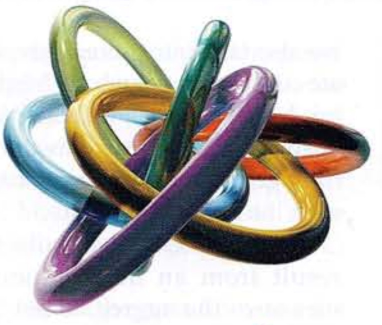
9

The Analysis of Competitive Markets



In Chapter 2, we saw how supply and demand curves can help us describe and understand the behavior of competitive markets. In Chapters 3 to 8, we saw how these curves are derived and what determines their shapes. Building on this foundation, we return to supply–demand analysis and show how it can be applied to a wide variety of economic problems—problems that might concern a consumer faced with a purchasing decision, a firm faced with a long-range planning problem, or a government agency that has to design a policy and evaluate its likely impact.

We begin by showing how consumer and producer surplus can be used to study the *welfare effects* of a government policy—in other words, who gains and who loses from the policy, and by how much. We also use consumer and producer surplus to demonstrate the *efficiency* of a competitive market—why the equilibrium price and quantity in a competitive market maximizes the aggregate economic welfare of producers and consumers.

Then we apply supply–demand analysis to a variety of problems. Because very few markets in the United States have been untouched by government interventions of one kind or another, most of the problems that we will study deal with the effects of such interventions. Our objective is not simply to solve these problems, but to show you how to use the tools of economic analysis to deal with them and others like them on your own. We hope that by working through the examples we provide, you will see how to calculate the response of markets to changing economic conditions or government policies and to evaluate the resulting gains and losses to consumers and producers.

CHAPTER OUTLINE

LIST OF EXAMPLES

9.1 EVALUATING THE GAINS AND LOSSES FROM GOVERNMENT POLICIES—CONSUMER AND PRODUCER SURPLUS

We saw at the end of Chapter 2 that a government-imposed price ceiling causes the quantity of a good demanded to rise (at the lower price, consumers want to buy more) and the quantity supplied to fall (producers are not willing to supply as much at the lower price). The result is a shortage—i.e., excess demand. Of course, those consumers who can still buy the good will be better off because they will now pay less. (Presumably, this was the objective of the policy in the first place.) But if

In §2.7, we explain that under price controls, the price of a product can be no higher than a maximum allowable ceiling price.

we also take into account those who cannot obtain the good, how much better off are consumers *as a whole*? Might they be worse off? And if we lump consumers and producers together, will their *total welfare* be greater or lower, and by how much? To answer questions such as these, we need a way to measure the gains and losses from government interventions and the changes in market price and quantity that such interventions cause.

Our method is to calculate the changes in *consumer and producer surplus* that result from an intervention. In Chapter 4, we saw that *consumer surplus* measures the aggregate net benefit that consumers obtain from a competitive market. In Chapter 8, we saw how *producer surplus* measures the aggregate net benefit to producers. Here we will see how consumer and producer surplus can be applied in practice.

Review of Consumer and Producer Surplus

For a review of consumer surplus, see §4.4, where it is defined as the difference between what a consumer is willing to pay for a good and what the consumer actually pays when buying it.

In an unregulated, competitive market, consumers and producers buy and sell at the prevailing market price. But remember, for some consumers the value of the good *exceeds* this market price; they would pay more for the good if they had to. *Consumer surplus* is the total benefit or value that consumers receive beyond what they pay for the good.

For example, suppose the market price is \$5 per unit, as in Figure 9.1. Some consumers probably value this good very highly and would pay much more

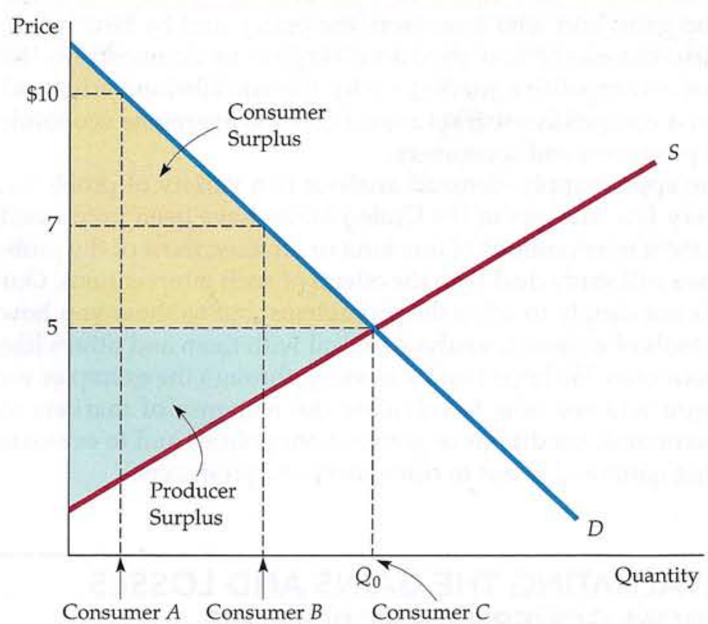


FIGURE 9.1 Consumer and Producer Surplus

Consumer *A* would pay \$10 for a good whose market price is \$5 and therefore enjoys a benefit of \$5. Consumer *B* enjoys a benefit of \$2, and Consumer *C*, who values the good at exactly the market price, enjoys no benefit. Consumer surplus, which measures the total benefit to all consumers, is the yellow-shaded area between the demand curve and the market price. Producer surplus measures the total profits of producers, plus rents to factor inputs. It is the green-shaded area between the supply curve and the market price. Together, consumer and producer surplus measure the welfare benefit of a competitive market.

than \$5 for it. Consumer *A*, for example, would pay up to \$10 for the good. However, because the market price is only \$5, he enjoys a net benefit of \$5—the \$10 value he places on the good, less the \$5 he must pay to obtain it. Consumer *B* values the good somewhat less highly. She would be willing to pay \$7, and thus enjoys a \$2 net benefit. Finally, Consumer *C* values the good at exactly the market price, \$5. He is indifferent between buying or not buying the good, and if the market price were one cent higher, he would forgo the purchase. Consumer *C*, therefore, obtains no net benefit.[1]

For consumers in the aggregate, consumer surplus is the area between the demand curve and the market price (i.e., the yellow-shaded area in Figure 9.1). Because *consumer surplus measures the total net benefit to consumers*, we can measure the gain or loss to consumers from a government intervention by measuring the resulting change in consumer surplus.

Producer surplus is the analogous measure for producers. Some producers are producing units at a cost just equal to the market price. Other units, however, could be produced for less than the market price and would still be produced and sold even if the market price were lower. Producers, therefore, enjoy a benefit—a surplus—from selling those units. For each unit, this surplus is the difference between the market price the producer receives and the marginal cost of producing this unit.

Producer surplus is not equal to profit as PS is only revenue - VC, whereas profit accounts for all costs revenue - TC).

For a review of producer surplus, see §8.6, where it is defined as the sum over all units produced of the difference between the market price of the good and the marginal cost of its production.

For the market as a whole, producer surplus is the area above the supply curve up to the market price; this is *the benefit that lower-cost producers enjoy by selling at the market price*. In Figure 9.1, it is the green triangle. And because producer surplus measures the total net benefit to producers, we can measure the gain or loss to producers from a government intervention by measuring the resulting change in producer surplus.

Application of Consumer and Producer Surplus

With consumer and producer surplus, we can evaluate the **welfare effects** of a government intervention in the market. We can determine who gains and who loses from the intervention, and by how much. To see how this is done, let's return to the example of *price controls* that we first encountered toward the end of Chapter 2. The government makes it illegal for producers to charge more than a *ceiling price* set below the market-clearing level. Recall that by decreasing production and increasing the quantity demanded, such a price ceiling creates a shortage (excess demand).

• **welfare effects** Gains and losses to consumers and producers.

Figure 9.2 replicates Figure 2.23 (page 57), except that it also shows the changes in consumer and producer surplus that result from the government price-control policy. Let's go through these changes step by step.

1. **Change in Consumer Surplus:** Some consumers are worse off as a result of the policy, and others are better off. The ones who are worse off are those who have been rationed out of the market because of the reduction in production and sales from Q_0 to Q_1. Other consumers, however, can still purchase the good (perhaps because they are in the right place at the right time or are willing to wait in line). These consumers are better off because they can buy the good at a lower price (P_{max} rather than P_0).

   How much better off or worse off is each group? The consumers who can still buy the good enjoy an *increase* in consumer surplus, which is given by

[1] Of course, some consumers value the good at *less* than \$5. These consumers make up the part of the demand curve to the right of the equilibrium quantity Q_0 and will not purchase the good.

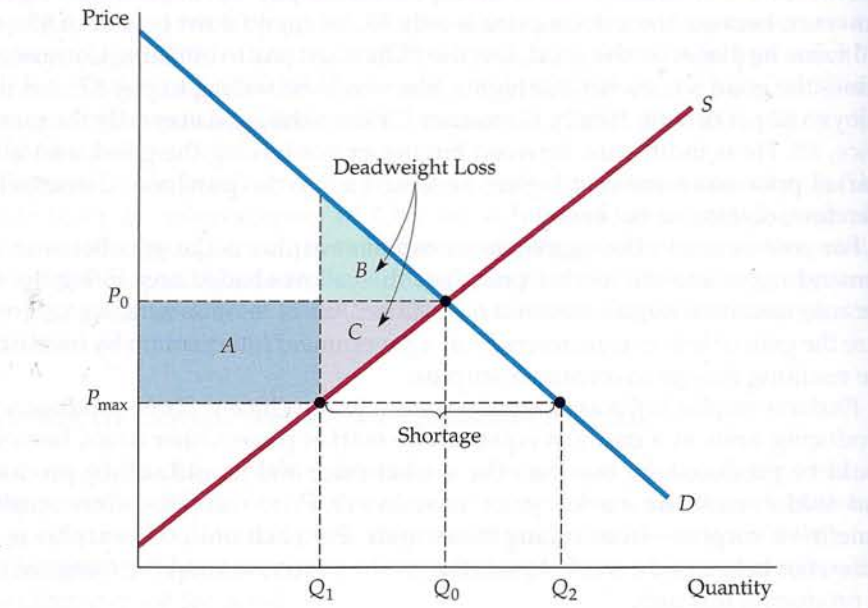


FIGURE 9.2 Change in Consumer and Producer Surplus from Price Controls

The price of a good has been regulated to be no higher than P_{max}, which is below the market-clearing price P_0. The gain to consumers is the difference between rectangle *A* and triangle *B*. The loss to producers is the sum of rectangle *A* and triangle *C*. Triangles *B* and *C* together measure the deadweight loss from price controls.

the blue-shaded rectangle *A*. This rectangle measures the reduction of price in each unit times the number of units consumers are able to buy at the lower price. On the other hand, those consumers who can no longer buy the good lose surplus; their *loss* is given by the green-shaded triangle *B*. This triangle measures the value to consumers, less what they would have had to pay, that is lost because of the reduction in output from Q_0 to Q_1. The net change in consumer surplus is therefore $A - B$. In Figure 9.2, because rectangle *A* is larger than triangle *B*, we know that the net change in consumer surplus is positive.

It is important to stress that we have assumed that those consumers who are able to buy the good are the ones who value it most highly. If that were not the case—e.g., if the output Q_1 were rationed randomly—the amount of lost consumer surplus would be larger than triangle *B*. In addition, we have ignored the opportunity costs of rationing. For example, those people who want the good might have to wait in line to obtain it. In that case, the opportunity cost of their time should be included as part of lost consumer surplus.

2. **Change in Producer Surplus:** With price controls, some producers (those with relatively lower costs) will stay in the market but will receive a lower price for their output, while other producers will leave the market. Both groups will lose producer surplus. Those who remain in the market and produce quantity Q_1 are now receiving a lower price. They have lost the producer surplus given by rectangle *A*. However, *total* production has also dropped. The purple-shaded triangle *C* measures the additional loss of

producer surplus for those producers who have left the market and those who have stayed in the market but are producing less. Therefore, the total change in producer surplus is $-A - C$. Producers clearly lose as a result of price controls.

3. **Deadweight Loss:** Is the loss to producers from price controls offset by the gain to consumers? No. As Figure 9.2 shows, price controls result in a net loss of total surplus, which we call a **deadweight loss**. Recall that the change in consumer surplus is $A - B$ and that the change in producer surplus is $-A - C$. The *total* change in surplus is therefore $(A - B) + (-A - C) = -B - C$. We thus have a deadweight loss, which is given by the two triangles B and C in Figure 9.2. This deadweight loss is an inefficiency caused by price controls; the loss in producer surplus exceeds the gain in consumer surplus.

• **deadweight loss** Net loss of total (consumer plus producer) surplus.

If politicians value consumer surplus more than producer surplus, this deadweight loss from price controls may not carry much political weight. However, if the demand curve is very inelastic, price controls can result in a *net loss of consumer surplus*, as Figure 9.3 shows. In that figure, triangle B, which measures the loss to consumers who have been rationed out of the market, is larger than rectangle A, which measures the gain to consumers able to buy the good. Here, because consumers value the good highly, those who are rationed out suffer a large loss.

The demand for gasoline is very inelastic in the short run (but much more elastic in the long run). During the summer of 1979, gasoline shortages resulted

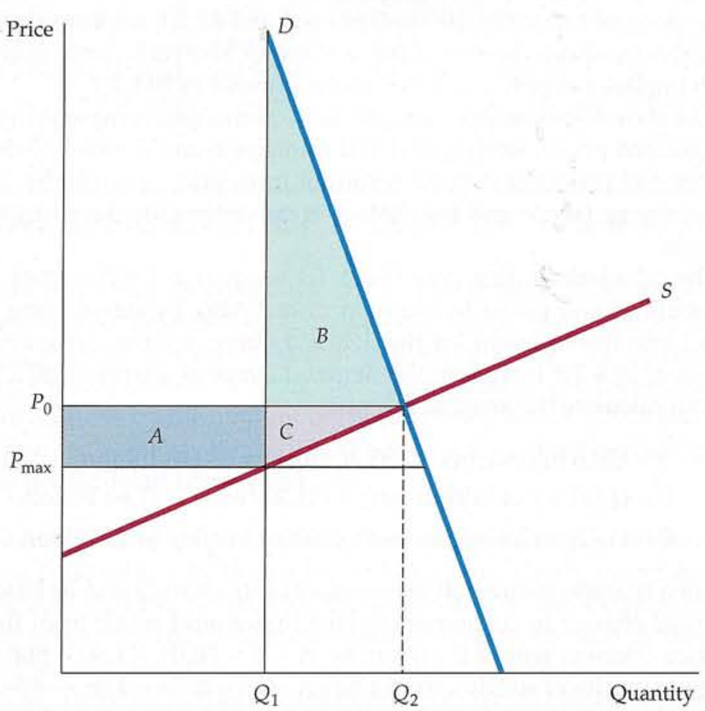


FIGURE 9.3 Effect of Price Controls When Demand Is Inelastic

If demand is sufficiently inelastic, triangle B can be larger than rectangle A. In this case, consumers suffer a net loss from price controls.

from oil price controls that prevented domestic gasoline prices from increasing to rising world levels. Consumers spent hours waiting in line to buy gasoline. This was a good example of price controls making consumers—the group whom the policy was presumably intended to protect—worse off.

