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2 The Theoretical Framework

Our aim is to examine the incentives to save and invest in the private nonfinancial corporate sector offered by the tax system in each country. Clearly, taxes are only one of the determinants of capital formation, and our four countries exhibit many important differences beyond differences in the taxation of capital income. But the structure of the tax system is often cited as an impediment to economic growth, and it is under the direct control of government. Taxation can affect many economic decisions, including labor supply, work effort, enterprise, and risk taking, as well as household savings and corporate investment in real assets. In this study we focus on the flow of private savings into real corporate investment and the flow of profits that result from this investment back to households. We do not explicitly discuss the effects of taxes on risk taking or work effort, and our analysis is limited to the incentives to save and invest. Since the exercise of "enterprise" usually involves some investment—that is, some sacrifice of present consumption for future returns—our estimated effective tax rates bear closely on the incentives or disincentives provided by government to channel resources into entrepreneurship.

2.1 The Measurement of Effective Tax Rates

The measurement of effective tax rates is not straightforward. Popular discussion tends to concentrate on the tax burden on corporate profits, especially in periods of rapid inflation. This corporate tax burden (or average effective corporate tax rate) may be a misleading measure for two reasons. First, it ignores the interaction between personal and corporate taxation. For example, interest payments that are deductible at the corporate level are taxed in the hands of the personal sector upon receipt.

The incentives to invest depend upon the combined weight of personal and corporate taxes. Second, the tax burden measures the observed tax rate on realized capital income. It does not measure the incentive for additional investment which is a function of the marginal tax rate. In what follows, we develop estimates of the effective *marginal* tax rate on capital income for each of the four countries.

To do this requires a precise definition of the margin involved. The margin considered here is a small increase in the level of real investment in the domestic nonfinancial corporate sector, financed by an increase in the savings of domestic households. An alternative marginal tax rate would be that applicable to an increase in profits that did not result from an addition to investment but that resulted, perhaps, from an unexpected increase in selling prices. Although the latter definition has its place, the former is preferred here because it is the margin relevant to the incentive effects of taxation.

The empirical study is restricted to domestic savings and investment. International capital flows are important in a number of areas, but the intricacies of double tax agreements and of the accounting behavior of multinational companies introduce complexities that are better deferred to a separate study. In any event, the bulk of investment in each of the countries studied here is financed domestically, and the effective tax rates presented below give a fairly accurate picture of the incentives provided by the different tax systems. Public-sector investment is also excluded from our study. Its determinants are unrelated to the tax system, and our focus is on taxation. Finally, we examine only corporate investment. This limitation means we ignore not only unincorporated business but also investment in residential housing. Again, most industrial investment is in the corporate sector. Details of the size of the corporate sector and the importance of foreign ownership of domestic capital are provided in the respective country chapters.

To assess the impact of taxation on investment, two approaches may be identified. The first is the econometric modeling of the process that generates time-series observations on savings and investment. A major problem with this approach is the complexity of the correct specification of tax variables, not to mention uncertainty, adjustment costs, and production lags. As a consequence, the very limited number of observations that are available, even with quarterly data, contain insufficient information for us to be confident of identifying the underlying process. Moreover, the relation between investment and taxation depends upon corporate financial policy and on the pattern of ownership of corporate securities. There is no unique cost of capital to the corporate sector that is independent of its ownership pattern and those other factors that determine its capital structure.

The second approach is to compute directly the tax "wedge" between the rate of return on investment and the rate of return on savings for a series of hypothetical marginal projects. In the absence of taxes, when the saver puts up money to finance a project he earns a rate of return equal to that earned on the project itself. With distortionary taxes the two rates of return can differ. The size of the tax wedge depends upon the system of corporate taxation, the interaction of these taxes with inflation, the tax treatment of depreciation and inventories, the personal tax code, the treatment of different legal forms of income (capital gains versus dividends, for example), the existence of wealth taxes, and a number of other details we examine below. It is clear, therefore, that the effective tax rate on an investment project depends upon the industry where it is located, the particular asset purchased, the way the investment is financed, and the identity of the investor who supplies the finance. In this study we shall compute estimates of the effective marginal tax rate for many different combinations of these factors. Such estimates are not to be regarded as a substitute for econometric analysis of investment behavior. Rather, they provide a description of the actual incentives offered by the tax system. We hope they will be useful as inputs to future econometric studies of investment and other aspects of corporate behavior. The effective tax rates calculated below are intended to summarize a very complicated tax code in a way that is intuitively appealing.

The tax wedge is the difference between the rate of return on investment and the rate of return on the savings used to finance the investment. We denote by p the pretax real rate of return on a marginal investment project, net of depreciation. It is the return society earns on a particular investment of one extra unit (dollar, pound, kroner, or mark). Let s denote the posttax real rate of return to the saver (whether a household or an institution) who supplied the finance for the investment. The tax wedge, w, is simply the difference between the two rates of return:

$$w = p - s. \tag{2.1}$$

The effective tax rate, t, we define to be the tax wedge divided by the pretax rate of return:

$$t = \frac{p - s}{p}. \tag{2.2}$$

This definition of the tax rate is a "tax-inclusive" measure in which the denominator includes the tax paid as well as the net income received. An alternative "tax-exclusive" measure would divide the tax wedge by the posttax return to the saver. This measure, t_e, is defined by:

$$t_e = \frac{p - s}{s}. \tag{2.3}$$

In presenting our results, we shall use all three measures of the distortion caused by taxes, but we shall be concerned primarily with estimates of the effective tax rate in (2.2). Nevertheless, in some circumstances the tax wedge may be more informative than the tax rate (when p is small, for example).

The link between the saver and the company that carries out the investment is the rate of return the company pays on the saver's financial claims. For example, if the saver lends money to the company in the form of a fixed-interest loan, then the company must pay an interest rate on the loan. We denote the real rate of interest on such financial claims by r and the corresponding nominal interest rate by i. If π denotes the rate of inflation, then in terms of instantaneous rates

$$r = i - \pi. \tag{2.4}$$

The interest rate r plays an intermediate role between the investment decisions by companies and savings decisions by households, and it is important in our analysis. For any given investment project we may ask the question, What is the minimum rate of return it must yield before taxes in order to provide the saver with the same net of tax return he would receive from lending at the market interest rate? This minimum pretax rate of return is called the cost of capital. It depends upon the asset and industry composition of the investment, the form of finance used for the project, and the saver who is providing the funds. For a given combination of these factors, we may express the relation between the cost of capital and the interest rate as

$$p = c(r). \tag{2.5}$$

The cost of capital function, $c(r)$, depends upon the details of the tax code, and we derive explicit expressions below.

