Chapter

26

Incidence of Taxation

In general, the art of government consists in taking as much money as possible from one class of citizens to give to the other.

Voltaire

Incidence of Commodity Taxes ♦ Incidence of Taxes on Factors of Production ♦ General Equilibrium Analysis ♦ Further Issues in Tax Incidence ♦ Tax Incidence in Australia

Economic incidence of taxation
The change in real income as a result of taxation

Statutory incidence of taxation
The party responsible for paying a tax

A fundamental finding of the study of tax incidence is that the real burden of tax is often different from the statutory incidence. The real burden (or **economic incidence**) of a tax is the change in real income of any economic agent that results. The analysis of economic incidence shows how taxes change the prices of commodities and factors of production and how these changes in prices affect in turn the distribution of income. As we will see, the price changes depend on the conditions of demand and supply and the structure of markets.

When a tax is imposed the relevant legislation states the **statutory incidence**—who will be responsible for paying the tax. However, many taxes can be shifted. If government levies an excise tax on wine, retailers may pass on part, or all, of the tax in higher prices to wine drinkers. Shifting occurs especially with indirect taxes on commodities. When taxes are imposed on producers but borne in higher prices by consumers, taxes are shifted forwards. When taxes are imposed on consumers, but producers receive lower prices as a result, taxes are shifted backwards. Taxes on factors of production may also be shifted. Employers may pay a payroll tax on payments to labour, but then pay labour lower wages. A tax on the return to owners of capital may reduce the supply of capital and increase the cost of capital to users of capital.

In the first two sections below, we discuss the incidence of taxes on commodities and on factors of production. In both cases we examine the effects in the market where the tax is levied and in related markets. This analysis, known as partial equilibrium analysis, brings out the major effects of taxes. However, sometimes a tax affects prices in multiple markets. For example, a tax on a major commodity can affect incomes in factor markets and this in turn may affect the demands for other commodities. To analyse such general effects, we employ a general equilibrium (multi-market) model. This is the subject of the third section. The last part of the chapter discusses various other topics including equivalent taxes, the incidence of a general value-added tax and tax incidence in Australia.

Incidence of Commodity Taxes

We start by examining the incidence of a unit tax on a commodity (any good or service) produced in a competitive market. A **unit tax** is a given amount of tax for each unit purchased. We then examine the incidence of an *ad valorem* tax. An ***ad valorem*** tax is a tax on the value of commodities sold.

Unit tax
A given amount of tax per unit purchased

Ad valorem tax
A tax on the value of sales

Incidence of commodity taxes in a competitive market

Figure 26.1a shows the effect of a unit tax in a competitive market for wine. The market demand curve is shown as *D(P)*. The market supply curve is represented pre-tax by the *S(P)* schedule. In a competitive market the supply curve is also a marginal cost curve. The pre-tax equilibrium is Q_1 litres of wine sold at price P_1. After a unit tax *(T)* is levied on wine producers, the supply curve shifts upwards to *S(P) + T*. For firms to produce the same quantity of wine with the tax as without it, the price of wine would have to rise by exactly the amount of the tax. At the new equilibrium, the gross price paid by consumers rises to $P_2 + T$, but the net price that producers receive after tax falls to P_2. The difference between the gross and net price is the tax. The quantity supplied (and consumed) falls from Q_1 to Q_2.

In Figure 26.1a, the direct burden of the tax (tax payments) equals area $(P_2 + T)ADP_2$. Although wine producers formally pay the tax, consumers bear the costs associated with the rectangle $(P_2 + T)ABP_1$ and producers pay the balance of P_1BDP_2. However, the tax revenues are not the full burden of the tax. With output falling from Q_1 to Q_2, there are additional losses of consumer and producer surplus given by areas *ABC* and *BCD* respectively. These losses are the deadweight loss (or excess burden) of the tax.

Now consider the outcome if the same unit tax were levied on consumers. As shown in Figure 26.1b, the market demand curve for wine would fall by exactly the amount of the tax to the new demand schedule *D(P) – T*. If consumers are willing to buy a million bottles of wine at $12 a bottle before a $1 tax is levied, they would be willing to pay $11 a bottle for the same quantity of wine after the tax is introduced. Because the wedge between the gross price paid by the consumer and the after-tax price received by the producer is the same regardless of who pays the tax to the tax office, the post-tax quantity and price equilibrium is the same as in Figure 26.1a. The algebra is shown in Box 26.1 overleaf. This is an important result: the distribution of the tax burden is independent of the statutory incidence.

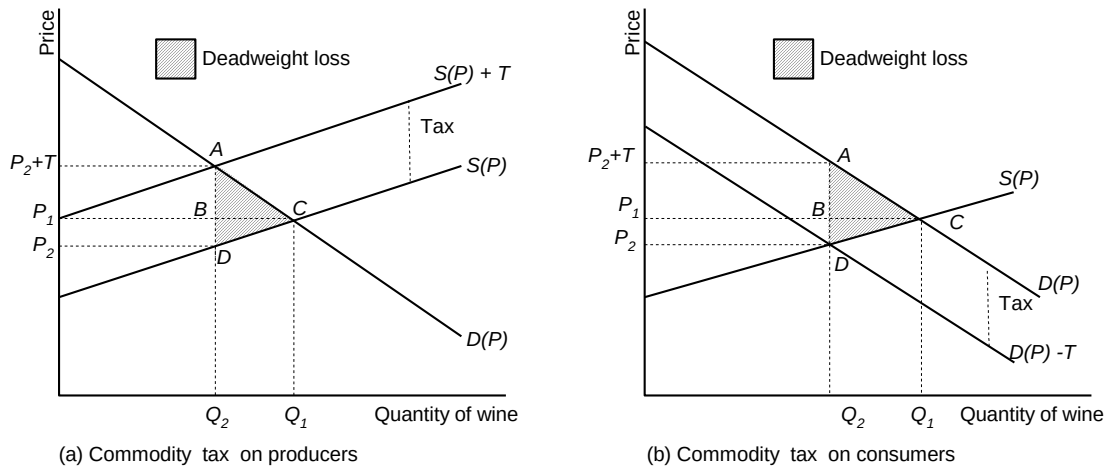


Figure 26.1 Commodity tax, prices and quantities in a competitive market

Box 26.1 Equivalence of a tax on producers and consumers

To show the equivalence of a tax on producers and consumers we first establish the pre-tax equilibrium price (P), based on linear demand and supply curves (Q_d and Q_s). We then examine how a unit tax (T) levied on consumers and producers separately affects the producer price (P^s) and the consumer price (P^c).

Suppose initially that

$$Q_d = a - bP^c \text{ and } Q_s = -c + dP^s \quad (26.1)$$

In equilibrium $$a - bP^c = -c + dP^s \quad (26.2)$$

and $$P^c = P^s = (a + c)/(b + d) \quad (26.3)$$

A tax on consumers reduces the price that they are willing to pay to producers.

So $$Q_d = a - b(P^s + T) \quad (26.4)$$

In equilibrium $$a - bP^s - bT = -c + dP^s \quad (26.5)$$

The price to producers is

$$P^s = (a + c - bT)/(b + d) \quad (26.6)$$

The price to consumers is

$$P^c = P^s + T \quad (26.7)$$

A tax on producers increases the price at which they are willing to supply consumers.

