

The impact of corporate taxation on the location of capital: A review

Michael P. Devereux and Rachel Griffith*

Summary

■ This paper surveys the empirical literature on the impact of corporate income taxes on the location of capital. We identify the main issues which arise in such empirical work, and link different studies in a general framework. We concentrate specifically on issues which arise in the formulation of economic policy. We conclude that the existing literature provides little by way of policy-relevant insights.■

JEL classification: F2, H3.

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Capital is becoming increasingly mobile between countries. Multinational companies face a choice of where to locate production facilities. Research and development need not take place in the same country as production. Head office and financing activities may take place in third and fourth countries. 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 in many different ways—for example, creating a flexible labour market or investing in good infrastructure. This paper focuses on the taxation of mobile capital—and more specifically the role of corporate income tax—in determining where productive activity is located.

There is now a large and growing academic literature on tax competition for mobile capital.¹ There have been numerous policy discussions and reports on the international aspects of taxing mobile capital, and especially on the threat of tax competition.² There have also been several recent international initiatives aimed at co-ordinating such taxation.³

Understanding the impact of taxes on the location of capital is an important first step in evaluating these issues. In this paper we survey empirical studies of the impact of corporate income taxes on the location of capital. We focus specifically on issues of policy: the next section discusses what might be the aim of policy makers in attempting to attract capital into their jurisdiction, and subsequent sections concentrate primarily on discussing what evidence is available to aid such policy aims. In doing so, we summarise the nature of the empirical

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¹ See Wilson (1999) for a survey of theoretical approaches.

² See i.a. Ruding Committee (1992) and European Commission (2001).

³ See European Commission (1997, 1998) and OECD (1998, 2000a).

literature. In particular, in Section 3, we discuss a number of papers in the context of a simple structural model of multinational firm decision making.

We limit this survey in two main ways:

- We focus on studies that include some measure of taxation as a possible factor in determining cross border flows of capital. We do not survey the general literature on the mobility of capital, or empirical studies of the determinants of where firms locate, that do not include corporate income taxes.
- We consider only studies of the impact of taxation on the location of real activity. We do not comment on the impact of taxes on financial decisions, or on ways in which firms can shift income between jurisdictions to reduce their tax liabilities, except to the extent that these issues are relevant for the location of real capital.

The structure of this paper is as follows. In Section 1, we discuss issues in the design of policy. In particular, we set out various possible aims of policy, and relate these to particular measures of capital, including foreign direct investment. Section 2 addresses a number of methodological issues, including the nature of the capital flows being considered, and the relevance of various measures of taxation. Section 3 reviews the findings from the empirical literature. Section 4 provides a brief summary, and discusses the extent to which policy conclusions can be drawn.

1. Issues in the design of policy

This paper discusses what insights the empirical literature on the impact of taxation on cross border flows of real capital has for economic policy in a small open economy. Before jumping into a review of the literature we briefly discuss what might be the aims of policy. There are two possible general aims in this area. The first concerns the size of the aggregate domestic capital stock. The second concerns the distribution of the aggregate capital stock across types of capital and across types of ownership. We consider these in turn.

In a simple framework of homogeneous capital, and in the absence of taxation and other distortions, the aggregate capital stock in a country will be determined by the equalisation of the marginal product of capital and the world rate of return. If the marginal product were higher than the world rate of return, it would induce higher in-

vestment. If it were lower, capital would flow elsewhere. However, for various reasons, the economy might not be at such an equilibrium. One important reason is taxation itself. In a small open economy, a source-based tax on capital income pushes up the required pre-tax rate of return, leaving the post-tax rate of return unaffected. Such a process usually requires a reduction in the stock of capital. One important lesson from empirical work could therefore be an understanding of how sensitive the aggregate capital stock is to changes in the effective tax rate. The economy could also be away from the equilibrium position for some other reason, e.g. a constraint on the availability of funds to finance investment, which may arise for a number of reasons.⁴

A second broad aim of policy may be to affect the distribution of the aggregate capital stock across types of capital. One important distinction in the context of cross border flows of capital may be the nationality of the owner. Theory suggests that multinationals should have some superiority over domestic firms. This is based on the presumption that, because there are costs to setting up production in a foreign country, if the multinational is to compete with local firms (which do not face such costs), then it must have some other advantages.⁵ Such advantages may take a number of forms. They may reflect lower production costs or a higher quality product, made possible by research and development undertaken in the multinational's home country or elsewhere. They may reflect a better organised and managed structure. However, the advantage may also reflect market power, due perhaps to advertising and branding.

