Empirical Evaluation of Interest Barrier Effects

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Non-Technical Summary

As of 2008, Germany has severely changed its thin capitalization rule by introducing the so-called interest barrier. This new rule aims at prohibiting tax avoidance of multinational firms by means of cross-border internal loans. For reasons of non-discrimination, the rule is, however, equally attributable on the national level and it is applicable to both internal and external debt. Since its beginning, the German interest barrier has had a very poor reputation as it was believed to distort financing decisions and hereby harm production efficiency.

Eight years after its introduction, the time has come to empirically evaluate the interest barrier. In this paper, we trace to what extent the interest barrier impacted firms' financing decisions. We distinguish between national and multinational firms as well as between the effects on internal debt to assets and external debt to assets.

Thin capitalization rules prevent firms from deducting excessive interest expenses from their tax base. Before 2008, the interest on internal debt going beyond 1.5 times the equity of the respective shareholder was not deductible. As of 2008, interest payments exceeding the interest earnings are generally only deductible at the amount of 30% of EBITDA once the exemption limit of an initial EUR 1 million is exceeded. In our empirical setup, we identify firms which would have been affected by the new interest barrier, had it already been in place in the years 2005 to 2007, i.e. before its actual coming into force. Then we analyze empirically how these firms adjusted their debt to assets ratios and their net interest payments as compared to the control group.

We found that the new interest barrier potentially affected 1.9 - 4.5 % of the companies in our sample. On average, these firms had higher debt ratios than the non-affected firms, which is in line with the general aim of thin-capitalization rules to target highly indebted companies. After the reform, the treated firms on average displayed stronger declining debt ratios as compared to the control group.

Our analysis does not provide empirical evidence for a pure interest barrier effect. Instead, there might be a general trend of highly indebted German firms to reduce their debt ratios after the crisis. In addition, the corporate income tax rate cut reduced the tax shield generated by debt-financed investment especially for the highly leveraged treatment group. We conclude that the few firms affected by this new regulation were either unable to adjust their leverage or avoided the interest barrier by utilizing its exception rules.

Das Wichtigste in Kürze

Mit der Einführung der sogenannten Zinsschranke hat Deutschland zum Jahr 2008 seine Unterkapitalisierungsregel tiefgreifend geändert. Mit dieser neuen Regelung wird primär das Ziel verfolgt, die von multinationalen Unternehmen durch grenzüberschreitende Kreditvergaben betriebene Steuervermeidung zu bekämpfen. Aus Gründen der Nichtdiskriminierung gilt die Regel jedoch gleichermaßen für rein nationale Unternehmen und für externes ebenso wie für internes Fremdkapital. Von Beginn an hatte die deutsche Zinsschranke einen sehr schlechten Ruf. Sie steht im Verdacht Finanzierungsentscheidungen zu verzerren und somit die Produktionseffizienz zu mindern.

Acht Jahre nach Einführung der Zinsschranke ist die Zeit reif für eine empirisch fundierte Evaluation. Wir untersuchen, inwieweit die Zinsschranke die Finanzierungsentscheidungen von Unternehmen beeinflusst hat. Dabei weisen wir die Einflüsse auf nationale und multinationale Unternehmen sowie auf die externe und interne Fremdkapitalquote jeweils gesondert aus.

Unterkapitalisierungsregeln verhindern bei Unternehmen mit übermäßiger Fremdfinanzierung den steuerlichen Zinsabzug. Vor dem Jahr 2008 waren Zinsen, die sich auf internes Fremdkapital in Höhe von mehr als dem 1,5-fachen des Anteilseignerkapitals bezogen, nicht abziehbar. Seit 2008 hängt die Abziehbarkeit dagegen nicht mehr von der Fremdkapitalquote, sondern von Zinszahlungen ab. So sind die Zinserträge übersteigenden Zinsaufwendungen nun grundsätzlich nur noch in Höhe von 30% des EBITDA abziehbar, sobald die Freigrenze von einer Million Euro überschritten ist. Wir identifizieren diejenigen Firmen, die von der neuen Zinsschranke getroffen worden wären, wenn diese bereits von 2005 bis 2007, also vor ihrer tatsächlichen Einführung, anwendbar gewesen wäre. Sodann untersuchen wir empirisch, wie solche Firmen im Vergleich zur Kontrollgruppe ihre Fremdkapitalquote und ihre Nettozinszahlungen angepasst haben.

Zwischen 1,9 und 4,5% der Unternehmen im Datensatz waren von der Zinsschranke potentiell betroffen. Im Durchschnitt hatten diese einen höheren Verschuldungsgrad als die nicht betroffen Firmen. Dies passt zur Intention von Unterkapitalisierungsregeln, vor allem hochverschuldete Unternehmen zu treffen. Nach der Reform gingen die Verschuldungsgrade der betroffen Firmen stärker zurück als die der Kontrollgruppe.

Die weitere Analyse deckt keinen reinen Zinsschrankeneffekt auf. Stattdessen deutet vieles auf einen generellen Trend hin, nachdem hoch verschuldete Firmen ihren Verschuldungsgrad nach der Krise reduzierten. Darüber hinaus reduzierte die Körperschaftsteuersenkung den Anreiz zur Fremdfinanzierung insbesondere für die hochverschuldeten Unternehmen. Insgesamt dürften die betroffenen Firmen entweder nicht in der Lage gewesen sein, ihre Verschuldung anzupassen, oder konnten einer Anwendung der Zinsschranke durch die zahlreichen Ausnahmen entgehen.

Interest Barrier Effects on the Capital Structure [*]

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Abstract:

This paper empirically estimates the effects of a new thin-capitalization rule on the financing behavior of German corporations employing a fixed effects difference-in-difference approach. We compare treatment and control groups separated by a hypothetical application of the new rule in three years before its introduction. Our analysis does not provide empirical evidence for a pure interest barrier effect. This indicates that the few affected firms were either unable to reduce their leverage or used exceptions. The observable trend towards less debt might stem from a general preference for lower debt ratios after the crisis or from the tax rate cut, which was introduced simultaneously.

Keywords:	Capital Structure, Corporate Taxation, Interest Barrier, Empirical Analysis, Firm-Level Data
JEL-Classification:	F23, H25, H32

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1 Introduction

In 2008, Germany comprehensively changed its corporate tax law in order to attract investment and to protect the corporate tax base. Besides a general tax rate reduction, the government introduced a new thin-capitalization rule, the so-called interest barrier, which aims at prohibiting tax avoidance of multinational firms by means of cross-border internal loans.[4] For reasons of non-discrimination, the rule is equally applicable at the national level and to both internal and external debt. In addition, several exceptions obviate the application of the interest barrier.

Former empirical studies analyzing the effects of thin-capitalization rules on financing behavior find evidence for a significant reduction of internal debt following the introduction of a thin-capitalization rule (Haufler and Runkel (2012), Weichenrieder and Windisch-bauer (2008), Büttner et al. (2012), Wamser (2008)). However, since its announcement, the German interest barrier has been criticized by many scientists[5] and companies [6] for violating the net principle and harming production efficiency.

This paper empirically evaluates to what extent medium and large sized corporations changed their financing behavior after the introduction of the interest barrier. After separating firms into groups of potentially treated and non-treated companies, we conducted a fixed effects difference-in-difference analysis at the plant level covering 6 years around the reform. We differentiated between national and multinational companies and between external and internal debt. Furthermore, we took into account that firms might have been hit by the former thin-capitalization rule.

We found that the new interest barrier potentially affected 1.9 - 4.5 % of the companies in our sample. On average, these firms had higher debt ratios than the non-affected firms, which is in line with the general aim of thin-capitalization rules to target highly indebted companies. After the reform, the treated firms on average displayed stronger declining debt ratios as compared to the control group.

Our analysis does not provide empirical evidence for a pure interest barrier effect. Instead, there might be a general trend of highly indebted German firms to reduce their debt ratios after the crisis. In addition, the corporate income tax rate cut reduced the tax

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[4]See BR-Drucks. 220/07 (2007), p. 53 for an official justification for the interest barrier and an estimation of the expected revenue impact and the administrative costs.

[5]See, e.g. Endres et al. (2007), Hey (2007) and Homburg (2007a).

[6]Bolik et al. (2010) report that most companies expected a higher tax burden as a result of the new interest barrier rule. Herzig et al. (2008) show that 43% of the companies expected to be harmed by the rule.

shield generated by debt-financed investment especially for the highly leveraged treatment group. We conclude that the few firms affected by this new regulation were either unable to adjust their leverage or avoided the interest barrier by utilizing its exception rules.

The remainder of the paper is organized as follows. After summarizing the relevant literature in section 2, section 3 describes the old and new German thin-capitalization rules as well as further changes in the German tax law as of 2008. Thereafter, section 4 develops the testable hypotheses. Section 5 discusses our identification strategy and section 6 provides a description of the data. Section 7 presents the empirical approach followed by our results in section 8. Finally, section 9 concludes.

2 Literature

Feld et al. (2013), Graham (2003) and Dwenger and Steiner (2012) provide overviews of the existing empirical literature on how taxes affect corporate financing decisions. In order to reduce the tax advantage of debt-financing, many countries introduced thin-capitalization rules that restrict the deductibility of interest expenses if a company is highly indebted (see Bohn (2009) and Zielke (2010) for overviews). Haufler and Runkel (2012) theoretically analyze the optimal thin-capitalization rules in an international tax competition framework. They find that thin-capitalization rules as well as tax rates are inefficiently lax or low in a world with tax competition. Therefore, tax coordination might increase efficiency. Mardan (2013) finds the optimal thin-capitalization rule to be less strict when firms are financially constraint because in such a setting, the governments face a trade-off between higher tax revenues and a lower level of investment.

Weichenrieder and Windischbauer (2008) and Wamser (2008) examine the effects of the 2001 reform of the German thin-capitalization rule on the capital structure of multinational enterprises. Comparing foreign-owned corporations that were potentially affected by the 2001 reform and non-treated foreign partnerships and foreign-owned branches located in Germany, Weichenrieder and Windischbauer (2008) carve out a limiting effect on internal leverage. In contrast, real investment is not found to have changed after the reform. Wamser (2008) suggests that companies substituted external for internal debt as the thin-capitalization rule only applied to internal debt. Overesch and Wamser (2010) investigate the 2001 and 2004 reforms of the German thin-capitalization rules and find a negative effect on the internal debt of German affiliates of multinational companies. Büttner et al. (2012) reveal a significant negative effect of tightening thin-capitalization rules on internal debt ratios of multinationals by studying the capital structure of firms

across 36 countries from 1996 to 2004. They find the internal debt ratio to decline by 12 - 24 % if a country with a corporate tax rate of 34 % introduces a thin-capitalization rule which restricts interest deductibility for expenses related to internal loans exceeding twice the equity. In addition, they carve out that the overall debt ratio also declines after the implementation of a thin-capitalization rule which suggests that the substitution of external for internal debt is rather limited. Recently, Blouin et al. (2014) analyze the effects of thin-capitalization rules in the context of U.S. multinational firms. In line with previous studies, the authors find a significant debt-reducing effect of different types of thin-capitalization rules on foreign affiliates' internal and total debt.

