Taxes and Private Firms' Capital Structure Choices

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Abstract

Using limitations to the deductibility of interest payments triggered by the introduction of interest ceiling rules globally, we show that affected private firms reduce leverage relative to unaffected firms. In support of a causal effect of taxes on private firms' capital structure choices, this effect holds in matched samples, for firms near limitation thresholds, and in countries that could not opt out of mandating these rules. Private firms adjust their leverage promptly in response to changes in tax incentives for debt financing, and these adjustments appear to be persistent. Placebo tests show no reduction in leverage for affected firms around pseudo-reform years. We also rule out a number of alternative explanations and confounding events.

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We investigate whether corporate taxes shape the capital structure decisions of private firms - - a question that remains surprisingly underexplored. Despite privately held firms accounting for a substantial fraction of economic activity even in the most developed countries (Moskowitz and Vissing-Jorgensen (2002)), most studies have focused on the highly selected sample of publicly traded firms. Importantly, and perhaps surprisingly, recent studies investigating whether private firms increase leverage in response to stronger tax incentives either find that private firms actually reduce leverage (Ivanov, Pettit, and Whited (2025); Cui, Wei, Xie, and Xing (2025)) or find no significant relationship between tax incentives and capital structure choices (Goodman, Isen, and Richmond (2024)). This recent evidence casts a scar on the validity of foundational concepts presented in finance textbooks.

To investigate whether corporate taxes influence the capital structure decisions of private firms, we exploit the introduction of interest ceiling rules across many countries from 2004 to 2022. These rules, which impose limitations on the general deductibility of interest payments to *all* types of lenders, including banks, have become increasingly common in the past decade. Countries frequently allow corporate taxpayers to deduct interest expenses fully up to a certain threshold. Limitations on the general deductibility of interest expenses often restrict the deductibility to a certain fraction of earnings before interest, taxes, depreciation, and amortization (EBITDA), earnings before interest and taxes (EBIT), or a specified debt-to-equity ratio.

Firms experiencing a reduction in the deductibility of their interest payments following the introduction of these rules have a direct tax incentive to reduce leverage, while firms in the same country that do not experience such a reduction in the deductibility of interest payments do not. We use a difference-in-differences framework to assess the effect of the staggered introduction of interest ceiling rules across countries. In this framework, we employ many thresholds triggering

the limitation to the deductibility of interest payments and provide *within-country* evidence that firms affected by the introduction of these rules (treated firms) reduce their leverage relative to unaffected firms (control firms).

In support of a causal effect of taxes on corporate capital structure choices, we show that the reduction in leverage (1) is statistically and economically significant in a matched sample; (2) remains significant in matched samples among firms near the thresholds triggering the limitation on the deductibility of interest expenses, and (3) is present in countries that could not "opt out" of adopting such rules. Because our tests include country-year fixed effects (in addition to industry-year fixed effects), these findings are entirely driven by differences between firms experiencing a reduction in their interest deductibility and those that are not, all within the same country- and industry-years. Importantly, the analyses that use matched samples eliminate all differences in firm characteristics between treated and control firms that might influence leverage adjustments, without materially affecting the estimates. Those tests also reveal no leverage adjustments in anticipation of the reforms but show an immediate and persistent response afterward. Thus, the parallel pretrends assumption holds up well, further validating our difference-in-differences specification.

Equally important, placebo tests show that the leverage effect does not exist around pseudo-reform years, regardless of whether we focus on countries that introduced interest ceiling rules or countries that did not. Neither does non-financial debt decline in response to the reforms. The absence of results from these placebo tests alleviates the concern that our results are spurious and corroborates our tax interpretation.

A number of robustness tests mitigate a vast array of concerns. The results are present before the introduction of the Anti-Tax Avoidance Directive by the EU, mitigating concerns that

the results might be driven by other provisions in the Directive unrelated to interest deductibility. The results are also robust to excluding countries and years that may present other size-varying incentives for debt or equity, such as countries that introduced large tax rate changes or introduced tax incentives for equity, and to focusing on pre-COVID years. We also use the Callaway and Sant'Anna's (2021) semi-parametric approach to check and confirm that our findings are robust to the concern of heterogeneous treatment effects. The conclusions are also unaffected when we cap leverage at one, focus on firms that did not appear to engage in income shifting, or focus on profitable or large firms, which are unlikely to experience any major increase in default risk as a result of the interest ceiling rules.

Importantly, we document that the conclusions also hold for smaller private firms, while they do not hold for firms that are closest to default and whose cost of borrowing is likely to be most affected by the reforms. Out of sample, the results hold for publicly traded firms.

We corroborate these baseline results by exploiting changes in tax rates and interest tax deductibility. Specifically, we investigate whether firms with lesser incentives to adjust leverage in response to corporate tax rate *changes* are less responsive to reforms affecting the tax rate. In particular, the incentives to change leverage depend on the extent to which interest payments are deductible. Firms with a larger fraction of deductible interest payments should increase leverage more in response to a tax rate increase. In support of this notion, we find that firms with greater incentives to adjust their leverage in response to tax rate changes adjust leverage more than other firms in the same country and industry.

As mentioned in the opening paragraph, our study is related to a small set of recent studies that investigate the relationship between debt and taxes among private firms. Ivanov et al. (2025), who use U.S. reforms affecting state-level corporate income tax rates, find that private firms,

especially relatively smaller private firms, significantly *increase* their leverage following corporate tax rate cuts. They argue that tax cuts increase firm profits and reduce default probabilities, which, in turn, leads firms to lever up. Their evidence is consistent with Cui et al. (2025), who use a sample of small, privately held Chinese firms. Cui et al. (2025) argue that the cash windfall resulting from the increased tax savings relaxes small firms' financial constraints, allowing them to more easily access the debt market. However, it is unclear whether the results are driven by the sample firms' private listing status or small size. Because small firms tend to be financially constrained and rely heavily on debt, their capital structure can be less sensitive to tax changes. Endogeneity remains a concern as well.

In contrast to Ivanov et al. (2025) and Cui et al. (2025), and consistent with the classic Modigliani-Miller framework taught in textbooks, we find that tax incentives to use debt are positively associated with private firms' leverage in the time series. The exploitation of interest ceiling rules and thresholds triggering the limitations globally represents a unique contribution of this study. In two contemporaneous studies, Goodman et al. (2024), and Sanati and Beyhaghi (2025) investigate the introduction of the interest ceiling rule in the US. Goodman et al. (2024) find no evidence of a reduction in leverage among small U.S. firms in response to this reform, while Sanati and Beyhaghi (2025) find that both private and publicly traded firms significantly reduce leverage. Our large, cross-country study supports the findings of Sanati and Beyhaghi (2025), as well as those of Fleckenstein, Longstaff, and Strebulaev (2020). The latter use aggregate data from tax filings by U.S. firms during 1926-2013 and document that U.S. private firms increase (cut) their leverage in response to increases (reductions) in the federal corporate income tax rate. Our paper extends their work by showing that the effect of the interest limitation rules is not unique

to the US, but exists in many other economies as well. The general effect of the rules further reinforces the traditional view that tax incentives matter for capital structure decisions.

Our study also relates to a large literature on the role of taxes in shaping the capital structure decisions of publicly traded firms, which we summarize in the next section. We contribute to this literature by documenting that the introduction of interest ceiling rules has a strong impact on leverage among publicly traded firms as well. Using cross-country data, we provide external validity to the findings of Carrizosa, Gaertner, and Lynch (2023) and Heitzman and Hanlon (2024).

A third contribution of our study is the construction of a large database that encompasses several aspects of the interest ceiling rules. We intend to make this database available to others upon publication. We believe the data collected will enable other researchers to address additional tax-related questions. Lastly, and no less importantly, our study makes an educational contribution by describing recent reforms that have substantially curbed the preference for corporate debt previously granted by the tax regulations in many jurisdictions.

1. Literature Review

A number of studies have documented a significantly positive relation between the tax benefits of debt and corporate financial leverage in the cross-section of publicly traded firms, both in the US (e.g., MacKie-Mason (1990); Graham (1996a, 1996b); Graham (1999)) and across countries (e.g., Rajan and Zingales (1995); Desai, Foley, and Hines (2004); Fan, Titman, and Twite (2012)). Additional research has also shown that, in the time series, corporate capital structure changes as a result of tax reforms. Examples of studies that find a positive relationship between changes in corporate tax rates and changes in corporate leverage include Givoly, Hahn, Ofer, and Sarig (1992), Doidge and Dyck (2015), Faccio and Xu (2015), Heider and Ljungqvist (2015), and

Fleckenstein et al. (2020). An exception is Bargeron, Denis, and Lehn (2018), who find that leverage barely changed following the introduction of corporate and personal income taxes in the US in the early 1900s. They suggest that considerations of financial flexibility may be responsible for this outcome. One criticism of this literature is that taxes do not appear to play a first-order role in shaping corporate leverage choices (Graham and Leary (2011), Graham (2013), Hanlon and Heitzman (2022)). This result, or lack thereof, is corroborated by survey responses from CFOs of large U.S. corporations (Graham and Harvey (2001), Graham (2022)).

In nearly all prior studies, interest expenses on arm's-length debt are assumed to be fully deductible from taxable income. However, since the early 2000s, some countries have introduced limitations on the deductibility of interest expenses from corporate income taxes (i.e., interest ceiling rules). These limitations reduce the tax benefit of debt and incentivize firms to lower their financial leverage. Carrizosa, Gaertner, and Lynch (2023) document that U.S. *publicly traded* firms affected by the 2017 interest ceiling rule significantly decrease their leverage after the introduction of the limitation - - a result that is confirmed by Heitzman and Hanlon (2024).

Prior research on the relationship between taxes and capital structure has been mostly based on publicly traded firms, primarily due to data limitations. Few recent exceptions investigating privately held firms are Fleckenstein et al. (2020), Ivanov et al. (2025), Cui et al. (2025), Goodman et al. (2024), and Sanati and Beyhaghi (2025). These studies, however, reach mixed conclusions. Fleckenstein et al. (2020) find the same positive tax effects on corporate financial leverage for private firms as for publicly traded firms. By contrast, Ivanov et al. (2025) document that corporate leverage rises after US state corporate income tax cuts, particularly for small private firms, but to a lesser extent for publicly traded firms. They argue that tax hikes lower firm profits and increase default probabilities which, in turn, lead firms to delever. Cui et al. (2025) also find small private

Chinese firms increase their leverage after a corporate income tax cut. Goodman et al. (2024) investigate the introduction of the interest ceiling rule in the US. Their focus is on smaller U.S. firms with revenues close to $25 million. They find no evidence of small private firms being affected by the reform. By contrast, Sanati and Beyhaghi (2025), who focus on the same reform, find that firms significantly reduce their leverage in response to the reduction in the tax benefits of debt.

