CORPORATE TAX ELASTICITIES
A READER'S GUIDE TO EMPIRICAL FINDINGS

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Abstract

Corporate taxes exert a variety of effects on business behaviour. A wealth of empirical evidence assesses the magnitude of these behavioural margins of taxation. This article offers an up-to-date review and aims to provide common ground by computing for each distortion the semi-elasticity of the corporate tax base. We pay particular attention to international investment where it is not a priory clear whether marginal investment decisions or discrete locations are most important. Using an extension of the meta analysis of De Mooij and Ederveen (2003), we explore the extent to which existing studies reveal differences in effect size between the intensive and extensive margins of international investment.

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1 INTRODUCTION

Corporate taxes influence business behaviour in several ways. For instance, firms exploit tax arbitrage opportunities between legal forms; they switch between debt and equity finance or reduce investment in response to tax; and multinationals can choose to allocate their income in foreign affiliates or modify their location decisions. On the quantitative importance of each of these behavioural margins of taxation is a wealth of empirical evidence. There is, however, little common ground for comparing the size of different distortions. This article offers an up-to-date review of empirical studies on various decision margins and compares them by computing the impact of different margins on a nations' corporate tax base.

We pay special attention to international investment choices. Theory is ambiguous on whether international investment is driven primarily by the company tax burden at the margin of new investment or by the average tax burden on company profits, which applies to e.g. discrete location choice. We extend the meta data base of De Mooij and Ederveen (2003) and perform meta regressions to assess the differential tax effect at the intensive and extensive investment margins.

Quantitative insight in the size of various tax margins is important for normative questions regarding the optimal design of corporate tax systems. For instance, to minimise distortions in organisational form, the government should reduce tax differences between corporate and non-corporate firms. Large debt-equity distortions provide an argument for a neutral tax treatment of interest and dividend. If marginal investment distortions are substantial, then a tax system that minimizes the effective marginal tax rate is more desirable, which typically calls for a narrow base and a high rate. However, if profit shifting and discrete location choices are relatively important, policies that reduce statutory tax rates are likely to be more efficient. Knowledge about the magnitude of different tax margins may also help to answer positive questions. For instance, it may explain recent developments in corporate tax systems in the OECD.

This article starts in section 2 by explaining the idea of tax base elasticities. It then assesses these elasticities at four decision margins. Section 3 analyses international investments in more detail by performing a meta analysis. Section 4 presents our final assessment.

2 CORPORATE TAX ELASTICITIES

The revenue implications of corporate tax changes can be illustrated by the Laffer curve. Clausing (2007) estimates Laffer curves for corporate taxes in a group of OECD countries and finds that the top is achieved at a rate of 33%. This result can be rephrased in terms of the semi-elasticity of the corporate tax base, which measures the percentage change in the corporate tax base in response to a 1%-point change in the tax rate. If we denote B_j as the jth component of the

corporate tax base and τ_j as the corporate tax rate applicable to that base, then total corporate tax revenue equals:

$$T = \sum_j \tau_j B_j \qquad (1)$$

Totally differentiating with respect to the tax rate yields for the change in corporate tax revenue:

$$dT = \sum_j [1 + \tau_j \varepsilon_j] B_j d\tau_j \qquad (2)$$

where ε_j denotes the semi-elasticity of the corporate tax base, defined as $\varepsilon_j = (\partial B_j / \partial \tau_j) / B_j$. If the top of the Laffer curve ($dT = 0$) is obtained when $\tau = 0.33$, expression (2) suggests that the semi-elasticity of the tax base is -3. Hence, a 1%-point increase in the corporate tax rate would reduce the corporate tax base by 3%. This effect may run via several behavioural responses. The analysis in this paper tries to assess which margins are quantitatively most important. In particular, we split the aggregate semi-elasticity of the tax base in (2) into five different parts:

$$\varepsilon = \varepsilon^{OF} + w^N \varepsilon^{DE} + w^M \varepsilon^{PS} + w^N \varepsilon^{INV} + w^F \varepsilon^{LOC} \qquad (3)$$

where the semi-elasticities refer to, respectively, the choice of organisational form (ε^{OF}), the response in the debt-equity ratio (ε^{DE}), multinational profit shifting (ε^{PS}), the investment distortion (ε^{INV}) and the inframarginal effect on location choices (ε^{LOC}). The last four semi-elasticities are pre-multiplied by shares because the behavioural response refers to a part of the corporate tax base. The variables w^N, w^M, and w^F stand for, respectively, the share of normal return on equity in the total corporate tax base (which comprises also economic rents), the share of profits made by multinationals, and the share of assets owned by foreigners. Our aim is to collect information about the ε's from existing empirical literature and combine this with information about the various shares. Thus, we disentangle the aggregate tax base elasticity into five components.

For each decision margin in (3), this section provides a short review of recent empirical studies, sometimes by referring to and extending earlier literature reviews. Moreover, we pay attention to the shares w^N, w^M and w^F. Note that the approach of partial tax base elasticities does neither justice to specific circumstances in practice e.g. in certain countries, sectors or times, nor does it take away uncertainty about effect sizes. Moreover, it only captures partial effects, not (general equilibrium) interactions. The purpose is to translate insights from empirical studies into policy-relevant indicators measuring the size of distortions induced by corporate taxation.

