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The tax-efficient use of debt in multinational corporations☆

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ABSTRACT

Affiliates of multinationals borrow a considerable amount from their parent company, even when the parent is located in a high-tax country. This is at odds with standard theories of a tax-efficient capital structure. We set up a model that analyzes the functioning of the internal capital market and investigates the trade-off between tax savings and capital market frictions within the group. We test the model on data of the universe of German multinationals. The empirical analysis largely supports our model in that: (i) smaller multinationals often rely on parental debt financing; (ii) larger multinationals are more likely to use internal banks; (iii) parental debt and external debt are substitutes and the mix depends on the relative cost of raising capital through the parent and the affiliates; (iv) local and within-group tax incentives play an important role in determining all three types of debt.

1. Introduction

It is well known that the optimal use of internal debt in multinational corporations (henceforth MNCs) is to let the affiliate located in the country with the lowest tax rate lend to other affiliates in the group.[1] However, affiliates also borrow a considerable amount from their parent company, even when the parent is located in a high-tax country (Møen et al., 2019). This cannot be explained by standard theories for a tax-efficient capital structure. Understanding why MNCs use their parent as a lender is important because it provides information about the inner workings of the internal capital market of MNCs and the factors at play. In this paper, we investigate the tax-efficient use of debt in MNCs with an emphasis on internal lending and borrowing. The purpose is to understand the parental debt puzzle, that is, the trade-off between tax savings and capital market frictions within the group. In order to do so, we set up a theory model and test its predictions using a dataset that includes information on all German MNCs.

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[1] See, for example, Mintz and Smart (2004).

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Our theory model allows affiliates of an MNC to be heterogeneous with respect to productivity, and it embeds all the costs and benefits of debt as described in the previous corporate finance literature.[2] The model adds to previous literature on MNCs' tax-efficient capital structure by modeling separately parental debt, non-parental internal debt, and external debt, taking into account non-tax costs and benefits, as well as set-up costs of using an affiliate as a group bank.

A main prediction from the model is that the tax-efficient financing structure in MNCs entails lending both from the parent and affiliates, and that the optimal behavior of the parent is to borrow in the financial market and reroute its borrowed funds to its affiliates. Another prediction is that external debt and rerouted parental debt are substitutes, and that the mix between them depends on differences in capital market transaction costs.[3] For given transaction costs, the theory model finds that higher tax rates increase the use of parental and external debt making them complements with respect to their debt tax shields. Finally, our analysis indicates that MNCs whose parent firms face a relatively high corporate tax rate have the strongest incentives to set up an internal bank in their lowest-taxed affiliate, and that scale economies in internal banks imply that large MNCs are more likely to use such internal banks.

We explore the theoretical results using a unique micro-level dataset provided by Deutsche Bundesbank. In contrast to most other firm-level datasets, the Bundesbank data report information on almost all German MNCs and their foreign affiliates. Furthermore, it contains information on external debt, as well as on internal debt from both parent companies and other affiliates within the group. Our main sample consists of 221,289 observations over a time span of 19 years (1999–2017). These observations relate to 8598 MNCs and 34,577 foreign affiliates located in 96 host countries. Summary statistics show that about 41% of the affiliates of German MNCs receive some positive amount of parental debt, and that the average share of parental debt in total assets is 7% for these affiliates. This corresponds to 15% of total debt, which is quite remarkable given that Germany is considered a high-tax country.[4] Looking at the group level, the share of MNCs using parental debt is about 29%. In contrast, only about 15% borrow internally from affiliates such as an internal bank. The combination of both modes of financing also turns out important as in 29% of all affiliate-year observations in our sample, affiliates receive both parental and internal debt simultaneously.

The empirical analysis confirms the main predictions from our theory. Although host country taxes are not clearly correlated with different types of debt financing, we see a relatively clear pattern when tax incentives arising at the firm level, such as the minimum tax within an MNC, are considered. This is strikingly illustrated by the 89 German MNCs that have operated on the Cayman Islands where the tax on corporate income is equal to zero. At a global level, these 89 MNCs hold 7,101 affiliates that are located in 149 countries. The internal debt-to-asset ratio of the latter affiliates is about 16%, on average. This is more than six percentage points higher than the grand sample mean.

The most important findings of our regression analysis, which conditions on affiliate-specific heterogeneity and exploits changes in taxes over time for identification, suggests a tax elasticity of the statutory tax rate in the host country of about 0.27 for the parental debt ratio. We show that this result is weakened if the parent is credit constrained. In this case, the tax sensitivity of parental debt in the affiliates is reduced, while the one of external debt increases. This is in line with our theory model, which predicts that parental and external debt are substitutes. We test substitution between internal debt (on the one hand) and external as well as parental debt (on the other hand) using IV regressions and find significant substitution elasticities of -1.8 (external debt) and -0.24 (parental debt).

A second set of empirical results shows that: (i) parental debt is mainly used by smaller MNCs that do not use an internal bank; (ii) the size of the MNC is a key determinant of whether a firm operates an internal bank for the purpose of lending to high-tax affiliates; and (iii) the lowest-taxed affiliate in a group is often used as an internal bank.[5] These findings are predicted by the theory model.

We provide a large number of additional checks, which largely confirm basic mechanisms of our theory model. These tests show, for example, that the tax-response function of external debt becomes flatter if affiliates Carryforward losses, and hence, benefit less from interest deductions. The results also prove robust to variations in how we measure the tax incentives.

The remainder of this paper is organized as follows: Section 2 presents related literature. Section 3 outlines the model. Section 4 suggests an empirical estimation approach. Section 5 presents the data, definitions and descriptive statistics. Section 6 summarizes basic results. Section 7 is central to our understanding of internal capital market mechanisms. Section 8 tests for substitutability, and Section 9 discusses different issues in measuring tax incentives. Section 10 concludes.

2. Related literature

There is a growing literature on how MNCs use debt financing to save taxes.[6] A major difference between domestic firms and MNCs is that the latter can use both external and internal debt to shift profits across jurisdictions.

[2] The trade-off theory in finance proposes a balancing of tax debt shields and non-tax costs and benefits of debt. See, e.g., Kraus and Litzenberger (1973). Recent empirical evidence for the trade-off theory is provided by van Binsbergen et al. (2010) and Korteweg (2010).

[3] If, for example, the headquarters cannot credibly commit to bail out its affiliates, parental debt can serve as a commitment device (see also Gertner et al., 1994; Chowdhry and Nanda, 1994). Inefficiencies in local credit markets, typically in developing countries, may also be a real constraint for external debt at the affiliate level (see Desai et al., 2004).

[4] The average parental debt-to-asset ratio in U.S. MNCs for the period 1982 and 1994 was 8%, which is about 18% of the external debt-to-asset ratio (Desai et al., 2004, Table 1).

[5] The first two findings also corroborate earlier studies on tax avoidance in general. For example, Rego (2003) shows that larger MNCs report lower effective tax rates due to tax avoidance strategies and Dyreng et al. (2008, p. 79) suggest that there are economies of scale to tax avoidance.

[6] See, e.g., Desai et al. (2004), Buettner et al. (2009), Mintz and Weichenrieder (2010), Park et al. (2013), and Buettner and Wamser (2013). A meta survey is provided by Feld et al. (2013).

The use of internal debt was first studied empirically by Collins and Shackelford (1997) and then both theoretically and empirically by Mintz and Smart (2004). The study by Mintz and Smart (2004) shows that MNCs should structure their internal lending activities such that borrowing occurs in high-tax jurisdictions and all internal debt is provided by the entity facing the lowest tax within the group. This implies, of course, that all interest income is declared at the low-tax jurisdiction. Hence, the firm maximizes the value of the tax-deductible interest expense and minimizes the tax paid on interest income within the group. They exploit data on Canadian provinces and provide evidence for their theoretical predictions. In line with Mintz and Smart (2004), Egger et al. (2010) find that foreign-owned firms, on average, exhibit a significantly higher debt ratio than their domestically owned counterparts in the host country, and that the debt-to-asset ratios of affiliates of MNCs are more tax-sensitive than the ones of domestic firms. Unlike our data, the data used by Egger et al. (2010) do not include information on internal debt at the firm level.

Egger et al. (2014) argue more generally that internal capital markets are established for reasons which can be broadly grouped into two categories: (i) profit shifting via debt shifting and tax savings; (ii) frictions in economic fundamentals with consequences for efficient resource allocation. Their model suggests that differences in economic fundamentals – such as weak institutional quality, underdeveloped financial markets, or high productivity – produce different levels of excess returns at host locations. Internal debt should be allocated to those entities where this excess return is highest.

Huizinga et al. (2008) study how differences in national tax systems affect the use of external debt and introduce the concept of external debt shifting. They assume that the parent firm provides explicit and implicit credit guarantees for the debt 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 MNCs will balance external debt across affiliates by taking into account the tax rate in all the countries where they are present. They test their model on firm data from 32 European countries in the Amadeus database covering the years 1994 to 2003. Their empirical investigation shows that tax changes do indeed lead to a re-balancing of debt. Following up on Huizinga et al. (2008), Sorbe et al. (2017) find evidence that external debt shifting increases total debt within the whole MNC. Like Egger et al. (2010), Huizinga et al. (2008) only have data on total debt and cannot empirically distinguish between mechanisms related to external and internal debt.

In contrast to the studies above, Møen et al. (2019) study the use of both internal and external debt. They show that both types of debt are of equal importance in MNCs' tax planning activities and that previous studies neglecting one type of debt suffer from an omitted variable bias when analyzing total debt.

Despite its significant role in MNCs, the use of parental debt has not received much attention in the literature, and the relationship between internal lending within the group and parental debt is a neglected issue. Chowdhry and Nanda (1994) predict that parental debt is a good commitment device that reduces bankruptcy risk in affiliates. Gertner et al. (1994) argue that parental debt can be used as a residual control right to decrease borrowing and agency costs of external debt.

In an empirical study, Desai et al. (2004) show that US MNCs replace external debt by internal debt coming from the parent. Their interpretation is that parental debt is used to overcome capital market imperfections and weak institutional settings (typically in developing countries). Aggarwal and Kyaw (2008) confirm the findings in Desai et al. (2004) using more recent data. Neither of these papers are able to explain the substantial use of parental debt in developed countries. Desai et al. (2004) also find that parental debt reacts to tax incentives and is used to save taxes. Their data does not provide information on internal borrowing from other affiliates, however. Thus, it remains unclear whether parental debt is used to substitute for internal debt from an internal bank or replaces affiliates' external borrowing from the capital market.

Dewaelheyns and van Hulle (2010) use Belgian data and focus on groups that have all their affiliates within Belgium. Despite the fact that there is no tax incentive for using internal debt in this case, affiliates are still financed by internal debt from the parent. Dewaelheyns and van Hulle (2010) argue that internal debt is used to minimize borrowing costs and that parental debt is rerouted external debt. Their study indicates that parental debt replaces external debt at least in purely domestic groups.

None of the papers above explain how the use of parental debt fits into a tax-efficient financial structure of an MNC. Nor do these papers explain why a high-taxed firm should be willing to incur additional tax payments by using parental debt as a debt-shifting device, instead of locating all internal lending in a separate internal bank in a low-tax jurisdiction.

3. Tax-efficient structures

This section will embed parental debt into a tax-efficient structure and derive predictions on the factors that determine capital-structure choice in MNCs. All formal derivations are relegated to Appendix B.

3.1. The parental debt puzzle

For any intra-company debt, its debt tax shield is maximized if the lowest-taxed affiliate in the MNC, rather than the parent company, acts as internal bank and conducts all lending to related affiliates (Mintz and Smart, 2004): As interest expense on internal borrowing is tax deductible, whereas internal lending causes taxable interest income, the net tax saving is given by the tax rate differential between the borrowing and the lending affiliate. For parental debt, financed by equity, the resulting debt tax shield is always inferior to the internal debt tax shield of an optimally placed internal bank, because costs of equity are non-deductible. Hence, whenever the parent acts as a lender, but does not face the lowest tax rate within the group, the MNC forgoes tax savings. This poses a parental debt puzzle, particularly when MNCs use parental and internal lending simultaneously.

The only way to embed parental debt consistently into a tax-efficient capital structure is to treat parental debt as rerouted external debt. In a tax-efficient MNC, the parent borrows in the capital market from third parties and reroutes the borrowed external debt to its affiliates as parental debt. For tax purposes, interest income from lending by the parent nets against the parent's interest expense at the

external capital market, and parental debt has then exactly the same tax consequences like external debt, directly borrowed by the affiliate. Furthermore, an efficient capital market realizes that parental debt effectively is external debt with all its non-tax benefits and costs. Consequently, the 'agency costs' of parental debt will complement and mimic those of external debt.[7] In the following, we incorporate such rerouted parental debt into a capital-structure model.

3.2. The model

An MNC has its parent domiciled in country p and has fully-owned affiliates in $i = 1, \ldots, n$ countries. We assume that the MNC operates one affiliate per country, which allows us to use index i for affiliates and host countries. Without loss of generality, we assume that the parent is a pure holding company and that all affiliates are directly owned by the parent.

The parent company owns technology $\theta \in [\underline{\theta}, \overline{\theta}]$ that increases the productivity of capital at each affiliate. Each affiliate has fixed assets K_i, which are used to produce a homogenous good with production function $y_i = f(\theta K_i)$, $f_K > 0$ and $f_{KK} < 0$. We assume that the production function is not too concave, so that higher productivity θ of the MNC implies higher optimal investment $K_i(\theta)$ in all its affiliates, i.e., $\frac{\partial K_i(\theta)}{\partial \theta} > 0, \ \forall i$.[8] This assumption is in line with empirical evidence from the trade literature, which shows that more productive firms are more likely to become MNCs and greater in size than less productive firms.[9]

In line with the literature, we assume that rental costs of capital are exogenous (small country assumption) and equal to r. Capital $K_i(\theta)$ in each affiliate is financed by equity E_i, external (third party) debt D_i^E, debt from the parent (parental debt) D_i^P, and debt D_i^I borrowed from related affiliates (internal debt). The balance sheet of affiliate i is $K_i(\theta) = E_i + D_i^E + D_i^P + D_i^I$, whereas the balance sheet of the parent p is $\sum_{i \neq p}(E_i + D_i^P) = E_p + D_p^E + D_p^I$.

Using external, internal, and parental debt entails different types of costs and benefits. Internal debt has many of the same properties as equity, but it is tax-deductible.[10] In line with the literature, we assume that the cost of internal debt is additively separable from the costs of other types of debt, and that the different cost functions of debt are convex in the debt-to-asset ratios, but proportional to capital employed.[11]

Internal debt financing from an internal bank is associated with costs related to tax-engineering expenses (e.g., lawyers and accountants) incurred to avoid thin-capitalization rules and/or controlled-foreign-company (CFC) rules (see, e.g., Mintz and Smart, 2004; Fuest and Hemmelgarn, 2005). We express the cost function of internal debt as

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

where $b_i^I = \frac{D_i^I}{K_i(\theta)}$ represents the internal debt-to-asset ratio in affiliate i, and η is a positive constant. Notice that setting up one of the affiliates as an internal bank causes additional costs. We capture these by adding a fixed set-up cost $C_B \geq 0$ at the level of the parent.

