Supply and Demand

1. One assumption of the supply and demand model is that all goods bought and sold are identical. Why do you suppose economists commonly make this assumption? Does the supply and demand model lose its usefulness if goods are not identical?

1. Economists make this assumption, along with many others, in order to capture the meaningful relationships of the real world in simplified models. The models then can predict how variables within these relationships change in response to economic factors. If goods are not identical, many predictions of the model will still prove to be correct. However, we would be less confident in the predictions resting most heavily on that assumption.

2. List the assumptions of the supply and demand model. Then, for each assumption, give one example of a market in which the assumption is satisfied, and one example of a market in which that assumption is not satisfied. Is it reasonable to use the supply and demand model when assumptions are violated?

2. *Assumption 1.* We focus on supply and demand in a single market. This assumption is satisfied if we look at the market for hotel rooms in Lincoln, Nebraska, which is likely to be independent of the market for hotel rooms in other cities. This assumption is not satisfied if we look at the market for gold in Lincoln, Nebraska, which would be dependent on gold's global supply and demand.

    Assumption 2. All goods sold in the market are identical. This assumption is satisfied if we look at the market for a commodity such as crude oil. If we look at shoes, the fact that there are countless distinctions between different types and styles of shoes means that the assumption is not satisfied.

    Assumption 3. All goods sold in the market sell for the same price, and everyone has the same information. This assumption is satisfied in a market such as retail gasoline stations. Although gas prices differ by a few cents per gallon between retailers, they match one another within a fairly close range. And prices are visible to anyone in the vicinity of the gas station. An example of a market where this assumption is not satisfied would be home furnishings. A furniture item such as a desk, for example, could have a significant price range, with the price of the most expensive desk being multiple times higher than that of an inexpensive one.

    Assumption 4. There are many buyers and sellers in the market. This assumption is satisfied in the market for fresh fruit, where there are many small orchards supplying produce and many consumers shopping for peaches, apples, oranges, and pears. In contrast, the market for intercity passenger rail transportation in the United States has only one seller: Amtrak. Such a market would not satisfy the assumption.

    The supply and demand model can still be useful even when these four assumptions are not met, because the basic economic relationships captured in the model apply even outside the boundaries of such assumptions.

*3. The demand for organic carrots is given by the following equation:

$$Q_O^D = 75 - 5P_O + P_C + 2I$$

where P_O is the price of organic carrots, P_C is the price of conventional carrots, and I is the average consumer income. Notice how this isn't a standard demand curve that just relates the quantity of organic carrots demanded to the price of organic carrots. This demand function also describes how other factors affect demand—namely, the price of another good (conventional carrots) and income.
a. Graph the inverse demand curve for organic carrots when $P_C = 5$ and $I = 10$. What is the choke price?
b. Using the demand curve drawn in (a), what is the quantity demanded of organic carrots when $P_O = 5$? When $P_O = 10$?
c. Suppose P_C increases to 15, while I remains at 10. Calculate the quantity demanded of organic carrots. Show the effects of this change on your graph and indicate the choke price. Has there been a change in the demand for organic carrots, or a change in the quantity demanded of organic carrots?

    d. What happens to the demand for organic carrots when the price of conventional carrots increases? Are organic and conventional carrots complements or substitutes? How do you know?

    e. What happens to the demand for organic carrots when the average consumer's income increases? Are carrots a normal or an inferior good?

3. a. We begin with the demand equation and substitute the given values for P_C and I:

$$Q_O^D = 75 - 5P_O + P_C + 2I$$

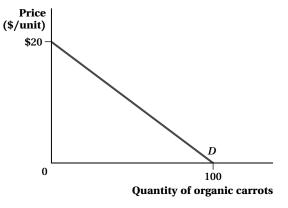$$Q_O^D = 75 - 5P_O + 5 + (2 \times 10)$$

