Chapter Fourteen

Taxation and Income Distribution

Struggle and contrive as you will, lay your taxes as you please, the traders will shift it off from their own gain.

—JOHN LOCKE

American policy debates about the tax system are dominated by the question of whether its burden is distributed fairly. A sensible discussion of this normative issue requires some understanding of the positive question of how taxes affect the distribution of income. A simple way to determine how taxes change the income distribution would be to conduct a survey in which each person is asked how many dollars he or she pays to the tax collector each year. Simple—but usually wrong. An example demonstrates that assessing correctly the burden of taxation is much more complicated.

Suppose the price of a bottle of wine is $10. The government imposes a tax of $1 per bottle, to be collected in the following way: Every time a bottle is purchased, the tax collector (who is lurking about the store) takes a dollar out of the wine seller's hand before the money is put into the cash register. A casual observer might conclude that the wine seller is paying the tax.

However, suppose that a few weeks after its imposition, the tax induces a price rise to $11 per bottle. Clearly, the proprietor receives the same amount per bottle as he did before the tax. The tax has apparently made him no worse off. Consumers pay the entire tax in the form of higher prices. On the other hand, suppose that after the tax the price increases to only $10.30. In this case, the proprietor keeps only $9.30 for each bottle sold; he is worse off by 70 cents per bottle. Consumers are also worse off, however, because they have to pay 30 cents more per bottle.[1] In this case, producers and consumers share the burden of the tax. Yet another possibility is that after the tax is imposed, the price stays at $10. If this happens, the consumer is no worse off, while the seller bears the full burden of the tax.

statutory incidence

Indicates who is legally responsible for a tax.

economic incidence

The change in the distribution of real income induced by a tax.

The **statutory incidence** of a tax indicates who is legally responsible for the tax. All three cases in the preceding paragraph are identical in the sense that the statutory incidence is on the seller. But the situations differ drastically with respect to who really bears the burden. Because prices may change in response to the tax, knowledge of statutory incidence tells us *essentially nothing* about who really pays the tax. In contrast, the **economic incidence** of a tax is the change in the distribution of private real income induced by a tax. Our focus in this chapter is on the forces that determine the extent to which statutory and economic incidence differ—the amount of **tax shifting.**

[1] Actually, the change in the prices faced by consumers and producers is only part of the story. There is also a burden due to the tax-induced distortion of choice. See Chapter 15.

tax shifting

The difference between statutory incidence and economic incidence.

TAX INCIDENCE: GENERAL REMARKS

Several observations should be kept in mind in any discussion of how taxes affect the distribution of income.

Only People Can Bear Taxes

In a discussion of a tax bill that was once being considered by Congress, a *Wall Street Journal* columnist observed that "the Senate voted to approve a major tax-law revamp that focuses mainly on corporations, but lawmakers also approved important changes that will benefit many people" [Herman, 2004a]. By drawing a sharp distinction between "corporations" and "people," the statement reflects a common fallacy—that businesses have an independent ability to bear a tax. True, the US legal system treats certain institutions such as corporations as if they were people. Although for many purposes this is a convenient fiction, it sometimes creates confusion. From an economist's point of view, people—stockholders, workers, landlords, consumers—bear taxes. A corporation cannot.

Given that only people can bear taxes, how should they be classified for purposes of incidence analysis? Often their role in production—what inputs they supply to the production process—is used. (Inputs are often referred to as *factors of production*.) The focus is on how the tax system changes the distribution of income among capitalists, laborers, and landlords. This is referred to as the **functional distribution of income.**

functional distribution of income

The way income is distributed among people when they are classified according to the inputs they supply to the production process (for example, landlords, capitalists, laborers).

Framing the analysis this way seems a bit old-fashioned. Perhaps in 18th-century England property owners never worked and workers owned no property. But in the contemporary United States, many people who derive most of their income from labor also have savings accounts and/or common stocks. (Often, these assets are held for individuals in pensions.) Similarly, some people own huge amounts of capital and also work full-time. Thus, it seems more relevant to study how taxes affect the way in which total income is distributed among people: the **size distribution of income.** Given information on what proportion of people's income is from capital, land, and labor, changes in the functional distribution can be translated into changes in the size distribution. For example, a tax that lowers the relative return on capital tends to hurt those at the top of the income distribution because a relatively high proportion of the incomes of the rich is from capital.[2]

size distribution of income

The way that total income is distributed across income classes.

Other classification schemes might be interesting for particular problems. When increases in the federal tax on cigarettes are proposed, the incidence by region receives a great deal of attention. (Are people from tobacco-growing states going to

[2] However, some low-income retirees also derive the bulk of their income from capital.

suffer disproportionate harm?) Alternatively, when proposals are made to change the taxation of land in urban areas, analysts often look at incidence by race. It is easy to think of further examples based on sex, age, and so forth.

Both Sources and Uses of Income Should Be Considered

In the previous wine tax example, it is natural to assume that the distributional effects of the tax depend crucially on people's spending patterns. To the extent that the price of wine increases, the people who tend to consume a lot of wine are made worse off. However, if the tax reduces the demand for wine, the factors employed in wine production may suffer income losses. Thus, the tax can also change the income distribution by affecting the sources of income. Suppose that poor people spend a relatively large proportion of their incomes on wine, but that vineyards tend to be owned by the rich. Then on the uses of income side, the tax redistributes income away from the poor, but on the sources side, it redistributes income away from the rich. The overall incidence depends on how both the sources and uses of income are affected. This distinction is important for understanding the debate over former Vice President Gore's proposal to clean up the Florida Everglades. Because the ecology of the Everglades is harmed by the runoff from sugar fields, he argued that sugar products be subjected to a special tax and the proceeds used to finance a cleanup. Opposition came not only from consumer groups who were concerned about the price of products using sugar but also from Florida *workers,* who realized that by reducing the demand for sugar, such a tax would hurt their incomes.

In practice, economists commonly ignore effects on the sources side when considering a tax on a commodity and ignore the uses side when analyzing a tax on an input. This procedure is appropriate if the most *systematic* effects of a commodity tax are on the uses of income and those of a factor tax on the sources of income. The assumption simplifies analyses, but its correctness must be considered for each case.

Incidence Depends on How Prices Are Determined

We have emphasized that the incidence problem is fundamentally one of determining how taxes change prices. Clearly, different models of price determination may give quite different answers to the question of who really bears a tax. This chapter considers several different models and compares the results.

A closely related issue is the time dimension of the analysis. Incidence depends on changes in prices, but change takes time. In most cases, responses are larger in the long run than the short run. Thus, the short- and long-run incidence of a tax may differ, and the time frame that is relevant for a given policy question must be specified.

Incidence Depends on the Disposition of Tax Revenues

Balanced-budget incidence computes the combined effects of levying taxes *and* government spending financed by those taxes. In general, the distributional effect of a tax depends on how the government spends the money. Expenditures on AIDS research have a very different distributional impact than spending on hot lunches for schoolchildren. Some studies assume the government spends the tax revenue exactly as the consumers would if they had received the money. This is equivalent to returning the revenue as a lump sum and letting consumers spend it.

Tax revenues are usually not earmarked for particular expenditures. It is then desirable to be able to abstract from the question of how the government spends the money. The idea is to examine how incidence differs when one tax is replaced with another, holding the government budget constant. This is called *differential tax incidence*. Because differential incidence looks at changes in taxes, a reference point is needed. The hypothetical "other tax" used as the basis of comparison is often assumed to be a **lump sum tax**—a tax for which the individual's liability does not depend upon behavior. (For example, a 10 percent income tax is *not* a lump sum tax because it depends on how much the individual earns. But a head tax of $500 independent of earnings *is* a lump sum tax.)

lump sum tax

A tax whose value is independent of the individual's behavior.

Finally, *absolute tax incidence* examines the effects of a tax when there is no change in either other taxes or government expenditure. Absolute incidence is of most interest for macroeconomic models in which tax levels are changed to achieve some stabilization goal.

Tax Progressiveness Can Be Measured in Several Ways

Suppose that an investigator has managed to calculate every person's real share of a particular tax—the economic incidence as defined previously. The bottom line of such an exercise is often a characterization of the tax as proportional, progressive, or regressive. The definition of **proportional** is straightforward; it describes a situation in which the ratio of taxes paid to income is constant regardless of income level.[3]

proportional

A tax system under which an individual's average tax rate is the same at each level of income.

average tax rate

Ratio of taxes paid to income.

Defining progressive and regressive is not easy and, unfortunately, ambiguities in definition sometimes confuse public debate. A natural way to define these words is in terms of the **average tax rate,** the ratio of taxes paid to income. If the average tax rate increases with income, the system is **progressive;** if it falls, the tax is **regressive.**

progressive

A tax system under which an individual's average tax rate increases with income.

regressive

A tax system under which an individual's average tax rate decreases with income.

Confusion arises because some people think of progressiveness in terms of the **marginal tax rate**—the *change* in taxes paid with respect to a change in income. To illustrate the distinction, consider the following very simple income tax structure. Each individual computes her tax bill by subtracting $3,000 from income and paying an amount equal to 20 percent of the remainder. (If the difference is negative, the individual gets a subsidy equal to 20 percent of the figure.) Table 14.1 shows the amount of tax paid, the average tax rate, and the marginal tax rate for each of several income levels. The average rates increase with income. However, the marginal tax rate is constant at 0.2 because for each additional dollar earned, the individual pays an additional 20 cents, regardless of income level. People could disagree about the progressiveness of this tax system and each be right according to their own definitions. It is therefore very important to make the definition clear when using the terms *regressive* and *progressive*. From here on, we assume they are defined in terms of average tax rates.

marginal tax rate

The proportion of the last dollar of income taxed by the government.

[3] However, the definition of income is not straightforward; see Chapter 17.

Table 14.1 **Tax liabilities under a hypothetical tax system**

Income	Tax Liability	Average Tax Rate	Marginal Tax Rate
$2,000	$−200	−0.10	0.2
3,000	0	0	0.2
5,000	400	0.08	0.2
10,000	1,400	0.14	0.2
30,000	5,400	0.18	0.2

Under this hypothetical tax system, each individual computes her tax bill by subtracting $3,000 from income and paying an amount equal to 20 percent of the remainder. While the marginal tax rate is constant at 20 percent, the average tax rate is increasing as income increases, which means the tax is progressive.

Measuring *how* progressive a tax system is presents an even harder task than defining progressiveness. Many reasonable alternatives have been proposed, and we consider two simple ones. The first says that the greater the increase in average tax rates as income increases, the more progressive the system. Algebraically, let T_0 and T_1 be the true (as opposed to statutory) tax liabilities at income levels I_0 and I_1, respectively (I_1 is greater than I_0). The measurement of progressiveness, v_1, is

$$v_1 = \frac{\frac{T_1}{I_1} - \frac{T_0}{I_0}}{I_1 - I_0} \tag{14.1}$$

Once the analyst computes the values of T_1 and T_0 and substitutes into Equation (14.1), the tax system with the higher value of v_1 is said to be more progressive.

The second possibility is to say that one tax system is more progressive than another if its elasticity of tax revenues with respect to income (i.e., the percentage change in tax revenues divided by percentage change in income) is higher. Here the expression to be evaluated is v_2, defined as

$$v_2 = \frac{(T_1 - T_0)}{T_0} \div \frac{(I_1 - I_0)}{I_0} \tag{14.2}$$

Now consider the following proposal: Everyone's tax liability is to be increased by 20 percent of the amount of tax he or she currently pays. This proposal would increase the tax liability of a person who formerly paid T_0 to $1.2 \times T_0$, and the liability that was formerly T_1 to $1.2 \times T_1$. Member of Congress A says the proposal will make the tax system more progressive, while member of Congress B says it has no effect on progressiveness whatsoever. Who is right? It depends on the progressivity measure. Substituting the expressions $1.2 \times T_0$ and $1.2 \times T_1$ for T_0 and T_1, respectively, in Equation (14.1), v_1 increases by 20 percent. The proposal thus increases progressiveness. On the other hand, if the same substitution is done in Equation (14.2), the value of v_2 is unchanged. (Both the numerator and denominator are multiplied by 1.2, which cancels out the effect.) The lesson here is that even very intuitively appealing measures of progressiveness can give different answers.[4] Again, intelligent public debate requires that people make their definitions clear.

[4] Note also that v_1 and v_2, in general, depend on the level of income. That is, even a single tax system does not usually have a constant v_1 and v_2. This further complicates discussions of the degree of progressiveness.

▸ PARTIAL EQUILIBRIUM MODELS

With preliminaries out of the way, we turn now to the fundamental issue of this chapter: how taxes affect the income distribution. Recall that the essence of the problem is that taxes induce changes in relative prices. Knowing how prices are determined is therefore critical to the analysis. In this section we analyze **partial equilibrium models** of price determination—models that look only at the market in which the tax is imposed and ignore the ramifications in other markets. This kind of analysis is most appropriate when the market for the taxed commodity is relatively small compared to the economy as a whole. The vehicle for our analysis is the supply and demand model of perfect competition.

partial equilibrium models

Models that study only one market and ignore possible spillover effects in other markets.

Unit Taxes on Commodities

We study first the incidence of a **unit tax,** so named because it is levied as a fixed amount per unit of a commodity sold. For example, the federal government imposes a tax on champagne of $3.40 per wine gallon and a tax on cigarettes of 39 cents per pack. Suppose that the price and quantity of champagne are determined competitively by supply (S_c) and demand (D_c) as in Figure 14.1. Before imposition of the tax, the quantity demanded and price are Q_0 and P_0, respectively.

unit tax

A tax levied as a fixed amount per unit of commodity purchased.

Now suppose that a unit tax of $\$u$ per gallon is imposed on each purchase, and the statutory incidence is on buyers. A key step in incidence analysis is to recognize that in the presence of a tax, the price paid by consumers and the price received by suppliers differ. Previously, we could use a supply-demand analysis to determine the *single* market price. Now, this analysis must be modified to accommodate two different prices, one for buyers and one for sellers.

We begin by determining how the tax affects the demand schedule. Consider an arbitrary point a on the demand curve. This point indicates that the *maximum* price

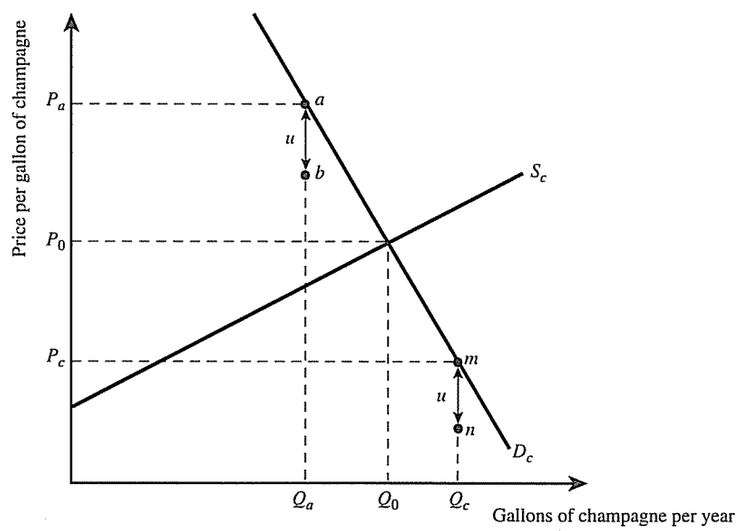


Figure 14.1
Price and quantity before taxation
A unit tax of $\$u$ per gallon changes the demand curve as perceived by suppliers. For example, the maximum price per gallon that people are willing to pay for Q_a is P_a. After the tax, when people pay P_a per gallon, producers only receive $P_a - u$ per gallon (which corresponds to point b). The new demand curve is located exactly u dollars below the old one.

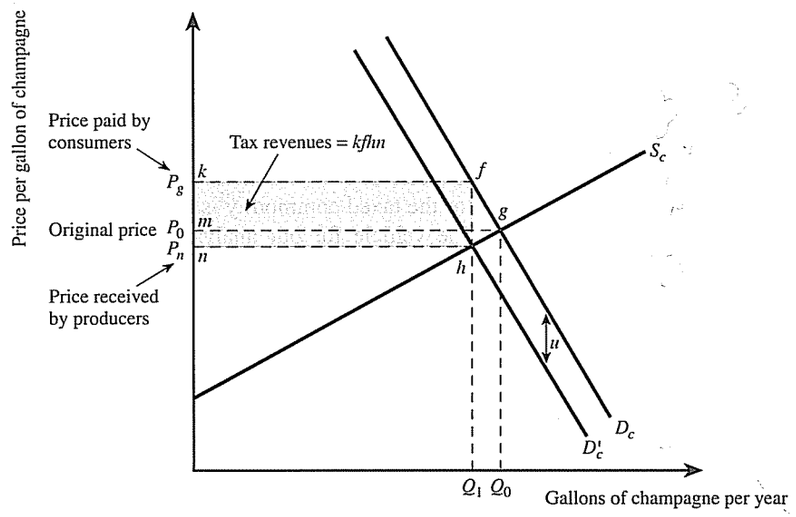


Figure 14.2
Incidence of a unit tax imposed on the demand side
After the imposition of the unit tax on consumers, the new equilibrium quantity is Q_1. The price received by producers is P_n, and the price paid by consumers is P_n plus u, which is P_g.

per gallon that people would be willing to pay for Q_a gallons is P_a. After the unit tax of u is imposed, the most that people would be willing to spend for Q_a is *still* P_a. There is no reason to believe the tax affects the underlying valuation people place on champagne. However, when people pay P_a per gallon, producers no longer receive the whole amount. Instead, they receive only $(P_a - u)$, an amount that is labeled point b in Figure 14.1. In other words, after the unit tax is imposed, a is no longer a point on the demand curve *as perceived by suppliers*. Point b is on the demand curve as perceived by suppliers, because they realize that if Q_a is supplied, they receive only $(P_a - u)$ per gallon. It is irrelevant to the suppliers how much consumers pay per gallon; all that matters to suppliers is the amount they receive per gallon.