These considerations may justify subsidising investment by multinationals, for two reasons. First, welfare may be higher if part of the benefit generated by multinationals is captured by residents. This may happen in a number of ways: for example, through higher tax revenues and higher wages. Second, the presence of multinational firms may have positive externalities. These externalities can take a number of forms—such as technological spillovers or increases in competition. Thus, for example, domestic firms may be able to copy the technically superior multinational to improve their own efficiency. Empirical research is unclear on the size or importance of these externalities—the early literature suggested that positive spillovers or external-

⁴ See i.a. Hubbard (1998) for a survey.

⁵ This is broadly the OLI approach of Dunning (1977).

ities from multinationals to other firms may be quite large,⁶ but the more recent literature finds a much smaller impact.⁷ But there is evidence to suggest that there is a beneficial effect of attracting activity by multinational firms.

Thus, to the extent to which multinational firms do generate positive externalities, then it may be optimal to tax them at a lower rate. But note that this may also apply to domestic-based multinationals. Recent empirical work suggests that domestic multinationals are similar to foreign multinationals.⁸ It may be as important for a government to consider the role of taxation in retaining the activities of its own successful firms as in attracting new foreign investments.

This discussion therefore suggests that the most important empirical issues for evaluating policy are to gain an understanding of the impact of taxes on aggregate investment and on the activities of those (domestic and foreign) multinationals that have positive externalities. This implies that the basic variables of interest are the aggregate capital stock, and the ownership of capital.

By contrast, much of the literature examines flows of foreign direct investment, or FDI, which is not the same as either of these. In national accounts, FDI measures capital flows between countries where the provider of the capital (typically a parent company) has control over the receiver of funds (typically an affiliate). But these flows should not be confused with “real” investment in the sense of a purchase of a factory, a shop or a piece of machinery. They are financial flows which differ from “real” investment in two main ways.

First, if a multinational corporation resident in, say, the USA, undertakes “real” investment in a foreign country, 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, a second possibility is that the Swedish subsidiary 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.

⁶ See, i.a. Blomström (1989), Borensztein et al. (1998), Caves (1974) and Globerman (1979).

⁷ See, i.a. Harrison and Aitken (2002) and Griffith, Simpson and Redding (2001).

⁸ See, i.a. Doms and Jensen (1998) and Griffith, Simpson and Windmeijer (2001).

This can be compared with the financing of a domestic Swedish firm. That firm could also raise finance from a Swedish bank. Alternatively, it has the option of borrowing from an American bank, or issuing shares in the New York stock market. In either of these cases—or if the Swedish bank raised part of its funding from the USA—the Swedish firm would be (directly or indirectly) financed from the USA. However, such flows would not be included in the FDI figures in national accounts, since the Swedish firm is not owned by a non-resident parent company. Instead, they would be included in foreign portfolio investment (FPI).

A second important difference between FDI and “real” investment is that FDI can fund other activities. In particular, a large proportion of FDI flows tend to finance mergers and acquisitions.⁹ For example, suppose the US multinational referred to above chose to buy a domestic Swedish firm, rather than undertake its own investment. Then if that purchase was financed by a flow of funds from the parent company, that would count as FDI from the USA to Sweden. Yet such FDI would not have contributed to the aggregate capital stock in Sweden: it reflects only a change in ownership from domestic to US.

