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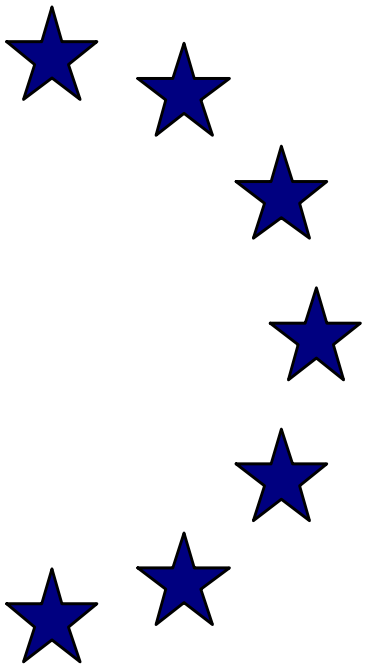

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What a difference does it make? Understanding the empirical literature on taxation and international capital flows

by

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What a difference does it make?

Understanding the empirical literature on taxation and international capital flows

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ABSTRACT

This study explains the variation in empirical estimates in the literature on the elasticity of foreign direct investment with respect to company tax levels. To that end, we extend the meta analysis of De Mooij and Ederveen (2003) by considering an alternative classification of the literature and by including new studies that have recently become available. We pay specific attention to two new dimensions: the spatial and the time dimension of the underlying studies.

Keywords: Foreign direct investment; corporate taxation; meta analysis.

JEL Code: E2, F2, H2

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Introduction

Discussions about company tax reform and tax harmonization in the EU usually start from the belief that corporate tax rates have an important impact on the international allocation of capital (see e.g. European Commission, 2001). The degree to which the location of capital is responsive to taxes is an empirical issue. The economic literature of the past 25 years has produced numerous studies that have explored it. Starting with aggregate time series studies on foreign direct investment, the literature has gradually evolved in the direction of panel and cross section analyses and, more recently, the use of micro data on firm investments. These 25 years of exploration has produced a number of insights. Literature reviews by Hines (1997; 1999), Devereux and Griffith (2002) and Devereux and Maffini (2006) summarize these findings.

The empirical literature on taxation and international capital flows suffers from a number of problems, however, in particular with respect to the data used and the identification of elasticities. Regarding the data, one would ideally use information about real investment decisions by multinational companies and the true tax rates that these companies would pay in different locations. Yet, both capital data and tax data are imperfect. Studies therefore rely on imperfect measures. With respect to capital, most studies use aggregate data on foreign direct investment (FDI), but this is an imperfect measure for real international capital flows. In particular, FDI measures financial flows rather than real investments in plant and equipment. Not all real investments by foreign companies will therefore be registered as FDI, while a substantial part of FDI may not be reflected in real capital. To illustrate, OECD (2002a) estimates that around 80% of all FDI in the OECD countries in 2000 was due to mergers and acquisitions. This part of FDI involves a change in ownership, but not necessarily an increase in real capital. Some studies use alternative indicators. For instance, some US studies use investment in property, plant and equipment. This is thought to be a better approximation of investment in real capital. Others have focused on the number of foreign locations, rather than on the amount of capital invested.

With respect to tax data, some studies adopt the statutory corporate income tax rate. This, however, does not capture various aspects of the tax base that are potentially important for location choices.[3] Most studies therefore rely on some measure of the effective tax rate as a proxy variable for the tax. The effective tax rate can be computed in several ways. Some studies use micro or macro data; others adopt marginal or average rates computed from the tax code. Hence, for both capital and tax data, studies use a great variety of approaches.

The second problem in the literature involves identification. Simple regressions of the tax variable on (aggregate) FDI may give misleading results for a number of reasons. First, decisions to undertake FDI may not only depend on location advantages, but also ownership advantages. Taxes can affect location and ownership advantages in different ways, which renders it difficult to determine the impact of taxes on the capital itself. Second, the impact of taxes on foreign investment depends on the tax regime in the country where the parent company resides. If it resides in a country that adopts the territorial principle (using the exemption method to avoid double taxation), foreign tax rates are typically more important for location choice than under the method of worldwide taxation (using foreign tax credits for

[3] The statutory tax rate is important for profit shifting by multinational corporations.

that purpose). Not controlling for this will yield estimates that are difficult to interpret. Third, various other institutional variables can affect the location of FDI, and may be correlated with the tax. Hence, regressions may suffer from omitted variable bias if important control variables are not included in the regression. Finally, effective tax rates may not be exogenous. This holds in particular for the average tax rates computed from data as these can be influenced by FDI flows themselves. This endogeneity problem may cause biased estimates. These issues complicate the identification of the true tax elasticity of FDI. To address these problems, studies follow alternative methodologies and estimation procedures. The empirical literature on taxation and FDI has thus produced a great variety of methodologies to identify the true effect size.

The substantial heterogeneity in the literature makes it impossible to simply compare the results from different studies. Hence, there is no single estimate that can be drawn from the literature on the tax-rate elasticity of foreign capital allocation. Devereux and Griffith (2002) thus conclude that "there can be no expectation from economic theory that such different approaches should generate the same elasticity". This conclusion will not satisfy policy makers, however, who have the responsibility to design optimal tax policies.[4] Indeed, they require the best possible information about effect sizes. Moreover, policy makers must have an idea under which circumstances effect sizes are higher or lower. While it is difficult to provide this information on the basis of an heterogeneous literature, a quantitative approach to the literature provides a method to make study results comparable. In De Mooij and Ederveen (2003), we have followed this approach by computing comparable semi-elasticities for all studies available in the literature. Overall, we thus constructed a meta sample of around 350 elasticity values, originating from 25 different studies. Moreover, we collected information about the underlying study characteristics, such as the type of data used, model specification, estimation method, etc. We also added out-of-sample information, such as time or country-specific variables. With this meta sample, we performed meta regressions to explain the systematic variation in study results. In this way, we shed light on the systematic and quantitative impact of different approaches for the reported elasticities in alternative studies.

This paper extends our earlier analysis in four ways. First, we take up the division in the literature used by Devereux and Griffith (2002) to categorize studies according to the type of capital data used. We thus use a different specification of the meta regression than in the previous study. Second, we include six new studies that have recently become available. This adds 78 new elasticities to our meta sample, that now contains 427 observations. By comparing the results from the old and new sample, we explore how these recent insights modify the conclusions from the previous meta analysis. Thirdly, we explore two alternative ways to compute the semi-elasticities. In the first method, also used in De Mooij and Ederveen (2003), we use sample means for the tax rates to derive the semi-elasticities from all studies. We thus evaluate the elasticities at the sample means. Some studies for the US, however, use small state statutory tax rates. If semi-elasticities are not constant, the evaluation at very low rates reduces the comparability of research findings. In this paper, we therefore evaluate the elasticities at the total tax burden, i.e. the federal plus state tax. A final contribution of this paper is that we pay more systematic attention to the spatial and the time dimension of the underlying studies. Regarding the spatial dimension, we analyze whether elasticities for particular groups of countries are systematically different, e.g. small countries,

[4] We do not discuss the reasons why countries benefit from foreign capital inflows. For more on the impact of FDI inflows on welfare, see OECD (2002b).

countries in peripheral areas, or European countries. Regarding the time dimension, we explore whether studies using data from certain periods produce systematically different results from others. The rest of this paper is organized as follows.
The next section presents our meta sample that we obtained from the literature. A literature review is attached as an appendix to this paper. Section 3 discusses the specification of the meta regression and reviews the regressors for which we will explore the impact on elasticity values. Section 4 presents our regression results. Finally, section 5 concludes.

