Solution to Selected Questions: CHAPTER 2
THE BASICS OF SUPPLY AND DEMAND

Questions For Review

2. Use supply and demand curves to illustrate how each of the following events would affect the price of butter and the quantity of butter bought and sold:

a. An increase in the price of margarine.

Butter and margarine are substitute goods for most people. Therefore, an increase in the price of margarine will cause people to increase their consumption of butter, thereby shifting the demand curve for butter out from D_1 to D_2 in Figure 2.2.a. This shift in demand causes the equilibrium price of butter to rise from P_1 to P_2 and the equilibrium quantity to increase from Q_1 to Q_2.

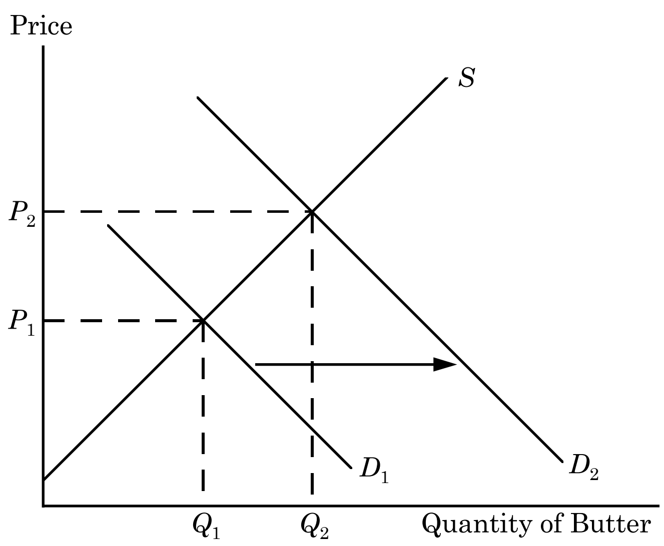


Figure 2.2.a

b. An increase in the price of milk.

Milk is the main ingredient in butter. An increase in the price of milk increases the cost of producing butter, which reduces the supply of butter. The supply curve for butter shifts from S_1 to S_2 in Figure 2.2.b, resulting in a higher equilibrium price, P_2 and a lower equilibrium quantity, Q_2, for butter.

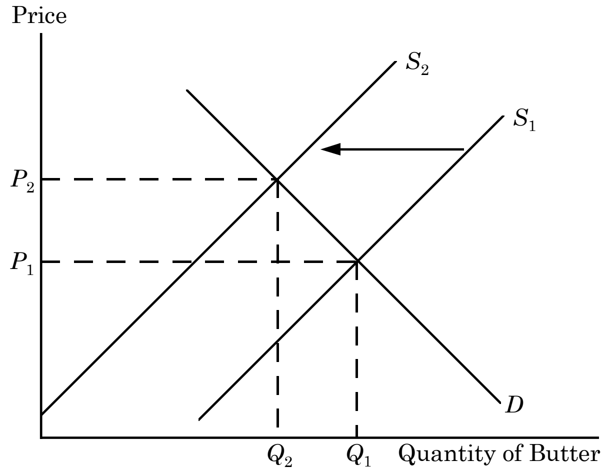


Figure 2.2.b

Note: Butter is in fact made from the fat that is skimmed from milk; thus butter and milk are joint products, and this complicates things. If you take account of this relationship, your answer might change, but it depends on why the price of milk increased. If the increase were caused by an increase in the demand for milk, the equilibrium quantity of milk supplied would increase. With more milk being produced, there would be more milk fat available to make butter, and the price of milk fat would fall.

This would shift the supply curve for butter to the right, resulting in a drop in the price of butter and an increase in the quantity of butter supplied.

c. A decrease in average income levels.

Assuming that butter is a normal good, a decrease in average income will cause the demand curve for butter to decrease (i.e., shift from D_1 to D_2). This will result in a decline in the equilibrium price from P_1 to P_2, and a decline in the equilibrium quantity from Q_1 to Q_2. See Figure 2.2.c.

