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Measuring Tax Burdens: An Overview

This paper has been prepared by the OECD Centre for Tax Policy and Administration, CTPA

A NOTE ON MEASURING TAX BURDENS

1.1 Introduction

In all countries, the rapid integration of national economies forces policy-makers to critically re-examine existing tax systems. It is in the context of this policy debate that policymakers and others seek to better grasp the impact of taxation on domestic investment, employment growth and overall economic performance. Policy-makers are concerned that present tax systems may discourage economic activity and destroy jobs, but face limitations on the amount of tax relief they can deliver, given the need to finance government expenditure. Thus, efficiency, competitiveness and revenue concerns are at stake. At the same time, increased difficulty in taxing income from capital resulting from the increasing mobility of capital may create pressures for a gradual shifting of the tax burden away from capital onto labour and consumption, raising equity and efficiency concerns.

In response to growing demand, policy-analysts have developed various measures to assess tax burdens and the impact of taxes on economic activity. This paper reviews the most common measures to gauge tax burdens:

i) nominal tax rates (Section 1.2);

ii) tax-to-GDP ratios (Section 1.3);

iii) average tax rates (Section 1.4);

iv) marginal effective tax rates (Section 1.5) and limitations (Section 1.6).

1.2 Nominal tax rates

The most basic and often-cited measures of tax burdens are nominal or 'statutory' tax rates. Nominal or 'headline' rates are relevant, because they have an important signal function, partly determine the value of tax concessions and are commonly an important factor in decision making on new investment.

As many would be quick to point out, however, nominal tax rates tell an incomplete story, because effective tax rates will usually be lower than nominal rates suggest. The reason being that household income and corporate profits determined in accordance with standard accounting practices may be reduced by specific provisions in the tax legislation before nominal rates are applied to a significantly smaller tax base (taxable income, profits). For example, under most tax systems individuals can defer taxation on part of their income set aside for old age, and in many cases imputed rent of home-owners goes untaxed while interest expenses are partly and — in rather exceptional cases — even fully deductible. Similarly, corporate profits determined following standard accounting practices may be reduced by specific provisions in the tax legislation, such as generous depreciation schemes and tax

incentives to promote investment aimed at R&D or particular regions, reserve provisions for tax purposes and because of international tax planning (see Box 1.A).

Why nominal rates may be deceptive (Box 1.A)

Assume accounting profit amounts to 100 units and the nominal corporate tax rate is 35 percent. If taxable profit of this firm is only 60 units, the corporate tax bill of 21 units reflects the nominal rate of 35 per cent applied to taxable profit of 60. The effective average tax rate in this case is much lower, i.e. 21 per cent: 21 units paid in tax over 100 in accounting profits.

Clearly, nominal tax rates will more closely indicate effective tax burdens where taxpayers have limited opportunities to reduce the tax base below earned income and book profits using such specific tax reliefs. It follows that the effective tax burden of households or corporations — on an individual basis or for households or corporations as a group — can only be measured by expressing taxes actually paid as a percentage of some adjusted measure of income or profits.[1]

Nominal rates as applied to taxable income or profit are relevant to tax planning incentives, since they generally determine the value of tax deductions — e.g., deduction of interest payments (see Box 1.B) — and income inclusions — relevant to transfer pricing incentives and thin capitalisation.

When nominal rates matter (Box 1.B)

If the nominal corporate tax rate in a country is 35 per cent, the value of deducting one additional currency unit of interest is 0.35 currency units. In the context of a multinational corporation considering where to book additional interest expense for tax purposes, the relevant comparison between jurisdiction A and B is thus a comparison of nominal corporate income tax rates in both jurisdictions.

1.3 Tax-to-GDP ratios

A second way to approach the tax burden of the household or corporate sector of the economy is to express total revenue from taxes paid by that sector as a percentage of Gross Domestic Product (GDP). Tax-to-GDP ratios must be interpreted with great caution.

Indeed, ratios of aggregate tax over GDP provide only limited information on the tax burden of the household or corporate sector, as may be demonstrated by a closer analysis of the ratio of corporate income tax (CIT) to GDP. First, such CIT-to-GDP ratios mask changes in corporate tax as a percentage of corporate profit. To see this, note that corporate tax relative to GDP is determined by the product of two ratios:

1. corporate tax divided by pre-tax corporate profit, and
2. pre-tax corporate profit as a share of GDP.

The first ratio, which is an average corporate income tax measure, will vary with changes in the nominal corporate tax rate and with changes in the corporate tax base. Changes in this ratio therefore reflect primarily changes in tax policy, the efficiency of the tax administration, compliance and tax planning — the way corporations respond to existing legal provisions. The second ratio, pre-tax

[1] This alternative approach produces average tax rates. Certain adjustments to accounting or book profit are required for an accurate measure of the corporate tax burden (e.g., adjustments for inflation, losses, foreign profits.)

corporate profits relative to GDP, will vary with fluctuations in the share of corporate profits in aggregate value-added in the economy.

Holding tax policy constant — i.e., assuming the rules determining corporate tax rates and the tax base are fixed — and assuming unchanged tax practice (administration, compliance), a drop in corporate profit over GDP would cause the corporate tax-to-GDP ratio to decline. This outcome could be mistakenly interpreted as indicating a reduction in corporate tax on corporate profits, when in fact this value is unchanged (see example in Box 1.C).