What implications then, does FDI have for the policy considerations discussed above? First, it should be recognised that FDI is a particular form of a cross-border financial flow. FDI flows in themselves may or may not lead to an increase in the aggregate capital stock. Increasing such flows might lead to a higher aggregate capital stock in an economy if the financial markets are failing in some way to provide sufficient finance for profitable investment projects. This is true whether the FDI itself is used for acquisitions or not, since the additional funds used to acquire an existing company can then be used by the domestic shareholders to finance other investment. However, FDI is not the only source of cross border finance—foreign portfolio investment also provides such finance. If the perceived problem is a shortage of available domestic finance, then inward FPI is just as useful as inward FDI. Hence focusing solely on FDI is not sufficient: attention should be focused on the inflow of all funds into the domestic economy—net of any outflow.

⁹ The OECD has suggested that mergers and acquisitions account for more than 60 per cent of all FDI (OECD, 2000b).

An alternative measure of cross-border capital flows might be greenfield investment by multinational companies. Suppose, for example, that there was a special tax concession for such investment by foreign multinationals, and suppose that this was successful in attracting additional investment. This on its own would not guarantee a higher capital stock. This is because higher investment by multinationals could crowd out domestic investment. There are at least three routes through which this could happen. The first is if multinational finances its operations locally. Domestic banks therefore lend their scarce funds to the multinational instead of to domestic firms, but there may be no overall increase in funds available for investment. Second, domestic firms could be crowded out through a process of product market competition. Third, domestic firms could be crowded out through competition for scarce factors of production—such as labour. In any of these cases, then, there may be simply a change of ownership and control, with little or no effect on the aggregate capital stock. However, as discussed above, this investment by multinationals may be important in its own right.

To sum up, two plausible policy aims are (i) to generate a higher domestic capital stock and (ii) to improve the efficiency of domestic economic activity, by encouraging more cross border ownership of capital. FDI flows will not necessarily contribute to the aggregate capital stock, since they are financial, rather than real flows, and they may crowd out domestic investment. Attracting real economic activity by multinationals may help to improve the efficiency of the domestic economy if the benefits of this can be captured domestically. But FDI flows are not the only way in which multinationals may finance activity; in particular local finance may be quite an important source. This means that FDI will at best be a noisy measure of multinational activity.

2. Methodological issues in empirical work

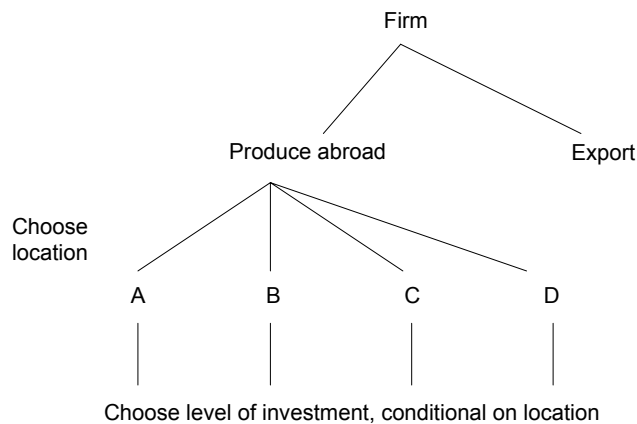
In Section 3 we review the empirical work that has aimed to test the sensitivity of capital movements to taxation. Before discussing these studies in detail, it is worth outlining some broad issues that arise. Drawing on the discussion in Section 1, we first consider what the studies are attempting to explain. We then look at how taxation is measured and finally briefly consider how different studies control for other determinants of capital and capital flows.

2.1. What is to be explained?

Despite the discussion above, the most common approach to investigating the determinants of capital movements has been to study FDI flows. A series of papers in the 1980s considered inward FDI into the United States and estimated the impact of various measures of corporate taxation. This research has 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.

Other approaches are perhaps more relevant for policy purposes. Before discussing these approaches in detail, it is useful to set out briefly a framework for considering the set of related decisions faced by multinationals.¹⁰ It is useful to think of three steps, summarised in Figure 1. First, a firm must decide whether to access a foreign market by producing at home and exporting, or by producing abroad. Second, if the firm decides to produce abroad it must decide where to produce (e.g. if the firm decides to produce in the EU it has to decide in which country to locate). Finally, the firm must decide the scale of its operation, summarised here by the size of its investment. Note that, in principle, the role of tax differs within these three stages; we discuss this below.

