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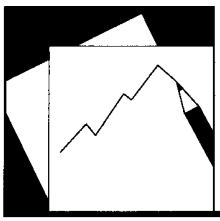

IMF Working Paper

The Tax Elasticity of Corporate Debt: A Synthesis of Size and Variations

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The Tax Elasticity of Corporate Debt: A Synthesis of Size and Variations

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Abstract

Although the empirical literature has long struggled to identify the impact of taxes on corporate financial structure, a recent boom in studies offers ample support for the debt bias of taxation. Yet, studies differ considerably in effect size and reveal an equally large variety in methodologies and specifications. This paper sheds light on this variation and assesses the systematic impact on the size of the effects. We find that, typically, a one percentage point higher tax rate increases the debt-asset ratio by between 0.17 and 0.28. Responses are increasing over time, which suggests that debt bias distortions have become more important.

JEL Classification Numbers: G30; H25.

Keywords: Debt bias; corporate tax; meta analysis.

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*"Companies are taxed heavily for making investments with equity; yet the tax code actually pays companies to invest using leverage" (*President Obama, February 7, 2011*)*

I. INTRODUCTION

Corporate income tax (CIT) systems contain a bias towards debt since they allow a deduction for interest but not for dividends or capital gains. Thus, CIT systems induce firms to have higher leverage ratios. This debt bias has received increasing policy interest recently (IMF, 2009; Claessens and others 2010; De Mooij, 2011). For instance—while not a cause of the financial crisis—debt bias might have contributed to the deepness of the crisis, since excessive leverage makes firms more vulnerable for economic shocks. Moreover, the growth of hybrid financial instruments and the increasing importance of multinationals engaging in international tax planning have made debt bias of increasing concern to revenue authorities. These considerations have triggered policy debates on CIT reform. For instance, many countries have introduced or tightened rules that restrict the deductibility of interest. Governments are also discussing comprehensive CIT reforms, such as the comprehensive business income tax (which disallows the deduction of interest) and the allowance for corporate equity (which grants firms a deduction for the normal return on equity). Some countries have actually introduced variants of the allowance for corporate equity, such as Belgium, Brazil, and Latvia. In other countries, tax committees have proposed reforms along these lines, such as the Mirrlees Committee in the U.K.

A key question underlying these discussions on debt bias is how much taxes actually matter for corporate debt policy. If behavioral responses were only weak, the welfare gains of CIT reforms will be small. However, if behavioral responses were large, the social benefits of eliminating debt bias can be substantial. For long, corporate finance literature has struggled with this. Empirical studies until the early 1990s produce insignificant tax effects, either suggesting that taxation has no impact on debt ratios or reflecting an inability to identify them. This casted doubt, even among experts. For instance, Nobel laureate Merton Miller (1977, p. 264) said: "*…the debt/asset ratio of the typical nonfinancial corporation in the 1950's was little different from that of the 1920's despite the fact that tax rates had quintupled—from 10 and 11 percent in the 1920's to 52 percent in the 1950's.*" Stewart Myers (1984) noted in his presidential address to the American Finance Association that, "*I know of no study clearly demonstrating that a firm's tax status has predictable, material effects on its debt policy. I think the wait for such a study will be protracted."* His provoking statement challenged a number of scholars to empirically assess the tax effect on debt. Yet, after several attempts by scholars, Myers was still not convinced in the late 1990s. In 1998, he concludes: '*tax incentives are probably of third-order importance in the hierarchy of corporate finance decisions*' (Myers, and others 1998).

During the last decade or so, many econometric studies have come to a different conclusion, namely that taxes do have a significant impact on debt ratios.[2] Yet, studies yield a large

[2] The literature is reviewed by Auerbach (2002), Graham (2003; 2008), Weichenrieder and Klautke (2008) and Gordon (2010).

variety in effect sizes and an equally large variety in methodologies. Weichenrieder and Klautke (2008), for instance, conclude that the marginal impact of the CIT rate on the debt-asset ratio ranges between 0.14 and 0.46, i.e., a 1 percentage point higher CIT rate is accompanied by an increase in the debt-assets ratio of between 0.14 and 0.46 percent. Gordon (2010) makes a distinction between external capital and the internal capital structure in case of a multinational and concludes that the effects for the former group are generally small, ranging from 0.1 to 0.22, while for the latter they range between 0.24 and 0.56.

This paper analyzes whether these numbers are sustained in the broadest possible set of estimates that we could find in the literature. To that end, we collect 267 estimates from 19 different studies. We make the outcomes comparable by computing a uniform tax elasticity of debt, defined as $\partial \ln(D/A)/\partial \tau$, where D/A stands for the debt-asset ratio and τ is the tax rate. We explain the variation in elasticities by performing a meta analysis, thereby exploring the systematic impact of several study characteristics on effect size. The results are then used to simulate typical elasticities that reflect, what we might call, a ―consensus estimate," which best reflects the findings from primary studies. We compute this estimate for alternative types of debt and for different countries in the sample.

The rest of this paper is organized as follows. Section II reviews the existing empirical literature on debt bias. Section III discusses how we design our meta database and presents its properties. Section IV shows the results of our meta regressions and simulated ‗consensus' elasticities. Finally, Section V concludes.

II. EMPIRICAL STUDIES ON DEBT BIAS

A major problem in empirically identifying the effect of taxes on corporate financial structure is the lack of variation in tax rates. Indeed, in most countries, corporations are subject to the same CIT rate, so one cannot exploit variation across firms. Initially, therefore, studies have used time series variation to identify tax effects. These estimates, however, often yield insignificant effects or coefficients of the wrong sign (Graham, 2003). The reason for this, however, might be that the variation in CIT rates over time is also generally small, which makes it difficult to identify tax effects. Subsequent literature has come up with four solutions to better identify tax effects. Each of these types is discussed below.

A. Variation in Non-debt Tax Shields

One way out of the lack of variation in tax rates, suggested by DeAngelo and Masulis (1980), is to use variation in non-debt corporate tax shields, such as depreciation allowances and tax losses that are carried forward. These tax shields may reduce the value of the interest deduction, as taxable profits can become negative. Non-debt tax shields thus substitute for debt and introduce a source of variation in the value of debt relief across firms. This allows one to identify whether taxes have an influence on capital structure. A number of empirical studies have used this idea but find no support for the debt-bias hypothesis (see, e.g., Bradley and others 1984; Titman and Wessels 1988). However, MacKie-Mason (1990) argues that these studies fail because they look at average debt ratios, which are largely determined by historical decisions. Apparently, these show no correlation with current non-debt tax shields.

MacKie-Mason argues that it is better to look at incremental decisions, i.e., the issuance of new debt. Moreover, he suggests that the substitution effect of non-debt tax shields should be more relevant for firms with a substantial probability of losing its deductibility, i.e., those with low profits. Using probit analysis, MacKie-Mason estimates the propensity of U.S. firms to issue bonds or equity. He finds that firms with high tax shields and a high probability of facing a zero tax rate are indeed less likely to finance their new investments by debt. This is the first convincing result in support of debt bias. Subsequent studies using this method have obtained similar results (Dhaliwal and others (1992); Shum (1996); Cloyd and others (1997); Ayers and others (2001)). Yet, none of these studies offers insight into the size of the effects of taxes on debt-asset ratios.