Before we model the cost function related to parental debt and external debt, note that both together constitute total external debt because we model parental debt as rerouted external debt (see the previous subsection). Following the literature, such (total) external debt carries costs, but also non-tax benefits: External debt is assumed to be beneficial in reducing informational asymmetries between managers and shareholders and in enforcing discipline on overspending managers (Jensen and Meckling, 1976; Jensen, 1986). However, too much external debt may induce managers to behave too risk-averse by refraining from profitable investments or create debt-overhang problems (Myers, 1977). As pointed out by Kraus and Litzenberger (1973), higher external borrowing increases the risk of bankruptcy. Such bankruptcy costs are then traded-off against the external debt tax shield.[12] Taken together, the costs and non-tax benefits imply a U-shaped cost of total external debt that we label 'agency costs'. Even in absence of taxation, there will be an optimal total external debt-to-asset ratio in each affiliate that minimizes these agency costs (see also Huizinga et al., 2008). We define this ratio as b^*.

In line with the literature and our discussion above, we assume affiliate-specific agency costs of debt that depend on the deviation from the non-tax related 'optimal' debt-to-asset ratio (b^*). As we define the external and parental debt-to-asset ratios in affiliate i by

[7] In contrast to parental debt, internal debt constitutes 'tax-preferred equity' and is mostly granted by small special-purpose entities that are established for tax reasons, unable to provide much monitoring. Prime examples are the financial coordination centers of the Norwegian MNCs Statkraft and Statoil (now renamed Equinor), located in Belgium. In 2012, these entities lent 61 billion NOK (USD 11.0 billion) and 85 billion NOK (USD 15.3 billion), respectively, to other related affiliates within their MNCs, but they had only six and 20, respectively, employees on their payrolls (Bjørnestad, 2012).

[8] See Appendix A for a proof. To focus on the capital structure choice, we neglect the optimal investment decision in the main model.

[9] See, e.g., Tomiura (2007) and Syverson (2011), particularly p. 335.

[10] 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 be seen as tax-favored equity. If internal debt is rerouted equity from the parent, there is no point in adding such debt to the monitoring cost function. Nevertheless, if it was added, a substitution effect would arise between internal and external debt to balance 'costs' of monitoring.

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

[12] 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. Hovakimian et al. (2004) and Aggarwal and Kyaw (2010) provide additional discussion.

$b_i^E = \frac{D_i^E}{K_i(\theta)}$ and $b_i^P = \frac{D_i^P}{K_i(\theta)}$, respectively, the first term in the following cost function captures these agency costs. A novelty of our model is that we additionally take into account that the parent and the affiliates may face (different) transaction costs of accessing the external capital market. To bring forward this point, we add transaction costs δ_E and δ_P that are quadratic in external and parental debt, respectively. In sum, we assume a cost function for total external debt (rerouted parental debt and external debt)

$$C^E(b_i^E, b_i^P) = \left[\frac{\mu}{2} \cdot \left(b_i^E + b_i^P - \overline{b}\right)^2 + \frac{\delta_E}{2} \cdot (b_i^E)^2 + \frac{\delta_P}{2} \cdot (b_i^P)^2\right] \cdot K_i(\theta), \tag{2}$$

where $\overline{b} = \left(1 + \frac{\delta_E \delta_P}{\mu(\delta_E + \delta_P)}\right) \cdot b^*$ is the adjusted optimal debt-to-asset ratio in absence of taxation and μ is a positive cost constant of deviating from this debt-to-asset ratio.

As alluded to above, the parameters δ_E and δ_P reflect different transaction costs of accessing the capital market for the parent and the affiliates. Such costs may stem from frictions in (local) capital markets such as information asymmetries and differences in collateral requirements in different countries. In addition, borrowing costs may be higher for an affiliate if it is located in a country where capital markets are underdeveloped, or if there is uncertainty related to whether the parent would bail out the affiliate in case of default. In contrast, the parent, being the ultimate owner, may be perceived as less risky.

Finally, following Huizinga et al. (2008), we assume that the parent firm is willing to bail out any affiliate facing bankruptcy. Different from Huizinga et al. (2008), we incorporate parental debt in the analysis. Let C_f be the overall bankruptcy costs at the parent level. They depend on the firm-wide debt-to-asset ratio defined as $b_f = \frac{\sum_i (D_i^E + D_i^P)}{\sum_i K_i(\theta)}$. As in Huizinga et al. (2008, p. 94), we assume that the overall bankruptcy costs are a convex function of the firm-wide debt-to-asset ratio and proportional to the MNC's overall assets. Using γ as a positive constant, the overall bankruptcy costs are specified at the holding (parent) level as

$$C_f = \frac{\gamma}{2} \cdot b_f^2 \cdot \sum_i K_i(\theta). \tag{3}$$

Economic and taxable profit in affiliate i, π_i^e and π_i^t, respectively, are defined as

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

where the rental costs of equity are not tax-deductible as is the case in most real-world tax systems. We also assume that costs C^E and C^I related to both types of debt are not tax-deductible. This assumption is necessary to derive well-defined structural equations for the empirical analysis.[13]

We let V_i^L and V_i^U be the values of an affiliate with and without debt financing in country i, and define t_i as the statutory corporate tax rate in country i. Affiliate i's profit after corporate taxation in country i is then

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

In a static one-period model such as this, the value of an MNC (V^L) and the MNC's after tax profit (Π_p) are identical and can be calculated by summing up profits across all affiliates. We assume that the parent firm operates under a territorial tax system so that inter-corporate dividends are received tax-free. This is the most relevant setting, particularly after the 2017 'Tax Cuts and Jobs Act' in the U.S.[14] Still, repatriated dividends π_i can be subject to a non-resident withholding tax in the country where the dividend is paid. However, in the empirical section, we focus mainly on countries that apply the exemption method and where withholding taxes do not matter (e.g., among countries of the European Union). We assume that it is costly to set up an internal bank and that the parent incurs costs $C_B \geq 0$. In reality, these costs may be specific to a country, but for simplicity we shall not index them. We discuss the implication of country-specific set-up costs in the empirical section.

The value of the consolidated MNC is

$$\Pi_p = V^L = \sum_i V_i^L - C_f - 1_I \cdot C_B = \sum_i \pi_i - C_f - 1_I \cdot C_B, \tag{5}$$

[13] The assumption is in line with Huizinga et al. (2008). Tax-deductible agency and tax-engineering costs of debt will quantitatively foster the use of debt, because it becomes cheaper. Qualitatively, however, there is no additional effect. See Schindler and Schjelderup (2012) for a related setting with tax deductibility, but without both overall bankruptcy costs and parental debt.

[14] Note that effectively, there is hardly any difference between territorial and world-wide taxation, as the repatriation tax only applies when profits are paid to the parent firm. Before 2018, U.S. MNCs, for example, avoided this tax by accumulating profits in offshore tax havens and utilizing the 'check-the-box' regime.

where 1_I is an indicator function that equals one if there is an internal bank as lending entity within the MNC and zero otherwise. The MNC will set up an internal bank and incur costs C_B if the net tax savings of the internal bank cover the fixed set-up costs plus the opportunity cost of not lending from the parent. The condition for an internal bank is

$$\sum_i \left[\left(t_i - \tau \right) r b_i^I - \frac{\eta}{2} \cdot \left(b_i^I \right)^2 \right] K_i(\theta) \geq C_B + \sum_{i=p}^{n} \left[\left(t_i - t_p \right) r b_i^I - \frac{\eta}{2} \cdot \left(b_i^I \right)^2 \right] K_i(\theta), \tag{6}$$

where τ represents the tax rate on interest income received by the internal bank. The condition holds with equality and the MNC is indifferent whether to set up an internal bank at a minimum productivity $\widehat{\theta}$, and a minimum size of the MNC (in terms of capital installed), $K(\widehat{\theta})$. Eq. (6) shows that the net marginal benefit of profit shifting by internal debt (left hand side) should at least equal its opportunity costs (right hand side). The condition implies that only productive ($\theta \geq \widehat{\theta}$) MNCs that have substantial fixed assets $\sum_i K_i(\theta)$, and a sufficiently high tax rate t_p in the parent country, will establish internal banks.[15]

To find the tax-efficient structure, the MNC maximizes global profits (5) given the internal lending constraint $\sum_i r \cdot b_i^I K_i(\theta) = 0$ with the Lagrange parameter λ_1 and the internal bank constraint (6) with the Lagrange parameter λ_2, see B for details.

3.3. The case of an internal bank

If there is an internal bank ($\lambda_2 = 0$), the multiplier $\lambda_1 = \tau > 0$ gives the shadow price of shifted interest expenses; in optimum, we have $\lambda_1 = \tau = \min_i t_i$ (see Mintz and Smart, 2004). Hence, the value of the internal debt tax shield $t_i - \tau$ is maximized by letting the affiliate with the lowest effective tax rate be the internal bank. To simplify the analysis to follow, we denote the affiliate facing the lowest tax rate by 1, i.e., $\min_i t_i = t_1$.

Examining the first-order condition for internal debt (A.7), we derive the optimal debt-to-asset ratio for internal debt b_i^I in the presence of an internal bank as

$$b_i^I = \frac{r}{\eta} \cdot \left(t_i - \lambda_1 \right) = \frac{r}{\eta} \cdot \left(t_i - t_1 \right) > 0, \forall \ i > 1. \tag{7}$$

Thus, the use of internal debt is driven by the internal debt tax shield $(t_i - t_1)$, traded off against tax-engineering costs (η). A larger tax shield $t_i - t_1$ increases the affiliate's internal debt-to-asset ratio. In the empirical part of the paper, we shall refer to t_1 as the minimum tax.[16] It also follows from Eq. (7) that the internal debt-to-asset ratio in the internal bank $\left(b_1^I \right)$ is always zero, as there is no tax gain from this affiliate to hold internal debt. Instead, the internal bank lends in total the amount $L_1 = \sum_{i>1} D_i^I$ to related affiliates.

Furthermore, Eqs. (6) and (7) show that it is profit maximizing to use internal debt in all affiliates (except for the internal bank) as long as the MNC is large enough.

Next, given our model, total external debt is the sum of the external and parental debt-to-asset ratio. By rearranging the first-order conditions (A.5) and (A.6), we first obtain the optimal external debt-to-asset ratio as[17]

$$b_i^E = \beta_0 + \beta_1 \cdot t_i + \beta_2 \cdot \sum_{j \neq i} \rho_j (t_i - t_j), \tag{8}$$

where $\beta_0 = \frac{\mu \delta_P}{(\mu+\gamma)(\delta_E+\delta_P)+\delta_E \delta_P} \cdot \overline{b} \geq 0$; $\beta_1 = \frac{\delta_P \cdot r}{(\mu+\gamma)(\delta_E+\delta_P)+\delta_E \delta_P} \geq 0$, and $\beta_2 = \frac{\gamma \delta_P (\delta_E+\delta_P) r}{[\mu(\delta_E+\delta_P)+\delta_E \delta_P][(\mu+\gamma)(\delta_E+\delta_P)+\delta_E \delta_P]} \geq 0$ and where we have denoted $\rho_j = \frac{K_j(\theta)}{\sum_j K_j(\theta)}$ as the share of real capital employed in affiliate j as share of total real capital in the MNC.

Following the trade-off theory, there is an optimal debt-to-asset ratio in absence of taxation, β_0, that trades off non-tax costs and non-tax benefits of debt. In addition, the MNC trades off agency costs at the affiliate level and overall bankruptcy costs against tax shields from external debt. The *standard tax shield* mechanism is represented by the second term on the RHS of Eq. (8) and can be used 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, there is an incentive to allocate most of the multinational's external debt to affiliates that produce the highest absolute tax savings (i.e., have the largest tax differentials). These tax effects are in line with previous literature (e.g., Huizinga et al., 2008; Møen et al., 2019). However, our effects additionally depend on transaction costs to access the capital market; we will discuss these below in the context of parental debt.

When we apply Eq. (8) together with the first-order conditions, the optimal parental debt-to-asset ratio follows as

[15] Small MNCs with few fixed assets use too little internal debt to cover the costs of operating an internal bank, that is, they miss out on economies of scale. MNCs with a very low parent tax rate save too little taxes by using an internal bank compared to using parental debt.

[16] With affiliate-specific set-up costs (as opposed to the affiliate-independent costs in our model), the affiliate with the lowest effective tax rate may not be chosen as the place for the internal bank. Countries like Belgium, Luxembourg and the Netherlands are prime locations for internal banks (see, e.g., Ruf and Weichenrieder, 2012, Table 4). These countries have institutions which lower the costs of setting up and running an internal bank.

[17] Details of the derivation are given in Appendix B.

$$b_i^P = \frac{\delta_E}{\delta_P} \cdot b_i^E = \frac{\delta_E}{\delta_P} \cdot (\beta_0 + \beta_1 \cdot t_i + \beta_2 \cdot \sum_{j \neq i} \rho_j (t_i - t_j)). \tag{9}$$

A first insight from this equation is that parental debt is proportional to external debt. It depends on the same tax incentives like external debt and increases with the standard tax shield and the weighted tax difference. The reason simply is that parental debt is rerouted external debt and features the identical tax characteristics. Hence, external and parental debt are complements with respect to changes in tax shields. In sum, external and parental debt constitute total external debt ($b_i^E + b_i^P$) that trades off affiliate-specific agency costs and overall bankruptcy costs against debt tax shields.[18]

Different from previous literature, our approach additionally highlights the impact of transaction costs to access the external capital market. We capture these capital market frictions by the cost parameters δ_E and δ_P. As follows from the middle part in Eq. (8), parental and external debt are substitutes with respect to transaction costs: $b_i^P / b_i^E = \delta_E / \delta_P$. The higher the costs to access the capital market and receive third-party debt at the affiliate level (δ_E), relative to the equivalent costs at the parent level (δ_P), the larger is the parental debt-to-asset ratio. In contrast, affiliates that face a frictionless, deep local capital market ($\delta_E = 0$) will not hold any parental debt, because there is no reason to reroute external debt.

To sum up, total external debt results as $b_i^E + b_i^P = \frac{\delta_P + \delta_E}{\delta_P} \cdot b_i^E$. Its level depends positively on all the well-known tax incentives. Its structure depends on arbitraging the costs to access the capital market via the parent and via the affiliate.

Collecting all results above and introducing the coefficient $\beta_3 = \frac{r}{\eta}$, the total debt-to-asset ratio $b_i = b_i^E + b_i^P + b_i^I$ of affiliate i can be written as

$$b_i = \left(1 + \frac{\delta_E}{\delta_P}\right)(\beta_0 + \underbrace{\beta_1 \cdot t_i}_{(i)} + \underbrace{\beta_2 \cdot \sum_{j \neq i} \rho_j (t_i - t_j))}_{(ii)} + \underbrace{\beta_3 \cdot (t_i - t_1)}_{(iii)}. \tag{10}$$

From Eq. (10), it follows that the total 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 $(t_i - t_1)$ due to the use of internal bank lending.