This simplifies to

$$Q_O^D = 100 - 5P_O$$

To find the inverse demand curve, we want to rearrange terms to express P as a function of Q:

$$5P_O = 100 - Q_O^D$$

$$P_O = 20 - 0.2Q_O^D$$

The choke price can be found by solving for the price that corresponds to a quantity demanded of zero:

$$P_O = 20 - (0.2 \times 0) = 20$$

    b. Substitute 5 for P_O in the demand function to find Q_O^D:

$$Q_O^D = 100 - 5P_O = 100 - 5(5) = 75$$

Substitute 10 for P_O in the inverse demand function to find Q_O^D:

$$P_O = 20 - 0.2Q_O^D$$

$$10 = 20 - 0.2Q_O^D$$

$$10 = 0.2Q_O^D$$

$$50 = Q_O^D$$

    c. We begin with the demand equation and substitute the given values for P_C and I:

$$Q_O^D = 75 - 5P_O + P_C + 2I$$

$$Q_O^D = 75 - 5P_O + 15 + (2 \times 10)$$

This simplifies to

$$Q_O^D = 110 - 5P_O$$

To find the inverse demand curve, we want to rearrange terms to express P as a function of Q:

$$5P_O = 110 - Q_O^D$$

$$P_O = 22 - 0.2Q_O^D$$

We can substitute 10 for the price of organic carrots to find the quantity demanded:
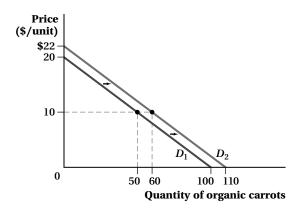
$$10 = 22 - 0.2Q_O^D$$

$$0.2Q_O^D = 12$$

$$Q_O^D = 60$$

We find the choke price by finding the price that would make quantity demanded equal to zero:

$$P_O = 22 - 0.2Q_O^D$$

$$P_O = 22 - (0.2 \times 0) = 22$$

The demand for organic carrots has changed because the entire curve has shifted to the right.

The graph for part 3a shows a downward-sloping demand curve labeled D. The vertical axis is labeled "Price ($/unit)" with $20 marked, and the horizontal axis is labeled "Quantity of organic carrots" with 100 marked. The line runs from $20 on the price axis to 100 on the quantity axis.

d. The demand for organic carrots has increased, shifting the demand curve to the right. This shows that the two goods are substitutes for one another, because an increase in the price of conventional carrots has led to a higher quantity of organic carrots demanded at any given price.

e. There is a positive coefficient (+2) on the variable for income. This means that an increase in income will shift the demand for organic carrots to the right. As a consequence, we know that organic carrots are a normal good.

*4. Out of the following events, which are likely to cause the demand for coffee to increase? Explain your answers.
   a. An increase in the price of tea
   b. An increase in the price of doughnuts
   c. A decrease in the price of coffee
   d. The Surgeon General's announcement that drinking coffee lowers the risk of heart disease
   e. Heavy rains causing a record-low coffee harvest in Colombia

4. a. Since tea and coffee are the classic examples of substitutes, as the price of tea increases, the demand for coffee is likely to increase.
   b. An increase in the price of doughnuts decreases the quantity demanded of doughnuts. Because doughnuts and coffee are complements, this will likely decrease the demand for coffee.
   c. A decrease in the price of coffee will decrease the quantity demanded of coffee via a movement along the demand curve.
   d. The Surgeon General's announcement will likely increase the number of people who are interested in drinking coffee and, thus, increase the demand for coffee.
   e. Heavy rain will decrease the supply of coffee. This can be shown as an inward shift of the supply curve. As a result, the equilibrium price increases and the equilibrium quantity decreases. This adjustment is accomplished via a movement along the demand curve.

5. How is each of the following events likely to shift the supply curve or the demand curve for fast-food hamburgers in the United States? Make sure you indicate which curve (curves) is affected and if it shifts out or in.
   a. The price of beef triples.
   b. The price of chicken falls by half.
   c. The number of teenagers in the economy falls due to population aging.
   d. Mad cow disease, a rare but fatal medical condition caused by eating tainted beef, becomes common in the United States.
   e. The Food and Drug Administration publishes a report stating that a certain weight-loss diet, which encourages the intake of large amounts of meat, is dangerous to one's health.
   f. An inexpensive new grill for home use that makes delicious hamburgers is heavily advertised on television.
   g. The minimum wage rises.