Concerning the German interest barrier, Bach and Buslei (2009a and 2009b) as well as Blaufus and Lorenz (2009a and 2009b) examine the number of potentially treated firms using pre-reform data. They find only about 560 - 600 companies to be affected by this new thin-capitalization rule. The tax revenues are estimated at EUR 750 million. The effect of the financial crisis on the number of affected firms is supposed to be rather limited because an immediate increase of a firm's tax burden is ruled out in the case of operational losses and because companies can react to the interest barrier by changing their capital structure. Apart from our paper, Buslei and Simmler (2012) as well as Alberternst and Sureth (2015) provide empirical ex-post evaluations of the interest barrier's effects on company behavior. Analyzing firms around the exemption limit of EUR one million in 2006 and 2008, Buslei and Simmler (2012) find that potentially treated firms significantly reduced their debt ratios after the introduction of the interest barrier. However, investment is not found to be affected by the reform. In addition, the effect on the leverage ratio is found to be particularly strong for firms that did not increase the number of subsidiaries. This result is interpreted as evidence that companies split up into smaller subsidiaries in order to fall beneath the exemption limit of the interest barrier. Alberternst and Sureth (2015) apply a propensity score matching for finding an appropriate control group. They find affected firms to lower their leverage 3 %-points stronger than non-affected firms after the reform.

We contribute to the empirical literature by evaluating the effects of the interest barrier on the financing decisions of German corporations in the short and medium term. We analyze three years instead of only one year before and after the reform, distinguish between nationals and multinationals, take into account a potential treatment by the old thin-capitalization rule, use a special procedure to derive the tax-EBITDA, sort out all potential members of tax consolidated groups, deliberately focus on corporations, elaborate on the different effects on internal and external debt in more detail, allow for industry-year-specific effects, and focus on financing decisions.

3 The German Corporate Tax Act 2008

Before 2008, the former thin-capitalization rule (Art. 8a KStG) was applicable to long-term internal debt provided by shareholders of at least 25 % of the company's equity or by entities affiliated to such shareholders. In order to determine non-deductible expenses, the debt and equity of each shareholder was compared separately. Interest expenses for internal lending exceeding 1.5 times the equity capital of the considered shareholder at the end of the preceding year were not deductible from the corporate tax base but reclassified as dividends. An exemption limit of EUR 250,000 for each shareholder and an escape clause for companies proving that the same amount of debt would have been provided by an external lender as well (arm's length principle) were the save havens of the former thin-capitalization rule.

From 2008 onward, this rule was replaced by the new interest barrier (Art. 4h EStG and Art. 8a KStG) This thin-capitalization rule worked as follows: If

- the net interest expenses exceed EUR 1 million,

- the company is part of a group or exhibits at least one 25 % shareholder receiving more than 10 % of the net interest expenses of the company and

- the net interest expenses exceed 30 % of the company's EBITDA,

net interest expenses exceeding 30 % of the EBITDA are classified as non-deductible expenses and thus taxable at the company level.

However, these interest expenses can be carried forward and credited against the EBITDA of the following periods. Consequently, if the company is adversely affected only in one year, but has enough earnings in the following years, the new rule only leads to a postponement of the deduction of parts of the interest expenses which lowers the net present value of the deductions. Another exception applies to company groups. If a company's equity-to-debt ratio was not more than one %-point lower than the ratio of whole group, the interest barrier did not take effect. In addition, tax-consolidated groups ("Organschaften") are treated as one company.

The emergence of the German interest barrier in 2007 was predominantly criticized in the German tax literature for being too far-reaching. For instance, the rule was said to overshoot the mark because it limited not only internal but also external debt-financing (see Hey (2007) and Homburg (2007a)). It was regarded as too harmful for companies

in financial distress (see Grotherr (2008), Herzig and Bohn (2007), Hey (2007), Köhler (2007) and Schwarz (2008)). And the equity test was seen as highly complex, bearing high administrative costs (see Dörfler and Vogl (2007), Ganssauge and Mattern (2008), Grotherr (2008), Thiel (2007) and Welling (2007)).

As a reaction, the law was adjusted in 2009 (see Rödding (2009)). The net interest escape clause was set to EUR 3 million backdating to 2008. In addition, as of 2010, the adjusted rule allows unused EBITDA (net interest expenses lower than 0.3 times the EBITDA) to be carried forward, increasing the EBITDA applicable for the interest barrier in the following year. Furthermore, the allowance for equity-to-debt ratios of company groups was adjusted. Since 2009, this ratio can be a maximum 2 %-points lower than the group's ratio .

Besides the interest barrier, the German corporate tax act of 2008 introduced further changes. The corporate income tax rate decreased from 25 % to 15 % and the basic index of the local business tax rate changed from up to 5 % to a flat 3.5 %. This lead to a change in the combined average profit tax rate from 39.4 % to 31.0 % (see ZEW (2012)).[7]

Furthermore, a new general flat tax of 25 % on capital income (Art. 20 and Art. 32d section 1 EStG) might have driven investors to favor financial investment over real investment. However, the flat tax rate is replaced by the possible higher progressive income tax rate in case of internal lending by a shareholder who is participated by at least 10 % (Art. 32d section 2 lit. c cc) EStG). Therefore, internal debt-financing faces a worst case scenario when the company is subject to both the interest barrier and Art. 32d section 2 EStG. In this case, interest expenses are non-deductible at the company level and at the same time highly taxed at the shareholder level. Therefore, the shareholder positions are important for the firm's optimal financing decision. Unfortunately, the data do not allow us to identify and distinguish shareholder positions. In our analysis, we thus focus on the company level. This seems unproblematic because most medium and large sized companies probably do not factor in the tax positions of their different shareholders either.

Further changes in the tax law can be considered negligible for the question analyzed

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[7]These values originate from the sum of the corporate tax rate, the solidarity surcharge (= 5.5 % of the corporate tax rate) and the local business tax. The local business tax is the product of a basic index and the local multiplier. For our calculations, we use average local multipliers of municipalities with more than 50,000 inhabitants provided by the Federal Statistical Office in Germany. We employ a multiplier of 4.29 before and of 4.32 after the reform. Before the reform, the local business tax was deductible from the corporate tax base. In addition, the local business tax no longer differentiates between different debt maturities. 50 % of interest expenses for long-term debt were deductible from the tax base of the local business tax before the reform. Since 2008, 75 % of all interest expenses can be deducted. This change has no clear impact on the choice between debt and equity.

here and are not accounted for in the following analysis, e.g. stricter transfer pricing rules and stricter loss deduction rules (Art. 8c KStG). The preferential treatment of retentions (Art. 34a EStG) is only relevant for partnerships, which we deliberately exclude from our empirical analysis. For an overview of all measures, see Homburg (2007b).

4 Development of Hypotheses

In the following, we show how the tax law influences the firms' financing decisions. The net present value of an equity-financed investment is given by

$$NPV_E = CF_0 + \sum_{t=1}^{T} \frac{[CF_t - (CF_t - DEP_t)\tau^C](1 - \tau^S)}{[1 + i(1 - \tau^I)]^t}, \tag{1}$$

where CF_0 is the amount of investment, CF_t is the cash flow in period t, DEP_t is the amount of depreciation, i is the interest rate and τ^C, τ^S and τ^I are the tax rates for corporate profits at the firm level and for dividends and interest income at the level of the capital provider, respectively. For a debt-financed investment, the net present value is

$$NPV_D = NPV_E + \sum_{t=1}^{T} \frac{(\gamma i D_t \tau^C - i D_t)(1 - \tau^S) + i D_t(1 - \tau^I)}{[1 + i(1 - \tau^I)]^t}, \tag{2}$$

where D_t is the amount of debt, iD_t are interest expenses and $\gamma \in [0, 1]$ is the fraction of interest payments that is deductible from the corporate tax base.[8] γ takes the value one if no thin-capitalization rules exist, and is less than one, if the company is affected by an interest barrier. Equation (2) shows that the net present value of a debt-financed investment is greater than the value of an equity-financed investment as long as enough interest expenses are deductible from the corporate tax base ($\gamma > \frac{\tau^I - \tau^S}{(1 - \tau^S)\tau^C}$). Therefore, firms generally have a tax-induced incentive to use debt rather than equity as a means of financing. This result was first derived by Modigliani and Miller (1963). Several other determinants of the capital structure choice such as legal constraints, risk considerations and the availability of debt, lead to the fact that we do not exclusively observe debt-financed investment. Still, the optimal amount of corporate debt is supposed to be positively affected by the tax advantage (see Graham (2003)).

Miller (1977) shows that, besides corporate taxation, also personal taxation influences

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[8]This result stems from $NPV_D = CF_0 + \sum_{t=1}^{T} \frac{[CF_t - (CF_t - DEP_t - \gamma i D_t)\tau^C - i D_t](1 - \tau^S) + i D_t(1 - \tau^I)}{[1 + i(1 - \tau^I)]^t}$, with only $\gamma \cdot iD_t$ deductible from the corporate tax base.

the tax advantage of debt. Therefore, equations (1) and (2), take into account shareholder taxation as well. However, for many, especially for large companies, the tax positions of individual shareholders are not known. As a consequence, many empirical studies about tax effects on corporate financing decisions do not account for personal taxes.[9] In a meta-study, Feld et al. (2013) show that tax effects are not different in studies that include personal taxation.[10] Therefore, we also abstain from investigating shareholder positions in this paper.

We are particularly interested in the effect of γ. Equation (2) shows that the tax advantage of debt increases with γ. Thus, a reclassification of parts of the interest payments into non-deductible expenses by a thin-capitalization rule (lowering γ) decreases the tax advantage of debt-financing and creates an incentive to lower the debt ratio.

The new interest barrier only lowers a company's optimal debt ratio if it reduces the amount of interest expenses deductible compared to the old rule. As the rules in Germany before and after 2008 are very different, a general conclusion about which regulation is stricter is not straightforward. Instead, an individual analysis of each company with a comparison of the non-deductible interest expenses under both rules is necessary.[11]

Concerning the old rule, the non-deductible interest expenses (NDI) are given by

$$NDI_{old} := \begin{cases} \left(1 - \dfrac{1.5}{\lambda D/E}\right) i\lambda D, & \text{if } \lambda D > 1.5 \cdot E \\ \\ 0, & \text{otherwise,} \end{cases} \tag{3}$$

where i is the interest rate on debt, E is the equity of the company considered and λ is the internal-debt-to-total-debt ratio.[12] Under the new rule, the amount of non-deductible

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[9]See, e.g., Altshuler and Grubert (2003), Desai et al. (2004), Huizinga et al. (2008), Buettner et al. (2012) and Dwenger and Steiner (2012).
[10]Graham (1999) finds that personal taxation also matters for the capital structure decision of companies. However, they "do not completely negate the corporate tax advantage of debt" (p.149). Overesch and Voeller (2010) include personal taxes in the variable measuring the tax advantage of debt as well and find a positive effect on the debt ratio development of European firms. However, they do not analyze subsidiaries of other corporations and restrict their sample to firms which are majority owned by individuals.
[11]For simplicity, we do not take into account the exemptions of the old and the new rule in this analytical part. For the same reason, we assume the company to only have one shareholder and the interest rate to be the same for both borrowing and lending.
[12]The term in parentheses represents the fraction of internal debt for which interest expenses are non-deductible. If the internal-debt-to-equity ratio is 3:1, for example, interest expenses for half of the internal debt are not deductible from the tax base. Thus, the term in parentheses is 0.5.

