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Taxation and foreign direct investment

A synthesis of empirical research

This paper reviews the empirical literature on the impact of company taxes on the allocation of foreign direct investment. We make the outcomes of 25 empirical studies comparable by computing the tax rate elasticity under a uniform definition. The mean value of the tax rate elasticity in the literature is around −3.3, i.e. a 1%-point reduction in the host-country tax rate raises foreign direct investment in that country by 3.3%. There exists substantial variation across studies, however. By performing a meta analysis, the paper aims to explain this variation by the differences in characteristics of the underlying studies. Systematic differences between studies are found with respect to the type of foreign capital data used, and the type of tax rates adopted. We find no systematic differences in the responsiveness of investors from tax credit countries and tax exemption countries.

1 Introduction

During the last decade, European countries have reduced company tax rates. Indeed, whereas the mean corporate income tax rate in the EU was 38% in 1990, it dropped to 33% in 2000 (Gorter en De Mooij, 2001). Although the average tax burden on companies has been rather stable during this period, some EU governments have recently launched proposals to also reduce it. To illustrate, Germany, Ireland and Portugal have recently reduced their taxes while the Netherlands, Italy and France are discussing proposals for tax reform and relief. These proposals are motivated by the growing internationalisation of businesses and the increasing mobility of capital. Indeed, by reducing tax rates, European countries aim to improve their investment climate for foreign companies.

Some people fear that these national tax reforms in Europe will end up in a degradation of tax systems and that they will threaten its redistributive function. Especially since the code of conduct on business taxation in the EU prohibits the use of tailor-made tax measures to attract foreign businesses, countries may compete more and more on the basis of the overall tax burden (Diaw and Gorter, 2001). Such tax competition may yield a suboptimal outcome for Europe. Indeed, cooperation may be beneficial and perhaps even Pareto improving for European countries. It has therefore been suggested to harmonise capital income tax rates in Europe.

Discussions about company tax reform and tax harmonisation rely heavily on the belief that tax rates have important implications for the behaviour of multinational firms. The economic literature tends to support this claim (for an overview see Hines, 1997). First, differences in statutory tax rates between countries provoke profit shifting through debt contracts, manipulation of transfer prices, and so on. Second, taxes affect the amount of dividend repatriations of subsidiaries to their parent companies. And finally, company taxes determine the allocation of real investments of multinational companies. This latter effect seems to attract most attention in debates on tax reform and tax harmonisation. The reason is perhaps that, compared to financial operations such as profit shifting and dividend repatriations, real investment behaviour is more important from a welfare-economic perspective.

Since the mid 1980's, numerous papers have analysed how foreign direct investment (FDI) or new plant decisions are affected by company taxes. A summary of the early literature is provided by the Ruding report (see CEC, 1992), which primarily refers to US studies. The report concludes that company taxes have a significant negative impact on the inflow of foreign investment. Hines (1997; 1999) reviews more recent US literature. He suggests a consensus estimate on the basis of the literature between –0.5 and –0.6, i.e. a 1% higher tax rate on companies leads to a reduction in FDI by 0.5% to 0.6%. A recent literature review by Gorter and De Mooij (2001) also includes studies for Europe which rely on FDI data. They suggest that

intra-European investment flows tend to be more responsive to tax rate differentials than do continental flows.

These literature surveys are helpful to get an impression of the empirical literature. However, they also have some limitations. First of all, the underlying studies are difficult to compare because of different specifications, different data and different methodologies. This is especially so because there is no commonly agreed theory of FDI that yields a preferred specification. Therefore, studies use different ad-hoc specifications to estimate the elasticity. Second, the underlying studies report different types of elasticities. This makes a direct comparison virtually impossible. Finally, although it is tempting to draw firm conclusions from a survey, this could be misleading. As Jeffrey Frankel (1997) asks in a comment to Hines' review: "Is there any selection going on here, whether by the authors in reporting their results, the journals in publishing them or Hines in choosing to include them in his survey?" (Frankel, 1997, pp. 448). More generally, ordinary surveys are typically subjective characterisations of the literature, sometimes accompanied by some type of vote counting in which the number of positive, negative, and insignificant elasticities are computed. This approach may well yield misleading conclusions, as is illustrated by the theory of meta analysis (see e.g. Cooper and Hedges, 1994).

These qualifications form the motivation for this paper. In particular, in addition to reviewing the empirical literature, this paper contains two main contributions. First, we make an attempt to translate the findings of 25 empirical studies into comparable elasticities.[1] Second, we correlate these elasticities to the characteristics of the underlying studies. This meta approach is interesting for at least three reasons.

First, compared to an ordinary survey, an advantage of meta analysis is that it makes the selection process explicit and verifiable. In fact, each literature survey is characterized by a selection process. Selection is justified to the extent that the quality of studies differs, but it is also unavoidable to the extent that it originates from publication bias. In many surveys the selection process remains implicit.

A second contribution of the meta analysis is that it yields useful information for future research. For instance, we explore whether there are systematic differences between studies that (i) use different types of effective tax rates on capital income; (ii) use different types of foreign capital data; (iii) use different control variables; (iv) use different specifications or estimation procedures, etc. These issues have been addressed in the underlying studies. Our study investigates in a different way how important they are. In a sense, the meta analysis is used to rethink the current state of the art in the literature, and to explore fruitful directions for future research. In this respect, meta analysis is more rigorous than an ordinary survey of the literature

[1] Annex 5A of the Ruding report does a similar exercise, but they had only three studies available at that time.

because of the multivariate character of the analysis. For instance, as this paper reveals, simple pairwise comparisons of study characteristics and effect size can yield misleading conclusions.

A third contribution of the meta analysis is that it yields interesting insights for policy makers. For instance, we are able to explore whether tax elasticities are systematically influenced by (i) the sample period of the underlying data; (ii) the source of finance of foreign investments; (iii) whether the investor is located in a tax exemption country or a tax credit country, and so on.

The rest of this paper is organized as follows. We start in section 2 with a discussion of the relationship between taxes and foreign direct investment. Section 3 gives a review of the empirical literature and provides a summary table with the main characteristics of the 25 studies that form our meta sample. Section 4 presents the meta analysis, starting with a simple analysis of variation, followed by a number of regressions. Finally, section 5 concludes.

2 Taxes and foreign direct investment: theory and data issues

2.1 Foreign direct investment

In statistical information on foreign capital flows, a usual distinction is between foreign portfolio investment (FPI) and foreign direct investment (FDI). FPI is defined as foreign investments in cases where the investor controls less than some fixed proportion of the capital stock that is invested in. The IMF guidelines propose a proportion of 10%. FPI generally refers to household investment in foreign securities, often channelled through financial intermediaries such as mutual funds or pension funds.

Foreign direct investment is, according to the IMF guidelines, defined as foreign investments in which the investor owns more than 10% of the stock that is invested in. This generally refers to investments by multinationals in foreign controlled corporations such as affiliates or subsidiaries. FDI flows consist of two broad categories: (i) direct net transfers from the parent company to a foreign affiliate, either through equity or debt, and (ii) reinvested earnings by a foreign affiliate. Other ways to finance the investments of subsidiaries, such as local borrowing or local issuance of shares, are not registered as FDI. In that sense, FDI may underestimate the total investment of corporations that are controlled by foreign parent companies.

Compared to FPI, FDI is generally thought to be more closely related to the allocation of real capital, the main interest in our analysis. Still, statistical information on FDI involves financial flows that do not necessarily correspond to the allocation of real investment. Indeed, FDI comprises several types of capital. First, it contains real investment in plant and equipment (PE), either in the form of new plant and equipment or plant expansions. Second, a major part of FDI consists of the financial flows associated with mergers and acquisitions. This implies a change

in ownership without any real investment taking place. Estimates by the OECD suggest that mergers and acquisitions account for more than 60% of all FDI in developed countries (OECD, 2000). Other components of FDI are joint ventures and equity increases. The latter component typically comprises investment in financial capital. The distinction between the different types of FDI is important because the different components may respond differently to taxes (Auerbach and Hassett, 1993).

Decisions by multinationals to undertake FDI are usually complex since they involve strategic decisions. The most widely accepted theory of FDI is probably the eclectic approach developed by Dunning (1981). For a multinational that seeks to maximize the value of the firm, FDI is attractive if the so-called OLI conditions are met, referring to Ownership, Location and Internalisation. First, there must be an ownership advantage for the multinational relative to ownership by local firms. This may have something to do with specific technological or organisational knowledge of the multinational, but could also relate to tax issues. Second, it must be attractive for the multinational to produce abroad because of some comparative locational advantage. Otherwise, the multinational would have chosen to export, rather than to invest. Finally, it should be attractive to undertake activities within the multinational, rather than buying or leasing them from other firms.

Taxes can affect all three OLI conditions. For instance, it can affect the tax treatment of a foreign firm, relative to domestically owned firms. The tax rate can also be a factor that determines the attractiveness of a location for undertaking investments. Note, however, that taxes are one of many potential locational factors. Other factors include a good infrastructure, the availability of workers with good knowledge, proximity to markets, or the proximity of other businesses due to network and agglomeration benefits.[2]

As noted above, FDI data can be problematic to the extent that its different components respond differently to taxes. In particular, only a fraction of FDI refers to the allocation of real capital in plant and equipment while, at the same time, other investments by foreign controlled companies are not registered as FDI. Therefore, it is difficult to infer the appropriate elasticity of real foreign capital from regressions that use the aggregate FDI data. To deal with this problem, a number of US studies have used information on investment in property, plant and equipment (PPE), which is thought to be a better approximation of investment in real capital. Others have focussed on the number of foreign locations, rather than the amount of capital. This variation in the use of data is important for our analysis since it allows us to explore how particular data affect the magnitude of elasticities.