5. a. An increase in the price of beef represents an increase in the cost of an input. This will cause the supply curve to shift in as the production becomes more expensive.
   b. Demand for fast-food hamburgers in the United States will likely shift in since many consumers see chicken and beef as substitutes. As chicken becomes less expensive, more people will consume chicken and reduce their consumption of hamburgers, resulting in a decrease in the demand for fast-food hamburgers.
   c. The demand curve shifts in.
   d. Consumers' awareness of the mad cow disease shifts the demand for fast-food hamburgers in.
   e. Fewer people will follow this diet, causing the demand curve to shift in.
   f. As consumers purchase the advertised inexpensive new grill, they are more likely to prepare hamburgers at home. Given that at-home hamburgers and fast-food hamburgers are likely to be substitutes in the minds of consumers, the demand for fast-food hamburgers can be expected to shift in.
   g. An increase in the minimum wage increases the supplier's cost of production, which leads to a decrease in supply. This is shown as a shifting in of the supply curve.

6. The supply of wheat is given by the following equation:

$$Q_W^S = -6 + 4P_W - 2P_C - P_F$$

where Q_W^S is the quantity of wheat supplied, in millions of bushels; P_W is the price of wheat per bushel; P_C is the price of corn per bushel; and P_F is the price of tractor fuel per gallon.

a. Graph the inverse supply curve when corn sells for $4 a bushel and fuel sells for $2 a gallon. What is the supply choke price?

b. How much wheat will be supplied at a price of $4? $8?

c. What will happen to the supply of wheat if the price of corn increases to $6 per bushel? Explain intuitively; then graph the new inverse supply carefully and indicate the new choke price.

d. Suppose instead that the price of corn remains $4, but the price of fuel decreases to $1. What will happen to the supply of wheat as a result? Explain intuitively; then graph the new inverse supply. Be sure to indicate the new choke price.

6. a. We begin with the supply equation and substitute values for the price of corn and the price of tractor fuel:

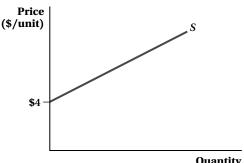$$Q_W^S = -6 + 4P_W - 2P_C - P_F$$

$$Q_W^S = -6 + 4P_W - (2 \times 4) - 2$$

$$Q_W^S = -16 + 4P_W$$

Now we rearrange terms to express price as a function of quantity supplied:

$$4P_W = 16 + Q_W^S$$

$$P_W = 4 + 0.25Q_W^S$$

To find the price that would make quantity supplied equal to zero, substitute a zero for Q_W^S:

$$P_W = 4 + (0.25 \times 0) = 4$$

The supply choke price is 4.

b. Using the supply equation, when $P_W = 4$:

$$Q_W^S = -16 + (4 \times 4) = -16 + 16 = 0$$

When $P_W = 8$:

$$Q_W^S = -16 + (4 \times 8) = -16 + 32 = 16$$

c. Wheat and corn are substitutes in production, so an increase in the selling price of corn that causes farmers to grow more corn will decrease the supply of wheat. Start with the supply equation again, substituting the value of 6 for the price of corn and 2 for the price of fuel:

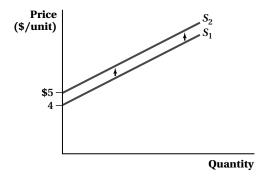$$Q_W^S = -6 + 4P_W - 2P_C - P_F$$

$$Q_W^S = -6 + 4P_W - (2 \times 6) - 2$$

$$Q_W^S = -20 + 4P_W$$

Convert this to an inverse supply function by expressing price as a function of quantity:

$$Q_W^S = -20 + 4P_W$$

$$4P_W = 20 + Q_W^S$$

$$P_W = 5 + 0.25Q_W^S$$

The price that would make Q_W^S equal to zero is 5. This is the supply choke price.

