DISCUSSION PAPER SERIES

No. 3247

EVALUATING TAX POLICY FOR LOCATION DECISIONS

Michael P Devereux and Rachel Griffith

PUBLIC POLICY

Centre for Economic Policy Research

www.cepr.org

Available online at: **www.cepr.org/pubs/dps/DP3247.asp**

ISSN 0265-8003

EVALUATING TAX POLICY FOR LOCATION DECISIONS

Michael P Devereux, University of Warwick, Institute for Fiscal Studies and CEPR
Rachel Griffith, Institute for Fiscal Studies and CEPR

Discussion Paper No. 3247
March 2002

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 3247

March 2002

ABSTRACT

Evaluating Tax Policy for Location Decisions*

We consider the impact of taxation when investors face a discrete choice between two or more mutually exclusive projects; in particular, we consider the location choice of multinationals. Such choices depend on an effective average tax rate. We propose a precise measure of this rate, which is shown to be equal to a weighted average of an effective marginal tax rate and an adjusted statutory tax rate, where the weights depend on the profitability of the investment. Estimates of the distribution of this measure are presented and compared for domestic and international investment in the USA, France, Germany, and the UK. We analyse the impact of harmonizing corporate tax rates in Europe on incentives to locate in France, Germany and the UK.

JEL Classification: H25 and H32
Keywords: investment, location choice, tax coordination and tax policy

Michael P Devereux
Department of Economics
Warwick University
Coventry
CV4 7AL
Tel: (44 24) 7652 8414
Fax: (44 24) 7652 3779
Email: m.p.devereux@warwick.ac.uk

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=103642

Rachel Griffith
Institute for Fiscal Studies
7 Ridgmount Street
London
WC1E 7AE
Tel: (44 20) 7291 4800
Fax: (44 20) 7323 4780
Email: rgriffith@ifs.org.uk

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=125339

* The authors would like to thank Stephen Bond, Michael Keen, Jan Sodersten and two anonymous referees for helpful comments on earlier drafts of this Paper. Responsibility for errors remains ours. This research was funded by the ESRC Centre for Microeconomic Analysis of Fiscal Policy at the Institute for Fiscal Studies; Devereux was supported by a Leverhulme Trust fellowship.

Submitted 12 February 2002

1. INTRODUCTION

The vast majority of theoretical and empirical research on investment has focused on marginal choices - typically how much to invest, given a diminishing expected return. By contrast, an important class of investment decisions - that of discrete choices - has been largely ignored. Yet there are many possible examples of such choices. The main focus of this paper is the choice facing a multinational between a limited number of mutually exclusive locations for its investment, and the impact of differences in taxation between locations on this choice. Other possible discrete choices include, for example, the choice of whether or not to undertake research and development.

As a consequence of the focus on marginal choices, the impact of public policy on investment has typically been modelled by evaluating the impact of taxation on the cost of capital - the minimum pre-tax rate of return on an investment required by the investor. Building on the seminal works of Jorgensen (1963) and Hall and Jorgensen (1967), one direction of empirical research has developed increasingly sophisticated measures of this relationship, summarised by the "effective marginal tax rate" (*EMTR*).[1] The basic approach is to construct a forward-looking hypothetical marginal investment project, for which the impact of tax on the cost of capital can be computed.

A second empirical approach has been to proxy the *EMTR* by the ratio of tax payments to profit, taken either from aggregate data or accounting data.[2] However, this second approach does not focus on marginal decisions; rather it generates a backward-looking measure of an *average* tax rate.[3] As Fullerton (1984) pointed out, such measures of the

---

[1] See, for example, Auerbach (1979) and King and Fullerton (1984), and for international investment, Alworth (1988), Keen (1991), OECD (1991), Ruding (1992) and Devereux and Pearson (1995).

[2] An example of the first approach is Mendoza et al (1994), and examples of the second are Collins and Shackelford (1995) and Swenson (1994).

[3] At the firm level, such measures reflect investments made by a firm over many previous periods, the return on those investments and the ways in which they were financed. Accounting data also reflect losses

"average effective tax rate are appropriate for measuring cash flows and distributional burdens, while marginal effective tax rates are designed to capture incentives to use new capital" (p. 30).

However, in this paper, we argue that discrete investment choices do depend on an *average* tax rate. An example is the model considered by Devereux and Griffith (1998a), in which a multinational firm expects to earn an economic rent on its investment by exploiting some firm specific advantage, such as a patent, but due to economies of scale in production it will not build more than one plant.[4] Conditional on the choice of location, the size of investment depends on the *EMTR*. But the choice of location depends on the level of post-tax net present value (NPV); for a given pre-tax NPV in each location, the impact of taxation on the location choice is through its effect on the post-tax NPV. This can be measured by an "effective average tax rate" (*EATR*).[5]

This paper develops a forward-looking measure of the *EATR*. Such a measure has the advantage, in common with the literature on the *EMTR*, that cash flows associated with specific new investment projects can be isolated. Hence the NPV of a hypothetical potential investment can be computed in the presence and absence of tax. This type of approach permits the analysis of the impact of current and expected future tax regimes on the NPV of a new investment project.

To construct an effective average tax rate, the difference in the NPV of the project in the presence and absence of tax must be scaled by some factor. The main measure we develop below scales the difference by the NPV of income generated by the project in

brought forward, and tax payments in several jurisdictions. Apart from the last, these problems are also present in national data; measures of the aggregate profit of firms are also liable to contain significant measurement error.

[4] A number of theoretical models, based loosely on the OLI framework of Dunning (1977, 1981), have this property. See for example, Caves (1996), Horstman and Markusen (1992) and Markusen (1995). Devereux and Griffith (1998a) provide evidence that the *EATR* - but not the *EMTR* - is an empirically significant factor in the decisions of US multinational firms as to where to locate production facilities within Europe.

the absence of tax. This is analogous to other measures of average tax rates, in which observed tax payments are divided by a measure of pre-tax income or profit. This measure of the $EATR$ has the attractive property that it can be shown to be equal to a weighted average of the $EMTR$ and the statutory tax rate, adjusted for personal taxes. For a marginal investment, it is equal to the $EMTR$. As the rate of profit rises, it converges to the adjusted statutory rate. It can therefore be interpreted as summarising the distribution of effective tax rates for an investment project over a range of profitability, with the $EMTR$ representing the special case of a marginal investment.

A second measure which we discuss scales the difference in the NPV of the project in the presence and absence of tax by the NPV in the absence of tax – equivalent to the NPV of economic rent. This is a simple transformation of the first measure. In general it yields values above the statutory tax rate, and is undefined for an investment which is marginal pre-tax, and hence has a zero pre-tax NPV.

Using simply the $EMTR$ to proxy for the impact of taxation in discrete choices may be seriously misleading. To see this, take the extreme case of a cash flow corporation tax. It is well known that such a tax is levied only on economic rent. Since marginal investments are not taxed, the $EMTR$ is zero. But such taxes may affect location decisions where an investment is expected to earn some economic rent; this effect is captured by the $EATR$.

The measure of the $EATR$ developed here can provide a useful tool for policy makers to analyse the impact of the tax system in isolation from other economic factors. In the empirical section of this paper we first examine the time series of alternative measures of effective and statutory tax rates in the UK and the USA. We then compare the actual tax regimes in 1999 in France, Germany and the UK with a hypothetical co-ordinated regime

[5] This is analogous to the labour supply decision where it is well known that the impact of tax on an individual's incentive to participate in the labour market is through the average tax rate, while the number of hours worked is affected by the marginal tax rate.

within the European Union, in which all countries have the same statutory tax rate and no tax credits are associated with dividend payments. Previous research has pointed out that harmonising statutory tax rates has relatively little effect on the dispersion of the *EMTR* across countries[6]. However, it has a much more significant effect on the *EATR* at higher rates of profitability.

The structure of the remainder of the paper is as follows. Section 2 sets out a framework in which the *EATR* is developed. This is presented mainly in the context of a domestic investment. The Appendix sketches the extension of the model to an international context, in which a multinational located in one country undertakes investment in a different country. Section 3 presents an empirical analysis, illustrating the nature of the measure developed; it also investigates the impact of hypothetical co-ordination of tax policy within the European Union. Section 4 briefly concludes.