Theoretically, it is unclear whether the tax benefit of debt should be an important determinant of private firms' capital structure. On one hand, as highlighted by Ivanov et al. (2025), private firms tend to be smaller than publicly traded firms and, because small firms tend to have high financial distress risks, the effect of tax benefits could be subsumed by the increase in default probabilities. A caveat is, naturally, that large private firms should not fall into that category. Another related consideration is financial constraints. If private firms are deeply financially constrained, they must rely heavily on debt.[1] Such reliance could weaken the impact of taxes on capital structure. Consistent with these ideas, Fleckenstein et al. (2020) do not find a tax effect on leverage for the smallest firms, both public and private. On the other hand, private firms face lower agency costs due to their more concentrated ownership structure.[2] Hence, their capital structure decisions will not be much influenced by managerial preferences for lower leverage (Berger, Ofek, and Yermack (1997)). As a result, leverage can be more sensitive to tax rate changes.

[1] There is an extensive literature on the financial constraints of private firms. For instance, Campello, Giambona, Graham, and Harvey (2011) and Brown, Gustafson, and Ivanov (2021) find that private firms rely on lines of credit when faced with liquidity shocks. Brav (2009) and Saunders and Steffen (2011) document that private firms borrow more and face significantly higher borrowing costs than publicly traded firms in the UK. Research on mergers and acquisitions also suggests that private target firms fare worse in the transactions due to financial constraints (Maksimovic, Phillips, and Yang (2013)) but gain valuable access to capital through the mergers (Erel, Jang, and Weisbach (2014); Flannery, Hanousek, Shamshur, and Tresl (2023)).

[2] Consistent with lower agency costs at private firms, prior research finds that private acquirers pay less for targets than publicly traded acquirers (Bargeron, Schlingemann, Stulz, and Zutter (2008)), hold less cash (Gao, Harford, and Li (2013)), invest more and are more responsive to changes in investment opportunities than publicly traded firms (Asker, Farre-Mensa, and Ljungqvist (2015)).

2. Data and Main Empirical Strategy

2.1. Accounting Data

Accounting variables are from Orbis, version "orbis5," as archived on the NBER servers. Orbis, a Bureau Van Dijk database, contains data on firms' balance sheets and income statements, industry sectors, locations, ownership, and the consolidation levels of their annual financial accounts. In our analyses, we restrict the sample to firms with consolidated financial statements, if available (Orbis consolidation codes C1 and C2), or unconsolidated financial statements (consolidation code U1), when consolidated statements are unavailable. To minimize data errors, firm-years with missing or negative total assets (TOAS), negative long-term debt (LTDB), negative loans (LOAN), negative current liabilities (CULI), negative non-current liabilities (NCLI), negative revenues (OPRE), negative depreciation and amortization (DEPR), negative interest payments (INTE), or negative financial expenses (FIEX) are excluded from the sample.

To mitigate the possibility that the sample may include firms that are not subject to corporate income taxes, we exclude firms with total assets that never exceed USD 50 million during 1997 to 2022.[3] We also exclude associations, foundations, and unlimited liability companies. Accounting identities are used to fill in missing values and to identify errors in the data. We drop observations when accounting identities do not hold.

The sample is further restricted to firms for which data permit the construction of our two measures of leverage: the long-term-debt-to-assets ratio, defined as end-of-year long-term debt

[3] To investigate the possibility that the sample might still include pass-through-like companies, we compute the fraction of firms that pay no taxes during the sample period despite reporting a positive aggregate pre-tax profit. Less than 1% of the firms in the sample fall into this group, suggesting that this issue, if present, is likely small.

scaled by total assets; and the debt-to-assets ratio, defined as end-of-year loans plus long-term debt, scaled by total assets.

For a firm to remain in the sample, we further require data on both concurrent and lagged revenues. We use lagged revenues as the measure of size and concurrent revenues to eliminate duplicates. Specifically, for each company in each year, we retain only the record with the highest concurrent revenues. We exclude firms with two-digit core NAICS codes 22 (utilities), 52 (finance and insurance companies), 92 (public administration), or three-digit core NAICS codes 611 (educational services), 622 (hospitals), 813 (religious, grantmaking, civic, professional, and similar organizations), and 814 (private households), as well as firms with no available core NAICS code in Orbis.

We further restrict the sample to firms with available data to construct the four "standard determinants" of leverage used in the literature, all lagged by one year: size (natural log of revenues), growth (natural log of revenues minus lagged natural log of revenues), profitability (operating income (OPPL) scaled by total assets), and asset tangibility (tangible assets (TFAS) scaled by total assets). We additionally control for two other factors that firms may, and often do, employ to shield income from corporate taxation: R&D (R&D expenses (RD) scaled by revenues) and depreciation and amortization (depreciation and amortization expenses (DEPR) scaled by revenues). When data on R&D expenses (or depreciation and amortization expenses) are missing, we replace the missing value with zero. To control for potential biases resulting from this replacement, we add two "missing data" indicators to the regressions, each taking the value of one if data are missing and zero if they are available. Unless otherwise specified, all accounting variables are denominated in US dollars.

After computing the dependent and independent variables, we restrict the sample to include observations for which the dependent variables are available from 1997 to 2022. In all analyses, firm-level variables are winsorized at the 1st and 99th percentiles to mitigate the effect of outliers.

To classify firms as private or public in a given year, we begin with the classification provided in Orbis, where firms are classified as "unlisted," "delisted," or "listed." We supplement this classification using listing or delisting dates and market values. We exclude firms' IPO and delisting years to avoid ambiguity in listing status during those years. Before requiring tax data availability, the resulting sample includes 216,474 private firms from 111 countries and 2,037,549 firm-year observations.

Additional data requirements, explained below in Section 2.2 and Section 5, result in a combined sample that includes 154,997 private firms from 76 countries[4] and 1,399,697 firm-year observations that is used in the analyses in Table 2 or Table 7. Table 1 gives univariate statistics for the sample of private firms used in those analyses. Variables definitions are provided in Appendix A.

[Insert Table 1 here]

The average long-term-debt-to-assets ratio is 15.51%, and the average debt-to-assets ratio is 29.35%. Leverage naturally increases as we move from the first measure, which is the least inclusive, to the second measure, which is the most inclusive. The average rate of revenue growth is 5.14%, the average profitability is 5.05%, and the average asset tangibility is 28.92%. The median firm's operating revenue is $52 million (=exp(17.7868)), which is about a third of the median revenues of publicly traded firms in OECD countries during 1981–2009 (Faccio and Xu, 2015).

[4] Of these, 2 countries are in Africa, 18 in Asia, 36 in Europe, 9 in North America, 2 in Oceania, and 9 in South America.

Of the firms in the countries that introduced interest ceiling rules, 9.41% experience a reduction in the deductibility of interest payments. More generally, for the overall sample, 75.31% of a firm's total interest payments are tax deductible.

2.2. Interest Limitation Rules

Our main tests focus on limitations to the deductibility of interest payments (also known as "interest ceiling" rules). These rules frequently limit the deductibility of all types of interest expenses, including interest on bank loans, to a certain fraction of EBITDA. Less frequently, the limit on the deductibility of interest expenses is triggered when the company's debt-to-equity surpasses a certain threshold or is based on EBIT.

To identify the presence of interest limitation rules, we begin by hand-collecting information from Ernst & Young's (E&Y) "Worldwide Corporate Tax Guide[s]" for the years 2004, 2005, 2010, 2015, 2020, and 2022 (the E&Y directories are available electronically starting from 2004). We use these data to train a text-parsing program, which is then employed to extract information potentially related to these regulations from the E&Y guides for all years. The extracted information is then manually verified for accuracy. For the most recent years, data availability allows us to supplement and cross-check data from the E&Y guides with information from PricewaterhouseCoopers's "Worldwide Tax Summaries Online," the OECD's "Dataset Interest Limitation Rules (ILR)," and various reports by the Tax Foundation. Whenever the information in these sources appears inconsistent, we conduct additional online searches to resolve the inconsistency. We undertake this process for each of the 188 tax jurisdictions included in the E&Y guides.

These searches allow us to determine that, between 2004 and 2022, 48 tax jurisdictions had interest ceiling rules in place at some point. Only two tax jurisdictions had limitations on the

general deductibility of interest expenses in 2004. By contrast, in 2022, 44 tax jurisdictions had such rules in place.[5] Many of the countries with such limitations are part of the European Union (EU). Some non-EU countries, such as Egypt, Mexico, Norway, the United States, Vietnam, and Zimbabwe, have also implemented similar limitations.

EU countries were permitted to allow standalone companies (i.e., companies that are not part of a business group) to deduct fully interest expenses. Cyprus, the Czech Republic, and Germany exempted standalone companies from the limitation. For companies that are part of business groups, in some tax jurisdictions, the limit on the deductibility of interest expenses is applied at the group level. In some instances, different limits on the deductibility of interest expenses apply to standalone and group-affiliated firms. One such case is Norway, a non-EU country, where the limit is set at NOK 5 million for standalone firms and NOK 25 million, in aggregate, for business groups.

In our analyses we focus on countries that implemented EBITDA-, EBIT-, or debt-to-equity-based interest ceiling rules between 2004 and 2022. We exclude the Philippines, Saudi Arabia, and Turkey because their rules are based on criteria that cannot be addressed with the available data, as well as Myanmar and Romania, which already had interest ceiling rules in place in 2004. Additionally, we exclude three territories (Guam, Northern Mariana Islands, and the US Virgin Islands) with no large private firms in Orbis, along with 15 countries (5 for publicly traded firms) with insufficient Orbis data to calculate changes in non-deductible interest payments. This results in a sample of 25 countries for private firms (and 35 countries for publicly traded firms),

[5] Specifically, in 2022, 33 countries had EBITDA-based limitations; four had EBIT-based limitations; four had limitations based on the debt-to-equity ratio; Turkey had a limitation based on the external liabilities-to-equity ratio; the Philippines had a complex regulation designed to offset the preferential tax treatment granted to interest earned on bank deposits; and Saudi Arabia had a limitation based on a firm's income from loan charges, other taxable income, and other tax-deductible expenses.

which is used in our main tests. Of the 25 countries in the private firms sample, two took effect in 2008, one in 2012, one in 2013, one in 2014, four in 2018, 12 in 2019, two in 2020, and one in 2021.[6]

2.3. Main Empirical Identification Strategy

An example will help us formulate our main empirical identification strategy. The interest ceiling rule in force in France since January 1, 2019, limits the interest deduction to the greater of 30% of EBITDA or EUR 3 million.[7] A consequence of this rule is that, beginning in 2019, and provided that taxable profits are sufficiently high, the deductibility of interest payments is capped at max(EUR 3 million, EBITDA x 0.30). Companies with interest payments in excess of this cap could fully deduct their net interest payments prior to 2019 but can only benefit from limited deductibility after 2019. By contrast, companies with payments below this cap could fully deduct their interest payments both prior to 2019 and after. Thus, holding everything else unchanged, the introduction of the "interest ceiling" rule should induce firms with interest payments above the cap to delever. In our main test, we examine the effect of the staggered implementation of interest ceiling rules using the following specification:

$$\begin{aligned} \text{Leverage}_{i,t} = \; & \alpha_1 \times \text{Post}_{c,t} \times \mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\} \\ & + B' \times \mathbf{X} + \delta_i + \zeta_{s,t} + \nu_{c,t} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

[6] One could worry that our results might be driven by the events in 2019. We conduct robustness tests using reforms taking place prior to 2019 and obtain similar results.