Why tax-GDP ratios can be deceptive (Box 1.C)

Assume the ratio of corporate income tax revenues to the value of GDP in countries A and B is 2.5 per cent and 5 per cent, respectively. This suggests that tax burdens are higher in country B. However, this need not be the case. If corporate earnings in countries A and B constitute 10 per cent and 20 per cent of GDP, respectively, the average effective tax rate for the corporate sector is 25 per cent in both cases since in country A corporations pay 2.5 per cent of GDP on their profits equal to 10 per cent of GDP, and corporations in country B pay relatively twice as much in taxes on profits that in relative terms are twice as high as in country A.

A second limitation of CIT-to-GDP ratios is that they include only one of several taxes corporations pay out of earnings. In a number of countries, other taxes paid by corporations may be important. In particular, taxes on capital, taxes on financial transactions and payroll taxes can be significant.

A third problem is that such ratios include negative profits (i.e., losses) in the denominator (GDP), which should be excluded when measuring the effective average tax rate on profitable firms.

Finally, CIT-to-GDP ratios may include corporate-level taxes on distributed earnings (i.e., equalisation taxes), which many would argue represent pre-payments of personal level taxes shareholders must pay and should therefore not be included in the measurement of corporate tax burdens.

1.4 Average tax rates

Average tax rates (ATR) are a third way to assess tax burdens of households or corporations. To calculate an average tax rate for an individual household, all relevant taxes paid are divided by a measure of household income, defined as the sum of consumption plus the change in net wealth of that particular household during a given time period (i.e., an economic definition of income) or, alternatively, measured following some legal definition of income. Taking recourse to ATR measures partially overcomes the limitations associated with a comparison of nominal rates and tax-to-GDP ratios. Their main advantage, relative to nominal tax rates, is that they take into account actual taxes paid. They also use a more narrowly defined (targeted) measure of tax base in comparison to tax-to-GDP ratios.

ATRs are mainly used in practice to analyse tax burdens on corporations, or the business sector as a whole (including unincorporated business) where, as noted, included in the denominator is a more narrow measure of aggregate business surplus than is total GDP. Average corporate tax rates take into account the impact of special relief (e.g., investment tax allowances, credits, enhanced depreciation provisions, donations to reserves to cover future risks) on marginal and infra-marginal investment, tax-planning and other factors determining final tax liabilities. Thus, the limitations inherent to tax burden measures such as nominal rates and tax-to-GDP ratios are partly lifted. Important differences may be observed, however, in the choice of the relevant tax base (denominator of the average tax ratio.)

To calculate an average tax rate for a corporation, the standard approach is to relate total taxes actually paid out of corporate earnings to an adjusted measure of corporate financial profit, with adjustments to

corporate financial (book) profit made to arrive at a measure of true (economic) income. To calculate an average rate for all corporations, total taxes actually paid out of corporate earnings are related, under the so-called 'implicit' tax rate approach, to the 'operating surplus' of the economy. The operating surplus of the corporate sector is a measure of domestic value-added at the corporate level accruing to suppliers of capital (gross output at producer's prices less the sum of intermediate and fixed capital consumption, wage costs (including employer social security contributions), and indirect taxes net of subsidies.) Viewed another way, corporate operating surplus captures domestic source income of capital suppliers generated at the corporate level and realised in the form of interest, rents, royalties, dividends and retained earnings. National Accounts also report separately (for most countries) the operating surplus of unincorporated business.

Total operating surplus of the economy will differ from aggregate commercial and true economic profits of corporations and unincorporated enterprises on account of a number of factors. One of the main differences is the inclusion in operating surplus of interest income paid (directly or indirectly) to households (savers.) This renders implicit corporate tax rates of questionable relevance, and suggests that the implicit tax rate approach be limited to analyses of average tax rates on income from capital (which factor returns to debt and equity capital in the denominator, with both corporate and personal tax on these amounts included in the numerator.) The implication is that more conventional average corporate tax rate measures relating corporate income taxes paid to corporate profit are called for.

However, profit-based average tax rates derived from aggregate or firm-level data may suffer from a number of shortcomings, for example the inclusion in the denominator of negative profits of loss-making firms, and the inclusion in the numerator of net domestic tax on foreign source income (excluded from the denominator.) Ideally, detailed micro-data should be used to enable a proper match of taxes actually paid on adjusted corporate profit at the firm level for a representative sample of firms. Adjustments to corporate book profit figures are necessary to improve consistency between numerator and denominator amounts, and to move towards a true definition of economic income. This micro-data set would allow one to determine measurement errors in average tax rates derived using aggregate data, and to establish average tax rates by sector, by firm size (small and medium-sized enterprises versus multinational corporations), and so on.

1.5 Marginal effective tax rates

Yet another way to analyse tax burdens is to calculate the 'wedge' that taxes drive between pre-tax and after-tax rates of return at the margin, that is, on the last currency unit invested where the marginal benefit of the investment just covers it marginal cost. The resulting marginal effective tax rates (METRs) can be calculated assuming a specific type or mix of investments (buildings, machinery, inventories), a specific or mixed source of finance (retained earnings, new equity, debt), and with reference to historic rates of inflation.

