Taxes and the size of the foreign-owned capital stock: which tax rates matter?

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Abstract

This paper analyses the impact of effective average and marginal tax rates on the size of the capital stock owned by foreign affiliates of US multinational companies. We use data on 19 OECD countries, 1983-1998. A simple two-stage model of location choice, and investment conditional on location, identifies the role of each form of effective tax rate. The empirical results indicate a large and significant role for the effective average tax rate, but not for the effective marginal tax rate. As shown in the theoretical model, this is consistent with the discrete location choice playing a more important role in determining the size of the foreign-owned capital stock.

1 Introduction

Capital is becoming increasingly mobile between countries. Multinational companies face a choice of where to locate production facilities, as well as R&D and other aspects of their organisation. In response to this mobility, there is increasing pressure on governments to maintain and attract capital into their jurisdictions. Governments may attempt to do this is in many different ways - for example, creating a flexible labour market or investing in good infrastructure. This paper focuses on the extent to which differences in the taxation of mobile capital - and specifically corporate income tax - determines where productive activity is located.

We investigate the role of corporate income tax on the distribution of capital owned by US multinational companies. The main innovation of the paper is that we consider in more detail than the previous literature the appropriate specification of a model of multinational behaviour, and the role of taxation. In common with the theoretical literature on multinational firms, and a small subset of the empirical literature on the role of tax, we distinguish two elements of the decision-making process: location and investment conditional on location.

We consider a multinational which aims to serve a foreign market which may transcend the boundaries of a particular country – the most obvious example is a US-based multinational seeking to serve the EU market. Given some fixed cost of setting up a plant, the multinational will not create a plant in every country, but will set up a single plant (or at least a limited number of plants) to serve the entire market. The first decision is therefore where to locate this plant. As pointed out by Devereux and Griffith (1998), who also provide evidence to this effect, this discrete choice depends in principle on the effective average corporate tax rate. Conditional on having chosen a location, however, the multinational must then choose the size of its capital stock. That is the standard problem addressed in the investment literature, and it is well known that in this case, the size of the capital stock depends in principle on the effective marginal tax rate. Of course, this distinction between the discrete and continuous choices is general, and applies to

other factors as well as tax. However, in the case of most other determinants of investment, there is no clear distinction between average and marginal rates; this would be largely true of wage rates, for example. Clearly distinguishing between the role of average and marginal tax rates therefore offers an indirect way of identifying the more general issue of the relative importance of the two types of decision for the aggregate capital stock owned by US multinationals.

We examine this issue using data on the aggregate capital stock owned by affiliates of US multinational companies in each of 19 OECD countries over the period 1983 to 1998. We concentrate on this measure since it is most closely related to the decisions we attempt to analyse. A small number of other papers have also used these data to examine the impact of taxes on foreign investment by US multinational companies. We briefly review these and other papers in Section 2 below. However, none of these papers adequately measures the two relevant forms of tax rate.

Section 3 sets up a simple, stylised, model which is helpful in describing the two-stage decision process, and in identifying the two roles of taxation. It also addresses the issue of aggregating from individual firm to aggregate investment behavior, and derives an estimable investment equation from the theory and aggregation assumptions. Section 4 describes the data, and Section 5 discusses estimation issues and presents the results. Section 6 concludes.

2 A brief review of previous empirical approaches

The most common approach to investigating the determinants of capital movements has been to study flows for foreign direct investment (FDI). A series of papers in the 1980s considered inward FDI into the United States and estimated the impact of various measures of corporate taxation. Slemrod (1990) surveys and extends this literature. It has

also been extended to consider cross sectional variation in FDI flows as well as time series variation, including the use of a panel of bilateral flows between several countries.

However, data on FDI is not well suited to examining the investment and location decisions of multinational companies. This is primarily because FDI measures financial flows, rather than real flows. For example, if a US multinational company undertakes "real" investment in, say Sweden, it may finance that investment in several ways. One of these would be to set up a Swedish subsidiary which is financed by a loan or an injection of new equity from the parent. In this case there would be a flow of funds from the USA to Sweden which would be included in the total FDI flow from the USA to Sweden. However, it is also possible that the Swedish affiliate raises funds locally, from a Swedish bank. In this case, there is no flow of funds from the USA to Sweden, and the FDI flow is unaffected. However, the capital stock in Sweden owned and controlled by US multinationals would have increased.

For these and related reasons, we therefore investigate measures of the capital stock owned by affiliates of multinational companies. Ideally, we would use firm-level data to identify separately the two stages of the decision-making process. Firm-level data has been used to examine each of the two parts of the process, though without differentiating clearly between the two. Devereux and Griffith (1998) used Compustat data to examine the impact of the effective average tax rate on the discrete location choice. And a large number of papers have used firm-level data to examine the continuous choice of the level of investment, ignoring the prior decision as to where to locate the plant. One paper closest to the spirit of this paper is Cummins and Hubbard (1995) – which uses Compustat data on the investment of foreign affiliates of individual US firms. They treat these affiliates as independent firms, and consider a standard investment model, ignoring the location choice. A similar approach is taken by Grubert and Mutti (2000) and Altshuler et al (2001), using confidential US tax return data, which incorporates detailed information about the activities of individual foreign affiliates of US firms. Desai et al (2004) also use confidential affiliate level data to examine the influence of other forms of taxation, as well as corporate income tax.

Another group of papers - Grubert and Mutti (1991), Wheeler and Mody (1992), Hines and Rice (1994) and Mutti and Grubert (2004) - uses the same data as in this paper to examine the geographical distribution of capital owned by US firms at a more aggregate level. These data, from the US Department of Commerce, contain information on the aggregate activities of affiliates of US firms within specific foreign countries. These previous studies have implicitly incorporated all the stages of the decision-making process into one reduced form, and attempted to evaluate the impact of tax on the final capital stock or level of investment in each jurisdiction. They have typically constructed a simple measure of the average tax rate using data on taxes paid in each jurisdiction. It is therefore not possible to identify from these studies whether, say, the capital stock of US affiliates in Sweden is affected more by the discrete choice of locating in Sweden, or by the choice of how much to invest, conditional on having chosen Sweden.

Grubert and Mutti (1991) and Hines and Rice (1994) both find large and significant negative effects of the average tax rate on the aggregate capital stock of affiliates. For example, Grubert and Mutti report that a reduction in the host country tax rate from 20% to 10% would result in an increase in the capital stock of 65%. Some of the estimates from Hines and Rice are even larger. Muti and Grubert (2004) compare export-oriented production with domestic-oriented production, and find that export-oriented production is particularly sensitive to tax differences. This is as might be expected: if the location of production is not determined by the need to have close proximity to a market, then it is likely to be more sensitive to other factors, such as taxation. By contrast, though, Wheeler and Mody (1992) find that tax does not play a significant role in investment decisions.