3.4. Multinationals without an internal bank

Small MNCs or MNCs with the parent company located in a low-tax jurisdiction (i.e., a very low tax rate t_p) will not find it profitable to set up an internal bank, see Eq. (6). Instead, their strategy is to use the parent company as the internal bank. In this case, parental debt has a dual role. The parent reroutes external debt (D_i^P) to its affiliates, but it also uses 'parental-internal' debt D_i^{PI} to replace equity in affiliate i. Without an internal bank, we have $\lambda_2 = 1$, while $\lambda_1 = \tau = t_p$. It then follows from the first-order condition (A.6)

$$b_i^{\text{PI}} = \frac{r}{\eta} \cdot (t_i - t_p) \quad \forall i > p \quad \text{and} \quad b_i^{\text{PI}} = 0 \quad \forall i \leq p. \tag{11}$$

Consequently, a 'parental-internal' debt-to-asset ratio $b_i^{\text{PI}} = D_i^{\text{PI}} / K_i(\theta)$ is optimal in all affiliates with a higher tax rate than the parent so that the 'parental-internal' debt tax shield becomes $t_i - t_p > 0$. Qualitatively, the tax incentives are equivalent to internal debt.

The determinants for external and standard parental debt are unaffected from the absence of an internal bank, and Eqs. (8) and (9) continue to apply. Thus, in MNCs with a productivity $\theta < \widehat{\theta}$, the optimal total debt-to-asset ratio in an affiliate i turns into

$$b_i = \left(1 + \frac{\delta_E}{\delta_P}\right)(\beta_0 + \beta_1 \cdot t_i + \beta_2 \cdot \sum_{j \neq i} \rho_j (t_i - t_j)) + 1_{\text{PI}} \cdot \underbrace{\beta_3 \cdot (t_i - t_p)}_{= b_i^{\text{PI}}}, \tag{12}$$

where 1_{PI} is an indicator function with $1_{\text{PI}} = 0$ if $t_i \leq t_p$.

3.5. Empirical predictions

To sum up our theoretical findings, only MNCs that are sufficiently productive and large, conditioned on the parent's tax rate, use both parental and internal debt in their optimal capital structure. Then, parental debt is always rerouted external debt. Parent companies facing a relatively high corporate tax rate have the strongest incentives to establish an internal bank in their lowest-taxed affiliate. Moreover, scale economies in running internal banks imply that large MNCs are more likely to use such affiliates.

Lending from an internal bank (i.e., internal debt) is not affected by the standard debt tax shield, nor the weighted tax differential, but it is sensitive to the maximum tax differential. In contrast, parental debt in MNCs with an internal bank positively depends on the two tax shields of external debt, but not on the maximum tax differential. Indeed, our model finds that parental and external debt are

[18] Note that in the absence of taxation, ($t_i = t_j = 0$) and overall bankruptcy costs ($\gamma = 0$), the optimal debt-to-asset ratios are $b_i^E = \frac{\delta_P b^*}{\delta_E + \delta_P}$ and $b_i^P = \frac{\delta_E b^*}{\delta_E + \delta_P}$, and for total external debt follows $b_i^E + b_i^P = b^*$ as defined in the previous subsection.

complements with respect to tax incentives. They are, however, substitutes with regard to non-tax costs of debt. Parental debt is used to arbitrage transaction costs of accessing the capital market, and its use increases relative to external debt with an affiliate's costs in accessing the external capital market. Affiliates facing a frictionless capital market do, however, not use parental debt.

When MNCs do not use an internal bank, parental debt is a mix of rerouted external debt to arbitrage transaction costs and disguised equity (i.e., internal debt) to benefit from the affiliates' tax shield. Parental debt in this case exhibits the same features with respect to non-tax factors as parental debt in MNCs with internal banks, but it responds positively to the tax differential to the parent, in addition to the tax determinants of external debt.

4. Empirical analysis

The empirical part of this paper is concerned with estimating the tax determinants of debt financing using Eqs. (7)–(10) as the points of departure. Our data allow us to distinguish between three different types of debt: (i) External debt b_{it}^{E}, (ii) Parental debt b_{it}^{P}, i.e., internal debt provided by the parent firm, and (iii) Internal debt provided by other entities within an MNC, b_{it}^{I}. Total debt is $b_{it}^{T} = b_{it}^{E} + b_{it}^{P} + b_{it}^{I}$. The debt variables vary at the affiliate-*i*-level and over time indexed by *t*. We are interested in estimating the effects of explanatory variables denoted by $\mathbf{X}_{it}$ on b_{it}^{d} with $d \in \{E, P, I\}$. The vector $\mathbf{X}_{it}$ includes affiliate-, industry-, and country-specific variables, as well as aggregate time effects. Details regarding the control variables are given in Section 5.

The debt variables b_{it}^{d} are defined as ratios which are bounded between 0 and 1.[19] The main estimation equation is given by

$$b_{it}^{d} = \beta^{CTI} \cdot CTI_{it} + X_{it} \cdot \boldsymbol{\beta}^{X} + c_i + d_t + \varepsilon_{it},$$

where β^{CTI} is the coefficient on the corporate tax incentive (CTI_{it}). Note that, following our theory model, three different types of tax measures will be relevant determinants of debt (see below for more details). We usually condition on affiliate-specific effects c_i to capture unobserved affiliate heterogeneity as well as aggregate time effects, d_t. The latter should also capture all aggregate shocks at the parent location.

5. Data, measurement issues, and descriptive statistics

Our empirical analysis is based on the *MiDi* database (*Mi*crodatabase *Di*rect investment) provided by Deutsche Bundesbank, which is the German central bank. *MiDi* reports balance sheets of foreign affiliates of German MNCs and has two key advantages for our analysis. First, German firms are required to report their foreign investments once they are above a reporting threshold according to German law.[20] This allows us to obtain a relatively complete picture of entire groups and their investments across countries. Second, we can distinguish between the three different types of debt financing, which were described in Section 4 above, at the level of the borrowing entity *i*.

Besides having access to superior data on intra-firm borrowing and lending, Germany is an interesting case for analyzing debt shifting. It is the fourth-largest economy in the world and hosts a large number of MNCs across all sectors of the economy. Among them are many large MNCs such as Volkswagen, the world-largest automotive company and number #7 in the 2020 Fortune Global 500 ranking of the world-largest MNCs, measured by sales revenue.

We start out calculating our tax incentive variables using a sample where all entities of the MNCs are included. This sample consists of 540,991 observations between the years 1999 to 2017.[21] Unfortunately, there is no information on the debt financing of the German parents. We can therefore not include the parent firms in the regressions.[22] We lose additional observations as the focus of our analysis is on majority-held foreign investments and on affiliates whose sales are non-zero. This leaves us with 221,289 observations in the empirical analysis. These observations relate to 8598 MNCs and 34,577 foreign affiliates located in 96 host countries.[23] We may also look at the size of the German investors (note that we do not have this information for all years). Based on the limited information available, the following numbers show that different measures of size are positively skewed: The median investor's balance sheet total amounts to about 256 million Euro, the mean value (grand sample mean) is substantially larger, 6282 million Euro. The right-skewness of firm size also reflects in investors' turnover (median: 11 million Euro; mean: 2211 million Euro) and in number of employees (median: 79; mean: 5328). Of course, the whole groups are significantly larger: the median group has a balance sheet total of 1019 million Euro (mean: 24,700 million Euro), a turnover of 971 million Euro (mean: 13,200 million Euro), and employs 4490 persons (mean: 51,373 persons).

The size of the estimation sample is quite stable over time, but grows somewhat during the early years.[24] For example, the sample

[19] In a previous version of the paper (see Møen et al., 2018), we account for the bounded nature of the debt ratio using the empirical approach suggested by Papke and Wooldridge (2008). The results are very robust and do not depend on the estimation approach.

[20] Lipponer (2011) provides a summary of the reporting requirements and the data. The reporting requirements have been changed a few times in the past. Since 2002, German firms have to report their international capital links if the balance-sheet total of the direct investment enterprise exceeds 3 million Euros.

[21] At this point, our sample includes 16,436 MNCs, and 82,160 foreign affiliates, operating in 194 host countries.

[22] However, since 2004, *MiDi* includes information on a parent's turnover, the number of employees, and the balance sheet total.

[23] For interested readers, additional tables in the online appendix also display the number of observations by country and parent industry.

[24] Note that in the online appendix, we provide a table summarizing the loss of observations due to data limitations and restrictions.

consists of 10,908 observations in 2002; the number of observations then grows over time; just before the financial crisis in 2007 we have 13,337 observations; there is no financial crisis effect (in terms of fewer observations in our sample) as we observe 14,761 affiliates in 2009; with 16,609, observations peak in the year 2012, and then go down again to 14,428 in 2016.

Panel A in Table 1 presents mean values and standard deviations of the dependent variables, both for all affiliates and for subsamples of small and large MNCs in which only the 25% smallest and largest MNCs are considered. In addition, we report the share of affiliates that have a positive level of external, parental, and internal debt, respectively. As can be seen from Table 1, 63% of the affiliates receive internal debt and 41% of the affiliates have positive parental debt.[25] An interesting pattern, which we will analyze in more detail below, is the difference between small and large MNCs: the parental debt ratio is higher for the small ones, whereas the internal debt ratio is higher for the large ones; the external debt ratio of the large MNCs is greater, but only by 1.4 percentage points.

Panel B in Table 1 presents mean values and standard deviations of the tax variables and control variables. Let us first introduce the different tax measures. The local (host-country) statutory tax rate faced by affiliate i in period t is denoted TAX_{it}. This variable corresponds to t_i in the theory model. The minimum or lowest tax rate within an MNC p (including the parent as an entity) is denoted $MINTAX_{it}$. This corresponds to t_1 in the theory model. The third tax variable we are interested in is the weighted tax rate, denoted $WTAX_{it}$. This is a measure of the relative tax-position of entity i within the MNC. The variable corresponds to $\sum_{j\neq i}\rho_j(t_i - t_j)$ in the theory model. The weights ρ_{jt} are determined using the share of the fixed assets of entity j, FA_{jt}, relative to firm p's total fixed assets. Hence, $\rho_{jt} = FA_{jt}/\sum_{jt}FA_{jt}$.[26] Note that all tax incentives are time-t-indexed. Especially the within-firm incentives change substantially over time (we also allow the number of affiliates related to parent p to change over time).

Our theory model focuses on how tax incentives and bankruptcy costs affect the optimal capital structure of affiliates of MNCs, but there are, of course, other relevant determinants of capital structure choice. To account for this, we augment our regression model with a set of control variables often used in the empirical literature. Our selection of controls is especially inspired by the papers by Rajan and Zingales (1995), Huizinga et al. (2008), and Buettner and Wamser (2013). We condition on the following time-varying affiliate-, country-, and parent-industry-specific characteristics: $log\ Sales_{it-1}$, $Tangibility_{it-1}$, $PPTA_{it-1}$, $Loss\ Carryforward_{it-1}$, $Inflation_{it}$, $Corruption_{it}$, $GDP\ growth_{it}$, ROL_{it}, $log\ DCP_{it}$, $log\ SMC_{it}$, $MTAS_{it}$, $MCAS_{it}$, $MORS_{it}$, $MPROFS_{it}$, $MDSHS_{it}$. The first four variables are calculated using information from *MiDi*. They all enter as lags ($t-1$) to address endogeneity concerns.

The log of the sales of affiliate i, $log\ Sales_{it-1}$, is included to capture size effects. Size is expected to be positively related to the ease of borrowing from external creditors (e.g., Graham and Harvey, 2001; Frank and Goyal, 2009). At the same time, good access to external debt may imply that parental or internal debt is not needed.[27] Furthermore, higher sales may also imply that a firm is able to retain earnings and therefore relies less on debt financing (the impact on external debt may then be negative as well).

As an additional subsidiary-specific control we include $Tangibility_{it-1}$, calculated as the ratio of fixed assets to total assets of subsidiary i. A higher share of fixed assets might imply easier access to external debt because fixed assets are used as collateral (Rajan and Zingales, 1995). However, high tangibility could be associated with more depreciation allowances and investment tax credits for investment in fixed assets. This might crowd out the value of the debt tax shield, in which case the impact of $Tangibility_{it-1}$ on all types of debt would be negative (see De Angelo and Masulis, 1980).

Previous studies also control for some type of profitability measure. We use $PPTA_{it-1}$, the lagged financial-profits-to-total-assets ratio, to do so. Huizinga et al. (2008) argue that profitable firms may be associated with less risk, and thus have a better access to the credit market. However, profitable firms may also retain additional earnings to finance new investments (Myers and Majluf, 1984), suggesting a negative relationship between profitability and leverage. Hence, the effect of this variable on the various types of debt is unclear.

The tax benefit of debt will be reduced if losses are carried forward for tax purposes (MacKie-Mason, 1990). The variable $Loss\ Carryforward_{it-1}$ is defined as an indicator variable, which equals one if a loss Carryforward is reported, and zero otherwise. For the interpretation of this regressor, it is important to note that losses from previous periods may also capture other subsidiary characteristics such as its maturity.

We also control for a selection of time-varying country-specific regressors to capture local institutions such as creditor rights, as well as financial market conditions: ROL_{it}, $log\ DCP_{it}$, and $log\ SMC_{it}$. ROL_{it} ('rule of law') is a country-specific indicator taken from the World Bank's Worldwide Governance Indicators database and captures "perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence". DCP_{it}, which is taken from the World Bank's World Development Indicators database, measures domestic credit provided to the private sector relative to country's *GDP*. Higher values thereof suggest a deeper capital market. SMC_{it}, which is taken from the World Bank's Global Financial Development database, measures the total value of all listed shares in the stock market in per cent of a country's *GDP* in period t. The latter two variables should be associated with a higher degree of financial depth and a more favorable (local) capital market, facilitating external debt financing (see also Levine and Zervos, 1998; Levine, 2005).

$Inflation_{it}$ measures average percentage changes in consumer prices and is provided by the IMF (World Economic Outlook database). Desai et al. (2004) argue that foreign affiliates of MNCs borrow more externally and less internally in countries with high

[25] Note, however, that the affiliates with positive internal debt belong to only 62% of the MNCs, while about 59% of the MNCs use positive amounts of parental debt. Conditional on positive parental debt, the average parental debt-to-asset ratio of the affiliates is about 17.5%.

[26] Alternatively, we use the total assets to determine the weights to calculate $WTAX_{it}$. Our results are unaffected by this.

[27] This argument has been made in previous studies, concluding that external and internal debt are substitutes; e.g., Desai et al. (2004), or Buettner et al. (2009).

Table 1
Descriptive statistics.