In sum, METRs are computed by deriving, for a representative group of investors and firms, the wedge that taxation creates between pre-tax and after-tax rates of return at the margin, taking into account nominal tax rates and basic rules determining tax deductions and tax credits. In theory, METRs measure the impact of taxation on required rates of return and thus investment incentives at the margin. METRs may be compared across investment projects, investor groups, methods of finance, and across countries. In 1991, the OECD published a study *Taxing Profits in a Global Economy* that included comprehensive work in this area.

Results of METR analysis — a highly theoretical construct — must be interpreted with due caution, bearing in mind the simplifying assumptions behind the neo-classical theory of investment upon which the methodology is based (as elaborated below in 1.6). Also, when calculating METRs only a part of

the tax system is taken into account, for example possibilities to form reserves are neglected. And finally the METR calculations assume that investors pay tax according to the nominal rates. It was already explained that taxpayers often pay lower effective rates, largely for reasons not included in METR calculations.

5.6 Limitations of METR analysis

This section considers marginal effective tax rate analysis, with an eye towards critically assessing its usefulness as a guide to the formulation of tax policy. The focus here is on METRs applicable to (physical) capital investment.[2]

METRs have enjoyed considerable support as summary statistics of the combined interaction of a range of tax parameters linked to investments decisions, and as indicators of how tax provisions compare over time, across industries and across countries. This widespread interest has encouraged many specialists to devote time and effort to measuring, cataloguing and promoting METRs as benchmark statistics to guide tax policy making. Given this development, it is important to reflect on the many caveats linked to the underlying framework, in order that METR results and their use can be placed in proper perspective.

The issues reviewed below suggest that METR analysis can be helpful if not pushed beyond its limits. METRs should be seen as rough proxy variables that summarise at a broad level the interaction of various tax rules relating to capital investment. METRs also provide a useful framework for identifying the various channels through which tax policy might be expected to influence investment behaviour — through the taxation of returns from investment; through the impact of tax deductions and credits on the effective purchase price of additional units of capital; and through the possible effects of corporate and shareholder-level taxation on the cost of funds (financial capital).

However, METRs do not offer a definitive assessment of the impact of tax policies on actual investment flows or capital stocks. A number of the key assumptions typically invoked are untenable in many instances, thus making comparisons across sectors or countries difficult. Also, the measurement of METRs is typically fraught with data and aggregation problems, so that even if the underlying assumptions hold, the resulting statistics may be off the mark. Moreover, owing to the static partial equilibrium framework from which METR statistics are derived, METR analysis by itself is incapable of assessing investment and capital stock responses to tax changes, factor substitution possibilities, timing issues, distributional effects, tax-planning responses, and a host of other areas that must be addressed when assessing alternative tax policy settings. Careful consideration of the range of conceptual and data problems touched on in this chapter suggests that METR statistics and comparisons across sectors or countries cannot be used confidently as an indicator of the influence of taxation on investment or as a guide to the setting of tax policy.

The goal of this chapter is to provide background material on some of the caveats associated with METR analysis in order to assist in the development of a consensus on the usefulness of METR statistics as guides to assessing tax policy positions and options. The development of a consensus view is important to ensure that accurate and consistent weight be attached to such measures in discussions of tax policy within and outside the OECD.

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[2] While taxes of various sorts impinge upon a variety of resource allocation decisions that firms and households take, this note focuses on the limitations of METR analysis as applied to investments in capital (of which there are a number of types, including physical, R&D and human), given that most METR efforts and complexities are concentrated in this area.

The following sub-section 5.6.1 reviews key assumptions that underlie conventional METR analysis, and questions whether these assumptions can be assumed to hold in all cases. To the extent that they cannot, caution must be exercised in relying on METR statistics as a basis for comparing the net influence of tax policy on investment incentives across sectors and countries. In sub-section 5.6.2 a range of problems imposed by data limitations and aggregation techniques is surveyed, which further caution against the use of METR statistics for tax policy analysis purposes.

5.6.1 Robustness of underlying assumptions

This sub-section critically reviews six assumptions underlying METR analysis.

Perfect competition and absence of economic rent

Most models used to calculate marginal effective tax rates assume that the representative firm operates in perfectly competitive markets, and takes output prices as given. While this assumption may hold in certain sectors, and in some countries, it will not hold in most cases most of the time. Firms often enjoy a degree of monopoly power, for example. This suggests inclusion in the denominator of the METR statistic of a measure of the elasticity of the representative firm's investment demand schedule.[3] However, data on this elasticity, and how it varies across sectors, countries and time would require access to detailed firm data which are generally unavailable to analysts.