B. Marginal Tax Rates and Incremental Debt

A second approach to identify tax effects from firm variation is by computing firm-specific marginal tax rates. Even though statutory CIT rates may be the same across firms, specific circumstances may cause variation in their tax burdens, as the non-debt tax shields reveal. Using this information, one can compute firm-specific marginal tax rates, thereby accounting for both non-debt tax shields and other possible differences across firms, such as the alternative minimum tax or progression in the CIT rate structure. Graham (1996) explores the impact of these simulated marginal tax rates on incremental financial decisions and reports significant tax effects. Subsequent studies using this methodology produce similar results. Alworth and Arachi (2001) apply Grahams‘ approach to Italian firms. They point to the potential endogeneity bias: corporations with substantial debt have large interest deductions, which reduces their taxable income and thus their average tax rate. To avoid endogeneity, they explore both the lagged simulated marginal tax rate and the before-financing marginal tax rate, used also by Graham and others (1998). Alworth and Arachi report a positive relationship between corporate taxes and incremental debt. Gropp (2002) uses a panel of German firms and explores the impact of statutory local business taxes on incremental debt. Also he reports positive tax effects on debt choices.[3]

The studies discussed here provide evidence in support of debt bias since firms facing higher marginal tax rates are more inclined to use debt at the margin. This, however, does not tell us by how much taxes increase debt ratios. Our main interest is in this relationship between the debt-asset ratio and the corporate tax advantage of debt. We now turn to this part of the literature.

C. Marginal Tax Rates and Debt Levels

A first group of studies on debt ratios uses the variation in tax marginal rates across firms within one country. Hence, the typical regression equation reads as:

[3] In an earlier paper, Givoly and others (1992) use firm-specific tax rates, based on micro data (computed as taxes paid over pre-tax income). They then estimate the impact of these taxes on incremental debt. To circumvent endogeneity, they take the lagged value of the average tax. They report a positive effect on incremental debt.

$$D_i/A_i = \alpha + \beta\tau_i + \gamma X_i + \varepsilon$$

where D_i/A_i denotes the debt-asset ratio for firm i, and τ_i stands for the firm-specific marginal tax rate, and X_i reflect other explanatory variables. Studies differ in the choice of the debt-asset ratio (all debt or only long-term or short-term debt), firm coverage (all firms, or some subset of firms distinguished by size, profitability or industry) and tax rate (only CIT or some correction for PIT). These studies and their main outcomes are summarized in Table 1.

Graham and others (1998) are the first to explore the relationship between long-term debt levels and company taxes.[4] Using a simulated forward looking before-financing tax rate to circumvent the endogeneity problem, they report a marginal tax effect on the debt-asset ratio of 0.07. Hence, a 10 percent-point higher marginal tax rate is associated with a 0.7 percent higher debt-asset ratio. Graham (1999) also uses firm-specific marginal tax rates, but looks at debt-asset ratios measured by market value instead of book value. The analysis yields the expected positive tax effects, with tax effects ranging from 0.02 to 0.2.[5] A few studies followed up on Graham's methodology, using data for other countries. Bartholdy and Mateus (2006) estimate the impact of the before-financing marginal tax rates on the debt ratio in Portugal and report a fairly large effect, especially for short-term debt. For long-term loans, they find an opposite, negative effect. Dwenger and Steiner (2009) estimate the impact of effective CIT rates on the financial leverage of German corporations on the basis of a pseudo-panel, constructed from corporate tax returns. Endogeneity of the effective CIT rate is controlled for by an instrumental variable, obtained from a microsimulation model of the corporate sector. They find an average tax effect of around 0.5. Moreover, the debt ratio is less responsive for small corporations and for corporations that benefit from non-debt tax shields.

Another contribution of Graham (1999) is the inclusion of personal income taxes (PIT) in the analysis of debt bias. Indeed, PIT would matter for debt if the marginal investor would be domestic and subject to personal tax on interest, dividends and capital gains. Indeed, in that case the so-called Miller-tax-term (*MTT*) should be used to measure the appropriate impact of taxes on debt. This term is: $MTT = \tau_{cit} - [\tau_i - (1 - \tau_{cit})\tau_e]$, where the tax advantage of debt is determined by the CIT (t_{cit}) as well as the PIT on interest (t_i) and equity returns (t_e). The latter is a formula of dividend and capital gains taxes, as well as the tax advantage of tax deferral under the capital gains tax. Graham reports regressions with the Miller tax term, without it, and with the PIT as a separate control. The choice matters as CIT and PIT rates interact in the Miller tax term. Indeed, Graham reports significant differences in effect size between regressions using the Miller term and those excluding PIT. Booth and others (2001) also take the *MTT* in their regressions. A number of other studies only control for PIT,

[4] In an earlier paper, Gentry (1994) already showed that publicly traded partnerships in the oil and gas exploration industry in the U.S. (which are not subject to CIT) feature significantly lower debt levels than similar firms that are run in the corporate form.

[5] Besides the marginal tax rate based on the federal CIT, Graham also uses state CIT rates. These coefficients are larger and run up to 0.46. However, Graham notes that due to measurement problems, this result is unreliable. Where therefore do not include this in our meta database.

without using the Miller term explicitly. For instance, Gordon and Lee (2001) note that there is considerably ambiguity in calculating the rate t_e. Therefore, they decide to ignore the interaction term in their regressions, but instead to control for the tax on interest income.

Table 1. Summary of Studies Using Single Country Data

Study	Data	Tax measure	Remarks	Results
Graham et al., 1998	Panel of non-financial US firms 1981-92	Simulated MTR*	Long-term debt	Significant tax effect
Graham, 1999	Panel of US firms 1980-1994	Simulated MTR*, Miller term; PIT control	Regressions by firm groups and years	PIT matters, estimate for Miller tax term differs from CIT
Gordon and Lee, 2001	Panel of US firms 1954-1995	Simulated MTR* minus PIT on interest	Panel and time series estimates; distinction short- and long-term debt	Larger effect for: (i) time series regressions; (ii) short-term debt; (iii) either small or large firms
Jog and Tang, 2001	Panel of Canadian firms 1984-1994	Statutory CIT change during this period in Can & US	Distinguish domestic and foreign controlled firms	Canadian firms without foreign affiliates are more responsive
Bartholdy and Mateus, 2006	Panel of Portugese firms 1990-2000	Simulated MTR*	Distinguish long and short-term debt	Large effect on short-term debt, insignificant for long-term debt
Gordon and Lee, 2007	Panel of US firms 1950-2000	Simulated MTR* minus PIT on interest divided by (1 - MTR)	Interaction with interest rates	Interest rates matter for tax effects
Dwenger and Steiner, 2009	Cross-section in German firms 1998 and 2001	ATR* in 2001 relative to 1998	Long-term debt; different firm size, risk groups and profit levels	Relatively large effects for large firms and more profitable firms

*MTR = marginal tax rate based on simulations; ATR = average tax rate based on either data or simulations

Gordon and Lee (2001) exploit the fact that small firms in the U.S. face a lower CIT rate than large firms due to progression in the rate structure. Using a panel of firms and time series variation from 1954 to 1995, they estimate an average marginal impact of taxes on debt between 0.05 in panel regressions to 0.36 in pure time series regressions. Gordon and Lee also find that tax effects for both small and large firms are significantly larger than for medium-sized companies, for which the estimated effect is not significantly different from

zero.[6] In a follow-up paper, Gordon and Lee (2007) use the same dataset, extended to the period 1950–2000. Their focus is on the importance of nominal interest rates for the attractiveness of debt. The tax effect on debt should be more responsive when interest rates are higher because the inflation component magnifies the benefit of debt finance. Their results indeed support this.