EXAMPLE 9.1 Price Controls and Natural Gas Shortages

In Example 2.10 (page 59), we discussed the price controls that were imposed on natural gas markets during the 1970s, and we analyzed what would happen if the government were once again to regulate the wholesale price of natural gas. Specifically, we saw that, in 2007, the free-market wholesale price of natural gas was about \$6.40 per thousand cubic feet (mcf), and we calculated the quantities that would be supplied and demanded if the price were regulated to be no higher than \$3.00 per mcf. Now, equipped with the concepts of *consumer surplus*, *producer surplus*, and *deadweight loss*, we can calculate the welfare impact of this ceiling price.

Recall from Example 2.10 that we found that the supply and demand curves for natural gas could be approximated as follows:

$$\textit{Supply:}\quad Q^S = 15.90 + 0.72P_G + 0.05P_O$$
$$\textit{Demand:}\quad Q^D = 0.02 - 1.8P_G + 0.69P_O$$

where Q^S and Q^D are the quantities supplied and demanded, each measured in trillion cubic feet (Tcf), P_G is the price of natural gas in dollars per thousand cubic feet (\$/mcf), and P_O is the price of oil in dollars per barrel (\$/b). As you can verify by setting Q^S equal to Q^D and using a price of oil of \$50 per barrel, the equilibrium free market price and quantity are \$6.40 per mcf and 23 Tcf, respectively. Under the hypothetical regulations, however, the maximum allowable price was \$3.00 per mcf, which implies a supply of 20.6 Tcf and a demand of 29.1 Tcf.

Figure 9.4 shows these supply and demand curves and compares the free market and regulated prices. Rectangle A and triangles B and C measure the changes in consumer and producer surplus resulting from price controls. By calculating the areas of the rectangle and triangles, we can determine the gains and losses from controls.

To do the calculations, first note that 1 Tcf is equal to 1 billion mcf. (We must put the quantities and prices in common units.) Also, by substituting the quantity 20.6 Tcf into the equation for the demand curve, we can determine that the vertical line at 20.6 Tcf intersects the demand curve at a price of \$7.73 per mcf. Then we can calculate the areas as follows:

$$A = (20.6 \text{ billion mcf}) \times (\$3.40/\text{mcf}) = \$70.04 \text{ billion}$$
$$B = (1/2) \times (2.4 \text{ billion mcf}) \times (\$1.33/\text{mcf}) = \$1.60 \text{ billion}$$
$$C = (1/2) \times (2.4 \text{ billion mcf}) \times (\$3.40/\text{mcf}) = \$4.08 \text{ billion}$$

(The area of a triangle is one-half the product of its altitude and its base.)

The annual change in consumer surplus that would result from these hypothetical price controls would therefore be $A - B = 70.04 - 1.60 = \$68.44$ billion. The change in producer surplus would be $-A - C = -70.04 - 4.08 = -\$74.12$ billion. And finally, the annual deadweight loss would be $-B - C = -1.60 - 4.08 = -\$5.68$ billion. Note that most of this deadweight loss is from triangle C, i.e., the loss to those consumers who are unable to obtain natural gas as a result of the price controls.

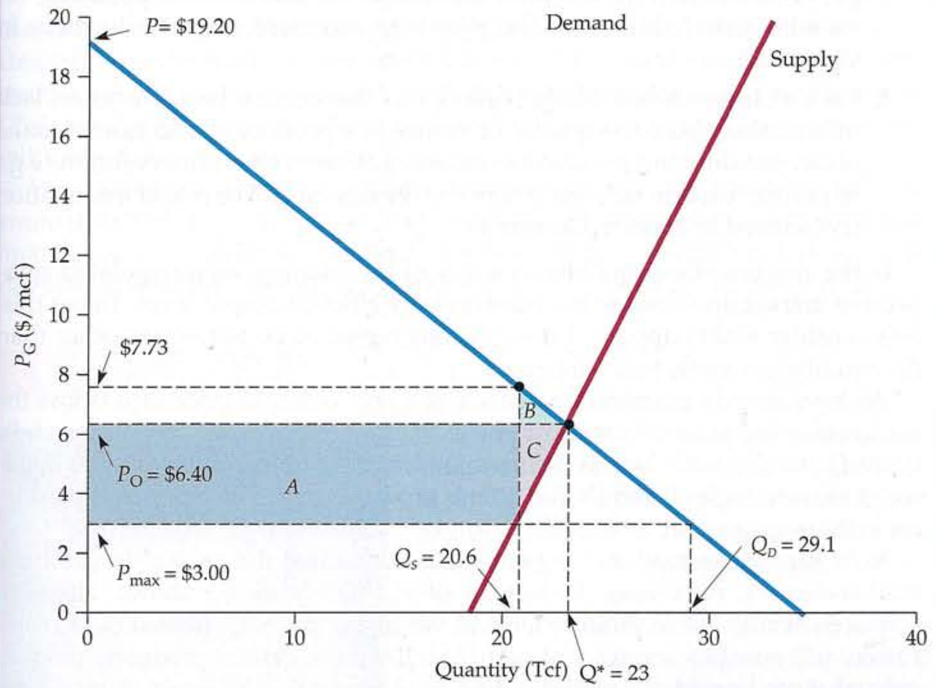


FIGURE 9.4 Effects of Natural Gas Price Controls

The market-clearing price of natural gas is $6.40 per mcf, and the (hypothetical) maximum allowable price is $3.00. A shortage of 29.1 – 20.6 = 8.5 Tcf results. The gain to consumers is rectangle *A* minus triangle *B*, and the loss to producers is rectangle *A* plus triangle *C*. The deadweight loss is the sum of triangles *B* plus *C*.

9.2 THE EFFICIENCY OF A COMPETITIVE MARKET

To evaluate a market outcome, we often ask whether it achieves **economic efficiency**—the maximization of aggregate consumer and producer surplus. We just saw how price controls create a deadweight loss. The policy therefore imposes an *efficiency cost* on the economy: Taken together, producer and consumer surplus are reduced by the amount of the deadweight loss. (Of course, this does not mean that such a policy is bad; it may achieve other objectives that policymakers and the public deem important.)

• **economic efficiency** Maximization of aggregate consumer and producer surplus.

Market Failure One might think that if the only objective is to achieve economic efficiency, a competitive market is better left alone. This is sometimes, but not always, the case. In some situations, a **market failure** occurs: Because prices fail to provide the proper signals to consumers and producers, the unregulated competitive market is inefficient—i.e., does not maximize aggregate consumer and producer surplus. There are two important instances in which market failure can occur:

• **market failure** Situation in which an unregulated competitive market is inefficient because prices fail to provide proper signals to consumers and producers.

• **externality** Action taken by either a producer or a consumer which affects other producers or consumers but is not accounted for by the market price.

1. **Externalities:** Sometimes the actions of either consumers or producers result in either costs or benefits that do not show up as part of the market price. Such costs or benefits are called **externalities** because they are "external" to the market. One example is the cost to society of environmental pollution by

a producer of industrial chemicals. Without government intervention, such a producer will have no incentive to consider the social cost of pollution. We examine externalities and the proper government response to them in Chapter 18.

2. **Lack of Information:** Market failure can also occur when consumers lack information about the quality or nature of a product and so cannot make utility-maximizing purchasing decisions. Government intervention (e.g., requiring "truth in labeling") may then be desirable. The role of information is discussed in detail in Chapter 17.

In the absence of externalities or a lack of information, an unregulated competitive market does lead to the economically efficient output level. To see this, let's consider what happens if price is constrained to be something other than the equilibrium market-clearing price.

We have already examined the effects of a *price ceiling* (a price held below the market-clearing price). As you can see in Figure 9.2 (page 312), production falls (from Q_0 to Q_1), and there is a corresponding loss of total surplus (the deadweight-loss triangles B and C). Too little is produced, and consumers and producers in the aggregate are worse off.

Now suppose instead that the government required the price to be *above* the market-clearing price—say, P_2 instead of P_0. As Figure 9.5 shows, although producers would like to produce more at this higher price (Q_2 instead of Q_0), consumers will now buy less (Q_3 instead of Q_0). If we assume that producers produce only what can be sold, the market output level will be Q_3, and again, there is a net loss of total surplus. In Figure 9.5, rectangle A now represents a transfer from consumers to producers (who now receive a higher price), but triangles B and C again represent a deadweight loss. Because of the higher price, some consumers are no longer buying the good (a loss of consumer surplus given by triangle B), and some producers are no longer producing it (a loss of producer surplus given by triangle C).

In fact, the deadweight loss triangles B and C in Figure 9.5 give an optimistic assessment of the efficiency cost of policies that force price above market-clearing

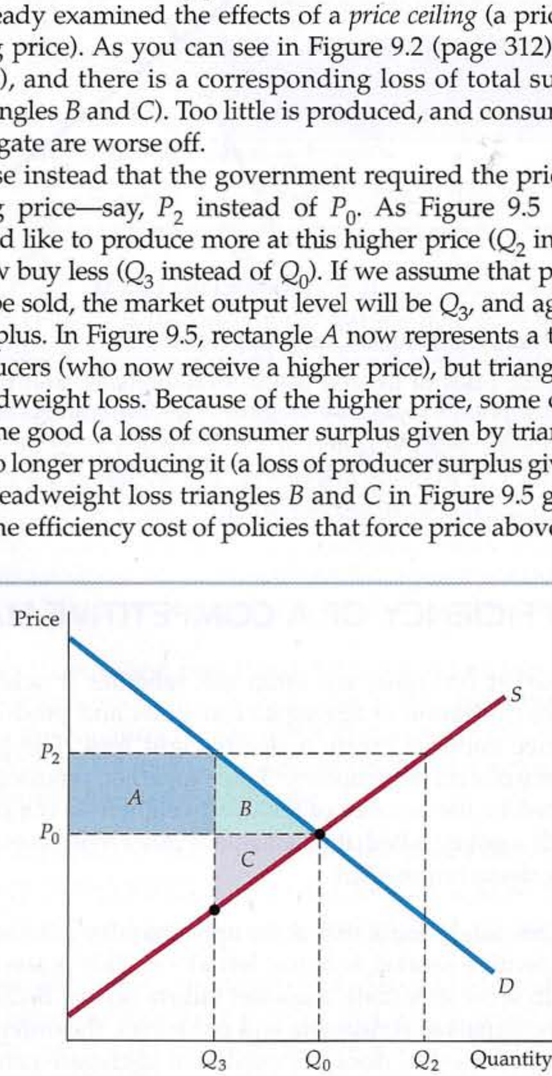


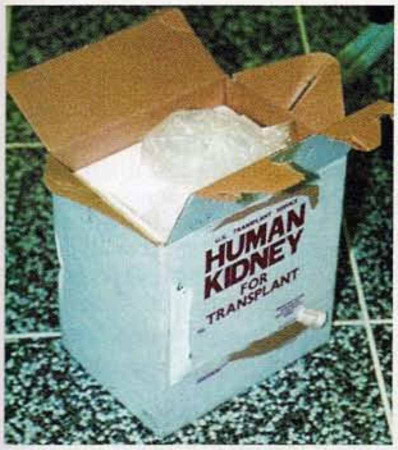
FIGURE 9.5 Welfare Loss When Price is Held Above Market-Clearing Level

When price is regulated to be no lower than P_2, only Q_3 will be demanded. If Q_3 is produced, the deadweight loss is given by triangles B and C. At price P_2, producers would like to produce more than Q_3. If they do, the deadweight loss will be even larger.

levels. Some producers, enticed by the high price P_2, might increase their capacity and output levels, which would result in unsold output. (This happened in the airline industry when, prior to 1980, fares were regulated above market-clearing levels by the Civil Aeronautics Board.) Or to satisfy producers, the government might buy up unsold output to maintain production at Q_2 or close to it. (This is what happens in U.S. agriculture.) In both cases, the total welfare loss will exceed the areas of triangles B and C.

We will examine minimum prices, price supports, and related policies in some detail in the next few sections. Besides showing how supply–demand analysis can be used to understand and assess these policies, we will see how deviations from the competitive market equilibrium lead to efficiency costs.

EXAMPLE 9.2 The Market for Human Kidneys



Should people have the right to sell parts of their bodies? Congress believes the answer is no. In 1984, it passed the National Organ Transplantation Act, which prohibits the sale of organs for transplantation. Organs may only be donated.

Although the law prohibits their sale, it does not make organs valueless. Instead, it prevents those who supply organs (living persons or the families of the deceased) from reaping their economic value. It also creates a shortage of organs. Each year, about 16,000 kidneys, 44,000 corneas, and 2200 hearts are transplanted in the United States.[2] But there is considerable excess demand for these organs, so that many potential recipients must do without them, some of whom die as a result. For example, as of July 2007, there were about 97,000 patients on the national Organ Procurement and Transplantation Network (OPTN) waiting list. However, only 29,000 transplant surgeries were performed in the United States in 2006. Although the number of transplant surgeries has increased by approximately 93 percent since 1990, the number of patients waiting for organs has increased by about 340 percent.[3]

To understand the effects of this law, let's consider the supply and demand for kidneys. First the supply curve. Even at a price of zero (the effective price under the law), donors supply about 16,000 kidneys per year. But many other people who need kidney transplants cannot obtain them because of a lack of donors. It has been estimated that 8000 more kidneys would be supplied if the price were \$20,000. We can fit a linear supply curve to this data—i.e., a supply curve of the form $Q = a + bP$. When $P = 0$, $Q = 16{,}000$, so $a = 16{,}000$. If $P = \$20{,}000$, $Q = 24{,}000$, so $b = (24{,}000 - 16{,}000)/20{,}000 = 0.4$. Thus the supply curve is

$$\textit{Supply:} \quad Q^S = 16{,}000 + 0.4P$$

Note that at a price of \$20,000, the elasticity of supply is 0.33.