2.1 Legal form

In most countries, incomes earned in sole proprietorships are subject to personal income tax. Incomes earned in (closely or widely held) corporations are first subject to corporate income tax and are then possibly taxed again at the personal level via taxes on profit distributions or realized capital gains (whereby sometimes double-tax relief is applied). The different tax treatment of corporate versus non-corporate income creates arbitrage opportunities. Indeed, if corporate income would be taxed lighter than non-corporate income, people would have an incentive to become entrepreneur, while entrepreneurs would have an incentive to incorporate so as to reduce their tax liability.

Yet, decisions on legal form of business are not only made on the basis of tax. For instance, some businesses organized in the corporate form may collect substantial non-tax benefits, such as gains from limited liability or the advantage of attracting capital. Others may incur costs from incorporation, e.g. due to capital requirements or legal obligations. Non-tax costs and benefits should therefore be weighed against the net tax advantage of corporate versus non-corporate income. Empirical evidence should guide us on how large the effects of taxation are.

A modest literature has explored the impact of taxes on the choice of legal form. Most of these studies use statutory corporate tax and top personal income tax rates as proxies for the tax burden on corporate and non-corporate income. Earlier studies reviewed in e.g. De Mooij and Nicodeme (2008), find that the effects of taxation are small, suggesting that non-tax factors are more important in determining legal form. Most of these studies use time series variation to identify the impact of tax. Goolsbee (2004) criticizes this approach as the variation in tax rates over time is small, making it difficult to properly identify tax effects. Goolsbee (2004) then uses cross-section data for US States and industries in the retail trade sector in 1992. He explores the impact of taxes on several indicators of the size of the corporate sector, including the share of companies, employment and sales. His estimates suggest a larger semi-elasticity of the corporate tax base with respect to the corporate tax rate than earlier studies: $\varepsilon^{OF} = -0.4$. De Mooij and Nicodeme (2008) use a panel of European data on the corporate share of companies and the corporate share of employment in different European countries between 1997 and 2003. In different specifications and for different indicators, they report a semi-elasticity of around -1.0. As a best-guess, we take an average of the results of Goolsbee and De Mooij and Nicodeme: $\varepsilon^{OF} = -0.7$. It implies that a 10%-point higher tax rate on corporations would ceteris paribus reduce the corporate share of business, and therefore the corporate tax base, by 7%.

2.2 Financial structure

While interest on debt is deductible from the corporate tax base as a cost, the return on equity is generally not. As a result, debt is almost everywhere tax favoured relative to equity. It induces

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firms to increase their leverage, thereby causing an erosion of the corporate tax base and a distortion in asset portfolios. Recent financial innovations − such as the arrival of hybrid financial products − seem to have increased this financial arbitrage.

The question is how large the impact of corporate taxation is on a firms' financial policy. On the one hand, the optimal source of finance generally depends on various non-tax factors, such as the risk of bankruptcy in case of the high debt ratio, or the importance of financial distress or agency costs. Moreover, thin capitalization rules may put limitations on the use of debt finance. On the other hand, taxes may create a substantial advantage of debt over equity, thereby affecting a firms' financial policy.

A number of studies aim to identify the impact of taxation on the financial leverage of firms. Graham (2003) reviews several studies. He concludes that most studies using time series data report small tax effects. A problem of these studies is, however, that identification is difficult in light of the small variation in tax rates over time. More recent studies using cross-section variation between companies typically report larger effects. For instance, Gordon and Lee (2001) exploit the variation in statutory tax rates between small and large companies in the US and find that a 1%-point increase in the corporate tax rate raises the debt/asset ratio at the margin by 0.36%-point, i.e. $\varepsilon^{DE} = -0.36$.

Thin capitalization also matters for financial structures within multinational firms. Headquarters investing in subsidiaries abroad can choose between debt and equity finance and the tax burden affects this choice of finance. When financed by debt, the interest is deductible for the subsidiary in the host country and taxed in the home country of the parent. When financed by equity, the dividend of the subsidiary is taxed at the rate of the host country and repatriated dividends are usually untaxed in the country of the parent (if that country uses an exemption system which is the case in continental Europe). To minimize the tax liability, a parent company will therefore prefer debt finance for subsidiaries located in high-tax countries and equity finance for subsidiaries in low-tax countries. Recent empirical studies explore the impact of taxation on the financial policies of multinationals, thereby using cross-country variation in tax rates. Altshuler and Grubert (2003) use data on foreign affiliates of US multinationals and estimate $\varepsilon^{DE} = -0.4$. Desai et al. (2003) arrive at $\varepsilon^{DE} = -0.25$. Huizinga et al. (2006) disentangle the domestic leverage effect and the international debt shifting effect and report semi-elasticities of 0.18 and 0.12, respectively. This would mean an overall value of $\varepsilon^{DE} = -0.3$. We consider -0.3 as the consensus estimate for the financial decision margin. It means that, if a corporate tax rate is 33%, removing discrimination would reduce the debt/asset ratio by 10%-point. The debt-equity response only matters for the normal return to capital, not for economic rents. We have no information, however, about the appropriate shares of normal returns and economic profits, i.e. of w^N. By assuming a share of one half for the normal return, we obtain for the relevance of the financial distortion that $w^N \varepsilon^{DE} = -0.15$.