So $$Q_s = -c + d(P^c - T) \quad (26.8)$$

In equilibrium $$a - bP^c = -c = dP^c - dT \quad (26.9)$$

The price to consumers is

$$P^c = (a + c + dT)/(b + d) \quad (26.10)$$

The price to producers is

$$P^s = P^c - T \quad (26.11)$$

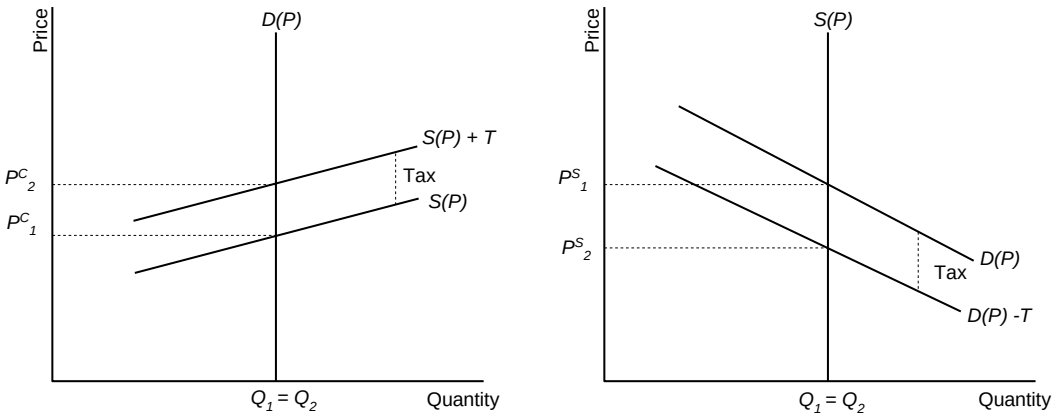
With quite simple manipulation it can be shown that the right-hand side (RHS) in Equation 26.6 = RHS in Equation 26.11 and that RHS in Equation 26.7 = RHS in Equation 26.10.

Thus, the gross price paid by consumers and the net price received by producers are independent of the party on which the tax is levied.

The key determinants of incidence of a commodity tax are the relative demand and supply elasticities for the commodity. The burden is borne by consumers or producers with the relatively more inelastic demand or supply respectively.

Two polar cases are shown in Figure 26.2. In panel (a), the tax is levied on producers, but demand is perfectly inelastic. In this case producers can pass all the tax on to consumers, with the consumer price rising from P^c_1 to P^c_2. In panel (b) the tax is levied on consumers, but the supply of the commodity is perfectly inelastic. In this scenario producers bear the whole cost, with the producer price falling from P^s_1 to P^s_2.

Now consider what would happen if demand or supply is perfectly elastic. If demand is perfectly elastic, firms cannot raise prices in response to a commodity tax. They have to reduce



(a) Incidence with inelastic demand (b) Incidence with inelastic supply

Figure 26.2 Incidence of commodity tax with inelastic demand and supply

Box 26.2 Incidence of a commodity tax

To estimate the incidence of a commodity tax we need to know how the price changes that result from the tax. If a commodity tax (T) is levied on producers, the change in price paid by consumers (ΔP^c) = $\Delta P^s + T$, where ΔP^s is the change in the price to producers, which is likely to be negative.

However, the percentage change in quantity must be the same for consumers and producers. Drawing on the standard elasticity formula, $\eta = \Delta P/P \times Q/\Delta Q$, the change in quantity formulae for consumers and producers are respectively:

$$\Delta Q/Q = \eta_d \times (\Delta P^s + T)/P \text{ and } \Delta Q/Q = \eta_s \times \Delta P^s/P$$

where d and s represent demand and supply respectively.

Note that η_d is negative and η_s is positive. Setting these two changes in quantity expressions equal to each other, the change in price to producers is given by:

$$\Delta P^s = [\eta_d/(\eta_s - \eta_d)] \times T$$

Equivalently in proportional terms:

$$\Delta P^s/T = [\eta_d/(\eta_s + \eta_d)] \times T$$

It may also be inferred from Equations 21.12 and 21.13 in the text that the relative impacts of the tax on the prices paid by consumers and producers are an inverse function of the respective elasticities:

$$\Delta P^c/\Delta P^s = \eta_s/\eta_d$$

output until their marginal cost plus the tax equals the consumer price. On the other hand, if supply is perfectly elastic, the consumer price rises by the full extent of the tax, and the quantity consumed falls, but the after-tax price received by producers is unchanged.

As shown in Box 26.2, the proportion of a commodity tax borne by producers is:

$$\Delta P^s/T = \eta_d/(\eta_s + \eta_d) \tag{26.12}$$

where ΔP^s is the change in the producer price, T is the unit tax, η is price elasticity and the subscripts d and s refer to demand and supply respectively. The burden borne by producers rises with the price elasticity of demand and falls with the price elasticity of supply. Similarly, the proportion of the tax borne by consumers is given by:

$$\Delta P^c/T = \eta_s/(\eta_s + \eta_d) \tag{26.13}$$

where ΔP^c is the change in the consumer price. The consumer burden falls with the price elasticity of demand and rises with the price elasticity of supply.

In practice, consumers usually bear more of the incidence of specific commodity taxes than do producers because the demand elasticity is less than the supply elasticity. Estimated demand price elasticities for commodities such as alcohol, tobacco and petrol, which often attract excise taxes and account for large amounts of public revenue, are usually low. For example, many studies have found that the price elasticity of demand for petrol is about –0.3 (Goodwin, 1992) and for tobacco about –0.4 (UK Department of Health, 1994). Factors of production are usually mobile at least between the supply of different goods and supply elasticities are high especially in the medium or long run. Accordingly, it is generally concluded that taxes on commodities are borne mainly by consumers.

Impacts on related commodities. So far, we have focused on the market on which the tax is imposed. When commodities are close substitutes the effects can flow over to a substitute market. Figure 26.3 overleaf shows how a tax on beer can affect suppliers and consumers of wine. In panel (a), a tax on beer shifts the supply curve to the left. The consumer price of beer rises from P^c_1 to P^c_2 and the quantity consumed falls from Q_1 to Q_2. As a result, in panel (b), the demand for wine, a substitute product, increases from D_1 to D_2 and both the price of wine and the quantity consumed increase. Suppliers of wine gain increased profits shown by area P_2ABP_1. Existing consumers of wine pay higher wine prices ($P_2 - P_1$) and indeed some may reduce their wine consumption. Consumers who switch from beer to wine also experience a loss of consumer surplus as beer was their preferred refreshment at pre-tax prices. Note that there may be a further market adjustment as the demand for beer may now rise following the

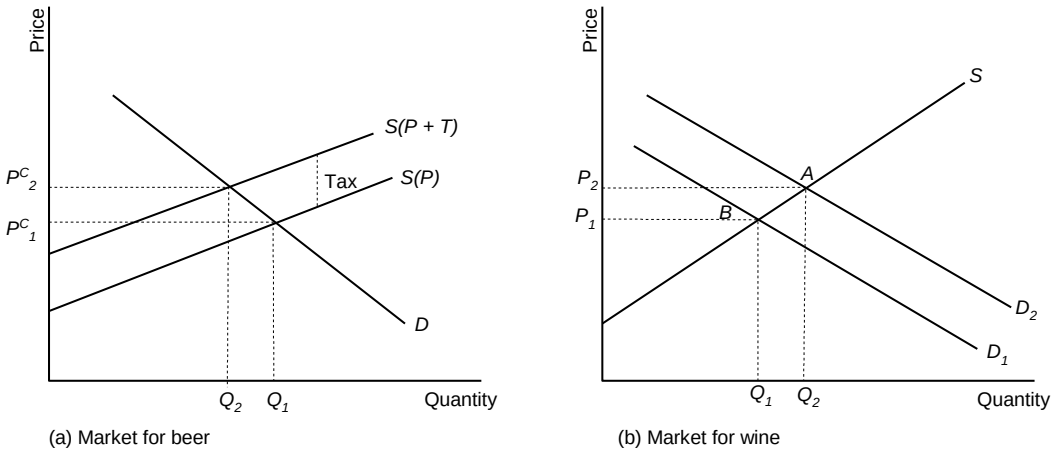


Figure 26.3 Effect of a tax on beer on markets for beer and wine

increase in the price of wine, and indeed further adjustments may continue until new market equilibria are achieved.

