18

TAX INCIDENCE

When Congress or a state legislature enacts a new tax, the debate usually includes some opinions about who should pay for running the government or for the particular program being supported by the tax. For example, when Congress adopted the Social Security tax to pay for the Social Security system, it levied half the tax on the employer and half on the employee. It thought that both parties should share in the costs of the Social Security system.

Economic reality, however—for better or worse—does not always follow the laws passed by legislatures. Thus, economists distinguish between those who bear the **burden** of a tax and those on whom a tax is imposed or levied. The *tax burden* is the true economic weight of a tax. It is the difference between the individual's real income before and after the tax has been imposed, taking full account of how wages and prices may have adjusted. Economists use a more neutral word to describe the effects of taxation—they ask, what is the **incidence** of the tax? Who actually pays, in the sense that real income is lowered? This chapter studies the incidence of various taxes.

The actual incidence of the tax may differ markedly from the intended incidence. Consider two taxes that are imposed on firms: the employer-paid portion of the Social Security tax and the corporation income tax.

As a result of either tax, wages might fall or prices might rise. If wages fall, we say that the tax **shifted backward** (to a factor of production, labor). If wages fall by the full amount of the tax, we say that they have been *fully shifted*; if wages fall by less than the amount of the tax, we say they have been *partially shifted*. If prices rise, we say that the tax **shifted forward** (to consumers). Most economists believe that most of the employer-paid portion of the Social Security tax is shifted backward and that the effect of the tax officially levied on employers is essentially the same as that levied on workers. Thus, although the government has levied only half of the tax on employees, the employees bear the full (or almost the full) burden of the tax in the form of lower wages.

There is considerable controversy over the incidence of the corporation income tax. Although one reason the tax is popular is that, ostensibly, firms and their shareholders pay the tax, most economists believe that a substantial portion of the tax is shifted. If firms raise their prices as a result of the tax, the tax is borne by consumers. If, as a result of the tax, demand for labor falls and wages fall, the tax is partially borne by workers, not investors. If the tax makes investing in the corporate sector less attractive, capital will move out of the sector, driving down the return to capital in the unincorporated sector. Thus, part of the burden of the corporate tax is on capital as a whole, not just capital in the corporate sector.

The study of tax incidence is one of the most important and difficult topics in the economics of the public sector. In the preceding chapter, we saw that one of the principles of a desirable tax system is that it should be *fair*. Fairness, however, depends not on whom the tax is imposed, but on who actually pays the tax—on the incidence of the tax. If it were decided, for instance, that fairness dictated that owners of capital should pay higher taxes, but the tax was levied in such a way that the owners of capital could shift the tax onto consumers or workers, then the tax would not have achieved its goal. Economics, not Congress, often determines who actually bears the burden of a tax, although in designing the tax Congress can often affect the outcome: two taxes, both imposed on corporations but differently designed, can have markedly different consequences.

Just as two taxes that look similar—in that both are imposed on, say, corporations—can have markedly different effects, two taxes that look different, in that they are imposed in quite different ways, can have identical effects. Such taxes are said to be **equivalent**.

In Chapter 17 we saw that another principle of a desirable tax system, besides fairness, is transparency. This has two implications. First, it is preferable to impose taxes whose incidence is clear. Second, because most individuals do not understand incidence analysis, it is preferable to impose taxes in a manner that makes the apparent incidence of a tax correspond to the actual incidence. Thus, imposing half of the Social Security tax on

FOCUS QUESTIONS

1. What is meant by the incidence of a tax? Why is it that those who ultimately bear the burden of a tax may differ markedly from those on whom the tax is legally imposed?
2. What determines who bears the burden of taxes? How does it depend on the elasticity of demand and supply? On whether markets are competitive or not? Why might it differ between the short run and the long run?
3. Why are some taxes that appear to be markedly different really equivalent?
4. Who bears the burden of taxation in the United States?

the employer contributes to the lack of transparency, as it makes workers believe that the employer actually bears half the burden of the tax.

The incidence of a tax depends on a number of factors—most important, on whether the economy is competitive; and if it is competitive, on the shape of the demand and supply curves. This chapter is divided into five sections. The first and second analyze incidence in perfectly competitive markets and in markets in which there is imperfect or no competition. The third analyzes some important equivalent tax structures. In the fourth section, some other important determinants of incidence are discussed, examining a tax on capital in the corporate sector. In the final section, we discuss briefly the implications of our analysis for the overall incidence of taxation in the United States.

Although this chapter focuses on the incidence of taxes, it should be clear that precisely the same issues arise in discussing subsidies and other benefits, such as those discussed in earlier chapters on government expenditures. If corn is subsidized, for instance, it may not be corn growers who really benefit: if the price of corn falls, the benefit is shifted forward to consumers; if the price of land on which corn is grown increases, the benefit is shifted backward to the owners of land. The principles elucidated here apply equally to the analysis of government benefit programs.

TAX INCIDENCE IN COMPETITIVE MARKETS

In this section, we will show that it makes no difference whether a tax on a commodity is legally imposed on the commodity's consumers or on its producers—it makes no difference whether producers of beer or its consumers "pay" the tax. What does make a difference is the shape of the demand and supply curves.

EFFECT OF TAX AT THE LEVEL OF A FIRM

Consider a commodity tax imposed at a fixed rate per unit of the good (e.g., so many cents per can of beer) that the firm must pay. Figure 18.1 illustrates the effect of the tax on the firm's production decision. In competitive markets, firms produce at the level at which price equals marginal costs.[1] If the firm has to pay the tax, then its effective cost of production has been increased, *by the amount of the tax*. Accordingly, the amount it is willing to supply at the price p_0 is reduced.

[1] At lower levels of output, increasing output increases revenues by more than the increased costs, so profits increase. The converse occurs at higher levels of output.

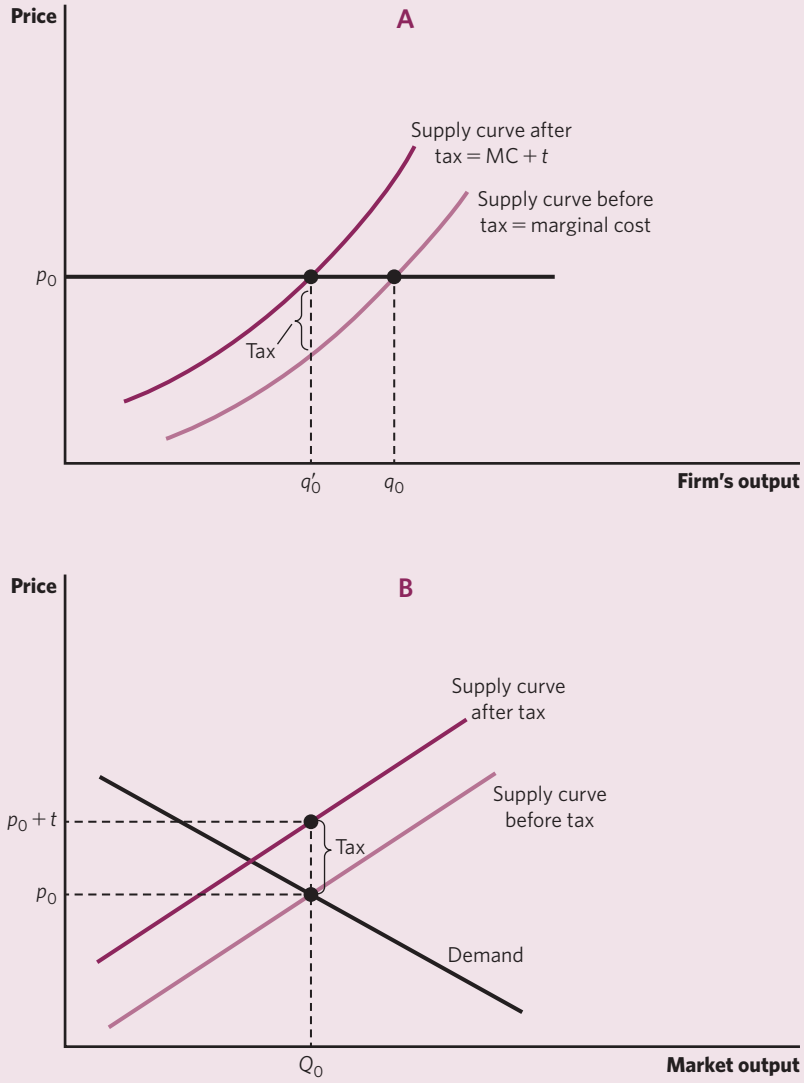


FIGURE 18.1

THE EFFECT OF A COMMODITY TAX ON SUPPLY

(A) Shows the effect of a commodity tax on the quantity supplied by a firm. At any price, p_0, the firm will supply a lower quantity. The tax can be thought of as increasing the marginal cost of production. Output supplied is reduced from q_0 to q_0'. (B) Shows the effect of a commodity tax on the market supply curve and equilibrium. At each price the market is willing to supply less (the supply curve shifts to the left), or, equivalently, the price required to elicit a given supply out of the market is higher, by an amount exactly equal to the tax.

The firm's supply curve gives the amount the firm is willing to supply at each price. Its supply curve is shifted, as illustrated in Figure 18.1A. This is, of course, true for *every* firm. The *market* supply curve gives the total amount that *all* firms are willing to supply at each price. It is simply the "sum" of the supply curves of each firm. Equivalently, we can think of the market supply curve as telling us what the market price must be for firms to be willing to produce a given level of output. The market supply curve, like the individual firm supply curves, is shifted, as illustrated in Figure 18.1B. The amount of the shift is easy to ascertain. If t is the tax rate, then the net

amount received by the firm when the price is $p_0 + t$ after the tax is the same as it would have received when the price was just p_0 before the tax; the quantity that each firm is thus willing to supply at the price $p_0 + t$ after the tax is the same as it would have been willing to supply at the price p_0 before the tax. In effect, the supply curve is shifted up by the amount of the tax.

IMPACT ON MARKET EQUILIBRIUM

We can now easily see the impact of the tax on prices and output. Figure 18.2 shows the equilibrium before taxes, at the intersection of the demand and supply curve, at which Q_0 bottles of beer are produced in equilibrium, at a price of $1 each.

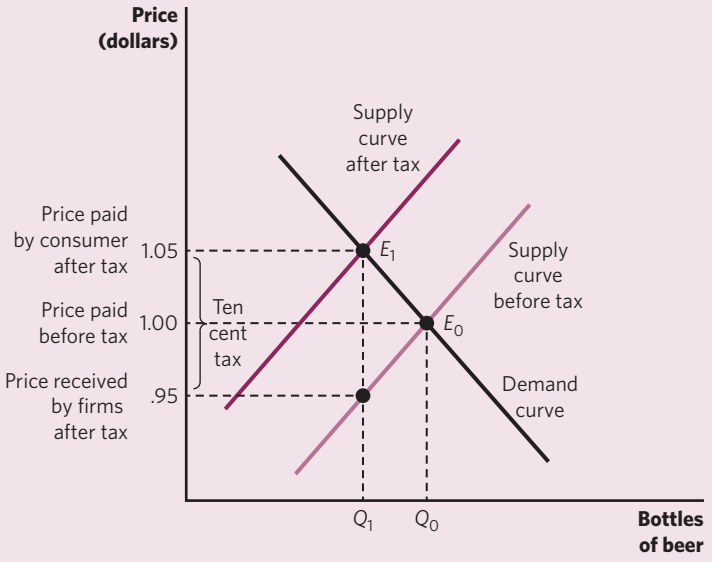
Assume that the tax on each producer is 10 cents per bottle of beer. The supply curve shifts up by that amount, and the price rises. Although the tax was nominally imposed on producers, consumers are forced to pay a part of the increased cost, through higher prices. Notice, however, that in this example, the price rises by less than 10 cents, to $1.05. Producers cannot shift the entire cost of the tax to consumers because as the price rises, the quantity demanded falls.

Each firm now receives the higher price of $1.05, and faces additional costs of 10 cents per bottle. The firms in Figure 18.2 produce less than before the tax, but more than they would have if consumers did not bear part of the additional cost.

FIGURE 18.2

EFFECT OF TAX ON PRICES AND QUANTITIES

The tax shifts the supply curve up by the amount of tax. This lowers the quantity consumed and raises the price paid by consumers.



DOES IT MATTER WHETHER THE TAX IS LEVIED ON CONSUMERS OR ON PRODUCERS?

Consider now what would happen if Congress passed a beer tax, but this time said that consumers would have to pay the tax. For each bottle of beer purchased, consumers would have to pay a 10-cent tax. What consumers care about, of course, is not who receives the money they pay, but simply the total cost of the beer—just as what producers care about is how much they receive. Return to Figure 18.2, which showed the effect of a 10-cent tax imposed on producers. At the new equilibrium output Q_1, producers receive \$0.95, after tax, and consumers pay \$1.05. In that situation, the producers mail the government a check for 10 cents for every bottle of beer. However, nothing would change if consumers, or the retailers from whom they buy beer, had to send a check in for the same amount. Producers would then pay no *direct* attention to the tax. They would sell the beer to consumers for 95 cents, and at that price they would be willing to produce Q_1. Consumers would pay the producers 95 cents and pay the government 10 cents, for a total price of \$1.05. At the total price of \$1.05, they are willing to purchase Q_1, so at Q_1—a consumer price of \$1.05 and a producer price of \$0.95—demand equals supply.

