Measuring Waste from Inefficiency

We know from Chapters 5 and 6 that consumer surplus and producer surplus are measures of how much consumers and producers gain from buying and selling in a market. The larger these two surpluses are, the better off people are.

**Maximizing the Sum of Producer Plus Consumer Surplus**

An attractive feature of competitive markets is that they maximize the sum of consumer and producer surplus. Producer and consumer surplus are shown in the market supply and market demand diagram in Figure 7-4. Recall that the producer surplus for all producers is the area above the supply curve and below the market price line, and that the consumer surplus for all consumers is the area below the demand curve and above the market price line. Both the consumer surplus and the producer surplus are shown in Figure 7-4. The lightly shaded gray area is the sum of consumer surplus plus producer surplus. The equilibrium quantity is at the intersection of the two curves.

**Deadweight Loss**

We can show that at the equilibrium price and quantity, consumer surplus plus producer surplus is maximized. Figure 7-4 also shows what happens to consumer surplus plus producer surplus when the efficient level of production does not occur. The middle panel of Figure 7-4 shows what the sum of consumer surplus and producer surplus is at market equilibrium. The top panel of Figure 7-4 shows a situation in which the quantity produced is lower than the market equilibrium quantity. Clearly, the sum of consumer and producer surplus is lower. By producing a smaller quantity, we lose the amount of the consumer and producer surplus in the darkly shaded triangular area $A + B$. The bottom panel of Figure 7-4 shows the opposite situation, in which the quantity produced is too high. In this case, we have to subtract the triangular area $C + D$ from the lightly shaded area on the left because price is greater than marginal benefit and lower than marginal cost, which means that consumer surplus and producer surplus are negative in the area $C + D$. In both the top and bottom panels of the figure, these darkly shaded triangles are a loss to society from producing more or less than the efficient amount. Economists call the loss in this darkly shaded area the **deadweight loss**. It is a measure of the waste from inefficient production.

Deadweight loss is not simply a theoretical curiosity with a morbid name; it is used by economists to measure the size of the waste to society of deviations from the competitive equilibrium. By calculating deadweight loss, economists can estimate the benefits and costs of many government programs. When you hear or read that the cost of U.S. agricultural programs is billions of dollars or that the benefit of a world-trade agreement is trillions of dollars, it is the increase or decrease in deadweight loss that is being referred to. To compute the deadweight loss, all we need is the demand curve and the supply curve.
Measuring Economic Loss
When production is less or more than the market equilibrium amount, the economic loss is measured by the loss of consumer surplus plus producer surplus. In the top diagram, the quantity produced is too small. In the bottom diagram, it is too large. In the middle diagram, it is efficient.

REMINDER
Another way to think about the lightly shaded areas in the graphs: The sum of consumer surplus plus producer surplus is the triangular area between the demand curve and the supply curve—shown by the lightly shaded area in the middle graph of Figure 7-4. The graph shows another way to think about this sum: The sum of consumer surplus plus producer surplus equals the marginal benefit minus the marginal cost of all the items produced.
The Deadweight Loss from Price Floors and Ceilings

In Chapter 4, we used the supply and demand model to examine situations in which governments have attempted to control market prices because they were unhappy with the outcome of the market, or because they were pressured by groups who would benefit from price controls. We examined two broad types of price controls: price ceilings, which specify a maximum price at which a good can be bought or sold, and price floors, which specify a minimum price at which a good can be bought or sold. An example of a price floor was the minimum wage, and an example of a price ceiling was a rent control policy.

Using the supply and demand model, we were able to illustrate some of the problems that stemmed from the imposition of price floors or ceilings. When a price floor that is higher than the equilibrium price is imposed, the result will be persistent surpluses of the good. This situation is illustrated by Figure 7-5. The surpluses imply that an inefficient allocation of resources is going toward the good whose price has been inflated artificially. Frequently, costly government programs will be created to buy up surplus production. When a price ceiling that is lower than the equilibrium price is imposed on a market, then the result will be persistent shortages of the good. These shortages mean that mechanisms like rationing, waiting lines, or black markets will be used to allocate the now scarce good. This situation is illustrated by Figure 7-7. Now that we understand the concepts of consumer and producer surplus as well as the idea of deadweight loss, we can use these tools to quantify the negative impacts of price ceilings and price floors.