Incidence of *ad valorem* taxes. With an *ad valorem* tax, levied as a proportion of the price of the good being taxed, the tax rises as the price increases. This is illustrated in Figure 21.4, which shows three demand curves. Curve D_1D_1 is the initial demand with no tax. Curve D_2D_1 is demand with an *ad valorem* tax, which tilts the demand curve as price increases. Demand with a unit tax is shown by the D_3D_3 curve, which is parallel to the D_1D_1 curve. When the tax payment is the same with an *ad valorem* tax as with a unit tax, the effects of the two taxes are the same. As shown in Figure 26.4, the equilibrium price received by producers (P_2) and the quantity supplied (Q_2) are the same with both forms of tax.

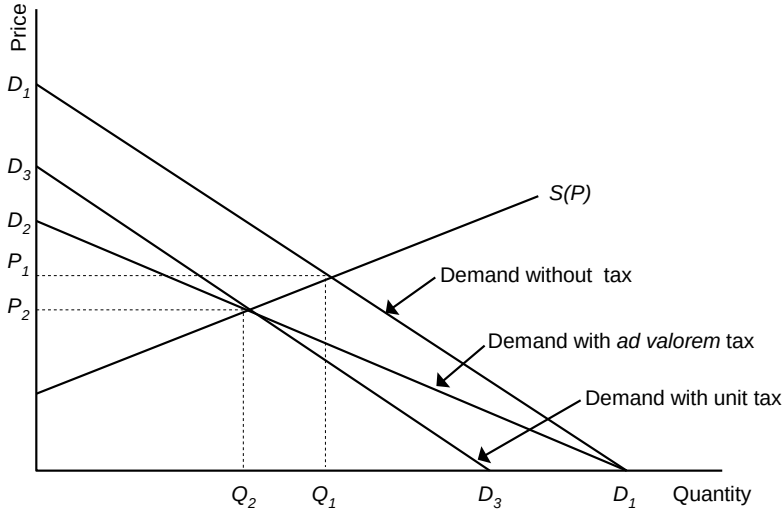


Figure 26.4 *Ad valorem* and unit commodity taxes

Of course, when the *ad valorem* tax is higher or lower in dollar terms than the unit tax, the outcome varies according to the amount of tax levied. Again, the distribution of the burden between consumers and producers depends on the relative price elasticities of demand and supply.

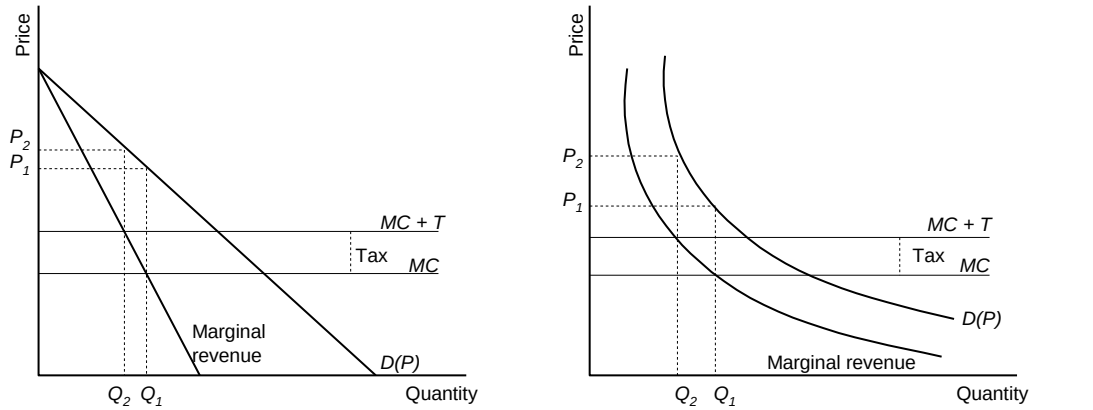
Traditionally governments levied unit taxes more often than *ad valorem* taxes. Unit taxes require data on quantities of items sold rather than on prices (or revenue) and quantity data are usually easier to obtain and monitor than prices. However, unit taxes are less equitable. It would scarcely be equitable to charge the same tax on a $10 bottle of wine as on a $50 bottle. Although unit taxes can vary with product quality, for example with the alcohol content of beer and spirits, the administration would generally be complex. As the variety of market goods rises, governments are increasingly using *ad valorem* taxes.

Commodity taxes with imperfect competition

The incidence of a commodity tax is different and more complex with imperfect competition. Typically, firms in imperfect competition face a downward-sloping demand curve. In the absence of price discrimination, this implies that marginal revenue is less than price and the marginal revenue curve sits below the demand curve. Figure 26.5a illustrates the case for a linear demand curve and a constant marginal cost schedule. With no commodity tax a profit-maximising firm produces up to the point where marginal revenue equals marginal cost (MC) and will produce output Q_1 at price P_1. Now suppose that a unit tax is imposed which increases the marginal cost of output to $MC + T$. The new equilibrium output is Q_2. The equilibrium price can be shown to rise by exactly half the tax from P_1 to P_2. Even though the firm has elastic supply at $MC + T$, the firm bears a substantial part of the tax.[1]

On the other hand, with a constant price elasticity demand curve as in panel (b), marginal revenue is a constant proportion of the price. In this case a unit tax increases the price by $[1/(1 - 1/\eta_d)] \times T$. Thus, if $\eta_d = 2$, the increase in price is twice the size of the tax. Indeed because, for a profit-maximising monopoly $\eta_d > 1$, the price always increases by more than the tax. In these cases consumers bear more than 100 per cent of the tax.

What happens if output is produced at increasing marginal cost? It can be shown that a commodity tax will lead to a smaller fall in output and a smaller increase in price. Indeed,



(a) Incidence with a linear demand curve

(b) Incidence with a constant price elasticity demand curve

Figure 26.5 Incidence of a unit commodity tax with a monopoly

[1] For a formal derivation of the results in this subsection, see Stiglitz (2000), Chapter 18.

with perfectly inelastic supply there would be no change in output or price. As in a competitive market, the whole tax would be borne by the producer. Although this is not usual, it could occur when a plant, such as a steel mill, operates at full capacity.