This situation is depicted diagrammatically in Figure 18.3. If we now interpret the price on the vertical axis to be the price received by the

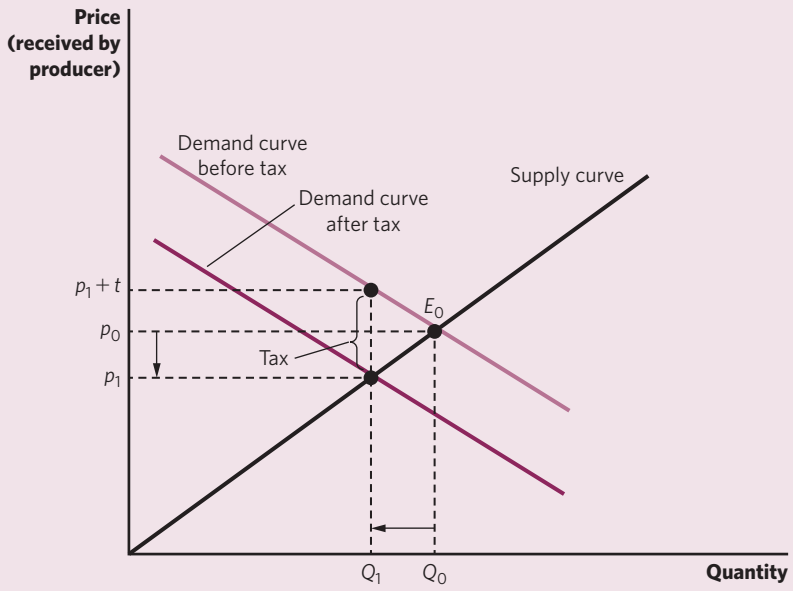


FIGURE 18.3

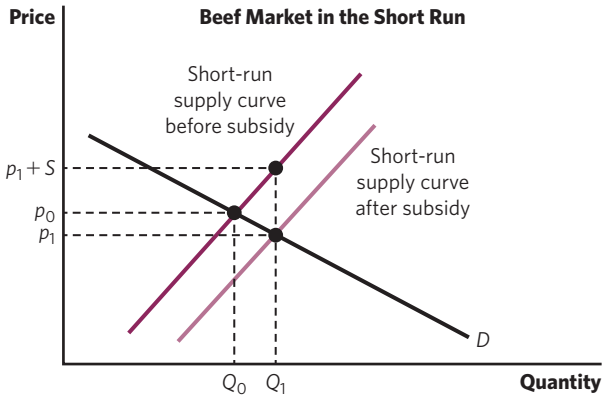
ALTERNATE VIEWS OF A TAX

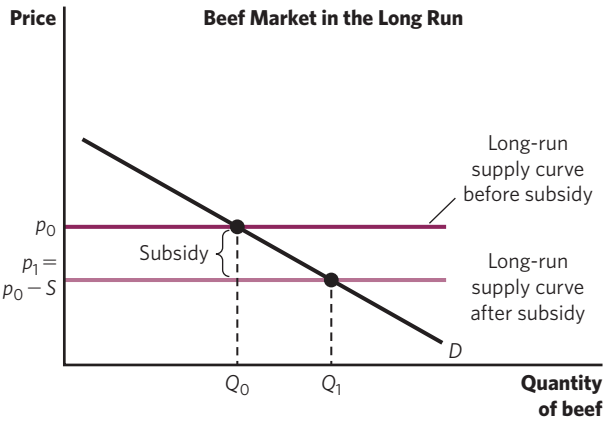
The effects of a tax can be viewed as either a downward shift in the demand curve or an upward shift in the supply curve (compare with Figure 18.2).

THE INCIDENCE OF GOVERNMENT BENEFITS

The framework we have developed for analyzing the incidence of taxes can be used to analyze the incidence of a government program or subsidy. Consider a subsidy for beef. For simplicity, assume that the government subsidizes beef at $1 a pound. In the short run, the supply curve is relatively inelastic, as depicted in the top figure on the right. That means there is a small quantity response, but a large price response: in the short run much of the benefit does go to farmers.

In the long run, however, as entry occurs and producers can expand their facilities, the supply curve for beef becomes relatively flat; there is a large supply of acreage that can be used for pasture, and even though it takes time to breed cattle, they can be bred, and the costs of breeding and feeding are roughly fixed. The bottom figure on the right for the long-run beef market shows a horizontal supply curve combined with a downward-sloping demand curve, and the before-subsidy equilibrium at Q_0. The subsidy can be thought of as shifting the supply curve as depicted. The new equilibrium entails a larger quantity, but the price received by farmers remains unchanged. In the long run, all the benefit of the subsidy is received by meat consumers, none by farmers.





producer (rather than the price paid by the consumer), the tax on consumers can be represented by a downward shift in the demand curve, by the amount of the tax. That is, if the producer receives p_1, the consumer must pay $p_1 + t$, and the level of demand is Q_1, just as it would be if, in the before-tax situation, producers had charged $p_1 + t$. It should be apparent

that it makes no difference whether Congress imposes the tax on the producers of beer or on the consumers of beer.

AD VALOREM VERSUS SPECIFIC TAXES

Not only does it make no difference on whom the tax is levied, but it also makes no difference whether the tax is levied as a given percentage of the price or as a fixed amount per unit output. The former is called an **ad valorem tax**, the latter, a **specific tax**.

The ad valorem tax can be thought of as shifting down the demand curve, with the amount by which it is shifted down depending on the price, as illustrated in Figure 18.4. At a zero price, at which the demand curve intersects the horizontal axis, there is no tax. The manufacturer receives a fixed percentage of the price paid by the consumer, say, 95 percent, if the ad valorem tax rate is 5 percent. E_1 is the after-tax equilibrium, at the intersection of the after-tax demand curve D_1D_1 and the supply curve. In the figure, the after-tax demand curve is also drawn for the case of a specific tax *that is of the same magnitude at the equilibrium* E_1. With the tax at the same level at the equilibrium, the demand curve is shifted down by the same amount at that level of output, and thus the equilibrium output, tax revenues, prices paid by consumers, and prices received by manufacturers are all the same.

In practice the two taxes often differ, because tax authorities cannot adjust appropriately for differences in qualities of goods. When the government levies a specific tax—say, so many cents per pack of cigarettes—the tax is the same regardless of the quality of the product. Thus, the tax is a higher

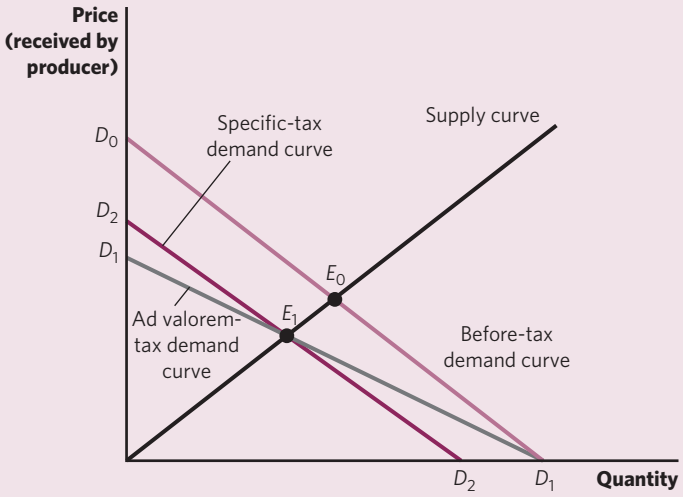


FIGURE 18.4

AD VALOREM AND SPECIFIC COMMODITY TAXES

In competitive markets, an ad valorem tax (a tax that is a fixed percentage of the price) and a specific tax (a tax that is a fixed amount per unit purchased) that raise the same revenue have the same effect on output.

TAX INCIDENCE

- The incidence of a tax describes who actually bears the tax. It does not depend on who writes the check to the government.
- It makes no difference whether a commodity tax is levied on producers or consumers.
- It makes no difference whether the Social Security tax (payroll tax) is paid half by the employer and half by the employee, or entirely paid by one or the other.
- In a competitive market, the incidences of an ad valorem tax and an equivalent specific tax are identical.

percentage of the price for low-quality goods than it is for higher-quality goods. In effect, the specific tax discriminates against lower-quality goods. Although, in principle, the government could adjust the specific tax rate to offset this bias, in fact it seldom does so.

On the other hand, it is often easier to monitor the quantity of a good sold than to monitor its price, particularly when firms sell more than one commodity. If these commodities are taxed at different ad valorem rates, there is an incentive to strike deals in which the higher-taxed commodity is underpriced on invoices, and the tax administrator may not be able to detect this. This kind of administrative problem has been the principal determinant of the form of taxation.

THE EFFECT OF ELASTICITY

The amount by which price rises—the extent to which consumers bear a tax—depends on the shape of the demand and supply curves, not on whom the tax is levied. In two limiting cases, the price rises by the full 10 cents, so the entire burden is borne by consumers. This occurs when the supply curve is perfectly horizontal, as in Figure 18.5A, or when the demand curve is perfectly vertical (individuals insist on consuming a fixed amount of beer, regardless of price), as in Figure 18.5B.

In two cases, the price paid by consumers does not rise at all; that is, the tax is borne entirely by producers, as shown in Figure 18.6. This occurs when the supply curve is perfectly vertical—the amount supplied does not depend at all on price—or when the demand curve is perfectly horizontal.

More generally, the steeper the demand curve or the flatter the supply curve, the more the tax will be borne by consumers; the flatter the demand curve or the steeper the supply curve, the more the tax will be borne by producers. We measure the steepness of a demand curve by the **elasticity of demand**; the elasticity of demand gives the percentage change in the quantity of the good consumed due to a

INCIDENCE IN COMPETITIVE MARKETS

- In competitive markets, incidence depends on the elasticity of demand and supply.
- A commodity tax is not borne at all by consumers if the demand curve is perfectly elastic, or by producers if the supply curve is perfectly elastic. It is borne completely by consumers if the demand curve is perfectly inelastic, or by producers if the supply curve is perfectly inelastic.

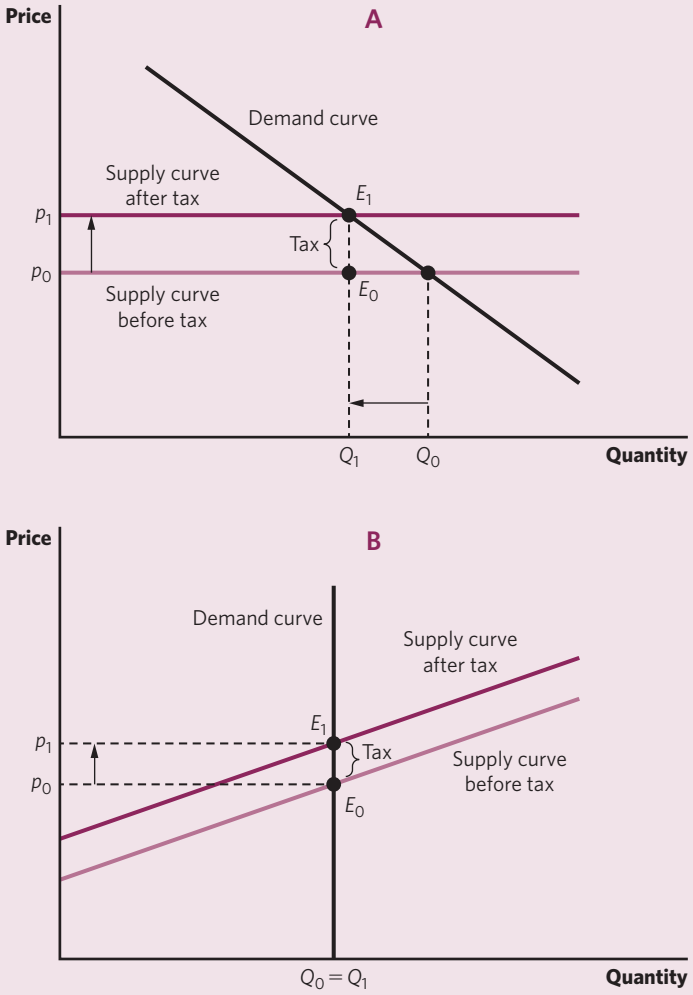


FIGURE 18.5

ELASTICITY OF SUPPLY AND DEMAND: TAX BORNE BY CONSUMERS

(A) With a perfectly elastic supply curve (horizontal supply curve), the price rises by the full amount of the tax; the entire burden of the tax is on consumers. (B) With a perfectly inelastic demand curve, the price rises by the full amount of the tax; the entire burden of the tax is on the consumers.

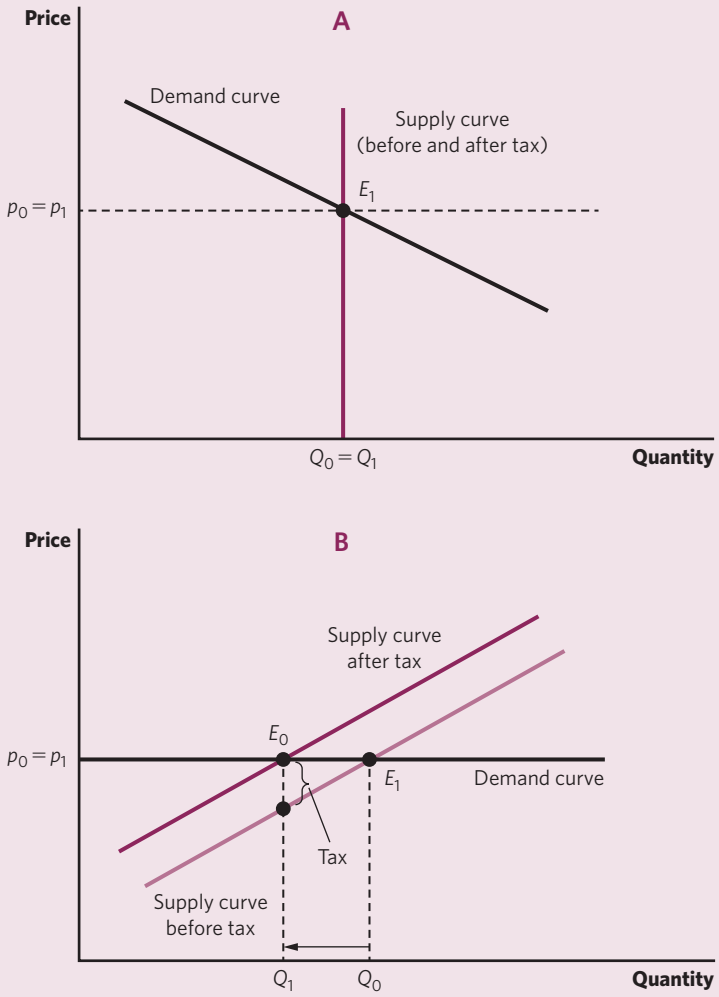
percentage change in its price. We thus say that the horizontal demand curve, on which a small reduction in the price results in an enormous increase in demand, is infinitely elastic; and the vertical demand curve, on which demand does not change at all with a reduction in price, has zero elasticity.

Similarly, we measure the steepness of a supply curve by the **elasticity of supply**; the elasticity of supply gives the percentage change in the quantity of the good supplied due to a percentage change in its price. We thus say that a vertical supply curve, on which the supply does not change at all with a change in price, has zero elasticity, whereas a horizontal supply curve has infinite elasticity.

FIGURE 18.6

ELASTICITY OF SUPPLY AND DEMAND: TAX BORNE BY PRODUCERS

(A) With a perfectly inelastic supply curve, the price does not rise at all; the full burden of the tax is on producers. (B) With a perfectly elastic demand curve (horizontal demand curve), the price does not rise at all; the entire burden of the tax is on producers.



The more elastic the demand curve and the less elastic the supply curve, the more the tax is borne by producers; the less elastic the demand curve and the more elastic the supply curve, the more the tax will be borne by consumers.

TAXATION OF FACTORS

The basic principles we have just derived apply to all taxes in competitive markets, including taxes on factors of production.