The Deadweight Loss from a Price Floor

Figure 7-6 shows how consumer and producer surplus are affected by the imposition of a price floor. Before the imposition of the price floor, the sum of consumer and producer surplus is given by the area of the triangle $ABC$, of which the area $BCD$ denotes consumer surplus and the area $ACD$ denotes producer surplus.

Now consider what happens to consumer surplus and producer surplus when a price floor is imposed. The impact on producer surplus is ambiguous. On the one hand, those producers who are fortunate enough to sell at a higher price will obtain more producer surplus. But because the quantity demanded is lower at the higher price, there will be a loss of producer surplus for those producers who previously were able to sell the good but now have no buyers. Producer surplus would be given by the area $AEFG$, which reflects an increase of $DEFI$ (shown in green) and a decrease of $CGI$ (shown in shaded
green) from the previous level of producer surplus. Consumer surplus is reduced unambiguously by the amount $CDEF$ (shown in orange). Overall, when we add up the lost consumer and producer surplus and the gained producer surplus, a deadweight loss is equivalent to the area $CFG$ in Figure 7-6.

**Figure 7-5**

**Price and Quantity Effects of a Price Floor**

If the price floor is set higher than the competitive market price, the quantity demanded by consumers decreases and the quantity supplied by firms increases, creating excess supply.

**Figure 7-6**

**The Deadweight Loss from a Price Floor**

The price floor creates an excess supply of goods at the new higher price. Consumers are unambiguously worse off. Producers may be better off or worse off depending on whether they are able to sell at the higher price. The sum of consumer and producer surplus is lower, indicating a deadweight loss associated with the floor.
The Deadweight Loss from a Price Ceiling

Figure 7-8 shows how consumer and producer surplus are affected by the imposition of a price ceiling. As before, before the imposition of the price ceiling, the sum of consumer and producer surplus is given by the area of the triangle $ABC$, of which the area $BCD$ denotes consumer surplus and the area $ACD$ denotes producer surplus.

**Figure 7-7**

**Price and Quantity Effects of a Price Ceiling**

If the price ceiling is set below the competitive market price, the quantity demanded by consumers increases and the quantity supplied by firms decreases, creating excess demand.

**Figure 7-8**

**The Deadweight Loss from a Price Ceiling**

The price ceiling creates an excess demand for goods at the new lower price. Producers are unambiguously worse off. Consumers may be better or worse off depending on whether they are able to buy at the lower price. The sum of consumer and producer surplus is lower, indicating a deadweight loss associated with the ceiling.
Now consider what happens to consumer surplus and producer surplus when a price ceiling is imposed. The impact on consumer surplus is ambiguous: Those consumers who are able to acquire the good at the lower price will obtain more consumer surplus. Because only a smaller quantity of goods is available for purchase, however, there will be a loss of consumer surplus for those who previously were able to buy the good but now cannot. Consumer surplus would be given by the area $BFGH$, which reflects an increase of $DHGI$ (shown in green) and a decrease of $CFI$ (shown in orange) from the previous level of consumer surplus. Producer surplus is reduced unambiguously by the amount $CDHG$ (shown by the green-shaded area). Overall, when we combine the lost consumer and producer surplus with the gained consumer surplus, a deadweight loss is equivalent to the area $CFG$ in Figure 7-8.

**REVIEW**

- Both price floors and price ceilings bring about deadweight loss. Some parties clearly lose; other parties may gain, but overall, the losses exceed the gains.
- In the case of a price floor, consumers unambiguously lose because they buy fewer units at a higher price. Some producers gain because they are able to sell at a higher price than before. Others lose because they are no longer able to sell the good because the government does not allow them to lower the price to attract buyers.
- In the case of a price ceiling, producers unambiguously lose because they sell fewer units at a lower price. Some consumers gain because they are able to buy the good at a lower price than before. Others lose because they are no longer able to buy the good, even though they are willing to pay more, because the government does not allow firms to raise the price.

