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Do Multinationals Shift Internal or External Debt?

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Abstract

Multinational companies can exploit the tax advantage of debt more aggressively than national companies by shifting debt from affiliates in low tax countries to affiliates in high tax countries. Previous papers have either omitted internal debt or external debt from the analysis. We are the first to model the companies' choice between internal and external debt shifting and show that it is optimal for them to use both types of debt to save taxes. Using a large panel of German multinationals, we find strong empirical support for our model. The estimated coefficients suggest that internal and external debt shifting are of about equal relevance. Since the tax variables that determine the incentive to shift internal and external debt are correlated both with each other and with the host country tax rate, previous estimates of the tax sensitivity of debt suffer from omitted variable bias.

JEL-Code: H250, G320, F230.

Keywords: corporate taxation, multinationals, capital structure, international debt-shifting, tax avoidance.

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1 Introduction

Globalization has made tax planning strategies of multinational companies a topic of great importance for practitioners and policy makers alike.[1] High corporate taxes make it profitable to finance investments by debt since interest paid is deductible from corporate profits. Both national and multinational companies benefit from this tax induced advantage of debt. Multinational companies, however, can shift debt from affiliates in low-tax countries to affiliates in high-tax countries so that the tax savings arising from the deductions in high-tax countries exceed the corresponding tax payments in low-tax countries.

Several recent papers find that such international debt shifting is an important aspect of multinational firms' capital structure. They disagree, however, on the mechanism. Huizinga et al. (2008) model the optimal allocation of *external* debt and find that ignoring international debt shifting understates the impact of national taxes on debt policies by about 25 %. Egger et al. (2010) model debt shifting by the use of *internal* debt and find that multinationals have a significantly higher debt-to-asset ratio than national firms, and that this difference is larger in high-tax countries.[2] Both Huizinga et al. (2008) and Egger et al. (2010) use *total* debt, i.e., the sum of internal and external debt, in their empirical analyses. Because of this, the papers do not provide unambiguous empirical evidence in favor of their respective theory models.

To settle this ambiguity, we model the joint allocation of internal and external debt in a multinational company, and show that the optimal debt shifting strategy is always to use both types of debt. Our model also predicts that studies of the tax sensitivity of debt that omit either internal or external debt shifting will suffer from omitted variable bias. Using a large panel of German multinationals where total debt can be split between its internal and external components, we find strong support for our model and prediction. The economic importance of the estimated coefficients can be illustrated by looking at a hypothetical case where a multinational group consists of two affiliates of equal size. If the affiliate located in the country with the highest tax rate experiences a 10 percentage points tax increase, the debt-to-asset ratio will fall by 1.4 percentage points in the low-tax country and increase by 4.6 percentage points in the high-tax country. For a company with an average debt-to-

[1] See Mintz and Weichenrieder (2010) for a recent account.

[2] Internal debt is also a topic in, e.g., Desai et al. (2004), Büttner et al. (2009), and Barion et al. (2010).

asset ratio at the outset, a 4.6 percentage points increase in the debt-to-asset ratio implies a 7.4 % increase in debt. About 40 percent of the increase in debt is due to the tax induced advantage of debt that both national and multinational firms benefit from, while about 60 percent is due to international debt shifting. In the case of international debt shifting we find that the shifting of internal and external debt is of about equal importance.

The financial structure of multinational firms is not determined by tax motives alone, a fact which is incorporated into our model. Important non-tax factors include the use of debt as a disciplining device for overspending managers, and the need to balance indebtedness against the probability of costly bankruptcy. In fact, early studies on firms' capital structure found no or very weak effects of tax incentives on the use of debt.[3] One reason for this may be the lack of variation in corporate tax rates in the time period these studies span. In the early to mid 1980s, however, most OECD countries liberalized their foreign exchange rules, thereby making capital fully mobile internationally. In the wake of this, most OECD countries reformed their tax systems, and the most prominent change being a substantial reduction in statutory corporate tax rates combined with a broadening of the tax base (see Devereux et al., 2002).

The tax sensitivity of debt has recently been established in a string of papers. Desai et al. (2004) analyze the capital structure of multinational corporations, using data from 3,900 U.S. multinationals and their foreign affiliates. The data set distinguishes borrowing from external sources and borrowing from parent companies, but does not allow them to take into account internal capital market transactions between affiliates. Desai et al. (2004) find that a 10 % rise in local tax rates leads to a 2.8 % higher affiliate debt as a fraction of assets. Furthermore, the estimated elasticity of external borrowing with respect to the tax rate is 0.19, whilst the tax elasticity of borrowing from parent companies is 0.35. Their study thus shows that internal debt is more tax sensitive than external debt, and they also find that affiliates in countries with weak creditor rights and shallow capital markets tend to borrow more from their parent companies than from external sources. Since their data does not include internal capital market transactions between affiliates, Desai et al. (2004) cannot study internal lending from affiliates of multinationals that serve as financial coordination

[3]For surveys of this literature see, e.g., Auerbach (2002) and Graham (2003). A notable exception is Mackie-Mason (1990) who avoids the lack of tax rate variation by focusing on whether a firm is near tax exhaustion.

centers performing banking services for the multinational firm. Such centers are widely used among some of the world's largest multinational firms and are located in countries with special tax provisions for such activities (e.g., Belgium). It is likely that their results for this reason underestimate the tax sensitivity of internal debt, all else equal. This would work against a bias from omitting international shifting of external debt.

Mintz and Smart (2004) study corporate taxation when firms operate in multiple jurisdictions and shift income using tax planning strategies. Their model predicts that a multinational firm should use internal debt so that its borrowing occurs in high-tax jurisdictions and declare all interest income in the affiliate located in the jurisdiction with the lowest effective tax rate. This way, the firm maximizes the value of the tax-deductible interest and minimizes the tax paid on interest income within the group. Their model also yields the results that income shifting affects real investments, government tax revenue, and tax base elasticities. The model is tested on Canadian data. Using their preferred estimate, the elasticity of taxable income with respect to tax rates for income shifting firms is 4.9, while for other comparable firms it is 2.3. Büttner and Wamser (2009) study borrowing and lending within German multinational companies. They find - just like Mintz and Smart (2004) - that tax differences within the multinational group have a robust impact on internal debt. They find, however, that the estimated effect is rather small.

Our study is most closely related to Huizinga et al. (2008) who study how differences in national tax systems affect the use of external debt. They assume that the parent firm provides explicit and implicit credit guarantees for the debts of all of its affiliates, and that a higher total debt-to-asset ratio for the group increases the risk of bankruptcy. This leads them to predict that multinational firms will balance external debt across affiliates by taking into account the tax rate in all the countries where they are present. An increase in the tax rate in one country will make it profitable to use more debt in the affiliate located in this country. More debt will, however, increase the risk of bankruptcy for the group. This effect is mitigated by lowering the use of debt in all other affiliates. By shifting external debt this way, multinationals can exploit the debt tax shield more aggressively than national firms while holding the overall risk of bankruptcy in check.

Huizinga et al. (2008) test their model on firm data from 32 European countries in the Amadeus data base covering the years 1994 to 2003. Their empirical investigation shows that tax changes do indeed lead to a rebalancing of debt. For a multinational firm with

affiliates of equal size in two countries, a 10 % overall tax increase in one country increases the debt-to-asset ratio in that country by 2.4 %, whilst the debt-to-asset ratio in the other country falls by 0.6 %. These results are, however, based on variation in total debt, as external debt cannot be isolated in the Amadeus database. It is therefore possible that the use of internal debt in multinational firms confounds the analysis.[4] Our model takes the study of Huizinga et al. one step further by allowing for internal debt. Moreover, we test our model on data that contain information on both internal and external debt. That way we can establish that the incentive to shift external debt does, in fact, affect external debt but not internal debt, and vice versa.

The remainder of this paper is organised as follows: Section 2 outlines the model. Section 3 presents the data set. Section 4 discusses the variables used in the empirical analysis. Section 5 provides descriptive statistics. Section 6 discusses potential endogeneity issues. Section 7 contains our empirical results. Section 8 explores the robustness of our results with respect to various sample and specification choices. Section 9 contains some concluding remarks.

2 The Model

A multinational company (henceforth MNC) is domiciled in country p, but has fully owned affiliates in $i = 1, ..., n$ countries. Without loss of generality we assume that the parent is a pure holding company and that all affiliates are directly owned by the MNC, i.e., there are no ownership chains. Each affiliate has fixed assets K_i and for the purpose of exposition we let this asset be capital used to produce a homogenous good by the production function $y_i = f(K_i)$. Rental costs of capital are exogenous (small country assumption) and equal to r. Capital K_i is financed either by equity E_i, external (third party) debt D_i^E, or internal debt D_i^I from related affiliates. The balance sheet of affiliate i can be stated as $K_i = E_i + D_i^E + D_i^I$, and the balance sheet of the MNC is $\sum_{i \neq p} E_i = E_p + D_p^E + D_p^I$. The MNC provides each

[4]It should be noted that Huizinga et al. (2008) discuss internal debt in an extension to the empirical analysis. In order to explore the robustness of their results, they utilize the tax rate differential between the parent firm and an affiliate. They do not find a significant effect of this variable and conclude that their main result is not affected by the incentive to use internal debt. As will become clear in the next section, it is the tax rate differential to the lowest taxed affiliate that is best suited as a variable to measure the use of internal debt.

affiliate i with the equity necessary to reach both a tax-efficient financing structure and the optimal level of real capital.

The use of external and internal debt leads to different types of benefits and costs for an affiliate.[5] Although internal debt holds many of the same properties as equity, it is, in contrast to equity, tax deductible.[6] However, the use of internal debt is costly due to various tax engineering expenses incurred in order to avoid or relax regulations such as thin capitalization rules and/or controlled-foreign-company (CFC) rules.[7] We adopt the common assumption that the cost functions of external and internal debt are (additively) separable, convex in the debt-to-asset ratios, and proportional in capital employed.[8] Thus, we can express the cost function of internal debt as

$$C^I(b_i^I) = \frac{\eta}{2} \cdot (b_i^I)^2 \cdot K_i, \quad \text{if} \quad b_i^I > 0, \quad \text{and} \quad C^I(b_i^I) = 0, \quad \text{if} \quad b_i^I \leq 0, \tag{1}$$

where $b_i^I = \frac{D_i^I}{K_i}$ represents the internal debt-to-asset ratio in affiliate i, and η is a positive constant.

