Topic 3: Equilibrium, Efficiency, and Externalities

ECN104: Introductory Microeconomics

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Market Equilibrium

- A market is said to be in **equilibrium** when no participant in the market has any incentive to change their behaviour

- In analyzing a market for a good, we are interested in finding:

  - The **equilibrium price**: the price at which it will sell

  - The **equilibrium quantity**: the quantity of it which will be sold

- In order to determine the equilibrium price and equilibrium quantity in a perfectly competitive market (i.e., a market in which the producers are perfectly competitive), all we need are the supply and demand functions for that market

A Simple Example

- Suppose that, in some market, the demand and supply functions are:

  Demand: $q = 5 - 0.5p$
  Supply: $q = -10 + 2p$

- The following table gives the quantity supplied and quantity demanded for some different prices:

Price	Quantity Demanded	Quantity Supplied
$6.50	1.75	3
6.00	2	2
5.50	2.25	1

Surpluses and Shortages

- At a price of $6.50: Quantity Demanded < Quantity Supplied (**Surplus**)

  Producers will not be able to sell all the quantity that they would like to; they will have an incentive to lower their prices

- At a price of $5.50: Quantity Demanded > Quantity Supplied (**Shortage**)

  Consumers will not be able to buy all the quantity that they would like to; they will have an incentive to offer higher prices

- At a price of $6.00: Quantity Demanded = Quantity Supplied (**Equilibrium**)

  No one has any incentive to change their behaviour

Exercise 3.1

Consider the following demand and supply functions:

Demand: $q = 10 - 2p$
Supply: $q = -5 + 3p$

At a price of $4, there is a:

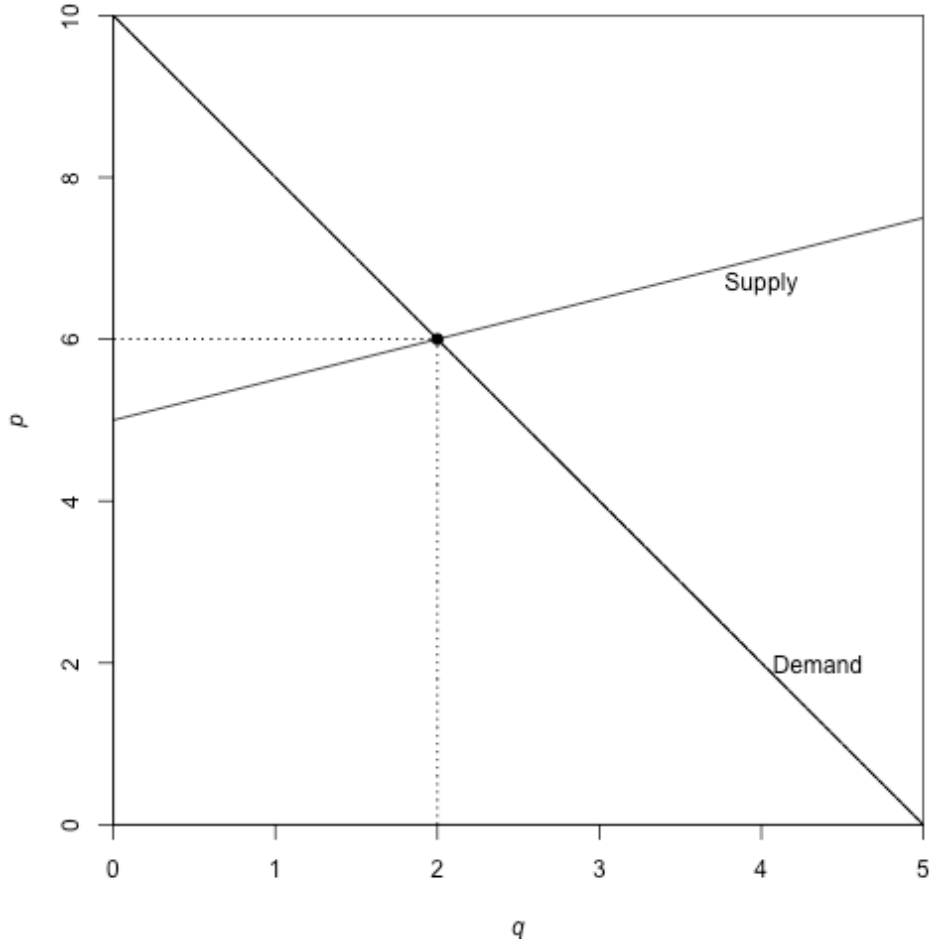
(a) shortage

(b) surplus

(c) neither a shortage nor a surplus.

Graphical Analysis

- Market equilibrium is found where the demand and supply functions intersect



Algebraic Analysis

- When the demand and supply functions are linear, it is easy to find the equilibrium price and equilibrium quantity algebraically

- For example, consider the demand and supply functions given earlier:

  Demand: $q = 5 - 0.5p$
  Supply: $q = -10 + 2p$

- To find the equilibrium price and equilibrium quantity, we solve the above system of linear equations for q and p, which gives:

  $q = 2$
  $p = 6$

Exercise 3.2

Consider the following demand and supply functions:

Demand: $q = 10 - 2p$
Supply: $q = -5 + 3p$

Find the equilibrium price and equilibrium quantity.

Changes in Demand and Supply

- If there is a change in demand or supply, there will be a change in both equilibrium price and equilibrium quantity

- There are four possibilities:

    - An increase in demand

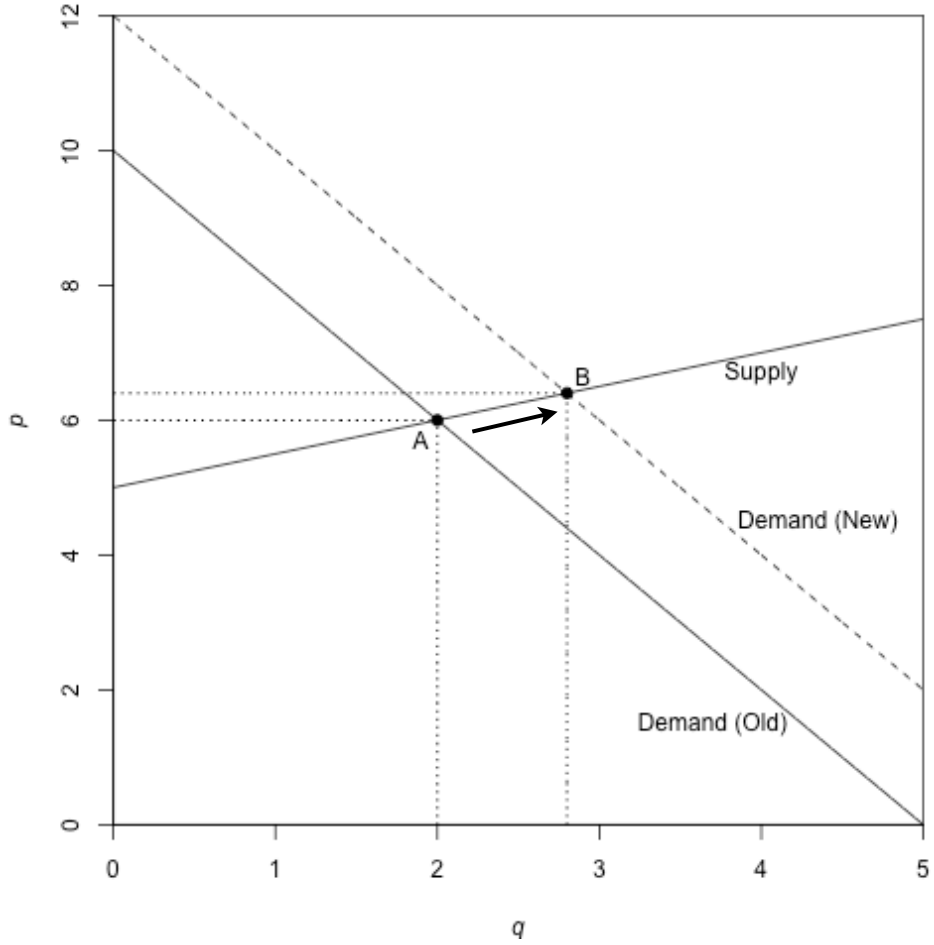
    - A decrease in demand

    - An increase in supply

    - A decrease in supply

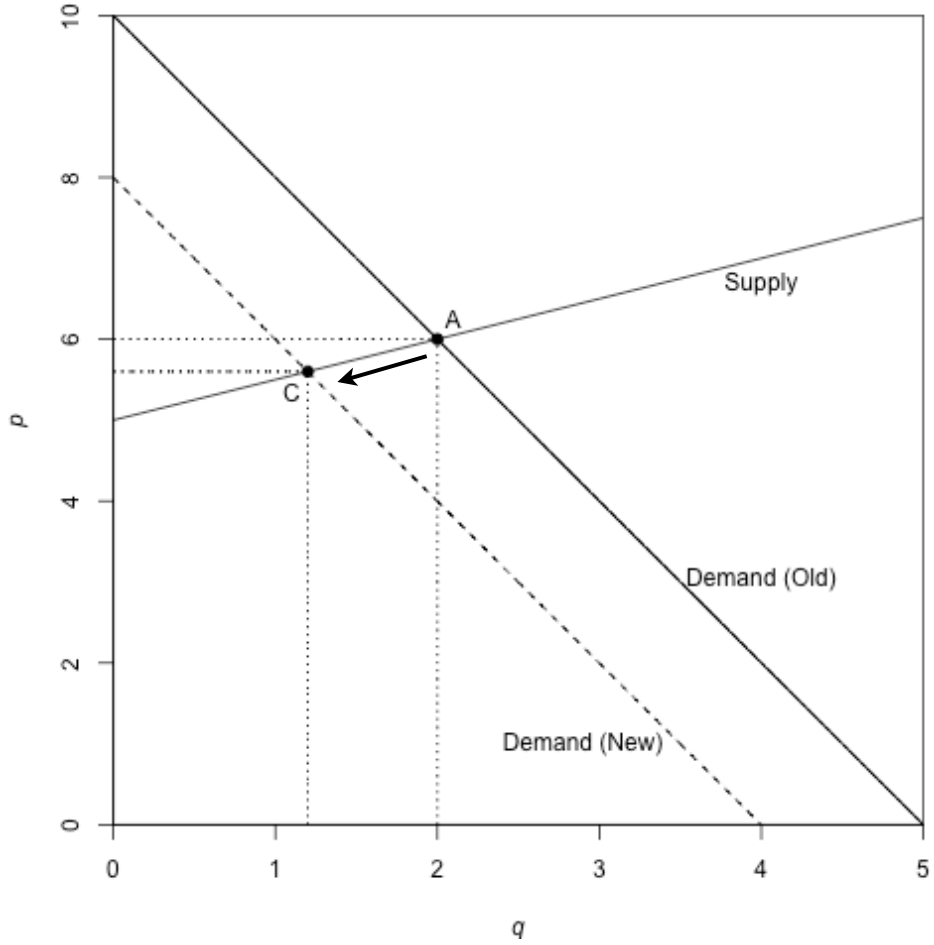
An Increase in Demand

- Both equilibrium price and equilibrium quantity increase



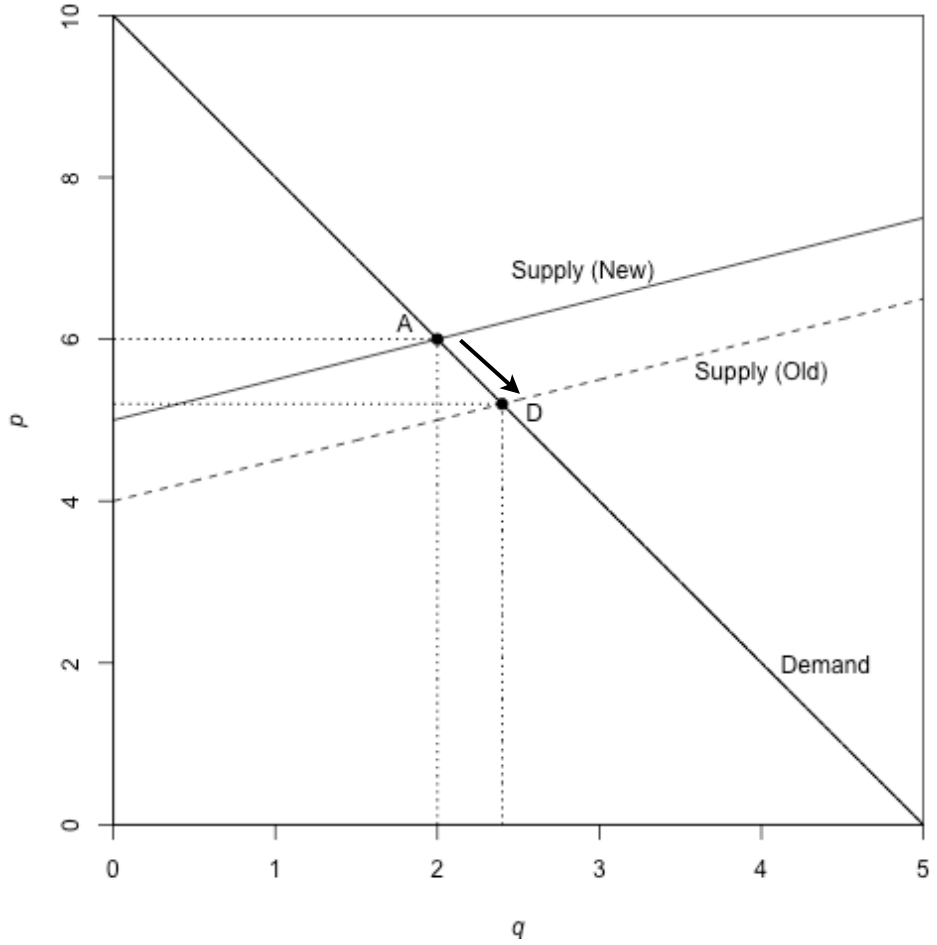
A Decrease in Demand

- Both equilibrium price and equilibrium quantity decrease



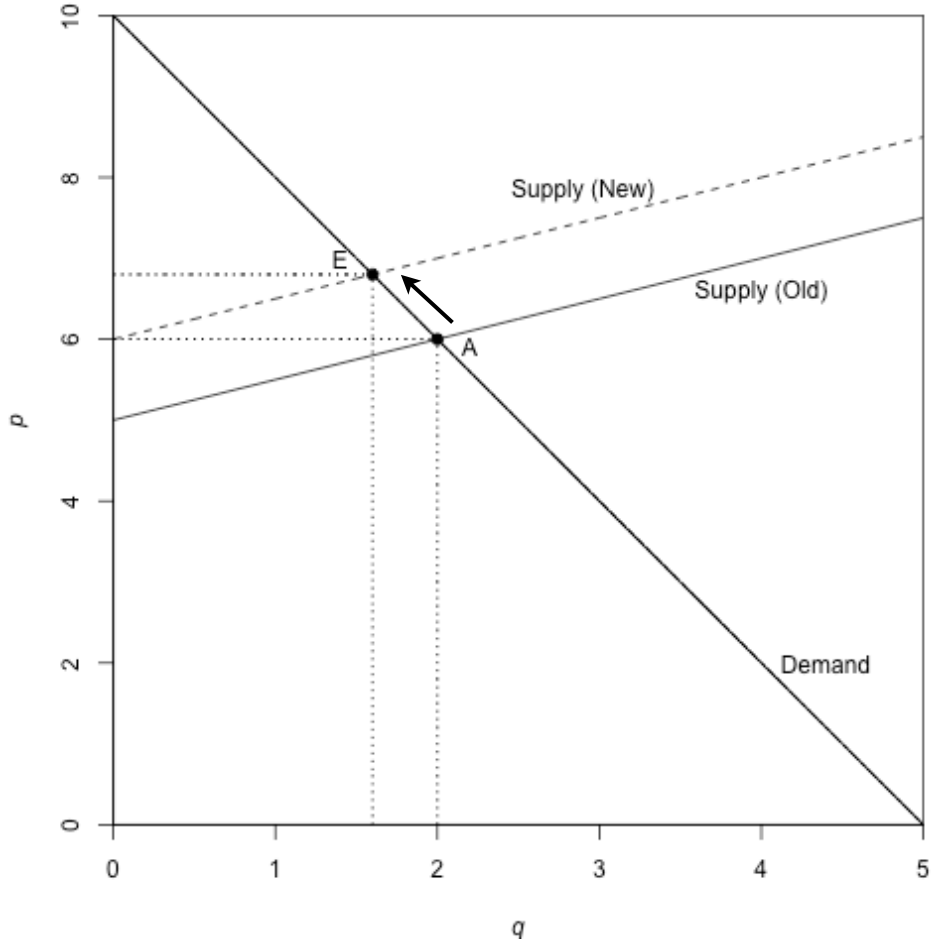
An Increase in Supply

- Equilibrium price decreases; equilibrium quantity increases



A Decrease in Supply

- Equilibrium price increases; equilibrium quantity decreases



Effects on Quantity Demanded and Quantity Supplied

- Notice that, when there is a change in demand (i.e., a *shift of* the line representing the demand function), there is a corresponding change in quantity supplied (i.e., a *movement along* the line representing the supply function)

- Similarly, when there is a change in supply (i.e., a *shift of* the line representing the supply function), there is a corresponding change in quantity demanded (i.e., a *movement along* the line representing the demand function)

Exercise 3.3

Assume that hot dogs and hamburgers are substitutes. If the price of hamburgers increases, then

(a) the equilibrium price of hot dogs will decrease.