Constructing a meta sample

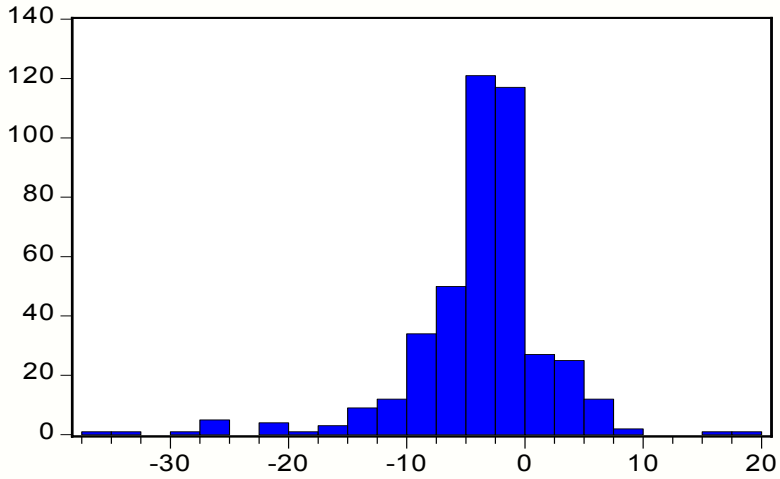
Appendix A provides a review of the literature on taxation and foreign capital flows. It extends the review in De Mooij and Ederveen (2003) by adding new studies and by providing a different structure to the literature. To make the study results suitable for a meta analysis, we transform the findings from each study into uniformly defined semi-elasticities (or tax rate elasticities). The semi-elasticity measures the percentage change in FDI in response to a 1%-point change in the tax rate, e.g. a decline from 30% to 29%. It is defined as $\partial \ln(FDI)/\partial t$.[5] To be able to transform marginal coefficients from studies into semi elasticities, we often require information about the mean value of the FDI variable. Only if we could obtain this information from the paper or from the authors, we included estimates in our meta sample. Moreover, to transform elasticities into semi-elasticities, we need information about the (mean value of the) tax rate.

Apart from reporting semi elasticities, we also discuss whether these statistics are found to be significant at the 5% confidence level. To that end, we collect information on standard errors of the estimated semi-elasticities. Yet, it is impossible to retrieve consistent estimates of standard errors as long as the estimated covariance matrix for coefficients is unknown. Unfortunately this is often the case since primary studies do not report full covariance matrices. A straightforward simplification is the assumption that off-diagonal elements cancel out, so that the Delta method can be applied. As most studies report these coefficients, we have used this method for computing standard errors.

In constructing out meta sample, we eliminate some of the extreme values. In particular, for each of the four categories of elasticities, we use only 95% of the observations by removing observations that are outside the range of plus and minus two times the standard deviation from the mean. In this way, especially the extreme negative values that cause skewed distributions are eliminated from the sample. Thus, we end up with a meta sample of 427 observations. Figure 2.1 shows the distribution of semi-elasticities for the entire meta sample. It reveals that the majority of semi-elasticities lies between -5 and 0. The mean value of the semi-elasticities is -3.72. The median is smaller, –2.91. Slightly more than 50% of all elasticities is found to be significant.

[5] With taxes, it is more common to look at semi-elasticities than normal elasticities as firms are likely to respond to changes in after-tax rates of return, irrespective of the exact level of the tax. In that case, one would expect the semi-elasticity to be independent of the tax rate, rather than the ordinary elasticity. The rest of this paper therefore concentrates on semi-elasticities.

Figure 2.1. Distribution of semi-elasticities (left panel) and elasticities (right panel) in the meta sample



To perform our meta-analysis, the studies have been carefully codified in a database in which we also include information about the underlying characteristics of an estimate. This includes:

- publication details, such as reference, year of publication, publication outlet;
- data characteristics for capital and taxes, including type of data, year and region;
- estimation characteristics, including functional form, regression characteristics, number of observations;
- background variables, such as other control variables and whether the parent is located in an exemption country of a credit country (if known).

Specification of the meta regression

Meta-analysis is a research method to synthesize research results. It is best seen as a statistical approach towards reviewing and summarizing the literature. It has been described as the "analysis of analyses". It provides a tool to compare and/or combine outcomes of different experiments with similar set-ups or, alternatively, differences in set-ups that can be controlled for. As such, it enables the researcher to draw more rigorous conclusions than would have been possible on the basis of either of the studies considered in isolation. Appendix B provides a brief discussion about the virtues and problems of meta analysis.

In performing our meta regressions, we estimate $y = \beta X + \varepsilon$, where y represents the vector of semi-elasticities, and X is a matrix of dummy variables that reflect various study characteristics. The parameter β thus measures the impact of each of the study characteristics (relative to some benchmark) on the elasticities. In the regressions, we will control via dummy variables for a selection of study characteristics, namely (i) the type of capital data used; (ii) the type of tax data used; (iii) whether the home country adopts a credit or an

exemption system; (iv) variables reflecting the spatial dimension; (v) variables reflecting the time dimension.[6]

[6] In some regressions, we also control for the source of finance of FDI, as the early time series models produce different results for transfer of funds and retained earnings. The majority of studies, however, does not distinguish with respect to the source of finance. All regressions include a dummy for Belgium as this country produces systematically very large elasticity values. As this might have to do with the Belgian coordination centers – which make a Belgium a huge net capital importer and exporter – we control for this specific circumstance.

Capital data

Devereux and Griffith (2002) divide the empirical studies on taxation and foreign investment in four main categories, distinguished with respect to the type of capital data used.

- Time series data on FDI. This category contains the early studies for especially the US.
- Cross-section data on the allocation of assets by US multinationals.
- Discrete choice models use count data on location choice.
- Panel data on FDI, often bilateral flows.

Appendix A uses this division in discussing the literature. To explore the systematic variation according to different types of capital data, we use dummies in the meta regression.

Type of FDI data

We also explore dummies for specific FDI types. Indeed, FDI contains real investment in plant and equipment, either in the form of new plant and equipment or plant expansions, as well as financial flows associated with mergers and acquisitions (M&As). The regressions control for these specific components of FDI as elasticities may differ among them. In particular, it seems that location advantages are the main reason for the location of plant and equipment. Mergers and acquisitions are primarily a matter of ownership advantage. For the latter, it matters whether higher taxes make it more attractive for capital to be foreign owned. As foreign ownership may become more attractive in case of higher tax rates if parent companies are shielded from these higher tax rates due to tax credits in their home country, the elasticity for M&A may well be of opposite sign. A number of studies for the US have used data on property, plant and equipment (PPE) rather than FDI. The dummy can measure whether this produces significantly different results. Some studies have used specific data on investment in plants or mergers and acquisitions, which we will also distinguish in the meta regressions.

Tax data

Studies use different types of tax rates to measure the tax effect on FDI. Some studies use the statutory corporate income tax. However, the tax treatment of FDI is generally a complex issue where many aspects play a role. Using the statutory tax rate can therefore be misleading. Most economists therefore argue that statutory tax rates are imperfect measures to determine the impact on investment behavior by multinational firms. Effective or average tax rates are thought to be a better approximation of the tax burden on foreign investment (for a review, see OECD, 2000). These tax rates can be computed in several ways. Most of the empirical studies use either of the following three tax rates.

i. Average tax rates (ATR's) computed from data. They measure the taxes paid by firms divided by a measure for operating surplus. The data refer either to micro or macro data.
ii. Marginal effective tax rates (METR) computed from tax codes. It measures the wedge between the pre- and post tax return on a marginal investment project that does not yield an economic rent. Hence, it refers to the incentive effects of taxes on marginal investment decisions.

iii. Average effective tax rates (AETR) from tax codes. It concerns the wedge between the pre- and post tax return on a typical investment project on which firms earn an economic rent. This is important for decisions regarding lumpy investment, investment in the presence of imperfect competition, or for location decisions of firms.

There is some discussion in the literature about the appropriate measure for the tax rate to be included in regressions. For instance, Swenson (1994) argues that average tax rates based on data are more informative than are effective tax rates based on tax codes as the latter usually do not pick up all elements of the tax code, including non-linearities, tax planning activities, complex tax provisions and discretionary administrative practices of tax authorities. In contrast to this, Devereux and Griffith (1998a) maintain that the ex-ante effective tax rates are superior to ex-post average tax rates because using the latter may cause endogeneity problems. In particular, the tax measure may well reflect the underlying profitability of the location. Devereux and Griffith argue that average effective tax rates are more appropriate than marginal effective tax rates as real investment decisions are usually inframarginal. The meta regressions can show whether the choice of tax data indeed matters systematically for the effect sizes.