Figure 1: NDI_{old} and NDI_{new} as functions of $\frac{D}{A}$ for different values of λ and r
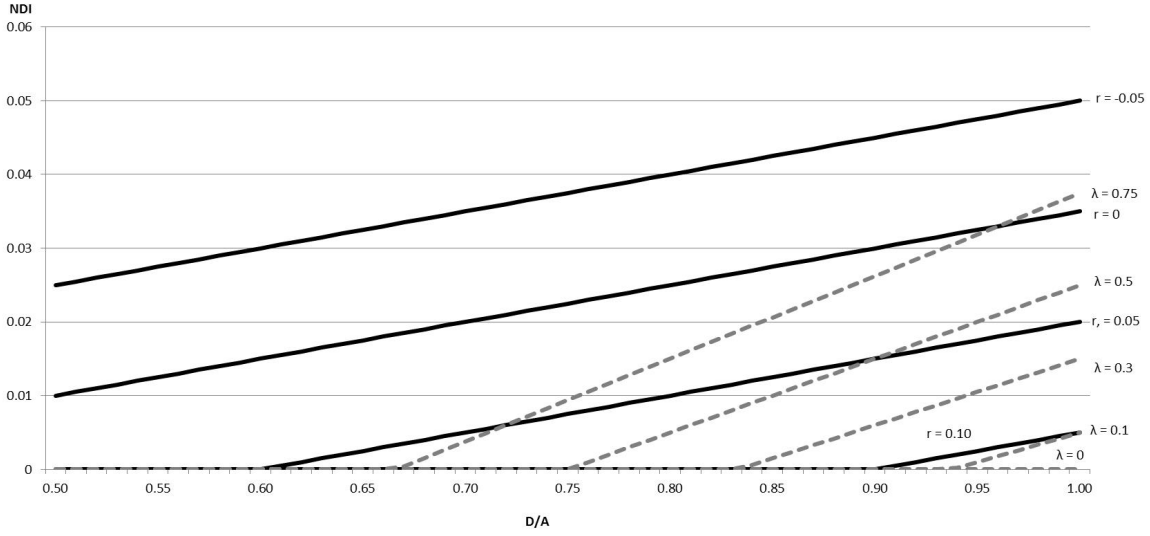
interest is given by

$$NDI_{new} := \begin{cases} i(D-V) - 0.3 \cdot EBITDA, & \text{if } i(D-V) > 0.3 \cdot EBITDA \\ 0, & \text{otherwise.} \end{cases} \tag{4}$$

Here, V are the lendings of the company given to other parties and $EBITDA$ is the sum of earnings before interest and taxes ($EBIT$) and the amount of depreciation in the considered period (DEP). Figure 1 shows the non-deductible interest expenses in relation to total assets under the old (dashed lines) and the new rule (solid lines) as a function of the debt-to-asset ratio $\frac{D}{A}$.[13]

A high debt ratio does not necessarily imply a stronger treatment by the new rule. The old rule leads to a higher amount of non-deductible expenses if r (:= EBIT divided by total assets) and λ are relatively high, i.e., for profitable firms with lots of internal debt. For firms facing a lower profitability and mainly external debt, NDI_{new} is likely to be higher than NDI_{old}. The non-deductible expenses grow faster if the debt ratio increases (for given values of r and λ) under the old rule, illustrated by the higher slopes of NDI_{old} in Figure 1.

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[13]Without loss of generality, $V = 0$, the ratio of depreciation to total assets $\frac{DEP}{A} = 5\%$ and $i = 5\%$ in this example. In our sample, the mean values of λ, r, $\frac{DEP}{A}$ and i are 28.5%, 8.5%, 4.5% and 3.2% respectively.

Based on these considerations, we state the first hypothesis:

H 1. *Companies treated by the new interest barrier (more strongly than by the old rule) show lower profitability (and relatively less internal debt) compared to non-treated firms.*

Once the interest barrier had been announced, companies could calculate to what extent they were affected (i.e., the amount of γ) and adjust their capital structure accordingly. Theoretically, companies could also avoid the interest barrier by tax structuring schemes (e.g., by selling highly debt-financed assets, by splitting up into smaller subsidiaries[14], by rearranging all subsidiaries into a tax consolidated group, or even by increasing investment[15]). However, most of these attempts might be prohibited by the tax costs of restructuring or by non-tax issues. In addition, selling assets and repaying debt nevertheless leads to a decline of the debt ratio. We state:

H 2. *After the introduction of the new interest barrier, the ex-ante hypothetically affected firms lowered their leverage. This holds especially true for firms more strongly affected by the new rule.*

The interest barrier was set up to prohibit legal but unpleasant tax avoidance by multinational firms. The provision of loans from subsidiaries in low-tax countries such as Ireland to company units in the high-tax country Germany with the primary intention to save taxes was to be prevented.[16] Multinationals with such financial structures should easily be able to adjust if necessary. As pointed out by Mintz and Weichenrieder (2010), firms aiming at excessive debt-financing can substitute other high-tax countries for Germany and thereby shift the burden of the interest barrier to foreign governments. Based on this rationale, cross-border financing constructs can be expected to be very elastic. National firms, by contrast, might have other motivations for using debt, including the sheer absence of alternatives to external financing. Therefore, they might not, or at least only to a lower extent, be able to lower their leverage.[17] This leads to our third hypothesis:

H 3. *Tthe treatment effect is stronger for companies belonging to multinational groups.*

It should be easier to adjust internal debt because it is easily convertible into equity, while reducing external debt either requires a shortening of the balance sheet or

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[14]See Buslei and Simmler (2012).

[15]See Hundsdoerfer et al. (2011).

[16]For example, Huizinga et al. (2008) provide empirical evidence for international debt and profit shifting of multinationals.

[17]Egger et al. (2010) show that the debt demand elasticity with respect to corporate tax rate changes is higher for multinationals than for national companies.

raising new equity. Before the reform, only internal debt was relevant for the old thin-capitalization rule. Therefore, the old rule might have distorted the choice between internal and external debt. With the introduction of the new interest barrier, the latter has become less attractive. The reform eliminated the discrimination between internal and external debt. Therefore, firms that are not affected by the new rule might increase their fraction of internal debt again. In contrast, companies that are affected can be expected to reduce debt in order to avoid non-deductible interest expenses. If internal debt is already low due to the old rule, only external debt is left to be reduced. This is especially true for national companies because they do not have incentives for excessive internal debt due to the absence of tax rate differentials between subsidiaries in different countries. We hypothesize:

H 4. *After the introduction of the new interest barrier, multinational companies reduced their internal debt relatively more than their external debt.*

5 Identification Strategy

Hypothesis H 1 is examined based on descriptive statistics in section 6. For testing H 2 to H 4, we defined a treatment and a control group and applied a difference-in-difference design. By dividing the sample according to pre-reform company characteristics, we ensure an exogenous group classification. The intuition is that companies which would have been affected by the new interest barrier in the years before its introduction, should be concerned about non-deductibility and adjust their leverage following the introduction of the new rule. In contrast, firms have no reason to react if a hypothetical pre-reform application of the new rule is not harmful. We used the original interest barrier introduced in 2008 for the definitions of the treatment and the control groups, because companies deciding on a reaction only had this information. The empirical analysis cannot account for the equity ratio escape clause as the crucial variables are not observed for all members of a company group. Therefore, some firms might be classified into the treatment group although theoretically they could use the equity clause. However, since the effort demanded from firms to prove that this exception is available is rather high, the distortion should not be very strong.

In a first step, we assign firms into the different groups only according to their net interest payments and their dependency status.[18] The treatment is defined as follows:

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[18]The idea not to take into account the EBITDA status of the companies in a first step due to the challenges in deriving the relevant EBITDA is inspired by Buslei and Simmler (2012).

$$Treat_i^1 = \begin{cases} 1, & \text{if net interest payments} > \text{EUR 1 million and} \\ & \text{company is group member in 2005 - 2007,} \\ 0, & \text{otherwise.} \end{cases} \qquad (5)$$

Company i is defined to be a group member if there is at least one 50 % subsidiary in Germany or abroad in the database, or if the company has at least one 25 % share-holder.[19] The treatment group consists of companies potentially harmed by a hypothetical application of the new interest barrier in the three years before its introduction because of not fulfilling two important requirements not to be harmed.[20] These firms should be concerned that some of their interest expenses might not be deductible after the reform if the EBITDA, which is difficult to predict, will not suffice. Therefore, we expect that treated firms more strongly reduced their debt ratios after the reform than non-treated firms.[21]

In a second step, we also accounted for the EBITDA definition which is relevant for tax purposes (tax-EBITDA). Even if the first two conditions (group member and high net interest expenses) are fulfilled, a company is not harmed if its tax-EBITDA is high enough, compared to its net interest expenses. The classification into treatment and control group is executed as follows:[22]

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[19]We used the Dafne wave 02/2012 and the ownership structure from this date to classify a company as a group member. As a consequence, the dependency status in our sample does not vary over time. The definition of the dependency status takes into account if a company is part of a group (50 % corporate shareholder or subsidiary, Art. 4h (2) b) ESTG) and if a stand-alone company potentially has a substantial shareholder whose interest earnings from the company are higher than 10 % of the company's net interest expenses (at least one 25 % shareholder, Art. 8a (2) KStG).

[20]As we do not have data for every firm in every year we defined the treatment variables $Treat_i^1 = 1$ as "treated in all years before the reform (2005 - 2007) where data are available" and $Treat_i^1 = 0$ as "not treated at least in one year (2005 - 2007)." We also used the definitions "treated in at least one year versus never treated" and "treated in every year versus never treated". The empirical results are virtually unaffected by the different definitions.

[21]The introduction of the interest barrier was already announced in 2007. Therefore, the treatment in 2007 might not be completely exogenous because firms might have reacted immediately after this new information. In robustness tests, we adjusted the definition of the treatment variables and only took into account the years 2005 - 2006 or only 2006. The results remained unchanged.

[22]In robustness checks, we adjusted $Treat_i^2$ so that it does not equal 1 for the treated firms but equals the hypothetical yearly average non-deductible interest expenses per assets for 2005 - 2007. With this adjustment, we capture the extent to which firms hypothetically are hit by the new interest barrier. The results do not change substantially when applying this refinement. They are available upon request.

$$Treat_i^2 = \begin{cases} 1, & \text{if net interest payments} > \text{EUR 1 million and} \\ & \text{company is group member and} \\ & \text{net interest expenses} > 30\,\% \text{ of tax-EBITDA in 2005 - 2007,} \\ 0, & \text{otherwise.} \end{cases} \tag{6}$$

Since the tax data are not available, we employed financial statements for our analysis. These might deviate from the the companies' tax figures. In particular, provisions are found to be a crucial determinant for differences between book and tax profits (see Spengel and Zinn (2012)). But according to the German valuation principle ("Maßgeblichkeitsprinzip"), profits for tax purposes can be derived from accounting profits. We followed Bach and Buslei (2009a) and Blaufus and Lorenz (2009a) in calculating the tax-EBITDA.[23] The use of the tax-EBITDA variable for the treatment classification has two drawbacks. First, a derivation of tax figures from accounting figures is not very precise and second, we lose several observations because of additional information needed to calculate the tax-EBITDA.

For some firms hit by the new interest barrier, the old thin-capitalization rule had been even more harmful. In addition, firms hit by the old rule might not have been able to adjust their leverage in order to avoid restrictions on interest deductibility. Therefore, we determined which firms were potentially treated by the old rule and excluded these companies from the analysis in a next step. We defined the potential treatment by the old rule as follows:[24]

$$Treat_i^{old} = \begin{cases} 1, & \text{if there is a 25\,\% shareholder and} \\ & \text{internal interest expenses} > \text{EUR 250,000 and} \\ & \text{internal debt to equity} > 1.5 \\ & \text{in at least one of the years 2005 - 2007,} \\ 0, & \text{otherwise.} \end{cases} \tag{7}$$

This is only a rough definition because, actually, the rule and the EUR 250,000 exemption limit were applied to each shareholder separately.[25] We cannot distinguish the

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[23] The detailed procedure is described in the Appendix.

