ESTIMATING EFFECTIVE TAX RATES ON CORPORATE INCOME

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This note explains the analytical framework and assumptions underlying the so-called King-Fullerton method of calculating effective corporate tax rates.

Effective Rates of Corporation Tax: An Informal Account

When measuring the effective tax burden on corporate investment, it is useful to distinguish between the average effective tax rate (AETR) and the marginal effective tax rate (METR).

The AETR measures the proportion of the value of an investment project which is paid in tax. It is given by the net present value of the corporation tax generated by the project divided by the present value of the pre-tax profit flows from the project. Below we show how the AETR can be calculated from information about the pre-tax rate of return, the rate of economic depreciation of the asset, the parameters of the corporate tax system, and the firm's discount rate (which will depend on the mode of investment finance).

In contrast, the METR measures the corporate tax burden on the *marginal* unit of investment which generates no net profit for the firm. Specifically, METR=$(c-\rho)/c$, where c is the real pre-tax rate of return on the marginal investment, and ρ is the company's real cost of finance, i.e., the net rate of return required by the investor supplying the funds for the project. The analysis below shows how the METR may be calculated. It also shows that the AETR is a weighted average of the METR and the statutory corporate tax rate, where the weight given to the statutory tax rate rises with the ratio of the firm's average to its marginal rate of return. For firms with a high average profitability the AETR will thus converge on the statutory tax rate, but for firms with low profitability the AETR will come close to the METR.

The AETR and the METR impact on different margins of decision-making. Once a firm has chosen a particular location, the optimal scale of its activities in this location will be influenced by the METR. For a given cost of finance, a higher METR implies a higher required minimum pre-tax return to the firm's investment and hence tends to reduce the optimal scale of investment. When it comes to the choice of location, the firm will consider the AETR as well as the METR. Having calculated the optimal scale of investment in the various alternative locations on the basis of their METRs, a profit-maximizing firm will choose that location which offers the highest total after-tax returns from the optimal plant size, and this will depend on the AETR.[1] Apart from influencing location decisions, the AETR may also affect the scale of investment in a given location by affecting the cash flows of firms whose ability to grow is constrained by limited access to external funding.

[1] This reasoning assumes that the fixed costs of setting up a business are so large that it is not profitable for firms to operate in all locations.

As these observations suggest, a government wishing to attract foreign direct investment via its tax policy should primarily focus on measures to reduce the AETR. On the other hand, if the main policy objective is to stimulate domestic investment in general, it may be more relevant to focus on the METR.

Below we describe in detail the method used to calculate effective tax rates. The analysis focuses only on the corporation tax and does not include personal taxes, since the cost of finance for companies with access to the international capital market is not affected by the domestic personal tax system. Even for companies without access to the world capital market, it is reasonable to abstract from personal taxes if the marginal supplier of funds to the firm is an institutional investor or a person evading personal income tax.

The average effective tax rate

The average effective tax rate (AETR) on the return to an investment project is defined as

$$AETR = \frac{PVT}{PV} \tag{1}$$

where *PVT* is the net present value of the corporation tax generated by the project, and *PV* is the net present value of the pre-tax profit flows from the project. Thus the AETR is the fraction of the value of the project which is paid in tax, assuming that the tax rules prevailing at the time of investment will be maintained in the future.

For simplicity, we consider investment in an asset which depreciates at the constant real exponential rate δ. If we treat time as a continuous variable and assume that the firm's cash flows rise in line with the general rate of inflation π, the gross nominal revenue at time t from a unit of investment made at time zero will be $\left(p+\delta\right)e^{-(\delta-\pi)t}$, where p is the real net rate of return before tax (i.e., the real pre-tax return net of depreciation), and e is the exponential function. Assuming that the firm maintains a constant debt-to-asset ratio β, the firm's debt at time t will be $\beta e^{-(\delta-\pi)t}$, since the asset depreciates at the nominal rate δ-π. If the real interest rate is r, the nominal interest rate is $r+\pi$. The tax code will normally allow firms to deduct all of their nominal interest payments $\left(r+\pi\right)\beta e^{-(\delta-\pi)t}$ from taxable income. Disregarding depreciation allowances and other capital allowances for the moment, the firm's tax bill in period t will then be $\tau\left[p+\delta-\left(r+\pi\right)\beta\right]e^{-(\delta-\pi)t}$, where τ is the statutory corporate tax rate.