[2]These numbers are for 2006. Source: Table 171 of the 2007 *Statistical Abstract of the U.S.*

[3]Source: Organ Procurement and Transplantation Network, **http://www.optn.org.**

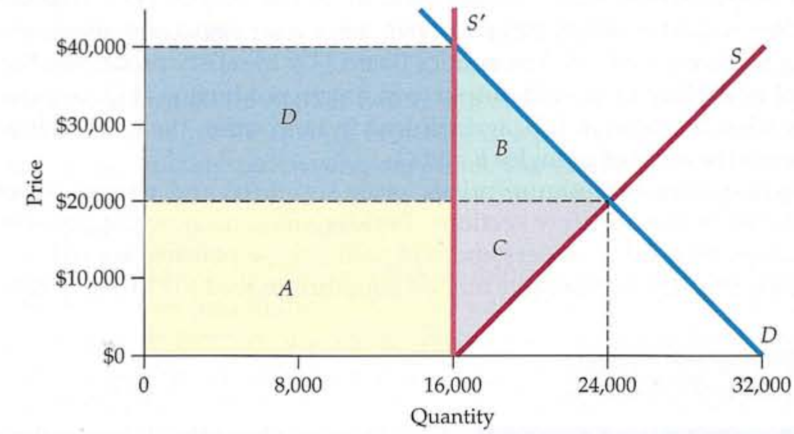


FIGURE 9.6 The Market for Kidneys and the Effect of the National Organ Transplantation Act

The market-clearing price is \$20,000; at this price, about 24,000 kidneys per year would be supplied. The law effectively makes the price zero. About 16,000 kidneys per year are still donated; this constrained supply is shown as S'. The loss to suppliers is given by rectangle A and triangle C. If consumers received kidneys at no cost, their gain would be given by rectangle A less triangle B. In practice, kidneys are often rationed on the basis of willingness to pay, and many recipients pay most or all of the \$40,000 price that clears the market when supply is constrained. Rectangles A and D measure the total value of kidneys when supply is constrained.

It is expected that at a price of \$20,000, the number of kidneys demanded would be 24,000 per year. Like supply, demand is relatively price inelastic; a reasonable estimate for the price elasticity of demand at the \$20,000 price is –0.33. This implies the following linear demand curve:

$$\textit{Demand:} \quad Q^D = 32{,}000 - 0.4P$$

In §2.6, we explain how to fit linear demand and supply curves from information about the equilibrium price and quantity and the price elasticities of demand and supply.

These supply and demand curves are plotted in Figure 9.6, which shows the market-clearing price and quantity of \$20,000 and 24,000, respectively.

Because the sale of kidneys is prohibited, supply is limited to 16,000 (the number of kidneys that people donate). This constrained supply is shown as the vertical line S'. How does this affect the welfare of kidney suppliers and recipients?

First consider suppliers. Those who provide kidneys fail to receive the \$20,000 that each kidney is worth—a loss of surplus represented by rectangle A and equal to (16,000)(\$20,000) = \$320 million. Moreover, some people who would supply kidneys if they were paid do not. These people lose an amount of surplus represented by triangle C, which is equal to (1/2)(8000)(\$20,000) = \$80 million. Therefore, the total loss to suppliers is \$400 million.

What about recipients? Presumably the law intended to treat the kidney as a gift to the recipient. In this case, those recipients who obtain kidneys *gain* rectangle A (\$320 million) because they (or their insurance companies) do not have to pay the \$20,000 price. Those who cannot obtain kidneys lose surplus of an amount given by triangle B and equal to \$80 million. This implies a net increase in the surplus of recipients of \$320 million – \$80 million = \$240 million. It also implies a deadweight loss equal to the areas of triangles B and C (i.e., \$160 million).

These estimates of the welfare effects of the policy may need adjustment for two reasons. First, kidneys will not necessarily be allocated to those who value them most highly. If the limited supply of kidneys is partly allocated to people with valuations below $40,000, the true deadweight loss will be higher than our estimate. Second, with excess demand, there is no way to ensure that recipients will receive their kidneys as gifts. In practice, kidneys are often rationed on the basis of willingness to pay, and many recipients end up paying all or most of the $40,000 price that is needed to clear the market when supply is constrained to 16,000. A good part of the value of the kidneys—rectangles A and D in the figure—is then captured by hospitals and middlemen. As a result, the law reduces the surplus of recipients as well as of suppliers.[4]

There are, of course, arguments in favor of prohibiting the sale of organs.[5] One argument stems from the problem of imperfect information; if people receive payment for organs, they may hide adverse information about their health histories. This argument is probably most applicable to the sale of blood, where there is a possibility of transmitting hepatitis, AIDS, or other viruses. But even in such cases, screening (at a cost that would be included in the market price) may be more efficient than prohibiting sales. This issue has been central to the debate in the United States over blood policy.

A second argument holds that it is simply unfair to allocate a basic necessity of life on the basis of ability to pay. This argument transcends economics. However, two points should be kept in mind. First, when the price of a good that has a significant opportunity cost is forced to zero, there is bound to be reduced supply and excess demand. Second, it is not clear why live organs should be treated differently from close substitutes; artificial limbs, joints, and heart valves, for example, are sold even though real kidneys are not.

Many complex ethical and economic issues are involved in the sale of organs. These issues are important, and this example is not intended to sweep them away. Economics, the dismal science, simply shows us that human organs have economic value that cannot be ignored, and that prohibiting their sale imposes a cost on society that must be weighed against the benefits.

9.3 MINIMUM PRICES

As we have seen, government policy sometimes seeks to *raise* prices above market-clearing levels, rather than lower them. Examples include the former regulation of the airlines by the Civil Aeronautics Board, the minimum wage law, and a variety of agricultural policies. (Most import quotas and tariffs also have this intent, as we

[4] For further analyses of these efficiency costs, see Dwane L. Barney and R. Larry Reynolds, "An Economic Analysis of Transplant Organs," *Atlantic Economic Journal* 17 (September 1989): 12–20; David L. Kaserman and A. H. Barnett, "An Economic Analysis of Transplant Organs: A Comment and Extension," *Atlantic Economic Journal* 19 (June 1991): 57–64; and A. Frank Adams III, A. H. Barnett, and David L. Kaserman, "Markets for Organs: The Question of Supply," *Contemporary Economic Policy* 17 (April 1999); 147–55. Kidney exchange is also complicated by the need to match blood type; for a recent analysis, see Alvin E. Roth, Tayfun Sönmez, and M. Utku Ünver, "Efficient Kidney Exchange: Coincidence of Wants in Markets with Compatibility-Based Preferences," *American Economic Review* 97 (June 2007).

[5] For discussions of the strengths and weaknesses of these arguments, see Susan Rose-Ackerman, "Inalienability and the Theory of Property Rights," *Columbia Law Review* 85 (June 1985): 931–69, and Roger D. Blair and David L. Kaserman, "The Economics and Ethics of Alternative Cadaveric Organ Procurement Policies," *Yale Journal on Regulation* 8 (Summer 1991): 403–52.

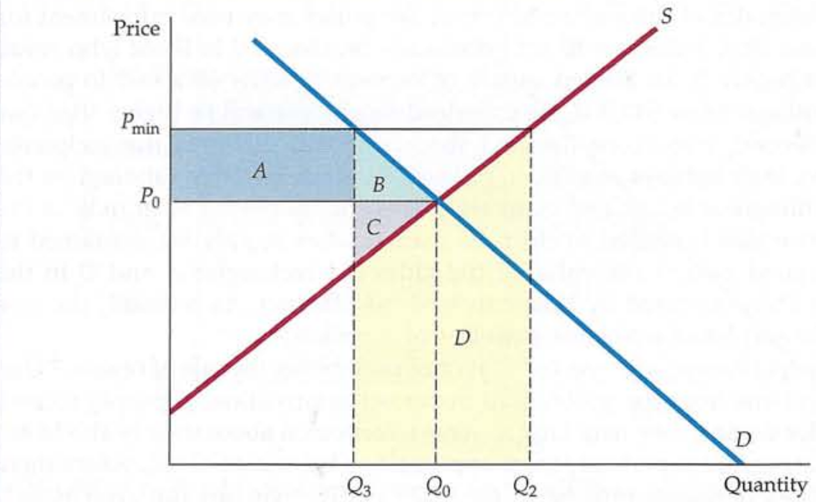


FIGURE 9.7 Price Minimum

Price is regulated to be no lower than P_{min}. Producers would like to supply Q_2, but consumers will buy only Q_3. If producers indeed produce Q_2, the amount $Q_2 - Q_3$ will go unsold and the change in producer surplus will be $A - C - D$. In this case, producers as a group may be worse off.

will see in Section 9.5.) One way to raise prices above market-clearing levels is by direct regulation—simply make it illegal to charge a price lower than a specific minimum level.

Look again at Figure 9.5 (page 316). If producers correctly anticipate that they can sell only the lower quantity Q_3, the net welfare loss will be given by triangles B and C. But as we explained, producers might not limit their output to Q_3. What happens if producers think they can sell all they want at the higher price and produce accordingly? That situation is illustrated in Figure 9.7, where P_{min} denotes a minimum price set by the government. The quantity supplied is now Q_2 and the quantity demanded is Q_3, the difference representing excess, unsold supply. Now let's determine the resulting changes in consumer and producer surplus.

Those consumers who still purchase the good must now pay a higher price and so suffer a loss of surplus, which is given by rectangle A in Figure 9.7. Some consumers have also dropped out of the market because of the higher price, with a corresponding loss of surplus given by triangle B. The total change in consumer surplus is therefore

$$\Delta CS = -A - B$$

Consumers clearly are worse off as a result of this policy.

What about producers? They receive a higher price for the units they sell, which results in an increase of surplus, given by rectangle A. (Rectangle A represents a transfer of money from consumers to producers.) But the drop in sales from Q_0 to Q_3 results in a loss of surplus, which is given by triangle C. Finally, consider the cost to producers of expanding production from Q_0 to Q_2. Because they sell only Q_3, there is no revenue to cover the cost of producing $Q_2 - Q_3$. How can we measure this cost? Remember that the supply curve is the aggregate marginal cost curve for the industry. The supply curve therefore gives us the additional cost of producing each incremental unit. Thus the area under the

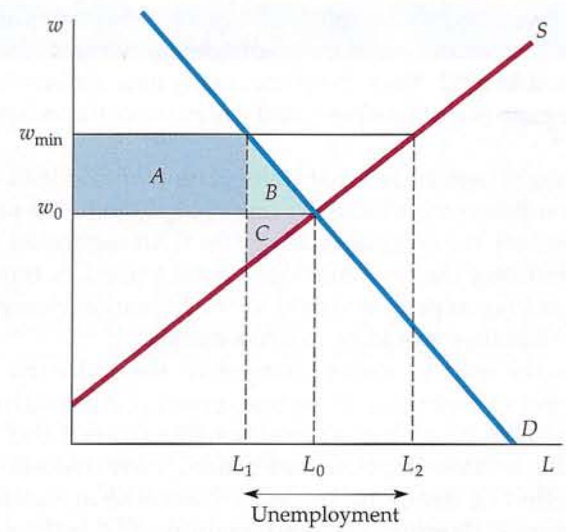


FIGURE 9.8 The Minimum Wage

Although the market-clearing wage is w_0, firms are not allowed to pay less than w_{min}. This results in unemployment of an amount $L_2 - L_1$ and a deadweight loss given by triangles B and C.

supply curve from Q_3 to Q_2 is the cost of producing the quantity $Q_2 - Q_3$. This cost is represented by the shaded trapezoid D. So unless producers respond to unsold output by cutting production, the total change in producer surplus is

$$\Delta \text{PS} = A - C - D$$

Given that trapezoid D can be large, a minimum price can even result in a net loss of surplus to producers alone! As a result, this form of government intervention can reduce producers' profits because of the cost of excess production.

Another example of a government-imposed price minimum is a minimum wage law. The effect of this policy is illustrated in Figure 9.8, which shows the supply and demand for labor. The wage is set at w_{min}, a level higher than the market-clearing wage w_0. As a result, those workers who can find jobs obtain a higher wage. However, some people who want to work will be unable to. The policy results in unemployment, which in the figure is $L_2 - L_1$. We will examine the minimum wage in more detail in Chapter 14.

EXAMPLE 9.3 Airline Regulation

Before 1980, the airline industry in the United States looked very different than it does today. Fares and routes were tightly regulated by the Civil Aeronautics Board (CAB). The CAB set most fares well above what would have prevailed in a free market. It also restricted entry, so that many routes were served by only one or two airlines. By the late 1970s, however, the CAB liberalized fare regulation and allowed airlines to serve any routes they wished. By 1981, the industry had been completely deregulated, and the CAB itself was dissolved in 1982. Since that time, many new airlines have begun service, others have gone out of business, and price competition has become much more intense.

Many airline executives feared that deregulation would lead to chaos in the industry, with competitive pressure causing sharply reduced profits and even bankruptcies. After all, the original rationale for CAB regulation was to provide "stability" in an industry that was considered vital to the U.S. economy. And one might think that as long as price was held above its market-clearing level, profits would be higher than they would be in a free market.

Deregulation did lead to major changes in the industry. Some airlines merged or went out of business as new ones entered. Although prices fell considerably (to the benefit of consumers), profits overall did not fall much because the CAB's minimum prices had caused inefficiencies and artificially high costs. The effect of minimum prices is illustrated in Figure 9.9, where P_0 and Q_0 are the market-clearing price and quantity, P_{min} is the minimum price, and Q_1 is the amount demanded at this higher price. The problem was that at price P_{min}, airlines wanted to supply a quantity Q_2, much larger than Q_1. Although they did not expand output to Q_2, they did expand it well beyond Q_1—to Q_3 in the figure—hoping to sell this quantity at the expense of competitors. As a result, load factors (the percentage of seats filled) were relatively low, and so were profits. (Trapezoid D measures the cost of unsold output.)

