Chapter 16

TAX INCIDENCE

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0. Introduction

The incidence of taxes is a fundamental question in public economics. The study of tax incidence is, broadly defined, the study of the effects of tax policies on the distribution of economic welfare. It bridges both the positive and normative aspects of public economics. Studying tax incidence requires characterizing the effects of alternative tax measures on economic equilibria. Tax policy decisions are based, at least in part, on their effects on the distribution of economic welfare. It is, therefore, little wonder that the study of tax incidence has attracted the attention of economic theorists, at least since Ricardo's discussion of taxes on rent. Certainly the study of the incidence of different types of tax policies in various economic environments continues to be an area of active research.

The distinctive contribution of economic analysis to the study of tax incidence has been the recognition that the burden of taxes is not necessarily borne by those upon whom they are levied. In general, the introduction of taxes, or changes in the mix of taxes, changes the economy's equilibrium. Prices of goods and rewards to factors are altered by taxes. In assessing the incidence of tax policies, it is necessary to take account of these effects. Changes in prices can lead to the shifting of taxes. Thus, for example, a tax on the hiring of labor by business may be shifted backwards to laborers in the form of lower wages or forward to consumers in the form of higher prices. The measurement of tax incidence is not an accounting exercise; rather it is an analytical characterization of economic equilibria under alternative assumptions about taxation.

Tax incidence is a part of the very broad study of how exogenous interventions affect the economy and is necessarily predicated on a theory of economic equilibrium. As such, tax incidence conclusions are critically dependent on which

Handbook of Public Economics, vol. II, edited by A.J. Auerbach and M. Feldstein
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theory of economic equilibrium is chosen. We follow the main thrust of the literature in studying the effects of taxes in competitive economies where markets clear. This assumption has been adopted extensively not so much for its realism as because of the absence of widely accepted, fully articulated alternatives to the competitive paradigm.

Even maintaining the assumption of perfect competition and market clearing, the question of tax incidence has been approached in many ways. This is a consequence of both the richness of the problem and the generality of models of competitive equilibrium. The incidence of a wide variety of tax instruments ranging from estate taxes, to excise taxes, to the corporate tax is of interest. Incidence has many dimensions that have attracted attention. These include the effects of taxes on the distribution of factor incomes, the degree of income inequality, the welfare of members of different generations, and the consumers of different products. Given the choice of model and the issue of concern, tax incidence results are generally ambiguous without additional restrictions on the precise nature of preferences and technology. As Arrow and Hahn (1971) emphasize, without further assumptions, virtually all comparative static experiments have ambiguous effects in the standard model of competitive equilibrium.

Our survey of the tax incidence literature is organized as follows. Section 1 reviews traditional approaches to the study of tax incidence. These include partial equilibrium analyses and studies based on the judgmental allocation of tax burdens to different population groups. A number of issues in the tax incidence literature, including the proper alternative to be considered in defining the incidence of a tax and the dimensions along which incidence should be measured, are also discussed. Section 2 introduces the general equilibrium analysis of tax incidence. A general equilibrium approach is necessary to treat the incidence of taxes which impact on large parts of the economy. The sensitivity of judgments about the incidence of taxation to a large number of elasticities is stressed.

Section 3 takes up the incidence of taxes in open economies. These may be thought of either as regions within a single country, or as different nations. We show that the incidence of alternative taxes hinges on what is assumed mobile. We also discuss the controversial question of the incidence of local property taxes.

Section 4 places the analysis of tax incidence in a dynamic context. This step is important for several reasons. The long-run incidence of any tax change will depend critically on its effects on capital accumulation and the resulting marginal productivities of capital and labor. The short-run burdens borne by the owners of productive assets will depend, in large part, on the instantaneous revaluation of these assets arising from both current and anticipated future tax changes. Perhaps most importantly, studying the intergenerational incidence of tax changes (the tax burden on successive generations) requires a dynamic model.

1. Preliminaries

1.1. The partial equilibrium analysis of tax incidence

Many of the fundamental principles of tax incidence may be illustrated in the simplest partial equilibrium setting. We therefore begin by considering the partial equilibrium analysis of an excise tax on a product. As discussed below, for partial equilibrium analysis to be appropriate, it is necessary that the product in question have a market that is small relative to the entire economy. The analysis is depicted in Figure 1.1. In the absence of taxation, equilibrium is attained where supply equals demand and the equation,

$$D(p) = S(p), \tag{1.1}$$

is satisfied. Now consider the introduction of an excise tax at rate τ. If the tax is collected from buyers, the new equilibrium will satisfy the condition that

$$D(p' + \tau) = S(p'), \tag{1.2}$$

while if the tax is collected from sellers, the new equilibrium will satisfy the condition that

$$D(p'') = S(p'' - \tau). \tag{1.3}$$

Comparing equations (1.2) and (1.3), it is clear that the determination of the

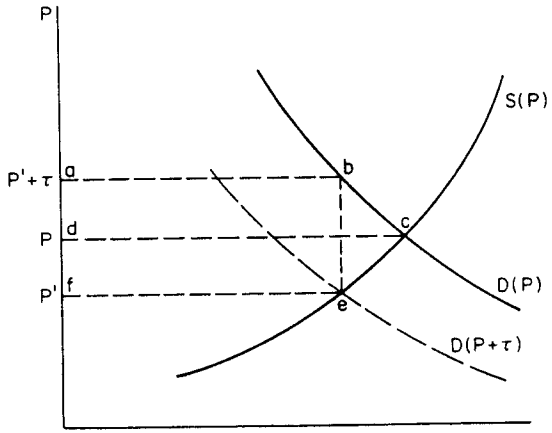

Figure 1.1. Incidence of a commodity tax.

equilibrium quantity, the price paid by consumers, and the net of tax receipts of producers does not depend on which side of the market the tax is levied, i.e. $p'' = p' + T$. Diagrammatically, the imposition of a tax can be analyzed as a shift in the demand curve facing suppliers, as in Figure 1.1, or as a shift in the supply curve facing consumers. The resulting equilibrium is the same in both instances. This principle, that the incidence of a tax does not depend on which side of the market it is levied, carries over to much more general contexts and underlies the general equilibrium tax equivalence results that we discuss below.

It follows immediately from this tax equivalence principle that the ultimate incidence of a tax cannot be assessed simply by looking at where the tax is proximately levied. For, as we have seen, shifting the tax assessment between consumers and producers has no real effects. The real equilibrium is invariant to whom the government requires mail in the tax payment.

In order to examine the incidence of an excise tax we begin by characterizing the change in equilibrium that results from the imposition of the tax. For convenience we think of the tax as being collected from consumers. Differentiating (1.2) yields:

$$\frac{\mathrm{d}p}{\mathrm{d}\tau} = \frac{D'}{S' - D'}, \tag{1.4}$$

where $D' = \mathrm{d}D(p)/\mathrm{d}p$, and $S' = \mathrm{d}S(p)/\mathrm{d}p$. More conveniently, we can write:

$$\frac{\mathrm{d}p}{\mathrm{d}\tau} = \frac{\eta_D}{\eta_s - \eta_D}, \tag{1.5}$$

where η_D represents the elasticity of demand, and η_s represents the elasticity of supply. At this point we are ready to assess the incidence of an excise tax. Consider the changes in consumers' and producers' surplus arising from introducing a small tax. For a small tax the change in consumer surplus equals minus the change in the consumer price times the initial quantity demanded, and the change in producer surplus equals the change in the producer price times the initial quantity supplied. Hence, we have

$$\frac{\mathrm{d}Cs}{\mathrm{d}\tau} = -\frac{\eta_s D(p)}{\eta_s - \eta_D} \tag{1.6}$$

and

$$\frac{\mathrm{d}Ps}{\mathrm{d}\tau} = \frac{\eta_D S(p)}{\eta_s - \eta_D}, \tag{1.7}$$

where the Cs and Ps represent, respectively, consumers' and producers' surplus.

Note that for a small tax change starting with no tax, minus the sum of the changes in consumers' and producers' surplus equals the tax revenue since $D(p) = S(p)$, and the change in tax revenue equals $\mathrm{d}\tau S(p)$. In terms of Figure 1.1 the change in consumer surplus is the area *abcd*, and the change in producer surplus is *dcef*. For very small taxes the sum of these taxes is essentially *abef*, the tax revenue.

Equations (1.6) and (1.7) illustrate a fundamental principle that will recur frequently in our discussion of tax incidence. Taxes tend to be borne by inelastic suppliers or demanders. It is instructive to consider the limiting cases of (1.6) and (1.7). If demand is completely inelastic or supply perfectly elastic, consumers will bear the entire burden of an excise tax. Conversely, if supply is perfectly inelastic or demand is perfectly elastic, the entire excise tax will be borne by suppliers. More generally, taxes are borne by those who can not easily adjust. The greater buyers' abilities to substitute other commodities for the taxed commodity, the greater their ability to shift taxes. Likewise, if producers have no fixed factors and can leave an industry where taxes are being levied, their supply curve is perfectly elastic and the tax must be borne by consumers. For if sellers were forced to bear the tax, they would earn a sub-normal rate of return leading them to cease production. Hence, in the new equilibrium producers receive the same price for producing as in the old equilibrium, while the price paid by consumers rises by the full amount of the tax.

While this analysis accurately describes the effects of introducing an excise tax in a small market where there are no pre-existing distortions, it is difficult to extend to other cases. In general, shifts in the demand curve such as would be caused by a tax change will be associated with changes in the demand for other products. This will alter their prices leading to changes in factor prices which will affect the position of both the supply and demand curves in Figure 1.1. In considering taxes which affect a large part of the economy, it is therefore necessary to adopt a general equilibrium perspective rather than the partial equilibrium view taken above. Two principles which emerge from this partial equilibrium analysis will remain valid. First, tax incidence does not depend on which side of a market the tax is assessed. Second, taxes will be shifted by those agents and factors that are more elastic in supply or demand.

1.2. Methodological issues

Before turning to the general equilibrium analysis of the effects of alternative tax instruments, it is useful to comment on several important methodological issues which arise in the study of tax incidence. The first question that arises is how should incidence be measured. A natural, but difficult to implement answer is that the incidence of a tax change can be assessed by looking at the compensating

variation associated with the tax change for each participant in the economy. As discussed in detail in Alan Auerbach's contribution to this Handbook (Chapter 2), the compensating variation provides a dollar measure of the impact of a given tax change on individual economic welfare. It equals the additional income needed to restore the consumer to his or her initial utility level given a change in consumer prices. The compensating variation may be computed as follows:

$$CV = e(q_1, u_0) - e(q_0, u_0), \tag{1.8}$$

where $e(\cdot)$ is the minimum expenditure function, which depends on the consumer price vector q, and the initial utility, u_0. In (1.8) q_1 is the post-tax price vector, and q_0 is the pre-tax price vector. Alternatively, similar measures discussed by Auerbach, such as the equivalent variation that replaces u_0 in (1.8) with the post-tax utility level, may be used in assessing tax reforms.

While the computation of the compensating variation associated with a tax change for each affected person reveals its incidence, actual compensating variations are not explicitly calculated in most theoretical or empirical work on tax incidence. In part, this is because of the difficulty involved in specifying individual expenditure functions. It is also due to the fact that most studies of tax incidence focus on the effects of taxes on different classes of individuals. Studies concerned with vertical equity focus on the differential effects of taxes on after-tax incomes of persons with varying levels of pre-tax income. Much of the literature studies the effects of alternative tax policies on the after-tax payments to different factors. This is thought to indicate how different tax changes affect workers, capitalists, land owners, etc. Other dimensions along which incidence is sometimes measured include region and date of birth. Intergenerational issues have been a particularly active subject of research in recent years. Studies of incidence along all these dimensions are best thought of as providing indications of salient features in the distribution of compensating variations associated with alternative tax policies.

In the partial equilibrium incidence calculation described above no attention was devoted to the question of what is done with the revenue raised by the excise tax. Specifying the use of the revenue was unnecessary given the partial equilibrium character of the analysis. Implicitly it was assumed that the revenue was not spent on the taxed good, but no more needed to be specified. In general equilibrium the effects of a tax change will depend on whether the tax is used to finance changes in government spending, rebates to consumers, or changes in other taxes. Thus, the incidence of a tax cannot be considered in isolation. Its incidence must be assessed along with a feasible disposition of tax revenue. This has led to the development of several different incidence concepts in the literature. The term "differential incidence" is used to describe comparisons of the incidence of different tax instruments that raise the same amount of revenue. The term "balanced budget incidence" is used to describe the effects of increased government spending financed by increases in the tax under consideration. No single concept is uniformly appropriate in assessing the incidence of a tax. The appropriate assumption about the use of tax revenue will depend on the nature of the tax reform being studied. In discussing tax incidence, however, it is important to be clear about the nature of the experiment being considered.