Jog and Tang (2001) use data on Canadian firms between 1984 and 1994, a period in which CIT rates dropped significantly in both Canada and the U.S. They use this change in tax rates to assess the impact on the debt ratio of Canadian firms, either with or without foreign controlled operations (primarily U.S. controlled). Their estimates suggest significant tax effects, which are especially large for domestic firms.

D. Cross-country Studies

A second group of studies exploits variation in tax rates across countries. Most of these studies estimate an equation of the following type:

$$D_i^C/A_i^C = \alpha + \beta\tau^C + \gamma X_i^C + \varepsilon$$

Where D_i^C/A_i^C is the debt-asset ratio or the leverage-asset ratio of firm i in country C and τ_C stands for the statutory CIT rate in the home country of that firm. A number of studies consider tax differences vis-à-vis the tax rate in foreign parent or subsidiary countries. Some of these studies concentrate on specific forms of debt, such as intracompany debt or external debt, or explicitly focus on foreign subsidiaries. Most use panel data and estimate a fixed effects model to control for unobserved time-, country- and/or firm variation. Studies differ considerably in their use of control variables. The studies and their main outcomes are summarized in Table 2.

Rajan and Zingales (1995) are the first to make use of cross-country variation in tax rates by comparing the financial policies of firms across G-7 countries. They document that companies in countries with a high tax advantage of debt feature higher incremental debt changes. One cannot, however, derive the direct effect size of taxes on the debt-asset ratio from their study. Booth and others (2001) use cross-country variation in the Miller tax term to identify an impact of taxes on aggregate debt ratios. They report significant effects on both short and long-term debt, with an impact of the tax on the debt ratio between 0.21 and 0.3.

[6] The explanation might be that small firms rely more heavily on credit from insiders, who are relatively responsive to tax. Intermediate firms more likely face credit constraints than large firms, who can issue corporate bonds. This makes the latter more responsive to tax.

Table 2 Summary of Studies Using Cross-country Variation

Study	Data	Tax measure	Remarks	Results
Booth et al., 2001	Cross-section of 17 countries	Miller tax term	Long and short term debt	Significant and insignificant effects
Altshuler and Grubert, 2003	U.S. firms with foreign affiliates 1996	Statutory CIT rates abroad	Internal and external debt	Significant for internal, mixed for external debt
Desai et al., 2004	U.S. affiliates 1982-1994 in 150 countries	ATR paid in subsidiary countries	Total, internal and external debt	Similar elasticities for internal and external debt
Mills and Newberry, 2004	U.S. firms 1987-1996 with parents in 16 countries	ATR and statutory CIT rate in parent country	Large non-financial subsidiaries	Significant effects, largest for statutory CIT
Mintz and Weichenrieder, 2005	German parents 1996-2002 investing in 68 countries	Statutory CIT of foreign affiliates	Wholly and partly owned, linear and quadratic	Large effects for wholly-owned subsidiaries
Ramb and Weichenrieder, 2005	German affiliates of foreign parents in 69 countries 1996-2001	Statutory CIT rate of Germany and foreign parents	Directly/indirectly owned	Only significant for profitable & directly owned firms
Moore and Ruane, 2005	EU multinationals between 2000-2003	ATR, Statutory CIT and AETR per country	Control for regime of double tax relief	Significant effects for all taxes
Buettner et al., 2006	German parents 1996-2004 investing in 24 countries	Statutory CIT rate in subsidiary countries	Explore impact of thin-cap rules in cross-country panel	Significant tax effects, moderated by thin-cap rules
Overesch and Wamser, 2006	German parents 1996-2004 investing in 31 countries	Statutory CIT rates in subsidiary countries	Internal debt; control for thin capitalization rules	Significant effects, mitigated by German thin-cap rules
Huizinga et al., 2008	EU multinationals investing in 33 countries	Marginal tax, Statutory CIT differential and withholding taxes	Subgroups, marginal tax and tax differences	Significant effects of marginal and tax differences
Buettner et al., 2009	German parents 1996-2004 investing in 24 countries	Statutory CIT rate in subsidiary countries	Distinguish internal and external debt	Significant effects for both types of debt
Buettner and Wamser, 2009	German parents 1996-2005 investing in 174 countries	Statutory CIT rate in subsidiary countries	Internal debt; majority-owned and CFCs	Significant but small effects on internal debt

* ATR = average tax rate based on data; AETR = average effective tax rate based on simulations.

Several studies use data on subsidiaries operating in different host countries. Altshuler and Grubert (2003) estimate the impact of the host country‘s corporate tax rate on the leverage ratios of 5,981 U.S. subsidiaries abroad. They find that affiliates in high-tax countries are significantly more financed with debt than affiliates in low-tax countries, but this result is only robust for intracompany loans, not for external borrowing. The estimated coefficients suggest a tax impact on the debt-asset ratio between 0.13 and 0.39. Desai and others (2004)

use other data on U.S. affiliates abroad between 1981 and 1994. They consider both internal and external debt. For the tax variable, they compute the ratio of foreign income tax and foreign pre-tax income and use the median of these rates as country-level observations. Their results suggest that the response of external debt is larger than for internal debt. Yet, this is because the share of external debt to total assets is much larger than the share of internal debt. If one looks at elasticities, i.e., the percentage change in debt of the respective categories, those for internal debt are actually larger than for external debt. Mills and Newberry (2004) match financial data of foreign affiliates with income tax return data in the U.S. In regressing the impact on debt ratios, they use both average tax rates in foreign affiliates and statutory tax rates applying to them. While the estimated coefficient is significant for both tax indicators, the one based on statutory CIT rates is four times as large.

A number of studies use the Midi database of the German Bundesbank on German inward and outward FDI. Mintz and Weichenrieder (2010) use the panel of investment by German parents in affiliates in 68 countries. They distinguish between wholly owned and partly owned firms, consider both linear and quadratic specifications to allow for non-linear tax effects and look at both internal and external debt.[7] Their results suggest significant and large tax effects on capital structure, more so for wholly-owned than for partly-owned affiliates. Buettner and others (2006) analyze the role of thin-capitalization rules for capital structure choice, using the same data but in 24 countries in the period 1996–2004. The results suggest significant tax effects on financial leverage. Buettner and others (2009) extend the panel to more countries and distinguish between internal and external debt. The results suggest that CIT rates exert a significant effect on both internal and third-party debt. Buettner and Wamser (2009) extend the data set further to cover foreign affiliates of German parents in 174 countries. The results suggest a robust impact of tax-rate differences on the use of internal debt. The marginal impact is, however, only in the order of 0.1, which is relatively small. This leads the authors to conclude that other forms of profit shifting are probably more important for German multinationals than profit shifting through changes in financial structure.