Figure 1. A decision tree for foreign investment



It is possible to use this form of decision tree to classify existing empirical studies into three groups. The groups are also separated by

¹⁰ See i.a. Horstmann and Markusen (1992).

the type of data that they use. The first group considers the discrete choices in the first two steps—whether to export and locate production abroad and where to locate. These studies use individual firm level data (in practice, data on US multinationals from Compustat). A second group of studies also uses individual firm level data but examines the determinants of the level of investment of foreign affiliates (exclusively of US firms); this corresponds to the lowest level of the decision tree. These studies use either Compustat data, or confidential firm level data from the US Treasury, based on tax returns.

Table 1. Summary of alternative approaches

Type of study	Empirical studies
Time series flows of FDI	Hartman (1984) Boskin and Gale (1987) Newlon (1987) Young (1988) Murthy (1989) Slemrod (1990)
Panel of FDI flows	Devereux and Freeman (1995) Billington (1999) Young (1999)
Discrete location choices of multinationals	Devereux and Griffith (1998) Kemsley (1998)
Cross-section allocation of assets of US multinationals, by affiliate	Wheeler and Mody (1992) Cummins and Hubbard (1995) Grubert and Mutti (2000) Altshuler, Grubert and Newlon (2001)
Cross-section allocation of assets of US multinationals, by location or industry	Grubert and Mutti (1991) Swenson (1994) Hines and Rice (1994) Grubert and Slemrod (1998) Hines (1996)
Location of R&D	Hines (1993) Bloom and Griffith (2001)

A third group of studies examines the geographical distribution of capital owned by US firms at a more aggregate level. This group makes use of data from the US Department of Commerce on the aggregate activities of affiliates of US firms within specific foreign countries, and on the aggregate activities of affiliates of non-US firms within states of the USA. Specifically, some studies consider the variation in the ownership of capital by US firms across countries, while others consider the variation in ownership of capital by non-US residents across US states. In some studies, data disaggregated by industry is used. These studies implicitly incorporate all the stages of the decision-making process into one reduced form, and attempt to

evaluate the impact of tax on the level of the foreign-owned capital stock or investment in each jurisdiction.

Table 1 summarises the approaches taken in the main studies which we consider in our review. The studies are divided into the broad categories discussed here. One further group which we identify is a set of studies which specifically examine investment in research and development, a type of investment that may be particularly mobile, and which might have particularly high externalities.

2.2. Measuring the taxation of capital

Just as the measures of capital used in empirical studies differ widely, so too do the measures of taxation. To some extent this should be expected, since taxation will affect different decisions differently and this requires different measures. However, the measures used do not always correspond to those suggested by theory. A summary of the approach taken by a variety of studies is provided in Table 2. It is useful first to relate the measures of taxation to the decision tree presented in Figure 1.

The first two stages of the decision tree are essentially discrete choices. We can assume that the firm chooses that option which generates the highest post-tax profit. The relevant measure of tax in this case is therefore an *average* tax rate since this captures the impact of tax on total profits. However, conditional on having chosen a location, the decision of how much to invest will be determined by the point at which the expected pre-tax rate of return is just equal to the cost of capital. In this case, the relevant measure is a *marginal* tax rate.

Corporate income tax systems are in general non-linear, and so the impact of tax varies with the rate of return. This means that the tax rate on a marginal investment (which just breaks even) may be very different from that on an infra-marginal investment. Hence the *marginal* tax rate can be very different from the *average* tax rate (and both can be quite different from the statutory rate).