The real discount rate of the suppliers of funds to the firm is ρ which may deviate from the real interest rate r to the extent that part of the investment is financed by equity[2]. Discounting the nominal tax payments made over the lifetime of the asset by the nominal discount rate $\rho+\pi$ and denoting the present value of all deductions for depreciation and other capital allowances by A, we thus obtain the following expression for the present value of the net taxes generated by the project:

[2] This assumes that equity is not a perfect substitute for debt.

$$PVT = \int_0^\infty \tau\left[p+\delta-(r+\pi)\beta\right]e^{-(\rho+\delta)t}dt - \tau A = \frac{\tau\left[p+\delta-\beta(r+\pi)\right]}{\rho+\delta} - \tau A \qquad (2)$$

Net of depreciation the project will generate flows of pre-tax income with a present value equal to

$$PV = \int_0^\infty pe^{-(\rho+\delta)t}dt = \frac{p}{\rho+\delta} \qquad (3)$$

Inserting (2) and (3) into (1), we get

$$AETR = \frac{\tau\left[p-\rho+(1-A)(\rho+\delta)-\beta(r+\pi)\right]}{p} \qquad (4)$$

The term *p*-*ρ* in the numerator of (4) is the pure rent from the project, defined as the difference between the actual pre-tax return and the investor's required return. This pure rent is taxed at the statutory corporate tax rate, thereby contributing to the average effective tax burden. The second term (*1*-*A*)(*p*+*δ*) in the numerator of (4) is the gross income flow from the project adjusted for the capital allowances that reduce the tax base, and the third term –*β*(*r*+*π*) captures the deduction for interest payments.

The marginal effective tax rate

The AETR may be calculated for any value of the pre-tax rate of return *p*. Of particular interest is the amount of tax collected on the *marginal* investment with a net-of-tax value equal to zero. Gross of tax and depreciation, the present value of the project is

$$PVG = \int_0^\infty (p+\delta)e^{-(\rho+\delta)t}dt = \frac{p+\delta}{\rho+\delta} \qquad (5)$$

Recalling that the initial investment outlay is one unit, the net-of-tax value of the project is therefore equal to *PVG*-*PVT*-1. Let *c* denote the value of *p* which ensures that the net-of-tax value of the project is exactly zero. Using (2) and (5), we find that this minimum required pre-tax rate of return (also referred to as the *cost of capital*) is given by

$$\begin{gathered} PVG - PVT - 1 = 0 \Rightarrow \\ c = \frac{(1-\tau A)(\rho+\delta)-\tau\beta(r+\pi)}{1-\tau} - \delta \end{gathered} \qquad (6)$$

Setting *p* equal to *c* in (4) and inserting (6) into the numerator, we obtain an expression for the marginal effective tax rate, i.e., the tax burden on a project which is just barely worth undertaking:

$$METR = \frac{\tau\left[(1-A)(\rho+\delta)-\beta(r+\pi)\right]}{(1-\tau)c} \qquad (7)$$

A more familiar measure of the marginal effective tax rate is

$$METR = \frac{c-\rho}{c} \qquad (8)$$

which says that the METR is the difference between the pre-tax and the after-tax rate of return, measured relative to the pre-tax return. By inserting (6) into the numerator of (8), one arrives at (7). Thus (7) and (8) are just alternative ways of expressing the same measure.

The relation between AETR and METR

If we insert (7) and (8) into (4), we get

$$AETR = \left(\frac{c}{p}\right)METR + \left(1-\frac{c}{p}\right)\tau \qquad (9)$$

showing that the AETR is a weighted average of the *METR* and the statutory tax rate, where the weight on the latter increases with the ratio of the average to the marginal rate of return. Thus, the greater the intramarginal return (the rent) earned by a company, the greater is the significance of the statutory tax rate for its AETR.

