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Capital Structure Choice and Company Taxation: A Meta-Study

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Abstract: This paper provides a quantitative review of the empirical evidence on the impact of taxation on corporate debt finance. On the basis of 626 primary estimates taken from 23 studies, we find that the median tax-rate elasticity of debt ratios is around 0.44. The median tax-rate elasticity of incremental debt changes amounts to 2.47. There is, however, considerable variation in estimated tax effects on financial leverage. By means of meta-regressions, the paper aims to systematically explain this variation in terms of underlying study characteristics. The meta-regressions indicate that the heterogeneity in the semi-elasticities from the different studies can be fairly well explained by the characteristics of these studies. We find that the estimated tax elasticities are more pronounced if large firms or holding companies are considered. Moreover, our results suggest significantly higher tax elasticities of intercompany debt supporting the view that tax planning strategies of multinational firms affect debt financing.

Keywords: Capital Structure, Corporate Income Tax, Tax-Elasticity, Meta-Analysis.

JEL Code: G30, H32, F23

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1. Introduction

Since the seminal work by Modigliani and Miller (1963), the value of the corporate tax shield generated by debt financing has been recognized. Interest expenses are generally deductible from corporate taxable income according to most tax systems. As this does not hold for equity payouts, there is an incentive for firms to finance investments with debt rather than equity. This incentive grows with the value of the interest tax shield, which rises with the marginal tax rate (MTR). Several theoretical models explain capital structure choices of firms by taking into account a trade-off between the costs and benefits of debt finance. The literature suggests that costs may be related to financial distress (Kraus and Litzenberger, 1973), personal taxes (Miller, 1977), or agency conflicts between equity and debt claimants (Jensen and Meckling, 1976; Myers, 1977). De Angelo and Masulis (1980) demonstrate that the MTR of a firm is influenced by various non-debt tax shields generated by other available allowances and reliefs provided by tax law.

Furthermore, not only corporate taxes at the location of the firm matter. First, taxation of capital income at the shareholder level often differentiates between the types of capital as well. Therefore, it can be expected that the relative tax benefits of different sources of finance have an impact on financing decisions and both corporate profit tax and personal capital income taxes have an impact on capital structure choices (Graham, 2003). Second, in case of multinational firms, debt financing might not only be motivated by domestic tax considerations. Multinational firms can in addition exploit international differences in tax levels across affiliate locations in order to reduce their overall taxes. By means of an internal reallocation of debt, multinationals might take advantage of shifting profits from high tax jurisdictions to low tax jurisdictions. Consequently, taxation should not only affect external but also internal debt. Furthermore, a multinational's capital structure should not only be influenced by local taxes. It should instead reflect the tax systems of all the countries where it is engaged.

Although the above mentioned theoretical arguments for the tax sensitivity of companies' finance structures are numerous, the empirical findings, however, have for years been rather weak (see Myers, 1984). During the last two decades, several empirical studies have provided evidence for significant tax effects on the capital structure of firms. However, the estimated tax elasticities of debt financing and the characteristics of the existing studies are very different. Therefore, we present a meta-study of the existing empirical studies. A meta-analysis is a research method to synthesize the previously obtained empirical evidence (Stanley, 2001).

This approach is complementary to traditional literature surveys. Meta-analysis generates a value added in that it is more objective and transparent than purely qualitative literature reviews because it constitutes a statistical approach towards reviewing the literature.

The purpose of our study is to explain the differences in estimated tax elasticities of debt financing by study characteristics and properties of the data considered in the primary studies. The meta-regressions reported in this paper indicate that the heterogeneity in the semi-elasticities from the different studies can be fairly well explained by the characteristics of these studies. While we do not find support for a publication bias, we find that the estimated tax elasticities are more pronounced if large firms or holding companies are considered. Moreover, our results support the view that enhanced tax planning opportunities of multinational firms affect debt financing. We find significantly higher tax elasticities of internal debt with respect to the local tax rate. Finally, our results can be used to compute “typical semi-elasticities”. Referring to our results, we suggest that the tax-rate elasticity of internal debt ratios in response to a variation of local taxes approximates a value of 0.7 while the corresponding semi-elasticity of the external debt ratio amounts to 0.3.

The rest of the paper is organized as follows. In Section 2, we survey the empirical evidence on the impact of taxes on capital structure choices. A description of the meta-regression investigation approach and our meta-sample is provided in Section 3. The results of the meta-regressions are presented in Section 4. Finally, Section 5 concludes.

2. Survey of the Empirical Evidence

Basically, we divide the existing literature into two major strands. On the one hand, several studies are based on a one-country sample. In this case, empirical researchers face the problem of identifying sufficient cross-sectional or time-series variation in firm-specific tax incentives because the tax system within a country often treats all firms identically. These studies exploit the variation in additional tax savings due to differences in profitability or because of an existing loss carryforward. On the other hand, another strand of the literature uses international data sets. Using international accounting and tax data rather than a mere national sample raises additional cross-sectional and intertemporal variation in the tax rates of the different countries.

Evidence based on one-country samples

The first studies which are able to solidly identify tax effects on corporate financing decisions exploit only national variation in tax burdens. An advantage lies in the fact that country-specific determinants of the financial structures are entirely controlled. In his groundbreaking work MacKie-Mason (1990) shows that U.S. corporations are less likely to resort to debt as marginal source of funds as long as they can claim important tax loss carry-forwards. Furthermore, firms with investment tax credits reduce leverage only if they are already close to tax exhaustion. MacKie-Mason's main innovation is to concentrate on those cases where tax shields indeed raise the probability of tax exhaustion. Only then, they indicate a lower MTR and produce significant effects on debt policy. Additionally, his probit analysis avoids problems arising from an endogenous corporate tax status by looking at incremental debt issuances, represented as a zero-one event, instead of debt levels.

There are numerous other papers which have also taken advantage of the supposed correlation between tax shields and the unobserved MTR (see e.g. Titman and Wessels, 1988; Trezevant, 1992; Downs, 1993; Barklay and Smith, 1995; Graham and Tucker, 2006). For instance, Graham and Tucker (2006) use a matched pairs approach to identify tax effects on the capital structure choice. They compare the use of debt financing of firms which are engaged in aggressive tax planning and of firms which do not use these structures. They find evidence that non-debt tax shields caused by the tax shelters act as a substitute for debt. In their sample, which consists of 76 firms, the 38 firms using tax shelters have debt ratios that are more than 5 percent lower than those of other firms which are not engaged in that type of tax planning.