1.3. Empirical incidence evaluations

Analytical work on tax incidence in various economic models of the type surveyed in this chapter has been complemented by empirical studies that have sought to evaluate the overall incidence of the tax system. Major studies of this type include Pechman and Okner (1974), Musgrave and Musgrave (1976), Browning and Johnson (1979), and Pechman (1985). Their approach and that of other authors working in this tradition is to postulate an incidence for each type of tax, and then use microdata on individuals to calculate the distribution of total tax burdens by income class. The finding of many of these studies is that despite the apparent progressivity of the income tax, the share of income paid in taxes does not increase rapidly with income. According to these studies the total tax system appears to be only slightly progressive over much of the income range. If one considers taxes net of transfer, the system appears highly progressive at the lower income range.

A number of problems have been raised with empirical incidence studies of this sort. Perhaps most serious is the need to make assumptions about the ultimate incidence of various types of taxes. As our subsequent analysis will make clear, this is very difficult to determine. And conclusions about the effects of taxation on the distribution of income can be no better than the judgments about the incidence of individual taxes on which they are based. Devanajour, Fullerton, and Musgrave (1982) do, however, provide some evidence suggesting the results of judgemental studies are fairly close to those of full-scale general equilibrium simulation exercises of the type described below.

A related problem with these incidence evaluations is that they measure taxes collected by the government from various income classes, but these tax collections may differ substantially from the tax burdens that are imposed on them. A good example is provided by the municipal interest exclusion in the United States. Taxpayers in high tax brackets tend to hold municipal bonds which are tax-free. But these bonds have lower yields than taxable bonds. Hence, high bracket taxpayers bear a burden imposed by the tax system even without transferring revenue to the government. Similar reasoning applies to investments in any tax-favored activity.

An understanding of the distributional impact of the tax system must be predicated on an understanding of its general equilibrium effects. We now turn to this question.

2. Static general equilibrium models of tax incidence

Static models of tax incidence take the economy's aggregate supplies of productive factors, such as physical capital, as given, and consider changes in equilibrium prices arising from commodity and factor taxes. While ignoring the intertemporal issue of human and nonhuman capital formation, static models can provide considerable insight into the incidence of taxation in the short run, i.e. before capital stocks have adjusted to changes in after-tax prices. In addition, many of the conclusions of static tax analysis can be directly applied to the case of long-run dynamic incidence.

In contrast to the implicit model underlying Figure 1.1, in which producers and consumers of goods are distinct agents, this section examines models in which all agents have identical consumption preferences, i.e. the producers (actually the owners of productive factors) are also the consumers. Hence, interest shifts from the question of whether producers or consumers bear the burden of a tax to the question of the division of the tax burden among the owners of productive factors.

As one would expect, the aggregate supply elasticities of and demand elasticities for particular factors play key roles in the analysis of the incidence of uniform commodity and factor taxation. In the case of differential commodity taxes or industry-specific factor taxes the structure of industrial demands for factors is of great importance for incidence; the ultimate incidence of industry-specific factor taxes depends not only on the demand conditions in taxed industries, which will typically attempt to reduce their demand for the tax factor, but also on the demand conditions for that factor in untaxed industries which will absorb factors released from the taxed sector.

2.1. Tax incidence in a one-sector general equilibrium model

2.1.1. Factor taxes

A one-sector general equilibrium model is useful for highlighting several of the main results in static tax incidence analysis. Let X be the economy's single commodity, which is produced using labor, L, and capital, K. The linear

homogeneous production function is given by

$$X = F(K, L), \tag{2.1}$$

where $F_L > 0$ and $F_K > 0$. The supply of capital, K, is totally inelastic in the short run, but the supply of labor is positively related to the real wage, W/P, where W is the wage rate, and P is the price of good X:

$$L = L(W/P), \tag{2.2}$$

where $L'(W/P) > 0$. In competitive equilibrium, marginal revenue products are equated to factor costs, giving:

$$PF_L(K, L) = W \tag{2.3}$$

and

$$PF_K(K, L) = r, \tag{2.4}$$

where r is the rental rate on capital. Equating labor supply and labor demand in (2.3) determines the equilibrium real wage and the equilibrium level of labor, i.e.

$$F_L(L(W/P), K) = W/P. \tag{2.5}$$

Given the equilibrium level of L, r/P, the real rental on capital, is determined by (2.4).

Consider first the incidence of a tax at rate τ on the rental of capital. Equation (2.4) becomes:

$$PF_K = r(1 + \tau). \tag{2.4'}$$

Since neither the supply of nor the demand for labor are affected by this tax, the equilibrium values of W/P, L, and F_K are unaffected. Capital, in this case, bears the full burden of the tax, since its real rental, r/P, falls from F_K to $F_K/1 + \tau$. The change in the real rents received by owners of capital is $F_K - F_K/(1 + \tau)K$, which equals $\tau(rK/P)$, the real taxes paid on the rental of capital. The entire incidence of the tax falls on capital since it is perfectly inelastic in supply to the economy and since it is taxed at the same rate in all its uses, which in this case is a single use, namely the production of X.

The results are different in the case of taxing elastically supplied labor at rate τ. Producers now equate the marginal revenue product of labor to the after-tax cost of hiring labor, i.e.

$$PF_L = W(1 + \tau). \tag{2.3'}$$

The demand and supply relations, equations (2.3′) and (2.2), respectively, determine the new equilibrium wage. The percentage change in W/P arising from an increase in τ, evaluated at $\tau = 0$, is given by

$$\frac{\frac{\partial(W/P)}{\partial\tau}}{W/P} = \frac{\eta^D}{\eta^S - \eta^D}, \tag{2.6}$$

where η^S is the (positive) elasticity of labor supply, and η^D is the (negative, since $F_{LL} < 0$) elasticity of labor demand. Evaluated at $\tau = 0$, the change in real tax revenue ($\tau(W/P)L$) is simply $(W/P)L$. The marginal losses in rents to labor, $[\partial(W/P)/\partial\tau]\cdot L$, and to capital, $[\partial(r/P)/\partial\tau]\cdot K$, expressed as a ratio of the marginal tax revenue, $(W/P)L$, are given by

$$\frac{\frac{\partial(W/P)}{\partial\tau}L}{(W/P)L} = \frac{\eta^D}{\eta^S - \eta^D} \tag{2.7}$$

and

$$\frac{\frac{\partial(r/P)K}{\partial\tau}}{(W/P)L} = \frac{\eta^S}{\eta^D - \eta^S}. \tag{2.8}$$

Note that the two ratios sum to -1, indicating that the full incidence of the tax falls on either capital or labor.

If labor supply is perfectly inelastic, $\eta^S = 0$, labor bears the full burden of the tax, i.e. the right-hand sides of (2.7) and (2.8) are -1 and 0, respectively. This result also holds if the demand for labor is perfectly elastic ($\eta^D = \infty$). At the opposite extreme labor may be perfectly elastic in supply ($\eta^S = \infty$), or the demand for the labor may be perfectly inelastic ($\eta^D = 0$), in which case capital bears the full burden of the tax. Note that capital always bears some burden of the tax provided $\eta^S \neq 0$ and $\eta^D \neq \infty$. In general, the larger the supply elasticity and the smaller the demand elasticity, the larger will be the share of the tax burden shifted to capital.

The elasticity of labor demand is related to the degree of substitutability between capital and labor. Equation (2.9) expresses this relationship for the case of a linear homogeneous production function, where σ is the elasticity of substitution of capital for labor with respect to increases in the wage–rental ratio, and θ_K is capital's share of output ($F_K K/F$):

$$\eta^D = -\sigma/\theta_K. \tag{2.9}$$

As $\sigma \to \infty$, i.e. as capital and labor become closer substitutes in production, $\eta^D \to -\infty$. Alternatively, as $\sigma \to 0$ and capital and labor approach perfect complementarity, $\eta^D \to 0$. Intuitively, when $\sigma = \infty$, capital and labor are perfect substitutes; hence, their after-tax user costs to competitive firms must be identical, and $W(1+\tau) = r$. But, assuming constant returns to scale, the production function in this case is of the form $F(K, L) = \alpha(K + L)$, where the constant α equals both F_K and F_L. Since $F_K = \alpha = r/P = (W/P)(1+\tau)$, W/P falls by the full amount of the tax. If, on the other hand, $\sigma = 0$, firms view their input as a fixed combination of capital and labor. From their perspective a tax on labor is identical to a tax on capital as long as it raises the cost of the fixed capital and labor input bundle by the same percentage. Since any reduction in the real wage, W/P, received by labor will reduce the supply of labor [assuming $L'(W/P) > 0$] and make part of the capital stock redundant, the equilibrium involves no change in W/P and a fall in r/P such that the loss to capitalists in real rents equals the tax revenue.

2.1.2. Commodity taxation

A proportional tax at rate τ on the consumption of good X creates a divergence between the price, P, paid by the consumer and the price $P/1+\tau$ received by producers. With a consumption tax the factor demand conditions are written as

$$\left(\frac{P}{1+\tau}\right)F_K(L(W/P), K) = r \tag{2.4″}$$

and

$$\left(\frac{P}{1+\tau}\right)F_L(L(W/P), K) = W. \tag{2.5″}$$

Multiplying (5′) and (6′) by $(1+\tau)$ reveals that a proportional consumption tax is structurally equivalent to a uniform proportional tax on factor inputs. A further equivalence result can be demonstrated by rewriting (2.5′) and (2.6′) in terms of the producer price q, where $q = P/1+\tau$, and the tax rate τ^*, where $\tau^* = \tau/1+\tau$:

$$qF_K\left(L\left(\frac{W(1-\tau^*)}{q}\right), K\right) = r \tag{2.4‴}$$

and

$$qF_L\left(L\left(\frac{W(1-\tau^*)}{q}\right), K\right) = W. \tag{2.5‴}$$

Equations (2.4‴) and (2.5‴) describe the identical tax structure as a uniform proportional income tax at rate τ^* on wages and capital rents; here r is the pre-tax return to capital paid by firms, while $r(1-\tau^*)$ is the post-(income) tax return to capital.

The equivalence in a static model between a uniform consumption tax, a uniform tax on factor returns (a value added tax), and an income tax is a general result that applies independent of the number of sectors and factors [Break (1974), Musgrave (1959), and McLure (1975)].[1]

Using (2.4″) and (2.5″) the incidence of the commodity tax expressed as a fraction of real marginal tax revenues (X) is

$$\frac{\frac{\partial(W/P)}{\partial\tau}\cdot L}{X} = \theta_L\left(\frac{\eta^D}{\eta^S-\eta^D}\right)$$

and

$$\frac{\frac{\partial(r/P)}{\partial\tau}\cdot K}{X} = -\theta_K - \theta_L\left(\frac{\eta^S}{\eta^S-\eta^D}\right), \tag{2.10}$$

where θ_L is labor's share of output. If $\eta^S = 0$ or $\eta^D = \infty$ capital and labor bear the burden of the tax in proportion to their respective shares of output. If $\eta^D = 0$ or $\eta^S = \infty$, capital bears the entire burden of the tax.

2.2. Tax incidence in a two-sector general equilibrium model

The static two-sector general equilibrium model permits the analysis of sector-specific factor taxes. Harberger's (1962) seminal analysis of the incidence of the corporate income tax focused attention on the elasticity of supplies of domestically mobile factors to particular industries, with such mobile factors able to switch industries in an attempt to avoid taxation. The research also identifies industry-specific factor demand conditions as critical for determining the incidence of a sector-specific factor tax. As indicated in the discussion of one-sector factor tax incidence, factor demand elasticities are closely related to elasticities of substitution in production.

A variety of taxes can be analyzed in this model. A thorough review is presented in McLure (1975) who also discusses a number of tax equivalence

[1]The equivalence also holds in a dynamic model provided final output in the investment goods industries is treated as consumption under the consumption tax and that purchases of newly produced investment goods are not deductible under the value added tax.

propositions. Since both capital and labor are assumed to be inelastically supplied, the incidence of a general factor tax is trivial. It is borne entirely by the taxed factor. The incidence of excise taxes on one of the commodities is more complex and is considered below. We focus on the case of a sector-specific tax such as the corporate tax. The two-sector general equilibrium model is the simplest framework in which such a tax can be investigated.

The two-sector general equilibrium model highlights the wide range of theoretically possible effects of a tax even in a very simple setting. A tax may actually benefit the taxed factor, or the taxed factor may lose more than the amount of tax revenue collected. Intermediate outcomes are also possible.

2.2.1. Assumptions of the model

The two-factor, two-sector model examined by Harberger assumes that economy-wide supplies of the two factors, capital and labor, are perfectly inelastic, but that capital and labor are perfectly mobile between sectors. The two industries are perfectly competitive, and the production functions of both industries exhibit constant returns to scale. The assumption that workers, owners of capital, and the government have identical homothetic preferences ensures that the redistribution between the three demanders of goods arising from the sector-specific factor tax has no impact on the aggregate demands for the two goods. The analysis thus abstracts from changes in the relative demands for the two goods that could arise if workers', capitalists', and the government's preferences differ.