The model also assumes that firms invest in capital up to the point where the after-tax marginal benefit from the last unit of installed capital just equals the after-tax marginal cost. This result is based on the assumption first that the firm's investment plans are generated by the managerial goal of maximising shareholder equity, and second that investment capital is infinitely divisible. In a number of cases, a firm's investment plans may not be driven by value-maximising behaviour. Other management objectives may be at work, and/or a firm may be earning significant (pure) economic rents — owing to barriers to entry into the industry or other factors — such that investment plans are not pushed up to the margin where project net benefits equal net costs. Moreover, investment projects will usually be 'lumpy' (i.e., not infinitely divisible). In such cases, investment in capital may proceed up to a point where economic rents are being earned at the margin (and these rents are not realised, as the acceptance of an additional investment project, requiring a large discrete increase in the capital stock, may push net project benefits below net project costs). In such cases where economic rents are earned at the margin, (relatively small) variations in METRs — generated by variations in income tax rates, investment tax credits, and/or other METR parameters — would not be expected to influence the level of investment as conventional METR analysis assumes.

Declining marginal productivity of capital

The neo-classical investment theory underlying METR analysis assumes that the marginal product of capital, that is the additional amount of output generated from an additional unit of installed capital, declines as the size of the overall capital stock increases. This yields an equilibrium result where firms invest just up to the point where the after-tax value of additional output generated by investment at the margin just equals its after-tax cost. The assumption of decreasing returns at the margin is adopted in most METR models examining investments in real physical capital, R&D and human capital.

However, this assumption may not hold across all sectors, countries and time. New insights from recent work in growth theory, for example, characterise knowledge capital as generating increasing

[3] In particular, assuming the monopolist maximises profits, the term (1–(1/h)) should appear in the denominator, where h is the elasticity of demand (positive for a downward sloping demand curve).

returns in the production of output at the margin.[4] Inputs of physical and human capital generate knowledge, and knowledge helps produce additional human capital. The possibility that the rate of return on capital may increase rather than decrease with increases in the capital stock, in this case knowledge capital, suggests that the extension of METR analysis to investments in knowledge capital may be inappropriate and provide a misleading indicator of tax effects.[5]

Financial structure and market arbitrage conditions

One of the most difficult and contentious areas in METR analysis involves the choice of the financial market arbitrage assumption to employ in the determination of the representative firm's cost of funds (r). Complications arise because income tax systems treat different types of finance differently, and different types of savers differently. Moreover, empirical uncertainty surrounds the extent to which tax burdens (or tax relief) tied to financial returns are borne by firms versus savers, and the extent, manner and timing in which differential tax treatment of financial assets is arbitraged away at the corporate or individual investor level. These are very much unresolved empirical issues, and one would expect that the answers vary depending on the time period, the country and even the sector being examined.

Many arbitrage assumptions have been used in the literature. While these will not be exhaustively reviewed here, a brief consideration of possible arbitrage assumptions under the so-called 'fixed–r' approach is illuminating.[6] The fixed–r approach assumes all projects earn the same after-corporate tax rate of return. For any given saver, this means that all (domestic) projects yield the same after-personal tax rate of return. Differences in the tax treatment of investment income across different investors imply that after-personal tax rates of return will vary across savers.

Within the fixed–r framework, several possibilities exist. One approach is to assume that arbitrage at the level of the firm equates the after-tax cost of debt finance with the (non-deductible) cost of equity finance, without distinguishing between retained earnings and new share issues.[7] Another is to assume that dividends have some intrinsic value to shareholders (perhaps offer a signalling function), and that firms trade off these intrinsic benefits against the tax cost of dividends compared with share repurchases, increasing dividend pay-out until they are indifferent at the margin between new share issues and retained earnings as a source of finance.[8]

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[4] Knowledge capital itself is taken to be the product of research investment which exhibits diminishing returns at the margin (i.e., doubling amounts invested in research in the pursuit of knowledge, holding other factors constant, will not double the amount of new knowledge produced). However, increments in knowledge capital generate increased amounts of output at the margin (due to partially appropriatable spillover effects.)

[5] See for example works by Romer (1989, 1994) who treats knowledge capital as non-rivalrous (i.e., can be shared with others at zero opportunity cost) and as being at least partly non-excludable.

[6] As described in the text, the 'fixed–r' approach treats the after-corporate tax rate of return as fixed across all investment projects. In contrast, the 'fixed–p' approach treats pre-corporate tax rates of return as fixed across projects. The latter approach is not viewed as an arbitrage assumption of how financial markets work, but rather as one technique for assessing how a particular project would be taxed under alternative tax and financing regimes. Arbitrage assumptions are still required under the fixed–p approach. Where METRs are calculated for each source of finance separately, for example as in King and Fullerton (1984), the fixed–p approach assumes that firms face the same after-tax cost of debt and equity finance (equal to the common cost of funds (r).)

[7] This might occur, for example, if the interest rate on debt rises with the amount borrowed (due, for example, to increased bankruptcy risk), so that firms continue to rely on cheaper debt finance (with deductible interest) up to the point where the costs of debt and equity are equated. See for example, Bradford and Fullerton (1981).

[8] See Poterba (1987).

Yet another approach is to assume that rates of return on retained earnings and new share issues are derived such that each alternative yields the same after-personal tax rate of return as that available on debt. Where tax treatment differs across shareholders, as for example between resident and non-resident shareholders, it is necessary to identify a 'marginal shareholder' whose tax treatment is relevant in the determination of the after-corporate tax cost of funds. The identification of such a shareholder is not always evident. Having chosen a representative shareholder, one might appeal to the 'new view' of dividend taxation which posits that dividend taxes are irrelevant to the determination of the cost of capital. Instead, one could use retained earnings to represent the marginal source of equity finance. Or one might choose to use a weighted average of the costs of retained earnings and new share issues.