	ALL OBS.		*SMALL MNCs*		*LARGE MNCs*		*POSITIVE DEBT*
	Mean	(sd)	Mean	(sd)	Mean	(sd)	Share
Panel A: Dependent Variables							
Share of external debt (b^E_{it} or ED_{it})	0.316	(0.250)	0.306	(0.254)	0.320	(0.246)	0.986
Share of parental debt (b^P_{it} or PD_{it})	0.072	(0.162)	0.091	(0.191)	0.055	(0.133)	0.409
Share of internal debt (b^I_{it} or ID_{it})	0.097	(0.183)	0.079	(0.172)	0.125	(0.203)	0.628

	Mean	(sd)
Panel B: Explanatory Variables		
TAX_{it}	0.285	(0.074)
$MINTAX_{it}$	0.177	(0.104)
$WTAX_{it}$	−0.006	(0.063)
log Sales$_{it-1}$	3.035	(1.435)
Tangibility$_{it-1}$	0.278	(0.262)
$PPTA_{it-1}$	0.037	(0.466)
Loss Carryforward$_{it-1}$	0.301	(0.459)
Inflation$_{it}$	2.908	(3.318)
Corruption$_{it}$	0.851	(0.916)
GDP growth$_{it}$	2.700	(3.282)
ROL_{it}	0.914	(0.842)
log DCP$_{it}$	4.480	(0.613)
log SMC$_{it}$	3.994	(0.758)
$MTAS_{it}$	8.086	(0.479)
$MCAS_{it}$	4.888	(0.521)
$MORS_{it}$	7.674	(0.644)
$MPROFS_{it}$	0.023	(0.021)
$MDSHS_{it}$	0.006	(0.017)

	ED	*PD*	*ID*	*TD*	*TAX*	*WTAX*	*MINTAX*
Panel C: Correlation Matrix for Key Variables.							
ED	1.000						
PD	−0.201	1.000					
ID	−0.239	−0.129	1.000				
TD	0.627	0.320	0.371	1.000			
TAX	0.016	0.007	0.021	0.032	1.000		
WTAX	0.050	−0.013	−0.007	0.033	0.659	1.000	
MINTAX	0.098	0.020	−0.140	0.008	0.322	0.118	1.000

The table reports descriptive statistics and correlation coefficients on the variables used in the regression analysis. *Panel A* reports descriptives on the dependent variables. The debt variables are defined as ratios where the numerator corresponds to the respective value of debt reported in *MiDi* and the denominator corresponds to total capital defined as the sum of "subscribed or called-up capital, endowment capital and contributions by partners", "capital reserves", "revenue reserves", "profit carried forward", and "liabilities". Columns denoted by *SMALL MNCs* and *LARGE MNCs* correspond to sub-samples where only the 25% smallest and largest MNCs, respectively, are considered. Whether an affiliate is assigned to small (large) is determined along the distribution of the parents' total assets. The column denoted by *POSITIVE DEBT* provides the shares of affiliate-year observations that use any positive amount of the various types of debt (shares of all observations). The total number of observations is 221,289. *Panel B* reports descriptive statistics on the explanatory variables used in the regression analysis. TAX_{it} is the statutory tax rate faced by affiliate i at a given host country. $MINTAX_{it}$ is the minimum tax rate observed within the MNC that affiliate i belongs to. $WTAX_{it}$ is the fixed-asset-weighted tax differential between the tax faced by affiliate i and the taxes at other locations within an MNC (see above, for a precise definition of this variable). *log Sales*$_{it-1}$ is the log of the sales reported for affiliate i, lagged by one period, $t-1$. *Tangibility*$_{it-1}$ is calculated as the share of fixed assets relative to total assets of affiliate i in year $t-1$. $PPTA_{it-1}$ is the lagged ratio of profit (of the financial year) divided by total assets. *Loss Carryforward*$_{it-1}$ is a binary indicator with value 1 if a loss carry forward is reported in our data for affiliate i at time $t-1$, and zero otherwise. *Inflation*$_{it}$ measures the average percentage changes in consumer prices. *Corruption*$_{it}$ measures control of corruption (higher values are associated with more control) at a location. *GDP growth*$_{it}$ measures the growth of the gross domestic product at the location of affiliate *i*. The total number of observations is 221,289. More detailed definitions of the explanatory variables (including data sources) are provided in the main body of the paper. *Panel C* reports Pearson correlation coefficients for a selection of key variables.

inflation. The underlying assumption is that external debt is often denominated in the local currency so that affiliates can hedge inflation risk through greater external borrowing. Huizinga et al. (2008) as well as Aggarwal and Kyaw (2008) argue that countries with higher inflation tend to have a higher risk premium and higher business risk in general, which discourages external borrowing.

The variable *Corruption*$_{it}$ is provided by the World Bank (Worldwide Governance Indicators). It measures *control of corruption* as "perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests" (see World Bank, Worldwide Governance Indicators). It varies in an interval of −2.5 to 2.5, higher values indicating less corruption. We expect that less corruption (an increase in *Corruption*$_{it}$) is associated with a lower external debt-to-asset ratio. If more corruption is associated with more political risk, our reasoning is in line with the findings of Desai et al. (2004) who argue that more risk should lead to more external debt financing as some of the risk may be shifted to external

capital providers.[28] Again, we cannot apply this argument to parental and internal debt. If the latter two types of debt are used to substitute for external debt, we expect the opposite impact of $Corruption_{it}$.

We further include $GDP\ growth_{it}$, which measures annual growth of a country's GDP. If a higher value of $GDP\ growth_{it}$ is associated with future growth, the effect on borrowing should be positive (Harris and Raviv, 1991). Rajan and Zingales (1995) as well as Myers (2001) suggest using the market-to-book-ratio of a firm as a proxy for growth opportunities, but this variable is not available in our data. In line with the debt-overhang theory of Myers (1977), they find that their measure is negatively related to borrowing. The *GDP growth* variable is taken from the World Bank's World Development indicators and may capture very generally the economic situations in host countries.

Note that common shocks (e.g., common tax shocks) at the level of the parent country (Germany) are captured by the year-specific dummy variables. We should also mention that the affiliate-specific effects nest parent fixed effects (we do not observe changes in ownership in our data). To make sure that the situation of the parent firm is adequately accounted for, we additionally control for parent-industry effects, as the parent firms are operating in very different sectors. For this, we use the micro-level dataset Orbis (provided by Bureau van Dijk). Note that we cannot merge the Orbis data at the firm-level with the parents in *MiDi* for the purpose of this project. What we can do, however, is to exploit the information from Orbis to determine industry-time-specific variables. In particular, we use median values of the following five variables:[29] First, $MTAS_{it}$ captures the median of the log of firms' *total assets* in a given sector and year; second, $MCAS_{it}$ captures the median of the log of firms' stock of *cash*; third, $MORS_{it}$ captures the median of the log of firms' *operating revenues*; fourth, $MPROFS_{it}$ is the median profitability defined as *EBIT* divided by *total assets* by industry and year; and fifth, $MDSHS_{it}$ is the median leverage (the long-term-debt-to-asset ratio) by industry and year.[30] The goal of including these variables is to capture time-varying determinants of financing decisions which are driven by parent-industry-specific conditions.

Pearson correlation coefficients between the key variables are provided in Panel C in Table 1. One interesting insight is that the debt variables are negatively correlated. This suggests that firms may avoid restrictions on one type of debt by using other types of debt financing. Another important finding is that the correlations between the other variables are not very high. The entry with one of the highest values, 0.66, is the correlation coefficient between *TAX* and *WTAX*.[31]

Table 2 presents some first descriptive evidence on how taxes affect average debt financing measured as the share of debt in total capital. A first remarkable result from Table 2 is that affiliates in high-tax countries ($TAX_{it} > 35\ \%$) are not that different from affiliates in low-tax countries ($TAX_{it} \leq 25\ \%$) with respect to average debt shares.[32] Parental and internal debt of affiliates located in high-tax countries exceed the average values of those affiliates located in low-tax countries by only 0.6 and 1.8 percentage points, and they exhibit an external debt-to-asset ratio that is lower than that of their low-tax counterparts. A possible explanation for the lack of a clear pattern is that the debt shares are conditioned on host-country tax incentives rather than MNC-specific ones.[33]

The next two sub-samples present average debt shares conditional on different values of $MINTAX_{it}$. Line three reports average debt shares for all observations with $MINTAX_{it} = 0$. This condition implies that at least one of the affiliated entities within an MNC must be located in a country that does not tax corporate profits. Line four shows average debt shares for affiliates belonging to MNCs where all entities are located in countries with a tax rate exceeding 35%. The latter condition implies that tax savings related to cross-border income shifting are rather modest.

Several findings stand out. First, the number of observations with $MINTAX_{it} = 0\%$ is relatively high when considering that the total number of affiliate-year observations in our estimation sample is 221,289 (note that the tax incentives are calculated from a bigger sample, see above). Second, internal debt financing seems to be clearly related to whether the MNC is operating a tax haven affiliate. The difference in the average internal debt-to-asset ratio is substantial: 9.3 percentage points. Third, parental debt is often used by those MNCs that do not operate low-tax affiliates. Finally, the average share of external debt is 6.5 percentage points higher if the minimum tax within the MNC is above 35%.

6. Main regressions

We start out presenting regression results for external, parental, and internal debt based on the specification suggested by our theory model.

6.1. External debt

Columns I and II (ED_{it}) in Table 3 contain results for the external debt-to-asset ratio based on the following estimation equation:

[28] See also Kesternich and Schnitzer (2010), as well as Desai et al. (2008), for similar arguments; Aggarwal and Kyaw (2008) make the point that this is particularly true if corruption means that there is an increased risk of expropriation.

[29] Alternatively, we use the mean (instead of the median) by industry. This does not change our regression results.

[30] While the median of $MDSHS_{it}$ is close to zero, reflecting the many zero values in Orbis, the mean value is higher with about 9.1%.

[31] The not reported cross-sectional correlation between *ROL* and *Corruption* is extremely high too. This seems, however, to be unproblematic in the regressions below. Note that we provide a full correlation matrix, including all controls and all dependent variables, in the online appendix to this paper.

[32] A country with a tax rate below 25% is considered as being a country with 'low' taxes according to the German CFC legislation (see below).

[33] Note that these statistics are based on a larger sample than the estimation sample below, as we do not lose observations through missing values in controls or other restrictions (see the online appendix for more information).

Table 2
Taxes and average debt.

		Share of total debt (Mean)	Share of parental debt (Mean)	Share of internal debt (Mean)	Share of external debt (Mean)	Obs. (N)
if TAX_{it}	≤25%	0.456	0.065	0.097	0.293	165,913
if TAX_{it}	>35%	0.473	0.071	0.115	0.287	81,778
if $MINTAX_{it}$	= 0%	0.467	0.057	0.148	0.263	79,546
if $MINTAX_{it}$	>35%	0.459	0.077	0.055	0.328	20,354

The debt variables are defined as ratios where the numerator corresponds to the respective value of debt reported in *MiDi* and the denominator corresponds to total capital defined as the sum of "subscribed or called-up capital, endowment capital and contributions by partners", "capital reserves", "revenue reserves", "profit carried forward", and "liabilities". TAX_{it} is the statutory tax rate faced by affiliate i at a given host country. $MINTAX_{it}$ is the minimum tax rate observed within an MNC that applies to affiliate i. Note that all statistics in this table are based on the largest available sample for which we have the information from *MiDi* and tax rates.

$$\mathrm{ED}_{\mathrm{it}} = \beta_1 \cdot \mathrm{TAX}_{\mathrm{it}} + \beta_2 \cdot \mathrm{WTAX}_{\mathrm{it}} + \mathrm{X}_{\mathrm{it}} \cdot \boldsymbol{\beta}_{\mathrm{x}} + c_i + d_t + \varepsilon_{\mathrm{it}}.$$

Here, ED_{it} denotes the external debt-to-asset ratio, c_i is an affiliate-specific effect, d_t are aggregate time effects, ε_{it} is an idiosyncratic error term, and $\mathbf{X}_{it}$ captures the set of exogenous controls. Note that our model suggests that TAX_{it} and $WTAX_{it}$ determine the external debt ratio. We therefore first focus on these two tax variables.

Column I shows that the local tax incentive, TAX_{it}, is not associated with a larger share of external debt financing (the coefficient is not only insignificant, it also tends towards zero). Thus, we cannot confirm the tax shield effect found in previous literature on capital structure choice and taxes. We should note, however, that we find a positive coefficient on TAX_{it} if, instead of affiliate-specific effects, we condition on parent fixed effects. The latter allows for cross-country variation if MNCs hold affiliates in more than just one country.[34]

In Column II, we add the weighted tax rate, $WTAX_{it}$. Our theory suggests that TAX_{it} and $WTAX_{it}$ should have a positive effect on external debt. We can confirm that $WTAX_{it}$ is positive and statistically significant, as expected.[35] Møen et al. (2019) use a similar model and find that TAX_{it} and $WTAX_{it}$ are both positive and significant when using parent-specific fixed effects instead of affiliate-specific fixed effects.

The coefficient of 0.053 for $WTAX_{it}$ implies that a ten-percentage points increase in the weighted tax differential is associated with a 0.5 percentage point higher external debt-to-asset ratio. Expressed as a semi-elasticity, a one percentage point higher weighted tax incentive leads to a 0.168 percent higher debt ratio. Although our estimates refer to external debt and to $WTAX_{it}$, it is worth noting that this finding is broadly in line with the magnitudes suggested in the meta-study by Feld et al. (2013).

Some of the control variables are significantly related to external debt financing as expected. An increase in sales as well as an increase in the tangible assets ratio improve borrowing conditions at the level of the affiliate. GDP growth (which we interpret as a proxy for growth opportunities) is positively related to the external debt-to-asset ratio. Two of the parent-industry variables are also significantly related to external debt financing. We will come back to an interpretation thereof in Section 8.

The results when including $MINTAX_{it}$ as an additional tax measures are presented in Table 4. We then find a positive and statistically significant coefficient on $MINTAX_{it}$. This suggests a substitutive relationship between internal and external debt. We do not want to stress this result too much as $MINTAX_{it}$ is not a determinant of external debt according to our theory model. It is also evident from Panel C in Table 1 that all tax incentives are highly correlated with each other, which raises concerns whether there is sufficient distinct variation to identify the effect of each single tax variable in the context of the fixed effects estimation. We come back to this specification issue below when presenting the results for total debt.[36]

6.2. Parental debt

Columns III and IV (PD_{it}) in Table 3 present results where the dependent variable is the parental debt-to-asset ratio. According to our theory model, parental debt is rerouted external debt and should be governed by the same determinants as external debt. Hence, TAX_{it} and $WTAX_{it}$ should have a positive effect.