Of course, point a was chosen arbitrarily. At any other point on the demand curve, the story is just the same. Thus, for example, after the tax is imposed, the price received by suppliers for output Q_c is at point n, which is found by subtracting the distance u from point m. Repeating this process at every point along the demand curve, we generate a new demand curve located exactly u dollars below the old one. In Figure 14.2, the demand curve so constructed is labeled D_c'. Schedule D_c' is relevant to suppliers because it shows how much they receive for each unit sold.

We are now in a position to find the equilibrium quantity of champagne after the unit tax is imposed. The equilibrium is where the supply equals demand as perceived by suppliers, output Q_1 in Figure 14.2. Thus, the tax lowers the quantity sold from Q_0 to Q_1.

The next step is to find the new equilibrium price. As noted earlier, there are really two prices at the new equilibrium: the price received by producers, and the price paid by consumers. The price received by producers is at the intersection of their effective demand and supply curves, which occurs at P_n. The price paid by consumers is P_n *plus* u, the unit tax. To find this price geometrically, we must go up from P_n a vertical distance exactly equal to u. But by construction, the distance between schedules D_c and D_c' is equal to u. Hence, to find the price paid by

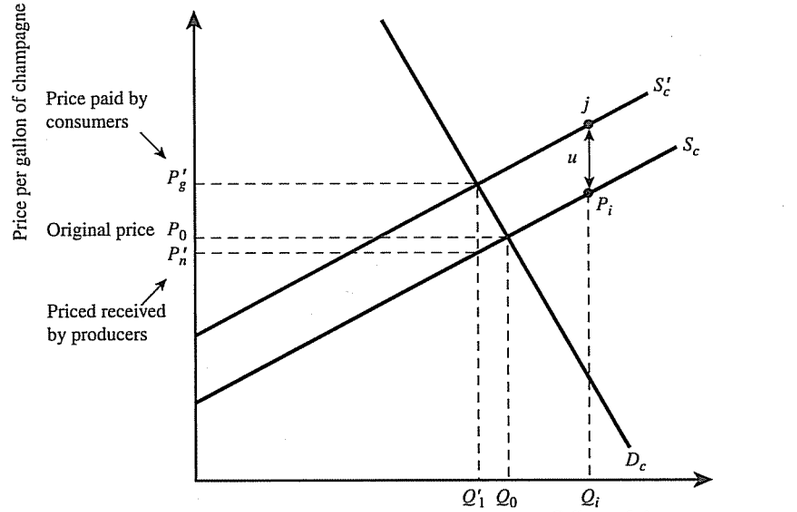


Figure 14.3
Incidence of a unit tax imposed on the supply side
A unit tax imposed on suppliers shifts up the supply curve by the amount of the tax. The posttax equilibrium quantity, price to consumers, and price to suppliers is the same as when the statutory incidence is on consumers.

consumers, we simply go up from the intersection of D_c' and S_c to the original demand curve D_c. The price so determined is P_g. Because P_g includes the tax, it is often referred to as the price *gross* of tax. On the other hand, P_n is the price *net* of tax.

The tax makes consumers worse off because P_g, the new price they face, is higher than the original price P_0. But the consumers' price does not increase by the full amount of the tax—$(P_g - P_0)$ is less than u. Producers also pay part of the tax in the form of a lower price received per gallon. Producers now receive only P_n, while before the tax they received P_0. Thus, the tax makes both producers and consumers worse off.[5] Notice that consumers and producers "split" the tax in the sense that the increase in the consumer price $(P_g - P_0)$ and the decrease in the producer price $(P_0 - P_n)$ just add up to $\$u$.

By definition, revenues collected are the product of the number of units purchased, Q_1, and the tax per unit, u. Geometrically, Q_1 is the width of rectangle *kfhn* and u is its height, so tax revenues are the area of this rectangle.

This analysis has two important implications:

The Incidence of a Unit Tax Is Independent of Whether It Is Levied on Consumers or Producers Suppose the same tax u had been levied on the suppliers of champagne instead of the consumers. Consider an arbitrary price P_i on the original supply curve in Figure 14.3. The supply curve indicates that for suppliers to produce Q_i units, they must receive at least P_i per unit. After the unit tax, suppliers still need to receive P_i per unit. For them to do so, however, consumers must pay price $P_i + u$ per unit, which is shown geometrically as point j. It should

[5] In terms of surplus measures, consumers are worse off by area *mkfg* and producers are worse off by *mghn*. The loss of total surplus exceeds the tax revenues by triangle *fhg;* this is the *excess burden* of the tax, as explained in Chapter 15. For a review of consumer and producer surplus, see the appendix at the end of this book.

now be clear where the argument is heading. To find the supply curve as it is perceived by consumers, S_c must be shifted up by the amount of the unit tax. This new supply curve is labeled S_c'. The posttax equilibrium is at Q_1', where the schedules S_c' and D_c intersect. The price at the intersection, P_g', is the price paid by consumers. To find the price received by producers, we must subtract u from P_g', giving us P_n'. A glance at Figure 14.2 indicates that $Q_1' = Q_1$, $P_g' = P_g$, and $P_n' = P_n$. Thus, the incidence of the unit tax is independent of the side of the market on which it is levied.

This is the same as our statement that the statutory incidence of a tax tells us nothing of the economic incidence of the tax. It is irrelevant whether the tax collector (figuratively) stands next to consumers and takes u dollars every time they pay for a gallon of champagne or stands next to sellers and collects u dollars from them whenever they sell a gallon. Figures 14.2 and 14.3 prove that what matters is the size of the disparity the tax introduces between the price paid by consumers and the price received by producers, and not on which side of the market the disparity is introduced. The tax-induced difference between the price paid by consumers and the price received by producers is referred to as the **tax wedge.**

tax wedge

The tax-induced difference between the price paid by consumers and the price received by producers.

The Incidence of a Unit Tax Depends on the Elasticities of Supply and Demand In Figure 14.2, consumers bear the brunt of the tax—the amount they pay goes up much more than the amount received by producers goes down. This result is strictly determined by the shapes of the demand and supply curves. In general, the more elastic the demand curve, the less the tax borne by consumers, other things being the same. Similarly, the more elastic the supply curve, the less the tax borne by producers, other things being the same. Intuitively, elasticity provides a rough measure of an economic agent's ability to escape the tax. The more elastic the demand, the easier it is for consumers to turn to other products when the price goes up, and therefore more of the tax must be borne by suppliers. Conversely, if consumers purchase the same amount regardless of price, the whole burden can be shifted to them. Similar considerations apply to the supply side.

Illustrations of extreme cases are provided in Figures 14.4 and 14.5. In Figure 14.4, commodity X is supplied perfectly inelastically. When a unit tax is imposed, the effective demand curve becomes D_X'. As before, the price received by producers (P_n) is at the intersection of S_X and D_X'. Note that P_n is exactly u less than P_0. Thus, the price received by producers falls by exactly the amount of the tax. At the same time, the price paid by consumers, P_g ($= P_n + u$), remains at P_0. When supply is perfectly inelastic, producers bear the entire burden. Figure 14.5 represents an opposite extreme. The supply of commodity Z is perfectly elastic. Imposition of a unit tax leads to demand curve D_Z'. At the new equilibrium, quantity demanded is Z_1 and the price received by producers, P_n, is still P_0. The price paid by consumers, P_g, is therefore $P_0 + u$. In this case, consumers bear the entire burden of the tax.[6]

The Cigarette Tax Debate Recently, the United States has been engaging in a major policy debate regarding cigarette taxation. In 2000, the 24-cent-per-pack federal tax was raised to 34 cents, and it is now 39 cents. But certain legislators would like to go further and increase the tax to $1 or more. Some proponents of the higher

[6] Note that as long as input costs are constant, the *long-run* supply curve for a competitive market is horizontal as in Figure 14.5. Hence, under these conditions, in the long run consumers bear the entire burden of the tax.

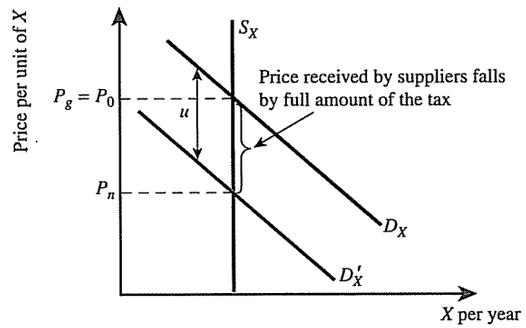


Figure 14.4
Tax incidence when supply is perfectly inelastic
A unit tax on a good that has perfectly inelastic supply causes the price received by producers to fall by exactly the amount of the tax. Producers therefore bear the entire burden of the tax.

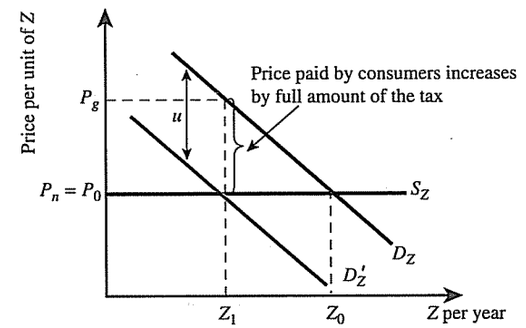


Figure 14.5
Tax incidence when supply is perfectly elastic
A unit tax on a good that has perfectly elastic supply causes the price paid by consumers to increase by exactly the amount of the tax. Consumers therefore bear the entire burden of the tax.

tax seem to be interested primarily in discouraging smoking, and others care more about punishing tobacco producers. Those who want to discourage smoking are implicitly assuming that the tax will drive up the price paid by consumers, and those who want to punish the tobacco producers expect the price they receive to go down. How can one determine which effect would prevail? Our model of tax incidence tells us what we need to find out: the supply and demand elasticities in the cigarette market.

Ad Valorem Taxes

We now turn to the incidence of an **ad valorem tax,** a tax with a rate given as a *proportion* of the price. For example, the state of Tennessee levies a 6 percent tax on purchases of food. Virtually all state and local taxes on restaurant meals and clothing are ad valorem.

ad valorem tax

A tax computed as a percentage of the purchase value.

Luckily, the analysis of ad valorem taxes is very similar to that of unit taxes. The basic strategy is still to find out how the tax changes the effective demand curve and compute the new equilibrium. However, instead of moving the curve down by the same absolute amount for each quantity, the ad valorem tax lowers it by the same *proportion*. To show this, consider the demand (D_f) and supply (S_f) curves for food

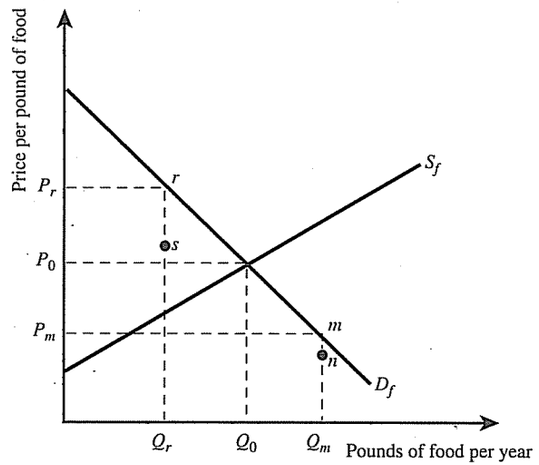


Figure 14.6
Introducing an ad valorem tax
An ad valorem tax on consumers shifts the demand curve down by the same proportion at each level of output.

in Figure 14.6. In the absence of taxation, the equilibrium price and quantity are P_0 and Q_0, respectively. Now suppose that a tax of 25 percent of the gross price is levied on the consumption of food.[7] Consider point m on D_f. After the tax is imposed, P_m is still the most that consumers will pay for Q_m pounds of food; the amount producers will receive is 75 percent of the vertical distance between point m and the horizontal axis, which is labeled point n. Hence, point n is one point on the demand curve perceived by producers. Similarly, the price at point r migrates down one quarter of the way between it and the horizontal axis to point s. Repeating this exercise for every point on D_f, the effective demand curve facing suppliers is determined as D_f' in Figure 14.7. From here, the analysis proceeds exactly as for a unit tax: The equilibrium is where S_f and D_f' intersect, with the quantity exchanged Q_1, the price received by food producers P_n, and the price paid by consumers P_g. As before, the incidence of the tax is determined by the elasticities of supply and demand.

This analysis is applicable to any number of situations. Suppose that Figure 14.7 were relabeled so that it represented the market for rental housing instead of the food market. Then we could show that the burden of the property tax doesn't depend on whether landlords or tenants pay the property tax. This is counter to the usual perception that landlords bear the burden simply because they write the check.

Taxes on Factors

So far we have discussed taxes on goods, but the analysis can also be applied to factors of production.

The Payroll Tax Consider the payroll tax used to finance the Social Security system. As noted in Chapter 11, a tax equal to 7.65 percent of workers' earnings

[7] Measuring ad valorem tax rates involves a fundamental ambiguity. Is the tax measured as a percentage of the net or gross price? In this example, the tax is 25 percent of the gross price, which is equivalent to a rate of 33 percent of net price. If the price paid by the consumer were $1, the tax paid would be 25 cents, and the price received by producers would be 75 cents. Expressing the 25 cent tax bill as a fraction of 75 cents gives us a 33 percent rate as a proportion of the net price.

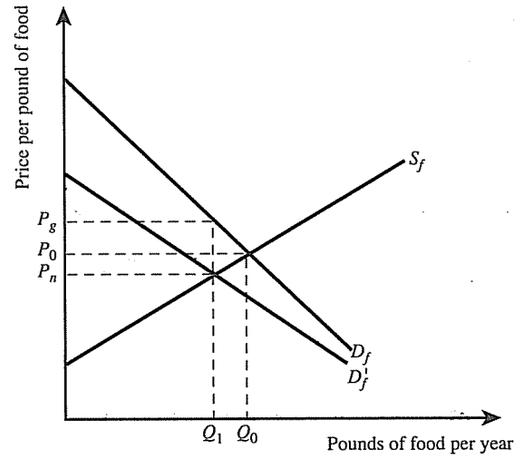


Figure 14.7
Incidence of an ad valorem tax
After the imposition of an ad valorem tax, the new equilibrium quantity is Q_1, the price received by the producers is P_n, and the price paid by consumers is P_g.

must be paid by their employers and a tax at the same rate paid by the workers themselves—a total of 15.3 percent.[8] This division has a long history and is a consequence of our lawmakers' belief that the payroll tax should be shared equally by employers and employees. But the *statutory distinction between workers and bosses is irrelevant*. As suggested earlier, the incidence of this labor tax is determined only by the wedge the tax puts between what employees receive and employers pay.

This point is illustrated in Figure 14.8, where D_L is the demand for labor and S_L is the supply of labor. For purposes of illustration, assume S_L to be perfectly inelastic. Before taxation, the wage is w_0. The ad valorem tax on labor moves the effective demand curve to D_L'. As usual, the distance between D_L' and D_L is the wedge between what is paid for an item and what is received by those who supply it. After the tax is imposed, the wage received by workers falls to w_n. On the other hand, w_g, the price paid by employers, stays at w_0. In this example, despite the statutory division of the tax, the wage rate received by workers falls by exactly the amount of the tax—they bear the entire burden.

Of course, we could have gotten just the opposite result by drawing the supply curve as perfectly elastic. The key point to remember is that nothing about the incidence of a tax can be known without information on the relevant behavioral elasticities. In fact, while estimates of the elasticity of labor supply vary, many economists believe that it is close to zero [Fuchs et al., 1998]. At least in the short run, labor probably bears most of the payroll tax, despite the congressional attempt to split the burden evenly.

Capital Taxation in a Global Economy The strategy for analyzing a tax on capital is essentially the same as that for analyzing a tax on labor—draw the supply and demand curves, shift or pivot the relevant curve by an amount depending on the tax rate, and see how the after-tax equilibrium compares with the original one. In an economy that is closed to trade, it is reasonable to assume that the demand curve slopes down (firms demand less capital when its price goes up), and that the supply

[8] After earnings exceed a certain level, the payroll tax rate falls. See Chapter 11.