Condition (2.5) may be thought of in two ways. On the one hand, we may view it as an expression of capital market equilibrium that determines the marginal yield on real investment of different types, using different financial instruments that would be chosen by profit-maximizing firms in an economy with an interest rate r. In this case p is determined by r. On the other hand, we may think of (2.5) as indicating the maximum interest rate such that savers would be indifferent between lending at this rate and receiving the after-tax proceeds of a given type of project, financed in a particular way, yielding a pretax return of p. In this case, the causation runs from p to r. In our study we make use of both interpretations.

The relation between the market interest rate and the return to the saver depends on the tax treatment of personal income. In none of the four countries studied here is the personal tax base defined as real income from capital. Rather, tax is charged on receipt of nominal interest income. Hence the posttax real rate of return to the saver is given by

$$s = (1 - m)(r + \pi) - \pi - w_p, \tag{2.6}$$

where m is the marginal personal tax rate on interest income and w_p is the marginal personal tax rate on wealth. In the absence of taxes, $p = s = r$. Savers provide funds to companies, these sums are invested in physical assets, and the profits accruing on the project are then distributed either to bondholders in the form of interest or to stockholders in the form of dividends and share value appreciation. As a result, savers earn the same rate of return on their savings as companies earn on their investment. In practice, taxes drive a wedge between the return on investment and the return on savings, and this wedge can be measured by comparing equations (2.5) and (2.6).

Using this approach, we measure effective marginal tax rates for each of four countries. But even within a single country the tax rate varies from one project to another depending upon the asset and industry in which the funds are invested, the nature of the financial claims on the profits (equity versus debt), and the ultimate recipient of the capital income. To investigate the distribution of effective tax rates within each country, we consider a series of hypothetical projects, where each project corresponds to a particular combination of asset, industry, financial instrument, and owner. The first set of calculations is for the effective marginal tax rate on each project, where all projects are assumed to have the same pretax rate of return. We call this *the fixed-p case*. For each project we then compute the value of s, the real posttax return to savers the project could sustain, from equations (2.5) and (2.6). From the fixed value of p and the calculated value of s, we compute both the tax wedge w and the effective marginal tax rate t. To compare tax systems across countries, we use the same value for p in all countries, and in most of our calculations we take a value of 10 percent per annum. The relation between the assumed value of p and the tax rate is discussed further below.

Comparing the tax rates corresponding to a common value for p provides a picture of the incentives offered by the tax system for particular kinds of investment projects. In other words, the fixed-p calculations describe tax schedules facing different projects. But, in turn, we would expect that the effect of these varying tax rates would be to stimulate investment in low-taxed projects relative to more highly taxed investments. We would expect the allocation of capital among the various combinations to adjust until an equilibrium is established in which there exist no further opportunities for mutually profitable transactions. For a given individual saver, arbitrage would result in an equilibrium in which the same net rate of return was earned on each project. We might therefore calculate an effective tax rate for each combination for a common value for s rather than a common value for p. Arbitrage opportunities are limited, however, and in particular we do not think it reasonable to assume that differences in personal tax rates can be eliminated by arbitrage. This arbitrage might be possible for a husband and wife (in systems where spouses are taxed separately), but it is unlikely to occur between unrelated persons. I may love my neighbor, but not enough to transfer the legal ownership of my assets to his care. Moreover, a substantial fraction of capital income now accrues to tax-exempt institutions (such as pension funds), and if arbitrage could eliminate differences in personal tax rates, then the only possible equilibrium would be one in which all effective personal tax rates on capital income were zero. This does not seem to us to be a reasonable assumption.

In practice, governments impose limits on the flow of savings from households to institutions precisely to prevent full tax arbitrage. Hence, in a second set of calculations for this study we assume that arbitrage leads to an outcome in which all projects offer the same rate of return to savers before personal tax. In other words, we assume a common value of r for all combinations, and we call this *the fixed-r case*. For any given saver (that is, given values of personal income and wealth tax rates), this case implies that all projects yield the same value of s. But the value of s varies from one saver to another if they face different personal tax rates. It must be stressed that when arbitrage eliminates differences among projects in the real rate of interest there must be differences in the pretax rates of return on investment. Hence the tax system distorts the allocation of resources. The value of p in this case is *not* uniform across projects. Allowing for the possibility of arbitrage in the capital market equilibrium does not rule out inefficiencies in the allocation of resources.

With a linear tax schedule, that is, one in which the rate of tax is independent of the value of p (or, equivalently, r) at which it is evaluated, the tax rate on any given project will be the same in the fixed-p case as in the fixed-r case. Under a nonlinear schedule, as happens in practice, the size of the tax rate depends upon the value of p at which it is evaluated. If the value for r in the fixed-r case implies a value for p different from that assumed in the fixed-p calculations, then the two cases yield different values for the tax rate. This results solely from the nonlinearity of the tax schedule. More significant differences between the two measures arise when we examine a weighted average of hypothetical projects in order to assess the average marginal tax rate on investment in the corporate sector as a whole.

2.2 Combinations of Hypothetical Projects

For each hypothetical project we compute an effective marginal tax rate for both the "fixed-p" and the "fixed-r" cases. A hypothetical project is defined in terms of a particular combination of characteristics that affect the tax levied on the returns from the project. The characteristics we examine include the asset in which the funds are invested, the industry of the project, the way the project is financed, and the ultimate recipient or owner of the returns. Each hypothetical project is described by a unique combination of these four characteristics. For each characteristic we examine three alternatives. First, the three assets are

1. machinery
2. buildings
3. inventories.

The category for machinery includes plant and machinery, equipment, and vehicles. We shall not be concerned with investment in financial assets, research and development, or other intangibles such as a good managerial team, trade contacts, or advertising goodwill. The study is limited also to reproducible assets, so we ignore investment in land.

Second, our three industries are

1. manufacturing
2. other industry
3. commerce.

The precise definition of industrial sectors is as follows. Manufacturing forms a natural grouping and corresponds to the same description in standard industrial classifications (SIC). For the United States, standard industrial classification manufacturing comprises SIC numbers 13–64. The "other industry" group consists mainly of construction, transportation, communications, and utilities. It corresponds to SIC numbers 11, 12 and 65–68. The "commerce" sector includes nonfinancial services and distribution, which are SIC numbers 69 and 72–77. Those activities excluded are agriculture, extractive industries, real estate, government, and financial services.

Third, our three sources of finance are

1. debt
2. new share issues
3. retained earnings.

Debt is defined to include both bond issues and bank borrowing.