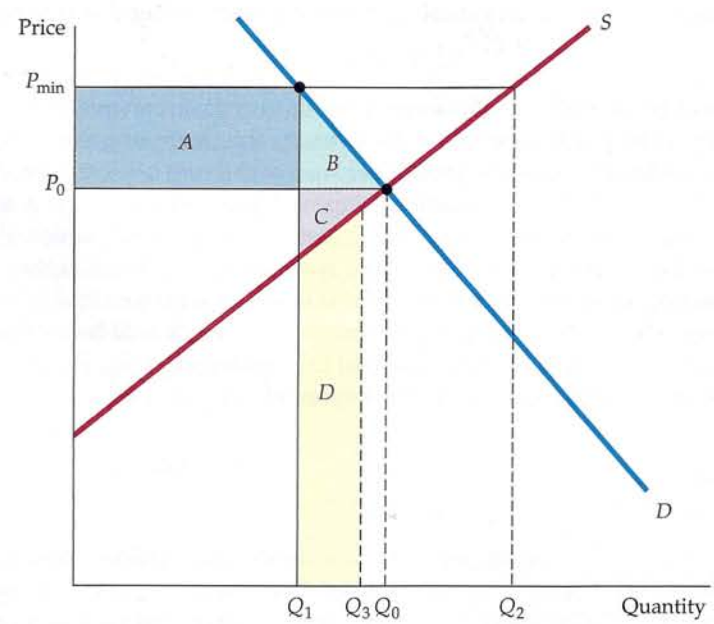


FIGURE 9.9 Effect of Airline Regulation by the Civil Aeronautics Board

At price P_{min}, airlines would like to supply Q_2, well above the quantity Q_1 that consumers will buy. Here they supply Q_3. Trapezoid D is the cost of unsold output. Airline profits may have been lower as a result of regulation because triangle C and trapezoid D can together exceed rectangle A. In addition, consumers lose $A + B$.

TABLE 9.1 Airline Industry Data

	1975	1980	1985	1990	1995	2000	2005
Number of Carriers	36	63	102	70	96	94	80
Passenger Load Factor (%)	54	58	61	62	67	72	78
Passenger Mile Rate (Constant 1995 dollars)	.218	.210	.165	.150	.129	.118	.092
Real Cost Index (1995 = 100)	101	122	111	109	100	101	93
Real Fuel Cost Index (1995 = 100)	249	300	204	163	100	125	237
Real Cost Index Corrected for Fuel Cost Changes	71	73	88	95	100	96	67

Table 9.1 gives some key numbers that illustrate the evolution of the industry.[6] The number of carriers increased dramatically after deregulation, as did passenger load factors. The passenger-mile rate (the revenue per passenger-mile flown) fell sharply in real (inflation-adjusted) terms from 1980 to 1985, and then continued to drop from 1985 through 2005. This decline was the result of increased competition and reductions in fares. And what about costs? The real cost index indicates that even after adjusting for inflation, costs increased by about 20 percent from 1975 to 1980, and then fell gradually over the next 15 years. Changes in cost, however, are driven to a great extent by changes in the cost of fuel, which is driven in turn by changes in the price of oil. (For most airlines, fuel accounts for over 20 percent of total operating costs.) As Table 9.1 shows, the real cost of fuel has fluctuated dramatically, and this had nothing to do with deregulation. Because airlines have no control over oil prices, it is more informative to examine a "corrected" real cost index which removes the effects of changing fuel costs. Real fuel costs increased considerably from 1975 to 1980, which accounts for most of the increase in the real cost index. (Had fuel costs not increased, the real cost index would have increased by only about 3 percent.)

From 1980 to 1995, airlines benefited from the fact that the cost of fuel declined by about 65 percent in real terms. As shown in Table 9.1, had the cost of fuel remained fixed, the real cost index would have increased by about 35 percent, due largely to increases in labor costs. Airline bankruptcies and renegotiated labor contracts pushed labor costs down during 2000–2005, so that, even though fuel costs rose sharply again, the real cost index fell.

What, then, did airline deregulation do for consumers and producers? As new airlines entered the industry and fares went down, consumers benefited. This fact is borne out by the increase in consumer surplus given by rectangle A and triangle B in Figure 9.9. (The actual benefit to consumers was somewhat smaller because *quality* declined as planes became more crowded and delays and cancellations multiplied.) As for the airlines, they had to learn to live in a more competitive—and therefore more turbulent—environment, and some firms did not survive. But overall, airlines became so much more efficient that producer surplus may have increased. The total welfare gain from deregulation was positive and quite large.[7]

[6] Department of Commerce, *U.S. Statistical Abstract*, 1986, 1989, 1992, 1995, 2002.

[7] Studies of the effects of deregulation include John M. Trapani and C. Vincent Olson, "An Analysis of the Impact of Open Entry on Price and the Quality of Service in the Airline Industry," *Review of Economics and Statistics* 64 (February 1982): 118–38; David R. Graham, Daniel P. Kaplan, and David S. Sibley, "Efficiency and Competition in the Airline Industry," *Bell Journal of Economics* (Spring 1983): 118–38; S. Morrison and Clifford Whinston, *The Economic Effects of Airline Deregulation* (Washington: Brookings Institution, 1986); and Nancy L. Rose, "Profitability and Product Quality: Economic Determinants of Airline Safety Performance," *Journal of Political Economy* 98 (October 1990): 944–64.

9.4 PRICE SUPPORTS AND PRODUCTION QUOTAS

• **price support** Price set by government above free-market level and maintained by governmental purchases of excess supply.

Besides imposing a minimum price, the government can increase the price of a good in other ways. Much of American agricultural policy is based on a system of **price supports**, whereby the government sets the market price of a good above the free-market level and buys up whatever output is needed to maintain that price. The government can also increase prices by *restricting production*, either directly or through incentives to producers. In this section, we show how these policies work and examine their impact on consumers, producers, and the federal budget.

Price Supports

In the United States, price supports aim to increase the prices of dairy products, tobacco, corn, peanuts, and so on, so that the producers of those goods can receive higher incomes. Under a price support program, the government sets a support price P_s and then buys up whatever output is needed to keep the market price at this level. Figure 9.10 illustrates this. Let's examine the resulting gains and losses to consumers, producers, and the government.

Consumers At price P_s, the quantity that consumers demand falls to Q_1, but the quantity supplied increases to Q_2. To maintain this price and avoid having inventories pile up in producer warehouses, the government must buy the quantity $Q_g = Q_2 - Q_1$. In effect, because the government adds its demand Q_g to the demand of consumers, producers can sell all they want at price P_s.

Because those consumers who purchase the good must pay the higher price P_s instead of P_0, they suffer a loss of consumer surplus given by rectangle A. Because of the higher price, other consumers no longer buy the good or buy less of it, and their loss of surplus is given by triangle B. So, as with the minimum price that we examined above, consumers lose, in this case by an amount

$$\Delta CS = -A - B$$

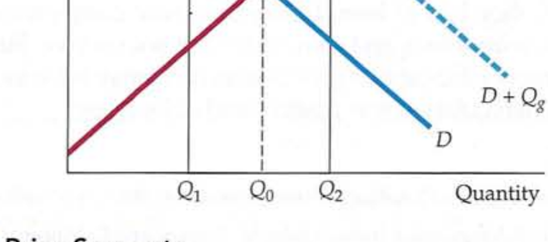


FIGURE 9.10 Price Supports

To maintain a price P_s above the market-clearing price P_0, the government buys a quantity Q_g. The gain to producers is $A + B + D$. The loss to consumers is $A + B$. The cost to the government is the speckled rectangle, the area of which is $P_s(Q_2 - Q_1)$.

Producers On the other hand, producers gain (which is why such a policy is implemented). Producers are now selling a larger quantity Q_2 instead of Q_0, and at a higher price P_s. Observe from Figure 9.10 that producer surplus increases by the amount

$$\Delta\text{PS} = A + B + D$$

The Government But there is also a cost to the government (which must be paid for by taxes, and so is ultimately a cost to consumers). That cost is $(Q_2 - Q_1)P_s$, which is what the government must pay for the output it purchases. In Figure 9.10, this amount is represented by the large speckled rectangle. This cost may be reduced if the government can "dump" some of its purchases—i.e., sell them abroad at a low price. Doing so, however, hurts the ability of domestic producers to sell in foreign markets, and it is domestic producers that the government is trying to please in the first place.

What is the total welfare cost of this policy? To find out, we add the change in consumer surplus to the change in producer surplus and then subtract the cost to the government. Thus the total change in welfare is

$$\Delta\text{CS} + \Delta\text{PS} - \text{Cost to Govt.} = D - (Q_2 - Q_1)P_s$$

In terms of Figure 9.10, society as a whole is worse off by an amount given by the large speckled rectangle, less triangle D.

As we will see in Example 9.4, this welfare loss can be very large. But the most unfortunate part of this policy is the fact that there is a much more efficient way to help farmers. If the objective is to give farmers an additional income equal to $A + B + D$, it is far less costly to society to give them this money directly rather than via price supports. Because price supports are costing consumers $A + B$ anyway, by paying farmers directly, society saves the large speckled rectangle, less triangle D. So why doesn't the government simply give farmers money? Perhaps because price supports are a less obvious giveaway and, therefore, politically more attractive.[8]

Production Quotas

Besides entering the market and buying up output—thereby increasing total demand—the government can also cause the price of a good to rise by *reducing supply*. It can do this by decree—that is, by simply setting quotas on how much each firm can produce. With appropriate quotas, the price can then be forced up to any arbitrary level.

This is exactly how many city governments maintain high taxi fares. They limit total supply by requiring each taxicab to have a medallion, and then limit the total number of medallions.[9] Another example is the control of liquor

[8]In practice, price supports for many agricultural commodities are effected through loans. The loan rate is in effect a price floor. If during the loan period market prices are not sufficiently high, farmers can forfeit their grain to the government (specifically to the Commodity Credit Corporation) as *full payment for the loan*. Farmers have the incentive to do this unless the market price rises above the support price.

[9]For example, as of 1995 New York City had not issued any new taxi medallions for half a century. Only 11,800 taxis were permitted to cruise the city's streets, the same number as in 1937! As a result, in 1995 a medallion could be sold for about \$120,000. It shouldn't be a surprise, then, that the city's taxicab companies have vigorously opposed phasing out medallions in favor of an open system. Washington, D.C., has such an open system: An average taxi ride there costs about half of what it does in New York, and taxis are more available.

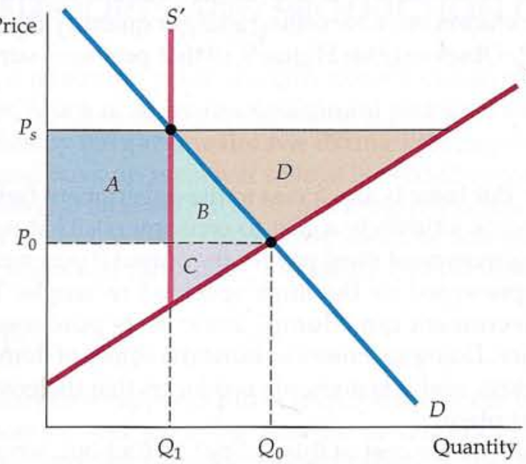


FIGURE 9.11 Supply Restrictions

To maintain a price P_s above the market-clearing price P_0, the government can restrict supply to Q_1, either by imposing production quotas (as with taxicab medallions) or by giving producers a financial incentive to reduce output (as with acreage limitations in agriculture). For an incentive to work, it must be at least as large as $B + C + D$, which would be the additional profit earned by planting, given the higher price P_s. The cost to the government is therefore at least $B + C + D$.

licenses by state governments. By requiring any bar or restaurant that serves alcohol to have a liquor license and then limiting the number of licenses, entry by new restaurateurs is limited, which allows those who have licenses to earn higher prices and profit margins.

The welfare effects of production quotas are shown in Figure 9.11. The government restricts the quantity supplied to Q_1, rather than the market-clearing level Q_0. Thus the supply curve becomes the vertical line S' at Q_1. Consumer surplus is reduced by rectangle A (those consumers who buy the good pay a higher price) plus triangle B (at this higher price, some consumers no longer purchase the good). Producers gain rectangle A (by selling at a higher price) but lose triangle C (because they now produce and sell Q_1 rather than Q_0). Once again, there is a deadweight loss, given by triangles B and C.

Incentive Programs In U.S. agricultural policy, output is reduced by incentives rather than by outright quotas. *Acreage limitation programs* give farmers financial incentives to leave some of their acreage idle. Figure 9.11 also shows the welfare effects of reducing supply in this way. Note that because farmers agree to limit planted acreage, the supply curve again becomes completely inelastic at the quantity Q_1, and the market price is increased from P_0 to P_s.

As with direct production quotas, the change in consumer surplus is

$$\Delta CS = -A - B$$

Farmers now receive a higher price for the production Q_1, which corresponds to a gain in surplus of rectangle A. But because production is reduced from Q_0 to Q_1, there is a loss of producer surplus corresponding to triangle C. Finally, farmers receive money from the government as an incentive to reduce production. Thus the total change in producer surplus is now

$$\Delta PS = A - C + \text{Payments for not producing}$$

The cost to the government is a payment sufficient to give farmers an incentive to reduce output to Q_1. That incentive must be at least as large as $B + C + D$ because that area represents the additional profit that could be made by planting, *given the higher price* P_s. (Remember that the higher price P_s gives farmers an incentive to produce *more* even though the government is trying to get them to produce *less*.) Thus the cost to the government is at least $B + C + D$, and the total change in producer surplus is

$$\Delta PS = A - C + B + C + D = A + B + D$$

This is the same change in producer surplus as with price supports maintained by government purchases of output. (Refer to Figure 9.10.) Farmers, then, should be indifferent between the two policies because they end up gaining the same amount of money from each. Likewise, consumers lose the same amount of money.

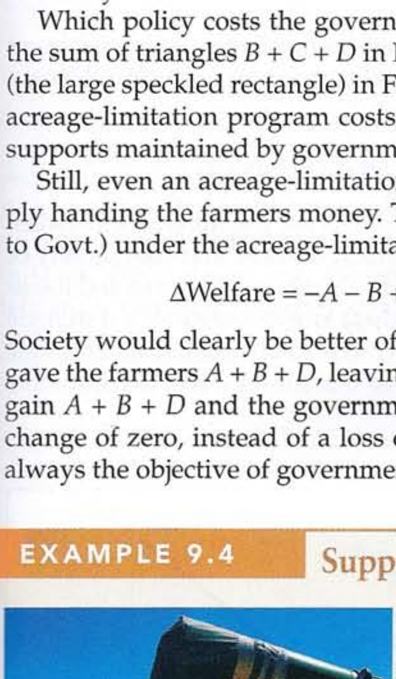
Which policy costs the government more? The answer depends on whether the sum of triangles $B + C + D$ in Figure 9.11 is larger or smaller than $(Q_2 - Q_1)P_s$ (the large speckled rectangle) in Figure 9.10. Usually it will be smaller, so that an acreage-limitation program costs the government (and society) less than price supports maintained by government purchases.

Still, even an acreage-limitation program is more costly to society than simply handing the farmers money. The total change in welfare ($\Delta CS + \Delta PS$ – Cost to Govt.) under the acreage-limitation program is

$$\Delta \text{Welfare} = -A - B + A + B + D - B - C - D = -B - C$$

Society would clearly be better off in efficiency terms if the government simply gave the farmers $A + B + D$, leaving price and output alone. Farmers would then gain $A + B + D$ and the government would lose $A + B + D$, for a total welfare change of zero, instead of a loss of $B + C$. However, economic efficiency is not always the objective of government policy.