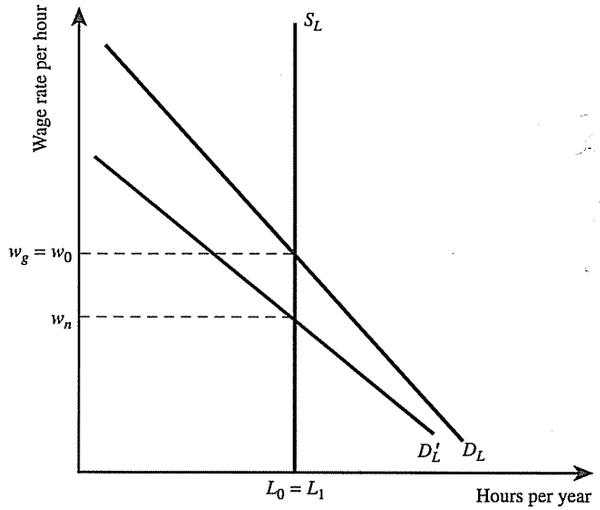


Figure 14.8
Incidence of a payroll tax with an inelastic supply of labor
If labor supply is perfectly inelastic, a payroll tax causes the wage received by workers to fall by the exact amount of the tax. Workers therefore bear the entire burden of the tax.

of capital slopes up (people supply more capital—save more—when the return to saving increases).[9] In this case, the owners of capital bear some of the burden of the tax, the precise amount depending on the supply and demand elasticities.

Suppose now that the economy is open and capital is perfectly mobile across countries. In effect, there is a single global market for capital, and if suppliers of capital cannot earn the going world rate of return in a particular country, they will take it out of that country and put it in another. In terms of a supply and demand diagram, the supply of capital to a particular country is perfectly elastic—its citizens can purchase all the capital they want at the going rate of return, but none whatsoever at a lower rate. The implications for the incidence of a tax on capital are striking. As in Figure 14.5, the before-tax price paid by the users of capital rises by exactly the amount of the tax, and the suppliers of capital bear no burden whatsoever. Intuitively, capital simply moves abroad if it has to bear any of the tax; hence, the before-tax rate of return has to rise.

Now, even in today's highly integrated world economy, capital is not perfectly mobile across countries. Moreover, for a country like the United States whose capital market is large relative to the world market, it is doubtful that the supply curve is perfectly horizontal. Nevertheless, policymakers who ignore globalization will tend to overestimate their ability to place the burden of taxation on owners of capital. To the extent that capital is internationally mobile, taxes on capitalists are shifted to others, and the apparent progressivity of taxes on capital is illusory.

Commodity Taxation without Competition

The assumption of competitive markets has played a major role in our analysis. We now discuss how the results might change under alternative market structures.

[9] However, saving need not increase with the rate of return. See Chapter 18.

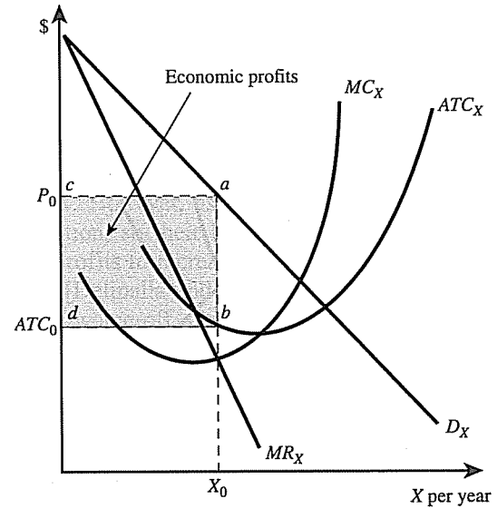


Figure 14.9
Equilibrium of a monopolist
The monopolist produces X_0 per year, charges a price of P_0, and receives profits of area *abdc*.

Monopoly The polar opposite of competition is monopoly—one seller. Figure 14.9 depicts a monopolist that produces commodity X. Before any taxation, the demand curve facing the monopolist is D_X, and the associated marginal revenue curve is MR_X. The marginal cost curve for the production of X is MC_X, and the average total cost curve, ATC_X. As usual, the condition for profit maximization is that production be carried to the point where marginal revenue equals marginal cost, at output X_0 where the price charged is P_0. Economic profit per unit is the difference between average revenue and average total cost, distance *ab*. The number of units sold is *db*. Hence, total profit is *ab* times *db*, which is the area of rectangle *abdc*.

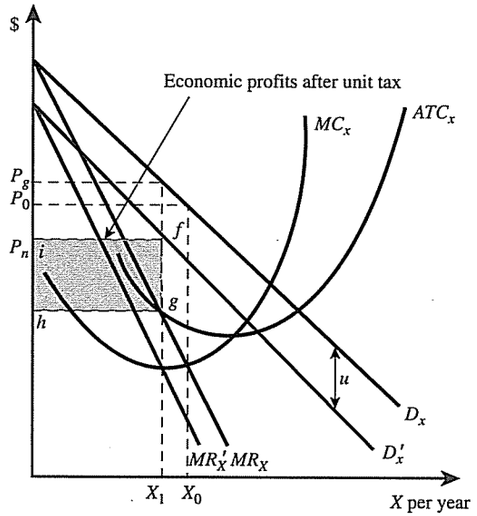
Now suppose that a unit tax of u is levied on X. For exactly the same reasons as before, the effective demand curve facing the producer shifts down by a vertical distance equal to u.[10] In Figure 14.10, this demand curve is labeled D'_X. At the same time, the marginal revenue curve facing the firm also shifts down by distance u because the tax reduces the firm's incremental revenue for each unit sold. The new effective marginal revenue curve is labeled MR'_X.

The profit-maximizing output, X_1, is found at the intersection of MR'_X and MC_X. Using output X_1, we find the price received by the monopolist by going up to D'_X, the demand curve facing him, and locate price P_n. The price paid by consumers is determined by adding u to P_n, which is shown as price P_g on the diagram. After-tax profit per unit is the difference between the price *received by the monopolist* and average total cost, distance *fg*. Number of units sold is *if*. Therefore, monopoly economic profits after tax are measured by area *fghi*.

What are the effects of the tax? Quantity demanded goes down ($X_1 < X_0$), the price paid by consumers goes up ($P_g > P_0$), and the price received by the monopolist goes down ($P_n < P_0$). Note that monopoly profits are lower under

[10] Alternatively, we could shift the marginal cost curve *up* by u. The final outcomes are identical.

Figure 14.10
Imposition of a unit tax on a monopolist
The imposition of a unit tax on a monopolistically produced good shifts the effective demand curve and the marginal revenue curve down by the amount of the tax. The tax reduces the equilibrium quantity from X_0 to X_1, increases the price paid by consumers from P_0 to P_g, decreases the price received by the producer from P_0 to P_n, and decreases the monopolist's profits from area *abcd* to area *fghi*.



the tax—area *fghi* in Figure 14.10 is smaller than area *abdc* in Figure 14.9. Despite its market power, a monopolist is generally made worse off by a unit tax on the product it sells. Public debates often assume that a firm with market power can simply pass on all taxes to consumers. This analysis shows that even a completely greedy and grasping monopolist must bear some of the burden. As before, the precise share of the burden borne by consumers depends on the elasticity of the demand schedule.

It is straightforward to repeat the exercise for an ad valorem tax on the monopolist (D_X and MR_X pivot instead of moving down in a parallel fashion); this is left as an exercise for the reader.

Oligopoly Between the polar extremes of perfect competition and monopoly is the oligopoly market structure in which there are a "few" sellers. Unfortunately, there is no well-developed theory of tax incidence in oligopoly. The reason for this embarrassing fact is simple: Incidence depends primarily on how relative prices change when taxes are imposed, but there is no generally accepted theory of oligopolistic price determination.

Still, we can get a sense of the issues involved by imagining the problem faced by the firms in an oligopolistic market. From the firms' point of view, the ideal situation would be for them to collude and jointly produce the output that maximizes the profits of the entire industry. This output level is referred to as the *cartel solution*. (A cartel is just a group of producers that act together to maximize profits. The international oil cartel OPEC is the most famous example.) The cartel solution requires each firm to cut its output to force up the market price. The problem for the firms is that the cartel solution is very difficult to obtain. Why? Once an agreement about how much each firm should produce is reached, each firm has an incentive to cheat on that agreement—to take advantage of the higher price and produce more than its quota of output. (Again, think about OPEC, and the problems it has in keeping its members from producing "too much" oil.) Consequently, output in an oligopolistic market is typically higher than the cartel solution. The firms would all be better off if there were some mechanism to force all of them to reduce their output.

What happens when this industry's output is subjected to a tax? As is the case both for competition and monopoly, the firms reduce their output. However, unlike the other market structures, this is not necessarily bad for the oligopolistic firms. To be sure, for any given level of before-tax profits, the firms are worse off, because they have to pay the tax. However, as the firms contract their outputs, they move closer to the cartel solution, so their before-tax profits increase. It is theoretically possible for before-tax profits to increase by so much that even after paying the tax, the firms are better off [Delipalla and O'Donnell, 2001]. Of course, it is also possible for the firms to be worse off. One needs more information on just how much the firms cut back their output to obtain a definitive answer.

As economic behavior under oligopoly becomes better understood, improved models of incidence will be developed. In the meantime, most economists feel fairly comfortable in relying on the predictions produced by competitive models, although they realize these are only approximations.

Profits Taxes

So far we have been discussing taxes based on sales. Firms can also be taxed on their **economic profits,** defined as the return to owners of the firm in excess of the opportunity costs of the factors used in production. (Economic profits are also referred to as *supranormal* or *excess* profits.) We now show that for profit-maximizing firms, a tax on economic profits cannot be shifted—it is borne only by the owners of the firm.

economic profit
The return to owners of a firm above the opportunity costs of all the factors used in production. Also called supranormal or excess profit.

Consider first a perfectly competitive firm in short-run equilibrium. The firm's output is determined by the intersection of its marginal cost and marginal revenue schedules. A proportional tax on economic profits changes neither marginal cost nor marginal revenue. Therefore, no firm has the incentive to change its output decision. Because output does not change, neither does the price paid by consumers, so they are no worse off. The tax is completely absorbed by the firms. Here's another way to get to the same result: If the tax rate on economic profits is t_p, the firm's objective is to maximize after-tax profits, $(1 - t_p)\Pi$, where Π is the pretax level of economic profits. But it is just a matter of arithmetic that whatever strategy maximizes Π is identical to the one that maximizes $(1 - t_p)\Pi$. Hence, output and price faced by consumers stay the same, and the firm bears the whole tax.

In long-run competitive equilibrium, a tax on economic profits has no yield, because economic profits are zero—they are all competed away. For a monopolist, there may be economic profits even in the long run. But for the same reasons given in the preceding paragraph, the tax is borne by the owners of the monopoly. If a firm is maximizing profits before the profits tax is imposed, the tax cannot be shifted.[11]

Because they distort no economic decisions, taxes on economic profits might appear to be very attractive policy alternatives. In 2006, for example, certain

[11] On the other hand, if the firm is following some other goal, it may raise the price in response to a profits tax. One alternative to profit maximization is revenue maximization; firms try to make their sales as large as possible, subject to the constraint that they earn a "reasonable" rate of return.

members of both political parties called for a "profits tax" on oil companies. However, profits taxes receive very little support from public finance specialists. The main reason is the tremendous problems in making the theoretical notion of economic profits operational. Economic profits are often computed by examining the rate of return that a firm makes on its capital stock and comparing it to some "basic" rate of return set by the government. Clearly, how the capital stock is measured is important. Should the original cost be used, or the cost of replacing it? And what if the rate of return is high not because of excess profits, but because the enterprise is very risky and investors have to be compensated for this risk? Considerations like these lead to major difficulties in administration and compliance.

Tax Incidence and Capitalization

Several years ago the coastal city of Port Hueneme, California, levied a special tax on beach properties. The tax was determined in part by how close the properties were to the ocean. For owners close to the water, the extra tax was $192 per year. Owners of beachfront property complained vociferously.

This episode leads us to consider the special issues that arise when land is taxed. For these purposes, the distinctive characteristics of land are that it is fixed in supply and it is durable. Suppose the annual rental rate on land is $\$R_0$ this year. It is known that the rental will be $\$R_1$ next year, $\$R_2$ two years from now, and so on. How much should someone be willing to pay for the land? If the market for land is competitive, its price is just equal to the present discounted value of the stream of the rents. Thus, if the interest rate is r, the price of land (P_R) is

$$P_R = \$R_0 + \frac{\$R_1}{1+r} + \frac{\$R_2}{(1+r)^2} + \cdots + \frac{\$R_T}{(1+r)^T} \tag{14.3}$$

where T is the last year the land yields its services (possibly infinity).

Now it is announced that a tax of $\$u_0$ will be imposed on land now, $\$u_1$ next year, $\$u_2$ two years from now, and so forth. From Figure 14.4 we know that because land is fixed in supply, the annual rental received by the owner falls by the full amount of the tax. Thus, the landlord's return initially falls to $\$(R_0 - u_0)$, in year 1 to $\$(R_1 - u_1)$, in year 2 to $\$(R_2 - u_2)$, and so on. Prospective purchasers of the land take into account the fact that if they purchase the land, they buy a future stream of tax liabilities as well as a future stream of returns. Therefore, the most a purchaser is willing to pay for the land after the tax is announced (P_R') is

$$P_R' = \$(R_0 - u_0) + \frac{\$(R_1 - u_1)}{1+r} + \frac{\$(R_2 - u_2)}{(1+r)^2} + \cdots + \frac{\$(R_T - u_T)}{(1+r)^T} \tag{14.4}$$

Comparing Equations (14.4) and (14.3), we see that as a consequence of the tax, the price of land falls by

$$u_0 + \frac{u_1}{1+r} + \frac{u_2}{(1+r)^2} + \cdots + \frac{u_T}{(1+r)^T}$$

capitalization

The process by which a stream of tax liabilities becomes incorporated into the price of an asset.

Thus, at the time the tax is imposed, the price of the land falls by the present value of *all future tax payments*. This process by which a stream of taxes becomes incorporated into the price of an asset is referred to as **capitalization.**

Because of capitalization, the person who bears the full burden of the tax *forever* is the landlord at the time the tax is levied. To be sure, *future* landlords write checks to the tax authorities, but such payments are not really a "burden" because they just balance the lower price paid at purchase. Capitalization complicates attempts to assess the incidence of a tax on any durable item that is fixed in supply. Knowing the identities of current owners is not sufficient—one must know who the landlords *were* at the time the tax was imposed. It's no wonder the owners of beach property in Port Hueneme were so upset![12]

▸ GENERAL EQUILIBRIUM MODELS

A great attraction of partial equilibrium models is their simplicity—examining only one market at a time is relatively uncomplicated. In some cases, however, ignoring feedback into other markets leads to an incomplete picture of a tax's incidence. Suppose, for example, that the tax rate on cigarettes is increased. To the extent that the demand for cigarettes decreases, so does the demand for tobacco. Farmers who formerly grew tobacco on their land may turn to other crops, perhaps cotton. As the supply of cotton increases, its price falls, harming the individuals who were already producing cotton. Thus, cotton producers end up bearing part of the burden of a cigarette tax.

More generally, when a tax is imposed on a sector that is "large" relative to the economy, looking only at that particular market may not be enough. **General equilibrium analysis** takes into account the ways in which various markets are interrelated.

general equilibrium analysis

The study of how various markets are interrelated.

Another problem with partial equilibrium analysis is that it gives insufficient attention to the question of just who the "producers" of a taxed commodity are. Think again of the cigarette tax and the desire of some policymakers to use it as an instrument to punish "the tobacco industry." Only people can pay taxes, and the producers of tobacco include the shareholders who finance the purchase of machinery, farmers who own the land on which the tobacco is grown, the workers in the factories, and so on. The division of the tax burden among these groups is often important. General equilibrium analysis provides a framework for investigating it.

Before turning to the specifics of general equilibrium analysis, note that the fundamental lesson from partial equilibrium models still holds: Because of relative price adjustments, the statutory incidence of a tax generally tells *nothing* about who really bears its burden.

Tax Equivalence Relations

The idea of dealing with tax incidence in a general equilibrium framework at first appears daunting. After all, thousands of different commodities and inputs are traded in the economy. How can we keep track of all their complicated interrelations? Luckily,

[12] When a land tax is anticipated before it is levied, presumably it is borne at least in part by the owner at the time the anticipation becomes widespread. If so, even finding out the identity of the landowner at the time the tax was imposed may not be enough.

for many purposes, useful general equilibrium results can be obtained from models in which there are only two commodities, two factors of production, and no savings. For illustration, call the two commodities food (F) and manufactures (M), and the two factors capital (K) and labor (L). There are nine possible ad valorem taxes in such a model:

t_{KF} = a tax on capital used in the production of food
t_{KM} = a tax on capital used in the production of manufactures
t_{LF} = a tax on labor used in the production of food
t_{LM} = a tax on labor used in the production of manufactures
t_F = a tax on the consumption of food
t_M = a tax on consumption of manufactures
t_K = a tax on capital in both sectors
t_L = a tax on labor in both sectors
t = a general income tax

partial factor tax

Tax levied on an input in only some of its uses.