THE PHILADELPHIA WAGE TAX

Many cities, including Philadelphia, levy a wage tax. A careful look at the incidence of the tax suggests that the burden of the tax is largely on landowners in Philadelphia. The supply curves for other factors, in particular for labor and capital, are relatively flat *in the long run*. Workers have a choice of working in Philadelphia or elsewhere. If their after-tax wage income is not commensurate with what they can receive elsewhere (taking into account the special amenities of Philadelphia), they will leave Philadelphia for employment elsewhere, and firms will not be able to recruit new workers. Thus, if a city such as Philadelphia imposes a wage tax, in the long run, wages must rise to fully offset the tax. Similarly, owners of capital have a choice of investing in Philadelphia or elsewhere. If their return is not commensurate with what they receive elsewhere, they will not invest in Philadelphia. Thus, after-tax wages and after-tax returns to capital are unaffected by the tax. Who, then, pays the tax? Only factors that are not mobile bear the brunt of the tax; land, in particular, is not mobile and is in inelastic supply.

Pittsburgh, across the state, takes a different route from Philadelphia, taxing unimproved land directly, and at a much higher rate than it taxes improvements. Pittsburgh is the only major U.S. city that uses a graded property tax—under which land and buildings are taxed at different rates. In 1979 and 1980, Pittsburgh restructured its property tax system so land was taxed at more than five times the rate on buildings (or improvements).*

*For more discussion on the property tax in Pittsburgh and the economic effects of this property tax experiment, see W. E. Oates and R. M. Schwab, "The Impact of Urban Land Taxation: The Pittsburgh Experience," *National Tax Journal* 50, no. 1 (March 1997): 1–21.

TAX INCIDENCE AND THE DEMAND AND SUPPLY FOR LABOR Figure 18.7A depicts the market demand and supply curves for labor. It makes no difference whether a tax on labor is imposed on consumers (in this case, the firms that pay for the use of labor) or on producers (in this case, the individuals who are selling their labor services); the incidence of the tax is the same. The distinction made by Congress, that half of the Social Security tax should be paid by the employer and half by the employee, makes absolutely no difference for the effect of the tax. The consequences would have been the same had Congress said that firms must pay the entire tax or that individuals must pay the entire tax.[2]

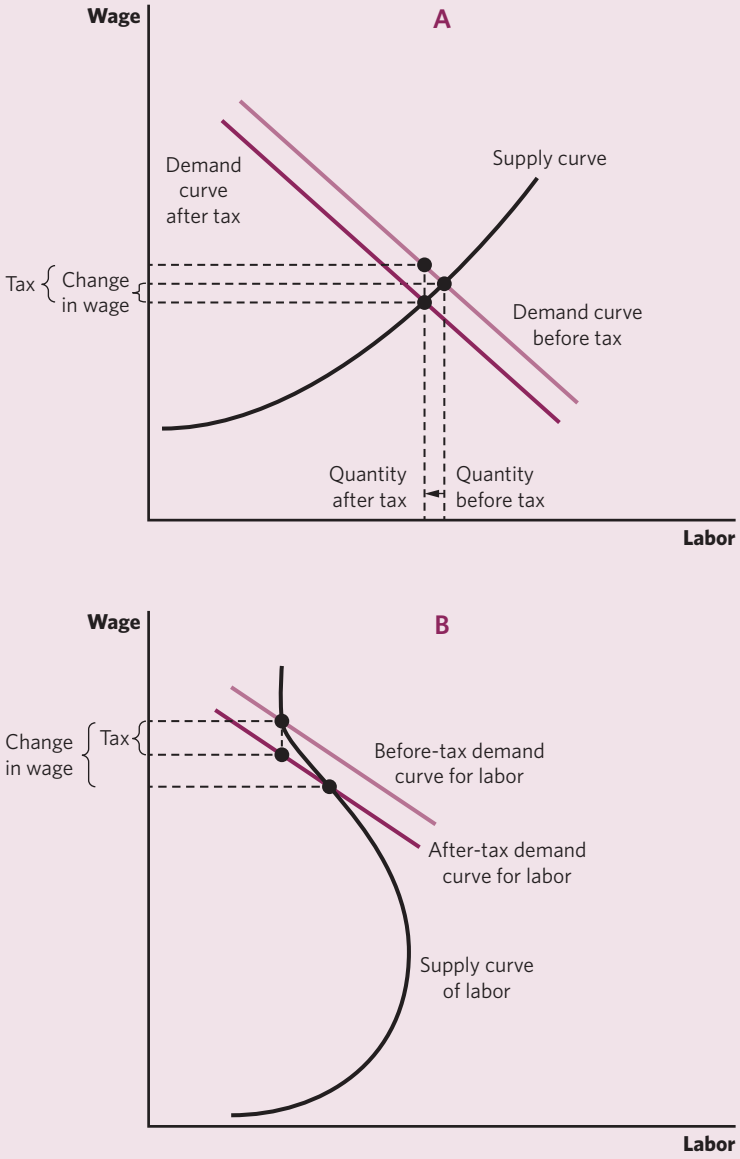
[2] There may be a short-run difference. If Congress had imposed the entire tax on firms, it is unlikely that wages would have fallen immediately. In the short run, the labor market would not have been in equilibrium, and firms would have absorbed a large part of the Social Security tax.

There are also some differences arising out of the income tax. Whereas the employee's contribution to Social Security is included in his or her income (on which the employee must pay income tax), the employer's contribution to Social Security is not. Also, if the individual works for more than one employer and pays more than the maximum Social Security, the individual can claim a refund of the excess, but the employer is not entitled to any refund.

FIGURE 18.7

COMPARING THE EFFECTS OF A TAX ON THE DEMAND FOR LABOR

(A) The effect of a tax on labor is to shift the demand curve for labor down. A tax on labor will lead to a lower wage and a lower level of employment. (B) With a backward-bending supply schedule, the wage may fall by more than the amount of the tax.



Who effectively pays the tax depends on the elasticity of demand and supply for labor. If, as is frequently claimed, the supply of labor is relatively inelastic—that is, almost vertical—most of the burden of the tax falls on workers, regardless of the legal imposition of the tax.

Some economists believe that the supply curve of labor actually is backward-bending, as illustrated in Figure 18.7B. As the wage rises above a certain level, the supply of labor actually decreases. Individuals decide that, at the higher standards of living that they can attain with the higher wages, they prefer to work less. Thus, higher wages reduce the supply of labor rather than increase it. In this case, a tax on labor may result in a reduction in the wage rate that is greater than the tax itself, as the decrease in wages induces a larger labor supply, which drives down the wage further.

TAXATION OF INELASTIC FACTORS As we have noted, if the supply elasticity of labor or of a commodity is zero, the tax is borne fully by the supplier. The classic example of a commodity with a zero supply elasticity is unimproved land. The supply of land is fixed. Thus, if a tax is imposed on unimproved land, the total burden of the tax will fall on the landowners.

Unfortunately, it is difficult to distinguish the value of land from the value of improvements to it. In many parts of the United States, for instance, land in the wilderness, with no access to roads, sewers, or water, has almost no commercial value. It is difficult to ascertain how much of the value of land in urban areas is inherent in the land and how much is attributable to improvements. Because the supply elasticity of land improvements is large, a land tax may be largely shifted.

Another example of a factor in long-run inelastic supply is crude oil. Hence, a tax on oil is borne primarily by the owners of oil deposits. Because a disproportionate share of the world's oil is owned by those outside the major consuming nations, the consuming nations have strong incentives to impose taxes on oil. Of course, owners of oil wells in the United States actively resist these taxes, and they are a sufficiently powerful lobbying group to have done so quite successfully. In the United States, taxes on oil are far lower than those in most Western European nations.

TAXATION OF PERFECTLY ELASTIC FACTORS Just as taxes imposed on perfectly inelastic factors of production are borne totally by the factor, taxes on perfectly elastic factors are not borne at all by the taxed factor; they are entirely shifted. This simple observation has important implications for tax policy. The supply of capital to a small country is usually thought of as being highly elastic: just as a small firm must take the price it pays for capital as given, so too does a small country in an open, global market. The country cannot induce capital to flow in if it pays less than the market rate of

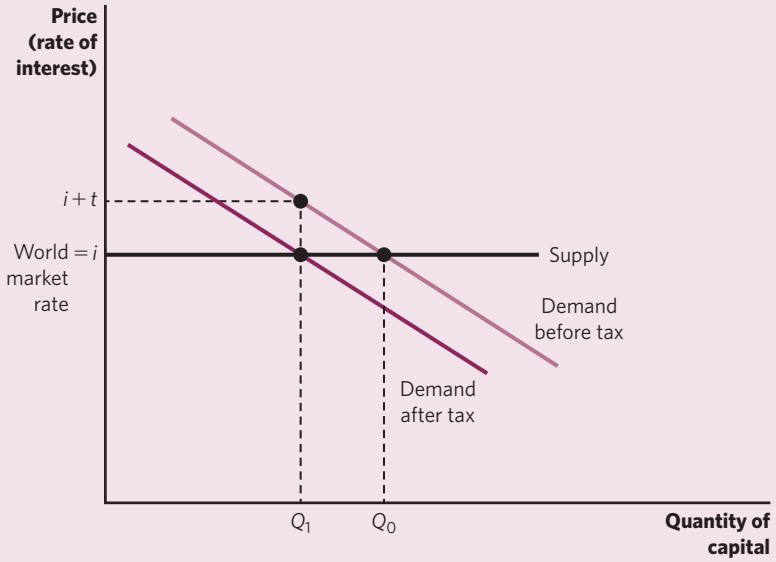
TAXATION OF FACTORS

- The incidence of a tax on a factor in a competitive market depends on the elasticity of supply and demand for the factor.
- The incidence of a tax on a factor whose supply is perfectly inelastic is borne completely by the factor.
- A tax on a factor whose supply is perfectly elastic is completely shifted.

FIGURE 18.8

PERFECTLY ELASTICALLY SUPPLIED FACTOR

The incidence of a tax imposed on a perfectly elastically supplied factor is always fully shifted. The demand curve is shifted down by the amount of tax, leaving the price received by suppliers unchanged.



interest, but at the market rate, it can obtain all the capital it could possibly absorb. Figure 18.8 plots the demand and supply of capital depending on the interest rate. With a tax on interest, the interest paid differs from the interest received. The capital owner must receive the market rate, however, or he or she supplies nothing. The users of capital must make up the difference, paying $i + t$. In the figure, the vertical axis represents the interest rate received, so the supply curve remains unchanged. The tax shifts the demand curve for capital down. At the new equilibrium, the interest rate received is unchanged. A tax on interest in this situation is fully shifted from capital owners to capital users.

TAX INCIDENCE IN ENVIRONMENTS WITHOUT PERFECT COMPETITION

The effect of the imposition of a tax depends critically on the nature of the market. The analysis in the preceding section assumed that markets are competitive. However, if markets are less than fully competitive—if, for instance, the industry consists of a monopoly or of firms acting collusively, so that their combined behavior is similar to that of a monopoly—the effect of a tax could be markedly different.

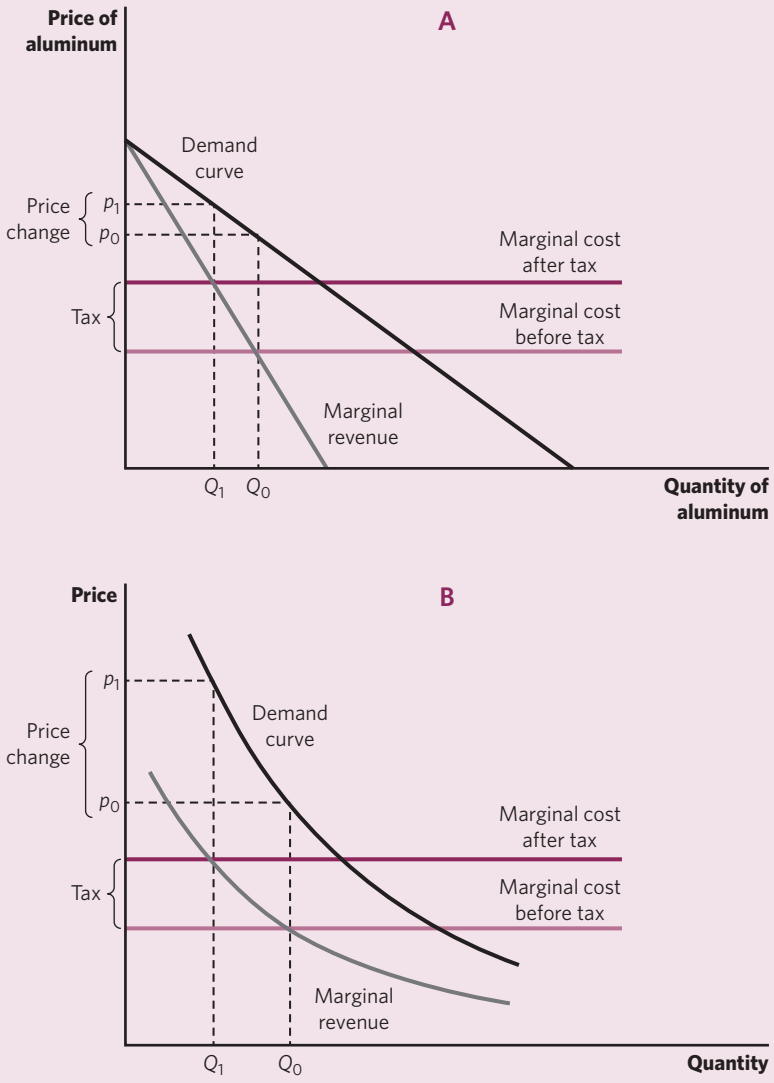


FIGURE 18.9

TAXING A MONOPOLY

(A) With linear demand and horizontal marginal cost curves, the price paid by consumers rises by exactly half the tax; consumers and producers share the burden of the tax. (B) With constant elasticity demand curves, the price rises by more than the tax.

In the absence of a tax, a monopolist will choose that level of output such that the cost of producing any additional output (the marginal cost) is just equal to the additional sales revenue it would receive (its marginal revenue). To maximize profits, the monopolist thus sets its **marginal cost** equal to its **marginal revenue**.

Figure 18.9 depicts the demand curve for aluminum, the marginal revenue curve, and the marginal cost of production. The marginal revenue curve lies below the demand curve. It represents the extra revenue the firm receives from selling an extra unit of output. The marginal revenue is the price the

firm receives for that extra unit, minus the loss it sustains on the other units it sells, because as it attempts to sell more, it must lower the price.[3] The monopolist chooses Q_0 as its level of output, the quantity at which the marginal cost and marginal revenue curves intersect. To find the price charged by the monopolist, we go up to the demand curve and locate price p_0.

A tax on aluminum can be viewed simply as an increase in the cost of production, which is to say, a shift upward in the marginal cost curve. This will reduce output to Q_1 and increase the price to p_1.

RELATIONSHIP BETWEEN THE CHANGE IN THE PRICE AND THE TAX

In the case of a competitive industry, we showed that the consumer price increased by an amount that normally was less than the tax, and that the magnitude of the price increase depended on the demand and supply elasticities. The results for a monopolist are more complicated.