Some studies do not examine tax effects on debt levels or changes, but focus on related variables such as leasing or interest expenses (see e.g. Sharpe and Nguyen, 1995; Ayers et al., 2001). As we are interested in the direct quantitative impact of a change in the MTR on corporate debt policy, we exclude these papers from the following survey. Instead we concentrate on those studies which simulate the MTR or employ a more direct observable proxy such as average or statutory tax rates. Moreover, we include only those papers which have used debt ratios or incremental relative debt changes as dependent variables.

In contrast to MacKie-Mason (1990) and related studies, Lasfer (1995) provides a more direct analysis as he explicitly computes effective tax rates in order to test for their influence on financial policies of British domestic corporations between 1972 and 1983. Furthermore, Lasfer puts a special focus on the role of agency costs, in particular the free cash flow hypothesis as

advanced by Jensen (1986). Employing both market and book leverage ratios as dependent variables, he is able to confirm agency costs effects on firm's capital structure. Significant tax effects, however, are only identified on book ratio leverage. Lasfer concludes that capital structures do not respond to taxation in the short term.

While Lasfer (1995) approximated the MTR by an effective tax rate defined as the ratio of estimated EBIT multiplied with the corporate income tax rate over pre-tax profits, Graham (1996) computes a more sophisticated company specific simulated tax rate. Expanding a method first employed by Shevlin (1990), he simulates MTRs over a forecasted stream of taxable income to account for tax loss carry-forwards and carry-backs as well as the effect of investment tax credits and alternative minimum taxes. Precisely, firm specific taxable income is supposed to follow a random walk with drift. The present value of the tax bill through past, current and future years is computed using the entire corporate tax schedule. Adding one dollar to taxable income in the current year to calculate the induced change in the present value of taxes owed and averaging the results of 50 estimates gives the management's expected MTR at the time of the financing decision. This is done for all firms in all sample years. Graham (1996) empirically documents a positive relation between corporate tax status, captured by the lagged MTR, and incremental debt policy for U.S. corporations. Shum (1997) follows a similar approach with a panel of Canadian companies and basically reproduces Graham's results.

Graham et al. (1998), however, show that the MTRs simulated according to Graham (1996) are endogenous to cumulative debt usage. They therefore suggest using a modified *before-financing* simulated tax rate in regressions which use debt levels instead of changes as left-hand variables. The simulation is now based on the firm's operating income after depreciation, but before interest expenses are deducted. It thus captures tax incentives linked to the investment decision, but it is not endogenous to the aggregate financing decisions. Employing the simulated before financing tax rate, Graham et al. (1998) report a significant positive relation with U.S. corporations' debt-to-value ratios. In a subsequent paper, both debt-to-value and change in debt-to-value are regressed on the appropriate versions of the simulated MTR (Graham, 1999). Furthermore, a focus is put on the personal tax penalty to debt financing. Graham (1999) shows that adjusting tax benefits for personal taxes is statistically important. Based on a panel of Italian firms, Alworth and Arachi (2001) follow Graham (1996) and analyze the effect of (lagged) *after financing* simulated MTRs on incremental corporate debt pol-

icy.¹ They identify significant tax effects on changes in total debt, bank loans and - to a lesser extent - bond issues. Their results are robust to the inclusion of time dummies and firm fixed effects, indicating sufficient time-series as well as cross-sectional variation of MTRs. This, however, contrasts with Graham (1999), who does not find any time-series effects of taxes in his study based on U.S. data.

Graham et al. (2004) modify the computation of pre-interest MTRs to include employee stock option deductions. In so doing, they follow a suggestion put forward by Hanlon and Shevlin (2002), who attribute failure to detect the supposed relation between MTRs and debt to the disregard of tax deductions from stock option exercise. Graham et al. (2004) use debt-to-value ratios as dependent variable and run tobit regressions on a cross-section of Nasdaq 100 and S&P 100 firms in the year 2000. The empirical results indeed show that accounting for the tax deductions associated with stock options provides important incremental power to explain debt policy. Amronin and Liang (2003) follow in the same lines and take account of the substantial non-debt tax shield value of option gains deductions. However, their analyses differ in some important points from those of Graham et al. (2004). In contrast to the latter, Amronin and Liang (2003) use incremental debt as dependent variable which is consistently regressed on lagged simulated *after financing* MTRs. Second, Amronin and Liang (2003) do not directly include employee stock option deductions in the simulation of MTRs. Instead, they separately proxy the effect of option grants on MTRs by the expected value of option grants normalized by firm's assets. Furthermore, Amronin and Liang (2003) control explicitly for the debt enhancing effect of commonly used hedging strategies which are intended to mitigate the exposure to overly high stock price gains. On the basis of panel data from 1995 to 2001 for a set of large nonfinancial firms in the S&P 500 Composite Index, the empirical relation between MTR and debt changes is not documented to be persistently significant. However, the proxies for the MTR diminishing effect of option grants and for hedging motives display coefficients with the expected opposing signs.

Dwenger and Steiner (2009) analyse the impact of taxes on the financial leverage by using a pseudo-panel of German firm data which is aggregated at the industry level. While they also consider a firm-specific measure of the effective tax rate, they control for a potential endogeneity of this tax rate by an instrumental variable approach. As the instrument variable they use the simulated tax rate which a corporation would face in a particular period if there had been

¹ In addition, Alworth und Arachi (2001) run one regression with before financing simulated tax rates, but that does not change the results.

no endogenous change of its financial structure. Accordingly, identification is mainly based on variation raised by a major German tax reform in 2000 and on macro-economic changes. The empirical results confirm a positive effect of the tax rate on corporate leverage of German.

According to Gordon and Lee (2001), identification of tax effects on corporate financial policy in MacKie-Mason (1990), Graham (1996) and related studies is mainly based on cross-sectional variation in tax rates.² This, however, only yields reliable tax coefficient estimates if the underlying causes for non-debt tax shields influencing the MTR do not themselves affect the firm's financial policy. Sufficient time-series variation in the data is, however, scarce since U.S. statutory tax rates have not varied much historically. In order to be able to exploit some extra time-series variation, Gordon and Lee (2001) take advantage of the progressive U.S. statutory tax rates for different firm sizes. They hold aggregate time series influences constant and exploit rich time variation in the *relative* tax rates of small and large companies. This variation is generated by past modifications of the corporate income tax scale. Using US Statistics of Income panel data, the results document tax effects which are rather large as compared to those found in earlier literature. Gordon and Lee (2007) follow a similar approach but additionally control for the effect interest rates exert on the net gain from debt financing. They show that estimated effects of taxes on corporate financial policy are particularly pronounced if the interaction of taxes with interest rates is taken into account.