The discount rate

Shares normally carry a risk premium compared to debt instruments, so we allow for the possibility that the required return on shares *s* may deviate from the real cost of debt *r*. The firm's discount rate is a weighted average of the costs of debt and equity, with the weight of debt being equal to the debt-asset ratio:

$$\rho = \beta r + (1-\beta)s \qquad (10)$$

Note that the cost of debt enters equation (10) gross of corporation tax, since our derivations of AETR and METR already allowed for the deductibility of interest payments.

The present value of capital allowances

Capital allowances in the tax code may take the form of ordinary depreciation allowances, an investment tax allowance (ITA), or an investment tax credit (ITC). An ITA is a deduction from taxable profit, whereas an ITC is a credit against the corporate tax bill. If the ITC amounts to a fraction φ of investment expenditure, it is equivalent to an ITA amounting to a proportion $a=\varphi/\tau$

of investment spending. Thus an ITC can easily be modelled as an equivalent rate of ITA. Since ITAs and ITCs are granted at the time of investment, we have

$$A = a + A^d \tag{11}$$

where A^d is the present value of the ordinary depreciation allowances (which are usually granted on top of any ITA or ITC). Equation (11) assumes that the firm has sufficient taxable income to be able to exploit all allowances, or that any tax losses may be carried forward with interest without limitations. If none of these assumptions are met, equation (11) will overestimate the value of capital allowances.

If the tax code allows depreciation of the historical cost basis according to the declining-balance method at the rate ϕ, the present value of the ordinary depreciation allowances will be

$$A^d = \int_0^\infty \phi e^{-(\phi+\rho+\pi)t} dt = \frac{\phi}{\phi+\rho+\pi} \tag{12}$$

This expression shows that, when the depreciation allowance is calculated on a historical cost basis without any adjustment for inflation, the real value of the allowance will be eroded by inflation.

An alternative method of depreciation is the straight-line method where firms can write down their assets by equal amounts per year over some specified period of n years. The annual depreciation allowance will then be $1/n$, so the present value of the allowances over the lifetime of the asset will be

$$A^d = \int_0^n \left(\frac{1}{n}\right) e^{-(\rho+\pi)t} dt = \frac{1-e^{-(\rho+\pi)n}}{n(\rho+\pi)} \tag{13}$$

Sometimes the straight-line method specifies the annual depreciation allowance as a proportion ϕ of the initial cost price of the asset (which may be indexed under real income accounting). In that case we have $n=1/\phi$.

Some benchmark cases

Given the tax parameters τ, ϕ, a, the financial variables r, s, π and β, and the true real depreciation rate δ, one can calculate the AETR and the METR from equations (6), (8), (9), (10), (11) plus (12) or (13), depending on the method of depreciation prescribed by the tax code.

In some interesting benchmark cases the expressions for the effective tax rates simplify considerably. For example, consider the case where investment is fully debt-financed (β=1 and $\rho=r$), no ITAs and nominal depreciation in accordance with the true decline in the nominal value of the asset (a=0 and $\phi=\delta-\pi$). From (12) and (6) we then get

$$A = \frac{\delta-\pi}{r+\delta} \tag{14}$$

$$c = r \tag{15}$$

Since ρ=*r* when β=1, it follows from (8), (9) and (15) that

$$METR = 0 \tag{16}$$

$$AETR = \tau\left(\frac{p-r}{p}\right) \tag{17}$$

Thus we see that in a tax regime with true economic depreciation (in nominal terms, when the tax code allows full deduction of nominal interest payments), the tax system does not distort the marginal investment when firms rely on debt finance. Still, the corporation tax captures some of the rent *p-r* accruing on the intramarginal investments, thereby possibly affecting the international location of investment.

By contrast , if we maintain the assumption of true economic depreciation but assume that investment is all equity-financed (β=0 and ρ=*s*), we find that
$c=s/(1-\tau)$ and

$$METR = AETR = \tau \tag{18}$$

In this case the effective tax rates coincide with the statutory tax rate, reflecting the fact that the tax code does not allow a deduction for the cost of equity finance.