Credit or exemption

The return to foreign direct investment may be subject to international double taxation. A foreign subsidiary is always subject to corporate income tax in the host country. These profits can be taxed again under the corporate income tax in the home country of the parent. As this international double taxation would strongly discourage international business activity, most countries avoid it by means of bilateral tax treaties based on the OECD Model Tax Convention or, in the EU, the Parent-Subsidiary Directive. In particular, countries either adopt a credit system (US, Japan, Greece, Ireland) or an exemption system (other EU countries) to avoid international double taxation.

Under the exemption system (or territorial taxation), foreign income that is taxed in the host country is exempt from taxation in the home country of the parent. Hence, profits are only taxed in the country where the subsidiary is located. Under a credit system (or worldwide taxation), tax liabilities in the host country of the subsidiary are credited against taxes in the home country of the parent, although firms are usually permitted to just claim credit for the domestic tax liability in case of excess foreign credits. Countries that adopt foreign tax credits generally also permit tax deferral until profits are repatriated to the parent company through dividend payments. Under credit and exemption systems, host country taxes exert different incentives for parent companies to undertake FDI. If the parent company is located in a country that adopts the exemption system, a higher tax rate in the host country makes it a less attractive location because of a lower net return on investment. Therefore, the probability to locate a plant in that country and the amount of investment in plant and equipment is likely to be lower. For mergers and acquisitions a higher tax in the host country will probably have minor implications because they affect domestic and foreign owners alike. In case the parent is located in a country that uses a credit system (in combination with tax deferral), a higher host-country tax yields more subtle effects on FDI. In particular, if the multinational finds itself in an excess credit position, the higher tax rate in the host country is not compensated by a higher domestic credit. Hence, the effect on real investment in plant and equipment would be the same as under the exemption system. If the multinational is not in an excess credit position, however, a higher foreign tax rate is compensated by a lower parents tax liability in

the home country. Hence, the higher tax rate in the host country would have no implications for FDI. The effect on foreign ownership through mergers and acquisitions may even be positive because, in contrast to local owners, foreign owners are shielded from the higher host country tax rate by the credit system. Hence, local owners may find it attractive to sell their stakes to foreign multinationals.

Hines (1996) and others have used the distinction between exemption and credit systems to estimate the tax rate elasticity of FDI. In particular, Hines measures the behavioral response to taxes from investors located in tax exemption countries, conditional on a zero response by investors from tax credit countries. Others have argued, however, that the distinction between credit countries and exemption countries is less important in practice. For instance, Tanzi and Bovenberg (1990) argue that excess foreign credit and tax deferral make the distinction between tax credit systems and tax exemption systems of little importance. This was also suggested by the empirical findings of Slemrod (1990) and Benassy-Quere (2003). Altshuler and Newlon (2003) have shown that many US multinationals appear to manage their income repatriations so that they face little home-country tax. In our meta regressions, we will explore whether there is indeed a systematic impact of the home-country tax regime on the reported elasticities.

Spatial differences

The belief that investment location is responsive to taxes is challenged by the new economic geography literature. This theory shows that location decisions may not be responsive if one allows for increasing returns to scale and transport costs. Indeed, these two aspects can make it attractive for firms to locate in agglomerations where profits are higher than elsewhere. The reason is that firms save on transport costs and benefit from agglomeration externalities. This creates location-specific agglomeration rents. Governments can tax the capital located in these agglomerations without inducing capital flight, because the tax largely applies to the location-specific rents, rather than to the margin of the investment. Note, however, that the new economic geography literature poses two qualifications on this result. First, capital is only quasi fixed. As soon as taxes become too high, some investors will move towards the periphery. This erodes the agglomeration benefits for the remaining companies so that other investors will follow. Ultimately, a large number of firms will leave the region. Secondly, the equilibrium in the allocation of firms is not necessarily characterized by agglomeration economies. It can alternatively be characterized by a separating equilibrium in which economic activity is divided across locations, rather than clustered in agglomerations. In that case, capital is very responsive to tax rates.

One issue put foreword in the new economic geography literature is that Europe can be divided into a core and a periphery. The core consist of regions with important agglomerations, while agglomeration rents in the periphery are generally low. Baldwin en Krugman (2000) thus argue that countries in the core of Europe should impose higher taxes than countries in the periphery. Moreover, the responsiveness of capital should be higher in the periphery. This latter hypothesis can be explored with the meta sample. Indeed, we can separate studies that apply to peripheral countries from those that apply to a core region. We group the Scandinavian countries, Southern European countries, Ireland, Australia and Canada under the peripheral countries. With the meta regressions, we explore whether elasticities for these countries are systematically different from those in other countries. In a similar vein, we explore whether there are systematic differences for elasticities obtained for

US investment and investments from European countries. We also make a distinction between large and small countries, where only the US, Japan, Germany, France and the UK are considered as large countries.

Time differences

Has capital become more mobile during the 1980's, as has been suggested by Altshuler et al? We first test this hypothesis by exploring the correlation of the median sample year in the underlying studies with the elasticities. This would, however, assume a linear relationship between time and the magnitude of the elasticity. To allow for non-linear time effects, we also experimented with several time dummies. In the analysis, we report the effects for two dummies. The dummies depend on the average sample year in a particular study. The first dummy refers to studies using an average sample year beyond 1980. The second dummy refers to studies using an average sample year beyond 1990.

Note that a significant impact of the time dummy can have different interpretations. In particular, it may capture an increasing mobility of capital across time. Alternatively, it may capture the evolution in the literature. Indeed, studies have gradually moved from time series towards cross-section and panel analysis and, more recently, the use of micro data. Part of this evolution might be captured by the other explanatory variables, such as the type of capital data. But the time dummy may also reflect this gradual change in study types.

Meta regression analysis

Table 4.1 shows the results of a first set of meta regressions. They show the effect of particular study characteristics, relative to a benchmark set of characteristics. The benchmark has the following properties: time series model, country statutory tax rate, no information/distinction between retained earnings or transfer of funds, no information/distinction between credit or exemption systems; no control variables. For presentational convenience, we have put a minus sign for all semi-elasticities before doing the regression analysis. Thus, we transformed the majority of semi-elasticities into positive figures. A positive coefficient for a dummy variable therefore means a higher elasticity in absolute terms, i.e. it means that an elasticity becomes more negative.

Table 4.1 starts with a regression that includes the type of capital data (Discrete Choice, Panel Data, Cross-section), the specific form of FDI (PPE, Plants and M&A) and the type of tax data (State STR, METR, AETR, micro ATR and macro ATR). Subsequently, we include other explanatory variables, such as the credit/exemption distinction and the source of finance.

We also use the regression results to calculate fitted values for the elasticities. In principle, this can be done for each set of study characteristics. In table 4.1, we present the results from an exercise where we take an unweighted average of the different study characteristics. That is, we take the constant from the regression and add the unweighted average of the coefficients for the four types of capital data, the six types of tax data, etc. (with a zero for the benchmark characteristic). In computing the typical elasticities, we take point estimates from the regressions, also if coefficients are not statistically significant. The elasticities are presented as positive values as we maintain the minus sign in the presentation. Hence, positive values measure a decline in FDI in response to a higher tax.

In earlier studies, we explored a number of other study characteristics that can explain the variation in elasticities. De Mooij and Ederveen (2003) include differences in estimation method, specification of the equation in the primary study, the sector to which the primary study refers, the publication status of the paper and study fixed effects. Ederveen and De Mooij (2003) pay special attention to the differences in tax rates. De Mooij and Ederveen (2005) pay special attention to various control variable in the primary studies. This paper takes new dimensions into account to gain further insight in their implications.