There is a large literature on the measurement of how tax affects firms' incentives to invest, which we do not have space to survey here.¹¹ However, there is one further important distinction to make. Some measures of tax are backward looking, in that they are based on

¹¹ The interested reader can see i.a. Hall and Jorgensen (1967), King and Fullerton (1984), OECD (1991), Keen (1991), Ruding Committee (1992), Devereux and Pearson (1995), Devereux and Griffith (2002).

past tax payments and past earnings, while others are forward looking measures, in that they are based on the expected impact of taxes on future earnings. In theory, an investment consists of cash flows in the present and future, which suggests that forward-looking measures should be generally preferred. In practice however there may be reasons why backward-looking measures capture important variation in tax rates that forward measures do not capture.

Table 2. Relating measures of capital and tax rates

	EMTR	EATR	Average Tax Rate	Other
Time series FDI	Slemrod (1990)		Hartman (1984) Boskin and Gale (1987) Newlon (1987) Young (1988) Murthy (1989)	
Panel FDI	Devereux & Freeman (1995)			Billington (1999) Young (1999)
Discrete choices of multinationals		Devereux & Griffith (1998)	Kemsley (1998)	
Cross-section allocation of assets of US multinationals, by affiliate	Cummins & Hubbard (1995)		Altshuler et al. (2001) Grubert & Mutti (2000)	
Cross-section allocation of assets of US multinationals, by location or industry			Grubert & Mutti (1991) Hines and Rice (1994) Swenson (1994)	Wheeler & Mody (1992) Hines (1996)

Notes. EMTR: effective marginal tax rate or cost of capital, forward looking, based on tax rules. EATR: effective average tax rate, forward looking, based on tax rules. Average tax rate: backward looking, based on observed tax payments. Other: usually, but not exclusively, the statutory corporation tax rate.

Forward-looking measures are often called “effective tax rates” (available for both marginal and average tax rates). These are calculated for a hypothetical investment on the basis of the legislation on the tax base and tax rate, and can be computed for any well-defined investment project. However, effective tax rates are usually computed for a specific type of investment, financed in a specific way (for example, a purchase of plant and machinery financed by borrowing). It

can therefore be difficult to find the appropriate measure when investment across many projects is aggregated (which is true even at the firm level). In addition, certain complexities of the tax system may be difficult to reflect in these forward-looking measures.

Marginal tax rates can generally only be calculated using effective tax rates. By contrast, though, average tax rates can also be calculated using backward-looking data on observed tax payments. For studies based on individual company decisions, one of the most common measures of the average tax rate is calculated by dividing the tax charge in the financial accounts by a measure of profit. At a more aggregate level, backward-looking tax rates can be based on national accounts.¹² Other attempts to measure average tax rates in the literature include using aggregate data to discriminate between the pre- and post-tax earnings of foreign-owned as opposed to domestic-owned firms.

Backward-looking average tax rates can be very different from the effective average tax rate. The principal reason is that effective tax rates are a forward-looking measure, which incorporates the tax payments due over the lifetime of an investment, along with all the other cash flows of the project. In contrast, the tax liabilities of a firm at any point in time reflects (i) the history of its investment up to that point (in determining what allowances it can claim in that period) (ii) tax liabilities in possibly several jurisdictions, (iii) the history of losses in the firm (that is, it may be carrying forward losses from some previous period), and (iv) the history of the tax system up to that point.

One other issue arises with the use of backward-looking average tax rates. That is, since they are based on data on profits and tax payments, they may depend directly on investment and the capital stock (this is not generally true of effective tax rates, which depend only on the tax legislation). This introduces what may be important endogeneity bias into regressions aiming to explain capital or investment using such measures. In particular, a period of high investment is likely to generate high allowances which depress the tax liability in that period. This will generate a negative correlation between investment and the average tax rate—but the direction of causation would be exactly the opposite of what the study was aiming to investigate. That is, instead of investment responding positively to a lower tax rate, the “average” tax rate falls as a result of higher investment. Such studies need to use

¹² See Mendoza et al. (1994) and Devereux, Griffith and Klemm (2002).

estimation techniques, such as instrumental variables, which can overcome this endogeneity problem.

One final issue which may be relevant for cross border investment flows is whether home country taxation is included. In theory this is not relevant for the marginal tax rate in the case in which the investment is financed by retained earnings.¹³ Some studies have therefore tried to distinguish between FDI financed by retained earnings from FDI financed by new equity.