External debt can be beneficial in reducing informational asymmetries between managers and shareholders and in enforcing discipline on overspending managers (see Jensen and Meckling, 1976; Jensen, 1986). However, too much external debt may induce managers to behave too risk-averse by refraining from profitable investments (Myers, 1977). As pointed out by Kraus and Litzenberger (1973), the preferences given to debt may also lead to excessive borrowing and higher risk of bankruptcy.[9] The costs and benefits of using external debt mean that there is an optimal external debt-to-asset ratio in absence of taxation, which we define as b^* in each affiliate. The cost function for external debt is written as

$$C^E(b_i^E) = \frac{\mu}{2} \cdot \left(b_i^E - b^*\right)^2 \cdot K_i - \frac{\mu}{2} \cdot (b^*)^2 \cdot K_i, \tag{2}$$

[5] See Hovakimian et al. (2004) and Aggarwal and Kyaw (2010) for recent overviews on factors affecting the optimal capital structure.

[6] See Gertner et al. (1994) for a discussion on internal debt and how it relates to external debt and equity. Chowdhry and Coval (1998, pp. 87f) and Stonehill and Stitzel (1969) argue that internal debt should in fact be seen as tax-favored equity.

[7] For a more detailed discussion, see Mintz and Smart (2004) and Fuest and Hemmelgarn (2005).

[8] See, e.g., Fuest and Hemmelgarn (2005) and Huizinga et al. (2008) for similar approaches.

[9] The 'trade-off' theory of capital structures balances bankruptcy costs with returns from the tax shield. See, for instance, Graham (2000), who estimates a tax shield value (before personal taxes) close to 10 % of the value of the firm.

where μ is a positive constant, $b_i^E = \frac{D_i^E}{K_i}$ represents the external debt-to-asset ratio in affiliate i, and the cost function is scaled to be zero when b_i^E is zero.

The use of external debt entails costs to the MNC related to the risk of bankruptcy. The link between external debt shifting and such bankruptcy costs at the holding level was first analyzed by Huizinga et al. (2008) who assume that MNCs are willing to bail out any affiliate facing bankruptcy.[10] We let C_f be the overall bankruptcy cost at the parent level of the MNC. It depends on the firm wide external debt-to-asset ratio defined as $b_f = \frac{\sum_i D_i^E}{\sum_i K_i}$. We also follow Huizinga et al. (2008, p. 94) and assume that overall bankruptcy costs are a convex function of the firm-wide debt-to-asset ratio, and proportional to the MNC's overall assets. The overall bankruptcy cost is specified at the holding level as follows

$$C_f = \frac{\gamma}{2} \cdot b_f^2 \cdot \sum_i K_i = \frac{\gamma}{2} \cdot \frac{\left(\sum_i D_i^E\right)^2}{\sum_i K_i}, \tag{3}$$

where γ is a positive constant.

True and taxable profit in affiliate i, π_i^e and π_i^t, is defined as

$$\pi_i^e = f(K_i) - r \cdot K_i - C^E(b_i^E) - C^I(b_i^I), \quad \pi_i^t = f(K_i) - r \cdot (D_i^E + D_i^I).$$

We assume that the rental costs of equity are not tax deductible as this is the case in most real-world tax systems. Moreover, neither the cost of external nor the cost of internal debt is deductible from the corporate tax base. This is a strong assumption which implies that not all the costs related to the debt-to-asset ratio show up on the income sheet for corporate taxation.[11] However, this assumption is necessary for deriving well-defined structural equations for the empirical investigation and is used in, e.g., Huizinga et al. (2008).

We let V_i^L and V_i^U be the values of an affiliate with and without debt-financing respectively in country i, and define t_i as the statutory corporate tax rate in country i. Affiliate

[10] Gopalan et al. (2007) find that business groups do in fact support financially weaker firms in the group in order to avoid default. They also find that bankruptcy by a group firm gives negative spillovers to other affiliates in the form of a significant drop in external financing, investments and profits, and an increase in the bankruptcy probability.

[11] Note, however, that this assumption does not imply that the costs of debt do not reduce potential withholding and repatriation taxes.

i's profit after corporate taxation in country i is then

$$\begin{aligned}\pi_i &= \underbrace{\pi_i^e - t_i \cdot \pi_i^t}_{=V_i^L} \\ &= \underbrace{(1-t_i)\cdot f(K_i) - r \cdot K_i}_{=V_i^U} + t_i \cdot r \cdot (D_i^E + D_i^I) - C^E(b_i^E) - C^I(b_i^I), \end{aligned} \tag{4}$$

where it is seen from (4) that affiliate specific debt costs, $C^E(b_i^E) + C^I(b_i^I)$, reduce potential dividend payouts.

In a static one-period model such as this, the value of an MNC $\left(V^L\right)$ and the MNC's after tax profit (Π_p) are identical and can be calculated by summing up profits across all affiliates. Repatriated dividends π_i can, in principle, be subject to a non-resident withholding tax, a parent tax rate on repatriated dividends (possibly adjusted for various credit schemes), and the corporate tax rate t_i. However, in the empirical section, we focus on European countries, where the exemption method is in place and where withholding taxes do not matter. Accordingly, we will neglect these issues.

The value of the holding (MNC) can now be written as

$$\Pi_p = V^L = \sum_i V_i^L - C_f = \sum_i \pi_i - C_f. \tag{5}$$

Maximizing Π_p, taking into account that the overall sum of lending and borrowing from related companies must be equal to zero ($\sum_i r \cdot D_i^I = 0$) and applying equations (1) to (4), the maximization problem can be stated as[12]

$$\begin{aligned}\max_{D_i^E, D_i^I} \Pi_p &= \sum_i \Big\{(1-t_i)\cdot f(K_i) - r \cdot K_i + t_i \cdot r \cdot (D_i^E + D_i^I) \\ &- \frac{\mu}{2} \cdot \left(\frac{D_i^E}{K_i} - b^*\right)^2 \cdot K_i - \frac{\mu}{2} \cdot (b^*)^2 \cdot K_i - \frac{\eta}{2} \cdot \left(\frac{D_i^I}{K_i}\right)^2 \cdot K_i \Big\} - \frac{\gamma}{2} \cdot \frac{\left(\sum_i D_i^E\right)^2}{\sum_i K_i} \\ s.t. &\sum_i r \cdot D_i^I = 0,\end{aligned}$$

[12]It can be shown that from the viewpoint of a shareholder in an MNC, maximizing profits of the MNC after global corporate taxation and maximizing the net pay-off on equity investment after opportunity costs and personal (income) taxes, yield identical results under mild assumptions.

The resulting first order conditions are

$$D_i^E : t_i \cdot r - \mu \cdot \left(\frac{D_i^E}{K_i} - b^* \right) - \gamma \frac{\sum_i D_i^E}{\sum_i K_i} = 0, \tag{6}$$

$$D_i^I : t_i \cdot r - \eta \cdot \frac{D_i^I}{K_i} - m \cdot r = 0, \tag{7}$$

where m is the Lagrangian multiplier. This gives the shadow price of shifted interest expenses. In optimum, we have $m = \min_i t_i$. It therefore follows that for the MNC to maximize the internal debt tax shield it should let the affiliate with the lowest effective tax rate conduct internal lending. For illustrative purposes we number the countries such that country 1 has the lowest tax rate, i.e., $\min_i t_i = t_1$.

Examining the condition for internal debt in equation (7), we derive the optimal debt-to-asset ratio in internal debt b_i^I as

$$b_i^I = \frac{r}{\eta} \cdot (t_i - m) = \frac{r}{\eta} \cdot (t_i - t_1) > 0, \forall\ i > 1. \tag{8}$$

The internal debt-to-asset ratio in the financial coordination center $\left(b_1^I\right)$ is zero, since it is not optimal for this affiliate to hold any internal debt. The amount of lending (L_1) conducted by the financial coordination center, is given by

$$L_1 = \sum_{i>1} D_i^I. \tag{9}$$

We see from these two conditions that it is profit maximizing for an MNC to use internal debt and that any analysis that omits internal debt does not model a tax-efficient financing structure.

An important implication of equation (7) is that any affiliate can provide internal debt, not only the parent firm. Furthermore, a tax efficient financing structure implies that it is the affiliate located in the country with the lowest effective tax rate that will be the financial coordination center (or the internal bank; we use these terms interchangeably).[13] This point

[13]Indeed, this seems to explain why countries such as Belgium, Luxembourg and the Netherlands attract so many financial coordination centers of MNCs (see, e.g., Ruf and Weichenrieder, 2009, Table 4). All these countries have special tax rules for financial operations that lead to very low effective tax rates. The absence of source taxes on dividends between EU member states then makes it easy to shift income streams tax free

was first brought forward in Mintz and Smart (2004) who refer to the location of the financial coordination center as a tax haven and to the variable $(t_i - t_1)$ as a net tax advantage. We refer to this variable as the *maximum tax difference* in the empirical part of the paper.

Turning to the optimal external debt-to-asset ratio, b_i^E, we obtain by rearranging equation (6)

$$b_i^E = \beta_0 + \beta_1 \cdot t_i + \beta_2 \cdot \sum_{j \neq i} \rho_j (t_i - t_j), \tag{10}$$

where details are given in Appendix A. We have defined $\beta_0 = \frac{\mu b^*}{\mu+\gamma}$, $\beta_1 = \frac{r}{\mu+\gamma}$ and $\beta_2 = \frac{\gamma r}{(\mu+\gamma)\mu}$. Moreover, $\rho_j = \frac{K_j}{\sum_j K_j}$ denotes the share of real capital employed in affiliate j in total real capital in the MNC.

The external debt-to-asset ratio (10) contains both the standard tax shield mechanism and the external debt shifting mechanism. The former is represented by the second term on the RHS and can be exploited by domestic firms as well. The higher the corporate tax rate in country i, the larger is the external debt tax shield and, all else equal, the higher is b_i^E. The external debt shifting mechanism is given by the third term, the *weighted tax difference*. For a given level of overall bankruptcy costs C_f, it is optimal to allocate external debt in those affiliates that produce the highest absolute tax savings, i.e., in those affiliates that have the largest tax differentials. Then, a tax rate increase in one affiliate leads to an international shifting of external debt, increasing the debt-to-asset ratio in the affiliate experiencing the tax increase (all else equal), but decreasing the debt-to-asset ratio in all other affiliates in order to keep overall bankruptcy costs in check. Note that a given tax change will change the weighted tax difference variable for affiliate i more, the smaller the relative size of affiliate i, since the weighted tax difference is a sum over all $j \neq i$. The intuition is simply that it is the level of debt that matters for the overall bankruptcy cost. When a certain amount of debt is shifted between a large and a small affiliate, the debt-to-asset ratio changes more in the small affiliate than in the large affiliate.

Using the above definitions, the overall debt-to-asset ratio in the financial coordination center is $b_1 = b_1^E + b_{1,}^I = b_1^E$, since $b_{1,}^I = 0$, and its debt-to-asset ratio is given by

$$b_1 = \beta_0 + \beta_1 \cdot t_1 + \beta_2 \cdot \sum_{j \neq 1} \rho_j (t_1 - t_j). \tag{11}$$

across affiliates.