2.2.2. The model

Denote the two industries as X and Y. The constant returns assumption permits the production function to be written in the intensive form:

$$X = L_x f(k_x) = K_x f(k_x)/k_x,$$
$$Y = L_y g(k_y) = K_y g(k_y)/k_y, \tag{2.11}$$

where L_x and L_y are, respectively, the quantities of labor used to produce goods X and Y, and k_x and k_y are the respective capital–labor ratios in industries X and Y. The function $f(\cdot)$ expresses the ratio of output of X to Lx, and $g(\cdot)$ is, similarly, output of Y per worker in industry Y. The respective economy-wide supplies of labor and capital, $\bar{L}$ and $\bar{K}$, must sum to their respective demands:

$$a_{lx}X + a_{ly}Y = \bar{L},$$
$$a_{kx}X + a_{ky}Y = \bar{K}, \tag{2.12}$$

where a_{lx}, a_{kx}, a_{ly}, and a_{ky} are input-output coefficients and are implicitly defined in (2.11). The equalities, required by competition in factor markets, between marginal revenue products and post-tax factor costs may be written as

$$P_x = \frac{w + (r + \tau_{kx})k_x}{f} = \frac{r + \tau_{kx}}{f'},$$

$$P_y = \frac{w + rk_y}{g} = \frac{r}{g'}, \tag{2.13}$$

where P_x and P_y are the respective prices of goods X and Y, W and r are the respective net rentals to labor and capital, and τ_{kx} is the tax on the rental of capital in the X industry.

The assumption of identical homothetic preferences of workers, capitalists and the government implies that aggregate demands can be written as

$$X = m(P_x/P_y)\cdot I,$$

$$Y = n(P_x/P_y)\cdot I, \tag{2.14}$$

where I is total disposable income of the private sector plus the government's tax revenues, i.e.

$$I = w\bar{L} + r\bar{K} + \tau_{kx}K_x. \tag{2.15}$$

The expressions (2.12), (2.13), and (2.14) provide eight equations in eight unknowns, X, Y, w, r, k_x, k_y, P_x, and P_y. One of these equations is, however, redundant, implying that one can only solve for relative prices. Specifically, the expressions in (2.14) satisfy

$$P_xX + P_yY = I = w\bar{L} + r\bar{K} + \tau_{kx}K_x. \tag{2.16}$$

The first equality in (2.13) implies $P_xX = wL_x + (r + \tau_{kx})K_x$. This expression and (2.16) imply $P_y = (w + rk_y)/g$, the third equation in (2.13).

2.2.3. *The incidence of a tax on capital in industry X*

Following the derivation in Atkinson and Stiglitz (1980), which employs Jones' (1965) technique of considering "equations of change", one can reduce the eight equations in (2.12), (2.13), and (2.14) to three equations in the percentage change in the three ratios: X/Y, P_x/P_y, and w/r. Let $\hat{z}$ denote the proportional change in a variable z. From (2.13) we have $P_xf' = P_yg' + \tau_{kx}$. Totally differentiating

this expression yields:

$$\hat{P}_x - \hat{P}_y = \frac{g''k_y}{g'}\hat{k}_y - \frac{f''k_x}{f'}\hat{k}_x + \frac{d\tau_{kx}}{r}. \tag{2.17}$$

Expression (2.13) also implies:

$$\left(\frac{w}{r + \tau_{kx}}\right) = \frac{f - f'k_x}{f'} \quad \text{and} \quad \frac{w}{r} = \frac{g - g'k_y}{g'}.$$

Total differentiation of these expressions gives:

$$\hat{k}_x = -\frac{f'\theta_{wx}}{f''k_x}(\hat{w} - \hat{r}) - \frac{f'\theta_{wx}}{f''k_x}\frac{d\tau_{kx}}{r},$$

$$\hat{k}_y = -\frac{g'\theta_{wy}}{g''k_y}(\hat{w} - \hat{r}), \tag{2.18}$$

where θ_{wx} and θ_{wy} are the respective labor shares in producing X and Y [e.g. $\theta_{wx} = (f - f'k_x)/f$]. Equations (2.17) and (2.18) imply:

$$\hat{P}_x - \hat{P}_y = (\theta_{wx} - \theta_{wy})(\hat{w} - \hat{r}) + \theta_{rx}\frac{d\tau_{kx}}{r}. \tag{2.19}$$

In (2.19) θ_{rx} is capital's cost share in X. The equation indicates that the relative price of X rises with increases in the wage-rental ratio if labor's cost share in X exceeds its cost share in Y.

We next consider percentage changes in factor demands. Total differentiation of (2.12) yields:

$$(\hat{a}_{lx} + \hat{X})\lambda_{lx} + (\hat{a}_{ly} + \hat{Y})\lambda_{ly} = 0,$$

$$(\hat{a}_{kx} + \hat{X})\lambda_{kx} + (\hat{a}_{ky} + \hat{Y})\lambda_{ky} = 0, \tag{2.20}$$

where $\lambda_{lx} = 1 - \lambda_{ly}$ is the share of total labor supply used in producing X, and $\lambda_{kx} = 1 - \lambda_{ky}$ is X's corresponding share of total capital. From the definitions of a_{lx}, a_{ly}, a_{kx}, and a_{ky} implied by (2.11) and (2.12), it is easy to show that

$$\hat{a}_{lx} = -\theta_{rx}\sigma_x(\hat{w} - \hat{r}) + \theta_{rx}\sigma_x\frac{d\tau_{kx}}{r},$$

$$\hat{\alpha}_{ly} = -\theta_{ry}\sigma_y(\hat{w} - \hat{r}),$$

$$\hat{a}_{kx} = \theta_{wx}\sigma_x(\hat{w} - \hat{r}) - \theta_{wx}\sigma_x\frac{d\tau_{kx}}{r},$$

$$\hat{a}_{ky} = \theta_{wy}\sigma_y(\hat{w} - \hat{r}), \tag{2.21}$$

where σ_x and σ_y are the respective elasticities of substitution of capital for labor in the two industries [e.g. $\sigma_x = \hat{k}_x/(\hat{w} - \hat{r})$]. Since $\lambda_{lx} - \lambda_{kx} = (1 - \lambda_{ly}) - (1 - \lambda_{ky}) = \lambda_{ky} - \lambda_{ly}$, subtracting the bottom equation in (2.20) from the top equation gives:

$$(\lambda_{lx} - \lambda_{kx})(\hat{X} - \hat{Y}) = \hat{a}_{kx}\lambda_{kx} - \hat{a}_{lx}\lambda_{lx} + \hat{a}_{ky}\lambda_{ky} - \hat{a}_{ly}\lambda_{ly}. \tag{2.22}$$

Substituting equation (2.21) into (2.22) yields:

$$(\lambda_{lx} - \lambda_{kx})(\hat{X} - \hat{Y}) = \left[(\theta_{wx}\lambda_{kx} + \theta_{rx}\lambda_{lx})\sigma_x + (\theta_{wy}\lambda_{ky} + \theta_{ry}\lambda_{ly})\sigma_y\right](\hat{w} - \hat{r}) - [\theta_{wx}\lambda_{kx} + \theta_{rx}\lambda_{lx}]\sigma_x \frac{d\tau_{kx}}{r}. \tag{2.23}$$

If X is more labor intensive than Y, $k_y > k_x$, which implies $\lambda_{lx} > \lambda_{kx}$, and increases in the wage–rental ratio are associated with increases in the ratio of X to Y.[2]

The corresponding equation for change in the relative demand for X and Y is obtained by differentiating the ratio of the demand for X to the demand for Y determined by (2.24)

$$\hat{X} - \hat{Y} = -\eta(\hat{P}_x - \hat{P}_y). \tag{2.24}$$

In (2.24) η is the elasticity of the demand for X relative to the demand for Y with respect to the relative price ratio. η is positive since both X and Y are assumed to be normal goods.

Equations (2.19), (2.23), and (2.24) are three equations in the unknowns $X - Y$, $\hat{w} - \hat{r}$, and $\hat{P}_x - \hat{P}_y$. The solution for $\hat{w} - \hat{r}$ is given by

$$(\hat{w} - \hat{r})\left[(\lambda_{lx} - \lambda_{kx})(\theta_{wx} - \theta_{wy})\eta + (\theta_{wx}\lambda_{kx} + \theta_{rx}\lambda_{lx})\sigma_x + (\theta_{wy}\lambda_{ky} + \theta_{ry}\lambda_{ly})\sigma_y\right] = \left[(\theta_{wx}\lambda_{kx} + \theta_{rx}\lambda_{lx})\sigma_x - \eta(\lambda_{lx} - \lambda_{kx})\theta_{rx}\right]\frac{d\tau_{kx}}{r}, \tag{2.25}$$

where the bracketed term on the right-hand side of (2.25) multiplying $(\hat{w} - \hat{r})$ is positive since $(\lambda_{lx} - \lambda_{kx})$ and $(\theta_{wx} - \theta_{wy})$ have the same sign.[3]

[2] To prove $k_y > k_x$ implies $\lambda_{lx} > \lambda_{kx}$ use the two equations $\lambda_{lx}k_x + \lambda_{ly}k_y = \bar{k}$, and $\lambda_{kx}/k_x + \lambda_{ky}/k_y = 1/\bar{k}$, where $\bar{k} = \bar{K}/\bar{L}$. Substituting out for $\bar{k}$ and some algebra yields the results.

[3] Note indicates that $\lambda_{lx} - \lambda_{kx} > 0$ if $k_y > k_x$. But

$$\theta_{wx} - \theta_{wy} = \theta_{wx}\theta_{ry} - \theta_{wy}\theta_{rx} = (wr/XY)L_xL_y(k_y - k_x).$$

In evaluating the incidence of the tax, we choose I, the level of total nominal income, as the numeraire. With I fixed, we have, from (2.16),

$$dw \cdot \bar{L} + dr\bar{K} = -K_x\, d\tau_{kx}. \tag{2.26}$$

The right-hand side of (2.26) is the marginal tax revenue evaluated at $\tau_{kx} = 0$. The equation indicates that the burden of the tax equals the burden on labor, $dw\bar{L}$, plus the burden on capital, $dr\bar{K}$. This equation can be rewritten as

$$\frac{\theta_l}{\theta_k}\hat{w} + \hat{r} = -\frac{K_x}{\bar{K}}\frac{d\tau_{kx}}{r}, \tag{2.26'}$$

where θ_l and θ_k are labor's capital's respective shares of total income. Obviously, if $\hat{w} = 0$, the tax is fully borne by capital, and vice versa if $\hat{r} = 0$.

Substituting for $\hat{w}$ from (2.26′) into (2.25) and expressing capital's burden as a share of the total burden gives:

$$\frac{-\frac{dr}{d\tau_{kx}}\bar{K}}{K_x} = \theta_k + \frac{\theta_l}{\lambda_{kx}}\left[\frac{(\theta_{wx}\lambda_{kx} + \theta_{rx}\lambda_{lx})\sigma_x - \eta(\lambda_{lx} - \lambda_{kx})\theta_{rx}}{D}\right], \tag{2.27}$$

where D is the bracketed term on the left-hand side of (2.25) multiplying $(w - r)$.

Consider, first, conditions under which the right-hand side of (2.27) is unity, i.e. capital bears the entire burden of the tax. A sufficient condition for this result is that both industries have the same elasticities of substitution and the same initial factor proportions. In this case $\lambda_{lx} = \lambda_{kx}$, and $\lambda_{ly} = \lambda_{ky}$ (see footnote 2), and the bracketed term on the right-hand side of (2.27) equals λ_{kx}, implying that the right-hand side of (2.27) equals $\theta_k + \theta_l = 1$. An alternative condition sufficient for capital to bear the entire tax burden is that all three substitution elasticities, σ_x, σ_y, and η, are equal. In this case the bracketed term in (2.27) equals λ_{kx}.

If factor intensities are initially equal (implying $\lambda_{lx} = \lambda_{kx}$) and if $\sigma_x = 0$, capital's share of the tax burden equals its share of total income, θ_k. Intuitively, if $\sigma_x = 0$, capital and labor are used in fixed proportions in X, and there is effectively only a single factor. The tax on capital in X, which in this case is equivalent to simply taxing X, raises the relative price of X leading to a reduction in its demand. To accommodate this reduced demand the X industry releases both capital and labor to the Y industry in the proportion that these factors are used in producing X. If the Y industry is using these factors in the same ratio, then it can expand production of Y to meet its increased demand with no change in factor proportions. Since Y's capital labor ratio, k_y, is unchanged, the ratio w/r upon which k_y depends [equation (2.13)] is unchanged. Hence, w and r both fall (relative to P_x and P_y) by the same percentage. This

same incidence outcome arises in the case that capital and labor are perfect substitutes in producing Y ($\sigma_y = \infty$). From industry Y's perspective, capital and labor are identical factors, and it will use both factors only if their net costs are equal. This implies $w = r$, where we measure capital in units such that one unit of capital is equivalent in production to one unit of labor.

