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Financial leverage and corporate taxation: Evidence from German corporate tax return data

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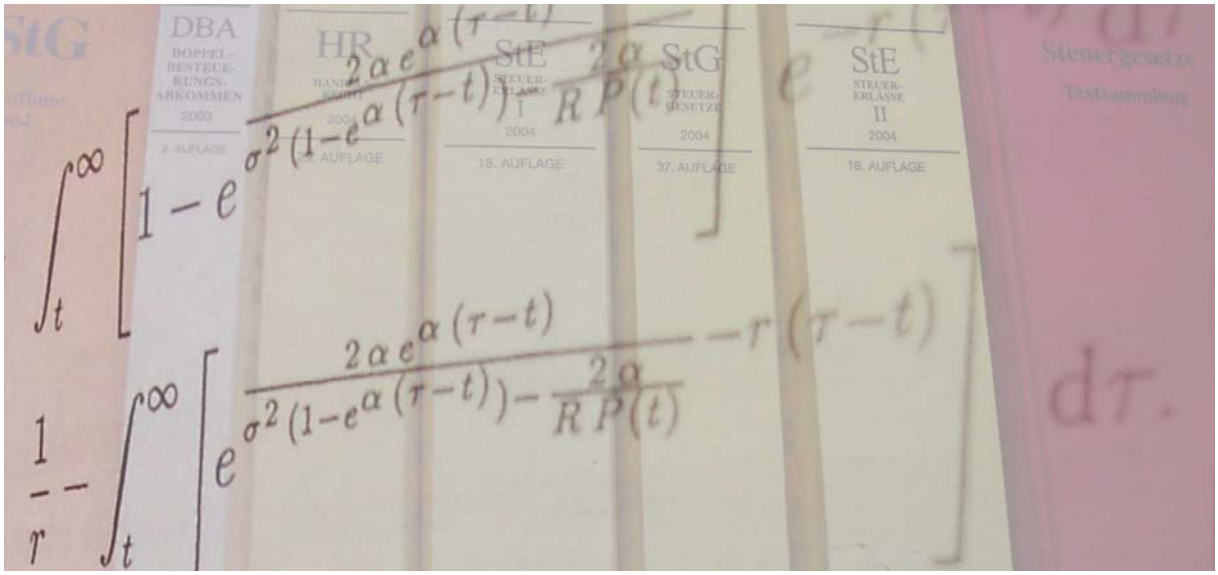

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Nadja Dwenger / Viktor Steiner

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Financial leverage and corporate taxation

Evidence from German corporate tax return data

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Abstract: We estimate the impact of effective profit taxation on the financial leverage of corporations on the basis of a pseudo-panel constructed from corporate tax return micro data for the period 1998-2001, a period which saw the introduction of a major corporate tax reform in Germany. The financial leverage is measured by the ratio of long-term debt to total capital. Endogeneity of the effective corporate tax rate is controlled for by an instrumental variable approach. Our instrument for the observed effective tax rate is the counterfactual tax rate a corporation would face in a particular period had there been no endogenous change of its financial structure. This counterfactual is obtained from a detailed microsimulation model of the corporate sector based on tax return micro data. We find a statistically significant and relatively large positive effect of the tax rate on corporate leverage: on average, an increase of the tax rate by 10 percent would increase the financial leverage by about 5 percent. We also find that the debt ratio is less responsive for small corporations and for corporations that benefit from various other forms of tax shields, in particular depreciation allowances and tax loss carry-forward. However, tax effects do not seem to depend on risk, although the level of economic risk does affect corporate leverage.