Finally, in some countries, another source of within-country tax variation arises from regional variation in tax rates. For instance, Gropp (2002) employs the regional variation in the tax levels that stems from different tax rates of the German local business tax. He also finds a positive tax effect of higher tax rates on the use of debt by German firms.

Evidence based on international samples

Studies based on cross-country samples are able to exploit international differences in tax levels as a rich source of variation. They, thus, do not have to cope with the limited variation in tax incentives challenging empirical analyses within countries. However, in case of international data, the sufficient control for country-specific differences that may explain capital structure choices is a challenging task.

² The work of Alworth und Arachi (2001) should be an exemption in this respect.

Rajan and Zingales (1995) have been the first to look at systematic determinants of capital structure choices across countries. Still, their study is based on consolidated financial statements. This makes it difficult to attribute local tax rates to the firm data. Therefore, the analyses remain rather descriptive in nature. Moreover, any identified correlations should be interpreted with care due to numerous institutional differences across countries which are not properly controlled for. Following Rajan and Zingales (1995), numerous papers use cross-country data to disentangle the determinants of corporate financial policies. We will again concentrate on those studies which produce point estimates of the marginal effect of a rise in tax rates on financial leverage.

Some papers exploit cross-country samples exclusively to examine the influence of domestic taxation on capital structures. Bartholdy and Mateus (2008) look at West European small and medium sized companies which are, however, only engaged in their domestic markets. They report economically important and significant effects of local taxes on debt ratios. Overesch and Voeller (2008) analyze the corporate debt policy of stand-alone corporations in 23 European states. They do not only consider taxation at the corporate level but widen the analysis to include taxes on investment income at the shareholder level. Their results show that the companies' debt ratio is significantly affected by the relative tax benefit of debt. Personal taxation is found to play an important role. Moreover, the analyses confirm a substitutive relationship between non-debt tax shields and tax incentives to use debt. Finally, debt ratios of smaller companies seem to be more heavily affected by the net tax gain from debt financing.

Further research questions emerge when multinational companies are looked at. As these have subsidiaries in at least one foreign country, multinational firms can exploit international differences in tax levels to reduce their overall tax burden. Numerous cross-country studies therefore analyze the international tax incentives on the internal reallocation of debt within multinationals. These papers necessarily deviate from Rajan and Zingales (1995) in that they use non-consolidated financial statements of affiliates. Only on the basis of this unconsolidated data host-country tax burdens can be attributed to internal leverage.

Altshuler and Grubert (2003) as well as Desai et al. (2004a) have been the first to examine balance sheet data of foreign affiliates of multinational corporations. Both studies empirically document a significant impact of local tax rates on affiliate leverage of U.S. multinationals. While Altshuler and Grubert (2003) use statutory tax rates in their analyses, Desai et al. (2004a) employ median effective tax rates defined as foreign income taxes paid over foreign

pretax income for each country. Separating total leverage into external and internal debt, Altshuler et al. (2003) only find significant tax effects on internal debt ratios. Desai et al. (2004a) report significant effects for both types of debt. While the marginal tax effect on companies' debt ratio is higher for external debt, the tax *elasticity* is, however, more pronounced for internal debt financing.

Jog and Tang (2001) exploit Canadian company data covering Canadian and foreign owned firms with and without foreign affiliates. They show that financial leverage of companies which are somehow affiliated to a multinational firm is less sensitive to domestic Canadian taxes than purely domestic firms.

Moore and Ruane (2005) as well as Huizinga et al. (2008) exploit tax level differences between European locations to assess tax effects on the capital structure of European multinationals. Moore and Ruane (2005) use a sample covering subsidiaries in 16 European states. Huizinga et al. (2008) also include parent companies into their leverage ratio analyses covering affiliate corporations in 33 European locations. Both studies report quite similar results and document a significantly positive impact of local taxes on affiliate leverage. Furthermore, Moore and Ruane (2005) focus on the impact of the system of double taxation relief in the parent country on the tax sensitivity of corporate fiscal policy. They find that multinational corporations based in home countries granting a tax credit for foreign taxes paid are less sensitive to local taxes with their capital structure choices.

Mintz and Weichenrieder (2005) analyse the impact of host-country taxes on the capital structures of affiliates of German multinationals. They also find a positive tax effect on total debt. Furthermore, they find a higher tax elasticity if a subsidiary is wholly-owned by the German parent company. Moreover, Mintz and Weichenrieder (2005) take account for different sources of debt. They only confirm a significant positive tax effect on internal debt, while they are unable to identify a statistically significant tax effect of host-country taxes on external debt financing of foreign affiliates of German parent companies. Büttner et al. (2006) use the same data set but, as opposed to Mintz and Weichenrieder (2005), do take into account the cross-section tax differences and do not entirely control for unobserved country-specific effects. When using the tax variation between different host countries of a multinational group, they find a positive effect of host-country taxes on both internal as well as external debt. Ruf (2008) also reconsiders the impact of host-country taxes on financial decisions of affiliates held by German parent companies. He employs different definitions of the financial leverage

and finds that the positive impact of host-country taxes on debt financing is mainly a consequence of the lack of retained earnings at high-tax locations rather than an incentive to use additional debt as a tax shield. Furthermore, he provides empirical evidence that a high corporate income tax rate increases the probability of multinationals establishing a finance company in the respective country which then carries significant amounts of debt.

Since debt financing is a potential channel through which profits are shifted from high- to low-tax countries, countries attempt to restrict the use of inter-company loans by imposing so-called thin-capitalization or earning stripping rules to limit adverse revenue consequences. Büttner et al. (2008) show that during the last decades, the number of countries that restrict the tax deductibility of interest payments associated with debt financing has significantly increased. Therefore, recent studies investigate the effects of thin-capitalization rules on debt financing. Büttner et al. (2008) analyze the effectiveness of thin-capitalization rules in OECD and European countries on debt financing of subsidiaries of German multinationals. The results suggest that thin-capitalization rules cause a reduction in internal debt and effectively remove the incentive to use such loans for tax planning.