2 A MEASURE OF THE *EATR*

This section describes the proposed measure of the effective average tax rate (*EATR*). Most of the analysis is based on a domestic setting. The Appendix extends the analysis to an international setting. The main features of the Appendix are briefly summarised at the end of this section.

A simple model is set up which can incorporate discrete investment, based on a value-maximising firm. In the tradition of King (1974), ignoring risk, the value of the firm can be derived from the capital market equilibrium condition. The standard expression for

[6] See, Devereux and Pearson (1995).

the value of the firm in period *t* is the net present value of the post-tax income stream, given by V_t:

$$V_t = \frac{\gamma D_t - N_t + V_{t+1}}{1+\rho} \qquad (2.1)$$

where D_t is the dividend paid in period *t*, N_t is new equity issued in period *t*, $\gamma = (1-m^d)/(1-c)(1-z)$ is a term measuring the tax discrimination between new equity and distributions and $\rho = (1-m^i)i/(1-z)$ is the shareholders' nominal discount rate. In turn, i is the nominal interest rate, m^i is the personal tax rate on interest income, m^d is the personal tax rate on dividend income, c is the rate of tax credit available on dividends paid, and z is the accruals-equivalent capital gains tax rate.

Net dividends paid by the firm can be found from the equality of sources and uses of funds in each period:

$$D_t = Q(K_{t-1})(1-\tau) - I_t + B_t - [1+i(1-\tau)]B_{t-1} + \tau\phi(I + K_{t-1}^T) + N_t \qquad (2.2)$$

where $Q(K_{t-1})$ is output in period *t*, which depends on the beginning of period capital stock, K_{t-1}, I_t is investment, B_t is one-period debt issued in period *t*, τ is the statutory tax rate, ϕ is the rate at which capital expenditure can be offset against tax, and K_{t-1}^T is the tax-written-down value of the capital stock at the beginning of period *t*. It is useful to define the present value of allowances per unit of investment – discounted at rate ρ - as A. Choosing the appropriate units of capital and output, the prices of output and capital goods are normalised to unity in period *t*.

The standard approach in deriving the cost of capital, and hence the effective marginal tax rate, *EMTR*, is to consider a perturbation of the capital stock in one period, say period *t*. That is, investment is increased in one period, and reduced in the next period, leaving the capital stock in all other periods unchanged. In general, the net present value, or economic rent R, to the shareholder of a perturbation in period t is equal to the change in the market value:

$$R = dV_t = \sum_{s=0}^{\infty} \left\{ \frac{\gamma dD_{t+s} - dN_{t+s}}{(1+\rho)^s} \right\}, \tag{2.3}$$

since the perturbation may also induce changes to cash flows in subsequent periods. Setting economic rent equal to zero at the margin, $dV_t / dK_t = 0$, defines the cost of capital and permits the optimal capital stock in period t to be found.

We follow the spirit of this approach in developing a measure of the effective average tax rate, $EATR$. We consider an investment which increases the physical capital stock of the firm by one unit in period t only, so that the change is $dK_t = 1$ and $dK_s = 0 \ \forall s \neq t$. This requires an increase in investment in period t of one unit: $dI_t = 1$ and a reduction in investment in period $t+1$ such that $dI_{t+1} = -(1-\delta)(1+\pi)$, where π is the nominal increase in prices between periods t and $t+1$. The addition to K_t increases output in period $t+1$. This generates a change in output of $dQ_{t+1} = p + \delta$, where p represents the real financial return and δ reflects the one-period cost of depreciation. The change in revenue is $dQ_{t+1}(1+\pi) = (p+\delta)(1+\pi)$.[7]

To evaluate this perturbation, we need to consider the change in dividends, dD_{t+s}, $s \geq 0$, implied by (2.2). This depends on the values of the change in investment in periods t and $t+1$, the change in net revenue in period $t+1$, changes in the source of finance summarised in Table 2.1 below, and all consequent changes in tax. The resulting expression can be usefully split into two parts: (i) the NPV attributable to investment

[7] We have simplified the presentation by assuming that the inflation rate is common to capital and output.

financed by retained earnings, R^{RE}, and (ii) the additional cost of raising external finance, F, defined below. In sum, $R = R^{RE} + F$.

Begin with the case in which the investment is financed by retained earnings, and where the return from the investment is distributed as a dividend. In this case, the post-tax economic rent, or NPV, is:

$$R^{RE} = -\gamma(1-A) + \frac{\gamma}{1+\rho}\{(1+\pi)(p+\delta)(1-\tau) + (1+\pi)(1-\delta)(1-A)\} \tag{2.4}$$

To model financing the investment through new equity or debt, we assume that there is no binding constraint on the use of dividends in period t+1 and subsequently.[8] Since dividends are the residual, this implies that all cash flows subsequent to the initial investment are matched by offsetting changes in dividends. The only exception is that, in the case of issues of new equity, most tax systems treat a repurchase of equity at its original price to be a repayment of capital which is not taxed. It is assumed that the firm takes advantage of this opportunity for the case of new equity finance. Any payment to shareholders above this amount is treated as a dividend payment, and taxed as such.

If either debt or new equity financed is used, there are therefore additional effects on the NPV, either indirectly through the impact on the dividend payment or, in the case of new equity directly through (2.3). Defining the change in debt in period t to be dB_t and the change in new equity to be dN_t, the "financial" element of the NPV is:

$$F = \gamma dB_t \left\{1 - \frac{1+i(1-\tau)}{1+\rho}\right\} - (1-\gamma)dN_t \left\{1 - \frac{1}{1+\rho}\right\}. \tag{2.5}$$

In the case of retained earnings, the investment is financed by a reduction in dividend payments in period t; hence debt and new equity issues are unaffected. In the case of new

[8] Edwards and Keen (1984) demonstrate that this assumption generates commonly-used measures of the cost of capital.

equity finance the firm issues new equity in period *t* of $1-\phi\tau$; this finances a physical investment of *1* since an immediate tax allowance worth $\phi\tau$ can be claimed. In period *t+1* the firm repurchases that equity at the original price. In the case of debt financed investment the firm borrows $1-\phi\tau$ in period *t* and repays that amount plus interest (at rate *i*) in period *t+1*. The implied values of F are shown in Table 2.1.

Table 2.1: Implications of alternative sources of finance

Retained Earnings	$dN_{t+s} = dB_{t+s} = 0 \quad \forall s$	$F = 0$
New Equity	$dB_{t+s} = 0 \quad \forall s$ $dN_t = 1\text{-}\phi\tau \;;\; dN_{t+1} = -dN_t$ $dN_{t+s} = 0 \quad \forall s > 1$	$F = \dfrac{-\rho(1-\gamma)}{(1+\rho)}(1-\phi\tau)$
Debt	$dN_{t+s} = 0 \quad \forall s$ $dB_t = 1-\phi\tau \;;\; dB_{t+s} = 0 \quad \forall s > 0$	$F = \dfrac{\gamma(1-\phi\tau)}{(1+\rho)}\{\rho - i(1-\tau)\}$

This framework easily permits the derivation of the cost of capital: set $R = 0$ and solve for the marginal financial rate of return, denoted $\tilde{p}$:

$$R = 0 \qquad \tilde{p} = \frac{(1-A)}{(1-\tau)(1+\pi)}\{\rho + \delta(1+\pi) - \pi\} - \frac{F(1+\rho)}{\gamma(1-\tau)(1+\pi)} - \delta. \tag{2.6}$$

To help to understand the $EATR$ measure developed below, it is useful to define a tax inclusive effective marginal tax rate (*EMTR*) as

$$EMTR = (\tilde{p} - r)/\tilde{p}\,. \tag{2.7}$$

This can be thought of as a measure of the impact of taxation on the scale of investment - that is, it measures the extent to which tax raises the cost of capital above *r*. Personal taxes are incorporated to the extent that they affect the post-tax income stream from the investment and the discount rate of the marginal shareholder; however, unlike some other definitions, here we define the *EMTR* relative to *r* rather than to the post-tax rate of return earned by the shareholder from some alternative investment.