JEL Classification: G32, G38, H25, H32

Keywords: financial leverage; financial structure; debt ratio; corporate income taxation; corporate tax return data

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1 Introduction

The effects of profit taxation on the corporate capital structure, or corporate leverage, have been the focus of much theoretical and empirical research in financial economics and public finance (for surveys see, e.g., Graham 2003, Auerbach 2002). While interest payments on debt lower a company's profit liable for taxation no similar deduction exists for the interest yield on equity. This preferential treatment of debt over equity distorts companies' financial policy. In particular, companies may excessively rely on debt for tax reasons. Furthermore, as equity generally does not constitute an obligation to pay interests on a regular basis, high equity ratios serve as security in distressed economic conditions. Boosting equity financing, however, may be undermined by the tax advantage of debt over equity through taxation. Understanding to what extent the preferential tax treatment of debt distorts companies' decisions and generates economic inefficiencies is therefore not only of substantial theoretical interest but also of great policy relevance.

Despite extensive research efforts, economists have had great difficulty providing empirical evidence that taxes indeed matter for the financial leverage of corporations. Estimated tax effects tend to be rather small, if present at all, and often only indirectly related to the financial leverage (see, e.g., Graham 2003 for a critical evaluation), which has led financial economists to doubt the empirical relevance of tax factors in corporate financing decisions (see, in particular, Myers 1984). There are two main problems empirical researchers face when trying to identify tax effects. First, there is often insufficient variation in statutory tax rates either across companies or over time in cross-section or time series data. Second, if an *effective* tax rate is used, this tax variable is likely to be endogenous to corporate financing decisions confounding tax-related effects in previous studies.

In this paper, we estimate the elasticity of the financial leverage to changes in the effective corporate tax rate (ETR) using a comprehensive tax return data set for the German economy. Following Gruber and Saez (2002), who applied this methodology to the estimation of the personal income tax elasticity, we control for potential endogeneity bias by instrumenting the observed tax rate by the counterfactual tax rate a corporation would face in a particular period had there be no endogenous change of corporate debt. This counterfactual is obtained from a detailed microsimulation model of the corporate sector based on tax return micro data for the years 1998 and 2001. This period saw the introduction of a substantial tax reform which provides sufficient exogenous variation in the ETR across corporations to identify the elasticity of corporate debt.

Since the German corporate income tax is proportional to taxable income[1], we cannot rely on the variation in statutory tax rates induced by the progressivity of the corporate tax schedule to

[1] The US, the UK and Japan tax corporate income in higher income brackets at a higher rate, some European countries (e.g., Belgium and the Netherlands) provide a basic allowance for corporate income. Overall, there seems to be a tendency to reduce the "progressivity" of the CIT (see, e.g., OECD 2007).

identify tax effects on corporate leverage. Rather, our identification is based on the variation of the ETR which also reflects various other tax shields, in particular unused loss carry-forward which has become of major quantitative importance for the corporate sector also in the German economy.[2] The huge difference in the amount of used loss carry-forward and other tax shields across corporations provides the exogenous variation in the ETR for our identification strategy of the debt elasticity.

The estimation is based on the corporate income tax statistics and the local business tax statistics that cover all corporations in Germany. While the broad coverage and detailed information on various tax shields are distinct advantages, the data set has the drawback that it is not available as a panel. For the estimation we therefore construct a pseudo-panel for 1998 and 2001 by aggregation of the individual-level corporate tax return data into about 1,000 groups defined by industry (up to the 5-digit level) and by region. This pseudo panel allows us to control for observed and unobserved time-invariant factors, which may be correlated with both the financial leverage and the ETR, and to derive at an instrumental variable for the potentially endogenous ETR.

Instrumental variable estimation of our preferred specification of the regression model yields a statistically significant and relatively large point estimate of the average tax elasticity of corporate leverage. This estimate implies that a reduction of the (proportional) statutory corporate tax rate by 10 percent would reduce corporate debt by 5 percent. Compared to previous studies this is a fairly large estimate of the financial leverage elasticity. This elasticity estimate also indicates that the response of the corporate tax base to changes in the effective tax rate in Germany (see Dwenger and Steiner 2008) is to a large extent driven by changes in the corporate leverage. We also find evidence for the hypothesis that the debt ratio is less responsive for small corporations, for corporations facing higher economic risks, and for corporations that benefit from various other forms of tax shields, in particular the amount of unused tax loss carry-forward and depreciation allowances.