(b) the equilibrium price of hot dogs will increase.

(c) the equilibrium quantity of hot dogs will decrease.

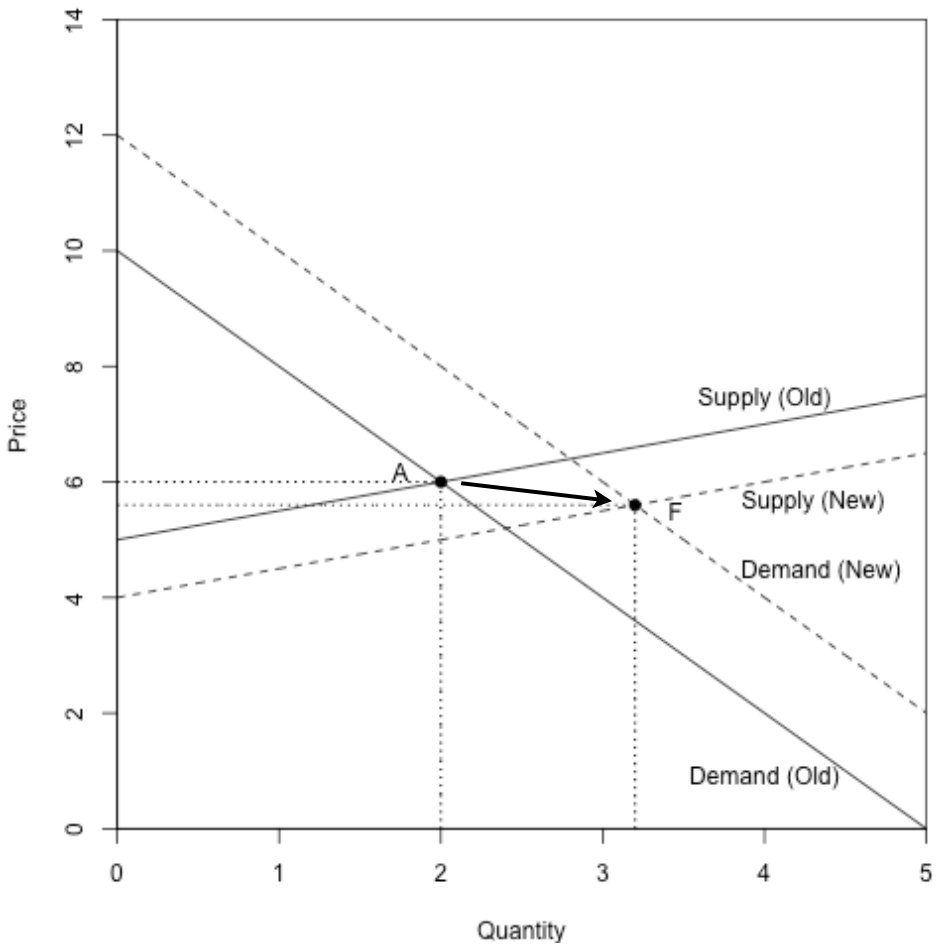
(d) the equilibrium quantity of hot dogs will increase.

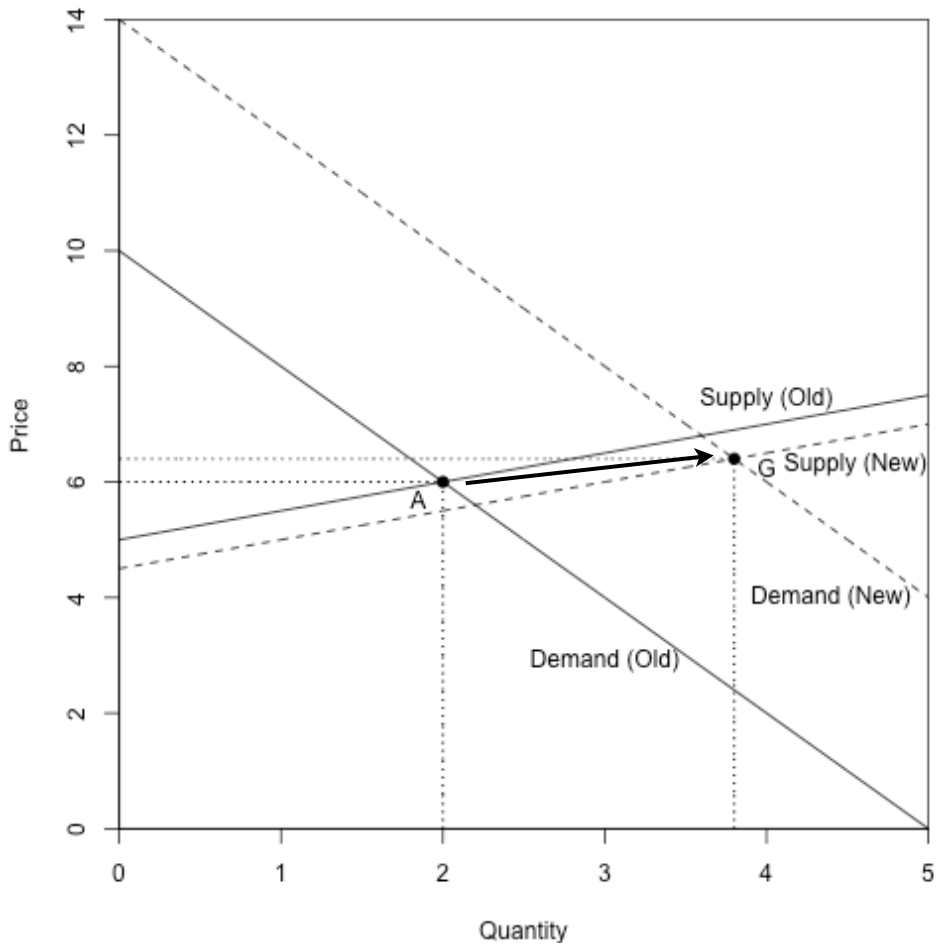
Simultaneous Changes in Demand and Supply

- If there is a simultaneous change in both demand and supply, the effects on equilibrium price and equilibrium quantity may be ambiguous
- For example, if both demand and supply increase, equilibrium quantity will definitely increase, but equilibrium price may either increase or decrease
    - The increases in demand and supply both put upward pressure on equilibrium quantity
    - The increase in demand puts upward pressure on equilibrium price
    - The increase in supply puts downward pressure on equilibrium price

Simultaneous Increases in Demand and Supply

- Equilibrium price may either decrease (left) or increase (right)





Exercise 3.4

If demand increases while supply decreases, equilibrium price will

(a) increase.

(b) decrease.

(c) either increase or decrease.

Efficiency

- A **Pareto improvement** occurs when someone is made better off without making anyone else worse off
- A situation is considered **efficient** if no Pareto improvement is possible
- A situation is considered **inefficient** if a Pareto improvement is possible
- We will show that the equilibrium in a perfectly-competitive market is efficient, and that price controls are inefficient

Exercise 3.5

Killing one person in order to save the lives of one million people _____ be considered a Pareto improvement

(a) would.

(b) would not.

Efficiency

- For example, suppose we have 10 cookies and 2 children, Andrea and Bobby
  - Initially, Andrea has 3 cookies and Bobby has 6 cookies (one cookie remains in the cookie jar)
  - If we give the cookie in the cookie jar to Andrea, a Pareto improvement has occurred (implying that the initial situation was inefficient)
  - After giving the last cookie to Andrea, the situation is efficient, since no Pareto improvement is possible (i.e., there is no way to give either child another cookie without taking one away from the other child)
- Notice that efficiency has nothing to do with *equity*

Efficiency

- Whenever total well-being is maximized, there is no possibility for a Pareto improvement (i.e., the situation is efficient)
    - When all the cookies are given out, it is impossible to give one child more cookies without taking some from the other child
- Whenever total well-being is not maximized, there is always a possibility for a Pareto improvement (i.e., the situation is inefficient)
    - When there are still cookies in the cookie jar, it is possible to give one child more cookies without taking some from the other child

Exercise 3.6

Suppose that there are 10 beers in the fridge, and two beer-drinkers. Which of the following situations is efficient?