Capital's share of the tax burden can also be less than its income share. A necessary condition for this outcome is that the X industry be more labor intensive than the Y industry. Suppose, for example, $\sigma_x = 0$ and $\lambda_{lx} > \lambda_{kx}$, then the second term in (2.27) is negative, indicating that capital's tax burden share is less than θ_k. In this case there is more labor relative to capital released from X to Y than industry Y is initially using to produce. To accommodate the initial relative excess supply of labor, the wage must fall relative to the rental on capital. It is indeed possible that more than 100 percent of the burden of the tax on capital is shifted onto labor; i.e. the right-hand side of (2.27) can be negative, and capital can be made absolutely better off by the capital tax levied on industry X.

At the other extreme, capital may bear more than 100 percent of the tax burden, i.e. labor may be made better off by the tax. Consider the outcome when capital and labor are perfect substitutes in X. In this case $\sigma_x = \infty$, and the demand for capital in X is perfectly elastic [see equation (2.7)]. From (2.27), when $\sigma_x = \infty$, capital's share of the tax burden is $\theta_k + (\theta_l)/(\lambda_{kx})$, which exceeds 1. From the perspective of industry X, capital and labor are identical factors, and the net costs to the industry of hiring labor and capital must be equal ($w = r + \tau_{kx}$); otherwise there would be an incentive to substitute one factor for the other. Capital bears more than 100 percent of the tax because, relative to the wage, the rental rate of capital declines in both industries by the full amount of the tax.

2.2.4. *The incidence of a commodity tax on good X*

Additional insight into formula (2.27) can be obtained by considering Mieskowski's (1967) observation that capital's share of the tax burden can be divided into output and substitution effects. Consider the term

$$\frac{-\theta_l \eta(\lambda_{lx} - \lambda_{kx})\theta_{rx}}{\lambda_{kx} D},$$

which is the second bracketed term in (2.27) multiplied by θ_l/λ_{kx}. This expression is precisely capital's share of the burden of a tax on the consumption of good x. To see this, note that in the case of a tax on good x, the relative changes in producer prices and outputs are given by equations (2.19) and (2.23), respectively, with a $d\tau_{kx}$ set to zero, and equation (2.24) is modified to

$$(\hat{x} - \hat{y}) = -\eta\left(\hat{P}_x - \hat{P}_y + \frac{d\tau_x}{P_x}\right), \tag{2.24'}$$

where τ_x is the per unit excise tax on good X. In addition, in (2.26) $d\tau_{kx}$ is set equal to zero. These revised versions of (2.19), (2.23), and (2.26), plus (2.24') can be solved together to derive the formula given above for $-d\bar{rK}/d\tau_x X$, capital's share of the incidence of an excise tax on good X. Note that if $\lambda_{lx} = \lambda_{kx}$, capital's and labor's shares of the tax burden are both zero, i.e. there is no change in the factor incomes received by capital and labor measured at producer prices, although capitalist and workers bear the tax burden as consumers. While income measured at producer prices is the numeraire and, therefore, does not change, real income of consumers falls because of the change in consumer prices. Consider the change in the cost measured in units of good x of consuming the initial bundle, X_0, Y_0. Let C denote this cost, then

$$C = \left(1 + \frac{\tau_x}{P_x}\right) X_0 + \frac{P_y}{P_x} Y_0, \tag{2.28}$$

and

$$P_x \frac{\partial C}{\partial \tau_x}\bigg|_{\tau_x = 0} = X_0, \tag{2.29}$$

since P_y/P_x is unchanged by τ_x when $\hat{w} - \hat{r} = 0$ [see equation (2.17) with $d\tau_{kx} = 0$]. Hence, measured at producer prices, the loss in real income to consumers from a marginal increase in τ_x equals the marginal tax revenue. Since capitalists and workers are assumed here to have identical tastes, they bear the burden of the tax in proportion to their share of total income.

Returning to equation (2.27), note that when $\sigma_x = 0$, the second term in (2.27) reduces to the output effect. This is what one would expect, since when $\sigma_x = 0$, a tax in industry X is effectively equivalent to an excise tax on good X. If $\sigma_x = 0$ and $\lambda_{lx} = \lambda_{kx}$, capitalists and workers bear the tax through a decline in their factor income rather than through an increase in the consumer price level.

2.2.5. *The relationship of welfare changes to the incidence of a sector-specific factor tax*

While the preceding analysis described changes in incomes of workers and owners of capital arising from a sector-specific factor tax, a full analysis of the associated welfare changes requires taking account of changes in the prices of the

two commodities, P_x and P_y. The assumption that workers and capitalists have identical homothetic preferences implies that they both view the price changes as equivalent to the same specific percentage change in their incomes, which can be positive, negative, or zero depending on the precise changes in prices. For example, the change in the welfare of workers can be calculated from their indirect utility function, V^w, as

$$\frac{dV^w}{d\tau_{kx}} = \lambda^w w\bar{L}\left[\theta_x \hat{P}_x + \theta_y \hat{P}_y + \frac{dw\bar{L}}{w\bar{L}}\right], \tag{2.30}$$

where λ^w is the worker's marginal utility of income, and θ_x and θ_y are the respective (and identical for workers and capitalists) expenditure shares on X and Y. A similar expression involving the terms $\theta_x \hat{P}_x + \theta_y \hat{P}_y$, reflecting price changes, and $d_r\bar{K}/r^{\bar{K}}$, reflecting income changes, holds for capitalists. Hence, the price related change in welfare, $\theta_x \hat{P}_x + \theta_y \hat{P}_y$, is the same fraction of income for both workers and capitalists, and the incidence terms, $dw\bar{L}$ and $dr\bar{K}$, describe differential changes in the welfare of workers and capitalists. Stated differently, workers and capitalists bear the tax both in terms of possible changes in their incomes and, in their roles as consumers, in terms of changes in consumer prices. However, the price changes are common to both and have the same welfare impact as a $\theta_x \hat{P}_x + \theta_y \hat{P}_y$ percentage change in income, while the direct percentage changes in incomes due to changes in factor payments can be quite different for the two groups.

In the special case that the direct percentage changes in incomes of workers and capitalists are equal, one could describe the tax as simply "falling on consumers" through changes in prices with no changes in factor incomes, i.e. since the model's numeraire can be freely choosen, we could choose w or r as numeraire. In the case that both factors share the burden in proportion to their incomes share, we have with the new numeraire convention $\hat{w} = \hat{r} = 0$. While nominal factor incomes remain constant, P_x and, possibly P_y rise and generate the same reduction in real factor incomes and welfare that arises if I is chosen as the numeraire.

2.2.6. *Extension to the case of differences in preferences*

Mieszkowski (1967) and Atkinson and Stiglitz (1980) extend the analysis of the incidence of sector-specific factor taxes to the case in which workers' and capitalists' preferences differ. The results can be illustrated with the following example. Let workers and the government consume only X, and let capitalists consume only Y. Then the new demand equations are

$$P_x X = w\bar{L} + \tau_{kx} K_x,$$
$$P_y Y = r\bar{K}, \tag{2.14'}$$

and the change in relative demands associated with the tax is given by

$$(\hat{X} - \hat{Y}) = -(\hat{P}_x - \hat{P}_y) + (\hat{w} - \hat{r}) + \frac{rK_x}{w\bar{L}} \frac{d\tau_{kx}}{r}. \tag{2.24'}$$

Using (2.24') rather than (2.24), capital's share of the tax burden is

$$-\frac{\frac{dr}{d\tau_{kx}}\bar{K}}{K_x} = \theta_k + \frac{\theta_l}{\lambda_{kx}}\left[\frac{(\theta_{wx}\lambda_x + \theta_{rx}\lambda_{lx})\sigma_x - (\lambda_{lx} - \lambda_{kx})(\theta_{vx} - rK_x/w\bar{L})}{D - (\lambda_{lx} - \lambda_{kx})}\right]. \tag{2.27'}$$

Equation (2.27') is identical to (2.27) for $\eta = 1$ except for the additional term $(\lambda_{lx} - \lambda_{kx})(rK_x/w\bar{L})$ in the numerator and the term $-(\lambda_{lx} - \lambda_{kx})$ in the denominator. When factor intensities are equal in X and Y we have the same result as above, namely that the incidence of the tax is independent of demand parameters. When $\lambda_{lx} \neq \lambda_{kx}$ demand elements enter, and the demand structure (2.14') can either reduce or increase the tax burden on capital. When the X industry is capital intensive the fact that workers and the government spend all their expanded income on X while capitalists adjust to their lower incomes simply by reduced consumption of Y implies a smaller ultimate share of the tax burden falling on capital. On the other hand, if X is labor intensive, the smaller increase in the incomes of workers relative to the $\lambda_{lx} = \lambda_{ly}$ case feeds back to lower r by more than would occur if demands were identical and homothetic.

2.3. *Estimates of tax incidence in static general equilibrium models*

Tax incidence formulae, like that given in equation (2.25), are appropriate only for small changes around an initial no-tax equilibrium. To examine the incidence of large tax changes as well as consider many more sectors and types of consumers, Shoven and Whalley (1972) constructed a computable general equilibrium model. Their method of calculating an equilibrium is based on Scarf's (1967, 1973) algorithm and related techniques.[4] The analysis of large perturbations of the equilibrium requires specifying explicit functional forms for preferences and production technologies. The parameter of these functions are then selected such that initial equilibrium values of the model are in rough accord with those actually observed in the economy. This calibration of the model is not an

[4] See Ballard, Fullerton, Shoven and Whalley (1984) for a description of recently developed computable general equilibrium models and their methods of solution.

Table 2.1
Calculations of corporate tax incidence from the Shoven–Whalley model.

Capital–Labor elasticities of substitution	Capital's share of the tax burden			
	$\eta = 1.0$		$\eta = 0.5$	
	2 Sectors (%)	12 Sectors (%)	2 Sectors (%)	12 Sectors (%)
$\sigma_x = 1$, $\sigma_y = 1$	100	100	118	117
$\sigma_x = 1$, $\sigma_y = 0.5$	117	NA	145	NA
$\sigma_x = 1$, $\sigma_y = 0.25$	128	NA	162	NA
$\sigma_x = 0.75$, $\sigma_y = 0.25$	105	104	141	137
$\sigma_x = 0.5$, $\sigma_y = 0.25$	75	NA	110	NA
$\sigma_x = 0.25$, $\sigma_y = 0.25$	33	39	62	62

Source: Shoven (1976, tables 4 and 6).
NA = not available.
Note: σ_x and σ_y are, respectively, elasticities of substitution in the taxed (x) and untaxed (y) industries. η is the elasticity of demand for x relative to y.

econometric procedure, although econometric findings, such as the estimated values of particular elasticities of substitution, are often used as part of the calibration.

Table 2.1, which is based on Shoven's (1976) reported results, shows calculations of corporate tax incidence for the United States for two-sector and twelve-sector variants of the Shoven–Whalley model. The table reports the share of the tax burden borne by capital for alternative elasticities of substitution of the assumed CES production and demand functions.

For this particular experiment the two- and twelve-sector models yield quite similar results. The incidence on capital is, however, very sensitive to the assumed elasticities of substitution. A low relative demand elasticity, a low elasticity of substitution in the noncorporate sector, and a high elasticity of substitution in the corporate sector imply reductions in the net income of capital well in excess of 100 percent of the corporate tax revenue. Alternatively, if capital and labor are both highly complementary in producing the two goods ($\sigma_x = 0.25$, $\sigma_y = 0.25$), capital's share of the tax burden is only a third.

While Shoven and Whalley's results on U.S corporate tax incidence, like Harberger's (1962) original calculations based on equation (2.25), are instructive for understanding tax incidence in static general equilibrium models, their assumed values for corporate income tax rates are subject to question. They estimate the effective marginal tax rate in different sectors by calculating taxes collected as a fraction of reported profits. There are a number of problems with this procedure. Stiglitz (1973), for example, points out that since interest is deductible from the corporate tax, the effective marginal tax on debt financed corporate capital is zero. Other research [e.g. Jorgenson (1963), Auerbach (1979a, 1979c), King and Fullerton (1984), Bradford (1981), Gordon (1985), Bulow and Summers (1984)], stresses the importance of depreciation and other investment incentives, the tax treatment of dividends and capital gains, and the risk sharing attributes of capital income taxation as critical elements for determining effective marginal taxes on capital income.

3. Tax incidence in open economies

Our analysis has so far maintained the assumption of immobile factors. This assumption is clearly inappropriate in considering taxes levied by a single locality from or towards which capital and labor can migrate. Increasingly, as capital becomes more mobile internationally, it is necessary to recognize the effects of international factor mobility in considering national tax policies as well. In order to focus on the effects of factor mobility, we return to the one-good general equilibrium model of Section 2.1. We further simplify this model by assuming that the factor complementary to capital – here labelled land – is supplied inelastically and is immobile.