**The Deadweight Loss From Taxation**

Another important application of deadweight loss is in estimating the impact of a tax. To see how, let’s examine the impact of a tax on a good. We will see that the tax shifts the supply curve, leads to a reduction in the quantity produced, and reduces the sum of producer surplus plus consumer surplus.

Figure 7-9 shows a supply and demand diagram for a particular good. In the absence of the tax, the sum of producer and consumer surplus is given by the area of the triangle $ABC$, of which the area $BCD$ denotes consumer surplus and the area $ACD$ denotes producer surplus.

**A Tax Paid by a Producer Shifts the Supply Curve**

A tax on sales is a payment that must be made to the government by the seller of a product. The tax may be a percentage of the dollar value spent on the products sold, in which case it is called an *ad valorem tax*. A 6 percent state tax on retail purchases is an ad valorem tax. Or it may be proportional to the number of items sold, in which case the tax is called a *specific tax*. A tax on gasoline of $0.50 per gallon is an example of a specific tax.

Because the tax payment is made by the producer or the seller to the government, the immediate impact of the tax is to add to the marginal cost of producing the product. Hence, the immediate impact of the tax will be to shift the supply curve. For example, suppose each producer has to send a certain amount, say, $0.50 per gallon of gasoline produced and sold, to the government. Then $0.50 must be added to the marginal cost per gallon for each producer.

The resulting shift of the supply curve is shown in Figure 7-9. The vertical distance between the old and the new supply curves is the size of the sales tax in dollars. The supply
curve shifts up by this amount because this is how much is added to the marginal costs of the producer. (Observe that this upward shift can just as accurately be called a leftward shift because the new supply curve is above and to the left of the old curve. Saying that the supply curve shifts up may seem confusing because when we say “up,” we seem to mean “more supply.” But the “up” is along the vertical axis, which has the price on it. The upward, or leftward, movement of the supply curve is in the direction of less supply, not more supply.)

A New Equilibrium Price and Quantity

What does the competitive equilibrium model imply about the change in the price and the quantity produced? Observe the new intersection of the supply curve and the demand curve. Thus, the price rises to a new, higher level, and the quantity produced declines.

The price increase, as shown in Figure 7-9, is not as large as the increase in the tax. The vertical distance between the old and the new supply curves is the amount of the tax, but the price increases by less than this distance. Thus, the producers are not able to “pass on” the entire tax to the consumers in the form of higher prices. If the tax increase is $0.50, then the price increase is less than $0.50, perhaps $0.40. The producers have been forced by the market—by the movement along the demand curve—to reduce their production, and by doing so they have absorbed some of the impact of the tax increase.

Deadweight Loss and Tax Revenue

Now consider what happens to consumer surplus and producer surplus with the sales tax. Because the total quantity produced is lower, there is a loss in consumer surplus and producer surplus. The right part of the triangle of consumer plus producer surplus, corresponding to the area $CFG$, has been cut off, and this is the deadweight loss to society, as shown in Figure 7-9.
Price Controls and Deadweight Loss in the Milk Industry

Since the 1930s, the federal government has intervened in the milk market (and other agricultural markets) to stabilize farm prices and provide some income protection for U.S. farmers. The government has used a combination of complex regulations that include government purchases and subsequent disposal of dairy products, import restrictions, export subsidies, and pricing mechanisms depending on the location and purpose of the production of milk. We can see how price controls lead to deadweight loss by looking more closely at one of these programs.

The Food and Agriculture Act of 1977 was aimed at sustaining higher prices received by dairy farmers. As we know, the competitive market price occurs when the quantity demanded equals the quantity supplied, but the higher price floor mandated by the government reduced the quantity demanded and gave farmers an incentive to produce more milk, causing excess supply. To support the price floor, the government purchased the excess supply of milk in the form of dry milk, butter, and cheese. Of course, this program came at a cost: close to $2 billion a year in net government expenditures in the early 1980s.