In the next section, we briefly review the empirical literature on the relationship between profit taxation and corporate leverage. Section 3 describes our empirical methodology to identify the leverage elasticity and the construction of our pseudo-panel used for its estimation. Estimation results for our basic specification of the regression model are summarized and discussed in section 4.1. Results for alternative specifications allowing tax rate effects to differ by size and risk and by the availability of other tax shields are presented in sections 4.2 and 4.3, respectively. Section 5 summarizes our main results and concludes.

[2] For similar developments in the U.S. see, e.g., Cooper and Knittel (2006) and Altshuler et al. (2008).

2 Previous Empirical Literature

As mentioned in the Introduction, the older empirical literature failed to find plausible or significant tax effects on the level of debt, i.e. on corporate leverage. There are two main factors which may have contributed to this failure: first, the limited time-series variation in the statutory tax rate within countries; and second, the endogeneity of the effective tax rate in cross-section and panel studies which achieve identification by making use of the cross-section variation in effective corporate tax rates within countries. The subsequent empirical literature has suggested various approaches to account for these factors. In the following we review this literature with the aim to make clear the similarities and differences between the previous literature and our empirical approach which is described in the next section.

While tax rates usually change little over time within a country, tax rates vary largely between countries. Rajan and Zingales (1995) make use of this cross-country variation and compare financial policies across G-7 countries. They find that companies in countries with high corporate income taxes use debt more excessively and thereby document a significant effect of corporate taxes on debt. Focusing on financing decisions of multinationals, Altshuler and Grubert (2002) and Desai, Foley and Hines (2004), among others, find modest tax effects of the host country's tax rate on the financing of multinationals' affiliates abroad. Similar results were found by Huizinga, Laeven and Nicodème (2008) for a large sample of European countries, as well as by Mintz and Weichenrieder (2005) and Buettner et al. (2006) for German multinationals.

An alternative identification strategy using cross-section or panel data on corporations within a country is based on the "substitution hypothesis" proposed by DeAngelo and Masulis (1980). According to this hypothesis, other corporate tax shields, such as depreciation allowances and tax loss carry-forwards, may substitute for debt and thus affect the financial leverage elasticity with respect to the tax rate.[3] The older empirical literature (see, e.g., Bradley, Jarrell, and Kim 1984, Marsh 1982, Titman and Wessels 1988, Fischer, Henkel and Zechner 1989) could not find convincing evidence supporting this hypothesis. MacKie-Mason (1990) argues that this may be due to the fact that previous studies analyzed debt ratios, which cumulate decisions made over many years, taken under varying circumstances. Instead, he suggests studying incremental decisions to issue debt, i.e. on the decision to issue new debt. Furthermore, he argues that the substitution effect of tax shields should be more applicable to firms with a substantial probability of losing the deductibility of their tax shields ("tax exhaustion hypothesis").

[3] Dammon and Senbet (1986) point out that an increase in investment-related tax shields does not necessarily lead to a decrease in debt. They argue that besides the substitution effect an income effect must be considered: Higher investment may lead to both higher output and earnings which turns interest deductions more valuable as tax shields.

Focusing on incremental financial decisions and estimating a probit model, MacKie-Mason shows that, in the US, companies with high tax shields and a high probability of facing a zero tax rate are indeed less likely to finance by debt. Dhaliwal, Trezevant und Wang (1992) and Trezevant (1992) also find that non-debt tax shields such as accelerated depreciations lead to a lower debt ratio if companies face a large risk of a tax rate of zero. This result was also replicated by Cloyd, Limberg and Robinson (1997) as well as by Ayers, Cloyd and Robinson (2001).