3 A simple model of location choice and investment[1]

Consider the decisions of a single monopoly, seeking to supply goods to the markets in countries, $i=1,..n$. Residents in each country are immobile. Hence the n markets are

[1] This model draws on the basic structure of Horstman and Markusen (1992).

segmented; there is no cross border shopping. We assume that fixed costs of setting up a plant are such that the monopolist will choose to produce in just one of the *n* countries.[2] In addition, transport costs from its home country are prohibitively high. The choice of whether to produce in country *i=1,..n* depends on the demand in each country, the fixed costs of setting up each plant, *F*, and the transport costs of moving the final product between the countries, of *s* per unit of output. The basic setting we have in mind is a multinational company operating in a regional setting, for example, a US company operating in Europe.

We assume a simple production function: one unit of output requires one unit of capital. Moreover, we make one of two assumptions about capital: either (i) the amount of capital available to the firm is fixed at $\overline{K}$ (fixed plant size), or (ii) the amount of capital available to the firm K, can be varied continuously (variable plant size).

Each country is small relative to the world economy: hence each takes the post-tax required rate of return on capital, denoted *r*, as given. Hence the cost of capital in the absence of taxation is the same in all countries. This is a simplifying assumption to enable us to demonstrate the impact of tax more clearly; it is relaxed in the empirical analysis below.

We assume that (inverse) demand in each country for the output of the multinational is of the form[3]:

$$p_i = p_i(q_i), \quad i=1,..n \tag{1}$$

where p_i is the price of the final good in country i and q_i is the amount of the good sold in country i. We allow preferences - and thus the size of the market - to differ between countries by not requiring $p_i(.) = p_j(.)$.

[2] Location in multiple countries can be studied in this framework, but at the cost of considerable analytical complexity, and the empirical predictions of the model are not changed qualitatively.
[3] This form of demand occurs if the representative consumer in each country has a quasi-linear demand function.

Each country imposes a standard source-based corporation tax, with tax rates τ_i, and with allowance rates, a_i. These allowance rates are assumed to apply both to expenditure on capital assets and to the fixed cost. They summarise, for example, depreciation allowances and any relief for the costs of finance. However, it is convenient to translate these parameters of the tax regimes into effective marginal and average tax rates; these are defined below.

We proceed by calculating the profit[4] that the firm will make from the option of locating in country i. If the monopoly produces in country *i*, then it maximises profit defined as

$$\pi_i = (1-\tau_i)\left\{p_i q_i + \sum_{j\neq i}(p_j - s)q_j\right\} - (1-a_i\tau_i)[rK + F]. \qquad (2)$$

The firm also faces a constraint that the sum of sales in each country i.e. total output must not exceed the capital employed i.e. $\sum_{i=1}^{n} q_i \leq K$.

In the case of variable plant size, K can be chosen optimally, so a firm will always choose the minimum amount of capital needed i.e. $\sum_{i=1}^{n} q_i = K$. Substituting this into (2) and rearranging, the firm will choose $q_1, ..q_n$ to maximise

$$\pi_i = (1-\tau_i)\left\{p_i q_i + \sum_{j\neq i}(p_j - s)q_j - (1+m_i)\left(r\sum_j q_j + F\right)\right\} \qquad (3)$$

[4] We are assuming that the multinational does not have an existing plant in any of the countries. If instead it already operates a plant in one of the countries, the analysis would be the same except that the fixed cost of setting up a new plant would be zero. Since these costs are fixed, the investment decision conditional on location would not be affected; however, the choice between the options may be affected. We discuss this further below.

Here, $m_i = \dfrac{\tau_i(1-a_i)}{1-\tau_i}$ is the *effective marginal tax rate* (EMTR). In this simple model, $(1+m_i)r$ is the standard user cost of capital. This is the usual way in which the investment literature treats the effect of tax on capital investment.

In the case of fixed plant size, the firm will choose $q_1, ..q_n$ to maximise

$$\pi_i = (1-\tau_i)\left\{p_i q_i + \sum_{j\neq i}(p_j - s)q_j - (1+m_i)\left(\overline{K}+F\right)\right\} \tag{4}$$

subject to $\sum_j q_j \leq \overline{K}$.

We begin by considering the case of variable plant size. In this case, from (3), the first-order conditions for the choice of q_i and $q_j,\ j \neq i$ are

$$p_i + p_i^{'} q_i = (1+m_i)r, \qquad p_j + p_j^{'} q_j = (1+m_i)r + s,\ j \neq i \tag{5}$$

That is, the firm equates the marginal revenue in any market from additional sales equal to the cost of capital, $(1+m_i)r$, plus (in the event that the good is exported from the location of production) the transport cost. So, generally, we can write maximised profit as

$$\pi_i^V = (1-\tau_i)\left\{p_i q_i^* + \sum_{j\neq i}(p_j - s)q_j^* - (1+m_i)\left(r\sum_j q_j^* + F\right)\right\} \tag{6}$$

where q_i^* is the optimal choice of q_i, implied by (5).

Now consider the case of fixed plant size. From (4), the first-order conditions for the choice of q_i, and $q_j,\ j \neq i$ are

$$p_i + p_i' q_i = \mu, \qquad p_j + p_j' q_j = \mu + s, \; j \neq i \tag{7}$$

where $\mu \geq 0$ is the Lagrange multiplier on the constraint $\sum_j q_j \leq \overline{K}$. A key point is that the allocation of production across regions is now *independent of the marginal effective tax rate m_i*; to see this, note that in (6), m_i just multiplies a constant $r\overline{K}$ and so does not affect the firm's decision of how to allocate fixed total output $\overline{K}$ across the different markets. So, generally, we can write maximised profit as

$$\pi_i^F = (1-\tau_i)\left\{p_i q_i^* + \sum_{j \neq i}(p_j - s)q_i^*\right\} - (1+m_i)\left(r\overline{K} + F\right) \tag{8}$$

where again q_i^* is the optimal choice of q_i.

The firm will choose to locate in country *i* if $\pi_i^V \geq \pi_j^V, \; j \neq i$ in the case of variable plant size, and if $\pi_i^F \geq \pi_j^F, \; j \neq i$ in the case of fixed plant size. On the face of it, this decision depends on the marginal effective tax rate. But, now we introduce another parameter of the tax system, the *effective average tax rate* (EATR). We will show that in the event of fixed plant size, conditional on the EATR, location decisions are independent of the EMTR. In the case of variable plant size, they depend on *both* EATR and EMTR.