2.3   Profit shifting

Across countries, taxable income of a multinational is divided among its affiliates on the basis of separate accounting. It means that the accounts of each affiliate terminate at the border (*the water's edge*) and that profits within these borders are taxed according to the rules and the rate of the country where the subsidiary resides. This allocation of profits on the source basis is often arbitrary, however. For instance, where should the multinational allocate shared costs and returns? And how should it value intrafirm deliveries or services? Due to this arbitrariness, multinationals have opportunities to manipulate this allocation and reduce the overall tax liability of the company. Separate accounting indeed allows for international tax arbitrage, which erodes the base of a nation's corporate tax.

   One important route for shifting multinational profits is the manipulation of transfer prices. Following the OECD Transfer Pricing Guidelines, transactions between entities of a multinational company in different countries should be traded on the basis of arms-length prices, i.e. prices that would apply to market transactions between unrelated parties. For a number of goods and services, however, there is no outside market. The uniqueness of many intangibles, such as brand names and intellectual property rights, makes it impossible to determine arms-length prices. It leaves the freedom for multinationals to determine their own prices on a discretionary basis. By charging an artificially low price for goods that are transferred from high-tax to low-tax countries, a multinational can reduce its overall tax liability.

   There is a rapidly growing literature showing that international profit shifting is an important phenomenon with big implications for government revenues. The character of these studies is diverse, however, which makes it difficult to infer a comparable indicator of the effect size. For the purpose in this paper, we rely on a handful of studies estimating the impact of statutory tax rate differentials on measures of profitability. The results of these studies are usually interpreted as indirect evidence of profit shifting. De Mooij (2005) summarizes these studies and reports that, on average, studies yield a semi-elasticity of $\varepsilon^{PS} = -2$. This semi-elasticity should be pre-multiplied by the share of multinational firms to which the reported elasticities apply. Using information from the ORBIS database, we find that this share (although it differs substantially across countries) is around 60% on average in Europe. Thus, the strength of the impact of profit shifting on the corporate tax base would be: $w^M \varepsilon^{PS} = -1.2$.

2.4   Investment

Neo-classical theory suggests that investment is driven by the Jorgenson concept of the cost of capital. The idea is that firms accumulate capital as long as the return to investment exceeds the cost of finance and depreciation. Due to decreasing returns to scale, there is a marginal project

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that just breaks even, i.e. which earns a return that precisely matches the costs. In the presence of taxation, the pre-tax rate of return on the marginal investment project is defined as the cost of capital.

To determine the effect of corporate taxes on investment, we need to asses: (i) the impact of the corporate tax on the cost of capital and (ii) the impact of the cost of capital on investment. The first effect depends on the corporate tax system. For instance, the more generous tax depreciation allowances or investment tax credits are, the smaller is the impact of taxes on the cost of capital. This impact is reflected by the effective marginal tax rate (EMTR), which is defined as the difference in the cost of capital in the presence and in the absence of tax, in percentage of the pre-tax cost of capital. On the second effect, there are two strands of empirical literature. One directly estimates the elasticity of the cost of capital on investment. Hassett and Hubbard (2002) review this literature and conclude that an elasticity between $-\frac{1}{2}$ and -1.0 is a good reflection of it. Alternatively, one can divide the substitution elasticity between labour and capital by the labour income share in production to infer the investment elasticity of the cost of capital indirectly. Chirinko (2002) provides a careful assessment of this empirical literature and concludes that a value between 0.4 and 0.7 is most plausible for the substitution elasticity. Assuming a labour income share of 80%, we again obtain an elasticity of investment to the cost of capital between $-\frac{1}{2}$ and -1.

From the definition of the EMTR, we can derive for the semi-elasticity of investment (I):

$$\Delta Log(I) = \alpha \Delta Log(c) = \frac{\alpha}{1 - EMTR} \Delta EMTR \tag{4}$$

where α stands for the investment elasticity of the cost of capital (i.e. the value between $-\frac{1}{2}$ and -1). A number of studies have computed EMTRs using information from tax codes. They usually report positive values for equity-financed investment but negative values for debt-financed investment (which is due to the deductibility of nominal interest). The weighted average of the EMTRs is usually reported to be positive. Its value is generally small, however. For an EMTR of say 10%, the semi-elasticity of investment to the EMTR, i.e. ε^{INV}, lies in the range of -0.55 to -1.1. As a best-guess, we take the average: $\varepsilon^{INV} = -0.8$. To determine the strength of the investment response for the aggregate corporate tax base elasticity, we pre-multiply this semi-elasticity with the share of normal returns in the corporate tax base. Taking $w^N = 0.5$ and assuming that these returns are taxed (i.e. that they are financed by equity), we obtain $w^N \varepsilon^{INV} = -0.4$.

Foreign investment

A share of total investment comes from abroad and is denoted as foreign investment. There are some special features of foreign capital flows that justify a separate analysis. As there is a large

literature on the specific impact of taxation on foreign capital flows, we can also infer from this to what extent the impact on total investment is determined by foreign capital flows.