Finally, our three ownership categories are

1. households
2. tax-exempt institutions
3. insurance companies.

The first category includes indirect household ownership through taxed intermediaries such as mutual funds or banks. The second category includes indirect tax-exempt ownership through pension funds, the pension business of life insurance companies, and charities. The third category includes funds invested as part of contractual savings made by households via the medium of insurance companies, principally life insurance policies, which are not tax exempt but are taxed at special rates. Our choices for these categories of owner are motivated by their different tax treatment. Although personal tax rates clearly vary within the personal sector, the schedule is common to all households, and in the individual country chapters below we describe the distribution of personal marginal tax rates in the respective countries. More substantial differences exist in the tax-exempt status given to pension funds and charitable holdings. Although deemed "tax exempt," institutions in this category may end up paying some tax because of the asymmetric nature of the tax system. For example, both Britain and Germany have imputation credits as part of their corporate tax systems. In Britain the credit is refunded to tax-exempt stockholders, whereas in Germany the credit is not refunded. The effect of this difference is that tax-exempt institutions in Germany do effectively pay some personal tax on dividend income. Finally, insurance funds are often taxed in special ways, as described in country chapters below, and we take into account the tax treatment of premiums and distributions.

With three categories for each of four characteristics, the number of distinct combinations we identify is 3^4, a total of eighty-one for each country. In chapter 7 we compute the effective marginal tax rate for each combination as well as the distribution of tax rates. To plot the distribution of tax rates, we need to know the proportion of investment identified with any given combination. We assume that the marginal increase in investment under consideration is proportional to the existing distribution of net capital stocks among assets and industries. Further, we assume that the saving required to finance the investment is proportional to existing ownership patterns. It might be argued that a marginal investment would not be allocated in proportion to existing stocks and that not all ownership categories would provide the marginal finance. For example, the size of funds held by the tax-exempt category might be limited by legal ceilings on the sums households can invest in this favored manner. Such limits are usually related to income, however, and we prefer to consider a marginal increase in savings and investment that corresponds to an equiproportionate expansion of the economy. Additional savings are assumed to be made by all these ownership categories and are invested in proportion to existing net capital stocks. Marginal investment is assumed to be proportional to net capital stocks rather than gross investment flows because the former are representative of long-run asset requirements, while the latter are influenced by differing asset depreciation rates. Inventories, for example, form an important component of net capital stock, while they account for a very small share of gross investment. With steady growth, the use of net capital stocks is equivalent to the use of *net* investment flows for the allocation of our marginal investment.

This assumption about the nature of the marginal increment to savings and investment determines the weights we apply to each combination when we compute the distribution of marginal tax rates. The reader who wishes to make alternative assumptions about marginal savings or investment may use the basic data on effective tax rates for each of the eighty-one combinations to plot his own distribution. These data are provided in Appendix B.

The mean of the distribution provides an estimate of the overall marginal tax rate on the capital income generated from a small equiproportionate increase in the capital stock. Let k denote a particular combination of asset, industry, source of finance, and category of owner. Also, let α_k denote the capital stock weight for that combination ($\Sigma\alpha_k = 1$). The mean tax wedge on the marginal capital income, $\bar{w}$, is

$$\bar{w} = \sum_{k=1}^{81} (p_k - s_k)\alpha_k . \tag{2.7}$$

For the kth combination, p_k and s_k are the real rates of return on the investment and on savings, respectively. The additional capital income generated, $\bar{p}$, is given by

$$\bar{p} = \sum_{k=1}^{81} p_k \, \alpha_k . \tag{2.8}$$

The overall mean marginal tax rate, $\bar{t}$, is

$$\bar{t} = \frac{\bar{w}}{\bar{p}} \quad \frac{\sum_{k=1}^{81} (p_k - s_k)\, \alpha_k}{\Sigma\, p_k \alpha_k} . \tag{2.9}$$

In addition to the overall mean marginal tax rate, we calculate conditional means by summing over appropriate subsets of combinations. For example, we compute the mean marginal tax rate on investment in machinery by summing over all combinations that involve machinery and that correspond, therefore, to different industries, sources of finance, and owners. There are twenty-seven such combinations. The construction of the α_k weights is described in section 3 of each country chapter, while overall and conditional means of marginal tax rates are presented in section 4 of each country chapter. These tax rates are compared and analyzed in more detail in chapter 7.

The overall mean tax rate derived from these calculations is an aggregate statistic for the difference between the return to investment and the return to saving in the economy as a whole. In many ways, however, the distribution of marginal tax rates around the mean provides more information. The variance of this distribution reflects the distortion of the pattern of savings and investment created by the tax system. The variation in tax rates has further implications for our measure of the aggregate marginal tax rate itself. If the tax rate applicable to all combinations were the same, then the overall marginal tax rate would be equal to this common value, for both the fixed-p and the fixed-r cases. But when tax rates vary, the mean marginal tax rate will be different in the two cases. In the fixed-p case, where p_k is the same for all combinations, equation (2.9) reduces to

$$\bar{t} = \Sigma \alpha_k t_k, \tag{2.10}$$

where t_k is the marginal tax rate for combination k. In the fixed-r case, the same equation reduces to

$$\bar{t} = \frac{\sum_k \alpha_k p_k t_k}{\sum_k \alpha_k p_k}. \tag{2.11}$$

The mean marginal tax rate in the fixed-p case is a weighted average of the individual tax rates, where the weights are the capital stock weights for each combination. In the fixed-r case, the weights are the product of the capital stock proportions and the pretax rates of return for each combination. In order to produce the same value of r, the more heavily taxed combinations require a higher value of p, and therefore they receive a higher weight ($\alpha_k p_k$) in the fixed-r case. Hence the mean marginal tax rate will be higher in the fixed-r case than in the fixed-p case.

The difference between the two means reflects the variance in tax rates among different combinations. To illustrate this argument, consider a simple example. Suppose there are two possible combinations and the capital stock weights are one-half for each combination. Suppose, further, the tax rate on the first combination is zero and that on the second is 50 percent. Then in the fixed-p case,

$$\bar{t} = .5(0) + .5(.5) = \frac{1}{4}.$$

If there are no personal taxes, then $r = s$ from equation (2.6). In other words, assume that the difference in the tax rates comes solely from the corporate tax treatment of the two combinations. Since $t_k = (p_k - r)/p_k$ in the fixed-r case, we have

$$p_k = \frac{r}{1 - t_k}. \tag{2.12}$$

Substituting this into (2.9) yields

$$\bar{t} = 1 - \left(\sum \frac{\alpha_k}{1 - t_k}\right)^{-1}. \tag{2.13}$$

For our example, we then have

$$\bar{t} = 1 - (0.5 + 1.0)^{-1} = \frac{1}{3}.$$

The greater weight given to the more heavily taxed combination produces a mean marginal tax rate of one-third in the fixed-r case, compared with one-quarter in the fixed-p case. The difference between the two measures can be large when some combinations are taxed and other combinations receive subsidies. Returning to our example with two equally weighted combinations, suppose one combination is taxed at 50 percent and the other receives a subsidy of 50 percent. In the fixed-p case the mean tax rate is zero. But in the fixed-r case the mean is equal to one-quarter, from equation (2.13). The fixed-r case uses weights given by $\alpha_k p_k$, the additional pretax profits that result from the marginal increment to the capital stock. If both combinations are to earn the same r, then the taxed combination must have a higher share of the additional pretax profits than of the capital stock.