To illustrate values of the *EMTR*, consider the case in which $m^i = z = 0$ and hence $\rho = i$, the nominal interest rate. Defining r to be the real interest rate,[9] the cost of capital is:

$$\tilde{p} = \frac{(1-A)}{(1-\tau)}\{r+\delta\} - \frac{F(1+r)}{\gamma(1-\tau)} - \delta \qquad (2.8)$$

and the equivalent *EMTR* is:

$$EMTR = \frac{(r+\delta)(\tau - A) - F(1+r)/\gamma}{(r+\delta)(1-A) - \delta(1-\tau) - F(1+r)/\gamma}. \qquad (2.9)$$

The general expression for the cost of capital in (2.6) is similar to measures of the cost of capital derived elsewhere. There are two principal difference from the well-known King and Fullerton (1984) formulation. First, here the net present value of depreciation allowances, A, is derived using the shareholders' discount rate, ρ. Second, the impact of alternative forms of financing is limited to periods t and $t+1$ in the case of new equity and period t in the case of debt. This implies that the allowance in period t - $\phi\tau$ - plays a role, rather than simply the net present value of allowances, A.

The effective average tax rate is defined for $p \geq \tilde{p}$, using the NPV in the absence of tax. This is defined as:

$$R^* = -1 + \frac{1}{1+i}\{(1+\pi)(p+\delta) + (1+\pi)(1-\delta)\} = \frac{p-r}{1+r} \qquad (2.10)$$

---

[9] That is, $1+i = (1+r)(1+\pi)$.

Note that in the absence of tax, the additional terms due to financing by new equity or debt (the pre-tax equivalent of F) both have a NPV of zero and so do not affect the pre-tax NPV.

We consider two measures of an effective average tax rate. Each is based on the difference between the NPV of the perturbation to the capital stock in the absence and presence of tax, $R^* - R$, which is a measure of the total impact of taxation on the investor. To construct a tax rate, however, it is necessary to scale this difference. The two most obvious alternatives for scaling are: (a) the NPV of the pre-tax total income stream, net of depreciation, $p/(1+r)$; and (b) the NPV of the economic rent, $R^* = (p-r)/(1+r)$. Our preferred measure – and the one illustrated in Section 3, below - is the former, on the grounds that scaling by total capital income, rather than economic rent, makes the measure comparable to other average tax rate measures, based on observed data on tax payments. However, it is clear that the two measures are simple transformations of each other.

Define the first measure as

$$EATR = \frac{R^* - R}{p/(1+r)}, \tag{2.11}$$

and the second as

$$EATRR = \frac{R^* - R}{R^*} = \frac{R^* - R}{(p-r)/(1+r)} = EATR\left(\frac{p}{p-r}\right). \tag{2.12}$$

The two measures have rather different properties, which we now explore. Most obviously, $EATRR$ is undefined for an investment which is marginal in the absence of tax, ie. when $R^* = 0$. Further, for an investment which earns a positive economic rent in the absence of tax, but is marginal in the presence of tax, ie. when $R^* > 0$ and $R = 0$, it is straightforward to see that $EATRR=1$. That is, the whole of the economic rent is taken in tax.

To investigate the properties of $EATR$, it is useful to rewrite R using the cost of capital as

$$R = (p - \tilde{p})\gamma(1-\tau)\frac{(1+\pi)}{(1+\rho)}. \tag{2.13}$$

Using this and the definition of the $EMTR$ in (2.7), $EATR$ can be rewritten as a weighted average of the $EMTR$, defined above, and an "adjusted statutory rate", T:

$$EATR = \left(\frac{\tilde{p}}{p}\right)EMTR + \left(1 - \frac{\tilde{p}}{p}\right)T \tag{2.14}$$

where

$$T = 1 - \gamma(1-\tau)\frac{(1+r)(1+\pi)}{1+\rho} \tag{2.15}$$

and the weights reflect the actual pre-tax rate of return on the investment, p, and the pre-tax rate of return on a marginal investment, $\tilde{p}$.

The two elements of (2.14) reflect the two extremes of the distribution of acceptable investment projects. For a marginal investment, $R=0$ and $p = \tilde{p}$: hence $EATR=EMTR$. At the other extreme, for a very profitable investment, as $R^* \to \infty$ and hence $p \to \infty$, then $EATR \to T$. This differs from the actual statutory tax rate only because of personal taxes. In the absence of personal taxes, then $1+\rho = 1+i = (1+r)(1+\pi)$ and $\gamma = 1$, implying that $T = \tau$. This is intuitive: for very profitable investment projects, allowances become insignificant: the only relevant factor is the rate at which income is taxed. It is straightforward to show that $EATRR$ also tends towards T as the rate of profit increases.

These properties of the two measures are summarised in Figure 1. $EATRR$ tends to an infinite rate as R^* tends to zero, and tends to the adjusted statutory rate T as R^* tends to infinity. In panel (a) of the Figure, $EMTR$ is below T. In this case, $EATR$ rises towards T as R^* increases. However, it is also possible for $EMTR$ to lie above T. In this case, $EATR$ also lies above T, and falls towards T as R^* increases. This is illustrated in panel (b) of Figure 1. In either case, the $EATR$ can therefore be seen as reflecting the whole schedule of effective tax rates over the range of profitability from a marginal investment, where $EATR=EMTR$, to a very high rate of profitability, where the $EATR=T$. Which of these cases holds is discussed further below.

Three further features of these measures are worth noting, in comparison with well-known properties of the $EMTR$. First, Auerbach (1979) showed that the $EMTR$ for investment financed by retained earnings is independent of the taxation of dividends paid to the shareholder, as long as the same rate of dividend tax is levied when the investment is made and when the returns are paid to the shareholders. As can be seen from the definition of R^{RE} in (2.4), the NPV of the investment is proportional to γ, reflecting the dividend tax. For marginal investment, $R=0$, and so the dividend tax has no effect. However, for $NPV>0$, a positive dividend tax reduces R. In turn, this increases both measures of the $EATR$; hence dividend taxes are relevant for discrete investment choices.

Second, it is well known that a "neutral" business tax, such as a cash flow tax[10], is levied only on economic rent, and hence has $EMTR=0$. Since the tax is proportional to economic rent, in this case $EATRR$ yields a value equal to the statutory tax rate for any level of profit. $EATR$ has a lower bound of zero for a marginal investment and an upper bound equal to the statutory tax rate.

[10] Such a tax implies that $A=\tau$, $\gamma=1$; ignore other personal taxes.

Third, it is also well known that a tax which gives relief for the true costs of economic depreciation, but no relief for the cost of finance, represents a tax on all capital income.[11] In this case, since the tax is proportional to capital income, $EATR$ yields a value equal to the statutory tax rate for any level of profit. Note that, in this case, the *EMTR* is also equal to the statutory rate. Relative to this case, then, $EATR$ is upward sloping if the tax regime is more generous to the marginal investment, so that *EMTR<T* (panel (a) of Figure 1), and downward sloping if it is less generous, so that *EMTR>T* (panel (b) of Figure 1).

The analysis so far has been confined to a domestic setting, in which the firm and investment are located in just one jurisdiction. The Appendix sketches the case of a cross-border investment. The basic approach is identical to that in the domestic setting. The difference is that a multinational firm located in a home jurisdiction may now invest - through a wholly-owned subsidiary - in a different host jurisdiction. This introduces a range of additional tax parameters, including taxes levied by the host country on the payment of interest and dividends by the subsidiary to the parent, and taxes levied by the home country on the receipt of such income. The subsidiary is assumed to be financed by the parent, using the same three sources of finance. This introduces an additional term, comparable to *F*, which captures the tax implications of the source of finance used by the subsidiary.

The $EATR$ for international investment has equivalent properties to that for domestic investment. In particular, $EATR$ reflects the whole distribution of possible tax rates; equal to the *EMTR* for a marginal investment and approaching an adjusted statutory rate for a very profitable investment. In this case, (ignoring personal taxes) the adjusted statutory rate is $1-\gamma(1-\sigma_{jn})(1-\tau_n)$, where τ_n is the statutory tax rate in the host

[11] Such a tax system implies $A = {}^{\delta\tau}\!/_{r+\delta}$ and $F = 0$. Again ignore other personal taxes.

country and σ_{jn} is the overall corporate tax rate levied (by host and home governments) on dividend payments from the subsidiary to the parent. In contrast to its effect on the *EMTR*,[12] σ_{jn} affects the $EATR$ of an international investment even when the investment is financed by retained earnings.

