

## >> Consumer and Producer Surplus

### Section 4: Applying Consumer and Producer Surplus: The Efficiency Costs of a Tax

The concepts of consumer and producer surplus are extremely useful in many economic applications. Among the most important of these is assessing the efficiency cost of taxation.

In Chapter 4 we introduced the concept of an *excise tax*, a tax on the purchase or sale of a good. We saw that such a tax drives a *wedge* between the price paid by consumers and that received by producers: the price paid by consumers rises, and the price received by producers falls, with the difference equal to the tax per unit. The *incidence* of the tax—how much of the burden falls on consumers, how much on producers—does not depend on who actually writes the check to the government. Instead, as we saw in Chapter 5, the burden of the tax depends on the price elasticities of supply and demand: the higher the price elasticity of demand, the greater the burden on producers; the higher the price elasticity of supply, the greater the burden on consumers.

We also learned that there is an additional cost of a tax, over and above the money actually paid to the government. A tax causes a *deadweight loss* to society, because less

of the good is produced and consumed than in the absence of the tax. As a result, some mutually beneficial trades between producers and consumers do not take place.

Now we can complete the picture, because the concepts of consumer and producer surplus are what we need to pin down precisely the deadweight loss that an excise tax imposes.



Figure 6-14 shows the effects of an excise tax on consumer and producer surplus. In the absence of the tax, the equilibrium is at  $E$ , and the equilibrium price and quantity are  $P_E$  and  $Q_E$ , respectively. An excise tax drives a wedge equal to the amount of the tax between the price received by producers and the price paid by consumers, reducing the quantity bought and sold. In this case, where the tax is  $T$  dollars per unit, the quantity bought and sold falls to  $Q_T$ . The price paid by consumers rises to  $P_C$ , the demand price of the reduced quantity, and the price received by producers falls to  $P_P$ , the supply price of that quantity. The difference between these prices,  $P_C - P_P$ , is equal to the excise tax,  $T$ .

What we can now do, using the concepts of producer and consumer surplus, is show exactly how much surplus producers and consumers lose as a result of the tax.

We saw earlier, in Figure 6-5 in Section 6.1: Consumer Surplus and the Demand Curve, that a fall in the price of a good generates a gain in consumer surplus that is equal to the sum of the areas of a rectangle and a triangle. A price increase causes a loss to consumers that looks exactly the same. In the case of an excise tax, the rise in the price paid by consumers causes a loss equal to the sum of the area of the dark blue rectangle labeled  $A$  and the area of the light blue triangle labeled  $B$  in Figure 6-14.

Meanwhile, the fall in the price received by producers causes a fall in producer surplus. This, too, is the sum of the areas of a rectangle and a triangle. The loss in producer surplus is the sum of the areas of the red rectangle labeled  $C$  and the pink triangle labeled  $F$  in Figure 6-14.

Of course, although consumers and producers are hurt by the tax, the government gains revenue. The revenue the government collects is equal to the tax per unit sold,

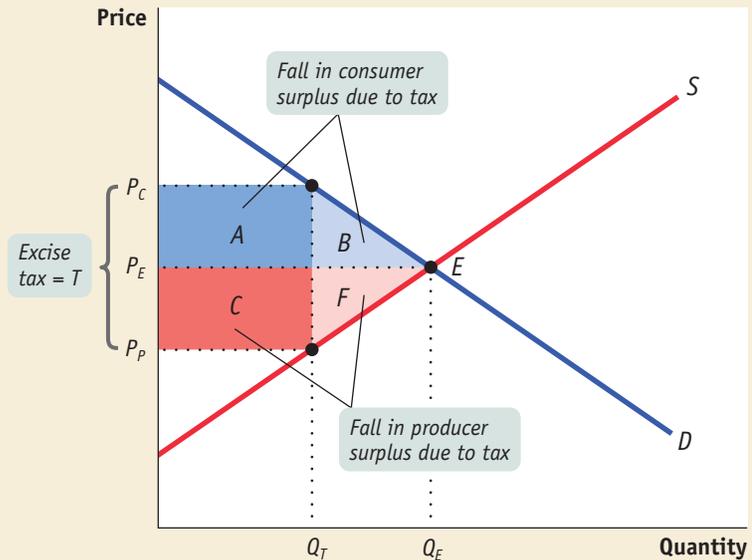
$T$ , multiplied by the quantity sold,  $Q_T$ . This revenue is equal to the area of a rectangle  $Q_T$  wide and  $T$  high. And we already have that rectangle in the figure: it is the sum of rectangles  $A$  and  $C$ . So the government gains part of what consumers and producers lose from an excise tax.