The choice between the fixed-p and the fixed-r distributions of marginal tax rates depends upon whether we are more interested in the tax schedule facing potential investors or in the proportion of marginal factor income that is taxed away. Both are of interest, and we present results for both distributions. The fixed-p calculations are a better guide to the schedule of tax rates levied on different combinations, and it is this distribution of marginal tax rates that determines the welfare losses resulting from the distortionary nature of the taxation of capital income. In contrast, the weighted averages in the fixed-r case are a better guide to the ratio of additional taxes paid to additional profits earned that results from a small increase in the corporate sector capital stock. If the tax schedule for each combination was linear, then the fixed-r weighted average tax rates would always exceed the fixed-p weighted averages. But in a nonlinear schedule it is possible (though it occurs only infrequently in our calculations) that the fixed-p tax rate exceeds the fixed-r tax rate for a given combination by enough to offset the fact that in the fixed-r case greater weight is given to combinations with high tax rates. Since our primary interest is in the effects of taxation on the incentive to invest, we focus mainly on the fixed-p results.

In recent years, the interaction between inflation and the tax system has been one of the most important aspects of the effect of taxes on savings and investment. The expected rate of inflation enters into both the determination of p in equation (2.5) and s in equation (2.6). We examine the effect of inflation in detail below, and we calculate effective tax rates for three different rates of inflation. First, a zero rate provides a benchmark against which to judge other figures, and it describes the impact the tax system would have if it were fully indexed. Second, we look at an inflation rate of 10 percent per annum, a midpoint in the historical experiences of our group of countries in the decade 1970–79. We hope it is not too optimistic to regard this rate as an upper bound on inflation for the next decade. This second rate enables us to compare tax systems across countries for a common, and significantly positive, rate of inflation. Finally, for each country we take the actual annual rate of inflation experienced in the decade 1970–79. This actual rate varied from 4.2 percent for Germany to 13.6 percent for Britain. The rate we take for each country is an average of the rates of increase of the price deflators for consumer goods and for investment goods in that country. Our interest is in the level of inflation, not in relative price changes, so we use a common inflation rate for all sectors of the economy.

2.3 The Cost of Capital Function

Given a value for p or, alternatively, given a value for r, we use equations (2.5) and (2.6) to compute a value for the effective tax rate. We therefore need an expression for the cost of capital function, $c(r)$, for each combination. In these expressions we shall assume that statutory tax rates are known and constant over time, that there is perfect certainty, and that inflation is uniform over time. Consider an investment project with an initial cost of one unit (a dollar, pound, mark, or crown). Let MRR denote the gross marginal rate of return to this increment to the capital stock, and assume that the asset depreciates at a constant exponential rate δ. The rate of return net of depreciation is

$$p = \mathrm{MRR} - \delta . \tag{2.14}$$

For convenience, we assume economic depreciation is exponential, but we distinguish carefully between economic depreciation and tax depreciation. The latter is not generally exponential (or, in discrete time, declining balance). For the moment we ignore corporate wealth taxes and the tax treatment of inventories. If the corporate tax rate is denoted by τ, and the rate at which the company discounts cash flows in nominal terms is denoted by ρ, then the present discounted value of the profits of the project, net of taxes, is[1]

$$V = \int_0^\infty (1-\tau)\mathrm{MRR}\, e^{-(\rho+\delta-\pi)u}\, du$$

$$= \frac{(1-\tau)\mathrm{MRR}}{\rho+\delta-\pi} . \tag{2.15}$$

Nominal profits increase at the rate of inflation, fall in value at the rate of depreciation, and are discounted at the rate ρ. The value of the discount rate is endogenous and depends not only on the real interest rate

1. To ensure convergence of the integral, we assume that $\rho + \delta - \pi$ is strictly positive. In the fixed-r case, this assumption places restrictions on the feasible range of values for r. Still, for apparently plausible values for r, the restrictions are violated in a few instances. The reader is referred to the country chapters for details. When p tends to zero, then the tax wedge w is a much more informative guide than the tax rate t that has p as its denominator.

and the inflation rate, but also on the source of finance, as we shall see below. The cost of the project is unity, the initial payment for the asset, minus the present discounted value of any grants or tax allowances given for the asset. The present value of such grants and allowances we denote by A. Hence the cost of the project is

$$C = 1 - A. \tag{2.16}$$

For any given discount rate, the value of MRR that equates V with C is the return the project must earn if it is to be an attractive investment. Looking at it the other way round, if MRR is a given return on a marginal project, then the net of tax interest rate the firm could afford to pay on the finance obtained to purchase the asset is the value of ρ that equates V with C. Setting V from equation (2.15) equal to C from (2.16) and using equation (2.14), we solve to obtain the following relation between p and ρ:

$$p = \frac{(1 - A)}{(1 - \tau)}(\rho + \delta - \pi) - \delta. \tag{2.17}$$

To derive an expression for A, we assume that grants and allowances for investment take one of three forms. These are: (1) standard depreciation allowances; (2) immediate expensing or free depreciation; and (3) cash grants (equivalent to tax credits). The proportion of the cost of an asset that is entitled to "standard" depreciation allowances is denoted by f_1, and the present value of tax savings from standard depreciation allowances on a unit of investment is A_d. If f_2 denotes the proportion of the cost of the project qualifying for immediate expensing at the corporate rate τ, then the tax saving from this write-off is $f_2\tau$. Finally, suppose that the proportion qualifying for grants is denoted by f_3, and that the rate of grant is g. Then

$$A = f_1 A_d + f_2\tau + f_3 g. \tag{2.18}$$

There is no need to restrict the sum of f_1, f_2, and f_3 to unity. At certain times it exceeds unity (for example, when accelerated depreciation does not reduce the base for standard depreciation allowances). Equation (2.18) is capable of describing the full range of tax allowances and investment incentives in the four countries studied here. The value of standard depreciation allowances will depend upon the pattern allowed for tax depreciation. Common examples are declining balance, straight line, and other schemes under which the firm may switch from one method of calculation to another partway through the asset's life. In each case the present discounted value may be computed from the parameters of the relevant legislation. Consider a simple example in which tax depreciation is granted at an exponential rate equal to a (this is the continuous-time version of declining-balance depreciation), and suppose that tax depreciation allowances are computed at historical cost. The value of standard depreciation allowances is given by

$$A_d = \int_0^\infty \tau a \, e^{-(a+\rho)u} du = \frac{\tau a}{a+\rho}. \tag{2.19}$$