[24] For the determination of the relevant equity we followed the former version of Art. 8a KStG. See calculations in the Appendix for details.

[25] In addition, a differentiation between long-term and short-term internal debt is not provided by the

internal debt per shareholder and therefore looked at the whole company. However, by excluding all companies with $Treat_i^{old} = 1$, we basically remove all firms that were hit by the old rule.

In a difference-in-difference design, we generally try to compare two groups of entities which are as equal as possible before the treatment. The treatment applies only to one of the groups. A different development of the two groups under consideration after the treatment indicates a treatment effect. In our case, the two groups are unequal by definition: Among others, treated firms are more highly indebted and show a lower profitability.[26] This does not pose a problem if we can control for variables that are correlated with the debt ratio and if we ensure that both groups developed in a similar way before the reform. We address the first point via a regression analysis with a set of observable control variables.[27] For the latter point, we compared the mean debt ratios in the treatment and control group per year before the reform (Figure 2 in the next section). If the development of the leverage is similar in both groups before the reform, but different after the reform, we can infer a treatment effect.

However, the introduction of the interest barrier is not the only relevant change which came into effect in 2008. As described in section 3, the tax rate was lowered, too. This might also lead to a decline in the debt ratios for highly indebted companies because the tax shield generated by interest expenses decreases if the tax rate is cut.[28] In addition, there might be a general time trend in the group of highly leveraged firms if they prefer to reduce the debt ratios continuously to a lower level after the crisis. As long as the average pre-reform debt ratio is higher in the treatment group, we cannot separate a possible interest barrier effect from other effects. Therefore, we also conducted regressions using treatment and control groups which show more similar average debt ratios in the pre-reform periods.

Dafne-database, thus we used all internal debt.

[26]See theoretical considerations in section 4 and the descriptive statistics in the next section.

[27]For the empirical approach, we followed the relevant empirical literature on capital structure choice and company taxation. Feld et al. (2013) and Graham (2003) provide summaries of these studies.

[28]This can be seen in equation (2), where the additional net present value of a debt-financed investment is increasing in the corporate income tax rate. Furthermore, the advantage of debt-financing is increasing in the amount of debt. Thus, the tax rate cut creates an incentive to reduce the debt ratios especially for the group of highly indebted firms.

6 Data and Descriptive Statistics

We analyzed the debt ratio development for an unbalanced panel of German limited liability corporations (AGs and GmbHs) between 2005 and 2010. The firm-level data are provided by the Dafne-database, a subsample of Amadeus of Bureau van Dijk, that contains detailed information on German companies. We used information from unconsolidated annual financial statements for all corporations showing total assets of more than EUR one million. Hence, we concentrate on medium and large sized firms. We dropped observations with implausible values for liabilities or profitability.[29] In addition, we excluded firms operating in the financial sector, the public administration, households acting as employers, and extraterritorial organizations.[30] Furthermore, we excluded all companies with a profit or loss agreement because these firms likely are part of a tax consolidated group, a German "Organschaft".[31] The final sample consists of 16,727 firm entities. Besides Dafne, we included statutory corporate tax rate data in the empirical analysis to control for tax rate effects on the companies' leverage. Table 7 in the Appendix lists and defines all variables used in our regression analysis.

Table 1: Numbers of companies

Panel A: $Treat_i^{old} = 0$ or $Treat_i^{old} = 1$

	nationals	multinationals		nationals	multinationals
$Treat_i^1 = 0$	7,287	3,063	$Treat_i^2 = 0$	6,326	2,881
$Treat_i^1 = 1$	315	172	$Treat_i^2 = 1$	113	63

Panel B: $Treat_i^{old} = 0$

	nationals	multinationals		nationals	multinationals
$Treat_i^1 = 0$	7,126	2,850	$Treat_i^2 = 0$	6,184	2,669
$Treat_i^1 = 1$	281	130	$Treat_i^2 = 1$	100	47

Numbers refer to companies for which we have at least one observation before (2005 - 2007) and after (2008 - 2010) the reform for the different definitions of the treatment variable and separated into purely domestic and multinational companies.

Table 1 illustrates the number of companies in the treatment and control group for which we have at least one observation before and after the reform. Panel A depicts numbers for

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[29]We excluded all companies with a debt-to-asset ratio higher than 1 or lower than 0, negative internal debt, an internal-to-all-debt ratio larger than 1 or a profitability (EBITDA/total assets) larger than 1 or lower than -1 in at least one year.

[30]The broad NACE Rev. 2 structure identifies 21 industries, hence, we used companies in 17 industries for our empirical analysis.

[31]Companies are not treated by the interest barrier if all subsidiaries are part of a tax consolidated group because such a company is seen as a stand-alone firm by the tax law. However, if subsidiaries exist outside this group, the interest barrier applies to the tax consolidated group as one firm and the other subsidiaries separately. Since we have no information about whether subsidiaries exist outside a tax consolidated group and since we are not able to look at the tax consolidated accounts, we did not account these firms in our analysis.

the sample including firms that were potentially hit by the old rule while Panel B displays the numbers from the smaller sample excluding such firms. Concentrating on Panel A, the control group is 21 (52) times larger than the treatment group in the $Treat_i^1$ ($Treat_i^2$) sample. Only 4.5 % (1.9 %) of firms are treated by the new interest barrier if we use $Treat_i^1$ ($Treat_i^2$) for identification. We defined a company as multinational if at least one 50 % corporate shareholder or subsidiary abroad exists.[32] The group of purely domestic firms is about twice as large as the group of multinationals.

Table 2 compares the pre-reform summary statistics for the treatment and control groups using $Treat_i^1$ and $Treat_i^2$.[33] On average, the treatment group shows a 13.3 %-points larger debt ratio than the control group using $Treat_i^1$. The difference is even higher (22.8 %-points) if we divide the sample based on $Treat_i^2$. In this respect, the aim of the interest barrier to target highly indebted firms is achieved. In particular, external debt is higher in the treatment group. The internal-to-all-debt ratio is 30.5 % for the non-treated and only 22.7 % for the treated firms ($Treat_i^1$). This difference is higher if we exclude companies that were potentially hit by the old rule (28.2 % compared to 13.9 %). The average profitability is higher for the non-treated firms. These two facts confirm hypothesis H 1.[34] Furthermore, the treatment group firms are on average more than six times larger than the control group firms[35], indicating that the EUR one million net interest escape clause especially shields smaller firms.[36] In addition, treated firms show a higher average tangibility, which might reflect a positive relationship between debt ratios and collateral. The share of loss-making firms is higher in the treatment group. In our empirical analysis, we controlled for the profit and loss position because prior losses might lead companies to take up more debt for paying their dues and for keeping their business running and because loss carry-forwards serve as a non-debt tax shield.[37]

Overall, the narrow definition of treatment using $Treat_i^2$ comes at the cost of greater differences between the two groups. Table 3 shows that the average (external) debt ratio

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[32]As we used year 2012 data, the classification into the national or multinational group is constant over time.

[33]Summary statistics for the sample without companies that were potentially hit by the old rule are available upon request.

[34]Wilcoxon-tests also clearly corroborate that the internal-to-all-debt ratios and the profitability were different for treated and non-treated firms, as p-values are almost zero.

[35]This is in line with the existing literature. Bach and Buslei (2009b) as well as Blaufus and Lorenz (2009b) expect the rule to be particularly harmful to large companies.

[36]The EUR one million net interest escape clause is the most important one for classification into the treatment or the control group in our sample: For only 2 % of the observations of non-treated firms (using $Treat_i^1$) the reason for non-treatment is independency.

[37]Following Overesch and Voeller (2010), we use a dummy to identify companies which are probably in a loss situation because the accounting data provided by Dafne do not necessarily reflect if the considered firm has a negative taxable profit.

Table 2: Summaries pre-reform

	$Treat_i^1 = 0$ (Obs. 21,382)				$Treat_i^2 = 0$ (Obs. 19,133)			
Variable	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
A_{it}	34,822	624,997	1,001	87,100,000	43,208	679,414	1,002	87,100,000
D/A_{it}	0.495	0.259	0.001	1.000	0.495	0.252	0.001	1.000
$In.\ D/A_{it}$	0.151	0.206	0.000	0.997	0.142	0.193	0.000	0.990
$Ex.\ D/A_{it}$	0.344	0.245	0	0.994	0.353	0.245	0	0.994
$Tangibility_{it}$	0.256	0.253	0	1.000	0.241	0.242	0	0.998
$Profitability_{it}$	0.122	0.137	-0.983	0.987	0.135	0.131	-0.983	0.987
$Loss_{it}$	0.185	0.388	0	1	0.143	0.350	0	1
τ_t^C	0.394	0.000	0.394	0.394	0.394	0.000	0.394	0.394
$Ln\ Employees_{it}$	4.469	1.232	0	9.285	4.478	1.226	0	9.949
$Net\ Interest_{it}$	-69	2,167	-81,000	280,895	-200	2,908	-164,598	280,895
	$Treat_i^1 = 1$ (Obs. 1,104)				$Treat_i^2 = 1$ (Obs. 383)			
Variable	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
A_{it}	269,196	959,136	4,095	19,000,000	269,534	1,127,045	4,095	15,300,000
D/A_{it}	0.627	0.187	0.060	0.997	0.723	0.165	0.060	0.998
$In.\ D/A_{it}$	0.142	0.218	0.000	0.972	0.172	0.246	0.000	0.972
$Ex.\ D/A_{it}$	0.485	0.248	0.000	0.991	0.551	0.256	0.000	0.991
$Tangibility_{it}$	0.516	0.342	0	0.999	0.442	0.382	0	0.999
$Profitability_{it}$	0.091	0.087	-0.312	0.726	0.052	0.085	-0.568	0.667
$Loss_{it}$	0.322	0.467	0	1	0.428	0.495	0	1
τ_t^C	0.394	0.000	0.394	0.394	0.394	0.000	0.394	0.394
$Ln\ Employees_{it}$	5.007	1.629	0	9.949	4.333	1.587	0	8.835
$Net\ Interest_{it}$	-5,681	29,877	-882,100	-1,005	-8,105	49,261	-882,100	285

Summary statistics of observations from years 2005 - 2007 in the sample including all firms that were potentially hit by the old rule. A_{it} and $Net\ Interest_{it}$ are depicted in thousand EUR. Variables are defined in Table 7.