[2] Business surveys usually find that taxes are important for corporate managers in making locational decisions, although usually not the most important one, see e.g. the Ruding report.

2.2 Taxation of foreign direct investment

The return to foreign direct investment may be subject to international double taxation. In particular, a foreign subsidiary is always subject to corporate income tax in the host country. These profits of the subsidiary 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. In the EU, the Parent-Subsidiary Directive ensures that countries either adopt a credit system or an exemption system to avoid international double taxation within the Union. The US and Japan adopt tax credit systems. In the EU, this holds for Greece, Italy and the UK. All other EU countries adopt the tax exemption system.

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. To illustrate, a Dutch firm that invests in a German subsidiary is subject to the German corporate income tax alone. Dividend payments to the Dutch parent company thus remain untaxed in the Netherlands. Countries that adopt the exemption system differ with respect to their application of these exemptions. In some countries, firms can claim tax exemptions only if they control a substantial share of a company and when a minimum of foreign corporate income tax is paid. Other countries impose less tight conditions on the ownership share or on the foreign tax paid.

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. For instance, the corporate income tax in Greece is 40% while Denmark adopts a rate of 32%. As Greece adopts the credit system, a Greek corporation that earns 100 euro in Denmark pays 32 euro corporate income tax in Denmark and an additional 8 euro in Greece. Would Greece have adopted the exemption system, the corporation would have been subject to the Danish corporate income tax alone. Governments generally limit the foreign tax credits that firms can claim. Indeed, if foreign tax payments exceed the tax liability in the home country of the parent company, there exists an excess foreign tax credit. In that case, firms are usually permitted to claim no more tax credit than the domestic tax liability, i.e. it is in effect exempt from taxation. If the tax liability in the home country of the parent exceeds the foreign tax payment, there is deficit tax credit. Tax credit countries differ with respect to the application of tax credits, e.g. whether excess foreign credits can be compensated by deficit tax credits elsewhere or whether compensation is allowed by carrying backward or forward the deficit foreign credit through time.

Countries that adopt foreign tax credits to avoid international double taxation generally also permit tax deferral. In particular, profits of foreign affiliates that are reinvested in that company are deferred until they are repatriated to the parent company through dividend payments. Only

upon the date of repatriation, is the parent company subject to corporate income tax in the home country. This makes the impact of home country taxation less important for investors from tax credit countries.

Under credit systems, home and host country taxes exert different incentives for parent companies to undertake FDI than under exemption systems. Indeed, exempt investors are subject to host country tax alone. Hence, home taxes do not matter for the amount of FDI. In contrast, credit investors will be taxed on a worldwide basis in the home country so that the home country tax does matter. The impact of the home-country tax is, however, rather subtle and, for instance, depends on the way in which FDI is financed (transfers and retained earnings) and whether there is excess foreign tax credit. This study does not focus on the impact of the home country tax, but rather on the host country tax.

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. This holds for FDI financed by retained earnings and equity transfers but not for debt-financed investment since the interest is generally deductible from corporate profits. 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. This is 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.

To summarize, a higher tax rate in the host country is likely to reduce FDI from exemption countries, primarily because it makes the host country less attractive as a location for investment in plant and equipment. For investors from tax credit countries, however, a higher tax rate in a host country yields ambiguous effects. On the one hand, it may reduce real investment to the extent that parents are in an excess credit position. On the other hand, it may encourage foreign ownership of capital in the host country. Empirical evidence should tell us which effect dominates.

2.3 Which tax matters?

Some studies use the statutory corporate income tax to measure the tax effects on FDI. However, the tax treatment of FDI is generally a complex issue, as we saw in the previous subsection. Using the statutory tax rate can therefore be misleading.[3] It is impossible, however, to capture all the complex details of the tax system that potentially affect foreign investment in an empirical analysis. Most studies therefore rely on some type of effective tax rate. An effective tax rate is a rough proxy variable that summarises the interaction of various tax rules on an investment. The effective tax rate can be computed in several ways. Most of the empirical studies use either of the following three tax rates.

(i) First, there are 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. The ATR's have the advantage that they take account of tax planning activities, complex tax provisions and discretionary administrative practices of tax authorities.

(ii) A second measure for the effective tax rate is the marginal effective tax rate (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.

(ii) Finally, some studies use the average effective tax rate (AETR). This measure is also based on tax codes, but it concerns the wedge between the pre- and post tax return on a typical investment project on which firms may earn an economic rent. This is important for decisions regarding lumpy investment, investment in the presence of imperfect competition, or for locational decisions of firms. Devereux and Griffith (1998a) argue that investment decisions are often inframarginal.

2.4 General equilibrium effects

An important limitation of empirical studies is that they cannot appropriately incorporate general equilibrium effects of taxation. In general, lower taxes not only raise the after-tax return to foreign investors, but may also change equilibrium prices on product markets, interest rates, wages and exchange rates.

One important mechanism of this kind has been emphasised by Scholes and Wolfson (1990). They argue that a higher effective tax on capital in a host country may actually raise the amount of FDI in that country, especially FDI undertaken by worldwide investors. The reason is that, in contrast to domestic investors, foreign investors from these countries are shielded from the higher host-country tax. Indeed, these foreign investors receive tax credits from the

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

government in the home country. Hence, whereas the after-tax return falls for domestic investors, it remains constant for foreign investors from tax credit countries. Even further, the return to capital may actually increase for investors from tax credit countries due to general equilibrium effects. This is because the lower after-tax return in the host country may endogenously raise the before-tax return on these investments. Indeed, if investors try to escape the higher tax rate in the host country (e.g. domestic investors or investors from tax exemption countries), the decline in capital will raise the marginal productivity of that capital and, therefore, the before-tax return. More generally, international capital mobility will ensure a uniform after-tax rate of return to capital so that a higher tax rate calls for an increase in the before-tax rate of return. In this way, foreign investors from worldwide countries may gain from the higher tax rate in the host country: they are shielded from the higher tax and benefit from the higher before-tax return. Accordingly, FDI can be encouraged by a higher effective tax rate in the host country. This argument was used by Scholes and Wolfson to explain the surge in FDI into the United States after the Tax Reform Act of 1986, which actually raised the average tax on investment in the US.

There can be several other general equilibrium effects of taxes as well. For instance, in correspondence with the benefit principle of taxation, countries with high taxes may indirectly compensate firms with investment incentives that are more difficult to measure. Examples are investment subsidies or spending on infrastructure. This suggests that it is not taxes alone that determines international investment decisions, but the combination of taxes and public spending.

The problem with these general equilibrium effects is that they can affect the tax rate elasticity that is measured in empirical studies. In particular, other variables in the estimated equation (e.g. the interest rate, public infrastructure) may sometimes pick up the indirect tax effects on foreign investment. In studies that do not include such control variables, the indirect effects can be picked up by the tax coefficient. Since studies differ with respect to those control variables, this confuses the interpretation of elasticities. In our meta analysis, we therefore explore whether particular control variables in the empirical studies have a systematic impact on the reported elasticities.

3 A review of empirical studies

This section starts with a review of empirical studies on taxation and foreign direct investment. In particular, all studies that include foreign capital on the left hand side and a measure for the tax rate on the right hand side have been considered, including working papers and unpublished articles. Only if we were unable to derive the appropriate elasticity values, we removed a study from our sample. In subsection 3.2, we make the outcomes of the studies comparable by

deriving uniformly defined elasticities. These form the basis for our meta analysis of the next section.

3.1 A review of the literature

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 - 1979 by the following three terms:

$$(1) \quad ln(K/Y) = a_1 ln[r(1-t)] + a_2 ln[r'(1-t)] + a_3 ln[(1-t')/(1-t)]$$

The first term on the right hand side of (1), *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 (1) 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 Hartmans 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) also 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.[4]

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 perfectly 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. Indeed, aggregate time series have been

[4] We rely on the paper by Slemrod (1990) to include Newlon's (1987) elasticities since we were unable to get the original PhD thesis of Newlon.

rarely used in subsequent contributions. Only recently, Billington (1999) and Broekman and van Vliet (2000) have used aggregate FDI flows to estimate the tax elasticity. 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 elasticities in the order of -2. Neither Billington nor Broekman and van Vliet distinguish between retained earnings and transfer of funds.

Swenson (1994) uses aggregate FDI inflows into the US between 1979-1991, but distinguishes 18 different industries. She regresses the log of FDI in the entire panel to the average tax rates, distinguished for the respective industries. For FDI, she uses different data than previous studies. In particular, instead of financial flows, she uses data that better correspond to foreign investment.[5] Swenson reports a positive elasticity for alternative specifications and alternative tax measures. She thus 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.

Some studies during the 1990's have taken up Slemrod's idea to exploit bilateral FDI flows. Cassou (1997) 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. Cassou is the last study in our sample that makes a distinction between FDI financed by retained earnings and transfer of funds.

Other studies have pooled bilateral FDI flows in order to construct a panel. First of all, Jun (1994) constructs a panel of FDI flows from 10 OECD countries into the US. Using a linear specification and alternative tax measures, he reports mainly insignificant results. Devereux and Freeman (1995) use a panel of bilateral FDI flows between 7 OECD countries during 1985 - 1989. Using a linear specification, they regress FDI flows to the user cost of capital, derived from Devereux and Pearsson (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 - 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.

[5] Swenson (1994) refers to Auerbach and Hasset (1993) to motivate her choice of data. Auerbach and Hasset (1993) distinguish three alternative data, namely affiliate data on new plant and equipment, acquisitions of existing US companies, and the establishment of new companies by foreign investors. It is not clear which series is used by Swenson (1994). She might also have used the sum of the three series as was done by Auerbach and Hassett. In our analysis, we have assumed that her capital data are similar to data on PPE.