Defining $\beta_3 = \frac{r}{\eta}$ and collecting terms, the total debt-to-asset ratio $b_i = b_i^E + b_i^I$ of affiliate $i > 1$ can then be written as

$$b_i = \beta_0 + \underbrace{\beta_1 \cdot t_i}_{(i)} + \underbrace{\beta_2 \cdot \sum_{j \neq i} \rho_j (t_i - t_j)}_{(ii)} + \underbrace{\beta_3 \cdot (t_i - t_1)}_{(iii)}, \forall\ i > 1, \tag{12}$$

From equation (12) it follows that the debt-to-asset ratio increases in; (i) the domestic tax rate t_i due to the standard tax shield effect; (ii) the capital-weighted tax-differential to all affiliates $\sum_{j \neq i} \rho_j (t_i - t_j)$ due to the overall bankruptcy costs; and (iii) the tax-differential to the financial coordination center $(t_i - t_1)$ due to the use of internal debt. Note that it is crucial for the external debt shifting mechanism (ii) that the parent company guarantees for debt at the affiliate level. If the MNC is not willing to bail out affiliates in need, it is not optimal to shift external debt. The internal debt mechanism (iii) is in that case the only driving force for international debt shifting.

3 Data

We use a micro-level dataset called the Midi data base, provided by the Deutsche Bundesbank, which holds information on German MNCs and private investors.[14] The database contains annual data on inward and outward foreign direct investments of German MNCs. We have used data on German owned corporations since these data contain information on the whole corporate structure of the MNCs, including the internal debt positions of all affiliates. This contrasts, e.g., the Amadeus database used by Huizinga et al. (2008) and others. The Amadeus database does not contain information on internal and external debt, and it is also limited to affiliates located in Europe.

In our analysis, we include foreign affiliates that are at least 50 percent owned by the MNC and have more than three million Euros in total assets.[15] We use data from 1996 to 2006.

Our main sample consists of 33,857 firm-year observations of foreign affiliates of German

[14] A full documentation is given by Lipponer (2009).

[15] From 2002 onwards only companies and investors with more than three million Euros in total assets are required to report to the Deutsche Bundesbank.

MNCs in Europe that belong to corporate groups that only have affiliates in Europe (30 countries). We focus on Europe, partly to make our analysis more comparable to the analysis of Huizinga et al. (2008), and partly because we believe other concerns than those we model may play a larger role for investment decisions outside Europe, such as how developed the financial markets are, the political stability of the country and the level of corruption.[16] Nevertheless, we have also constructed two extended samples. One that includes all affiliates of German MNCs in Europe irrespective of whether the MNC has affiliates outside Europe as well, and one that includes affiliates in all countries where we have complete tax and macro variables (68 countries). These samples are substantially larger, see section 8.2.

The number of observations dropped due to geographic restrictions and our trimming procedures is given in Table 1. We have removed observations with missing values for tax and macroeconomic variables and observations where the debt-to-asset ratios are outside the $[0, 1]$-interval.[17] Following Büttner and Wamser (2009), we have also dropped affiliates with zero sales from the sample so that the analysis is restricted to productive affiliates.

Table 1: Geographic restrictions and trimming procedures

	Number of obs.	Percentage
(1) All observations of foreign affiliates 1996 to 2006	303 871	100 %
(2) Removes affiliates that enter the sample more than once	292 495	96 %
(3) Removes firms with affiliates outside Europe	90 292	30 %
(4) Removes firms where the weighted tax variable cannot be constructed	63 074	21 %
(5) Removes minority owned affiliates	53 096	17 %
(6) Removes affiliates with assets less than 3 million Euro	43 541	14 %
(7) Removes affiliates with zero sales	37 322	12 %
(8) Removes affiliates with missing macro-variables	34 046	11 %
(9) Removes affiliates with debt-to-asset ratio outside the [0,1]-interval	33 857	11 %
Final sample	33 857	11 %

[16] Aggarwal and Kyaw (2010) find a relationship between debt in MNCs and political risk.

[17] When the "weighted tax difference"-variable cannot be constructed (see restriction 4 in Table 1), it is usually because the parent company assets share or tax data are missing.

4 Variable definitions

4.1 Dependent variables

We use three different debt-to-asset ratio variables in our regression analysis. The *total debt-to-asset ratio* (T-DAR) is constructed as the ratio between total non-equity liabilities and total assets.[18] The *internal debt-to-asset ratio* (I-DAR) is constructed as the ratio between liabilities of German foreign affiliates to related parties and total assets, thus including the liabilities to affiliated parties abroad as well as liabilities to German affiliates and the German parent company.[19] The *external debt-to-asset ratio* (E-DAR) is the difference between the total debt-to-asset ratio and the internal debt-to-asset ratio.

4.2 Tax variables

In the main analysis, the *host country tax rate*, t_i, is the host country statutory tax rate. We use tax data collected by the University of Toronto's International Tax program and published in Mintz and Weichenrieder (2010).[20] According to the model predictions, the tax rate variable is relevant for the external debt-to-asset ratio of the affiliates and represents the standard debt tax shield mechanism. The coefficient for this variable is expected to be positive due to the fact that interest payments on debt are tax deductible.

The *weighted tax difference*, $\sum_{j \neq i} \rho_j (t_i - t_j)$, is a weighted sum of statutory tax differences between the tax rate in the country where the affiliate is located (country i) and the tax rate faced by each of its affiliated companies (including the parent which is always German in our case).[21] The weights are the asset share of each of the affiliates in the total assets of the corporate group. Since data on the total assets of the parent company are not available in MiDi before 2002, we use imputed values for the years 1996 to 2001. The imputed values are

[18] We have computed liabilities as "liabilities" plus "other liabilities." It is not entirely clear what is included in the variable "other liabilities", but accruals for pensions are one example. Whether or not "other liabilities" are included have little effect on the empirical results.

[19] Büttner and Wamser (2009) do not count loans from the parent companies in the internal debt ratio as they claim such loans cannot be given for tax reasons. Our model does not justify such a choice, but our findings are robust to excluding parent debt.

[20] We are grateful to Martin Ruf for providing the data to us electronically. For all countries, the rates reflect the general corporate tax rates, including average or typical local taxes.

[21] This is the variable that corresponds to the variable called '*tax incentive to shift debt*' in Huizinga et al. (2008).

based on the first available value for each firm, usually the 2002 value. We have checked that our main results are robust to other imputation procedures. The weighted tax difference variable affects external debt through the external debt shifting mechanism of Huizinga et al. (2008). We expect the coefficient to be positive, meaning that the higher the weighted difference (either due to an increase in the tax rate in the country where the affiliate is located, or due to a decrease in the tax rate in a country where one of the other affiliates is located) the higher the use of external debt.

The *maximum tax difference*, $(t_i - t_1)$, is the difference between the host country tax rate and the group-specific lowest tax rate. This variable is the main determinant for tax-motivated debt shifting by internal debt. The higher the maximum tax difference, the more an affiliate is expected to borrow from the lowest taxed affiliate within the group.

The weighted tax difference and the maximum tax difference variables are defined before we remove observations with missing or outlying values from the sample.

4.3 Control variables

Our theory model focuses on how tax incentives and bankruptcy costs affect the optimal capital structure of MNCs. Obviously there may be other relevant factors that are not included in our model. To account for this, we augment our regression analysis with a set of control variables commonly used in the empirical literature. Our choice is in particular inspired by Rajan and Zingales (1995), Huizinga et al. (2008) and Büttner and Wamser (2009). We also include time and industry dummies, and parent (group) fixed effects. The fixed effects account for unobserved heterogeneity with respect to debt policy between the MNCs included in our sample.

We have been able to construct three firm level control variables:

The *fixed asset ratio* is measured as the ratio of fixed assets to total assets. The relationship between the fixed asset ratio and external debt is ambiguous. Firms with a high ratio of fixed assets to total assets may find it easier to borrow externally using these assets as collateral, as pointed out, e.g., by Rajan and Zingales (1995). However, depreciable assets carry tax deductible allowances that may be a substitute for the tax shield offered by debt, as suggested by DeAngelo and Masulis (1980).

Firm size is measured by sales. More precisely, we control for firm size using dummy

variables for the sales quintile to which a firm belongs in a given year. The smallest firms are in the left-out category. This means that a positive relationship between firm size and debt will show up as positive signs for the rest of the sales quintile dummies. We expect a positive relationship between size and the external debt-to-asset ratio, since large firms may be more diversified and thus less risky borrowers (see, e.g., Frank and Goyal, 2009). Sales are also correlated with cashflow and favorably lending conditions. It is hard to predict the effect of size on firms' internal-debt-to-asset ratio, but to the extent that internal and external debt are substitutes, we might expect a negative relationship.

Loss carryforward is a dummy variable that equals one if the company has losses to be carried forward that can reduce their future tax liabilities. The idea is that the demand for debt tax shields may be lower if there are non-debt tax shields available (MacKie-Mason, 1990). Thus, we expect a negative relationship between the loss carryforward dummy and both internal and external debt-to-asset ratios.

We have also been able to collect data on three country-level factors that are expected to affect the debt-to-asset ratio of the affiliates of MNCs:

Inflation is the annual percentage change in the consumer price index, as reported in the World Economic Outlook Database of the International Monetary Fund. The inflation variable is expected to have a negative effect on the debt-to-asset ratio, since high inflation reduces the real value of interest payments to be deducted and thereby the tax advantage of debt (Mintz and Weichenrieder, 2010). In addition, countries with high inflation tend to have a higher risk premium, something which discourages external borrowing (Huizinga et al., 2008).

Corruption is the level of corruption in each of the host countries as measured by the log of the Bribe Payers Index (BPI), provided by Transparency International. It is meant to serve as a proxy for legal system efficiency and political risk in the host country. The index measures the propensity to pay bribes, and is expressed as a number between 0 and 10, with 10 indicating lowest perceived propensity to pay bribes. Hence, the higher the index, the less corrupt is the country. The corruption variable can be expected to have positive sign (negative effect of corruption on the debt-to-asset ratio) as it can be more difficult to obtain credit in corrupt countries. Also, firms may consider it less safe to borrow money in countries where corruption is a problem. However, corruption may cause firms to substitute external debt for internal debt, since the parent companies, when facing the risk of expropriation, will

prefer to risk the debt of external parties rather than their own debt (Aggarwal and Kyaw, 2008).