Generally, the EATR is the proportion of the profit arising from the investment which is taken in tax. This could be defined with reference to (i) the profit which would have been earned had there been no tax at all; or (ii) the pre-tax profit which would be earned, conditional on the effects of tax on the level of investment. In what follows, we use the second reference profit. Let this be denoted π_i^{pre}. Now we define the EATR in country *i* as λ_i, where

$$\lambda_i = \frac{\pi_i^{pre} - \pi_i}{\pi_i^{pre}}. \tag{9}$$

By definition, the actual post-tax profit made from locating in country *i* can be written (just by rearranging (9)) as

$$\pi_i(\lambda_i,\ m_i) = (1-\lambda_i)\pi_i^{pre}(m_i) \tag{10}$$

Note that in (10), π_i generally depends on m_i because π_i^{pre} does so. Now consider first the case of fixed plant size. Then, π_i^{pre} is simply obtained by setting $\tau_i = m_i = 0$ in (8) i.e.

$$\pi_i^{pre} = \left\{p_i q_i^* + \sum_{j\neq i}(p_j - s)q_i^*\right\} - \left(r\overline{K} + F\right)$$

This is clearly independent of m_i, because q_i^* is independent of m_i . Intuitively, in this case, as already remarked, m_i does not affect the allocation of output across different countries; from (7), that is determined entirely by the shadow price of output and s, the transport cost. So, from (10), the post-tax profit from locating in country *i* is entirely determined by the EATR. In particular, other things equal the higher is λ_i , the lower is profit from locating in country *i*.

By contrast, in the case of variable plant size, from (5), m_i does affect the allocation of output across different countries. Setting $\tau_i = m_i = 0$ in (6), we obtain

$$\pi_i^{pre} = \left\{p_i q_i^* + \sum_{j\neq i}(p_j - s)q_j^* - \left(r\sum_j q_j^* + F\right)\right\} \tag{11}$$

and so, as m_i affects q_i^*, it does affect π_i^{pre}. Specifically, differentiating (11), we see that

$$\frac{\partial \pi_i^{pre}}{\partial m_i} = \left(p_i + p_i^{'}q_i - r\right)\frac{\partial q_i^*}{\partial m_i} + \sum_{j\neq i}\left(p_j + p_j^{'}q_j - r - s\right)\frac{\partial q_j^*}{\partial m_i} \tag{12}$$

Combining (12) with (5), we get;

$$\frac{\partial \pi_i^{pre}}{\partial m_i} = rm_i \sum_{j=1}^{n} \frac{\partial q_j^*}{\partial m_i} = rm_i \frac{\partial K}{\partial m_i} < 0 \qquad (13)$$

because from (5), $\frac{\partial q_j^*}{\partial m_i} < 0$. So, from (10) and (13), with variable plant size, the profit from locating in *i* is decreasing in both λ_i and m_i. Moreover, from (13), the size of the effect of impact of λ_i and m_i depends on how responsive is total capital to m_i.

Aggregation and Empirical Specification

In this paper we do not have data on individual firm decisions, but only on the aggregate capital stock in each country owned by US multinational companies. We therefore need to consider the aggregation of the discrete and marginal choices. In aggregating, we must allow firms to differ from each other; otherwise they would all make the same choice, which is inconsistent with what we observe in the data.

To do this, we adopt the probabilistic choice framework of McFadden (Madalla, 1983) where firm heterogeneity is modeled via the use of random variables. From (10) above, we know that the profit from locating in country i for any firm[5] can generally be written $\pi_i = \pi(\lambda_i, m_i, X_i)$, where λ_i, m_i are tax rates as defined above, and X_i is a vector of variables specific to country *i*. The probabilistic choice model hypothesizes that a firm chooses country *i* if

[5] Obviously, this profit will generally depend also on firm-specific variables such as whether (and how much) the firm has invested in a location before. However, with aggregate data, we have no way of identifying these effects, except by using country averages of these firm characteristics as regressors. Empirically, we include two such variables: the log of amount of investment in country i in the previous period, and the log of sales in the current period. Formally, these variables are included in X_i.

$$\pi(\lambda_i, m_i, X_i) + \varepsilon_i \geq \pi(\lambda_j, m_j, X_j) + \varepsilon_j, \quad j \neq i$$

The random variable ε_i captures unobserved variations in preferences of the individual firm, as well as computational mistakes by that firm (Madalla, 1983). Then, it is well-known that if $\varepsilon_1, \varepsilon_2, ...\varepsilon_n$ are i.i.d. with a type I extreme value distribution[6], then the probability that a firm chooses to locate in country *i* is simply

$$p_i = \frac{\exp(\pi(\lambda_i, m_i, X_i))}{\sum_{j=1}^{n} \exp(\pi(\lambda_j, m_j, X_j))} \tag{14}$$

Also, if a firm locates in country *i*, it will invest some amount, which will only depend on m_i and X_i, which we assume takes the form

$$a_i = \exp(\phi m_i + \eta X_i) \tag{15}$$

The link with the theory is that in the event of fixed plant size, $a_i = \overline{K}$, and that in the event of variable plant size, $a_i = \sum_i q_i^*$. So, in the event of fixed plant size, a_i will be independent of m_i, although the plant size may depend on other country characteristics X_i.

The *expected investment* by the firm in country i is $k_i = p_i a_i$. To find a tractable expression for k_i, we assume that profit $\pi_i = \pi(\lambda_i, m_i, X_i)$ is linear in the explanatory variables:

$$\pi(\lambda_i, m_i, X_i) = \alpha\lambda_i + \beta m_i + \gamma' X_i \tag{16}$$

Then, (14), (15) and (16) combine to give

[6] That is, $F(\varepsilon_i \leq \varepsilon) = \exp(-\exp(-\varepsilon))$.

$$\ln k_i = \ln p_i + \ln a_i = \alpha\lambda_i + (\beta + \phi)m_i + (\gamma + \eta)' X_i + A \qquad (17)$$

where $A = -\ln \sum_{j=1}^{n} \exp(\alpha\lambda_j + \beta m_j + \gamma' X_j)$.

So, if the number of firms is large, we can assume that observed investment in country *i* at time *t*, k_{it}, is equal to expected investment, implying from (17) an estimating equation of the form

$$\ln k_{it} = a_1\lambda_{it} + a_2 m_{it} + a_3' X_{it} + A_{it} \qquad (18)$$

This will be the equation to be estimated. In fact we assume $A_{it} = \eta_i + \mu_t + \varepsilon_{it}$, where η_i, μ_t are country and time dummies respectively, and the ε_{it} are i.i.d. The theory suggests the following sign restrictions: in general, $a_1, a_2 < 0$, but if plant size is not variable, we would expect to see $a_2 \cong 0$.