Looking at the first specification for parental debt where only the local tax, TAX_{it}, is included, the estimated coefficient implies that a 10 percentage points higher statutory tax rate leads to a 0.7 percentage point higher parental debt ratio. The corresponding semi-elasticity (elasticity) is about 0.96 (0.273). This is broadly in line with earlier findings such as Desai et al. (2004). It generally suggests that the tax responsiveness of parental debt is relatively high.

[34] The coefficient (std.err.) we find when conditioning on parent-specific effects equals 0.145 (0.029). The estimates with parent-specific effects are available upon request. We prefer the ones with affiliate-specific effects as we believe that these produce unbiased estimates on the tax variables.
[35] In the specification with parent-specific effects we find positive and statistically significant effects for both TAX_{it} and $WTAX_{it}$.
[36] A regression of *WTAX* (the dependent variable) on *TAX* and *MINTAX*, using the same regression specification as in Table 3, suggests that a lot of variation in *WTAX* is explained by these variables. We find coefficients (std.err.) of 0.73 (0.008) (*TAX*) and -0.115 (0.009) (*MINTAX*). The adjusted R^2 of such a regression (accounting for affiliate-specific heterogeneity) amounts to 89%.

Table 3
Basic results for specific types of debt.

	ED_{it}		PD_{it}		ID_{it}		
	I	II	III	IV	V	VI	VII
TAX_{it}	0.002	−0.035	0.069***	0.094***	−0.021	−0.008	
	(0.03)	(0.036)	(0.019)	(0.022)	(0.015)	(0.015)	
$WTAX_{it}$		0.053***		−0.036***			
		(0.020)		(0.014)			
$MINTAX_{it}$						−0.056***	
						(0.009)	
$TAXDIFF_{it}$							0.046***
							(0.008)
log Sales$_{it-1}$	0.016***	0.016***	0.000	0.000	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tangibility$_{it-1}$	0.014***	0.014***	0.013***	0.013***	0.011***	0.011***	0.011***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
$PPTA_{it-1}$	−0.0001	−0.0002	−0.004**	−0.004**	−0.005***	−0.005***	−0.005***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Loss Carryforward$_{it-1}$	0.002	0.002	0.017***	0.017***	0.019***	0.020***	0.019***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation$_{it}$	0.0004	0.0004	0.001**	0.001**	0.0003	0.0003	0.0003
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Corruption$_{it}$	0.003	0.003	−0.009***	−0.009***	−0.008***	−0.007**	−0.007**
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
GDP growth$_{it}$	0.002***	0.002***	−0.000	−0.000	−0.0002	−0.0002	−0.0002
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
ROL_{it}	−0.003	−0.003	0.007*	0.007*	−0.005	−0.005	−0.005
	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
log DCP$_{it}$	0.003	0.003	−0.005	−0.005	0.005**	0.005**	0.005**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
log SMC$_{it}$	0.005*	0.005	−0.005***	−0.005***	0.003*	0.003*	0.004**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$MTAS_{it}$	0.001	0.001	−0.005*	−0.005*	−0.002	−0.002	−0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
$MCAS_{it}$	0.014***	0.014***	−0.029***	−0.029***	0.002	0.002	0.002
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$MORS_{it}$	−0.009***	−0.009***	0.020***	0.020***	0.005**	0.005**	0.005**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$MPROFS_{it}$	0.089	0.092	0.321***	0.319***	−0.174***	−0.178***	−0.178***
	(0.068)	(0.068)	(0.058)	(0.058)	(0.056)	(0.055)	(0.055)
$MDSHS_{it}$	0.055	0.054	−0.045*	−0.044*	0.008	0.0113	0.012
	(0.040)	(0.040)	(0.025)	(0.025)	(0.030)	(0.030)	(0.030)
Constant	0.272***	0.286***	0.116***	0.106***	0.039**	0.052***	0.029*
	(0.030)	(0.031)	(0.0240)	(0.023)	(0.017)	(0.018)	(0.016)
Adj. R-sq	0.688	0.688	0.626	0.626	0.660	0.661	0.661

The table presents OLS estimates. Dependent variable is the external (ED_{it}), parental (PD_{it}), and internal (ID_{it}) debt-to-asset ratio of affiliate i at time t, respectively. All regressions include aggregate year dummies and affiliate-specific fixed effects. Definitions and descriptive statistics on the explanatory variables are provided in Section 5. Robust standard errors are reported in parentheses (clustered at the county-year level). Estimates are based on 221,289 observations.

*** Significance at the 1% level.
** Significance at the 5% level.
* Significance at the 10% level.

Moving on to the next column where TAX_{it} and $WTAX_{it}$ are included simultaneously, we see that TAX_{it} is still positive and significant as expected. However, $WTAX_{it}$ has a negative and significant impact rather than the positive coefficient, as predicted by our theory model. Knowing that $WTAX_{it}$ and TAX_{it} are highly correlated and noticing that the coefficient (std.err.) on *TAX* becomes larger, while the coefficient on *WTAX* is large and negative, the estimate on $WTAX_{it}$ should be interpreted with caution. Taken at face value, however, the negative impact of $WTAX_{it}$ indicates that external debt substitutes for parental debt under certain conditions. This is also consistent with the negative correlation between parent and external debt shown in Panel C in Table 1.

The strong responsiveness to TAX_{it} indicates that parent firms can flexibly respond to changes in tax rates by using parental debt. In order to assess the estimated joint effect of TAX_{it} and $WTAX_{it}$, we can look at the effect of a tax reform on a typical firm.[37] This firm holds 10 affiliates in 9 different countries, where one is a tax haven country (with zero tax).

The average tax over all affiliates is 23%, and we may focus on a change in the corporate tax rate faced by the affiliate in the country

[37] We define a typical firm in a given year as the median firm in terms of number of foreign affiliates held by the MNC.

Table 4
All types of debt and all tax incentives.

	ED_{it}	PD_{it}	ID_{it}	TD_{it}	TD_{it}
TAX_{it}	−0.080**	0.100***	0.012	0.050	0.0309
	(0.037)	(0.022)	(0.018)	(0.033)	(0.0389)
$WTAX_{it}$	0.089***	−0.040***	−0.027*		0.0214
	(0.021)	(0.014)	(0.015)		(0.0223)
$MINTAX_{it}$	0.088***	−0.011	−0.059***		0.0181
	(0.010)	(0.007)	(0.009)		(0.0113)
$log\ Sales_{it-1}$	0.016***	0.000	0.003***	0.018***	0.018***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Tangibility_{it-1}$	0.014***	0.013***	0.011***	0.038***	0.038***
	(0.004)	(0.003)	(0.004)	(0.005)	(0.005)
$PPTA_{it-1}$	−0.0001	−0.004**	−0.005***	−0.009***	−0.009***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)
$Loss\ Carryforward_{it-1}$	0.002	0.017***	0.020***	0.038***	0.038***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
$Inflation_{it}$	0.0004	0.001**	0.0003	0.001***	0.001***
	(0.0003)	(0.0002)	(0.0002)	(0.0004)	(0.0004)
$Corruption_{it}$	0.003	−0.009***	−0.007**	−0.013***	−0.014***
	(0.004)	(0.003)	(0.003)	(0.005)	(0.005)
$GDP\ growth_{it}$	0.001***	−0.000	−0.0002	0.001***	0.001***
	(0.0003)	(0.0002)	(0.0002)	(0.0004)	(0.0004)
ROL_{it}	−0.002	0.007*	−0.005	−0.000	0.000
	(0.007)	(0.004)	(0.004)	(0.008)	(0.008)
$log\ DCP_{it}$	0.003	−0.005	0.005**	0.004	0.004
	(0.004)	(0.004)	(0.002)	(0.006)	(0.006)
$log\ SMC_{it}$	0.005*	−0.005***	0.003*	0.003	0.003
	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
$MTAS_{it}$	0.001	−0.005*	−0.002	−0.006*	−0.006*
	(0.003)	(0.003)	(0.002)	(0.004)	(0.004)
$MCAS_{it}$	0.014**	−0.029***	0.002	−0.013***	−0.013***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
$MORS_{it}$	−0.008***	0.020***	0.005**	0.016***	0.016***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
$MPROFS_{it}$	0.100	0.318***	−0.180***	0.236***	0.238***
	(0.068)	(0.058)	(0.055)	(0.078)	(0.077)
$MDSHS_{it}$	0.049	−0.043*	0.0120	0.019	0.017
	(0.039)	(0.025)	(0.030)	(0.032)	(0.032)
Constant	0.275***	0.107***	0.045**	0.426***	0.428***
	(0.031)	(0.023)	(0.018)	(0.035)	(0.035)
Adj. R-sq	0.689	0.626	0.661	0.705	0.705

The table presents OLS estimates. Dependent variable is the external debt-to-asset ratio (ED_{it}), the parental debt-to-asset ratio (PD_{it}), the internal debt-to-asset ratio (ID_{it}), or the total debt-to-asset ratio (TD_{it}) of affiliate i at time t. All regressions include aggregate year dummies and affiliate-specific fixed effects. Definitions and descriptive statistics on the explanatory variables are provided in Section 5. Robust standard errors are reported in parentheses (clustered at the county-year level). Estimates are based on 221,289 observations.

*** Significance at the 1% level.

** Significance at the 5% level.

* Significance at the 10% level.

with the highest tax rate. Assume that TAX_{it} in that country equals 34% and is reduced by a reform to 20% ($\Delta TAX = 0.14$). If, ceteris paribus, we use the findings from Table 3, the total effect is a decrease of the parental debt-to-asset ratio by approximately one percentage point in the average affiliate: $0.094 \cdot (-0.14) - 0.036 \cdot (1 - 0.28) \cdot (-0.14) = -0.0095$.[38]

Looking briefly at the control variables, one remarkable finding is that sales are not related to parental debt. This contrasts the effect of sales on external debt, but makes sense as high sales are a positive signal to external creditors only. The variable $Tangibility_{it}$, on the other hand, affects parental debt financing in a similar way as it affects external debt. This supports our theory model, and one explanation may be that higher values of this variable indicate higher demand for debt financing in general. Another interesting finding, confirming earlier results (e.g., Gopalan et al., 2007), suggests that it is rather the unprofitable, loss-making firms that are parental-debt financed. For example, while the profitability measure, *PPTA*, is negatively related to parental debt, the coefficient on $Loss\ Carryforward_{it}$ is positive. Finally, the negative estimate on *SMC* suggests that MNCs are able to avoid adverse local capital market conditions by using more parental debt (compare this to the positive estimate on *SMC* for external debt in Table 3). Taken together,

[38] Note that the marginal effect of a tax rate change in affiliate i working via the weighted tax differential (i.e., external debt shifting) is given by $\beta^{WTAX} \cdot (1 - \rho_i) \cdot \Delta TAX_i$, see also Section 3. In our sample, the mean affiliate size is $\bar{\rho} = 28\%$ (relative to total assets of the MNC group). Note as well that the median-ρ is substantially smaller with 7%.

these findings suggest that parental debt increases with the transaction cost of accessing the local capital market, as our theory model predicts.

Table 4 (column PD_{it}) eventually suggests that the lowest tax within the firm, $MINTAX_{it}$, is not significantly related to parental debt, as expected.

6.3. Internal debt

Columns V to VII (ID_{it}) in Table 3 contain regression results for the internal debt-to-asset ratio. According to our theory model, the level of internal debt supplied by non-parent entities is determined by $MINTAX_{it}$, and profit shifting is the driving mechanism. This prediction comes through in the data. The coefficient on TAX_{it} is insignificant and very close to zero. The coefficient on $MINTAX_{it}$ is negative and significant, meaning that the internal debt-to-asset-ratio increases when the lowest tax rate within the firm falls and therefore the tax differential and scope for tax arbitrage increases. The latter finding is in line with Buettner and Wamser (2013).[39]

From a quantitative perspective, the implied effect of $MINTAX_{it}$ is substantial but not huge – a one-standard-deviation higher minimum tax rate implies a reduction of internal debt by about 0.6 percentage points. Expressed as an elasticity, we find that a 1 percent increase in $MINTAX_{it}$ leads to 0.10 percent less internal debt financing. Yet, we should mention that the interpretation of the coefficient does not take into account the specific situation of a firm in a specific country. Obviously, not all MNCs operate entities in tax haven countries. In the last column of Table 3 we include *TAXDIFF*, the difference between *TAX* and *MINTAX*, i.e. $TAX_{it} - MINTAX_{it}$. The estimated coefficient on *TAXDIFF* is positive, as expected. We finally find some indication of a substitutive relationship between internal and external debt by including all three tax variables at the same time (see Table 4, column ID_{it}, and the negative coefficient on $WTAX_{it}$).

Putting together all the results presented in Table 3, our findings suggest that firms arbitrage not only across countries and taxes, but also over different types of debt financing, depending on other determinants. For example, neither $PPTA_{it-1}$ nor $Loss\ Carryforward_{it-1}$ have an effect on external debt, while they are important determinants of parental and internal debt financing. The results also suggest that parental debt is in many ways similar to external debt, but in other respects also similar to internal debt. This may be important when designing tax policy.

6.4. Total debt

The last two columns of Table 4 present results for the total debt-to-asset ratio. Many of the non-tax control variables are now statistically significant and they all have the expected sign. Interestingly, none of the tax variables is significantly related to total debt financing. Of course, the affiliate-fixed-effects approach comes at the cost of removing all cross-sectional variation.[40] The insignificant estimates may just be the result of the latter. We can easily test whether this is true by regressing the total debt share on parent fixed effects (instead of the affiliate-specific effects). Doing so suggests a highly significant estimate on TAX_{it} of 0.122 (*std.err.* of 0.030) and a highly significant negative estimate on $MINTAX_{it}$ of -0.034 (0.016). The coefficient on $WTAX_{it}$ is not statistically significant.

An alternative interpretation, conditional on the affiliate fixed effects and related to the last point, is the substitution hypothesis (see Desai et al., 2004) that firms broadly try to keep the overall debt ratio at a certain level and then arbitrage across different types of debt. The latter then depends on local tax incentives as well as tax incentives within the MNC. We will come back to this issue in Section 8.

7. A closer look at the internal capital market mechanisms

The main regressions in Section 6 study intensive margin adjustments for different types of debt in response to changes in tax incentives. As highlighted in our theory, there are fixed costs associated with setting up a tax-optimizing internal debt scheme. In this section, we explore what factors influence the choice of using parental and non-parental internal debt. We start out exploring the characteristics of internal lenders.

7.1. Who are the internal lenders?

We define a binary variable, $LEND_{it}$, to indicate whether the balance sheet of affiliate i shows positive lending in period t ($LEND_{it} = 1$) or not ($LEND_{it}$=0). With this definition, 12,466 affiliate-year observations are identified as lenders. These relate to 4100

[39] The analysis of Buettner and Wamser (2013) is also based on *MiDi* data, but they focus exclusively on internal debt, use a different time span as well as different specifications of the regressions.