Studies using data on financial FDI flows or stocks have some serious limitations. As illustrated by Auerbach and Hasset (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) explore the sensitivity of US investors in 33 countries with respect to foreign effective tax rates. They find a significant semi-elasticity of investment of around −0.7. Using the same method, 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 different data. First, Hines and Rice use data for more countries, including a number of tax havens. Second, Hines and Rice use data on all nonbank companies while Grubert and Mutti concentrate on manufacturing firms alone. The higher elasticity reported by Hines and 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.

Grubert and Mutti (2000) exploit micro data of more than 500 US tax returns to construct an aggregated data set on average effective 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 and Mutti report significantly negative elasticities. Altshuler et al. (2001) have exploited similar data as Grubert and Mutti and use a similar specification. They focus on the distinction in elasticities between 1984 and 1992. For 1984, they find an elasticity that is 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 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 different specification than Slemrod: 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. Hines 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. Hines reports significantly negative elasticities that are larger than found in most previous studies. The approach of Hines was later used by Gorter and Parikh (2000) and Benassy-Quere et al. (2001), who both use a panel of bilateral FDI flows between OECD countries. Both studies report significant tax effects on FDI by exemption countries.

Swenson (2001) takes up the qualifications by Auerbach and Hasset (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 total amount of investment and comprise 46 countries investing in 50 US states.

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 significantly negative.

A different strand of literature on taxation and foreign investment analyses the impact of host country taxes on the probability that a multinational chooses a location for an 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. He reports a significantly 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) also find a significant adverse impact of the average effective tax rate on the probability of US firms locating in either France, Germany or the UK.

3.2 Constructing a database

The studies discussed above use different specifications, thus producing coefficients with different interpretations. Moreover, authors either do not report the corresponding elasticity values or adopt different definitions of elasticities. To make the outcomes of various studies comparable, we transformed the coefficients of each of the studies into a uniformly defined elasticity. Below, we discuss three choices for the elasticity, namely, the semi-elasticity (or tax rate elasticity), the ordinary elasticity and an alternative elasticity that is closely related to the elasticity of the after-tax rate of return.

Semi elasticities

We first look at the so-called tax rate elasticities or semi-elasticities. Their interpretation is easy: they measures the percentage change in FDI in response to a 1%-point change in the tax rate, e.g. a decline from 35% to 34%. Hence, the level of the tax rate is irrelevant for the size of the semi-elasticity. More formally, the semi-elasticity is defined as:

$$semi\text{-}elasticity \equiv \frac{\partial \ln FDI}{\partial t}$$

Table 3.1 Summary statistics of the studies in our meta sample

		Number of elasticities	Mean semi-elasticity	Median	Max	Min.	Std. Dev.	Number of significant elasticities	Mean significant semi-elasticity
1	Hartman, 1984	6	– 2.6	– 3.5	2.0	– 4.0	2.3	3	– 3.5
2	Bartik, 1985	3	– 6.9	– 6.6	– 5.7	– 8.5	1.4	3	– 6.9
3	Boskin&Gale, 1987	12	– 5.8	– 2.7	0.3	– 21.2	7.6	4	– 9.5
4	Newlon, 1987	2	– 0.4	– 0.4	3.5	– 4.3	5.5	1	– 4.3
5	Young, 1988	12	– 1.1	– 2.1	5.3	– 9.2	4.2	8	– 1.0
6	Murthy, 1989	4	– 0.6	– 0.7	0.5	– 1.6	1.0	2	– 1.4
7	Slemrod, 1990	58	– 5.5	– 3.5	17.8	– 84.5	14.4	24	– 9.5
8	Grubert&Mutti, 1991	6	– 1.7	– 1.6	– 0.6	– 3.3	1.2	3	– 0.7
9	Papke, 1991	2	– 4.9	– 4.9	– 0.9	– 8.8	5.6	1	– 8.8
10	Hines & Rice, 1994	4	– 10.7	– 5.0	– 1.2	– 31.7	14.1	2	– 5.0
11	Jun, 1994	10	– 0.5	– 1.3	5.9	– 5.4	3.2	1	5.9
12	Swenson, 1994	10	1.3	2.7	5.1	– 8.1	4.3	6	1.6
13	Devereux&Freeman, 1995	4	– 1.6	– 1.6	– 1.4	– 1.7	0.1	1	– 1.7
14	Hines, 1996	46	– 10.9	– 10.2	– 1.1	– 36.7	8.2	21	– 15.0
15	Pain&Young, 1996	6	– 1.5	– 1.4	– 0.4	– 2.8	1.2	3	– 2.6
16	Cassou, 1997	17	– 7.5	– 2.8	3.1	– 44.7	13.5	4	– 4.3
17	Shang-Jin Wei, 1997	5	– 5.2	– 5.0	– 4.7	– 6.2	0.6	5	– 5.2
18	Devereux&Griffith, 1998	10	– 0.8	– 0.9	0.0	– 1.2	0.4	8	– 0.9
19	Billington, 1999	2	– 0.1	– 0.1	– 0.1	– 0.1	0.0	2	– 0.1
20	Broekman&Vliet, 2000	3	– 3.3	– 3.5	– 2.5	– 4.0	0.8	3	– 3.3
21	Gorter&Parikh, 2000	15	– 4.6	– 4.6	4.3	– 14.3	4.3	10	– 5.7
22	Grubert&Mutti, 2000	15	– 4.0	– 4.2	– 1.7	– 5.8	1.2	14	– 4.1
23	Altshuler et al., 2001	20	– 2.7	– 2.6	– 1.4	– 4.0	0.8	13	– 3.0
24	Benassy et al., 2001	4	– 5.0	– 5.0	– 2.2	– 7.9	3.0	3	– 5.8
25	Swenson, 2001	95	– 4.0	– 3.2	8.0	– 29.9	8.4	34	– 9.3
		371	– 4.8	– 3.2	17.8	– 84.5	9.0	179	– 6.6

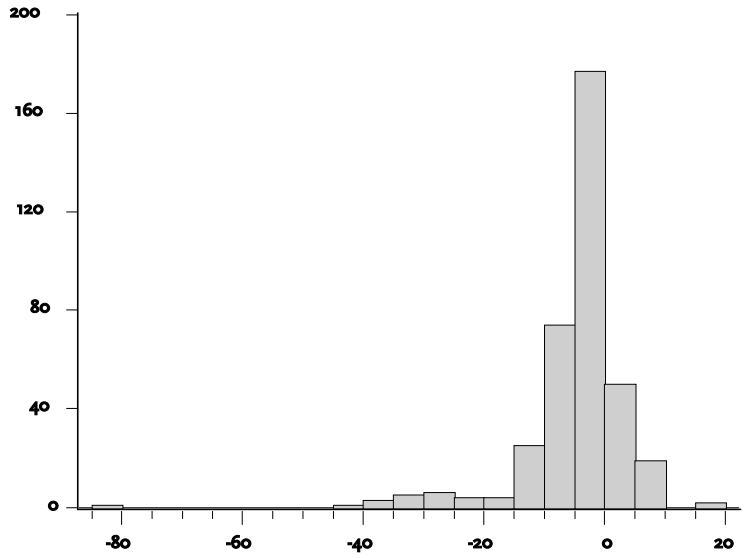
The procedure to derive semi-elasticities from each of the original studies is described in more detail in the appendix. Table 3.1 lists the 25 studies that we reported above and shows some characteristics of the semi-elasticities we obtained from them. Overall, we have obtained 371 semi-elasticities that, together, form our meta sample.[6] Table 3.1 reveals a great variation among the 25 studies. First of all, the number of semi-elasticities derived from each study differs: it ranges from 2 semi-elasticities (Newlon, Papke and Billington) to 95 (Swenson, 2001). Secondly, there is great variation in the mean value of the semi-elasticity, ranging from –10.9 (Hines) to +1.3 (Swenson, 1994). As shown by the maxima in table 3.1, ten of the 25 studies report at least one positive semi-elasticity. The majority of semi-elasticities, however, is negative. A third

[6] The sample can be downloaded from http://www.cpb.nl/eng/general/org/afdelingen/eca/taxcomp.html.

observation from table 3.1 involves the standard deviation of the reported semi-elasticities. In some studies, the elasticities feature a large dispersion with standard deviations exceeding 10 (Slemrod, Hines&Rice and Cassou), while others show more moderate dispersions. A final source of heterogeneity among the studies concerns the number of significant semi-elasticities. Overall, less than half of the semi-elasticities is significantly different from zero. However, whereas some studies report only significant parameters, others include a large number of insignificant ones. The mean value of the significant semi-elasticities is somewhat larger (in absolute terms) than of the entire sample.

The distribution of the entire meta sample of 371 semi-elasticities is depicted in figure 3.1. The mean value in the meta sample is −4.8 and the standard deviation equals 9. More than 80% of all observations (300 out of 371) has a negative sign. The most extreme observations have values of −84.5 and +17.8, both obtained from Slemrod's study. Because of some extreme values left from the mean, the median semi-elasticity in the sample is smaller than the mean, namely −3.2. The extreme values thus seem to have an important impact on the characteristics of the distribution of semi-elasticities.