3.1. A simple model of factor mobility

Analysis of tax incidence in a simple one-good, two-factor, two-country model provides important insights into the differences in incidence results in open and closed economies. Following Bradford (1978), assume that the two factors of production are capital and land and that capital is internationally mobile. In contrast to the analysis in Section 2.1, of a country-wide tax on capital in a closed economy, a tax on capital imposed by one country on income earned by capital in that country is not fully borne by the capital initially in the country imposing the tax. Since capital is internationally mobile, reductions in capital rentals in one country imply reductions in the other. Hence, the incidence of the tax borne by capital is spread evenly across all capital, regardless of the country in which it is ultimately used. In contrast to capital owners, landowners in the two countries are differentially affected by the tax; there is a loss in rental income to landowners in the country imposing the tax on capital and a gain to landlords in the country with no tax on capital.

To see this let $F(K)$ and $G(K)$ be the respective production functions in countries A and B. K_A is the capital in country A, and $\bar{K} - K_A = K_B$ is the capital in country B, where $\bar{K}$ is total world-wide capital. If r is the rental on capital, and τ is the tax on capital in country A, we have

$$r + \tau = F'(K_A); \qquad r = G'(K_B) \tag{3.1}$$

From these equations and the constraint $K_A + K_B = \bar{K}$ it is easy to show that the ratio of the change in worldwide capital income, $dr\bar{K}$, to the change in tax revenue, $d\tau K_A$, calculated at the no tax equilibrium, is given by

$$\frac{(dr/d\tau)\bar{K}}{K_A} = -\frac{\eta_A \bar{K}}{(\eta_B K_B + \eta_A K_A)} \leq 0, \tag{3.2}$$

where η_A and η_B are the (nonnegative) respective demands for capital in countries A and B. Note that we are implicitly assuming that all tax revenue is used to purchase the one good in the model. Suppose the functions $F(\cdot)$ and $G(\cdot)$ are identical, then $\eta_A = \eta_B$, and $K_A = K_B$ initially. In this case the right-hand side of (3.2) equals -1, and world-wide capital bears the full marginal burden of the tax. In the case that the demand for capital in B is perfectly inelastic, $\eta_B = 0$, or is perfectly elastic in A, $\eta_A = \infty$, world-wide capital bears more than 100 percent of the tax. If, at the opposite extreme, capital is in perfectly elastic demand in country B or in perfectly inelastic demand in A, world-wide capital bears none of the burden of the tax.

Land rents in A, R_A, and B, R_B, are expressed in (3.3):

$$R_A = F(K_A) - (r+\tau)K_A; \qquad R_B = G(K_B) - rK_B, \tag{3.3}$$

and these expressions imply:

$$\frac{dR_A/d\tau}{K_A} = -\frac{\eta_B K_B}{\eta_B K_B + \eta_A K_A} \leq 0,$$

$$\frac{dR_B/d\tau}{K_A} = \frac{\eta_A K_B}{\eta_B K_B + \eta_A K_A} \geq 0. \tag{3.4}$$

Note that the three tax burden expressions in (3.2) and (3.4) sum to -1. In the case of identical production functions, while world-wide capital bears the full burden of the tax, landowners in country A lose rents equal to half of marginal tax revenues, while landlords in B gain rents equal to half of marginal tax revenues. In the extreme cases that either $\eta_B = 0$ or $\eta_A = \infty$, landowners in country A suffer no loss in rents, while landowners in B enjoy marginal increases in rents equal to K_B. If $\eta_B = \infty$, or $\eta_A = 0$, landlords in A bear the full marginal burden of the tax with no change in the rents of capitalists or landowners in B.

The lesson of this model is that a country in an open world economy or a state or locality within a country is likely to bear a significant fraction of the burden of a tax it levies on an internationally or domestically mobile factor. From (3.4) it is easy to see that the smaller is the country, state, or locality imposing the tax relative to the world or domestic economy (the smaller is the ratio of K_A to K_B), the larger is the burden on immobile factors, in this case land, in the taxing jurisdiction. In the limit as K_B/K_A approaches infinity the marginal loss in land rents in country A equals the amount of marginal taxes raised [equation (3.4)]. While one could say in this case that land in country A bears the full burden of the tax, it is also the case that world-wide capital income is reduced by η_A/η_B times the marginal tax revenue, and land rents in country B rise by η_A/η_B times the marginal tax revenue. In the symmetric case where the home and foreign countries have the same production function, a tax on domestic capital is borne completely by capital on a world-wide basis. At the other extreme when the taxing jurisdiction is very large relative to the rest of the world-wide or country-wide economy ($K_B/K_A \approx 0$), capital bears the full burden of the tax, and there are no marginal changes in land rents in either A or B.

3.2. *Further implications of the simple open economy model*

This simple open economy model has several further implications for the analysis of taxes in open economies. It suggests a sharp distinction between taxes on savings and investment. The former are based on capital income earned by domestic residents regardless of the location of their capital, while the latter involve the taxation of income from capital that is located in the home country. First, in this static model a tax levied by country A at the personal level on the capital income received by its residents regardless of where that capital is invested is equivalent to a lump-sum wealth tax and will be fully borne by domestic capital owners. In contrast, as just described, if country A taxes, at the business level, capital income earned on domestic capital (regardless of ownership) the tax will fall on foreign as well as domestic capital owners and can also lower the income of domestic factors such as labor and land. Hence, from the perspective of the taxing country a tax on investment income at the business level is, at least in part and possibly in full, effectively a tax on wages and land rents, while a tax on capital income at the personal level has little or no affect on wages or land rents.

Second, consider a tax on capital income at the business level that distinguishes domestically-owned from foreign-owned capital. An example would be a tax on the repatriation of foreign capital income. If this tax is sufficiently high it may pay foreigners to stop investing in the home country, and the resulting equilibrium in this case would be one of autarky in which domestic residents only invest at home and foreigners only invest in their own countries. If τ is the domestic tax on foreign capital income earned domestically, r^d is the domestic pre-tax rate of return, and r^f is the return to foreign capital invested in the foreign country, the condition for autarky is that $r^f > r^d - \tau$, and $r^d > r^f$. In this case both domestic residents and foreigners earn a higher return at the margin by investing in their own countries. While this tax would collect no revenue, by

driving out foreign domestic investment it raises the return to domestic capital and lowers the return to fixed domestic factors of production. Note that the incidence of a law prohibiting foreign investment would be identical to that of a tax that drives out such investment.

3.3. Incidence of the property tax

The simple open economy model is also useful for thinking about the controversial issue of the incidence of local property taxes. Since property taxes are typically levied on both land and capital, one might decompose the incidence of the tax into that arising from taxing land and that from taxing capital. In the simple static open economy model discussed at the beginning of this section, a tax on land rents is fully borne by landowners. However, as described above, the tax on capital may be shifted. The extent of shifting will depend not on the size of the local property tax per se, but on its size relative to that in other communities. To see this, consider the two-city (country) model in which τ_A is the property tax in city A and τ_B the tax in city B. The conditions corresponding (3.1) are

$$F'(K_A) = r + \tau_A,$$

$$F'(\bar{K} - K_A) = r + \tau_B. \tag{3.1'}$$

Clearly if $\tau_A = \tau_B = \tau$, r falls by the full amount of the tax and capital bears the full burden of property taxes levied on capital. If τ_A exceeds τ_B the differential tax, $\tau_A - \tau_B$, will lower land rents in A and increase rents in B. Capital will bear the differential tax in part, in full, or more than in full depending on differences in capital demand elasticities and, given such differences, in the relative size of the two cities. To see this, one need only replace τ by $\tau_A - \tau_B$ and r by $r + \tau_B$ in equations (3.1) and (3.3).

This "new view" of the incidence of the property tax associated with Mieszkowski (1972, 1984), Mieszkowski and Zodrow (1984), and Zodrow and Mieszkowski (1983, 1984) contrasts sharply with the "benefit tax" argument of Tiebout (1956) which is extensively examined by Rubinfeld in Chapter 11 of this Handbook. In Tiebout's model individuals can costlessly establish new communities providing the level of local public goods they most desire. As formally modeled by Atkinson and Stiglitz (1980), in setting up new communities the Tiebout result holds if one assumes that founders of communities take as given the utility levels of individuals they hope to attract. Hence, they must offer competitive utility levels to potential residents. The model also assumes perfect mobility of all productive factors. The tax used to finance local public goods makes no difference in the Tiebout local public goods equilibrium, because it is

fully internalized by individuals living in their communities; any individual in the Tiebout model is free to establish a new community identical to his existing community. The individual might, for example, live in a community where taxes are levied on land rents; but he can costlessly set up a new community that provides the same local public goods and attracts the same residents, but that exempts the individual from paying taxes on land rents, and instead, taxes the individual on his wages, or in the value of this car, or his consumption of food, etc. Provided the same amount of taxes are paid by the individual, there will be no real difference between the new and the old community.

The fact that the individual is free at the margin to establish a new community and pay for local public goods in any way he prefers means that the individual internalizes the tax, i.e. the individual views the tax as equivalent to a payment to purchase the type of community he most prefers given the level of utility that must be provided to attract residents to the community. Since the equilibrium is the same whether the local tax is labelled a wage, property, income, sales, or other tax, the incidence is unaffected by the tax base chosen. Hence, in the Tiebout model the incidence of local taxes does not fall on particular factors of production, but is fully borne by individual residents. We can say that each resident bears the burden of the taxes paid, just as one can say that an individual buying a private goods bears the burden of paying for that good.

Atkinson and Stiglitz's (1980) derivation of the Tiebout result assumes that each resident employs his productive factors in his own community. But one can modify this assumption and may still end up with the same real equilibrium. Consider, for example, a Tiebout equilibrium in which individuals own capital and initially employ that capital in their own community. Also assume that the production function depends on land and capital. Suppose the local tax is nominally assessed on local property including all capital and land in the community. In such a setting owners of capital would not be indifferent to employing their capital locally or employing it in another community. When employed locally, the taxes paid on capital are simply viewed as part of the payment for local public goods. However, if the capital were employed in another community and earned the same pre-tax return, the taxes paid on capital to the other community would not be viewed as effectively purchasing local public goods at the margin, since the owner of the capital invested in someone else's community derives no utility from the local public goods provided by any but his own community.

One assumption, suggested by Hamilton (1975, 1976, 1983), Fischel (1975), and White (1975) that might permit the Tiebout result to go through in this setting is that each community zones a section of land for productive enterprises. Suppose that firms have identical production functions and use capital and labor in fixed proportions. Suppose, further, that the property tax rate in the industrial zone is the same as that in the rest of the community, that community members are homogeneous, and own equal shares of the land in the industrial zone. Also

assume that firms require no local public goods to operate, i.e. they have no demand for local public goods. Now if land rents in each zoned area fall by the amount of the property tax levied on land and capital in the industrial zones, owners of capital will receives the same net return if they invest in their own community or some other community, since what they pay in property taxes they save in reduced land rents. In this model the industrial zones are identical to communities that do not provide local public goods and have no property taxes. Consider now the lower land rents received by local residents owning land in the industrial zones. This lower land rent is effectively part of the price they pay for their local public goods, i.e. while firms in the industrial zones send in the property tax check to the local government, the local residents effectively pay this tax in the form of receiving reduced land rents. In this model, taxes on capital, whether or not they are identical across communities, are fully shifted from owners of capital onto local community residents.

As Rubinfeld points out in Chapter 11 of this Handbook, the assumptions required for the "benefit tax" view to hold precisely appear far from being satisfied in actual settings. While the "new view" of the property tax appears to be correct, at least in the short run for additional increases in property tax rates, many of the forces leading to the "benefit tax" result appear to be at play, albeit slowly; hence, it may be incorrect to view the local property tax simply according to the "new view", since a large fraction of the distortions from this tax may have been offset over time by benefit tax forces, such as changes in zoning and migration across localities and states.

4. Dynamic models of tax incidence

The analysis of tax incidence presented in the preceding section was entirely static. This made it impossible to study two important dimensions of tax incidence. First, taxes will, in general, affect savings and investment decisions, leading to effects on capital accumulation which, in turn, will alter the marginal productivities of both capital and labor and, thus, factor returns. Second, when taxes are altered, the prices of taxed and possibly nontaxed assets are likely to change, thus capitalizing the effects of the tax change. The windfall capital gains and losses associated with tax reforms are an important aspects of their incidence. A closely related issue is intergenerational incidence. Tax policies may burden members of different generations differently. Where capitalization effects are important, the owners of taxed assets at the time the tax is imposed may bear up to the entire future burden of the tax.

In this section we develop a sequence of models illustrating intertemporal aspects of tax incidence. We begin by considering tax incidence in the context of the life-cycle, overlapping generations model of Diamond (1965, 1970). The overlapping generations model distinguishes members of different generations

explicitly and so is ideal for studying intergenerational incidence. For reasons of analytical convenience, we follow Diamond in working with a model in which only two generations are alive at any point in time.

In the discussion we distinguish between fiscal policies that directly redistribute across generations without having direct effects on relative prices and policies that directly affect relative prices, but only indirectly alter the intergenerational redistribution of resources. Actual fiscal policies generally combine these two effects, but considering each separately enhances one's intuition about dynamic fiscal policy. In addition, much of the concern with deficit and related policies that redistribute across generations is with their income effects; hence, it is useful to clarify precisely how the income effects from intergenerational redistribution can alter savings.