(a) Give each beer-drinker 5 beers.

(b) Give one beer-drinker 2 beers, and the other beer-drinker 8 beers.

(c) Give each beer-drinker 4 beers, and pour out the remaining 2.

(d) Both (a) and (b).

Equilibrium and Efficiency

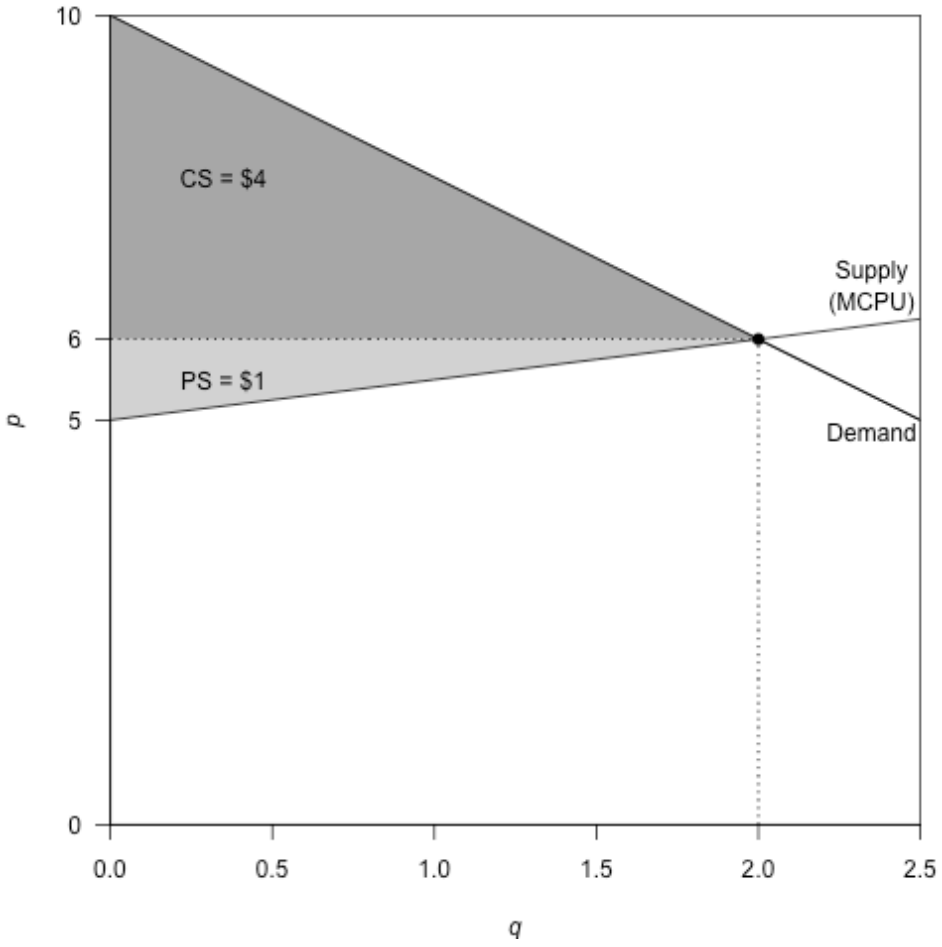
- We measure the well-being of consumers using consumer surplus (CS)
- We measure the well-being of producers using producer surplus (PS)
- Total well-being is thus the sum of CS and PS
- To see that the equilibrium in a perfectly competitive market is efficient, return to the earlier example where

  Demand: $q = 5 - 0.5p$

  Supply: $q = -10 + 2p \quad \Rightarrow \quad \text{MCPU} = 5 + 0.5q$

Equilibrium and Efficiency

- CS + PS = $5



Exercise 3.7

Consider the following demand and supply functions:

Demand: $q = 10 - 2p$
Supply: $q = -5 + 3p$

What is consumer surplus?

Price Controls

- Governments often attempt to fix the price of a good at a level above or below its equilibrium level

- When the price is artificially fixed above the equilibrium price, we call it a **price floor**

    - Example: Minimum wages

- When the price is artificially fixed below the equilibrium price, we call it a **price ceiling**

    - Example: Rent-controlled apartments

Price Floors

- Suppose there is a price floor at $6.50
- At this price, quantity demanded is 1.75, but quantity supplied is 3
- As a result, only 1.75 will be sold (consumers can’t be forced to buy more than this)

Exercise 3.8

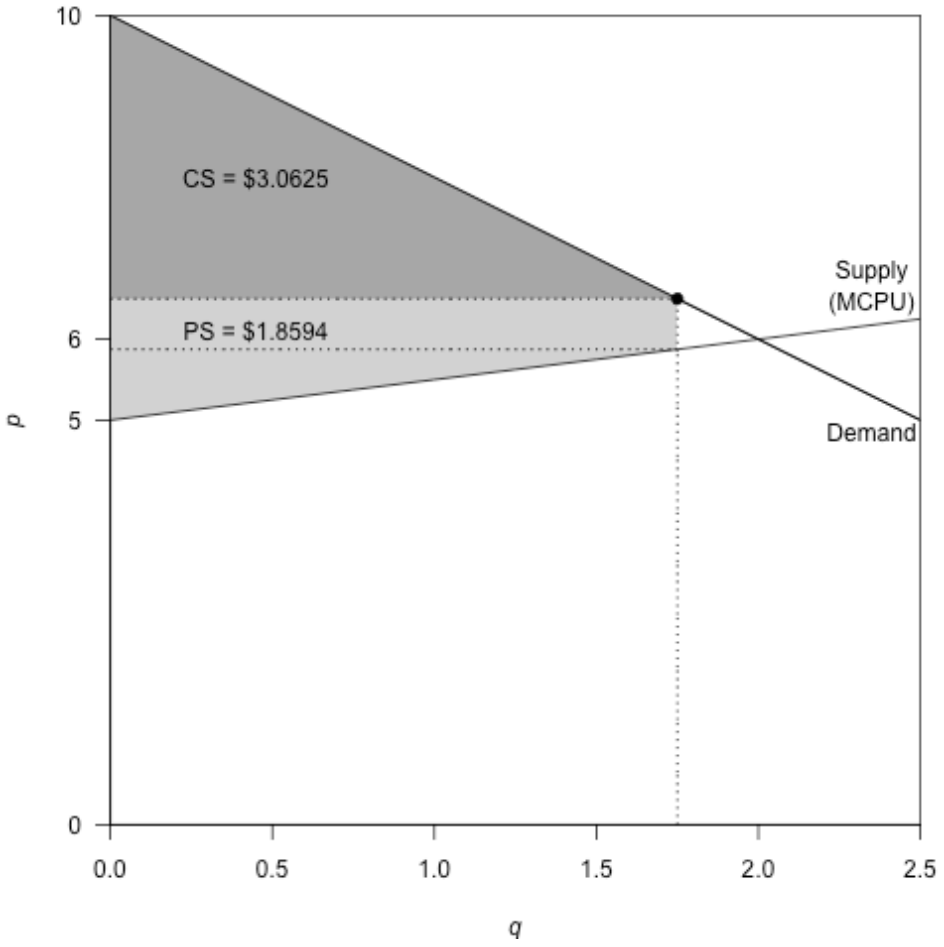
Increasing the minimum wage would be expected to _____ unemployment.