There is a potentially severe endogeneity bias in empirical estimates relying on the variation of after-financing tax rates across corporations to identify tax effects on financial leverage. This bias occurs because corporations with substantial debt have large interest deductions, which reduce their taxable income and their after-financing tax rate. There have been various attempts in the literature to account for this spurious correlation and the resulting endogeneity of the effective tax rate.

Shevlin (1990) and Graham (1996) use company specific simulated marginal tax rates to identify tax rate effects on corporate leverage. They calculate simulated tax rates based upon the forecasted future stream of taxable income and the actual tax-code formulas. Also using simulated before-financing tax rates, as implied by theory, Graham, Lemmon and Schallheim (1998) for the first time document a positive relation between debt *levels* and the corporate tax rate. Alworth and Arachi (2001) follow the Graham-Shevlin simulation methodology and provide evidence on the relationship between corporate taxes and debt using panel data on incremental financing decisions of Italian companies.

Using a difference-in-difference estimator and variation induced by the progressivity of the corporate tax system in the U.S., Gordon and Lee (2001) estimate an average elasticity of debt with respect to corporate taxation of about 0.15. Identification of tax effects is based on the strong and non-testable “common trend” assumption, i.e. unobserved time varying factors affecting corporate debt must not differ between corporations affected by the reforms. Furthermore, these estimates are specific to the analyzed reforms and it is not clear whether they can be generalized to other situations.

Gordon and Lee also find that tax effects for both small and large firms are significantly larger that for medium-sized companies, for which the estimated leverage elasticity is not significantly different from zero. Furthermore, the elasticity of debt may also vary with economic risk because the asymmetric treatment of profits and gains discourage borrowing if companies face larger risks (see, e.g., MacKie-Mason 1990, Auerbach 1985, Strebulaev 2007), which in turn may also affect estimated tax effects on corporate leverage. Thus in the estimation of tax effects on financial leverage it seems important to account for both the endogeneity of the effective tax rate and the potential interactions between tax effects and the size of corporations as well as the economic risks they face.

3 Empirical Methodology

3.1 Identification and estimation

We want to estimate the elasticity of the financial leverage with respect to the average effective tax rate, ETR. The financial leverage will be measured by the ratio of *debt* to *total equity*. Our measure of the ETR is the ratio of the *corporate income tax assessed* to *Earnings Before Interest, Taxes and Depreciation (EBITD)* in a given year. EBITD thus measures profit liable to corporate income taxation before the use of various tax shields, i.e. before the deduction of interest payments, of tax losses carried forward or carried back, and before the deduction of depreciation allowances. EBITD can be calculated from our tax return data by adding interest payments and depreciation allowances to Adjusted Gross Income (AGI), see Appendix A2.[4]

For our analysis, a relatively broad measure of profit is important to take interdependencies between different tax shields into account when analyzing tax effects on corporate leverage. For a given level of current profits, corporations with tax loss carry-forward, for instance, may face very different ETR compared to those corporations that do not possess a stock of previously accrued losses. As we show below, it is of great importance to account especially for the use of loss carry-forward in the calculation of the ETR.[5] The variation in the amount of used loss carry-forward across corporations also provides one important source of exogenous variation in the ETR for our identification strategy. Other sources of variation are interest payments and depreciation allowances.

The main methodological problem is that the elasticity of financial leverage with respect to the ETR is unlikely to be identified by a simple regression of log(debt ratio) on log(ETR), for two reasons. First, unobserved time-invariant factors which may be correlated with both the financial leverage and the ETR could confound the elasticity estimate. These factors may include firm-size effects (see, e.g., Lemmon, Roberts and Zender 2008) and persistent inter-industry differences in leverage ratios as already documented by, e.g., Bradley, Jarrell and Kim (1984). Second, spurious correlation between the debt ratio and the ETR may be induced by the relation of the corporate income tax assessed and the amount of used tax loss carry-forward. Furthermore, depreciation

[4] We do not have to add a potential tax loss carry-forwards as the Adjusted Gross Income is the profit before the use of tax losses carried forward.