But there is a part of the loss to producers and consumers from the tax that is not offset by a gain to the government—specifically, the two triangles  $B$  and  $F$ . The dead-

**Figure 6-14**

### A Tax Reduces Consumer and Producer Surplus

Before the tax, the equilibrium price and quantity are  $P_E$  and  $Q_E$ , respectively. After an excise tax of  $T$  per unit is imposed, the price to consumers rises to  $P_C$  and consumer surplus falls by the sum of the dark blue rectangle, labeled  $A$ , and the light blue triangle, labeled  $B$ . The tax also causes the price to producers to fall to  $P_P$ ; producer surplus falls by the sum of the red rectangle, labeled  $C$ , and the pink triangle, labeled  $F$ . The government receives revenue from the tax,  $Q_T \times T$ , which is given by the sum of the areas  $A$  and  $C$ . Areas  $B$  and  $F$  represent the losses to consumer and producer surplus that are not collected by the government as revenue; they are the dead-weight loss to society of the tax.



weight loss caused by the tax is equal to the combined area of these triangles. It represents the total surplus that would have been generated by transactions that do not take place because of the tax.

Figure 6-15 is a version of the same picture, leaving out the shaded rectangles—which represent money shifted from consumers and producers to the government—and showing only the deadweight loss, this time as a triangle shaded yellow. The base of that triangle is the tax wedge,  $T$ ; the height of the triangle is the reduction the tax causes in the quantity sold,  $Q_E - Q_T$ . Notice that if the excise tax *didn't* reduce the quantity bought and sold in this market—if  $Q_T$  weren't less than  $Q_E$ —the deadweight loss represented by the yellow triangle would disappear. This observation ties in with the explanation given in Chapter 4 of why an excise tax generates a deadweight loss to society: the tax causes inefficiency because it discourages mutually beneficial transactions between buyers and sellers.

The idea that deadweight losses can be measured by the area of a triangle recurs in many economic applications. Deadweight-loss triangles are produced not only by excise taxes but also by other types of taxation. They are also produced by other kinds of distortions of markets, such as monopoly. And triangles are often used to evaluate other public policies besides taxation—for example, decisions about whether to build new highways.



The general rule for economic policy is that other things equal, you want to choose the policy that produces the smallest deadweight loss. This principle gives valuable guidance on everything from the design of the tax system to environmental policy. But how can we predict the size of the deadweight loss associated with a given policy? For the answer to that question, we return to a familiar concept: elasticity.

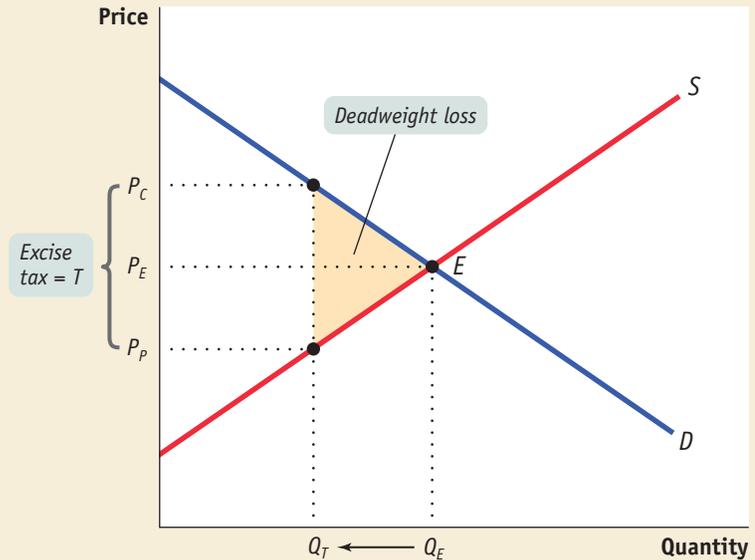
## Deadweight Loss and Elasticities

The deadweight loss from an excise tax arises because it prevents some mutually beneficial transactions from occurring. In particular, the producer and consumer surplus that is forgone from these missing transactions is equal to the size of the deadweight loss itself. This means that the larger the number of transactions that are impeded by the tax, the larger the deadweight loss.