Table 4.1. Regression results of two specifications[a]

	Benchmark simulation		Extended set of regressors	
Constant	0.79		0.60	
Capital data (time series)				
Discrete choice	-3.10	**	-3.17	**
Panel data	1.13		1.71	*
Cross section	7.02	**	7.41	**
Specific FDI types (all FDI)				
PPE	-3.26	**	-3.41	**
Plants	1.96	**	2.18	**
M&A	-7.54	**	-7.32	**
Tax data (Country STR)				
State STR	5.95	**	5.37	**
METR	1.43	**	1.68	**
AETR	3.85	**	3.93	**
Micro ATR	-0.02		-0.50	
Macro ATR	2.18	*	2.65	**
Finance/double tax (Not)				
Retained Earnings			0.09	
Transfers			-1.30	
Exempt			0.90	
Credit			0.17	
Regression description				
Number of observations	427		427	
Adjusted R-squared	0.46		0.46	
Durbin-Watson	1.89		1.93	
Typical semi-elasticity	2.1		2.1	

[a] Benchmark assumption is mentioned between brackets; * (**) means statistically significant at the 10% (5%) level.

Benchmark regressions

Table 4.1 reveals that, compared to time series models, studies using panel data do not produce significantly different results. In contrast, there are significant differences with discrete choice models and cross-section studies. In particular, cross-section studies yield systematically larger semi-elasticities (in absolute terms). This is consistent with the relatively large average semi-elasticity reported in appendix A. Table 4.1 reveals that discrete choice models produce smaller semi-elasticities. This may be unexpected as appendix A suggests that the semi-elasticities for discrete choice models are typically larger than for panel data or time-series models. The regressions in table 4.1, however, reveal that it is not the type of capital data that is responsible for this, but other characteristics in the discrete choice models.

For instance, a number of discrete choice models adopt the average effective tax rate to measure the impact of taxes. This tax measure explains largely the relatively high elasticities reported in these studies. When controlling for the type of tax data, the regressions in table 4.1 reveal that discrete choice models themselves actually reduce the size of the semi-elasticity, rather than increase it.

The elasticities for new plants and plant expansions tend to be systematically larger than for FDI. It suggests that real investment in plants are more responsive to taxes than other forms of FDI. This effect is robust for both specifications of the meta regression. Estimates based on M&A data produce smaller elasticities. This latter is consistent with ownership advantages being inversely related to the host-country tax. Studies using data on property, plant and equipment produce significantly smaller elasticities than studies using FDI.

The coefficient for various tax rates should be interpreted as the impact relative to studies that adopt the country statutory tax rate. We see that, except for average tax rates based on micro data, the alternative tax rates typically produce larger semi-elasticities. This holds, first of all, for the state statutory tax rates, which produce the largest semi-elasticities. This is no surprise if one believes that ordinary tax elasticities are constant. In that case, the semi-elasticities based on studies with state statutory rates are evaluated at very low rates and thus produce large values. The coefficient of the METR and AETR is also significantly positive. Hence, studies using these effective rates of tax produce elasticities that are significantly larger than studies using statutory rates. Thereby, the average effective tax -- determining the impact on inframarginal investment decisions -- produces the largest elasticities. The marginal effective tax rate -- which measures the incentives at the margin of the investment -- suggests that lower capital costs also attract foreign capital. The impact on the margin of investments is smaller, however, than that of inframarginal investment projects. The negative but insignificant result for the average tax rates based on micro data suggests that these tax variables may be problematic in identifying the true impact of taxes on FDI. Indeed, the endogeneity problem mentioned before may be responsible for relatively small elasticities reported by studies using micro data to determine the tax measure. Note that the coefficient for macro average tax rates is positive, although less significant.

For other study characteristics, a few observations are worth noting. First, while estimates for parents from tax exemption countries produce larger elasticities than for credit countries, this impact is not statistically significant. Hence, we do not find support for larger elasticities in exemption countries. Second, we do find support for a significant difference in semi-elasticities for retained earnings and transfer of funds.

The last row in table 4.1 suggests a typical elasticity of 2.1 on the basis of the meta regression. Hence, a 1%-point reduction in the host country tax would raise foreign investment by 2.1%.

Effect of adding new studies to the meta sample

The results in table 4.1 cannot be directly compared with those reported in De Mooij and Ederveen (2003). The reason is that we use a different set of regressors in this study. To explore the impact of adding new studies to the meta sample, table 4.2 compares the same meta regression for two alternative samples. The left hand side repeats the results of the regression in table 4.1. The right hand side shows the same regression outcomes if we use the

sample from De Mooij and Ederveen (2003). The latter sample contains 70 observations less, which are derived from the six most recent studies. Hence, table 4.2 yields insight in the consequences of adding new study results to the 2003 findings. The table suggests that some differences are indeed important.

Table 4.2. Regression results for the new and old meta sample

	New extended meta sample				Previous smaller meta sample			
	Benchmark simulation		Extended set of regressors		Benchmark simulation		Extended set of regressors	
Constant	0.79		0.60		-1.07		-1.39	
Capital data (time series)								
Discrete choice	-3.10	**	-3.17	**	-5.90	**	-5.53	**
Panel data	1.13		1.71	*	2.48	**	2.62	**
Cross section	7.02	**	7.41	**	7.72	**	7.92	**
Specific FDI types (all FDI)								
PPE	-3.26	**	-3.41	**	-4.34	**	-4.26	**
Plants	1.96	**	2.18	**	3.09	**	3.09	**
M&A	-7.54	**	-7.32	**	6.41	**	6.42	**
Tax data (Country STR)								
State STR	5.95	**	5.37	**	9.45	**	9.10	**
METR	1.43	**	1.68	**	3.47	**	3.86	**
AETR	3.85	**	3.93	**	12.76	**	12.65	**
Micro ATR	-0.02		-0.50		1.33	**	1.31	**
Macro ATR	2.18	*	2.65	**	3.88	**	4.33	**
Finance/double tax (Not)								
Retained Earnings			0.09				0.33	
Transfers			-1.30				-1.01	
Exempt			0.90				0.46	
Credit			0.17				0.06	
Regression description								
Number of observations	427		427		357		357	
Adjusted R-squared	0.46		0.46		0.49		0.49	
Durbin-Watson	1.89		1.93		2.01		2.03	
Typical semi-elasticity	2.1		2.1		3.2		3.1	

First of all, the old sample suggests that studies using panel data produce significantly larger elasticities than studies using time series data. This is no longer the case with the new sample. Moreover, the difference between time series estimates and cross-section or discrete choice models is larger than with the new meta sample.

Also the differences for the specific types of FDI compared to general FDI are more pronounced under the old sample, except for mergers and acquisitions.

With respect to tax rates, we see that the old sample suggests that average tax rates based on micro data produce significantly larger elasticities than studies using statutory tax rates. Under the new sample, this is no longer the case. For other tax variables, we find that the difference in elasticity values for studies using the statutory tax rates becomes less pronounced.

The old and new samples do not produce significantly different results for the source of finance or the relief for international double taxation. Indeed, both samples suggest that differences are insignificant.

The typical elasticities are larger under the old sample, namely slightly above 3. Hence, the new studies in this paper have reduced the predicted value of the typical elasticity.

Effects of alternative computation of elasticities

In our meta sample, we compute the semi-elasticities by using sample means for the tax rates. This is often necessary to transform marginal coefficients from the primary studies into semi-elasticities. The mean tax rates are obtained from the original studies. For US studies that use state statutory tax rates, these sample means are substantially smaller than for other studies. Indeed, whereas most mean rates are in the order of 30%, state statutory rates are around 6% on average. Thus, elasticities in these studies are evaluated at relatively low rates.

This section explores an alternative way to compute the values for the semi-elasticity. In particular, we evaluate the elasticities not necessarily at the sample means but at a measure for the total tax. For most studies, this does not change the semi-elasticity. For studies using state statutory tax rates, however, it matters significantly. Indeed, by evaluating the semi-elasticity at a substantially higher tax rate, it usually produces a smaller value for the semi-elasticity (although this depends on the underlying specification of the regression equation). For instance, if a primary study produces an ordinary elasticity, the semi-elasticity is obtained by dividing the ordinary elasticity by the tax rate. For a high tax, this produces a substantially smaller semi-elasticity.

We thus constructed an alternative data set of semi-elasticities. We used the sum of the federal tax rate and the state statutory tax rate as a measure for the total tax. This alternative data set is used in similar regressions as before. The regression results are presented in table 4.3.