In these latter cases, one typically assumes that the after-tax return on bonds should be used as the benchmark opportunity cost. However, even under this assumption, one must choose a given bond and corresponding interest rate, recognising that bond rates will vary by term and risk, with theory offering little guidance. Another complicating factor is that firms, to varying degrees across different sectors and countries, are relying increasingly on new financial (derivative) products, while most METR studies account only for conventional bonds and equity, thus missing the most active part of financial markets. Moreover, the factors used to weight different costs of finance (either in the determination of an overall cost of funds, or in weighting individual METRs each based on a single financing instrument) are typically based on historic average data, which in certain cases may be unrepresentative for forward-looking marginal investment projects.

Choosing a particular arbitrage assumption and holding it fixed across different METR calculations is not problematic if the exercise is one of attempting to summarise differences in the tax treatment of different investment projects, under the given set of arbitrage and other assumptions. However, as with the other assumptions and parameters entering a METR statistic, results that suggest that investment incentives in one project-type are more or less tax-distorted than those in another project-type are only as robust as the underlying assumptions themselves. This follows from the fact that the presence or absence of various tax parameters in the cost of funds expression depends uniquely on the arbitrage assumption. Where the correct arbitrage condition varies across time, or by country or by sector, METR statistics that use a fixed arbitrage assumption across cases will produce inaccurate investment incentive comparisons across time, countries and sectors.

Loss offsetting

METR analysis implicitly assumes that tax systems treat revenues and losses symmetrically, or in other words provide full or perfect loss offsetting. For this symmetry to hold, governments must provide taxpayers with full refundability of negative tax liabilities (or some equivalent, such as a carry-forward of tax losses and unused tax credits with interest). In practice, this is never the case. Tax systems generally provide only imperfect loss offsetting. While most corporate tax systems contain carry-back and carry-forward provisions for losses, these typically have a limited duration, and the carry-forward of losses is without interest. Moreover, the corporate tax rate applicable to a carry-back or carry-forward may differ from the current corporate rate.

In principle, capital cost allowance and investment tax credit parameters used to determine the net cost of physical capital should be adjusted to account for tax loss situations so that they reflect the (expected) present discounted value of the tax relief they represent. Similarly, interest deductions should be discounted in arriving at the cost of debt finance. On the revenue side, the corporate tax rate

applicable to marginal revenues should be discounted in loss carry-forward situations.[9] These adjustments work in opposite directions, and therefore *a priori* it is uncertain whether imperfect loss offsetting increases or decreases effective tax rates.

Failure to account for imperfect loss offsetting means that METRs will be biased, either positively or negatively, and to a degree which will vary across sectors, countries and over time as the tax loss position of firms (including the build-up of pools of tax losses) varies across sectors, countries and over time. Loss positions will be influenced by a host of factors including the percentages of firms in start-up versus mature states, differences in the timing of business cycles and exposure to economic shocks, and differences in current and past availability of investment tax incentives (which in many countries largely account for tax losses.) Another source of bias stems from the fact that countries differ in terms of their rules governing loss transfers within corporate groups. The limited amount of information on such factors suggests that the net effect of these distortions could be significant.

Treatment of risk (uncertainty)

Closely related to the issue of loss-offsetting is the treatment of risk. METR analysis often employs static expectations and assumes perfect certainty. This assumes that firms expect that the future values of all parameters in the METR expression, including tax rates, will remain unchanged from their current values, and that these values are expected with certainty. Many would agree that these assumptions are counter-factual. Frequent changes to the tax code attest to the fact of the non-static nature of tax rates and parameters, and moreover future tax changes are often announced. Also, future movements of output and input prices, and interest rates and inflation rates are generally uncertain, suggesting that firms would consider a range of probable values for these parameters, rather than assigning a fixed single value to them, when assessing their investment incentives. This is particularly the case when the project is longer term and the capital commitments are not easily reversible; more on the issue of capital irreversibility in what follows.

The literature suggests that METR analysis should distinguish between different types of risk, including income risk and capital risk.[10] *Income risk* refers to uncertainty regarding future net revenues arising from the stochastic movement of output and current input prices or demand faced by the firm. *Capital risk* refers to uncertainty regarding the economic rate of depreciation of installed capital, due either to an unknown future purchase price of capital or to a stochastic rate of physical depreciation or obsolescence.

If the tax system grants full loss offsets or its treatment approaches that, it may not be necessary to adjust METR expressions for income risk, as the government in this case shares equally in the profits and losses of the company — for example sharing 35 per cent of the profits and 35 per cent of the income risk, assuming a 35 per cent corporate income tax rate. The cost of bearing income risk is thus implicitly fully deducted under a full loss offset tax system, with no additional tax distortions being introduced for income-risky investments versus comparable riskless investments.