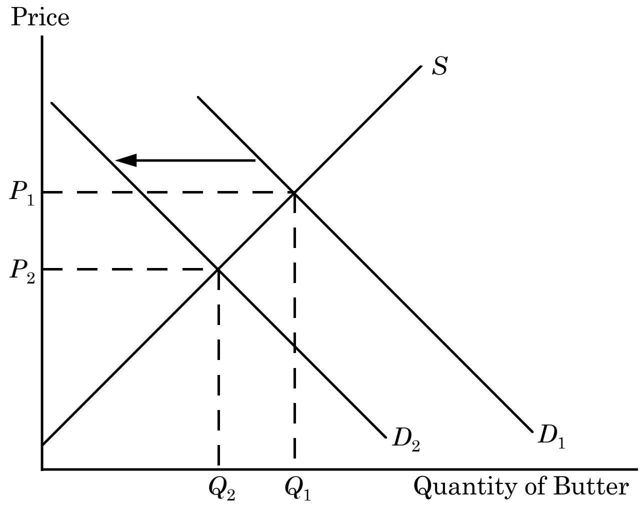


Figure 2.2.c

7. Are the following statements true or false? Explain your answers.

a. The elasticity of demand is the same as the slope of the demand curve.

False. Elasticity of demand is the percentage change in quantity demanded divided by the percentage change in the price of the product. In contrast, the slope of the demand curve is the change in quantity demanded (in units) divided by the change in price (typically in dollars). The difference is that elasticity uses percentage changes while the slope is based on changes in the number of units and number of dollars.

b. The cross-price elasticity will always be positive.

False. The cross price elasticity measures the percentage change in the quantity demanded of one good due to a one percent change in the price of another good. This elasticity will be positive for substitutes (an increase in the price of hot dogs is likely to cause an increase in the quantity demanded of hamburgers) and negative for complements (an increase in the price of hot dogs is likely to cause a decrease in the quantity demanded of hot dog buns).

c. The supply of apartments is more inelastic in the short run than the long run.

True. In the short run it is difficult to change the supply of apartments in response to a change in price. Increasing the supply requires constructing new apartment buildings, which can take a year or more. Therefore, the elasticity of supply is more inelastic in the short run than in the long run, or said another way, the elasticity of supply is less elastic in the short run than in the long run.

13. Suppose the demand for natural gas is perfectly inelastic. What would be the effect, if any, of natural gas price controls?

If the demand for natural gas is perfectly inelastic, the demand curve is vertical. Consumers will demand the same quantity regardless of price. In this case, price controls will have no effect on the quantity demanded, but they will still cause a shortage if the supply curve is upward sloping and the regulated price is set below the market-clearing price, because suppliers will produce less natural gas than consumers wish to purchase.

Exercises

2. Consider a competitive market for which the quantities demanded and supplied (per year) at various prices are given as follows:

Price (Dollars)	Demand (Millions)	Supply (Millions)
60	22	14
80	20	16
100	18	18
120	16	20

a. **Calculate the price elasticity of demand when the price is $80 and when the price is $100.**

$$E_D = \frac{\frac{\Delta Q_D}{Q_D}}{\frac{\Delta P}{P}} = \frac{P}{Q_D}\frac{\Delta Q_D}{\Delta P}.$$

With each price increase of $20, the quantity demanded decreases by 2 million. Therefore,

$$\left(\frac{\Delta Q_D}{\Delta P}\right) = \frac{-2}{20} = -0.1.$$

At $P = 80$, quantity demanded is 20 million and thus

$$E_D = \left(\frac{80}{20}\right)(-0.1) = -0.40.$$

Similarly, at $P = 100$, quantity demanded equals 18 million and

$$E_D = \left(\frac{100}{18}\right)(-0.1) = -0.56.$$

b. **Calculate the price elasticity of supply when the price is $80 and when the price is $100.**

$$E_S = \frac{\frac{\Delta Q_S}{Q_S}}{\frac{\Delta P}{P}} = \frac{P}{Q_S}\frac{\Delta Q_S}{\Delta P}.$$

With each price increase of $20, quantity supplied increases by 2 million. Thus,

$$\left(\frac{\Delta Q_S}{\Delta P}\right) = \frac{2}{20} = 0.1.$$

At $P = 80$, quantity supplied is 16 million and

$$E_S = \left(\frac{80}{16}\right)(0.1) = 0.5.$$

Similarly, at $P = 100$, quantity supplied equals 18 million and

$$E_S = \left(\frac{100}{18}\right)(0.1) = 0.56.$$

c. What are the equilibrium price and quantity?

The equilibrium price is the price at which the quantity supplied equals the quantity demanded. As we see from the table, the equilibrium price is P* = \$100 and the equilibrium quantity is Q* = 18 million.

d. Suppose the government sets a price ceiling of \$80. Will there be a shortage, and if so, how large will it be?

With a price ceiling of \$80, price cannot be above \$80, so the market cannot reach its equilibrium price of \$100. At \$80, consumers would like to buy 20 million, but producers will supply only 16 million. This will result in a shortage of 4 million.