There are two alternative views on how corporate tax policies affect cross-border investment. The first view is the neoclassical approach, which follows the same logic as above. Assuming that capital is mobile across countries, investors will seek the most profitable investment opportunities across the globe. This ultimately equalizes the after-tax rates of return in all locations. The relevant tax for investors in deciding about the size of their foreign direct investment (FDI) is then the EMTR. It applies to, for instance, multinationals that have already established foreign subsidiaries and who decide on how much to invest in each of these locations.

The second view considers discrete location choices. It may apply to investments that are lumpy. Alternatively, it can be relevant for multinationals that earn a firm-specific economic rent. For instance, (quasi) rents associated with patents, brand names, know-how or market power, are typically mobile across borders. A firm earning such a rent can decide on the location of its plant based on the total tax bill. For this decision, the average effective tax rate (EATR) on corporate income matters, not the EMTR. Indeed, the higher is the tax burden on the income earned in a location, the lower is the probability that a firm will locate its plant.

These alternative theories are not necessarily conflicting. Indeed, firms may first decide on the location of their plants and then, conditional on location, determine the amount of investment. For the first choice, the EATR matters; for the second choice the EMTR matters. It leaves open the question what we can say about the most relevant decision margin. How sensitive are the intensive and extensive investment margins to corporate tax? Which part of the corporate tax system (and, therefore, which indicator of tax) induces the largest behavioural effects? Empirical evidence should guide us to the most likely answers. We discuss this in the next section.

3   A META ANALYSIS OF FOREIGN INVESTMENT ELASTICITIES

There is a large empirical literature exploring the impact of corporate taxes on international capital flows. The typical study regresses a measure of the company tax burden on a measure of foreign capital flows or stocks, thereby controlling for other factors affecting investment. Surveys by Hines (1999), Devereux and Griffith (2002) and De Mooij and Ederveen (2003) conclude that according to this literature, company taxes have a significant effect on foreign investment.

The literature is heterogeneous in a number of respects. First, studies adopt alternative measures of capital: some use aggregate data on FDI (time series, cross section and panels), others rely on measures for property, plant and equipment (mainly US investment abroad), and

again others adopt count data on the number of foreign locations. Second, studies use different measures of the tax burden: some use statutory corporate tax rates (sometimes for US states on inward investment), others rely on the EMTR, the EATR, or average tax burdens computed from micro or macro data. Finally, studies differ in their way of identifying the tax effect on investment. For instance, some consider the tax regime in the country where the parent company resides (credit or exemption), some studies differ in the control variables they use, and researchers use different theoretical specifications and econometric methodologies.

This section uses a previously constructed meta sample on the semi-elasticity of foreign investment (De Mooij and Ederveen, 2003) to assess the most relevant decision margin for international firms, i.e. marginal investment versus discrete location. We extend the previous analysis in two directions. First, we add six recent studies to the sample. Second, we concentrate on a particular classification of studies regarding the use of capital data and the use of tax indicators. In particular, the focus is on the difference in effect size for location choice versus marginal investment choice. Since meta analysis is not common in economics, we first briefly review the pros and cons of this methodology.

3.1   Meta analysis

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

Virtues of a meta analysis

Although meta analysis has been developed for sciences with an experimental setting, the methodology can be also employed in economics (see Florax et al. (2002) for a more elaborate discussion). In this connection, meta analysis should be seen as a complement to a traditional literature review. Indeed, compared to an ordinary survey, meta analysis has some distinct potential advantages. First of all, meta-analysis constitutes a more systematic approach towards analysing the sources of (quantitative) variation in previously obtained research results. The underlying studies in the literature are often difficult to compare because of different specifications, different data and different methodologies, as is the case with taxation and FDI. The statistical nature of meta analysis implies that it compares studies in a systematic way.

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

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

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

Problems with meta analysis

Meta-analysis is not free from problems. A first and rather obvious problem is how to attain a representative sample of the literature. Modern bibliographical tools, such as EconLit and other (online) databases, and the easy availability of working papers through the Internet, do not prevail that it may be difficult to assess whether the sample of studies is in the end representative of the population of studies. Even more aggravating is the possibility that the studies that have been published constitute a biased sample of what has actually been found by researchers. For instance, editors of journals could have a tendency to reject 'negative' or insignificant results. This may also lead to self-censoring so that negative results are put away in the file drawer and even do not appear in unpublished working papers. Research results found in the literature are then necessarily biased towards significant 'positive' results, and a meta-analysis would thus be concerned a biased representation of what has been published. This problem of publication bias, however, also applies to ordinary literature surveys. One advantage of meta analysis, is that the researcher can test for the presence of publication bias in a certain literature.

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

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

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

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

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

3.2 The meta data base

In De Mooij and Ederveen (2003), we collected several estimates on the impact of taxation on foreign investment. For each study, the marginal coefficient was transformed into a uniformly defined semi-elasticity, which measures the percentage change in FDI in response to a 1%-point change in the tax rate (i.e. $\partial \ln(\text{FDI})/\partial t$). To be able to transform marginal coefficients from studies into semi-elasticities, information was often required about the mean value of the FDI variable or the tax rate. Only if this information was available, an estimate was included in the meta sample. Also information was collected on whether a tax coefficient was significant at the 5% confidence level. We arrived at a total sample of 371 elasticities but excluded some extreme values which left us with 351 observations. Using regression analysis, we explained the variation in semi-elasticities by the variation in the underlying study characteristics.