First, the steeper the marginal cost curve, the smaller the change in output and hence the smaller the increase in price. With a perfectly vertical marginal cost schedule, there is no change in output and no change in price; the tax is borne by producers. A supply (or marginal cost) curve is perfectly vertical if no increase in price calls forth an increase in supply. This result parallels that for competitive markets.

On the other hand, with a horizontal marginal cost schedule, as in Figure 18.9, the extent to which producers or consumers bear the tax depends on the *shape* of the demand curve. (Contrast this to competitive markets, in which the consumer would bear the entire tax.) Figure 18.9 illustrates two possibilities. With a linear demand curve, as in Figure 18.9A, the price rises by exactly half the tax.[4] With a constant

[3] Recall that, in contrast, a perfectly competitive firm must take the market price as fixed, but can sell any amount of output at that price. Its marginal revenue is simply the market price.

[4] With a linear demand curve,

$$p = a - bQ,$$

price and output are related linearly.

Revenue, pQ, is given by

$$pQ = aQ - bQ^2,$$

so marginal revenue, MR, is

$$a - 2bQ.$$

This is set equal to marginal cost plus the tax:

$$a - 2bQ = \text{MC} + t$$

or

$$2a - 2bQ = 2p = a + \text{MC} + t$$

or

$$p = \frac{a + \text{MC} + t}{2}.$$

Hence, if t increases by, say, \$2, p increases by \$1.

elasticity demand curve, in which a 1 percent increase in the price results in, say, a 2 percent reduction in the demand, regardless of the price level, marginal revenue is a constant fraction of the price[5]:

$$\text{MR} = p\left(1 - \frac{1}{\eta^d}\right),$$

where η^d is the elasticity of demand (a constant).

Because the monopolist sets marginal revenue equal to marginal cost,

$$\text{MR} = \text{MC} \quad \text{or}$$

$$p\left(1 - \frac{1}{\eta^d}\right) = \text{MC} \quad \text{or}$$

$$p = \frac{\text{MC}}{1 - 1/\eta^d}.$$

A tax has the same effect as raising the marginal cost of production; that is,

$$p = \frac{\text{MC} + t}{1 - 1/\eta^d}.$$

Hence, the price increases by a multiple $1 / (1 - 1/\eta^d)$ of the tax. If η^d is 2, then the increase in price is twice the tax.

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[5] This formula is general. In the case of a constant elasticity demand curve, η^d is constant. To derive the formula, recall that marginal revenue is the extra revenue received from producing one more unit. Revenue is just the price received per unit, p, times the number of units sold, Q. Thus, when a firm sells one more unit, it receives p, but to sell the additional unit, it must have reduced its price from its previous level. Denote the change in price by Δp. The firm loses this amount on all sales, Q. Thus, the net gain is

$$\text{MR} = p + \Delta p \cdot Q = p\left(1 + \frac{\Delta p}{p} \cdot Q\right).$$

Recall, too, that

$$-\frac{\Delta Q/Q}{\Delta p/p} = -\frac{\text{change in } Q/Q}{\text{change in } p/p}$$

is just the percent change in quantity as a result of a percent change in price, which is just the elasticity of demand.

Here, the change in quantity is just 1; that is, $\Delta Q = 1$, so we can rewrite

$$-\frac{\Delta p}{p} \cdot Q = -\frac{\Delta p}{p} \cdot \frac{Q}{\Delta Q} = -\frac{\Delta p/p}{\Delta Q/Q} = \text{elasticity of demand} = \eta^d.$$

So,

$$\text{MR} = p\left(1 - \frac{1}{\eta^d}\right).$$

AD VALOREM VERSUS SPECIFIC TAXES

There is another important difference between the taxation of competitive and monopolistic industries. In the case of competitive industries, the form in which the tax is levied makes no difference. We can choose between a specific tax, which is specified as a fixed amount per unit of output, and an ad valorem tax, which is specified as a percentage of the value of the output. All that matters for determining the effect of the tax is the magnitude of the difference (in equilibrium) between the price received by producers and the price paid by consumers, what we refer to as the *wedge* between the two.

In the case of monopolistic industries, however, ad valorem and specific taxes have quite different effects. We show in the appendix to this chapter that for any given revenue raised by the government, the monopolist's output will be higher with an ad valorem tax than with a specific tax.

TAX INCIDENCE IN OLIGOPOLIES

Between the extremes of perfect competition and monopoly is the oligopoly market structure. In an **oligopoly**, such as the airline market and the rental car market, every producer interacts strategically with every other producer. If one producer changes its prices or output, the other producers may also change their prices or outputs, but these responses may be hard to predict.

There is no widely accepted theory of firm behavior in oligopoly, so it is impossible to make any definite predictions about the incidence of taxation in this case. Some economists believe that oligopolists are not likely to raise the prices they charge consumers when taxes change. Each oligopolist may believe that if it raises its price, other firms will steal its market share. An opposite conclusion follows if each oligopolist expects that its competitors will match its price increase after a tax is imposed. In this case, all will raise their prices and thereby shift the burden of the tax to consumers.

Although economists have explored the incidence of taxes in an oligopoly under different specific behavioral assumptions, until they gain a better understanding of oligopolistic behavior, there can be no general theory of the incidence of a tax in an oligopolistic market.

TAX INCIDENCE IN MONOPOLIES OR IMPERFECTLY COMPETITIVE MARKETS

- In monopolies or imperfectly competitive markets, tax incidence depends on the shape of the demand and supply curves; there may be more than 100 percent shifting.
- In a monopoly, with constant marginal cost, and with constant elasticity demand curves, there will always be more than 100 percent shifting of specific commodity taxes. With linear demand curves, price rises by half the tax.

EQUIVALENT TAXES

In the discussion thus far, several instances have been pointed out in which taxes appear to be different—a tax on employers to finance Social Security and a tax on employees; a tax on the producers of beer or a tax on beer consumers—but are really equivalent. Many other examples of taxes that appear to be very different (and that from an administrative point of view *are* different) are, from an economic point of view, equivalent.

INCOME TAX AND VALUE-ADDED TAX

An obvious example follows from the basic identity between national income (the total of what all the individuals in our society receive) and national output (the total of what they all produce). Because the value of income and the value of output must be the same, a uniform tax on income (a tax that taxes all sources of income at the same rate) and a uniform tax on output (a tax that taxes all outputs at the same rate) must be equivalent. A comprehensive uniform sales tax is a uniform tax on output and is thus equivalent to a uniform income tax.

The production of any commodity entails a large number of steps. The value of the final product represents the sum of the value added at each stage of production. We could impose the tax at the end of the production process, or at each stage along the way. A tax at the end of the production process is called a *sales tax*. A tax imposed at each stage of the production process is called a *value-added tax*. Thus, a uniform value-added tax and a comprehensive uniform sales tax are equivalent—and both are equivalent to a uniform income tax.

The value-added tax is used in most European countries, and there has been some discussion in the United States about introducing such a tax. Because a uniform value-added tax is equivalent to a uniform (proportional) income tax, replacing our current income tax system with a value-added tax would be equivalent to replacing it with a proportional income tax system.

The value-added tax in Europe typically exempts investment goods. It is imposed only on consumption. Thus, the European form of the value-added tax is equivalent to a tax on consumption. Because consumption is equal to income minus savings, a consumption tax is equivalent to a tax on income in which savings are exempted.

EQUIVALENCE OF CONSUMPTION AND WAGE TAXES

Suppose that individuals receive no inheritances and leave no bequests. Then a uniform tax on wages and a uniform tax on consumption are equivalent. To put it another way, a consumption tax is equivalent to an income tax in which interest and other returns to capital have been exempted. (Our present tax system, in which part of the return to capital is tax exempt, can be viewed as somewhere between a consumption tax and an income tax.)

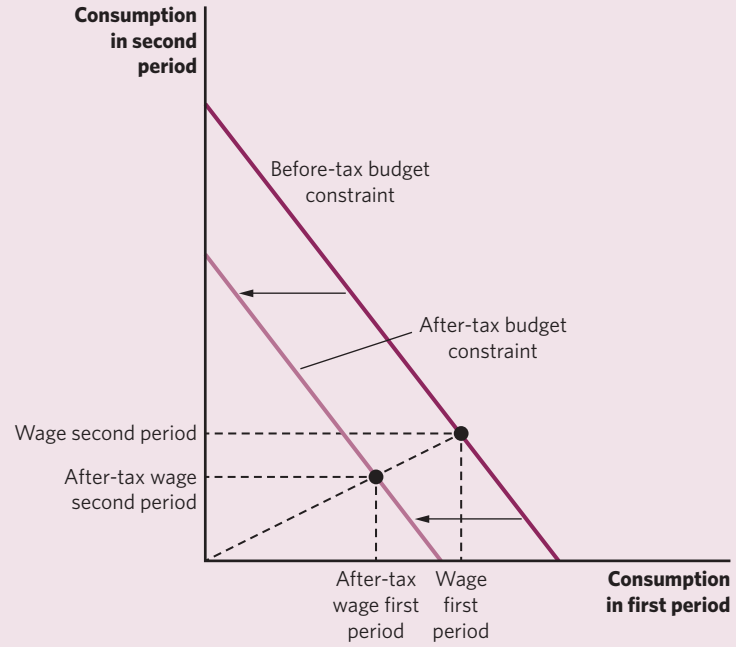
The equivalence may be seen most clearly by looking at the lifetime budget constraint of an individual (with no inheritances or bequests). For simplicity, we divide the life of the individual into two periods: wage income is w_1 in the first period and w_2 in the second. The individual has to decide how much to consume the first period of life, while young, and how much when older. If the individual reduces consumption today by a dollar and invests it, next period he or she will have $1 + r$ dollars, where r is the rate of interest. With a 10 percent interest rate, he or she will have \$1.10. The budget constraint is a straight line, depicted in Figure 18.10.

Consider what happens to the individual's budget constraint when a wage tax of 20 percent is imposed. The amount that he or she can consume shifts down. The slope of the budget constraint remains unchanged:

FIGURE 18.10

COMPARING THE EFFECTS OF A CONSUMPTION TAX AND WAGE TAX

A consumption tax and a wage tax have exactly the same effect on the individual's budget constraint.



it is still the case that by giving up $1 of consumption in the first period, the individual can get $1.10 next period.

Now, consider what happens to the individual's budget constraint when a 20 percent consumption tax is imposed. Just as before, the amount that he or she can consume shifts down, and the slope of the budget constraint remains unchanged. If the individual spends $1 today, he or she gets 20 percent fewer goods because of the tax; however, when the individual spends $1 tomorrow, he or she also gets 20 percent fewer goods because of the tax. The trade-off between spending today and spending tomorrow remains unchanged. A wage tax and a consumption tax are equivalent.[6] Only the timing of the revenues to the government differs between the two taxes; this may be important if capital markets are imperfect.

There are, again, several ways that equivalent taxes can be imposed. We can impose a tax on wage income in each period, exempting all interest, dividends, and other returns on capital, or we can tax consumption in each period, which can be calculated by having the individual report his or her total income minus total savings.

EQUIVALENT TAXES

- Two sets of taxes are equivalent if their incidence is exactly the same.
- Income taxes and value-added taxes (without exemption for investment) are equivalent.
- Consumption taxes and value-added taxes with an exemption for investment are equivalent.
- Consumption and wage taxes are equivalent.
- Lifetime income and consumption taxes (in the absence of bequests and inheritances) are equivalent.

EQUIVALENCE OF LIFETIME CONSUMPTION AND LIFETIME INCOME TAXES

This analysis has one other important interpretation. Continuing with our example in which the life of an individual is divided into two periods, we can write the budget constraint[7] as

$$C_1 + \frac{C_2}{1+r} = w_1 + \frac{w_2}{1+r}.$$

[6] If there are bequests and inheritances, a wage-plus-inheritance tax is equivalent to a consumption-plus-bequest tax. These equivalency relations require a perfect capital market, but are true even if there is risk. See A. B. Atkinson and J. E. Stiglitz, *Lectures on Public Economics* (New York: McGraw-Hill, 1980), Lecture 3.

[7] This can be seen in a slightly different way. An individual's savings (borrowings) are the difference between wages and consumption in the first period:

$$w_1 - C_1.$$

Consumption in the second period is thus second-period wage income plus the savings with its interest minus borrowings with interest:

$$C_2 = w_2 + (1+r)(w_1 - C_1).$$

Rearranging terms, we have

$$C_1(1+r) + C_2 = (1+r)w_1 + w_2.$$

Dividing by $(1+r)$, we obtain the budget constraint in the form presented in the text.

The left-hand side of the equation is the present discounted value of the individual's consumption, and the right-hand side is the present discounted value of wage income. In the absence of bequests and inheritances, the present discounted value of consumption must equal the present discounted value of (wage) income. Thus, a lifetime consumption tax and a tax based on lifetime income are equivalent, as we saw in Chapter 17.

A CAVEAT ON EQUIVALENCE

The fact that two taxes are equivalent does not mean that there are no effects when one tax is switched to the other (or from some third tax to either of the two). Equivalence means only that the two taxes have exactly the same effects in the long run; in the short run—including the transition period as the tax is adopted—the effects may differ markedly. Take, for example, a switch from a lifetime income tax to a lifetime consumption tax. Leaving aside the problems of transition, the result would be that the elderly would face double taxation: in their youth, they paid taxes on wages, and in their retirement, they pay taxes on their consumption; or, say, a value-added tax is imposed. In the short run, prices consumers face rise, and more of the burden of the tax in the short run may be shifted to consumers than if the same revenues were raised by an income tax.

OTHER FACTORS AFFECTING TAX INCIDENCE

So far, we have shown that what determines who bears the burden of any tax is not who Congress says should bear it, but certain properties of demand and supply curves, and the nature of the market—whether it is competitive, monopolistic, or oligopolistic.

TAX INCIDENCE UNDER PARTIAL AND GENERAL EQUILIBRIUM

Several other important factors need to be taken into account in incidence analysis. First, there is an important distinction between a tax in a single industry and a tax affecting many industries. Earlier, we considered a tax

BEHAVIORAL ECONOMICS, MANAGERIAL CAPITALISM, AND TAX INCIDENCE

We have seen in this chapter how the incidence of a tax (who ultimately pays, and the full consequences of paying) depends on the nature of the market—whether markets are, for instance, highly competitive or more monopolistic. In recent years, economists have focused on ways in which economic behavior may not be well described by the standard models; and, if that is so, the analysis of tax incidence will have to be modified accordingly.

One important school of thought, called **behavioral economics**, focuses on behavior that is often not consistent with, or well explained by, the standard model of rational individuals maximizing their lifetime utilities that we have employed in earlier chapters. In some cases, behavioral responses may in fact be greater than predicted by the standard theory, sometimes smaller (see Chapter 10, "Private Sector Responses to Government Programs").

For instance, government programs to encourage savings through special programs such as IRAs (described in more detail in Chapter 21) may be more effective than standard theory predicts, because individuals like the idea of a "sale"—here, there is a special tax deal—*even though at the margin there is no benefit* (and standard theory says what really matters is how the tax system affects returns on the margin). The special program calls attention to the importance of savings, and people respond.