**Figure 6-15**

### The Deadweight Loss of a Tax

A tax leads to a deadweight loss because it creates inefficiency: some mutually beneficial transactions never take place because of the tax, namely the transactions  $Q_E - Q_T$ . The yellow area here represents the value of the deadweight loss: it is the total surplus that would have been gained from the  $Q_E - Q_T$  transactions. If the tax had not discouraged transactions—had the number of transactions remained at  $Q_E$ —no deadweight loss would have been incurred.



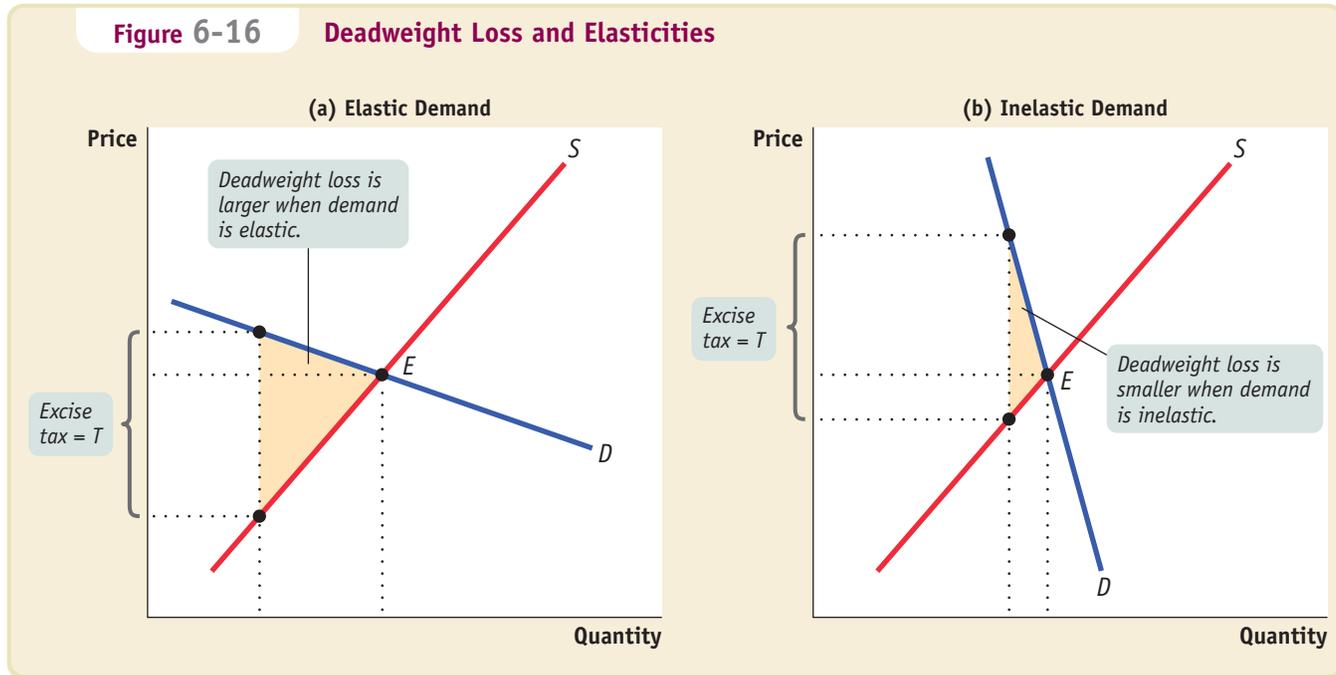
This gives us an important clue in understanding the relationship between elasticity and the size of deadweight loss from a tax. Recall that when demand or supply is elastic, it means that the quantity demanded or the quantity supplied is relatively responsive to price. So a tax imposed on a good for which either demand or supply, or both, is elastic will cause a relatively large decrease in the quantity transacted and a large deadweight loss. And when we say that demand or supply is inelastic, we mean that the quantity demanded or the quantity supplied is relatively unresponsive to price. As a result, a tax imposed when demand or supply, or both, is inelastic will cause a relatively small decrease in quantity transacted and a small deadweight loss.