EXAMPLE 9.4 Supporting the Price of Wheat



In Examples 2.5 (page 38) and 4.3 (page 129), we began to examine the market for wheat in the United States. Using linear demand and supply curves, we found that the market-clearing price of wheat was about \$3.46 in 1981, but it fell to about \$2.78 by 2002 because of a drop in export demand. In fact, government programs kept the actual price of wheat higher and provided direct subsidies to farmers. How did these programs work, how much did they end up costing consumers, and how much did they add to the federal deficit?

First, let's examine the market in 1981. In that year, although there were no effective limitations on the production of wheat, the price was increased to \$3.70 by government purchases. How much would the government have had to buy to get the price from \$3.46 to \$3.70? To answer this question, first write the equations for supply and for total private (domestic plus export) demand:

$$\textit{1981 Supply:} \quad Q_S = 1800 + 240P$$

$$\textit{1981 Demand:} \quad Q_D = 3550 - 266P$$

By equating supply and demand, you can check that the market-clearing price is \$3.46, and that the quantity produced is 2630 million bushels. Figure 9.12 illustrates this.

To increase the price to \$3.70, the government must buy a quantity of wheat Q_g. *Total* demand (private plus government) will then be

$$\textit{1981 Total demand:} \quad Q_{DT} = 3550 - 266P + Q_g$$

Now equate supply with this total demand:

$$1800 + 240P = 3550 - 266P + Q_g$$

or

$$Q_g = 506P - 1750$$

This equation can be used to determine the required quantity of government wheat purchases Q_g as a function of the desired support price P. To achieve a price of \$3.70, the government must buy

$$Q_g = (506)(3.70) - 1750 = 122 \text{ million bushels}$$

Note in Figure 9.12 that these 122 million bushels are the difference between the quantity supplied at the \$3.70 price (2688 million bushels) and the quantity of private demand (2566 million bushels). The figure also shows the gains and losses to consumers and producers. Recall that consumers lose rectangle A and triangle B. You can verify that rectangle A is $(3.70 - 3.46)(2566) = \$616$ million, and triangle B is $(1/2)(3.70 - 3.46)(2630 - 2566) = \$8$ million, so that the total cost to consumers is \$624 million.

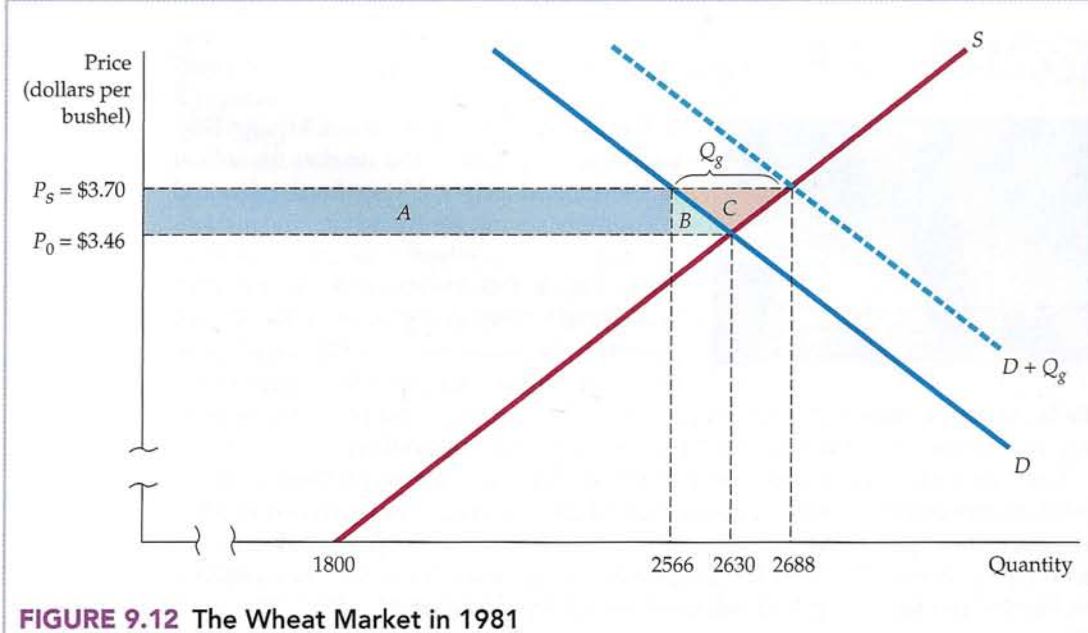


FIGURE 9.12 The Wheat Market in 1981

By buying 122 million bushels of wheat, the government increased the market-clearing price from \$3.46 per bushel to \$3.70.

The cost to the government is the \$3.70 it pays for the wheat times the 122 million bushels it buys, or \$451.4 million. The total cost of the program is then \$624 million + \$451.4 million = \$1075 million. Compare this with the gain to producers, which is rectangle *A* plus triangles *B* and *C*. You can verify that this gain is \$638 million.

Price supports for wheat were expensive in 1981. To increase the surplus of farmers by \$638 million, consumers and taxpayers had to pay \$1076 million. In fact, taxpayers paid even more than that. Wheat producers were also given subsidies of about 30 cents per bushel, which adds up to another \$806 million.

In 1985, the situation became even worse because of the drop in export demand. In that year, the supply and demand curves were as follows:

$$\textit{1985 Supply:} \quad Q_S = 1800 + 240P$$

$$\textit{1985 Demand:} \quad Q_D = 2580 - 194P$$

You can verify that the market-clearing price and quantity were \$1.80 and 2232 million bushels, respectively. The actual price, however, was \$3.20.

To increase the price to \$3.20, the government bought wheat and imposed a production quota of about 2425 million bushels. (Farmers who wanted to take part in the subsidy program—and most did—had to agree to limit their acreage.) Figure 9.13 illustrates this situation. At the quantity 2425 million bushels, the supply curve becomes vertical. Now, to determine how much wheat Q_g the government had to buy, set this quantity of 2425 equal to total demand:

$$2425 = 2580 - 194P + Q_g$$

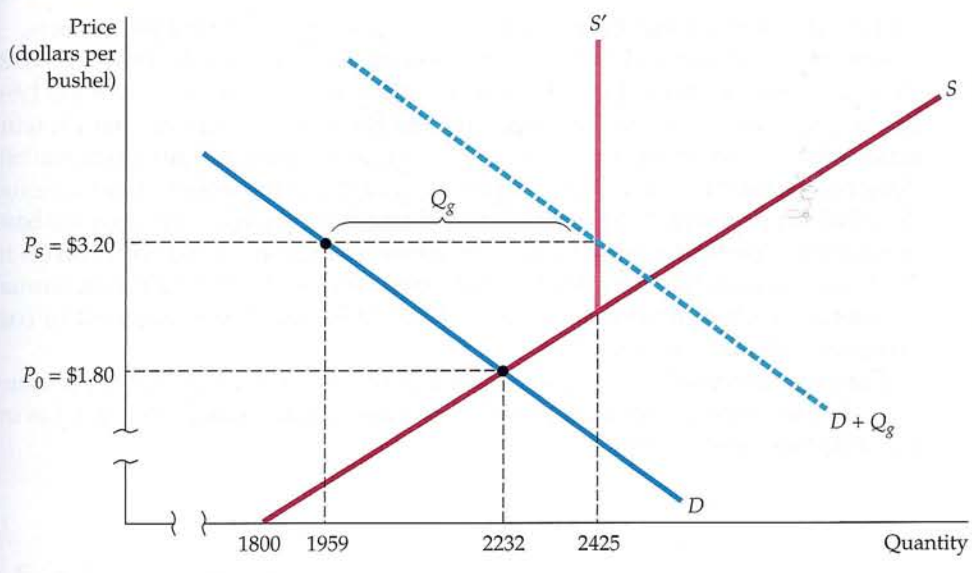


FIGURE 9.13 The Wheat Market in 1985

In 1985, the demand for wheat was much lower than in 1981, because the market-clearing price was only \$1.80. To increase the price to \$3.20, the government bought 466 million bushels and also imposed a production quota of 2425 million bushels.

or

$$Q_g = -155 + 194P$$

Substituting \$3.20 for P, we see that Q_g must be 466 million bushels. This program cost the government (\$3.20)(466) = \$1491 million.

Again, this is not the whole story. The government also provided a subsidy of 80 cents per bushel, so that producers again received about \$4.00 for their wheat. Because 2425 million bushels were produced, that subsidy cost an additional \$1940 million. In all, U.S. wheat programs cost taxpayers nearly \$3.5 billion in 1985. Of course, there was also a loss of consumer surplus and a gain of producer surplus; you can calculate what they were.

In 1996, the U.S. Congress passed a new farm bill, nicknamed the "Freedom to Farm" law. It was designed to reduce the role of government and to make agriculture more market oriented. The law eliminated production quotas (for wheat, corn, rice, and other products) and gradually reduced government purchases and subsidies through 2003. However, the law did not completely deregulate U.S. agriculture. For example, price support programs for peanuts and sugar remained in place. Furthermore, pre-1996 price supports and production quotas would be reinstated unless Congress renewed the law in 2003. (Congress did not renew it—more on this below.) Even under the 1996 law, agricultural subsidies remained substantial.

In Example 2.5, we saw that the market-clearing price of wheat in 2007 had increased to about \$6.00 per bushel. The supply and demand curves in 2007 were as follows:

$$\textit{Demand:}\quad Q_D = 2900 - 125P$$

$$\textit{Supply:}\quad Q_S = 1460 + 115P$$

You can check to see that the market-clearing quantity is 2150 million bushels.

Congress did not renew the 1996 Freedom to Farm Act. Instead, in 2002, Congress and the Bush administration essentially reversed the effects of the 1996 bill through passage of the Farm Security and Rural Investment Act, which reinstates subsidies for most crops, in particular grain and cotton.[10] Although the bill does not explicitly restore price supports, it calls for the government to issue "fixed direct payments" to producers based on a fixed payment rate and the base acreage for a particular crop. Using U.S. wheat acreage and production levels in 2001, we can calculate that this bill cost taxpayers nearly \$1.1 billion in annual payments to wheat producers alone.[11] The 2002 farm bill was projected to cost taxpayers \$190 billion over 10 years.

Congress revisited agricultural subsidies in 2007. For most crops, previous subsidy rates were either maintained or increased, thus making the burden on U.S. taxpayers even higher.

[10]See Mike Allen, "Bush Signs Bill Providing Big Farm Subsidy Increases," *The Washington Post*, May 14, 2002; see David E. Sanger, "Reversing Course, Bush Signs Bill Raising Farm Subsidies," *The New York Times*, May 14, 2002.

[11]Estimated 2001 Wheat direct payments = (payment rate)*(payment yield)*(base acres)* 0.85 = (\$0.52)*(40.2)*(59,617,000)*0.85 = \$1.06 billion.

9.5 IMPORT QUOTAS AND TARIFFS

Many countries use **import quotas** and **tariffs** to keep the domestic price of a product above world levels and thereby enable the domestic industry to enjoy higher profits than it would under free trade. As we will see, the cost to taxpayers from this protection can be high, with the loss to consumers exceeding the gain to domestic producers.

- **import quota** Limit on the quantity of a good that can be imported.
- **tariff** Tax on an imported good.

Without a quota or tariff, a country will import a good when its world price is below the price that would prevail domestically were there no imports. Figure 9.14 illustrates this principle. S and D are the domestic supply and demand curves. If there were no imports, the domestic price and quantity would be P_0 and Q_0, which equate supply and demand. But because the world price P_w is below P_0, domestic consumers have an incentive to purchase from abroad and will do so if imports are not restricted. How much will be imported? The domestic price will fall to the world price P_w; at this lower price, domestic production will fall to Q_s, and domestic consumption will rise to Q_d. Imports are then the difference between domestic consumption and domestic production, $Q_d - Q_s$.

Now suppose the government, bowing to pressure from the domestic industry, eliminates imports by imposing a quota of zero—that is, forbidding any importation of the good. What are the gains and losses from such a policy?

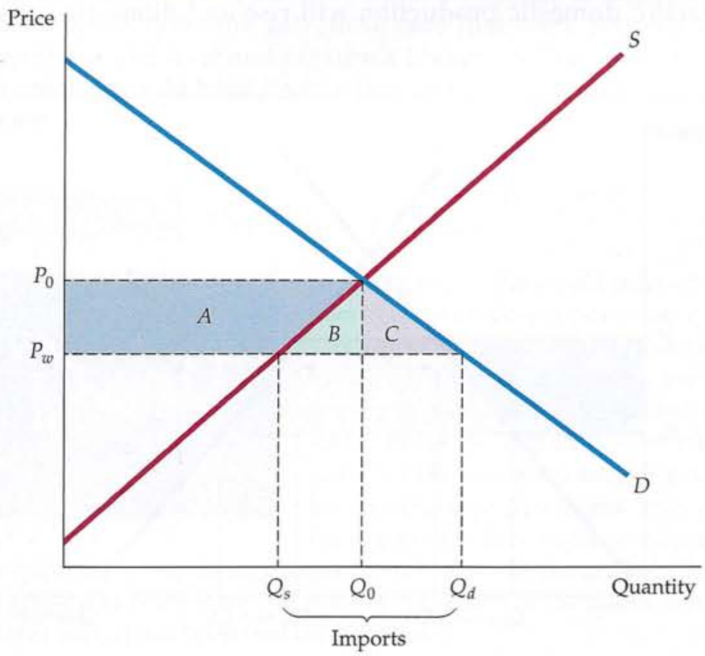


FIGURE 9.14 Import Tariff or Quota That Eliminates Imports

In a free market, the domestic price equals the world price P_w. A total Q_d is consumed, of which Q_s is supplied domestically and the rest imported. When imports are eliminated, the price is increased to P_0. The gain to producers is trapezoid A. The loss to consumers is $A + B + C$, so the deadweight loss is $B + C$.

With no imports allowed, the domestic price will rise to P_0. Consumers who still purchase the good (in quantity Q_0) will pay more and will lose an amount of surplus given by trapezoid A and triangle B. In addition, given this higher price, some consumers will no longer buy the good, so there is an additional loss of consumer surplus, given by triangle C. The total change in consumer surplus is therefore

$$\Delta\text{CS} = -A - B - C$$

What about producers? Output is now higher (Q_0 instead of Q_s) and is sold at a higher price (P_0 instead of P_w). Producer surplus therefore increases by the amount of trapezoid A:

$$\Delta\text{PS} = A$$

The change in total surplus, ΔCS + ΔPS, is therefore $-B - C$. Again, there is a deadweight loss—consumers lose more than producers gain.