d. Start with the supply equation again, substituting the value of 4 for the price of corn and the value of 1 for the price of fuel:

$$Q_W^S = -6 + 4P_W - 2P_C - P_F$$
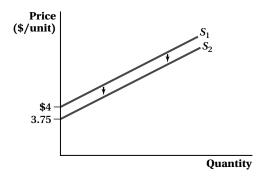
$$Q_W^S = -6 + 4P_W - (2 \times 4) - 1$$

$$Q_W^S = -15 + 4P_W$$

Convert this to an inverse supply function by expressing price as a function of quantity:
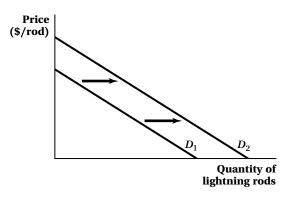
$$4P_W = 15 + Q_W^S$$
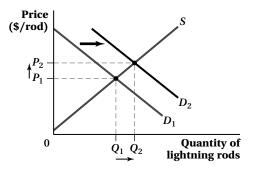
$$4P_W = 15 + Q_W^S$$

$$P_W = 3.75 + 0.25Q_W^S$$

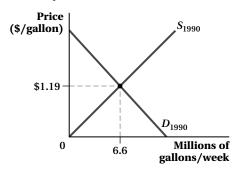At a price of 3.75, quantity supplied would be zero. This is the supply choke price.

7. Collectors of vintage lightning rods formerly had to drift from antique store to antique store hoping to find a lightning rod for sale. The invention of the Internet reduced the cost of finding lighting rods available for sale.
   a. Draw a diagram showing how the invention and popularization of the Internet have caused the demand curve for lightning rods to shift.
   b. Suppose that the only change in the market for lightning rods is the change you described in (a). How would that change affect the equilibrium price of lightning rods and the equilibrium quantity of lightning rods sold?

7. a. The invention and popularization of the Internet have caused an increase in the demand for lightning rods.
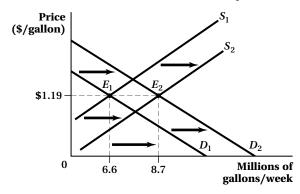

b. Assuming the supply curve is fixed and not a special case in terms of elasticity (as depicted below), then the equilibrium price of lightning rods and the equilibrium quantity will increase.

8. In March 2002 the retail price of gasoline was $1.19 per gallon—exactly the same as it was in August 1990. Yet, total gasoline production and consumption rose from 6.6 million gallons per week in 1990 to 8.7 million gallons per week in 2002. Using the graph below, draw the appropriate shifts in the demand and supply curves to explain these two phenomena.

8. As stated in the problem, the total consumption as well as the production of gasoline increased. So both supply and demand increase. Shifts are such that the equilibrium price remains constant, but the equilibrium quantity increases from 6.6 million to 8.7 million, that is, the horizontal price line $1.19 goes through the old and new equilibrium points.

9. When the demand for toilet paper increases, the equilibrium quantity sold increases. Consumers are buying more, and producers are producing more.
   a. How do producers receive the signal that they need to increase production to meet the new demand?
   b. Based on the facts given above, can you say that an increase in the demand for toilet paper causes an increase in the supply of toilet paper? Carefully explain why or why not.

9. a. Producers react to the signal of a higher price that has resulted from an increase in demand. Along a given supply curve, they expand the quantity supplied.
   b. No, the increase in demand does not cause an increase in supply. It causes only an increase in quantity supplied along a stationary supply curve.

*10. Suppose the demand for towels is given by $Q^D = 100 - 5P$, and the supply of towels is given by $Q^S = 10P$.
   a. Derive and graph the inverse supply and inverse demand curves.
   b. Solve for the equilibrium price and quantity.
   c. Suppose that supply changes so that at each price, 20 fewer towels are offered for sale. Derive and graph the new inverse supply curve.
   d. Solve for the new equilibrium price and quantity. How does the decrease in supply affect the equilibrium price and quantity sold?
   e. Suppose instead that supply does not change, but demand decreases so that at each price 25 fewer towels are desired by consumers. Solve for the new equilibrium price and quantity. How does the decrease in demand affect the equilibrium price and quantity sold? How do those changes compare to your response in (d)?