Table 3: Summaries post-reform

	$Treat_i^1 = 0$ (Obs. 28,414)				$Treat_i^2 = 0$ (Obs. 25,108)			
Variable	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
A_{it}	31,037	117,976	447	7,312,721	37,424	163,200	526	15,200,000
D/A_{it}	0.478	0.260	0.000	1	0.479	0.253	0.000	1
$In.\ D/A_{it}$	0.145	0.201	0.000	0.997	0.136	0.189	0.000	0.994
$Ex.\ D/A_{it}$	0.333	0.244	0	0.992	0.342	0.244	0	0.992
$Tangibility_{it}$	0.259	0.253	0	0.998	0.240	0.237	0	0.998
$Profitability_{it}$	0.114	0.137	-0.999	0.947	0.124	0.134	-0.977	0.947
$Loss_{it}$	0.185	0.388	0	1	0.155	0.362	0	1
τ_t^C	0.310	0.000	0.310	0.310	0.310	0.000	0.310	0.310
$Ln\ Employees_{it}$	4.558	1.184	0	9.419	4.545	1.177	0	9.930
$Net\ Interest_{it}$	-140	1,321	-105,655	51,225	-247	2,041	-110,898	51,225
	$Treat_i^1 = 1$ (Obs. 1,387)				$Treat_i^2 = 1$ (Obs. 497)			
Variable	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
A_{it}	274,489	1,066,178	3,727	21,100,000	332,334	1,575,419	3,727	21,100,000
D/A_{it}	0.599	0.201	0.040	0.997	0.676	0.195	0.043	0.997
$In.\ D/A_{it}$	0.162	0.232	0.000	0.977	0.208	0.267	0.000	0.977
$Ex.\ D/A_{it}$	0.437	0.248	0.000	0.978	0.468	0.270	0.000	0.974
$Tangibility_{it}$	0.472	0.342	0	0.986	0.390	0.365	0	0.969
$Profitability_{it}$	0.080	0.089	-0.301	0.790	0.059	0.077	-0.169	0.523
$Loss_{it}$	0.332	0.471	0	1	0.414	0.493	0	1
τ_t^C	0.310	0.000	0.310	0.310	0.310	0.000	0.310	0.310
$Ln\ Employees_{it}$	5.038	1.607	0	9.930	4.427	1.560	0	8.856
$Net\ Interest_{it}$	-5,669	25,482	-563,800	39,832	-8,550	41,235	-563,800	19,739

Summary statistics of observations from years 2008 - 2010 in the sample including all firms that were potentially hit by the old rule. A_{it} and $Net\ Interest_{it}$ are depicted in thousand EUR. Variables are defined in Table 7.
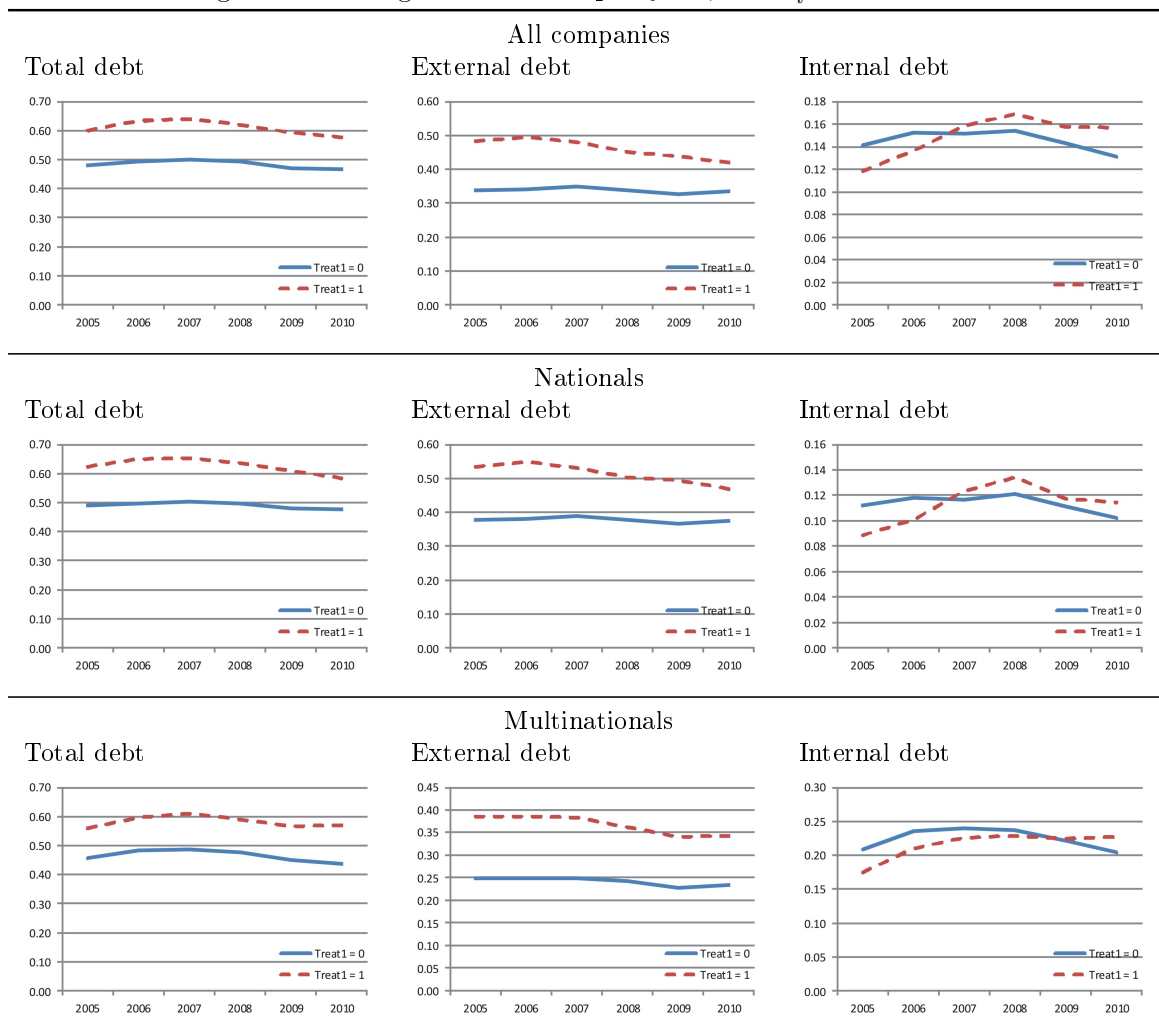
Figure 2: Average debt ratios per year, $Treat_i^1$ classification

declines more strongly in the treatment group after the reform.[38] In addition, the average tangibility and profitability also decrease slightly over time.

Figure 2 depicts the development of the mean debt ratios over time by treatment ($Treat_i^1 = 0$ and $Treat_i^1 = 1$), by type of company (national or multinational) and by type of debt (total debt, external debt and internal debt). The ratio of total debt to assets in the treatment group is, on average, more than 10 %-points higher than in the control group in the pre-reform period. The development until 2007 for treated and non-treated firms is similar and does not change noticeably after the reform. The story is similar for external debt, but on average the debt ratio decreases more strongly after the reform for the treatment group. For internal debt, the developments differ between the two groups. The treatment group shows a lower initial value than the control group, but internal

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[38]Compare the detailed analysis in section 8.

Figure 3: Non-deductible expenses for "$Treat_i^2 = 1$ companies" before and after the reform
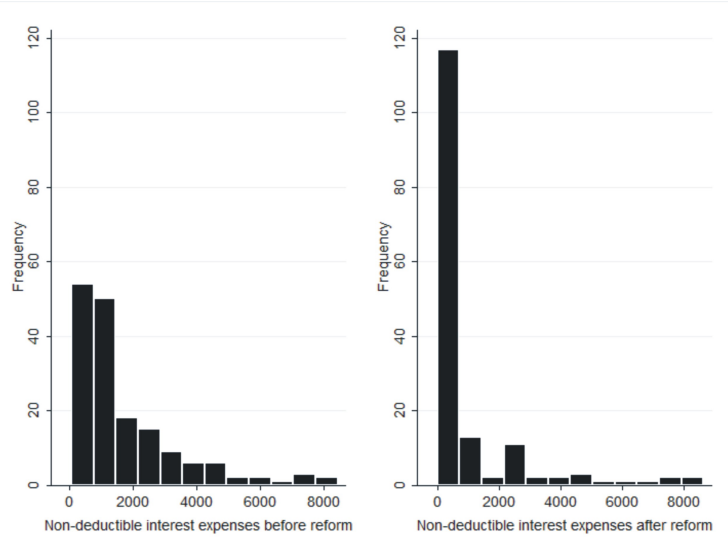
Notes: The figures show the frequency distribution of the average amount of non-deductible expenses before the reform (2005-2007) and after the reform (2008 - 2010) in thousand EUR when applying the rules of the interest barrier for the treatment group ($Treat_i^2 = 1$) as applicable in the considered years (including the EUR 3 million net interest escape clause from 2008 onward).

debt increases faster, leading to an intersection and a larger mean ratio for the treatment group in the later years. Only for multinationals, the pre-reform development is similar for the two groups. We get analogous results when separating treatment and control group using $Treat_i^2$.[39] The difference in the development of internal debt turns out even higher. Regarding the external debt ratio, the purely domestic treated firms experience a decline from year to year while the development is rather constant for non-treated firms. This indicates that significant regression results concerning the external debt ratio in the subsample of national firms do not reflect a treatment effect but rather an adjustment towards a lower target debt ratio by the more indebted treatment group.[40]

Figure 3 depicts histograms of the average non-deductible interest expenses when applying the interest barrier hypothetically in 2005 - 2007 (left hand side) and after the reform (right hand side).[41] The number of companies with non-deductible interest expenses close to zero is much higher after the reform. The median of average non-deductible expenses

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[39]The graphs for separation according to $Treat_i^2$ can be found in Figure 4 in the Appendix.

[40]The graphs for the debt development for the subsample of companies which were not harmed by the old rule before the reform ($Treat_i^{old} = 0$) look very similar. They are available upon request.

[41]We applied the interest barrier for the years 2005 - 2010 and calculated the yearly average non-deductible interest expenses per company in the treatment group ($Treat_i^2 = 1$) for which we have at least one observation before and after the reform. For the calculation, we accounted for the EUR 3 million net interest escape clause for the years as of 2008 and for a potential tax-EBITDA carry-forward from years 2007 to 2009 for the year 2010. The histograms show results for average non-deductible interest expenses lower than the 95 % quantile for reasons of visualization.

is EUR 1.1 million in the pre-reform period and zero in the post-reform period. There-
fore, at least half of the hypothetically treated companies in our sample are not affected
by the new rule after its introduction at all. We can rule out that this development is
explained by an increasing profitability because the average profitability before and after
the reform does not differ in a statistically significant way. However, this development
should not be interpreted as empirical evidence for a causal interest barrier effect on the
financing decision because the higher net interest escape clause reduces the number of
treated firms. In addition, what we observe can be the result of a general trend towards
declining leverage ratios in the sample, as indicated in Figure 2.

7 Empirical Approach

We applied a difference-in-difference approach in order to test hypotheses H 2 to H 4. The
baseline estimation equation is:

$$D/A_{it} = \beta_0 + \beta_1 \cdot Treat_i^1 + \beta_2 \cdot Reform_{it} + \beta_3 \cdot Treat_i^1 * Reform_{it} + \epsilon_{it}. \qquad (8)$$

The dependent variable is the debt ratio of company i in year t. $Treat_i^1$ indicates if a
company is in the treatment (control) group by the value one (zero). $Reform_{it}$ equals zero
for pre-reform (2005 - 2007) and one for post-reform (2008 - 2010) observations. A negative
and significant coefficient of the interaction of both variables, $Treat_i^1 * Reform_{it}$, indicates
that the debt ratio of the treated firms on average declines compared to the companies in
the control group after the reform. This interaction is our variable of interest. ϵ_{it} is the
normally distributed error term.

As the estimated coefficients measured by equation (8) might be biased by unobserved
factors, we included the following control variables in the estimation equation. $\boldsymbol{X}_{it}$ is
a matrix of time-varying firm-specific variables[42] and δ_{jt} is an industry-time-fixed effect
capturing general industry-specific leverage time trends. The time-fixed effects capture
the reform dummy due to collinearity.[43] Finally, we also added company-fixed effects,
δ_i, in order to capture all time-constant effects that are responsible for a company to
be a high- or low-leveraged firm in general. Therefore, all time-constant variables are
not identified, in particular the treatment dummy in equation (8). The final estimation

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[42]See the result tables in section 8 and Table 7 in the Appendix for a list and a definition of the considered
variables.