(a) increase

(b) decrease

Price Floors

- CS + PS = $4.9219 (a loss of $0.0781 compared to the equilibrium price)



Exercise 3.9

Consider the following demand and supply functions:

Demand: $q = 8 - p$
Supply: $q = -2.5 + 0.5p$

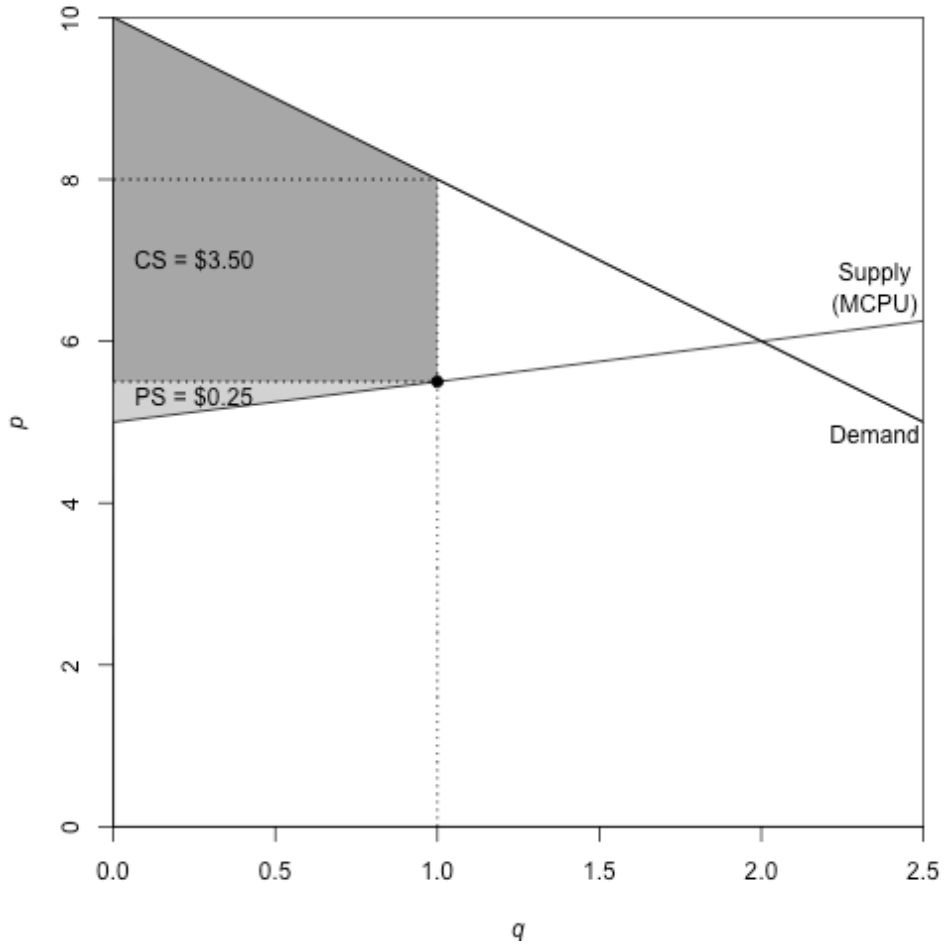
If a price floor is imposed at \$7.50, what is the *loss* in consumer surplus?

Price Ceilings

- Suppose there is a price ceiling at $5.50
- At this price, quantity demanded is 2.25, but quantity supplied is 1
- As a result, only 1 will be sold (producers can’t be forced to sell more than this)

Price Ceilings

- CS + PS = $3.75 (a loss of $1.25 compared to the equilibrium price)



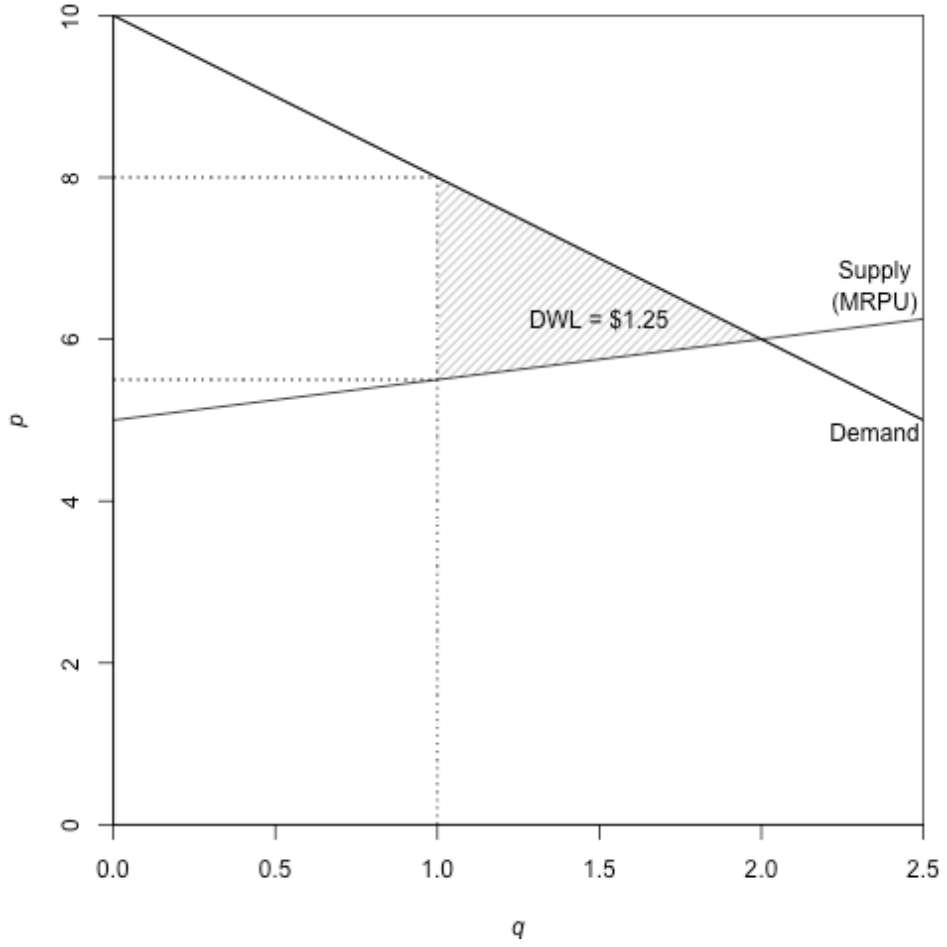
Deadweight Loss

- Clearly, at any price other than the equilibrium price, the *sum* of CS and PS is not maximized (i.e., the situation is inefficient), even though CS or PS (but not both) may individually be higher than they are at the equilibrium price

- The **deadweight loss** (DWL) is the difference between the maximum sum of CS and PS (i.e., the sum of CS and PS that would be achieved at the equilibrium price) and the actual sum of CS and PS

Deadweight Loss

- DWL can be calculated as the area of the shaded region (a triangle)



Exercise 3.10

Consider the following demand and supply functions:

Demand: $q = 8 - p$
Supply: $q = -2.5 + 0.5p$

What is the deadweight loss from imposing a price floor at $7.50?

The Invisible Hand

- Remarkably, total well-being in a perfectly competitive market is maximized when individual consumers and producers seek to maximize their own well-being

- Adam Smith: Although the individual

  > "intends only his own gain...he is...led by an **invisible hand** to promote an end which was no part of his intention"

  (from *An Inquiry into the Nature and Causes of the Wealth of Nations*, 1776)

- As we will see shortly, the invisible hand often doesn't work too well in reality (i.e., whenever markets aren't perfectly competitive)

The Deadweight Loss from Taxes

- We now want to show that taxes are inefficient
- To see this, suppose that producers have to pay a $1 per unit tax in the previous example
- This tax can be seen as an increase in the MCPU by $1, i.e., the MCPU is now