Consider now an *ad valorem* tax. In a competitive market, for a given tax revenue, an *ad valorem* tax has the same price and output effects as a unit tax. However, in a monopoly market an *ad valorem* tax produces a smaller rise in price and smaller fall in output than does a unit tax. The reason is that an *ad valorem* tax is a tax on marginal revenue (MR) and, in a monopoly, MR < *P*. A unit tax reduces MR by the exact amount of the tax. An *ad valorem* tax reduces MR by less than the tax. Suppose that a product sells for \$100, produces MR of \$50 and is subject to a \$10 unit tax. The equivalent *ad valorem* tax on the product would be 10 per cent but this would reduce MR by \$5 (not \$10). Because a profit-maximising monopolist sets MR = MC, if MR falls by less than MC, there is a smaller impact on output and price and a smaller impact on consumers than with a unit tax.

In summary, the incidence of a commodity tax in monopolistic markets depends on several factors. The tax is borne mainly by consumers when the tax is a unit tax, the demand curve is non-linear, the monopolist can discriminate between customers and marginal cost is constant. The monopolist bears a greater proportion of the tax when the tax is an *ad valorem* tax, the demand curve is linear, the firm cannot discriminate between consumers and marginal cost is rising.

Incidence in oligopoly markets. Tax incidence in oligopoly markets is less well determined. Incidence depends again on how taxes change prices. However, there is no single explanation of price determination in an oligopoly market and no unique price equilibrium. Without an equilibrium price there is no basis for predicting how taxes will change price. Prices depend on how firms compete or collude with each other. In most models of firm behaviour in oligopoly markets, except the Bertrand model, firms expand output until MR= MC and P > MR as in the monopoly model. The incidence is here similar to that in the monopoly model described above. In the Bertrand model of oligopoly behaviour, P = MC and the incidence is likely to be as in in a competitive market.[2]

Incidence of Taxes on Factors of Production

Analysis of the incidence of taxes on the earnings of factors of production (labour, land and capital) follows similar lines to that for commodity taxes. The economic incidence depends on the relative elasticity of factor demand and supply, not on who nominally pays the tax. The relatively less elastic side of the market bears a higher share of the tax.

Three other general points may be noted. First, as with commodity taxes, incidence depends on the nature of the market. Most factor markets are competitive, with many buyers and sellers. However, some markets are not fully competitive, for example some labour markets are unionised or regulated, and this will affect the tax incidence. Second, most taxes on factors of production are *ad valorem* taxes. Labour is taxed on the value of its output or on wages paid, not on hours worked. Third, taxes on factors may be general or selective. For example, some payroll taxes and some land taxes apply only to certain payrolls and types of land respectively. However, as we will see, these taxes usually also affect the untaxed payroll labour or land.

Taxation of payments to labour

Labour may be taxed either by a personal income tax or by a group payroll tax. We consider first an **income tax**. This may be levied on a pay-as-you-earn (PAYE) basis with the tax

[2] See Varian (2006), Chapter 27.

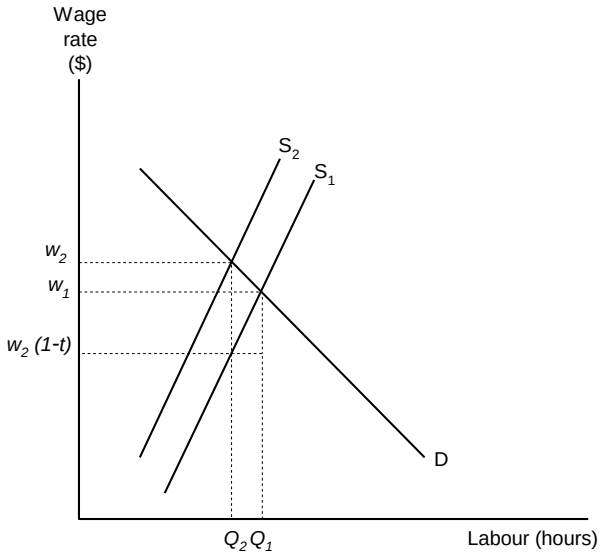


Figure 26.6 Incidence of income tax on labour

remitted by the employer or annually on the worker's declared income. The method of payment does not affect the analysis or the real outcome. Figure 26.6 depicts the demand and supply of labour as a function of the wage rate (w). The supply of labour (measured in labour hours) is shown as relatively inelastic. An income tax typically shifts the labour supply curve leftwards from S_1 to S_2 as workers offer less hours for lower take-home wages. In this case the gross wage rate shifts from w_1 to w_2, but the after-tax wage rate falls to $w_1(1 - t)$ where t is the tax rate. If labour supply is relatively inelastic, labour will bear most of the tax, but employers will also bear a small part in higher gross wages. Thus, although income tax is generally described as a direct tax on workers, some effects will be borne by employers. The quantity of labour hours will fall from Q_1 to Q_2.

We turn now to **payroll tax**. In many OECD countries, payroll tax is a general tax levied as a percentage of the total labour income of all employees. In this case the payroll tax works like personal income tax. For any given tax rate, the tax paid on the marginal worker is the same whether paid on the increment to total wage payments or as a tax on an individual income. The incidence effects are therefore as described for a personal income tax on labour.

However, in Australia the states levy a payroll tax as a selective tax on the total payroll of companies above a threshold amount. This raises fresh issues. Figure 26.7a overleaf shows the effects of the payroll tax on the taxed sector. The schedules D_1 and D_2 show the demand by large firms for labour without and with payroll tax respectively. Labour supply is more elastic than in Figure 26.6 because labour can work in the untaxed sector. Because labour supply is more elastic, work hours fall proportionately more and large firms bear more of the tax burden than with a general income tax. On the other hand, the burden on the employee is less with the take-home wage rate falling only from w_1 to w_2. But this is not the full story. Panel (b) shows the effects in the untaxed labour sector. Because employment and wages decline in the taxed sector, labour supply to the untaxed sector increases from S_1 to S_2. Employment in this sector increases to Q_2 and the wage rate falls to w_2. Indeed, if workers are indifferent between working in the two sectors, the wage falls by the same amount in the untaxed sector as in the taxed sector! On the other hand, firms in the untaxed sector gain from paying lower wages. However, if the labour supply curve is upward sloping, the fall in the wage rate from w_1 to w_2 will result in lower total employment.