Ramb and Weichenrieder (2005) analyze the financial structure of German inward FDI using a panel of more than 8,000 non-financial affiliates. Their analysis considers both intracompany and third-party debt and both directly held and indirectly held affiliates. The estimates suggest small tax effects in general, but these become considerably larger if only profitable firms are considered. Overesch and Wamser (2006) also use German inbound investment to explore the impact of intra-company finance, thereby controlling for German thin-capitalization rules that changed during that period. They report a significant impact of tax rate differences on the use of intra-company debt.

Two studies use a European panel of firms to estimate the impact of taxes on debt ratios. First, Moore and Ruane (2005) assess the impact of taxes on the financial structure of European FDI flows and consider three alternative tax measures: the statutory CIT rate, the

[7] They also report different effects for directly and indirectly held subsidiaries. We only take the results for directly held firms.

average tax rate based on firm-level data, and the forward looking average effective tax rate that is often used in investment regressions. They also control for the system of double-tax relief. The results suggest significant tax effects on the financial structure of FDI. Huizinga and others (2008) include two tax variables simultaneously in their model of capital structure. First, they consider a measure for the marginal tax rate, which should capture the impact on third-party debt. Second, they include a measure for the difference between the national CIT rate for a firm and foreign CIT rates applying to foreign affiliates. Thereby, they also take account of withholding taxes applying to foreign interest and dividend payments. Using a large panel of the Amadeus database, they find that both the national tax rate and the international tax difference have significant and large effects on debt policy of European multinationals.

III. Constructing a Meta Sample

A. Tax Elasticities of Debt

The 19 studies listed in Tables 1 and 2 adopt a variety of approaches and specifications. Therefore, their results cannot be directly compared. For instance, some studies consider the impact of tax variables on the debt-asset ratio, while others estimate the impact on the debt-equity ratio. Moreover, some studies estimate a linear specification, while others consider a quadratic relationship or another non-linear expression. To compare outcomes, we require one common indicator. An obvious candidate would be marginal coefficient that measures the impact of the tax rate on the debt-asset ratio, i.e., ∂ (D/A)/ ∂t. It measures the absolute change in the debt-asset ratio in response to a one percentage-point change in the tax rate. Most studies in fact directly estimate this marginal tax impact. The problem is, however, that estimates apply to different measures of debt. For instance, some refer to intra-company debt, third-party debt, short-term debt or long-term debt, while others take total debt or total leverage (comprising a larger share of corporate liabilities than debt). Obviously, the broader the debt indicator, the larger will be the reported absolute impact on the debt-asset ratio. This complicates comparing estimates. Therefore, we calculate the tax elasticity of debt, $\partial \ln(D/A)/\partial\tau$, which can more easily be compared across debt variables. It measures the percentage change in the debt-asset ratio in response to a one percentage-point change in the tax rate. For studies reporting the marginal tax effect on the debt-asset ratio, the tax elasticity can be calculated by dividing the marginal coefficient by the mean value of the debt-asset ratio reported in the study. For non-linear equations, one generally also needs the mean value of the tax rate to compute the elasticity.

The 267 tax elasticities obtained from these 19 studies comprise our meta sample. Table 3 summarizes its properties. Therein, we make a distinction between studies that rely on variation of tax rates across firms within one country, and studies that use cross-country variation in tax rates. Seven studies of the first type yield 97 tax elasticities of debt. The average elasticity is 0.78, i.e., a one percentage-point higher tax rate raises debt by 0.78 percent. The median is slightly smaller at 0.69. The variation across estimates is large, reflected by a standard deviation of 0.72. Three quarters of the estimates is significantly different from zero at the 5 percent level. Five of the seven studies are published in refereed journals. Twelve studies use cross-section variation in tax rates. Overall, we obtain

170 estimates from these studies. The average tax elasticity of debt in these studies is slightly smaller at 0.58. The median is 0.51. The variation is also smaller, with a standard deviation of 0.43. Of all estimates of the second type, 79 percent is statistically significant. Eight of these studies are published in refereed journals or book chapters.

Table 3. Summary of Tax Elasticities of Debt in Different Studies

Study	Observations	Mean (Median)	Standard Deviation	Percentage significant 1/[b]	Published
Single-country studies					
Graham et al., 1998	1	.52	.00	100	Yes
Graham, 1999	23	.53	.32	83	Yes
Gordon and Lee, 2001 2/[a]	19	.71	.47	84	Yes
Jog and Tang, 2001	12	1.37	.61	50	Yes
Bartholdy and Mateus, 2006	3	2.33	3.21	67	No
Gordon and Lee, 2007	28	.59	.37	75	Yes
Dwenger and Steiner, 2009	11	.88	.37	73	No
Subtotal	97	.78 (.69)	.72	75	
Cross-country studies					
Booth et al., 2001	3	.81	.37	33	Yes
Altshuler and Grubert, 2003	6	.59	.45	83	Yes
Desai et al., 2004	20	.58	.20	100	Yes
Mills and Newberry, 2004	2	.70	.60	100	Yes
Mintz and Weichenrieder, 2005	27	.55	.48	22	Yes
Ramb and Weichenrieder, 2005	8	.11	.18	38	Yes
Moore and Ruane, 2005	5	1.17	.16	80	No
Buettner et al., 2006	7	.59	.37	100	No
Overesch and Wamser, 2006	15	1.22	.81	93	No
Huizinga et al., 2008	35	.53	.13	100	Yes
Buettner et al., 2009	6	.60	.11	100	Yes
Buettner and Wamser, 2009	15	.38	.12	89	No
Subtotal	170	.58 (.51)	.43	79	
Total	267	.65 (.51)	.57	78	