[7] As of 2022, 15 of the 33 countries with an EBITDA-based limitation in place had an exemption threshold of EUR 3 million. Italy, Kenya, Peru, Uganda, and Zambia had an exemption threshold of zero; the Netherlands, Portugal, Romania, and Spain had an exemption threshold of EUR 1 million; and the UK had an exemption threshold of GBP 2 million. Other EU countries also had exemption thresholds below the maximum limit set by the EU. Additionally, as of 2022, the deduction limit was 30% of EBITDA in all countries except for Finland (25%), the Netherlands (20%), and Norway (25%).

where *i* denotes the firm (i.e., firm-consolidation type), *c* the country, *s* the industry sector, and *t* the year.[8] $\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$ is an indicator that takes the value of 1 if a company has an incentive to reduce its leverage following the introduction of the interest ceiling rule, as explained below, and 0 otherwise, and $\text{Post}_{c,t}$ is an indicator variable that takes the value of 1 if an interest ceiling rule is in force in country c on January 1st of year t, and 0 otherwise. $\mathbf{X}$ is a vector of firm-level controls, δ_i are firm fixed effects, $\zeta_{s,t}$ are industry-year fixed effects, and $\nu_{c,t}$ are country-year fixed effects. Due to the inclusion of the firm-fixed effects, the regression coefficients isolate how leverage changes as the independent variables change over time. The inclusion of industry-year fixed effects accounts for time-varying costs of financial distress, which, as documented by Davydenko, Strebulaev, and Zhang (2012), tend to be industry-related and time-varying, as well as other time trends that vary across industries due to variation in regulation or competition, among many other factors (e.g., Leary and Roberts (2014)). The inclusion of country-year fixed effects eliminates the need to control for country-level variables.

Standard errors are double-clustered at the country-year level to account for the correlation of responses to the same tax reform across different firms in the country passing the reform, and at the four-digit NAICS industry code level to allow for time-series correlations and within-industry comovements.

To determine a company's incentive to reduce its leverage following the introduction of the interest ceiling rule, we use interest payments and earnings measured over the years t-3 through t-1, where t is the year the interest ceiling rule becomes effective. Firms are likely to use data from the most recent years when making long-term decisions. Using the time-series averages also allows us to lessen the impact of tax loss carrybacks and carryforwards. To account for the possibility that

[8] When a firm's consolidation type in Orbis changes, we treat observations before and after the change as distinct entities to ensure data consistency.

the deduction limit may change after the initial adoption, we compute the exemption threshold and the deduction limit using their average values over years t, t+1, and t+2. Before the implementation of the interest ceiling rule, all interest payments are deductible as long as they do not exceed taxable profits, and as long as taxable profits are positive. After the implementation, interest payments are subject to the additional deduction limits from the interest ceiling rule. Consequently, for firms in countries with EBITDA-based deduction limits, the change in the amount of non-deductible interest payments is calculated as:

$$\Delta \text{ Non-deductible interest payments}_i = \max(0, \min(\Sigma \text{ EBIT}, \Sigma \text{ Interest})) - \max\{0, \min[\Sigma \text{ EBIT}, \Sigma \text{ Interest}, \max(\Sigma \text{ Exemption threshold}, \Sigma \text{ EBITDA x Deduction limit})]\} \quad (2)$$

for firms in countries with EBIT-based deduction limits, the change in the amount of non-deductible interest payments amounts to:

$$\Delta \text{ Non-deductible interest payments}_i = \max(0, \min(\Sigma \text{ EBIT}, \Sigma \text{ Interest})) - \max\{0, \min[\Sigma \text{ EBIT}, \Sigma \text{ Interest}, \max(\Sigma \text{ Exemption threshold}, \Sigma \text{ EBIT x Deduction limit})]\} \quad (3)$$

and, for firms in countries with limits based on the debt-to-equity ratio, the change in the amount of non-deductible interest payments amounts to:

$$\Delta \text{ Non-deductible interest payments}_i = \max(0, \min(\Sigma \text{ EBIT}, \Sigma \text{ Interest})) - \max\{0, \min[\Sigma \text{ EBIT}, \Sigma \text{ Interest}, \Sigma \text{ Interest x } (\Sigma \text{ Deduction limit}/3) / (\Sigma \text{ debt-to-equity}/3)]\} \quad (4)$$

All variables in (2)-(4) are measured in local currency. In the equations above, the term before the subtraction represents the allowed interest deduction before the implementation of the interest ceiling rule, and the term after the subtraction represents the allowed interest deduction after the implementation of the interest ceiling rule.

With this in mind, we construct an indicator, $\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i>0\}$, that takes the value of one if the allowed interest deduction before the introduction of the interest ceiling rule exceeds the allowed interest deduction after the introduction of the interest ceiling rule, and zero otherwise. By construction, the firm-level variable $\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i>0\}$ is time-invariant. Therefore, the inclusion of firm fixed effects in the specifications eliminates the need to estimate the coefficients of the variable itself.

To mitigate the impact of confounding factors, we focus on a narrow time window around the introduction of the interest limitation rule in a given country, starting the sample three years prior to the introduction and ending the sample at the end of the second year following the introduction of the rule. The resulting sample, used in Table 2, contains 290,862 firm-years and 55,283 firms from 25 countries.

3. Results

3.1. *Main tests*

As a starting point, in Table 2, we focus on 25 countries that introduced EBITDA-based, EBIT-based, or debt-to-equity-based limitations and for which sufficient data are available to determine whether a private firm is affected by the newly introduced rules. The test is based on model (1), which was discussed in detail in Section 2.2. The regression results are reported in Panel A of Table 2.

[Insert Table 2 here]

Consistent with a tax narrative, the results in Panel A of Table 2 show that firms that experience a reduction in the deductibility of interest payments following the introduction of the interest ceiling rule significantly reduce their leverage after the introduction of the reform. As an example, the total debt-to-assets ratio declines by 214 basis points.

To put the estimated effect in perspective, we first check the distribution of the annual change in leverage. Throughout our sample, the mean values of the annual changes in long term debt-to-assets, and total debt-to-assets ratios are -25, and -29 basis points, respectively. Thus, the leverage effect documented in Table 2, Panel A, is quite large. For example, the effect on the total debt-to-assets ratio amounts to 7.3 times the mean annual change in the variable. We also compare our effect with prior literature studying leverage adjustments. For instance, Roberts and Sufi (2009) find that, in the eight quarters following a covenant violation, the average firm reduces its leverage ratio by 235 basis points. Our estimated effect for the adoption of the interest ceiling rule is similar in magnitude.

A comparison of the univariate statistics between treated and control firms in the year prior to the reform, reported in Panel B of Table 2, however, shows that the two sets of firms differ on many observable dimensions. This raises the concern that the observed decline in leverage may be spurious. To investigate whether it is part of a pre-existing declining trend, in Figure 1, we display the coefficients of the year-by-year interaction between T, the time relative to the introduction of the interest ceiling rule in a country, and the indicator $\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$. The year prior to the introduction of the rule serves as the benchmark. Regardless of the leverage measure used, the results point to an immediate, persistent, and significant reduction in the leverage of affected firms following the introduction of the interest ceiling rule. The plot also

demonstrates that the reductions in the leverage ratios are unlikely due to the continuation of their pre-existing *declining* time trends. Admittedly, the pretrends are not exactly parallel between the treated and control firms, calling for further analysis.

[Insert Figure 1 here]

To further address concerns about differences between the two samples, in Table 3, we focus on a matched sample of control firms. Control firms are selected by matching firms affected by the introduction of the interest ceiling rule with firms that are not affected. The matched firms must be in the same country and are matched on size, growth, profitability, tangibility, R&D, and depreciation (including their missing value indicators) in the year before the introduction of the interest ceiling rule, using a nearest-neighbor algorithm with a caliper of 0.15. The results show that, even among this second set of similar firms, those experiencing an increase in non-deductible interest payments experience a significantly larger reduction in leverage after the implementation of the interest ceiling rule.

[Insert Table 3 here]

It is reassuring that, after matching, the two samples are indistinguishable on observable determinants of leverage (Panel B of Table 3). Figure 2 further shows that no pre-existing departures from the parallel trends hypothesis are observed in the matched sample. Moreover, the coefficient estimates of interest are barely affected by matching the samples on observable characteristics, indicating that these characteristics do not play a major role in explaining the decline in leverage experienced by affected firms after the reforms.

We take one step further to consider a specification that plausibly offers the strongest identification. We note that firms with higher leverage ratios or more interest payments are more likely to have positive non-deductible interest payments. At the same time, such firms are also

more likely to be over-leveraged and plan to deleverage. To alleviate this concern, we next focus on the interest payments and examine the subsample of firms with interest payments within a narrow bandwidth of the interest ceiling. This test, thus, captures the local effect of an increase in non-deductible interest payments after the introduction of the new rule among firms with similar ratios of interest payments to EBITDA.

This bandwidth is defined as firms with interest payments either (a) within USD1.25 million or (b) within 25% of the maximum deduction allowed.[9] Fewer than 25% of the firms in the sample fall into this bandwidth. We further increase comparability between treated and control firms by matching them using the the nearest-neighbor matching algorithm employed in Table 3. The results, presented in Table 4, show that, among these plausibly most similar firms, only those experiencing an increase in non-deductible interest payments reduce leverage after the implementation of the new interest ceiling rule. The effects remain economically similar to those in the full sample.

[Insert Table 4 here]

Importantly, as shown in Panel B of Table 4, treated and control firms are similar on all the observable dimensions. Furthermore, as displayed in Figure 3, the two samples are nearly identical in terms of differences in leverage relative to the year preceding the reform, further alleviating concerns about existing pre-trends.

3.2. *Placebo tests*

We further address the concern that the leverage of affected, plausibly highly leveraged firms, would have declined even in the absence of the interest ceiling rule using placebo tests. Heitzman and Hanlon (2024) and Goodman et al. (2024) document that, in the U.S., firms affected

[9] We allow both a fixed dollar amount and a fractional bandwidths because the deduction limit is either a fixed amount or a fixed fraction of EBITDA, EBIT, or debt-to-equity.

by the interest limitation rule experienced a reduction in leverage even in the years leading up to the reform. They conclude that the tax consequences of the reform had only a modest impact on leverage.

We note, again, that our parallel trends results contrast with the findings of Heitzman and Hanlon (2024) and Goodman et al. (2024). Nevertheless, to investigate whether the changes we document would have occurred regardless of the introduction of the interest limitation rule, we conduct two placebo tests using fake reform years.

First, we re-run our tests for firms in countries that eventually introduced interest ceiling rules, using the same set of affected and unaffected firms but randomly generated event years. As in our main tests, we focus on the six years surrounding the randomly generated placebo reform years. The results, presented in columns (1) and (2) of Table 5, show no evidence that the leverage of affected firms would have declined more than the unaffected firms in the absence of the reform.