This paper adds 78 new elasticities from six recent studies.[3] We eliminate outliers, which we define as observations that are outside the range of plus and minus two times the standard deviation from the mean. In this way, especially negative outliers that cause a skewed distribution are eliminated from the sample.[4] We end up with a meta sample of 427 observations which is used in this paper. Figure 1 shows the distribution of these semi-elasticities. The x-axis shows intervals of values for the semi-elasticity and the y-axis shows the number of observations in each of these intervals.

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[3] The studies are Buettner (2002), Desai et al. (2004), Benassy-Quere et al. (2003), Stoewhase (2003, 2005) and Buettner and Ruf (2004). They are discussed in more detail in De Mooij and Ederveen (2006).

[4] Most of these outliers are reported in older studies using time series of panel data. Including the extremes considerably increases the coefficient for exemption systems as the large negative outliers refer to those countries. The significance of some tax measures becomes weaker but do not change signs. For an analysis of the influence of outliers, see De Mooij and Ederveen (2003).

Figure 1   **Distribution of semi-elasticities**
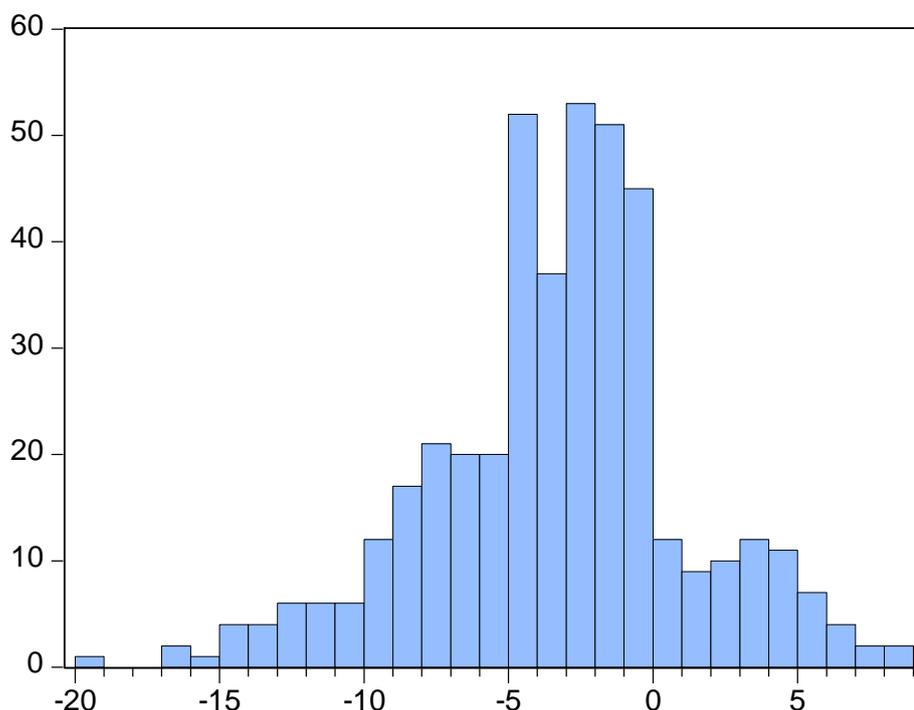
The mean value in the sample is − 3.3, i.e. a 1%-point increase in a tax measure in a certain location reduces foreign capital by 3.3%. The distribution is somewhat skewed to the left due to some large negative values. The median is therefore smaller: − 2.9. The standard deviation of 4.4 suggests that the variation across studies is large.

An important issue in meta analysis is the quality of the primary studies. Ordinary literature surveys usually provide a subjective judgement of the quality of studies which contains important value added for the reader. The reviews by Hines (1999) and Devereux and Griffith (2002) reflect on this in more detail. In meta analysis, one may take into account quality differences by weighting observations with standard errors of the estimated coefficients. The problem in our meta sample is, however, that the required standard errors are often missing. Therefore, we do not account for quality differences.

3.3   Specification

We estimate an equation of the form $y = \beta X + \varepsilon$, where y represents the vector of semi-elasticities, and X is a matrix of dummy variables reflecting various study characteristics. The information about study characteristics is contained in the meta database, usually in form of dummies that indicate whether a certain characteristic applies to an estimate or not. The

parameter β thus measures the systematic impact of each study characteristic on the reported semi-elasticities in the literature. In the regressions, we control via dummy variables for the following underlying characteristics of an estimate.[5]

- Data characteristics, including type of capital and time;
- Type of tax used in the regression;
- Background variables, such as the regime for double-tax relief in the parent country (exemption or credit) and source of finance (retained earnings or transfers).

Table 1 summarises our classification of the types of capital data and types of tax measures. It shows the number of semi-elasticities based on a certain category as well as the number of significant semi-elasticities.