In 1994, economists Peter Helmberger and Yu-Hui Chen estimated what would happen if the government deregulated the milk market. In the short run, they found that consumer surplus would increase by $3.9 billion a year, producer surplus would decrease by $4 billion, and net government expenditures would decrease by $600 million, eliminating a deadweight loss of $500 million a year. As you can see, the price floor is $500 million more expensive than a simple program in which the government directly transfers $3.9 billion from consumers to farmers and throws in an extra $100 million. Interestingly, though, consumers would be much more likely to protest against such a blatant transfer of income than they are to complain about the much more wasteful and inefficient price support program.

The Federal Agricultural Improvement and Reform (FAIR) Act of 1996 mandated the elimination of the price support program by the end of 1999. However, the dairy subsidies were soon reinstated by the farm bill signed by President Bush in May 2002, which increased total agricultural subsidies from $100 billion to close to $200 billion a year. As part of that bill, a program called the Milk Income Loss Contract (MILC) was established. Under this program, the market price of drinking milk in Boston was chosen as the standard for the rest of the country. When that price fell below $16.94 per 100 pounds, all U.S. dairy farmers receive a government subsidy of 45 percent of the difference between the Boston market price and $16.94. Another farm bill, passed in 2008, allowed for the $16.94 price standard to be adjusted upward depending on the price of feed. In December 2010, the adjusted price standard was $18.05. However, the actual price of milk in Boston had risen sharply to $20.21, which meant that farmers were not receiving any payment under the MILC program. That farm bill also established support prices of $1.05 per pound for butter and $1.10 per pound for cheddar cheese barrels.

The current system of dairy subsidies will be reexamined by Congress in 2012. As the renewal date approaches, you should read news articles about the policy debate surrounding the renewal of dairy subsidies and see for yourself how much economic analysis is employed in public policy debates.
Consumer surplus is now given by the triangle $BEF$, while producer surplus is given by the triangle $AGH$ (keep in mind that producers do not receive the new price; they only get the new price less the tax). The tax generates revenue for the government that can be used to finance government activity. Some of what was producer surplus and consumer surplus thus goes to the government. If the tax is $1 and 100 items are sold, the tax revenue is $100. This amount is shown by the green rectangle $EFGH$ on the diagram. Adding up consumer and producer surplus plus the government revenue gives us an area corresponding to $ABFG$, which differs from the original sum of consumer and producer surplus ($ABC$) by the magnitude of the deadweight loss ($CFG$). So even though taxes may be necessary to finance the government, they cause a deadweight loss to society in the form of lost consumer surplus and producer surplus that are no longer available to anyone in the economy.

**REVIEW**

- The impact of a tax on the economy can be analyzed using consumer surplus and producer surplus.
- Taxes are necessary to finance government expenditures, but they lower the production of the item being taxed.
- The loss to society from the decline in production is measured by the reduction in consumer surplus and producer surplus, the deadweight loss due to the tax.

**Informational Efficiency**

We have shown that a competitive market works well in that the outcome is Pareto efficient. For every good, the sum of consumer surplus and producer surplus is maximized. These are important and attractive characteristics of a competitive market.

Another important and attractive characteristic of a competitive market is that the market processes information efficiently. For example, in a competitive market, the price reflects the marginal benefit for every buyer and the marginal cost for every seller. If a government official were asked to set the price in a real market, there would be no way that such information could be obtained, especially with millions of buyers and sellers. In other words, the market seems to be informationally efficient. Pareto efficiency is different from this information efficiency.

In the 1930s and 1940s, as the government of the former Soviet Union tried to centrally plan production in the entire economy, economists became more interested in the informational efficiency of markets. One of the most outspoken critics of central planning, and a strong advocate of the market system, was Friedrich Hayek, who emphasized the importance of the informational efficiencies of the market. In Hayek’s view, a major disadvantage of central planning—in which the government sets all the prices and all the quantities—is that it is informationally inefficient.

If you had all the information about all the buyers and sellers in the market, you could set the price to achieve a Pareto efficient outcome. To see Hayek’s point, it is perhaps enough to observe that, without private information about every one of the millions of buyers and sellers, you or any government official would not know where to set the price. However, economists do not have results as neat as the first theorem of welfare