[Insert Table 5 here]

Second, in columns (3) and (4) of Table 5, we focus on firms based in countries that never introduced a reform, again using randomly generated pseudo-reform years. As in Table 2, we restrict the reform to occur between 2004 and 2020. To identify "affected" firms, we consider fake EBITDA-based reforms, which are the norm in our main sample, with a limitation of 30% of EBITDA and a threshold of USD 3.6 million (approximately EUR 3 million as of 2017). Once again, we find no evidence of a reduction in leverage for affected firms in the absence of a true reform. Overall, these results thus support our interpretation that the reduction in leverage is a consequence of the limitation on the tax benefits of interest deductibility.

In a third placebo test, we use non-financial debt scaled by total assets as the dependent variable. Since non-financial debt typically does not carry interest payments, its use is not expected

to decline among firms affected by the limitation. If anything, the opposite may be true, as affected firms might substitute financial debt with non-financial debt. Consistent with a tax-based interpretation of the observed decline in financial leverage, the results reported in regression (5) of Table 5 show no corresponding decline in non-financial leverage.

3.3. *Robustness tests*

In this section, we discuss a number of additional robustness tests meant to address other explanations for the evidence documented. The results related to these robustness tests are plotted in Figure 4. To facilitate comparison with the results in Tables 2 – 4, we first plot the coefficients based on those tables in Figure 4. In many of the tests presented in this section, we take advantage of the cross-country nature of the database to rule out competing explanations.

[Insert Figure 4 here]

3.3.1. Heterogenous treatment effects

Recent econometrics literature suggests that when a difference-in-differences test exploits treatments at different times, there can be heterogeneity in the treatment effect (e.g., Callaway and Sant'Anna (2021)). Thus, we check whether our results are robust to heterogeneous treatment effects using the Callaway and Sant'Anna (CS) approach. Specifically, for each leverage measure, we estimate all dynamic effects of the adoption of an interesting ceiling rule on affected firms relative to unaffected firms using CS's doubly-robust estimands under inverse probability weighting. In this process, the variables are demeaned at appropriate levels to achieve firm fixed effects, country-year fixed effects, and industry-year fixed effects. Since clustering by year or industry is not feasible in the CS approach, we instead cluster the standard errors at the country level in addition to bootstrapping. Because firm clusters are nested in country clusters, country-level clustering automatically accounts for serial correlations in the data. The results, shown in the

fourth line plotted in Figure 4 for each measure of leverage, suggest that our baseline findings are robust to the possibility of heterogeneous treatment effects. The estimated average treatment effects under the CS approach are even larger in magnitude than our baseline estimates from Panel A of Table 2.

3.3.2. Countries in which the interest limitation rule was mandated

A potential concern with the results is that a country may adopt an interest ceiling rule voluntarily for reasons related to corporate capital structure. To alleviate this concern, we focus on EU countries. The reason given in official EU documents for the introduction of the Anti-Tax Base Erosion and Profit Shifting Directive was to limit the shifting of income to low-tax jurisdictions.

The introduction of EBITDA-based limitations was mandated in the EU, which imposed a terminal date by which all EU countries had to introduce the reform in question. All EU countries were required to implement this directive by January 1, 2019, at the latest. Countries that already had rules in place, considered "equally effective" in limiting income shifting, were allowed to postpone the implementation of the directive until January 1, 2024. The EU further mandated that all EU countries limit the deductibility of "net borrowing costs" (interest paid minus interest received by a corporate taxpayer) to a fraction of EBITDA, not to exceed 30%. EU countries were granted the option to allow corporate taxpayers to fully deduct interest payments up to a threshold of 3 million Euros. Most countries chose to permit firms to deduct interest payments up to the maximum ceiling permitted by the EU and postponed the introduction of the reform for as long as permitted, making the reforms in question, and their introduction, plausibly exogenous.

The results based on EU countries are reflected in the fifth line plotted in Figure 4 for each measure of leverage. The coefficients on $\text{Post}_{c,t} \times \mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$ remain statistically significant and economically similar to those in the full sample.

3.3.3. EU countries before 2016

The purpose of these limitations was to curb tax base erosion and profit shifting. Most notably, following the adoption of the anti-tax avoidance package by the European Union (EU) in 2016, all EU countries have implemented such limitations. To mitigate the concern that our results might be driven by other provisions in the Anti-Tax Base Erosion and Profit Shifting Directive unrelated to interest deductibility, we further restrict the sample to the period prior to 2016 - - still focusing on EU countries only. The corresponding results are shown by the sixth line plotted in Figure 4 for each measure of leverage. Once again, the conclusions remain unchanged. This test also addresses the concern that our results could be driven by the many reforms that become effective in 2019.

3.3.4. Capping leverage

One further concern relates to outliers. For example, despite winsorizing the variables at the 1st and 99th percentiles, the maximum value of the second measure of leverage still exceeds 100%. To mitigate this concern, we cap leverage at 1. As shown in Figure 4, the results are not materially affected.

3.3.5. Excluding unprofitable firms

In all analyses presented so far, the sample of unaffected firms includes both sufficiently profitable firms with earnings that fall above the threshold triggering the limitation, as well as firms with negative profits. Those firms would not have benefited from the deductibility of interest expenses even regardless of the introduction of the interest limitation rule. Furthermore, unprofitable firms are especially likely to experience an increase in the marginal cost of using debt (i.e., an increase in default risk) resulting from the loss of tax deductibility, while firms farther from default (i.e., profitable firms) should not be meaningfully affected by such considerations.

Given these considerations, we verify the robustness of our results by excluding firms with negative operating income. The results, shown by the eighth line plotted in Figure 4 for each measure of leverage, are not materially affected by this change.

3.3.6. Excluding countries that introduced large tax rate changes

In some countries, the introduction of the interest ceiling rule coincided with other major tax reforms. For example, the Tax Cuts and Jobs Act of 2017 not only introduced an interest limitation rule in the U.S. but also severely reduced the top statutory corporate income tax rate from 35% to 21% and replaced a progressive tax system with a flat tax rate, thereby clouding the interpretation of the impact of the U.S. reform on firm leverage. To mitigate the possibility that the discontinuity we documented reflects other aspects of tax reforms, we exclude countries that introduced a "major" tax change (e.g., one that changed the top statutory tax rate by more than 1 percentage point between the first and the last year in the event window). (Top statutory corporate income tax rates are from the Tax Foundation's "Corporate Tax Rates around the World" database.) Despite this change substantially reducing the sample size, our results remain statistically and economically significant even after excluding countries that introduced a large change to the top statutory corporate income tax rate.

3.3.7. Excluding countries that introduced tax incentives for equity

A small number of countries allow a notional interest deduction for equity. The notional interest deduction is typically structured as a percentage of book equity, with the percentage either fixed or determined based on government bond yields. In some cases, the notional interest deduction is capped, potentially confounding the effect of the interest limitation rule. To eliminate this possible confounding effect, we exclude countries that had a notional interest deduction in place at any time during the event window. These countries are identified based on information in

the E&Y Worldwide Tax Guides, PricewaterhouseCoopers's Tax Summaries, Asen (2020), Klemm (2006), Kock and Gérard (2018), and Van Campenhout and Van Caneghem (2013), using the procedure described in Faccio and Xu (2025). As displayed in Figure 4, our conclusions are unaffected by this change.

3.3.8. Focusing on firms with low earnings variability

The interest limitation rules suffer from what could be a serious complication: being based on earnings, which can be shifted back or forward to mitigate the consequences of the tax reform. To mitigate the concern that the results may reflect income shifting over time, in the next two tests we restrict our analyses to firms with small earnings variability, defined as the difference between the highest and lowest profitability ratio during the event window, that is, (1) below the median or (2) in the bottom quartile of the distribution. Even when restricting our attention to such low earnings variability firms, we continue to find a significant decline in leverage for firms affected by the introduction of the interest ceiling rule.

4. Alternative interpretations and additional results

This section examines how our main results vary by firm size or distance to default and check their external validity among publicly traded firms.

4.1. Firm Size

The effect of taxes on capital structure may vary with firm size. As discussed in Section 1, small firms tend to be financially constrained and rely heavily on debt, which makes their capital structure less sensitive to tax changes. Small firms also tend to be riskier and closer to default than large firms. Thus, comparing the magnitude of our estimates by firm size helps us evaluate the

concern that the results may either be impacted by financial constraints or reflect the impact of the reform on default risk rather than on the tax benefits of debt.

In Figure 5, we plot the results for each size quintile. (Quintiles are defined based on total assets). The conclusions are similar to those drawn for the entire sample. Specifically, the results do not become insignificant or counterintuitive when we focus on smaller private firms. Thus, we do not find evidence that financial constraints and reliance on debt make small firms insensitive to tax incentives. The effect is sizable and statistically significant for larger firms as well, mitigating Ivanov et al.'s (2025) concern that the reduction in leverage may instead reflect a more pronounced increase in default risk.

[Insert Figure 5 here]

4.2. Distance to Default

To further investigate the possibility that the results could be driven by default risk, we compute each firm's Z''-score following Altman, Iwanicz-Drozdowska, Laitinen, and Suvas (2017). The Z''-score is specifically tailored to private firms. Using Orbis data, Altman et al. (2017) document that it performs well in predicting default risk in an international setting.

In Figure 6, we plot the results by Z''-score quintiles. We form quintiles based on each firm's average Z''-score during the event window. Quintile 1 (5) consists of firms with the lowest (highest) Z''-scores, i.e., the firms that are closest to (farthest from) default. If our results were driven by default risk, firms closest to default should be most affected by the reform, as the cost of borrowing increases disproportionately with default risk. However, contrary to a default risk-based story, the results are economically small and statistically insignificant for the firms closest to default, and become increasingly economically larger (and statistically stronger) as we move to firms farthest from default.

[Insert Figure 6 here]

4.3. Publicly Traded Firms

We also investigate whether the interest ceiling rules have similar effects on publicly traded firms as an external validity test. The results, presented in Table 6, parallel those in Panel A of Table 2. Due to greater data availability for publicly traded firms, the results in Table 6 cover interest ceiling rules introduced in 35 countries. The results are highly consistent with those found in Table 2 for private firms. The coefficients on the interaction term, $Post_{c,t} \times \mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$, are negative and significant in all specifications.

[Insert Table 6 here]

5. Combining all limitations to interest deductibility

In this last section, in addition to the limitations triggered by the introduction of the interest ceiling rules, we incorporate the other two limitations that are triggered by provisions normally contained in the tax laws. The first common limitation occurs when taxable profits are zero or negative. Ignoring tax carrybacks and carryforwards, interest payments are not deductible when taxable profits are negative. The second limitation arises when interest payments exceed EBIT because interest payments are fully deductible only when taxable profits are sufficiently large. Thus, changes in the corporate income tax rate should be inconsequential for firms that have either no taxable profits or taxable profits below interest payments in the long run. We combine these additional limitations with those triggered by the introduction of the interest ceiling rules, and for each year and firm, we calculate the ratio of deductible interest as a fraction of total interest paid (Fraction of deductible interest) where deductible interest is computed in ways consistent with Equations (2) through (4).