Imports could also be reduced to zero by imposing a sufficiently large tariff. The tariff would have to be equal to or greater than the difference between P_0 and P_w. With a tariff of this size, there will be no imports and, therefore, no government revenue from tariff collections, so the effect on consumers and producers would be the same as with a quota.

More often, government policy is designed to reduce but not eliminate imports. Again, this can be done with either a tariff or a quota, as Figure 9.15 shows. Under free trade, the domestic price will equal the world price P_w, and imports will be $Q_d - Q_s$. Now suppose that a tariff of T dollars per unit is imposed on imports. Then the domestic price will rise to P^* (the world price plus the tariff); domestic production will rise and domestic consumption will fall.

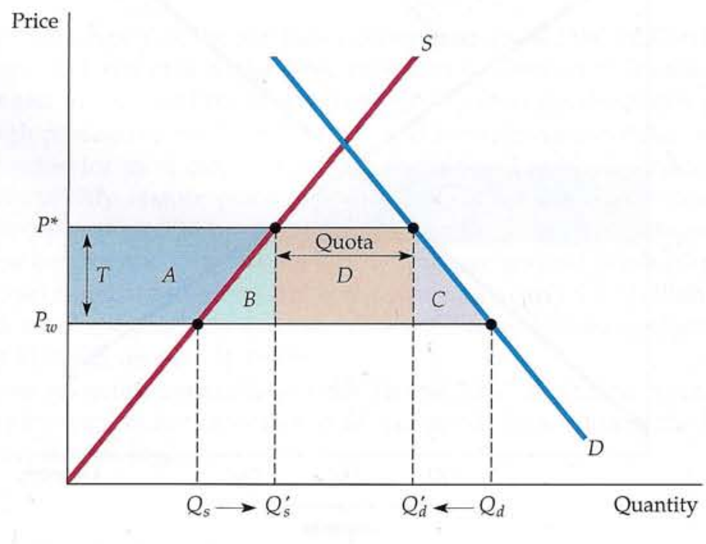


FIGURE 9.15 Import Tariff or Quota (General Case)

When imports are reduced, the domestic price is increased from P_w to P^*. This can be achieved by a quota, or by a tariff $T = P^* - P_w$. Trapezoid A is again the gain to domestic producers. The loss to consumers is $A + B + C + D$. If a tariff is used, the government gains D, the revenue from the tariff, so the net domestic loss is $B + C$. If a quota is used instead, rectangle D becomes part of the profits of foreign producers, and the net domestic loss is $B + C + D$.

In Figure 9.15, this tariff leads to a change of consumer surplus given by

$$\Delta CS = -A - B - C - D$$

The change in producer surplus is again

$$\Delta PS = A$$

Finally, the government will collect revenue in the amount of the tariff times the quantity of imports, which is rectangle D. The total change in welfare, ΔCS plus ΔPS plus the revenue to the government, is therefore $-A - B - C - D + A + D = -B - C$. Triangles B and C again represent the deadweight loss from restricting imports. (B represents the loss from domestic overproduction and C the loss from too little consumption.)

Suppose the government uses a quota instead of a tariff to restrict imports: Foreign producers can only ship a specific quantity ($Q'_d - Q'_s$ in Figure 9.15) to the United States and can then charge the higher price P^* for their U.S. sales. The changes in U.S. consumer and producer surplus will be the same as with the tariff, but instead of the U.S. government collecting the revenue given by rectangle D, this money will go to the foreign producers in the form of higher profits. The United States as a whole will be even worse off than it was under the tariff, losing D as well as the deadweight loss B and C.[12]

This situation is exactly what transpired with automobile imports from Japan in the 1980s. Under pressure from domestic automobile producers, the Reagan administration negotiated "voluntary" import restraints, under which the Japanese agreed to restrict shipments of cars to the United States. The Japanese could therefore sell those cars that were shipped at a price higher than the world level and capture a higher profit margin on each one. The United States would have been better off by simply imposing a tariff on these imports.

EXAMPLE 9.5 The Sugar Quota

In recent years, the world price of sugar has been as low as 4 cents per pound, while the U.S. price has been 20 to 30 cents per pound. Why? By restricting imports, the U.S. government protects the \$3 billion domestic sugar industry, which would virtually be put out of business if it had to compete with low-cost foreign producers. This policy has been good for U.S. sugar producers. It has even been good for some foreign sugar producers—in particular, those whose successful lobbying efforts have given them big shares of the quota. But like most policies of this sort, it has been bad for consumers.

[12]Alternatively, an import quota can be maintained by rationing imports to U.S. importing firms or trading companies. These middlemen would have the rights to import a fixed amount of the good each year. These rights are valuable because the middleman can buy the product on the world market at price P_w and then sell it at price P^*. The aggregate value of these rights is, therefore, given by rectangle D. If the government *sells* the rights for this amount of money, it can capture the same revenue it would receive with a tariff. But if these rights are given away, as sometimes happens, the money becomes a windfall to middlemen.

To see just how bad, let's look at the sugar market in 2005. Here are the relevant data for that year:

U.S. production:	15.2 billion pounds
U.S. consumption:	20.5 billion pounds
U.S. price:	27 cents per pound
World price:	12 cents per pound

At these prices and quantities, the price elasticity of U.S. supply is 1.5, and the price elasticity of U.S. demand is -0.3.[13]

In §2.6, we explain how to fit linear supply and demand functions to data of this kind.

We will fit linear supply and demand curves to these data, and then use them to calculate the effects of the quotas. You can verify that the following U.S. supply curve is consistent with a production level of 15.2 billion pounds, a price of 27 cents per pound, and a supply elasticity of 1.5:

$$\textit{U.S. supply:} \qquad Q_S = -7.48 + 0.84P$$

where quantity is measured in billions of pounds and price in cents per pound. Similarly, the −0.3 demand elasticity, together with the data for U.S. consumption and U.S. price, give the following linear demand curve:

$$\textit{U.S. demand:} \qquad Q_D = 26.7 - 0.23P$$

These supply and demand curves are plotted in Figure 9.16. At the 12-cent world price, U.S. production would have been only about 2.6 billion pounds and U.S. consumption about 23.95 billion pounds, most of this imports. But fortunately for U.S. producers, imports were limited to only 5.3 billion pounds, which pushed the U.S. price up to 27 cents.

What did this policy cost U.S. consumers? The lost consumer surplus is given by the sum of trapezoid *A*, triangles *B* and *C*, and rectangle *D*. You should go through the calculations to verify that trapezoid *A* is equal to \$1335 million, triangle *B* to \$945 million, triangle *C* to \$255 million, and rectangle *D* to \$795 million. The total cost to consumers in 2005 was about \$3.3 billion.

How much did producers gain from this policy? Their increase in surplus is given by trapezoid *A* (i.e., about \$1.3 billion). The \$795 million of rectangle *D* was a gain for those foreign producers who succeeded in obtaining large allotments of the quota because they received a higher price for their sugar. Triangles *B* and *C* represent a deadweight loss of about \$1.2 billion.

[13] Prices and quantities are from Won W. Koo and Richard D. Taylor, "2006 Outlook of the U.S. and World Sugar Markets, 2005–2015," Agribusiness & Applied Economics Report No. 589, *Center for Agricultural Policy and Trade Studies*, North Dakota State University, 2006. The elasticity estimates are based on Morris E. Morkre and David G. Tarr, *Effects of Restrictions on United States Imports: Five Case Studies and Theory*, U.S. Federal Trade Commission Staff Report, June 1981; and F. M. Scherer, "The United States Sugar Program," Kennedy School of Government Case Study, Harvard University, 1992. For a general discussion of sugar quotas and other aspects of U.S. agricultural policy, see D. Gale Johnson, *Agricultural Policy and Trade* (New York: New York University Press, 1985); and Gail L. Cramer and Clarence W. Jensen, *Agricultural Economics and Agribusiness* (New York: Wiley, 1985).

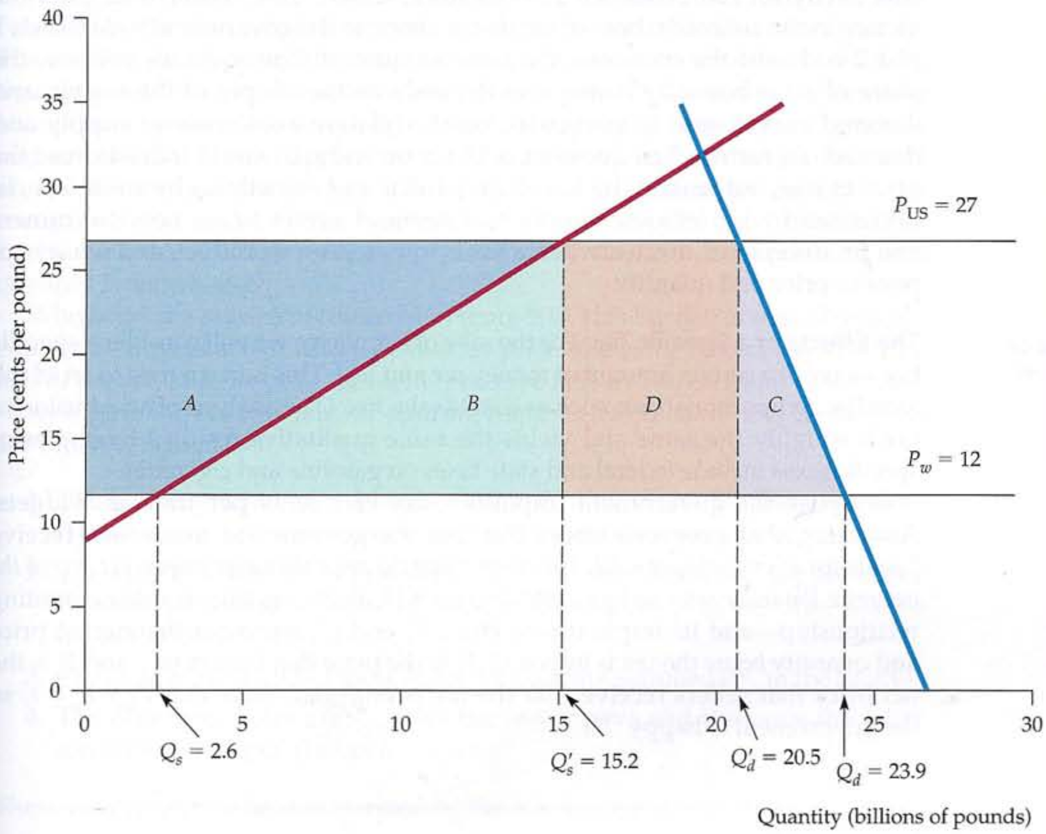


FIGURE 9.16 Sugar Quota in 2005

At the world price of 12 cents per pound, about 23.9 billion pounds of sugar would have been consumed in the United States in 2005, of which all but 2.6 billion pounds would have been imported. Restricting imports to 5.3 billion pounds caused the U.S. price to go up by 15 cents. The cost to consumers, $A + B + C + D$, was about \$3.3 billion. The gain to domestic producers was trapezoid A, about \$1.3 billion. Rectangle D, \$795 million, was a gain to those foreign producers who obtained quota allotments. Triangles B and C represent the deadweight loss of about \$1.2 billion.

9.6 THE IMPACT OF A TAX OR SUBSIDY

What would happen to the price of widgets if the government imposed a \$1 tax on every widget sold? Many people would answer that the price would increase by a dollar, with consumers now paying a dollar more per widget than they would have paid without the tax. But this answer is wrong.

Or consider the following question. The government wants to impose a 50-cent-per-gallon tax on gasoline and is considering two methods of collecting it. Under Method 1, the owner of each gas station would deposit the tax money (50 cents times the number of gallons sold) in a locked box, to be collected by a government agent. Under Method 2, the buyer would pay the tax (50 cents times the number of gallons purchased) directly to the government. Which method costs the buyer more? Many people would say Method 2, but this answer is also wrong.

The burden of a tax (or the benefit of a subsidy) falls partly on the consumer and partly on the producer. Furthermore, it does not matter who puts the money in the collection box (or sends the check to the government)—Methods 1 and 2 both cost the consumer the same amount of money. As we will see, the share of a tax borne by consumers depends on the shapes of the supply and demand curves and, in particular, on the relative elasticities of supply and demand. As for our first question, a $1 tax on widgets would indeed cause the price to rise, but usually by *less* than a dollar and sometimes by *much* less. To understand why, let's use supply and demand curves to see how consumers and producers are affected when a tax is imposed on a product, and what happens to price and quantity.

• **specific tax** Tax of a certain amount of money per unit sold.

The Effects of a Specific Tax For the sake of simplicity, we will consider a **specific tax**—a tax of a certain amount of money *per unit sold*. This is in contrast to an *ad valorem* (i.e., proportional) *tax*, such as a state sales tax. (The analysis of an ad valorem tax is roughly the same and yields the same qualitative results.) Examples of specific taxes include federal and state taxes on gasoline and cigarettes.

Suppose the government imposes a tax of t cents per unit on widgets. Assuming that everyone obeys the law, the government must then receive t cents for every widget sold. *This means that the price the buyer pays must exceed the net price the seller receives by t cents.* Figure 9.17 illustrates this simple accounting relationship—and its implications. Here, P_0 and Q_0 represent the market price and quantity *before* the tax is imposed. P_b is the price that buyers pay, and P_s is the net price that sellers receive *after* the tax is imposed. Note that $P_b - P_s = t$, so the government is happy.

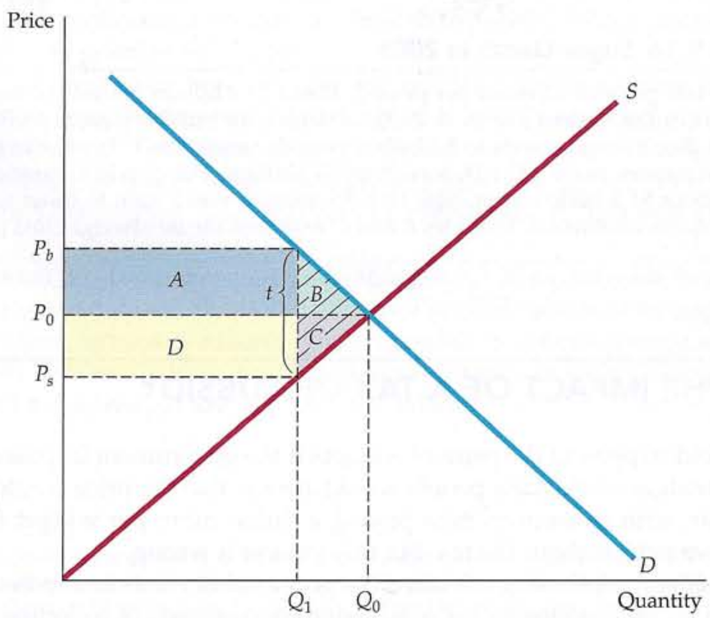


FIGURE 9.17 Incidence of a Tax

P_b is the price (including the tax) paid by buyers. P_s is the price that sellers receive, less the tax. Here the burden of the tax is split evenly between buyers and sellers. Buyers lose $A + B$, sellers lose $D + C$, and the government earns $A + D$ in revenue. The deadweight loss is $B + C$.