In case of multinational firms, not only the tax level of the host-country but in addition also international differences in tax levels across affiliate locations should affect the capital structures. By means of an internal reallocation of debt, multinationals might take advantage of shifting profits from high-tax jurisdictions to low-tax jurisdictions. Huizinga et al. (2008) compute a tax rate differential between the host-country tax rate and a weighted average of the tax rates available within the multinational firm. Using European firm-level data, they estimate a significant effect of this tax differential on affiliates debt financing in addition to a positive effect of the host-country tax rate. In so doing, Huizinga et al. (2008) empirically split the total tax effect into a purely domestic effect and an international profit shifting effect which additionally affects the debt policy of companies affiliated to multinational firms. They find that ignoring this second channel underestimates the tax response by about 29%.

While Huizinga et al. (2008) analyze tax effects on the total amount of debt, Büttner and Wamser (2007) pay particular attention to potential profit shifting incentives by means of intercompany debt. They consider data of foreign affiliates of German parent companies. Since the tax level at the German parent level was rather high during the considered period, they focus on internal debt provided by other affiliates that are not located in Germany. According to Mintz and Smart (2004), this study employs the tax rate differential between the host-

country tax rate and the minimum tax rate available within the whole multinational group. The empirical results suggest that this tax rate differential explains much of the variation in intercompany loans whereas the host-country tax rate proves to be statistically insignificant.

Finally, some empirical studies focus on the tax asymmetries between affiliate and parent company. Newberry and Dhaliwal (2001) analyze the location of international bond offerings of US multinationals. They find that the location of bond offerings significantly depends on the tax status of the parent company. The probability of a bond offering by a foreign affiliate significantly increases if the US parent company has a loss carryforward or an excess tax credit position. More recent papers consider data of affiliates that are located in one country only. Since the parent companies are located in various countries, the tax rate of the parent countries is expected to negatively affect the affiliates' internal borrowing from their parent companies. Accordingly, Mills and Newberry (2004) find a negative impact of the tax level of the parent companies on the debt financing of foreign controlled affiliates in the U.S. This finding is confirmed by Ramb and Weichenrieder (2005) as well as by Overesch and Wamser (2009) for foreign affiliates located in Germany.

Moreover, Overesch and Wamser (2009) as well as Weichenrieder and Windischbauer (2008) employ reforms of the German thin-capitalization rules in 2001 and 2004. Since different types of affiliates were asymmetrically treated by these reforms, quasi-experimental settings enable to identify an impact of restrictions of the tax deductibility of interest payments on debt financing of foreign affiliates located in Germany. The empirical results confirm a negative impact of the German thin-capitalization rules on the use of debt financing by foreign affiliates located in the high-tax country Germany.

3. Meta-Analysis

Meta-analysis is a research method to synthesize previously obtained empirical evidence on a given topic. Stanley (2001) systematically introduces the concept of meta-analysis into the economic literature. Florax, de Groot and de Mooij (2002) present an instructive overview of its distinct benefits as well as possible pitfalls and limitations. Turning to applications, De Mooij and Ederveen (2003) present the first meta-study in international economics. They analyze the empirical evidence on the relationship between local taxes and foreign direct investment. A recent meta-analysis by Feld and Heckemeyer (2009) updates the meta-sample and

broadens the scope of the analysis. Furthermore, meta-analyses are particularly common in environmental economics (see Nelson and Kennedy, 2009).

Basically, meta-analysis constitutes a statistical approach towards reviewing the literature which is complementary to traditional literature surveys. Meta-analysis generates a value added in that it is more objective and transparent than purely qualitative literature reviews. As in all empirical analyses, the construction and characteristics of the exploited data sample have to be made explicit. Furthermore, the econometric approach *systematically* explains the quantitative variation in primary research results. Despite these important benefits, meta-analysis is not free from any potential pitfalls, of course. De Mooij and Ederveen (2003), however, argue that these potential caveats are also inherent to traditional literature surveys. What is more, meta-analysis provides even better or more transparent remedies to these potential pitfalls than a qualitative review.

One issue that might hamper conclusions from a literature survey is the potential problem of publication bias in previous research. Authors and referees of primary literature might even unconsciously prefer statistically significant results over the reporting of insignificant effects in published work. Particularly authors struggling with imprecise estimates would then seek to produce large effect size estimates. Therefore, many meta-analytical techniques designed to identify publication bias draw on the correlation of primary effect size estimates and their respective standard errors. An alternative procedure is the inclusion of dummies for published studies in order to capture any systematic difference to results from yet unpublished studies.³ Furthermore, in meta-analyses sampling multiple estimates from primary studies, the potential problem of observation dependence should econometrically be accounted for. Furthermore, meta-analysis allows for an explicit weighting of study results according to certain criteria. In many meta-analyses, standard errors of primary estimates are used as weights in the meta-regressions. Basically, this is a way to cope with the heteroscedasticity in the meta-regression disturbances which is by definition inherent to meta-analyses (Feld and Heckemeyer, 2009). Some meta-studies employ weighting schemes that are primarily meant to reflect the varying quality of primary research. However, consistent quality weights are difficult to find. For reasons of transparency and objectivity, we will therefore employ no quality weights in this study.

³ We will rely on dummies for published studies, as we could not derive appropriate standard errors for some primary results and thus would lose an unnecessarily high number of observations.

3.1 The Meta-Sample

Constructing the meta-sample is the most cumbersome task in a meta-analysis. Relevant studies must be evaluated and their central characteristics have to be coded primarily in the form of dummy variables. Most importantly, effect size measures from different studies must be made comparable. Regressions can differ in their econometric specifications. Thus, estimated coefficients might have different interpretations. Furthermore, as we want to assess the tax rate sensitivity of corporate financial policy, it is useful to take account of differing base levels in leverage across samples and/or types of debt. Therefore, we transform coefficients extracted from the studies into a uniformly defined semi-elasticity.⁴ In the present context, a semi-elasticity, also called tax-rate elasticity, measures the percentage change in the financial leverage in response to a one percentage-point change in the tax rate. Equation (1) gives a formal definition with ϵ_{is}^{semi} as the semi-elasticity, t as the tax rate and debt as being measured in debt-to-asset ratios or debt changes-to-assets.

$$(1) \quad \epsilon_{is}^{semi} = \frac{\partial \ln(debt)}{\partial t}$$

As most studies on the relationship between taxes and corporate financial policy use a linear specification in levels, tax coefficients reflect the marginal effect of a change in the tax rate on financial leverage. To obtain the corresponding semi-elasticity, we divide by the sample mean of the dependent variable (debt ratio or changes in debt-to-assets). If primary effects are measured as elasticities instead, we divide by the sample mean value of the tax rate. Consequently, we could calculate the semi-elasticities only if we could get hold of the necessary information about sample means.⁵ In total, we sampled 626 semi-elasticities from the studies surveyed above. Table 1 provides an overview on the studies considered by our meta-sample.