Empirical Issues

A number of empirical issues need to be considered. First, there is the issue of control variables. In the above framework, both the decision of where and how much to invest depend on the controls X_i. Variables specific to the country can be divided into two categories. First, there are country characteristics that might plausibly make investment in a particular country more or less profitable. In principle, relevant variables would include measures of country size, openness, the size of existing production activity in that country/industry, which might be expected to generate positive externalities in production, demographics and differences in costs across countries. The specific list of variables is given in Table 1 below. Included in this list is the real interest rate, which measures the cost of capital in the absence of taxation.

The second type of variable that will affect the decision of a firm to locate in country *i* will be the variables relating to the characteristics of the firm, such as its sales, profit, and the amount (if any) already invested in country i. However, with our aggregate data, we have no way of identifying these effects for any individual firm. But we can calculate the sales, profits, and previous investments of all the firms in the sample in country *i* in a given period. So, strictly speaking, these are also country characteristics, and thus are also included in X_i.

The second issue is dynamics. The decision of any firm to invest in a country will generally depend strongly on how much it has invested there before. As with other firm-specific variables, we do not measure past investments at the level of the individual firm, but we do measure them at the level of the country. Specifically, to capture dynamics, we include the log of last period's capital stock in country *i*, $\ln k_{i,t-1}$, as one of the regressors in X_i.

The final issue is functional form. The aggregation procedure above imposes the restriction that the dependent variable is the log of the capital stock. However, it does not impose strong restrictions on whether controls enter linearly or in logs (or some other form). That is, variables in X_i can be the logs or other transformations of the underlying control variables.

4 Data

Our data on the investment positions of US multinationals is from the Bureau of Economic Analysis of the US Department of Commerce. This provides data on the aggregate operations of foreign affiliates of US parent companies. Most of the variables are available aggregated to the level of individual countries (they are also available by industry). We have extracted data from this source on the aggregate value of the capital stock owned by the affiliates of US parents in 19 OECD countries over the period 1983 to 1998. In addition, we have also extracted data on sales and net income.

Figure 1 gives an indication of the size of the capital stock owned by affiliates of US multinationals in each country; the Figure presents the mean capital stock over the period analysed, 1983 to 1998, for each country, in 1995 prices ($billion). There is clearly a very unequal distribution across countries. On average, over this period, the value of the capital stock in the UK and Canada was far larger than elsewhere, with over $50 billion. Only three other countries - Germany, Australia and France – had an average in excess of $10 billion.

Figure 2 shows the total net investment into these countries over time (as measured by the difference in the capital stock between successive years); and also the mean value of the capital stock across all the countries. The mean capital stock roughly tripled in real terms over this period. However, the total investment line shows that this rise was a volatile process, with high investment in the late 1980s and again in the mid 1990s, but also with periods – notably in 1991/2 - where there was a net reduction in the aggregate real capital stock.

We use data on the corporation tax regimes of these countries. There are two broad approaches to the measurement of effective tax rates on capital income. One is based on the ratio of tax payments to a measure of the profit of the company, or at aggregate level, to the operating surplus of the economy. This approach is not ideal for analyzing the impact of taxes on investment flows, for several reasons. First, at best it is a measure only of an effective average tax rate, and so does not measure either the statutory rate or the EMTR. Second, it does not necessarily reflect the impact of taxes on the incentive to invest in a particular location, because tax revenues depend on the history of past investment and profit and losses of a firm. Third, this measure – especially at the aggregate level - can vary considerably according to underlying economic conditions, even when tax regimes do not change; the variation is therefore due to factors outside the immediate control of the government. Fourth, at a more disaggregated level, then the amount of tax paid is endogenous: higher investment generates a higher allowance and hence lower tax.

The tax rate measures used in this paper are therefore based instead on an analysis of the legislation underlying different tax regimes. We use the measures of the effective average tax rate and effective marginal tax rate proposed by Devereux and Griffith (2003), which broadly correspond to those set out in Section 2. Following the standard approach, they consider the taxation of a hypothetical unit perturbation to the capital stock. In this paper, we consider investments in buildings and in plant and machinery, financed by equity and debt. We take a weighted average of the effective tax rates for each of these four different types of investment.[7]

We construct the EATR, the cost of capital and also the effective marginal tax wedge – equal to the difference between the cost of capital and the real rate of interest – using data on the statutory tax rate, τ, and the allowance rules, for all the observations for which we have the BEA data ie. 19 OECD countries between 1983 and 1998. These data have also been used in other studies: see, for example, Devereux, Griffith and Klemm, (2002) and Devereux, Lockwood and Redoano (2004). More details of their construction are given in these papers. Briefly, the statutory rate is typically the headline rate of corporation tax. However, in many countries there are additional local corporation taxes (typically using a very similar tax base), which vary within each country. Where appropriate, we have included "typical" local taxes. The cost of the increased capital stock is offset by tax allowances, defined by the legislation. The additional revenue is taxed under the statutory tax rate. In the empirical analysis below, we use the cost of capital instead of the effective marginal tax rate. This is because there are cases where the denominator of the effective marginal tax rate – the real rate of interest - is close to zero, which generates very high values of the effective marginal tax rate.

Figures 3-5 below show key features of our tax rate variables. As shown in Figure 3, which presents the statutory rate for each country in both 1983 and 1998, almost all countries have reduced their statutory rates, many significantly. It is interesting to note

[7] Following Chennells and Griffith (1997), the weights are assumed to be: plant and machinery 64%, industrial buildings 36%; and equity 65%, debt 35%.

that Germany, essentially the last country in 1998 with a high tax rate, has subsequently cut its tax rate substantially. Ireland is the only country which stands out from the others - here we have used the special 10% rate for manufacturing used in Ireland throughout the period analysed.

Figure 4 presents our estimates of effective average tax rates, in the same format. This measure has also tended to fall in most countries, in some cases substantially. However, the rate-reducing, base-broadening reforms which occurred in many countries have not had such a dramatic effect on effective tax rates as on the statutory rate, due to the offsetting effect of the broader base. This is even more apparent in the case of the effective marginal tax wedge, shown in Figure 5, where in many countries there has actually been an increase over the period considered. For example, the 1984 tax reform in the UK substantially reduced capital allowances on both types of asset analysed here; in computing the tax wedge this outweighs the very substantial reduction in the statutory rate which occurred at the same time. A thorough description of the development of these taxes is provided in Devereux, Griffith and Klemm (2002).

Finally, it is worth noting that we do not incorporate international aspects of tax, such as taxes levied by the USA on repatriation of profit. The main reason is that there is plenty of evidence that multinational companies are skilled at tax planning. This implies that the straightforward calculation of effective tax rates taking into account additional taxes at an international level may be seriously misleading. We believe that a more reasonable approach is to assume that multinational firms typically avoid any further tax at an international level. Hence we include only the taxes levied in the source country.