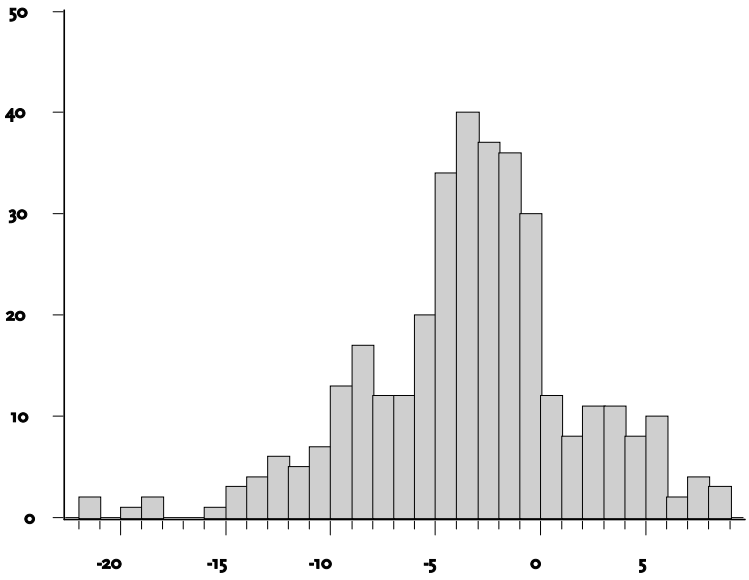
Figure 3.1 Distribution of semi-elasticities



In figure 3.2, we have eliminated some extreme values from the sample. In particular, the figure excludes semi-elasticities that are two standard deviations larger or smaller than the mean. Thus, it includes only semi-elasticities between −22.8 and +13.2. This comprises 95% of the observations, i.e. the sample size drops from 371 to 351. The mean value of the semi-elasticity in

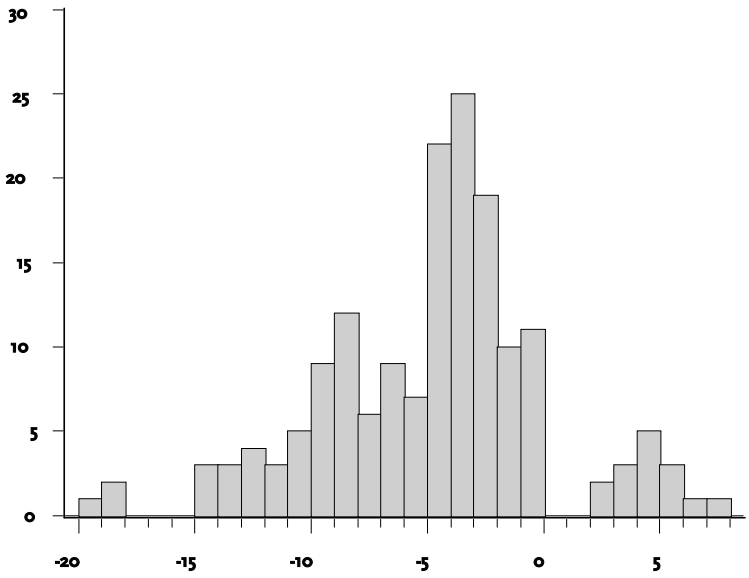
figure 3.2 is −3.3, i.e. more than 1.4 smaller in absolute terms than the mean value in figure 3.1. Also the median drops slightly. Apparently, the number of extreme negative semi-elasticities is larger than the number of extreme positive semi-elasticities. As we can see from figure 3.2, the majority of observations lies between −5 and 0.

Figure 3.2 Distribution of semi-elasticities, excluding extreme values



As observed from table 3.1, more than half of all semi-elasticities is not significantly different from zero at the 95% confidence level. Figure 3.3 shows the distribution if only the significant elasticities are considered. Here, we have also eliminated the extreme values, so that 166 observations remain. In figure 3.3, the mean value of the semi-elasticities is −4.8, which is more than 1.4 higher than the corresponding value in figure 3.2. By comparing figures 3.2 and 3.3, we see that all the small positive semi-elasticities are insignificant. The median of the significant semi-elasticities is −4.2 which is more than 1 percentage point larger in absolute terms than the corresponding value in figure 3.2.

Figure 3.3 Distribution of significant sem-elasticities, excluding extreme values



Elasticities

The semi-elasticity can be transformed into an ordinary elasticity by multiplying with the tax rate, i.e.

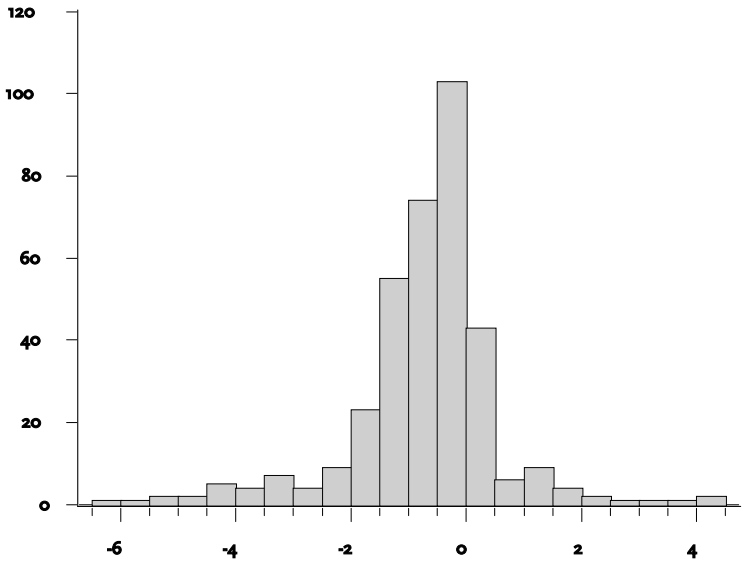
$$elasticity \equiv \frac{\partial \ln FDI}{\partial \ln t} = semi\text{-}elasticity \times t$$

The ordinary elasticity measures the FDI impact of a 1% change in the tax rate, rather than a 1%-point change (as the semi-elasticity does). For instance, it measures a reduction in the tax rate from 35% to 34.65%. Hence, the elasticity depends on the magnitude of the tax at which the marginal FDI impact is evaluated. We have used the tax rates adopted in each of the underlying studies (see the appendix) to compute these elasticities. The tax rates differ substantially across studies. This is because of different types of tax rates, different countries, and different time periods. In particular, some studies use statutory tax rates in US states with a mean value of 6%. Many others adopt country tax rates, usually some form of effective tax or average tax, with values between 20% and 50%. The mean value of the tax rates in our sample is 26.8%.

The distribution of the ordinary elasticities is reported in figure 3.4. Again, we have eliminated 5% of the elasticities, i.e. those that are more than two times the standard deviation larger or smaller than the mean. The mean of the tax elasticity of FDI is −0.7 while the median

is −0.5.[7] This is close the "consensus estimate" of −0.5 to −0.6, suggested by Hines (1997; 1999), which is based on casual observation.

Figure 3.4 Distribution of the tax elasticity, excluding extreme values



Elasticity of the after-tax return

A third class of elasticities presented in the literature is closely related to the elasticity of the after-tax rate of return to FDI. In particular, if one adopts a log specification, i.e. ln FDI = α ln[(1-t)r], and assumes a constant gross rate of return to FDI, r, then the marginal coefficient α directly measures the elasticity of FDI with respect to the after-tax rate of return. Formally, this elasticity reads as follows:

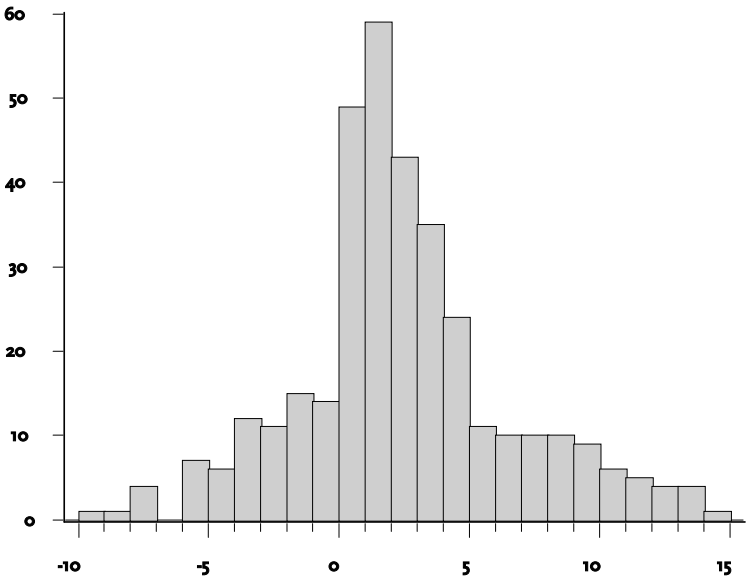
$$\textit{elasticity of the after-tax return} \equiv \frac{\partial \ln FDI}{\partial \ln (1-t)} = - \textit{semi-elasticity} \times (1 - t)$$

Figure 3.5 demonstrates the distribution of the elasticity of the after-tax rate of return, using the semi-elasticities and the tax rates of the underlying studies. The 5% most extreme values are eliminated from the sample. The mean elasticity is equal to 2.4 while the median is slightly smaller than 2. Compared to the consensus estimate of unity reported in the surveys by Hines, this is substantially larger. This is remarkable, especially since the tax elasticity in figure 3.4 corresponds very well to the consensus elasticity reported by Hines. Apparently, Hines uses a

[7] If also the extreme elasticities are included in the computation, we arrive at a mean elasticity of -1.1.

higher tax rate to translate the tax elasticity into an elasticity of the after-tax rate of return. Indeed, to arrive at an unit elasticity of the after-tax return, the tax rate should be slightly more than 40% if one starts from a tax elasticity of –0.7. With a tax rate of 26.8%, the tax elasticity of –0.7 corresponds to an elasticity of the after-tax return of about 2.