The situation is however different for capital-risky investments. In most countries, tax depreciation allowances are based on the original cost of the asset, and thus do not change with unanticipated

[9] In the case of a loss carry back, no adjustment generally would be required. The value of the reduction in the loss carry-back caused by the additional revenue from a marginal investment is determined by the current corporate tax rate (assuming that the current corporate tax rate and that applicable in the carry back period are the same.)

[10] See Auerbach (1983), Gordon (1985), Bulow and Summers (1984), and Gordon and Wilson (1989).

changes in the market value of installed capital, as can occur with unanticipated technological change or unanticipated tax changes. The implication is that, even where negative taxes are refunded, the tax system does not provide deductions of the full cost of bearing capital risk and thus the METR expression should take into account this tax distortion on risky assets.

Capital risk may be accounted for in theory by increasing the economic rate of depreciation (without an equivalent increase in the tax depreciation rate.) However, in practice it is difficult to measure the risk premium associated with capital risk. Some have argued that a firm's market value equals its asset value, and so fluctuations in market value reflect changes in the value of underlying assets.[11] This view suggests that capital asset pricing models (CAPMs) could be used to assess capital risk premiums. However, other work has shown that it is the correlation between the economic cost of depreciation and consumption that is relevant, and that this correlation could be negative, implying that CAPM estimates for capital risk premiums would be inappropriate.[12]

Capital irreversibility

In addition to ignoring the complications introduced by uncertainty, most METR analysis implicitly assumes that capital investments are reversible in full and without cost. This characterisation is clearly inappropriate for most types of capital. Capital will often be task or industry specific, and where it is not, the costs of removing it from a given installation and transferring it to another may be significant. If the conversion of capital to alternative uses is extremely costly, if not impossible, then the capital investment is said to be irreversible.

Relatively little research has been undertaken to determine the implications of irreversibility for the measurement of capital demand and METRs, despite the apparent importance of this factor.[13] The available evidence examining the implications of capital irreversibility suggests that the METR on irreversible capital can be significantly higher than that on fully reversible capital, depending on the level and type of risk, and is generally increasing in income and capital risk.[14] The implication is that ignoring this feature would tend to bias cross-sector or cross-country METR results, as a result of different risk characteristics across different investment cases.

5.6.2 Data limitations

The preceding sub-section reviewed conceptual problems associated with METR analysis. This sub-section discusses limitations to METR analysis arising from data problems.

Perhaps the most central data problem encountered in this area arises from the fact that many of the required variables are unobservable due to the forward-looking nature of investment decisions. Another is the modelling uncertainty over underlying production technologies of the 'representative' firm. Yet another arises from the fact that aggregation is inevitable, given that firm-level data are generally not available. The following briefly reviews some of the difficulties in obtaining representative values for key parameters used in standard METR equations for capital investment.

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[11] See Bulow and Summers (1984).

[12] See Gordon and Wilson (1989).

[13] Exceptions include Bertola and Caballero (1991) and McKenzie (1992). Pindyck (1991) provides a review of earlier research.

[14] Bertola and Caballero (1991) present a model which generalises the derivation of the Jorgenson user cost of capital to an environment with irreversible capital and risk. McKenzie (1992) uses the same approach to examine the implications of irreversibility and different sources of risk for the measurement of METRs.

Corporate-level tax parameters

METR expressions for capital investment generally include a corporate income tax rate and a term measuring the present value of tax depreciation allowances claimed on a unit of investment at the margin. Investment tax credit rate(s) may also enter, if applicable. Typically, current nominal corporate tax rates, capital cost allowance and investment tax credit rates are applied, despite the fact that expectations over the future values of these rates may not be static, and full loss offsetting generally is not provided. The problem facing the model builder is that the tax (and price) parameter values entering the METR equation should be the ones expected by investment decision-makers. The difficulty is that underlying expectation formation processes (which one would expect to vary between investment cases) are generally unknown. Similarly, detailed information on the past and expected future loss positions of firms are unknown, thus making the task of adjusting parameter values to account for imperfect loss offsetting highly uncertain — a challenge therefore often ignored by model builders.

The appropriate rate at which to discount future capital cost allowances is also less than clear. In the case where tax depreciation is not indexed for inflation, there is agreement that a nominal rate should be used. But should the nominal rate correspond to the real cost-of-finance term entering the METR equation directly, or should it be the nominal rate on government bonds in light of the fact that, at least for a taxable firm, the stream of tax relief is more or less certain? Alternatively, investment managers may use some other (unknown) rate.

Another complication related to discounting tax parameters in recognition of imperfect loss offsetting is how to account for tax planning opportunities. Where incentives exist for taxpayers to shift domestic profits offshore, through transfer pricing techniques and tax motivated financial structures for example, the use of the nominal corporate income tax rate in the METR equation will tend to overstate the rate at which investment income is taxed at the margin. But the question arises of how to accurately account for this effect. In particular, to what extent should the corporate income tax rate be reduced below its statutory value? The answer might vary across sectors and countries, and would be expected to change over time as the percentage of firms in the domestic economy with global operations (and global tax-planning opportunities) increases, and as the array of sophisticated tax-planning techniques evolves. Moreover, the ability of firms to tax-plan around the nominal rate depends on the existence (or not) and the strength of provisions aimed at protecting the domestic income tax base (e.g., transfer pricing rules and enforcement, thin capitalisation rules).