We investigate the role of this variable in the tax-leverage relationship in a sample containing all countries with available corporate income tax rate data from 1997 to 2022 using the following specification:

$$\begin{aligned} \text{Leverage}_{i,t} = {} & \alpha_1 \times \text{Fraction of Deductible Interest}_{i,t} \\ & + \alpha_2 \times \text{Fraction of Deductible Interest}_{i,t} \times \text{Corporate Income Tax Rate}_{c,t-1} \\ & + B' \times \mathbf{X} + \delta_i + \zeta_{s,t} + \nu_{c,t} + \varepsilon_{i,t} \end{aligned} \tag{5}$$

The fraction of deductible interest should be negatively correlated with leverage as higher leverage firms have larger interest payments. More importantly, under the tax incentive for capital structure considerations, firms with a higher fraction of deductible interest have a greater incentive to increase leverage following an increase in the corporate income tax rate.

To investigate whether the data support this notion, we estimate regressions that test model (5). These regressions include country-year fixed effects (in addition to industry-year and firm level fixed effects). The focus is on the extent of interest deductibility, along with its interaction with the corporate income tax rate. The results are tabulated in Table 7.

[Insert Table 7 here]

The results show that firms with a larger fraction of deductible interest payments increase leverage more in response to a tax-increasing reform. Following a 10 percentage point tax rate increase, a firm with fully deductible interest payments increases its total debt-to-total assets ratio by 165 basis points (=0.1650 x 0.10), or 5.9% of the mean leverage. In contrast, a firm with interest payments that are only half deductible increases its total debt-to-total assets ratio by 82 basis points.

6. Conclusions

Using a large sample of 154,997 unique private firms spanning over a quarter of a century, we document that corporate taxes are a significant determinant of corporate capital structure choices. Our main results exploit a large number of limitations on the deductibility of interest expenses introduced following the adoption of interest ceiling rules globally, as well as other limitations to the full deductibility of interest payments around reforms affecting the corporate income tax rate. The results of these tests provide strong evidence supporting a causal link between taxes and corporate capital structure choices. Specifically, in support of a causal effect of taxes on leverage, the results are present among (1) firms matched on standard determinants of capital structure, (2) firms with interest payments within a narrow bandwidth of the new interest ceiling limit, and (3) countries that could not opt out of the introduction of the interest ceiling rule. Additionally, the results are absent when pseudo-reform years are used in the regressions.

The cross-country nature of our setting permits the assessment of the robustness of our results through a battery of robustness tests. For example, we can rule out that the results reflect other (non–debt tax shield–related) provisions contained in the EU's 2016 Anti-Tax Base Erosion and Profit-Sharing Directive, as they also hold when focusing on pre-2016 reforms in EU countries. The results are not attributable to other provisions in the tax codes that are, in some countries, size-related, such as progressive tax rates (e.g., in the U.S. prior to 2018) or tax incentives for equity (e.g., in Belgium). They are also not driven by COVID-19 and related government loan programs to support small businesses. A number of other alternative explanations, such as profit shifting around the reform or proximity to default, are also ruled out. The conclusions are corroborated by tests focusing on publicly traded firms and by tests of

corporate tax rate changes that exploit all limitations to interest deductibility. Equally importantly, we show that the results also hold for small, presumably financially constrained, firms and are not driven by default risk.

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Figure 1. Difference-in-differences coefficient plots over time relative to the reform: Full sample.

The figure below plots the coefficient estimates, along with the 10% and 90% confidence intervals, of T $\times \mathbf{1}\{\Delta$ Non-deductible interest payments$_i > 0\}$, where T is the time relative to the year in which the interest ceiling rule was introduced in a given country. The plots shown here are for the full sample used in Table 2. The year preceding the introduction of the rule serves as the benchmark year.

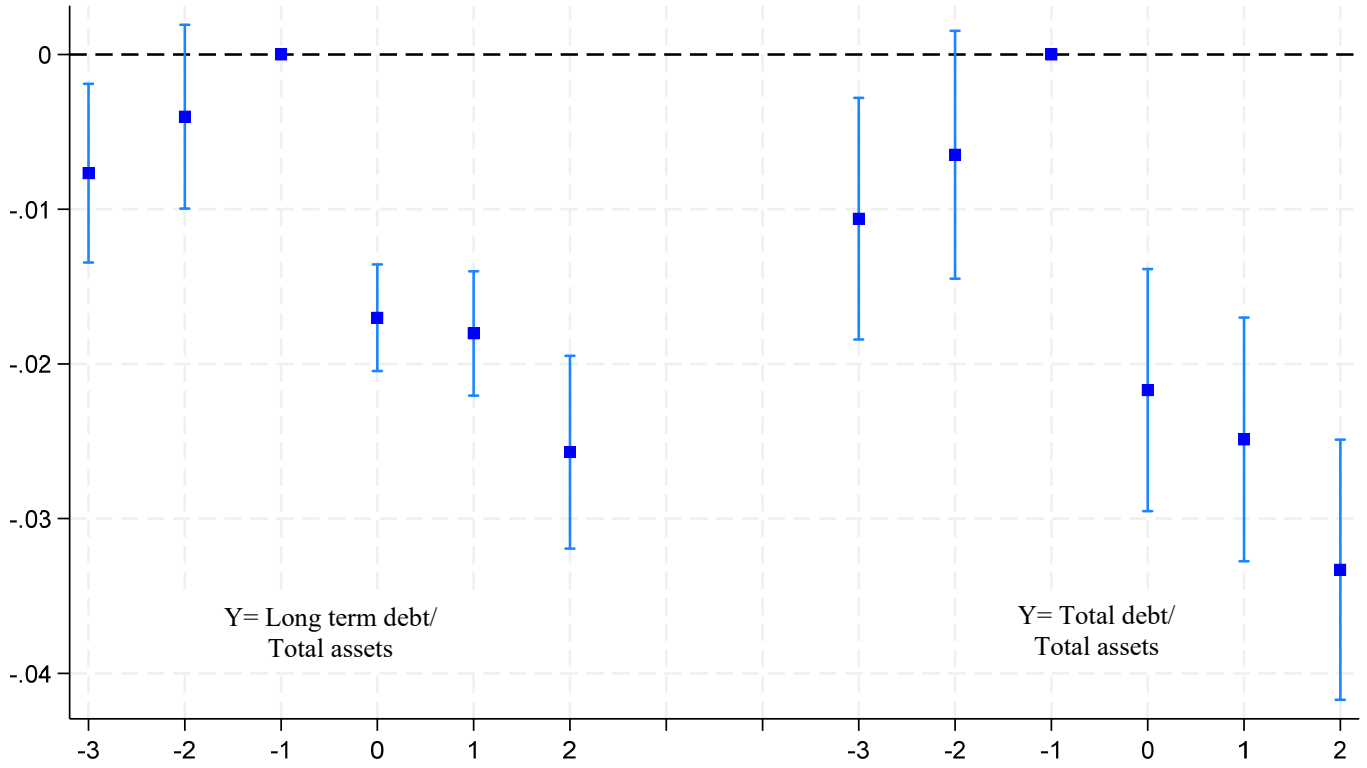

Figure 2. Difference-in-differences coefficient plots over time relative to the reform: Nearest neighbor matched sample.

The figure below plots the coefficient estimates, along with the 10% and 90% confidence intervals, of T $\times \mathbf{1}\{\Delta$ Non-deductible interest payments$_i > 0\}$, where T is the time relative to the year in which the interest ceiling rule was introduced in a given country. The plots shown here are for the nearest neighbor matched sample used in Table 3. The year preceding the introduction of the rule serves as the benchmark year.

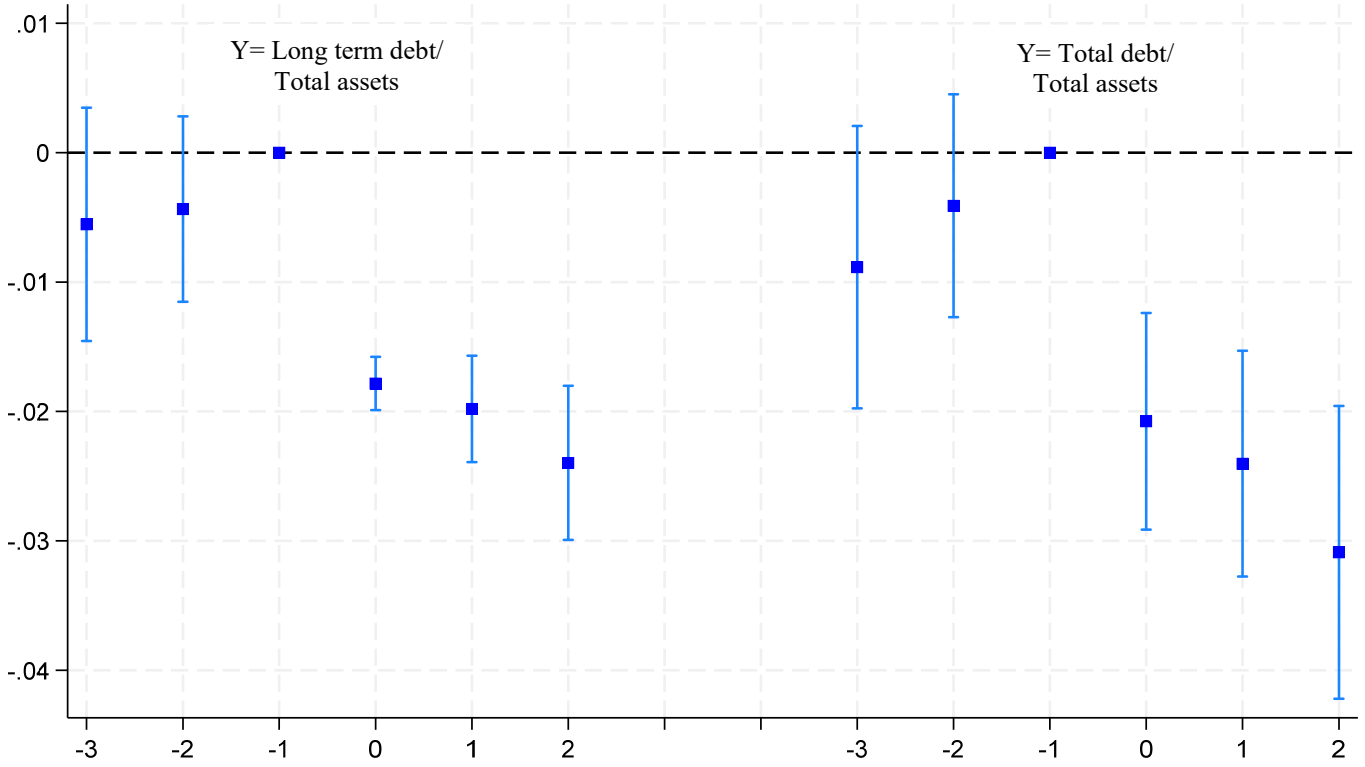

Figure 3. Difference-in-differences coefficient plots over time relative to the reform: Nearest neighbor matched sample of firms close to the interest limitation threshold.