Figure 3.5 Distribution of the elasticity of the after-tax rate of return, excluding extreme values



4 Meta analysis of the tax-rate elasticities

This section presents a meta analysis of the semi-elasticities.[8] Meta analysis refers to the statistical analysis of results from individual studies. Next to summarizing results found by previous studies, it aims to add knowledge by relating the variation in estimates of elasticities to the underlying differences in study characteristics. In doing so, meta analysis goes beyond an ordinary survey of the literature. Moreover, the statistical analysis forces one to be explicit in the selection process of the original studies. This is not to say that meta analysis is without

[8] We choose for the semi-elasticities because their interpretation is most straightforward and independent of the tax rate. We have also run regressions with the ordinary elasticities. This gives us the same qualitative conclusions as the analysis of semi-elasticities.

problems. Especially, sample selection and publication bias, heterogeneity, and dependence of observations may cause problems.

First of all, an important methodological problem of meta analysis is the possibility of 'publication bias'. This occurs if only statistically significant results with the 'correct' size are being published. One reason might be that editors of journals prefer to publish these 'correct' results. In our sample, we included several unpublished studies. In this way, we gain some insight in the importance of this aspect of publication bias. It should be noted, however, that some of these papers may be published in a journal in the future. Another aspect of publication bias is that researchers do not write up their 'unsatisfactory' results. It is therefore impossible to include these results in the meta-analysis.[9] Incidentally, about half of the semi-elasticities in our sample are statistically insignificant at the five percent level.

A closely related concept is sample selection bias (or 'retrieval bias'). This occurs when only studies are collected that use the same theoretical perspective, or studies that are published in the same journal. This can be harmful when there is a systematic relationship between the characteristics of the sampling process and the significance of the effect size.

Heterogeneity is almost inherent to meta-analysis as studies differ in numerous dimensions. In particular, different studies use different variables, different samples, and different estimation techniques. In our meta sample, the estimated elasticities are obtained from 25 different studies, each with their own characteristics. Indeed, the studies show considerable heterogeneity in terms of the type of tax rate used, the kind of foreign capital data that is explored, and the countries that are considered. This heterogeneity renders a direct comparison of studies difficult. At the same time, however, the diversity in study characteristics makes it possible to examine their effect on the magnitude and significance of the elasticity.

Related to heterogeneity is the problem of dependence. Because multiple elasticities are used from each study, the observations in our meta sample are mutually dependent. For instance, we draw no less than 95 elasticities from the Swenson (2001) study. Bijmolt and Pieters (2001) show, however, that taking all elasticities from the underlying studies in a meta analysis is preferable to representing each study by a single value only.[10]

These problems of meta analysis imply that the results should be interpreted with caution. However, the same problems apply to ordinary literature surveys. As illustrated before, meta analysis may still yield additional insights as compared to surveys. Below, subsection 4.1 starts with a simple analysis of variation. Subsection 4.2 presents the meta regressions.

[9] Florax (2001) discusses several techniques to identify and remedy this type of publication bias.

[10] Bijmolt and Pieters (2001) also discuss different approaches to deal with multiple measurements and show that the optimal procedure explicitly deals with the nested error structure.

4.1 ANOVA type of study

This section performs an ANalysis Of VAriation (ANOVA) which refers to the pairwise correlations between the elasticities and their underlying study characteristics. This gives a first indication of how the variation in elasticities is correlated with the variation in, for instance, the specification in the original study, the data that are used, the estimation procedure, etc. The ANOVA does not yet justify firm conclusions on the systematic impact of these study characteristics on the elasticities, however. Indeed, this would require a multivariate analysis which is presented in section 4.2. The ANOVA is only a first step in analysing the variation in elasticities.[11]

We present the ANOVA results for a selection of study characteristics. These are presented in table 4.1. The second column of this table shows how many observations in our meta sample feature each of the study characteristics. For instance, the first three rows reveal that 40 observations in our meta sample relate to semi-elasticities for retained earnings, 42 refer to transfer of funds, and 269 refer to investments where the source of finance is not specified. Among the other study characteristics that are of interest in table 4.1, we see the distinction between tax credit and tax exemption countries, the type of foreign capital data used, and the type of tax rate used.

Table 4.1 also reveals the percentage of semi-elasticities per study characteristic that is significantly positive, insignificant, or significantly negative. The last row of table 4.1 shows that 4% of all semi-elasticities has an unexpected significantly positive sign, 53% is insignificant, and 43% has a significant and expected negative sign.

We observe from table 4.1 that semi-elasticities for transfer of funds are typically less significant when compared to other sources of finance. Likewise, the semi-elasticities for tax exemption countries are less often significantly negative (in 30% of the cases) than are the semi-elasticities for tax credit countries (54% of the cases) or unspecified semi-elasticities (48% of the cases). The 24 semi-elasticities for mergers and acquisitions (M&A) are typically positive or insignificant. The opposite holds true for the semi-elasticities for plants (comprising new plants and plant expansions). Compared to studies using FDI data, we observe from table 4.1 that studies using PPE data yield a higher percentage significant elasticities. Similarly, studies using micro ATR's, AETR's or country statutory tax rates yield relatively often a significant elasticity. The opposite holds true for studies using state statutory tax rates or macro ATR's. Somewhat surprisingly, published studies yield a smaller share of significant semi-elasticities than unpublished studies.

[11] In a sense, the ANOVA reflects what might be implicitly done in ordinary literature surveys. The advantage of the ANOVA is that it makes the procedure explicit and reproducable.

Studies with a linear specification (as compared to a log specification) and those using cross-section data (as opposed to time series or panel data) also feature a higher percentage significant semi-elasticities.

Table 4.1 Study characteristics and the sign of semi-elasticities

	Number of observations	Percentage of the semi-elasticities		
		significantly positive	insignificant	significantly negative
Source of finance				
Retained Earnings	40	3	55	43
Transfers	42	5	62	33
Finance unspecified	269	4	51	45
Taxation of foreign source income				
Exempt	137	2	68	30
Credit	116	2	44	54
System unspecified	98	10	42	48
Type of foreign capital data				
Number of Locations	116	5	62	33
Capital	235	4	48	48
PPE	84	6	39	55
Plants	43	0	65	35
M&A	24	21	71	8
FDI	151	3	53	44
Manufacturing	182	4	56	40
No specific industry	165	5	49	46
Type of tax data				
Country statutory rate	12	0	50	50
State statutory rate	134	4	64	31
Marginal effective tax rate	57	2	58	40
Average effective tax rate	9	0	11	89
Micro tax rate	80	8	31	61
Macro average tax rate	58	3	59	38
Home tax	34	3	62	35
Else	317	4	52	44
Other characteristics				
Unpublished	43	2	42	56
Published	308	5	54	41
Logarithmic	193	7	55	38
Linear	158	1	49	49
OLS	183	3	49	49
Cross section	96	0	41	59
Time series	102	3	58	39
Panel	153	8	57	35
All	351	4	53	43

Table 4.2 ANalysis Of VAriation

Semi-elasticity[a]	Benchmark sample		Including extremes		Significant	
Number of observations	351		371		166	
Source of finance						
Retained Earnings (unspecified)	0.14		3.15	**	0.08	
Transfers (unspecified)	– 1.40		– 2.54	*	– 0.52	
Taxation of foreign source income						
Exempt (unspecified)	2.16	**	5.21	**	4.96	**
Credit (unspecified)	0.56		0.81		0.92	
Type of foreign capital data						
Number of Locations (Capital)	– 1.08	*	– 1.00		– 0.01	
PPE (FDI)	2.65	**	2.41	**	0.80	
Plants (FDI)	3.67	**	4.20	**	3.83	**
M&A (FDI)	– 5.17	**	– 6.64	**	– 2.95	
Manufacturing (all)	1.56	**	1.35		1.86	**
Type of tax data						
State statutory rate (CSTR[b])	2.81	*	4.56	*	5.48	**
Marginal effective tax rate (CSTR [b])	1.08		3.60		4.14	**
Average effective tax rate (CSTR[b])	– 0.76		– 0.76		– 0.99	
Micro average tax rate (CSTR[b])	0.92		1.28		1.32	
Macro average tax rate (CSTR[b])	1.25		2.54		2.09	
Control for home tax (not controlled)	– 2.70	**	– 0.64		– 2.46	*
Other characteristics						
Unpublished (published)	– 0.13		– 1.73		– 0.26	
Logarithmic (linear)	– 1.88	**	– 2.43	**	– 2.02	**
OLS (other)	– 1.32	**	– 1.66	*	– 1.93	**
Cross section (panel)	2.92	**	3.30	**	0.98	
Time series (panel)	0.31		1.51		0.50	
Average sample year	0.05		0.02		0.02	

A * means that a variable is significant at the 10% confidence level; ** at the 5% level.
[a] All semi-elasticities are pre-multiplied by a minus sign
[b] CSTR = Country Statutory Tax Rate

For the various study characteristics introduced in table 4.1, table 4.2 reveals the ANOVA results. The correlations are presented relative to some benchmark set of study characteristics. These benchmark choices are given between brackets in each of the rows of table 4.2. We perform the ANOVA for three different samples. First, we look at the meta sample that excludes extreme values, i.e. semi-elasticities that lie outside the range of plus and minus two times the standard deviation from the mean. This so-called base sample contains 351 observations (first column of table 4.2). Second, we analyse the meta sample when these extreme observations are also included. This sample contains 371 observations (second column of table 4.2). Finally, we

restrict the benchmark sample to the 166 semi-elasticities that are significantly different from zero (third column of table 4.2).