3. Refer to Example 2.5 (page 38) on the market for wheat. In 1998, the total demand for U.S. wheat was Q = 3244 – 283P and the domestic supply was Q_S = 1944 + 207P. At the end of 1998, both Brazil and Indonesia opened their wheat markets to U.S. farmers. Suppose that these new markets add 200 million bushels to U.S. wheat demand. What will be the free-market price of wheat and what quantity will be produced and sold by U.S. farmers?

► **Note**: The answer at the end of the book (first printing) used the wrong demand curve to find the new equilibrium quantity. The correct answer is given below.

If Brazil and Indonesia add 200 million bushels of wheat to U.S. wheat demand, the new demand curve will be $Q + 200$, or

$$Q_D = (3244 - 283P) + 200 = 3444 - 283P.$$

Equate supply and the new demand to find the new equilibrium price.

$$1944 + 207P = 3444 - 283P, \text{ or}$$

$$490P = 1500, \text{ and thus } P = \$3.06 \text{ per bushel.}$$

To find the equilibrium quantity, substitute the price into either the supply or demand equation. Using demand,

$$Q_D = 3444 - 283(3.06) = 2578 \text{ million bushels.}$$

5. Much of the demand for U.S. agricultural output has come from other countries. In 1998, the total demand for wheat was $Q = 3244 - 283P$. Of this, total domestic demand was $Q_D = 1700 - 107P$, and domestic supply was $Q_S = 1944 + 207P$. Suppose the export demand for wheat falls by 40 percent.

a. U.S. farmers are concerned about this drop in export demand. What happens to the free-market price of wheat in the United States? Do the farmers have much reason to worry?

Before the drop in export demand, the market equilibrium price is found by setting total demand equal to domestic supply:

$$3244 - 283P = 1944 + 207P, \text{ or}$$

$$P = \$2.65.$$

Export demand is the difference between total demand and domestic demand: $Q = 3244 - 283P$ minus $Q_D = 1700 - 107P$. So export demand is originally $Q_e = 1544 - 176P$. After the 40 percent drop, export demand is only 60 percent of the original export demand. The new export demand is therefore, $Q'_e = 0.6Q_e = 0.6(1544 - 176P) = 926.4 - 105.6P$. Graphically, export demand has pivoted inward as illustrated in the figure below.

The new total demand becomes

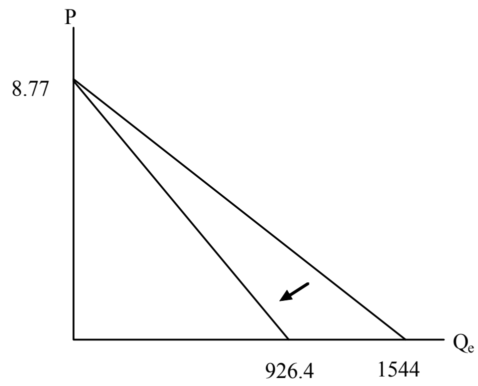
$$Q' = Q_D + Q'_e = (1700 - 107P) + (926.4 - 105.6P) = 2626.4 - 212.6P.$$

Equating total supply and the new total demand,

$$1944 + 207P = 2626.4 - 212.6P, \text{ or}$$

$$P = \$1.63,$$

which is a significant drop from the original market-clearing price of \$2.65 per bushel. At this price, the market-clearing quantity is about Q = 2281 million bushels. Total revenue has decreased from about \$6609 million to \$3718 million, so farmers have a lot to worry about.



b. Now suppose the U.S. government wants to buy enough wheat to raise the price to \$3.50 per bushel. With the drop in export demand, how much wheat would the government have to buy? How much would this cost the government?

With a price of \$3.50, the market is not in equilibrium. Quantity demanded and supplied are

$$Q' = 2626.4 - 212.6(3.50) = 1882.3, \text{ and}$$

$$Q_S = 1944 + 207(3.50) = 2668.5.$$

Excess supply is therefore 2668.5 – 1882.3 = 786.2 million bushels. The government must purchase this amount to support a price of \$3.50, and will have to spend \$3.50(786.2 million) = \$2751.7 million.