3 EMPIRICAL APPLICATION

In this section some of the properties of $EATR$ are examined. Section 3.1 presents a number of measures of corporation tax in the UK and the USA over the period 1979 to 1999 for a simple hypothetical investment in plant and machinery, financed by retained earnings. Sections 3.2 and 3.3 illustrate the impact of partial harmonisation in the European Union on the distribution of effective tax rates for the same form of investment, using 1999 data for the USA, France, Germany and the UK - in this case imposing on the European countries the same overall statutory tax rate and abolishing imputation systems.[13] Section 3.2 presents the impact on the range of domestic effective tax rates in each country. Section 3.3 presents the impact on the range of effective tax rates faced by a US multinational investing in each of the European countries.[14]

Note that throughout this empirical application we assume that the personal tax rates of the marginal shareholder are zero, ie. $m^i = m^d = z = 0$. For countries without any other form of tax relief on dividends, such as the USA, this is equivalent to setting $\gamma = 1$. However, in some countries, zero-rated shareholders can benefit from a tax credit associated with a

[12] See Hartman (1985).

[13] Using $EATR$ to compare the tax regimes in different countries raises the issue of what values of p should be chosen. Note that, even if all parameters other than the tax system were identical in two countries, differences in the *EMTR* would induce a different scale of investment in each country, which would in turn lead to a different average value of p. However, to allow for such differences would require further assumptions about the revenue and cost functions of the investment.

dividend payment. In this case, $\gamma = 1/(1-c) > 1$. The simulation of abolishing imputation systems implies that c is set to zero, in which case $\gamma = 1$ in all countries.

We make the assumption that the marginal shareholder has zero personal tax rates for a number of reasons. First, it allows us to focus on the impact of corporation taxes. Beyond this, though, in an international context, it is possible that the marginal shareholder is non-resident (and may be a parent company), so that applying the tax rates of residents may be inappropriate.[15] Further, probably the largest single group of shareholders - represented by pension funds - generally have zero tax rates on dividend income and capital gains. In this analysis, Figures 2 and 3 are based on the marginal shareholder being a zero-rated resident, who benefits from any tax credit associated with dividend payments. Figure 4 is based on the marginal shareholder being a US multinational (which in turn has zero rated shareholders).

3.1 Tax schedules in UK and USA

The two panels of Figure 2 illustrate the development of the domestic corporation tax system over the period 1979 to 1999 for the USA and the UK, as applied to a domestic investment in plant and machinery, financed by retained earnings. The tax rates shown in each panel are: the statutory tax rate on retained earnings (including typical local taxes); the *EMTR*; the adjusted statutory tax rate, $T = 1 - \gamma(1-\tau)$ (since personal taxes are assumed to be zero), and values of *EATR* corresponding to pre-tax rates of return (ie. p) of 30%, 70% and 100%.

Figure 2 illustrates several of the properties of *EATR* discussed above. Since the USA had no tax relief associated with dividends payments throughout the period, then in the

---

[14] A description of the tax systems used to calculate the effective tax rates is available in Chennells and Griffith (1997), Devereux and Griffith (1998b), and Devereux, Lammersen and Spengel (2000).

absence of personal taxes, $\gamma = 1$ and hence $T = \tau$. Prior to the 1986 tax reform in the USA, the *EMTR* was considerably lower than the statutory rate. The tax reform reduced the statutory tax rate considerably, but also reduced allowances; the net effect was to increase the *EMTR*. However, given that the statutory tax rate remained higher than the *EMTR*, then both before and after 1986, *EATR* rose with profitability. The impact of the tax reform on the discrete choice of US firms as to whether to locate new activity in the USA rather than elsewhere therefore depends on the expected profitability of the investment. Ceteris paribus, at relatively low rates of profitability, the tax reform discouraged locating in the USA; but at high rates of profitability, it encouraged locating in the USA.

A similar, but more dramatic, pattern occurred in the UK. Prior to the 1984 tax reform in the UK, investment in plant and machinery financed by retained earnings was effectively taxed as if by a cash flow tax, with a 100% allowance, implying an *EMTR* of zero. While the statutory tax rate was high (52%), the adjusted statutory rate was moderated by the imputation system - tax exempt shareholders received a tax rebate associated with dividend payments which created a value of γ considerably higher than 1.[16] The 1984 reform raised the *EMTR* to a level comparable to that in the US. However, the impact of the dividend tax credit meant that the adjusted statutory tax rate, *T*, fell below the *EMTR*. As a result, between 1984 and 1997, *EATR* fell as profitability rose. However, in 1997, the dividend tax credit was abolished for tax exempt shareholders, implying that, as in the USA, $\gamma = 1$; at this point, *T* became equal to τ. Since this exceeded the *EMTR*, there was another switch in the distribution of *EATR*, so that since 1997 *EATR* has risen with profitability.

[15] In this case, dividend tax credits should be taken into account only if they are received by the non-resident investor.

3.2 Co-ordination in the EU: domestic effective tax rates

The methodology developed in this paper is useful for simulating the impact of tax reform on investment incentives. One interesting area of tax reform is the potential co-ordination of tax regimes with the European Union. Various proposals have been made (see, for example, the Ruding Committee, 1992, and the European Commission, 2001). Previous studies, however, have considered the impact of alternative forms of co-ordination only on the *EMTR*.[17]

In contrast, Figure 3 considers the impact of one form of co-ordination on the whole distribution of domestic effective tax rates. Panel (a) of the Figure presents the distribution for 1999 of $EATR$ for a range of levels of profitability in France, Germany and the UK, again for investment in plant and machinery financed by retained earnings. The extreme left of each line represents the *EMTR*; as the profitability of the hypothetical investment rises, $EATR$ may rise or fall, as discussed above.

Panel (a) illustrates the difficulty in ranking effective tax rates across countries. At the margin, the UK has the lowest rate, just below France and considerably below Germany. This reflects the relatively high statutory tax rates in France and Germany. The generous tax treatment of dividends in France and Germany has no impact on the *EMTR*. However, this generous treatment does affect $EATR$ - to such an extent that in both countries the $EATR$ for domestic investment falls as profitability rises. By contrast, as noted above, in 1999, the opposite is true for the UK. As a result, the ranking of these three countries changes: at higher rates of profitability, the UK has the highest $EATR$, followed by Germany and then France.

---

[16] It should be noted, though, that in general, non-UK multinationals did not receive a tax rebate on dividends received by their UK subsidiaries (US multinationals did, but at a lower rate); for them, $\gamma = 1$ throughout the period.
[17] See, for example, Ruding Committee (1992) and Devereux and Pearson (1995).

Previous research on co-ordination has suggested that harmonising either the tax rate on its own, or the tax base on its own, does not significantly reduce the dispersion of the *EMTR* across countries. We investigate this further here, by imposing a common statutory tax rate on all three countries (at 40.5%, an average of their 1999 rates). We also impose an abolition of tax credits associated with dividends, so that $\gamma = 1$ in all cases. As a result the adjusted statutory tax rate, *T*, is now the same for all three countries.

The results are shown in panel (b) of Figure 3. The impact on the *EMTR* supports earlier results: there is some reduction in the dispersion of the *EMTR* across the three countries, but the range remains fairly wide. However, given that the adjusted statutory tax rate is now the same for all three countries, then not surprisingly at high levels of profitability, the three countries have very similar values of *EATR*.

Clearly an important element of the co-ordination introduced here is the abolition of tax credits on dividends, ensuring that $\gamma = 1$. Without this, the adjusted statutory tax rates would be different in the three counties, and there would remain significant differences in the *EATR*, even at high levels of profitability. However, differences in the personal tax treatment of dividends play an important role mainly because Figure 3 presents the case of domestic investment, financed by zero-rated domestic shareholders. In order to investigate location decisions more fully, it is necessary to model the tax regimes faced by a multinational choosing to locate in one of these countries.

3.3 Coordination in the EU: international effective tax rates

Results presented in Devereux and Griffith (1998a) indicate that the *EATR* plays a direct and significant role in determining the location choices of US multinational firms. In Figure 4, we therefore present measures of the effective tax rates faced by a US multinational investing in each of the three countries. The 2 panels correspond to those of Figure 3 - however, each panel shows the distribution of effective tax rates for a US multinational investing at home, as well as in the other three countries.