The figure below plots the coefficient estimates, along with the 10% and 90% confidence intervals, of T $\times \mathbf{1}\{\Delta$ Non-deductible interest payments$_i > 0\}$, where T is the time relative to the year in which the interest ceiling rule was introduced in a given country. The plots shown here are for the nearest neighbor matched sample of firms near the threshold triggering the limitation used in Table 4. The year preceding the introduction of the rule serves as the benchmark year.

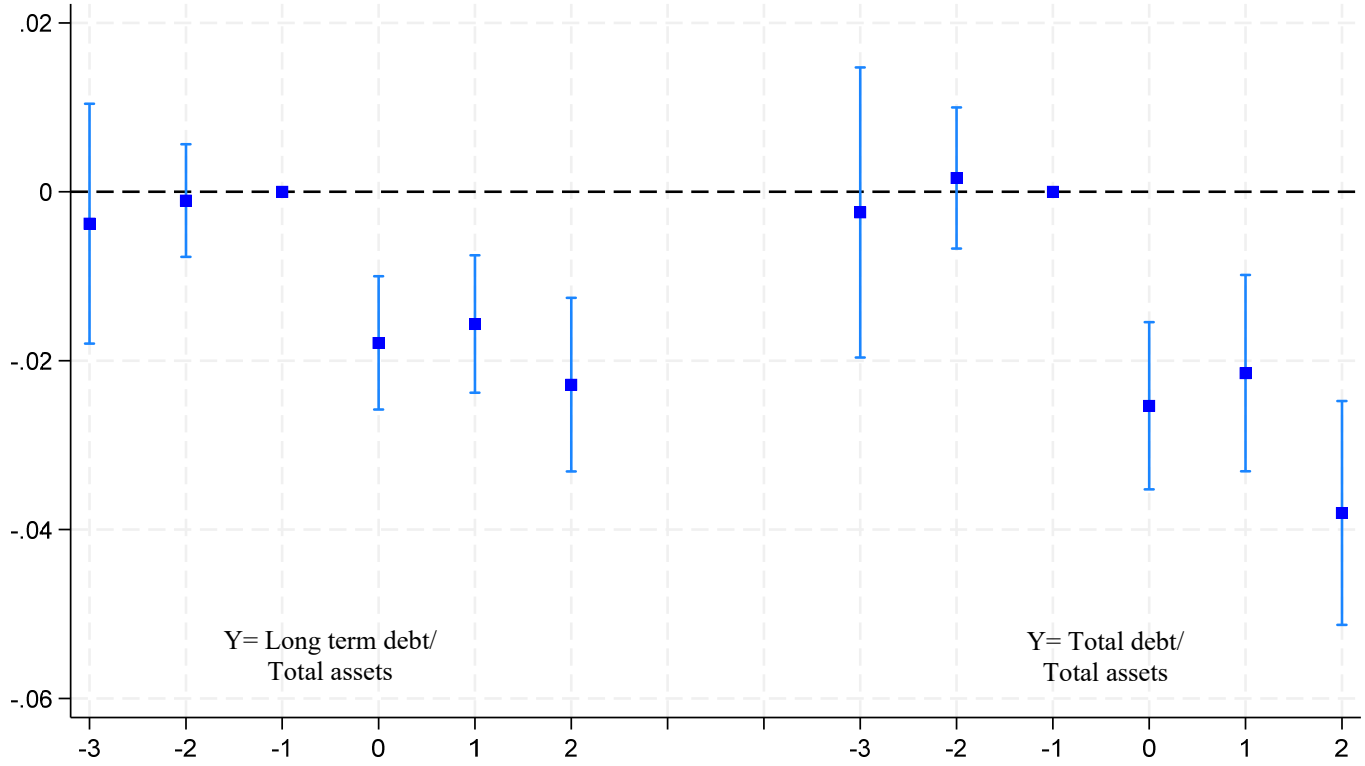

Figure 4. Robustness tests.

The figure below plots, the coefficient estimates, along with the 10% and 90% confidence intervals, of Post $\times \mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$, where T is the time relative to the year in which the interest ceiling rule was introduced in a given country. The coefficients from the regressions in Tables 2 - 4 are plotted first to facilitate visual comparison with robustness tests.

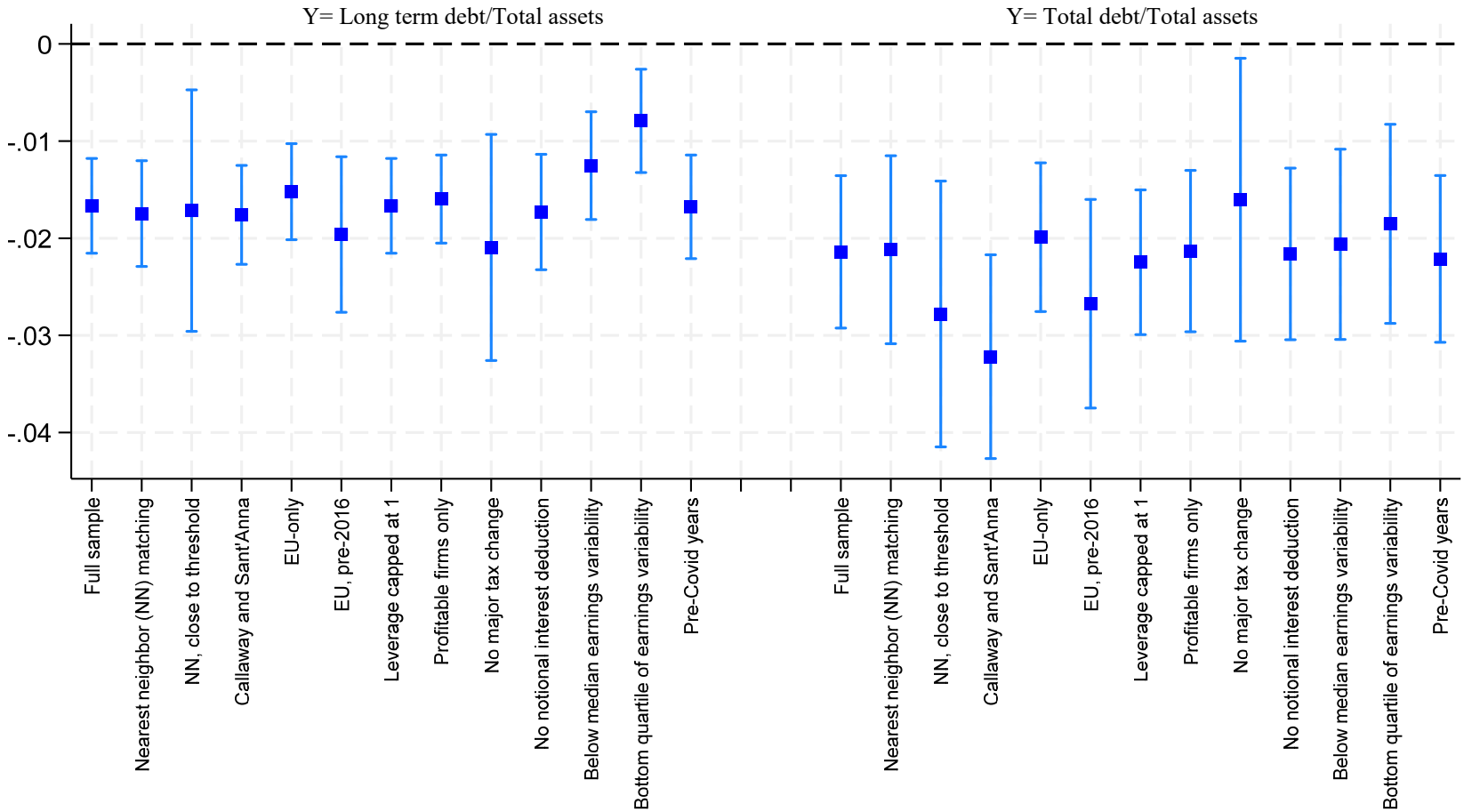

Figure 5. Results by firm size.

The figure below plots, by size quintile (Q1-Q5), the coefficient estimates, along with the 10% and 90% confidence intervals, of Post $\times \mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$, where T is the time relative to the year in which the interest ceiling rule was introduced in a given country. Q1 (Q5) is the smallest (largest) quintile of firms by total assets.

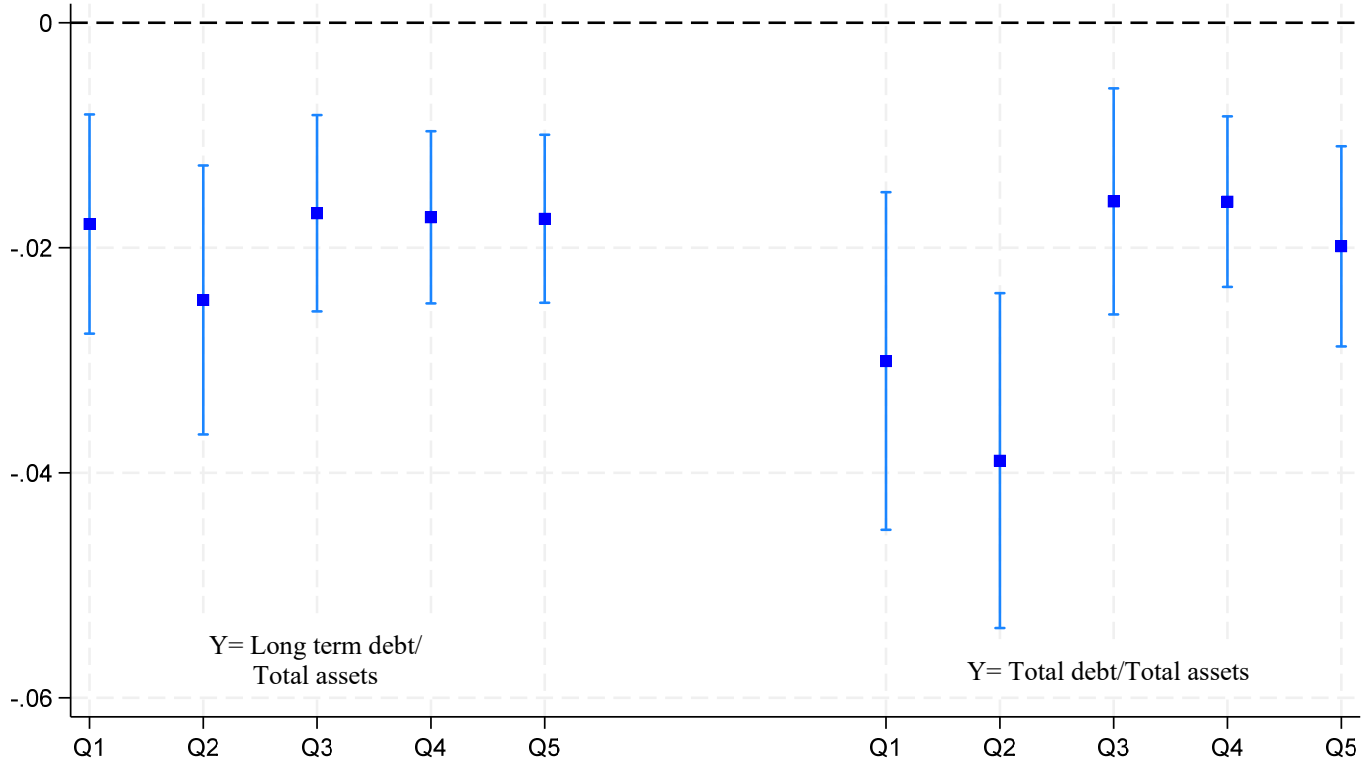

Figure 6. Results by Z'' score.