[43]In addition, we do not separately show the constant which is one of the fixed-effects dummies.

equation is

$$D/A_{it} = \beta_1 \cdot Treat_i^1 * Reform_{it} + \boldsymbol{X}_{it}\boldsymbol{\beta} + \delta_{jt} + \delta_i + \epsilon_{it}, \qquad (9)$$

where $\boldsymbol{\beta} = (\beta_2 \cdots \beta_n)^\top$ is the coefficient vector for $n-1$ control variables. This equation is used to test hypothesis H2. We tested H3 by interacting $Treat_i^1 * Reform_{it}$ with an indicator variable for multinationals, $Mult_i$. A significant coefficient of $Treat_i^1 * Reform_{it}$ would show the reform effect for national companies, and a joint significance of $Treat_i^1 * Reform_{it}$ and the three-way interaction $Treat_i^1 * Ref_{it} * Mult_i$ would show a corresponding reform effect for multinationals.[44] The last hypothesis concerning different adjustments of external and internal debt was tested by employing the external or internal debt-to-asset ratio instead of total debt as the dependent variable.[45]

8 Results

Table 4 presents the regression results for the sample divided into treatment and control groups by $Treat_i^1$. Column (1) depicts the outcome of a simple difference-in-difference approach as described in equation (8). The constant (not shown) is 0.495 which implies that the average debt ratio in the control group before the reform is 49.5 %. The coefficient of $Treat_i^1$ indicates that potentially harmed companies on average had a 13.3 %-points higher debt ratio before the reform than companies in the control group. The reform dummy is negative and significant. Therefore, the average debt ratio in the control group is 1.7 %-points lower after the reform compared to the pre-reform value. The negative coefficient of the interaction term $Treat_i^1 * Reform_{it}$ indicates that the change of the pre- to post-reform debt ratio is 1.2 %-points lower for the treatment group compared to the control group. In other words, the treatment group's average debt ratio declined more than the control group's ratio. However, this difference-in-difference effect is not statistically significant, which implies that we cannot reject the hypothesis that the development of the leverage is equal for both groups.

In the second column of Table 4, we added the time-varying control variables and industry-year-fixed effects; the interaction of $Treat_i^1$ and $Reform_{it}$ is negative and significant indicating that, after controlling for other factors, the average debt ratio in the treatment group declines more or increases less by 2.7 %-points compared to the control

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[44]Of course, we also included all other necessary interactions with $Mult_i$. There is only one additional interaction left which is not captured by the fixed effects, namely $Reform_{it} * Mult_i$.

[45]We also estimated all equations using $Treat_i^2$ instead of $Treat_i^1$.

Table 4: Baseline regressions, $Treat_i^1$

Dependent variable	(1) D/A_{it}	(2) D/A_{it}	(3) D/A_{it}	(4) D/A_{it}	(5) Ex. D/A_{it}	(6) In. D/A_{it}	(7) D/A_{it}	(8) Ex. D/A_{it}	(9) In. D/A_{it}
$Treat_i^1$	0.1325***	0.1389***							
	(0.000)	(0.000)							
$Reform_{it}$	-0.0168***								
	(0.000)								
$Treat_i^1 * Reform_{it}$	-0.0116	-0.0267***	-0.0140***	-0.0214***	-0.0112*	-0.0102	-0.0175***	-0.0131**	-0.0044
	(0.154)	(0.002)	(0.007)	(0.001)	(0.074)	(0.149)	(0.005)	(0.043)	(0.462)
$Reform_{it} * Mult_i$				-0.0046	0.0030	-0.0076***	-0.0037	0.0030	-0.0068**
				(0.110)	(0.243)	(0.009)	(0.201)	(0.253)	(0.019)
$Treat_i^1 * Ref_{it} * Mult_i$				0.0200*	-0.0064	0.0263**	0.0235**	-0.0090	0.0325**
				(0.061)	(0.586)	(0.040)	(0.045)	(0.498)	(0.013)
$Tangibility_{it}$		0.2192***	0.0474*	0.0450*	0.0651**	-0.0201	0.0511*	0.0733***	-0.0223
		(0.000)	(0.079)	(0.097)	(0.016)	(0.460)	(0.065)	(0.008)	(0.405)
$Profitability_{it}$		-0.3305***	-0.2959***	-0.2959***	-0.1576***	-0.1382***	-0.2948***	-0.1658***	-0.1290***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Loss_{it}$		0.1783***	0.1459***	0.1469***	0.0667***	0.0802***	0.1523***	0.0721***	0.0802***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\tau_t^C * Loss_{it}$		-0.2384***	-0.3267***	-0.3297***	-0.1555***	-0.1742***	-0.3468***	-0.1664***	-0.1803***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\tau_t^C * Tangibility_i$		-0.4372***	-0.1809***	-0.1749***	-0.0507	-0.1243*	-0.1776***	-0.0847	-0.0929
		(0.000)	(0.003)	(0.005)	(0.429)	(0.061)	(0.005)	(0.194)	(0.156)
$Ln\ Employees_{it}$		-0.0342***	0.0087**	0.0087**	0.0185***	-0.0098***	0.0089**	0.0182***	-0.0093**
		(0.000)	(0.021)	(0.023)	(0.000)	(0.009)	(0.023)	(0.000)	(0.013)
Year-industry dummies	–	✓	✓	✓	✓	✓	✓	✓	✓
Company-fixed effects	–	–	✓	✓	✓	✓	✓	✓	✓
Observations	52,287	52,287	52,287	52,287	52,287	52,287	50,177	50,177	50,177
Companies	16,727	16,727	16,727	16,727	16,727	16,727	16,203	16,203	16,203
R^2	0.0120	0.1925	0.1222	0.1224	0.0576	0.0320	0.1213	0.0624	0.0302
F_1	–	–	–	0.03	3.14*	2.27	0.36	3.59	5.88**

$Treat_i^1 * Reform_{it}$ equals one if the observation is made after the interest barrier introduction and the firm would have been potentially treated by the new rule in the three years before the reform, see Equation (5) for details. F_1 is the statistic of a joint significance test of $Treat_i^1 * Reform_{it}$ and $Treat_i^1 * Ref_{it} * Mult_i$. Other variables are described in Table 7. Regressions (7) to (9) exclude companies that were potentially treated by the old rule in 2005, 2006 or 2007. Observations of German corporations between 2005 and 2010 stem from the Dafne-database. Standard errors are clustered at the subsidiary level in regressions (3) to (9), p-values are shown in parentheses. *, ** and *** denotes significance at the 10%-, 5%- and 1%-level.

group. Starting from column (3), we further added company-fixed effects. The interaction effect remains significant but shows a lower absolute value in column (3).

Columns (4) to (6) of Table 4 illustrate to what extent the effect differs between types of firms and kinds of debt. F_1 depicts the value of a joint significance test statistic for $Treat_i^1 * Reform_{it}$ and $Treat_i^1 * Ref_{it} * Mult_i$. Regression (4) again focuses on total debt. For national firms, the average debt ratio of the treatment group decreases more or increases less by 2.1 %-points than the control group's debt ratio. However for multinationals, we did not observe a significantly different development for the two groups before and after the reform. Concerning external debt the reform effect is negative and significant for both nationals and multinationals (compare column (5)). This result does not vary significantly with regard to the multinational status and amounts only to half the value carved out for total debt. For internal debt, we did not find any significant reform effect (compare column (6)).

Regressions (7) to (9) of Table 4 exclude all companies which were potentially harmed by the old thin-capitalization rule applicable before the reform ($Treat_i^{old} = 1$). Results differ in the following manner. The significance of the reform effect concerning external debt increases for national firms, but loses significance for multinationals (see column (8)). In addition, the effect on internal debt becomes positive and significant for multinationals (see column (9)). The outcome of the internal debt ratio analysis stems from the different development of the treatment and control groups already in the pre-reform periods and might reflect a general trend as seen in Figure 2. The significant regression result for the interaction effect should thus not be interpreted as a reform effect.

Together with Figure 2, Table 4 indicates a small treatment effect of a reduction of debt ratios by one to two %-points. However, it is not possible to separate an interest barrier effect from other effects. The reason is, that in our sample, the treatment group is more highly indebted than the control group before the reform. This might, together with the tax rate cut of 10 %-points and the corresponding tax shield reduction already create incentives for these firms to stronger reduce their debt ratios. In addition, we observed a possible substitution effect between external and internal debt. This might be partly explained by the abolishment of the discrimination of internal debt by the old thin-capitalization rule, which enable firms to increase the internal debt towards a new economically efficient level.

The control variables generally show the expected effects. The mainly positive and often significant coefficient of $Tangibility_{it}$ reflects that companies with lots of collateral have an easier and broader access to loans which allows them to increase their leverage.

Table 5: Baseline regressions, $Treat_i^2$

Dependent variable	(1) D/A_{it}	(2) D/A_{it}	(3) D/A_{it}	(4) Ex. D/A_{it}	(5) In. D/A_{it}	(6) D/A_{it}	(7) Ex. D/A_{it}	(8) In. D/A_{it}
$Treat_i^2$	0.2278***							
	(0.000)							
$Reform_{it}$	−0.01647***	0.1765***						
	(0.000)	(0.000)						
$Treat_i^2 * Reform_{it}$	−0.0306**	−0.0300**	−0.0290***	−0.0237**	−0.0053	−0.0241**	−0.0279**	0.0038
	(0.013)	(0.028)	(0.005)	(0.038)	(0.683)	(0.014)	(0.023)	(0.757)
$Reform_{it} * Mult_i$			−0.0052*	0.0026	−0.0078***	−0.0038	0.0022	−0.0060**
			(0.072)	(0.322)	(0.008)	(0.196)	(0.419)	(0.038)
$Treat_i^2 * Ref_{it} * Mult_i$			0.0138	−0.0232	0.0370*	0.0118	−0.0077	0.0195
			(0.412)	(0.276)	(0.088)	(0.536)	(0.739)	(0.337)
$Tangibility_{it}$		0.2583***	0.0584*	0.0796***	−0.0212	0.0683**	0.0889***	−0.0206
		(0.000)	(0.054)	(0.008)	(0.487)	(0.027)	(0.004)	(0.494)
$Profitability_{it}$		−0.3848***	−0.3180***	−0.1737***	−0.1443***	−0.3171***	−0.1820***	−0.1351***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Loss_{it}$		0.1869***	0.1514***	0.0822***	0.0692***	0.1559***	0.0858***	0.0701***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\tau_t^C * Loss_{it}$		−0.2771***	−0.3377***	−0.1987***	−0.1391***	−0.3506***	−0.2027***	−0.1478***
		(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.002)
$\tau_t^C * Tangibility_i$		−0.4221***	−0.1448**	−0.0521	−0.0927	−0.1615**	−0.0828	−0.0787
		(0.001)	(0.039)	(0.466)	(0.207)	(0.025)	(0.256)	(0.280)
$Ln\ Employees_{it}$		−0.0301***	0.0108***	0.0196***	−0.0087**	0.0112***	0.0191***	−0.0079**
		(0.000)	(0.009)	(0.000)	(0.032)	(0.008)	(0.000)	(0.050)
Year-industry dummies	–	✓	✓	✓	✓	✓	✓	✓
Company-fixed effects	–	–	✓	✓	✓	✓	✓	✓
Observations	45,121	45,121	45,121	45,121	45,121	43,312	43,312	43,312
Companies	14,300	14,300	14,300	14,300	14,300	13,870	13,870	13,870
R^2	0.0144	0.1869	0.1317	0.0640	0.0340	0.1314	0.0690	0.0320
F_1	–	–	1.26	6.69***	3.24*	0.54	3.29*	2.04

$Treat_i^2 * Reform_{it}$ equals one if the observation is made after the introduction of the interest barrier and the firm would have been hypothetically treated by the new rule in the three years before the reform, see Equation (6) for details. F_1 is the statistic of a joint significance test of $Treat_i^2 * Reform_{it}$ and $Treat_i^2 * Ref_{it} * Mult_i$. Other variables are described in Table 7. Regressions (6) to (8) exclude companies that were potentially treated by the old rule in 2005, 2006 or 2007. Observations of German corporations between 2005 and 2010 stem from the Dafne-database. Standard errors are clustered at the subsidiary level in regressions (3) to (8), p-values are shown in parentheses. *, **, and *** denotes significance at the 10%-, 5%- and 1%-level.