10. a. The inverse supply is

$$P = \frac{Q^S}{10}$$

whereas the inverse demand is

$$P = 20 - \frac{1}{5}Q^D$$

The graph is shown at the right.

b. Define Q_E and P_E as equilibrium quantity and price, respectively. In equilibrium, price is such that quantity demanded is equal to quantity supplied. Therefore in equilibrium,

$$\frac{Q^S}{10} = 20 - \frac{Q^D}{5}$$

$$\frac{Q_E}{10} = 20 - \frac{Q_E}{5}$$

$$Q_E = 200 - 2Q_E$$

$$3Q_E = 200$$

$$Q_E = \frac{200}{3} = 66\frac{2}{3}$$

The equilibrium price is then

$$P_E = \frac{Q_E}{10} = \frac{\frac{200}{3}}{10} = \frac{20}{3} = 6\frac{2}{3}$$

c. The new supply function is

$$Q^S = 10P - 20$$

Hence, the new inverse supply function is

$$P = \frac{1}{10}Q^S + 2$$

d. Solving for the new equilibrium price and quantity, we get

$$\frac{Q^S}{10} + 2 = 20 - \frac{Q^D}{5}$$

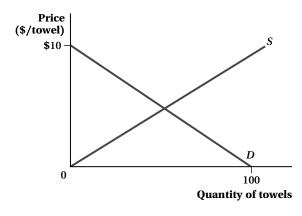$$\frac{Q_E}{10} + 2 = 20 - \frac{Q_E}{5}$$

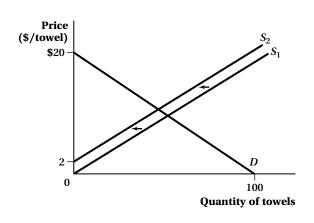$$Q_E + 20 = 200 - 2Q_E$$

$$3Q_E = 180$$

$$Q_E = 60$$

The equilibrium price is now

$$P_E = \frac{Q_E}{10} + 2 = \frac{60}{10} + 2 = 8$$

The decrease in supply has lowered the equilibrium quantity to 60 and raised the equilibrium price to 8.

e. If the quantity of towels demanded at any given price is 25 less than before, this means that the demand equation becomes $Q^D = 75 - 5P$ and the inverse demand is $P = 15 - 0.2Q^D$.

Therefore, in equilibrium,

$$\frac{Q^S}{10} = 15 - \frac{Q^D}{5}$$

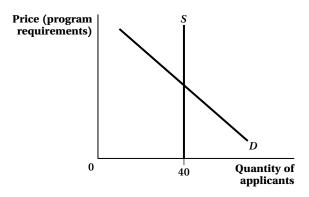$$\frac{Q^E}{10} = 15 - \frac{Q^E}{5}$$

$$Q^E = 150 - 2Q^E$$

$$3Q^E = 150$$

$$Q^E = 50$$

The equilibrium price is now $P_E = \dfrac{Q^S}{10} = \dfrac{50}{10} = 5$.

The decrease in demand has lowered both the equilibrium price and quantity. This is in contrast to the decrease in supply that lowered the equilibrium quantity and raised the equilibrium price.

11. Your university has an honors program that accepts exactly 40 freshmen each year. Every year before soliciting applications, students are informed of the standards for program participation. The admissions staff observed that whenever the difficulty of the program requirements increased (decreased), they received fewer (more) applicants than in the previous year and have since begun to adjust requirements for each incoming group of students in an attempt to equate the number of applicants with the number of spots in the program. Though the system is not perfect, the administrators are able to estimate their applicant pool with relative accuracy.
   a. In this situation, what is the "price" that determines how many students will apply to the honors program? Also, assume that the people who run the honors program do not plan to expand or contract it. Depict the demand and supply curves that represent this situation.
   b. How does the way "price" is determined in this situation differ from the way we normally think about the determination of equilibrium price?

11. a. The program requirements can be treated as the price. The supply curve is vertical and intersects the quantity of freshmen at 40. On the other hand, the demand curve is downward-sloping; that is, an increase in the "price" attracts fewer applicants.

   b. The equilibrium "price" in this particular case is determined by the university.