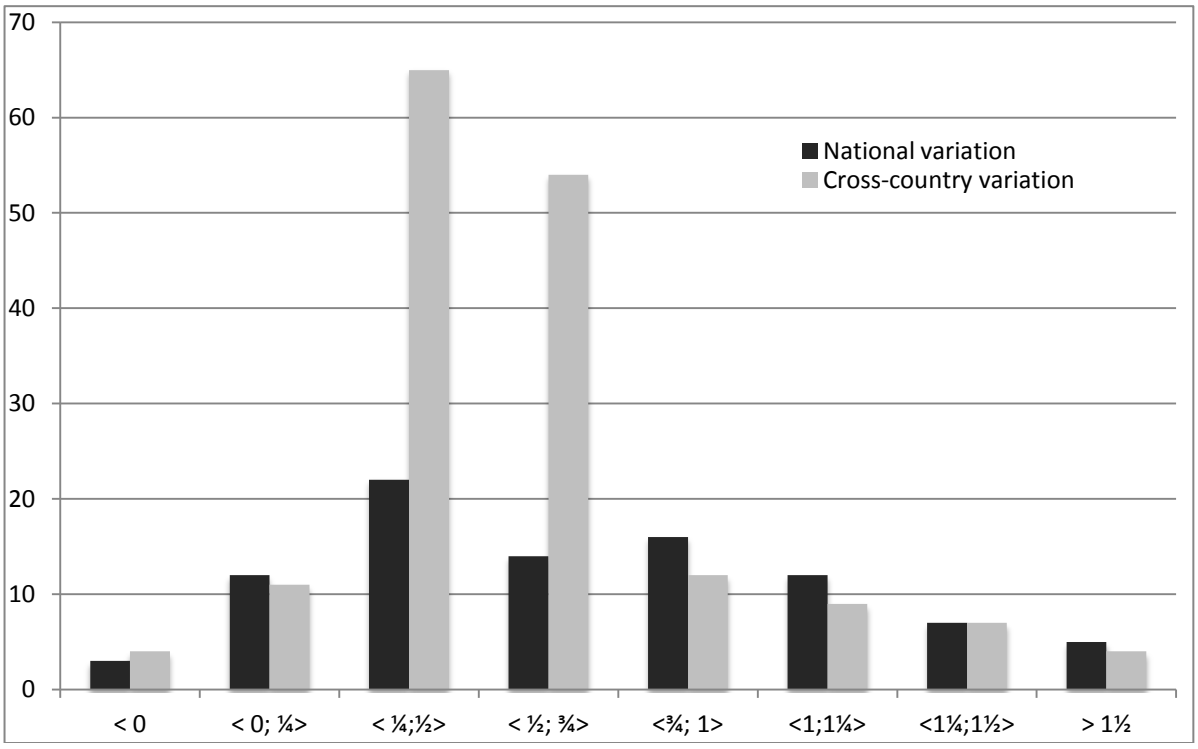
1/Significant means that the estimated coefficient is significant at the 5% level (determined by the reported standard error, the t-value or the p-value of the marginal coefficient).

2/ The results in Gordon and Lee (2001) differ from those in the working paper Gordon and Lee (1999). In our meta regressions, we include both estimates to reduce the risk of publication bias.

The higher average elasticity for single-country studies than for cross-country studies offers little support for the claim that multinationals respond more aggressively to taxes than domestic firms do. One should, however, be careful in drawing this conclusion. Indeed, the distinction is hard to make as national data also include multinationals, while cross-section data capture also the impact on third-party debt. We will later explore in more detail whether different components of debt respond differently to taxes.

Figure 1 shows the frequency distribution of tax elasticities of debt, distinguished by the two groups of studies. The majority of estimates for both types lies between ¼ and ½. Few observations are outside the range between 0 and 1½. The figure also reflects the relatively small variation in results for the cross-country studies.

Figure 1. Frequency Distribution of the Tax Elasticity of Debt



Apart from point estimates used to compute the tax elasticity of debt, we also collect information about standard errors of the estimated elasticities. Yet, it is not always possible to retrieve consistent estimates of standard errors, e.g., when the constructed tax elasticities are derived from more than one estimated coefficient, since the covariance matrix of the estimated elasticity is generally unknown. A simplification is then to assume that off-diagonal elements cancel out. We use this method to compute standard errors.

B. Variation in Study Characteristics

The studies in Table 3 vary in numerous ways. Table 4 shows four dimensions on which we will focus our attention. First, studies differ in their debt indicator. For instance, 87 elasticities are based on the ratio of total debt to assets, while 36 refer to a broader concept of financial leverage. The latter includes not only short- and long-term debt, but also accounts payable to creditors, deferred taxes and other non-debt liabilities. Rajan and Zingales (1995) note that these ratios differ markedly. Indeed, in our meta sample, the average ratio of debt-to-assets is 26 percent, while the average leverage-to-asset ratio goes up to 57 percent. The question is whether this choice matters for the reported tax elasticity. If only debt is responsive to tax and other components of leverage are not, then a study using

debt should yield a larger tax elasticity of debt than a study using leverage. Table 4 shows that, indeed, studies using broad leverage yield an elasticity of 0.64 on average, while studies using total debt yield an elasticity of 0.78. Note that this difference might be caused by other sources of variation that are correlated with the debt indicator. Our meta regressions will be able to identify whether the difference is indeed the result of the choice of debt variable.

Table 4. Analysis of Variation of the Tax Elasticity of Debt

	No. of Observations	MeanTax Elasticity
Variation in debt variables		
Leverage-asset ratio	36	.64
Debt-asset ratio	87	.78
Internal debt	90	.64
External debt	42	.40
Long-term debt	9	.40
Short-term debt	6	1.36
Variation in tax variables		
Statutory tax rate	231	.64
Miller tax term	7	.45
Average tax rate	36	.74
Control for PIT	97	.58
Control for non-debt-tax-shields	110	.66
Variation between countries		
Parent/firm in USA	99	.60
Parent/firm in Germany	102	.63
Parent/firm in Portugal	3	2.33
Parent/firm in Canada	12	1.37
Parent/firm location varies/unknown	51	.54
Variation in publication status		
Published	181	.60
Unpublished	86	.76

A number of studies make a further distinction in the debt variable. For instance, 90 estimates refer to intracompany debt, while 42 refer to third-party debt.[8] Somewhat remarkable, the mean ratio of intracompany debt-to-assets in the meta sample (0.24) and the mean ratio of third-party debt-to-assets (0.35) add up to much more than the ratio of total debt-to-assets (0.26). In fact, it comes close to the ratio of total leverage-to-assets. This is because studies reporting intracompany debt often use the concept of leverage that is more

[8] Huizinga and others (2008) include two tax terms simultaneously in their regression: the marginal tax should capture effects on third-party debt, and the tax differential between the parent and its subsidiaries should capture effects on intracompany debt within the multinational firm. We include both terms in our meta sample, where the former is referred to as an elasticity applying to third-party debt and the latter an elasticity applying to intracompany debt.

broadly defined, i.e., including non-debt liabilities. Table 4 shows that the tax elasticity of intracompany debt in our meta sample is 0.64, while that of external debt is 0.40, on average. Hence, intracompany debt seems to be relatively responsive. This might be plausible as multinational firms may find it relatively easy to restructure their capital in (foreign) subsidiaries in response to tax differences. Indeed, a number of studies suggest that intracompany debt is relatively responsive (Altshuler and Grubert, 2003; Desai and others 2004; Overesch and Wamser, 2006;[9] Mintz and Weichenrieder, 2010). These claims find further support in Egger and others (2010) who show that foreign-owned subsidiaries in Europe exhibit higher debt ratios than domestically-owned subsidiaries, a difference that rises in the statutory CIT rate in the country of the subsidiary. However, there are also studies showing little support for relatively large responses by multinationals (Buettner and Wamser, 2009; Huizinga and others 2008; Ramb and Weichenrieder, 2005). Table 4 thus shows that the elasticities for intracompany debt are smaller than estimates for total debt, but not larger than those for total leverage.