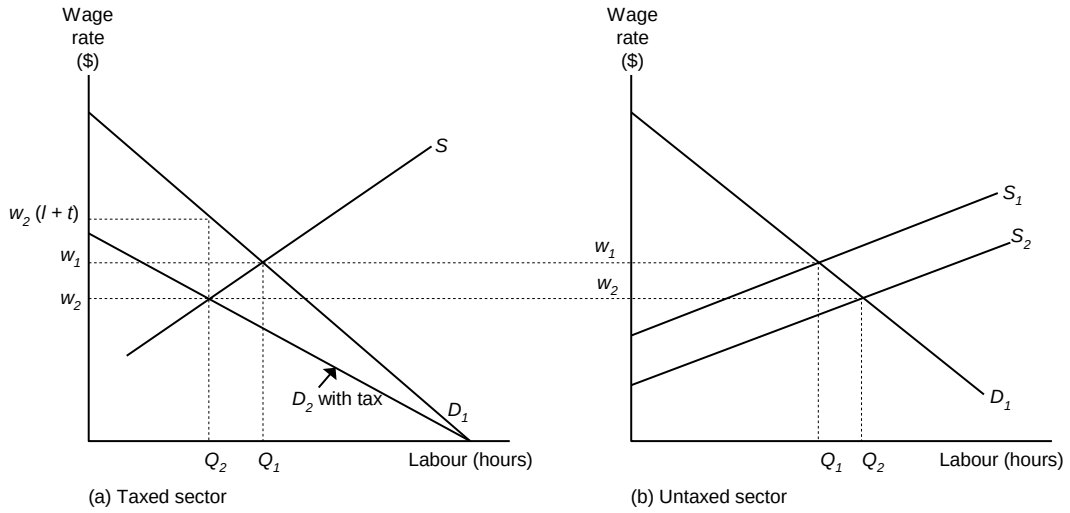


Figure 26.7 Incidence of selective payroll tax

Taxation of income from capital

Turning to taxation of income from capital, we again present two scenarios: with an inelastic and an elastic supply of capital. Figure 26.8a overleaf presents a fixed supply of capital that is independent of the rate of return on capital (interest rates). This could occur in the absence of foreign capital.[3] It also shows the demand for capital, with demand increasing as the price of capital falls. With no tax on income from capital, Q_1 capital would be supplied with a rate of return r_1. If a tax rate (t) is levied on the income, the quantity of capital supplied would be unchanged. However, suppliers of capital would receive a return of $r_1(1 - t)$. The whole burden of the tax would be borne by suppliers of capital.

Figure 26.8b presents a scenario with capital in perfectly elastic supply (S_1) due to the availability of foreign capital to a small open economy. In the absence of a tax on income from capital, Q_1 capital would be supplied with a return of r_1. In this case imposing a tax on income from capital would shift the supply curve upwards as shown to S_2. The amount of capital demanded would fall to Q_2 and the gross return on capital would rise to r_2. However, the net return to lenders would fall exactly to $r_1 = r_2(1 - t)$. Although a tax on income from capital may be intended partly as a tax on foreign capital, the tax does not change the after-tax return paid to foreign lenders, who simply lend less to the local economy. In this scenario, the whole tax is borne by local firms who pay r_2 for capital instead of r_1.

Taxation of returns to land

The total supply of land is perfectly inelastic. It follows that a general *ad valorem* tax on land has no impact on the quantity of land available. Such a tax reduces the value of land to the landowner and is borne entirely by the landowner. The tax cannot be shifted. The same applies to a tax on a natural resource such as an oil field or a diamond deposit. A general *ad*

[3] The domestic supply of capital is fixed if the substitution and income effects of interest rates on savings cancel out. As the interest rate rises, savers have more incentive to save because of the substitution effect but less need to save because of the income effect of higher returns.

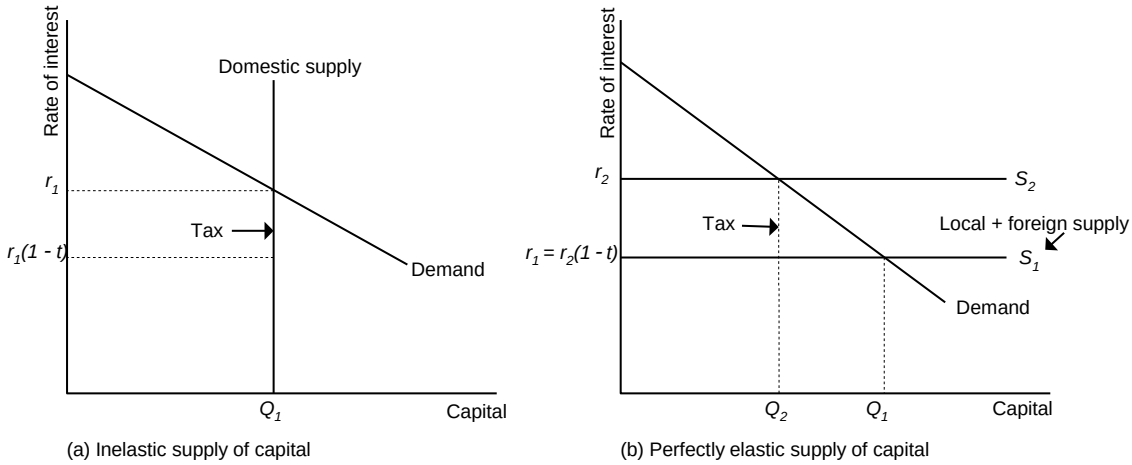


Figure 26.8 Incidence of taxation of capital

valorem tax on income directly attributable to a natural resource reduces its capital value by the discounted present value of the tax. This tax is borne wholly by the owner of the resource.

The actual incidence of taxation of land and natural resources is often more complex for two reasons. First, many taxes on land are selective; they vary with land use. When land has several uses, as it often does, the supply of land to any specific use is price elastic. Landowners switch to land uses with lower taxes. This reduces the supply of heavily taxed land. The users of this land will bear some of the tax by paying increased rents. On the other hand, the supply of land for untaxed uses will increase and so reduce the value of untaxed land. Thus, owners of untaxed land indirectly bear some of the tax on taxed land.

Second, nearly all land is improved and most exploitation of natural resources is made possible by the application of capital. Farmland is cleared, drained and made suitable for crops. Urban land is serviced with roads, water, sewerage services and so on. Thus, market prices of land and natural resources usually include the value of improvements and are payments for capital as well as for land. Nevertheless, in informed markets, in so far as the supply of capital is elastic and the supply of land is perfectly inelastic, a tax on the combined value will be borne entirely by the land component (i.e. it will reduce the value of the land). Capital must obtain the same return when combined with land as it would in other uses.

Tax capitalisation

So far, we have assumed that a tax is borne when it is levied. However, this is not necessarily true. Some taxes are borne before they are levied! This process is known as tax capitalisation. Tax capitalisation occurs when a stream of present and expected future taxes is incorporated into the present capital value of an asset. This commonly occurs with periodic land taxes. Suppose that land rent is $\$R$ per annum and that the rate of interest is r. The capital price (P) of the land equals:

$$P = R_0 + \frac{R_1}{(1+r)} + \frac{R_2}{(1+r)^2} + \ldots + \frac{R_n}{(1+r)^n} \qquad (26.14)$$

where land provides rent for n years. Now suppose that the rent is taxed at rate t each year, the price of the land becomes:

$$P^t = R_0(1-t) + \frac{R_1(1-t)}{(1+r)} + \frac{R_2(1-t)}{(1+r)^2} + \ldots + \frac{R_n(1-t)}{(1+r)^n} \qquad (26.15)$$

The difference between the asset price of land in Equations 26.15 and 26.14 is the discounted value of the future tax payments. The asset price falls by the present value of all future tax payments. In fact, it falls by $(1-t)$.

Tax capitalisation occurs whenever tax is levied on income from a durable asset. It applies to structures and land, financial instruments, licences to run hotels and taxis, and indeed to any asset whose income is taxed. Although future owners of the asset pay the periodic taxes to the tax authority, the owner of the asset when the tax is announced bears the burden of the expected changes in after-tax income. If there is doubt whether a tax will be legislated or retained, there will be less than a one-off full fall in the value of an asset when it is announced. On the other hand, if people fear that government may increase the tax later, the price of an asset may fall by more than 100 per cent of the present value of actual future tax payments!