The first four taxes, which are levied on a factor in only some of its uses, are referred to as **partial factor taxes.**

Certain combinations of these taxes are equivalent to others. One of these equivalences is already familiar from the theory of the consumer.[13] Taxes on food (t_F) and manufactures (t_M) at the same rate are equivalent to an income tax (t).[14] To see this, just note that equiproportional taxes on all commodities have the same effect on the consumer's budget constraint as a proportional income tax. Both create a parallel shift inward.

Now consider a proportional tax on both capital (t_K) and labor (t_L). Because in this model all income is derived from either capital or labor, it is a simple matter of arithmetic that taxing both factors at the same rate is also equivalent to an income tax (t).

Perhaps not so obvious is the fact that partial taxes on both capital and labor in the food sector at a given rate ($t_{KF} = t_{LF}$) are equivalent to a tax on food (t_F) at the same rate. Because capital and labor are the only inputs to the production of food, making each of them more expensive by a certain proportion is equivalent to making the food itself more expensive in the same proportion.

More generally, any two sets of taxes that generate the same changes in relative prices have equivalent incidence effects. All the equivalence relations that can be derived using similar logic are summarized in Table 14.2. For a given ad valorem tax rate, the equivalences are shown by reading across the rows or down the columns. To determine the incidence of all three taxes in any row or column, only two have to be analyzed in detail. The third can be determined by addition or subtraction. For example, from the third row, if we know the incidence of taxes on capital and labor, then we also know the incidence of a tax on income.

In the next section, we discuss the incidence of four taxes: a food tax (t_F), an income tax (t), a general tax on labor (t_L), and a partial tax on capital in manufacturing (t_{KM}). With results on these four taxes in hand, the incidence of the other five can be determined by using Table 14.2.

[13] The theory of the consumer is outlined in the appendix at the end of this book.
[14] Note that given the assumption that all income is consumed, an income tax is also equivalent to a tax on consumption expenditure.

Table 14.2 Tax equivalence relations

t_{KF}	and	t_{LF}	are equivalent to	t_F
and		and		and
t_{KM}	and	t_{LM}	are equivalent to	t_M
are		are		are
equivalent		equivalent		equivalent
to		to		to
t_K	and	t_L	are equivalent to	t

Source: McLure [1971, p. 29].

Any two sets of taxes that generate the same changes in relative prices have equivalent incidence effects. For example, a proportional tax on both capital (t_K) and labor (t_L) is equivalent to an income tax (t).

The Harberger Model

Harberger [1974] pioneered the application of general equilibrium models to tax incidence. The principal assumptions of his model are as follows:

1. *Technology.* Firms in each sector use capital and labor to produce their outputs. In each sector, a simultaneous doubling of both inputs leads to a doubling of output, *constant returns to scale.* However, the production technologies may differ across sectors. In general, the production technologies differ with respect to the ease with which capital can be substituted for labor (the **elasticity of substitution**) and the ratios in which capital and labor are employed. For example, the capital-labor ratio in the production of food is about twice that used in the production of textiles [Congressional Budget Office, 1997]. The industry in which the capital-labor ratio is relatively high is characterized as **capital intensive;** the other is **labor intensive.**
2. *Behavior of factor suppliers.* Suppliers of both capital and labor maximize total returns. Moreover, capital and labor are perfectly mobile—they can freely move across sectors according to the wishes of their owners. Consequently, the net marginal return to capital must be the same in each sector, and so must the net marginal return to labor. Otherwise, it would be possible to reallocate capital and labor in such a way that total net returns could be increased.[15]
3. *Market structure.* Firms are competitive and maximize profits, and all prices (including the wage rate) are perfectly flexible. Therefore, factors are fully employed, and the return paid to each factor of production is the value of its marginal product—the value to the firm of the output produced by the last unit of the input.
4. *Total factor supplies.* The total amounts of capital and labor in the economy are fixed. But, as noted above, both factors are perfectly free to move between sectors.
5. *Consumer preferences.* All consumers have identical preferences. A tax therefore cannot generate any distributional effects by affecting people's uses of income. This assumption allows us to concentrate on the effect of taxes on the sources of income.

elasticity of substitution

A measure of the ease with which one factor of production can be substituted for another.

capital intensive

An industry in which the ratio of capital to labor inputs is relatively high.

labor intensive

An industry in which the ratio of capital to labor inputs is relatively low.

[15] The appendix at the end of this book explains why maximizing behavior results in an allocation in which marginal returns are equal.

6. *Tax incidence framework.* The framework for the analysis is differential tax incidence: We consider the substitution of one tax for another. Therefore, approximately the same amount of income is available before and after the tax, so it is unnecessary to consider how changes in aggregate income may change demand and factor prices.

Clearly, these assumptions are somewhat restrictive, but they simplify the analysis considerably. Later in this chapter, we consider the consequences of dropping some of them. We now employ Harberger's model to analyze several different taxes.

Analysis of Various Taxes

A Commodity Tax (t_F) When a tax on food is imposed, its relative price increases (although not necessarily by the amount of the tax). Consumers therefore substitute manufactures for food. Consequently, less food and more manufactures are produced. As food production falls, some of the capital and labor formerly used in food production are forced to find employment in manufacturing. Because the capital-labor ratios probably differ between the two sectors, the relative prices of capital and labor have to change for manufacturing to be willing to absorb the unemployed factors from food production. For example, assume that food is the capital-intensive sector. (US agriculture does, in fact, use relatively more capital equipment—tractors, combines, and so forth—than many types of manufacturing.) Therefore, relatively large amounts of capital must be absorbed in manufacturing. The only way for all this capital to find employment in the manufacturing sector is for the relative price of capital to fall—including capital already in use in the manufacturing sector. In the new equilibrium, then, *all* capital is relatively worse off, not just capital in the food sector. More generally, a tax on the *output* of a particular sector induces a decline in the relative price of the *input* used intensively in that sector.

To go beyond such qualitative statements, additional information is needed. The greater the elasticity of demand for food, the more dramatic will be the change in consumption from food to manufactures, which ultimately induces a greater decline in the return to capital. The greater the difference in factor proportions between food and manufactures, the greater must be the decrease in capital's price for it to be absorbed into the manufacturing sector. (If the capital-labor ratios for food and manufactured goods were identical, neither factor would suffer relative to the other.) Finally, the harder it is to substitute capital for labor in the production of manufactures, the greater the decline in the rate of return to capital needed to absorb the additional capital.

Thus, on the sources side of the budget, the food tax tends to hurt people who receive a proportionately large share of their incomes from capital. Given that all individuals are identical (assumption 5), there are no interesting effects on the uses side. However, were we to drop this assumption, then clearly those people who consumed proportionately large amounts of food would tend to bear relatively larger burdens. The total incidence of the food tax then depends on both the sources and uses sides. For example, a capitalist who eats a lot of food is worse off on both counts. On the other hand, a laborer who eats a lot of food is better off from the point of view of the sources of income, but worse off on the uses side.

An Income Tax (t) As already noted, an income tax is equivalent to a set of taxes on capital and labor at the same rate. Since factor supplies are completely fixed (assumption 4), this tax cannot be shifted. It is borne in proportion to people's initial incomes. The intuition behind this result is similar to the analogous case in the partial

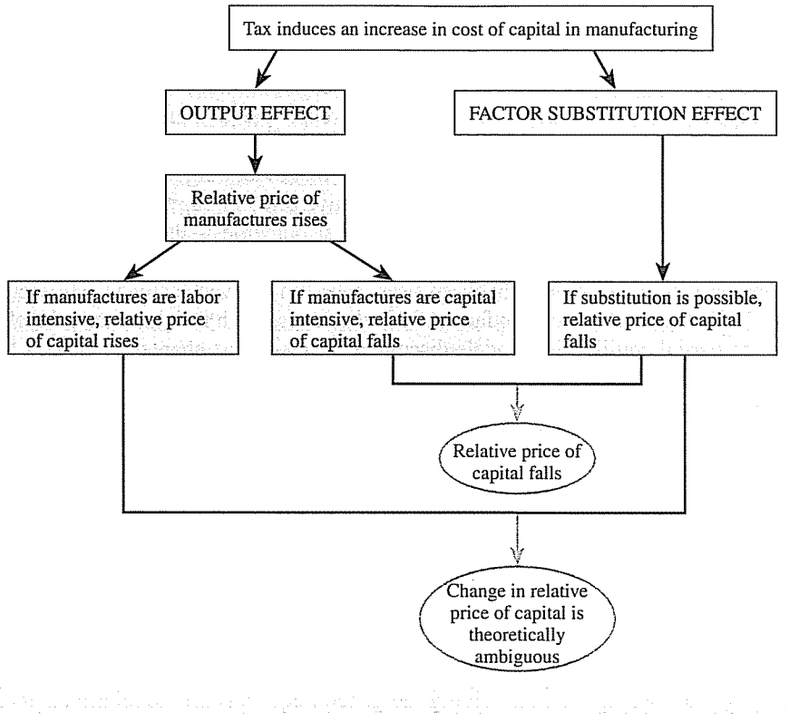


Figure 14.11
Incidence of a partial factor tax in a general equilibrium model
A tax on capital in the manufacturing sector leads to an output effect and a factor substitution effect. The output effect leads to an increase in the price of manufactures, which decreases the amount of capital and labor used in manufacturing. If the manufacturing sector is capital intensive, the relative price of capital falls. If it is labor intensive, the relative price of capital rises. The factor substitution effect leads producers to use less capital and more labor, leading to a drop in the relative price of capital.

equilibrium model; since the factors cannot "escape" the tax (by opting out of production), they bear the full burden.

A General Tax on Labor (t_L) A general tax on labor is a tax on labor in *all* its uses, in the production of both food and manufactures. As a result, there are no incentives to switch labor use between sectors. Further, the assumption of fixed factor supplies implies labor must bear the entire burden.

A Partial Factor Tax (t_{KM}) When capital used in the manufacturing sector *only* is taxed, there are two initial effects:

1. *Output effect.* The price of manufactures tends to rise, which decreases the quantity demanded by consumers.
2. *Factor substitution effect.* As capital becomes more expensive in the manufacturing sector, producers there use less capital and more labor.

The flowchart in Figure 14.11 traces the consequences of these two effects.

The output effect is described on the left side. As its name suggests, the output effect arises from reducing production in manufacturing. When the price of manufactures increases and demand falls, capital and labor are released from manufacturing and must find employment in the production of food. If the manufacturing sector is labor intensive, then (relatively) large amounts of labor have to be absorbed in the food sector, and the relative price of capital increases. If, on the other hand, the manufacturing sector is

capital intensive, the relative price of capital falls. Thus, the output effect is ambiguous with respect to the final effect on the relative prices of capital and labor.

This ambiguity is not present with the factor substitution effect, as depicted in the right-hand side of Figure 14.11. As long as substitution between capital and labor is possible, an increase in the price of capital induces manufacturers to use less capital and more labor, tending to decrease the demand for capital and its relative price.

Putting the two effects together, we see that if manufacturing is capital intensive, both effects work in the same direction, and the relative price of capital must fall. But if the manufacturing sector is labor intensive, the final outcome is theoretically ambiguous. Even though the tax is levied on capital, it can make labor worse off! More generally, as long as factors are mobile between uses, a tax on a given factor in *one* sector ultimately affects the return to *both* factors in *both* sectors. Such insights cannot be obtained with the partial equilibrium models discussed earlier in this chapter.

Much of the applied research on incidence in general equilibrium models has focused on the corporation income tax. Such work assumes that the two sectors are "corporate" and "noncorporate," and that the corporation income tax is an ad valorem tax on capital only on its use in the corporate sector. Given the theoretical ambiguity of the effect of a partial factor tax on the demand for capital, empirical work is required to find its incidence. Although different studies have reached different conclusions, the most typical finding is that much of the tax is shifted to the owners of all capital [President's Advisory Panel on Federal Tax Reform, 2005, p. 34].

Some Qualifications

Changing the assumptions underlying the general equilibrium model affects its implications for tax incidence in the following ways:

Differences in Individuals' Tastes By assumption 5, all consumers have the same preferences for the two goods. When they do not, tax-induced changes in the distribution of income change aggregate spending decisions and hence relative prices and incomes. Consider, for example, a tax on capital in the corporate sector. As noted above, most analyses suggest that it is shifted to the owners of all capital. And because capital tends to be a relatively important source of income for high-income individuals, the tax would appear to be progressive. However, as noted by Fullerton and Rogers [1997], the tax also raises the relative prices of goods produced in capital-intensive industries such as agriculture and petroleum refining, whose outputs (food and gasoline) are purchased in high proportions by families at the low end of the income scale. Thus, when we allow for differences in uses between high- and low-income families, the tax becomes less progressive than it first appears.

Immobile Factors By assumption 2, resources are free to flow between sectors, seeking the highest rate of return possible. However, for institutional or technological reasons, some factors may be immobile. For example, if certain land is zoned for residential use, it cannot be used in manufacturing, no matter what the rate of return. Abandoning perfect mobility can dramatically affect the incidence of a tax. For example, earlier we showed that if factors are mobile, the incidence of a partial factor tax is ambiguous, depending on the outcome of several conflicting effects. If the factor is immobile, however, the incidence result is clear-cut: The taxed factor bears the whole burden. Intuitively, this is because the factor cannot "escape" taxation by migrating to the other sector. Note also that because the return to the taxed immobile factor falls by just the amount of the tax, the prices of capital and labor in the untaxed sectors are unchanged, as is the price of the good in the taxed sector.

Variable Factor Supplies By assumption 4, the total supplies of both factors are fixed. In the long run, however, the supplies of both capital and labor to the economy are variable. Allowing for growth can turn conclusions from the static model completely on their heads. Consider a general factor tax on capital. When the capital stock is fixed, this tax is borne entirely by the capital's owners. In the long run, however, less capital may be supplied due to the tax.[16] To the extent this occurs, the economy's capital-labor ratio decreases, and the return to labor falls. (The wage falls because labor has less capital with which to work, and hence is less productive, other things being the same.) Thus, a general tax on capital can hurt labor.

Because the amount of calendar time that must elapse before the long run is reached may be substantial, short-run effects matter. On the other hand, intelligent policy also requires consideration of the long-run consequences of taxation.

An Applied Incidence Study

The theory of tax incidence has served as a framework for a number of attempts to estimate how the US tax system affects the distribution of income. Table 14.3 reports the findings of a recent study by the Congressional Budget Office [2004b]. The study estimates the incidence of all federal taxes. The average tax rate ranges from 5.6 percent for households in the lowest income quintile to 31.2 percent for households in the top one percent of the population. This top 1 percent pays 21.3 percent of all federal taxes. These figures suggest that the federal tax system is quite progressive.

However, it should be clear by now that all incidence results depend crucially on the underlying assumptions. This study assumes that there is no shifting of the personal income tax, that payroll taxes are borne by workers, and that commodity taxes are borne by consumers in proportion to their consumption of the taxed items. These assumptions help simplify the problem considerably. But the theory of tax incidence suggests that they are questionable, especially in the long run.

Table 14.3 Average federal tax rates and share of federal taxes by income quintile (2006)

Income Category	Average Federal Tax Rate	Share of Federal Taxes
Lowest quintile	5.6%	1.1%
Second quintile	12.1	5.2
Third quintile	15.7	10.3
Fourth quintile	19.8	19.0
Highest quintile	26.5	64.2
All quintiles	21.6	100.0
Top 1%	31.2	21.3

Source: Congressional Budget Office [2004b]. These figures are based on projections that rely on assumptions about inflation and income growth. They include all tax law as of 2001.

According to this applied incidence study, the average federal tax rate ranges from 5.6 percent for households in the lowest quintile to 31.2 percent for households in the top one percent of the income distribution. The top one percent pays 21.3 percent of all federal taxes.

[16] However, the supply of capital does not necessarily decrease. See Chapter 18.

Another limitation of the analysis is that it is based on annual incomes. Using some measure of lifetime income would be more appropriate and could change the results importantly. To see why, we begin by noting that a substantial amount of empirical research suggests people's consumption decisions are more closely related to some lifetime income measure than the value of income in any particular year. Just because a person's income is *temporarily* high or low in a year does not have that great an impact on how much the person consumes.

Assume that the consumption of commodity X is proportional to lifetime income. Assume further that the supply curve for X is horizontal, so that consumers bear the entire burden of any tax on X. Then a tax on X would be proportional with respect to lifetime income. However, in any particular year, some people have incomes that are temporarily higher than their permanent values and some lower. A person with a temporarily high income spends a relatively small proportion of his annual income on X because he does not increase his consumption of X due to the temporary increase in income. Similarly, a person with a temporarily low income devotes a relatively high proportion of her income to good X. In short, based on annual income, good X's budget share appears to fall with income, and a tax on X looks regressive. Consistent with this theory, several investigators have found that incidence results are very sensitive to whether lifetime or annual measures are employed. For example, Fullerton and Metcalf [2002, p. 1847] state that although state and local sales taxes are regressive with respect to an annual measure of income, they are progressive when a lifetime measure of income is used. We conclude that even though studies based on annual income are suggestive, the results should be viewed with some caution.