$Profitability_{it}$ is negatively related to the debt ratio development, i.e., profitable companies can more easily reduce their leverage due to their access to internal financing via retained earnings. The positive and significant effect of $Loss_{it}$ indicates that companies which made losses in the past need to raise debt in order to pay their dues and to keep their businesses running. Overesch and Voeller (2010) use the interactions between $Loss_{it}$ and τ_t^C and, in addition, τ_t^C and $Tangibility_{it}$ in order to show that the positive tax effect on the debt-to-asset ratio decreases for firms with high non-debt tax shields. We found the same expected negative effects on the total, internal and external leverage for $\tau_t^C * Loss_{it}$ and on total debt for $\tau_t^C * Tangibility_{it}$.[46] The number of employees negatively impacts internal debt, but positively affects the use of external debt. This is plausible because the firm size may boost the ability to tap external sources.

Table 5 presents results for the sample divided by $Treat_i^2$. This definition of treatment also takes into account the information about the tax-EBITDA. Apart from that, the specifications are identical to Table 4. As most results are similar to those of Table 4, we concentrate on the differences. The interaction effect in the difference-in-difference regressions without firm-fixed effects in column (1) and (2) is about 3 %-points. This slighty larger effect compared to Table 4 can be observed for the other regressions as well. Treated national firms decrease their external debt ratio on average 2.4 %-points more (or increase it less) than nationals in the control group (compare column (4)). For multinationals, this effect amounts to an additional 2.3 %-points. However, this difference is not statistically significant. Figure 4 shows a general declining trend for the external debt ratios of treated national firms. The statistically significant result concerning external debt for nationals in column (4) thus cannot be interpreted as a causal interest barrier or tax rate effect. The development rather indicates that there might be a lower target debt ratio for those firms in general. The effect on internal debt for multinationals is now significantly positive (compare column (5)). Results are similar for a subsample without companies being harmed by the old rule before the reform, as shown in columns (6) to (8) .

Adjustment of the treatment and control group compositions

The previous analysis reveals that the treatment and control group differ substantially in several characteristics. Most importantly, the treatment group exhibits a higher average pre-reform debt ratio than the control group. Therefore, we cannot separate a possible

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[46]Coefficients for τ_t^C are not identified, because the variation of this variable is the same for all considered companies and thus captured by the time-fixed effects.

interest barrier effect from other treatment effects. In order to isolate the effect driving the results, we adjusted the composition of the two groups. The aim is to find two groups with similar levels of debt in the years prior to the tax reform. If we still find a significant treatment effect, it can be traced back to the interest barrier introduction. For that reason, we conducted the following two approaches.[47]

For a first group adjustment, we excluded all companies with net interest expenses below zero or above EUR two million in the sample period. By concentrating on firms with positive net interest expenses, we sorted out companies that are most likely never concerned about the interest barrier. The restriction on EUR two million excludes firms with very high absolute amounts of debt.[48] In the face of the positive correlation of net interest expenses and the total assets of the companies, this procedure also ensures a more comparable size of companies in the treatment- and control groups.

As a second group adjustment, we only changed the control group in order to arrive at a subsample with a debt pattern similar to the treatment group. We only kept the subgroup of the highest indebted companies of the control group in such a way that the median value of the average pre-reform debt ratio of the remaining companies equals the median value of the treatment group.[49] Summary statistics and the development of the mean debt ratio per group of the new samples used in the group adjustment analyses are available upon request.

Panel A of Table 6 presents results for the analyses of the adjusted groups using $Treat_i^1$. Columns (1) to (3) depict the outcome for the first adjustment. Again, we separately analyzed total, external and internal debt. The sample size is about 45 % compared to the baseline regressions. The summary statistics and graphs of the debt development indicate more comparable groups: The mean pre-reform debt ratio in the treatment group is only two %-points higher than in the control group and the treatment group even starts with a lower value in 2005. For multinationals, however, the comparability is still limited. In addition, external debt remains higher in the treatment group whereas internal debt is higher in the control group. The development of the average debt ratios over time before

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[47]We show results using the samples without companies that were potentially harmed by the old thin-capitalization rule, i.e., without firms for which $Treat_i^{old} = 1$. Results for the larger sample including these companies are qualitatively identical.

[48]We have chosen the value EUR two million because the distance to the EUR one million net interest escape clause threshold is the same as from zero. Buslei and Simmler (2012) also restrict their analysis to companies within a small range of the EUR one million threshold.

[49]The median value of the average pre-reform debt ratio of the treatment group using $Treat_i^1$ is 61.8 % when excluding all companies potentially harmed by the old rule. For the group adjustment, we then used all firms in the control group which have a higher average pre-reform debt ratio and the same number of firms with the next smaller debt ratios.

Table 6: Group adjustment analysis

Panel A: Using $Treat_i^1$

Dep. var.	(1) D/A_{it}	(2) Ex. D/A_{it}	(3) In. D/A_{it}	(4) D/A_{it}	(5) Ex. D/A_{it}	(6) In. D/A_{it}
$Treat_i^1 * Reform_{it}$	−0.0136	−0.0220*	0.0084	−0.0067	−0.0042	−0.0025
	(0.126)	(0.085)	(0.475)	(0.309)	(0.551)	(0.706)
$Reform_{it} * Mult_i$	−0.0012	0.0049	−0.0061	−0.0117***	0.0018	−0.0136***
	(0.770)	(0.272)	(0.194)	(0.001)	(0.603)	(0.000)
$Treat_i^1 * Ref_{it} * Mult_i$	0.0190	0.0051	0.0139	0.0331***	−0.0081	0.0412***
	(0.403)	(0.817)	(0.539)	(0.006)	(0.557)	(0.002)
Year-ind. dummies	✓	✓	✓	✓	✓	✓
Company-fix. eff.	✓	✓	✓	✓	✓	✓
Observations	23,314	23,314	23,314	30,610	30,610	30,610
Companies	7,902	7,902	7,902	9,085	9,085	9,085
R^2	0.1845	0.0918	0.0383	0.1886	0.0878	0.0409
F_1	0.07	0.88	1.30	6.57**	1.06	10.78***

Panel B: Using $Treat_i^2$

Dep. var.	(1) D/A_{it}	(2) Ex. D/A_{it}	(3) In. D/A_{it}	(4) D/A_{it}	(5) Ex. D/A_{it}	(6) In. D/A_{it}
$Treat_i^2 * Reform_{it}$	−0.0062	−0.0382	0.0320	0.0006	−0.0198	0.0204
	(0.757)	(0.216)	(0.316)	(0.953)	(0.153)	(0.131)
$Reform_{it} * Mult_i$	−0.0030	0.0025	−0.0054	−0.0191***	−0.0054	−0.0137**
	(0.488)	(0.578)	(0.243)	(0.000)	(0.316)	(0.016)
$Treat_i^2 * Ref_{it} * Mult_i$	−0.0024	0.0246	−0.0270	0.0323	0.0114	0.0210
	(0.961)	(0.628)	(0.562)	(0.105)	(0.643)	(0.335)
Year-ind. dummies	✓	✓	✓	✓	✓	✓
Company-fix. eff.	✓	✓	✓	✓	✓	✓
Observations	19,926	19,926	19,926	16,636	16,636	16,636
Companies	6,674	6,674	6,674	5,029	5,029	5,029
R^2	0.2118	0.1061	0.0447	0.2527	0.1074	0.0477
F_1	0.04	0.11	0.02	3.64*	0.17	5.76**

Panel A of the table contains results using $Treat_i^1$, Panel B contains results using $Treat_i^2$. The full tables including results for all control variables are available upon request. $Treat_i * Reform_{it}$ equals one if the observation is made after the introduction of the interest barrier and the firm would have been hypothetically treated by the new rule in the three years before the reform, see Equations (5) and (6) for details. F_1 is the statistic of a joint significance test of $Treat_i * Reform_{it}$ and $Treat_i * Ref_{it} * Mult_i$. Companies that were potentially treated by the old rule in 2005, 2006 or 2007 are excluded. Regressions (1) to (3) restrict the sample to companies with net interest expenses between EUR zero and EUR two million. Regressions (4) to (6) restrict the control group to firms with the largest debt ratios before the reform in order to match the median value of debt ratios of the control and the treatment group. Observations of German corporations between 2005 and 2010 stem from the Dafne-database. Standard errors are clustered at the subsidiary level, p-values are shown in parentheses. *, ** and *** denotes significance at the 10%-, 5%- and 1%-level.

the reform is comparable for the two groups, especially for nationals and for total debt and external debt. Regression results indicate only little evidence for a treatment effect. Only national companies significantly adjusted their external leverage in the expected

way (compare column (2) of Table 6).

Columns (4) to (6) depict results for the analysis of the second group adjustment. The sample size shrinks to 59 % compared to the baseline regressions. The treatment and control groups are very similar. The average pre-reform debt ratio is less than two %-points lower in the treatment group and the development of the leverage is also more or less comparable. However, internal debt ratios are still much higher for the control group. For the smaller subgroup of multinationals, even this adjustment of the group separation does not lead to equally leveraged firms. The regression results in columns (4) to (6) of Table 6 do not show any significant treatment effect. Only the average total and internal debt ratio of treated multinationals significantly increases compared to non-treated firms. Again, these results cannot be attributed to the tax reform, because the pre-reform developments of this group's internal debt ratios were too different for treated and non-treated firms.

Panel B of Table 6 contains the results of the analyses after the group adjustments using the second treatment definition, $Treat_i^2$. Again, the new sampling leads to more comparable groups (except for the internal debt ratios). In line with the $Treat_i^1$ analysis, the sample of the second group adjustment analysis consists of the most similar treatment and control groups. However, the better comparability again comes at the expense of vanishing treatment effects in the regression analysis. The positive effect on the multinationals' total and internal debt (columns (4) and (6)) cannot be linked to the tax reform because of the different development of the treatment and control groups in the pre-reform period.