Growth opportunities are measured as the median annual sales growth in each industry group in each country. We follow Huizinga et al. (2008) in this respect who find a positive association between growth opportunities measured this way and debt-to-asset ratios. Building on Harris and Raviv (1991), their interpretation is that growth opportunities signal future growth and possibly an ability to borrow. According to Myers (1977), however, highly debt-financed companies are more likely to pass up profitable investment opportunities since the return will mostly benefit existing debt-holders. Firms expecting high future growth should therefore use less debt. This is confirmed by Rajan and Zingales (1995) and others, see Myers (2001). One possible reason why the results differ may be that Rajan and Zingales follow Myers (1977) and use the market-to-book-ratio as a proxy for growth opportunities.

5 Descriptive statistics

Descriptive statistics for the main variables in the European sample are presented in Table 2. The 33,857 affiliate year observations represent 8,191 affiliates that belong to 3,660 parent companies observed for 11 years. There are on average 3.95 observations per affiliate and 9.3 observations per corporate group (parent company). The distribution of the latter is, however, rather skewed. The number of subsidiaries per group varies substantially with the smallest number of observations per group being one, whereas the largest groups have several hundred affiliates.

We separate out the group-specific lowest taxed affiliates in the main sample in order to see whether these have the characteristics that our model predicts. The group-specific lowest taxed affiliates are the affiliates that our model predicts to serve as financial coordination centers in their group, lending money to the parent company and the other affiliates. We see from Table 2 that the lowest taxed affiliates are on average smaller in size, both in terms of assets and sales. More importantly, their net lending is indeed larger than that of the other affiliates, but on average they still have net debt. Their average internal debt (in absolute terms) is about half that of the others. Only 3.8 % of the affiliates have positive net lending. Out of these, 61 % are the lowest taxed affiliates within their group. This suggests that many internal loans are given directly from the parent company, despite the high tax level

in Germany. One explanation for this may be agency costs as pointed out by Dischinger and Riedel (2009).

The average tax rate for the firms in our sample is 31 %, with a standard deviation of 6.2 percentage points. The average for the subsample of the group-specific lowest taxed affiliates is 29.3 %, which is 4 percentage points lower than for the other affiliates. This shows that the dispersion of tax rates in Europe is relatively small. The average value of the weighted tax difference variable is -6.2 %. The negative value reflects that the German parent companies are not included. These companies will typically have a positive weighted tax difference since Germany is a high-tax country.

Finally, we see that the lowest taxed affiliates constitute as much as 56 % of the sample. This is partly because the relatively highly taxed German parent companies are not included, and partly because affiliates belonging to parent companies with only one affiliate or all affiliates in one country, are automatically labeled the lowest taxed affiliate.

Table 2: Summary statistics.

	Full sample		**Lowest tax affiliate**		**Other affiliates**	
	Mean	(St.dev.)	Mean	(St.dev.)	Mean	(St.dev.)
Host country tax rate	0.310	0.062)	0.293	(0.065)	0.333	(0.051)
Weighted tax difference	-0.069	(0.068)	-0.084	(0.069)	-0.051	(0.062)
Maximum tax difference	0.039	(0.058)	0.000	(0.000)	0.089	(0.056)
Total debt-to-asset ratio	0.620	(0.259)	0.604	(0.265)	0.641	(0.249)
External debt-to-asset ratio	0.431	(0.259)	0.432	(0.261)	0.431	(0.258)
Internal debt-to-asset ratio	0.189	(0.236)	0.173	(0.228)	0.210	(0.243)
Internal net lending	-5 431	(62 483)	-3 932	(54 643)	-7 332	(71 148)
Total assets	43 604	(316 448)	40 904	(360 242)	47 028	(250 093)
Sales	43 343	(201 571)	35 563	(153 494)	53 209	(249 210)
Fixed asset ratio	0.295	(0.280)	0.329	(0.289)	0.251	(0.261)
Loss carry forward	0.253	(0.435)	0.251	(0.444)	0.255	(0.436)
Inflation	2.790	(4.620)	3.030	(5.700)	2.510	(2.650)
Log(Corruption index)	1.870	(0.317)	1.85	(0.339)	1.89	(0.285)
Growth opportunities	0.105	(0.151)	0.111	(0.152)	0.098	(0.149)
Number of firm-year obs.	33 857		18 929		14 928	
Number of parent firms	3 660		3 656		1 505	
Number of affiliates	8 191		5 345		4 613	

6 Identification and endogeneity issues

There are three sources of variation in our tax variables that identify the effects on the firms' capital structure. First, corporate tax rates vary across countries and within countries over time. This variation is relevant for all three tax variables. Second, variation in the multinational groups' location patterns will generate variation in the maximum and weighted tax difference variables. Finally, variation in the allocation of capital across affiliates within groups generates additional variation in the weighted tax difference variable. In our theoretical model we have implicitly assumed that all of this variation is exogenous with respect to the firms' internal and external debt-to-asset ratios. This assumption deserves further consideration.

Although large MNCs are influential and likely to lobby for generous tax regimes, we have no reason to believe that the result of this lobbying in a particular country is systematically linked to the use of internal or external debt by the firms that are located there. It is somewhat more plausible that countries on their own initiative respond to the firms' debt shifting strategies by changing their tax regimes. Huizinga et al. (2008) do not, however, find support for such a hypothesis in their study when they instrument the effective tax rate with the countries' population size. Hence, it seems reasonable to assume that corporate statutory tax rates are close to exogenous with respect to the firms' capital structure.

The MNCs' investment decisions represent a greater concern as investment decisions are obviously made simultaneously with capital structure decisions and determine both the location patterns of the firms and their allocation of capital across affiliates. We do not model these decisions. One example of such an endogeneity problem is that firms, using internal debt financing extensively for non-tax reasons, may also find it particularly profitable to set up financial coordination centers in low-tax countries. Our response to this problem is to follow the approach of Huizinga et al. (2008) and include both a set of affiliate specific control variables and a parent specific fixed effect. As discussed by Büttner and Wamser (2009), these variables should, at least to a large extent, control for variation in the internal or external debt ratio that is not caused by tax planning, but that is possibly correlated with our tax variables.

Büttner and Wamser (2009) discuss a related example where an MNC initially does not have an affiliate in a country, but later establishes an affiliate there in response to the tax

rate being lowered below the current minimum tax rate within the group. This change in the location pattern will increase the maximum tax difference variable for all the original affiliates. Büttner and Wamser think of this as an endogenous change in the incentive to engage in debt-shifting that may potentially bias their estimates even when parent specific fixed effects are included in the specification. It is not obvious that this framing is correct. Although the change in the location pattern is clearly an endogenous choice, the resulting change in the tax difference variable reflects a response to an exogenous change in the tax rates. Put differently, when the debt structure of an affiliate changes because a new sister company is established and this changes the tax incentive variables, this is an effect we want to capture. If the sensitivity of the location pattern with respect to taxes varies between MNCs, this might be a concern, but such differences are likely to be permanent and should be absorbed by the parent fixed effects. When controlling for parent fixed effects, we only utilize variation in the tax variables within each multinational group.

7 Empirical results

In this section we test the empirical predictions of our model. We start out analyzing debt-to-asset ratios and potential omitted variable biases before checking that separate regressions for internal and external debt-to-asset ratios yield results that are consistent. In particular, we check whether tax variables that according to our model are irrelevant in these equations have significant explanatory power. In the next section, we discuss robustness with respect to various sample and specification choices.

7.1 The total debt-to-asset ratio

The optimal total debt-to-asset ratio is the sum of the optimal internal and external debt-to-asset ratios and is therefore determined by all three tax variables discussed above. In our regression we build on equations (11) and (12). We add control variables and industry, year and parent (group) fixed effects. We use a dummy variable to account for the difference between the affiliate located in the country having the lowest effective tax rate (the predicted financial coordination center) and the other affiliates in the group. The exact specification is

$$
\begin{aligned}
b_{pit} &= \beta_0 + \beta_1 t_{pit} + \beta_2 \sum_{j \neq i} \rho_{pjt}(t_{pit} - t_{pjt}) + \beta_3 (t_{pit} - t_{p1t}) NLS_{pit} \\
&\quad + \beta_4 NLS_{pit} + \gamma X_{pit} + \delta_t + \sigma_I + \alpha_p + \varepsilon_{pit} \qquad (13)
\end{aligned}
$$

The dependent variable b_{pit} is the total debt-to-asset ratio of affiliate i belonging to parent company p in year t. On the right hand side, t_{pit} is the *host country tax rate* which affects the optimal level of external debt. $\sum_{i \neq j} \rho_{pjt}(t_{pit} - t_{pjt})$ is the *weighted tax difference* variable, which also affects the optimal level of external debt, and $(t_{pit} - t_{p1t})$ is the *maximum tax difference* variable, which affects the optimal level of internal debt. X_{pit} is a vector of firm- and country level control variables, δ_t is a vector of time dummies, σ_I is a vector of industry dummies, α_p is a parent specific fixed effect and ε_{it} is an error term. NLS_{pit} is a dummy variable that is 1 if affiliate pi is **n**ot the **l**owest taxed **s**ubsidiary in the group in year t, and zero otherwise. Hence, it is a dummy for not being a predicted financial coordination center. The interaction between this dummy and the maximum tax difference variable captures the fact that the maximum tax difference variable affects internal debt for all firms except the predicted financial coordination center which should lend out money. The coefficient on the NLS_{pit}- dummy itself should be close to zero. The main parameters of interest are the coefficients β_1, β_2 and β_3. We see from Table 3, columns (1) and (2) that all three are positive and statistically significant at the one percent level. Comparing columns (1) and (2), we see that none of the coefficients appears to be particularly sensitive to the inclusion of firm and country level control variables.

Focusing on Table 3, column (2), we see that when the host country tax rate increases by one percentage point, the direct effect is that the total debt-to-asset ratio of the affiliate increases by 0.197 percentage points. This is very close to the estimate of 0.184 in Huizinga et al. (2008). They call this a "domestic effect", as it is relevant for domestic and multinational firms alike. Next come the two international debt shifting effects that are only relevant for multinational firms. When the weighted tax difference increases by one percentage point, the total debt-to-asset ratio of the affiliate increases by 0.279 percentage points. This estimate is about twice as large as what Huzinga et al. (2008) report based on data from the Amadeus database. Finally, when the maximum tax difference variable increases by one percentage point, the total debt-to-asset ratio of the affiliate increases by 0.120 percentage points.

Table 3: Effect of tax variables on the total debt-to-asset ratio.