For presentational convenience, we have put a minus sign for all semi-elasticities before doing the ANOVA analysis and the regression analysis. Thus, we transformed the majority of semi-elasticities into positive figures. In table 4.2, we indicate cross correlations that are statistically significant at the 5% (or 10%) level by a ** (or *).

Retained earnings, transfers and FDI

As discussed in section 2.1, statistical information on FDI comprises investments that are financed by retained earnings and transfer of funds. The majority of studies does not distinguish with respect to the source of finance (see table 4.1). However, the early literature pays due attention to the distinction between retained earnings and transfers. In particular, Hartman, Boskin&Gale, Young, Murthy and Newlon all suggest that retained earnings are more responsive to taxes than are transfers. The first two rows of table 4.2 reflects these findings in our ANOVA: it reveals that the semi-elasticity of retained earnings is 0.14 larger than that of unspecified semi-elasticities, while the semi-elasticity of transfers is 1.4 smaller. Both coefficients of the ANOVA are not statistically significant, however.

If we include the 20 extreme observations (second column of table 4.2), the differences become more pronounced and statistically significant: the semi-elasticity for retained earnings is 3.15 larger than that of unspecified semi-elasticities, while that of transfers is 2.54 smaller. Hence, the extreme observations tend to have a disproportionate impact on the correlation of semi-elasticities with the source of finance. If we restrict the sample to significant semi-elasticities alone (third column of table 4.2), the difference between retained earnings, transfers and unspecified samples almost disappears.

Exemption and credit systems

The next observation from table 4.2 refers to the distinction between tax credit systems and tax exemption systems. As argued in section 2.2, investors from tax exemption countries are more likely to respond to changes in host country taxes than investors from tax credit countries. Table 4.2 confirms this observation. The first column suggests that, compared to studies that do not specify the home country of the investor, semi-elasticities that refer to investors from tax exemption countries are 2.16 larger. This effect is statistically significant. For investors from tax credit countries, the semi-elasticity is 0.56 larger but not significant. If we include extreme observations in the sample (second column), or if we restrict the sample to significant parameters (third column), the difference in elasticities between exemption and credit countries becomes more pronounced. Hence, the ANOVA tends to support the hypothesis that investors from tax exemption countries are more responsive to taxes than are investors from tax credit

countries. However, the higher responsiveness of investors from tax credit countries as compared to unspecified investors (which comprises a mixture of credit and exempt investors) is not consistent with the theory.

The choice of foreign investment data

The total amount of foreign capital is equal to the number of foreign locations, multiplied by the average amount of capital invested in each of these locations. Table 4.2 shows that, compared to foreign capital data, data on the number of locations yield a semi-elasticity that is 1.08 smaller. This effect is significant at the 10% confidence level. This suggests that not only the number of foreign locations responds negatively to tax rates, but also the average amount of capital that is invested in each of these locations. If we restrict the sample to significant elasticities alone, however, the difference between foreign capital and the number of foreign locations disappears.

Compared to financial flow data for FDI, more narrow measures for foreign capital yield substantially different semi-elasticities. To illustrate, data on PPE yield a 2.65 higher elasticity, while plants feature a 3.67 higher semi-elasticity than FDI. Mergers and acquisitions, in contrast, features a 5.17 smaller semi-elasticity and thus gets a different sign. These results are robust with respect to the sample used.[12] They are also consistent with the theory. Indeed, section 2.2 concludes that mergers and acquisitions are unlikely to expand in response to lower host-country tax rates, while investment in plants and equipment is more likely to increase.

As was apparent from the discussion about the differences between Grubert&Mutti and Hines&Rice, restricting the sample to manufacturing firms is likely to yield smaller semi-elasticities. Table 4.2, however, suggests the opposite. Indeed, we find that data for manufacturing firms tend to yield larger instead of smaller semi-elasticities. Section 4.2 will explore whether this result carries over to our multivariate analysis.

The choice of tax data

Studies use different types of tax rates to measure the tax effect on FDI. In particular, most economists argue that country statutory tax rates are imperfect measures to determine the impact on investment behaviour by multinational firms. Effective or average tax rates are thought to be a better approximation of the tax burden on foreign investment. Table 4.2 reveals that the type of tax indeed matters for the semi-elasticities. In particular, studies using METR's or ATR's based on either micro or macro data, yield higher semi-elasticities than studies adopting the country statutory rates. The AETR's exert an opposite effect, however.

[12] Only the study by Swenson (2001) makes an explicit distinction between plants and mergers and acquisitions. The outcomes of our ANOVA thus reflect her findings.

We observe from table 4.2 that studies using state statutory tax rates in the US (Hines; Swenson, 2001) also yield larger elasticities. This may be because these rates are proportional to the METR as the tax base of US states is, to a large extent, uniformly determined at the federal level.

Hartman (1985) claims that home-country taxes have no impact on FDI, at least not for FDI financed by retained earnings. In contrast, Slemrod and Pain&Young, among others, have suggested that it could matter if a study includes the magnitude of the home-country tax rate in the analysis as a control variable. This is confirmed by table 4.2. Indeed, studies that include this variable report a semi-elasticity that is 2.7 smaller than studies that do not include it.

Other study characteristics

The lower part of table 4.2 reveals the cross correlation between some other study characteristics and the semi-elasticities. We see that unpublished studies yield smaller semi-elasticities than published ones. Also logarithmic specifications and estimations via OLS tend to yield relatively small semi-elasticities. Compared to studies using panel data, cross sections tend to yield an, on average, 2.92 higher semi-elasticity.

Has capital become more mobile during the 1980's, as has been suggested by Altshuler et al? We test this hypothesis by exploring the correlation of the median sample year in the underlying studies with the semi-elasticity. Table 4.2 suggests that studies using more recent data indeed yield higher elasticities (see the last row). The effect is not statistically significant, however.

A number of other study characteristics have been explored but not reported here.[13] Some of these results were difficult to interpret, possibly because they are correlated with other characteristics that are responsible for the different magnitude of the elasticities. This is a more general problem of the pairwise comparisons in the ANOVA. The multivariate analysis in the next section should take up these cross correlations and, therefore, provide a more rigorous insight into the causes of structural differences in the estimated semi-elasticities.

4.2 Meta regressions

This section presents the meta regressions. We have experimented with different combinations of study characteristics. In particular, table 4.3 shows the regression results for five different combinations of explanatory variables. The first column contains only the main variables of interest, i.e. those that have been discussed in the previous section. In the second column of table 4.3, we control for some additional study characteristics such as published/unpublished,

[13] The ANOVA can be found on our website, http://www.cpb.nl/eng/general/org/afdelingen/eca/taxcomp.html for a broader set of study characteristics.

log/linear specification, ols/other estimator, cross section/time series/panel data, stock/flow of FDI, and inward/outward FDI. In the third column, we include study-fixed effects, i.e. a dummy variable for each study from which we obtained more than 10 semi-elasticities. This may be seen as a modest attempt to deal with the dependency problem discussed above. The fourth column of table 4.3 includes dummy variables that reflect whether the underlying studies themselves control for variables like GDP, population size, agglomeration effects, exchange rates,

Table 4.3 Meta regressions for different combinations of study characteristics

	Base regression[a]	More characteristics[b]	Study fixed effects[c]	Control variables[d]	Country-fixed effects[e]
Retained Earnings	0.83	1.55	0.40	1.68	0.53
Transfers	– 0.95	0.00	– 0.84	0.30	– 1.26
Exempt	0.76	– 0.33	1.13	– 0.76	1.65 *
Credit	0.87	– 0.32	1.26 *	-0.37	1.46
Number of Locations	– 6.97 **	– 2.30	– 4.79 **	– 1.65	– 8.21 **
PPE	– 0.43	1.06	– 1.12	3.33 *	– 2.19
Plants	3.25 **	5.54 **	6.14 **	5.09 **	3.54 **
M&A	– 7.55 **	– 5.26 **	– 4.66 **	– 5.70 **	– 7.29 **
Manufacturing	0.06	0.04	– 0.54	1.23	– 1.54
State statutory rate	7.87 **	5.84 **	12.78 **	3.29	10.83 **
Marginal effective tax rate	3.08 **	4.95 **	4.02 **	3.92 **	3.64 **
Average effective tax rate	8.09 **	2.02	5.81 **	8.15 **	5.25 **
Micro tax rate	1.27 **	0.60	1.08	0.14	0.61
Macro average tax rate	2.64 **	4.31 **	3.19 **	3.40 **	2.61 *
Home tax	– 2.24 *	– 2.45 *	– 2.24 *	– 0.47	– 2.39 *
Average sample year	0.08	0.07	0.12	0.00	0.09 *

[a] Including a constant and a dummy for Belgium.
[b] As column 1 plus dummies for unpublished (published), log(linear), OLS(other), cross section/time series (panel), stock (flow) data, inward (outward) investment.
[c] As column 1 plus dummies for the studies of Swenson (2001), Slemrod, Hines, Altshuler et al., Cassou, Gorter&Parikh, Grubert&Mutti, Boskin&Gale, and Young.
[d] As column 1 plus dummies if the following control variables were included: tax on domestic investors, GDP, population, openness, agglomeration effects, unemployment, exchange rate, wages.
[e] As column 1 plus dummies for US, UK, Japan, France, Germany, Canada, Netherlands, Australia, Sweden, Italy, Switzerland, Denmark, Portugal and Finland.

unemployment and openness. The final column of table 4.3 shows the regression results if we include country-fixed effects, i.e. a dummy variable for each investing country if it could be identified from the underlying study. This controls for unobserved heterogeneity of investing countries, such as special features of their tax systems.[14]

[14] We control for Belgium as an investing country in all regressions. The reason is that Belgium is only distinguished separately in the Swenson (2001) study in which it yields a very high semi-elasticity.