Table 1 summarises the data used in this paper. As well as the data on US affiliates and the measures of taxation, we use a number of country-specific control variables which reflect other influences on the location choices. We include a measure of country size (GDP relative to the USA); two measures of openness (the trade to GDP ratio, and a

dummy variable indicating whether there are significant capital controls[8] – this is based on data from Quinn 1997, and takes the value of 1 in the absence of controls, and 0 in the presence of controls); the size of the government sector, proxied by the ratio of public consumption to GDP; and a number of demographic variables.

5 Econometric specification and results

We estimate the model set out above:

$$\ln k_{it} = a_1\lambda_{it} + a_2 m_{it} + a_3 \ln k_{i,t-1} + a_4 \ln Y_{it} + a_5' Z_{it} + \eta_i + \mu_t + \varepsilon_{it} \qquad (19)$$

where λ_{it} and m_{it} represent the EATR and the cost of capital, $\ln Y_{it}$ represents the log of sales of US affiliates, in Z_{it} is a vector of other control variables, η_i is a country-specific fixed effect and μ_t is a fixed year effect.

We include the lagged dependent variable, since it is highly likely that there is persistence in the capital stock series. We include sales of US affiliates as a proxy for income expectations, as is normal in investment equations. Note that both of these variables can be thought of as being included in Z_{it} in the theoretical section above. It is likely that both of these variables are endogenous: we therefore instrument them using their own lags, and the lag of net income, all from period *t-2*. We present a test of the over-identifying restrictions implied by the instruments. We cluster standard errors by country to account for any remaining serial correlation (we also present a test of serial correlation); standard errors are also robust to heteroscedasticity. We estimate the model in levels, including dummy variables to account for the fixed effects.

The results are presented in Table 2. We begin in columns 1 to 2 by including three measures of tax separately: the effective average tax rate (column 1) and the cost of

[8] The precise variable we use is described in more detail in Devereux, Lockwood and Redoano (2004).

capital (column 2). We include the real interest rate in the first column: this is replaced by the cost of capital in column 2. In all cases, we include lagged log of the capital stock, log sales, and the control variables. All the specifications in Table 1 comfortably pass the test of over-identifying restrictions. They also comfortably pass the test of serial correlation; but the standard errors are in any case clustered to account for serial correlation.

The lagged dependent variable is highly significant, as would be expected. In addition, the total sales of all affiliates in country *i* has a positive and significant effect on investment in country *i*, with an elasticity of around 0.2. This is consistent with standard investment models, where this term proxies for the expected rate of profit of current investment. Several of the other control variables are also significant across the whole table. Abolishing capital controls has a significant and positive impact on investment by US affiliates. This effect is also substantial: abolishing capital controls (moving the dummy variable from 0 to 1), would increase the capital stock owned by US multinationals by 5% in the short run and 15% in the long run. Conditional on this effect, though, the other measure of openness – total trade as a proportion of GDP – is not significant. The size of the public sector, measured by the ratio of public consumption to GDP, has a negative impact on investment; this may reflect aversion to big government by US multinational companies. Other control variables are not significant: this may reflect the fact that they do not change significantly over time; country fixed effects are also included.

Column 1 demonstrates that the effective average tax rate has a negative and significant impact on investment, as predicted by the location choice part of the model in Section 2. The size of the effect of the host country tax rate is substantial. A one percentage point reduction in the effective average tax rate implies an increase in the capital stock of nearly 0.5% in the short run, and around 1.5% in the long run. Based on the average capital stock of just over $11 billion (in 1995 prices), this represents an increase of the order of $54 million (1995 prices) in the short run and $160 million (1995 prices) in the long run. This short run effect represents an increase in average investment of over 6%.

This contrasts significantly with column 2, where the cost of capital is used instead of the EATR. The cost of capital is not significant. Given the two-stage model described in Section 2, this is consistent with the capital stock being relatively fixed, conditional on location. This is tested more formally in column 3, where – as the model suggests – both the EATR and cost of capital are included. It is clear from column 3 that the results of column 1 and 2 continue to hold. This is consistent with the discrete locational choice playing an important role in the size of the capital stock owned by affiliates of US multinationals in other countries. It is also consistent with the size of the capital stock not being very flexible, conditional on that location choice.

This result is broadly consistent with most of the large empirical literature on the impact of taxes on the level of investment, in that the cost of capital does not usually play a substantial role. However, in contrast to this literature, the effective average tax rate appears to play an important role in the location decision; and by implication, it is the location decision which appears to determine the ultimate size of the capital stock in each location.

Column 4 explores the possibility that companies do not take into account details of the definition of the tax base in each country, but consider only the statutory rate. Excluding both the EATR and the cost of capital, then column 4 suggests that the statutory tax rate does appear to play a significant role in determining the size of the capital stock (as recently suggested by Buettner and Ruf (2006), for example). One possible explanation for this is that, in a world where profit shifting is relatively easy, then it may be the statutory rate which is critical in determining the overall level of tax on the multinational's activities.

However, this is not borne out by the results in column 5 where, to test this possibility more thoroughly, we include all three measures of tax. The results are striking: the effect of the EATR remains highly significant, and the coefficient is very similar to that in columns 1 and 3. The cost of capital is again insignificant. But now the statutory rate is also insignificant. These results suggest that the significance of the statutory rate in

column 4 is due to it being a proxy for the EATR. In column 5, conditional on the EATR, it plays no independent role.

6 Conclusions

This paper has re-examined the role of taxes in determining the size of the foreign-owned – specifically owned by US multinationals - capital stock in OECD countries. Its main contribution is to examine carefully the decision-making process of multinational companies, and to address the particular form of effective tax rate relevant for each part of the decision. It sets out a simple model of a two-stage process. In stage 1, the company makes a discrete location choice, which is affected by the effective average tax rate. In stage 2, conditional on the location choice, the company chooses the scale of its investment, a decision affected by the effective marginal tax rate.

The empirical results indicate a large and significant impact of the effective average tax rate, but no statistically significant impact of the effective marginal tax rate. Indirectly, this suggests that the more important part of the decision-making process is the first stage. The decision as to where to locate seems to be a fine one, easily affected by differences in taxation. However, conditional on location, there is no evidence of any impact of taxation on the scale of investment.