Figure 1 shows two histograms which illustrate the distribution of tax-rate elasticities respectively of debt ratios and incremental debt (changes in debt-to-assets). Estimated tax effects on debt ratios are dispersed around a sample mean semi-elasticity of 0.63 with a standard deviation of 1.11. There are almost no considerable outliers in the meta-sample. The distribution of estimated tax rate elasticities of incremental debt shows a much higher statistical spread. On

⁴ The meta-analyses on FDI and taxation provided by De Mooij and Ederveen (2003) as well as Feld and Heckemeyer (2009) also use this effect size indicator. Desai, Foley and Hines (2004) calculate tax elasticities to compare the tax sensitivity of internal vs. external debt. Please keep in mind that the semi-elasticity is not an indicator of statistical significance but an economic measure of responsiveness.

⁵ Information on sample means is not always provided in the primary studies. Although we tried to ask the authors for the relevant information, the lack of information explains the (preliminary) exclusion of a few studies.

average over all studies assessed, the tax-rate elasticity of incremental debt is estimated at 3.26. The standard deviation of these primary estimates within the meta-sample equals 4.71. Extreme values are more frequent than in the distribution of estimates based on debt ratios and reach a minimum of -7.25 and a maximum of 19.00.

Figure 1: Distribution of tax-rate elasticities

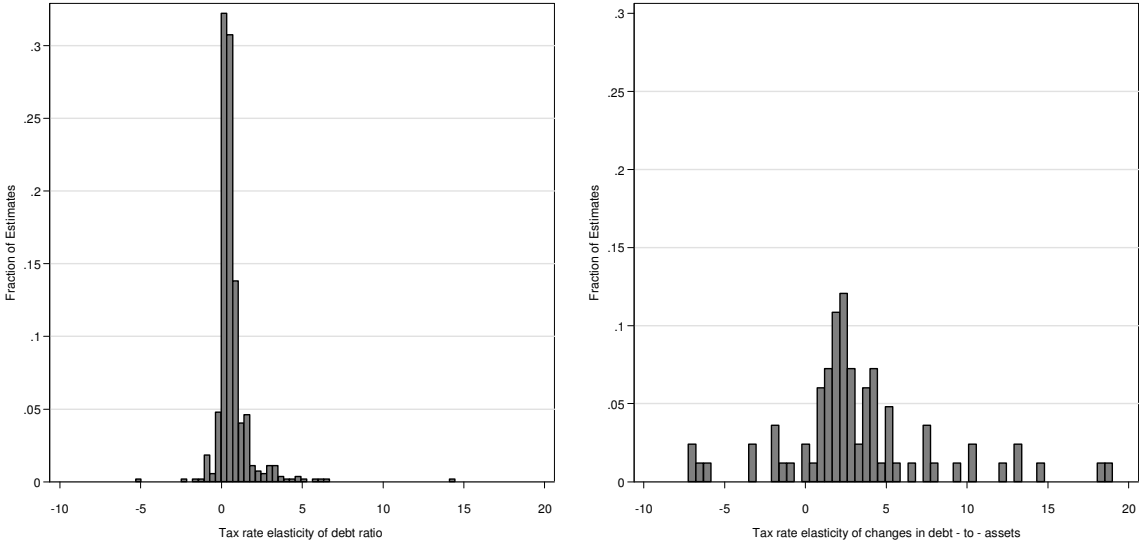


Table 1 gives a more detailed overview of the studies covered and the derived semi-elasticities. The mean tax-rate elasticities of studies vary between 0.01 (Lasfer, 1995) and 3.30 (Dwenger and Steiner, 2009). The underlying numbers of estimates per study, however, differ substantially. While some studies contain only two regressions (Graham et al., 1998; Mills and Newberry, 2004), others produce large series of estimates with up to 97 tax coefficients (Graham, 1999). There is also considerable variation within several studies as shown by coefficients of variation taking absolute values above 1 (e.g. Bartholdy and Mateus, 2008; Overesch and Völler, 2008; Büttner and Wamser, 2009).

Table 1: Summary statistics of the studies in our meta sample

	Study authors and year of publication	Dependent variable	Number of estimates	Mean semi-elasticity	Median	Minimum	Maximum	Coefficient of variation
1	Lasfer, 1995	Debt ratio	6	0.01	0.01	-0.02	0.06	3.00
2	Altshuler and Grubert, 2003	Debt ratio	6	0.61	0.68	-0.03	1.42	0.82
3	Graham, 1996	Incremental	44	4.63	4.03	-7.25	19.00	1.26
4	Graham et al., 1998	Debt ratio	2	-0.21	-0.21	-0.93	0.52	-4.90
5	Graham, 1999	Debt ratio	97	0.52	0.56	-0.18	1.16	0.56
6	Alworth and Arachi, 2001	Incremental	33	1.49	1.95	-6.98	5.28	1.52
7	Gordon and Lee, 2001	Debt ratio	16	0.56	0.44	-0.96	1.44	1.09
8	Amromin and Liang, 2003	Incremental	6	2.98	3.76	0.97	4.27	0.53
9	Desai et al., 2004a	Debt ratio	32	0.96	0.57	0.36	5.00	1.02
10	Graham et al., 2004	Debt ratio	15	1.61	1.63	0.57	2.84	0.32
11	Mills and Newberry, 2004*	Debt ratio	2	0.70	0.70	0.28	1.12	0.86
12	Moore and Ruane, 2005	Debt ratio	43	1.17	1.19	-0.08	3.15	0.44
13	Ramb and Weichenrieder, 2005**	Debt ratio	8 (5)	0.18 (0.25)	0.13 (0.22)	-0.15 (-0.15)	0.70 (0.70)	1.39 (1.24)
14	Büttner et al., 2006	Debt ratio	12	0.59	0.58	0.42	0.81	0.20
15	Büttner and Wamser, 2007**	Debt ratio	48	0.38	0.57	-1.04	1.04	1.45
16	Gordon and Lee, 2007	Debt ratio	32	0.24	0.27	-0.11	0.49	0.67
17	Huizinga et al., 2008**	Debt ratio	57 (29)	0.29 (0.44)	0.30 (0.43)	0.01 (0.21)	0.65 (0.65)	0.59 (0.18)
18	Bartholdy and Mateus, 2008	Debt ratio	81	0.27	0.006	-5.31	14.46	6.93
19	Büttner et al., 2008	Debt ratio	9	0.41	0.65	-0.39	0.82	1.20
20	Overesch and Völler, 2008	Debt ratio	28	0.16	0.18	-0.40	0.66	1.5
21	Ruf, 2008	Debt ratio	21	1.45	0.71	0.38	3.31	0.89
22	Overesch and Wamser, 2009*	Debt ratio	15	1.21	0.76	0.67	2.80	0.67
23	Dwenger and Steiner, 2009	Debt ratio	13	3.30	3.74	-1.47	6.69	0.77
	Total	Debt ratio	543	0.63	0.44	-5.31	14.46	1.76
	Total	Incremental	83	3.26	2.47	-7.25	19	1.44