[40] Note that we generally may have the problem of limited variation in TAX_{it} (which measures the local tax incentive). In addition, Panel C in Table 1 suggests that TAX_{it} and $WTAX_{it}$ are highly correlated. This can also be shown from regressions where we use $WTAX_{it}$ as the dependent variable and regress it on TAX_{it} and all the other determinants of capital structure. See footnote 36, where this is done. A general point, which we would like to mention, is the following one: The specification that comes out of our theory model for *total debt* is $b_i = \beta_1 \cdot t_i + \beta_2 \sum_{j \neq i} \rho_j (t_i - t_j) + \beta_3 \cdot (t_i - t_1)$. The ideal empirical specification would rather be $b_i = \beta_1 \cdot t_i + \beta_2 \sum_{j \neq i} \rho_j t_j + \beta_3 \cdot t_1$ so as to have the most distinct variation in the tax incentives. The estimate of β_1 would in this case capture a composite effect of the different debt mechanisms at play, and of the different weights. Unfortunately, it is not possible to interpret such an estimate in light of our theory.

affiliates held by 1942 MNCs and constitute about 5.2% of the affiliate-year regression sample (note that the information on $LEND_{it}$ is available for a total of 238,599 observations).

The entities with $LEND_{it} = 1$ should be the ones that provide internal debt to other borrowing affiliates within a firm, i.e., these are the internal banks. Although our census-type data provides a relatively complete picture of MNCs, the bilateral lending-borrowing relationships are unobserved. This prevents a clear test of hypotheses related to the lending behavior. What we can examine, however, is whether the pattern of lending is consistent with what we would generally expect to be a relevant determinant of positive lending.

Column 1 in Table 5 refers to a pooled probit estimation including time dummies; column 2 refers to an estimation which includes affiliate-specific effects (i.e., the means of the explanatory variables as additional regressors; see Møen et al., 2018, a previous version of the paper); column 3 adds $MINTAX_{it}$ and a dummy variable indicating whether affiliate i is the lowest-tax affiliate within the MNC. The results in Table 5 show the following. First, the probability of being a lender is higher when entity i is located in a low-tax country. The marginal effect of TAX_{it} evaluated at the mean is approximately -0.05, which seems to be a rather modest effect. Second, the probability of positive lending is increasing in sales. Sales may be a proxy for affiliate size or may indicate that an affiliate is more able to retain earnings (which are then provided as internal debt). Third, the share of tangible assets is negatively related to lending. This seems plausible given that the affiliates with $LEND_{it} = 1$ should be the internal banks. Fourth, the higher the minimum tax within the

Table 5
Determinants of positive internal lending.

	I	II	III
TAX_{it}	−0.578***	−0.493*	−0.306
	(0.149)	(0.266)	(0.270)
$MINTAX_{it}$			−0.288**
			(0.135)
Lowest tax affiliate$_{it}$			0.048**
			(0.024)
log Sales$_{it-1}$	0.113***	0.023*	0.023*
	(0.007)	(0.013)	(0.013)
Tangibility$_{it-1}$	−0.191***	−0.594***	−0.592***
	(0.037)	(0.065)	(0.065)
$PPTA_{it-1}$	0.071***	0.012	0.013
	(0.022)	(0.018)	(0.018)
Loss Carryforward$_{it-1}$	−0.093***	−0.024	−0.024
	(0.018)	(0.017)	(0.017)
Inflation$_{it}$	−0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)
Corruption$_{it}$	0.028	0.017	0.034
	(0.036)	(0.049)	(0.049)
GDP growth$_{it}$	−0.020***	−0.006**	−0.006**
	(0.003)	(0.003)	(0.003)
ROL_{it}	0.056	−0.072	−0.084
	(0.039)	(0.068)	(0.067)
log DCP$_{it}$	−0.035	0.230***	0.221***
	(0.023)	(0.054)	(0.054)
log SMC$_{it}$	0.073***	−0.048	−0.052*
	(0.019)	(0.031)	(0.030)
$MTAS_{it}$	−0.018	−0.482***	−0.026
	(0.036)	(0.113)	(0.043)
$MCAS_{it}$	0.047	−0.875***	0.084**
	(0.033)	(0.153)	(0.038)
$MORS_{it}$	−0.053*	0.670***	−0.038
	(0.031)	(0.132)	(0.038)
$MPROFS_{it}$	0.351	1.678	1.863**
	(0.978)	(1.398)	(0.891)
$MDSHS_{it}$	−0.613	−0.470	0.194
	(0.511)	(0.507)	(0.390)
Marginal Effects			
TAX_{it}	-0.057	-0.048	-0.030
$MINTAX_{it}$			-0.028
Lowest tax affiliate$_{it}$			0.005

The table reports estimates from a Probit model with $LEND_{it}$ as dependent variable. All regressions include aggregate year dummies; specifications II and III add affiliate-specific effects (means) using the approach described in Møen et al. (2018), following Mundlak (1978) and Chamberlain (1980). Definitions and descriptive statistics on the explanatory variables are provided in Section 5. Robust standard errors are reported in parentheses. Estimates are based on 221,289 observations.

*** Significance at the 1% level.

** Significance at the 5% level.

* Significance at the 10% level.

MNC, the lower is the probability that *i* has positive lending. And finally, being the lowest-tax affiliate within the MNC makes it rather likely that internal lending is provided.[41]

7.2. Who are the MNCs that operate lending entities?

The regressions shown in Table 5 are based on subsidiary-level observations. It is also interesting to analyze whether parent *p* is operating a lending entity. To examine this, we define a new binary variable at the group level: $LEND_{pt}$ is one if MNC *p* is operating at least one lending entity and zero otherwise. $LEND_{pt} = 1$ holds for about 15% of the MNCs in our data.

As above, we use a binary response model. Note, however, that our dataset provides only limited information about parent firms. This means that the list of potential *p*-specific determinants of $LEND_{pt}$ is limited.

Table 6 suggests that firms are more likely to operate at least one affiliate with positive lending if (i) the balance-sheet total of the whole corporate group, BST_{pt}, is larger; (ii) the average entity of *p* is larger in terms of total assets, TA_{pt}, and in terms of average fixed assets of the foreign affiliates, FA_{pt}.[42] This confirms the general expectation that being large facilitates operating an internal capital market.[43]

7.3. Determinants of parental debt

The average share of parental debt financing in our sample is about 7%, and our data suggest that many MNCs provide parental lending from Germany even if the affiliates face relatively low taxes in their host countries.[44] The share of parental debt is negatively correlated with both external and internal debt (see Panel C in Table 1).

As pointed out in the theory section, it would be tax-efficient to provide all internal debt from the lowest-taxed entity within the group in a world without capital market frictions. Our theory model offers two explanations of why we observe lending from parent companies in situations where the parent is not the lowest-taxed entity within the group. First, parent companies may have a cost advantage in raising external capital in their home market compared to the affiliates raising external capital in their local markets. Going back to the model, this relative cost is given by δ_E/δ_P and the larger the ratio, the larger is the cost advantage of the parent and the higher is the optimal parental debt-to-asset ratio, cf. Eq. (9). This mechanism captures that parental debt and external debt are substitutes. Second, there may be fixed costs associated with setting up an internal bank. For small MNCs and companies with modest within-group tax differences, therefore, the tax advantage of setting up an internal bank may not be sufficiently large to warrant the cost. It may then be optimal to finance affiliates directly from the parent. Such 'parental internal debt' will be financed through parent equity and is used instead of equity in the affiliate.

The relative cost advantage of the parent company will vary with the degree to which the parent is credit constrained in its home market. We therefore proxy the parent cost advantage ratio with a credit constraint indicator provided by the German economic research institute, Ifo. Ifo conducts regular surveys of Germany businesses to assess banks' lending policies. The variable CCI_{pt} (Credit Constraint Indicator) measures the share of firms (in the home market) that feel that credit access is restrictive. Note, thus, that the variable applies to the parent *p*. On average in our sample, almost 27% of firms report that this is the case. Although all parent firms are operating from Germany, CCI_{pt} varies over time and is measured for different levels of company size (firms are classified as small if their turnover is below 10 million euros, and the number of employees is below 50; firms are classified as large if their turnover is above 50 million euros and the number of employees is above 249; firms in-between these values are defined as medium sized).

Table 7 presents results where we explore the effect of CCI_{pt} on parental and external debt in affiliate-level regressions conditioning

[41] Note that in column III, *TAX* is no longer significantly related to the probability of positive lending once *MINTAX* and *Lowest-tax affiliate* are included. The estimated coefficient on *MINTAX* is in the context of the lending affiliate difficult to interpret since it is measured at the group level, while the dependent variable *LEND* is measured at the affiliate level. We find it plausible, however, that the negative estimate of *MINTAX*, to some extent, captures the effect of *TAX* which remains negative, but becomes insignificant.

[42] The variable BST_{pt} is measured in logs at the consolidated corporate group level, while TA_{pt} and FA_{pt} refer to averages over all affiliates that belong to an MNC, also in logs. The regressions also condition on aggregate time effects and averages of the country-specific variables where the averages are calculated over all countries the MNC is holding affiliates in, weighted by the number of affiliates in these countries. The estimated coefficients on most of these averages at the level of countries (e.g., average GDP growth or corruption perception) should not be interpreted, but are included for the sake of controlling for average conditions in host countries. Apart from that, we believe that the negative tax effect makes sense. As the average tax level in the group increases towards the level of Germany, the tax differential within the group becomes smaller and there will be little to gain from setting up an internal bank.

[43] Note that we have decided against including $MINTAX_{it}$ as an additional regressor. Even though we argue that all estimates presented in Table 6 should primarily be interpreted as correlations, $MINTAX_{it}$ is obviously determined simultaneously with the choice of location for the lending entity. It is therefore endogenous. In this respect, it is important to note that all regressions in the previous sections are estimated at the affiliate level and analyze different outcomes. We believe that the endogeneity issue is far less relevant there, and we provide endogeneity tests in the online appendix that support this view. Note also that if we add $MINTAX_{it}$ to the specifications in Table 6, we get a coefficient of -4.15 with standard error (0.36). As one would expect, a high minimum tax makes it unlikely that the MNC operates a lending entity.

[44] For about 40% of the MNCs in our data, Germany is the minimum-tax country. While this seems to be a significant share, this number may be biased as it assumes an average local business tax in Germany. In reality, the local business tax varies across German municipalities (and larger cities where most of the MNCs should be located have higher taxes), but we do not have information about the municipality in which an MNC is located.

Table 6
Who operates a lending entity?

	I	II	III
log BST$_{pt}$	0.096***	0.093***	0.088***
	(0.006)	(0.006)	(0.006)
$\overline{\text{log TA}}_{pt}$		0.094***	0.069***
		(0.013)	(0.015)
$\overline{\text{log FA}}_{pt}$			0.085***
			(0.024)
$\overline{\text{TAX}}_{pt}$	−0.512**	−0.598**	−0.600**
	(0.252)	(0.256)	(0.255)
$\overline{\text{log Sales}}_{pt-1}$	0.042***	−0.029*	−0.066***
	(0.012)	(0.016)	(0.018)
$\overline{\text{Tangibility}}_{pt-1}$	−0.226***	−0.811***	−0.775***
	(0.059)	(0.094)	(0.094)
$\overline{\text{PPTA}}_{pt-1}$	0.010	0.017	0.016
	(0.019)	(0.019)	(0.019)
$\overline{\text{Loss Carryforward}}_{pt-1}$	0.020	0.033	0.033
	(0.029)	(0.030)	(0.029)
$\overline{\text{Inflation}}_{pt}$	−0.006	−0.006	−0.006
	(0.005)	(0.005)	(0.005)
$\overline{\text{Corruption}}_{pt}$	0.099	0.106	0.108*
	(0.064)	(0.065)	(0.064)
$\overline{\text{GDP growth}}_{pt}$	−0.020***	−0.021***	−0.021***
	(0.006)	(0.006)	(0.006)
$\overline{\text{ROL}}_{pt}$	−0.074	−0.065	−0.065
	(0.066)	(0.067)	(0.066)
$\overline{\text{log DCP}}_{pt}$	−0.027	−0.032	−0.038
	(0.040)	(0.040)	(0.040)
$\overline{\text{log SMC}}_{pt}$	0.055*	0.053	0.051
	(0.033)	(0.033)	(0.033)
$\overline{\text{MTAS}}_{pt}$	0.064	0.036	0.028
	(0.057)	(0.058)	(0.058)
$\overline{\text{MCAS}}_{pt}$	0.030	0.023	0.014
	(0.059)	(0.059)	(0.059)
$\overline{\text{MORS}}_{pt}$	−0.026	0.001	0.013
	(0.050)	(0.050)	(0.050)
$\overline{\text{MPROFS}}_{pt}$	−4.669***	−5.199***	−5.234***
	(1.580)	(1.593)	(1.578)
$\overline{\text{MDSHS}}_{pt}$	−1.025	−0.968	−1.046
	(0.709)	(0.722)	(0.706)
Marginal Effects			
$\overline{\text{TAX}}_{pt}$	−0.113	−0.131	−0.132
log BST$_{pt}$	0.021	0.020	0.019
$\overline{\text{log TA}}_{pt}$		0.021	0.015
$\overline{\text{log FA}}_{pt}$			0.019
Observations	61,951	61,810	61,810

The table reports estimates from a Probit model with *LEND$_{pt}$* (measured at the level of the parent *p*) as dependent variable. All regressions include aggregate year dummies. Definitions of the explanatory variables are provided in Section 7.2. The '$\overline{\text{bar}}$' indicates that variables are means at the MNC level. Robust standard errors are reported in parentheses. Estimates are based on 221,289 observations.

*** denotes significance at the 1% level.
** denotes significance at the 5% level.
* denotes significance at the 10% level.

on all the non-tax control variables used in Tables 3 and 4.[45] The findings are consistent with our theory. An increase in the credit constraint indicator *CCI$_{pt}$* (a reduction in δ_E/δ_P) is associated with significantly less parental debt financing. The coefficient on *CCI$_{pt}$* for external debt financing is positive, but insignificant. This suggests that favorable access to credit capital at the parent location is an

[45] These controls are not reported to save space. Estimated coefficients hardly change compared to the basic results.

Table 7
Credit constraint indicator and debt.

	Parental debt			*External debt*	
CCI_{pt}	−0.075***	−0.033**	CCI_{pt}	0.012	0.014
	(0.008)	(0.014)		(0.010)	(.010)
$CCI_{pt} \times TAX_{it}$		−0.141***	$CCI_{pt} \times WTAX_{it}$		0.153**
		(0.042)			(0.063)
TAX_{it}		0.098***	$WTAX_{it}$		0.002
		(0.021)			(0.022)

The table presents OLS estimates. Dependent variable is the parental debt-to-asset ratio (PD_{it}) or the external debt-to-asset ratio (ED_{it}) of affiliate i at time t. The variable CCI_{pt} measures the share of firms that feel that credit access is restrictive. All regressions include aggregate year dummies and affiliate-specific fixed effects. Note that all regressions include the standard set of control variables used before. These are not reported. Definitions and descriptive statistics on the explanatory variables are provided in Section 5. Robust standard errors are reported in parentheses (clustered at the county-year level). Estimates are based on 221,289 observations.
***Significance at the 1% level. **Significance at the 5% level. *Significance at the 10% level.

important reason for why parental debt is used. Let us highlight that this particularly confirms the role of parental debt as rerouted external debt.