[5] Bach and Dwenger (2007) show that the volume of yet unused losses from the past in the German corporate sector has increased from Euro 128.3 billion in 1992 to Euro 380.2 billion in 2001, which amounts to about 330% of corporate profits in 2001. Similar results for the US are reported by Cooper and Knittel (2006) who also report that large stocks of net operating losses have been generated in the US in this period which are highly concentrated over a relatively small number of companies.

allowances not only affect the corporation's tax assessed, but may also be correlated with its debt ratio, thereby inducing spurious correlation between the corporation's debt ratio and its ETR.[6]

Whilst it seems therefore impossible to identify the financial leverage elasticity with respect to the ETR on the basis of a single cross section, we argue that this elasticity can be identified by taking advantage of the pseudo-panel structure of our corporate tax return data and changes to the corporate tax system introduced by the Tax Relief Act (*Steuerentlastungsgesetz*) in the period 1998-2001. Our data come from corporate tax returns and from local business tax returns covering this period. Since these data are only available as single cross sections, we construct a pseudo-panel for the estimation, as described in Section 3.2.1. We control for potential endogeneity bias by, first, accounting for fixed effects and, second, by instrumenting the ETR following the methodology which Gruber and Saez (2002) proposed for the estimation of the personal income tax elasticity. Our identification strategy consists of instrumenting a corporation's ETR for 2001 by the simulated ETR the corporation would face in 2001 if its debt ratio had not changed *endogenously* between 1998 and 2001. Thereby, we only use changes in the tax law and macroeconomic effects exogenous to the individual corporation to identify the elasticity of debt with respect to the effective tax rate.

The Tax Relief Act significantly reduced the statutory corporate income tax rate: In 1998, the corporate income tax in principle amounted to 45 percent for retained earnings and to 30 percent for distributed earnings while the tax rate was generally reduced to 25 percent in 2001.[7] It changed the taxation of dividends from the tax credit method ("imputation method") to the half-income method and thereby also affected personal income taxation.[8] The reform also broadened the tax base by lowering depreciation allowances, by introducing the requirement to reinstate original values, and by cutting the use of a tax loss carry-back. As the tax reform did not affect corporations equally, we observe substantial variation in the change of their effective tax rates, due to the following factors:

First, every year a share of 20 percent of German corporations use a tax loss carry-forward or a tax loss carry-backward to offset current profits. These corporations do not pay any corporate income tax and thus have an effective tax rate of zero which remains unaffected by changes in the

[6] If fixed assets may be used as collateral for debt, depreciation allowances and the debt ratio are likely to be positively correlated since the amount of depreciation allowances and the value of fixed assets are positively correlated.

[7] Corporations are also liable to the local business tax (*Gewerbesteuer*). This tax is levied on an adjusted profit measure (including a share of interest payments on long-term debt) at a rate which varies across municipalities (for details, see Bach et al. 2008, Fossen and Bach 2008). In general, the local business tax paid by a corporation is a deductible expense. Since there was no change in the local business tax between 1998 and 2001 and the municipality specific rates hardly changed in this period (German Federal Statistical Office 1998, 2001), we have not taken it into account in our ETR simulation.

[8] Unfortunately, we do not have any information about a corporation's shareholders. We neither know their participation quota nor do we have any knowledge about other sources of income or about their personal income tax. As personal income taxation in Germany is highly progressive (see, e.g., Bach, Corneo and Steiner 2008) and as taxation partly depends on the participation quota this lack of information prevents us from including *personal* income taxation into our analysis. To simplify the analysis we do not include the solidarity surcharge which amounts to 5.5 percent in 1998 and 2001. As the solidarity surcharge is a proportional surcharge on the corporate income tax assessed, omitting the surcharge should not influence our results.

statutory tax rate. Note that the use of tax loss carry-forward is not at the corporation's discretion because unused tax loss carry-forward has to be set off in the full amount against current profits.