There are other assets (buildings in Germany and the United Kingdom, for example) for which the tax system usually provides straight-line depreciation. In this case a tax lifetime, L, is specified for each asset, and the asset may be written down for tax purposes by $1/L$ per unit in each year until L years have elapsed. With straight-line depreciation,

$$A_d = \int_0^L \tau \left(\frac{1}{L}\right) e^{-\rho u} du = \frac{\tau(1 - e^{-\rho L})}{\rho L}. \tag{2.20}$$

There exist more complicated depreciation formulas such as the United States allowances for double declining balance with a switch to sum-of-the-years'-digits partway through the tax life of the asset. Where relevant, these formulas are described in section 2.3 of each country chapter. For computational purposes we simply note that the value of A_d is a nonlinear function of the firm's discount rate, which in turn is a function of the real interest rate.

We turn now to the effect of wealth taxes on corporations and to the tax treatment of inventories in periods of inflation (which itself is akin to a wealth tax). Consider first a tax on the net worth of the company such that an addition to the net capital stock of one unit raises the wealth tax base by a unit. If the rate of corporate wealth tax is w_c, then in the absence of a tax on corporate profits the wealth tax reduces the marginal rate of return from MRR to MRR $- w_c$. When there is a tax on profits at the rate τ, and the wealth tax is not deductible for corporation tax purposes, the net of tax return to the company is reduced to $(1-\tau)\text{MRR} - w_c$. When the wealth tax is deductible from the corporate profits tax base, the posttax return is $(1-\tau)(\text{MRR} - w_c)$. Equation (2.10) now becomes

$$\begin{aligned} V &= \int_0^\infty [(1-\tau)\text{MRR} - (1-d_1\tau)w_c] \, e^{-(\rho+\delta-\pi)u} du \\ &= \frac{[(1-\tau)\text{MRR} - (1-d_1\tau)w_c]}{\rho+\delta-\pi}, \end{aligned} \tag{2.21}$$

where $d_1 = 1$ if corporate wealth taxes are deductible against the corporate tax base, and
$= 0$ if wealth taxes are not deductible.

The remaining issue in the specification of the cost of capital function is the tax treatment of inventories in periods of inflation. During each accounting period, the book value of inventories changes for two reasons.

First, there may be an increase in the volume of inventories; second, there may be a rise in the price of inventories. In part, this latter component of the increase in book value reflects general inflation and would not be taxed under a corporate tax system based on real profits. But in some countries the use of historical cost accounting means that the inflationary gain on inventories is taxed as current profits when inventories are turned over. This realization of inventory profits for tax purposes can occur fairly soon if traditional FIFO (first in, first out) accounting is used, or it can be postponed almost indefinitely if LIFO (last in, first out) accounting is used. We assume that v denotes the proportion of inventories taxed on historical cost principles. Then a marginal investment of one unit of inventories, if there are no relative price changes, will incur an additional tax of $\tau v \pi$ per annum. This modifies equation (2.21), resulting in the general form

$$V = \frac{[(1-\tau)\mathrm{MRR} - (1 - d_1\tau)w_c - d_2\tau v\pi]}{\rho + \delta - \pi}, \tag{2.22}$$

where d_2 equals unity for inventories and zero for other assets. We may summarize our discussion on the cost of capital by noting that if we combine equation (2.22) with the definition of p, then the relation between the pretax real rate of return on a project and the firm's discount rate is given by

$$p = \frac{1}{(1-\tau)}[(1-A)(\rho + \delta - \pi) + (1 - d_1\tau)w_c + d_2\tau v\pi] - \delta. \tag{2.23}$$

It can easily be checked that, when there are no taxes, the values of both p and s as given by equations (2.23) and (2.6), respectively, are equal to the real interest rate.

The final step in our calculations is to relate the firm's discount rate to the market interest rate. With perfect certainty and no taxes, the two would be equal. In a world of distortionary taxes, however, the discount rate will differ from the market interest rate and, in general, will depend upon the source of finance. For debt finance, since nominal interest income is taxed and nominal interest payments are tax deductible, the rate at which firms will discount after-tax cash flows is the net of tax interest rate. In other words, for the case of debt finance,

$$\rho = i(1-\tau). \tag{2.24}$$

For the two other sources of finance, the discount rate depends upon both the personal tax system and the corporate tax system. We define the corporate tax system in terms of two tax variables. The first, defined above, is the basic corporate tax rate τ, the rate of tax paid if no profits are distributed. The second variable measures the degree of discrimination between retentions and distributions. The tax-discrimination variable is denoted by θ and is defined as the opportunity cost of retained earnings in terms of gross dividends forgone. Gross dividends are dividends before deduction of personal income tax. Hence θ equals the additional dividends shareholders could receive if one unit of post-corporate-tax earnings were distributed. For a detailed discussion of these issues, see King (1977, chap. 3).

Under a classical system[2] of corporation tax (such as that in the United States), no additional corporate tax is collected (or refunded) when dividends are paid out, so the value of θ is unity. With an imputation system (such as that in the United Kingdom), a tax credit is attached to dividends paid out, so the value of θ exceeds unity. From the definition of θ, we know that if one unit of profits is distributed, θ is received by shareholders as dividends and $(1-\theta)$ is collected in tax. Hence the additional tax per unit of gross dividends is equal to $(1-\theta)/\theta$. The total tax liability of the company—that is, total taxes excluding personal income tax on both dividends and interest and excluding any capital gains tax on retained earnings—is given by

$$T = \tau Y + \left(\frac{1-\theta}{\theta}\right)G, \tag{2.25}$$

where Y denotes taxable income and G denotes gross dividends paid by the company.

With an imputation system of corporation tax, part of the company's tax bill is imputed to the stockholders. If the rate of imputation is c, then the stockholder receives a dividend before personal tax equal to the cash dividend plus the tax credit of $c/(1-c)$ per unit dividend. Hence, $(\theta - 1)$ equals the tax credit per unit, and $\theta = 1/(1-c)$. When full imputation at the corporate tax rate is granted (such that dividends are fully deductible against profits for corporate tax purposes,[3] as in West Germany), then $\theta = 1/(1-\tau)$.