Table 4.3. Regression results for a sample where elasticities are evaluated at the overall tax rate[a]

	Elasticities evaluated at sample means				Elasticities evaluated at Total tax			
	Benchmark simulation		Extended set of regressors		Benchmark simulation		Extended set of regressors	
Constant	0.79		0.60		0.79		0.56	
Capital data (time series)								
Discrete choice	-3.10	**	-3.17	**	-3.10	**	-3.16	**
Panel data	1.13		1.71	*	1.13		1.71	*
Cross section	7.02	**	7.41	**	7.04	**	7.41	**
Specific FDI types (all FDI)								
PPE	-3.26	**	-3.41	**	-3.26	**	-3.37	**
Plants	1.96	**	2.18	**	0.53		0.76	
M&A	-7.54	**	-7.32	**	-6.47	**	-6.24	**
Tax data (Country STR)								
State STR	5.95	**	5.37	**	5.93	**	5.30	**
METR	1.43	**	1.68	**	1.44	**	1.67	**
AETR	3.85	**	3.93	**	3.85	**	3.93	**
Micro ATR	-0.02		-0.50		-0.02		-0.49	
Macro ATR	2.18	*	2.65	**	2.18	*	2.65	**
Finance/double tax (Not)								
Retained Earnings			0.09				0.13	
Transfers			-1.30				-1.26	
Exempt			0.90				1.01	
Credit			0.17				0.15	
Regression description								
Number of observations	427		427		427		427	
Adjusted R-squared	0.46		0.46		0.46		0.46	
Durbin-Watson	1.89		1.93		1.89		1.93	
Typical semi-elasticity	2.1		2.1		2.0		2.0	

Table 4.3 reveals that most coefficients do not change much under this alternative computation of semi-elasticities. Indeed, the results for different types of capital data, different tax rates and the source of finance and double taxation relief remain broadly the same. The major difference occurs with the specific type of FDI that is considered. In particular, whereas plant data yield a significantly larger semi-elasticity under the first regression than ordinary FDI data, this is no longer the case with the second regression. This raises the question which semi-elasticity is more appropriate. We believe that the evaluation of elasticities at the state statutory rate is somewhat misleading as it differs considerably from other studies. To improve the comparability of the study outcomes, we therefore prefer the

alternative semi-elasticity (i.e. evaluated at the total tax rather than the state statutory tax). This alternative measure is also used in the next section.

Differences according to spatial and time dimension

This section adds information about the spatial and time dimensions of the regressions. First, we exploit information about countries to analyze systematic differences between groups of investing countries. We designed elasticity groups that apply to EU investors, US investors, investors from small countries, and investors from peripheral countries. Although differences between host countries would have been interesting as well, the literature provides too little variation to explore this dimension. Second, we include the time dimension by means of either the average sample mean or a dummy for studies with an average sample mean beyond a certain year. Table 4.4. shows the simulation results.[7]

We see that adding information about investing countries does not change any of the previous findings. Moreover, none of the country dummies is significant, suggesting that there is no significant systematic variation across groups of countries for which elasticities are computed. The coefficient for peripheral countries is positive, suggesting a higher responsiveness of investors from these regions. Yet, also this coefficient is not statistically significant.

The average sample year appears in table 4.4 with a positive coefficient. It suggests that studies using more recent data produce larger elasticities than studies using older data. Yet, the coefficient is not statistically significant. Across time, however, the change in elasticity values may be non-linear. The dummies for studies using post 1980 and post 1990 data can therefore shed further light on the time dimension. Table 4.4 shows that studies using data before 1980 produce significantly higher elasticities than studies using post-1980 data. In fact, this difference appears to be quite strong. Studies using post-1990 data, however, produce larger elasticities as well. It suggests that especially studies using data from the 1980 produce small elasticity values. It is therefore difficult to conclude that the responsiveness of foreign capital to tax rates has gradually increased over time. If anything, the literature does provide some support for elasticities that are higher in the 1990s than in the 1980s. But the rise in the responsiveness of capital seems far from linear across time.

The typical semi-elasticities under the alternative specifications tend to be higher than in the benchmark regression. Indeed, the value increases from 2 to between 2.7 and 3.9 for the alternative specifications.

[7] We have performed regressions for the spatial and time variables both separately and simultaneously. The outcomes are similar so that we only present the results from the simultaneous regression.

Table 4.4. Regression results[a]

	Benchmark		Spatial variables		Average sample year		Time dummies	
Constant	0.56		0.75		0.54		0.47	
Capital data (time series)								
Discrete choice	-3.16	**	-3.10	**	-3.29	**	0.28	**
Panel data	1.71	*	1.40	*	1.57		5.47	*
Cross section	7.41	**	7.62	**	7.26	**	10.31	**
Specific FDI types (all FDI)								
PPE	-3.37	**	-3.34	**	-3.34	**	-2.56	**
Plants	0.76		0.78	**	0.76		1.06	
M&A	-6.24	**	-6.21	**	-6.24	**	-5.94	**
Tax data (Country STR)								
State STR	5.30	**	4.91	**	5.33	**	5.68	**
METR	1.67	**	1.69	**	1.67	**	1.51	**
AETR	3.93	**	4.00	**	3.93	**	3.91	**
Micro ATR	-0.49		-0.38		-0.49		-0.64	
Macro ATR	2.65	**	2.39	**	2.65	**	2.66	**
Finance/double tax (Not)								
Retained Earnings	0.13		0.20		0.12		0.14	
Transfers	-1.26		-1.19		-1.27		-1.29	
Exempt	1.01		1.09		0.98		1.28	
Credit	0.15		0.35		0.13		0.58	
Spatial dimension								
Investing EU			0.03					
Investing US			-0.80					
Investment small country			-1.18					
Investment periphery			2.44					
Time dimension								
Average sample year					0.01			
Post 1980							-4.33	**
Post 1990							0.84	*
Regression description								
Number of observations	427		427		427		427	
Adjusted R-squared	0.38		0.39		0.38		0.38	
Durbin-Watson	1.92		1.89		1.91		1.93	
Typical semi-elasticity	2.0		2.7		2.7		3.9	

Conclusions

This paper presents a synthesis of research results from the literature on taxation and foreign direct investment. We transform the results from a variety of studies into uniformly defined semi-elasticities. On average, the literature reports semi-elasticities with a median value of –2.9. More than half of the 427 elasticities that we collected turn out to be insignificant. The average values for elasticities hide substantial variation in research results, however. This heterogeneity in methodologies does not justify the presentation of a single consensus estimate from the empirical literature. Yet, it offers information that can be used to explain the variation in research results. Indeed, we perform a meta analysis that tries to identify study characteristics that significantly affect elasticity values.

Our results suggest that the type of capital data is important for the magnitude of the elasticity. In particular, studies using discrete choices regarding location produce systematically smaller elasticities than studies using FDI values. Hence, it seems that the amount of capital invested is more responsive to taxes than the location decisions themselves. Moreover, there is support for relatively large elasticities in studies using cross-section data as compared to panel studies and time series models. With respect to tax data, a robust finding is that studies using the effective tax rates produce larger elasticities than studies using statutory tax rates. The elasticities from studies using average effective tax rates obtained from tax codes tend to produce the largest elasticities. The meta regressions do not support different elasticity values for credit and exemption countries, for higher elasticity values in more recent years, or for higher elasticities for certain regions.

Future studies on the relationship between taxation and FDI can take the results from our meta regressions as point of departure as it provides a state of the art of existing findings. Moreover, the meta analysis offers insights in which factors systematically matter for the research findings and which should thus require specific attention in future research.