The two-period model may be misleading in its portrayal of the behavior of actual economies, and multi-period models may yield rather different behavior in some circumstances. An illustrative simulation of switching tax regimes is presented based on the Auerbach and Kotlikoff (1987) 55-period life-cycle simulation model. We also show in this section how introducing bequest motives can alter the intergenerational incidence of certain tax policies that arises in the life-cycle model without bequest motives. These models presented in the first part of this section assume a single good that can either be consumed or used as capital. In addition, there are zero costs of transforming a unit of capital into a unit of consumption, and vice versa. Introducing such adjustment costs or adding additional assets, such as land, to the model, permits the possibility of asset evaluation associated with the changes. Asset revaluation is examined first within the partial equilibrium model of Summers (1981b) in which changes in corporate policy alter the stock value of firms. Next, Feldstein's (1977) two-period model of land rent taxation is presented to illustrate asset revaluation in a general equilibrium context.

The general message of this section is that tax policies can have important effects on the time path of capital formation, the evolution of factor prices and asset values, and the intergenerational distribution of welfare. The models and examples of policy presented in this section indicate the range of incidence effects arising from dynamic tax policy; but these models and examples only illustrate potential intertemporal tax incidence effects; they certainly do not represent an exhaustive characterization of the government's intertemporal fiscal policies, nor do they illustrate all possible time paths of dynamic tax incidence.

4.1. Tax incidence in a life-cycle, overlapping generations model

We begin by considering the simplest overlapping generations model in which individuals live for two periods, working only in the first period. Capital does not depreciate in this model, and there is no technical progress. We assume that the

population and labor force grows exogenously at rate n. Individuals who are young at time t maximize a utility function $U_t = (C_{1,t}, C_{2,t+1})$ subject to the budget constraint

$$C_{2,t+1} = (w_t - C_{1,t})(1 + r_{t+1}), \tag{4.1}$$

where r_{t+1} is the interest rate at $t+1$, and w_t is the wage at time t. If the government has no assets the total capital stock in period $t+1$ simply corresponds to the assets of the private sector at $t+1$. But since young workers initially have no wealth, private assets at time $t+1$ equal the wealth of the old. The wealth of the elderly at $t+1$, in turn, equals the saving they did when young. Capital per worker can thus be expressed as

$$k_{t+1}(w_t, r_{t+1}) = \frac{w_t - C_1(w_t, r_{t+1})}{1+n}, \tag{4.2}$$

where $k_{t+1}(w_t, r_{t+1})$ represents the capital–labor ratio at time $t+1$, and $C_1(\cdot)$ represents the first-period consumption function. We assume a standard concave production function $f(k)$, with $f'(k) > 0$ and $f''(k) < 0$, and that factors are compensated competitively. In the steady state the condition

$$k = \frac{w(k) - C_1[w(k), r(k)]}{1+n} \tag{4.3}$$

must be satisfied. Diamond (1970) points out that the steady state will be stable as long as

$$\left(\frac{1}{1+n}\right)\left[\frac{\partial w}{\partial k} - \frac{\partial C_1}{\partial k}\right] < 1. \tag{4.4}$$

4.1.1. Price effects

4.1.1.1. The incidence of a capital income tax. As stressed above, the incidence of a tax depends critically on government's use of its tax revenue. To highlight price effects, we examine the case of a capital income tax, assuming that the tax revenue is fully rebated in a lump-sum transfer to individuals in their second period of life. The steady-state condition then becomes

$$k = \frac{w(k) - C_1[w(k), r(k)(1-\tau)]}{1+n}. \tag{4.5}$$

Note that when the tax revenue, $T = \tau r(w - C_1)$, is compensated in period, 2 the

budget constraint in the presence of taxation,

$$C_1 + \frac{C_2}{1 + r(1-\tau)} = w + \frac{T}{1 + r(1-\tau)}, \tag{4.6}$$

reduces to (4.1). While the compensated tax leaves the consumer's budget constraint unchanged, it alters the consumer's perceived after-tax price of C_2; hence, in (4.5) C_1 is written as a function of the after-tax interest rate as well as the wage. If the utility function is concave, it is easy to verify that the derivative of C_1 with respect to the compensated interest income tax rate τ is positive, i.e.

$$\frac{\partial C_1}{\partial \tau} > 0. \tag{4.7}$$

Hence, from (4.4), (4.5), and (4.7), we have

$$\frac{\partial k}{\partial \tau} = \frac{-\frac{\gamma C_1}{\partial \tau}\Big/(1+n)}{1 - \left(\frac{\partial w}{\partial k} - \frac{\partial C_1}{\partial k}\right)\Big/(1+n)} < 0. \tag{4.8}$$

Thus, an interest income tax compensated in the second period unambiguously reduces capital intensity. This means that the pre-tax return to capital rises and the wage falls. The tax is thus at least partially shifted to labor. Indeed, as Diamond (1970) shows, it is possible that capital intensity will decline so much that the post-tax return to capital actually rises. Under the assumption of a linear homogeneous production function, and expressing output per worker as f, equation (4.9) indicates how $r(1-\tau)$ changes with τ:[5]

$$\frac{\partial r(1-\tau)}{\partial \tau} = \frac{rk(1+n)\left[\frac{(r-n)}{(1+r)}\frac{\partial C_1}{\partial w} - 1 - \frac{(1+n)}{kf''}\right]}{\left\{\left[1/f'' + \left(k - \frac{\partial C_1}{\partial w}k + \frac{\partial C_1}{\partial r}\right)\right]\Big/1+n\right\}}. \tag{4.9}$$

[5] This derivative is evaluated at $\tau = 0$, and uses the fact that

$$\frac{\partial C_1}{\partial \tau} = \frac{-\partial C_1 r}{\partial r} + \frac{\partial C_1}{\partial w}\frac{rk(1+n)}{(1+r)},$$

$$\frac{\partial w}{\partial k} = -kf'',$$

and

$$\frac{\partial C_1}{\partial k} = \frac{\partial C_1}{\partial w}\frac{\partial w}{\partial k} + \frac{\partial C_1}{\partial r}\frac{\partial r}{\partial k}.$$

Since $\partial w/\partial k = -f''k$ the denominator in (4.9) is negative assuming (4.4). Hence, the long-run after-tax return to capital rises, provided

$$\frac{(1+n)\sigma f}{rw} < 1 - \frac{r-n}{1+r}\frac{\partial C_1}{\partial w}, \tag{4.10}$$

where $\sigma = -(rw/fkf'')$ is the elasticity of substitution. Hence, the smaller the elasticity of substitution, the larger will be the net of tax return to capital.

4.1.1.2. The incidence of labor income tax. Consider next the question of the incidence of a labor income tax in a growing economy. This question was first examined by Feldstein (1974c) who stressed that in the long run this may depend only on its effect on capital intensity. He noted that reductions in labor supply that are not associated with changes in the long-run saving rate will have no effect on long-run capital intensity, and concluded that the elasticity of labor supply potentially has no effect on the long-run incidence of a labor income tax. Feldstein's point can be illustrated in the two-period model by assuming that first-period labor supply per worker, L, is variable, while second-period labor supply is zero. In this case the steady-state formula for the capital stock in the presence of a labor income tax, that is compensated in the first period, is

$$k = \frac{T + w(k)(1-\tau)L[w(k)(1-\tau)+T, r(k)] - C[w(k)(1-\tau)+T, r(k)]}{(1+n)L[w(k)(1-\tau)+T, r(k)]}, \tag{4.11}$$

where $T = \tau wL$.

Assuming that utility is homothetic in C_1 and C_2, and separable from L, C_1 is proportional to $w(1-\tau)L + T$. In this case it is immediate from (4.11) that steady-state k is unaffected by responses in L to changes in τ since both the numerator and denominator of (4.11) rise or fall by the same percentage.

Kotlikoff and Summers (1979) make the point that the effects of a labor income tax on the timing of labor supply over the life cycle will affect its long-run incidence. This is because changes in the time stream of labor income over individuals' lifetimes will, in general, affect the national savings rate. Such effects may be important if, for example, taxes affect retirement ages, or the elasticity of labor supply differs at different ages. To see this, assume that labor supply in the second period as well as the first period is variable. Denote by L_1 and L_2 first- and second-period labor supply, respectively, by T_1 first-period consumption of the first-period tax, and by T_2 second-period compensation of the second-period tax. The formula for the steady-state capital stock is now:

$$k = \frac{T_1 + wL_1 - C_1}{(1+n)L_1 + L_2}. \tag{4.12}$$

Assuming that utility is homothetic in C_1 and C_2 and separable from both L_1 and L_2, C_1 will be proportional to $w(1-\tau)[L_1 + (L_2/1+r)] + T_1 + T_2/1+r$, which equals simply $w(L_1 + L_2/1+r)$. Hence, if L_1 and L_2 change by the same proportion in response to the compensated wage tax, the effect on long-run k of the labor supply response is zero. However, L_1 and L_2 will not, in general, change in the same proportion. If, for example, L_2 falls by a greater percentage than L_1 in response to the compensated wage tax, this labor supply response will lead to a larger steady-state value of k than would otherwise be the case.

4.1.2. Income effects

4.1.2.1. Explicit intergenerational redistribution. Turning to direct intergenerational income effects from tax policy, consider for the case of a compensated capital income tax how switching the compensation from a payment to the elderly to a payment to young workers affects the results. In this case the steady-state budget constraint (4.6) is given by

$$C_1 + \frac{C_2}{1+r(1-\tau)} = w + T, \tag{4.6'}$$

and (4.5) becomes:

$$K = \frac{w(k) + T - C_1[w(k)+T, r(k)(1-\tau)]}{1+n}. \tag{4.5'}$$

Comparing (4.6') with (4.6), it is clear that providing the compensation in the first rather than the second generation raises lifetime income by $[Tr(1-\tau)]/[1+r(1-\tau)]$ and produces an income effect which raises C_1 beyond what occurs with second-period compensation, assuming C_1 is a normal good. But if C_2 is also normal, then some part of the extra present value of resources associated with first-period compensation, T_1, will be saved for second-period consumption. Hence, relative to the case of second-period compensation, first-period compensation leads to more steady-state savings. In the case of first-period compensation the change in the steady-state capital stock associated with an increase in the capital income tax rate is

$$\left(\frac{\partial k}{\partial \tau}\right)_1 = \left(\frac{\partial k}{\partial \tau}\right)_2 + \frac{\frac{rk}{(1+n)^2}\left(1 - \frac{\partial C_1}{\partial w}\right)}{1 - \left(\frac{\partial w}{\partial k} - \frac{\partial C_1}{\partial k}\right)\frac{1}{1+n}}, \tag{4.7'}$$

where $[\partial k/\partial \tau]_2$ denotes the expression in (4.8) for a second-period compensated

tax, and $[\partial k/\partial \tau]_1$ denotes the derivative of k with respect to a tax on capital income that is compensated in the first period.

This analysis of switching compensation from the second to the first period illustrates a general proposition of life-cycle models, namely that redistribution from older to younger generations raises savings. While the equations presented above do not describe the economy's transition path to the new steady state, it is easy to see that switching from second- to first-period compensation reduces the resources of the initial generation of elderly and, correspondingly, raises the lifetime resources of successive generations. Since in the life-cycle model older generations have larger marginal propensities to consume than younger generations, intergenerational redistribution towards younger generations lowers total private consumption and raises national saving. The associated increase in capital formation, in the case of a closed economy, leads to increases in pre-tax wages and declines in pre-tax returns to capital.

4.1.2.2. Implicit intergenerational redistribution. A variety of government fiscal policies redistribute resources across generations, thus potentially altering the time path of pre- and post-tax factor returns and altering the intergenerational distribution of welfare. Government deficit policy associated with temporary reductions in tax rates and subsequent increases in tax rates in excess of their initial values is a prime example of intergenerational redistribution. In this case initial generations gain at the expense of future generations because initial generations enjoy the benefits of the tax cut, but escape through death or retirement the subsequent tax rate increase.