▸ CONCLUSIONS

We began this chapter with an innocent question: Who bears the burden of a tax? We saw that price changes are the key to finding the burden of a tax, but that price changes depend on a lot of things: market structure, elasticities of supply and demand, mobility of factors of production, and so on. At this stage, an obvious question is: What do we really know?

For taxes that may reasonably be analyzed in isolation, the answer is "Quite a bit." A partial equilibrium incidence analysis requires only information on the market structure and the shapes of the supply and demand curves. In cases other than a clear-cut monopoly, the competitive market paradigm provides a sensible starting point. Estimates of supply and demand curves can be obtained using the empirical methods discussed in Chapter 2. Incidence analysis is on firm ground.

Even in general equilibrium models, incidence analysis is straightforward for a tax on an immobile factor—the incidence is entirely on the taxed factor. More generally, though, if a tax affects many markets, incidence depends on the reactions of numerous supply and demand curves for goods and inputs. The answers are correspondingly less clear.

Unfortunately, it seems that many important taxes such as the corporate tax fall into the last category. Why is this? It may be for the very reason that the incidence is hard to find. (What are the political chances of a tax that clearly hurts some important group in the population?) Complicated taxes may actually be simpler for a politician because no one is sure who actually ends up paying them.

In any case, the models in this chapter tell us what information is needed to understand the incidence even of very complex taxes. To the extent that this information is currently unavailable, the models serve as a measure of our ignorance. This is not altogether undesirable. As St. Jerome noted, "It is worse still to be ignorant of your ignorance."

Summary

- Statutory incidence is the legal liability for a tax, while economic incidence is the actual burden of the tax. Knowing the legal incidence usually tells us little about economic incidence.
- Economic incidence is determined by the price changes induced by a tax, and depends on both individuals' sources and uses of income.
- Depending on the policy being considered, it may be appropriate to examine balanced budget, differential, or absolute incidence.
- In partial equilibrium competitive models, tax incidence depends on the elasticities of supply and demand. The same general approach can be used to study incidence in a monopolized market. For oligopoly, however, there is no single accepted framework for tax analysis.
- Due to capitalization, the burden of future taxes may be borne by *current* owners of an inelastically supplied durable commodity such as land.
- General equilibrium incidence analysis often employs a two-sector, two-factor model. This framework allows for nine possible taxes. Certain combinations of these taxes are equivalent to others.
- In a general equilibrium model, a tax on a single factor in its use only in a particular sector can affect the returns to all factors in all sectors.
- Applied tax incidence studies indicate that the federal tax system is quite progressive. But such studies rest upon possibly problematic assumptions.

Discussion Questions

1. In 2004, the city of Cologne, Germany, instituted a "pleasure tax." Among other things, the tax applied to massage parlors, table-dancing clubs, and brothels. Many sex workers complained that the tax was unjust because it was levied on them rather than on the men who patronize their services. One sex worker said, "I can't increase what I charge" to make up for the tax increase.
   a. Implicit in the sex worker's assertion is an assumption about the elasticity of demand for her services. What is that assumption, and do you think it is realistic?
   b. What would be the economic implications for sex workers if the tax was instead levied on their patrons?
2. In 2004, Congress adopted a Medicare prescription drug benefit which would, in effect, subsidize the purchase of drugs by the elderly. Opponents of the new subsidy argued that it would only result in higher prices for prescription drugs, with little benefit to the elderly. Under what conditions is this view likely to be correct? Do you think that these conditions are realistic? (Note: Although the prescription drug program is very complicated, for purposes of this problem, simply model the benefit as an ad valorem subsidy.)
3. For commodity X, average cost is equal to marginal cost at every level of output. Assuming that the market for X is competitive and the demand curve is linear, analyze the effects when a unit tax of u dollars is imposed. Now analyze the effects of the same tax assuming that the market for X is a monopoly. Discuss the differences.
4. Use a general equilibrium framework to discuss the possible incidence of a tax on cigarettes.

5. In an effort to reduce alcohol consumption, the government is considering a $1 tax on each gallon of liquor sold (the tax is levied on producers). Suppose that the demand curve is $Q^D = 500{,}000 - 20{,}000P$ (where Q^D is the number of gallons of liquor demanded and P is the price per gallon), and the supply curve for liquor is $Q^S = 30{,}000P$ (where Q^S is the number of gallons supplied).
   a. Compute how the tax affects the price paid by consumers and the price received by producers.
   b. How much revenue does the tax raise for the government? How much of the revenue comes from consumers, and how much from producers?
   c. Suppose that the demand for liquor is more elastic for younger drinkers than for older drinkers. Will the liquor tax be more, less, or equally effective at reducing liquor consumption among young drinkers? Explain.
6. Suppose that the demand curve for a particular commodity is $Q^D = a - bP$, where Q^D is the quantity demanded, P is the price, and a and b are constants. The supply curve for the commodity is $Q^S = c + dP$, where Q^S is quantity supplied and c and d are constants. Find the equilibrium price and output as functions of the constants a, b, c, and d.

   Suppose now that a unit tax of u dollars is imposed on the commodity. Show that the new equilibrium is the same regardless of whether the tax is imposed on producers or buyers of the commodity.
7. Suppose that the income tax in a certain nation is computed as a flat rate of 5 percent, but no tax is levied above $50,000 in taxable income. Taxable income, in turn, is computed as the individual's income minus $10,000; that is, everyone gets a $10,000 deduction. What are the marginal and average tax rates for each of the following three workers? (Evaluate the marginal tax rate at each person's current income level.)
   a. A part-time worker with annual income of $9,000.
   b. A retail salesperson with annual income of $45,000.
   c. An advertising executive with annual income of $600,000.

   Is the tax progressive, proportional, or regressive with respect to income?
8. Assume that in a given country, tax revenues, T, depend on income, I, according to the formula

$$T = -4{,}000 + 0.2I$$

   Thus, for example, when a household has an income of $50,000, its tax burden is $-4{,}000 + 0.2 \times 50{,}000$, or $6,000. Is this a progressive tax schedule? [Hint: Compute average tax rates at several different levels of income.]

   Now let's generalize the tax schedule in this problem to:

$$T = a + tI$$

   where a and t are numbers. (For example, in the tax schedule above, $a = -4{,}000$ and $t = 0.2$.) Write down a formula for the average tax rate as a function of the level of income. Show that the tax system is progressive if a is negative, and regressive if a is positive. [Hint: The average tax rate is T/I.]
9. In 2002, New York City increased the tax rate on cigarettes from 8 cents a pack to $1.50 a pack. A month after the increase, a spokesman for the mayor noted that "fewer cigarettes are being sold, and the city is making more money" [Cooper, 2002, p. B7]. Assume for simplicity that the supply of cigarettes to New York City is perfectly elastic.
   a. Assuming that the spokesman's facts are correct, what must be true of the elasticity of the demand for cigarettes in New York City?
   b. Recall that the spokesman's comment was made just one month after the tax increase was enacted. As more time passes, what do you expect to happen to the elasticity of the demand curve, and how will this affect tax revenues for New York City?
10. A *New York Times* editorialist recently advocated a cut in the payroll tax. Among other advantages, he argued that it would "stimulate hiring, since employers shoulder half the burden of the tax" [Conley, 2004]. Sketch a model that is consistent with this argument. Is it realistic?

Chapter Fifteen

Taxation and Efficiency

Waste always makes me angry.

—RHETT BUTLER IN *GONE WITH THE WIND*

Taxes impose a cost on the taxpayer. It is tempting to view the cost as simply the amount of money that he or she hands over to the tax collector. However, an example indicates that this is just part of the story.

Consider Breyer Dazs, a citizen who typically consumes 10 ice cream cones each week, at a price of $1 per cone. The government levies a 25 percent tax on his consumption of ice cream cones, so now Dazs faces a price of $1.25.[1] In response to the price hike, Dazs reduces his ice cream cone consumption to zero, and he spends the $10 per week on other goods and services. Obviously, because Dazs consumes no ice cream cones, the ice cream tax yields zero revenue. Do we want to say that Dazs is unaffected by the tax? The answer is no. Dazs is worse off because the tax has induced him to consume a less desirable bundle of goods than previously. We know that the after-tax bundle is less desirable because, before tax, Dazs had the option of consuming no ice cream cones. Since he chose to buy 10 cones weekly, this must have been preferred to spending the money on other items. Thus, despite the fact that the tax raised zero revenue, it made Dazs worse off.

A variety of real-world taxes illustrate this point. For example, many cities levy high taxes on airport rental cars as a way of collecting revenues from out-of-towners [Johnson, 2005]. One frequent flyer explained that he stopped flying to Boston to avoid that city's $10 tax on car rentals, and instead flies through Chicago to Manchester, New Hampshire. Another traveler to Medford, Oregon, stated that he avoids the tax on airport rental cars by instead taking a taxi downtown and renting a car there (where there is no tax). Clearly, while these travelers are not directly paying the tax on airport car rentals, it still makes them worse off.

These examples are a bit extreme. Normally, we expect that an increase in price will diminish the quantity demanded but not drive it all the way to zero. Nevertheless, the basic result holds: Because a tax distorts economic decisions, it creates an **excess burden**—a loss of welfare above and beyond the tax revenues collected. Excess burden is sometimes referred to as *welfare cost* or *deadweight loss*.[2] In this chapter we discuss the theory and measurement of excess burden, and explain its importance for evaluating actual tax systems.

excess burden

A loss of welfare above and beyond taxes collected. Also called welfare cost or deadweight loss.

[1] As emphasized in Chapter 14, the price paid by the consumer generally does not rise by the full amount of the tax. This assumption, which is correct if the supply curve is horizontal, is made here only for convenience.
[2] See Chapters 6 and 9 for a discussion of the deadweight losses of some expenditure programs.

▸ EXCESS BURDEN DEFINED

Ruth has a fixed income of I dollars, which she spends on only two commodities: barley and corn. The price per pound of barley is P_b and the price per pound of corn is P_c. There are no taxes or "distortions" such as externalities or monopoly in the economy, so the prices of the goods reflect their social marginal costs. For convenience, these social marginal costs are assumed to be constant with respect to output. In Figure 15.1, Ruth's consumption of barley is measured on the horizontal axis and her consumption of corn on the vertical axis. Her budget constraint is line AD, which has slope $-P_b/P_c$ and horizontal intercept I/P_b.[3] Assuming Ruth wants to maximize her utility, she chooses a point like E_1 on indifference curve i, where she consumes B_1 pounds of barley and C_1 pounds of corn.

Now suppose the government levies a tax at a percentage rate of t_b on barley so the price Ruth faces becomes $(1 + t_b)P_b$. (The before-tax price is unchanged because of our assumption of constant marginal social costs.) Imposition of the tax changes Ruth's budget constraint. It now has a slope of $-[(1 + t_b)P_b/P_c]$ and horizontal intercept $I/[(1 + t_b)P_b]$. This is represented in Figure 15.1 as line AF. (Because the price of corn is still P_c, lines AF and AD have the same vertical intercept.)

Note that at each consumption level of barley, the vertical distance between AD and AF shows Ruth's tax payments measured in corn. To see this, consider an arbitrary quantity of barley B_a on the horizontal axis. Before the tax was imposed, Ruth could have both B_a pounds of barley and C_a pounds of corn. After the tax, however, if she consumed B_a pounds of barley, the most corn she could afford would be C_b pounds. The difference (distance) between C_a and C_b must therefore represent the amount of tax collected by the government measured in pounds of corn. We can convert tax receipts to dollars by multiplying distance C_aC_b by the price per pound of corn, P_c. For convenience, we measure corn in units such that $P_c = 1$. In this case, the distance C_aC_b measures tax receipts in corn *or* dollars.

So far, we have not indicated Ruth's choice on her new budget constraint, AF. Figure 15.2 shows that her most preferred bundle is at E_2 on indifference curve ii, where her consumption of barley is B_2, her consumption of corn is C_2, and her tax bill is the associated vertical distance between AD and AF, GE_2. Clearly, Ruth is worse off at E_2 than she was at E_1. However, *any* tax would have put her on a lower indifference curve.[4] The important question is whether the barley tax inflicts a greater utility loss than is necessary to raise revenue GE_2. Alternatively, is there some other way of raising revenue GE_2 that would cause a smaller utility loss to Ruth? If so, the barley tax has an excess burden.

To investigate this issue, we need to find a dollar equivalent of the loss that Ruth suffers by having to move from indifference curve i to ii. One way to measure this is the **equivalent variation**—the amount of income we would have to take away from Ruth (before the barley tax was levied) to induce her to move from i and ii. The equivalent variation measures the loss inflicted by the tax as the size of the reduction in income that would cause the same decrease in utility as the tax.

equivalent variation

A change in income that has the same effect on utility as a change in the price of a commodity.

To depict the equivalent variation graphically, recall that taking away income from an individual leads to a parallel movement inward of her budget line. Hence, to find the equivalent variation, all we have to do is shift AD inward, until it is tangent to indifference curve ii. The amount by which we have to shift AD is the equivalent variation. In Figure 15.3, budget line HI is parallel to AD and tangent to indifference curve ii. Hence, the vertical distance between AD and HI, ME_3, is the equivalent variation. Ruth is indifferent between losing ME_3 dollars and facing the barley tax.

[3] The construction of budget constraints and the interpretation of their slopes and intercepts are discussed in the appendix at the end of this book.

[4] This ignores benefits that might be obtained from the expenditures financed by the tax.

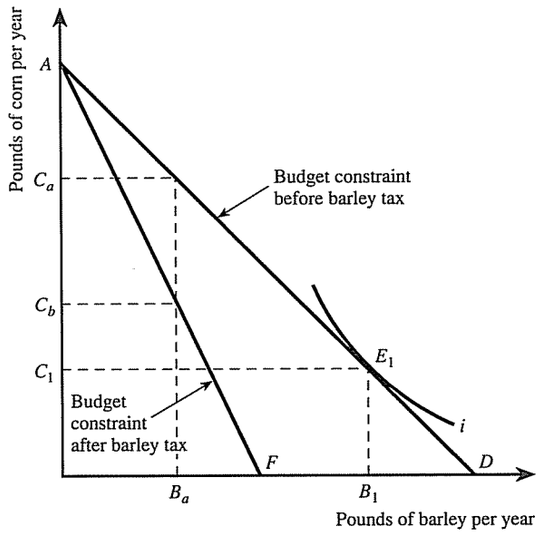


Figure 15.1
Effect of a tax on the budget constraint
With budget constraint AD, Ruth maximizes utility at E_1. The barley tax increases the price for barley and changes her budget constraint to line AF.

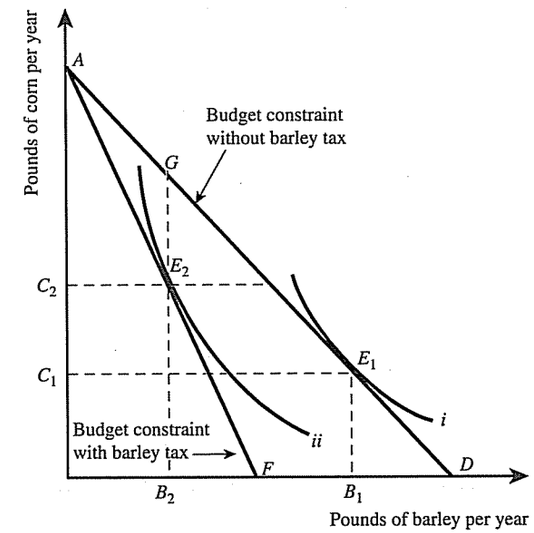
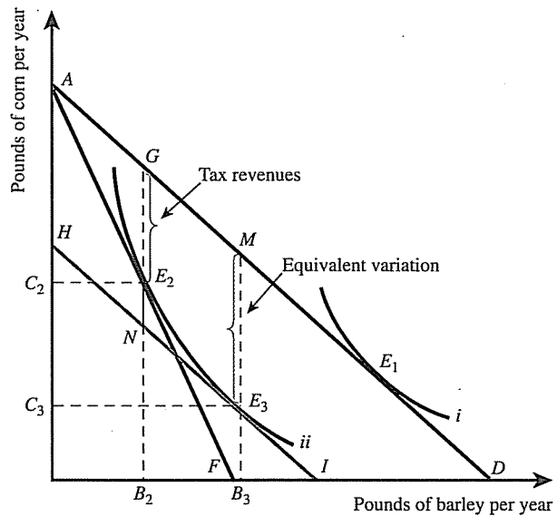


Figure 15.2
Effect of a tax on the consumption bundle
After the tax, Ruth maximizes utility at E_2. Her tax bill is the vertical distance between AD and AF, which is GE_2.