In panel (a), all four $EATR$s rise with the rate of profitability. Compared to Figure 3, this is because dividend tax credits available to domestic shareholders of French and German companies are not available to US corporate shareholders. Hence, in Figure 4, $\gamma = 1$ in France and Germany. In addition, the statutory tax rate in France and Germany exceeds the US rate, and so there is no taxation of dividends paid to the parent. This implies that $\sigma_{jn} = 0$, and hence T is the host country statutory tax rate. By contrast, the UK does offer a tax credit on dividend payments to US companies. In addition, the UK statutory rate is below the US rate, and so US multinationals must pay US tax on dividends received from their UK subsidiary.

The distribution of effective tax rates indicates significant changes in the rankings as perceived by a US multinational. At the margin, Germany offers the lowest tax rate, and the UK the highest. However, as profitability increases, the high German tax rate becomes more important, and Germany becomes the least favourable location for investment. By contrast, at high rates of profitability, the UK is the most favourable European location, due to the low tax rate and tax credit for US multinationals.

Harmonising statutory tax rates in the European countries - again at 40.5%, and therefore exceeding the US rate - implies that there is no longer any US tax liability on repatriation of dividends. However, in this simulation, we have kept the tax credit which the UK offers US multinationals. At very high levels of profitability, this factor is the main difference between the European countries as host countries; and as a result the UK becomes the most tax-favoured location in Europe for US multinationals.

4 CONCLUSIONS

This paper has investigated the role of taxation in cases in which an investor faces a choice between two or more mutually exclusive projects that earn more than the minimum required rate of return. There are a number of circumstances in which such a choice is likely to occur, including choice of location and choice of technology. For example, the location choice of multinationals is typically modelled in this way (see Horstman and Markusen, 1992, and Markusen, 1995). The choice of which project to undertake depends on the level of the post-tax economic rent that would be earned from each option. The impact of taxation on the choice cannot therefore be measured in the standard way by analysing a marginal investment.

A new measure - an effective average tax rate ($EATR$) - is proposed, which summarises the impact of tax in such choices, and which builds on the standard approach to measuring the effective marginal tax rate ($EMTR$). This measure of $EATR$ has the attractive property that it is equal to a weighted average of an $EMTR$ and an adjusted statutory tax rate. It can therefore be interpreted as summarising the distribution of effective tax rates for an investment project over a range of profitability; the $EMTR$ represents the special case of a marginal investment.

Estimates of the $EATR$ are presented for the USA, France, Germany and the UK. A time series (1979-1999) is presented for the UK and the USA to illustrate the pattern of the whole distribution of effective tax rates over this period. Especially in the UK, there has been considerable change in the distribution over time. The benefits of harmonising the statutory tax rate and treatment of dividends in the European Union are investigated using data from 1999. These benefits depend on the underlying profitability of the mobile investments. At low rates of profitability, this form of co-ordination has only relatively small effects on the distribution of effective tax rates between countries. However, there is a much greater effect at higher rates of profitability. Given that location choices are typically made by highly profitable multinational companies, this analysis suggests that such a form of co-ordination may be more efficient than previously recognised.

REFERENCES

Alworth, J. (1988) *The finance, investment and taxation decision of multinationals*, Basil Blackwell: New York

Auerbach, A.J. (1979) "Wealth maximization and the cost of capital", *Quarterly Journal of Economics*, 21:107-127

Caves, R. (1996) *Multinational Enterprise and Economic Analysis*, 2nd edition, Cambridge, England: Cambridge University Press

Chennells, L. and Griffith, R. (1997) *Taxing profits in a changing world*, Institute for Fiscal Studies.

Collins, J.H. and D.A. Shackelford (1995) "Corporate Domicile and Average Effective Tax Rates: The Cases of Canada, Japan, the UK and USA", *International Tax and Public Finance*, Vol 2, 55-83.

Devereux, M.P. and R. Griffith (1998a) "Taxes and the location of production: evidence from a panel of US multinationals", *Journal of Public Economics*, 68(3), 335-367

Devereux, M.P. and R. Griffith (1998b) "The taxation of discrete investment choices", *Institute for Fiscal Studies Working Paper* 98/16.

Devereux, M.P., L. Lammersen and C. Spengel (2000) "The effective levels of company taxation in the member states of the EU", ", *Institute for Fiscal Studies.*

Devereux, M.P. and M. Pearson (1995) "European tax harmonisation and production efficiency", *European Economic Review*, 39, 1657-1681.

Dunning, J.H. (1977) "Trade, location of economic activity and MNE: a search for an eclectic approach", in B. Ohlin, P.O. Hesselborn and P.M. Wijkman eds. *The International Allocation of Economic Activity*, London: Macmillan, 395-418.

Dunning, J.H. (1981) *International Production and the Multinational Enterprise*, London: George Allen and Unwin.

Edwards, J.S.S and M.J. Keen (1984) "Wealth maximization and the cost of capital: a comment", *Quarterly Journal of Economics*, XCVIII, 211-214.

European Commission (2001) *Company Taxation in the Internal Market*, Brussels: European Commission.

Fullerton, D. (1984) "Which effective tax rate?", *National Tax Journal*, 37, 23-41.

Hall. R.E. and D. Jorgensen (1967) “Tax policy and investment behavior”, *American Economic Review*, 57, 391-414.

Hartman D.G. (1985) “Tax policy and foreign direct investment”, *Journal of Public Economics*, 26, 107-121.

Horstmann, I. and Markusen, J. (1992) “Endogenous market structures in international trade (natura facit saltum)” *Journal of International Economics*, 32, 109-129

Jorgensen, D.W. (1963) "Capital theory and investment behaviour", *American Economic Review*, 53, 247-59

Keen, M.J. (1991) “Corporation tax, foreign direct investment and the single market” in L.A. Winters and AJ Venables (eds.) *The Impact of 1992 on European Trade and Industry*, Cambridge University Press: Cambridge

King. M.A. (1974) “Taxation, investment and the cost of capital”, *Review of Economic Studies*, 41, 21-35.

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

Markusen, J. (1995) “The boundaries of multinational enterprises and the theory of international trade”, *Journal of Economic Perspectives*, 9(2), 169-189.

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*, 297-323.

OECD (1991) *Taxing Profits in a Global Economy*, Paris: OECD.

Ruding Committee (1992) *Report of the Committee of Independent Experts on Company Taxation*, Brussels: European Commission.

Swenson, D. (1994) “The impact of US tax reform on foreign direct investment in the United States”, *Journal of Public Economics*, 54, 243-266.

APPENDIX
THE *EATR* FOR INTERNATIONAL INVESTMENT

The approach used in Section 2 can be extended to measure the *EMTR* and *EATR* for an international investment. In this Appendix we sketch the derivation of these effective tax rates; details are available in Devereux and Griffith (1998b). The basic approach is to consider a parent firm located in the "home" country j which undertakes investment in the "host" country n through a wholly-owned subsidiary. The parent firm is assumed to be owned by shareholders located in j.

We take account of taxes levied by the government of n on income earned by the subsidiary in n , corporate taxes levied by the government in j on the same income and personal taxes levied by the government in j on the shareholders. Tax parameters carry a subscript j or n to identify the country which levies the tax. The precise nature of the combined tax system is that in Keen (1991) and OECD (1991). It is useful to note two tax parameters: σ_{jn} is the overall corporate tax rate levied on dividend payments from the subsidiary to the parent and ω_{jn} is the overall corporate tax rate levied on interest payments from the subsidiary to the parent.

Suppose that the analysis in Section 2 refers to the domestic activities of the parent firm. Allowing for this firm to have a foreign subsidiary does not affect the general expression for the value of the firm in (2.1); this remains the firm's maximand. However, the sources and uses of funds statement (2.2) must be extended to allow for financial flows to and from the subsidiary, together with any consequential tax effects. This must include new equity in the subsidiary provided by the parent and lending to the subsidiary by the parent. It also must include dividends and interest received by the parent from the subsidiary, net of taxes paid to the host country government. Finally it must include further taxes due in the home country on the income earned in the host country.

As in the domestic case, we consider a perturbation in the capital stock of the firm – in this case the subsidiary – in period *t*. This is achieved by changing investment in the subsidiary in periods *t* and *t+1* in the same way as in section 2. We consider three ways in which the subsidiary finances the increase in investment, again corresponding to domestic case: retained earnings, new equity issued to the parent and borrowing from the parent. The parent also continues to choose between these three sources of finance. We do not consider the case of borrowing in the host country *n*; this would be a straightforward extension.