	Dependent variable: *Total debt-to-asset ratio*						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tax rate	0.177***	0.197***	0.214***	0.394***	0.465***	-	-
	(0.048)	(0.048)	(0.046)	(0.035)	(0.027)	-	-
Weighted tax difference	0.319***	0.279***	0.291***	-	-	0.468***	-
	(0.048)	(0.048)	(0.045)	-	-	(0.027)	-
Maximum tax diff. x NLS	0.127***	0.120***	-	0.171***	-	-	0.404***
	(0.043)	(0.042)	-	(0.041)	-	-	(0.036)
NLS	-0.014***	-0.013***	-	-0.011***	-	-	-0.005
	(0.004)	(0.004)	-	(0.004)	-	-	(0.004)
Sales quintile 2	-	0.022***	0.022***	0.022***	0.022***	0.022***	0.022***
	-	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Sales quintile 3	-	0.050***	0.049***	0.050***	0.050***	0.049***	0.050***
	-	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Sales quintile 4	-	0.060***	0.060***	0.060***	0.061***	0.059***	0.060***
	-	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Sales quintile 5	-	0.078***	0.079***	0.080***	0.080***	0.078***	0.080***
	-	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Fixed asset ratio	-	0.048***	0.048***	0.048***	0.047***	0.047***	0.046***
	-	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Loss carry forward	-	0.087***	0.087***	0.087***	0.087***	0.087***	0.088***
	-	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Inflation	-	-0.000	-0.001	-0.001	-0.001	-0.000	-0.001
	-	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log of corruption	-	-0.017***	-0.018**	-0.018***	-0.019***	-0.017**	-0.014**
	-	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
Growth opportunities	-	0.015	0.014	0.014	0.012	0.012	0.005
	-	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Lowest tax affiliates excl.	No	No	No	No	No	No	No
Parent, industry and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	33 857	33 857	33 857	33 857	33 857	33 857	33 857
Number of parent companies	3 660	3 660	3 660	3 660	3 660	3 660	3 660
R-square	0.5262	0.5464	0.5462	0.5459	0.5456	0.5459	0.5438

The regressions are estimated by ordinary least squares. The reported standard errors are heteroskedasticity robust and allow for clustering of errors within corporate groups.
* significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

Note that a tax change in any country j where the group has an affiliate will affect the total debt-to-asset ratio in affiliate pi through the weighted tax difference variable. An increase in the host country tax rate increases the weighted tax difference and, thereby, the total debt-to-asset ratio, while an increase in the tax rate in another country decreases the weighted tax difference and thereby the total debt-to-asset ratio. For affiliate pi, a change in the host country tax rate, t_{pit}, by one percentage point will affect the debt-to-asset ratio through all three variables given that pi itself is not the financial coordination center. The total effect will be $\beta_1 + \beta_2(1 - \rho_{pit}) + \beta_3$. The effect is decreasing in the relative size of affiliate pi because shifting a certain amount of external debt from a small to a large affiliate will change the debt-to-asset ratio in the small affiliate more than in the large affiliate.

The coefficients on the control variables are largely as expected. We will discuss these coefficients when estimating their effects on internal and external debt separately in the next two subsections.

Table 4: Correlation matrix.

	Host country tax rate	Weighted tax difference	Maximum tax difference
Host country tax rate	1		
Weighted tax difference	0.4140	1	
Maximum tax difference	0.3782	0.2977	1

The three tax variables discussed above are correlated by construction, and the correlation coefficients are around 0.3 to 0.4, as displayed in Table 4. We see from Table 3, column (2), that the multicolinearity between them does not hinder statistically identifying the effects of each of the three variables separately. However, the correlation will cause an omitted variable bias if one or more variables is left out of the regression. From Table 3, columns (5) to (7), we see that if only one of the tax variables is included, the omitted variable bias is severe. In column (5), where the host country tax rate is the only included tax variable, the bias is 136 %. See, e.g., Jog and Tang (2001) and Mintz and Weichenrieder (2010, ch. 5) for analyses using specifications that lack the tax difference variables.[22] In columns (3)

[22]Note that the specification in Mintz and Weichenrieder (2010, ch. 5) includes affiliate specific fixed effects while we control for fixed effects at the group level. Affiliate fixed effects will absorb a lot more of the variation in the tax variables than group fixed effects, and the two specifications are therefore not directly comparable. The specification used by Jog and Tang (2001) also include variables that may reduce the bias.

and (4) only one of the three tax variables is missing. Except Huizinga et al. (2008), all previous papers using the total (or external) debt-to-asset ratio as the dependent variable, omit the weighted tax difference variable. The omitted variable bias is then about 100 % for the host country tax rate and about 40 % for the maximum tax difference variable. When the maximum tax difference variable is omitted, as in Huizinga et al. (2008), the omitted variable bias is more modest, about 9 % for the host country tax rate and about 4 % for the weighted tax difference variable. It is hard to assess how general these results are with respect to magnitude, but our results clearly suggest that the bias may be substantial.

Table 5: Relative importance of different mechanisms.

	Coef.	Change in t_{it}	ρ_{it}	Percentage point change in total debt-to-asset ratio	Relative contribution
Tax rate	0.197	0.10		1.97	43 %
Weighted tax difference	0.279	0.10	0.5	1.40	31 %
Maximum tax difference x NLS	0.120	0.10		1.20	26 %
Total				4.57	100 %

To further illustrate the economic importance of the three mechanisms discussed above, it may be useful to look at a hypothetical example inspired by Huizinga et al. (2008). Consider a MNC consisting of two affiliates of equal size (implying that ρ_{pit} is 0.5). Assume that the affiliate located in the country with the highest tax rate experiences a 10 percentage point tax increase while all else remains equal. Table 5 reports the results based on our estimated coefficients. We see that the total effect of the tax change is a 4.57 percentage point increase in the debt-to-asset ratio. For a company with an average debt-to-asset ratio at the outset (0.62), this will imply a 7.4 % increase in total debt. If we decompose this effect, we see that the direct effect – where the mechanism is the firm's preference for debt over equity – seems to be the largest. Next comes the external debt shifting mechanism leading to external debt shifting, and, finally, the internal debt shifting mechanism affecting the total debt-to-asset ratio through internal debt. The latter two are of about equal importance. Note that the 1.40 percentage point increase in total debt that is due to external debt shifting, will reduce the total debt-to-asset ratio by 1.40 percentage point for the other affiliate.

7.2 The external debt-to-asset ratio

According to our theory model, external debt is determined by the *host country tax rate* and the *weighted tax difference* variable, while the *maximum tax difference* variable should not be relevant. Based on equation (10), we run the following regression:

$$b_{pit}^{E} = \beta_0 + \beta_1 t_{pit} + \beta_2 \sum_{i \neq j} \rho_{pjt}(t_{pit} - t_{pjt}) + \gamma X_{pit} + \delta_t + \sigma_I + \alpha_p + \varepsilon_{pit}, \tag{14}$$

where b_{pit}^{E} is the external debt-to-asset ratio of affiliate i belonging to parent company p in year t. The other variables are explained in the previous subsection.

We see from Table 6, columns (1) and (2), that both the host country tax rate and the weighted tax difference variable have a positive and significant effect on external debt, although the coefficients are smaller than the estimates we obtain from the total debt-to-asset ratio regression. Comparing columns (1) and (2), we see that the coefficient on the weighted tax difference variable is reduced by about 35 % when the set of control variables is included in the regression. It is the controls for size and inflation that affect the weighted tax difference variable the most. However, even after the inclusion of control variables, the coefficient on the weighted tax difference is of economic significance. We see from column (2) that when the weighted tax difference increases by one percentage point, the external debt-to-asset ratio of the affiliate increases by 0.172 percentage points.

When the host country tax rate increases by one percentage point, the external debt-to-asset ratio increases by 0.147 percentage points. The latter coefficient corresponds to a semielasticity of external debt of 0.34 (evaluated at its mean), i.e., a one percentage point increase in the host country tax rate increases the external debt-to-asset ratio by 0.34 %. Using a specification similar to our column (4), Desai et al. (2004) find that the external debt-to-asset ratio increases by 0.246 percentage points when the host country tax rate increases by one percentage point. This is relatively close to our corresponding estimate in column (4) of 0.296. The corresponding semielasticities are 0.55 and 0.69, respectively.[23]

According to our theory model, the maximum tax difference variable should not affect the external debt-to-asset ratio, and we see from Table 6, column (3), that the coefficients on the maximum tax difference variable and the NLS dummy are indeed very close to zero

[23]The semielasticity implied by the coefficient reported in Desai et al. (2004) is taken from Büttner and Wamser (2009).

Table 6: Effect of tax variables on the external debt-to-asset ratio.

	Dependent variable: *External debt-to-asset ratio*					
	(1)	(2)	(3)	(4)	(5)	(6)
Tax rate	0.132***	0.147***	0.158***	0.296***	-	-
	(0.048)	(0.048)	(0.049)	(0.027)	-	-
Weighted tax difference	0.267***	0.172***	0.188***	-	0.294***	-
	(0.048)	(0.047)	(0.050)	-	(0.026)	-
Max. tax difference x NLS	-	-	0.0084	-	-	0.215***
	-	-	(0.043)	-	-	(0.036)
NLS	-	-	-0.006	-	-	-0.001
	-	-	(0.004)	-	-	(0.004)
Sales quintile 2	-	0.040***	0.040***	0.041***	0.040***	0.040***
	-	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Sales quintile 3	-	0.079***	0.079***	0.080***	0.079***	0.079***
	-	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Sales quintile 4	-	0.106***	0.106***	0.106***	0.105***	0.106***
	-	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Sales quintile 5	-	0.143***	0.143***	0.144***	0.142***	0.144***
	-	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Fixed asset ratio	-	0.012	0.012	0.012	0.012	0.010
	-	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Loss carry forward	-	0.031***	0.031***	0.031***	0.031***	0.031***
	-	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Inflation	-	-0.0011***	-0.0012***	-0.0012***	-0.001***	-0.0012***
	-	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log of corruption	-	0.025***	0.025***	0.025***	0.026***	0.028***
	-	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Growth opportunities	-	0.004	0.004	0.003	0.003	-0.003
	-	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Lowest tax affiliates excl.	No	No	No	No	No	No
Parent, industry and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	33 857	33 857	33 857	33 857	33 857	33 857
Number of parent companies	3 660	3 660	3 660	3 660	3 660	3 660
R-square	0.5146	0.5331	0.5331	0.5329	0.5330	0.5318

The regressions are estimated by ordinary least squares. The reported standard errors are heteroskedasticity robust and allow for clustering of errors within corporate groups.
* significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

In column (4), we show that omitting the weighted tax difference variable will lead to an almost 100 % bias in the coefficient on the host country tax rate. This specification corresponds to the one used by Altshuler and Grubert (2003), Desai et al. (2004), Ruf (2008) and Büttner et al. (2009).

In columns (5) and (6), we demonstrate that both the weighted tax difference variable and the maximum tax difference variable, when included alone, have a coefficient of similar size and significance as that of the host country tax rate in column (4).