Figure 15.3
Excess burden of the barley tax
The vertical distance ME_3 is the equivalent variation of the barley tax. Ruth is indifferent between losing ME_3 dollars and facing the barley tax. The excess burden is E_2N, which is the difference between the equivalent variation and the barley tax revenue.



Note that the equivalent variation ME_3 exceeds the barley tax revenues of GE_2. To see why, just observe that ME_3 equals GN, because both measure the distance between the parallel lines AD and HI. Hence, ME_3 exceeds GE_2 by distance E_2N. This is really quite a remarkable result. It means that the barley tax makes Ruth worse off by an amount that actually exceeds the revenues it generates. In Figure 15.3, the amount by which the loss in welfare (measured by the equivalent variation) exceeds the taxes collected—the excess burden—is distance E_2N.

lump sum tax
A tax whose value is independent of the individual's behavior.

Does *every* tax entail an excess burden? Define a **lump sum tax** as a certain amount that must be paid regardless of the taxpayer's behavior. If the government levies a $100 lump sum tax on Ruth, there is nothing she can do to avoid paying the $100, other than to leave the country or die. In contrast, the barley tax is not a lump sum tax, because the revenue yield depends on Ruth's barley consumption.

Let us analyze a lump sum tax that leaves Ruth as well off as the barley tax. To begin, we must sketch the associated budget line. It must have two characteristics: First, it must be parallel to AD. (Because a lump sum tax simply takes away money from Ruth, it does not change the relative prices of barley and corn; two budget lines embodying the same price ratio must be parallel.) Second, because of the stipulation that Ruth attain the same utility level as under the barley tax, the budget line must be tangent to indifference curve *ii*.

Budget line HI in Figure 15.3, which is tangent to indifference curve *ii* at point E_3, satisfies both these criteria. If confronted with this budget line, Ruth would consume B_3 pounds of barley and C_3 pounds of corn. The revenue yield of the lump sum tax is the vertical distance between E_3 and the before-tax budget constraint, or distance ME_3. But we showed earlier that ME_3 is also the equivalent variation of the move from indifference curve *i* to *ii*. This comes as no surprise, since a lump sum tax is just a parallel shift of the budget line. Because the revenue yield of a lump sum tax equals its equivalent variation, *a lump sum tax has no excess burden.*

In short, a lump sum tax that leaves Ruth on the *same indifference curve* as the barley tax generates more revenue for the government. Alternatively, if we compared a lump sum tax and a barley tax that raised the *same revenue*, the lump sum tax would leave Ruth on a higher indifference curve.

The skeptical reader may suspect that this result is merely an artifact of the particular way the indifference curves are drawn in Figure 15.3. This is not the case. One can prove that as long as the indifference curves have the usual shape, a tax that changes relative prices generates an excess burden.[5] Alternatively, a tax that changes relative prices is inefficient in the sense that it lowers individual utility more than is necessary to raise a given amount of revenue.

Questions and Answers

The previous section's discussion of excess burden raises some important questions.

If Lump Sum Taxes Are So Efficient, Why Aren't They Widely Used? Lump sum taxation is an unattractive policy tool for several reasons. Suppose the government announced that every person's tax liability was $2,000 per year. This is a lump sum tax, but most people would consider it unfair because the loss of $2,000 presumably hurts a poor family more than a rich family. In 1990, the government of British Prime Minister Margaret Thatcher implemented a tax that in some ways resembled a lump sum tax. The property tax that had financed local government was replaced by a head tax; in each local jurisdiction the amount depended on that jurisdiction's per capita revenue needs. The tax was lump sum in the sense that a person's tax liability did not vary with the amount of income earned or property owned; it did vary, however, with a person's choice of where to live. The perceived unfairness of that tax was one of the factors that led to Prime Minister Thatcher's downfall in 1990, and it was repealed in 1991 by her successor, Prime Minister John Major.

As a way of producing more equitable results, one might consider making people pay different lump sum taxes based on their incomes. A rich person might be required to pay $20,000 annually, independent of his or her economic decisions, while a poor person would pay only $500. The problem is that people entering the workforce would soon realize that their eventual tax burden depended on their incomes, and adjust their work and savings decisions accordingly. In short, because the amount of income individuals earn is at least in part under their control, the income-based tax is not a lump sum tax.

Ultimately, to achieve an equitable system of lump sum taxes, it would be necessary to base the tax on some underlying "ability" characteristic that measured individuals' *potential* to earn income. In this way, high- and low-potential people could be taxed differently. Because the base is potential, an individual's tax burden would not depend on behavior. Even if such an ability measure existed, however, it could not possibly be observed by the taxing authority. Thus, individual lump sum taxes are best viewed as standards of efficiency, not as major policy options in a modern economy.

Are There Any Results from Welfare Economics That Would Help Us Understand Why Excess Burdens Arise? Recall from Chapter 3 that a necessary condition for a Pareto efficient allocation of resources is that the marginal

[5] As noted, this assumes there are no other distortions in the economy. For a proof, see Auerbach and Hines [2002].

rate of substitution of barley for corn in consumption (MRS_{bc}) equals the marginal rate of transformation of barley for corn in production (MRT_{bc}). Under the barley tax, consumers face a price of barley of $(1 + t_b)P_b$. Therefore, they set

$$MRS_{bc} = \frac{(1 + t_b)P_b}{P_c} \tag{15.1}$$

Equation (15.1) is the algebraic representation of the equilibrium point E_2 in Figure 15.3.

Producers make their decisions by setting the marginal rate of transformation equal to the ratio of the prices *they receive*. Even though Ruth pays $(1 + t_b)P_b$ per pound of barley, the barley producers receive only P_b—the difference goes to the tax collector. Hence, profit-maximizing producers set

$$MRT_{bc} = \frac{P_b}{P_c} \tag{15.2}$$

Clearly, as long as t_b is not zero, MRS_{bc} exceeds MRT_{bc}, and the necessary condition for an efficient allocation of resources is violated.

Intuitively, when MRS_{bc} is greater than MRT_{bc}, the marginal utility of substituting barley consumption for corn consumption exceeds the change in production costs necessary to do so. Thus, utility would be raised if such an adjustment were made. However, in the presence of the barley tax there is no *financial* incentive to do so. The excess burden is just a measure of the utility loss. The loss arises because the barley tax creates a wedge between what the consumer pays and what the producer receives. In contrast, under a lump sum tax, the price ratios faced by consumers and producers are equal. There is no wedge, so the necessary conditions for Pareto efficiency are satisfied.

Does an Income Tax Entail an Excess Burden? The answer is generally yes, but it takes a little thinking to see why. Figure 15.3 showed the imposition of a lump sum tax as a downward parallel movement from AD to HI. This movement could just as well have arisen via a tax that took some proportion of Ruth's income. Like the lump sum tax, an income reduction moves the intercepts of the budget constraint closer to the origin but leaves its slope unchanged. Perhaps, then, lump sum taxation and income taxation are equivalent. In fact, if income were fixed, an income tax *would* be a lump sum tax. However, when people's choices affect their incomes, an income tax is *not* generally equivalent to a lump sum tax.

Think of Ruth as consuming *three* commodities, barley, corn, and leisure time, l. Ruth gives up leisure (supplies labor) to earn income that she spends on barley and corn. In the production sector, Ruth's leisure is an input to the production of the two goods. The rate at which her leisure time can be transformed into barley is MRT_{lb} and into corn MRT_{lc}. Just as a utility-maximizing individual sets the marginal rate of substitution between two commodities equal to their price ratio, the MRS between leisure and a given commodity is set equal to the ratio of the wage (the price of leisure) and the price of that commodity.

Again appealing to the theory of welfare economics, the necessary conditions for a Pareto efficient allocation of resources in this three-commodity case are

$$MRS_{lb} = MRT_{lb}$$
$$MRS_{lc} = MRT_{lc}$$
$$MRS_{bc} = MRT_{bc}$$

A proportional income tax, which is equivalent to a tax at the same rate on barley and corn, leaves the third equality unchanged, because producers and consumers still face the same *relative* prices for barley and corn. (The tax increases both prices by the same proportion, so their ratio is unchanged.) However, it introduces a tax wedge in the first two conditions. To see why, suppose that Ruth's employer pays her a before-tax wage of w, and the income tax rate is t. Ruth's decisions depend on her after-tax wage, $(1 - t)w$. Hence, she sets $MRS_{lb} = (1 - t)w/P_b$. On the other hand, the producer's decisions are based on the wage rate he or she pays, the before-tax wage, w. Hence, the producer sets $MRT_{lb} = w/P_b$. Consequently, $MRS_{lb} \neq MRT_{lb}$. Similarly, $MRS_{lc} \neq MRT_{lc}$. In contrast, a lump sum tax leaves all three equalities intact. Thus, income and lump sum taxation are generally not equivalent.

The fact that the income tax breaks up two equalities while taxes on barley and corn at different rates break up all three is irrelevant for determining which system is more efficient. Once *any* of the equalities fails to hold, a loss of efficiency results, and the sizes of the welfare losses cannot be compared merely by counting wedges. Rather, the excess burdens associated with each tax regime must be computed and then compared. There is no presumption that income taxation is more efficient than a system of commodity taxes at different rates, which is referred to as *differential commodity taxation*. It *may* be true, but this is an empirical question that cannot be answered on the basis of theory alone.

If the Demand for a Commodity Does Not Change When It Is Taxed, Does This Mean That There Is No Excess Burden? The intuition behind excess burden is that it results from distorted decisions. If there is no change in the demand for the good being taxed, one might conclude there is no excess burden. This conjecture is examined in Figure 15.4. Naomi, the individual under consideration, begins with the same income as Ruth and faces the same prices and taxes. Hence, her initial budget constraint is AD, and after the barley tax, it is AF. However, unlike Ruth, Naomi does not change her barley consumption after the barley tax; that is, $B_1 = B_2$. The barley tax revenues are E_1E_2. Is there an excess burden? The equivalent variation of the barley tax is RE_3. This exceeds the barley tax revenues of E_1E_2 by E_2S. Hence, even though Naomi's barley consumption is unchanged by the barley tax, it still creates an excess burden of E_2S.

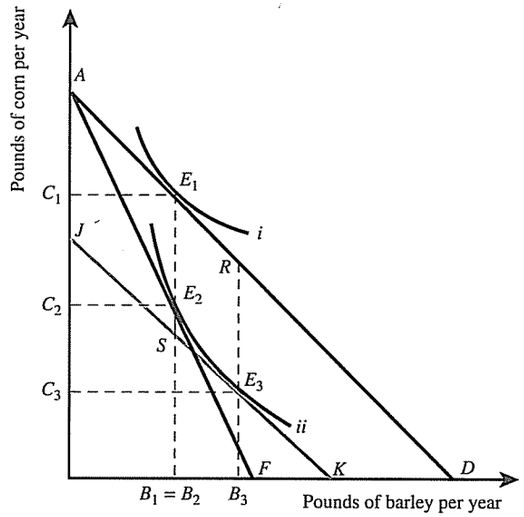
The explanation of this paradox begins with the observation that even though Naomi's barley consumption doesn't change, her corn consumption does (from C_1 to C_2). When the barley tax changes barley's relative price, the marginal rate of substitution is affected, and the composition of the commodity *bundle* is distorted.

A more rigorous explanation requires that we distinguish between two types of responses to the barley tax. The movement from E_1 to E_2 is the *uncompensated response*. It shows how consumption changes because of the tax and incorporates effects due to both losing income and the tax-induced change in relative prices. Now, we can imagine decomposing the move from E_1 to E_2 into a move from E_1 to E_3, and then from E_3 to E_2. The movement from E_1 to E_3 shows the effect on consumption of a lump sum tax. This change, called the **income effect,** is due solely to the loss of income because relative prices are unaffected. In effect, then, the movement from E_3 to E_2 is strictly due to the change in relative prices. It is generated by giving Naomi enough income to remain on indifference curve ii even as barley's price rises due to the tax. Because Naomi is compensated for the rising price of barley

income effect

The effect of a price change on the quantity demanded due exclusively to the fact that the consumer's income has changed.

Figure 15.4
Excess burden of a tax on a commodity whose ordinary demand curve is perfectly inelastic
Naomi purchases the same amount of barley after the tax as before the tax. Nonetheless, the tax still yields an excess burden of E_2S.



with additional income, the movement from E_3 to E_2 is called the *compensated response*, also sometimes referred to as the **substitution effect.**[6]

substitution effect

The tendency of an individual to consume more of one good and less of another because of a decrease in the price of the former relative to the latter.

The compensated response is the important one for calculating excess burden. Why? By construction, the computation of excess burden involves comparing tax collections at points E_2 and E_3 on indifference curve *ii*. But the movement from E_3 to E_2 along indifference curve *ii* is precisely the compensated response. Note also that it is only in moving from E_3 to E_2 that the marginal rate of substitution is affected. As shown earlier, this change violates the necessary conditions for a Pareto efficient allocation of commodities.

compensated demand curve

A demand curve that shows how quantity demanded varies with price, holding utility constant.

An ordinary demand curve depicts the uncompensated change in the quantity of a commodity demanded when price changes. A **compensated demand curve** shows how the quantity demanded changes when price changes *and* simultaneously income is compensated so that the individual's commodity bundle stays on the same indifference curve. A way of summarizing this discussion is to say that excess burden depends on movements along the compensated rather than the ordinary demand curve.

Although these observations may seem like theoretical nit-picking, they are actually quite important. Policy discussions often focus on whether or not a given tax influences observed behavior, with the assumption that if it does not, no serious efficiency problem is present. For example, some argue that if hours of work do not change when an income tax is imposed, then the tax has no adverse efficiency consequences. We have shown that such a notion is fallacious. A substantial excess burden may be incurred even if the uncompensated response of the taxed commodity is zero.

[6] See the appendix at the end of this book for further discussion of income and substitution effects and compensated demand curves.

▸ EXCESS BURDEN MEASUREMENT WITH DEMAND CURVES

The concept of excess burden can be reinterpreted using (compensated) demand curves. This interpretation relies heavily on the notion of consumer surplus—the difference between what people would be *willing* to pay for a commodity and the amount they actually have to pay. As shown in the appendix at the end of this book, consumer surplus is measured by the area between the demand curve and the horizontal line at the market price. Assume that the compensated demand curve for barley is straight line D_b in Figure 15.5. For convenience, we continue to assume that the social marginal cost of barley is constant at P_b, so that the supply curve is the horizontal line marked S_b.[7] In equilibrium, q_1 pounds of barley are consumed. Consumer surplus, the area between the price and the demand curve, is *aih*.

Again suppose that a tax at percentage rate t_b is levied on barley, so the new price, $(1 + t_b)P_b$, is associated with supply curve S_b'. Supply and demand now intersect at output q_2. Observe the following characteristics of the new equilibrium:

- Consumer surplus falls to the area between the demand curve and S_b', *agf*.
- The revenue yield of the barley tax is rectangle *gfdh*. This is because tax revenues are equal to the product of the number of units purchased (*hd*) and the tax paid on each unit: $(1 + t_b)P_b - P_b = gh$. But *hd* and *gh* are just the base and height, respectively, of rectangle *gfdh*, and hence their product is its area.
- The sum of posttax consumer surplus and tax revenues collected (area *hafd*) is less than the original consumer surplus (*ahi*) by area *fid*. In effect, even if we returned the tax revenues to barley consumers as a lump sum, they would still be worse off by triangle *fid*. The triangle, then, is the excess burden of the tax.

This analysis provides a convenient framework for computing an actual dollar measure of excess burden. The area of triangle *fid* is one-half the product of its base (the tax-induced change in the quantity of barley) and height (the tax per pound). Some simple algebra shows that this product is equivalent to

$$\tfrac{1}{2}\eta P_b q_1 t_b^2 \tag{15.3}$$

where η (Greek *eta*) is the absolute value of the compensated price elasticity of demand for barley.[8] (A proof is provided in Appendix A at the end of the chapter.)

Equation (15.3) has some important implications. First, it indicates that excess burden is higher for a tax applied to a good with a higher compensated price elasticity of demand. A high (absolute) value of η indicates that the compensated quantity demanded is quite sensitive to changes in price. Thus, the presence of η in Equation (15.3) makes intuitive sense—the more the tax distorts the (compensated) consumption decision, the

[7] The analysis is easily generalized to the case when the supply curve slopes upward. See footnote 8.

[8] The formula is an approximation that holds strictly only for an infinitesimally small tax levied in the absence of any other distortions. When the supply curve is upward sloping rather than horizontal, the excess-burden triangle contains some producer surplus as well as consumer surplus. The formula for excess burden then depends on the elasticity of supply as well as the elasticity of demand. In this case, the excess burden is

$$\tfrac{1}{2}\frac{P_b q}{\frac{1}{\eta} + \frac{1}{\varepsilon}} t_b^2$$

where ε is the elasticity of supply. Note that as ε approaches infinity, this expression collapses to Equation (15.3). This is because an ε of infinity corresponds to a horizontal supply curve as in Figure 15.5.