Moreover, for certain (inbound) investment projects, foreign corporate tax rates will influence domestic investment plans, meaning that the use of domestic corporate tax rates to explain domestic investment incentives may be misleading. In general, foreign tax rates will matter where foreign (inbound) investors are taxed in their home country on their foreign source income at rates in excess of domestic (host country) tax rates. The importance of taking into account foreign investors and their tax position will vary across sectors, countries and time. Historical data on patterns of inbound investment would generally provide an unreliable indicator of the importance of inbound investment, and (forward-looking) information on the domestic investment plans of offshore investors is typically unavailable. Moreover, modelling the interaction of domestic and foreign tax systems accurately would require detailed knowledge of the global operations of inbound investors in order to establish tax planning opportunities. A simplifying approach that is often implicitly used is to assume that domestic (host) country tax rates exceed those in the home country of foreign investors. But even if this were the case, the domestic statutory tax rate may overstate the rate at which domestic source profits are taxed to the extent that significant amounts of domestic profit can be shifted to low or zero-tax rate jurisdictions.

Shareholder-level tax parameters

Personal income tax rates also enter METR analysis, both in the determination of the net return to savers and, depending on the arbitrage assumption, in the calculation of the firm's cost of funds. Relevant personal tax rates generally include an (ordinary) income tax rate, a dividend tax rate, and an effective (accrual) capital gains tax rate.

Different tax wedges may be measured for different groups of savers, and for different types of investment returns (interest, retained earnings, new share issues.) Given the number of possible combinations, METRs are usually derived for broad groups of savers (e.g., domestic households, tax-exempt institutions). For the domestic (taxable) household group, a weighted average income tax rate is generally called for. If available, information on the distribution in prior years of investment income across taxable income classes is used to derive the weights. These may be appropriate in the calculation of a historic (backward-looking) METR series, but may be misleading for the purpose of deriving a current period or forward-looking METR. Similarly, where the net return to savers is measured as a weighted average of returns on interest, retained earnings and new share issues, a weighting scheme that relies on historic data may misrepresent the actual distribution of returns on funds used to finance current or future investment at the margin.

A number of expressions found in the literature to measure the net return to savers include a capital gains tax rate term. A data complication encountered here arises out of the fact that while in practice capital gains are subject to tax on a realisation basis, the METR model assumes that they are taxed on an accrual basis. Thus a representative effective accrual-equivalent capital gains tax rate must be derived. In order to convert a statutory (realisation based) capital gains tax rate to its accrual equivalent, one must make assumptions regarding the expected holding period of equity shares. METR modellers typically must rely on historic information on the average holding period of some basket of shares, which may generate an unreliable estimate of the average expected holding period of shares in firms in a given sector, country and time. For example, optimal holding periods required for preferential tax treatment will vary between countries and over time. An appropriate discount rate must also be chosen. The approach is inevitably *ad hoc* and subject to measurement error.

As noted above, shareholder-level tax rates may also factor into the formula for the firm's cost of finance. Because different taxpayer groups — such as domestic households, financial institutions, tax-exempt entities, non-resident investors — are subject to different tax treatment, a choice must be made to identify the 'marginal' shareholder or 'tax clientele' whose tax treatment is relevant to the determination of the cost of funds (i.e., capitalised into share prices.) One would not expect that the identity of the marginal shareholder group would hold consistently across different sectors, given the varying importance of investor groups (e.g., domestic households, financial institutions, tax-exempt entities and non-residents) across sectors, countries and time. Yet, typically, insufficient information is available to identify marginal shareholder groups, and an arbitrary choice will be made and assumed to consistently hold across all (domestic) cases.

Economic depreciation

One of the key parameters entering METR expressions for depreciable capital is the (true) rate of economic depreciation.[15] This rate generally cannot be observed and must be inferred. Often second-hand markets do not exist for many types of capital goods, and even where they do, information on the prices at which these goods are transacted is typically unavailable to METR modellers. The typical

[15] This depreciation parameter, along with the real cost of finance, determines the flow cost of holding a currency unit's worth of capital for one period.

approach taken is to use reported (and often dated) information on service lives, and to make some arbitrary assumption about the depreciation profile (e.g., exponential).

A key problem in measuring economic depreciation, and one that is often ignored, is that the term should take into account not only physical wear and tear, but also expected relative price changes (i.e., the change in the capital goods price index relative to the output price index.) Expected relative price changes can occur as a result of a number of considerations. For example, news of the imminent release of new capital technology that will render currently installed capital obsolete would reduce the value of the latter. Similarly, an announcement of an investment tax credit targeted at capital expenditures made after some future date would depress the value of capital stock installed today. A range of such factors could influence investment decisions, yet information on these factors is generally unknown and not taken into account by the METR modeller.

Required rates of return

A number of conceptual problems associated with the choice of the appropriate arbitrage assumption and financial structure were already considered. At a minimum, it is generally necessary to choose a representative interest rate, and depending on the arbitrage (or non-arbitrage) assumption, some independent measure of the cost of equity may be required as well.