General Equilibrium Analysis

Most of our discussion of tax incidence has focused on the impacts of taxes in single markets. We have also considered some related or multi-market effects. For example, we examined how a tax on beer can affect the price and output of wine and how a tax on payrolls of large firms can affect wages and employment in untaxed firms. These were first steps towards a general equilibrium (economy-wide) analysis but we were working primarily with single markets and using partial equilibrium (PE) models.

In many cases PE models can explain the full incidence of a tax. Moreover, the basic drivers of incidence (relative demand and supply elasticities) are the same in economy-wide models as in PE models. But a PE model cannot capture all the effects of large tax changes across many markets, for example the impacts of a tax on carbon. For such changes we are likely to need a general equilibrium (GE) model of the economy. These models can be very large and complex and run into thousands of equations in a computable GE model. However, we can gain important insights into the effects of a tax change on an economy by drawing on the simple but classic GE model proposed by Harberger (1974).

Suppose that an economy contains two factors of production, capital and labour, and produces two commodities, manufactures and services. In this model the total supply of capital and labour is fixed. However, capital and labour are mobile and can move between the manufacturing and service sectors. Also, in this economy all income is consumed; there are no savings. This economy is depicted in Figure 26.9.

In this economy there are nine possible *ad valorem* taxes.

- A general income tax. In the absence of savings, a general tax on income from labour and capital is equivalent to a uniform tax on expenditure on manufactures and services.
- Two selective factor taxes: a tax on labour or on capital.
- Two selective commodity taxes: a tax on manufactures or on services.
- There are also four partial factor taxes. A partial factor tax is a tax levied on a factor in a selective use. The four partial factor taxes are a tax on capital used to produce manufactures or services or a tax on labour in one of these activities.

To analyse the effects of these taxes, following Harberger we assume that factors of production are fully employed, the economy is competitive. and prices and wages are flexible. Suppliers of capital and labour seek to maximise their after-tax income. Therefore, the after-tax marginal return to capital and to labour is the same in manufacturing and services. Factors of production are paid the value of their marginal product. We also assume initially that consumers have similar preferences. This means that changes in the distribution of income between labour and capital do not affect the use of income.

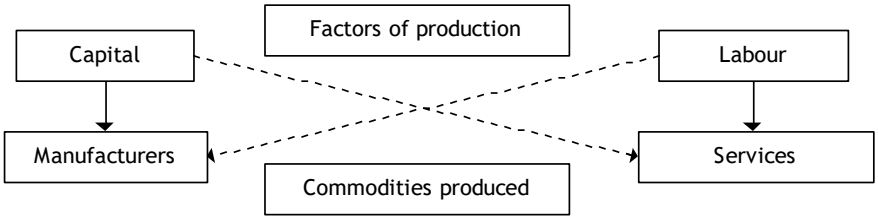


Figure 26.9 A simple general equilibrium model

We now examine the incidence of the four main types of *ad valorem* taxes starting with a **general income tax**. In this model, because factor supplies are fixed, this tax is borne wholly by income earners. The owners of the factors bear the cost; they cannot escape the taxes. Further, because capital and labour are the source of all income in this model, a general tax on income is equivalent to a uniform tax at the same rate on both factors of production. In addition, with no savings, income equals expenditure. With these assumptions, a general tax on income is equivalent to, and has the same incidence as, a uniform tax on consumption of manufactures and services.

Consider, secondly, **selective factor taxes**. Because labour supply is fixed labour bears the full cost of a selective tax on earnings of labour. With a tax on labour in manufacturing and services, labour has no incentive to switch from one sector to the other. Likewise, with a fixed supply of capital, a tax on capital is borne by owners of capital.

The incidence of **selective consumption taxes** is more complex. However, it is relevant to many economies, including Australia where the GST covers less than 60 per cent of all goods and services. Consider, for example, a tax on manufactures which raises their price. The consumption of manufactures falls and demand for services rises. Some capital and labour move from manufacturing into services. At this point, production technology is important. Suppose that manufacturing is capital intensive and services are labour intensive. Services will have to absorb a relatively large amount of capital. This causes the price of capital used in the services sector to fall. The size of the fall depends on the ease with which capital can be substituted for labour. The greater the substitutability of capital for labour, the lower the fall in price of capital. However, because capital used in services cannot earn less than capital used in manufacturing, the return to capital in both sectors must fall. In general, a tax on the output of one sector induces a decline in the relative price of the input that is used relatively intensively in that sector. Moreover, the greater the elasticity of demand for services, the greater the switch from manufactures to services and therefore the greater the decline in the relative price of capital.

Now allow consumer preferences to vary. Suppose that individuals with labour income prefer manufactures and individuals with capital income prefer services. If income from labour rises relative to income from capital, demand for manufactures will increase. A GE model would incorporate the effects of changes in the distribution of income on changes in demand for manufactures and services.

Fourth, we consider the incidence of a **partial factor tax**, for example a payroll tax on labour used in manufacturing. Such a tax has output and substitution effects. The output effect occurs because a tax on labour in manufactures raises the price of manufactures. This reduces consumption of manufactures and increases the demand for services. Labour and capital move from manufacturing to services. If manufacturing is capital intensive, a large amount of capital must be absorbed in the labour-intensive service sector and the price of capital falls relative to the price of labour. If manufacturing is labour intensive, labour must be absorbed

in the services sector and the relative price of labour falls. Thus, a tax on labour in manufactures has output effects that change the relative price of labour and capital, depending on the factor intensity of labour and capital in manufacture and services. The substitution effect arises because a tax on labour in manufacturing causes capital to be substituted for labour in manufacturing. This reduces the price paid to labour.

Combining output and substitution effects, if manufacturing is labour intensive the two effects work in the same direction. Both reduce the price of labour. If manufacturing is capital intensive, the switch in demand from manufactures to services increases the demand for labour and its price and reduces the price of capital. This output effect on the relative price of labour may more than offset the substitution effect. Thus, even though the tax is levied on labour, it can make owners of capital worse off. Conversely, a tax on capital in a labour-intensive sector can make labour worse off. The general point is that a tax on a factor in one sector ultimately affects the returns to factors in both sectors.

The Harberger model illustrates the key features of general equilibrium models, especially how a change in relative prices in one commodity or factor market can affect prices in other markets. More detailed models expand the range of consumers, factors and sectors that may be affected by taxes. They also relax the assumption that factor supplies are fixed and often add a time dimension to the behaviour of consumers and producers. Cordes and Watson (1998) provide a guide to extensions of the model.

Further Issues in Tax Incidence

We have seen that some taxes are equivalent to others. For example, a general tax on income is equivalent to a general tax at the same rate on all factors of production. We discuss below equivalent taxes and the implications for the overall incidence of a tax system. We see why a comprehensive income tax causes savings to be taxed twice. We also examine the incidence of a general value added tax (VAT or the equivalent goods and services tax, GST, in Australia), and see when the incidence is similar to a tax on income or one on consumption.