Notes:

* Study analyses the effect of variation in foreign or average company tax rates.

** Study analyses the effects of variation both in local tax rate as well as in foreign or average company tax rate. Therefore, we separately added aggregate information on the tax-rate elasticities measured on the basis of local tax variation in a second row.

3.2 The Meta-Regressions

We will now examine if the identified variation in the tax-rate elasticities correlates with underlying study characteristics. To this aim, we regress the semi-elasticities on a set of dummy variables which reflect properties both at the study level and at the level of individual regressions. The meta-regression equation thus takes the form given in equation (2), where ϵ_{is}^{semi} represents the i^{th} semi-elasticity sampled from study s . ϵ_0^{semi} is the intercept and \mathbf{x}_s and \mathbf{z}_{si} are vectors with study-specific and model-specific variables respectively. u_{si} is the error term satisfying standard linear assumptions.

$$(2) \quad \epsilon_{si}^{semi} = \epsilon_0^{semi} + \mathbf{x}_s \boldsymbol{\beta} + \mathbf{z}_{si} \boldsymbol{\delta} + u_{si}$$

While the basic meta-regression specification is straightforward, there exists a large set of meta-analytic estimators which might be used to estimate (2). Standard meta-analytic estimators are based on weighted least squares (WLS) techniques. Precisely, observations are weighted with the inverse of the primary standard errors before applying standard OLS. This procedure yields efficient meta-estimates if observations are independent. Still, even if pooled estimators are permitted, we will refrain from using WLS estimation. As these techniques weight each observation with primary standard errors, they are basically equivalent to OLS regressions of t-values on study characteristics (which consequently transform into continuous variables). The results thus would allow for conclusions about the relationship between effect significance and study characteristics. The focus of this study, however, is not on statistical significance of primary estimates but on the tax sensitivity of leverage as measured by tax-rate elasticities. Furthermore, if observations are not independent due to unobserved study-specific effects, cluster-econometric estimators are generally preferred. As fixed effects approaches are, however, quite costly in terms of losing information of the impact of study-level characteristics and random effects techniques generally rely on rather daring assumptions, we will simply use pooled OLS with clustered-standard errors as a precaution against dependency. Additionally, to avoid any distortions caused by outliers, we exclude those semi-elasticities from the analysis which are two standard deviations larger or smaller than the mean.

4. Results

Table 2 shows the meta-regression results. The first column presents a basic specification. Results from an augmented specification are given in the second column. By the inclusion of particular dummy variables reflecting specific study characteristics, we automatically define an underlying *benchmark study*. The coefficients for each dummy variable reflect the estimated impact on primary tax-rate elasticities when the study design deviates from the benchmark in that specific point. Respective benchmark characteristics are indicated in brackets for every control dummy in Table 2. In addition to the first two regressions, the third column shows results from a re-estimate of the augmented specification. However, in this case, we weight each observation with the inverse of the total number of primary estimates extracted from that respective study. In so doing, we weight each *study* equally, while with unweighted OLS each *observation* is assigned an equal weight. Switching the weighting scheme reveals whether the identification of partial correlations between study characteristics and tax-rate elasticities is dominated by only few (large) studies. The fourth column again shows results from simple OLS for the augmented specification, but here the focus lies on published studies only. This last regression might give some further indication about the possible presence of publication bias. Furthermore, as all published articles in the meta-sample appeared in high-quality journals, this last regression is also an effective quality filter. Looking exclusively at published studies implies a sharp reduction of the meta-sample which drops by almost 50% to 337 observations.

We carefully formulate our results on the basis of all four regressions. Generally, the dummy which controls for the level shift between tax-rate elasticities of respectively debt ratios and incremental debt is highly significant. This was clearly expected since percentage reactions of corporate debt policy to a change in the tax burden are calculated relative to very different base levels. Furthermore, we do not find a systematic difference in research results between published and (not yet) published studies. The average sample year controlled for in the first regression shows no significant coefficient. On this basis, we thus cannot conclude that tax responsiveness has increased over time. Interestingly, we find that studies employing simulated tax rates *ceteris paribus* estimate smaller tax effects on financial policy as compared to studies relying on statutory tax rates. Effective tax rates seem to yield higher estimates, but this result is not robust to an equal weighting of studies. Studies excluding financial firms from their samples estimate significantly lower tax-rate elasticities according to all regressions except regression (3).

Table 2: Meta-regression results

Dependent Variable: Semi-elasticity	POLS	POLS	WLS	POLS
Variables	(1)	(2)	(3)	(4)
Incremental debt (Debt ratio)	2.096***	2.417***	1.524***	2.123***
	(0.292)	(0.247)	(0.460)	(0.406)
Published (Unpublished)	-0.0483	-0.105	0.00128	-
	(0.240)	(0.150)	(0.257)	-
Average sample year	0.00629			-
	(0.0123)			-
External debt (Internal debt)	-0.108	-0.233	-0.416**	-0.996***
	(0.330)	(0.308)	(0.181)	(0.173)
Total debt (Internal debt)	0.151	-0.0900	0.305	-0.460
	(0.327)	(0.321)	(0.427)	(0.318)
Local tax (Foreign tax)	0.592**	0.649**	0.384*	0.531**
	(0.229)	(0.249)	(0.221)	(0.223)
Simulated tax rate (STR)	-0.302	-0.728*	-1.849***	-1.216**
	(0.363)	(0.424)	(0.363)	(0.445)
Effective tax rate (STR)	0.275	0.234	-0.258	0.440**
	(0.217)	(0.209)	(0.427)	(0.197)
Small firms (not specified)	-0.0646	0.0598	-0.222	-0.226***
	(0.111)	(0.127)	(0.136)	(0.0454)
Large firms (not specified)	0.629*	0.688**	1.514***	0.937*
	(0.363)	(0.260)	(0.411)	(0.451)
Maturity long (not specified)	0.175	0.151	0.254	-0.148
	(0.148)	(0.149)	(0.296)	(0.134)
Maturity short (not specified)	-0.277	-0.0263	0.224	0.122
	(0.300)	(0.175)	(0.236)	(0.0858)
Directly held (not specified)	0.299	0.306	-1.143*	0.377*
	(0.286)	(0.306)	(0.635)	(0.200)
Indirectly held (not specified)	-0.356	-0.759*	-1.544**	-
	(0.356)	(0.433)	(0.655)	-