We have collected 9 estimates for long-term debt and 6 for short-term debt. The average tax elasticity for short-term debt is 1.36 while that of long-term debt is 0.40. This difference is consistent across studies, i.e., Gordon and Lee (2001; 2007) and Bartholdy and Mateus (2006). The difference between short and long-term debt is explained by Kane and others (1985) who develop a model of debt maturity and taxes. In the model, short-term debt has the benefit of flexibility, but involves a transaction cost associated with repeatedly renewing debt. High taxes make flexibility more valuable and, therefore, will reduce the maturity of debt. This explains a larger elasticity of short-term debt compared to long-term debt since high CIT rates may induce firms to shift from long-term to short-term debt.

Most studies use variation in statutory CIT rates to identify tax effects. The 231 elasticities yield an average value of 0.64. Thirty-six estimates are based on ex-post average tax rates, computed from firm-level data. On average, they yield slightly larger elasticities, with an average of 0.74. Studies also differ in their treatment of other tax-relevant indicators, such as non-debt tax shields and personal taxes. In particular, studies using simulated marginal tax rates use statutory CIT rates, but then take account of non-debt tax shields in computing the relevant tax indicator. Other studies take statutory CIT rates and use non-debt tax shields as a separate control variable. In total, 106 elasticities take non-debt tax shields into account in some way. On average, these elasticities have a similar value as those not controlling for non-debt tax shields. A number of studies take account of PIT rates in estimating the corporate tax elasticity of debt. This is important if CIT rates are determined simultaneously with PIT rates. Moreover, CIT and PIT may interact in computing the tax advantage of debt, as is revealed by the Miller tax term. Seven estimates use the Miller tax term and report lower than average elasticities. Another 62 estimates control for PIT in a different way and produce elasticities that are close to the sample mean.

[9] The results of Overesch and Wamser (2006) suggest that elasticities are especially large for holding companies, while those for other firms are not particularly large. Mintz and Weichenrieder (2010) report larger effects for wholly-owned than for partially-owned subsidiaries.

The third dimension is country variation. For 99 estimates we know that either the firm (in single country studies) or the multinational parent (in cross-country studies) resides in the U.S. Table 4 shows that these estimates are slightly below the average. The average for the 102 German firms is 0.63 and approximately equal to the sample mean. Estimates for Portugese and Canadian firms are larger, but they both originate from only one single study. The difference in elasticities between countries could be explained by institutional differences. For instance, Germany, Portugal, and Canada exempt foreign profits from tax so that tax relief enjoyed in foreign affiliates fully translates into tax savings for the multinational. In contrast, the U.S. provides a credit for taxes paid abroad so that tax relief in foreign affiliates may have little value for the parent since it will ultimately face the domestic tax. Therefore, one may expect elasticities to be smaller in the U.S. than elsewhere. Yet, tax deferral and excess foreign tax credits may render the U.S. system more similar to a territorial system. Another difference between countries is the scope of the interest deductibility. In particular, Germany has gradually tightened its thin capitalization rules over time and since 2007 adopts earnings stripping rules that limit interest deductibility to no more than 30 percent of earnings before interest, taxes, depreciation, and amortization. Empirical studies reveal that the tightening of these restrictions has had a marked impact on debt ratios (Weichenrieder and 2008; Overesch and Wamser, 2006). Since 1986, the U.S. adopts interest allocation rules, which may also affect the location of borrowing (Altshuler and Mintz, 1995). Overall, it is difficult to determine whether elasticities in one country should be larger or smaller since a variety of institutional differences may affect the responsiveness of companies to tax rates.

The final source of variation across estimates is the status of the underlying publication. In particular, we can make a distinction between estimates in published studies (181 estimates) and unpublished studies (86 estimates). Table 4 shows that elasticities from published studies are slightly smaller on average than those in unpublished studies. The publication status measured in this way may serve as a measure for quality. Indeed, peer review might be a check on the appropriate methodology, specification and data. However, the quality of publication outlets differs. Indeed, some journals adopt higher quality standards than others, although this may not only reflect quality, but also innovations. As an indicator for quality, we use the classification by the Tinbergen Institute, which ranks journals in three classes: (1) generally accepted top-level journals; (2) very good journals covering economics in general and top journals in each field; (3) good journals for all research fields. We assign values of 5, 4, and 3 to these three journals. Journals not listed by the institute and chapters in books receive a value of 2, while unpublished studies receive a value of 1. This quality indicator is used as a control in the meta regressions.

IV. META ANALYSIS

A. Methodology

This section discusses results from the following meta regressions:[10]

$$\varepsilon_{td} = \alpha + \beta X + e$$

Where ε_{td} stands for the tax-elasticity of debt and X is a matrix of study characteristics. The latter contains primarily dummy variables that reflect whether a particular characteristic applies (dummy = 1) or not (dummy = 0). The coefficients β denote the systematic impact of a certain characteristic, relative to some benchmark. The characteristics analyzed in the regressions are those presented in Table 4.

The error term e is assumed to be normally distributed and independent across observations. However, primary studies differ in the precision of the estimated coefficients, e.g., due to different sample sizes. This may cause heteroscedasticity. To remedy this, we first weight all observations by $1/\sigma_\varepsilon$, where σ_ε reflects the standard error of the estimated coefficient. Hence, more precise estimates receive more weight in the meta regressions. This weighted least squares (WLS) estimate also reflects a form of quality control, as more precise estimates may reflect better quality. To check the importance of weighting observations, we also show a meta regression where observations are not weighted, i.e., where weights are all equal to one. Second, we compute heteroskedasticity-robust standard errors using the Huber-White estimator.

A controversial issue in meta-analyses concerns the number of elasticities one includes from one single study. Taking more than one elasticity creates dependence of observations as elasticities are derived from the same data. Yet, Bijmolt and Pieters (2001) show that incorporating within-study variation outperforms procedures that take only one value per study. In the case of the tax elasticity of debt, the within study variation is indeed substantial and provides important information to identify systematic differences between estimates. Therefore, we consider all 267 estimates in our meta regressions. To compare with the alternative of using just one observation per study, we also present a regression where we take the average tax elasticity from each study.[11] Thereby, we concentrate only on characteristics that differ across studies. We also present one regression with study fixed effects, which exploits only the between-study variation.

[10] For a discussion about the value, opportunities, caveats, and problems in using meta analysis in economics, see e.g., Stanley (2001) or Florax and others (2002).

[11] For studies reporting separate elasticities for intra-company debt, third-party debt and total debt, we take three elasticities as they are from independent data (Altshuler and Grubert, 2003; Desai, and others 2004; Huizinga and others 2008; Mintz and Weichenrieder, 2010).