12. Consider the market for van Gogh paintings and assume no forgeries are possible.
   a. Is the supply of van Gogh paintings somewhat elastic, somewhat inelastic, perfectly elastic, or perfectly inelastic? Why?
   b. Draw the supply curve for van Gogh paintings.
   c. Suppose there are only 10 van Gogh paintings in the world, and the demand curve is $Q = 50 - 0.5P$. What is the equilibrium price?
   d. A tragic fire destroys five of the paintings. What is the new equilibrium price?

12. a. Due to the limited number of van Gogh paint-
    ings, the supply is perfectly inelastic.
    b. The supply curve is simply a vertical line.
    c. $Q^S = 10$ and $Q^D = 50 - 0.5P$. In equilibrium, $Q^S = Q^D$ so that

    $$Q^S = 10 = 50 - 0.5P = Q^D$$
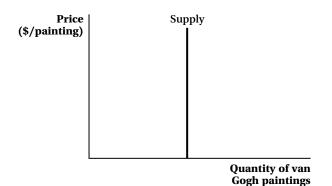
    $$10 = 50 - 0.5P$$

    $$P_E = 80$$

Therefore, the equilibrium price is 80.
    d. The quantity supplied becomes $Q^S = 5$ and the demand equation remains unchanged, so that

    $$5 = 50 - 0.5P$$

    $$P_E = 90$$

The new equilibrium price is 90.

Price ($/painting) **Supply**

Quantity of van Gogh paintings

*13. Suppose the demand for down pillows is given by $Q^D = 100 - P$, and that the supply of down pillows is given by $Q^S = -20 + 2P$.
    a. Solve for the equilibrium price.
    b. Plug the equilibrium price back into the demand equation and solve for the equilibrium quantity.
    c. Double-check your work by plugging the equilibrium price back into the supply equation and solving for the equilibrium quantity. Does your answer agree with what you got in (b)?
    d. Solve for the elasticities of demand and supply at the equilibrium point. Which is more elastic, demand or supply?
    e. Invert the demand and supply functions (in other words, solve each for P) and graph them. Do the equilibrium point and relative elasticities shown in the graph appear to coincide with your answers?

13. a. In equilibrium, $Q^S = Q^D$ so that

    $$Q^D = 100 - P = -20 + 2P = Q^S$$

    $$100 - P = -20 + 2P$$

    $$P_E = 40$$

The equilibrium price for pillows is 40.
    b. The equilibrium quantity is

    $$Q_E = 100 - P_E = 60$$

    c. The equilibrium quantity using the supply equation is

    $$Q^S = -20 + 2P_E = 60 = Q_E$$

Hence, $Q^S = Q^D = Q_E$, just like what was obtained in (b).
    d. The elasticity of supply or demand can be calculated using the expression

    $$E = \frac{1}{\text{slope of the inverse demand curve}} \times \frac{P}{Q}$$

Note that $P = 40$ and $Q = 60$ at the equilibrium point. The slope of the demand curve is -1, so that

    $$E_D = \frac{1}{-1} \times \frac{40}{60} = -\frac{2}{3}$$

whereas the slope of our supply curve is 0.5, so

    $$E_S = \frac{1}{0.5} \times \frac{40}{60} = \frac{4}{3}$$

The elasticity of demand lies within the interval $-1 < E_D < 0$. Hence, the demand is inelastic. The coefficient of elasticity of supply indicates that supply is elastic. Out of the two, the supply is more elastic.

e. Inverting the demand function, we get

$$Q^D = 100 - P$$

$$P = 100 - Q^D$$

Inverting the supply function yields

$$Q^S = -20 + 2P$$

$$P = 0.5Q^S + 10$$
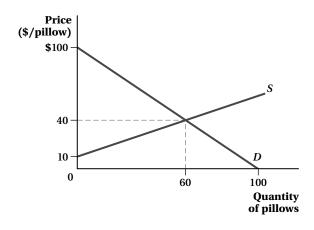
At the equilibrium, we get

$$100 - Q^D = \frac{Q^S}{2} + 10$$

$$100 - Q_E = \frac{1}{2}Q_E + 10$$

$$\frac{3}{2}Q_E = 90$$

$$Q_E = 60$$

$$P_E = 100 - Q_E = 40$$

Therefore, the equilibrium point coincides with our previous answer. Since the equilibrium point is the same and since the slopes of both curves are also unchanged, the elasticities will correspond to the previously derived coefficients in part (d).

