. What is the new supply curve?

b. What are the new equilibrium price and quantity?

c. What happens to consumer and producer surplus?
a. Quantity supplied rises by 200, so we simply add it to the equation for $Q^S$:

$$Q^s_2 = 15P - 400 + 200 = 15P - 200$$

b. The new equilibrium occurs where $Q^D = Q^S_2$

$$2,800 - 25P = 15P - 200$$
$$3,000 = 40P$$
$$P^* = $75$$

Plugging this into either the demand or supply equation:

**Demand:** $Q^* = 2,800 - 25(75) = 925$ tires

**Supply:** $Q^* = 15(75) - 200 = 925$ tires

The new equilibrium price is $75 and the new equilibrium quantity is 925 tires per week.
We need to calculate the consumer and producer surplus both before and after the shift then compare the two.

Before the Supply Shift:

i. Equilibrium: \( P^E = 80; \ Q^E = 800 \)

ii. Demand Choke Price: \( Q^D = 0 \)
   \[ Q^D = 0 = 2,800 - 25P \rightarrow P^D_{\text{choke}} = $112 \]

iii. Supply Choke Price: \( Q^S_1 = 0 \)
   \[ Q^S_1 = 0 = 15P - 400 \rightarrow P^S_{\text{choke}} = $26.67 \]

Consumer Surplus: \( CS = \frac{1}{2} \times Q^E \times (P^D_{\text{choke}} - P^E) \)
\[
CS = \frac{1}{2} \times 800 \times (112 - 80) \\
CS_{\text{initial}} = $12,800
\]

Producer Surplus: \( PS = \frac{1}{2} \times Q^E \times (P^E - P^S_{\text{choke}}) \)
\[
PS = \frac{1}{2} \times 800 \times (80 - 26.67) \\
PS_{\text{initial}} = $21,332
\]
c. We need to calculate the consumer and producer surplus both before and after the shift then compare the two

**After the Supply Shift:**

i. **Equilibrium:** $P^E = $75; $Q^E = 925$ (found in b)

ii. **Demand Choke Price:** $Q^D = 0; P^D_{choke} = $112
   - Unchanged because the demand curve has not shifted

iii. **Supply Choke Price:** $Q^S_2 = 0$
   \[ Q^S_2 = 0 = 15P - 200 \rightarrow P^S_{choke} = $13.33

**Consumer Surplus:**
\[ CS = \frac{1}{2} \times Q^E \times (P^D_{choke} - P^E) \]
\[ CS = \frac{1}{2} \times 925 \times (112 - 75) \]
\[ CS_{new} = $17,112.50 \]

**Producer Surplus:**
\[ PS = \frac{1}{2} \times Q^E \times (P^E - P^S_{choke}) \]
\[ PS = \frac{1}{2} \times 925 \times (75 - 13.33) \]
\[ PS_{new} = $28,522.38 \]
c. Comparing the initial and the new values:

Before the Supply Shift:

i. Consumer Surplus: \( CS_{\text{initial}} = 12,800 \)
ii. Producer Surplus: \( PS_{\text{initial}} = 21,332 \)

After the Supply Shift:

i. Consumer Surplus: \( CS_{\text{new}} = 17,112.5 \)
ii. Producer Surplus: \( PS_{\text{new}} = 28,522.38 \)

Change in Consumer Surplus = \( CS_{\text{new}} - CS_{\text{initial}} \)

= $17,112.50 - $12,800

• Consumer surplus has increased by $4,312.50

Change in Producer Surplus = \( PS_{\text{new}} - PS_{\text{initial}} \)

= $28,522.38 - $21,332

• Producer surplus has increased by $7,190.38
The demand and supply for cola in a market is represented by

\[ Q^D = 15 - 10P \]
\[ Q^S = 40P - 50 \]

Where \( Q \) is in millions of bottles per year and \( P \) is dollars per bottle. The current equilibrium price is $1.30, and 2 million bottles are sold per year.