Equivalent taxes

When the incidence of two sets of taxes is the same, the taxes are called equivalent. Table 26.1 shows some tax equivalence relations in a single period with no savings. There are again two factors of production, capital (K) and labour (L), and two commodities, manufacturing (M) and services (S). There is an *ad valorem* tax rate (t) and Y is income. The table indicates six sets of equivalent taxes (one in each of the three rows plus one in each of the three columns). We have already met the equivalences in the last row and last column—the equivalence of income tax to a uniform and equal tax on either the factors of production or the consumption of manufactures and services (if there are no savings). Partial tax rates on capital (labour) used in manufacturing and services are equivalent to a general tax on capital (labour). Also, equal tax rates on capital and labour used in producing manufacturing (services) are equivalent to a general tax rate on manufactures (services).

Table 26.1 Tax equivalence relations with no savings

t_{KM}	and	t_{LM}	are equivalent to	t_M
and		And		and
t_{KS}	+	t_{LS}	are equivalent to	t_S
are equivalent to		are equivalent to		are equivalent to
t_K	and	t_L	are equivalent to	T_Y

Source: Rosen and Gayer (2014, p. 315) adapted from McClure (1971).

Introducing savings. So far savings have been excluded. Introducing savings complicates matters. A general tax on consumption is equivalent to a general tax on income that excludes income from capital. In effect this is equal to a uniform tax on income from labour (wages).[4] This can be shown using a two-period model. Suppose Emma earns a wage income (W_1, W_2) in two periods and saves nothing. The present value of her lifetime income, $PV(Y)$, is:

$$PV(Y) = W_1 + \frac{W_2}{(1+r)} \tag{26.16}$$

where r is her rate of time discount. Because Emma consumes exactly her wage income in each period, the present value of her consumption (C) is the same as the present value of her wage income.

$$PV(C) = C_1 + \frac{C_2}{(1+r)} = PV(Y) \tag{26.17}$$

Now suppose that Emma consumes less than her wage in period one. She would save ($W_1 - C_1$). Her consumption in period two would be the sum of her wage and her savings plus interest.

$$C_2 = W_2 + (W_1 - C_1)(1+r) \tag{26.18}$$

This implies that:

$$C_2 + C_1(1+r) = W_2 + W_1(1+r) \tag{26.19}$$

and

$$C_1 + \frac{C_2}{(1+r)} = W_1 + \frac{W_2}{(1+r)} \tag{26.20}$$

Given perfect bond markets and no tax, the present value of wage income equals the present value of consumption, whatever the pattern of consumption.

Now introduce taxation (t). With no savings the present value of the wage after tax is:

$$PV(Y) = W_1(1-t) + W_2\frac{(1-t)}{(1+r)} \tag{26.21}$$

To consider the effect of savings, we assume that Emma saves S_1 of her wage in period one and consumes these savings plus after-tax interest and her regular wage in period two. The present value of her consumption is then:

$$PV(C) = W_1(1-t) - S_1 + \frac{S_1}{(1+r)} + \frac{S_1 r(1-t)}{(1+r)} + \frac{W_2(1-t)}{(1+r)} \tag{26.22}$$

Emma gives up S_1 and gains $S_1[1 + r(1 - t)]/(1 + r)$. If the returns from savings are exempt from tax, Emma would gain as much as she had forgone. A tax on wages would be the same as a tax on consumption. Savings can be exempted by taxing an individual's labour income and exempting returns on capital or by taxing individuals on their total income less their savings, which is their consumption.

However, if the returns on savings are taxed the present value of consumption is less than the present value of wages. In effect, there is double taxation of savings. To illustrate this, consider the choice between consuming an after-tax income of $W_1(1 - t)$ in year one and investing this after-tax income at a rate of return r in perpetuity. Note that the return would be taxed in each year. The present value of the perpetual investment equals:

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[4] In this analysis inheritances and bequests are ignored. It can be shown that a tax on labour income plus inheritances and gifts is equivalent to a tax on consumption plus bequests and gifts.

$$PV(C) = W_1\frac{(1-t)r(1-t)}{(1+r)} + W_1\frac{(1-t)r(1-t)}{(1+r)^2} + \ldots + W_1\frac{(1-t)r(1-t)}{(1+r)^{\infty}} \qquad (26.23)$$
$$= W_1\frac{(1-t)r(1-t)}{r} = W_1(1-t)(1-t)$$

Equation 26.23 shows that savings are taxed twice.[5] Savers consume less of their lifetime income in terms of present values and pay more in tax than do non-savers. We now consider the incidence of a general value-added tax (VAT). The incidence depends on how investment is treated.

Incidence of a general value-added tax

In the most common form of VAT, used in Australia and the European Union, capital goods are effectively exempt from VAT. Accordingly, VAT works as a consumption tax. However, it can be designed as an income tax equivalent inclusive of savings.

An example may illustrate these statements. Suppose that a shirtmaker purchases wool and machinery, manufactures shirts and sells the shirts to retailers. Table 26.2 shows the value-added process and the implications for the value-added tax. The shirtmaker purchases wool and machinery valued at $3000 and sells the shirts to a retailer for $6000. The retailer sells the shirts to customers for $8000. Column 3 shows the value added at each stage in this process. Value added is defined here as the difference between the firm's sales and purchases. In effect the shirtmaker writes off the full cost of the machinery purchased in this accounting period. The total value added in this process is $8000. Column 4 shows the VAT paid with a 10 per cent tax rate applied at each stage of production.

In the Australian (GST) system the shirt manufacturer would invoice the retailer $600 for GST and claim a rebate of $300 for GST paid on inputs. The total GST paid is $800, which equals 10 per cent of the value of the retail sales. With this design, the GST (or the VAT) is a consumption tax. It is equivalent to a general sales tax on consumption goods.

This definition of value added underestimates the real value added of the shirtmaker because it overestimates the real cost of the machinery. Suppose that the shirtmaker can deduct only the amount by which the machinery depreciates, say 20 per cent in this period, or $400. The real value added, and income, of the shirt manufacturer is $4600. This is $6000 (sales) less $1000 for materials and $400 for use of machinery. Total value added in the whole process would be $9600, which is the real value of income earned. Also, if the shirtmaker paid $460 VAT on the real value added of $4600, total VAT would be $960. Expressed another way, the real income of all factors in this period is $9600. This output

Table 26.2 Example of a value-added tax for a shirt manufacturer

	Purchases	*Sales*	*Value added*	*VAT @10%*
Inputs				
Material (wool)	0	1000	1000	100
Machinery	0	2000	2000	200
Total inputs	3000	3000		
Manufacturer	3000	6000	3000	300
Retailer	6000	8000	2000	200
Total			8000	800

[5] The present value of any perpetual income stream (y) equals y/r, where r is the discount rate.

comprises $8000 of consumption goods and $1600 of investment goods. If firms can deduct only the amount by which investment goods depreciate, the tax base becomes total income inclusive of investment output. With this tax design, the VAT is equivalent to a uniform income tax. It is also equivalent to a general sales tax on consumption and investment goods.

Balanced budget incidence

So far, we have considered only the incidence of taxes. To obtain a complete picture of tax incidence we should also account for the way in which taxes are spent. Tax incidence analysis that takes account of both the incidence of taxes and the benefits received from revenue raised is known as balanced budget incidence.

Where the benefits accrue mainly to low income households, taxes may be proportional or even regressive and the balanced budget incidence can be progressive. Suppose that all taxpayers are taxed a given percentage of their income to provide health care services only for households on below average incomes. The tax would be proportional, but the balanced budget incidence would be progressive. In the section below, we look at the distribution of cash and various other benefits as well as the distribution of taxes.