We then additionally include TAX_{it} and the interaction between TAX_{it} and CCI_{pt}.[46] This takes us closer to Eq. (9) and tests whether the responsiveness of parental and external debt to taxes depends on whether the parent is credit constrained or not. The findings suggest that the parental debt tax-responsiveness of affiliate i is significantly reduced if the parent is credit constrained. This is in line with our theory. In the external debt regression, we find that $WTAX_{it}$, as the relevant tax determinant of external debt, is only significant if the parent is credit constraint (the interaction between $WTAX_{it}$ and CCI_{pt} is positive and statistically significant, while $WTAX_{it}$ is positive but insignificant). We believe that this makes sense as profitable parents may rather use equity to finance foreign investments.

Note that in a previous version of the paper (see Møen et al., 2018), we have included an alternative variable to capture the financial situation of the parent. In particular, we used the sales over total assets ($SATA_{pt}$) of the parent firm to proxy for parents' financial solvency and better access to external credit at home and in the host country. When including $SATA_{pt}$ now, we find coefficients that are not only close to zero but also insignificant. Compared to the earlier estimates, this clearly is related to the new debt specifications where we condition on five additional variables at the parent-industry level. It seems that these variables capture most of the variation of $SATA_{pt}$.

7.4. Who is using parental debt?

Our theory predicts that small MNCs should be more inclined to use parental debt financing than large MNCs as they cannot bear the fixed cost of setting up an internal lending entity. Likewise, MNCs with small within-group tax differences will also have a reduced likelihood of setting up an internal bank. To see whether this is a pattern we find in our data, we use an approach similar to that in Table 6 and run regressions on the extensive margin of parental debt usage. We define a binary indicator $PDEBT_{pt}$ and assign a value of 1 if at least one affiliate receives parental debt financing and zero if none of the affiliates within the MNC shows a positive amount of parental debt financing. Almost 29% of our parent-year observations have $PDEBT_{pt}$ equal to 1.

Using the same set of controls as in Table 6, the estimates provided in Table 8 suggest that parental debt is used by smaller firms, as $log\ BST_{pt}$, $log\ TA_{pt}$, and $log\ FA_{pt}$ are all negatively related to $PDEBT_{pt}$. To further support the argument that parental debt is used mainly in the absence of an internal lending entity, column 4 in the same table includes $LEND_{pt}$, i.e., the dependent variable from above, to show that it is negatively correlated with $PDEBT_{pt}$. Hence, we can conclude that parental debt is used if firms are small and cannot afford an internal lending entity. The latter is consistent with our theory.[47]

8. Substitutability of parent, external and internal debt

Previous findings by Desai et al. (2004) indicate that greater borrowing from parents substitutes for external borrowing. We mostly provide indirect evidence that there is a substitutive relationship between the three types of debt. This can be seen from the findings on different explanatory variables that have a positive (or negative) effect on one type of debt and a negative (or positive) effect on another type or vice versa. For example, Table 3 suggests that the variable *MORS* (the log of the operating revenues at the

[46] Note that for reasons of simplicity and interpretability, we have not included the other tax incentives here, but only the relevant ones.
[47] When we examine the probability of positive lending at the level of the MNC in Table 8, we have decided against including $MINTAX_{it}$. This is because the argument presented in footnote 43 naturally applies to this analysis as well. However, if we ignore the endogeneity concern and include $MINTAX_{it}$, we estimate a coefficient of 2.76 with a standard error of 0.30. This suggests that a higher minimum tax makes it more likely that the MNC uses parental debt, something which confirms all our previous findings. Finally note that, instead of $MINTAX_{it}$, one may argue that we could include $MAXTAX_{it}$ – the within-firm maximum tax rate. $MAXTAX_{it}$ might be less prone to endogeneity as firms are less likely to self-select into countries with high tax rates. We estimate a negative and significant effect of $MAXTAX_{it}$ with a coefficient of −2.354 and a standard error of 0.287.

Table 8
Who is using parental debt?

	I	II	III	IV
log BST$_{pt}$	−0.024***	−0.022***	−0.017***	−0.012**
	(0.005)	(0.005)	(0.005)	(0.005)
$\overline{\text{log TA}}_{pt}$		−0.054***	−0.031***	−0.028**
		(0.010)	(0.012)	(0.012)
$\overline{\text{log FA}}_{pt}$			−0.088***	−0.080***
			(0.022)	(0.021)
LEND$_{pt}$				−0.291***
				(0.031)
$\overline{\text{TAX}}_{pt}$	0.926***	0.981***	0.992***	0.952***
	(0.241)	(0.241)	(0.242)	(0.241)
$\overline{\text{log Sales}}_{pt-1}$	−0.053***	−0.014	0.025	0.020
	(0.011)	(0.013)	(0.015)	(0.015)
$\overline{\text{Tangibility}}_{pt-1}$	0.060	0.392***	0.369***	0.328***
	(0.052)	(0.078)	(0.079)	(0.079)
$\overline{\text{PPTA}}_{pt-1}$	−0.035	−0.036	−0.034	−0.033
	(0.024)	(0.024)	(0.024)	(0.024)
$\overline{\text{Loss Carryforward}}_{pt-1}$	0.226***	0.221***	0.221***	0.222***
	(0.027)	(0.027)	(0.027)	(0.027)
$\overline{\text{Inflation}}_{pt}$	−0.014***	−0.014***	−0.014***	−0.015***
	(0.005)	(0.005)	(0.005)	(0.005)
$\overline{\text{Corruption}}_{pt}$	0.061	0.057	0.056	0.061
	(0.059)	(0.059)	(0.059)	(0.059)
$\overline{\text{GDP growth}}_{pt}$	0.001	0.002	0.001	0.0003
	(0.005)	(0.005)	(0.005)	(0.005)
$\overline{\text{ROL}}_{pt}$	−0.095	−0.101	−0.105*	−0.107*
	(0.062)	(0.062)	(0.062)	(0.062)
$\overline{\text{log DCP}}_{pt}$	−0.054	−0.050	−0.043	−0.046
	(0.035)	(0.035)	(0.035)	(0.035)
$\overline{\text{log SMC}}_{pt}$	−0.004	−0.003	−0.001	0.0025
	(0.029)	(0.029)	(0.029)	(0.028)
$\overline{\text{MTAS}}_{pt}$	−0.154***	−0.137***	−0.130***	−0.128***
	(0.045)	(0.045)	(0.046)	(0.045)
$\overline{\text{MCAS}}_{pt}$	−0.096**	−0.095**	−0.087**	−0.088**
	(0.044)	(0.044)	(0.044)	(0.044)
$\overline{\text{MORS}}_{pt}$	0.297***	0.283***	0.270***	0.270***
	(0.041)	(0.041)	(0.042)	(0.041)
$\overline{\text{MPROFS}}_{pt}$	12.42***	12.72***	12.73***	12.53***
	(1.245)	(1.244)	(1.248)	(1.239)
$\overline{\text{MDSHS}}_{pt}$	1.022*	0.981*	1.024*	0.969*
	(0.538)	(0.532)	(0.534)	(0.530)
Marginal Effects				
$\overline{\text{TAX}}_{pt}$	0.304	0.321	0.325	0.311
log BST$_{pt}$	−0.008	−0.007	−0.006	−0.004
$\overline{\text{log TA}}_{pt}$		−0.018	−0.010	−0.009
$\overline{\text{log FA}}_{pt}$			−0.029	−0.026
LEND$_{pt}$				−0.095
Observations	61,951	61,810	61,810	61,810

The table reports estimates from a Probit model with *PDEBT*$_{pt}$ (measured at the level of the parent *p*) as dependent variable. All regressions include aggregate year dummies. All explanatory variables are means at the MNC level except *BST*$_{pt}$ which is the balance-sheet total of the corporate group, see Section 6.2 for definitions. Robust standard errors are reported in parentheses.

*** Denotes significance at the 1% level.

** Denotes significance at the 5% level.

* Denotes significance at the 10% level.

parent-industry level) has a negative effect on external debt (*coeff* −0.009; *std.err.* 0.003), while the effect of *MORS* on parental debt (*coeff* +0.020; *std.err.* 0.002) as well as internal debt (*coeff* +0.005; *std.err.* 0.002) is positive. This is consistent with the argument that if parents have more internal funds (operating revenues) to pass on to foreign affiliates (even to the tax haven affiliates), this is done via the internal capital market, suggesting that parental and internal debt ratios are positively related to *MORS*. At the same time, the internal funds may substitute for external debt, implying a negative correlation with the external debt-to-capital ratio.

We would also interpret Table 2 as descriptive evidence supporting the substitution hypothesis: the total debt share remains relatively constant irrespective of the local tax or the within-firm tax incentives (while external, parental, and internal debt shares differ substantially). Also the findings on the determinants of binary outcomes $LEND_{it}$, $LEND_{pt}$, as well as $PDEBT_{pt}$ are consistent with this logic, as the coefficients estimated on firm-level explanatory variables go in opposite directions: while it seems to be significantly more likely to use parental debt if firms are small, the large MNCs tend to establish low-tax affiliates. We interpret this as evidence that if internal (tax haven) debt is associated with too high a cost (see the λ_2-constraint in the theoretical model), then firms resort to parental debt financing even if this is not optimal, from a pure tax point of view.

A true simultaneous system of equations for the three different types of debt is difficult to estimate because all types of debt are simultaneously determined by the same fundamentals: it is the same strategic choice and parental and external debt are even determined by the same tax incentives, according to our theory model. Panel A in Table 9 first ignores the possible endogeneity of external and parental debt and provides results where we have regressed the share of internal debt (ID_{it}) on external debt (ED_{it}) as well as parental debt (PD_{it}), in separate regressions. Note that the estimation specifications are the same as above. This allows us to calculate substitution elasticities for external as well as parental debt. Our findings suggest elasticities of −0.818 and −0.090, respectively, see Table 9.

As the latter two debt variables are clearly endogenous, we may exploit distinct variation in the tax variables between internal debt, on the one hand, and parental as well as external debt, on the other hand. This suggests an instrumental variable approach where *WTAX* and *TAX* serve as instruments for the two endogenous debt shares ED_{it} and PD_{it}. The results are shown in the lower part of Panel

Table 9
Substitution elasticities and correlation.

Panel A: Substitution elasticities

	Internal debt
Exogenous debt shares	
ED_{it}	−0.257***
	(0.004)
Substitution elasticity	−0.818
PD_{it}	−0.121***
	(0.003)
Substitution elasticity	−0.090
Endogenous debt shares	
ED_{it}	−0.556***
	(0.179)
Substitution elasticity	−1.811
Instruments first stage	
TAX_{it}	0.012
	(0.037)
$WTAX_{it}$	0.080***
	(0.023)
PD_{it}	−0.318*
	(0.173)
Substitution elasticity	−0.236
Instruments first stage	
TAX_{it}	0.106***
	(0.024)
$WTAX_{it}$	−0.069***
	(0.017)

Panel B: Correlation Matrix of Residuals

	ED_{it}	PD_{it}	ID_{it}
ED_{it}	1.000		
PD_{it}	−0.218	1.000	
ID_{it}	−0.325	−0.113	1.000
Breusch−Pagan test of independence:			
chi2(3) = 36789.287, Pr = 0.000			

Panel A of this table presents OLS estimates. Dependent variable is the internal debt-to-asset ratio (ID_{it}) of affiliate *i* at time *t*. All regressions include aggregate year dummies and affiliate-specific fixed effects. Note that all regressions include the standard set of control variables used before. These are not reported. Definitions and descriptive statistics on the explanatory variables are provided in Section 5. Robust standard errors are reported in parentheses (clustered at the county-year level). Estimates are based on 221,289 observations. *Panel B* presents a correlation matrix of residuals based on the specifications from above using a SUR (seemingly unrelated regression) estimation model. Dependent variable is the external debt-to-asset ratio (ED_{it}), the parental debt-to-asset ratio (PD_{it}), or the internal debt-to-asset ratio (ID_{it}) of affiliate *i* at time *t*. All regressions include aggregate year dummies and affiliate-specific fixed effects. Definitions and descriptive statistics on the explanatory variables are provided in Section 5.
***Significance at the 1% level. **Significance at the 5% level. *Significance at the 10% level.

A in Table 9. The approach is based on the identifying assumption that external and parental debt are both determined by *WTAX* and *TAX*, while it is *MINTAX* that determines internal debt financing (see the results on internal debt in Table 3).

The findings of the instrumental variable strategy suggest high substitution elasticities of −1.811, and −0.236: a 1% higher share of external debt reduces internal debt by 1.8%; a 1% higher share of parental debt reduces internal debt by about 0.24%

We finally estimate a seemingly unrelated regression (SUR), which allows us to test for correlation in the residuals. To do so, we specify the equations as in the respective parts of Table 3, with the three types of debt as dependent variables. While the SUR estimation does not change the basic findings from above, we can show that there is negative correlation in the residuals which points at a substitutive relationship between the different types of debt. Panel B in Table 9 reports these correlations and provides a Breusch-Pagan test of independence, which is clearly rejected. Note that, for all results provided above, we have decided to estimate the equations on the different types of debt separately, as this more flexibly allows us to adjust estimations (for example with regard to clustering standard errors).

We do not want to stress the results on the substitution elasticities (with endogenous debt) too much because the distinct variation in *WTAX* and *TAX* is limited, as mentioned above. However, different pieces of evidence conclusively suggest that there is a substitutive relationship between internal and the other two types of debt.

9. Robustness

Let us finally explore the robustness of our main findings with respect to a number of measurement issues concerning the tax incentives. First, we test for heterogeneity in tax incentives depending on whether affiliates carry forward losses. Second, we test whether tax incentives are inaccurately measured because of the German CFC legislation. We provide the findings of these tests and a detailed discussion thereof in the online appendix. In a previous version of the paper, we have also tested for possible endogeneity of the minimum tax, allowed for preferential tax treatment in Belgium, the Netherlands, Luxembourg, and Switzerland, and have provided tests for sub-samples of our data. Some of these tests can also be found in the online appendix.

9.1. Tax-responsiveness under losses

The empirical analysis we have presented before can be understood as an approach where statutory tax incentives are used to capture the value of a one-unit reduction in taxable profits. If affiliate *i* carries forward losses, we would expect that the short-run tax incentive to use additional debt goes to zero, as the marginal benefit of interest deduction under losses is zero in the short-run. The online appendix provides additional tests where we use interactions between *Loss Carryforward*$_{it-1}$ and the relevant tax variables, *WTAX*$_{it}$, *TAX*$_{it}$, and *MINTAX*$_{it}$, depending on the type of debt we are analyzing (note that all regressions are conditional on the same set of control variables as above). Our results confirm, as expected, that particularly in case of external debt, the interaction between *WTAX*$_{it}$ and *Loss Carryforward*$_{it-1}$ has a negative sign, meaning that affiliates whose tax bases, and therefore marginal tax rates, go to zero are less responsive to taxes.