**Answer the following questions:**

a. Calculate the price elasticity of demand and the price elasticity of supply at the current equilibrium

b. Calculate the share of a tax that will be borne by consumers and the share borne by producers

c. If a tax of $0.15 per bottle is created, what do buyers now pay for a bottle? What will sellers receive?
a. The elasticity of demand and supply are

\[ E^D = \frac{\Delta Q^D}{\Delta P} \times \frac{P}{Q^D} = \frac{1}{\text{slope}} \times \frac{P}{Q^D} \Rightarrow E^D = -10 \times \frac{1.3}{2} = -6.5 \]

\[ E^S = \frac{\Delta Q^S}{\Delta P} \times \frac{P}{Q^S} = \frac{1}{\text{slope}} \times \frac{P}{Q^S} \Rightarrow E^S = 40 \times \frac{1.3}{2} = 26 \]

b. The share of a tax borne by consumers and producers is:

Share born by consumer = \[ \frac{E^S}{E^S + |E^D|} = \frac{26}{26 + 6.5} = 0.8 \text{ or } 80\% \]

Share born by producer = \[ \frac{|E^D|}{E^S + |E^D|} = \frac{6.5}{26 + 6.5} = 0.20 \text{ or } 20\% \]
c. If there is a tax of $0.15 per bottle, buyers pay 80%, or $0.12 per bottle ($0.15 \times 0.80$), and sellers pay 20%, or $0.03 per bottle ($0.15 \times 0.2$)

Initial Equilibrium Price = $1.30
- Price buyer now pays = $1.30 + 0.12
  \[ P_b = $1.42 \]
- Price seller now receives = $1.30 - 0.03
  \[ P_s = $1.27 \]
The supply and demand for soda in a market is represented by

\[ Q_D = 12 - 8P \]
\[ Q_S = 50P - 60 \]

Where \( Q \) is in millions of bottles per year and \( P \) is dollars per bottle, The current equilibrium price is $1.17, and 2.62 million bottles are sold per year.

**Answer the following questions:**

a. Calculate the price elasticity of demand and the price elasticity of supply at the current equilibrium

b. Calculate the share of a tax that will be borne by consumers and the share borne by producers

c. If a tax of $0.10 per bottle is created, what do buyers now pay for a bottle? What will sellers receive?
figure it out

a. The elasticity of demand and supply are

\[ E^D = \frac{\Delta Q^D}{\Delta P} \times \frac{P}{Q^D} = \frac{1}{\text{slope}} \times \frac{P}{Q^D} \rightarrow \]

\[ E^D = -8 \times \frac{1.17}{2.62} = -3.75 \]

\[ E^S = \frac{\Delta Q^S}{\Delta P} \times \frac{P}{Q^S} = \frac{1}{\text{slope}} \times \frac{P}{Q^S} \rightarrow \]

\[ E^S = 50 \times \frac{1.17}{2.62} = 22.33 \]

b. The proportion of a tax borne by buyers and sellers is:

Share born by consumer = \[ \frac{E^S}{E^S + |E^D|} = \frac{22.33}{22.33 + 3.75} \]

= 0.856 or 85.6%

Share born by producer = \[ \frac{|E^D|}{E^S + |E^D|} = \frac{3.75}{22.33 + 3.75} \]

= 0.144 or 14.4%
c. If there is a tax of $0.10 per bottle, buyers pay 85.6%, or $0.0856 per bottle (0.10 \times 0.856), and sellers pay 14.4%, or $0.0144 per bottle (0.10 \times 0.144)

Initial Equilibrium Price = $1.17

- Price buyer now pays = $1.17 + 0.0856
  \[ P_b = \$1.2256 \]

- Price seller now receives = $1.17 − 0.0144
  \[ P_s = \$1.1556 \]
Consider the supply and demand for ethanol in small town below,

\[ Q^D = 9,000 - 1,000P \]
\[ Q^S = 2,000P - 3,000 \]

Where \( Q \) measures gallons per day and \( P \) represents the price per gallon.