Tax Incidence in Australia

To show the estimated incidence of most taxes as well of benefits we draw on the ABS (2007) analysis of household incomes in 2009–10 (which appear to be the latest such estimates). The results are shown by equivalised private income quintile in Table 26.3. Equivalised income allows for the different sizes and composition of households. Using the modified OECD scale, in these calculations the first adult in a household is given a weight of one, each extra person who is 15 years or older is allocated 0.5 points and each child under the age of 15 is allocated 0.3 points. Equivalised household income is total household income divided by the sum of the household's equivalence points.

Private income includes income from labour and capital. Social assistance benefits in cash are direct Australian government benefits. Social transfers in kind are the value of government transfers in kind for education, health, housing and social security. This totalled just over 50 per cent of all Commonwealth, state and local government expenditure.

Table 26.3 Distribution of household income, benefits and taxes by equivalised private income quintile, 2009-10

	Lowest quintile %	*Second quintile* %	*Third quintile* %	*Fourth quintile* %	*Highest quintile* %
Private income	3	9	16	24	48
Benefits					
Social assistance benefits in cash	58	26	10	4	2
Social transfer in kind	30	22	18	15	14
Total	39	24	16	12	10
Taxes					
Taxes on income	0	4	12	23	61
Taxes on production	14	15	18	22	31
Total	6	9	14	23	49
Final income	13	14	16	21	36
Equivalised private income	2	10	17	25	46
Equivalised final income	13	14	17	21	35

Source: ABS, *Government Benefits, Taxes and Household Income*, Cat. No. 6537.0, 2009-10.

The distribution of direct taxes was derived from income tax statistics. The distribution of indirect taxes, including the goods and services tax, was estimated based on expenditure data obtained from the 2009-10 *Household Expenditure Survey*. Overall 60 per cent of taxes on production were allocated to households. The study assumed that households bear all the costs of both income tax and consumption taxes and that there is no shifting of the taxes to employers or to suppliers of goods and services. Thus, it may not reflect the complete or real economic incidence of taxation that we have discussed in much of this chapter.

It may be noted that in Table 26.3 the data in most of the table refer to the households in each quintile. The last two rows are slightly reweighted based on the 20 per cent of all individuals in each quintile. This is described as a person weighting and gives equal weighting to people in large households to those in smaller ones although the incomes are still based on the concept of an equivalised household.

Taking the weighting in the final two rows, in 2009-10 individuals in households in the highest quintile received 48 per cent of all private income and those in the lowest quintile received only 3 per cent. After direct and indirect taxation and the distribution of benefits, the percentages change to 35 per cent and 13 per cent respectively.

Overall taxes were broadly proportional to private income. The income tax was highly progressive but taxes on production were regressive. However, the provision of social assistance in cash and in kind was highly progressive, especially benefits in cash.

Summary

- Economic tax incidence is often different from statutory incidence. Statutory incidence indicates who is legally responsible for paying a tax. Economic incidence shows which party actually bears the tax.
- In a competitive market, the burden of a commodity tax depends on the relative price elasticities of demand and supply. Consumers bear most of the tax when demand is inelastic and supply elastic. Producers bear most of the tax when supply is inelastic and demand elastic. Taxes are borne to the extent that they cannot be escaped.
- A monopolist, or any firm with some market power, can pass on more of a commodity tax to consumers when it can discriminate between customers, the marginal revenue curve is non-linear, the supply curve is elastic, and the tax is *ad valorem* rather than a unit tax.
- The analysis of the incidence of taxes on factors of production is similar to the analysis of commodity tax incidence. The effective incidence of a tax on a factor depends on the relative elasticities of demand and supply, not on who nominally pays the tax.
- The owners of land, capital and labour bear most of the tax when supply is inelastic and demand elastic. Users of factors bear most of the tax when their demand for factors is inelastic and the supply is elastic.
- Tax capitalisation occurs when a stream of present and future taxes is incorporated into the present capital value of an asset.
- When the incidence of two sets of taxes is the same the taxes are called equivalent taxes. A general tax on income is equivalent to a general tax on all factors of production. It is also equivalent to a comprehensive and uniform sales tax on all output, including investment goods. A general tax on consumption is equivalent to a general tax on labour income (which excludes income from savings).
- Partial equilibrium analysis examines the incidence of price and wage changes within markets. General equilibrium analysis examines the incidence of price and wage changes across the economy. It shows how a change in relative prices in one commodity or factor market can affect prices in other commodity or factor markets.
- In Australia, the overall tax system is broadly proportional. The income tax is progressive, but consumption taxes are regressive. However, the distribution of benefits, especially cash benefits, is highly progressive.

Questions

1. Why is the statutory incidence of taxation often irrelevant when determining the actual effects of taxation? What determines the economic incidence of a commodity tax?
2. Under perfect competition to what extent does the incidence of a commodity tax depend on whether the tax is a unit tax or an *ad valorem* tax? What difference will an *ad valorem* tax have under monopoly production?
3. Will an income tax be borne entirely by workers or will firms bear any of the tax?
4. Who bears the incidence of a partial payroll tax levied on firms with a labour payroll in excess of one million dollars?
5. What is tax capitalisation and when is it likely to occur?
6. Assume that a good is fixed in supply at 30 units. Demand for the good can be represented by the demand equation $Q^d = 50 - 4P$ where P is the price per unit. If government imposes a tax on the producer equal to \$4 per unit determine:
   i. The price paid by consumers before and after the tax is imposed.
   ii. The price producers receive before and after the tax is imposed.
   iii. The amount of revenue raised as a result of the tax.
7. Suppose that demand for shirts is represented by the equation $Q^d = 80 - 3P$ and supply of shirts is given by $Q^s = 40 + P$. If a commodity tax of \$2 per shirt is imposed on production of shirts, determine:
   i. The pre-tax equilibrium price and quantity combination.
   ii. The post-tax equilibrium price and quantity combination.
   iii. The burden of tax borne by consumers and producers.
8. Suppose that Bruce earns \$40 000 each year, and saves a quarter of that income in year 1 for consumption in year 2.

   If the rate of interest is 5 per cent and the tax on wages or consumption is 20 per cent determine the following:
   i. The present value of Bruce's income and consumption without taxation.
   ii. The present value of Bruce's income and consumption with tax.
   iii. What inference can be drawn about taxation equivalence?
9. The auction house Sotheby's traditionally charged a percentage of the sale price as a commission on both vendor and purchaser and was heavily criticised for double charging. Show that the final price to the consumer is the same regardless of whether Sotheby's charges the whole commission to the vendor or to the purchaser or splits the commission equally or in any other proportion between them. What is the implication for commodity taxation?
10. An economy has two factors of production, labour and capital. Labour is in inelastic supply (there is no immigration). Capital is in perfectly elastic supply (as in a small open economy). Drawing on the Harberger general equilibrium model, show how all taxes, whether on labour or capital or output, will fall on labour. How does this outcome change with migration?
11. Suppose that there exists a general consumption tax such as a VAT or GST that covers two-thirds of all consumption goods. Are firms likely to pass all the tax on to consumers? When would they not do so?
12. What are the main differences between an income tax, a social security levy on employers and a payroll tax? Do they have any different real economic incidence?
13. What methods would you employ to determine the incidence of a carbon tax? What results would you expect?

Further Reading

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