With respect to tax incidence, perceptions of fairness in distribution of the tax burden—whether, on average, high-income taxpayers pay more than low-income taxpayers—and their impact on tax compliance can be affected more by the mass media than by statistics. For example, despite progressivity in the income tax and the large share of total revenue coming from high-income taxpayers, newspaper articles identifying particular individuals or corporations that use the prowess of highly paid tax lawyers to reduce their tax burden create widespread popular resentment and potentially less willingness to pay one's own taxes. Behavioral economics studies how such perceptions of fairness are formed.

Another major strand of modern economics focuses on the behavior of corporations. Proponents of **managerial capitalism** argue that corporations are not really controlled by their owners, as claimed by the theory of **shareholder capitalism**, but by their managers, and if we are to understand how corporations respond to the incidence of taxes, we have to focus more on the decision making of managers and the incentives they face.

For example, how does preferential tax treatment of capital gains versus earned income affect the form and magnitude of executive compensation? Does this help explain why senior managers now receive a large portion of their pay in the form of corporate stock, and why their total compensation has grown so much? How does this, in turn, affect managerial decision making in the trade-off between actions that will increase share price in the short term but harm long-term corporate competitiveness?

on a small industry (beer). The presumption is that such a tax will not, for instance, have any significant effect on the wage rate. Although the reduction in the demand for beer will reduce the demand for labor in the beer industry, the assumption is that this industry is so small that workers released from their jobs can find employment elsewhere without any significant effect on the wage rate. We refer to this kind of analysis, in which we assume that all prices and wages (other than those on which attention is explicitly focused) remain constant, as **partial equilibrium analysis**.

Unfortunately, many taxes affect many industries simultaneously. The corporate income tax affects all incorporated businesses. If, as a result of the tax, incorporated businesses reduce their demand for capital, the capital released cannot be absorbed by the rest of the economy (the unincorporated sector) without reducing the return to capital there. Thus, we cannot assume that what the corporate sector must pay to obtain capital is independent of the tax imposed on that sector. To analyze the impact of the corporation tax requires analyzing its effect on the equilibrium of the entire economy, not just the businesses on which the tax is imposed. Such an analysis is called a **general equilibrium analysis**. In many instances, the general equilibrium impact of a tax may be markedly different from the partial equilibrium effect. For instance, if capital can be shifted relatively easily from the incorporated to the unincorporated sectors of the economy, the tax on corporate capital must be borne equally by capital in *both* sectors of the economy; they both must have the same after-tax return.

The overall incidence of the corporation income tax, like the tax on any factor, depends on the elasticity of demand and supply curves. Although we will postpone until Chapter 23 a fuller discussion of the incidence of the corporation income tax, we can see why the general equilibrium impact may be markedly different from the apparent effect by considering the limiting case in which the supply curve of capital is perfectly elastic.

Savers insist on a return r^*, as depicted in Figure 18.11. Below r^*, they supply no capital; at r^*, they are willing to supply an arbitrarily large amount. That means that the *after*-tax return to capital—in both the corporate and the unincorporated sector—must be r^*, so the before-tax return in the corporate sector must be $r^* + t$. The tax simply raises the before-tax cost of capital in the corporate sector. This has two effects. First, it raises the price of the products produced in the corporate sector, reducing demand for them; demand is shifted to the unincorporated sector. Second, within the corporate sector, firms use more labor and less capital. In general, some of the tax is shifted to workers and some is shifted forward to consumers of the goods the corporate sector produces. However, the magnitude of the effect on, say, workers, depends on, for instance, how easily firms in the corporate sector can substitute labor for capital and on the relative labor intensity of goods in the unincorporated and

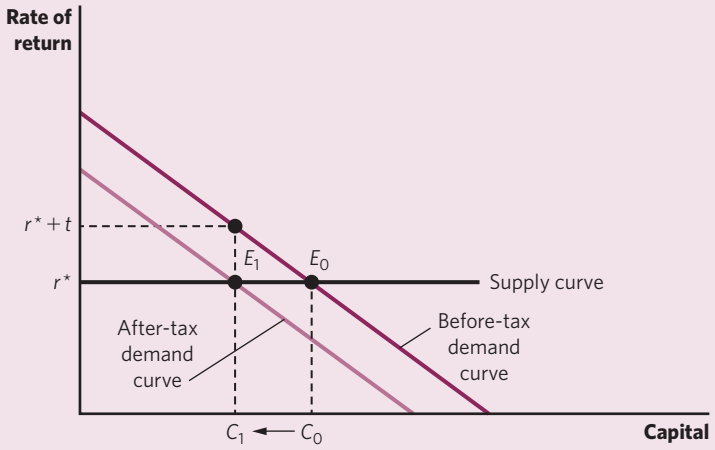


FIGURE 18.11

INCIDENCE OF TAX ON THE RETURN TO CAPITAL IN THE CORPORATE SECTOR

With an infinite elasticity of supply of capital, providers of funds must obtain the same after-tax return as they did before the tax was imposed. The tax is fully shifted.

corporate sectors. If firms in the corporate sector can easily substitute labor for the more costly capital, and if goods in the unincorporated sector are relatively labor intensive, then the general equilibrium effects may lead to an overall increase in the demand for labor, so wages actually increase, if labor is inelastically supplied. In that case, the burden of the corporate income tax lies on consumers of the goods produced by the corporate sector. Workers and owners of capital may both be adversely affected by the price increase, but the *relative* impact may depend as much on consumption patterns as on anything else. If owners of capital largely consume services produced by the unincorporated sector, while workers consume more manufactured goods, then more of the burden of the tax may be borne by workers.

Three important points emerge from this analysis:

1. Corporations do not bear taxes, people do: shareholders, workers, consumers.

2. Because of general equilibrium responses, the impacts of corporation taxes are felt not just in the corporate sector but throughout the economy.

3. The effects may vary depending on the period of analysis and on various assumptions about the structure of the economy. Can we assume that the overall stock of capital is fixed, or that capital can be shifted from one use to another with some degree of ease or difficulty? Can labor be easily substituted for capital? Can labor and capital move from one sector of the economy to another? The answers to such questions are critical to determining the effects of the tax.

SHORT-RUN VERSUS LONG-RUN EFFECTS

A distinction must also be made between the incidence of the tax in the long run and in the short run. Many things are fixed in the short run that can vary in the long run. Although capital currently being used in one industry (like steel) cannot easily be shifted for use into another, in the long run new investment can be shifted to other industries. Thus, a tax on the return to capital in the steel industry may have markedly different effects in the long run than in the short run.

If savings are taxed, the short-run effect may be minimal. In the long run, however, the tax may discourage savings, and this may reduce the capital stock. The reduction in the capital stock will reduce the demand for (and productivity of) labor, and this, in turn, will lead to a lowering of wages. As a result, the *long-run incidence* of a tax on savings (or capital) may be on workers, even if the *short-run incidence* is not.

The short run may differ from the long run also because of dynamics of adjustment. For instance, even in fairly competitive markets, firms frequently set prices initially by certain rules of thumb, which entail a given markup over variable costs. The long-run equilibrium in these industries has the markup adjust to the competitive level. In the short run, the market may be out of equilibrium.

The distinction between short-run and long-run effects is important, because governments and politicians are often shortsighted. They observe the immediate effect of a tax without realizing that the full consequences may not be those that they intended.

A number of factors affect the disparity between the short-run and long-run effects, and between the partial and general equilibrium effects.

OPEN VERSUS CLOSED ECONOMY

One of the most important factors is whether the economy is closed (does not trade with other countries) or open. If a small, open country like Switzerland imposed a tax on capital, the before-tax rate of return would have to adjust fully to offset the tax, otherwise investors would withdraw their funds from Switzerland and invest elsewhere; the tax would be borne by land and labor. Effectively, the supply schedule for capital is infinitely elastic. The same analysis applies, of course, to any state within the United States.

ASSOCIATED POLICY CHANGES

The final aspect of incidence analysis that needs to be discussed here is that it is almost never possible for the government to change only one policy at a time. There is a basic government budget constraint, which says that tax revenues plus the increase in the size of the deficit (increased borrowing) must equal government expenditures. If the government raises some tax rate, it must either lower another, reduce its borrowing, or increase its expenditure. Different combinations of policies will have different effects. We cannot simply ask the question: What would happen if the government increased income taxes? We need to specify whether the income tax is to be accompanied by a reduction in some other tax, by an increase in government expenditure, or by a reduction in government borrowing. (Often the accompanying change is taken to be understood but not made explicit; for example, if taxes are raised, there will be a smaller deficit.)

We call the analysis of a tax increase accompanied by a decrease in some other tax **differential tax incidence analysis**; we call the analysis of a tax increase accompanied by an increase in government expenditure a **balanced budget tax incidence analysis**. Such exercises have become particularly relevant in recent years as budgetary processes in the United States have been reformed in an attempt to control the deficit. Under what are called "Pay-As-You-Go" (PAYGO) rules, any increase in expenditure has to be matched by a decrease somewhere else, or by a new source of tax revenue.[8]

Sometimes we are interested in analyzing combinations of policies that leave some important economic variable unchanged. For example, a tax increase may lead to a reduction in output. We may want to distinguish the effects of a tax program on the level of output (and the effects that this may have, say, on its distribution) from the direct effects of the tax itself; thus, we may look at combinations of policies that leave the level of national output unaffected.

FACTORS AFFECTING INCIDENCE

Time span: short run versus long run

- Demand and supply curves are likely to be more elastic in the long run than in the short run.

Open versus closed economy

- Supply curves of factors are more elastic in an open economy.

Mix of policy changes

- Differential tax analysis: one tax is substituted for another, keeping revenue constant.
- Balanced budget analysis: expenditure is changed as tax revenues change.
- Balanced growth analysis: a mix of policies which leaves capital accumulation unaffected.

[8] Much of the focus on balanced budget incidence relates to macroeconomic consequences. Lower taxes or increased expenditures lead to higher levels of aggregate demand, unless offset by tighter monetary policy. Today, most analyses of tax and expenditure incidence assume that the monetary authorities will take offsetting actions to maintain the economy at full employment. These offsetting actions have, of course, distribution and other general equilibrium effects. Thus, a full analysis of the incidence of any set of tax or expenditure policies needs to take into account the consequences of the offsetting actions of the monetary authorities.

TAX INCIDENCE OF SPECIFIC TAX PROVISIONS

Just as we can analyze the incidence of a payroll tax or any other particular tax, we can analyze the incidence of a particular provision of the tax code—and the incidence is often not what it seems, or is supposed to be.

Consider, for instance, the provision that allows states and municipalities to issue tax-exempt bonds. The provision is supposed to allow them to benefit from lower borrowing costs. If the top marginal tax rate is approximately 40 percent, then an individual in the top rate would be indifferent between buying a taxable bond of equal risk yielding 10 percent and a tax exempt bond yielding 6 percent. Given the large amounts borrowed, this provision could be of enormous benefit to states and localities.

In practice, however, things do not work out like this. The yield on municipal bonds is lower as a result of the tax preferred treatment, but only slightly so. As an example, assume that the interest rate fell to 8 percent. That would mean that rich individuals would get a much higher *after-tax* income by investing in municipal bonds. Half the benefits of the tax provision go to helping states and municipalities, but half of the benefits go to enriching those at the top.

Similarly, many taxes have an effect on the level of capital accumulation. The fall in the capital stock, in turn, may lower wages. Again, one may want to distinguish the direct from the indirect effects of a tax resulting from its impact on capital accumulation. This is particularly the case if one believes that other instruments can be used to offset these indirect effects. If an inheritance tax reduces capital accumulation, for example, it may be possible to undo the effects by providing an investment tax credit. We may examine a set of policies whose effect is to leave capital accumulation unaffected; incidence analysis of this sort is called **balanced growth incidence analysis**.

INCIDENCE OF TAXES IN THE UNITED STATES

In this chapter, we have explained why the actual burden of taxes does not necessarily fall on those on whom the tax is imposed. Officially, the United States, like most advanced countries, has a **progressive** tax system, one

in which the rich are supposed to pay a higher proportion of their income in taxes than the poor. The income tax imposes a 35 percent tax rate on the rich, whereas poor families receive as much as a 45 percent subsidy (through the earned income tax credit). However, there is a consensus that, overall, the U.S. tax system is far less progressive than the official tax code might suggest. (A tax system is said to be **regressive** if the poor pay a higher percentage of their income in taxes than the rich do.)[9]

There are three reasons for this view. First, the income tax itself is less progressive than appears, because it has certain specific design features that allow certain types of income or categories of individuals to escape taxation, at least partially. For instance, capital gains are taxed at lower rates than other forms of income, and there are a variety of special provisions, discussed later, that lower the **effective tax rate** even more. Individuals can put away savings into tax-exempt accounts, and richer individuals tend to avail themselves of this opportunity more than poor individuals. There may be, as we shall see, good reasons for these and other provisions of the tax code, but their net effect is to reduce the progressivity of the tax system.

Second, the income tax itself is only one of several taxes; many of the other taxes, such as state and local sales taxes[10] and the payroll tax, are less progressive, or even regressive.[11]

Third, the incidence of many taxes differs from those on whom the tax is legislated; workers often bear the effect of taxes that are "intended" for others. As noted previously, there is a consensus among economists that workers, not employers, bear the full burden of the employer share of the Social Security tax. There is also a consensus that much of the corporation income tax is shifted, although there is disagreement about both the extent and to whom it is shifted. As world capital markets have become more integrated, it becomes more likely that the tax is not borne by capital. Whether it is shifted forward to consumers or back to workers is less apparent, but in either case, its impact is less progressive than it would be if it were borne by the owners of corporations.

Precise estimates of the overall burden of the federal tax system clearly depend on assumptions concerning who bears the burden of various

[9] The discussion that follows considers progressivity in terms of the ratio of annual taxes to annual income. A more appropriate measure would be lifetime taxes relative to lifetime income or consumption. This distinction is important. Changes in tax policy that may look regressive in the annual measure may not be so in terms of the more fundamental measure, as we shall see in later chapters.

[10] State and local sales taxes tend to be at fixed rates, but they are levied only on the purchases of certain goods. The fraction of income spent on those goods tends to be lower for richer individuals than for the poor; in states where food is exempt, it is the middle-income individuals who pay the highest percentage of their income.