In summary, the group adjustments yield more comparable treatment and control groups. In the regression analysis, the treatment effects almost disappear. This indicates that the effect carved out in the baseline estimations mainly stems from non-interest barrier effects such as the tax rate cut or a general wish of highly indebted firms to reduce their debt-ratios again. Only in the first group adjustment analysis for the sample divided by $Treat_i^1$, the treated national firms still show a significantly stronger decline in external debt compared to the control group after the reform. Concerning the hypotheses derived in section 4, we cannot confirm H 2 and H 3 because the analysis does not provide robust empirical evidence for a pure interest barrier effect. If at all, a treatment effect can be found for nationals and external debt. Therefore, we reject H 4.[50]

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[50]When repeating the analysis using $Treat_i^1$ for group separation and the smaller sample of the $Treat_i^2$ analysis, we found that the differences in the results of the $Treat_i^2$ analysis compared to the $Treat_i^1$ analysis are not related to the smaller number of observations, but to the altered treatment group definition.

9 Conclusion

We analyzed the introduction of a new thin-capitalization rule on the financing behavior of German corporations. Our results indicate a robust reform effect only if the treatment group shows a higher average pre-reform debt ratio than the control group. The effect vanishes if we only compare firms with similar leverage in the pre-reform period. This result implies that highly indebted firms generally try to reduce their debt-ratios to a lower level or that the simultaneous cut in the corporate income tax rate, which decreases the tax shield generated by highly debt-financed investments, is more effective in reducing a firm's leverage and avoiding excessive debt-financing than the new interest barrier.

Furthermore, we found a potential treatment effect especially for national firms and for external debt. Multinational companies were not found to react particularly strongly. Therefore, the goal of the interest barrier to avoid excessive cross-border lending from low-tax countries by multinational companies does not seem to have been achieved.

Several reasons might explain why our analysis does not provide evidence for a pure interest barrier effect on the financing decision. First, the number of affected firms is low indicating that the interest barrier is harmful only for a few companies. Second, the affected companies might not be able to adjust their leverage or just wait for an increase of earnings in the future in order to offset the non-deductible expenses later. Third, many companies might not be really affected because of the increased exemption limit from EUR one million to EUR three million. Fourth, many firms might be able to avoid the application of the interest barrier. For instance, it is possible to include all subsidiaries in a tax consolidated group which is treated as a single firm and therefore not captured by the interest barrier. Apart from that, firms can split up into smaller subsidiaries in order to take advantage of the net interest escape clause.[51]

10 Appendix

10.1 Definition of Tax-EBITDA

We followed Bach and Buslei (2009a) and Blaufus and Lorenz (2009a) in calculating the tax-EBITDA.

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[51]Buslei and Simmler (2012) show that part of the firms affected by the interest barrier are increasing the number of subsidiaries instead of adjusting their leverage after the reform.

simulated taxable profit ("Maßgeblicher Gewinn") =	

net income

following Bach and Buslei (2009a), page 9:

+	taxes on income and earnings
−	95 % of earnings from shareholdings
−	95 % of earnings from selling substantial shareholdings
−	95 % of extraordinary earnings - affiliated companies
−	earnings from mergers and restructurings
+	extraordinary expenses - affiliated companies
+	losses from mergers and restructurings
−	taxable investment allowance
−	earnings from shareholdings based on profit-or-loss agreement (parent)
+	expenses from loss adoption based on profit-or-loss agreement (parent)
+	profits transferred based on profit-or-loss agreement (subsidiary)
−	earnings from loss adoption based on profit-or-loss agreement (subsidiary)

following Blaufus and Lorenz (2009a), page 324:

+	change in provisions for contingent losses
+	change in provisions for expenses
+	change in adjustment item
+	change in start-up and business-expansion expenses

We only used observations with available data for *net income* and *taxes on income and earnings*. Most of the remaining variables used to calculate the simulated taxable profit have a low coverage in the Dafne-database. We interpret missing values as zero. After this calculation, the tax-EBITDA was defined as follows:

$$\text{tax-EBITDA} := \text{simulated taxable profit} + DEP + \text{net interest expenses} \qquad (10)$$

10.2 Definition of Relevant Equity for Old Thin-Capitalization Rule

We calculated the proportional equity capital according to the former Art. 8a KStG, which was applicable until the new interest barrier was introduced. We used one year lagged variables from Dafne.

proportional equity capital =	
subscribed equity / equity account / capital shares	
−	subscribed capital unpaid
−	shareholdings
+	capital reserve
+	retained earnings / revenue reserves
+	profit-/loss carry-forward
+	net income

Most variables used to calculate the proportional equity capital have a low coverage in the Dafne-database. We interpret missing values as zero. We do not derive any conclusion about the potential treatment by the old rule, if the calculated proportional equity capital is negative.

Table 7: Variable definitions

A_{it}	Total assets in thousand EUR.
CF_t	Cash flow in period t (CF_0 is the amount of investment).
D	Total debt.
D/A_{it}	Total liabilities (accounting figure liabilities) divided by total assets, measured in %-points ($0.01 =$ one percent).
DEP_t	Depreciation in period t.
Ex. D/A_{it}	External liabilities (total debt - internal debt) divided by total assets, measured in %-points ($0.01 =$ one percent).
γ	Fraction of interest payments that is deductible from the corporate tax base.
i	Interest rate.
iD_t	Interest expenses in period t.
In. D/A_{it}	Internal liabilities (liabilities to shareholders, to affiliated enterprises and to enterprises in which participations are held) divided by total assets, measured in %-points ($0.01 =$ one percent).
λ	Internal-to-total-debt ratio.
Ln Employees$_{it}$	Logarithm of number of employees.

|	
$Loss_{it}$	Dummy variable, 1 if the profit before taxes was negative in the year before the observation.
$Mult_i$	Dummy variable, 1 if the company is classified in the group of multinational companies, i.e., if the company has at least one 50 % corporate shareholder or subsidiary abroad.
ndi	Yearly average pre-reform non-deductible interest expenses to asset ratio according to a hypothetical application of the new interest barrier in the three years before the reform.
NDI_{old}, NDI_{new}	Non-deductible interest expenses under the old and new rule, respectively.
$Net\ Interest_{it}$	Net interest result in thousand EUR (= earnings - expenses).
NPV_E, NPV_D	Net present value of equity- (subscript E) or debt- (subscript D) financed investment.
$Profitability_{it}$	EBITDA divided by total assets, measured in %-points (0.01 = one percent).
r	EBIT as a fraction of total assets.
$Reform_{it}$	Dummy variable, 1 if observation is made in the years 2008 - 2010, zero if observation is made in years 2005 - 2007.
τ^C	Combined corporate tax rate, including the statutory corporate tax rate, the solidarity surcharge and the local business tax, measured in %-points (0.01 = one percent).
$Tangibility_{it}$	Tangible assets divided by total assets, measured in %-points (0.01 = one percent).
$Treat_i^1$	Dummy variable, 1 if company would have been potentially treated by the new interest barrier in the three years before the reform ignoring the EBITDA status.
$Treat_i^2$	Dummy variable, 1 if company would have had non-deductible interest expenses according to the new interest barrier in the three years before the reform.
$Treat_i^{old}$	Dummy variable, 1 if company is supposed to have had non-deductible interest expenses according to the old thin-capitalization rule in at least one year before the reform.

Table 7: Variable definitions (continued)

$Treat_i^2 ndi$	Equals ndi, if $Treat_i^2$ equals 1 and zero otherwise.
V	Lendings to other parties.
β_1, β_2, β_3, $\boldsymbol{\beta}$, δ_{it}, δ_j	Parameters to be estimated.
$\boldsymbol{X}_{it}$	Control variables.
ϵ_{it}	Error term.

The general source of the variables is the Dafne-database provided by Bureau van Dijk. Some variables were built by own computations using the information from Dafne. Variables with names combining the above variables by $*$ are interactions of the respective variables. The statutory tax rates are calculated by using information from the IBFD Global Corporate Tax Handbooks and the Federal Statistical Office of Germany.

Figure 4: Average debt ratios per year, $Treat_i^2$ classification
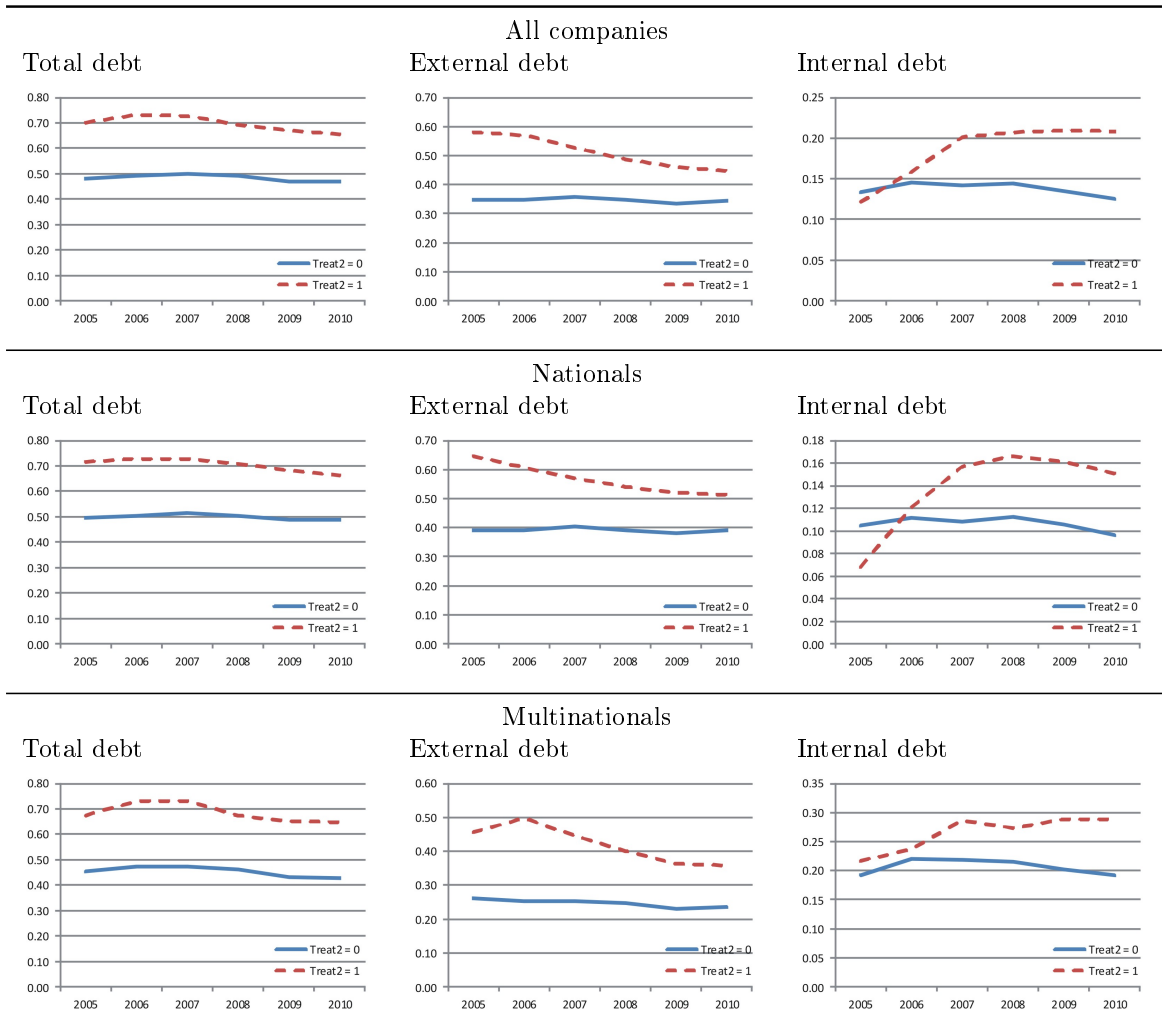
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