B. Meta Regressions

Table 5 shows the results of seven meta regressions. The dependent variable in the first six regressions is the tax elasticity of debt, while in regression (7) we use the standard error associated with that elasticity. Coefficients for most variables reflect the systematic impact of a certain characteristic, relative to a benchmark that is denoted between parentheses. All regressions include the average sample year of the estimates, except the regression with study fixed effects (as the average sample year is usually fixed within a study). The first column of Table 5 takes one observation per study and exploits only across-study variation. The second column includes study-fixed effects and thus exploits only within-study variation. Column (3) exploits both across-study and between-study variation and includes a number of dummies for study characteristics. Column (4) adds the sample means of the debt-asset ratio and the tax rate to check for non-linear relationships between taxes and debt bias. The debt ratio, however, is highly correlated with the dummies for debt categories and thus changes their estimated coefficients. Column (5) adds the variation in publication quality. Column (6) shows the same meta regression as in column (5), but without weighting observations by standard errors. Finally, column (7) explores the systematic variation in the precision of estimates by regressing standard errors on study characteristics.

We see in Table 5 that estimates based on within-country variation in tax rates are generally larger than those based on cross-country variation, but the difference is not statistically significant. Standard errors for the former group tend to be larger, although the difference with cross-country studies is again not statistically significant. The average sample year of the data in primary studies has a significant positive coefficient in regression (3), (4) and (5). This suggests that the responsiveness of debt structure to taxes is gradually rising over time. The increasing concern for debt bias by revenue authorities therefore seems justified. Standard errors tend to fall over time, reflecting more precise estimates in studies using more recent data.

The coefficient for leverage in columns (3) and (6) is negative, suggesting smaller tax elasticities when broader measures of leverage are used. However, this effect is not significant. The coefficient turns positive in columns (4) and (5) where the mean value of the debt ratio is included. As the leverage-to-asset ratio is, on average, twice as large as the debt-to-asset ratio, the regressions in column (4) and (5) are consistent with a larger elasticity of leverage than for debt. The coefficient for the debt share is statistically significant in regressions (4) and (5). Hence, the tax elasticity tends to be smaller for higher debt-asset ratios. Elasticities for broad leverage measures are more precise than those for debt, which is reflected by the negative coefficient for leverage in column (7).

A robust finding is that elasticity for long-term debt is systematically smaller than for other types of debt. This effect is significant in all regressions. Elasticities for long-term debt are also more precise than those for general debt. The coefficient for short-term debt is generally insignificant, except when we do not weight observations where we find a significant positive coefficient (see column (6)).

Table 5. Meta Regressions on the Tax Elasticity of Debt

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	.90*	1.03***	−.06	−.06	−.08	.58*	.47***
	(.51)	(0.18)	(.26)	(.35)	(.35)	(.32)	(.09)
Single country (cross-country)	−.04		.08	.12	.13	.10	.05**
	(.19)		(.12)	(.14)	(.14)	(.14)	(.02)
Average sample year index (1971 = 1)	.00		.02**	.02***	.02***	.00	−.01***
	(.01)		(.01)	(.01)	(.01)	(.01)	(.00)
Variation in debt variables							
Leverage (all debt)	−.00	.08	−.12	.06	.05	−.41	−.09**
	(.19)	(.06)	(.12)	(.16)	(.16)	(.24)	(.04)
Internal debt (all debt)	.10	.30***	−.11	−.18	−.19	−.07	−.07**
	(.27)	(.06)	(.13)	(.13)	(.13)	(.14)	(.03)
External debt (all debt)	−.07	.20***	−.15	−.13	−.14	−.38***	−.13***
	(.20)	(.06)	(.13)	(.12)	(.12)	(.14)	(.03)
Long-term debt (all debt)		−.51***	−.27*	−.37**	−.37**	−.40	−.12**
		(.18)	(.16)	(.16)	(.16)	(.36)	(.05)
Short-term debt (all debt)		.05	.13	−.01	.00	.54	−.10*
		(.22)	(.20)	(.24)	(.24)	(.38)	(.06)
Debt-asset ratio				−.78*	−0.79*	.71	
				(.46)	(.46)	(.71)	
Variation in tax variables							
Average tax rate (CIT rate)			.29***	.30***	.31**	.20*	−.10**
			(.11)	(.10)	(.10)	(.11)	(.03)
Miller tax term (CIT rate)			−.07	−.05	−.06	−.17	−.03
			(.14)	(.14)	(.14)	(.20)	(.02)
Control for PIT rates (no control)			.21**	.21**	.19**	.01	−.01
			(.09)	(.09)	(.09)	(.15)	(.02)
Control for non-debt-tax-shields (no control)			−.05	−.07	−.06	−.01	−.21***
			(.08)	(.08)	(.08)	(.08)	(.04)
Tax rate				.41*	.43*	.00	
				(.22)	(.22)	(.08)	
Country variation							
Parent/firm in US	.14		.22	.24	.22	−.18	−.02
	(.16)		(.15)	(.15)	(.16)	(.19)	(.03)
Parent/firm in Germany	−.19		.21*	.20*	.21*	.01	.14***
	(.37)		(.12)	(.11)	(.12)	(.16)	(.04)
Parent/firm in Portugal	1.63***		1.40	1.27	1.27	1.56	.15***
	(.40)		(1.58)	(1.59)	(1.59)	(1.45)	(.05)
Parent/firm in Canada	.87***		1.11***	1.03***	1.00***	.50	−.04
	(19)		(.24)	(.24)	(.24)	(.31)	(.08)
Variation in publication status							
Quality publication (rank 1–4)	−.11				.02	−.00	−.02*
	(.11)				(.03)	(.04)	(.01)
Study fixed effects	No	Yes	No	No	No	No	No
No. of observations	24	267	267	267	267	267	267
R-squared	.26	.44	.27	.29	.29	.27	.37

Dependent variable in regressions (1)-(6) is the tax elasticity of debt, in regression (7) the standard error associated with the elasticity; Heteroskedasticity-robust standard errors of the meta regressions between parentheses. Coefficients reflect differences relative to a benchmark assumption stated between parentheses. *, ** and *** indicate significance at 10%, 5% and 1% level. Regressions by WLS (with $1/\sigma_\varepsilon$ as weights), except columns (6) and (7) which are OLS. Column (1) contains only one observation per study.

The coefficient for intracompany debt is neither consistently signed, nor significantly different from zero nor different from the coefficient of third-party debt. Hence, we do not find support for the claim that the responsiveness of intracompany debt is systematically larger than that of external debt. It reflects the ambiguity in the literature as discussed before. Note, however, that regression (2) yields a significant positive coefficient for internal debt, revealing the results from within-study variation. Indeed, studies that directly compare internal and external debt tend to support a larger elasticity for intracompany debt. Yet, this result is not sustained if we include between-study variation. It may suggest that multinationals respond stronger in changing their intracompany debt relative to third-party debt if tax rates change, but that multinationals do not respond stronger in adjusting their capital structure than purely national companies. Regression (7) shows that standard errors for elasticities of both internal and external debt are smaller than those for total debt.