How do we determine what the market quantity will be after the tax is imposed, and how much of the tax is borne by buyers and how much by sellers? First, remember that what buyers care about is the price that they must pay: P_b. The amount that they will buy is given by the demand curve; it is the quantity that we read off of the demand curve given a price P_b. Similarly, sellers care about the net price they receive, P_s. Given P_s, the quantity that they will produce and sell is read off the supply curve. Finally, we know that the quantity sold must equal the quantity bought. The solution, then, is to find the quantity that corresponds to a price of P_b on the demand curve, and a price of P_s on the supply curve, such that the difference $P_b - P_s$ is equal to the tax t. In Figure 9.17, this quantity is shown as Q_1.

Who bears the burden of the tax? In Figure 9.17, this burden is shared roughly equally by buyers and sellers. The market price (the price buyers pay) rises by half of the tax, and the price that sellers receive falls by roughly half of the tax.

As Figure 9.17 shows, market clearing requires *four conditions* to be satisfied after the tax is in place:

1. The quantity sold and the buyer's price P_b must lie on the demand curve (because buyers are interested only in the price they must pay).
2. The quantity sold and the seller's price P_s must lie on the supply curve (because sellers are concerned only with the amount of money they receive net of the tax).
3. The quantity demanded must equal the quantity supplied (Q_1 in the figure).
4. The difference between the price the buyer pays and the price the seller receives must equal the tax t.

These conditions can be summarized by the following four equations:

$$Q^D = Q^D(P_b) \tag{9.1a}$$

$$Q^S = Q^S(P_s) \tag{9.1b}$$

$$Q^D = Q^S \tag{9.1c}$$

$$P_b - P_s = t \tag{9.1d}$$

If we know the demand curve $Q^D(P_b)$, the supply curve $Q^S(P_s)$, and the size of the tax t, we can solve these equations for the buyers' price P_b, the sellers' price P_s, and the total quantity demanded and supplied. This task is not as difficult as it may seem, as we will demonstrate in Example 9.6.

Figure 9.17 also shows that a tax results in a *deadweight loss*. Because buyers pay a higher price, there is a change in consumer surplus given by

$$\Delta CS = -A - B$$

Because sellers now receive a lower price, there is also a change in producer surplus given by

$$\Delta PS = -C - D$$

Government tax revenue is tQ_1, the sum of rectangles A and D. The total change in welfare, ΔCS plus ΔPS plus the revenue to the government, is therefore $-A - B - C - D + A + D = -B - C$. Triangles B and C represent the deadweight loss from the tax.

In Figure 9.17, the burden of the tax is shared almost evenly between buyers and sellers, but this is not always the case. If demand is relatively inelastic and supply is relatively elastic, the burden of the tax will fall mostly on buyers. Figure 9.18(a) shows why: It takes a relatively large increase in price to reduce the quantity demanded by even a small amount, whereas only a small price decrease is needed to reduce the quantity supplied. For example, because cigarettes are addictive, the elasticity of demand is small (about –0.4); thus federal and state cigarette taxes are borne largely by cigarette buyers.[14] Figure 9.18(b) shows the opposite case: If demand is relatively elastic and supply is relatively inelastic, the burden of the tax will fall mostly on sellers.

So even if we have only estimates of the elasticities of demand and supply at a point or for a small range of prices and quantities, instead of the entire demand and supply curves, we can still roughly determine who will bear the greatest burden of a tax (whether the tax is actually in effect or is only under discussion as a policy option). In general, *a tax falls mostly on the buyer if E_d/E_s is small, and mostly on the seller if E_d/E_s is large.*

In fact, by using the following "pass-through" formula, we can calculate the percentage of the tax borne by buyers:

$$\text{Pass-through fraction} = E_s/(E_s - E_d)$$

This formula tells us what fraction of the tax is "passed through" to consumers in the form of higher prices. For example, when demand is totally inelastic, so

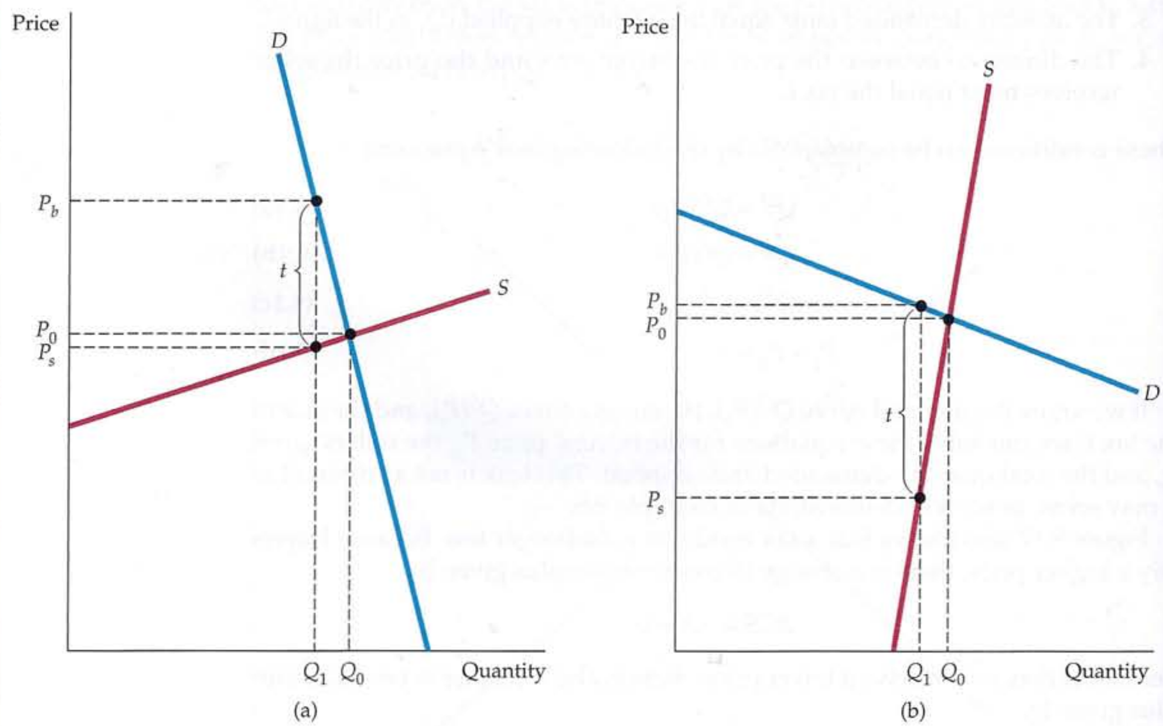


FIGURE 9.18 Impact of a Tax Depends on Elasticities of Supply and Demand

(a) If demand is very inelastic relative to supply, the burden of the tax falls mostly on buyers. **(b)** If demand is very elastic relative to supply, it falls mostly on sellers.

[14] See Daniel A. Sumner and Michael K. Wohlgenant, "Effects of an Increase in the Federal Excise Tax on Cigarettes," *American Journal of Agricultural Economics* 67 (May 1985): 235–42.

that E_d is zero, the pass-through fraction is 1 and all the tax is borne by consumers. When demand is totally elastic, the pass-through fraction is zero and producers bear all the tax. (The fraction of the tax that producers bear is given by $-E_d/(E_s - E_d)$.)

The Effects of a Subsidy

A **subsidy** can be analyzed in much the same way as a tax—in fact, you can think of a subsidy as a *negative tax*. With a subsidy, the sellers' price *exceeds* the buyers' price, and the difference between the two is the amount of the subsidy. As you would expect, the effect of a subsidy on the quantity produced and consumed is just the opposite of the effect of a tax—the quantity will increase.

• **subsidy** Payment reducing the buyer's price below the seller's price; i.e., a negative tax.

Figure 9.19 illustrates this. At the presubsidy market price P_0, the elasticities of supply and demand are roughly equal. As a result, the benefit of the subsidy is shared roughly equally between buyers and sellers. As with a tax, this is not always the case. In general, *the benefit of a subsidy accrues mostly to buyers if E_d/E_s is small and mostly to sellers if E_d/E_s is large.*

As with a tax, given the supply curve, the demand curve, and the size of the subsidy s, we can solve for the resulting prices and quantity. The same four conditions needed for the market to clear apply for a subsidy as for a tax, but now the difference between the sellers' price and the buyers' price is equal to the subsidy. Again, we can write these conditions algebraically:

$$Q^D = Q^D(P_b) \tag{9.2a}$$

$$Q^S = Q^S(P_s) \tag{9.2b}$$

$$Q^D = Q^S \tag{9.2c}$$

$$P_s - P_b = s \tag{9.2d}$$

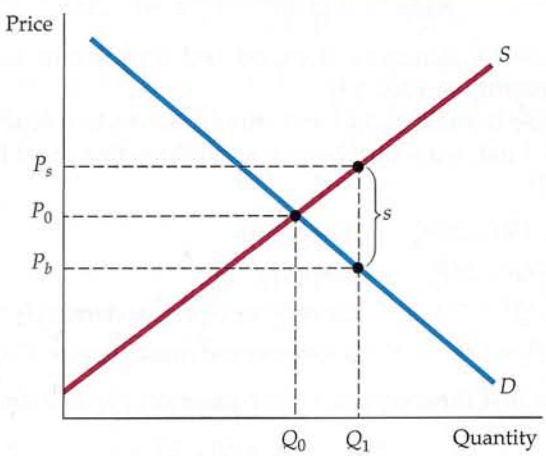


FIGURE 9.19 Subsidy

A subsidy can be thought of as a negative tax. Like a tax, the benefit of a subsidy is split between buyers and sellers, depending on the relative elasticities of supply and demand.

To make sure you understand how to analyze the impact of a tax or subsidy, you might find it helpful to work through one or two examples, such as Exercises 2 and 14 at the end of this chapter.

EXAMPLE 9.6 A Tax on Gasoline

The idea of a large tax on gasoline, both to raise government revenue and to reduce oil consumption and U.S. dependence on oil imports, has been discussed for many years. Let's see how a \$1.00-per-gallon tax would affect the price and consumption of gasoline.

We will do this analysis in the setting of market conditions during 2005–2007—when gasoline was selling for about \$2 per gallon and total consumption was about 100 billion gallons per year (bg/yr).[15] We will also use intermediate-run elasticities: elasticities that would apply to a period of about three to six years after a price change.

In §2.5, we explain that demand is often more price elastic in the long run than in the short run because it takes time for people to change their consumption habits and/or because the demand for a good might be linked to the stock of another good that changes slowly.

A reasonable number for the intermediate-run elasticity of gasoline demand is –0.5 (see Example 2.6 in Chapter 2—page 44). We can use this figure, together with the \$2 and 100 bg/yr price and quantity numbers, to calculate a linear demand curve for gasoline. You can verify that the following demand curve fits these data:

$$\textit{Gasoline demand:} \qquad Q^D = 150 - 25P$$

Gasoline is refined from crude oil, some of which is produced domestically and some imported. (Some gasoline is also imported directly.) The supply curve for gasoline will therefore depend on the world price of oil, on domestic oil supply, and on the cost of refining. The details are beyond the scope of this example, but a reasonable number for the elasticity of supply is 0.4. You should verify that this elasticity, together with the \$2 and 100 bg/yr price and quantity, gives the following linear supply curve:

$$\textit{Gasoline supply:} \qquad Q^S = 60 + 20P$$

You should also verify that these demand and supply curves imply a market price of \$2 and quantity of 100 bg/yr.

For a review of the procedure for calculating linear curves, see §2.6. Given data for price and quantity, as well as estimates of demand and supply elasticities, we can use a two-step procedure to solve for quantity demanded and supplied.

We can use these linear demand and supply curves to calculate the effect of a \$1-per-gallon tax. First, we write the four conditions that must hold, as given by equations (9.1a–d):

$$Q^D = 150 - 25P_b \qquad \text{(Demand)}$$
$$Q^S = 60 + 20P_s \qquad \text{(Supply)}$$
$$Q^D = Q^S \qquad \text{(Supply must equal demand)}$$
$$P_b - P_s = 1.00 \qquad \text{(Government must receive \$1.00/gallon)}$$

Now combine the first three equations to equate supply and demand:

$$150 - 25P_b = 60 + 20P_s$$

[15] Of course, this price varied across regions and grades of gasoline, but we can ignore this here. Quantities of oil and oil products are often measured in barrels; there are 42 gallons in a barrel, so the quantity figure could also be written as 2.4 billion barrels per year.

We can rewrite the last of the four equations as $P_b = P_s + 1.00$ and substitute this for P_b in the above equation:

$$150 - 25(P_s + 1.00) = 60 + 20P_s$$

Now we can rearrange this equation and solve for P_s:

$$20P_s + 25P_s = 150 - 25 - 60$$
$$45P_s = 65, \text{ or } P_s = 1.44$$

Remember that $P_b = P_s + 1.00$, so $P_b = 2.44$. Finally, we can determine the total quantity from either the demand or supply curve. Using the demand curve (and the price $P_b = 2.44$), we find that $Q = 150 - (25)(2.44) = 150 - 61$, or $Q = 89$ bg/yr. This represents an 11-percent decline in gasoline consumption. Figure 9.20 illustrates these calculations and the effect of the tax.

The burden of this tax would be split roughly evenly between consumers and producers. Consumers would pay about 44 cents per gallon more for gasoline, and producers would receive about 56 cents per gallon less. It should not be surprising, then, that both consumers and producers opposed such a tax, and politicians representing both groups fought the proposal every time it came up. But note that the tax would raise significant revenue for the government. The annual revenue would be $tQ = (1.00)(89) = \$89$ billion per year.