The figure below plots, by Z'' score quintile (Q1-Q5), the coefficient estimates, along with the 10% and 90% confidence intervals, of Post $\times \mathbf{1}\{\Delta$ Non-deductible interest payments$_i > 0\}$, where T is the time relative to the year in which the interest ceiling rule was introduced in a given country. Q1 (Q5) is the closest to (farthest from) default quintile of firms by total assets.

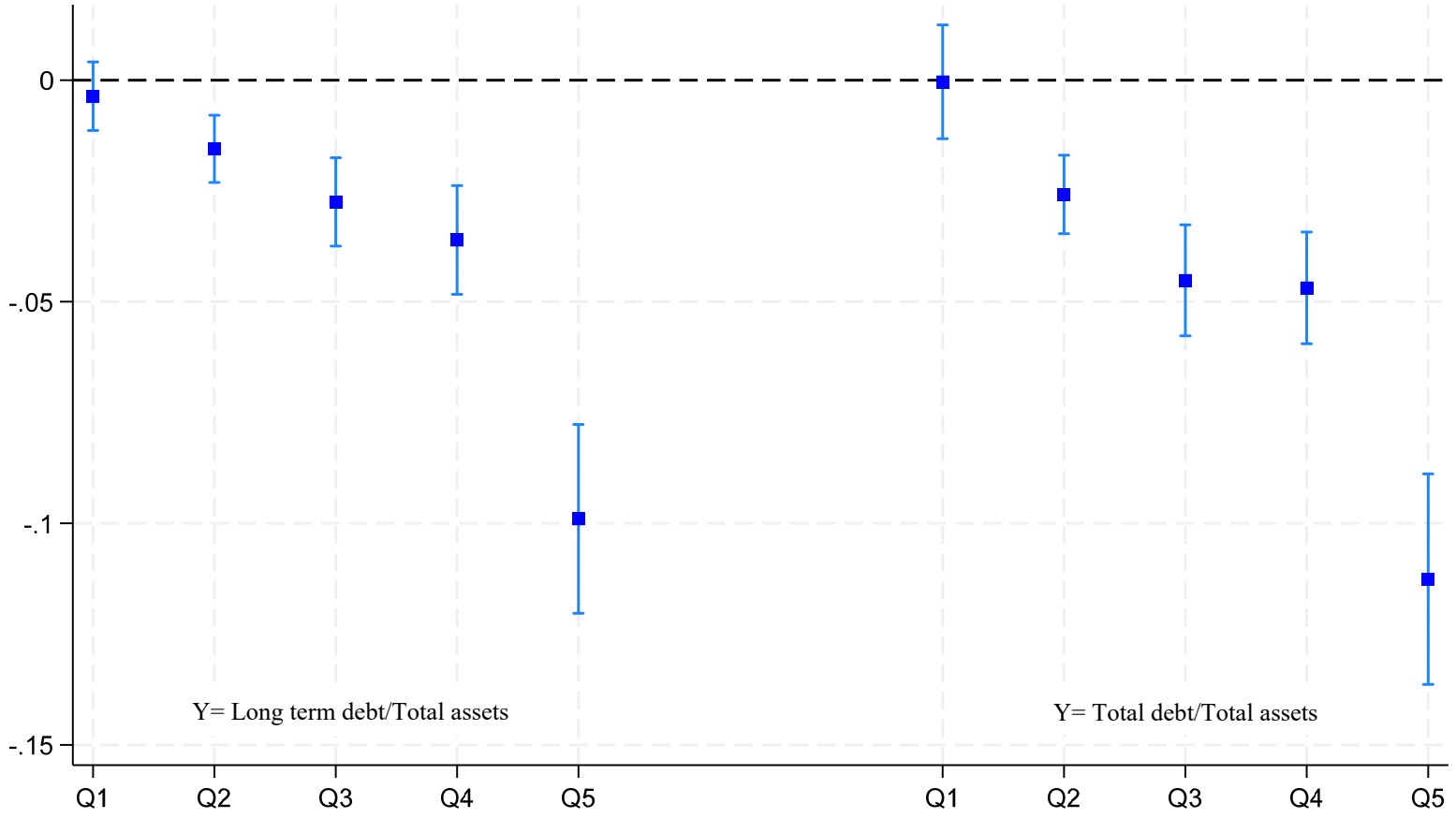

Table 1. Summary statistics.

The sample is restricted to private firms with available end-of-year data on long-term debt, loans, shareholders' funds, total assets, revenues, and lagged revenues. Variable definitions are provided in Section 2 and Appendix A. Some of the variables are available only for a subset of country-years.

	Mean	Std. Dev.	Min	10th Pct	Median	90th Pct	Max
$(\text{Long term debt/Total assets})_t$	0.1551	0.2354	0	0	0.0268	0.5232	0.9835
$(\text{Total debt/Total assets})_t$	0.2798	0.2935	0	0	0.1955	0.7015	1.3065
$\ln(\text{Revenues})_{t-1}$	17.5489	1.9012	9.6659	15.2033	17.7868	19.6134	22.5723
$\ln(\text{Revenues})_{t-1}$-$\ln(\text{Revenues})_{t-2}$	0.0514	0.5073	-2.4487	-0.2844	0.0428	0.4043	2.4330
$(\text{Operating income/Total assets})_{t-1}$	0.0505	0.1044	-0.4139	-0.0270	0.0391	0.1594	0.4613
$(\text{Tangible assets/Total assets})_{t-1}$	0.2892	0.2884	0	0.0022	0.1962	0.7776	0.9753
$(\text{R\&D/Revenues})_{t-1}$	0.0004	0.0047	0	0	0	0	0.0773
Missing $\text{R\&D}_{t-1}$	0.9249	0.2636	0	1	1	1	1
$(\text{Depreciation/Revenues})_{t-1}$	0.0590	0.1271	0	0	0.0147	0.1576	0.9343
Missing $\text{depreciation}_{t-1}$	0.2076	0.4056	0	0	0	1	1
$\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$	0.0941	0.2920	0	0	0	0	1
$(\text{Fraction of deductible interest})_t$	0.7531	0.4113	0	0	1	1	1
$(\text{Corporate income tax rate})_{t-1}$	0.2931	0.0714	0	0.2000	0.3000	0.3825	0.5680

Table 2. Limitations triggered by the introduction of interest ceiling rules: All firms in countries that introduced interest ceiling rules.

Panel A presents OLS regression results. $\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$ is an indicator that takes the value of 1 if a company has an incentive to reduce its leverage following the introduction of the interest ceiling rule, and 0 otherwise. $\text{Post}_{c,t}$ is an indicator that takes the value of 1 if year t coincides with or follows the introduction of the interest ceiling rule in country c, and 0 if it precedes its introduction. The sample is restricted to the three years that precede the introduction of the interest ceiling rule in a country through the two years that follow the introduction of the rule. Non-deductible interest payments are determined based on equations (2) through (4). The remaining variables are defined in Sections 2 and 3. Standard errors double-clustered at the industry and at the country-year levels are shown in parentheses below the regression coefficients. Panel B reports the means of the explanatory variables for the treatment and control groups in the year preceding the introduction of the interest ceiling rule, along with the p-values from a t-test for the equality of means. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Regressions results.

	(1) (Long term debt/Total assets)$_t$	(2) (Total debt/ Total assets)$_t$
$\text{Post}_{c,t} \times \mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$	-0.0167***	-0.0214***
	(0.0030)	(0.0048)
$\ln(\text{Revenues})_{t-1}$	0.0020*	0.0039***
	(0.0011)	(0.0015)
$\ln(\text{Revenues})_{t-1}$-$\ln(\text{Revenues})_{t-2}$	0.0011	0.0027**
	(0.0008)	(0.0012)
$(\text{Operating income/Total assets})_{t-1}$	-0.0654***	-0.1646***
	(0.0093)	(0.0208)
$(\text{Tangible assets/Total assets})_{t-1}$	0.0620***	0.0585***
	(0.0113)	(0.0144)
$(\text{R\&D/Revenues})_{t-1}$	-0.0375	-0.1474
	(0.0867)	(0.1639)
Missing $\text{R\&D}_{t-1}$	0.0005	-0.0034
	(0.0029)	(0.0060)
$(\text{Depreciation/Revenues})_{t-1}$	0.0170**	0.0319***
	(0.0067)	(0.0069)
Missing $\text{depreciation}_{t-1}$	0.0065*	0.0084**
	(0.0038)	(0.0038)
Country-year FEs	Yes	Yes
Industry-year FEs	Yes	Yes
Firm FEs	Yes	Yes
Number of observations	290,862	290,862
Number of countries	25	25
Number of firms	55,283	55,283
R^2	0.8301	0.8585

Table 2. Limitations triggered by the introduction of interest ceiling rules: All firms in countries that introduced interest ceiling rules. (Cont'd).

Panel B: Summary statistics for the treatment and control groups.

	Treatment group N = 5,193	Control group N = 49,163	p-value
$\ln(\text{Revenues})_{t-1}$	17.2438	17.5416	0.0000
$\ln(\text{Revenues})_{t-1}$-$\ln(\text{Revenues})_{t-2}$	0.1064	0.0677	0.0000
$(\text{Operating income/Total assets})_{t-1}$	0.0388	0.0497	0.0000
$(\text{Tangible assets/Total assets})_{t-1}$	0.2959	0.2672	0.0000
$(\text{R\&D/Revenues})_{t-1}$	0.0002	0.0006	0.0000
Missing $\text{R\&D}_{t-1}$	0.9596	0.9729	0.0000
$(\text{Depreciation/Revenues})_{t-1}$	0.0798	0.0846	0.0284
Missing $\text{depreciation}_{t-1}$	0.0227	0.0281	0.0247

Table 3. Limitations triggered by the introduction of interest ceiling rules: Nearest neighbor matched samples.