14. Determine the effects of the following events on the price and quantity of beer sold. Assume that beer is a normal good.
   a. The price of wine, a substitute for beer, decreases.
   b. The price of pizza, a complement to beer, increases.
   c. The price of barley, an ingredient used to make beer, increases.
   d. Brewers discover they can make more money producing wine than they can producing beer.
   e. Consumers' incomes increase as the economy emerges from a recession

14. a. When the price of wine decreases, consumers will increase their consumption of wine and this, in turn, will cause a leftward shift in the demand for beer. Both the equilibrium price and equilibrium quantity of beer will decrease.
   b. When the price of pizza increases, consumers will decrease their consumption of pizza and this, in turn, will decrease the demand for beer. A lower equilibrium price and quantity will result.
   c. The higher price of barley increases costs for suppliers of beer. This causes the supply of beer to shift to the left, resulting in a higher equilibrium price and lower equilibrium quantity.
   d. Firms will leave the beer industry to enter the winemaking industry. This causes a decrease in the supply of beer, which leads to a higher equilibrium price and lower equilibrium quantity.
   e. Assuming that beer is a normal good, the increase in incomes will cause a rightward shift in demand. Both the equilibrium price and quantity will increase.

15. Suppose that budding economist Buck measures the inverse demand curve for toffee as $P = \$100 - Q^D$, and the inverse supply curve as $P = Q^S$. Buck's economist friend Penny likes to measure everything in cents. She measures the inverse demand for toffee as $P = 10{,}000 - 100Q^D$, and the inverse supply curve as $P = 100Q^S$.
   a. Find the slope of the inverse demand curve, and compute the price elasticity of demand at the market equilibrium using Buck's measurements.
   b. Find the slope of the inverse demand curve, and compute the price elasticity of demand at the market equilibrium using Penny's measurements. Is the slope the same as Buck calculated? How about the price elasticity of demand?

15. a. We first find the market equilibrium quantity

$$P = 100 - Q^D = Q^S = P$$

$$Q_E = 50$$

The equilibrium price is

$$P_E = 50$$

The slope of the inverse demand curve is –1; hence, the price elasticity of demand is

$$E_D = \frac{1}{-1} \times \frac{\$50}{50} = -1$$

The demand at the equilibrium is unit-elastic.

b. The market equilibrium quantity is

$$P = \$10{,}000 - 100Q^D = 100Q^S = P$$

$$Q_E = 50$$

The equilibrium price is

$$P_E = 5{,}000 \text{ cents}$$

The slope of the inverse demand function is −100. The price elasticity of demand is

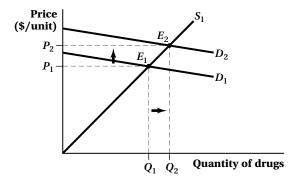$$E_D = \frac{1}{-100} \times \frac{5{,}000}{50} = -1$$

The slope is 100 times greater compared to Buck's calculations. However, the price elasticity of demand is unchanged because the price elasticity of supply and that of demand are not affected by the unit of measurement used.
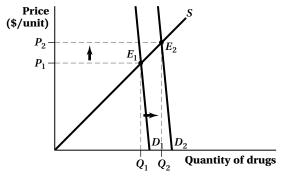
16. Some policy makers have claimed that the U.S. government should purchase illegal drugs, such as cocaine, to increase the price that drug users will face and therefore reduce their consumption. Does this idea have any merit? Illustrate this logic in a simple supply and demand framework. How does the elasticity of demand for illegal drugs relate to the efficacy of this policy? Are you more or less willing to favor this policy if you are told demand is inelastic?

16. It does have merit. The demand curve will shift out when government becomes an added purchaser and the price the drug users will face will increase. I would not support such a policy because drug usage is an addiction; that is, the demand for drugs is quite inelastic.

Assuming the demand for illegal drugs is elastic, the price and quantity demanded increase as a result of the movement along the supply curve.

Assuming the demand curve for illegal drugs is inelastic, due to the intervention, both price and quantity increase.