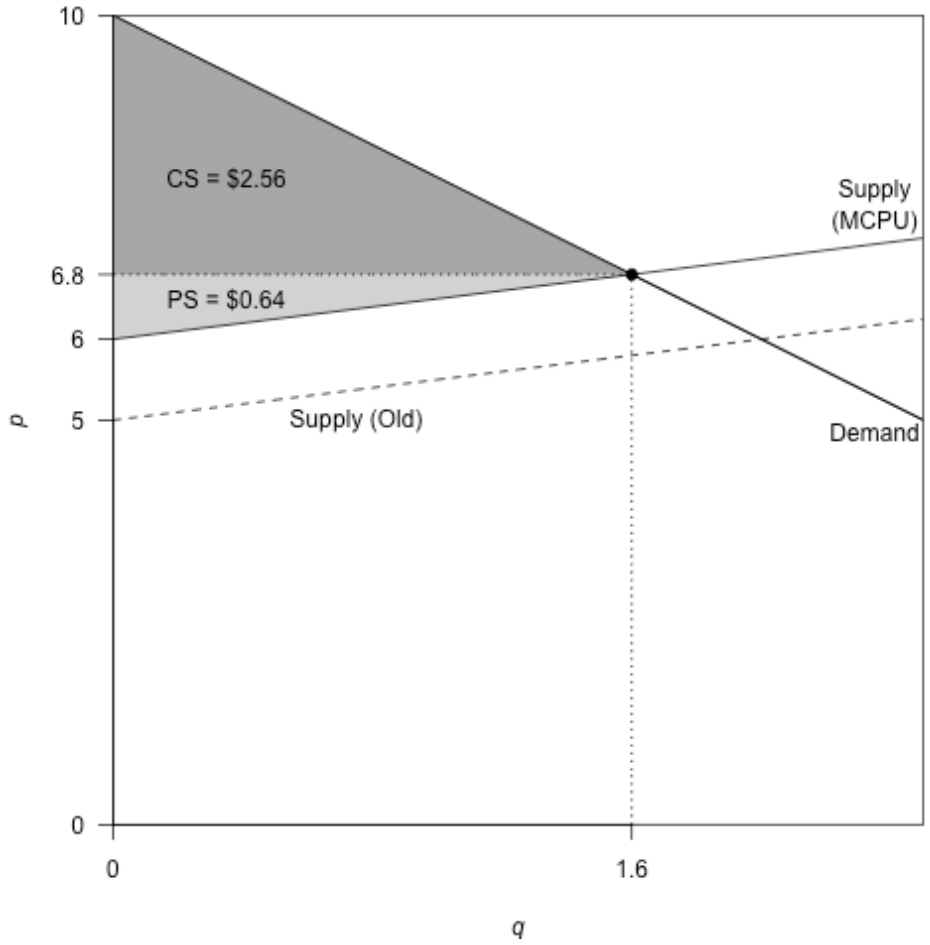
$$\text{MCPU} = 5 + 0.5q + 1$$

$$= 6 + 0.5q$$

- Given the new MCPU, the equilibrium price is $6.80 and the equilibrium quantity is 1.6 (make sure you understand where these figures come from)

The Deadweight Loss from Taxes

- CS + PS = $3.20 (a loss of $1.80 compared to the case with no tax)



The Deadweight Loss from Taxes

- The problem with this analysis is that we forgot about what happened to the **government revenue** (or **GR**) raised from the tax:

  GR = Tax per unit × Quantity

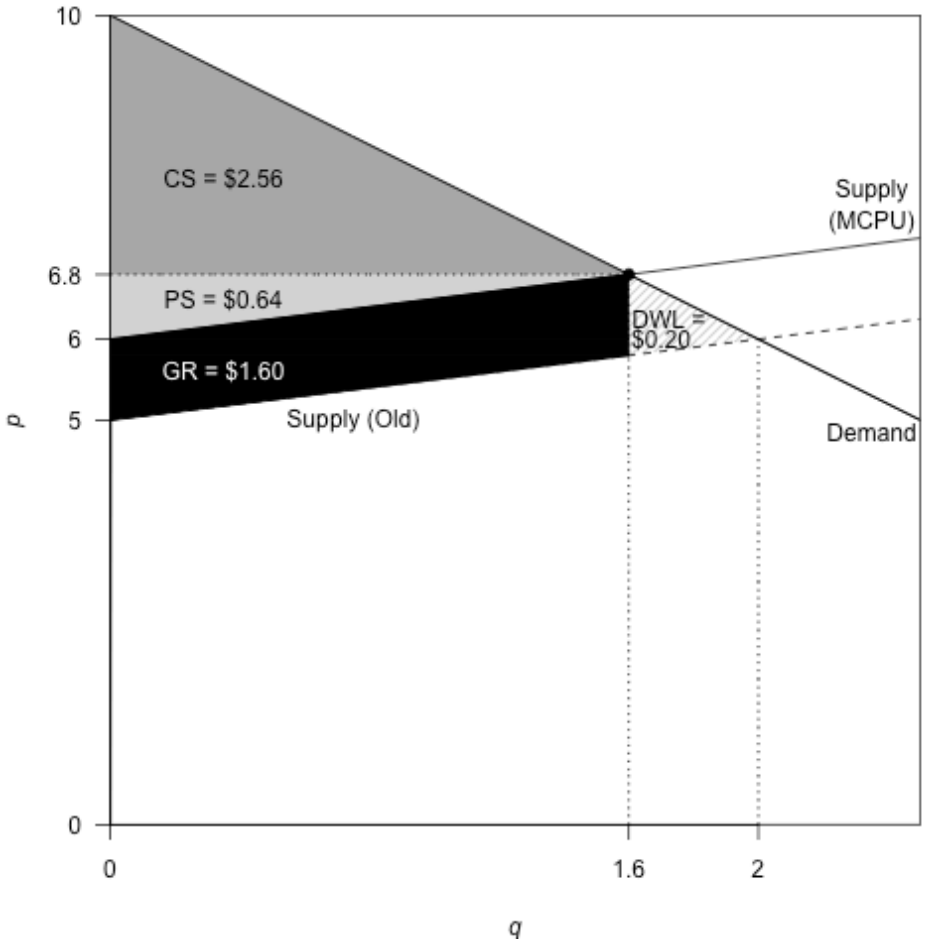
  here, GR = $1.60

- Since this tax revenue ends up in someone's pocket, it has increased total well-being

- Thus, our calculation of deadweight loss should exclude GR

The Deadweight Loss from Taxes

- CS + PS + GR = $4.80



Exercise 3.11

Consider the following demand and supply functions:

Demand: $q = 8 - p$
Supply: $q = -2.5 + 0.5p$

What is the deadweight loss from imposing a $1 per-unit tax on sellers?

The Deadweight Loss from a Monopoly

- We now want to show that monopolies are inefficient

- To see this, let's return to the example we used when we first introduced monopolies, where the demand function was

  $q = 800 - 100p$

  and the MCPU function was

  $MCPU = -1 + q/200$

The Deadweight Loss from a Monopoly

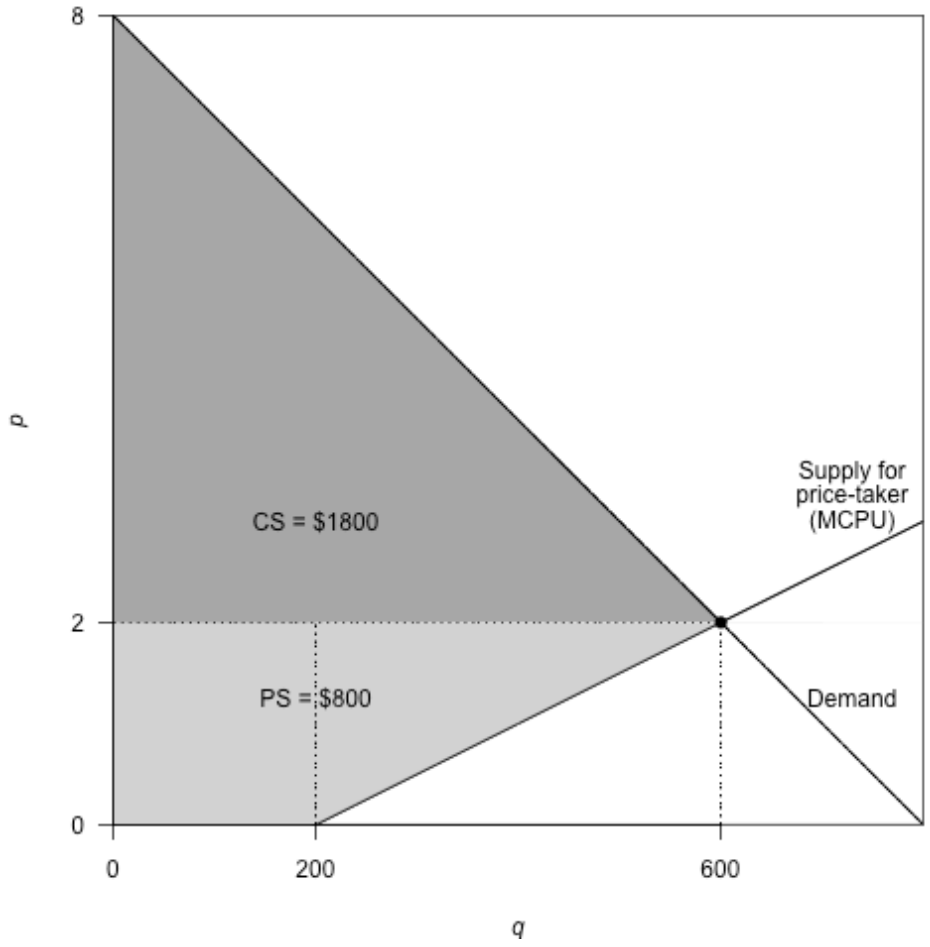
- As a point of comparison, we first imagine that the producer is a price-taker
- Recall that for a price-taker, at the profit-maximizing level of total product: p = MCPU
- Thus, if this producer were a price-taker, it would have the inverse supply function

$$p = -1 + q/200$$

- In this case, the “equilibrium” price would be $2 and the “equilibrium” quantity would be 600 (make sure you know where these figures come from)