While explicit deficit policy is a clear mechanism of intergenerational redistribution, there are a variety of other, quite subtle, intergenerational redistribution mechanisms at the government's disposal. Summers (1981b) shows that balanced budget changes in the tax structure can significantly alter the level of long-run savings because of its attendant intergenerational income effects. Take, as an example, the case of a balanced budget switch from a consumption to a wage tax in our simple two-period life-cycle model in which labor is supplied only in the first period and workers work full time independent of the wage. The steady-state budget constraint in the case of a consumption tax is

$$C_1(1+\tau_c) + C_2\frac{(1+\tau_c)}{1+r(k_c)} = w(k_c), \tag{4.13}$$

and the formula for steady-state capital per worker, k_c, is

$$k_c = \frac{w(k_c)C_1[w(k_c)/(1+\tau_c), r(k_c)]}{1+n}. \tag{4.14}$$

In the case of a wage tax the budget constraint is

$$C_1 + \frac{C_2}{1+r(k_w)} = w(k_w)(1-\tau_w), \tag{4.15}$$

and steady-state capital per worker, k_w, is:

$$k_w = \frac{w(k_w)(1-\tau_w) - C_1[w(k_w)(1-\tau_w), r(k_w)]}{1+n}. \tag{4.16}$$

Now if $(1+\tau_c)^{-1} = 1-\tau_w$ and $k_w = k_c$, the two budget constraints are identical; however, comparing (4.14) and (4.16), it is clear that steady-state capital under a consumption tax, k_c, exceeds steady-state capital under a wage tax, k_w. The intuitive explanation for this is that even assuming $(1+\tau_c)^{-1} = 1-\tau_w$, switching from a consumption to a wage tax relieves the tax burden on the first generation of elderly at the time of the tax switch. Consequently, their consumption rises relative to what occurs under a consumption tax. While the consumption of the initial generation of young workers does not change [assuming $(1+\tau_c)^{-1} = 1-\tau_w$ and noting that the initial period wage is that of the consumption tax steady state], initial period total private consumption rises and national saving falls. The induced initial decline in the capital stock lowers subsequent first-period saving of young workers because of the associated change in factor prices.

The assumption that $(1+\tau_c)^{-1} = 1-\tau_w$ is not, however, necessarily valid either in the initial or subsequent periods. If G is the assumed constant level of government consumption per worker, the steady-state balance budget equation for τ_c is

$$\tau_c\left\{C_1[w(k_c)/(1+\tau_c), r(k_c)] + C_2[w(k_c)/(1+\tau_c), r(k_c)]\left(\frac{1}{1+n}\right)\right\} = G. \tag{4.17}$$

The corresponding equation in the balanced budget wage tax steady state is

$$\tau_w w(k_w) = G. \tag{4.18}$$

In actual simulations of multi-period models, Summers (1981b) and Auerbach and Kotlikoff (1983a), find $(1+\tau_c)^{-1} < 1-\tau_w$, i.e. on a wage tax equivalent basis the steady-state consumption tax is less than the steady-state wage tax.

Other fiscal policies that redistribute towards early generations and away from future generations are unfunded "pay as you go" Social Security and policies involving reductions in investment incentives [Auerbach and Kotlikoff (1983b)].

4.2. Income effects with intergenerational altruism and the possible neutrality of intergeneration transfers

As just described, in life-cycle models in which each generation cares only about its own consumption, intergenerational redistribution can alter the course of capital formation and the factor returns received by different generations. In contrast, in Barro's (1974) model of intergenerational altruism, nondistortionary redistribution across generations has no impact on any real variable, including capital formation and factor returns. Since government deficit policy constitutes one of many mechanisms by which the government transfers resources across generations, Barro's model implies that nondistortionary deficit policies would neither reduce capital formation nor affect any other real variables.

Barro's proposition can be clarified by considering the intergenerationally altruistic utility function given in (4.19):

$$U_t = U\{C_t, l_t, U_{t+1}[C_{t+1}, l_{t+1}, U_{t+2}(C_{t+2}, l_{t+2}, \dots)]\}$$
$$= V(C_t, l_t, C_{t+1}, l_{t+1}, \dots). \tag{4.19}$$

In (4.19) the utility of generation t depends on the consumption and leisure enjoyed by generation t, C_t and l_t, as well as the utility of children, generation $t+1$. But since the utility of children, generation $t+1$, is a function of C_{t+1}, l_{t+1}, and their children's utility, U_{t+2}, U_t is a function of C_t, l_t, C_{t+1}, l_{t+1}, and U_{t+2}. Recursive substitution of the arguments of U_{t+2}, U_{t+3}, etc. implies that U_t can be written as a function $V(\cdot)$ of all levels of consumption and leisure of current and future family members. Thus, continuous altruistic intergenerational linkages effectively imply that generation t cares about the consumption and leisure of all future descendants.

In choosing its time path of consumption and leisure, Barro's altruistic infinite horizon family maximizes (4.19) subject to the infinite horizon budget constraint given by

$$\sum_{s=0}^{(x)} \frac{C_{t+s} + E_{t+s}}{1 + R_{t+s}} = H_t + A_t - T_t. \tag{4.20}$$

In (4.20) $1/1 + R_{t+s}$ is the price at time t of a dollar received at $t+s$, H_t is the present value of the infinite horizon family's full time endowment of human capital, A_t is the family's net worth at time t, and T_t is the present value of the family's taxes less transfers. Consider now nondistortionary redistribution between family members of different generations that leaves unchanged the present value of the family's net tax payments. Such redistribution leaves T_t and, therefore, the budget constraint (4.20) unchanged. Since (4.9) is maximized subject to (4.20), this policy has no impact on the Barro family's time path of consumption and leisure and, therefore, no impact on saving, investment, or labor supply.

4.3. Transition effects

A crucial question in assessing analyses of steady-state tax incidence is the length of time it takes the economy to converge to a new steady state following tax reforms. This issue is taken up by Bernheim (1981), Auerbach and Kotlikoff (1983a), and Chamley (1981). Not surprisingly, their results indicate that the rate of transit between steady states depends on all the parameters of the model being considered. Bernheim's results suggest convergence to a new steady state at an exponential rate of between 5 and 20 percent per year following a tax reform. This implies that the half-life of the adjustment process is likely to exceed 15 years in many cases. The explicit life-cycle model of Auerbach and Kotlikoff implies a somewhat greater speed of adjustment, as does Chamley's (1981) infinite horizon model. Chamley (1981) makes the point that the process of adjustment is faster with myopic than with rational expectations.

As an illustration of these transition effects, consider Auerbach and Kotlikoff's simulation results [see Kotlikoff (1984) and Auerbach and Kotlikoff (1987)] describing the transition paths from balanced budget structural tax changes. In the Auerbach–Kotlikoff life-cycle model, agents live for 55 periods, corresponding to adult ages of 21 to 75, and are concerned only with their own welfare, i.e. they have no bequest motive. The model incorporates variable labor supply, including endogenous retirement, with preferences over current and future values of consumption and leisure described by a CES utility function. The production sector is characterized by a CES production function. An important contribution of the model is that it solves the economy's perfect foresight equilibrium transition path from an initial to a final steady-state equation. During this transition there is market clearing for all goods, factors, and assets.

Equation (4.21) presents the CES utility function of consumption, C, and leisure, l, underlying the life-cycle policy simulations described below:

$$U = \sum_{a=1}^{55} \left(\frac{1}{1+\delta}\right)^{a-1} \left[\mu C_a^{(1-1/\rho)} + (1-\mu) l_a^{(1-1/\rho)}\right]^{(1-\gamma)/(1-1/\rho)}. \tag{4.21}$$

In (4.21) δ is the time preference rate, ρ is the "static" elasticity of substitution between consumption and leisure at each age a, μ is a consumption share parameter, and γ is the intertemporal elasticity of substitution between consump-

tion and leisure at different ages. The reciprocal of γ equals the coefficient of relative risk aversion.

Baseline parameter values for δ, μ, γ, ρ, and σ, the elasticity of substitution of capital for labor in the production function, are 0.015, 1.5, 0.25, 0.8 and 1, respectively. These figures are mid-range estimates based on a variety of empirical studies many of which are cited in Auerbach, Kotlikoff and Skinner (1983).

Table 4.1 contains the simulation results for changes in the tax base from proportional income taxation to either proportional consumption, wage, or capital income taxation with each designed to yield equal revenues. The simulated economy has an initial steady-state capital–output ratio of 3.7, a capital–labor ratio of 5, a pre-tax wage normalized to 1, a 6.7 percent pre-tax real interest rate, a 3.7 percent net national saving rate, and a 15 percent proportional tax on all income. Since there are no transfer programs, receipts from the 15 percent income tax are solely used to finance government consumption. In each of Table 4.1's simulations government consumption per capita is held fixed, and the tax rate of the specified tax base is adjusted to produce revenues equal, on an annual basis, to the exogenous path of government consumption.

Table 4.1 displays the large impact structural tax policies can have on an economy's saving rate and related variables. Relative to the initial income tax regime, long-run saving rates are 19 percent larger under a consumption tax, 8 percent larger under a wage tax, and 32 percent smaller under a capital income tax. Changes in the economy's saving rate during the transition period are even more dramatic; in the first year after the switch to consumption taxation, the saving rate rises to 9.3 percent from an initial value of 3.7. In the case of the capital income tax, there is a negative 2.9 percent saving rate in the first year of the transition, and saving rates remain negative for over a decade.[6] The figures in Table 4.1 would, of course, all be magnified in absolute value if one started with a larger initial steady-state income tax. For example, a structural shift to consumption taxation starting from a 30 percent income tax ultimately increases the capital–labor ratio by 63 percent, rather than the 24 percent increase of Table 4.1.

These changes in after-tax prices of factors and goods obviously alter the utility levels of each cohort alive at the time of the tax change or born thereafter. One measure of these utility differences is the equivalent percentage increase in full lifetime resources needed in the original income tax regime to produce each cohort's realized level of utility under the specified alternative tax regimes. For cohorts living in the new long-run equilibrium under consumption, wage, and

[6]Such swings in saving rates are within the range of U.S. historical experience, although U.S. saving experience is certainly neither solely nor primarily a reflection of historical changes in fiscal policy.

Table 4.1
Structural tax change[a] (switch from 15 percent proportional income tax to specified proportional tax regimes

Initial steady State				Wage rate (pre-tax)			Real interest rate (pre-tax)			Net national saving rate		
	Capital–labor ratio			Tax base			Tax base			Tax base		
Year of transition	Consumption	Wage	Capital income	Consumption	Wage	Capital income	Consumption (%)	Wage (%)	Capital income (%)	Consumption (%)	Wage (%)	Capital income (%)
	5.0	5.0	5.0	1.00	1.00	1.00	6.7	6.7	6.7	3.7	3.7	3.7
1	4.8	5.1	4.8	0.99	1.00	0.99	6.9	6.6	6.8	9.3	5.3	−2.9%
5	5.1	5.1	4.4	1.01	1.01	0.97	6.5	6.5	7.3	8.2	5.0	−1.9
10	5.4	5.2	4.1	1.02	1.01	0.95	6.3	6.4	7.7	7.2	4.7	−1.0
50	6.2	5.4	3.0	1.05	1.02	0.88	5.7	6.3	9.7	4.5	4.0	2.0
150	6.2	5.4	2.9	1.06	1.02	0.87	5.7	6.3	10.1	4.4	4.0	2.5

[a]Simulations assume a population growth rate of 1.5 percent, a time preference rate of 1.5 percent, "static" and intertemporal elasticities of substitution in consumption and leisure of 0.8 and 0.25, respectively, and a Cobb–Douglas production function.

capital income tax regimes the equivalent variations are 2.32 percent, −0.89 percent, and −1.14 percent.[7] These figures are smaller than the long-run changes in wage rates indicated in Table 4.1, because they encompass the additional amount of both lifetime leisure and consumption that could hypothetically be afforded in the old steady state. Stated differently, since 65 percent of lifetime resources are spent on leisure in the initial steady state, a 2.32 percent increase in full-time resources would permit a 6.63 (2.32/0.35) percent increase in lifetime consumption, holding leisure constant.

4.4. *Asset prices and tax incidence*

In both the static and dynamic models we have considered so far, there are no costs of adjustment impeding the accumulation or reallocation of capital. In addition, there has been no distinctions made concerning the tax treatment of different assets. As a consequence, there was no scope in these models for variation in the prices of capital goods and other assets. Studies of tax incidence within this framework focus on the effects of tax changes on the wage and after-tax rate of return, because the constancy of the relative price of assets precludes any wealth effects.

The implausibility of these assumptions may be seen by noting their implication that corporate shareowners would not lose relative to homeowners from increases in the tax burdens on corporate capital. More generally, standard general equilibrium models have the counterfactual implication that all owners of capital should have the same preferences about tax policy, since all capital will be equally affected. Capitalists would have no reason particularly to oppose taxes on their industry. This is because the standard approach to tax incidence ignores an important aspect of the actual economy's response to such a tax change, namely that adjustment in the relative stocks of capital goods is neither instantaneous nor costless. Hence, the short-run supplies of capital goods can be quite inelastic, implying upward-sloping short-run supply curves of firms as well as short-run rents that are capitalized in asset markets.

Take the example of a reduction in corporate taxes. In the short run, the price of existing corporate capital would rise, and of existing homes would fall, as

[7]One perhaps surprising feature of these numbers is that steady-state utility is lower under wage taxation than under income taxation despite an 8 percent increase in capital intensity. Despite the 21 percent greater capital stock in the wage tax steady state, aggregate steady-state consumption is lower reflecting the smaller aggregate supply of labor induced by the increased wage tax. While the new steady state has sufficient resources to sustain a higher level of welfare, the choice between consumption and leisure is suboptimally skewed towards leisure by the new post-tax intertemporal price structure imposed by a wage tax. Auerbach, Kotlikoff and Skinner (1983) demonstrate that assuming the CES utility function given in (3.40), wage taxation is less efficient than income taxation over a wide range of parameter values.

investors reallocated their portfolios. The price changes would capitalize the expected present value of the effects of the tax reform on future returns, conferring windfall gains on the owners of corporate capital, and losses on homeowners. These price changes would act as signals to the suppliers of new capital, calling forth more plant and equipment and fewer homes, until their relative prices were again equated to their relative long-run marginal costs of production.