Consider now the appropriate discount rate for the firm when financing investment by new share issues. Potential investors would require a rate of return on the money they subscribe to the company equal to $i(1-\mathrm{m})$, where i is the nominal market interest rate. Suppose the project yields a return net of corporate income tax of ρ. Then this required yield (that is, the firm's discount rate) must be such as to equate the net of tax dividend yield with the investor's opportunity cost rate of return. The former is

2. Our taxonomy of corporate tax systems follows the convention established by the debate in the European Economic Community. For a full discussion, see King (1977, chap. 3).

3. A system where dividends are fully deductible at the corporate level and fully taxed at the personal level is equivalent to a system where tax is collected on all profits at the corporate level but is rebated to individuals on dividends received at the personal level. Recipients are taxable on gross dividends $\theta = 1/(1-c)$, but they receive credit for $c/(1-c)$, the amount paid at the corporate level on those profits.

equal to $(1 - m)\theta\rho$, and the latter is $(1 - m)i$. This means that for new share issues the firm's discount rate is given by

$$\rho = \frac{i}{\theta}. \tag{2.26}$$

The use of retained earnings enables investors to accumulate at a rate of return that is taxed by capital gains tax rather than income tax. This is often attractive because the effective rates of capital gains tax are usually significantly lower than income tax rates. If the yield of a project is ρ, then the investor would require a yield such that $\rho(1 - z) = i(1 - m)$, where z is the effective tax rate on accrued capital gains. The discount rate for the retained earnings is, therefore, given by[4]

$$\rho = i\left(\frac{1 - m}{1 - z}\right). \tag{2.27}$$

In practice, capital gains are taxed only on realization, and to allow for the benefit of this deferral of tax, we must convert the statutory rate, z_s, into an effective accrued tax (or EAT) rate. For this purpose we use a simple model of investor behavior. Let λ be the proportion of accumulated accrued gains realized by investors in a particular tax bracket in each period. That is, a capital gain of one unit accruing in period one will lead to a realized gain of λ in period one and an unrealized gain of $1 - \lambda$. In the second period realizations are equal to $\lambda(1 - \lambda)$. In the third period, realizations are $\lambda(1 - \lambda)^2$, and so on. If we assume that λ is constant, then the present discounted value of the stream of tax payments resulting from a unit of accrued gain is given by

$$z = \lambda z_s \sum_{j=0}^{\infty} \left(\frac{1 - \lambda}{1 + \rho_p}\right)^j = \frac{\lambda z_s}{\lambda + \rho_p}, \tag{2.28}$$

where ρ_p is the investor's nominal discount rate. In general, the investor's nominal discount rate is equal to $s + \pi$.

When computing marginal tax rates, we substitute the expression for z from (2.28) into equation (2.27). The EAT rate z is thus endogenous to the calculations, because of its dependence on the market interest rate. The tax treatment of capital gains is described in the appropriate sections

4. In practice, we often have data for the personal tax rate on dividend income that is different from the tax rate on interest income. This difference occurs because holders of equity are typically in higher tax brackets than holders of debt (and not because of different tax schedules for interest and dividends). A potential investor in equity, with a single personal tax rate m_e, would receive $(1 - m_e)\theta\rho$ on dividends, $(1 - z)\rho$ on retained earnings, or $(1 - m_e)i$ on alternative investments. Hence equations (2.26) and (2.27). His value for s is $i(1 - m_e) - \pi - w_p$, and we have enough information to find both p and s for any combination involving equity finance. A potential investor in debt, with personal tax rate m_d, would receive a net return $s = i(1 - m_d) - \pi - w_p$. The firm's discount rate for debt finance is $i(1 - \tau)$, from equation (2.25), and again we can calculate the difference between p and s.

of each country chapter. Except where capital gains are taxed as they accrue (as for insurance companies in Sweden), we take a value of 0.1 for λ. This value implies that corporate shares have a mean holding period of ten years (King 1977, chap. 3).

There is one further point to note concerning retained earnings. For this source of finance the cost of capital is a function of personal tax rates. The required rate of return on a hypothetical investment project depends upon the tax rate of the investor. Yet by their very nature, retained earnings cannot be attributed to only one group of stockholders (given the restrictions on the tax treatment of stock dividends), and so the cost of capital for a firm financing out of retained earnings must be the same for all stockholders. There are several ways out of this dilemma. One would be to consider a hypothetical project carried out by a firm owned entirely by a single investor whose tax rate would uniquely determine the cost of capital. Another would be to examine an equilibrium of the capital market in which high tax rate investors owned equity and low tax rate investors owned debt. A segmented equilibrium of this kind is sometimes known as a "Miller equilibrium" (Miller 1977; Auerbach and King 1983). Neither approach, however, is consistent with the fact that in all four countries both tax-exempt investors and individuals facing the highest marginal tax rates own corporate equity. A marginal project financed out of retained earnings will use funds attributable to all types of investors in proportion to their stockownership. Hence, we assume that for retained earnings the cost of capital is a weighted average of the values given by expression (2.27), where the weights are the shareownership proportions of the different investors.[5]

2.4 Computing Effective Tax Rates

The equations above enable us to calculate the tax wedge w and the marginal tax rate t for each combination. In the fixed-r case, we first

5. Further intuition for these equations is provided in section 7.4 (in the comparative results chapter), where we look at the simple case with economic depreciation allowances, no investment tax credits, no corporate wealth taxes, and no inflation. In this simple case, equation (7.2) shows that discount rates for debt, new shares, and retained earnings reduce to $r(1-\tau)$, r, and $r(1-m)$, respectively. Equation (7.6) shows that effective tax rates reduce to m for debt, $\tau + m(1-\tau)$ for new shares, and τ for retained earnings. An interpretation for new share issues is that the investment earns corporate profits taxed at rate τ and that the after-tax profits $(1-\tau)$ are distributed and taxed again at rate m. It is not necessary, however, to assume that the income is actually distributed. Rather, the dividend tax is relevant because it must be paid anytime profits are distributed. For retained earnings finance, on the other hand, the dividend tax is not relevant because it must ultimately be paid whether these funds are reinvested or not. (See Auerbach 1979; Bradford 1980; King 1977.) Finally, we might note that chapter 8 further discusses how the assumption of arbitrage at the personal level implies discount rates that differ by source of finance at the firm level. An alternative assumption of arbitrage at the firm level would imply rates of return that depend on source of finance at the personal level. These differences might be resolved in a model with uncertainty, but in this model they provide a further reason to emphasize the fixed-p case rather than the fixed-r case (which must choose a particular kind of arbitrage).

compute s from (2.6), and then the firm's discount rate from equations (2.24) through (2.28). With the resulting value of ρ, we compute p from (2.23). In the fixed-p case, however, the calculations are more complicated. Given a value for p, we solve (2.23) for the discount rate, but iteration is required because the discount rate enters the expression for depreciation allowances in a nonlinear fashion. For complicated depreciation schemes the function is highly nonlinear, but we have checked that our solution is unique in the feasible range. Then, given a discount rate, we solve for the market interest rate. (In the case of retained earnings, further iteration is required because the capital gains tax rate depends upon the interest rate.) Then we solve for the posttax real rate of return to savers, s.