Apart from different control variables, we have also varied with the sample in our regressions. In particular, table 4.4 shows the regressions with the main variables of interest in case of three samples. The first column of table 4.4 uses the sample of 351 observations, i.e. the sample that excludes the extreme values (this sample is also used in table 4.3). The second column includes the 20 extreme observations. The third column of table 4.4 is restricted to the 166 significant semi-elasticities.

Below, we discuss the regression results for each of the main variables of interest. By discussing the results for the different specifications and different samples, we immediately elaborate on the robustness of the results.

Table 4.4 Meta regressions with different samples

	Base regression		Include extremes		Only significant	
Retained Earnings	0.83		4.99		1.79	
Transfers	– 0.95		– 1.16		– 0.82	
Exempt	0.76		4.28	**	3.15	**
Credit	0.87		1.81		1.97	**
Number of Locations	– 6.97	**	– 4.32	*	– 3.59	
PPE	– 0.43		3.09		– 0.30	
Plants	3.25	**	2.71	**	1.47	
M&A	– 7.55	**	– 8.12	**	– 12.32	**
Manufacturing	0.06		– 1.64		0.17	
State statutory rate	7.87	**	6.94	**	7.43	**
Marginal effective tax rate	3.08	**	3.89	**	7.07	**
Average effective tax rate	8.09	**	3.27		4.14	
Micro tax rate	1.27	**	0.46		0.27	
Macro average tax rate	2.64	**	2.98		4.91	**
Home tax	– 2.24	*	0.88		– 2.21	
Average sample year	0.08		0.09		0.19	**

Retained earnings and transfers

Regarding the source of finance of FDI, all regressions reveal that the semi-elasticity for retained earnings is larger than semi-elasticities for unspecified data. For transfers, we usually report a negative coefficient. This reflects the findings by Hartman, Boskin&Gale, Newlon, Young and Murthy that retained earnings are more responsive to taxes than are transfer of funds.[15] However, the coefficients are never significant in our meta regressions.

[15] We have also run a regression with a sample that excludes these studies. In that case, we find results opposite from those reported in tables 4.3 and 4.4. In particular, retained earnings then yields a smaller semi-elasticity than transfers.

Given the qualifications by Newlon (1987) and Slemrod (1990), we should be careful to conclude that retained earnings are indeed more sensitive to taxes than are transfers (see section 3.1). Indeed, these authors point at a number of serious problems with the earlier studies that may cause misleading conclusions. For our meta analysis, it is nevertheless important to incorporate the distinction in the source of finance, since it controls for a special feature of the earlier studies.

Exemption and credit countries

From tables 4.3 and 4.4, we observe that the semi-elasticities for exemption systems or credit systems are neither systematically different from each other nor from unspecified systems. Only if we include the 20 extreme observations in the sample (second column of table 4.4) or if the sample is restricted to significant elasticities alone (third column of table 4.4), is the semi-elasticity in tax exemption countries higher than for tax credit countries and also higher than for unspecified investing countries. In these cases, however, we still find an unexpected positive coefficient for tax credit countries.

The majority of these results is thus not consistent with the theory, that suggests that investors from exemption countries are more responsive to taxes than are investors from tax credit countries. The regression results also provide weaker support for the distinction between exemption and credit countries than our ANOVA[16]. Actually, most of the regressions suggest no systematic difference between the two types of systems. The explanation for this result might be that credit systems are accompanied by excess foreign tax credits and tax deferral. Indeed, as Tanzi and Bovenberg (1990) have argued, these aspects of tax credit systems render them an effective source-based taxation of capital. This blurs the distinction between tax credit countries and tax exemption countries.

Choice of foreign investment data

In all cases, the semi-elasticity for the number of foreign locations is smaller than that of total foreign capital. Indeed, the coefficient in our regressions is significantly negative in the majority of cases. This suggests that both the number of foreign locations and the amount of foreign capital per location are negatively correlated with the tax rate.

Studies using data on plants yield a significantly higher semi-elasticity than others while data on mergers and acquisitions yield a significantly smaller one. This reflects the findings by Swenson (2001). In fact, her study is the only study in our sample that makes a distinction between plants and mergers&acquisitions. Her results are consistent with the theory: it suggests

[16] Part of this difference is resolved by the explicit inclusion of a dummy for Belgium in the regressions, that invariably yields a very high and significant estimated coefficient.

that investments in real capital are more responsive to host-country tax rates than are cross-border mergers and acquisitions.

We do not find strong evidence that studies using PPE data yield higher semi-elasticities than those using FDI. Indeed, regressions show both negative and positive signs for the PPE dummy, but the coefficient is typically insignificant. Note from table 4.1, however, that studies using PPE data do yield more significant results. Hence, although PPE may not have a systematic impact on the size of elasticities, it could affect the significance.

In contrast to our ANOVA, tables 4.3 and 4.4 suggest that manufacturing firms are not more responsive to taxes than are other firms. Indeed, some of the regressions suggest the opposite, i.e. that studies using only manufacturing data yield smaller elasticities than studies using all FDI data. The effect is never significant, however. It thus does not find strong support for the claim put forward by Altshuler et al., namely, that the Hines&Rice elasticity exceeds the Grubert&Mutti elasticity because the first study uses all FDI data whereas the latter concentrates on data for manufacturing firms. We also do not find evidence for the opposite, however, as the ANOVA did.

Choice of tax rates

Average tax rates (based on either micro data or macro data) and effective tax rates (marginal or average) exert a larger effect on foreign direct investment than country statutory rates do. Indeed, the coefficients for the former categories of tax rates are always positive and usually significant.

Especially METR's yield higher semi-elasticities. Indeed, its coefficient is significant at the 5% level in all regressions. Compared to the micro and macro ATR's, it seems to perform better in the sense that it exerts a bigger effect on the elasticities. The difference in coefficients for the METR and the ATR's is not statistically significant, however.

Important to note is that the AETR appears in the regression with a positive and mostly significant coefficient. This contrasts with the findings from the ANOVA. Hence, the pairwise comparisons tend to be misleading. In particular, the AETR is used only by the study of Devereux&Griffith. Their relatively small semi-elasticities are not due to the AETR, but because of other characteristics. For instance, the Devereux&Griffith study uses data on the number of locations which exerts a negative impact on the value of the semi-elasticity. By including the variation in other dimensions, the regressions in tables 4.3 and 4.4 suggest that the AETR yields a positive, rather than a negative, impact on the size of the semi-elasticity.

Timing

Regarding the timing, we find that studies using more recent data tend to yield higher elasticities. Indeed, the median year of the sample period exerts a positive effect on the value of

the semi-elasticity. This is consistent with the conclusion from Altshuler et al., which suggests that capital has become more responsive to taxes during the 1980's. Note that the coefficient for the median year of the sample period is not significant in the majority of cases, however.

5 Conclusions

Applying meta analysis to the tax rate elasticity of FDI has some pitfalls. First of all, the substantial heterogeneity among studies renders a direct comparison of elasticities problematic. For instance, it makes it difficult to specify the appropriate meta regressions that should identify study characteristics responsible for the variation in elasticities. Secondly, some observations in the meta sample are dependent because they originate from the same study. Indeed, a relatively small number of studies has a disproportional impact on the meta sample because some authors have (and others have not) decided to present a whole set of regression results. A third pitfall refers to publication bias. In particular, a number of elasticities might not have been reported by authors because they were either insignificant or of the unexpected sign.

These pitfalls qualify the results from our meta analysis. However, the same limitations apply to ordinary literature surveys as well. Moreover, compared to ordinary surveys, meta analysis contains an important value added in making the heterogeneity among studies more transparent, the selection process verifiable, and studies better comparable. Furthermore, the meta regressions provide a rigorous analysis in the variation of elasticities and the structural impact of various study characteristics. Thus, meta analysis teaches us more about the literature. In fact, whereas regression analysis in general can be seen as a method to better understand the underlying data, meta regressions can be seen as a method to better understand the existing literature, which comprises the data of the meta sample.

The paper reveals a number of insights from the empirical literature on company taxation and foreign direct investment. On average, we find that the tax rate elasticity of foreign capital is around −3.3. There is, however, substantial variation among studies. This can be partly explained by the underlying study characteristics. For instance, we find that studies using data on the number of foreign locations yield systematically smaller elasticities than those using data on foreign capital. The same holds true for data on mergers and acquisitions, as compared to aggregate FDI data. Data on new plants and plant expansions, however, yield systematically higher elasticities than FDI data. Studies using data on property, plant and equipment do not systematically report higher or lower elasticities than studies using FDI data, although the elasticities for the former studies are typically more often significant.

Also the choice of the tax data seems to matter for the variation in elasticities. In particular, studies using effective tax rates or average tax rates yield larger elasticities than studies adopting country statutory tax rates. The effective tax rates based on tax codes (marginal and average) tend

to yield relatively high elasticities as compared to average tax rates based on micro data or macro data.

Another important finding is that the distinction between investments from tax credit countries and tax exemption countries is irrelevant for the size of the elasticities. This is consistent with the claim that excess foreign tax credits and tax deferral blur the distinction between exemption systems and credit systems.

For future research, our findings suggest that controlling for the home country tax rate in regressions matters for the value of the tax rate elasticity. Regarding the specification, we find that studies using a linear specification find systematically larger elasticities than studies using a log specification. Also studies using cross section data report systematically higher elasticities than others. Finally, our meta regressions suggest that the unpublished status of a paper exerts a positive effect on the elasticity values, as compared to the published status.