Panel A presents OLS regression results. $\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$ is an indicator that takes the value of 1 if a company has an incentive to reduce its leverage following the introduction of the interest ceiling rule, and 0 otherwise. Matched firms are in the same country as treated firms and are matched on size, growth, profitability, tangibility, R&D, and depreciation in the year before the introduction of the interest ceiling rule, using a nearest-neighbor algorithm with a caliper of 0.15. $\text{Post}_{c,t}$ is an indicator that takes the value of 1 if year t coincides with or follows the introduction of the interest ceiling rule in country c, and 0 if it precedes its introduction. The sample is restricted to the three years that precede the introduction of the interest ceiling rule in a country through the two years that follow the introduction of the rule. Non-deductible interest payments are determined based on equations (2) through (4). The remaining variables are defined in Sections 2 and 3. Standard errors double-clustered at the industry and at the country-year levels are shown in parentheses below the regression coefficients. Panel B reports the means of the explanatory variables for the treatment and control groups in the year preceding the introduction of the interest ceiling rule, along with the p-values from a t-test for the equality of means. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Regression results.

	(1) (Long term debt/Total assets)$_t$	(2) (Total debt/ Total assets)$_t$
$\text{Post}_{c,t} \times \mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$	-0.0175***	-0.0212***
	(0.0033)	(0.0059)
Other control variables as in Table 2	Yes	Yes
Country-year FEs	Yes	Yes
Industry-year FEs	Yes	Yes
Firm FEs	Yes	Yes
Number of observations	39,127	39,127
Number of countries	16	16
Number of firms	7,301	7,301
R^2	0.8596	0.8716

Panel B: Summary statistics for the treatment and control groups.

	Treatment group N = 4,121	Control group N = 3,249	p-value
ln(Revenues)$_{t-1}$	17.5017	17.5568	0.1724
ln(Revenues)$_{t-1}$-ln(Revenues)$_{t-2}$	0.1071	0.1006	0.4480
(Operating income/Total assets)$_{t-1}$	0.0389	0.0392	0.6682
(Tangible assets/Total assets)$_{t-1}$	0.2648	0.2644	0.9562
(R&D/Revenues)$_{t-1}$	0.0001	0.0001	0.6558
Missing R&D$_{t-1}$	0.9886	0.9868	0.4777
(Depreciation/Revenues)$_{t-1}$	0.0656	0.0666	0.6731
Missing depreciation$_{t-1}$	0.0165	0.0020	0.9497

Table 4. Limitations triggered by the introduction of interest ceiling rules: Nearest neighbor matched samples of firms near the threshold triggering the limitation.

Panel A presents OLS regression results. $\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$ is an indicator that takes the value of 1 if a company has an incentive to reduce its leverage following the introduction of the interest ceiling rule, and 0 otherwise. The sample is restricted to the subset of firms with interest payments either (a) within $1.25 million or (b) within 25% of the maximum deduction allowed. Within this subsample, matched firms are in the same country as treated firms and are matched on size, growth, profitability, tangibility, R&D, and depreciation in the year before the introduction of the interest ceiling rule, using a nearest-neighbor algorithm with a caliper of 0.15. $\text{Post}_{c,t}$ is an indicator that takes the value of 1 if year t coincides with or follows the introduction of the interest ceiling rule in country c, and 0 if it precedes its introduction. The sample is restricted to the three years that precede the introduction of the interest ceiling rule in a country through the two years that follow the introduction of the rule. Non-deductible interest payments are determined based on equations (2) through (4). The remaining variables are defined in Sections 2 and 3. Standard errors double-clustered at the industry and at the country-year levels are shown in parentheses below the regression coefficients. Panel B reports the means of the explanatory variables for the treatment and control groups in the year preceding the introduction of the interest ceiling rule, along with the p-values from a t-test for the equality of means. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Regressions results.

	(1) (Long term debt/Total assets)$_t$	(2) (Total debt/ Total assets)$_t$
$\text{Post}_{c,t} \times \mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$	-0.0172**	-0.0278***
	(0.0076)	(0.0083)
Other control variables as in Table 2	Yes	Yes
Country-year FEs	Yes	Yes
Industry-year FEs	Yes	Yes
Firm FEs	Yes	Yes
Number of observations	18,910	18,910
Number of countries	11	11
Number of firms	3,296	3,296
R^2	0.8449	0.8551

Panel B: Summary statistics for the treatment and control groups.

	Treatment group N = 1,904	Control group N = 1,477	p-value
ln(Revenues)$_{t-1}$	17.1782	17.1947	0.7414
ln(Revenues)$_{t-1}$-ln(Revenues)$_{t-2}$	0.1214	0.1207	0.9488
(Operating income/Total assets)$_{t-1}$	0.0391	0.0376	0.1840
(Tangible assets/Total assets)$_{t-1}$	0.2766	0.2785	0.8665
(R&D/Revenues)$_{t-1}$	0.0000	0.0001	0.2248
Missing R&D$_{t-1}$	0.9968	0.9959	0.6587
(Depreciation/Revenues)$_{t-1}$	0.0614	0.0651	0.2644
Missing depreciation$_{t-1}$	0.0126	0.0129	0.9469

Table 5. Placebo tests.

The table presents OLS regression results. $\mathbf{1}\{\Delta \text{ Non-deductible interest payments}_i > 0\}$ is an indicator that takes the value of 1 if a company has an incentive to reduce its leverage following the introduction of a placebo interest ceiling rule, and 0 otherwise. $\text{Post}_{c,t}$ is an indicator that takes the value of 1 if year t coincides with or follows the placebo reform year, and 0 if it precedes the placebo reform year. The sample is restricted to the three years that precede the placebo reform year through the two years that follow it. Non-deductible interest payments are determined based on equation (2), assuming a limitation of 30% of EBITDA and a threshold of USD 3.6 million (approximately EUR 3 million as of 2017). The remaining variables are defined in Sections 2 and 3. Standard errors double-clustered at the industry and at the country-year levels are shown in parentheses below the regression coefficients. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Countries that implemented the reform		Countries that did not implement the reform		Non-financial debt
	(1)	(2)	(3)	(4)	(5)
	(Long term debt/Total assets)$_t$	(Total debt/ Total assets)$_t$	(Long term debt/Total assets)$_t$	(Total debt/ Total assets)$_t$	(Non-financial debt/Total assets)$_t$
Placebo reform$_{c,t}$×$\mathbf{1}\{\Delta$ Non-deductible interest payments$_i > 0\}$	0.0008	-0.0096	-0.0098	-0.0029	
	(0.0040)	(0.0064)	(0.0094)	(0.0112)	
$\text{Post}_{c,t}$×$\mathbf{1}\{\Delta$ Non-deductible interest payments$_i > 0\}$					0.0077
					(0.0049)
Other control variables as in Table 2	Yes	Yes	Yes	Yes	Yes
Country-year FEs	Yes	Yes	Yes	Yes	Yes
Industry-year FEs	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes
Number of observations	143,807	143,807	33,023	33,023	290,862
Number of countries	20	20	26	26	25
Number of firms	28,471	28,471	6,559	6,559	55,283
R^2	0.8412	0.8557	0.8025	0.8475	0.861

Table 6. Publicly traded firms.

The table presents the results for publicly traded firms. The variables are defined in Sections 2 and 3. Standard errors double-clustered at the industry and at the country-year levels are shown in parentheses below the regression coefficients. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1) (Long term debt/Total assets)$_t$	(2) (Total debt/ Total assets)$_t$
$Post_{c,t} \times \mathbf{1}\{\Delta$ Non-deductible interest payments$_i > 0\}$	-0.0206***	-0.0279***
	(0.0073)	(0.0075)
Other control variables as in Table 2	Yes	Yes
Number of observations	26,343	26,343
Number of countries	35	35
Number of firms	5,005	5,005
R^2	0.8469	0.8781

Table 7. The effect of taxes on leverage, depending on interest deductibility.

The table presents OLS regression results. The variables are defined in Sections 2 and 3. Standard errors double-clustered at the industry and at the country-year levels are shown in parentheses below the regression coefficients. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1) (Long term debt/Total assets)$_t$	(2) (Total debt/ Total assets)$_t$
(Fraction of deductible interest)$_{i,t}$	-0.0262*** (0.0052)	-0.0921*** (0.0089)
(Fraction of deductible interest)$_{i,t}$ x x (Corporate income tax rate)$_{c,t-1}$	0.0338** (0.0154)	0.1650*** (0.0253)
Other control variables as in Table 2	Yes	Yes
Country-year FEs	Yes	Yes
Industry-year FEs	Yes	Yes
Firm FEs	Yes	Yes
Number of observations	1,301,113	1,301,113
Number of countries	75	75
Number of firms	153,792	153,792
R^2	0.7423	0.7696

Appendix A. Variables definitions.

Variable name	Definition
(Long term debt/Total assets)$_{i,t}$	End-of-year long-term debt (LTDB) scaled by end-of-year total assets (TOAS).
(Total debt/Total assets)$_{i,t}$	End-of-year loans (LOAN) plus long-term debt (LTDB), scaled by end-of-year total assets (TOAS).
ln(Revenues)$_{i,t-1}$	Natural log of revenues (OPRE). The variable is lagged by one year.
ln(Revenues)$_{i,t-1}$- ln(Revenues)$_{i,t-2}$	Natural log of revenues (OPRE) minus lagged natural log of revenues. The variable is lagged by one year.
(Operating income/Total assets)$_{i,t-1}$	Operating income (OPPL) scaled by total assets (TOAS). The variable is lagged by one year.
(Tangible assets/Total assets)$_{i,t-1}$	Tangible assets (TFAS) scaled by total assets (TOAS). The variable is lagged by one year.
(R&D/Revenues)$_{i,t-1}$	R&D expenses (RD) scaled by revenues (OPRE). The variable is lagged by one year.
Missing R&D$_{i,t-1}$	Indicator that takes the value of one if data on R&D expenses (RD) are missing, and zero otherwise. The variable is lagged by one year.
(Depreciation/Revenues)$_{i,t-1}$	Depreciation and amortization expenses (DEPR) scaled by revenues (OPRE). The variable is lagged by one year.
Missing depreciation$_{i,t-1}$	Indicator that takes the value of one if data on depreciation and amortization expenses (RD) are missing, and zero otherwise. The variable is lagged by one year.
1{Δ Non-deductible interest payments$_i$ > 0}	Indicator that takes the value of one if company *i* has an incentive to reduce its leverage following the introduction of the interest ceiling rule, and zero otherwise.
Post$_{c,t}$	Indicator that takes the value of one if year *t* coincides with or follows the introduction of the interest ceiling rule in country *c*, and zero if it precedes its introduction.
(Fraction of deductible interest)$_{i,t}$	Ratio of deductible interest payments as a fraction of total interest paid. The variable accounts for (1) the interest limitation rule in place (if any); (2) the non-deductibility of interest expenses when pre-tax income is negative; and (3) the limited deductibility of interest expenses when pre-tax income is lower than interest expenses.
(Corporate income tax rate)$_{c,t-1}$	Top statutory corporate income tax rate in force in country *c* as on January 1 of year *t*.