2.3. Conditioning variables

No-one would argue that taxes are the sole determinant of investment or location decisions. In trying to identify the impact of tax, it is therefore important to allow for the effects of other factors. If this is not done, then it may be the case that any effect attributed to taxation may in fact be due to some other factor. Suppose for example, that inflows of investment do not depend on taxes at all. Instead firms choose to locate near other firms in the same industry. It may be that where there are a large number of firms located close to each other, they have political influence which enables them to drive down the tax rate. Ignoring the agglomeration of other firms within the same industry might lead to the spurious conclusion that low tax rates are attracting new firms. Another example is the link between taxes and government expenditure, such as investment in infrastructure. Such spending may attract capital; but if it is excluded from the analysis, and if it is financed by taxes on capital, then a regression may indicate a positive correlation between firms' taxes and firms' investment decisions that is spurious.

The studies described below differ in the extent to which they allow for other factors to influence firms' behaviour. Some explicitly allow for factors such as the local wage rate (adjusted for productivity) and proximity to other firms or demand. Others use a measure of the observed rate of return on investment, which may incorporate the effects of such factors, but which may itself be endogenous, since it may depend on the size of investment flows. Still others use econometric methods to control for unobservable factors.

¹³ See Hartman (1985). This is because the rate at which tax is saved when the original dividend is foregone to fund the investment is the same as the rate charged when the return from the investment is paid. These two effects cancel out in determining the required rate of return on the investment.

3. Empirical findings

We now turn to a discussion of the empirical literature. We do not aim to provide a comprehensive survey of all relevant work, in part because there already exist at least two recent surveys in this area.¹⁴ Instead, we select those papers that shed light on the two fundamental issues of policy raised in section 1.

Slemrod (1990) provides a useful review and extension of preceding work on inflows of FDI to the USA. Previous work¹⁵ had closely followed the approach of Hartman (1984), who regressed an annual time series of FDI inflows into the USA on a measure of the post-tax rates of return and the relative tax rates of US and non-US investors. One of the main problems with this approach is that it is very difficult to distinguish the impact of taxes from other contemporaneous macroeconomic events.

Slemrod critiqued and extended this early literature in several ways. He introduced new control variables, including US unemployment, the real exchange rate and a measure of relative GDP. His more significant innovations were that he introduced the use of a forward-looking effective marginal tax rate,¹⁶ and he looked separately at inflows of FDI from seven different countries. The second of these innovations was intended to allow for tax effects to differ according to whether the foreign investor be taxed at home on repatriations of income from the USA (ie. depending on whether the foreign country operated a credit or exemption system, and on its tax rate). However, the results generally did not support the basic hypothesis that differences in home country taxation would affect inflows to the USA. Slemrod discusses several reasons for this, including the poor quality of the data and the ability of firms from foreign tax credit countries to defer home country taxation.

Devereux and Freeman (1995) extends this approach further. They examined bilateral FDI flows between seven countries. They estimated the effect of tax using a panel data approach. They also used a more sophisticated measure of the effective marginal tax rate, which takes account of both home and host country taxation relevant for each FDI flow, and which therefore varies across country pairs, as

¹⁴ Hines (1999) and De Mooij and Ederveen (2001).

¹⁵ See Hartman (1984), Boskin and Gale (1987), Newlon (1987), Young (1988) and Murthy (1989).

¹⁶ From Auerbach and Hines (1988).

well as over time.¹⁷ They found a significant impact of this measure in explaining the size of FDI flows relative to GDP, but not on the balance between domestic investment and outward FDI. They attempt to identify the size of the tax effects by considering a hypothetical large tax reform in the USA. While this has a large effects on FDI inflows from countries with exemption systems, there are only small effects from countries with credit systems. In aggregate, since the major sources of FDI into the US are from countries with credit systems, the impact on total flows is rather small.