[11] The payroll tax is a fixed percentage of wage income, up to a cap. Thus, higher-wage individuals pay a tax on only a portion of their wage income, and because wealthier individuals, on average, derive a smaller fraction of their income from wages, payroll taxes are an even smaller percentage of the total income for richer individuals. Interpreting whether the Social Security system is regressive as a result is far more controversial, for we need to take into account not only the contributions but also the benefits. Historically, as we saw in Chapter 16, richer individuals have gotten back far more in excess of what they contributed than did poorer individuals, but today, there is a close correspondence between contributions and payments, except for the poor, who receive back more than they contribute.

taxes, such as Social Security payroll taxes and the corporation income tax. Figure 18.12 looks at the effective federal individual income tax rates, whereas Figure 18.13 looks at the effective tax rates, including all federal taxes, assuming that workers bear the full burden of payroll taxes (including those supposedly paid by employers) but that the corporation tax is attributed to households according to their share of capital income. What is remarkable is that although the overall tax rates are clearly higher, the pattern is strikingly similar, with differences in tax rates from quintile to quintile being roughly comparable.

There was a high degree of progressivity at the bottom in 2007, with the poorest 20 percent of the population paying approximately 4 percent of their income in taxes, less than half that of the next quintile's 11 percent. On the other hand, at the very top, progressivity was limited, with the top 1 percent paying only a few percentage points more in taxes than those in the top 10 percent. The data probably overstate the overall degree of progressivity of the U.S. tax system because, as already noted, state and local taxes tend to be less progressive than federal taxes. Also, because only realized capital gains are included in income, the unrealized capital gains—which, until the financial crisis of 2008, were huge—are not included. To include them would result in a lower effective tax rate among the richest Americans. The 2001 and 2003 tax cuts under George W. Bush, by lowering marginal tax rates and providing still further special treatment of capital gains, reduced the progressivity of the tax system, undoing some of the increase in progressivity that was introduced in 1993, when marginal tax rates on upper-income individuals were raised from 28 percent to close to 40 percent. Although they were due to expire at the end of 2010, the Bush tax cuts were extended through 2012.[12]

The issue of incidence has played a major role in recent tax reforms. With each proposal, tables have been drawn up showing how effective tax rates would change. Because politicians find it hard to defend tax cuts for the very rich, a great deal of effort goes into trying to find alternative ways of characterizing the impact of a tax change. For instance, advocates of cutting capital gains tax rates—the main beneficiaries of which are the very rich—argue that such cuts will induce these individuals to sell more of their assets; and because capital gains are taxed only when the asset is sold, at least initially, tax collections from the rich will go up, even if, in the long run, tax collections go down. Thus, advocates of capital gains tax cuts for upper-income individuals focused not on the cut in tax rates, but

[12] The increased flows of international capital suggest that more of the burden of the corporate income tax may be borne by consumers and less by capital than is reflected in the figure. In that case, the overall degree of progressivity is less than depicted.

Because benefits are roughly commensurate with Social Security contributions, the *net* tax imposed by the Social Security system is associated only with its redistributions. Lower-income individuals receive somewhat more than they contribute, and higher-income individuals receive somewhat less. Figure 18.13 looks at only payroll taxes, not benefits.

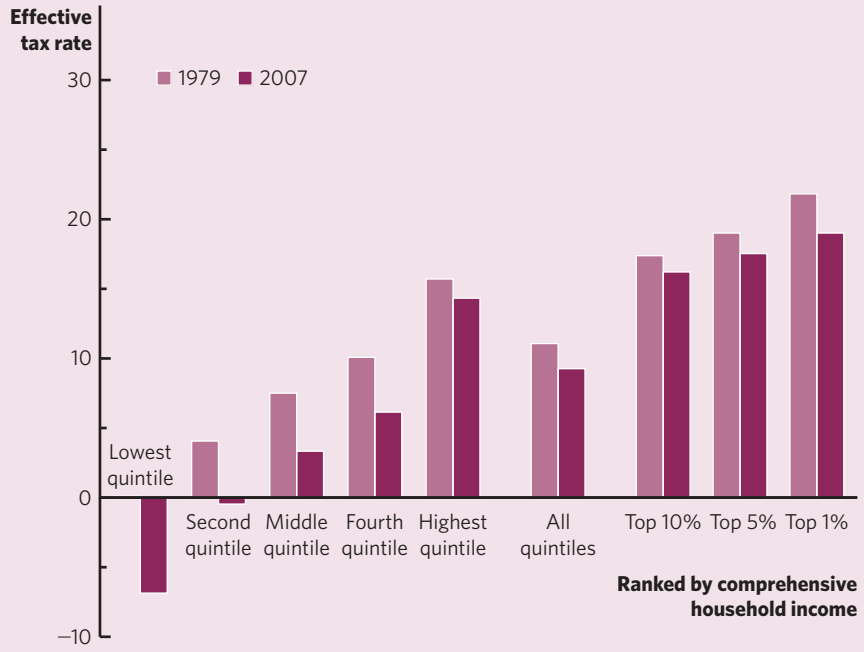


FIGURE 18.12

PROGRESSIVITY OF FEDERAL INDIVIDUAL INCOME TAX

Effective tax rates on the individual income tax (the ratio of tax payments to incomes) were far lower than the legislated rates, as a result of a variety of special provisions. Still, the tax schedule exhibited considerable progressivity.

SOURCES: Urban Institute and Brookings Institution Tax Policy Center, and the Congressional Budget Office.

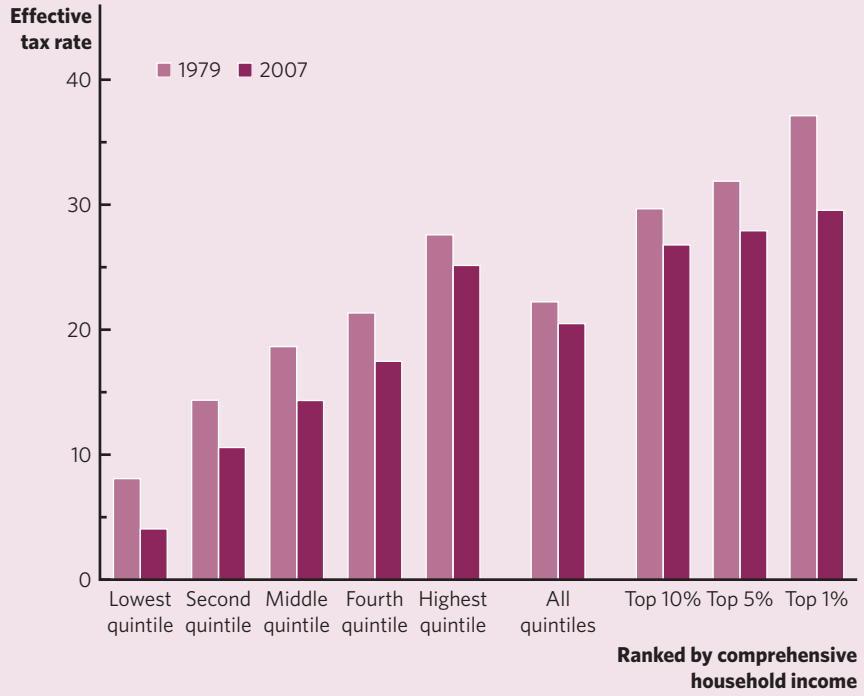


FIGURE 18.13

PROGRESSIVITY OF FEDERAL TAX STRUCTURE

When all federal taxes are included, effective tax rates are higher, and remain progressive.

SOURCES: Urban Institute and Brookings Institution Tax Policy Center, and the Congressional Budget Office.

on the increases in tax payments in the initial years. More generally, controversies over incidence—for instance, over who really pays taxes such as the corporation income tax—play a key role in debates over whether particular reforms increase or decrease the progressivity of the tax system. At issue are matters of both theory and empirical analysis, and the impacts often depend on detailed provisions of the tax code. The following chapters of this book will elucidate many of the key issues in these debates.

REVIEW AND PRACTICE

SUMMARY

1. It makes no difference whether a tax is imposed on the suppliers of a factor or commodity or on the consumers. Instead, who bears the burden of the tax depends on the demand and supply elasticities, and on whether the market is competitive or noncompetitive. Taxes induce changes in relative prices, and this market response determines who bears the tax.
2. In a competitive market, if the supply is completely inelastic or if demand is completely elastic, the tax is borne by producers. If the supply is completely elastic or demand is completely inelastic, the tax is entirely borne by consumers.
3. A tax on a monopolist may be shifted more than 100 percent—that is, the price paid by consumers may rise by more than the tax.
4. The general equilibrium incidence of a tax, taking into account repercussions in all industries, may differ from the partial equilibrium incidence. The incidence of a tax may be different in the long run than in the short run.
5. It is almost never possible for the government to change one policy at a time. Differential tax incidence focuses on how substituting one tax for another will affect the distribution of the tax burden.
6. A tax on output (a uniform sales tax), a proportional income tax, and a uniform value-added tax are all equivalent. A uniform tax on wages and a uniform tax on consumption are equivalent.
7. Empirical studies of who bears the burden of the set of taxes imposed in the United States show that the degree of progressivity of the tax structure depends on assumptions concerning the incidence of taxes on corporations and on payrolls. The current United States tax structure has some progressivity, though less than appears "on paper."

KEY CONCEPTS

Ad valorem tax
Balanced budget tax incidence analysis
Balanced growth incidence analysis
Behavioral economics
Differential tax incidence analysis
Effective tax rate
Elasticity of demand
Elasticity of supply
Equivalent taxes
General equilibrium analysis

Managerial capitalism
Marginal cost
Marginal revenue
Oligopoly
Partial equilibrium analysis
Progressive
Regressive
Shareholder capitalism
Shifted backward
Shifted forward
Specific tax
Tax burden
Tax incidence

QUESTIONS AND PROBLEMS

1. Consider a mineral that is in fixed supply, $Q^S = 4$. The demand for the mineral is given by $Q^D = 10 - 2p$, where p is the price per pound and Q^D is the quantity demanded. The government imposes a tax of $2 per pound on the consumer.
   a. What is the price paid by the consumer before the tax is imposed, and in the post-tax equilibrium?
   b. What is the price received by producers?
   c. How much revenue is raised?
2. Consider a small town in which workers are highly mobile (i.e., they can be induced to leave the town if opportunities elsewhere improve slightly). What do you think the incidence of a tax on wages in that town would be, compared with the incidence in a town in which workers are immobile?
3. It is frequently asserted that taxes on cigarettes and beer are regressive, because poor individuals spend a larger fraction of their income on such items than do better-off individuals. How would your estimate of the degree of regressivity be affected if you thought these commodities were produced by:
   a. Competitive industries with inelastic supply schedules?
   b. Monopoly with a linear demand schedule?
   c. Monopoly facing a constant elasticity demand schedule?
4. It is often asserted that gasoline taxes used to finance highway construction and maintenance are fair because they make users of roads pay for them. Who do you think bears the burden of such taxes?
5. If you believed that a proportional consumption tax was the best tax, what are various ways in which you could levy it? Might there be differences in administrative costs associated with levying such a tax in different ways?
6. In what ways may the actual incidence of a government expenditure program differ from the legislated intent? Why might the effects be different in the short run than in the long run? Illustrate with examples drawn from Part Four of the book, or with a discussion of the effects of government farm programs. Similarly, discuss how the short-run and long-run effects of a regulatory program, such as rent control, may differ.

APPENDIX: COMPARISON OF THE EFFECTS OF AN AD VALOREM AND SPECIFIC COMMODITY TAX ON A MONOPOLIST

Suppose the government imposes a tax on the output of a monopolist. We asserted in the text that an ad valorem tax (a tax based on a fixed percentage of the value of sales) would reduce output less than a specific tax (a fixed tax on each unit sold) for any given revenue raised by the government.

The reason is that the ad valorem tax reduces marginal revenues by less than the tax, whereas the specific tax reduces marginal revenues by exactly the amount of the tax. Because a monopolist sets marginal revenue equal to marginal cost, if marginal revenue is reduced by less, output is reduced by less.

We can see this diagrammatically in Figure 18.14. Figure 18.14A illustrates the effect of a specific commodity tax. Earlier, we represented the effects of such a tax by an increase in the marginal cost. Alternatively, we can represent the effects of this tax as a *decrease* in the price received by the firm at any given quantity sold, that is, as a downward shift in the demand schedule. Both the demand and marginal revenue schedules shift down by the magnitude of the tax, t.

With an ad valorem tax, if an individual pays a price p for a commodity, the amount received by the producer is $p(1 - \hat{t})$, where $\hat{t}$ represents the ad valorem tax rate. Thus, the tax paid is a function of the market price. If the price were zero, there would be no tax paid, as we saw in the text. The effect of the tax is to rotate the demand curve as in Figure 18.14B, rather than to shift it down uniformly as in Figure 18.14A. The ad valorem tax at rate $\hat{t}$ reduces revenue by a fixed percentage—to $(1 - \hat{t})pQ$—and therefore lowers marginal revenue by the same percentage—to $(1 - \hat{t})\mathrm{MR}_{bt}$; that is, to $1 - \hat{t}$ times the before-tax level. The marginal revenue schedule, too, is rotated around the point at which it intersects the horizontal axis.

The important point is that the marginal revenue is reduced by $\hat{t} \times \mathrm{MR}$, and because marginal revenue is less than the price, it is reduced by less than $\hat{t} \times p$, the tax revenue per unit of the product sold. By contrast, with the specific tax, marginal revenue is decreased by precisely the amount of the specific tax. Thus, for any given level of equilibrium output—any given reduction in marginal revenue—the ad valorem tax raises more revenue, as shown in the figure; or, equivalently, for any given tax revenue per unit ($t = \hat{t} \times p$), output will be higher with an ad valorem tax, so price will be lower and total government revenue will be higher.