The functional relationship between p and s is, in general, nonlinear. The values of the tax wedge and the tax rate thus depend upon the values of p and r at which they are evaluated. We investigate these relationships in chapter 7. For most of our tax rate calculations, we use a value of 10 percent per annum for p, or 5 percent per annum for r.

One of the important relationships we investigate is the effect of inflation on effective marginal tax rates. In the fixed-p case, we assume the same 10 percent value for p, the real pretax return, at all inflation rates. But in the fixed-r case we must be more careful. With an unindexed personal tax system, higher inflation generally widens the dispersion of effective tax rates. A tax-exempt investor remains tax exempt, but a taxed investor pays tax not only on the real return but on the inflation premium as well. This increased dispersion of effective tax rates is an inevitable consequence of the arbitrage mechanism underlying our fixed-r assumptions, in which all differences in posttax rates of return are arbitraged away, *except* for those resulting from differences in personal tax rates. With an unindexed personal tax system, therefore, an arbitrage equilibrium is characterized by the dispersion of effective tax rates being an increasing function of the inflation rate.

When comparing different projects at a given inflation rate in the fixed-r case, arbitrage requires a constant real rate of return r. This arbitrage argument is not relevant, however, when making ceteris paribus comparisons among different inflation rates. It would be possible to assume that r is fixed across inflation rates, but this real rate of return $(i - \pi)$ is relevant to tax-exempt investors only. Since nominal interest is taxed, other investors would experience a real after-tax return s that is a decreasing function of the inflation rate. Instead, as our benchmark, we choose to assume that the average value of s over *all* ownership groups is a constant across inflation rates. As a consequence, the value of r is held constant across projects at any one inflation rate, but it is not held constant across different inflation rates. (This assumption and its alternatives are further investigated in section 7.5.)

It is evident from (2.6) that if the average value of s over ownership groups is to be independent of the inflation rate, then the nominal interest rate implied by our fixed-r calculations must rise with each percentage point increase in inflation by a factor equal to unity divided by unity minus the average personal tax rate. We stress that this is not an assumption about how inflation actually affects nominal market interest rates. There has been a great deal of debate about the effect of inflation on interest rates, but our assumption is merely a ceteris paribus decision about the value of r at which to measure tax rates. While alternative assumptions are explored in chapter 7, the results for the fixed-r case in each country chapter are based on the benchmark described here.

It is clear from the equations above that the effective marginal tax rate depends upon the particular asset in which an investment is made, and upon the industry, source of finance, and category of owner. To obtain the solution to the system of equations for each combination, and to compute the weighted averages, it is necessary to resort to a computer program. Yet it is possible in simple cases to illustrate how the equations operate and to demonstrate that they accord with our intuition. To proceed, we consider two very special tax systems. Consider first a personal expenditure tax on all investors combined with a cash flow corporation tax in which all investment outlays are immediately expensed (with negative tax payments where required) and in which interest payments are not tax deductible. We know that this tax regime imposes no tax wedge between the return to savers and the return to investors (for example, King 1977, chap. 8). With a cash flow corporation tax and no interest deductibility, the firm's discount rate will be equal to the market interest rate for all sources of finance. With this regime of immediate expensing for all types of investment, then, $f_1 = f_3 = w_c = v = 0$. Also, f_2 equals unity, and hence $A = \tau$. The result is that the value for p in each combination is equal to the real market interest rate $(i - \pi)$. With a personal expenditure tax, $m = z = w_p = 0$, and hence $s = p$. Thus the tax wedge and the marginal tax rate are both equal to zero.

The other special case we consider is that of complete integration of the corporate income tax and personal income tax and indexation of the resulting integrated tax system. No corporate taxes as such are levied in this case, and the investors' discount rate becomes that of the firm. With an indexed tax system, this rate is equal to $(1 - m)r + \pi$. There are no wealth taxes and no taxation of inflationary gains on inventories. Tax allowances are given only for true economic depreciation at replacement cost. Hence $f_2 = f_3 = 0$, and f_1 equals unity, so $A_d = m\delta/(\delta + \rho - \pi)$. With this expression it is easy to see from equation (2.17) that $p = r$, the real market rate of interest.[6] It is also clear that $s = r(1 - m)$. Hence, for every

6. When $f_2 = f_3 = 0$, $f_1 = 1$, and $A_d = \dfrac{m\delta}{\delta + \rho - \pi}$, then (2.17) becomes

combination, the effective marginal tax rate is equal to the investor's personal tax rate.

In practice, as we shall see, the complex tax systems that all of our four countries levy on corporate income mean not only that the effective marginal tax rate differs from the standard of either an income tax or an expenditure tax, but that the tax rates vary enormously from one combination to another. One of the major aims of our study is to document this phenomenon empirically and to provide estimates of the magnitude of the effect and of the proportion of investment that is channeled through each of the combinations. These estimates enable us to compute a distribution of marginal tax rates.

We conclude this chapter by noting a number of detailed points concerning our methodology. First, we have omitted taxes on gifts and estates from our calculations. These taxes may well be important in particular instances where the principal motive for saving is to pass on wealth to succeeding generations. Much saving, however, is channeled through contractual schemes for life-cycle saving, and there are well-known opportunities for avoiding taxes on gifts and estates. In each country chapter we set out some relevant information concerning these taxes, but their rates are not incorporated into our calculations.