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Table 1: Data Description

variable	description	mean	standard deviation
Data on Affiliates of US multinationals, from Bureau of Economic Analysis			
K_{it}	capital stock (property, plant and equipment) of affiliates of US multinational companies in period t, country i (billion $ 95)	11.25	17.14
$invest_{it}$	net investment in period t, country i = $K_{it} - K_{i,t-1}$, (billion $ 95)	0.808	2.07
π_{it}	net income of affiliates of US multinational companies in period t, country i (billion $ 95)	2.68	3.36
Y_{it}	net sales of affiliates of US multinational companies in period t, country i (billion $ 95)	50.25	61.2
Tax rate data			
$EATR_{it}$	effective average tax rate in period t, country i; as described in the text	0.287	0.077
τ_{it}	statutory corporation tax rate in period t, country i	0.403	0.116
$cost\ of\ capital_{it}$	pre-tax required rate of return = real rate of interest, plus marginal tax wedge, period t, country i	0.112	0.034
Controls			
r_{it}	real interest rate in period t, country i	0.064	0.027
Capital controls dummy	Dummy variable measuring extent of capital controls in period t country i; data from Quinn (1997)	0.60	0.49
siz_t	GDP_{it} as a proportion of USA GDP_t	0.083	0.098
Trade/ GDP	(imports + exports)/GDP in period t, country i	0.59	0.26
Public consumption/ GDP	public consumption as a proportion of GDP in period t, country i	0.188	0.043
Inflation rate	inflation rate in period t, country i	0.046	0.043

Table 2. Results

	1	2	3	4	5
dep var:	$ln(K_{jt})$	$ln(K_{jt})$	$ln(K_{jt})$	$ln(K_{jt})$	$ln(K_{jt})$
EATR	-0.478	-	-0.460	-	-0.456
	(3.72)**		(3.99)**		(2.90)**
cost of capital	-	-0.083	-0.208	-	-0.205
		(0.24)	(0.60)		(0.61)
τ_{it}	-	-	-	-0.280	-0.004
				(2.64)*	(0.04)
real rate of interest	-0.250	-	-	0.125	-
	(0.54)			(0.29)	
$ln(K_{j,t-1})$	0.676	0.687	0.678	0.697	0.678
	(11.84)**	(11.48)**	(11.76)**	(12.06)**	(11.19)**
$ln(Sales_{jt})$	0.229	0.181	0.227	0.201	0.227
	(2.67)*	(1.98)	(2.65)*	(2.37)*	(2.61)*
capital controls dummy	0.054	0.062	0.054	0.051	0.054
	(2.63)*	(2.68)*	(2.66)*	(2.33)*	(2.65)*
public consumption/GDP	-1.428	-1.311	-1.440	-1.416	-1.440
	(1.87)	(1.71)	(1.88)	(1.89)	(1.86)
size	0.976	1.251	0.946	0.852	0.943
	(1.29)	(1.62)	(1.27)	(1.19)	(1.30)
trade/GDP	0.156	0.200	0.161	0.199	0.161
	(0.77)	(0.90)	(0.84)	(0.96)	(0.84)
inflation rate	-0.317	-0.531	-0.323	-0.352	-0.324
	(0.80)	(1.38)	(0.82)	(0.91)	(0.82)
country fixed effects	yes	yes	yes	yes	Yes
year fixed effects	yes	yes	yes	yes	Yes
test of over-identifying restrictions	0.331	0.391	0.334	0.382	0.334
test of serial correlation	0.661	0.536	0.709	0.615	0.635
R^2	0.998	0.998	0.998	0.998	0.998
Observations	266	266	266	266	266

Notes.

1. All columns include country fixed effects and year effects, There is a balanced panel of 19 countries and 14 years, 1985 to 1998. (Earlier years are used for lagged variables).
2. Robust t statistics in parentheses; * significant at 5%; ** significant at 1%. Standard errors are clustered y country.
3. $ln(K_{j,t-1})$ and $ln(Sales_{jt})$ are treated as endogenous. Instruments are $ln(Net\ Income_{j,t-2})$ $ln(Sales_{j,t-2})$ and $ln(K_{j,t-2})$. The test of over-identifying restrictions is from Wooldridge (2002). It is distributed as $\chi^2(1)$ (ie. there is one degree of freedom, with 2 endogenous regressors and 3 instruments). The figure given in the table is the p-value.
4. The test for serial correlation shows the p-value of the significance of the lagged residuals included in a regression of the dependent variables on the explanatory variables: see Wooldridge (2002).

Figure 1. Mean Capital Stock owned by Affiliates of US Multinationals, 1983-1998 ($billion, 1995)