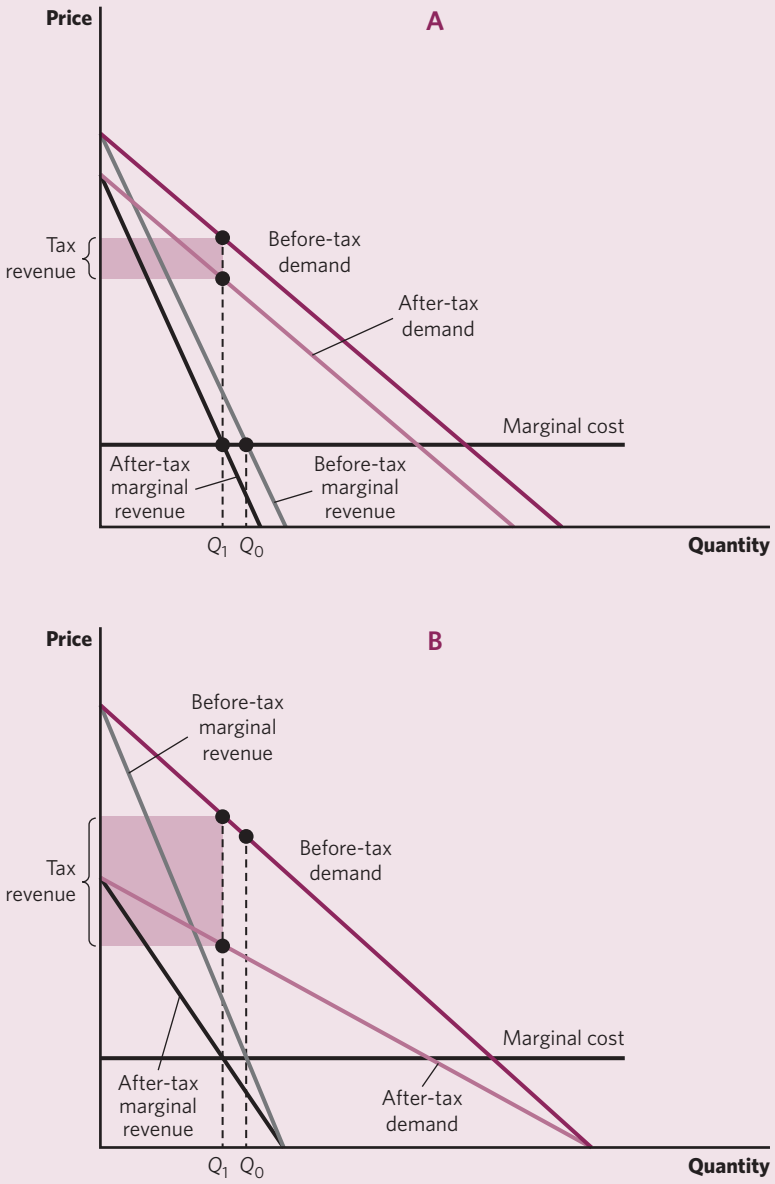


FIGURE 18.14

COMPARING THE EFFECTS OF A SPECIFIC TAX AND AN AD VALOREM TAX ON A MONOPOLIST

(A) The effects of a specific commodity tax on a monopolist can be viewed either as a shift upward in the marginal cost schedule (as in the earlier diagrams) or, as here, a shift downward in the demand and marginal revenue schedules. (B) Analysis of the effects of an ad valorem tax on a monopolist. For any given level of output, Q_1, tax revenue is higher with an ad valorem tax than with a specific tax.

19

TAXATION AND ECONOMIC EFFICIENCY

All taxes affect economic behavior. They transfer resources from individuals to the government. As a result, individuals must alter their behavior in some way. If they do not adjust the amount of work they do, they must reduce their consumption. They may work more, enjoying less leisure; by working more, they need reduce their consumption less.

No matter how individuals adjust, an increase in taxes must make them worse off.[1] However, some taxes reduce individuals' welfare less, for each dollar of revenue raised, than do other taxes. Tax policy is concerned with designing tax structures that minimize welfare loss for any given amount of revenue raised—while still attaining the other objectives of tax policy discussed in Chapter 17. This chapter analyzes the determinants of welfare loss; Chapter 20 then uses the results to describe the basic principles of optimal taxation.

This chapter is divided into six sections. The first analyzes the effects of a tax on a consumption good, such as beer. After describing the effects

[1] This ignores, of course, the benefits that may accrue from the increased government expenditures that result from the increased taxes. In a sense, this chapter looks at the "costs" of government programs, which are associated with the taxes to finance them, whereas earlier chapters in the book looked at the benefits. An overall assessment requires balancing the two. Throughout this chapter, we also ignore general equilibrium effects: before-tax wages and prices will be assumed to be unaffected by the imposition of a tax.

qualitatively, the second section shows how the distortions can be quantified. The third section analyzes inefficiencies associated with taxes on producers. The fourth and fifth sections show how the same principles may be applied to taxes on the return to savings and wages. The final section discusses various attempts to quantify the effects of taxation on labor supply.

FOCUS QUESTIONS

1. How is the efficiency loss associated with taxation measured? On what does its magnitude depend?
2. What is meant by the income effect and substitution effects of a tax? Why do they normally reinforce each other for taxes on commodities, but work against each other for taxes on wages and interest?
3. How large are the efficiency losses associated with taxes on labor and savings?

EFFECT OF TAXES BORNE BY CONSUMERS

We begin the analysis with the simplest case: that of a tax borne fully by consumers. For example, let's assume that Crusoe's income is fixed, and he can choose between purchasing two commodities: soda and beer. His budget constraint is the line *SB* in Figure 19.1. This gives the various combinations of soda and beer that he can purchase. If he spent all his income on soda, he could purchase the amount *S*; if he spent all his income on beer, he could purchase the amount *B*.

Suppose that the government imposes a tax on beer. What will be the effect? (Throughout this section, we will assume that the consumer price rises by the full amount of the tax; that is, consumers bear the full burden of the tax. This will happen if the supply curves for beer and soda are infinitely elastic, as we showed in Chapter 18.) The tax on beer shifts the budget constraint in to *SB′*. Crusoe can still, if he wishes, spend all his income on soda, in which case he obtains *S* units of soda. Beer, however, is now more expensive, so he can purchase less of it with his income.

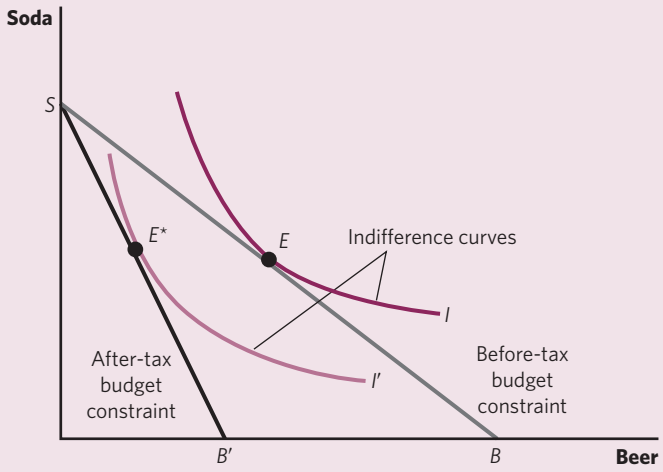


FIGURE 19.1

EQUILIBRIUM AFTER THE IMPOSITION OF A TAX ON BEER

The effect of the tax is to shift the budget constraint down and, thus, the equilibrium changes from *E* to *E**.

Initially, Crusoe allocated his income by choosing point E on this budget constraint. This is the point of tangency between the budget constraint and the indifference curve. After the imposition of the tax, there is a new equilibrium, at point E*. At E^*, Crusoe consumes less beer than at E.

SUBSTITUTION AND INCOME EFFECTS

The tax decreases an individual's consumption of beer, for two reasons. First, the tax—like any tax or loss of income—makes the individual worse off, by leaving him or her with less money to spend. Normally, when an individual is worse off, he or she consumes less of all goods. The amount by which the individual's consumption of the taxed good is reduced because he or she is worse off is called the **income effect** of the tax. Second, the tax makes beer more expensive than other goods. When a good becomes relatively more expensive, individuals find substitutes for it. The extent to which consumption of the taxed good is reduced because of the increased *relative price* is the **substitution effect**.

Figure 19.2 shows how to decompose the movement from E to E^*—the reduction in beer consumption—into income and substitution effects. We first ask, how would consumption of beer have been reduced if we had taken away income from the individual—to put him or her on the new, lower indifference curve—but, at the same time, had not changed relative prices? This change is reflected in the budget constraint $\hat{S}\hat{B}$, which is parallel to the original budget constraint (implying the same prices) but tangent to the indifference curve I', at $\hat{E}$. The corresponding reduction in beer consumption is the income effect.

The movement from $\hat{E}$ to E^*, and the corresponding reduction in beer consumption, is the substitution effect. It represents the reduction in consumption *due solely to changes in relative prices*.

Income and substitution effects work in the same direction in the case of a beer tax: beer consumption drops continually as we move from E to $\hat{E}$ to E^*.

DETERMINING THE SIZE OF THE SUBSTITUTION EFFECT The magnitude of the substitution effect depends on how easy it is to substitute other goods for the taxed good. This is reflected in the shape of the indifference curves. If they are relatively flat, then substitution is easy, and the substitution effect is large.[2] Figure 19.2B illustrates the extreme case in which indifference curves are L-shaped and there is no substitution effect.

[2] More precisely, it depends on the *elasticity of substitution,* which is defined as the percentage change in relative quantities consumed from a percentage change in relative prices. The L-shaped indifference curves in Figure 19.2B have a zero elasticity of substitution. The other extreme case is a straight-line indifference curve, in which case the elasticity of substitution is said to be infinite.

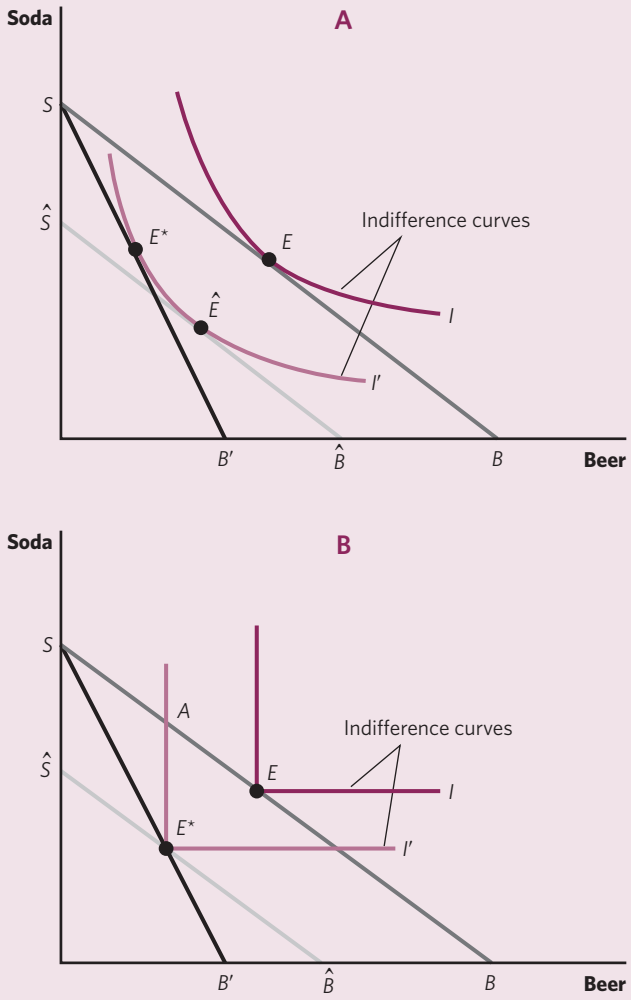


FIGURE 19.2

INCOME AND SUBSTITUTION EFFECTS OF A TAX ON BEER CONSUMPTION

(A) Decomposes the movement from E to E^* into income and substitution effects. The movement from E to $\hat{E}$ is the income effect, and the movement from $\hat{E}$ *to* E^* is the substitution effect. (B) Represents the case in which there is no substitution effect; indifference curves are L-shaped.

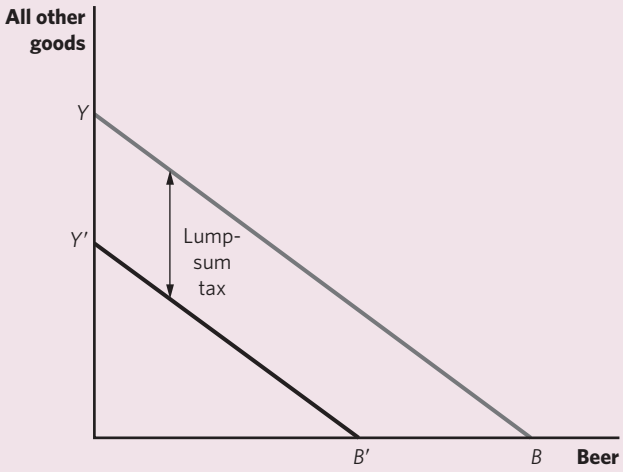
QUANTIFYING THE DISTORTIONS

Any tax must have effects on consumption. After all, the purpose of a tax is to transfer purchasing power from the individual to the government. Individuals must reduce their consumption of something. An efficient tax minimizes the welfare loss per unit revenue raised. Chapter 17 introduced the concept of a lump-sum tax, a tax that the individual must pay regardless of what he or she does. Such a tax simply moves the budget

FIGURE 19.3

LUMP-SUM TAX

The vertical distance between the two budget constraints measures the magnitude of the lump-sum tax.



constraint in a parallel way, as illustrated in Figure 19.3. In the figure, we have put expenditures on beer on the horizontal axis and expenditures on all other goods on the vertical axis. Thus, point Y, at which the individual consumes no beer, measures his or her income before tax; point Y' measures his or her income after tax; and the vertical distance YY', measures the lump-sum tax. The budget constraint is

$$\text{Expenditures on beer} + \text{expenditures on all other goods} = \text{income} - \text{lump-sum taxes},$$

where expenditures on beer $= p_B B$, the price of beer times the quantity of beer purchased.

We compare the effect of any tax—such as a tax on beer—with the effect of a lump-sum tax by asking: For the same revenue, how much worse off are individuals with the tax on beer than they would have been with the lump-sum tax? The extra loss in welfare is called the *deadweight loss*. Equivalently, we can ask: For the same effect on individual welfare, how much *extra* revenue would a lump-sum tax have raised? How much *less* revenue does the beer tax raise? The difference in revenue is how we measure the deadweight loss of the tax.