The Deadweight Loss from a Monopoly

- CS + PS = $2600



The Deadweight Loss from a Monopoly

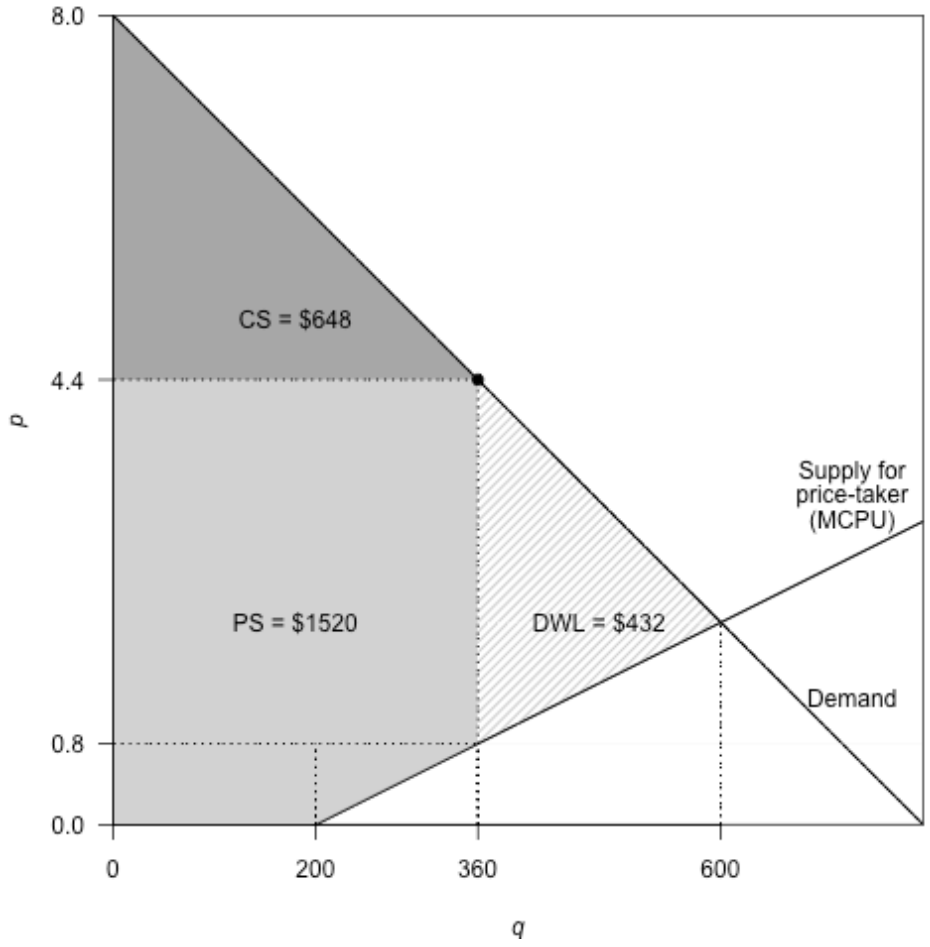
- As a monopolist, this producer has the MRPU function

  $$MRPU = 8 - 0.02q$$

  and the profit-maximizing level of total product is 360, while the price charged will be $4.40 (we found these figures when we first went through this example, but make sure you understand where they come from)

The Deadweight Loss from a Monopoly

- CS + PS = $2168



Exercise 3.12

Suppose that a monopolist faces a demand function given by

$$q = 20 - 2p$$

and has an MCPU function given by

$$\text{MCPU} = 0.5q$$

What is the deadweight loss created by this monopoly?

Monopolistic Competition

- Recall that a monopolist has no competitors which produce an *identical* good
- However, a monopolist may have “competitors” which produce *similar* goods
    - Example: Jeans produced by Levi’s are similar to jeans produced by GAP
- We refer to this as **monopolistic competition**
- Since a monopolistic competitor is still, by definition, a monopolist, it will still create a deadweight loss
- However, the greater the degree of “competition” that a monopolistic competitor faces, the smaller is the deadweight loss that it will create

Monopolistic Competition

- The degree of “competition” between monopolistic competitors depends on how similar the goods that they produce are
  - If the goods are very similar, the deadweight losses will be very small
    - Example: RBC vs. Scotiabank vs. TD vs. CIBC vs. BMO
  - If the goods are very dissimilar, the deadweight losses will be very large
    - Example: Microsoft vs. Apple

Monopolistic Competition

- The more similar are the goods produced by different monopolistic competitors, the easier it is for consumers to substitute between them

- If consumers can easily substitute between different goods, then they will be more sensitive to changes in price, i.e., PED will be higher at any given price

- For example, suppose the demand function in the previous example changed to

$$q = 700 - 50p$$

Monopolistic Competition

- If the producer were a price-taker, the “equilibrium” price and “equilibrium” quantity would be the same as before ($2 and 600, respectively), however:

  - with this new demand function, PED at the “equilibrium” is -1/6

  - with the old demand function, PED at the “equilibrium” is -2/6

  (make sure you understand where all of these figures come from)

- In other words, with the new demand function, consumers are *less* sensitive to changes in price (which means that they must find it harder to find substitutes for these goods)

- Thus, we can predict that the deadweight loss from monopoly is now *larger* than before

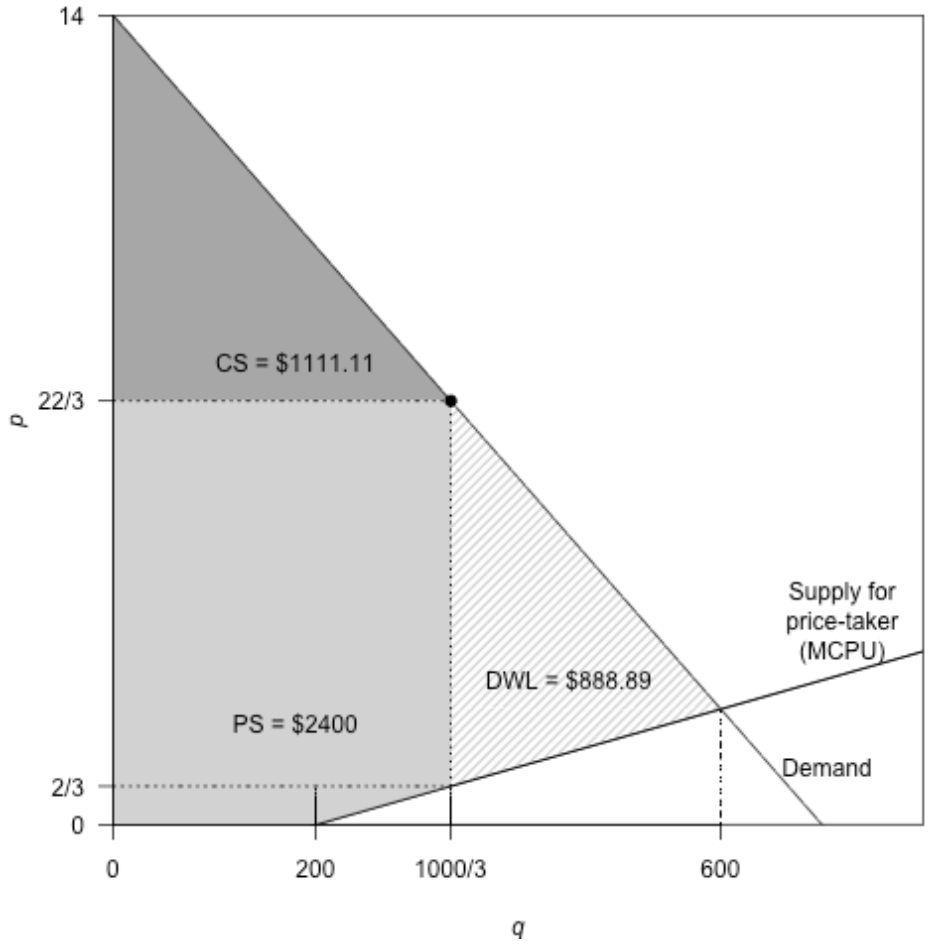
Monopolistic Competition

- As a monopolist, this producer has the MRPU function

  $$\text{MRPU} = 14 - 0.04q$$

  and the profit-maximizing level of total product is 1000/3, while the price charged will be $22/3 (make sure you know where these figures come from)

Monopolistic Competition



Exercise 3.13

If Microsoft decided to release its Office software for Linux, it seems likely that consumers would become _____ sensitive to changes in the price of Windows.