The NPV generated by the perturbation of the subsidiary's capital stock takes the same form as for the domestic case; we label this $R_n = R_n^{RE} + F + F_n$. The first element, R_n^{RE}, corresponds to the economic rent generated by a perturbation in the capital stock financed by retained earnings:

$$R_n^{RE} = \gamma(1-\sigma_{jn})\left\{ \begin{array}{l} -(1-A_n) \\ + \dfrac{\{E(1+\pi_n)(p_n+\delta)(1-\tau_n) + E(1+\pi_n)(1-\delta)(1-A_n)\}}{1+\rho} \end{array} \right\}. \qquad \text{(A.1)}$$

where parameters have the same meaning as in Section 2, except that a subscript *n* indicates that it refers to the host country, and the present value of allowances in the host country is calculated by exchanging them into the home currency, and applying the discount rate of the shareholders of the parent company. The exchange rate is normalised at unity in period *t* and takes the value *E* in period *t+1*.[18]

[18] The expression $E(1+\pi_n)-1$ therefore reflects the nominal price change in the host country expressed in the currency of the home country.

The second element, F summarises the net present value of the cash flows associated with new equity and debt financing of the parent firm, and is identical to the expressions in (2.5) and Table 2.1[19]. The third element, F_n, summarises the net present value of cash flows associated with new equity and debt finance of the subsidiary:

$$F_n = \frac{\gamma dB_t}{1+\rho}\left\{E\left[\sigma_{jn}(1+i(1-\tau_n)) - \omega_{jn} i\right] - \gamma\sigma_{jn}\right\} - \gamma\sigma_{jn} dN_t \left\{1 - \frac{E}{1+\rho}\right\}. \qquad \text{(A.2)}$$

Substituting for dB_t and dN_t yields the expressions in Table A.1.

Table A.1: Values of F_n for alternative forms of investment

Source of subsidiary finance	
Retained Earnings	$F_n = 0$
New Equity	$F_n = \frac{\gamma\sigma_{jn}}{(1+\rho)}(1-\phi_n\tau_n)[E-(1+\rho)]$
Debt	$F_n = \frac{\gamma(1-\phi_n\tau_n)}{(1+\rho)}\{\sigma_{jn}[E(1+i(1-\tau_n))-(1+\rho)] - E\omega_{jn} i\}$

These expressions correspond closely to (2.4) and (2.5). The new variables σ_{jn} and ω_{jn} reflect the impact on overall tax liabilities on the flows of dividends and interest respectively from the subsidiary to the parent.

This framework permits the derivation of measures of the cost of capital for international investment. Define the cost of capital to be the real return in the home currency for which $R_n = 0$. Denote this $\tilde{\rho}_n = E(1+\pi_n)p_n/(1+\pi)$. It is straightforward to show that this is:

[19] Except that the allowance of $\tau\phi$ in Table 2.1 should be replaced by $\tau_n\phi_n$.

$$R_n = 0 \qquad \tilde{p}_n = \frac{(1-A_n)}{(1+\pi)(1-\tau_n)}\{\rho + \delta E(1+\pi_n) - [E(1+\pi_n)-1]\} - \frac{(F+F_n)(1+\rho)}{\gamma(1+\sigma_{jn})(1+\pi)(1-\tau_n)} - \frac{\delta E(1+\pi_n)}{(1+\pi)} \tag{A.3}$$

The *EMTR* for an international investment is $EMTR_n = (\tilde{p}_n - s)/\tilde{p}_n$, where s is again the post-tax rate of return to the shareholder.

We define the *EATR* for international investment as:

$$EATR_n = \frac{R_n^* - R_n}{E(1+\pi_n)\,p_n \big/ 1+i} \tag{A.4}$$

where R_n is defined as the sum of (3.1), (2.5) and (3.2), and

$$R_n^* = \frac{\{E(1+\pi_n)(1+p_n)-(1+i)\}}{1+i}. \tag{A.5}$$

and where the denominator is again the NPV of the income stream from the perturbation to the capital stock of the subsidiary.

To give more intuition, note that for the special case of purchasing power parity, $E(1+\pi_n) = (1+\pi)$, and no personal taxes in the home country on interest income or capital gains, $m^i = z = 0$, these expressions simplify to:

$$R_n^* = \frac{p_n - r}{1+r}\ , \tag{A.5b}$$

$$R_n = \frac{\gamma(1-\sigma_{jn})}{1+r}\{(p_n+\delta)(1-\tau_n)-(r+\delta)(1-A_n)\} + F + F_n \tag{A.3b}$$

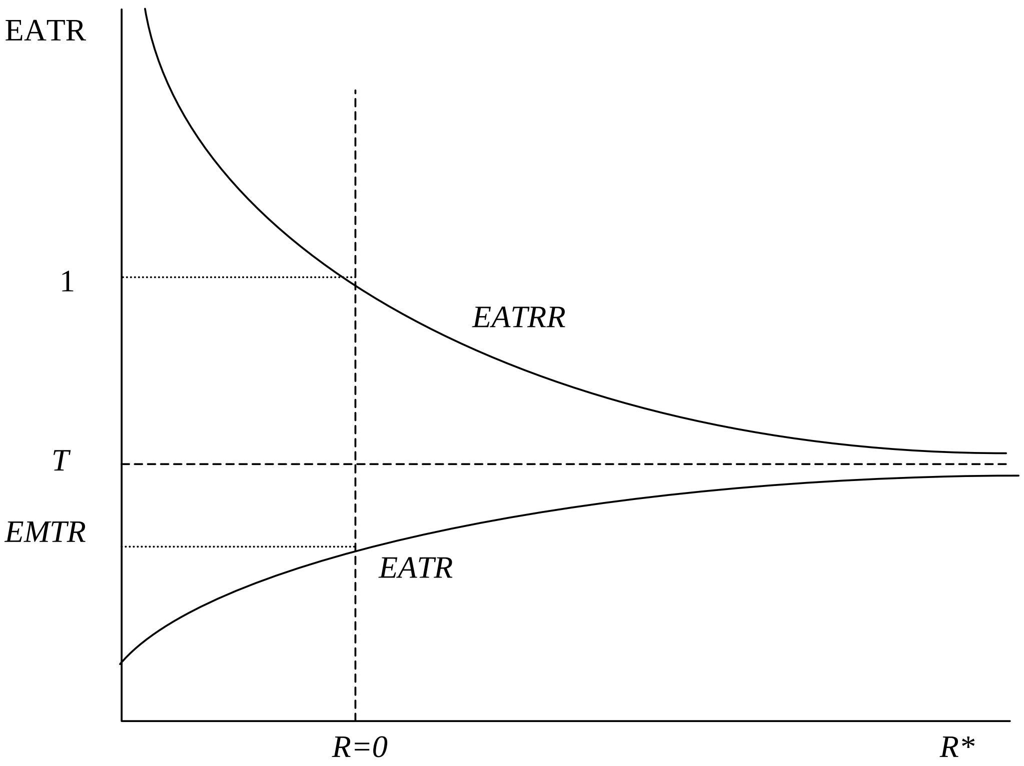
and

$$EATR_n = \frac{R_n^* - R_n}{p_n \big/ 1+r} = 1 - \gamma(1 - \sigma_{jn})(1 - \tau_n)$$
$$- \frac{\left\{ r\left[1 - \gamma(1-\sigma_{jn})(1 - A_n)\right] - \delta\gamma(1-\sigma_{jn})(\tau_n - A_n) + (F + F_n)(1+r)\right\}}{p_n} \qquad \text{(A.4b)}$$