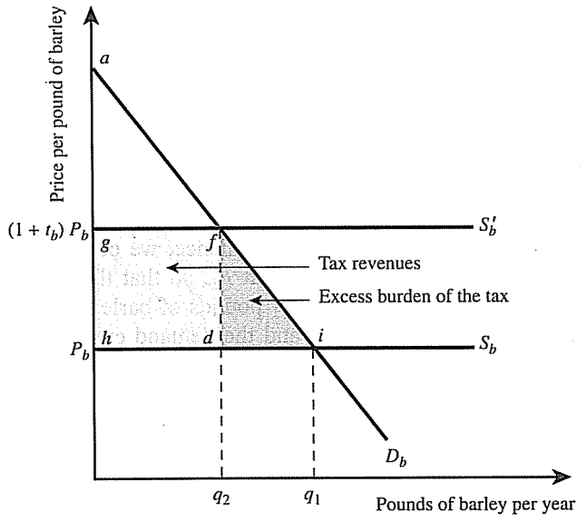


Figure 15.5
Excess burden of a commodity tax
The tax causes consumer surplus to drop by *gfih*, but raises only *gfdh* in tax revenue. The difference, *fid*, is the excess burden of the tax.

higher the excess burden. $P_b \times q_1$ is the total revenue expended on barley initially. Its inclusion in the formula shows that the greater the initial expenditure on the taxed commodity, the greater the excess burden.

Equation (15.3) also indicates that it is better to tax many commodities at a lower rate than to tax a few commodities at a higher rate. In other words, a broader tax has less excess burden than a narrow tax. This is because of the presence of t_b^2, which implies that as the tax rate increases, excess burden goes up with its square. Doubling a tax quadruples its excess burden, other things being the same. Therefore, two relatively small taxes will have a smaller excess burden than one large tax that raises the same amount of revenue, other things being the same. Because excess burden increases with the square of the tax rate, the *marginal* excess burden from raising one more dollar of revenue exceeds the *average* excess burden. That is, the incremental excess burden of raising one *more* dollar of revenue exceeds the ratio of total excess burden to total revenues. This fact has important implications for cost-benefit analysis. Suppose, for example, that the average excess burden per dollar of tax revenue is 12 cents, but the marginal excess burden per additional dollar of tax revenue is 27 cents [Jorgenson and Yun, 2001, p. 302]. The social cost of each dollar raised for a given public project is the dollar plus the incremental excess burden of 27 cents. Thus, a public project must produce marginal benefits of more than $1.27 per dollar of explicit cost if it is to improve welfare.

Airline-Ticket Taxation Let's illustrate Equation (15.3) with a real-world example. Airplane tickets are taxed by the federal government at a rate of 10 percent. What is the excess burden of this tax? The equation tells us that we have to know the price elasticity of demand. According to the survey of Oum et al. [1992], a reasonable estimate is about 1.0. We also need the product of price per ticket and number of tickets sold—airline-ticket revenues. This figure is roughly $86 billion annually [US Bureau of the Census, 2006b, p. 697]. Substituting all of this information into Equation (15.3) tells us that the airline ticket tax imposes an annual excess burden of $\frac{1}{2} \times 86 \times (0.10)^2$ billion, or $430 million.

Preexisting Distortions

This analysis has assumed no distortions in the economy other than the tax under consideration. In reality, when a new tax is introduced, there are already other distortions: monopolies, externalities, and preexisting taxes. This complicates the analysis of excess burden.

Suppose that consumers regard gin and rum as substitutes. Suppose further that rum is currently being taxed, creating an excess burden "triangle" like that in Figure 15.5. Now the government decides to impose a tax on gin. What is the excess burden of the gin tax? In the gin market, the gin tax creates a wedge between what gin consumers pay and gin producers receive. As usual, this creates an excess burden. But the story is not over. If gin and rum are substitutes, the rise in the consumers' price of gin induced by the gin tax increases the demand for rum. Consequently, the quantity of rum demanded increases. Now, because rum was taxed under the status quo, "too little" of it was being consumed. The increase in rum consumption induced by the gin tax helps move rum consumption back toward its efficient level. There is thus an efficiency gain in the rum market that helps offset the excess burden imposed in the gin market. In theory, the gin tax could actually lower the overall excess burden. This is an example of the **theory of the second best:** In the presence of existing distortions, policies that in isolation would increase efficiency can decrease it and vice versa. (Appendix B at the end of the chapter has a graphical demonstration of this phenomenon.)

theory of the second best
In the presence of existing distortions, policies that in isolation would increase efficiency can decrease it, and vice versa.

We have shown, then, that the efficiency impact of a tax or subsidy cannot be considered in isolation. To the extent that there are other markets with distortions, and the goods in these markets are related (either substitutes or complements), the overall efficiency impact depends on what is going on in all the markets. To compute the overall efficiency impact of a set of taxes and subsidies, it is generally incorrect to calculate separately the excess burdens in each market and then add them up. The aggregate efficiency loss is not equal to the "sum of its parts."

This result can be quite discomfiting because strictly speaking, it means that *every* market in the economy must be studied to assess the efficiency implications of *any* tax or subsidy. In most cases, practitioners simply assume that the amount of interrelatedness between the market of their concern and other markets is sufficiently small that cross-effects can safely be ignored. Although this is clearly a convenient assumption, its reasonableness must be evaluated in each particular case.

A controversy from the field of environmental economics provides an instance where accounting for preexisting distortions is important. Recall from Chapter 5 that in the presence of an externality, a tax can enhance efficiency. A Pigouvian tax in effect forces a polluter to take into account the costs that he imposes on other people and induces him to reduce output. Now, recall also that the US income tax system is highly inefficient. By distorting labor supply and other decisions, the income tax creates large excess burdens. Linking these two observations together, some have proposed that we increase reliance on environmental taxes and use the revenues to reduce income tax rates. This idea is called the **double-dividend hypothesis** because the scheme increases efficiency both in the market with the polluter and in the markets that are distorted by the income tax.

double-dividend hypothesis
If the proceeds from a Pigouvian tax are used to reduce income tax rates, then efficiency increases in both markets. The logic may not hold because the Pigouvian tax exacerbates preexisting distortions in the labor market.

However, there is a possible flaw in this logic. To see why, note that the pollution taxes drive up the prices of the goods that are produced using polluting technology.

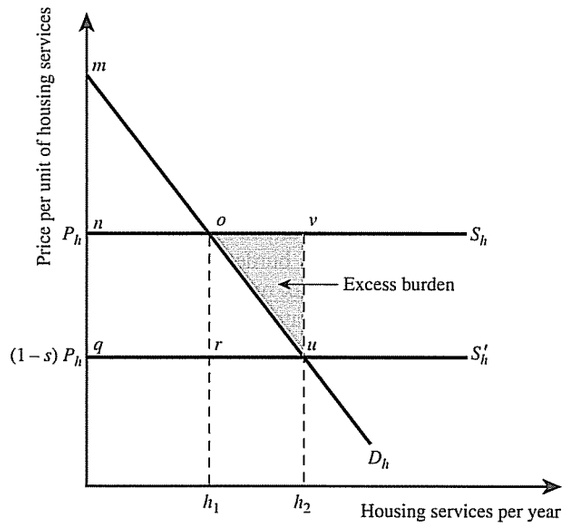


Figure 15.6
Excess burden of a housing subsidy
The housing subsidy increases consumer surplus by *nouq*. However, this is exceeded by the cost of the subsidy to the government, which is *nvuq*. The difference, *ovu*, is the excess burden generated by the subsidy.

However, when commodity prices go up, in effect this is a decrease in the real wage rate—a given dollar amount of wages buys you fewer goods and services. Put another way, the environmental taxes are, to some extent, also taxes on earnings. So if the labor market is already distorted because of an income tax, the environmental tax exacerbates the problem. It turns out that the added excess burden in the labor market can actually outweigh the efficiency gains from correcting the externality [Parry and Oates, 2000]. Put another way, the efficient pollution tax can be lower than in a situation in which there is not a preexisting income tax. This is not to say that Pigouvian taxation is a bad idea, only that its consequences for efficiency depend on the extent to which existing taxes already distort the labor market.

The Excess Burden of a Subsidy

Commodity subsidies are important components of the fiscal systems of many countries. In effect, a subsidy is just a negative tax, and like a tax, it is associated with an excess burden. To illustrate the calculation of the excess burden of a subsidy, we consider the subsidy for owner-occupied housing provided by the federal government via certain provisions of the personal income tax. (See Chapter 18 for details of the law.)

Assume that the demand for owner-occupied housing services is the straight line D_h in Figure 15.6. Supply is horizontal at price P_h, which measures the marginal social cost of producing housing services. Initially, the equilibrium quantity is h_1. Now suppose that the government provides a subsidy of s percent to housing producers. The new price for housing services is then $(1 - s)P_h$ and the associated supply curve is S_h'. The subsidy increases the quantity of housing services consumed to h_2. If the purpose of the subsidy was to increase housing consumption, then it has succeeded. But if its goal was to maximize social welfare, is it an appropriate policy?

Before the subsidy, consumer surplus was area *mno*. After the subsidy, consumer surplus is *mqu*. The benefit to housing consumers is the increase in their surplus, area *nouq*. But at what cost is this benefit obtained? The cost of the subsidy program is the quantity of housing services consumed, *qu*, times the subsidy per unit,

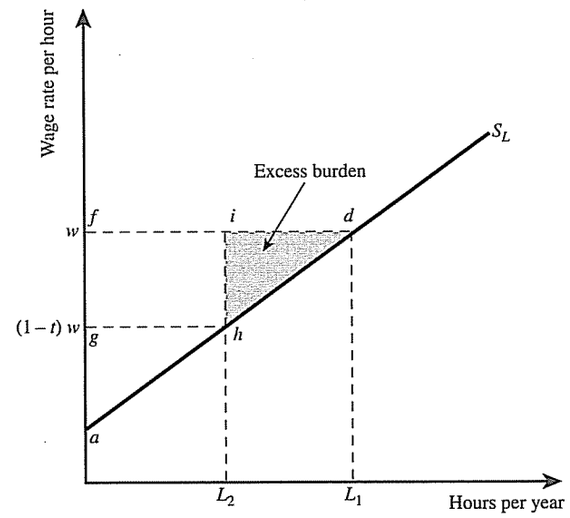


Figure 15.7
Excess burden of a tax on labor
In this example, a tax on labor generates an excess burden of *hid*.

nq, or rectangle *nvuq*. Thus, the cost of the subsidy actually exceeds the benefit—there is an excess burden equal to the difference between areas *nvuq* and *nouq*, which is the shaded area *ovu*. For someone who owns a $500,000 home, a rough estimate of the excess burden is $1,600 annually.[9]

How can subsidizing a good thing like housing be inefficient? Recall that any point on the demand curve for housing services measures how much people value that particular level of consumption. To the right of h_1, although individuals do derive utility from consuming more housing, its value is less than P_h, the marginal cost to society of providing it. In other words, the subsidy induces people to consume housing services that are valued at less than their cost—hence, the inefficiency.[10]

A very important policy implication follows from this analysis. One often hears proposals to help some group of individuals by subsidizing a commodity that they consume heavily. We have shown that this is an inefficient way to aid people. Less money could make them as well off if it were given to them as a direct grant. In Figure 15.6, people would be indifferent between a housing subsidy program costing *nvuq* and a direct grant of *nouq*, even though the subsidy program costs the government more money.[11] This is one of the reasons many economists prefer direct income transfers to commodity subsidies.

The Excess Burden of Income Taxation

The theory of excess burden applies just as well to factors of production as it does to commodities. In Figure 15.7, Jacob's hours of work are plotted on the horizontal

[9] This figure is based on the assumption that the marginal tax rate is 0.35, the compensated price elasticity is 0.8, the nominal interest rate is 5 percent, the property tax is 2.5 percent of house value, the risk premium for housing investments is 4 percent of house value, and the maintenance and depreciation costs are both 2 percent of house value.

[10] Alternatively, after the subsidy the marginal rate of substitution in consumption depends on $(1 - s)P_h$, while the marginal rate of transformation in production depends on P_h. Hence, the marginal rate of transformation is not equal to the marginal rate of substitution, and the allocation of resources cannot be efficient.

[11] This result is very similar to that obtained when we examined in-kind subsidy programs in Chapter 12. That chapter also discusses why commodity subsidies nevertheless remain politically popular.

THE LIGHTER SIDE OF PUBLIC FINANCE

American Way of Tax*

Humorist Russell Baker never uses the term excess burden *in the column reproduced below. Nevertheless, he gives an excellent description of the phenomenon.*

NEW YORK—The tax man was very cross about Figg. Figg's way of life did not conform to the way of life several governments wanted Figg to pursue. Nothing inflamed the tax man more than insolent and capricious disdain for governmental desires. He summoned Figg to the temple of taxation.

"What's the idea of living in a rental apartment over a delicatessen in the city, Figg?" he inquired. Figg explained that he liked urban life. In that case, said the tax man, he was raising Figg's city sales and income taxes. "If you want them cut, you'll have to move out to the suburbs," he said.

To satisfy his local government, Figg gave up the city and rented a suburban house. The tax man summoned him back to the temple.

"Figg," he said, "you have made me sore wroth with your way of life. Therefore, I am going to soak you for more federal income taxes." And he squeezed Figg until beads of blood popped out along the seams of Figg's wallet.

"Mercy, good tax man," Figg gasped. "Tell me how to live so that I may please my government, and I shall obey."

The tax man told Figg to quit renting and buy a house. The government wanted everyone to accept large mortgage loans from bankers. If Figg complied, it would cut his taxes.

Figg bought a house, which he did not want, in a suburb where he did not want to live, and he invited his friends and relatives to attend a party celebrating his surrender to a way of life that pleased his government.

The tax man was so furious that he showed up at the party with bloodshot eyes. "I have had enough of this, Figg," he declared. "Your government doesn't want you entertaining friends and relatives. This will cost you plenty."

Figg immediately threw out all his friends and relatives, then asked the tax man what sort of people his government wished him to entertain. "Business associates," said the tax man. "Entertain plenty of business associates, and I shall cut your taxes."

To make the tax man and his government happy, Figg began entertaining people he didn't like in the house he didn't want in the suburb where he didn't want to live.

Then was the tax man enraged indeed. "Figg," he thundered, "I will not cut your taxes for entertaining straw bosses, truck drivers, and pothole fillers."

"Why not?" said Figg. "These are the people I associate with in my business."

"Which is what?" asked the tax man.

"Earning my pay by the sweat of my brow," said Figg.

"Your government is not going to bribe you for performing salaried labor," said the tax man. "Don't you know, you imbecile, that tax rates on salaried income are higher than on any other kind?"

And he taxed the sweat of Figg's brow at a rate that drew exquisite shrieks of agony from Figg and little cries of joy from Washington, which already had more sweated brows than it needed to sustain the federally approved way of life.

"Get into business, or minerals, or international oil," warned the tax man, "or I shall make your taxes as the taxes of 10."

Figg went into business, which he hated, and entertained people he didn't like in the house he didn't want in the suburb where he did not want to live.

At length the tax man summoned Figg for an angry lecture. He demanded to know why Figg had not bought a new plastic factory to replace his old metal and wooden plant. "I hate plastic," said Figg. "Your government is sick and tired of metal, wood, and everything else that smacks of the real stuff, Figg," roared the tax man, seizing Figg's purse. "Your depreciation is all used up."

There was nothing for Figg to do but go to plastic, and the tax man rewarded him with a brand new depreciation schedule plus an investment credit deduction from the bottom line.

* By Russell Baker, *International Herald Tribune,* April 13, 1977, page 14.

axis and his hourly wage on the vertical. Jacob's compensated labor supply curve, which shows the smallest wage that would be required to induce him to work each additional hour, is labeled S_L. Initially, Jacob's wage is w and the associated hours of work L_1. In the same way that consumer surplus is the area between the demand curve and the market price, worker surplus is the area between the supply curve and the market wage rate. When the wage is w, Jacob's surplus is therefore area *adf*.

Now assume that an income tax at a rate t is imposed. The after-tax wage is then $(1 - t)w$, and given supply curve S_L, the quantity of labor supplied falls to L_2 hours. Jacob's surplus after the tax is *agh*, and the government collects revenues equal to *fihg*. The excess burden due to the tax-induced distortion of the work choice is the amount by which Jacob's loss of welfare (*fdhg*) exceeds the tax collected: area *hid* (= *fdhg* − *fihg*). In analogy to Equation (15.3), area *hid* is approximately

$$\tfrac{1}{2}\varepsilon\omega L_1 t^2 \tag{15.4}$$

where ε is the compensated elasticity of hours of work with respect to the wage.

A reasonable estimate of ε for an American male is about 0.2. For illustrative purposes, suppose that before taxation, Jacob works 2,000 hours per year at a wage of $20 per hour. A tax on earnings of 40 percent is then imposed. Substituting these figures into Equation (15.4), the excess burden of the tax is about $640 annually. One way to put this figure into perspective is to note that it is approximately 4 percent of tax revenues. Thus, on average, each dollar of tax collected creates an excess burden of 4 cents.