As another benchmark case, suppose again that investment is fully financed by equity but that the tax code allows full expensing of investment instead of a gradual write-off over time (*a*=1 and A^d =0). It then follows from (6) through (9) that

$$METR = 0 \tag{19}$$

$$AETR = \tau\left(\frac{p-s}{p}\right) \tag{20}$$

Thus a tax regime with full expensing does not distort equity-financed investment at the margin, since the corporation tax falls only on the rent *p-s* earned on the intramarginal investments. Note that these results will hold even if the tax code does not prescribe real income accounting. Under full expensing, results similar to (19) and (20) would also obtain under debt finance (with *s* replaced by *r*) if interest payments were non-deductible. However, with interest deductibility, full expensing will drive the METR and possibly also the AETR below zero. Even under equity finance the METR (and potentially the AETR) will turn negative if the combination of ordinary depreciation allowances and ITAs implies a value of *A* in excess of 100 percent.

Effective tax rates under an ACE system

Under an ACE system the present value of allowances includes the value of the ACE allowance, i.e. the present value of the imputed return on the net equity *E* reported in the company's tax accounts. If a company invests one unit at time zero in an asset that is written down for tax purposes at the rate ϕ on a historical cost basis according to the declining-balance method, the assumption of a fixed debt-asset ratio β means that the net equity recorded in the firm's tax accounts at time *t* will be

$$E_t = e^{-\phi t} - \beta e^{-(\delta-\pi)t} \qquad (21)$$

If the imputed rate of return on equity is *i*, the present value of the ACE allowance then becomes

$$A^e = i\left[\int_0^\infty e^{-(\phi+\rho+\pi)t}dt - \int_0^\infty e^{-(\delta+\rho)t}dt\right] = i\left[\frac{1}{\phi+\rho+\pi} - \frac{\beta}{\rho+\delta}\right] \qquad (22)$$

Inserting this into (2) and abstracting from any ITA or ITC so that $A=A^d$, where A^d is given by (12), we obtain

$$PVT = \frac{\tau\left[p+\delta-\beta\left(r+\pi-i\right)\right]}{\rho+\delta} - \tau A^a, \qquad A^a \equiv \frac{\phi+i}{\phi+\rho+\pi} \qquad (23)$$

where A^d is the sum of the present values of the depreciation allowances and the ACE allowances triggered by one unit of equity-financed investment. From this and (3) we find

$$AETR \equiv \frac{PVT}{PV} = \frac{\tau\left[p-\rho+\left(1-A^a\right)\left(\rho+\delta\right)-\beta\left(r+\pi-i\right)\right]}{p} \qquad (24)$$

To derive the cost of capital for the purpose of calculating the METR, we set *p*=*c* and insert (5) and (23) into the break-even condition *PVG*-*PVG*-1 = 0 to find

$$c = \frac{\left(1-\tau A^a\right)\left(\rho+\delta\right)-\tau\beta\left(r+\pi-i\right)}{1-\tau} - \delta \qquad (25)$$

Suppose now that the imputed nominal return to equity corresponds to the company's nominal cost of finance so that

$$i = \rho+\pi \qquad (26)$$

From (23) it follows that the present value of the allowances generated by a unit of equity-financed investment will then be

$$A^a = 1 \qquad (27)$$

In other words, when the imputed rate of return is set at the ‘right’ level, an equity-financed investment is treated as if it could be immediately expenses, as under a cash flow tax.

Furthermore, let us focus on the risk-adjusted cost of capital by abstracting from the equity premium, i.e., let us set $s = r$ so that the cost of finance becomes

$$\rho = \beta r + (1 - \beta) s = r \tag{28}$$

From (24) through (28) and the definition of the METR we then find that the ACE system implies

$$c = r \tag{29}$$

$$METR = 0 \tag{30}$$

$$AETR = \tau \left(\frac{p - r}{p} \right) \tag{31}$$

In other words, under an ACE system with a proper choice of the imputed rate of return, the cost of capital will equal the real interest rate and the METR will be zero. These results hold regardless of the mode of finance and regardless of the rate of inflation, so an ACE system with an appropriately chosen imputed rate of return is neutral towards financing and investment decisions, just like a cash flow tax.