8. In Example 2.8 we examined the effect of a 20-percent decline in copper demand on the price of copper, using the linear supply and demand curves developed in Section 2.6. Suppose the long-run price elasticity of copper demand were –0.75 instead of –0.5.

a. Assuming, as before, that the equilibrium price and quantity are *P = \$2 per pound and *Q** = 12 million metric tons per year, derive the linear demand curve consistent with the smaller elasticity.**

Following the method outlined in Section 2.6, we solve for a and b in the demand equation $Q_D = a - bP$. Because –b is the slope, we can use –b rather than ΔQ/ΔP in the elasticity formula. Therefore, $E_D = -b\left(\frac{P^*}{Q^*}\right)$. Here E_D = –0.75 (the long-run price elasticity), $P^* = 2$ and $Q^* = 12$. Solving for b,

$$-0.75 = -b\left(\frac{2}{12}\right), \text{ or } b = 0.75(6) = 4.5.$$

To find the intercept, we substitute for b, Q_D (= Q^*), and P (= P^*) in the demand equation:

$$12 = a - 4.5(2), \text{ or } a = 21.$$

The linear demand equation is therefore

$$Q_D = 21 - 4.5P.$$

b. Using this demand curve, recalculate the effect of a 20-percent decline in copper demand on the price of copper.

The new demand is 20 percent below the original (using our convention that quantity demanded is reduced by 20% at every price); therefore, multiply demand by 0.8 because the new demand is 80 percent of the original demand:

$$Q'_D = (0.8)(21 - 4.5P) = 16.8 - 3.6P.$$

Equating this to supply,

$$16.8 - 3.6P = -6 + 9P, \text{ or}$$

$$P = \$1.81.$$

With the 20-percent decline in demand, the price of copper falls from \$2.00 to \$1.81 per pound. The decrease in demand therefore leads to a drop in price of 19 cents per pound, a 9.5 percent decline.

10. Example 2.9 (page 54) analyzes the world oil market. Using the data given in that example:

a. Show that the short-run demand and competitive supply curves are indeed given by

$$\boldsymbol{D = 35.5 - 0.03P}$$

$$\boldsymbol{S_C = 18 + 0.04P.}$$

The competitive (non-OPEC) quantity supplied is $S_c = Q^* = 20$. The general form for the linear competitive supply equation is $S_C = c + dP$. We can write the short-run supply elasticity as $E_S = d(P^*/Q^*)$. Since $E_S = 0.10$, $P^* = \$50$, and $Q^* = 20$, $0.10 = d(50/20)$. Hence $d = 0.04$. Substituting for d, S_c, and P in the supply equation, $c = 18$, and the short-run competitive supply equation is $S_c = 18 + 0.04P$.

Similarly, world demand is $D = a - bP$, and the short-run demand elasticity is $E_D = -b(P^*/Q^*)$, where Q^* is total world demand of 34. Therefore, $-0.05 = -b(50/34)$, and $b = 0.034$, or 0.03 rounded off. Substituting $b = 0.03$, $D = 34$, and $P = 50$ in the demand equation gives $34 = a - 0.03(50)$, so that $a = 35.5$. Hence the short-run world demand equation is $D = 35.5 - 0.03P$.

b. Show that the long-run demand and competitive supply curves are indeed given by

$$\boldsymbol{D = 47.5 - 0.27P}$$

$$\boldsymbol{S_C = 12 + 0.16P.}$$

Do the same calculations as above but now using the long-run elasticities, E_S = 0.4 and E_D = –0.4: $E_S = d(P^*/Q^*)$ and $E_D = -b(P^*/Q^*)$, implying 0.4 = d(50/20) and –0.4 = –b(50/34). So d = 0.16 and b = 0.27.

Next solve for c and a: $S_c = c + dP$ and $D = a - bP$, implying 20 = c + 0.16(50) and 34 = a – 0.27(50). So c = 12 and a = 47.5.

c. **In Example 2.9 we examined the impact on price of a disruption of oil from Saudi Arabia. Suppose that instead of a decline in supply, OPEC production *increases* by 2 billion barrels per year (bb/yr) because the Saudis open large new oil fields. Calculate the effect of this increase in production on the supply of oil in both the short run and the long run.**

OPEC's supply increases from 14 bb/yr to 16 bb/yr as a result. Add 16 bb/yr to the short-run and long-run competitive supply equations. The new total supply equations are:

Short-run: $S_T' = 16 + S_c = 16 + 18 + 0.04P = 34 + 0.04P$, and

Long-run: $S_T'' = 16 + S_c = 16 + 12 + 0.16P = 28 + 0.16P$.

These are equated with short-run and long-run demand, so that:

$34 + 0.04P = 35.5 - 0.03P$, implying that P = \$21.43 in the short run, and

$28 + 0.16P = 47.5 - 0.27P$, implying that P = \$45.35 in the long run.