All firm-level control variables, except the fixed asset ratio, are highly significant. The signs of the coefficients for the size dummy variables indicate that there is a positive relationship between the size of the firms and their external debt-to-asset ratio. This is as expected and indicates that bigger firms are more diversified and have easier access to external debt. The coefficient on the fixed asset ratio is positive, but never statistically significant. The loss carry forward dummy is both positive and significant. This is the opposite of what we would expect, and indicates that tax shields from the presence of loss carryforwards do not necessarily serve as a substitute for debt tax shields. One simple interpretation is that affiliates experiencing financial difficulties (affiliates with negative loss carryforwards) lose equity and rely more on debt financing (Gopalan et al., 2007).[24] Of the country-level variables, inflation is significant through all the specifications. Its coefficient shows a negative sign. This is as expected, and may be explained by the fact that firms are reluctant to borrow external funds in inflationary, and thus more unstable, environments. Also in more corrupt countries, borrowing from external sources seems to be less attractive, as indicated by the positive coefficient for the log of corruption variable. Our finding here is in line with Aggarwal and Kyaw (2008). We find no significant effect of growth opportunities on the external debt-to-asset ratio.

7.3 Internal debt-to-asset ratio

Our model predicts that internal debt is always part of a tax-efficient capital structure, and that the only relevant tax variable is the *maximum tax difference*, i.e., the tax difference

[24]Inspired by Büttner et al. (2011), we have also tried to interact the loss carryforward dummy with the tax variables and to run separate regressions for firms with and without loss carryforwards. Büttner et al. find that loss carryforwards reduce the firms' tax elasticity with respect to the debt-to-asset ratio. We do not find any clear-cut evidence for this effect in our sample.

between the host country tax rate and the tax rate faced by the lowest taxed affiliate within the group (the predicted financial coordination center). Based on equation (8), we use the following specification:

$$b^I_{pit} = \beta_0 + \beta_1(t_{pit} - t_{p1t}) + \gamma X_{pit} + \delta_t + \sigma_I + \alpha_p + \varepsilon_{pit}, \forall i > 1 \tag{15}$$

The dependent variable b^I_{pit} is the internal debt-to-asset ratio, and the other variables are explained above. We exclude the predicted financial coordination centers from the sample used for this regression, as the internal debt of these centers is described by equation (9), and discussed as part of the descriptive statistics.

The regression results are given in Table 7. We see from columns (1) and (2) that the coefficients on the maximum tax difference variable are not particularly sensitive to the inclusion of firm level control variables. Focusing on column (2), we see that when the maximum tax difference variable increases by one percentage point, the internal debt-to-asset ratio of the affiliate increases by 0.243 percentage points. This is considerably more than the corresponding estimate in the total debt-to-asset ratio regression above. The semielasticity, i.e., the percentage increase in the internal debt-to-asset ratio, evaluated at its mean, is 1.30. This can be compared to the semielasticities of internal debt of 1.02 in Desai et al. (2004) and 0.69 reported in Büttner and Wamser (2009).[25] Note that Büttner and Wamser subtract internal loans from the German parent companies when they calculate the internal debt ratio and this reduces their left hand side variable considerably.

According to our theory model, the host country tax rate and the weighted tax difference variable should not affect the internal debt-to-asset ratio. In Table 7, column (3), we test this prediction. We see that the coefficient on the host country tax rate fits the prediction perfectly, while the coefficient on the weighted tax difference variable is slightly higher than the coefficient on the maximum tax difference variable and significant at the ten percent level. One reason for this may be that our structural model is too stylized, and does not capture the fact that other concerns than taxes also influence where an MNC places its financial coordination center. This will create measurement error in our maximum tax difference variable. An example of such a concern may be the financial infrastructure offered at various

[25]The semielasticity implied by the coefficient reported in Desai et al. (2004) is taken from Büttner and Wamser (2009).

Table 7: Effect of taxes on the internal debt-to-asset ratio.

	Dependent variable: *Internal debt-to-asset ratio*				
	(1)	(2)	(3)	(4)	(5)
Tax rate	-	-	0.003	-	0.285***
	-	-	(0.102)	-	(0.052)
Weighted tax difference	-	-	0.162*	0.282***	-
	-	-	(0.090)	(0.048)	-
Maximum tax difference	0.206***	0.243***	0.146***	-	-
	(0.041)	(0.040)	(0.057)	-	-
Sales quintile 2	-	-0.004	-0.004	-0.004	-0.003
	-	(0.007)	(0.007)	(0.007)	(0.007)
Sales quintile 3	-	-0.027***	-0.026***	-0.027***	-0.026***
	-	(0.008)	(0.008)	(0.008)	(0.008)
Sales quintile 4	-	-0.055***	-0.055***	-0.055***	-0.054***
	-	(0.008)	(0.008)	(0.008)	(0.008)
Sales quintile 5	-	-0.070***	-0.070***	- 0.070***	-0.070***
	-	(0.008)	(0.008)	(0.008)	(0.008)
Fixed asset ratio	-	0.048***	0.050***	0.049***	0.049***
	-	(0.013)	(0.013)	(0.013)	(0.013)
Loss carry forward	-	0.060***	0.059***	0.060***	0.060***
	-	(0.005)	(0.005)	(0.005)	(0.005)
Lowest tax affiliate excl.	Yes	Yes	Yes	Yes	Yes
Parent, industry and year fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	14 928	14 928	14 928	14 928	14 928
Number of parent companies	1 505	1 505	1 505	1 505	1 505
R-square	0.3834	0.4019	0.4022	0.4019	0.4017

The regressions are estimated by ordinary least squares. The reported standard errors are heteroskedasticity robust and allow for clustering of errors within corporate groups.
* significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

locations. Moreover, so far we have based our analysis on statutory tax rates that are not adjusted for special tax regimes designed to attract financial coordination centers. In cases where the financial coordination center is not located in the lowest taxed affiliate according to statutory tax rates, the weighted tax difference variable may be a better proxy for the relevant tax difference.

Looking next at potential omitted variable biases, columns (4) and (5) show that when the maximum tax difference variable is omitted, either two of the other tax variables will pick up the effect with a coefficient of similar size and significance level.

All control variables are significant. Contrary to the effect of size on external debt, the effect of size on internal debt is negative. If internal and external debt can be considered as substitutes (Desai et al., 2004, Büttner et al., 2009), this may indicate that bigger firms have easier access to external finance and thus less demand for internal debt. Looking back at the effect of size on total debt estimated in Table 3, we see that the positive effect of size on external debt dominates. The sign of the fixed asset ratio coefficient is positive, something which contradicts the idea that depreciation allowances and debt are substitutable forms of tax shields. Our finding here is in line with Rajan and Zingales (1995).[26] The coefficient for the loss carryforward variable is positive and significant. This is similar to the effect on the external debt-to-asset ratio that we discussed above

8 Robustness tests

8.1 Adjustment for preferential tax regimes and CFC rules

The results in the previous section show that all three tax mechanisms in our model are significant and well identified, but the economic importance – particularly of the internal debt mechanism – is relatively modest. There may be several reasons for this. One possibility is simply that debt shifting is not a very important vehicle for tax avoidance. Another possibility is that statutory tax rates are not a good approximation for the effective tax rates relevant for firms' debt shifting decisions. This will create measurement error in our tax variables that will bias the estimated coefficients towards zero. A particular concern is that some countries provide widespread tax benefits for the internal banks or financial

[26] See also DeAngelo and Masulis (1980).

coordination centers that are at the heart of the internal debt mechanism. Examples of such preferential tax regimes are the coordination center regime in Belgium, the coordination center and special financial institution regimes in the Netherlands, the coordination center and financial holding regimes in Luxembourg and the management companies regime in Switzerland (see, e.g., Malherbe, 2002). Under the Belgian system, for example, the tax base of financial coordination centers consists of business expenses minus wages and financial costs, rather than profit. If a German MNC locates an internal bank in a country with a preferential tax regime for financial coordination centers, we will not capture this when we calculate the maximum tax difference variable. This is because the average statutory tax rates used in the previous analyses are relatively high in all of these countries. A quick check through available company registers in the Netherlands, Belgium and Luxembourg reveals that many large German MNCs do have financial service affiliates or coordination centers in either Belgium, the Netherlands or Luxembourg.

In order to explore whether the relatively small coefficient on the maximum tax difference variable is due to measurement errors, we try to adjust our statutory tax rates for companies involved in financial service and holding activities in Belgium, the Netherlands, Luxembourg and Switzerland. For the selected companies, we adjust the tax rate down to 10 %. This choice is based on available micro data for Norwegian companies that have financial coordination centers in these countries and pay an average corporate tax of about 10 % of their profit.[27]

Regression results for the total debt-to-asset ratio with adjustment for Preferential Tax Regimes as explained above are presented in the column labeled 'PTR' in Table 8. We see that our results are robust to this adjustment. The coefficient for the tax rate variable has gone up. However, the coefficients on the weighted tax difference and maximum tax difference variables have become somewhat smaller. This suggests that our adjustment may have increased rather than decreased the extent of measurement error in the tax rates. One likely reason for this is that an adjustment procedure based on country and industry classification alone is too rough. It is, for example, possible that the use of financial coordination centers is limited to large MNCs. However, restricting the sample to affiliates of particularly large parent companies does not change the results. Another reason may be the German

[27]The data source is the Annual Reports of International Activity to the Norwegian Directorate of Taxes ('Utenlandsoppgaven'). No reliable source for the effective tax rate for German companies was found.

Table 8: Preferential tax regimes and CFC-rules

	Original (1)	PTR (2)	PTR/CFC (3)
Tax rate	0.196***	0.226***	0.001**
	(0.048)	(0.046)	(0.000)
Weighted tax difference	0.279***	0.236***	0.171***
	(0.048)	(0.047)	(0.046)
Maximum tax diff. x NLS	0.120***	0.083**	0.098***
	(0.043)	(0.034)	(0.033)
NLS dummy	-0.013***	-0.009**	0.003
	(0.004)	(0.004)	(0.004)
Lowest tax affiliates excl.	No	No	No
Parent, industry and year fixed effects	Yes	Yes	Yes
Number of observations	33 857	33 857	33 857
Number of parent companies	3 660	3 660	3 660
R-square	0.5456	0.5462	0.5437

The dependent variable is the total debt-to-asset ratio. PTR implies control for Preferential Tax Regime rules. CFC implies control for Controlled Foreign Corporation rules. The regressions are estimated by ordinary least squares. The reported standard errors are heteroskedasticity robust and allow for clustering of errors within corporate groups.
* significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

Controlled Foreign Corporation rules (CFC rules) that restrict the possibility to exploit preferential tax regimes. Ruf and Weichenrieder (2009) assess the working of these rules and conclude that they are quite effective. In very general terms, German CFC rules apply to the passive investment income of foreign affiliates of German firms that are effectively taxed by a corporate tax of less than 25 % (less than 30 % before 2001). Passive investment income includes interest income from intra-group financing. Income that falls under the CFC rules is taxed by the German corporate tax rate, which has been one of the highest in Europe. Inspired by Ruf and Weichenrieder (2009), we used the following procedure to adjust for the effect of the CFC rules: We assume that the CFC-rules are relevant for companies with positive net lending, and adjust the tax rate up to the German corporate tax rate for these affiliates if, in absence of the CFC-rules, they would face a tax rate lower than the accepted minimum. As we can see from the column labeled 'PTR/CFC' in Table 8, this adjustment fails in the sense that the coefficients on the tax rate and weighted tax difference variables become even smaller than with the PTR-adjustment alone. With this adjustment, however, the maximum tax difference variable is slightly larger than with the PTR adjustment alone.