However, the amount consumed by drug users will decrease in both cases once one subtracts the amounts sold to the government. The more inelastic the demand is, the smaller is the quantity response by illegal drug users. Therefore, such would not be an optimal policy in this situation. Increasing the (legal/penal) cost of supplying and demanding illegal drugs would be far more effective since it would shift the actual supply and demand curves in, reducing the quantity used by drug addicts.
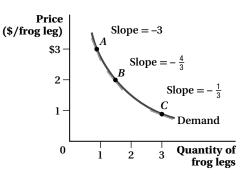
*17. Suppose that a typical consumer has an inverse demand for frog's legs given by the following:

$P = \dfrac{3}{Q^D}$. A graph of that inverse demand curve is given

in the figure to the right.
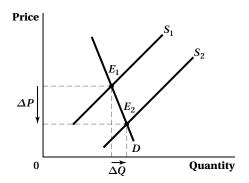
Show that the demand curve is unit-elastic.

17. Consider increasing frog's legs from 1 to 3; that is, by 200%. On the other hand, the price decreases from $3 to $1; that is, by 200%. Hence, the price elasticity of demand is

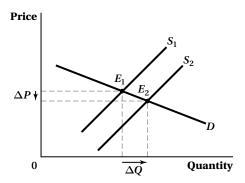$$E_D = \frac{\%\Delta Q^D}{\%\Delta P} = \frac{200\%}{-200\%} = -1$$

The demand curve is unit-elastic.

18. The cross-price elasticity of demand measures the percentage change in the quantity of a good demanded when the price of a different good changes by 1%. The income elasticity of demand measures the percentage change in the quantity of a good demanded when the income of buyers changes by 1%.
   a. What sign might you expect the cross-price elasticity to have if the two goods are shampoo and conditioner? Why?
   b. What sign might you expect the cross-price elasticity to have if the two goods are gasoline and ethanol? Why?
   c. What sign might you expect the cross-price elasticity to have if the two goods are coffee and shoes? Why?
   d. What sign might you expect the income elasticity to have if the good in question is hot stone massages?
   e. What sign might you expect the income elasticity to have if the good in question is Ramen noodles?
   f. What sign might you expect the income elasticity to have if the good in question is table salt?

18. a. Cross-price elasticity would likely be negative, because an increase in the price of shampoo would likely cause people to use less conditioner. The higher price of shampoo would decrease the quantity of shampoo demanded, so people would buy less conditioner, which is a complement good.
   b. Gasoline and ethanol are viewed as substitutes. An increase in the price of gasoline would cause an increase in the demand for ethanol. This gives us a positive number for cross-price elasticity.
   c. There is not an obvious connection between these two goods. Most likely, cross-price elasticity would be zero. A change in the price of one does not have a predictable effect on the quantity of the other.
   d. A hot stone massage is considered a luxury good, so demand would increase as incomes increase. The income elasticity would be positive.
   e. We can expect a negative number for income elasticity. Ramen noodles are viewed as a low-cost meal. People will buy more Ramen noodles when incomes decrease.
   f. Table salt is a necessity, and the amount purchased is largely independent of income. Zero would be the most likely number for income elasticity.

19. Which of the following cases will result in the largest decrease in equilibrium price? The largest change in equilibrium quantity? Verify your answers by drawing graphs.
   a. Demand is highly inelastic; there is a relatively large increase in supply.
   b. Demand is highly elastic; there is a relatively small increase in supply.
   c. Supply is highly inelastic; there is a relatively small decrease in demand.
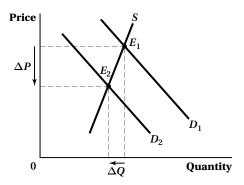   d. Supply is highly elastic and demand is very inelastic; there is a relatively large increase in supply.

19. a. Because demand is inelastic, the rightward shift of sup-
    ply will cause a fairly significant decrease in price.

  b. If the demand curve is flat and the shift in supply is rela-
     tively small, then price decreases only slightly.

  c. The price will fall due to the decrease in demand. Equi-
     librium quantity decreases only slightly because the sup-
     ply curve is steep.

  d. This scenario will result in the largest decrease in price
     because the demand curve is steep and the supply curve
     is flat.