With respect capital data, we distinguish between studies using financial data on the amount of capital invested in each location, and studies using count data on the number of locations. While the former best relate to marginal investment, the latter better measure discrete location decisions. If the two types of data yield the same effect sizes, the effects of taxation on investment might be entirely driven by discrete choice. If capital data yield larger elasticities, however, the amount of capital is likely to be responsive as well. Table 1 shows that about one third of the sample consists of semi-elasticities based on number of locations and about two-thirds is based on financial investment data.

Among the studies using financial data, we distinguish two categories: data on foreign direct investment (FDI) and US data on property plant and equipment (PPE). The latter is thought to be more closely related to real capital investment. The studies using count data are divided into three categories: those making no distinction as to what type of locations are counted and those based on either new plants/plant expansions or mergers and acquisitions. For mergers and acquisitions, the impact of taxes can be very different than for greenfield investment (see e.g. Scholes and Wolfson, 1990). In particular, a higher tax in the host country can make foreign ownership more attractive because, in contrast to local owners, foreign owners can be shielded from the higher tax rate by the credit system in the home country (as e.g. applied in the US and the UK).

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[5] In De Mooij and Ederveen (2003), we have reported the systematic impact of other sources of variation. For instance, we analyse the difference between unpublished and published studies, variation in the specification of the estimated equation (linear, logarithmic, quadratic), variation in estimation techniques (OLS, IV, other) and the type of data (panel, cross section, time series). Regarding the latter, note that studies using panel or time series data largely coincide with FDI.

Table 1 Summary information meta database: study characteristics, observations and significance

	Number of semi-elasticities	Number of significant semi-elasticities
Capital data		
Financial data		
Foreign direct investment (FDI)	208	115
Property plant & equipment (PPE)	73	45
Count data		
Number of locations	68	32
Number of new plants/plant expansions	43	15
Number of mergers & acquisitions	24	7
Other	11	7
All	427	221
Type of tax data		
Effective marginal tax rate	74	35
Approximation average tax		
Country statutory rate	29	14
Statutory rate in US states	133	48
Effective average tax rate	36	29
Micro tax rate	94	67
Macro average tax rate	61	28
All	427	221
Source of finance		
Retained Earnings	39	18
Transfers	84	47
Mixed	304	156
System for double tax relief		
Exempt	162	60
Credit	118	67
Mixed	147	94

With respect to tax data, we distinguish between estimates based on the EMTR and those determined by an indicator for the average tax burden. The former include studies that estimate the impact of the cost of capital, from which we derive the semi-elasticity of the EMTR. The EMTR measures incentive effects on marginal investment decisions. The EATR can be written as a weighted average of the EMTR and the statutory corporate tax rate and measures both investment responses and location decisions. If the EMTR yields systematically lower elasticities than the EATR, it indicates that taxes matter more at the extensive margin than at the intensive margin. In the meta sample, we have 74 estimates using the EMTR. Other estimates are based on average tax rate measures.

Among the studies using the average tax, 36 estimates use ex-ante EATR computations along the lines of Devereux and Griffith (1998). These studies show the highest rate of significant semi-elasticities (over 80%). In the US context, 133 estimates use State statutory tax

rates, which approximate average effective tax rates in the US rather good due to the common federal base. Other studies either use either country statutory tax rates (29) or average tax rates computed from firm accounts (94) or macro data (61).

Apart from differences in capital data and tax measures, we include three other study differences in our meta regressions. The first is the source of finance (retained earnings versus transfer of funds). The second refers to the system of double tax relief used in the home country of the investor. Under the exemption system, foreign income is exempt from taxation in the home country of the parent so that the tax in the host country matters for the return on the investment. Under the credit system, in contrast, tax liabilities in the host country of the subsidiary are credited against taxes in the home country of the parent. In that case, the ultimate tax burden on investment is determined by the tax rate of the home country of the parent. The tax in the host country is then expected to matter less. In the meta sample, 162 semi-elasticities apply to countries where the investor is located in an exemption county, 118 apply to credit countries and for the other estimates the country of the investor is unknown. The final variable that may affect reported semi-elasticities is time. To the extent that capital has become more mobile over time, one may expect that taxes exert a larger impact on international investment. However, time may also reflect an improvement in the quality of data or econometric techniques to identify the impact of taxes.

3.4   Meta regressions

Table 2 shows the outcome of two meta regressions. The coefficients show the effect of particular study characteristics, relative to a benchmark. The benchmark refers to a study using FDI data, the EMTR, an unspecified source of finance or system for double-tax relief and no post 1980 data. For presentational convenience, we have put a minus sign for all semi-elasticities before doing the regression analysis. Thus, we transformed most semi-elasticities into positive figures. A positive coefficient for a dummy variable therefore means a higher elasticity in absolute terms, i.e. the semi-elasticity becomes more negative. Both regressions in Table 2 use the entire meta sample excluding outliers. They differ in the study characteristics included.

Table 2 shows a significant negative coefficient for *Number of locations*. Hence, studies relying on count data produce significantly smaller semi-elasticities than studies relying on FDI. It suggests that not only the decision to locate, but also the decision on the amount of capital invested is responsive to tax.