Overall, we conclude that the statutory tax rates we use in the main analysis are the best

available approximation to the effective tax rates faced by MNCs. This is not to deny that preferential tax regimes may be important. It is rather to admit that the data we have are not rich enough to construct firm specific effective tax rates. Therefore, we should emphasize again that our estimates in Tables 3, 7 and 6 are downward biased by measurement error to the extent that the effective corporate tax rates deviate from the statutory tax rates.

8.2 Extended sample

In the main analysis, we have restricted the sample to German MNCs that have all their affiliates within Europe. The reasons for this are discussed in section 3, but it implies that large MNCs with activities worldwide are under-represented. It is therefore important to check whether our results are sensitive to this sample choice.

In this section, we run the main regressions on two extended samples, a "World sample" and an "extended European sample." These samples are about three times larger than the original sample. The World sample includes affiliates in all countries where we have complete tax data and other necessary macro variables (68 countries).[28] The extended European sample is constructed by following Huizinga et al. (2008), i.e., we include all affiliates of German MNCs in Europe (30 countries), irrespective of whether the MNCs also have affiliates outside Europe. We calculate the tax variables as if the affiliates outside Europe were not relevant. Huizinga et al. (2008) are forced to proceed this way since they do not have information about affiliates outside Europe. The procedure implicitly assumes that financial markets in non-European low-tax countries are not developed to the extent that MNCs want to use them for financial coordination purposes.

[28]In the World sample, we only include affiliates that belong to corporate groups that have all affiliates located within the 68 countries covered. Without this restriction, the sample size increases by about 25,000 observations. As compared to Table 9, columns (7) to (8) below, the coefficients on the weighted tax difference variable then fall notably, and become insignificant. The other coefficient stays about the same.

Table 9: Extended samples

	Original European sample			Extended European sample			World sample		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	T-DAR	E-DAR	I-DAR	T-DAR	E-DAR	I-DAR	T-DAR	E-DAR	I-DAR
Tax rate	0.197***	0.147***		0.209***	0.206***		0.217***	0.202***	
	(0.048)	(0.048)		(0.034)	(0.032)		(0.031)	(0.029)	
Weighted tax difference	0.279***	0.172***		0.211***	0.199***		0.139***	0.092***	
	(0.048)	(0.047)		(0.033)	(0.031)		(0.030)	(0.028)	
Maximum tax difference x NLS	0.120***		0.243***	0.149***		0.127***	0.028		0.077***
	(0.042)		(0.040)	(0.024)		(0.018)	(0.017)		(0.014)
NLS	-0.013			-0.009***			-0.009***		
	(0.004)			(0.003)			(0.002)		
Control variables included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lowest tax affiliate excluded	No	No	Yes	No	No	Yes	No	No	Yes
Parent, industry and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	33 857	33 857	14 928	88 861	88 861	59 148	105 772	105 772	72 904
Number of parent companies	3 660	3 660	1 505				5 904	5 904	3 287
R-square	0.546	0.533	0.402	0.419	0.435	0.289	0.432	0.439	0.301

The regressions are estimated by ordinary least squares. The reported standard errors are heteroskedasticity robust and allow for clustering of errors within corporate groups.
* significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

The regression results are reported in Table 9. For comparison, columns (1) to (3) summarize the main results from our previous analyses. Columns (4) to (6) give results from the extended European sample while columns (7) to (9) give results from the World sample. We see that the coefficients estimated from the extended European sample are relatively close to the coefficients from the original sample, but they are more precisely estimated and the model performs better in the sense that the coefficients from the external and internal debt-to-asset ratio regressions are quite close to the corresponding coefficients from the total debt-to-asset ratio regressions. The improved fit is most likely due to the larger sample size, but it could also be that the small MNCs, which are over-represented in the original sample, engage less in tax planning. We explore this question further in the next section.

When including affiliates outside Europe, the results are qualitatively the same as before, but the model appears to perform less well. The cross-equation restrictions are further from being fulfilled, and the coefficients on the weighted tax difference and the maximum tax difference are much smaller. The maximum tax difference variable actually turns insignificant in the total debt-to-asset ratio regression. These results are consistent both with the idea that the data quality is better for European countries, and that concerns other than those we model may play a role for investments outside Europe. Relevant concerns not modeled may be how developed the financial markets are, the political stability of the country and the level of corruption. Additionally, withholding taxes, which we disregard in our structural model, also become relevant in a sample that includes non-European countries.

8.3 Splitting the sample into small and large MNCs

Large MNCs may both have more opportunities to engage in tax planning and lower costs associated with tax planning. In this subsection, we explore this issue by splitting the original European sample into large and small MNCs. In Table 10, columns (1) and (2), we split according to the number of foreign affiliates; in columns (3) and (4), we split according to the total assets of the group. Overall, we see that the results for small and large MNCs are quite similar, particularly when splitting the sample into below and above median assets (65 million Euro). When splitting according to the number of affiliates, we see that the estimated coefficients are somewhat smaller for MNCs with only one or two foreign affiliates. These MNCs constitute 43 % of the sample. Note that the parent company fixed effect in

this subsample is close to an affiliate fixed effect and absorbs a lot of the total variation in the debt-to-asset ratio.

Table 10: Small vs large MNCs

	(1) Small MNCs $\leqslant$ 2 affiliates	(2) Large MNCs $\geqslant$3 affiliates	(3) Small MNCs $<$ 65 mln Euro	(4) Large MNCs $\geqslant$65 mln Euro
Tax rate	0.121**	0.281***	0.216***	0.206*
	(0.056)	(0.087)	(0.056)	(0.107)
Weighted tax difference	0.230***	0.346***	0.215***	0.295***
	(0.061)	(0.079)	(0.062)	(0.101)
Maximum tax difference x NLS	0.026	0.052	0.137**	0.130**
	(0.102)	(0.053)	(0.065)	(0.058)
NLS	0.003	-0.021***	-0.008	-0.019***
	(0.009)	(0.005)	(0.007)	(0.006)
Control variables included	Yes	Yes	Yes	Yes
Lowest tax affiliate excluded	No	No	No	No
Parent, industry and year fixed effects	Yes	Yes	Yes	Yes
Number of observations	14 553	19 304	16 914	16 943
R-square	0.733	0.426	0.645	0.457

The dependent variable is the total debt-to-asset ratio. The regressions are estimated by ordinary least squares. The reported standard errors are heteroskedasticity robust and allow for clustering of errors within corporate groups.
* significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

8.4 Non-linear tax responses

All regression equations derived from our theory model are linear in the tax variables. This linearity is a result of the quadratic functional form chosen for the cost functions. We have, in this respect, followed the previous literature. It is, however, not obvious that the firms' response is linear. It might be, e.g., that firms can exploit tax differences almost costlessly up to some point, let us say where thin capitalization rules become binding, and that further increases in the debt-to-asset ratio have almost prohibitive costs. It is also possible that for higher tax rates the marginal impact on debt financing is reduced as the findings of Mintz and Weichenrieder (2010, ch. 5.2) suggest. In order to explore this, we try out two simple non-linear specifications. We start out by looking at the total debt-to-asset ratio regression. Table 11, column (1), restates our baseline specification, while column (2) shows the result of introducing a second order term in all tax variables. We see that the linear specification

is well supported by the data. Only one of the three second order terms is significant, and the significance level of this coefficient is only ten percent. In column (4) we look at the internal debt-to-asset ratio regression. Also in this case, the second order specification is insignificant, and it is very close to zero.

If choosing a cubic cost function, it is possible to derive a closed form solution for the internal debt-to-asset ratio equation. As compared to a quadratic cost function, the cubic cost function allows the costs to increase more slowly at first, and then more steeply after a certain point. It is easy to show that this implies that the internal debt-to-asset ratio will be a function of the square root of the maximum tax difference. This specification is used in column (5). We see that it performs about as well as the linear specification, but when introducing a linear term in addition to the square root term in column (6), we see that it is the linear term that comes out as significant. Taken together, our analyses strongly suggest that the linear specification used in our main analysis is a satisfactory approximation to reality.

9 Concluding remarks

What shapes a tax-efficient financing structure for a multinational company is a central issue in economic theory, and a practical question for multinationals with affiliates in different countries. The literature in this field has established that multinational companies use both internal and external debt, and that the debt-to-asset ratio of a multinational company depends on tax factors and agency- and bankruptcy costs. Despite this fact, no single paper in the literature studies both internal and external debt in combination with taxes and bankruptcy costs. We have developed a model that incorporates all these mechanisms and test the empirical implications of this model using the MiDi database provided by the Deutsche Bundesbank.

Two of the tax mechanisms we investigate influence the debt-to asset ratio of the affiliates by affecting the external debt-to-asset ratio. These are the standard debt tax shield mechanism relevant for national and multinational firms alike, and an external debt shifting mechanism recently proposed by Huizinga et al. (2008). The former depends on the tax rate alone, the latter on a weighted tax difference between the local tax rate and the tax rate facing all other affiliates in the group. International shifting of internal debt is determined

Table 11: Non-linear specifications

	(1) T-DAR	(2) T-DAR	(3) I-DAR	(4) I-DAR	(5) I-DAR	(6) I-DAR
Tax rate	0.196***	0.307**				
	(0.047)	(0.149)				
$(\text{Tax rate})^2$		-0.203				
		(0.239)				
Weighted tax difference	0.279***	0.369***				
	(0.048)	(0.068)				
$(\text{Weighted tax difference})^2$		0.380*				
		(0.208)				
Maximum tax difference x NLS	0.120***	0.190*	0.243***	0.233***		0.432**
	(0.042)	(0.105)	(0.040)	(0.109)		(0.176)
$(\text{Maximum tax difference})^2$ x NLS		-0.382		0.045		
		(0.468)		(0.475)		
$\sqrt{\text{Maximum tax difference}}$ x NLS					0.128***	-0.109
					(0.023)	(0.099)
NLS	-0.013***	-0.016***				
	(0.004)	(0.005)				
Control variables included	Yes	Yes	Yes	Yes	Yes	Yes
Lowest tax affiliate excluded	No	No	Yes	Yes	Yes	Yes
Parent, industry and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	33 857	33 857	14 928	14 928	14 928	14 928
Number of parent companies	3 660	3 660	1 505	1 505	1 505	1 505
R-square	0.546	0.546	0.402	0.402	0.402	0.402

The regressions are estimated by ordinary least squares. The reported standard errors are heteroskedasticity robust and allow for clustering of errors within corporate groups.
* significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

by the tax difference between the local tax rate and the tax rate of the lowest taxed affiliate within the group.