A number of other papers examine the impact of various tax measures on FDI flows and find broadly similar results.¹⁸ However, as argued in Section 1, the relevance of FDI flows for policy purposes is limited. We therefore turn to a number of papers which use more disaggregated data, specifically data on the distribution of affiliates of US multinationals and their capital expenditure across host countries, and the distribution of affiliates of non-US multinationals and their capital expenditure within the USA. One way to understand the approach of these papers was given in the previous section and summarised in Figure 1.

We classify empirical papers according to which level of the decision tree they consider. Thus, for example, Kemsley (1998) examines the impact of tax on the decision of whether to export or produce abroad—the top level decision. He uses individual US firm data from Compustat to examine the determinants of the ratio of exports to foreign production sales. This is regressed on the average foreign tax rate for the firm (foreign taxes expressed as a proportion of foreign profit), the US statutory tax rate and an estimate of whether the firm is in a binding foreign tax credit position. He also controls for a number of other factors, including country risk. Kemsley finds that taxes induce US firms who are in a binding foreign tax credit position to prefer exports to foreign production. He also finds that US firms are more likely to use exports to serve high-tax foreign markets than low-tax ones.

Devereux and Griffith (1998) concentrate primarily on the second stage of the decision tree: where to produce. They also use Compustat data and investigate the choice of US firms as to whether—conditional on having chosen to locate in Europe—to locate in the

¹⁷ The measure is described in OECD (1991) and Devereux and Pearson (1995).

¹⁸ See, for example, Billington (1999), Cassou (1997) and Young (1999).

UK, France or Germany. The main contribution of this paper is to analyse the impact of effective average—as opposed to marginal—tax rates on this discrete decision. There is strong evidence that effective average—but not marginal—tax rates are significant in this decision. The size of the effect varies between countries, but as an example, the results indicate that a one percentage point fall in the UK effective average tax rate would increase the probability of a US firm choosing to locate in the UK by around one per cent.

A third paper—Cummins and Hubbard (1995)—investigates the final element of the decision tree. They use 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. The equation they estimate—using a panel of data on affiliates—is the Euler equation. It includes a term which captures the cost of capital and which is implicitly affected by the effective marginal tax rate. The innovations in this paper are that the cost of capital includes both host and home country tax parameters and that the model is applied to foreign affiliates. Cummins and Hubbard find that they cannot reject the version of the model which includes these tax effects, thus concluding that taxes do matter.

Two other papers are also directed towards the third branch of the decision tree. Grubert and Mutti (2000) and Altshuler et al. (2001) use confidential tax return data available only to researchers inside the US government, which incorporates detailed information about the activities of individual foreign affiliates of US firms. An implicit assumption in these papers is that decisions have already been made to set up an affiliate in a particular country, as opposed to exporting or setting up in another country. Given this approach the relevant tax rate to use is the effective marginal tax rate. However, both of these papers rely on a backward-looking average tax rate measure.

Each of these five papers are clearly aimed at estimating the impact of tax on only one level of the decision tree mapped out above. However, three other papers—Grubert and Mutti (1991), Wheeler and Mody (1992) and Hines and Rice (1994)—make use of data from the US Department of Commerce on the aggregate activities of affiliates of US firms within specific foreign countries. Wheeler and Mody investigate the level of investment in property, plant and machinery (ppe) in each country, while the other two papers aim to analyse the level of the capital stock (of ppe).

It is useful to think of these papers as encompassing all three of the decisions described above. That is, they reduce the structural decision tree of Figure 1 to a single equation. The aggregate capital stock of affiliates in, say, Sweden, should be affected by the discrete choices, as well as the choice of how much to invest in Sweden conditional on having decided to invest there. This is in contrast to the set of papers examining the scale of investment of individual affiliates—which implicitly exclude any potential affiliate which decided not to set up in a particular jurisdiction.