The four panels of Figure 6-16 illustrate the positive relationship between price elasticity of either demand or supply and the deadweight loss of taxation. In each panel, the size of the deadweight loss is given by the area of the shaded triangle. In panel (a), the deadweight-loss triangle is large because demand is relatively elastic—a large number of transactions fail to occur because of the tax. In panel (b), the same supply curve is drawn as in panel (a), but demand is now relatively inelastic; as a result, the triangle is small because only a small number of transactions are forgone. Likewise, panels (c) and (d) contain the same demand curve but different supply curves. In panel (c), an elastic supply curve gives rise to a large deadweight-loss triangle, but in panel (d) an inelastic supply curve gives rise to a small deadweight-loss triangle.

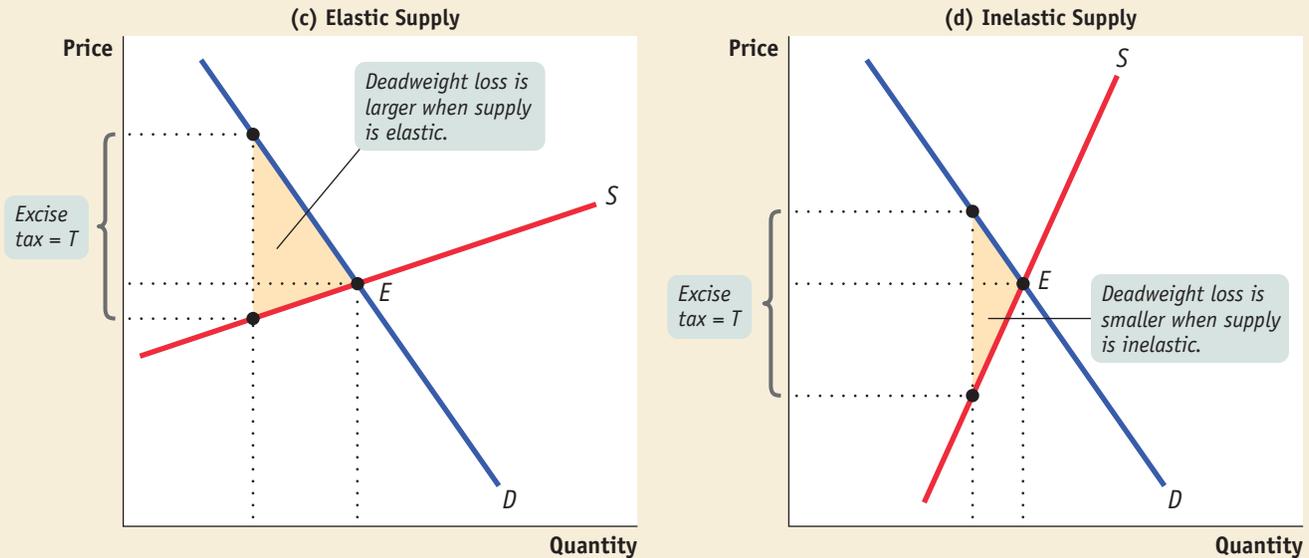
As the following story illustrates, the implication of this result is clear: if you want to lessen the efficiency costs of taxation, you should devise taxes to fall on goods for which either demand or supply, or both, is relatively inelastic. And this lesson carries a flip-side: using a tax to purposely decrease the amount of a harmful activity, such as underage drinking, will have the most impact when that activity is elastically demanded or supplied. In the extreme case in which demand is perfectly inelastic (a

vertical demand curve), the quantity demanded is unchanged by the imposition of the tax. As a result, the tax imposes no deadweight loss. Similarly, if supply is perfectly inelastic, (a vertical supply curve), the quantity supplied is unchanged by the tax and there is also no deadweight loss.

**Figure 6-16** Deadweight Loss and Elasticities



**Figure 6-16** Deadweight Loss and Elasticities (continued)



Demand is elastic in panel (a) and inelastic in panel (b), but the supply curves are the same. Supply is elastic in panel (c) and inelastic in panel (d), but the demand curves are the same. The deadweight losses are larger in panels (a) and (c) than in panels (b) and (d) because the greater the

elasticity of demand or supply, the greater the tax-induced fall in the quantity transacted. In contrast, when demand or supply is inelastic, the smaller the tax-induced fall in the quantity transacted, and the smaller the deadweight loss.