The extreme volatility of asset prices in the U.S. economy suggests that these "capitalization" effects are of substantial importance. The ratio of the market value of corporate capital to its replacement cost has varied by a factor of more than two over the last 15 years. The relative price of the stock of owner-occupied housing has increased very substantially. Bulow and Summers (1984) point to evidence of substantial volatility in the prices of specific used capital goods. Even more extreme volatility has been observed in the relative price of nonreproducible assets such as land, gold, and Rembrandts. Such relative price changes represent important transfers of wealth, and must be considered if the incidence of tax changes is to be accurately assessed.

A second type of example suggests the importance of focusing on asset prices in examining tax incidence. Investment can be stimulated by reducing the corporate tax rate or by the use of incentives for new investment such as the investment tax credit or accelerated depreciation. In the long run, these two types may be designed to have very similar effects. But their incidence will differ dramatically. Because the former policy benefits old as well as new capital, it will confer a windfall gain on the owners of capital at the time that reform is announced. On the other hand, investment incentives may actually confer a windfall loss on the holders of existing capital [Summers (1981b), Auerbach and Kotlikoff (1983b), Auerbach and Hines (1986)]. This distinction cannot be captured within the standard general equilibrium model, but requires a framework in which the distinction between new and old capital is a meaningful one.

4.4.1. *Asset prices and investment: An illustrative partial equilibrium model*

The following partial equilibrium model of valuation of a firm's capital is a simplified version of the framework used in Summers' (1981b). Assume that there is one type of nondepreciable capital that is supplied elastically because of either internal or external adjustment costs. That is,

$$K = I\big(P_K(1+s)\big), \quad I' > 0,\ I(1) = 0, \tag{4.22}$$

where K is the firm's capital stock, P_K is the price of its capital goods relative to consumption goods, s is the subsidy paid to the purchase of new investment goods, and $I(\cdot)$ is the firm's net rate of investment function. Note that $\dot{K}$ can be

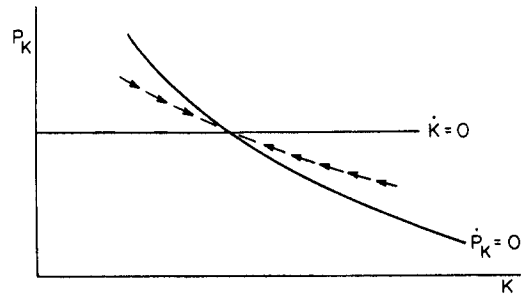

Figure 4.1. The dynamics of capital accumulation.

negative. Assume further that the capital good K is used in a production process where it earns a total return $F'(K)K$ and that $F''(K)$ is negative. Finally, assume that all returns are paid out and that investors require some fixed rate of return, ρ, to induce them to hold the capital assets. The returns to holding a unit of capital come in the form of rents $F'(K)$ and capital gains so that

$$\rho = \frac{F'(K)(1-\tau)}{P_K} + \frac{\dot{P}_K}{P_K}. \tag{4.23}$$

Equations (4.22) and (4.23) describe the dynamics of the adjustment of the quantity and price of capital. The phase diagram is depicted in Figure 4.1 for $\tau = s = 0$. Equilibrium occurs at the intersection of the two schedules at the point where $F'(K) = \rho$. Note that the system displays saddle point stability. Except along a unique path marked by the dark arrows, the system will not converge. Only along this path does the supply of investment exactly validate the future returns capitalized into the market price of capital goods. Such saddle point stability is characteristic of asset price models. It implies that at any point in time, the stock of capital and the assumption of saddle point stability uniquely determine the asset price of capital.

The phase diagram in Figure 4.1 can be used to examine the effects of various type of tax changes. In Figure 4.2 the effect of a tax on the asset's marginal product is considered. Such a tax does not affect its supply curve so that the $\dot{K} = 0$ locus does not shift. The reduction in after-tax returns due to the increase in τ leads to the leftward shift in the $\dot{P}_K = 0$ locus. Such an increase in the tax rate has no immediate effect on the capital stock, but the market price of capital drops from E_1 to B. As capital is decumulated, the marginal product of capital rises, and the system converges from B to E_2 where P_k again equals its equilibrium value. Note that after the first instant (i.e. after the capital loss)

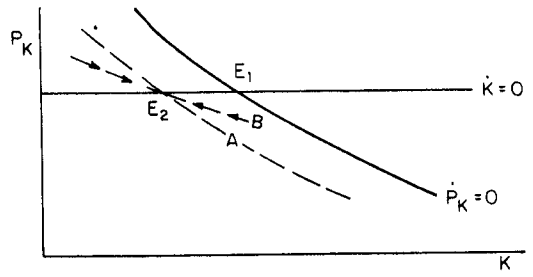

Figure 4.2. The effects of a corporate tax increase.

investors always receive a fixed return ρ as reduced rents are made up for by capital gains as equilibrium is restored. The position of the adjustment path depends on the elasticity of supply of the capital good. If the elasticity is substantial (the line with arrows is flatter), adjustment is rapid so that the tax change has little effect on the asset price of capital. If the supply of capital is relatively inelastic, there is a larger movement in the price of capital. In the limiting case where the supply of capital is completely inelastic, the relative price of capital declines to point A along the $\dot{P}_K = 0$ locus.

The effect of a subsidy (raising s) to new capital investment which does not apply to existing capital, such as accelerated depreciation or the investment tax credit, is depicted in Figure 4.3. This shifts the $\dot{K} = 0$ schedule, but has no effect on the return from owning capital and so does not affect the $\dot{P}_K = 0$ locus. Such a subsidy leads to an increase in long-run capital intensity, but also reduces the market value of existing capital goods. This illustrates that tax measures that encourage investment may hurt existing asset holders. The magnitude of the loss will depend upon the elasticity of the supply of capital. If it is high, owners of

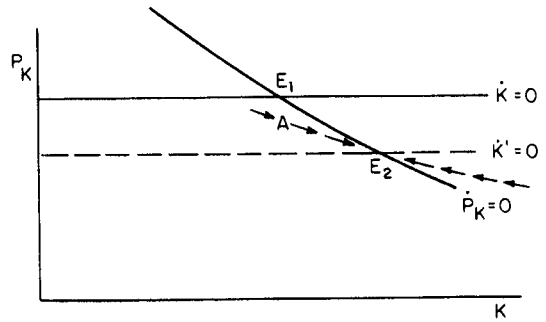

Figure 4.3. The effects of an investment subsidy.

existing capital will suffer a loss close to the subsidy rate. If not, they will continue to earn rents during the period of transition so the loss will be smaller.

That a subsidy to capital may hurt capitalists may at first seem counterintuitive. It occurs because the subsidy is available only to new capital which is a perfect substitute for existing capital in this model. The adverse effect of a reduction in new car prices on used car prices illustrates the effect considered here.

4.4.2. *Tax capitalization in a general equilibrium model*

This section illustrates how capitalization and changes in factor prices interact to determine tax incidence in general equilibrium. Consider a tax on land rents in the simple two-period life-cycle model presented above, but altered to include two assets, land and capital, but to exclude population growth. Such a model is considered by Feldstein (1977) in his seminal contribution on the relationship of capitalization to tax incidence. The lifetime budget constraint (4.1) is unaltered and is duplicated here for reference:

$$C_{2,t+1} = (w_t - C_{1,t})(1 + r_{t+1}). \tag{4.1}$$

The capital stock in period $t+1$ corresponds to the period t savings of young workers that is not invested in land. Letting P_t stand for the price of land in period t, T for the inelastic stock of land, and K_t, as above, for the period t stock of capital, we have that capital per worker in $t+1$ equals:

$$K_{t+1} = w_t - C_{1,t}(w_t, r_{t+1}) - P_t T. \tag{4.24}$$

The production function determining output per worker, $F(K_t, T, L)$, is assumed to be homogeneous of degree one in capital, and inelastically supplied land and labor. Pre-tax land rents, corresponding to the marginal product of land, F_{Tt}, are taxed at rate θ. Since land and capital are perfect substitutes, the return to holding land must equal the return to holding capital:

$$r_{t+1} = \frac{F_{Tt}(1-\theta) + P_{t+1} - P_t}{P_t}. \tag{4.25}$$

In the steady state we have from (4.25) and (4.24):

$$k + \frac{F_T(1-\theta)}{r} = w - C_1(w, r) \tag{4.26}$$

and

$$\frac{\partial k}{\partial \theta}\Big|_{\theta=0} = \frac{P}{1 + \left(\frac{F_{TK}}{F_K} - \frac{F_T F_{KK}}{F_K^2}\right) - \left(\frac{\partial w}{\partial k} - \frac{\partial C_1}{\partial k}\right)}, \tag{4.27}$$

where $r = F_K$. The above expression is positive if the denominator is positive, a requirement for steady-state stability. Hence, a tax on land rents raises capital intensity and, therefore, the real wage in the long run. The intuition behind this result is that the land rent tax involves a redistribution from initial elderly landowners to subsequent generations. As described above, such redistribution leads to increased savings. The initial generation of elderly suffer a windfall loss in their resources because of the tax on current land rents, and, generally, because of a reduction in the initial period price of the land. Chamley and Wright (1986) provide an extensive analysis of the dynamic incidence of the land tax in this type of model. They show that the initial generation of elderly landowners is always worse off because of the imposition of the tax. In addition, the initial price land can fall by more or less than the present value of future tax revenues.

Consider, as an illustration of the dynamic incidence of a land rent tax, the special case in which consumption in periods 1 and 2 are perfect substitutes at rate $1/(1+\rho)$; that is,

$$U(C_{1t}, C_{2t}) = U\left(C_{1t} + \frac{1}{1+\rho} C_{2,t}\right). \tag{4.28}$$

The first-order conditions for utility maximization imply:

$$r_t = \rho. \tag{4.29}$$

With this preference function, first-period consumption is perfectly elastic with respect to the interest rate. Since r_t is pegged by ρ, K_t is also pegged, since $\rho = r_t = F_K(K_t, T, L)$ and T and L are given. But pegging K_t means that w_t is also pegged. Hence, in (4.24) K_{t+1} and w_t are unaffected by the land rent tax, and C_1 rises by the amount of the decline in $P_t T$. The price of land can be expressed via (4.25) as the present discounted value of the after-tax marginal product of land. Since the marginal products of land and capital are fixed, we have

$$P = \frac{F_T(1-\theta)}{\rho}, \quad \forall t. \tag{4.30}$$

Hence, in response to the introduction of a land rent tax the initial price of land falls by the present discounted value of all future government tax receipts. In this case the burden of the future as well as the current tax rent tax falls entirely on the initial generation of elderly landowners. The initial young and future generations are unaffected by this tax because the wage and interest rate they face do not change.

Obviously, this strong result arises because of assumption (4.28). In what may be the more likely event that both the price of land falls by less than the present value of future taxes and capital increases over time, the initial generation of elderly will bear most of the burden of the tax and future generations will be better off due to the tax. The initial generation of young workers will, however, bear some fraction of the tax burden, because the increased capital accumulation will post-date their appearance in the labor market. Hence, they will not enjoy a higher wage and will not be better off; on the contrary, when this initial young generation is old, it will receive a lower return on its saving, because the marginal product of capital will be lower due to the increase in capital formation. Through this channel the initial young generation will share some fraction of the burden of the tax.

In this model, as in others presented in this chapter, the equilibrium may not be unique. More specifically, for certain combinations of preferences and production functions there may be an infinity of transition paths for the capital stock and the price of land, all of which ultimately converge to the same steady state [Chamley and Wright (1986)]. The possibility of multiple asset price equilibria in models of this kind is discussed more generally by Calvo (1978). In such settings intertemporal incidence, like other variables in the economy, are not uniquely determined.

5. Conclusion

Economics is at its best when it offers important insights that contradict initial, casual impressions. The theory of tax incidence provides a rich assortment of such insights. Tax incidence's basic lesson that real and nominal tax burdens are not necessarily related means that taxes on capital may be born by workers, that investment incentives may be injurious to capitalists, that taxation of foreigners may simply represent indirect domestic taxation, and that generations alive many decades in the future may be supporting those currently alive. The study of tax incidence is both fun, because it offers such surprising findings, and very important, because of its implications about the impacts of government policies. Much of the current tax incidence literature considers settings of certainty, perfect information, and market clearing. As more sophisticated models relax these assumptions, the theory of tax incidence will be enriched and, with all probability, provide even more surprising and exciting economic insights.

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