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Appendix A: a review of the literature

Time series FDI

The literature on taxation and FDI starts with Hartman (1984). He explains the aggregate inflow of direct investment in the United States as a ratio of GNP (*K/Y*) between 1965 and 1979 by the following three terms:

$$ln\ (K/Y) = \alpha 1\ ln\ [r(1-t)] + \beta\ ln\ [r'(1-t)] + \gamma\ ln\ [(1-t')/(1-t)]$$

The first term on the right hand side, *ln[r(1-t)]*, measures the after-tax rate of return on US investment for foreign investors. According to Hartman, this reflects the impact on new investment. The second term, *ln[r'(1-t)]*, is the gross rate of return on investment in the US, reduced by the US tax on FDI. This variable is said to reflect the effect of acquiring existing capital on which no extraordinary return is earned. The third term on the right hand side of the equation is a relative tax term, capturing a valuation effect. In particular, if a tax change makes it more attractive for domestic firms to invest, it becomes more expensive for foreign investors to acquire a US firm. The focus of Hartman's paper is on the distinction between FDI financed out of retained earnings and transfer of funds. Hartman claims that retained earnings should be more sensitive to US taxes because mature firms will use retained earnings as the marginal source of finance (which is cheaper than transfer of new funds). Hartman's results imply that, indeed, the tax rate elasticity for retained earnings is significant while for transfers the results are insignificant.

A number of subsequent papers have extended, modified or criticized Hartman's paper. Boskin and Gale (1987) extend the Hartman analysis by using a longer time series from 1956 - 1984 and alternative data for the rate of return. They also experiment with a linear instead of a log specification. The results of Boskin and Gale more or less confirm the main findings of Hartman, i.e. the impact of US taxes on retained earnings is more robust than the impact on transfer of funds. Young (1988) extends the Hartman analysis by means of a somewhat longer sample period from 1953 - 1984, a slightly different specification with a lagged investment term, and revised investment data. He confirms Hartman's original conclusions and even reports positive rather than negative semi-elasticities for transfer of funds. Murthy (1989) re-estimates Young's result by maximum likelihood estimation, rather than OLS, in order to adjust for the presence of autocorrelation. His elasticities are somewhat larger than those in Young (1988) while the significance of the parameters improves. The qualitative conclusions, however, remain the same.

Newlon (1987) casts doubts on the studies in the realm of Hartman. First, Newlon shows that these studies have not used the appropriate data for the rate of return on FDI for 1965-1973. Second, he notes that there is a problem of spurious correlation. In particular, the after-tax rate of return on FDI is constructed as the total earnings by foreign controlled companies, divided by invested capital. Since total earnings comprise reinvested earnings and repatriations, the rate of return variable contains the same component (and is almost equivalent if repatriations are low) as the dependent variable. To deal with these problems, Newlon (1987) uses alternative data. His conclusions are nevertheless in line with the previous findings of Hartman and others.

Slemrod (1990) also criticizes the earlier studies. First, he argues that the focus of the literature on the Hartman specification is unjustified since it lacks a properly specified model. In such a situation, one should investigate different specifications. Second, Slemrod raises doubts on the FDI data which are constructed from periodic benchmark surveys. This construction implies that mismeasurement becomes larger, the further a year is away from the benchmark year. To correct for this, Slemrod includes dummies for the gap between a year and the benchmark year. Moreover, he includes also a dummy for post 1974 observations since the BEA changed the definition of FDI in that year. Third, Slemrod controls for other variables that affect FDI (and which are potentially correlated with the tax term). Finally, Slemrod uses an alternative measure for the tax rate, namely the marginal effective tax rate derived by Auerbach and Hines (1988). With these four modifications, Slemrod re-estimates the tax rate elasticities in several ways. He finds that retained earnings are not responsive to US taxes, while for transfers a significant elasticity is found. This result is opposite to that of Hartman and others. Slemrod also explores the response of aggregate FDI, which is equal to the sum of retained earnings and transfers. The results suggest that taxes exert a significant negative effect on this aggregate FDI variable.

Another contribution of Slemrod (1990) is that he controls for the tax system in the home country of the parent. In particular, Slemrod argues that the tax response by investors from credit countries (Japan, UK and Italy) should be different from those of exemption countries (Germany, Netherlands, Canada and France). To explore this claim, he considers the bilateral investments flows from seven industrialized countries in the US and then looks whether there is a systematic difference between the two types of investors. The picture that emerges from this exercise is not clear, though. In fact, the country-specific evidence yields mixed results on the tax effect on FDI, including many insignificant coefficients. Moreover, Slemrod finds that the level of the home country tax rate and the difference in statutory tax rates between the investing country and the US do not change the results much.

Slemrod's qualifications to the earlier literature have made researchers reluctant to continue using aggregate time series data along the lines of Hartman. Only Cassou (1997) took up Slemrod's idea to exploit time series data on bilateral FDI flows. He repeats Slemrod's analysis for individual countries investing in the US, thereby using data between 1970 - 1989 and replacing the Netherlands by Sweden. He reports primarily insignificant results, especially for retained earnings.

Table 5.1 summarizes the main finding from the studies using time series data. We see that mean value of the 111 semi-elasticities is -4.91. The median value of 2.88 suggests a strong skewness in the distribution due to some extreme negative values. The large standard deviation is consistent with this. Less than half of the 111 reported elasticities is significantly different from zero (at the 5% confidence level). The study of Slemrod has by far the largest impact on the sample mean as we obtain 58 elasticities from his study. The study of Newlon provides only 2 elasticities.

Table 5.1. Summary of results from studies using time series data

	Semi-elasticity			No. obs	No. sign
	Mean	Median	Std. Dev.		
Hartman, 1984	-2.60	-3.46	2.30	6	3
Newlon, 1987	-0.42	-0.42	5.47	2	1
Boskin & Gale, 1987	-5.80	-2.68	7.56	12	4
Young, 1988	-1.05	-2.07	4.17	12	8
Murthy, 1989	-0.62	-0.71	1.00	4	2
Slemrod, 1990	-5.47	-3.51	14.36	58	24
Cassou, 1997	-7.46	-2.76	13.46	17	4
All	-4.91	-2.88	12.06	111	46

Cross-sectional allocation of assets

Studies using data on financial FDI flows or stocks have some serious limitations. As illustrated by Auerbach and Hassett (1993), FDI comprises a number of different components that can respond very differently to tax rates. Therefore, studies using aggregate FDI flows are difficult to interpret and strongly influenced by the composition of the FDI aggregate. A number of cross section studies in the US have therefore used data on property, plant and equipment (PPE) which is believed to be more closely related to real investment.

Grubert and Mutti (1991) were the first to explore this alternative indicator for foreign investment. They explore the sensitivity of US investors in 33 countries with respect to foreign average tax rates. They find a significant semi-elasticity of investment of around -0.7. Using the same methodology and similar data, Hines and Rice (1994) find a higher semi-elasticity between -3.3 and -6.6. The difference in magnitudes of the Grubert&Mutti and Hines&Rice elasticities is explained by the use of slightly different data. First, Hines&Rice use data for more countries, including a number of tax havens. Second, whereas Hines&Rice use data on all nonbank companies, Grubert&Mutti concentrate on manufacturing firms alone. The higher elasticity reported by Hines&Rice suggests that capital flows to tax havens and by non-manufacturing firms (which may contain much more financial capital) are probably more responsive to taxes than is real capital.

In a later study, Grubert and Mutti (2000) exploit micro data of more than 500 US tax returns to construct an aggregated data set on average tax rates and investment in plant and equipment by US multinationals in 60 locations. Using different specifications and different concepts of the average tax rate, Grubert&Mutti report significantly negative elasticities. Altshuler et al. (2001) exploit similar data as Grubert&Mutti and use a similar specification. They focus on the distinction in elasticities for 1984 data and 1992 data. For 1984, they find an elasticity that is much smaller than for 1992. This suggests that capital has become more responsive to taxes during the 1980s.

Hines (1996) builds on Slemrod's idea to use information on individual countries' direct investment into the US. He uses data for 1987 on PPE from seven investing countries into 50 different US states and explores the impact of state corporate income taxes on the allocation of FDI. Hines uses a specification where he explains the share of FDI by an investing country in each of the 50 US states in terms of total investment in the US. He assumes that countries

using the tax credit system will not respond to US tax rates since investors in these countries will be compensated by means for foreign tax credits. Hence, the elasticity for territorial countries is derived conditional on a zero elasticity for worldwide investors. This is a novel way to identify the true elasticity of FDI for territorial countries. Hines reports significant negative elasticities. As he uses relatively small state statutory rates, the difference between elasticities and semi-elasticities in his study is relatively large.