In measuring the cost of debt finance, the choice of an appropriate interest rate is generally arbitrary. Interest rates vary according to the term of maturity of debt, and the market's risk assessment, which generally will be a function of the borrowing firm's financial position and the value of its property. In principle, some weighted-average interest rate should be used, but typically very little information is available to guide the choice over which interest rates to include and what weights to use.

Where equity rates of return are measured independently (rather than being assumed to be determined according to some arbitrage condition), one of a number of estimating approaches may be taken. For example, modellers may use (reciprocals of) adjusted price-earnings ratios, which are reported for various stock indexes. However, this approach and others suffer from the fact that they are essentially backward-looking, reflecting past earnings performance rather than expected future performance, and therefore may provide unreliable indicators of expected required rates of return.

Inflation rate

Another key term in the METR equation is the expected inflation rate, which is subtracted from the nominal cost of funds to arrive at a real cost of funds estimate. As with other parameters, it is the expected value of this rate, and not necessarily its current period value, which is relevant. However, the manner in which investment managers form expectations over this rate is unclear. Static expectations may apply in some cases, or alternatively various forecasting techniques may be used. An average METR statistic would in principle then involve some average of these estimation techniques, which of course are unknown.

Often METR analysis proceeds by simply assuming an expected inflation rate, and showing through sensitivity analysis that the METR results will differ significantly, depending on the expected inflation rate chosen. If the intention is simply to aggregate into a summary statistic the combined effect of various tax parameters thought to influence investment, and to compare this effect across different investment cases as a useful indicator of differential tax treatment, then such an approach generally would not be problematic.

REFERENCES

Altshuler, R. and A.J. Auerbach 1990, "The Significance of Tax Law Asymmetries: An Empirical Investigation", *Quarterly Journal of Economics*, 105, 61–86.

Auerbach, A.J. 1983, "Corporate Taxation in the United States", *Brookings Papers on Economic Activity*, 2, 451–505.

Baker & McKenzie 1999, Survey of the Effective Tax Burden in the European Union, Amsterdam. Report commissioned by the Ministry of Finance, the Netherlands.

Bertola, G. 1988, Adjustment Costs and Dynamic Factor Demands: Investment and Employment Under Uncertainty. Unpublished Ph.D. thesis, Cambridge Mass., MIT.

Bertola, G. and R. Caballero 1991, "Irreversibility and Aggregate Investment", Princeton University, mimeo.

Bradford, D.F. and D. Fullerton 1981, "Pitfalls in the Construction and use of Effective Tax Rates", in Hulten, C.R. (ed.), *Depreciation, Inflation and the Taxation of Income from Capital*, Washington: The Urban Institute, 251–278.

Bulow, J.I. and L.H. Summers 1984, "The Taxation of Risky Assets", *Journal of Political Economy*, 92, February, 20–39.

Devereux, M.P. and R. Griffith, The Taxation of Discrete Investment Choices, Working Paper Series No. W98/16, The Institute for Fiscal Studies, London.

Eurostat 1997, Structures of the Taxation Systems in the European Union, 1970–1995. Series 2A, Luxembourg.

Gordon, R.H. 1985, "Taxation of Corporate Capital Income: Tax Revenues Versus Tax Distortions", *Quarterly Journal of Economics*, 100, February, 1–27.

Gordon, R.H. and J.D. Wilson 1989, "Measuring the Efficiency Cost of Taxing Risky Capital Income", *American Economic Review*, 79, 427–439.

Holland, D. and S. Myers, 1979, "Trends in corporate profitability and capital costs", in R. Lindsay ed., *The nation's capital needs: Three studies* (Committee on Economic Development, Washington.)

Jarass, L., and G.M. Obermair 1997, "More Jobs, Less Tax Evasion, Cleaner Environment," Wiesbaden. Report commissioned by the European Commission.

King, M.A. and D. Fullerton 1984, *The Taxation of Income from Capital*, University of Chicago Press.

McKenzie, K.J. 1992, "The Implications of Risk and Irreversibility for the Measurement of Marginal Effective Tax Rates on Capital", Discussion Paper No.137, University of Calgary.

Mendoza, E.G., A. Razin, and L.L. Tesar 1994, "Effective tax rates in macroeconomics. Cross-country estimates of tax rates on factor incomes and consumption," *Journal of Monetary Economics*, 34, 297–323.

Mintz, J.M. 1988, "An Empirical Estimate of Corporate Tax Refundability and Effective Tax Rates", *Quarterly Journal of Economics*, 103, 225–231.

OECD, *Tax Expenditures: Recent experiences*, Paris, 1996.

OECD, *Taxing Wages 1998-1999*, Paris, 2000.

Pindyck, R.S. 1991, "Irreversible Investment, Capacity Choice, and the Value of the Firm", *Journal of Economic Literature*, 24, 1110–1148.

Poterba, J. 1987, "Tax Policy and Corporate Saving", *Brookings Papers on Economic Activity*, 2, 455–515.

Romer, P. 1989, "Increasing Returns and New Developments in the Theory of Growth", *NBER Working Paper Series*, Working Paper No. 3098, 1–31.

_____ 1994, "The Origins of Endogenous Growth", *Journal of Economic Perspectives*, 8, 322.