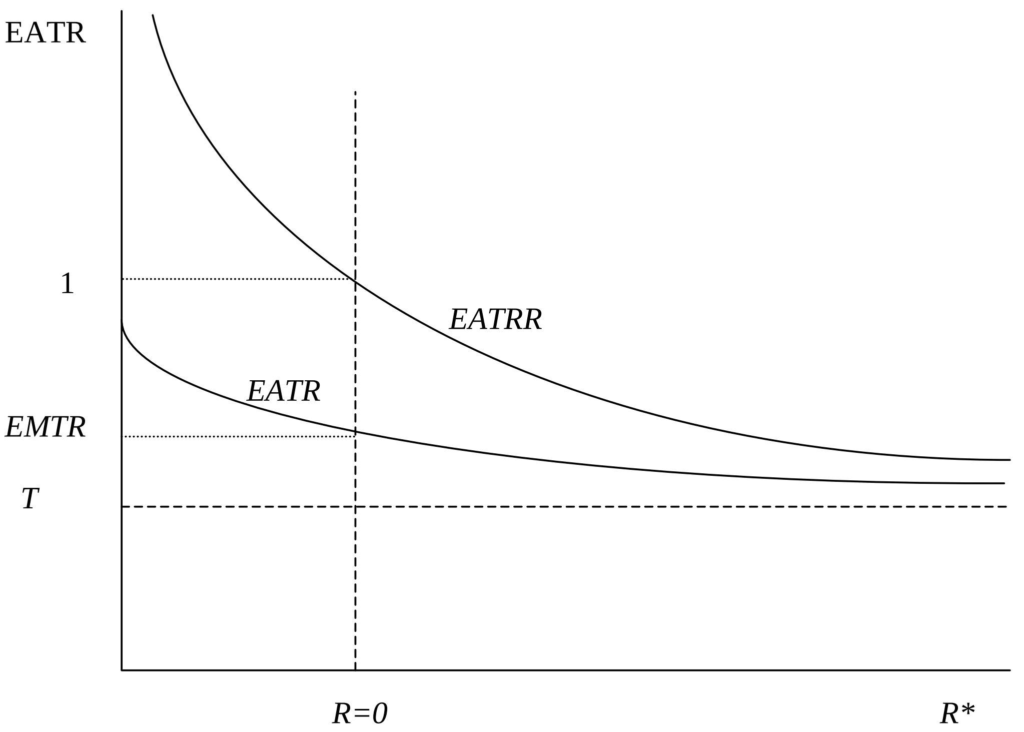
This expression is similar to (2.13) for the domestic case. There are three main differences. First, most of the tax variables refer to the host country, *n*, rather than the home country. Second, an additional term $1-\sigma_{jn}$ appears in several places, reflecting the additional tax on dividends paid by the subsidiary to the parent. Third, there is an additional financing term, F_n, reflecting the tax implications of financing the subsidiary.

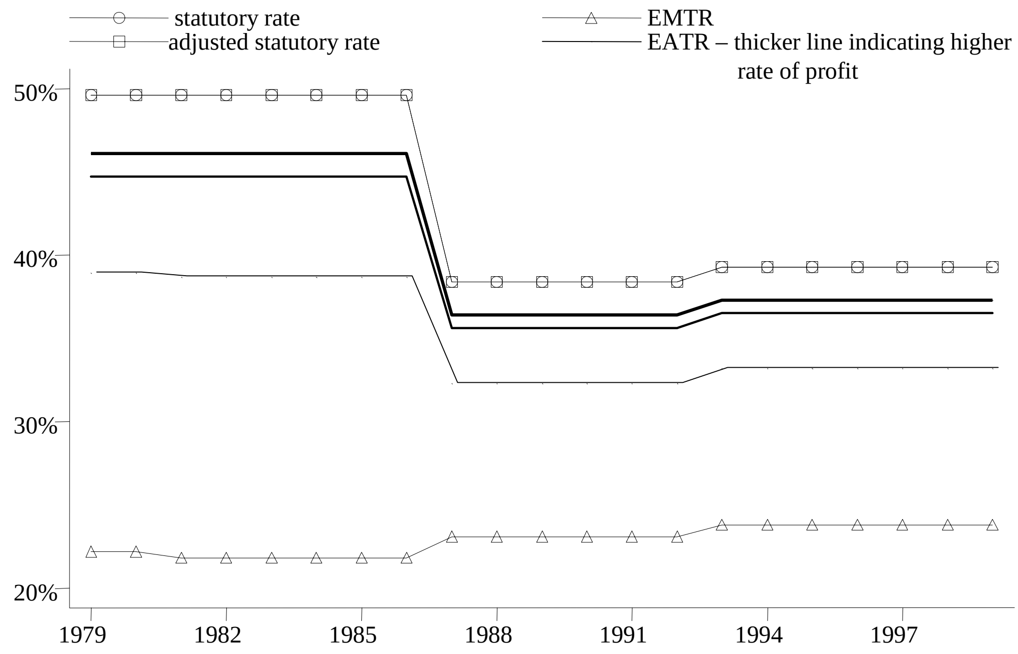
FIGURE 1 ILLUSTRATION OF THE EATR MEASURES