We assume that all relevant tax allowances can be claimed. We assume that firms engaging in our hypothetical investment projects have positive taxable profits or, equivalently, that the tax system is symmetric in that it makes refunds on losses at the same rate at which it taxes profits. In practice, there are firms with negative taxable profits that are unable to claim allowances. Tax losses can be carried forward, and in some cases backward, so the fact that taxable income is currently negative need not mean that the tax allowances are lost forever. However, in the cases of Britain and Sweden there are grounds for believing the problem cannot be overlooked. Simulations of marginal tax rates for companies that have exhausted tax allowances are contained in section 4 of those two country chapters. One of the main reasons for the rapid growth of leasing has been the wish of "tax-exhausted" firms to lease assets from companies

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$$p = \left(\frac{1 - \dfrac{m\delta}{\delta + \rho - \pi}}{1 - \tau} \right) (\rho + \delta - \pi) - \delta$$

$$= \frac{\delta(1 - m) + \rho - \pi}{1 - \tau} - \delta.$$

In the integrated system, $\rho = (1 - m)r + \pi$ (see text) and $\tau = m$. In this case,

$$p = \frac{\delta(1 - m) + r(1 - m) + \pi - \pi}{1 - m} - \delta$$

$$= r.$$

with positive taxable profits who could claim the tax allowances. Where this is possible the effectiveness of tax allowances is not diminished.

We have made no explicit allowance for risk in our calculations, and the equations above assume perfect certainty. In itself this is not a significant assumption, in that the effect of risk is mainly to alter the required rate of return on an investment project. A project that is unusually risky will require a high rate of return, particularly if it has a high covariance with other projects, thus reducing its value as an investment hedge. These differences mean that the value of r we choose to use in the fixed-r calculations might differ for projects with varying degrees of risk. But we wish to evaluate the incentives provided by the tax system, and it seems sensible to use a common value of r (or p) for all projects. Risk might vary from one industry to another or one asset to another, and it is possible that our investor groups would have different degrees of risk aversion and would choose different portfolios accordingly. These considerations mean that we might wish to evaluate marginal tax rates at different values for the real rate of return required by savers, but they do not alter the principles underlying calculations of the magnitude of the wedge the tax system imposes between a given rate of return on a project and the rate of return that can be paid out to the supplier of finance.

The definition of tax-exempt institutions includes pension funds. The tax treatment of contributions to pension funds does indeed imply a zero marginal tax rate on capital income, provided the income tax rate against which contributions may be deducted is equal to the income tax rate at which ultimate pension benefits are taxed when paid out. In practice, individuals may have higher tax rates during their working life when making contributions than during retirement when receiving pension benefits. To the extent that tax rates fall after retirement, the effective tax on capital income from pension funds is negative rather than zero. Our calculations slightly overstate the true marginal tax rate on capital income in this case.

One difficult problem concerns the tax treatment of funds deposited by households (or institutions) in banks and then lent by banks to companies. This indirect form of debt finance, in contrast to direct purchase of corporate bonds, has been growing in recent years. We assume in our calculations that the banking system acts as a competitive financial intermediary and that, at the margin, it earns no monopoly profits on interest receipts. Hence the only taxes we assume are collected on interest receipts in connection with corporate borrowing from banks are personal taxes levied on investors' interest income. At this point we draw a distinction between time deposits and checking accounts. The former pay interest at market rates (except in the United States, where legal restrictions hold rates down; see chap. 6 for further discussion of the tax treatment in this case), and investors pay income tax on such interest income. For time deposits, we assume that interest payments are taxed at investors' marginal tax rates. But where funds lent to firms originate from an addition to checking accounts, then, in those countries where checking accounts do not pay interest, the income accrues to households in the form of tax-free banking services. On accounts of this type we assume that the effective personal tax rate is zero. We assume that a marginal investment financed by bank borrowing would come from the two types of accounts in proportion to their existing deposits, such that the average marginal personal tax rate on interest paid to banks is a weighted average of zero (for checking accounts) and the investor's marginal tax rate (for time deposits). A diagrammatic illustration of our assumptions concerning the tax treatment of debt finance is given in chapter 3, where this issue is first discussed with reference to a particular country. Refer to that discussion for an empirical analysis of the taxation of interest income.

Net trade credit is excluded from our definition of debt finance. This exclusion causes the magnitude of debt finance to be understated, particularly for the "other industry" sector in Sweden. The matter is discussed further in individual country chapters.

Finally, we have estimated rates of true economic depreciation for use in our calculations. In our exposition, it was convenient to assume that assets decayed exponentially, but in most countries national accounts estimates of depreciation and capital stocks employ the assumption of straight-line depreciation with lifetimes obtained from surveys or other sources. To exploit these sources of data concerning asset lives, we ask, What rate of exponential depreciation would give the same present discounted value of the depreciation stream as is implied by straight-line depreciation with an asset life of L years? If we discount at the real interest rate (we are measuring real flows here), then the answer to this question is the exponential rate δ given by

$$\text{(2.29)} \qquad \frac{\delta}{r+\delta} = \frac{1}{rL}(1 - e^{-rL}).$$

Rearranging this yields

$$\text{(2.30)} \qquad \delta = \frac{r(1 - e^{-rL})}{rL - (1 - e^{-rL})}.$$

Although the value of δ in equation (2.30) depends upon the real discount rate, a good approximation may be found in cases where the product of the real discount rate and the asset life is small. Formally, it is possible to show that[7]

$$\text{(2.31)} \qquad \lim_{r \to 0} (\delta) = \frac{2}{L}.$$

7. Applying L'Hôpital's rule twice.

Table 2.1 **Exchange Rates, End of 1980**
(units of row currency per unit of column currency)

	United States	United Kingdom	Sweden	Germany
United States	1.000	2.385	0.229	0.510
United Kingdom	0.419	1.000	0.096	0.214
Sweden	4.373	10.417	1.000	2.230
West Germany	1.959	4.680	0.448	1.000

Source: International Monetary Fund, *International Financial Statistics*.

We use the asset lives provided by national accounts data and convert to equivalent rates of true economic depreciation using equation (2.31).

2.5 Data Requirements

The data requirements for our study are as follows. First, we need a detailed description of the statutory tax rates embodied in the tax system and a detailed description of the parameters embodied in the rules that enter into the definition of the cost of capital equations. Given these data, we calculate effective marginal tax rates for all eighty-one combinations. Second, we need weights for the proportion of total net capital stock that can be identified with each combination. The construction of both kinds of data is described in detail in each country chapter. The first section of each chapter contains an introduction to the tax system and general background on its rules. The tax system itself is described in section 2. The capital stock weights are described in section 3. All data refer to the calendar year 1980, or to the nearest tax year if the fiscal year differs from the calendar year. To enable the reader to compare monetary values across countries, we show in table 2.1 the matrix of exchange rates ruling at the end of 1980. Our aim is to provide sufficient information about the methods employed and the data used in our computations so that other investigators may, first, repeat our calculations to confirm the results and, second, extend the coverage to earlier time periods and to a wider range of countries.