There is systematic variation across estimates with respect to the tax variable used. First, studies using the average tax rate computed from firm-level data, instead of the statutory CIT rate, produce systematically larger tax elasticities. Indeed, the coefficient is positive and significant, except for the regression in column (6) that does not weight observations by standard errors. The standard errors are smaller in studies using average tax rates. Second, estimates for the Miller tax term tend to be slightly smaller, but the difference with the CIT rate is not significant. Third, studies that control for PIT rates yield significantly larger elasticities for the CIT variable. This is an important message for future research as it indicates that regressions ignoring the role of PIT may overestimate the importance of debt bias. Fourth, we see from Table 5 that estimates that control for non-debt corporate tax shields yield smaller elasticities than those that do not control for it, although the difference is not significant in any regression. However, studies with controls yield significantly lower standard errors. Finally, debt bias tends to be non-linear in tax rate. Indeed, the tax rate at which the elasticity is measured exerts a positive effect on the elasticity, suggesting that the responsiveness to tax is larger, the higher is the CIT rate.

There are some systematic differences across countries. For Portugal and Canada, we find a positive and large coefficient, suggesting much larger elasticities. As there is only one study responsible for each of these results (Bartholdy and Mateus (2006) for Portugal; Jog and Tang (2001) for Canada), these estimates may also be interpreted as study-fixed effects. For both the U.S. and Germany, there is a larger number of studies available. We see that studies using data for either the U.S. or Germany yield elasticities that are somewhat larger than studies where the residence of the firm/parent is variable. This may further strengthen the claim that the responsiveness in high-tax countries is larger than in low-tax countries as both the U.S. and Germany feature relatively high CIT rates. Studies using German data yield higher standard errors than those for other countries.

Finally, we see that publication status does not matter systematically. Regression (5) shows that the publication rank exerts a small and statistically insignificant impact on reported tax elasticities.[12] Regression (7) shows that a higher publication rank tends to be correlated with a smaller standard error, reflecting more precise estimates.

[12] We get the same insignificant result if we take the dummy for publication in the regression.

C. Simulated Tax Elasticities

This section simulates tax elasticities of debt. We do this for (1) alternative debt variables, (2) separately for the U.S. and Germany, (3) for high and low tax rates, and (4) for two different years. In the simulations, we use the point estimates from regression (5) in Table 5. Invariant dummy variables are set at the sample means from the meta sample. For respective debt or country variables, we set the dummy variable to which the elasticity refers at 1 and dummy variables to which the elasticity does not refer at 0. The debt-ratio and the tax rate are set at the mean value applying to the relevant category. For example, in simulating the tax elasticity for intracompany debt, we set the dummy for intracompany debt at 1, the dummies for all other debt variables at 0, the debt ratio at its mean in the meta sample of 0.24, and all other dummies at their sample means (i.e., the number of observations in that category as a percentage of the total number of elasticities). We thus obtain simulated tax elasticities for six different types of debt. For country-specific elasticities, we use the sample mean of the debt variable per country and set the relevant country dummy at 1 and dummies for other countries at 0. For different tax rates, we apply the alternative tax rates (33 and 15 percent) and for the specific years different values for the average sample year (1992 and 2011). The simulated tax elasticities are shown in the third column of Table 6. Next to the tax elasticity of debt, we also compute the marginal tax impact on the debt-asset ratio by multiplying with the appropriate debt-asset ratio (shown in the second column of Table 6). The latter is presented in the last column of Table 6. It compares best with the coefficient that is generally reported in primary studies.

Table 6 shows that the simulated tax elasticity for total leverage is 0.5 and for total debt 0.7. Hence, the narrower category of debt liabilities is more responsive to tax than the broader category of liabilities. However, when we compute the marginal tax impact on the debt-asset ratio, we obtain a value of 0.28 for leverage and 0.17 for debt. Hence, the non-debt liabilities tend to respond to taxes too, albeit less than debt liabilities. Therefore, studies using broader measures for financial leverage report higher values for the marginal tax impact. A coefficient of 0.28 would mean that a 10 percent-point lower CIT rate reduces the debt-asset ratio by 2.8 percent, e.g., from 50 to 47.2 percent. Hence, a country with a CIT rate of 36 percent that would fully eliminate the corporate tax advantage of debt, would see the average corporate debt-asset ratio fall by 10 percent, e.g., from 50 to 40.

We see the elasticities for both intracompany debt and third-party debt are similar to those for total leverage, but smaller than that of total debt. Due to the small debt share of intracompany debt compared to third-party debt, the tax impact on the debt-asset ratio for intracompany debt is below that of third-party debt. Table 6 shows that the simulated elasticity for short-term debt is larger than the elasticity of long-term debt.

The tax impact for firms/parents from Germany and the US are larger than those for firms from mixed countries, but the difference is small. At a rate of 33 percent, the consensus tax impact on the debt-asset ratio is 0.19, which drops to 0.16 at a rate of 15 percent. If we use data for 1992, the simulated tax elasticity of the debt asset ratio would be equal to 0.19. Using 2011 data, this value would have risen to 0.3, reflecting an increase in responsiveness over time.

Table 6 Simulated Tax Elasticities

	Debt share	Tax elasticity of debt	Tax effect on debt-asset ratio
Debt variable			
Leverage	.57	.5	.28
Total debt	.26	.7	.17
Intra-company debt	.24	.5	.12
Third-party debt	.36	.5	.17
Short-term debt	.10	.8	.07
Long-term debt	.14	.4	.04
Country			
US debt	.26	.7	.18
German debt	.29	.7	.19
Tax rate			
Debt at 33% rate 1/	.30	.6	.19
Debt at 15% rate	.30	.5	.16
Time			
Debt in year 1992[a]	.30	.6	.19
Debt in year 2011	.30	1.0	.30

Source: Based on Regression (5) in Table 5

1/ Mean value of the meta sample

V. CONCLUSIONS

How responsive is a firm‘s capital structure to the tax advantage of debt? This study uses the largest set of empirical studies available and then applies meta regression techniques to obtain a ‗consensus estimate‘ from the literature. The average tax elasticity of debt is found to be somewhere between 0.5 and 0.7. It corresponds to a tax impact on the debt-asset ratio—the indicator usually estimated in empirical studies—of 0.17 for narrow measures of debt and 0.28 for broad measures of financial leverage. These ‗consensus estimates‘ are on the lower end of the range reported by previous review articles. Still, the effect is sizable and more than three-quarter of the elasticities obtained is statistically significant. Moreover, studies using more recent data report systematically larger elasticities. For instance, for 2011 data one would expect to obtain an impact that is 1.5 times as large as the average found in the literature.

The paper makes an attempt to explain the systematic variation in elasticity values across studies. This yields some lessons for future research on taxation and capital structure. For instance, studies should not only carefully consider the type of debt variable, but also pay due attention to the tax variables they adopt. Indeed, we find that there are significant differences between studies using average tax rates and those using statutory tax rates. Moreover, studies that control for PIT rates on interest and equity yield significantly smaller elasticities than studies ignoring them. Studies that control for non-debt tax shields are systematically more precise, reflected in smaller standard errors of the estimates. We also find support for non-linearities in the tax effect on debt. In particular, firms tend to be more responsive if tax rates are higher. The meta regressions offer some support for systematic differences between

effects on broad indicators of financial leverage and elasticities for more narrow debt categories. However, the often-heard claim that multinationals are relatively responsive in adjusting their internal capital structure compared to firms in adjusting their third-party debt is not sustained. Indeed, we find no systematic difference between the values of elasticities for intracompany debt and third-party debt.

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