(a) less

(b) more

Externalities

- Up to this point, we have only considered the costs and benefits experienced by the actual consumers and producers of various goods
- Often, costs and benefits are also experienced by “outside” parties
- **Negative externality**: A cost experienced by an outside party
    - Example: Air pollution from a steel producer
- **Positive externality**: A benefit experienced by an outside party
    - Example: Pollination from a beekeeper

Negative Externalities

- The **social MCPU** (or **SMCPU**) **function** is equal to the (private) MCPU function plus the external cost per unit

- For example, if the MCPU function is

  $$MCPU = 5 + 0.5q$$

  and there is a $1 external cost per unit, then the SMCPU function is

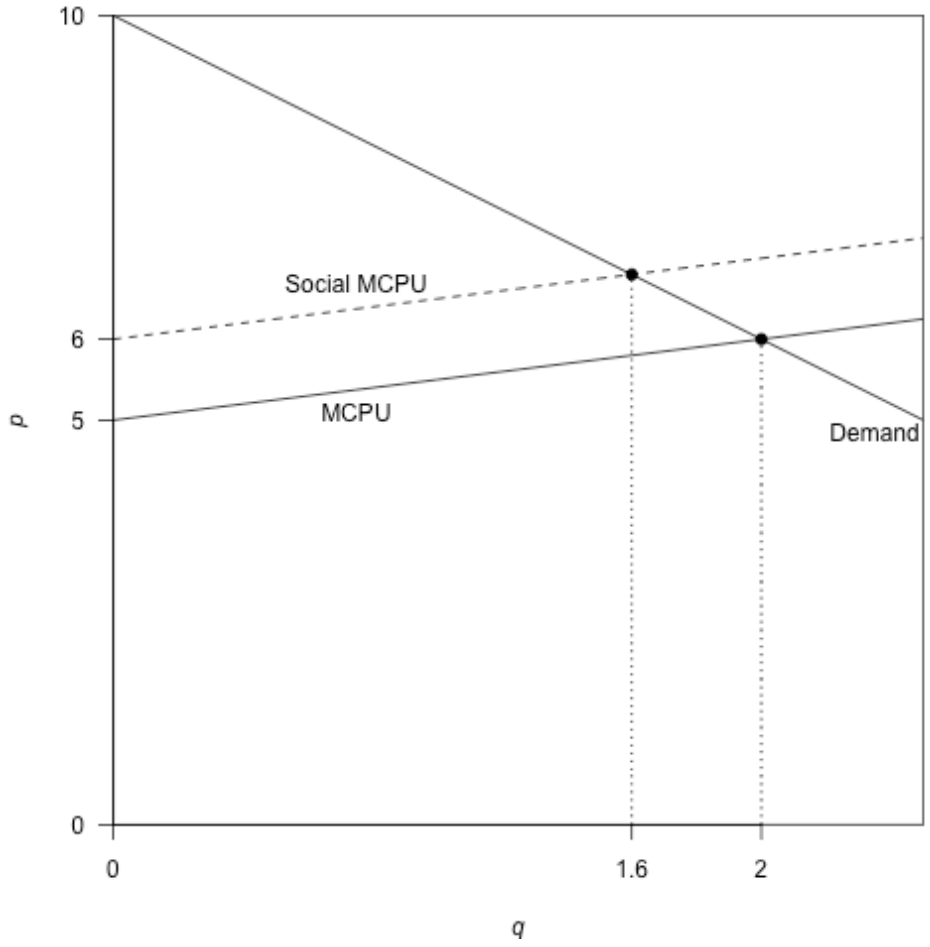
  $$SMCPU = 6 + 0.5q$$

- In what follows, we use the demand function

  $$q = 5 - 0.5p$$

Negative Externalities

- The socially optimal quantity (1.6) is *less* than the equilibrium quantity (2)



Negative Externalities

- When a negative externality is present, the equilibrium quantity is “too high”
- The government can “correct” a negative externality by imposing a per unit tax equal to the external cost per unit ($1 in the previous example)
  - As we saw before, the (private) MCPU function is increased by the amount of the per unit tax
  - Thus, the MCPU function is made equal to the social MCPU function that would have existed in the absence of the tax

Exercise 3.14

When a negative externality is present, we could say that the equilibrium price is _____ for consumers to demand the socially optimal quantity.

(a) “too high”

(b) “too low”

Positive Externalities

- The **social inverse demand function** is equal to the (private) inverse demand function plus the external benefit per unit

- For example, if the inverse demand function is

  $p = 10 - 2q$

  and there is a $1 external benefit per unit, then the social inverse demand function is

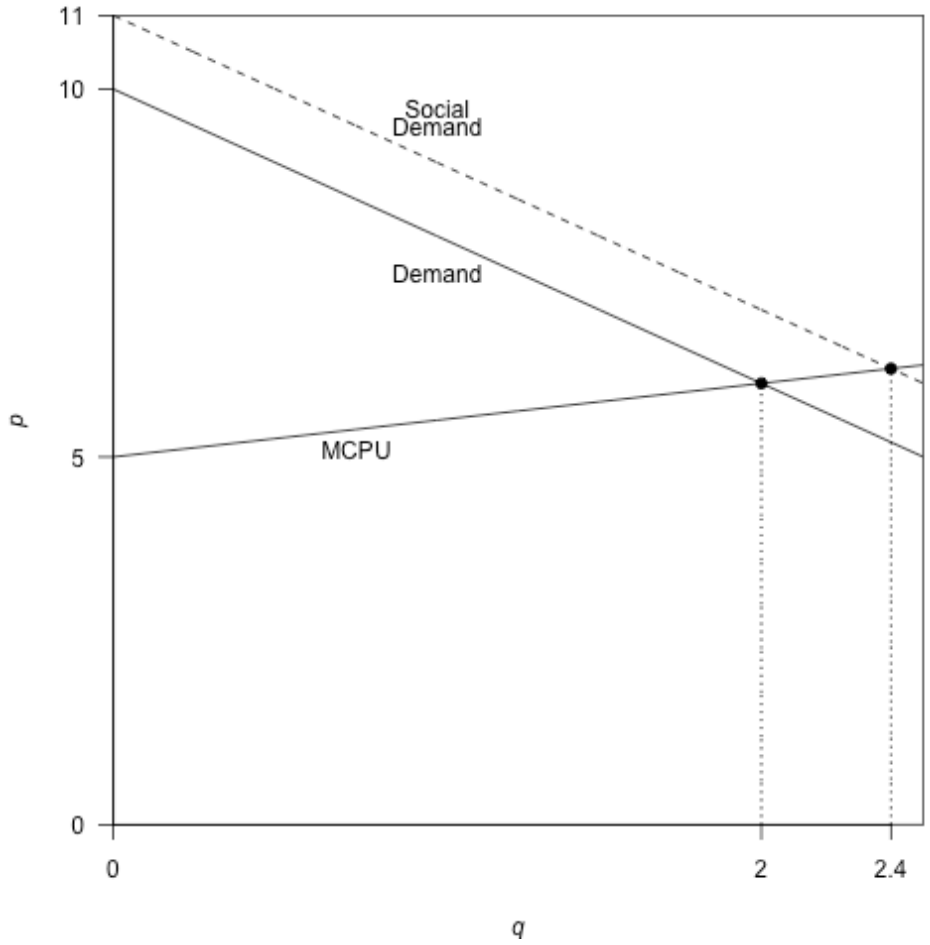
  $p = 11 - 2q$

- In what follows, we use the supply function

  $q = -10 + 2p$

Positive Externalities

- The socially optimal quantity (2.4) is *greater* than the equilibrium quantity (2)



Positive Externalities

- When a positive externality is present, the equilibrium quantity is “too low”
- The government can “correct” a positive externality by giving consumers a per unit subsidy equal to the external benefit per unit ($1 in the previous example)
  - The per unit subsidy increases the price that consumers are willing to pay for a certain quantity by the amount of the subsidy
  - Thus, the inverse demand function is made equal to the social inverse demand function that would have existed in the absence of the subsidy

Exercise 3.15

When a positive externality is present, we could say that the equilibrium price is _____ for producers to supply the socially optimal quantity.

(a) “too high”

(b) “too low”