(a) EMTR < T

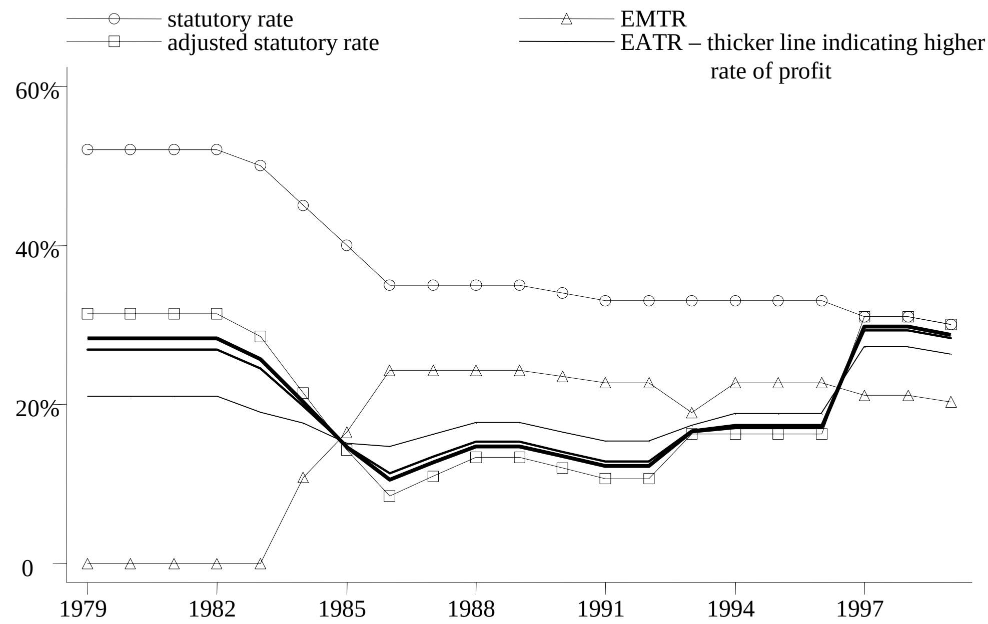


(b) EMTR > T



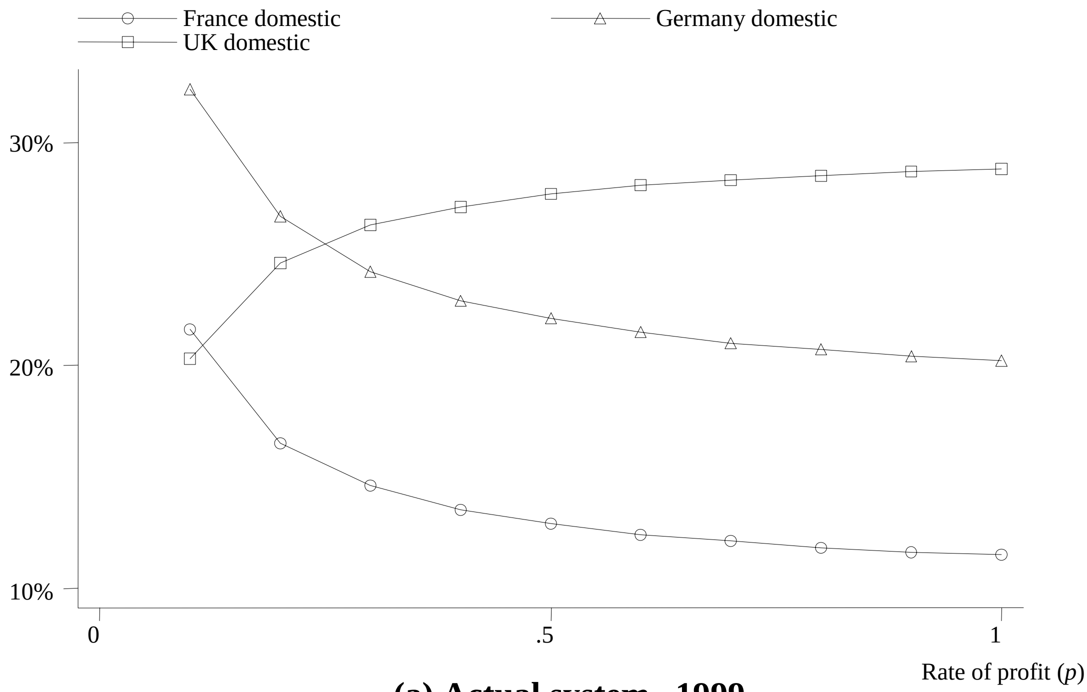


USA

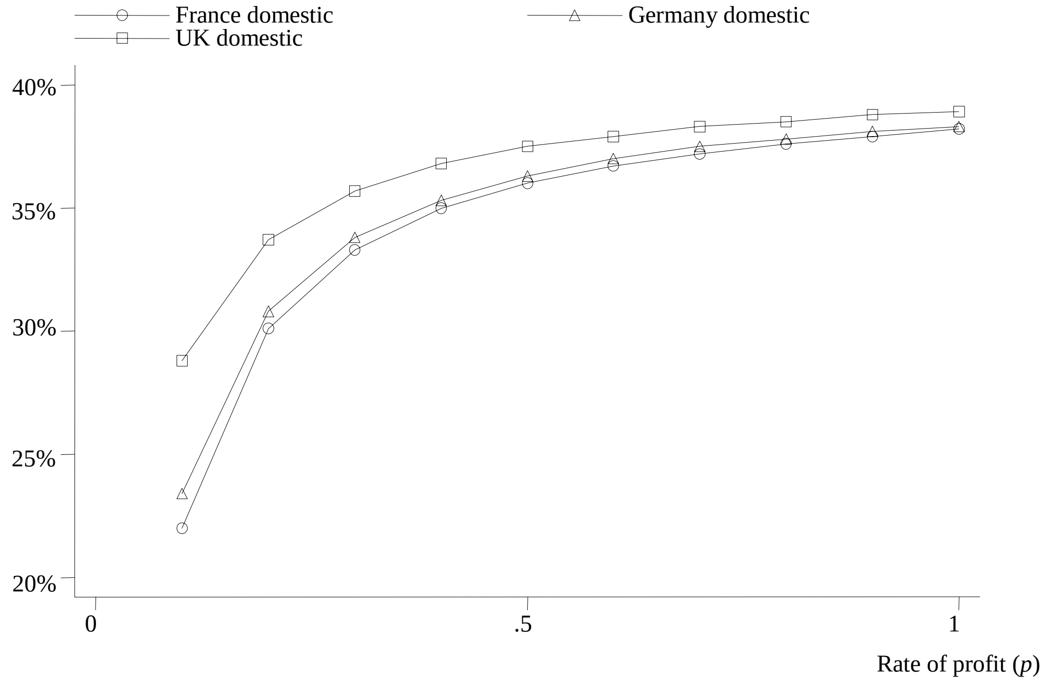


UK

Figure 2: Tax rates on domestic investment in plant and machinery, financed by retained earnings

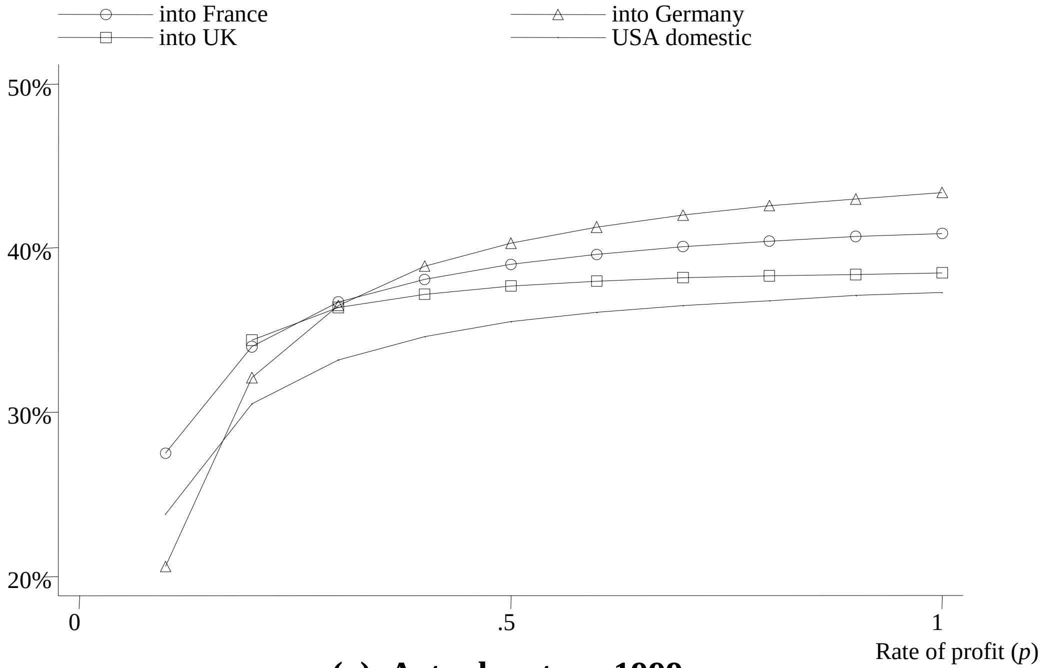


(a) Actual system, 1999

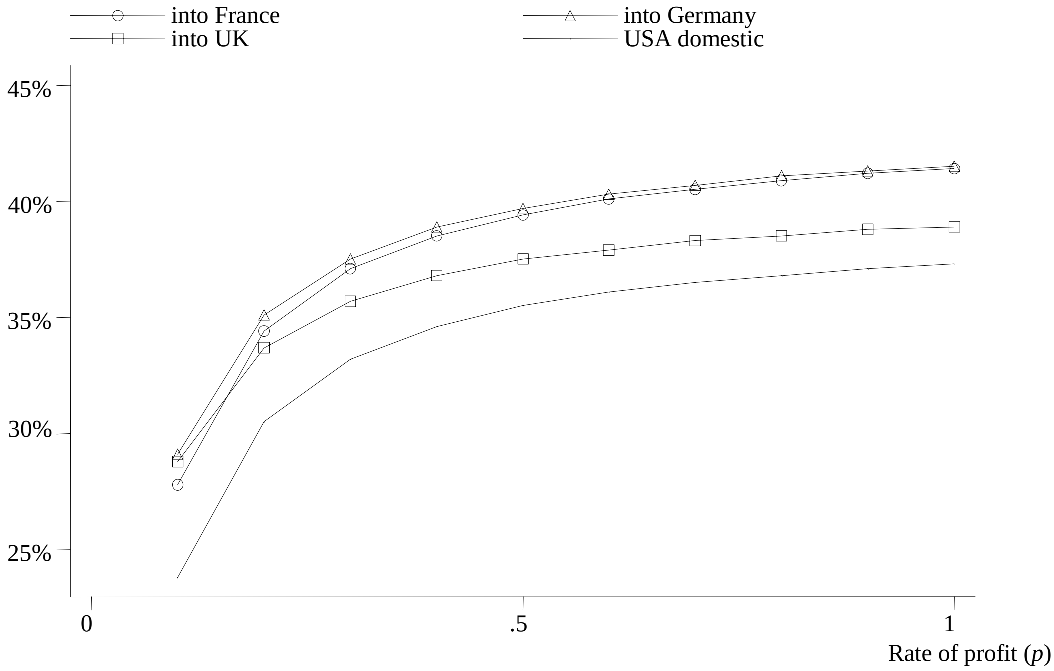


(b) Harmonised statutory rate, no tax credit on dividends

Figure 3: Tax rates on domestic investment in plant and machinery, financed by retained earnings



(a) Actual system, 1999



(b) Harmonised statutory rate, no tax credit on dividends

Figure 4: Tax rates on US firm investment in plant and machinery, financed by retained earnings in parent, and new equity in subsidiary