Second, the statutory and effective tax rate in 1998 was dependent on the ratio between retained and distributed earnings: A corporation which completely abstained from the distribution of earnings was taxed at the corporate tax rate of 45 percent; whereas a corporation which distributed its whole profit was subjected to a corporate income tax rate of 30 percent only. The splitting of the tax rate is a specific feature of the tax credit method, which was abolished by the Tax Relief Act; since 2001, the tax rate on corporate income is uniform and does not depend on a corporation's payout ratio.[9] This implies that the reduction in the effective tax rate was much larger for those corporations which retained most of their earnings than for the corporations distributing their whole profit.

Third, some corporations were subject to reduced statutory corporate income tax rates in 1998. Mutual insurance societies, private foundations, and business enterprises of a public corporation benefited from a reduced tax rate of 42 percent in 1998. At the same time a flat tax of 25 percent applied to different sources of foreign income. The Tax Relief Act, by contrast, does not provide any reductions in statutory tax rates but equally applies the tax rate of 25 percent to every corporation. As a result, the reduction in the statutory and in the effective tax rate between 1998 and 2001 was smaller for all those corporations which benefited from reduced taxation in the past.[10]

Fourth, the change in the effective tax rate also depends on the asset structure. This means, for instance, that corporations with large real investments in both years saw their tax base broadened in 2001 because of lower depreciation allowances for new acquired goods compared to 1998.

And fifth, corporations with a fiscal year differing from the calendar year only switched to the half income method and the lower tax rate in 2002. In 2001, they were still taxed under the tax credit method and had to pay a tax rate of 40 percent. This means that the reduction in the effective tax rate for these particular corporations was much smaller than for the ones taxed according to the half income method in 2001.[11]

Simulated tax liabilities and effective tax rates are computed using the business taxation microsimulation model BizTax.[12] First, EBITD and all income related components of the 1998

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[9] Under the tax-credit method the tax burden on the corporate level is only meant as a mean to ensure taxation of capital income and is credited against the personal income tax of the shareholder. Under the half income method the corporate income tax is definite. Half of the dividends are additionally subject to personal income tax.

[10] Some corporations even saw their tax rate rising: Operators of merchant ships in the international bodies of water were liable for a reduced rate of 22.5 percent in 1998; in 2001, the universal tax rate of 25 percent applied.

[11] Blasch and Weichenrieder (2007) present the transitional rules and analyse whether listed corporations align their fiscal year to the calendar year due to this rule.

[12] BizTax is a microsimulation model for business taxation in Germany based on official tax return data developed at DIW Berlin in cooperation with the Federal Ministry of Finance (see Bach et al. 2008). In addition to a detailed local business tax module, it also contains a CIT simulation module which replicates the corporate income tax assessed by

cross section are aged to 2001 values using a nominal growth rate which is exogenous to the individual corporation. There are 13 different inflation parameters for different sources of income (profits and losses, dividends and income from interest, differentiated by financial and non-financial corporations).[13] Using BizTax we then simulate the corporate tax liability according to the corporate income tax law 2001 based on the inflated income components. The simulated ETR for 2001 is obtained by relating the simulated tax liability for 2001 to the inflated EBITD of 1998.

One might be concerned that this simulated ETR is not completely exogenous for those corporations which offset part (or the whole) of their profits in 1998 against losses from the past or from 1999 (loss carry-back) because the amount of profits that can be offset against losses from other periods is a function of the tax rules. The Tax Relief Act broadened the tax base and consequently increased profits liable for taxation.[14] This had two implications: first, a rise in the effective tax rate, and second the need of a larger volume of losses from other periods to offset a higher profit. The ability to offset a higher profit resulting from the tax reform could be related to unobserved factors which may also influence the debt ratio. To address this potential endogeneity, we inflate the amount of profits which is offset against losses from other periods in 1998 and use this amount as an upper limit for the profits that can be offset against losses in our simulation of a corporation's ETR for 2001.[15] In a similar vein, we use the inflated amount of allowable deductions that are effectively used in 1998 when we simulate the corporation's ETR for 2001.