The current equilibrium price is $4, and 5,000 gallons per day; suppose the government wants to create a subsidy of $0.375 per gallon to encourage the use of ethanol.

**Answer the following questions:**

a. What will happen to the price buyers pay per gallon, the price sellers receive per gallon, and the number of gallons consumed per day?

b. How much will this subsidy cost the government?
a. The first step is determining how the subsidy affects prices

\[ P_b + \text{subsidy} = P_S \]

The price the seller receives is larger than the price paid by the buyers because of the subsidy,

\[ P_S = P_b + 0.375 \]

Supply and demand are given by

\[ Q^D = 9,000 - 1,000P_b, \quad Q^S = 2,000P_S - 3,000 \]

Substituting in for \( P_S \)

\[ Q^S = 2,000(P_b + 0.375) - 3,000 = 2,000P_b - 2,250 \]

Equating the new supply and original demand, and solving for \( P_b \)

\[ 2,000P_b - 2,250 = 9,000 - 1,000P_b \rightarrow P_b = \$3.75 \]
figure it out

The new producer price is given by

\[ P_S = P_b + 0.375 \rightarrow P_S = $4.125 \]

To estimate the quantity of ethanol sold after the subsidy we can plug \( P_b \) into the demand equation or \( P_S \) into the supply equation

\[ Q^D = 9,000 - 1,000(3.75) \rightarrow Q^D = 5,250 \text{ gallons} \]
\[ Q^S = 2,000(4.125) - 3,000 \rightarrow Q^S = 5,250 \text{ gallons} \]

So, the price paid by consumers has decreased by about $0.25 per gallon to $3.75, the price received by the seller has increased by about $0.125 per gallon to $4.125, and the number gallons of ethanol sold per day has increased by 250 gallons to 5,250.

b. How much did this cost the government?

Cost = subsidy \( \times Q = 0.375 \times (5,250) = $1,968.75 \text{ per day} \)
For years the government has subsidized higher education through grants; consider the demand and supply for college credit hours at a local private liberal arts college

\[ Q^D = 8,000 - 500P \]
\[ Q^S = 1,000P - 2,500 \]

where \( P \) is the price, in hundreds of dollars, and \( Q \) is the number of credit hours per semester.

The current equilibrium price is $700, and 4,500 credit hours are taken *per semester*; suppose the government subsidizes credit hours at a rate of $200 per hour.

**Answer the following questions:**

a. What will happen to the price paid by students, the price received by the college, and the number of credit hours completed?

b. What is the cost of the subsidy to the government?
figure it out

a. The first step is determining how the subsidy affects prices

\[ P_b + \text{subsidy} = P_s \]

In this problem,

\[ P_b + 2 = P_s \]

Supply and demand are given by

\[ Q^D = 8,000 - 500P_b; \quad Q^S = 1,000P_s - 2,500 \]

Substituting in for \( P_s \)

\[ Q^S = 1,000(P_b + 2) - 2,500 = 1,000P_b - 500 \]

Equating supply and demand, and solving for \( P_b \)

\[ 8,000 - 500P_b = 1,000P_b - 500 \rightarrow P_b = \$566.7 \]
The new producer price is given by

\[ P_b + 200 = P_s \rightarrow P_s = $766.7 \]

To estimate the credit hours taken after the subsidy we can plug \( P_b \) into the demand equation or \( P_s \) into the supply equation

\[ Q^D = 8,000 - 500(5.667) \rightarrow Q^D = 5,166.50 \]

\[ Q^S = 1,000(7.667) - 2,500 \rightarrow Q^S = 5,166.50 \quad (\text{rounding}) \]

So, the price paid by consumers has decreased by about $133, the price received by the college has increased by about $67, and the number of credit hours consumed has increased by about 667

b. How much did this cost the government?

\[ \text{Cost} = \text{subsidy} \times Q = $200 \times 667 = $133,400 \]