These models using aggregate data are interesting, but they raise issues of principle. If the aggregate capital stock of US affiliates in, say, Sweden, reflects each stage of the decision tree, then both effective average and marginal tax rates may be relevant to the decision (possibly in a rather complex way). Unfortunately, none of these papers raise or discuss this issue. In fact, they all use a backward-looking average tax rate measure, based on aggregate tax payments and profits in each jurisdiction.¹⁹ 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 per cent to 10 per cent would result in an increase in the capital stock of 65 per cent. Some of the estimates from Hines and Rice are even larger. By contrast, though, Wheeler and Mody find that tax does not play a significant role in investment decisions.

Three possible reasons for these different results are: (i) the differences in the dependent variable, (ii) differences in the calculation of the host country tax rate and (iii) differences in control variables. Wheeler and Mody—in contrast with the other two papers—control for a number of other important factors, including openness, risk, infrastructure, market size, labour costs, and relations with the West and with neighbours. It is possible that the other two papers find a spurious effect of tax resulting from the absence of these control variables. This is an area which merits further research. What is

¹⁹ Although the tax measure used by Wheeler and Mody is not clearly described.

needed is an analysis of *why* results differ across studies, e.g. by authors' replicating results from other studies with their data, rather than surveys that attempt to average across a large range of studies that differ in many significant ways.

A further area of research considers the location of firms' research and development (R&D) activities. This might be of particular interest for at least two reasons. First, it may be that R&D activities have the most important externalities. Foreign firms setting up new research labs are likely to bring new technologies into the economy and these are likely to have some beneficial impact on local firms either through the spillover of ideas or the training of staff. We mention two studies in this area. Hines (1993) considers the impact of specific US tax reforms in the 1980s and concludes that these are unlikely to have a significant impact on the location of US firms' R&D. Bloom and Griffith (2001) use aggregate data on a panel of countries. They look at the impact of both the domestic tax treatment of R&D and of the foreign treatment of R&D. They find a significant impact for both. These results suggest that R&D is footloose and moves easily in response to cross-country changes in its tax treatment. There are a number of possible explanations for these different results. One is that the data is different. Hines uses firm level data to look at the response of US firms to a change in the tax regime in their home country. Bloom and Griffith look at the impact at the aggregate level and consider movements between a group of countries. It may also be that R&D is more mobile in more open economies than in the US.

4. Summary and policy implications

It is tempting to conclude a survey such as this with a definitive, and consensus, estimate of the impact of taxation on cross-border capital flows. For example, some recent surveys present a single elasticity as a central estimate. We do not follow this approach; in fact, we do not mention any numerical estimates in this conclusion. There are two broad reasons.

First, as should be clear from the previous section, and from Table 2, there is very great heterogeneity across the different studies surveyed. A number of studies consider foreign direct investment flows. Others look at discrete choices between locations, while still others focus on the activity of affiliates of multinational firms. Further, these studies use a great variety of different measures of taxation. There is

no reason to expect the sensitivity of different measures of capital to different measures of tax to be the same. That is, there can be no expectation from economic theory that such different approaches *should* generate the same elasticity.

Second, the variety of different approaches reflects important differences in the type of analysis undertaken. In Figure 1, we outline a simple structural framework which can be used to understand the investment and location decisions of multinational firms. It is not the only possible framework, but it is one which has been extensively used. Such a structural model gives a framework for understanding the different roles which taxation may play. And it gives a framework for econometric techniques—such as controlling for higher level discrete decisions when investigating lower level decisions on the size of investment.

Many of the papers in the literature proceed independently of any structural model. Many of the earlier papers investigate FDI, which we argue is of limited importance for policy. More recent papers tend to estimate parameters from reduced form equations with little attempt to relate these to a structural model. Further, many of them rely on backward-looking average tax rates, despite the structural model indicating a role for marginal tax rates, and despite there being serious econometric problems involved in their use.

So what can we conclude? First, there is some evidence that taxes affect firms' location and investment decisions, although we do not have a very good idea about the size of this effect. Second, future research on these issues should take structural models of investment more seriously. And, finally, even if we had been able to offer a single elasticity to answer the question of the impact of taxation on cross-border flows of capital, there would still be a number of unresolved issues for policy formation; in particular, it would also be necessary to identify the benefits of higher inward investment and how they accrue.

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