In Germany, 40 percent of all corporations report a negative AGI, and this share slightly decreased between 1998 and 2001 (see Appendix A3). Our tax return data unfortunately do not contain information which would allow us to model these losses. We therefore restrict our regression analysis to corporations with positive AGI and try, in an alternative model specification, to control potential selection effects by including the change in the share of corporations with positive profits within groups in the observation period.

In the estimation we also control for other factors which might be correlated with both the debt ratio and the ETR. First, we estimate the regression of log(debt ratio) on log(ETR) in first differences allowing for group-fixed effects which may be correlated with the ETR. Second, we control for time-varying factors including the number of corporations within a group and the share

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tax authorities for more than 99 percent of all corporations; these corporations account for more than 99 percent of the overall corporate income tax revenue. BizTax can be used to simulate the corporate income tax liability of each corporation under past regulations, under the current law as well as under different tax reform scenarios. Currently the model does not predict behavioral responses of companies which may be triggered by tax reforms, e.g. changes in financing and investment decisions or entries and exits of firms.

[13] These parameters were computed in such a way that inflated profits and interests reflect the changes in the corresponding aggregates in the national accounts and the Bundesbank corporate balance sheet statistics.

[14] Profit refers to Adjusted Gross Income which is the profit liable for corporate income taxation before the use of tax losses carried forward.

[15] Since our microsimulation tax model does not include a switching rule between loss and profit, a corporation reporting a profit in 1998 is assumed also to do so in 2001.

of corporations still taxed under the tax credit method in 2001. These variables should also control for changes within groups in the observation period which could affect the efficiency of our estimates, in particular the standard error of the estimated elasticity of the debt ratio.

Financial leverage may also depend on corporate size and on the economic risks corporations face. We control the effect of corporate size on financial leverage by the average amount of capital, which we measure at the start of our observation period in order to avoid the potential endogeneity of this variable. We measure economic risk by the variation coefficient of sales. This risk measure is calculated using sales information from the value added tax (VAT) statistics of the German Federal Statistical Office from 1998 to 2005. Sales information is available at the same level of aggregation as the one used for the construction of our pseudo-panel data. Descriptive statistics of the variation coefficient and other control variables are contained in Appendix A3.[16]

Using the pseudo panel described in the previous section and taking first differences of equations for the two cross sections in log-levels, our basic estimating equation is given by:

$$(1) \qquad \log\left(\frac{debt\ ratio_{g,2001}}{debt\ ratio_{g,1998}}\right) = \alpha + \beta \log\left(\frac{ETR_{g,2001}}{ETR_{g,1998}}\right) + \gamma' z_g + \delta' \Delta x_g + u_g$$

where g indicates the industry/region group, α is a constant, β is the elasticity of debt we want to estimate, γ and δ are column vectors of regression coefficients, z_g contains our measures of corporate size and economic risk as defined above, and Δx_g is a column vector composed of first differences of the time-varying control variables, and $u_g = u_{g,2001} - u_{g,1998}$ is a first-differenced error term, which may or may not be serially correlated.

Assuming the β coefficient can be consistently estimated by an IV regression based on equation (1), it measures the elasticity of corporate debt with respect to the ETR, i.e. $\beta \equiv (\Delta debt\ ratio / \Delta ETR) \times (ETR / debt\ ratio)$. β=0 implies that the debt ratio does not react to changes in the effective tax rate at all; β=1 indicates that a decrease in the effective tax rate of one percent decreases the debt ratio by one percent. We will not only estimate β for the whole population of companies but also estimate separate elasticities by size, by risk and by characteristics that may be related to other tax shields, such as generosity of depreciation allowances or the amount of unused tax loss carry-forward.