Exclusively wholly owned (not)	0.517	0.427	-1.257	-
	(0.357)	(0.326)	(0.734)	-
Holding companies (not)	2.350***	2.356***	2.025***	1.860***
	(0.289)	(0.279)	(0.394)	(0.0776)
Financial firms excluded (not)	-0.593**	-0.574***	0.230	-0.331**
	(0.218)	(0.178)	(0.275)	(0.150)
Host country Germany (not)	0.651**	0.753**	1.079**	0.0192
	(0.238)	(0.282)	(0.396)	(0.435)
Control for firm size (not)		0.146	0.392	0.466
		(0.205)	(0.266)	(0.410)
Control for non-debt tax shields (not)		-0.232	0.768	0.124
		(0.149)	(0.471)	(0.158)
Control for growth options (not)		-0.0827	0.107	0.211
		(0.146)	(0.222)	(0.261)
Control for collateral (not)		0.240	-0.227	0.171
		(0.218)	(0.169)	(0.199)
Time fixed effects included (not)		0.308**	-0.242	0.0282
		(0.134)	(0.309)	(0.240)
Cross-section fixed effects included (not)		0.146	0.888**	-0.0696
		(0.153)	(0.381)	(0.132)
Panel data (no panel data)		-0.826***	-0.610*	-0.884***
		(0.254)	(0.312)	(0.231)
Constant	-12.54	0.383	0.0346	0.782
	(24.71)	(0.367)	(0.591)	(0.449)
Observations	602	602	602	337
Adj. R ²	0.38	0.43	0.60	0.48
<p>Clustered standard errors in parentheses; ***/**/* denotes significance at the 1%/5% /10% level. All study/model characteristics are coded as dummy variables (except average sample year). Thus, a base model represents the characteristics redundant to the variables explicitly included. The base characteristics are indicated in parentheses for each study dimension. Estimated coefficients of the dummies indicate the effect on primary semi-elasticities of choosing a characteristic in lieu of the base specification.</p>				

While most control variables employed in primary regressions (non-debt tax shields, growth options, collateral) as well as time and cross-section fixed effects do not systematically affect primary tax effect estimates, we find some robust evidence for panel data studies to produce smaller semi-elasticities than cross-sectional or time series studies. Studies with a focus on Germany seem to yield higher estimates, which might be an indicator for increased tax planning of Germany based multinational affiliates which are known to engage in profit shifting activities within Europe (Huizinga and Laeven, 2008). We will discuss further results in more detail and put them into perspective with the underlying prior evidence or theoretical conceptions.

Type of debt

Desai et al. (2004a) focus on potential differences in tax responsiveness between types of debt. Indeed, they report that internal debt is more responsive to local taxes than external debt. They put forward that this is consistent with the profit shifting hypothesis. Numerous other studies also consider different types of debt in separate regressions or focus exclusively on internal debt. Our results support the view that enhanced tax planning opportunities of multinational firms affect debt financing. Our meta-regressions (3) and (4) show that external debt indeed is less responsive to taxes than internal funds. The corresponding coefficients in the first two regressions, however, are not significant. Between total debt and internal debt, however, there is no significant difference in research results.

Variation in local or foreign taxes

A multinational's affiliate capital structure reflects local corporate tax rates as well as tax rate differences within the multinational group, i.e. vis-à-vis the parent firm or other foreign subsidiaries. In some studies, both the pure effect of domestic taxation and the profit shifting incentive arising from within-group tax differences are explicitly analyzed (e.g. Büttner and Wamser, 2007; Huizinga et al., 2008). Other studies only concentrate on the effect of either local tax rates or foreign tax rates (see also Table 1 with notes). However, we may capture the difference between results reflecting the (total) effect of local tax rates on corporate debt and those reflecting only the profit shifting channel. To this aim, we construct a dummy variable equal to one if the tax-rate elasticity is derived from the marginal effect of the local tax rate on corporate debt and equal to zero if it reflects variation in non-local tax rates. As the tax-rate elasticity based on local tax variation should reflect both the purely domestic tax incentives as well as profit shifting motives, we expect it to be larger than its counterpart based on

non-local tax variation only capturing the shifting incentive. All our meta-regressions indeed find that variation in local tax rates induce significantly stronger total responses in corporate financial policy as compared to non-local tax rates.

Debt maturity

Debt maturity is another aspect highlighted particularly in Gordon and Lee (2007). They generally find that taxes interact with interest rates when influencing corporate financial policy. Evaluated at average interest rates, Gordon and Lee (2007) find that both long-term and short-term debt considerably reacts to tax incentives. Studies which exclusively focus on long-term debt are Graham (1996) and Dwenger and Steiner (2009). We do not find any evidence that the specific use of long-term or short-term debt as dependent variable significantly alters estimated tax effects relative to studies based on total debt.

Firm size

Our results suggest that primary regressions based on samples of explicitly large firms yield higher tax-rate elasticities than studies which do not consider firm size in detail. However, the results for small company samples are ambiguous. There are only few studies in our meta-sample which directly contrast estimates for large and small firms. Gordon and Lee (2007) in particular find that large firms adjust their debt levels positively in response to a rise in the tax advantage of debt.⁶ Instead, especially with rising long term interest rates small firms are discouraged from debt use. Given the much higher failure rates among small firms, Gordon and Lee (2007) judge their results to be plausible. Bartholdy and Mateus (2008) elaborate in detail on the differences between SMEs and large listed firms with respect to agency and asymmetric information problems which influence capital structure choices. They find theoretical arguments for and against a higher tax-rate elasticity of debt in small firms. Their empirical findings indeed show a higher tax sensitivity of small firms. We can only trace this finding in regression (4) from Table 2. Instead, data on large firms produce high tax effect estimates according to all meta-regressions.