The cost to consumers and producers, however, will be more than the \$89 billion in tax revenue. Figure 9.20 shows the deadweight loss from this tax as the two

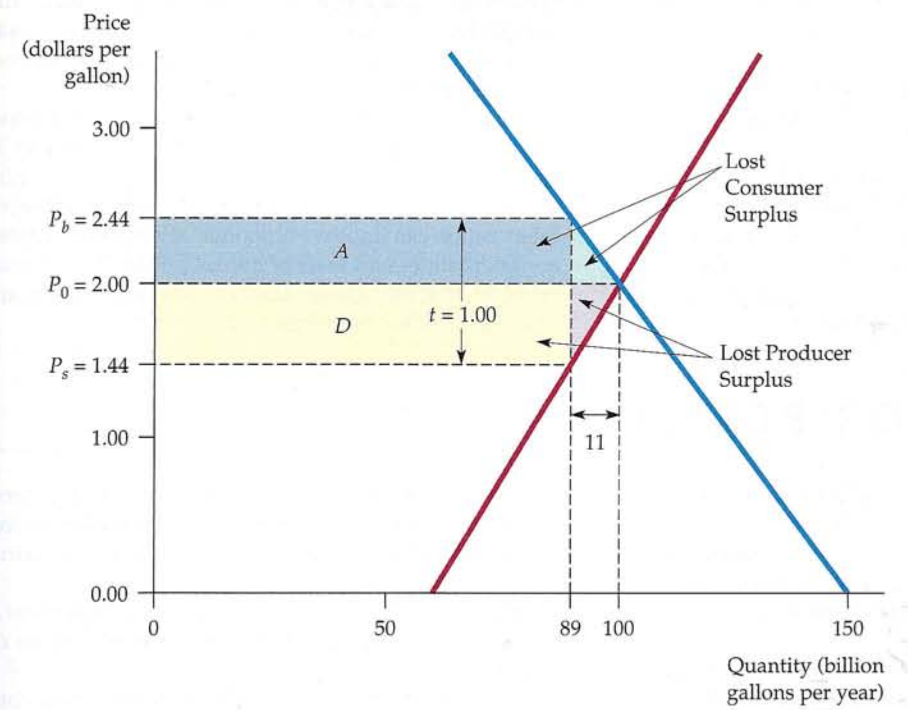


FIGURE 9.20 Impact of \$1 Gasoline Tax

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. The two triangles show the deadweight loss of \$5.5 billion per year.

shaded triangles. The two rectangles A and D represent the total tax collected by the government, but the total loss of consumer and producer surplus is larger.

Before deciding whether a gasoline tax is desirable, it is important to know how large the resulting deadweight loss is likely to be. We can easily calculate this from Figure 9.20. Combining the two small triangles into one large one, we see that the area is

$$(1/2) \times (\$1.00/\text{gallon}) \times (11 \text{ billion gallons/year})$$
$$= \$5.5 \text{ billion per year}$$

This deadweight loss is about 6 percent of the government revenue resulting from the tax, and must be balanced against any additional benefits that the tax might bring.

SUMMARY

1. Simple models of supply and demand can be used to analyze a wide variety of government policies, including price controls, minimum prices, price support programs, production quotas or incentive programs to limit output, import tariffs and quotas, and taxes and subsidies.
2. In each case, consumer and producer surplus are used to evaluate the gains and losses to consumers and producers. Applying the methodology to natural gas price controls, airline regulation, price supports for wheat, and the sugar quota shows that these gains and losses can be quite large.
3. When government imposes a tax or subsidy, price usually does not rise or fall by the full amount of the tax or subsidy. Also, the incidence of a tax or subsidy is usually split between producers and consumers. The fraction that each group ends up paying or receiving depends on the relative elasticities of supply and demand.
4. Government intervention generally leads to a deadweight loss; even if consumer surplus and producer surplus are weighted equally, there will be a net loss from government policies that shifts surplus from one group to the other. In some cases, this deadweight loss will be small, but in other cases—price supports and import quotas are examples—it is large. This deadweight loss is a form of economic inefficiency that must be taken into account when policies are designed and implemented.
5. Government intervention in a competitive market is not always bad. Government—and the society it represents—might have objectives other than economic efficiency. There are also situations in which government intervention can improve economic efficiency. Examples are externalities and cases of market failure. These situations, and the way government can respond to them, are discussed in Chapters 17 and 18.

QUESTIONS FOR REVIEW

1. What is meant by *deadweight loss?* Why does a price ceiling usually result in a deadweight loss?
2. Suppose the supply curve for a good is completely inelastic. If the government imposed a price ceiling below the market-clearing level, would a deadweight loss result? Explain.
3. How can a price ceiling make consumers better off? Under what conditions might it make them worse off?
4. Suppose the government regulates the price of a good to be no lower than some minimum level. Can such a minimum price make producers as a whole worse off? Explain.
5. How are production limits used in practice to raise the prices of the following goods or services: (a) taxi rides, (b) drinks in a restaurant or bar, (c) wheat or corn?
6. Suppose the government wants to increase farmers' incomes. Why do price supports or acreage-limitation programs cost society more than simply giving farmers money?
7. Suppose the government wants to limit imports of a certain good. Is it preferable to use an import quota or a tariff? Why?
8. The burden of a tax is shared by producers and consumers. Under what conditions will consumers pay most of the tax? Under what conditions will producers pay most of it? What determines the share of a subsidy that benefits consumers?
9. Why does a tax create a deadweight loss? What determines the size of this loss?

EXERCISES

1. In 1996, Congress raised the minimum wage from \$4.25 per hour to \$5.15 per hour, and then raised it again in 2007. (See Example 1.3 [page 13].) Some people suggested that a government subsidy could help employers finance the higher wage. This exercise examines the economics of a minimum wage and wage subsidies. Suppose the supply of low-skilled labor is given by

$$L^S = 10w$$

where L^S is the quantity of low-skilled labor (in millions of persons employed each year), and w is the wage rate (in dollars per hour). The demand for labor is given by

$$L^D = 80 - 10w$$

   a. What will be the free-market wage rate and employment level? Suppose the government sets a minimum wage of \$5 per hour. How many people would then be employed?
   b. Suppose that instead of a minimum wage, the government pays a subsidy of \$1 per hour for each employee. What will the total level of employment be now? What will the equilibrium wage rate be?

2. Suppose the market for widgets can be described by the following equations:

$$\textit{Demand:}\quad P = 10 - Q$$

$$\textit{Supply:}\quad P = Q - 4$$

where P is the price in dollars per unit and Q is the quantity in thousands of units. Then:
   a. What is the equilibrium price and quantity?
   b. Suppose the government imposes a tax of \$1 per unit to reduce widget consumption and raise government revenues. What will the new equilibrium quantity be? What price will the buyer pay? What amount per unit will the seller receive?
   c. Suppose the government has a change of heart about the importance of widgets to the happiness of the American public. The tax is removed and a subsidy of \$1 per unit granted to widget producers. What will the equilibrium quantity be? What price will the buyer pay? What amount per unit (including the subsidy) will the seller receive? What will be the total cost to the government?

3. Japanese rice producers have extremely high production costs, due in part to the high opportunity cost of land and to their inability to take advantage of economies of large-scale production. Analyze two policies intended to maintain Japanese rice production: (1) a per-pound subsidy to farmers for each pound of rice produced, or (2) a per-pound tariff on imported rice. Illustrate with supply-and-demand diagrams the equilibrium price and quantity, domestic rice production, government revenue or deficit, and deadweight loss from each policy. Which policy is the Japanese government likely to prefer? Which policy are Japanese farmers likely to prefer?

4. In 1983, the Reagan administration introduced a new agricultural program called the Payment-in-Kind Program. To see how the program worked, let's consider the wheat market:
   a. Suppose the demand function is $Q^D = 28 - 2P$ and the supply function is $Q^S = 4 + 4P$, where P is the price of wheat in dollars per bushel, and Q is the quantity in billions of bushels. Find the free-market equilibrium price and quantity.
   b. Now suppose the government wants to lower the supply of wheat by 25 percent from the free-market equilibrium by paying farmers to withdraw land from production. However, the payment is made in wheat rather than in dollars—hence the name of the program. The wheat comes from vast government reserves accumulated from previous price support programs. The amount of wheat paid is equal to the amount that could have been harvested on the land withdrawn from production. Farmers are free to sell this wheat on the market. How much is now produced by farmers? How much is indirectly supplied to the market by the government? What is the new market price? How much do farmers gain? Do consumers gain or lose?
   c. Had the government not given the wheat back to the farmers, it would have stored or destroyed it. Do taxpayers gain from the program? What potential problems does the program create?

5. About 100 million pounds of jelly beans are consumed in the United States each year, and the price has been about 50 cents per pound. However, jelly bean producers feel that their incomes are too low and have convinced the government that price supports are in order. The government will therefore buy up as many jelly beans as necessary to keep the price at \$1 per pound. However, government economists are worried about the impact of this program because they have no estimates of the elasticities of jelly bean demand or supply.
   a. Could this program cost the government *more* than \$50 million per year? Under what conditions? Could it cost *less* than \$50 million per year? Under what conditions? Illustrate with a diagram.
   b. Could this program cost consumers (in terms of lost consumer surplus) *more* than \$50 million per year? Under what conditions? Could it cost consumers *less* than \$50 million per year? Under what conditions? Again, use a diagram to illustrate.

6. In Exercise 4 in Chapter 2 (page 62), we examined a vegetable fiber traded in a competitive world market and imported into the United States at a world price of

\$9 per pound. U.S. domestic supply and demand for various price levels are shown in the following table.

Price	U.S. Supply (million pounds)	U.S. Demand (million pounds)
3	2	34
6	4	28
9	6	22
12	8	16
15	10	10
18	12	4

Answer the following questions about the U.S. market:

a. Confirm that the demand curve is given by $Q_D = 40 - 2P$, and that the supply curve is given by $Q_S = 2/3P$.

b. Confirm that if there were no restrictions on trade, the United States would import 16 million pounds.

c. If the United States imposes a tariff of \$3 per pound, what will be the U.S. price and level of imports? How much revenue will the government earn from the tariff? How large is the deadweight loss?

d. If the United States has no tariff but imposes an import quota of 8 million pounds, what will be the U.S. domestic price? What is the cost of this quota for U.S. consumers of the fiber? What is the gain for U.S. producers?

7. The United States currently imports all of its coffee. The annual demand for coffee by U.S. consumers is given by the demand curve $Q = 250 - 10P$, where Q is quantity (in millions of pounds) and P is the market price per pound of coffee. World producers can harvest and ship coffee to U.S. distributors at a constant marginal (= average) cost of \$8 per pound. U.S. distributors can in turn distribute coffee for a constant \$2 per pound. The U.S. coffee market is competitive. Congress is considering a tariff on coffee imports of \$2 per pound.

a. If there is no tariff, how much do consumers pay for a pound of coffee? What is the quantity demanded?

b. If the tariff is imposed, how much will consumers pay for a pound of coffee? What is the quantity demanded?

c. Calculate the lost consumer surplus.

d. Calculate the tax revenue collected by the government.

e. Does the tariff result in a net gain or a net loss to society as a whole?

8. A particular metal is traded in a highly competitive world market at a world price of \$9 per ounce. Unlimited quantities are available for import into the United States at this price. The supply of this metal from domestic U.S. mines and mills can be represented by the equation $Q^S = 2/3P$, where Q^S is U.S. output in million ounces and P is the domestic price. The demand for the metal in the United States is $Q^D = 40 - 2P$, where Q^D is the domestic demand in million ounces.

In recent years the U.S. industry has been protected by a tariff of \$9 per ounce. Under pressure from other foreign governments, the United States plans to reduce this tariff to zero. Threatened by this change, the U.S. industry is seeking a voluntary restraint agreement that would limit imports into the United States to 8 million ounces per year.

a. Under the \$9 tariff, what was the U.S. domestic price of the metal?

b. If the United States eliminates the tariff and the voluntary restraint agreement is approved, what will be the U.S. domestic price of the metal?

9. Among the tax proposals regularly considered by Congress is an additional tax on distilled liquors. The tax would not apply to beer. The price elasticity of supply of liquor is 4.0, and the price elasticity of demand is –0.2. The cross-elasticity of demand for beer with respect to the price of liquor is 0.1.

a. If the new tax is imposed, who will bear the greater burden—liquor suppliers or liquor consumers? Why?

b. Assuming that beer supply is infinitely elastic, how will the new tax affect the beer market?

10. In Example 9.1 (page 314), we calculated the gains and losses from price controls on natural gas and found that there was a deadweight loss of \$5.68 billion. This calculation was based on a price of oil of \$50 per barrel.

a. If the price of oil were \$60 per barrel, what would be the free-market price of gas? How large a deadweight loss would result if the maximum allowable price of natural gas were \$3.00 per thousand cubic feet?

b. What price of oil would yield a free-market price of natural gas of \$3?

11. Example 9.5 (page 333) describes the effects of the sugar quota. In 2005, imports were limited to 5.3 billion pounds, which pushed the domestic price to 27 cents per pound. Suppose imports were expanded to 10 billion pounds.

a. What would be the new U.S. domestic price?

b. How much would consumers gain and domestic producers lose?

c. What would be the effect on deadweight loss and foreign producers?

12. The domestic supply and demand curves for hula beans are as follows:

$$\textit{Supply:}\quad P = 50 + Q$$
$$\textit{Demand:}\quad P = 200 - 2Q$$

where P is the price in cents per pound and Q is the quantity in millions of pounds. The U.S. is a small producer in the world hula bean market, where the current price (which will not be affected by anything we do) is 60 cents per pound. Congress is considering a tariff of 40 cents per pound. Find the domestic price of hula beans that will result if the tariff is imposed. Also compute the dollar gain or loss to domestic consumers, domestic producers, and government revenue from the tariff.

13. Currently, the social security payroll tax in the United States is evenly divided between employers and employees. Employers must pay the government a tax of 6.2 percent of the wages they pay, and employees must pay 6.2 percent of the wages they receive. Suppose the tax were changed so that employers paid the full 12.4 percent and employees paid nothing. Would employees be better off?

***14.** You know that if a tax is imposed on a particular product, the burden of the tax is shared by producers and consumers. You also know that the demand for automobiles is characterized by a stock adjustment process. Suppose a special 20-percent sales tax is suddenly imposed on automobiles. Will the share of the tax paid by consumers rise, fall, or stay the same over time? Explain briefly. Repeat for a 50-cents-per-gallon gasoline tax.

***15.** In 2007, Americans smoked 19.2 billion packs of cigarettes. They paid an average retail price of $4.50 per pack.

a. Given that the elasticity of supply is 0.5 and the elasticity of demand is –0.4, derive linear demand and supply curves for cigarettes.

b. Cigarettes are subject to a federal tax, which was about 40 cents per pack in 2007. What does this tax do to the market-clearing price and quantity?

c. How much of the federal tax will consumers pay? What part will producers pay?