Regressing the total debt-to-asset ratio on these tax mechanisms shows that all of them are relevant, and that their effect can be identified separately despite the variables being correlated by construction. However, the correlations cause a severe omitted variable bias if one or more variables is left out.

We illustrate the economic importance of the estimated coefficients by analyzing a hypothetical example inspired by Huizinga et al. (2008). Consider a multinational group consisting of two affiliates of equal size (implying that ρ_{pit} is 0.5). If the affiliate located in the country with the highest tax rate experiences a 10 percentage point tax increase while all else remains equal, the total effect of the tax change is a 4.57 percentage point increase in the total debt-to-asset ratio. For a company with an average debt-to-asset ratio at the outset this implies a 7.4 % increase in total debt. The direct effect – where the mechanism is the firm's preference for debt over equity – is the largest. Next comes the external debt shifting mechanism leading to external debt shifting, and, finally, the internal debt mechanism affecting total debt-to-asset ratio through internal debt. The latter two are of about equal importance.

We have tested the robustness of our results in a number of ways. Splitting the sample into large and small MNCs, we find only minor differences in the tax response between the two groups. Allowing for non-linearities in the tax response, we find that our linear specification is well supported. Extending the sample, utilizing all affiliates of German MNCs in Europe, irrespective of whether the MNC also has affiliates outside Europe, we obtain coefficients that are close to those estimated on the original sample, but that are more precise. Moreover, the model performs better in the sense that the coefficients from the external and internal debt-to-asset ratio regressions are quite close to the corresponding coefficients from the total debt-to-asset ratio regressions. Extending the sample further, including MNCs with affiliates in all 68 countries for which we have complete tax and macro data, we obtain results that are qualitatively the same as in the original sample, but with the external debt shifting mechanism and internal debt mechanisms being less pronounced. We speculate that the data quality is better for European countries, and that concerns other than those we model may play a larger role for investment decisions outside Europe.

We also check robustness with respect to adjusting the tax variables to preferential tax

regimes for financial service affiliates in the BeNeLux countries and Switzerland. This leads to a decrease in size for the weighted and maximum tax difference coefficients. When we make a further adjustment to allow for German CFC rules, the coefficient for the internal debt mechanism is lower than in the original regression, but higher than in the regression where only preferential tax regimes were controlled for. The coefficients for the two other tax variables become considerably smaller. These results may partly reflect that our adjustment procedure, based on country and industry classification, is too rough, and partly that the German CFC rules are effective in restricting the possibility to exploit preferential tax regimes as concluded by Ruf and Weichenrieder (2009). Overall, it seems that the statutory tax rates we use in the main analysis are the best available approximation to the effective tax rates faced by MNCs. This is not to deny that preferential tax regimes and other special rules such as CFC may be important. It is rather to admit that the data we have are not rich enough to construct firm specific effective tax rates. Our main estimates are therefore likely to be downward biased by measurement error.

Appendix A Optimal external debt-to-asset ratio

In order to derive the optimal debt-to-asset ratio of affiliate i in external debt, b_i^E, we start by reordering the first order condition (6) to

$$\mu \cdot b_i^E = \mu \cdot b^* + t_i \cdot r - \gamma b_i^E \cdot \rho_i - \gamma \cdot \sum_{j \neq i} b_j^E \cdot \rho_j, \tag{16}$$

where $\rho_i = \frac{K_i}{\sum_i K_i}$ represents the share of real capital employed in affiliate i in total real capital employed by the MNC.

Subtracting equation (6) evaluated for affiliate j from equation (6) evaluated for affiliate i delivers

$$b_j^E = b_i^E - \frac{t_i - t_j}{\mu} \cdot r \tag{17}$$

Applying (17) in (16), this leads to

$$\begin{aligned} \mu \cdot b_i^E &= \mu \cdot b^* + t_i \cdot r - \gamma \cdot b_i^E \cdot \rho_i \\ &- \gamma \cdot b_i^E \cdot \sum_{j \neq i} \rho_j + \gamma \cdot \sum_{j \neq i} \frac{t_i - t_j}{\mu} \cdot r \cdot \rho_j. \end{aligned} \tag{18}$$

Note that these rearrangements necessarily require potential withholding taxes to be equalized across all countries. This holds true both for our modeling and for the approach taken in Huizinga et al. (2008).

Since

$$\sum_{j \neq i} \rho_j = \sum_{j \neq i} \frac{K_j}{\sum_i K_i} = \frac{\sum_i K_i - K_i}{\sum_i K_i} = 1 - \rho_i, \tag{19}$$

we can substitute equation (19) into (18). Then, by collecting all terms with a b_i^E on the left hand side and rearranging, we end up with the optimal external debt-to-asset ratio (10) in the text.

Appendix B Summary statistics by country

Country	Obs.	Tax rate		Max. tax diff.		Weigh. tax diff.		T-DAR		I-DAR		E-DAR	
		mean	(st.dev.)	mean	(st.dev.)	mean	(st.dev.)	mean	(st.dev.)	mean	(st.dev.)	mean	(st.dev.)
Italy	2 256	0.382	(0.053)	0.076	(0.081)	-0.014	(0.042)	0.733	(0.215)	0.237	(0.264)	0.497	(0.265)
Belgium	1 469	0.371	(0.030)	0.076	(0.068)	-0.025	(0.050)	0.638	(0.256)	0.207	(0.246)	0.431	(0.264)
Greece	207	0.363	(0.035)	0.064	(0.071)	-0.043	(0.052)	0.704	(0.226)	0.206	(0.290)	0.498	(0.290)
France	4 785	0.360	(0.0223)	0.050	(0.062)	-0.041	(0.050)	0.650	(0.241)	0.193	(0.235)	0.457	(0.249)
Spain	2 033	0.350	(0.000)	0.061	(0.067)	-0.036	(0.061)	0.618	(0.244)	0.178	(0.223)	0.440	(0.247)
Malta	12	0.350	(0.000)	0.032	(0.059)	-0.009	(0.018)	0.307	(0.290)	0.092	(0.179)	0.214	(0.252)
Netherlands	2 633	0.335	(0.021)	0.046	(0.059)	-0.053	(0.057)	0.599	(0.278)	0.180	(0.236)	0.420	(0.274)
Portugal	479	0.325	(0.043)	0.045	(0.056)	-0.061	(0.045)	0.590	(0.261)	0.171	(0.221)	0.419	(0.249)
Luxembourg	428	0.320	(0.034)	0.039	(0.056)	-0.062	(0.046)	0.650	(0.275)	0.179	(0.277)	0.471	(0.322)
Austria	3 770	0.318	(0.039)	0.040	(0.055)	-0.069	(0.064)	0.648	(0.247)	0.164	(0.212)	0.484	(0.256)
Denmark	580	0.305	(0.206)	0.042	(0.049)	-0.081	(0.057)	0.630	(0.242)	0.185	(0.219)	0.446	(0.237)
Great Britain	2 458	0.303	(0.007)	0.026	(0.045)	-0.082	(0.059)	0.608	(0.269)	0.221	(0.234)	0.387	(0.232)
Czech rep.	2 562	0.301	(0.041)	0.039	(0.051)	-0.075	(0.050)	0.607	(0.251)	0.212	(0.249)	0.395	(0.256)
Sweden	646	0.280	(0.000)	0.032	(0.044)	-0.101	(0.067)	0.682	(0.222)	0.259	(0.254)	0.424	(0.225)
Norway	240	0.280	(0.000)	0.038	(0.049)	-0.085	(0.060)	0.698	(0.189)	0.209	(0.231)	0.489	(0.230)
Finland	183	0.278	(0.014)	0.024	(0.041)	-0.081	(0.050)	0.539	(0.301)	0.203	(0.262)	0.336	(0.259)
Switzerland	2 753	0.273	(0.053)	0.019	(0.041)	-0.092	(0.080)	0.527	(0.276)	0.113	(0.180)	0.413	(0.261)
Russia	271	0.258	(0.040)	0.022	(0.040)	-0.083	(0.050)	0.589	(0.265)	0.230	(0.279)	0.359	(0.279)
Poland	2 829	0.254	(0.061)	0.018	(0.039)	-0.102	(0.056)	0.619	(0.254)	0.189	(0.239)	0.431	(0.268)
Estonia	32	0.252	(0.012)	0.047	(0.048)	-0.099	(0.054)	0.687	(0.215)	0.227	(0.306)	0.460	(0.320)
Slovenia	131	0.250	(0.000)	0.018	(0.029)	-0.108	(0.059)	0.486	(0.246)	0.138	(0.187)	0.347	(0.203)
Slovakia	438	0.238	(0.062)	0.018	(0.039)	-0.106	(0.052)	0.626	(0.243)	0.222	(0.242)	0.404	(0.255)
Bulgaria	92	0.225	(0.069)	0.007	(0.019)	-0.133	(0.049)	0.554	(0.304)	0.191	(0.229)	0.363	(0.286)
Croatia	84	0.218	(0.049)	0.021	(0.043)	-0.119	(0.050)	0.704	(0.242)	0.372	(0.319)	0.332	(0.279)
Latvia	74	0.210	(0.044)	0.007	(0.018)	-0.100	(0.083)	0.643	(0.296)	0.140	(0.217)	0.503	(0.283)
Romania	210	0.207	(0.061)	0.007	(0.019)	-0.120	(0.055)	0.538	(0.281)	0.213	(0.251)	0.324	(0.255)
Ireland	385	0.205	(0.086)	0.005	(0.019)	-0.164	(0.075)	0.497	(0.301)	0.156	(0.223)	0.341	(0.271)
Hungary	1 720	0.200	(0.000)	0.005	(0.014)	-0.145	(0.078)	0.555	(0.264)	0.185	(0.234)	0.369	(0.254)
Lithuania	96	0.183	(0.044)	0.003	(0.012)	-0.154	(0.049)	0.584	(0.220)	0.230	(0.229)	0.354	(0.243)
Total	33 857	0.310	(0.062)	0.039	(0.058)	-0.069	(0.068)	0.620	(0.259)	0.189	(0.235)	0.431	(0.260)

The countries are ranked according to mean statutory tax rate.

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