Ownership structure

Related to the issue of holding structures is the question whether tax effects on corporate financial policy differ according to ownership structures. Desai, Foley and Hines (2004b) argue

⁶ Other studies which focus exclusively on large listed firms are Graham, Lang and Shackelford (2002) as well as Amromin and Liang (2003).

that the coordination costs related to the tax efficient structuring of multinationals' operations decline with higher ownership shares. Empirical evidence for this hypothesis is found by Büttner and Wamser (2007) who report a higher tax sensitivity of debt for *wholly-owned* foreign subsidiaries of German multinationals. Surprisingly, according to our meta-results, the estimated relationship between primary tax-rate elasticities and the focus on wholly-owned companies is not significant and the sign of the coefficient is not robust to an equal weighting of studies. A possible explanation might be that this issue has not yet been analyzed by a broad set of studies.

Holding structure

The implications of a company's holding structure for its financial tax sensitivity have been examined in particular by Ramb and Weichenrieder (2005) who exploit German inbound FDI data.⁷ While they do not find significant tax effects on external debt for directly held German affiliates, they can, however, show that these directly held firms react to German tax rates by adjusting their intra-company loans. This reaction is even more pronounced for rather profitable firms. Indirectly held firms do not turn out to react significantly to host country tax incentives. Ramb and Weichenrieder (2005) point at the very low mean profitability of this group of German affiliates. Three further studies (Overesch and Wamser, 2009; Büttner et al. 2006, 2008) rely exclusively on data from directly held firms. Looking at the results from our meta-regressions, the evidence is ambiguous. Results from our first two regressions indeed suggest that directly held companies yield higher tax-rate elasticities but this relationship is not significant. Indirectly held firms only indeed react to a lesser extent with significant coefficients in meta-regressions (2) and (3). The coefficient for research results based on directly held firms, however, changes signs when we assign an equal weight to each study. In the last regression it turns again positive, and this time it is significant.

Holding companies

The special role of holding companies in corporate tax planning has been highlighted only recently by Ruf (2008). Overesch and Wamser (2009) also put a certain focus on this specific

⁷ Mintz and Weichenrieder (2005) also run separate regressions on samples of directly and indirectly owned subsidiaries. However, due to missing information about sample means, we have not yet included that study in our meta-sample.

group of companies. Ruf (2008) argues that mergers and acquisitions might be used to implement tax induced debt financing in high tax countries with holdings taking the role of vehicles that receive the internal loans. Consolidating the resulting interest payments with the profits of the target company within fiscal unions allows shifting profits to low tax countries. Ruf (2008) indeed report significantly higher tax effects on corporate finance for holdings than for ordinary affiliates. Overesch and Wamser (2009) also report higher tax sensitivities when focusing on holding companies, which might hint at their role as special tax-planning entities. The effects are so pronounced that our meta-regressions show significant coefficients for holding companies (vs. ordinary firms) throughout regressions (1) to (4).

5. Conclusions

The impact of taxation on capital structure choices has been analyzed by several previous empirical studies. However, the estimated tax elasticity of debt financing and the characteristics of the existing studies are very different. Therefore, we present a meta-study of the existing empirical studies. The main interest of our study is the influence of several study characteristics on the estimated tax rate effects on debt financing. The meta-regressions reported in this paper indicate that the heterogeneity in the semi-elasticities from the different studies can be fairly well explained by the characteristics of these studies.

Our results suggest that characteristics of the firms considered by a study matter. We find significantly more pronounced tax effects if large firms or holding companies are considered. Moreover, our results support the view that enhanced tax planning opportunities of multinational firms affect in particular internal debt. We find significantly higher tax elasticities of internal debt with respect to the local tax rate. Moreover, estimated tax rates elasticities are significantly less pronounced if panel data are considered. However, in the meta-regressions we do not find support for a publication bias.

Finally, we can use the meta-regression results to compute some “typical semi-elasticities” for studies with particular characteristics. These typical tax effects can, however, only give some indication about differences in tax effects without being directly applicable to future studies in the sense of a “forecasting” of estimated tax-rate elasticities. Still, they might convey some intuition. For the calculation of the typical tax-rate elasticities, we take the results from the third regression in Table 2, which equally weights each primary study. Furthermore, we base these elasticities on an assumed panel data study which employs time and cross-section fixed effects. We then calculate typical tax-rate elasticities both for studies which analyse debt

changes to assets (incremental debt) and debt ratios. We look at semi-elasticities respectively for internal and external debt in response to a variation of the local tax rate or non-local, i.e. foreign or average company, taxes. The corresponding results of these calculations are shown in Table 3. Referring to these typical values, we suggest that the tax-rate elasticity of internal debt ratios in response to a variation of local taxes approximates a value of 0.7 while the corresponding semi-elasticity of the external debt ratio amounts to 0.3. A variation in non-local taxes which particularly will induce reactions via the profit shifting incentive comes along with a tax-rate elasticity of 0.3 in the case of internal debt ratios and -0.1 in the case of external debt. The relations between the semi-elasticities are similar for incremental debt - though, of course, at higher response levels.

Table 3: Typical tax-rate elasticities

	Internal debt		External debt	
	Variation in...		Variation in...	
	Foreign tax rates	local tax rates	Foreign tax rates	local tax rates
Incremental debt	1.8	2.2	1.4	1.8
Debt ratio	0.3	0.7	-0.1	0.3

Typical tax-rate elasticities are computed on the basis of results from an equal weighting of studies (regression (3) in Table 2). All tax-rate elasticities shown in this table assume an underlying panel data study employing time and cross-section fixed effects.

If we suggest that the response of internal debt ratios to a variation in non-local taxes reflects particularly the profit shifting incentive while the total effect of local taxes on internal debt ratios reflects the overall effect of domestic taxation and profit shifting motives, we might argue that neglecting profit shifting incentives in primary estimations generally might lead to an understatement of the overall effect by around 50%. We thus would evaluate the profit shifting incentive to be even more important than Huizinga et al. (2008), who estimate its relative share in the overall tax effect to amount to approx. 25%. We, however, have to underscore the crudeness of these interpretations. As our meta-regression results depicted in Table 2 have shown, there is a non-negligible variation in meta-coefficient estimates depending on the specification, weighting scheme or meta-sample used.

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