MEASURING DEADWEIGHT LOSS USING INDIFFERENCE CURVES

Figure 19.4 contrasts the effect of a tax on beer with a lump-sum tax. The beer tax rotates the individual's budget constraint down, from YB to YB'. The income raised by the tax is the vertical distance between the

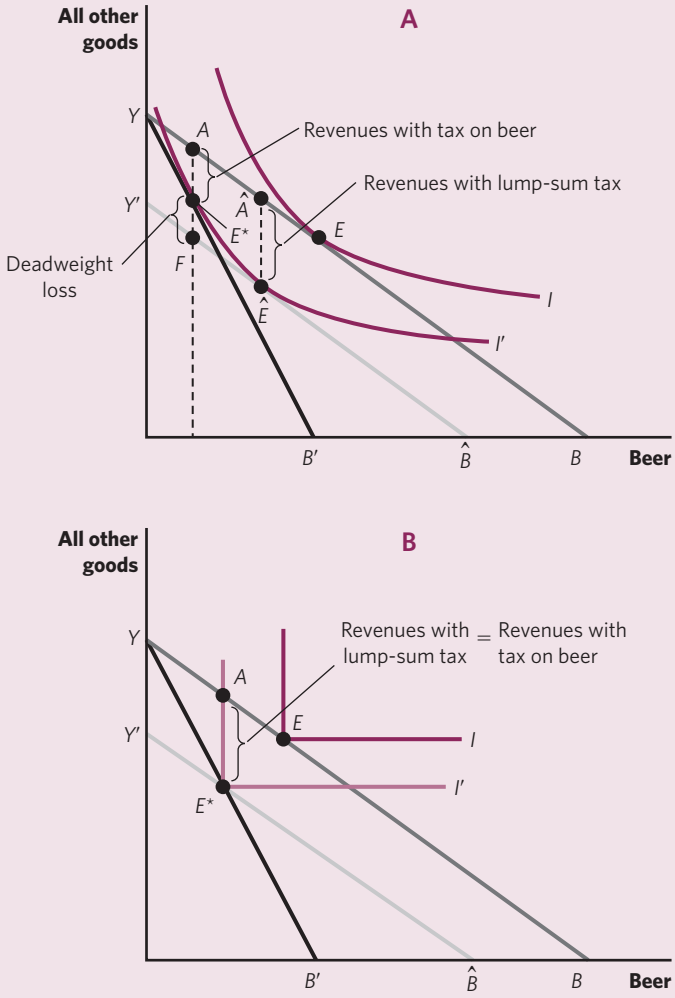


FIGURE 19.4

MEASURING THE DEADWEIGHT LOSS USING INDIFFERENCE CURVES

Individuals choose the amount of beer to consume by the tangency between their indifference curve and the budget constraint. The beer tax rotates the budget constraint. The lump-sum tax moves the budget constraint down parallel. (A) The extra revenue raised by the lump-sum tax is E^*F. (B) When there is no substitution effect, the beer tax has no deadweight loss; a lump-sum tax and a tax on beer raise the same revenue.

before-tax budget constraint and the after-tax budget constraint. Clearly, when no beer is consumed (point Y), no revenue is raised. The more beer that is consumed, the greater the tax revenue. The revenue raised is AE.*

The lump-sum tax with the same effect on utility moves the budget constraint from YB to $Y'\hat{B}$ and the equilibrium is now $\hat{E}$. The revenue raised is again the vertical difference between the new and the old budget constraints—this represents the amount of income that had to be taken away to leave the individual on the same indifference curve. Because the new and old budget constraints are parallel, the vertical distance $\hat{A}\hat{E}$ is exactly equal to AF. (The vertical distance between parallel lines is the same at any location.) Thus, *the lump-sum tax with the same effect on*

*utility raises an additional revenue in the amount of E*F. E*F* is the measure of the deadweight loss associated with the tax.

The *magnitude of the deadweight loss depends on the substitution effect*. This is illustrated in Figure 19.4B, which is identical to Figure 19.4A, except now the indifference curves are L-shaped, so there is no substitution effect, and it is apparent that there is no deadweight loss.

MEASURING DEADWEIGHT LOSS USING COMPENSATED DEMAND CURVES

Another way of measuring deadweight loss makes use of the concepts of consumer surplus and compensated demand curves introduced in Chapter 7. Assume we have imposed a tax of 30 cents per bottle of beer, and, with the tax, Crusoe consumes ten bottles a week. We ask him how much he would be willing to give to the government if the tax were eliminated. In other words, what lump-sum tax would leave him at the same utility level reached when he was subject to the 30-cent tax on beer? Clearly, Crusoe would be willing to pay at least 30 cents $\times$ 10 per week. Any extra revenue that such a tax would generate is the deadweight loss associated with the use of a distortionary tax system.

We now show how to calculate the deadweight loss using a consumer's *compensated demand curve*. The compensated demand curve gives Crusoe's demand for beer, assuming that as the price is lowered, income is being taken away from him in such a way as to leave him on the same indifference curve. We use the compensated demand curve because we wish to know how much more revenue we could have achieved with a nondistortionary tax, still leaving Crusoe just as well off as with the distortionary tax.

Assume that initially the price of a bottle of beer is $1.50, including the 30-cent tax, and Crusoe consumes ten bottles a week. We then ask him how much extra he would be willing to pay to consume eleven bottles a week. He is willing to pay only $1.40. The total amount that he would be willing to pay us as a lump-sum tax if we lowered the tax from 30 cents to 20 cents (and lowered the price of beer from $1.50 to $1.40) is 10 cents $\times$ the 10 bottles he previously purchased, or $1.00 (the area *FGCD* in Figure 19.5A).

We now ask Crusoe to assume that he is in a situation in which we levied a $1.00 lump-sum tax and charged $1.40 each for eleven bottles of beer. How much *extra* would he be willing to pay for one extra bottle? Assume that he said $1.30. We can now calculate the total lump-sum tax that he would be willing to pay if the price were reduced from $1.50 to $1.30. He would be willing to pay 20 cents a bottle for the first ten bottles (the area *JKCD*), and 10 cents for the next (the area *GKLH*), for a total of $2.10.

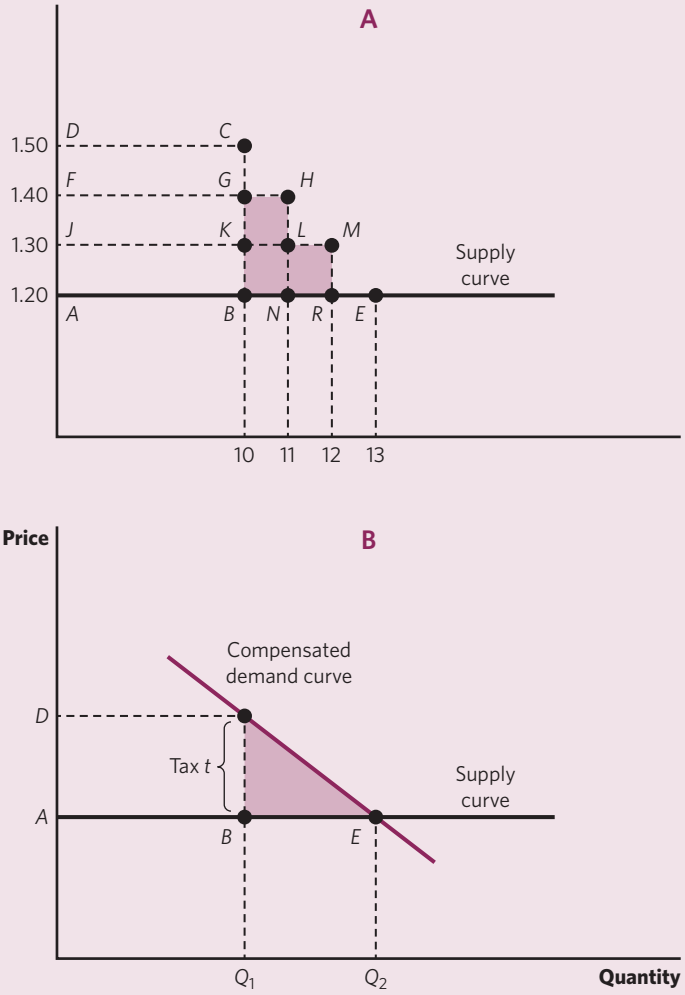


FIGURE 19.5

USING COMPENSATED DEMAND CURVES TO MEASURE DEADWEIGHT LOSS

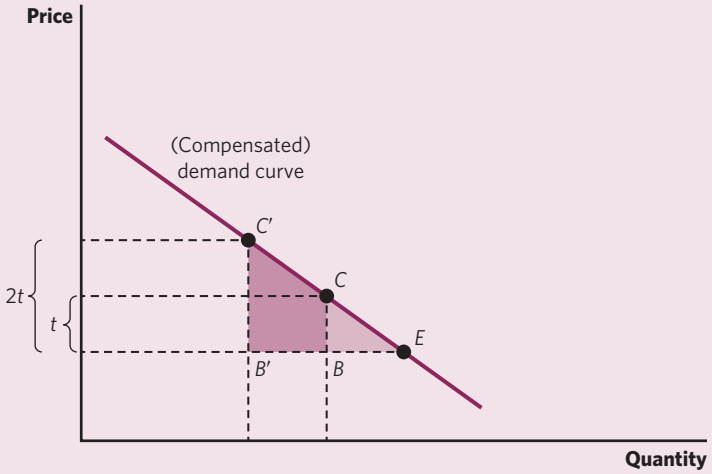
Government revenue is area *ABCD*. (A) Shows how much the individual would be willing to pay to have the price of beer reduced from $1.50 to $1.20, keeping him or her at the same level of utility. The difference between this and the tax revenue raised (the area *ABCD*) is the deadweight loss (the shaded area). (B) Illustrates the case in which the level of consumption can be varied in very small increments.

Finally, we ask him to assume that he is in a situation in which we levied a $2.10 lump-sum tax and charged $1.30 each for twelve bottles. How much extra would he be willing to pay for one extra bottle? Assume that he said $1.20. We could now calculate the total lump-sum tax that he would be willing to pay for the elimination of the 30-cent tax. He would be willing to pay 30 cents on the first ten bottles (the area *ABCD*), 20 cents on the next bottle (the area *BNHG*), and 10 cents on the twelfth bottle (the area *NRML*), for a total of $3.30. The tax revenue from the tax was $3.00 (the area *ABCD*). The deadweight loss is 30 cents (the shaded area).

FIGURE 19.6

EFFECT OF AN INCREASE IN TAX RATE ON THE DEADWEIGHT LOSS

A doubling of the tax rate more than doubles the deadweight loss. (The area $B'C'E$ is four times the area BCE.)



More generally, the amount that an individual would be willing to pay to have the price reduced by 1 cent is just 1 cent times the quantity consumed. As we lower the price, the quantity consumed increases. In Figure 19.5B, the total the individual would be willing to pay to have the price reduced from D to A is the area $AECD$, which takes account of the change in the after-tax quantity consumed as the price is reduced. Of that, however, $ABCD$ is the tax revenue (the tax AD—which equals BC—times the quantity consumed, AB). Hence, the deadweight loss—the difference between the two—is just the triangle BCE. Figure 19.6 shows that as we double the tax rate, we more than double the deadweight loss.

Figure 19.7 shows that, for a given tax rate, the deadweight loss is greater the flatter—or, more precisely, the more elastic—the demand curve. (Remember that the elasticity of the demand curve gives the percentage change in demand as a result of a 1 percent change in price.)

We now make these insights more precise.

CALCULATING THE DEADWEIGHT LOSS

Return to Figure 19.5, in which we used compensated demand curves to measure deadweight loss. The height of the triangle, BC, is equal to the tax, t. BE is the change in quantity as a result of the tax. Recall that the elasticity of demand gives the percentage change in quantity as a result of a 1 percent change in price, that is,

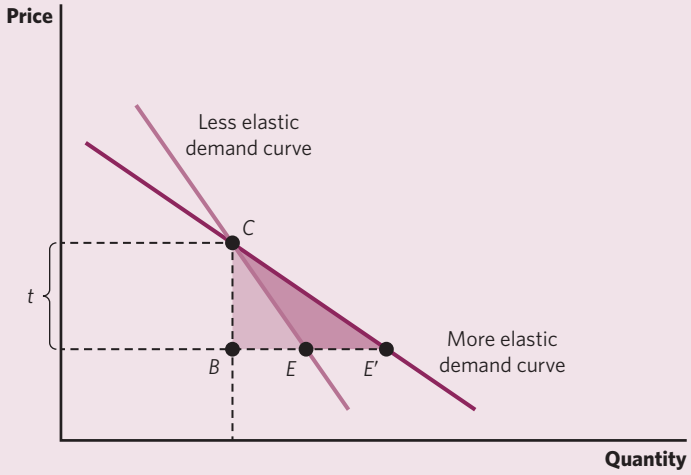


FIGURE 19.7

EFFECT OF AN INCREASE IN THE (COMPENSATED) ELASTICITY OF DEMAND ON DEADWEIGHT LOSS

An increase in the elasticity of the (compensated) demand curve increases the deadweight loss. (*BEC* is deadweight loss from the less elastic demand curve, *BE′C* from the more elastic demand curve.)

$$\eta = \frac{\Delta Q/Q}{\Delta p/p}$$

where the symbol ΔQ represents the change in quantity and the symbol Δp represents the change in price. (The symbol Δ is the [capital] Greek letter delta and is conventionally used to represent a change. The symbol η is the Greek letter eta and is conventionally used to represent the elasticity of demand.) Rearranging, we can write the change in quantity as

$$\Delta Q = \frac{\Delta p}{p} Q\eta.$$

This equation has the natural interpretation that the change in quantity will be larger, the larger the change in price and the larger the elasticity of demand. However, the change in price is just the per unit tax, t. Thus, substituting, we obtain

$$BE = \frac{t}{p} Q\eta.$$

Now the area of the triangle BCE is just

$$\begin{aligned}\frac{t \cdot BE}{2} &= \frac{1}{2}\frac{t^2}{p} Q\eta \\ &= \frac{1}{2}\left(\frac{t}{p}\right)\left(\frac{t}{p}\right) pQ\eta \\ &= \frac{1}{2}\hat{t}^2\, pQ\eta\end{aligned}$$

where $\hat{t} \equiv t/p$ is the tax *rate*, the ratio of the tax to the price.

DEADWEIGHT LOSS OF A TAX

The deadweight loss of a tax increases with the magnitude of the substitution effect (or the elasticity of the compensated demand curve) and with the *square* of the tax rate.

DETERMINANTS OF DEADWEIGHT LOSS

The preceding formula identifies two of the primary determinants of deadweight loss. Deadweight loss increases with the *square* of the tax rate. High tax rates are far more distortionary than low tax rates.

Deadweight loss increases with the *elasticity of the compensated demand curve*.[3] The latter is precisely the substitution effect identified earlier as the critical determinant of deadweight loss. When indifference curves are very flat, the elasticity of the compensated demand curve is large—that is, a small percentage change in price leads to a large change in consumption. (Remember, the compensated demand curve simply describes a movement along an indifference curve, as, by definition, individuals are being compensated to keep them on the same indifference curve.) Many of the goods on which excise taxes are imposed have relatively low elasticities of demand, so the deadweight loss is relatively small. For instance, the 10 percent airline ticket tax is estimated to have a deadweight loss equal to 2.5 percent of the revenue raised (on the basis of an estimated 0.5 price elasticity of demand), an 8 percent beer tax generates a deadweight loss equal to 1.2 percent of the revenue raised (on the basis of an estimated price elasticity of 0.3), and a 15 percent cigarette tax is estimated to lead to a deadweight loss equal to 3 percent of the revenue raised (on the basis of a price elasticity of demand of 0.4).

EFFECT OF TAXES BORNE BY PRODUCERS

Up to now, this chapter has focused on the distortionary effects of a tax on a consumption good. We assumed that supply curves were horizontal, so the entire burden of the tax was on consumers.

At least in the short run, however, most supply curves are upward sloping. This means that part of the burden of any tax on a consumption good will fall on producers. Will this cause an excess burden on producers, above and beyond the direct burden of the tax revenue? The answer

[3] Recall from Chapter 7 that the compensated demand curve is closely related to the ordinary demand curve. When price rises, say, as a result of the tax, individuals are worse off. If the individual previously purchased 100 bottles a beer a year, a 10-cent price increase makes him or her worse off; if we gave the individual $10, he or she would be fully compensated. The effect of a compensated price increase is just the ordinary direct effect, plus the effect of giving an individual an extra $10. If the individual spends only 0.1 percent of his or her income on beer, then the extra income induces an additional beer expenditure of 10 cents: there is little difference between the impact of a compensated and an uncompensated change.