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Appendix: Deriving comparable elasticities

Empirical studies on the effect of taxation on FDI generally report different types of coefficients. These have to be transformed into elasticities. However, the definition of elasticities also differs among studies. Indeed, one can distinguish the following alternatives:

$\epsilon = dlnK/dlnt$, the tax elasticity
$\epsilon_s = dlnK/dt$, the tax-rate elasticity or semi-elasticity
$\epsilon_a = -dlnK/dt * (1-t)$, the elasticity of the after-tax rate of return

In these expressions, K denotes a measure for foreign capital and t stands for the tax on K in the foreign country. As can be derived from the above definitions, the three alternative elasticities are related to each other in the following way:

(1) $\epsilon_s = \epsilon/t = \epsilon_a/(1-t)$

Expression (1) suggests that, once we know the value of either elasticity and the mean value of the tax rate, we can derive all three forms of elasticities. This is important to be able to compare different studies and to perform our meta analysis.

Transforming marginal coefficients into elasticities often requires additional information on the mean value of the dependent and/or independent variables. If possible, we take these mean values from the respective studies. If they are not reported, we take them either from other studies or from external data sources. The data sources of these variables are reported below.

The remainder of this appendix discusses how we derived elasticities from the various specifications used in the literature. Thereby, we use the following notation.

K = measure for foreign capital, usually FDI, PPE or the number of locations
Y = GDP or GNP
E = foreign investors'earnings in the host country
r (r') = gross rate of return to foreign (domestic) investors in the host country
t (t') = measure for the average tax on foreign (domestic) investors, i.e. the corporate tax (plus personal tax)
c = user cost of capital

We will now describe the various specifications and the corresponding derivations of elasticities.

(2) **Hartman (1984)** $ln(K/Y) = a_0 + a_1 ln[r(1-t)] + a_2 ln[r'(1-t)] + a_3 ln[(1-t')/(1-t)]$

$\epsilon_a = [a_1 + a_2 + a_3 (t'-t)/(1-t')]$

Specification (2) is also used by Boskin and Gale (1987), Newlon (1987), Young (1988) and Murthy (1989). The mean values for *t* and *t'* are taken from the data reported in Hartman (1984) for the period 1965-1979. For the other studies, we take the mean values reported by Young, who reports data for the period 1953-1984.

Note (1): In deriving the tax elasticities from the Hartman equation, we have assumed that *dt* = *dt'*, i.e. the change in the tax on domestic and foreign investors is equivalent. This is because *t'* ≡ *t* + personal taxes on domestic savers. Hence, it does not seem plausible for the US government to raise *t* while keeping *t'* constant: then it would have to change two tax rates. However, in computing the elasticity ϵ, Young (1988) explores a change in the tax rate *t* alone. Likewise, the elasticities reported in Table 5A.11 in the Ruding Report are derived under the same implausible assumption. By looking at changes in the corporate rate for domestic and foreign investors alike, our approach makes the comparison with other studies also easier.

Note (2): When Hartman uses *ln(K/E)* instead of *ln(K/Y)*, we assume that *E* is entirely subject to corporate tax. Hence, we substract an extra *[1/(1-t)]* from the right-hand side variable to compute the elasticities from this expression.

Note (3): To correct for a negative transfer of funds, Hartman (1984) adds a constant of 1.676 to all observations for *K/Y* before taking logarithms. This implies that we should premultiply the elasticities with [1+ 1.676/(*K/Y*)] to obtain the correct elasticity (see also Slemrod (1990), endnote 8). However, in re-estimating Hartman's result, we discovered that he adds 1,676 billion to the transfer of funds before transforming, rather than a constant to the *K/Y* ratio. Therefore, the Hartman elasticity is computed slightly different, namely 1+1,676/*K*. This was correctly noticed by Boskin and Gale (1987). For estimations on retained earnings, Boskin&Gale do add a constant of 3.88 to *K/Y*.

When we re-estimated Young's (1988) results, we discovered that he also adds 1,676 billion to the transfer of funds, similar to Hartman. However, in contrast to Boskin&Gale, he adds 3,880 to retained earnings before taking logs. Hence, the results of Young are not directly comparable to those of Boskin&Gale.

The computation of elasticities in Table 5A.11 of the Ruding report have assumed that all studies have added a constant to the *K/Y* ratio, in contrast what has been done by some of the studies. Hence, the table does not report the correct elasticities. Newlon (1987), Slemrod (1990) and Cassou (1997) seem to consistently add a constant to the *K/Y* ratio.

Note (4): Young (1988) analyzes the log-specification of Hartman and includes a lag for *K* as an independent variable. To compute the long-run elasticity, we have to divide the elasticity by (1-a_4), where a_4 is the coefficient for the lagged *K*. This procedure is also followed by Pain and Young (1996).

(3) **Boskin and Gale (1987)** $K/Y = a_0 + a_1 [r(1-t)] + a_2 [r'(1-t)] + a_3 [(1-t')/(1-t)]$

$\epsilon_s = - Y/K [r\, a_1 + r' a_2 + a_3 (t'-t)/(1-t)^2]$

The mean values for *Y/K, r, r', t'*,and *t* are taken from Young (1988).

(4) **Slemrod (1990)** $ln(K/Y) = a\, ln\, t$

$\epsilon = a$

This specification is used (sometimes in the form *ln K* rather than *ln K/Y)* by Swenson (1994), Pain and Young (1996), Cassou (1997) and Shang-Jin Wei (1997). The marginal effective tax rates in Slemrod (1990) are taken from Hines and Auerbach (1988) as referred to in Slemrod's paper. Swenson (1994) and Pain and Young (1996) report the tax rates in their studies from which we derived the mean values. The tax rate in Shang-Jin Wei is obtained from Desai and Hines (1996).

Note 1: We only use four elasticities from Shang-Jin Wei (1997) as we were unable to determine the correct elasticity values from most of his reported coefficients.

Note 2: We were unable to derive elasticities from Table 6 in Swenson (1994) because the specification of the estimated equation is not clear.

(5) **Slemrod (1990)** $K/Y = a\, t$

$\epsilon_s = a\, .\, Y/K$

In his NBER discussion paper, Slemrod (1990) reports the mean values of the dependent variable *Y/K*. Broekman and Van Vliet (2000) use the same specification. They also report the *Y/K* values in their study, as well as the tax rates.

(6) **Grubert and Mutti (1991)** $ln\ K = a\ ln\ (1\text{-}t)$

$\epsilon_a = -a$

This is also used by Grubert and Mutti (2000) and Altshuler, Grubert and Newlon (2001). The tax rate for Grubert and Mutti (1991) is taken from the reported tax rates in Hines and Rice (1994), where we take the average rate for 15 EU countries as the mean. For the studies of Grubert and Mutti (2000) and Altshuler et al. (2001), we also take the EU mean reported in the studies.

Note: Grubert and Mutti (2000) and Altshuler, Grubert and Newlon (2001) include a variable *trade . ln (1-t)*, where *trade* is a discrete variable between 1 and 4 related to the openness of an economy. For EU countries, the value of *trade* is zero. We evaluate the elasticity for EU countries and thus assume a zero value for *trade*.

(7) **Grubert and Mutti (1991)** $ln\ K = a\ .\ 1/t$

$\epsilon_s = -a\ /\ t^2$

(8) **Hines and Rice (1994)** $ln\ K = a\ t + b\ t^2$

$\epsilon_s = \mathbf{a + 2\ b\ t}$

Billington (1999) also uses this specification with a = 0. The mean value of the tax rate in Hines and Rice (1994) is taken from the elasticities reported in that study. For Billington, we made an educated guess on the basis of figure 1 in his article.

(9) **Devereux and Freeman (1995)** $K/Y = a\ .\ c$

$\epsilon_s = Y/K\ .\ a\ .\ c/(1\text{-}t)$

where we use the fact that $t = (c\text{-}r)/c$. The mean values of the cost of capital and the marginal effective tax rate are taken from Devereux and Pearson (1995). The mean value of Y/K is derived from the OECD data base on foreign direct investment for the corresponding years.

(10) **Hines, 1996** $K_i/K = a\, s_i\, t$

$\epsilon_s = a$

where K_i/K denotes the share of investment into location i as a share of total foreign investment and s_i the population share of location i in the total. This expression is also used by Gorter and Parikh (2000). The mean tax rate is reported in the studies of Hines and Gorter and Parikh.

Note: In a personal correspondence with Hines, we learned that he imposes the condition of a zero tax rate for credit countries. This is not consistent with his idea of a zero response by tax credit countries, which would require a zero coefficient for the US state's statutory tax rates. Gorter and Parkikh (2000) have followed this latter procedure.

(11) **Bartik (1985)** $ln\ P(location) = a\ (1\text{-}t)$

$\epsilon = a\ (1\text{-}P)$

where P stands for the probabilty and the mean values of P and t are given in Table 1 of Bartik.

(12) **Papke (1991)** $ln\ P(location) = a\ .\ t$

$\epsilon_s = a$

Which is similar to Swenson (2001). Papke (1991) reports the values of the taxes for various industries, but we only include two average elasticities in our sample. In particular, the industry-specific elasticities from Papke are not used. From the computations of elasticities by Swenson (2001) in table 6 of her study, we were able to determine the mean value of taxes used. From Swenson, we do not include the elasticities for joint ventures, equity increases and other capital.

(13) **Devereux and Griffith (1998b)** $Odds\ ratio = a\ .\ t$

$\epsilon_s = a\ .\ P(1\text{-}P)$

see footnote 24 in Devereux and Griffith (1998b). From the computation of elasticities in that paper, we could determine the mean value of P. The average effective tax rate in Devereux and Griffith is taken from Chennells and Griffith (1997) as mentioned in the paper.