Table 5.2 summarizes the results from cross-section studies. We find a mean value for the semi-elasticity of -7.47. This is higher than the mean value found in the time series studies. It is explained primarily by the large elasticities reported by Hines (1996): he reports an average semi-elasticity of -12.37. Hines' elasticities are particularly relevant as we draw 34 elasticities from the study. The lower median semi-elasticity of -4.27 suggests also a skewed distribution due to some extreme values left from the mean. Regarding significance, we find that 48 out of the 78 reported elasticity values are significantly different from zero.

Table 5.2. Summary of results from cross-section studies

	Semi-elasticity			No. obs	No. sign
	Mean	Median	Std. Dev.		
Grubert & Mutti, 1991	-1.71	-1.59	1.18	6	3
Hines & Rice, 1994	-10.71	-4.96	14.14	4	2
Hines, 1996	-12.37	-11.31	7.61	34	17
Grubert & Mutti, 2000	-3.95	-4.23	1.26	14	13
Altshuler, et al., 2001	-2.71	-2.58	0.77	20	13
All	-7.47	-4.27	7.41	78	48

Discrete choice models

The third category of studies that can be found in the literature on taxation and foreign investment analyses the impact of the host country tax rate on the probability that a multinational chooses that location for its investment. In particular, Bartik (1985) explains the probability of location for new plants into each of the 50 US states by, among others, the state statutory corporate income tax rate. He reports a significant negative elasticity. In the same spirit, Papke (1991) explains the location of plant births in 50 US states by the effective tax rates on specific industries. He reports very different elasticity values for the various industries. Devereux and Griffith (1998b) explore decisions of US firms that choose to locate in France, Germany or the UK. Using a logit model, they report a significant adverse impact of the average effective tax rate on location. The average tax rate computed from data is found to have no significant impact.

In his study on FDI inflows into 50 US states, Hines (1996) performs some regressions with data on the number of locations, rather than the amount of capital invested. Thereby, he adopts the linear probability model. The results suggest significant elasticities, but somewhat smaller than for FDI flows. Also Grubert and Mutti (2000) show one regression in which they used data an number of locations, rather than total capital value.

Swenson (2001) takes up the qualifications by Auerbach and Hassett (1993) and distinguishes between 6 different components of FDI: new plants, plant expansions, mergers and acquisitions, joint ventures, equity increases, and other FDI. The data refer to the number of investment projects, rather than the value of the investment. The data comprise 46 countries investing in 50 US states. Like Hines (1996), Swenson uses the variation in state statutory rates to identify the tax effect on FDI decisions. The tax elasticity of new plants and plant expansions appears to be significantly negative for most investing countries. Hence, real investments decline in response to higher US state corporate tax rates. However, the effect of mergers and acquisitions is significantly positive in all cases. This suggests that, if mergers and acquisitions take up a larger share of aggregate FDI, it becomes less likely that the tax effect on aggregate FDI will be negative.

In a recent study, Buttner and Ruf (2004) follow Devereux and Griffith (1998) to explain the choice of location by German multinationals in other EU countries in the non-financial sector. Thereby, they use microdata on location choices obtained from the Bundesbank between 1996 and 2001. Buttner&Ruf use alternative measures of the tax rate, including statutory rates, average rates and average effective taxes. Moreov, they estimate a linear probability model as well as a logit model and explore alternative subsamples. They find mixed results regarding significance, while elasticities are small compared to other studies.

Stoewhase (2003) uses count data from German multinationals that choose to locate in a number of EU countries between 1991 and 1998. Thereby, he concentrates on decisions regarding profit shifting versus investment by distinguishing between different types of firms. The results suggest that production firms do indeed respond to effective tax rates, but not to statutory rates. For companies that are important for profit shifting, statutory tax rates are more important.

Table 5.3. Summary results from discrete choice models

	Semi-elasticity			No. obs	No. sign
	Mean	Median	Std. Dev.		
Bartik, 1985	-6.90	-6.55	1.42	3	3
Papke, 1991	-4.85	-4.85	5.59	2	1
Hines, 1996	-6.71	-3.43	8.65	12	4
Devereux & Griffith, 1998	-5.24	-5.88	2.47	10	8
Grubert & Mutti, 2000	-4.24	-4.24	NA	1	1
Swenson, 2001	-3.51	-2.81	7.40	95	34
Stoewhase, 2003	-7.36	-6.82	1.12	5	5
Buttner & Ruf, 2004	-0.42	-0.39	0.35	15	6
All	-3.80	-3.07	6.74	143	62

Table 5.3 summarizes the main findings from the studies using discrete choice models. The mean value for the semi-elasticity is -3.8. This elasticity is low compared to studies using time series data or cross section data. It may suggest that, apart from the choice of location, also the choice regarding the amount of capital invested is responsive to taxes. The study by Swenson (2001) has a large impact on the mean values in table 2.3 as we take 95 elasticities

from her paper. In the discrete choice models, more than half of the reported elasticities is not significantly different from zero. This is especially due to the findings from Swenson.

Panel FDI data

The last category of studies uses panel data. Thereby, three studies adopt aggregate FDI data while others consider bilateral flows. The aggregate studies are Swenson (1994), Billington (1999) and Broekman and van Vliet (2000). Swenson (1994) uses aggregate FDI inflows into the US between 1979 and 1991 and distinguishes between 18 different industries. She regresses the log of FDI to the average tax rates, distinguished for the respective industries. Swenson reports a positive elasticity for alternative specifications and alternative tax measures. This confirms the Scholes and Wolfson (1990) hypothesis, suggesting that higher effective tax rates in the US will raise FDI from investors in tax credit countries. Billington uses a panel of 7 OECD countries between 1986 - 1993 with aggregate FDI inflows. He regresses the log FDI to the square of the statutory tax rates and reports significant but small elasticities. Broekman and van Vliet focus on aggregate FDI inflows in 15 EU countries using data from 1989-1998. Using a simple linear specification, they report semi-elasticities in the order of -2.

Most a panel studies use bilateral FDI flows for a number of years. Jun (1994) constructs a panel of FDI flows from 10 OECD countries into the US between 1980 and 1989. Using a linear specification and alternative tax measures, he primarily reports insignificant results. Devereux and Freeman (1995) adopt a panel of bilateral FDI flows between 7 OECD countries during 1985 and 1989. Using a linear specification, they regress FDI flows to the user cost of capital, derived from Devereux and Pearson (1995). Devereux and Freeman find small negative elasticity values, but most coefficients are not significant. Pain and Young (1996) focus on FDI from Germany and the UK into 11 locations during 1977 and 1992. They use a log specification and include lagged FDI in their estimation. Moreover, they stress the importance of the home country tax for the responsiveness of FDI to host country tax rates. The long-run elasticity in Pain and Young's study is significantly negative and large for the UK, but insignificant and small for Germany. Using a similar specification and bilateral FDI from 11 investing countries into 46 locations in 1991, Shang-Jin Wei (1997) finds significant negative elasticities.

The approach of Hines to estimate the elasticity for exemption countries conditional on a zero elasticity for credit countries was taken up by Gorter and Parikh (2000) and by Benassy-Quere et al. (2001). Both studies use a panel of bilateral FDI flows between OECD countries and report significant tax effects.

Buettner (2002) adopts FDI flows financed by transfer of funds (not retained earnings) in the EU between 1991 and 1998. He uses alternative tax measures and a log-linear specification in which he includes also public expenditure variables. The results are mixed. Desai et al. (2004) estimate a model using outward FDI stocks of US multinationals in the manufacturing sector in 1984 and 1992. They include both indirect tax variables and direct tax measures in their regression. For both taxes, they report significant elasticities. Benassy-Quere et al. (2003) use similar data as Buettner for FDI financed by transfer of funds in the OECD, but using a longer time frame between 1984 and 2000. For alternative specifications regarding control variables or subsamples, they report mainly significant elasticities. Finally, Stoewhase (2005) uses bilateral FDI data that are divided between three sectors: agriculture, manufacturing and

services. He explains the share of FDI and exports by alternative tax parameters. Only for the manufacturing and service sectors does he find significant results.