For studies using financial data, *PPE* tends to produce larger semi-elasticities than FDI. One explanation is that PPE better reflects greenfield investments, which depends on location advantages. FDI contains also investment through mergers and acquisitions on which higher taxes exert an opposite effect due to the ownership advantage. Another explanation might be

that PPE data only exist for US investment and that capital flows into and out of the US are relatively sensitive to taxes. With the meta analysis, we cannot distinguish between these two explanations.

Table 2: Meta regression results

	(1)	(2)
Constant: FDI & EMTR	2.77 (0.50)**	2.51 (0.91)**
Capital data (relative to FDI)		
Property Plant Equipment	2.00 (0.54)**	1.99 (0.67)**
Count data		
Number of locations	− 2.22 (0.63)**	− 2.72 (0.81)**
Locations – Plants	− 0.40 (0.76)	− 0.59 (0.90)
Locations – M&A	− 9.90 (0.81)**	− 10.09 (0.94)**
Tax measures (relative to EMTR)		
STR in US states	3.14 (0.81)**	3.26 (0.90)**
STR in countries	− 1.13 (0.54)**	− 1.57 (0.60)**
EATR	2.35 (0.66)**	1.88 (0.75)**
Micro ATR	− 0.15 (0.70)	− 1.16 (0.81)
Macro ATR	− 0.30 (0.79)	0.67 (0.94)
Other characteristics of the data (relative to mixed data)		
Retained Earnings		0.02 (1.16)
Transfers		-1.00 (0.69)
Exemption country		0.98 (0.57)*
Credit country		0.34 (0.69)
Post 1980 data		-0.36 (0.91)
Post 1990 data		1.88 (0.49)**
Regression statistics		
Observations	427	427
Adjusted R-squared	0.34	0.36
Durbin-Watson	1.50	1.54

[a] Semi-elasticities are pre-multiplied by − 1 before regressions were run. Coefficients reflect the difference in semi-elasticity relative to the benchmark set of study characteristics, which is FDI data and the EMTR. Standard errors between brackets, * and ** denote statistical significance at 10% and 5% level, respectively. We include a special dummy for investment into Belgium and for capital data used in Swenson (1994) which is different from the other categories of capital data.

Among the studies using count data, those referring to *plants* (new plants and plant expansions) produce larger semi-elasticities than those referring to number of locations. It provides further support that location choices are relatively responsive to tax. Count data on *mergers and acquisitions* yield semi-elasticities with an opposite sign. It confirms that higher taxes in host countries make it more attractive for capital to be foreign owned due to the tax shelter provided by credit systems.

The benchmark study uses the EMTR as the indicator for the corporate tax burden. Table 2 reveals whether the *average tax burden* produces different outcomes. For the *EATR*, the meta regressions suggest a positive effect. Hence, lumpy investment or discrete location choices tends to be more responsive to tax. Note that a relatively large number of studies using the EMTR (or cost of capital) produce insignificant semi-elasticities: 39 out of 74 based on the EMTR are insignificant; for the EATR this is only 7 out of 36.

Studies using *country statutory tax rates* produce significantly smaller semi-elasticities than studies using the EMTR. Hence, statutory tax rates are probably a poor indicator to measure the impact of corporate tax systems on investment. This does not apply to *state statutory tax rates* in the US, however. Indeed, the semi-elasticity from studies using this tax indicator is usually larger than from studies using the EMTR. It may indicate that differences in state statutory tax rates in the US form a relatively good approximation for the differences in average effective tax rates.

Table 2 shows that studies based on *average tax rates* computed from data do not yield different semi-elasticities from studies using the EMTR. In estimating elasticities, however, average tax rates suffer from possible endogeneity problems while they do not measure the tax burden on future but on past investments. Therefore, they are less appropriate indicators to measure investment incentives.

The coefficient for *tax exemption countries* is weakly significant and positive. The coefficient for *credit countries* is insignificant. It suggests that investment from exemption countries tend to be more responsive to tax than investment from credit countries, which is consistent with the theory.

The coefficient for post 1980 data in Table 2 is insignificant. For post-1990 data, we find a positive coefficient. The interpretation of this result can be twofold. On the one hand, it may provide evidence for a growing responsiveness of capital to taxation over time. This is consistent with the results reported by Altshuler et al. (2001) who find that elasticities obtained from a cross-section for the 1980s were considerably smaller than those obtained from a cross-section for the 1990s. On the other hand, the higher elasticities may also reflect changes in the quality of estimates over time, e.g. due to better data and advances in econometric methodologies. The meta analysis is unable to distinguish between the two.

3.5   Predicted semi-elasticities

From the meta regressions in Table 2, we can infer fitted values for the semi-elasticity of foreign investment under a particular set of study characteristics. Table 3 presents such predicted values for two types of capital data and three alternative tax measures. Thereby, we take the regression results from the second column of Table 2. In computing the predicted values, we set dummies on credit/exemption and retained earnings/transfer of funds equal to

zero. The post-80 and post-90 dummies are set equal to one. In Table 3, we present semi-elasticities with their original sign, i.e. no longer pre-multiplied by − 1.