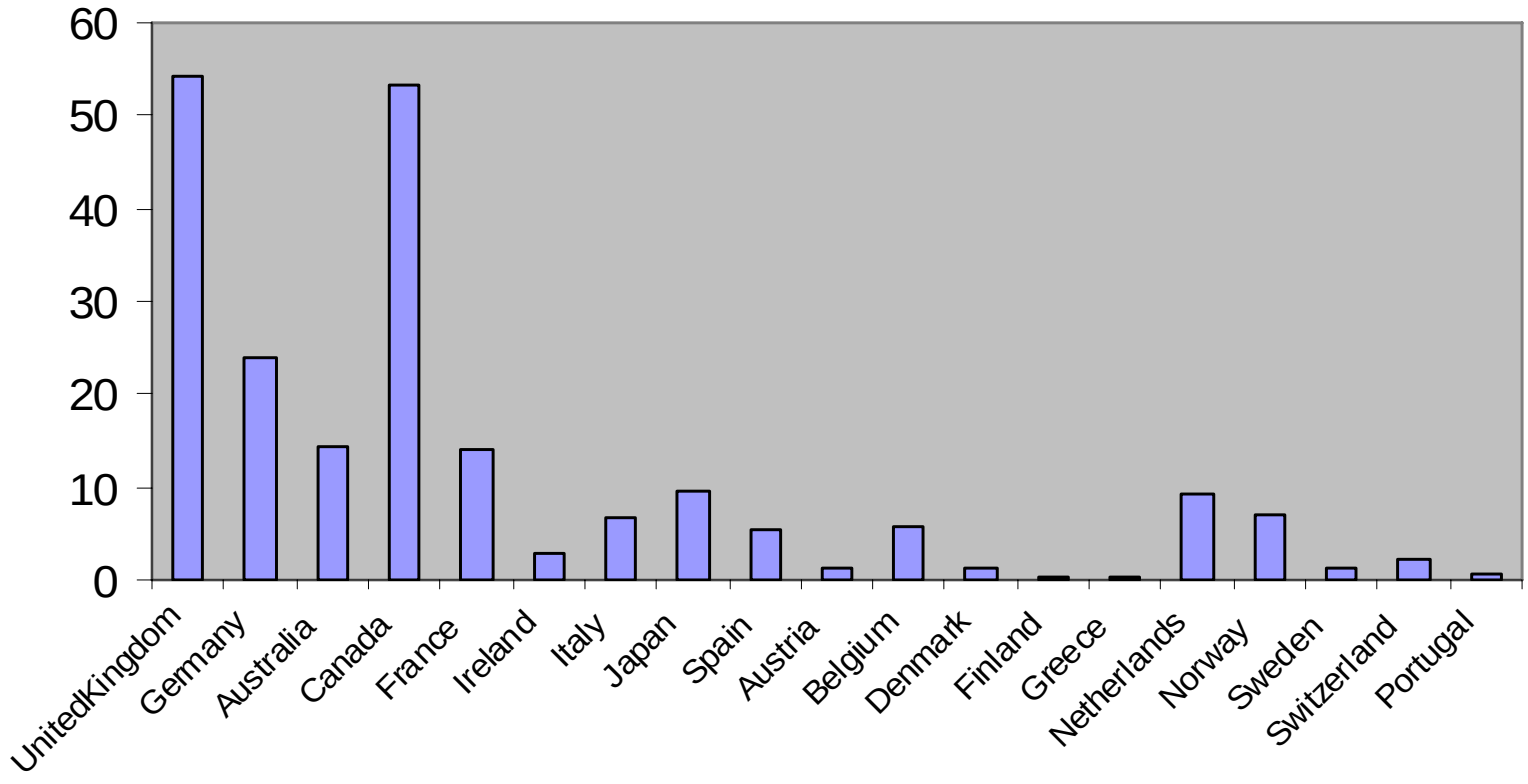

Figure 2. Development of capital stock and investment over time ($ billion, 1995)