Table 5.4. Summary results from panel data studies

	Semi-elasticity			No. obs	No. sign
	Mean	Median	Std. dev.		
Swenson, 1994	1.26	2.72	4.25	10	6
Jun, 1994	-0.50	-1.26	3.17	10	1
Devereux & Freeman, 1995	-1.56	-1.55	0.12	4	1
Pain & Young, 1996	-1.51	-1.38	1.22	6	3
Shang-Jin Wei, 1997	-5.20	-5.00	0.64	5	5
Billington, 1999	-0.10	-0.10	0.01	2	2
Gorter & Parikh, 2000	-4.56	-4.64	4.25	15	10
Broekman & Vliet, 2000	-3.35	-3.51	0.77	3	3
Benassy-Quere et al., 2001	-5.03	-5.01	3.03	4	3
Buttner, 2002	-1.52	-1.59	0.58	23	12
Benassy-Quere et al., 2003	-5.37	-4.22	3.21	19	19
Desai, et al., 2004	-0.64	-0.64	0.02	2	2
Stoewhase, 2005	-5.26	-4.30	2.71	14	11
All	-2.94	-2.51	3.51	117	78

Table 5.4 summarizes the finding from panel studies, from which we obtain 117 elasticities. The mean value of the semi-elasticity equals -2.9. Two-third of the elasticities reported in the literature is significantly different from zero. This is larger than for any other category of studies. Also the variability in results is rather small, as can be seen from the standard deviation.

Appendix B: meta analysis

Meta-analysis is a research method to synthesize research results. It is best seen as a statistical approach towards reviewing and summarizing the literature. It can alternatively be described as the “analysis of analyses”. As a research method, it has a longstanding and by now fairly strong position in psychology, education, and medical research. Meta-analysis provides a tool to compare and/or combine outcomes of different experiments with similar set-ups or, alternatively, differences in set-ups that can be controlled for. As such, it enables the researcher to draw more rigorous conclusions than would have been possible on the basis of either of the studies considered in isolation.

Virtues of a meta analysis

Although meta analysis has been developed for sciences with an experimental setting, the methodology can be also employed in economics.[8] In this connection, meta analysis should be seen as a complement to a traditional literature review. Indeed, compared to an ordinary survey, meta analysis has some distinct potential advantages. First of all, meta-analysis constitutes a more systematic approach towards analysing the sources of (quantitative) variation in previously obtained research results. The underlying studies in the literature are often difficult to compare because of different specifications, different data and different methodologies, as is the case with taxation and FDI. The statistical nature of meta analysis implies that it compares studies in a systematic way.

Secondly, meta-analysis is more 'objective' than the traditional literature review, although it is not necessarily free from subjectivity either. Indeed, each literature survey is characterized by a selection process. This is justified to the extent that the quality of studies differs. The main advantage of meta analysis as compared to a literature review is that it makes the selection process verifiable since the meta analyst has to be explicit on his selection criteria.

Thirdly, meta-analysis opens up the possibility of investigating non-sampling issues such as research design, model specification and estimation technique, which are usually relatively constant within a study. The multivariate set-up of meta regressions allows for the assessment of marginal effects of study characteristics, everything else remaining constant.This yields useful information for both future research and economic policy. Indeed, it adds knowledge to economic science by assessing the systematic impact of the underlying differences in study characteristics on the variation in estimates of the effect size.

Fourthly, given its quantitative orientation meta-analysis usually goes beyond what is called vote-counting. Vote-counting is often, more or less implicitly, used in literature reviews. It refers to simply counting and tallying significant results of a specific sign as well as zero-results. The inference that a specific category occurs in a majority of cases is usually taken as evidence for the size and direction of the 'true effect'. Vote-counting is, however, not very powerful in coming up with the right conclusion. It tends to result in a bias towards drawing the conclusion that the estimated relationship under consideration is statistically insignificant. It is especially prone to suggesting the wrong conclusion when the number of available studies increases.

Problems with meta analysis

Meta-analysis is not free from problems. A first and rather obvious problem is how to attain a representative sample of the literature. Modern bibliographical tools, such as EconLit and other (online) databases, and the easy availability of working papers through the Internet, do not prevail that it may be difficult to assess whether the sample of studies is in the end representative of the population of studies. Even more aggravating is the possibility that the studies that have been published constitute a biased sample of what has actually been found by researchers. For instance, editors of journals could have a tendency to reject 'negative' or insignificant results. This may also lead to self-censoring so that negative results are put away

[8] A good textbook on meta analysis is Cooper and Hedges (1994). For overviews of meta-analysis and its applications in applied micro- and macroeconomics, see Button et al. (1999), Stanley (2001) or Florax et al. (2002).

in the file drawer and even do not appear in unpublished working papers. Research results found in the literature are then necessarily biased towards significant 'positive' results, and a meta-analysis would thus be concerned a biased representation of what has been published. This problem of publication bias, however, also applies to ordinary literature surveys. One advantage of meta analysis, is that the researcher can test for the presence of publication bias in a certain literature.

A second problem of meta analysis is concerned with the comparability of estimated effect sizes. This is not always straightforward. For instance, elasticities estimated using a double logarithmic specification are generally different from point elasticities evaluated at the sample mean of taxes and quantities. There is no a priori preference for one or the other, and it is impossible to favour either of them on the basis of statistical or theoretical arguments. Alternatively, elasticities may be different in their time horizon (short vs. long-run elasticities), or even more complex, their base may be different. In a strict sense, the elasticity estimates obtained by different methods are incomparable. This is not necessarily detrimental to performing a valid and thorough meta-analysis. Indeed, a meta analysis can explore whether such differences systematically matter for effect sizes.

A third problem is related to the formidable heterogeneity among studies. In medicine and the sciences replication is a common characteristic. In economics, on the contrary, it seems to be a common desideratum of research that the investigator be 'original' and 'innovative'. As a result, it is not straightforward to account for all this heterogeneity, and many meta-analysts rely on simple fixed or random effects to account for such differences. Two circumstances aggravate this problem even further. One is common to all research: how to account for quality differences among studies? In economic meta-analyses this is usually not addressed, except for the variation in precision of effect sizes due to differing sample sizes of the underlying studies. In principle, meta analysis can explicitly allow for quality differences between studies. The problem is, however, that it is inherently difficult to use objective quality indicators to weigh the different observations. Therefore, meta analysis cannot fully replace a literature review in which the subjective judgement of the reviewer regarding quality of primary studies is important. The other problem is more typical of economic research: in contradistinction to experimental sciences, economists are generally rather 'sloppy' in adequately reporting statistical results as well as providing sufficient information about the statistical characteristics of the sample observations. Although providing insufficient or incomplete information may not be all that relevant for the study as such, it is extremely relevant for the comparison of results among different studies, and it is of paramount importance for a proper and justifiable construction of a good database.

A final problem, common to meta-analyses in the experimental sciences as well as the non-experimental sciences, concerns the assumption of independence of the observations. In the (experimental) sciences this assumption can usually be defended because the tradition of doing replications makes that one estimate per study can be sampled, without running into degrees of freedom problems. In economics, however, the generally much more limited number of available studies, which as a rule provide various 'competing' specifications, necessitates the meta-analyst to sample more than one observation per study. As these observations are derived from the same data, the lack of independence is obvious. The potentially negative effects of this problem (e.g., biased estimates in the meta-analysis) are usually simply disregarded.

All of these problems are increasingly recognized in the community working on meta-analysis. Fortunately, this results in the development of new, and more sophisticated techniques (e.g., multilevel techniques, and tests and estimators taking into account publication bias), to cope with the potentially negative effects of disregarding these problems inherent to meta-analysis. This is of course of paramount importance for the validity and the credibility -- and in the end, as a result, the acceptance -- of a relatively new technique, such as meta-analysis.

Since there is an abundance of (primary) empirical studies, meta analysis could easily be applied to taxation and FDI. Estimating just one other elasticity usually has a small value added to the literature. In that case, a meta regression may be a good alternative: it combines all the available information and comes up with summary statistics that can be useful for policy makers that are interested in 'consensus estimates'. Moreover, meta regressions can yield important information for future research as it reveals which study characteristics drive the variation in study results.