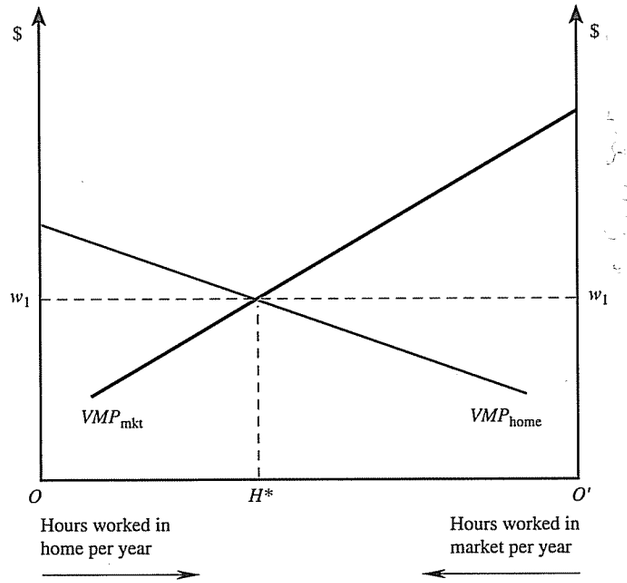
Of course, wage rates, tax rates, and elasticities vary across members of the population, so different people are subject to different excess burdens. Moreover, the excess burden of taxing labor also depends on tax rates levied on other factors of production. Jorgenson and Yun [2001] estimated that for plausible values of the relevant elasticities, the excess burden of labor income taxation in the United States is about 27 percent of the revenues raised. As we show in Chapter 18, however, there is considerable uncertainty about the values of some of the key elasticities. Hence, this particular estimate must be regarded cautiously. Still, it probably provides a good sense of the magnitudes involved.

▸ DIFFERENTIAL TAXATION OF INPUTS

In the income tax example just discussed, we assumed that labor income was taxed at the same rate regardless of where the labor was supplied. But sometimes the tax on an input depends on where it is employed. For instance, because of the corporate income tax, capital employed in the corporate sector faces a higher rate than capital in the noncorporate sector. Another example is the differential taxation of labor in the household and market sectors. If an individual does housework, valuable services are produced but not taxed.[12] On the other hand, if the same individual works in the market, the services are subject to the income and payroll taxes. The fact that labor is taxed in one sector and untaxed in another distorts people's choices between them.

[12] The value of housework was expressed nicely by a biblical author who wrote at a time when it was assumed homes were managed only by females. In Proverbs 31, he discusses in detail the many tasks performed by the woman who "looketh well to the ways of her household" (v. 27). His general conclusion is that "her price is far above rubies" (v. 10). Unfortunately, price data on rubies during the biblical era are unavailable.

Figure 15.8
The allocation of time between housework and market work
The horizontal distance OO' measures the total amount of labor available to society. Individuals allocate labor between housework and market work so that the value of the marginal product of labor is the same in both sectors, which occurs at H^*.



To measure the efficiency cost, consider Figure 15.8. The horizontal distance OO' measures the total amount of labor available in society. The amount of labor devoted to work in the home is measured by the distance to the right of point O; the amount of labor devoted to work in the market is measured by the distance to the left of point O'. Thus, any point along OO' represents some allocation of labor between the home and the market.

Now, define the *value of marginal product* (*VMP*) of hours worked in the household sector as the dollar value of the *additional* output produced for each hour worked. The schedule (VMP_{home}) in Figure 15.8 represents the value of the marginal product of household work. It is drawn sloping downward, reflecting the reasonable assumption that as more hours are spent in the home, the incremental value of those hours decreases. This is just a manifestation of the law of diminishing marginal returns. Similarly, VMP_{mkt} shows the value of the marginal product of hours worked in the market sector. (Remember that movements to the left on the horizontal axis represent *increases* in the amount of labor allocated to market work.) Although we expect both schedules to be decreasing with respect to the amount of labor employed in the respective sectors, there is no reason to expect the schedules to have the same shapes, so they are not drawn as mirror images of each other.

How is the allocation of labor between the two sectors determined? Assume that individuals allocate their time between housework and market work to maximize their total incomes. It follows that the value of the marginal product of labor is the same in both sectors. If it were not, it would be possible for people to reallocate labor between the sectors to increase their incomes.[13] In Figure 15.8, the equilibrium occurs where

[13] For further discussion of why this must be true, see the appendix at the end of this book.

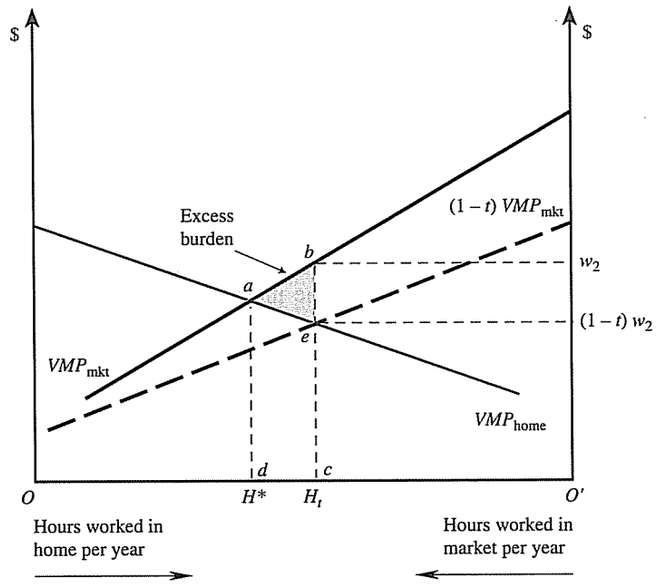


Figure 15.9
Excess burden of differential taxation of inputs
A tax on market wages at rate t lowers the wage rate from VMP_{mkt} to $(1 - t)$ VMP_{mkt}. As a result, people begin working less in the market and more at home, which moves the economy to H_t. The associated excess burden is *abe*.

OH^* hours are devoted to housework and $O'H^*$ hours to market work. The value of the marginal product of labor in both sectors is w_1 dollars. Competitive pricing ensures that the wage in the market sector is equal to the value of the marginal product.

Now assume that a tax of t is levied on income from market work, but the return to housework is untaxed. At any amount of labor employed in the market, the tax creates a wedge between the *VMP* and the associated wage rate. For example, if the value of the marginal product is $10 and the tax rate is 25 percent, then the wage rate will only be $7.50. More generally, the imposition of a tax on market wages at rate t lowers the wage rate from VMP_{mkt} to $(1 - t)VMP_{mkt}$. Geometrically, this amounts to moving every point on VMP_{mkt} down by t percent, as illustrated in Figure 15.9. Clearly, the original allocation is no longer an equilibrium, because at H^* the return to working in the household exceeds the rate in the market. That is, at H^*, VMP_{home} is greater than $(1 - t)VMP_{mkt}$. As a result, people begin working less in the market and more at home, which moves the economy rightward from H^*. Equilibrium is reached when the *after-tax* value of marginal product in the market sector equals the value of marginal product in the household sector. In Figure 15.9, this occurs when people work OH_t hours in the home and $O'H_t$ hours in the market.

At the new equilibrium, the after-tax *VMP*s in the two sectors are both equal to $(1 - t)w_2$. However, the *before-tax VMP* in the market sector, w_2, is greater than the *VMP* in the household sector, $(1 - t)w_2$. This means that if more labor were supplied to the market sector, the increase in income there (w_2) would exceed the loss of income in the household sector, $(1 - t)w_2$. But there is no incentive for this reallocation to occur, because individuals are sensitive to the returns they receive *after tax*, and these are already equal. The tax thus creates a situation in which there is

"too much" housework and "not enough" work in the market. In short, the tax leads to an inefficient allocation of resources in the sense that it distorts incentives to employ inputs in their most productive uses. The resulting decrease in real income is the excess burden of the tax.

To measure the excess burden, we must analyze Figure 15.9 closely. Begin by observing that as a result of the exodus of labor from the market, the value of output there goes down by *abcd*, the area under VMP_{mkt} between H^* and H_t.[14] On the other hand, as labor enters the household sector, the value of output increases by *aecd*, the area under the VMP_{home} curve between H^* and H_t. Therefore, society comes out behind by area *abcd* minus area *aecd*, or triangle *abe*, which is the excess burden of the tax. The base of this triangle is just the size of the tax wedge, $w_2 - [(1 - t)w_2]$ or tw_2. Its height is the increase in the amount of time devoted to work at home, distance H^*H_t, which we denote ΔH. Taking advantage of the formula for the area of a triangle, we can then represent the excess burden as

$$\tfrac{1}{2}(\Delta H)tw_2$$

The greater the change in the allocation of labor (ΔH) and the greater the tax wedge (tw_2), the greater the excess burden. In general, whenever a factor is taxed differently in different uses, it leads to a misallocation of factors between sectors and hence an excess burden.

▸ DOES EFFICIENT TAXATION MATTER?

Every year dozens of documents relating to the details of government spending and taxation are published. You would look in vain, however, for an "excess burden budget" documenting the distortionary impact of government fiscal policies. It's not hard to understand why. Excess burden does not appear in anyone's bookkeeping system. It is conceptually a rather subtle notion and is not trivial to calculate. Nevertheless, although the losses in real income associated with tax-induced changes in behavior are hidden, they are real, and according to some estimates, they are very large. We have emphasized repeatedly that efficiency considerations alone are never enough to determine policy. As Chief Justice Warren Burger remarked in a different context, "Convenience and efficiency are not the primary objectives—or the hallmarks—of democratic government." Still, it is unfortunate that policymakers often ignore efficiency altogether.

The fact that a tax generates an excess burden does not mean that the tax is bad. One hopes, after all, that it will be used to obtain something beneficial for society either in terms of enhanced efficiency or fairness. But to determine whether or not the supposed benefits are large enough to justify the costs, intelligent policy requires that excess burden be included in the calculation as a social cost. Moreover, as we see in Chapter 16, excess burden is extremely useful in comparing alternative tax systems. Providing estimates of excess burden is an important task for economists.

[14] The vertical distance between *VMP* and the horizontal axis at any level of input gives the value of *marginal* product for that level of input. Adding up all these distances gives the value of the *total* product. Thus, the area under *VMP* gives the value of total product.

Summary

- Taxes generally impose an excess burden—a cost beyond the tax revenue collected.
- Excess burden is caused by tax-induced distortions in behavior. It may be examined using either indifference curves or compensated demand curves.
- Lump sum taxes do not distort behavior but are unattractive as policy tools. Nevertheless, they are an important standard against which to compare the excess burdens of other taxes.
- Excess burden may result even if observed behavior is unaffected, because it is the compensated response to a tax that determines its excess burden.
- When a single tax is imposed, the excess burden is proportional to the compensated elasticity of demand, and to the square of the tax rate.
- Excess-burden calculations typically assume no other distortions. If other distortions exist, the incremental excess burden of a new tax depends on its effects in other markets.
- Subsidies also create excess burdens because they encourage people to consume goods valued less than the marginal social cost of production.
- The differential taxation of inputs creates an excess burden. Such inputs are used "too little" in taxed activities and "too much" in untaxed activities.

Discussion Questions

1. Which of the following is likely to impose a large excess burden?
   a. A tax on land.
   b. A tax of 24 percent on the use of cellular phones. (This is the approximate sum of federal and state tax rates in California, New York, and Florida.)
   c. A subsidy for investment in "high-tech" companies.
   d. A tax on soda bought in a cup or glass but not bought in a bottle or can. (Such a tax exists in Chicago.)
   e. A 10-cent tax on a deck of cards that contains no more than 54 cards. (Such a tax exists in Alabama.)
   f. A tax on blueberries. (Such a tax exists in Maine.)
2. In 2005, Michigan considered cutting the general sales tax (a tax on most goods at the same rate) and replacing it with a tax on a few products, such as insurance policies. Using Equation (15.3), discuss whether this proposal would increase or decrease efficiency.
3. "In the formula for excess burden given in Equation (15.3), the tax is less than one. When it is squared, the result is smaller, not bigger. Thus, having t_2 instead of t in the formula makes the tax less important." Comment.
4. Some countries rely relatively heavily on taxes that distort economic behavior, and others do not. A recent econometric study found that countries in the latter category tend to grow faster than countries in the former [Kneller et al., 1999]. Use the discussion surrounding Figure 15.9 to explain this phenomenon.
5. In the United Kingdom, each household that owns a television pays a compulsory levy that is equivalent to $233 per year. The total revenue collected, which is over $7 billion annually, goes to the British Broadcasting Corporation. Do you think that such a tax is likely to have a substantial excess burden relative to the revenues collected?
6. In 2004, Congress voted to subsidize the purchase of capital goods in the manufacturing

sector. Nonmanufacturing industries are not eligible for the subsidy. Using the discussion surrounding Figure 15.8, discuss why this subsidy would lead to an inefficient allocation of capital between the manufacturing and nonmanufacturing sectors. (Hint: Reinterpret the horizontal axis as measuring the total amount of capital in the economy, and the two curves as measuring the value of marginal product of capital in the respective sectors.) Also show on your diagram the amount of the excess burden generated by the manufacturing subsidy.

7. Under the US tax system, capital that is employed in the corporate sector is taxed at a higher rate than capital in the noncorporate sector. This problem will analyze the excess burden of the differential taxation of capital.

   Assume that there are two sectors, corporate and noncorporate. The value of marginal product of capital in the corporate sector, VMP_c, is given by $VMP_c = 100 - K_c$, where K_c is the amount of capital in the corporate sector, and the value of the marginal product of capital in the noncorporate sector, K_n, is given by $VMP_n = 80 - 2K_n$, where K_n is the amount of capital in the noncorporate sector. Altogether there are 50 units of capital in society.

   a. In the absence of any taxes, how much capital is in the corporate sector and how much in the noncorporate sector? (Hint: Draw a sketch along the lines of Figure 15.9 to organize your thoughts.)

   b. Suppose that a unit tax of 6 is levied on capital employed in the corporate sector. After the tax, how much capital is employed in each sector? What is the excess burden of the tax?

8. In an effort to reduce alcohol consumption, the government is considering a \$1 tax on each gallon of liquor sold (the tax is levied on producers). Suppose that the supply curve for liquor is upward sloping and its equation is $Q = 30{,}000P$ (where Q is the number of gallons of liquor and P is the price per gallon). The demand curve for liquor is $Q = 500{,}000 - 20{,}000P$.

   a. Draw a sketch to illustrate the excess burden of the tax. Next use algebra to calculate the excess burden. Show graphically the excess burden generated by the \$1 unit tax. (Hint: Compare the losses of both consumer and producer surplus to tax revenues.)

   b. Suppose that each gallon of liquor consumed generates a negative external cost of \$0.50. How does this affect the excess burden associated with the unit tax on liquor?

Appendix A

▸ FORMULA FOR EXCESS BURDEN

This appendix shows how the excess burden triangle *fdi* of Figure 15.5 may be written in terms of the compensated demand elasticity. The triangle's area, A, is given by the formula

$$A = \tfrac{1}{2} \times \text{base} \times \text{height} \qquad (15A.1)$$
$$= \tfrac{1}{2} \times (di) \times (fi)$$

fd is just the difference between the gross and net prices (ΔP_b):

$$fd = \Delta P_b = (1 + t_b) \times P_b - P_b = t_b \times P_b \qquad (15A.2)$$

di is the change in the quantity (Δq) induced by the price rise:

$$di = (\Delta q) \qquad (15A.3)$$

Now, note that the definition of the price elasticity, η, is

$$\eta = \frac{\Delta q P_b}{\Delta P_b q}$$

so that

$$\Delta q = \eta\left(\frac{q}{P_b}\right)\Delta P_b \qquad (15A.4)$$

We saw in (15A.2) that $\Delta P_b = t_b \times P_b$, so that (15A.4) yields

$$\Delta q = \eta \times \frac{q}{P_b} \times (t_b P_b) = \eta \times q \times t_b \qquad (15A.5)$$

Finally, recall that $di = \Delta q$ and substitute both (15A.5) and (15A.2) into (15A.1) to obtain

$$A = \tfrac{1}{2}(di)(fd)$$
$$= \tfrac{1}{2}(\eta q t_b) \times (t_b P_b)$$
$$= \tfrac{1}{2} \times \eta \times P_b \times q \times (t_b)^2$$

as in the text.

Appendix B

▸ MULTIPLE TAXES AND THE THEORY OF THE SECOND BEST

This appendix discusses the measurement of excess burden when a tax is imposed in the presence of a preexisting distortion.

In Figure 15.B, we consider two goods, gin and rum, whose demand schedules are D_g and D_r, and whose before-tax prices are P_g and P_r, respectively. (The prices represent marginal social costs and are assumed to be constant.) Rum is currently taxed at a percentage rate t_r, so its price is $(1 + t_r)P_r$. This creates an excess burden in the rum market, triangle abc. Now suppose that a tax on gin at rate t_g is introduced, creating a wedge between what gin consumers pay and gin producers