9.2. Minimum tax and the German CFC rule

German tax law and particularly §§7 − 14 of the German Foreign Transactions Tax Act (*Außensteuergesetz, AStG*) aim at preventing MNCs from an excessive use of internal lending and borrowing for reasons of tax planning and profit shifting. If a foreign entity is treated under CFC law, the exemption of foreign source income is no longer granted and foreign income is included in the taxable income of the German parent.

In line with §8(3) of the German CFC law, the online appendix presents estimates that account for German CFC legislation by using an interaction term between an indicator variable called *CFC*$_{it}$ and *TAX*$_{it}$. *CFC*$_{it} = 1$ if *MINTAX*$_{it}$ is below 25% (30% until 2000), and zero otherwise. If the average firm is affected by Germany's CFC rule, we would expect that an interaction term between *CFC*$_{it}$ and *TAXDIFF*$_{it}$ is negative and significant, as the positive impact of the tax differential should then be reduced. Our results do not, however, confirm such a relationship as the estimated coefficient is not significant at any common level of statistical significance. The estimated coefficient on *CFC*$_{it}$ is also close to zero and not statistically significant. A detailed discussion and interpretation of this result can be found in the online appendix.

9.3. Additional tests and results in the online appendix

More tests and additional results are presented in the online appendix. In these tests, we address (i) endogeneity issues of the minimum tax variable by accounting for potential selection into setting up a new minimum tax affiliate; (ii) the possibility of preferential tax treatment in some countries; and (iii) variations in the sample. It seems that endogeneity is not an important issue and that the results are not driven by countries providing preferential tax treatment. With respect to varying the sample, the results suggest that profit shifting through internal non-parental lending usually involves a low-tax or tax haven location outside the OECD area.

10. Conclusions

The main objective of this paper is to explain the use of parental debt and the functioning of an internal capital market within MNCs. For this purpose, we first propose a rich theory model, which not only explains the determinants of the tax-efficient debt

structure of MNCs, but also provides guidance on what influences the extensive margins of using an internal bank or the parent as a lender. While previous research has provided evidence on the intensive margins of internal debt, external debt, or total debt of affiliates of MNCs, none of the earlier studies have provided evidence on debt financing provided by the parent firm.

The results of our empirical analysis suggest the following: First, parental debt financing is responsive to tax incentives, and acts as a substitute for external debt in response to capital market conditions. The findings are consistent with the predictions from the theory model, which we use to precisely determine tax incentives to inform our empirical specifications. Second, parental debt is mainly used by smaller firms, and in the absence of an internal lending entity. Third, the size of the MNC is a key determinant of whether a firm operates an internal bank (which is operated for the purpose of lending to high-tax affiliates). Fourth, we find evidence that parental debt provided to foreign affiliates is raised through external borrowing at the location of the parent firm.

We can only to some extent explain the fact, however, that in about 59% of all affiliate-year observations, no parental debt is used. Several factors could explain why this is the case. One, already built into the model as a corner solution, may be that some MNCs' affiliates do not face transaction costs in accessing the external capital market. Another could be that external lenders are better at monitoring than the parent, and that the difference in monitoring capability may be group- or affiliate-specific. To incorporate the latter features into a modeling framework is left for future work.

The central policy implication from our research is that policies to prevent firms from using an internal capital market to shift profits have to be carefully designed. We provide a number of results suggesting that parental debt, while responding to taxes, is primarily used to avoid capital market imperfections. Too strict measures may come at the cost of a less efficient allocation of financing capital within MNCs.

Declaration of Competing Interest

The authors declare that they have no relevant or material financial interests that relate to the research de-scribed in the above paper.

Appendix A. Optimal investment and differences in productivity

Denote effective capital costs, evaluated at the tax-efficient capital structure, by $\tilde{r}$. Then, the maximization problem of parent company p for optimal production and investment of real capital K_i can be stated as

$$max_{K_i}\Pi_p = \sum_i \{(1-t_i)\cdot f(\theta K_i) - \tilde{r}\cdot K_i\}, \tag{A.1}$$

and the first-order conditions read

$$f_K(\theta K_i)\cdot\theta = \frac{\tilde{r}}{1-t_i}, \ \ \forall \ i. \tag{A.2}$$

Straightforward comparative statics shows that

$$\frac{dK_i}{d\theta} = -\frac{f_{KK}\cdot\theta K_i + f_K}{f_{KK}\cdot\theta^2} > 0 \ \ \forall \ i, \tag{A.3}$$

as long as the production function is not too concave, i.e., as long as f_{KK} is not too large in absolute terms. The condition is fulfilled for any Cobb-Douglas production function $f(\theta K_i) = (\theta K_i)^{\alpha}$ with $\alpha > 0$, for example.

Hence, under mild conditions, an increase in productivity θ will increase capital investment in all affiliates of the parent company p. The implication is that more productive MNCs are also larger and have a higher demand for financial capital.

Appendix B. Deriving the tax-efficient capital structure

To derive the tax-efficient capital structure in each of its affiliates, the MNC maximizes its global after-tax profits.[48] 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 that the participation constraint for setting up an internal bank, Eq. (6), must hold, the maximization problem can be stated as

[48] It can be shown that 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, i.e., approaching the problem from a shareholder's point of view, yield identical results, given some weak assumptions.

$$
\begin{aligned}
max_{D_i^E, D_i^P, D_i^I} \Pi_p \quad = \quad & \sum_i \{(1-t_i)\cdot f(\theta K_i(\theta)) - r\cdot K_i(\theta) + t_i\cdot r\cdot (D_i^E + D_i^P + D_i^I) \\
- \quad & \left[\frac{\mu}{2}\cdot\left(b_i^E + b_i^P\right) - \bar{b}\right)^2 + \frac{\delta_E}{2}\cdot\left(b_i^E\right)^2 + \frac{\delta_P}{2}\cdot\left(b_i^P\right)^2\right] K_i(\theta) \\
- \quad & \frac{\eta}{2}\cdot\left(b_i^I\right)\Big)^2 \cdot K_i(\theta)\} - \frac{\gamma}{2}\cdot b_f^2 \cdot \sum_i K_i(\theta) - 1_I \cdot C_B \\
s.t. \quad & \sum_i r\cdot D_i^I = 0, \quad D_i^I \geq 0, \qquad (\lambda_1) \\
& -\sum_i \left[\left(t_i - \tau\right) r b_i^I - \frac{\eta}{2}\cdot\left[b_i^I\right]^2\right] K_i(\theta) + C_B \\
& + \sum_{i=p}^{n}\left[\left(t_i - t_p\right) r b_i^I - \frac{\eta}{2}\cdot\left[b_i^I\right]^2\right] K_i(\theta) \leq 0, \qquad (\lambda_2)
\end{aligned}
\tag{A.4}
$$

where we used Eqs. (1) to (4) in Eq. (5).

The resulting first-order conditions are

$$D_i^E: \; t_i\cdot r - \mu\cdot\left(b_i^E + b_i^P - b^*\right) - \delta_E\cdot b_i^E - \gamma\cdot b_f = 0, \tag{A.5}$$

$$D_i^P: \; t_i\cdot r - \mu\cdot\left(b_i^E + b_i^P - b^*\right) - \delta_P\cdot b_i^P - \gamma\cdot b_f = 0, \tag{A.6}$$

$$D_i^I: \; \left\{t_i\cdot r - \eta\cdot b_i^I - \lambda_1\cdot r - \lambda_2\cdot\left[\left(t_p - \tau\right) r\right]\right\} D_i^I = 0, \quad \text{and} \tag{A.7}$$

$$\text{PC}: \lambda_2\cdot\left\{-\sum_i\left[\left(t_i-\tau\right) r b_i^I - \frac{\eta}{2}\cdot\left(b_i^I\right)^2\right] K_i(\theta) + C_B + \sum_{i=p}^{n}\left[\left(t_i - t_p\right) r b_i^I - \frac{\eta}{2}\cdot\left(b_i^I\right)^2\right] K_i(\theta)\right\} = 0, \tag{A.8}$$

where λ_1 is the Lagrangian multiplier associated with the internal lending constraint $\sum_i r\cdot D_i^I = 0$ and λ_2 is the Lagrangian multiplier associated with the internal bank condition (6).

Examining the slackness condition (A.8), we see that the Lagrange multiplier is positive, $\lambda_2 > 0$, whenever the condition for setting up the internal bank (6) is binding. In this case, it is not tax-efficient to set up an internal bank because costs are too high.

First, we focus on the case with an internal bank. Hence, $\lambda_2 = 0$, and the multiplier $\lambda_1 = \tau > 0$ gives the shadow price of shifted interest expenses. In optimum, we have $\lambda_1 = \tau = \min_i t_i$ (see Mintz and Smart, 2004), because otherwise, the FOC (A.7) would be violated for those affiliates with $t_i < \tau$. Denoting the tax rate in the lowest-taxed affiliate by t_1, the minimum tax rate becomes $\lambda_1 = t_1$ and the first-order condition (A.7) simplifies to

$$\left(t_i - t_1\right)\cdot r - \eta\cdot b_i^I = 0. \tag{A.9}$$

Solving this expression for b_i^I leads to the optimal internal debt-to-asset ratio in Eq. (7) in the main text.

Turning to the optimal external and parental debt-to-asset ratios, we subtract FOC (A.6) from FOC (A.5) to establish the relationship

$$-\delta_E b_i^E + \delta_P b_i^P = 0 \quad \Rightarrow \quad b_i^P = \frac{\delta_E}{\delta_P}\cdot b_i^E. \tag{A.10}$$

In order to derive the optimal external debt-to-asset ratio of affiliate i, b_i^E, we then subtract Eq. (A.5) evaluated for affiliate j from Eq. (A.5) evaluated for affiliate i. This delivers

$$
\begin{aligned}
\left(t_i - t_j\right) r - \mu\left(b_i^E - b_j^E\right) - \mu\left(b_i^P - b_j^P\right) - \delta_E\left(b_i^E - b_j^E\right) \quad &= \quad 0, \\
\left(t_i - t_j\right) r - \frac{\mu\left(\delta_E + \delta_P\right) + \delta_E\delta_P}{\delta_P}\left(b_i^E - b_j^E\right) \quad &= \quad 0,
\end{aligned}
\tag{A.11}
$$

where we used $b_i^P = \frac{\delta_E}{\delta_P} b_i^E$ from Eq. (A.10) to replace b_i^P. Hence, we find

$$b_j^E = b_i^E - \frac{\delta_P}{\mu\left(\delta_E + \delta_P\right) + \delta_E\delta_P}\cdot\left(t_i - t_j\right)\cdot r. \tag{A.12}$$

Next, we define the relative capital share of an affiliate i in total real capital employed by the MNC as $\rho_i = \frac{K_i(\theta)}{\sum_i K_i(\theta)}$ and rearrange the first-order condition (A.5) to

$$\begin{aligned}\frac{\mu(\delta_P+\delta_E)+\delta_E\delta_P}{\delta_P}\cdot b_i^E &= \mu\bar{b}+t_i\cdot r-\frac{\gamma(\delta_E+\delta_P)}{\delta_P}\cdot b_i^E\cdot\rho_i-\frac{\gamma(\delta_E+\delta_P)}{\delta_P}\sum_{i\neq j}b_j^E\cdot\rho_j \\ &= \mu\bar{b}+t_i\cdot r-\frac{\gamma(\delta_E+\delta_P)}{\delta_P}\cdot b_i^E\cdot\rho_i-\frac{\gamma(\delta_E+\delta_P)}{\delta_P}\sum_{i\neq j}b_i^E\cdot\rho_j \\ &+ \frac{\gamma(\delta_E+\delta_P)}{\delta_P}\cdot r\sum_{i\neq j}\frac{(t_i-t_j)\rho_j\cdot\delta_P}{\mu(\delta_E+\delta_P)+\delta_E\delta_P},\end{aligned} \tag{A.13}$$

where we have used Eq. (A.12) to replace b_j^E in the first line.

Utilizing that by definition $\sum_i\rho_i=1$ so that $\sum_{i\neq j}\rho_j=1-\rho_i$, we can further collect terms and rearrange expression (A.13) to

$$\frac{(\mu+\gamma)(\delta_P+\delta_E)+\delta_E\delta_P}{\delta_P}\cdot b_i^E=\mu\bar{b}+t_i\cdot r+\frac{\gamma(\delta_E+\delta_P)}{\mu(\delta_E+\delta_P)+\delta_E\delta_P}\cdot r\sum_{i\neq j}(t_i-t_j)\rho_j. \tag{A.14}$$

Division by $\frac{(\mu+\gamma)(\delta_P+\delta_E)+\delta_E\delta_P}{\delta_P}$ and defining $\beta_0=\frac{\mu\delta_P}{(\mu+\gamma)(\delta_E+\delta_P)+\delta_E\delta_P}\bar{b}$, $\beta_1=\frac{\delta_P\cdot r}{(\mu+\gamma)(\delta_E+\delta_P)+\delta_E\delta_P}$ and $\beta_2=\frac{\gamma\delta_P(\delta_E+\delta_P)r}{[\mu(\delta_E+\delta_P)+\delta_E\delta_P][(\mu+\gamma)(\delta_E+\delta_P)+\delta_E\delta_P]}$ according to the main text, delivers the optimal external debt-to-asset ratio (8).

When we insert the optimal external debt-to-asset ratio b_i^E in Eq. (A.10), we also receive the optimal parental debt-to-asset ratio b_i^P as given by (9).

Finally, we turn to the case where there is no internal bank and the internal bank constraint is binding. Formally, $\lambda_2>0$ and $1_I=0$. That also implies $D_i^I=0\ \forall\ i\neq p$ so that there is no internal debt in affiliates where $t_i\leq t_p$, see Eq. (A.7). All internal lending will be done by the parent and goes as parental-internal debt D_i^{PI} to affiliates with $t_i>t_p$.

Applying $\lambda_1=\tau=t_p$, the FOC (A.7) turns into

$$(t_i-t_p)\cdot r-\eta\cdot b_i^{\mathrm{PI}}=0\quad\forall i\geq p\quad\text{and}\quad D_i^{\mathrm{PI}}=0\quad\forall i<p. \tag{A.15}$$

Rearranging this expression leads to the optimal 'parental-internal' debt-to-asset ratio $b_i^{\mathrm{PI}}=D_i^{\mathrm{PI}}K_i$ in Eq. (11) in the main text.

As the derivation of the optimal external and parental debt-to-asset ratios b_i^E and b_i^P do not depend on the internal bank constraint (6), these debt-to-asset ratios and their derivations are unaffected from whether there is an internal bank, and our previous analysis of total external debt remains unchanged.

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcorpfin.2021.102119.

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