Table 3	Predicted semi-elasticities using the meta regressions of Table 2	
	Financial data	Count data on number of locations
Effective marginal tax rate	− 4.0	− 1.3
Effective average tax rate	− 5.9	− 3.2
Country statutory tax rate	− 2.4	0.3

Table 3 shows that the typical semi-elasticity of FDI with respect to the EMTR is − 4.0. Huizinga and Nicodeme (2006) present data on the foreign ownership share of capital in European countries (i.e. the share w^F) and report an average of 20%. Hence, the 4% inflow of capital in response to a 1%-point reduction in the EMTR will raise the aggregate capital stock in a country by 0.8%. The corresponding semi-elasticity of the tax base via an inflow of foreign capital would require pre-multiplying this by the share of the normal return, which we assume to be 0.5. Hence, $w^F \cdot w^N \cdot \varepsilon^{FDI} = 0.4$. This is equal to the tax base elasticity of investment as reported above. It suggests that all additional capital invested in response to a reduction in the cost of capital comes from abroad. This is consistent with perfect capital mobility.

The predicted semi-elasticity of the EATR is − 5.9 when applied to financial data. It suggests that the extensive margin of investment matters more than the intensive margin. However, the impact of the EATR on financial data captures both marginal and discrete investments. To isolate the impact on the extensive margin of investment, we take the impact of the EATR on the number of locations, i.e. the semi-elasticity of −3.2. To determine the semi-elasticity of the tax base via discrete location choices, this should be pre-multiplied by the share of foreign capital of 20%. Thus, we obtain for the semi-elasticity of the tax base: $w^F \varepsilon^{LOC} = -0.65$. This effect comes on top of the impact via marginal investments.

It is tempting to compare our predictions based on meta regressions with recent findings in the literature that are not included in the meta data base. It shows another way of how our meta analysis may be used in assessing new evidence. We discuss four such studies. First, Devereux and Lockwood (2006) estimate the long-run semi-elasticity of investment using financial data for three alternative indicators of tax. For the EATR the results suggest a statistically significant semi-elasticity of − 1.5. For the EMTR (derived from the cost of capital measure), the corresponding value is − 0.5 but insignificant. For the statutory tax rate, the semi-elasticity is −0.9, but this coefficient turns insignificant when also the EATR is included in the regression. The values of these semi-elasticities are somewhat lower than previous findings. The relatively large value for estimates based on the EATR are consistent with the outcome from the meta analysis. Bellak and Leibrecht (2008) estimate the semi-elasticity using FDI flows into Central and Eastern European countries. They consider two alternative tax variables. For the EATR, they report a significant semi-elasticity of − 4.3. For the statutory tax rate, the result becomes

insignificant and the semi-elasticity drops to − 1.9. This comes close to our predictions from the meta regressions. Bellak et al. (2008) estimate similar equations but concentrate on the impact of labour costs on FDI. The estimated semi-elasticity of the EATR in their study lies between −4.3 and − 4.7. Bénassy-Quéré et al. (2007) use a panel of FDI and estimate the impact of either the statutory corporate tax rate or the EATR using a double log specification. Their estimates suggest a significant semi-elasticity of the statutory corporate tax between − 4 and − 6, which is relatively large compared to previous findings. The semi-elasticity of the EATR is a bit higher at a round − 6.

4   CONCLUSIONS

How large are distortions of corporate taxes at various decision margins? By reviewing and using existing empirical evidence, this paper computes for five decision margins the semi-elasticity of the total corporate tax base. Table 4 summarizes our assessment. It suggests that empirical studies on profit shifting yield the largest tax base elasticities. Also studies on international investment responses yield substantial effects, both via marginal investments and especially via discrete location decisions. A few studies suggest that distortions on legal form might be substantial too. The reported semi-elasticity for financial leverage is relatively small. The five responses to tax cannot be simply added since they depend on different tax measures. If the different tax measures would all increase by 1%-point and we ignore interactions between responses, we would arrive at an aggregate effect on the tax base of − 3.1. This comes close to the aggregate Laffer-curve estimates by Clausing (2007).

Table 4   Semi-elasticity of the corporate tax base for five decision margins

Behavioural margin	Relevant tax	Effect size
1. Organisational form	Corporate vs. personal tax	− 0.7
2. Financial policy	Debt/equity discrimination	− 0.15
3. Profit shifting	Statutory tax rate	− 1.2
4. Investment – intensive	EMTR	− 0.4
5. Investment – extensive	EATR	− 0.65

The relatively large elasticity of profit shifting may explain why countries engage in fierce competition with their statutory tax rates in order to attract multinational profits. Indeed, we observe a steady decline in these rates over the last few decades (see e.g. Loretz, 2008). Moreover, the large investment responses may explain why governments engage in tax competition for mobile capital. Especially average effective tax rates seem to have been falling over the last decade, which is well understood by the large elasticity of discrete locations.

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From a normative perspective, the outcomes provide an argument for a neutral tax treatment of incomes earned in different legal forms. Moreover, they offer an argument in favour of tax harmonisation if governments would seek to minimize fiscal spillovers via profit shifting and international investment distortions. As long as this harmonisation is not achieved, they rationalize a country's policy of corporate tax rate reduction, possibly combined with base broadening or shifting to other taxes.

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