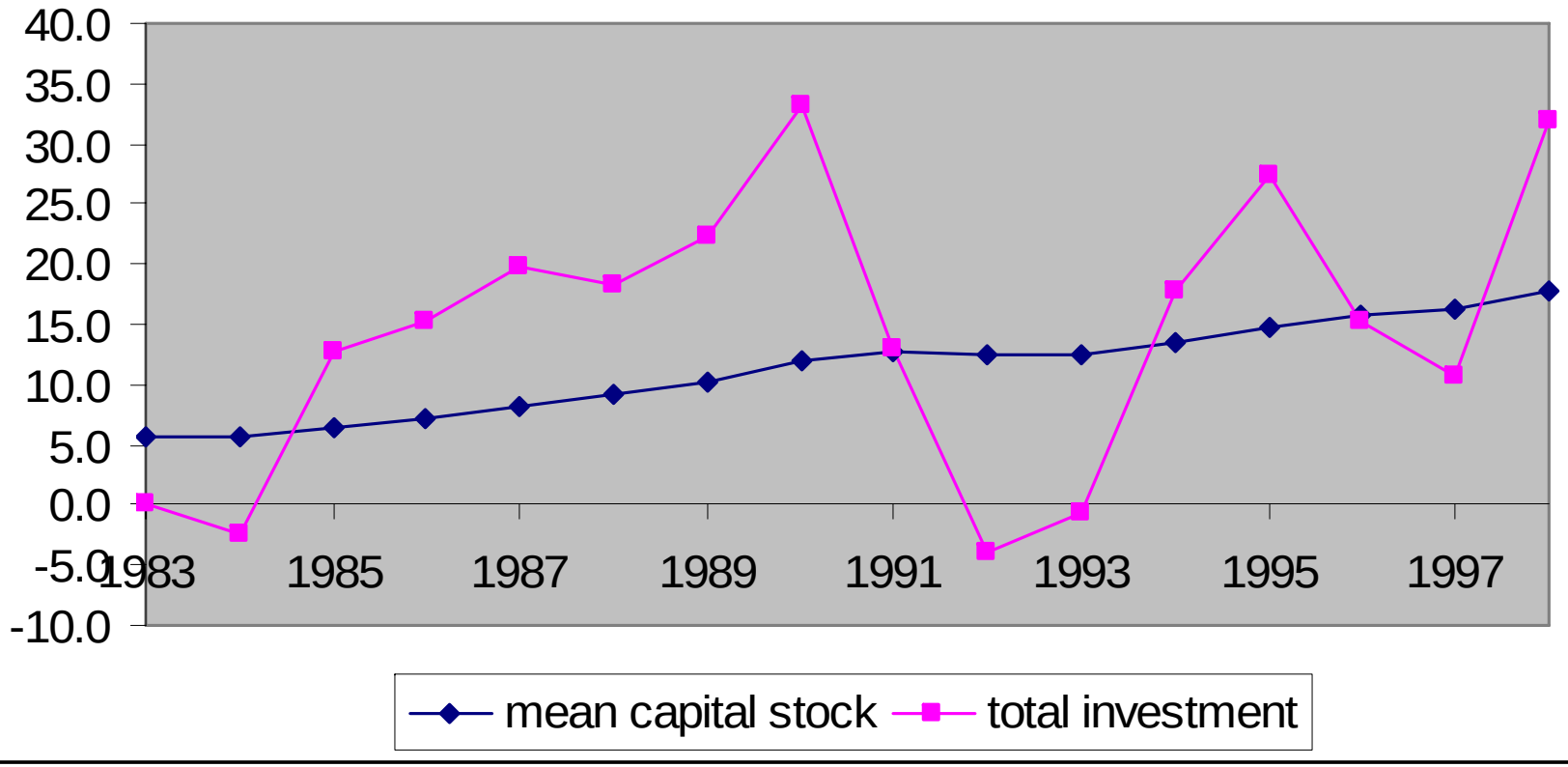

Figure 3. Statutory Corporation Tax Rates 1983 and 1998

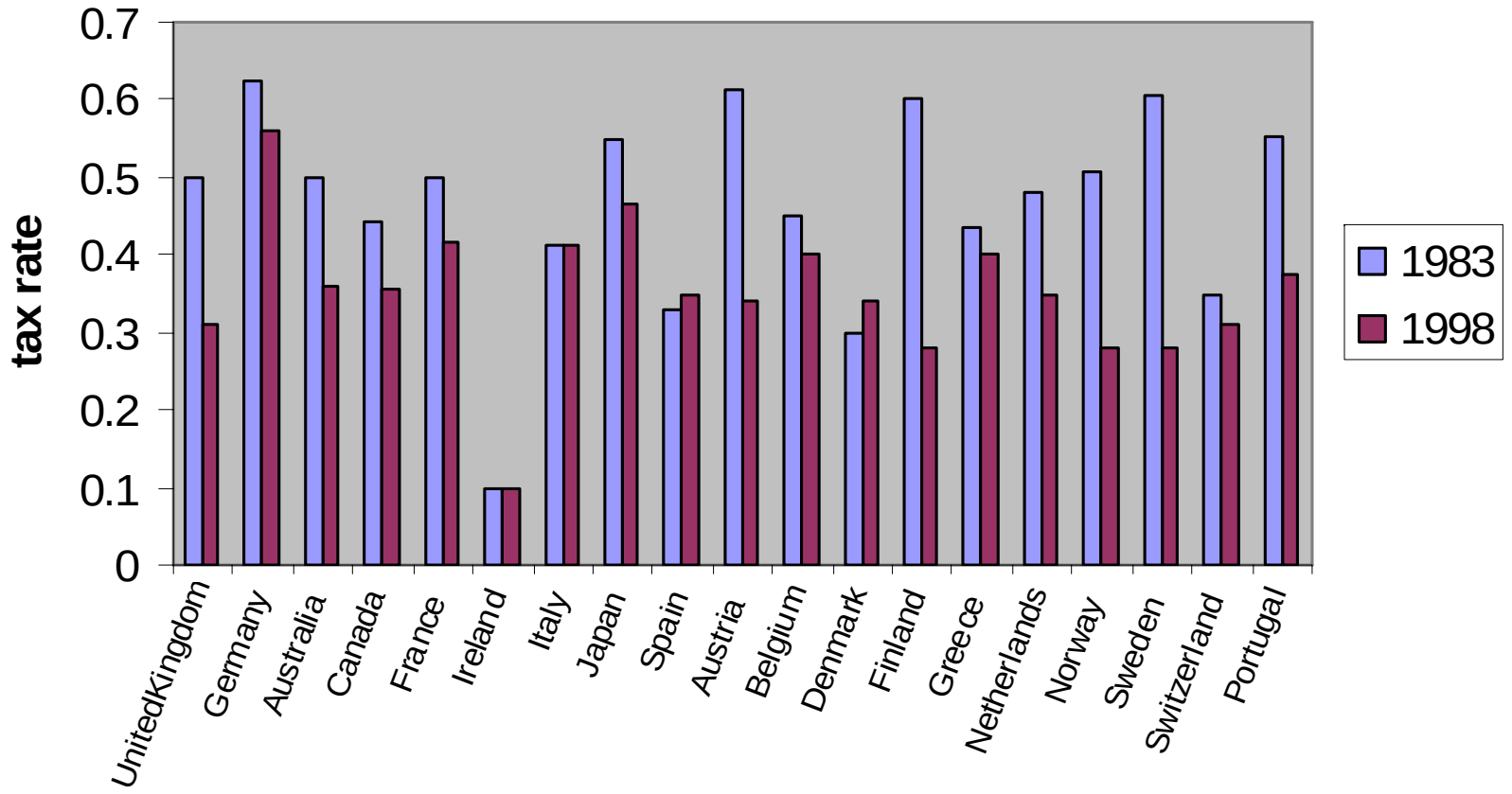

Figure 4. Effective Average Tax Rates 1983 and 1998

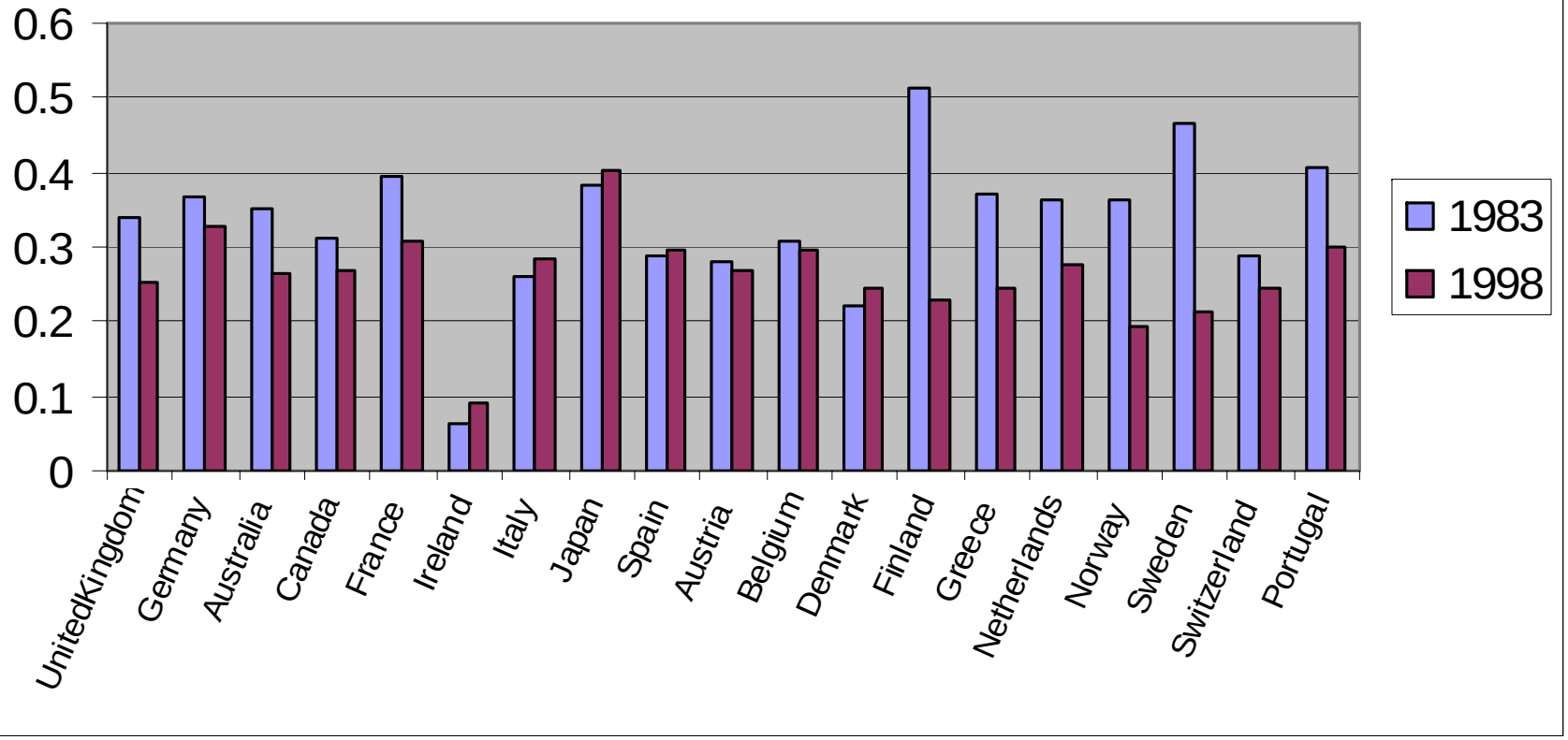

Figure 5. Effective Marginal Tax Wedge
1983 and 1998