Since the ETR is not under the direct control of the government, the elasticity of the financial leverage with respect to the *statutory tax rate* (τ), which is under its direct control, is the more interesting quantity from a policy perspective. This elasticity is related to β by the relation

[16] We use the coefficient of variation rather than the variance of sales to account for differences in the volume of sales across industries. For the purpose of a more intuitive interpretation of our estimation results, we normalize the coefficient of variation by its standard error in the estimation.

$\eta_{debt\ ratio,\tau} = \beta \times \eta_{ETR,\tau}$, where $\eta_{ETR,t} \equiv (\Delta ETR / \Delta\tau) \times (\tau / ETR)$. If deductions and allowances *D* were proportional to EBITD with factor of proportionality *d*, and in the absence of loss carry-forward and loss carry-back, $ETR = (1\text{-}d) \times \tau$ and $\eta_{ETR,\tau} = 1$. Thus, a given percentage change in the statutory tax rate would translate into a proportional change of debt with the factor of proportionality given by β, which needs to be estimated econometrically. In case deductions are not proportional to EBITD, or in the presence of loss carry-forward and loss carry-back, an estimate of the elasticity $\eta_{ETR,\tau} = 1 + \eta_{D,\tau}$, with $\eta_{D,\tau} \equiv (\Delta D / \Delta\tau) \times (\tau / D)$, is also required; this elasticity can be obtained by microsimulation.

3.2 Data

3.2.1 Construction of a pseudo-panel from corporate tax return data

The German corporate income tax return data and the local business tax statistics we use in this study are provided by the German Federal Statistical Office every three years.[17] The latest year currently available is 2001. We restrict our analysis to the period 1998-2001. Although tax return data are also available for 1995, there was no tax reform between this year and 1998 affecting corporate taxation which we could use for our analysis. The year 1992, the only other year for which micro data on tax returns is available, could not be included in our analysis because classification of industries was changed between 1992 and 1998, and it turned out impossible to classify industries in the data set for 1992 comparably to those used in 1998 and 2001, which is a requisite for the construction of the pseudo panel data.

The micro data on corporate tax returns represent all corporations subject to the German corporate income tax, which means nearly 740,000 firms in 1998 and about 810,000 in 2001. The data are constructed from all tax returns filed in a given year and provide information on more than 100 items that are relevant for calculating the corporate income tax. Information on tax loss carry-forwards and on the corporate income tax assessed is also part of the dataset. In the dataset the amount of equity capital is recorded at the individual corporate level as the sum of retained earnings since 1977 and contributions to capital as far as they occurred after the company was founded. Furthermore, it records information on firms' characteristics such as industry, region, and legal form.

[17] Individual data have been made anonymous. Researchers have access to the data through the research centres of the Statistical Offices (www.forschungsdatenzentren.de). Some information in English on these data is available under: http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/Navigation/Statistics/FinanzenSteuern/Steuern/Koerperschaftsteuer/Koerperschaftsteuer.psml
http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Statistiken/FinanzenSteuern/Steuern/Gewerbesteuer/Aktuell,templateId=renderPrint.psml

Information about interest on long-term debt is not available in the corporate income tax statistics but can be derived from the local business tax statistics which cover the same population of corporations and are available for the same years as the corporate tax statistics. Similarly to the corporate income tax statistics, the local business tax statistics are constructed from all tax returns filed for local business taxation.[18] The data set includes information on fixed assets and, most importantly for our analysis, information on interest payments on long-term debt as half of these interest payments is liable to the local business tax. The definition of long-term debt is quite broad including debt which is not paid back within 12 months and debt which is taken out to improve business operations or to expand.

Tax return data offer several distinct advantages compared to accounting data. First, they provide a broad coverage of the corporate sector. Second, they record the corporate income tax actually assessed, together with information on tax shields such as depreciation allowances.[19] Third, they also contain certain components important for the calculation of the effective tax rate like the actual and potential amount of loss carry-forward. On the other hand, there are also some disadvantages of these data. In particular, we can only use the 1998 and 2001 cross-sections for our purpose and these data are currently not available as a panel. We, therefore, had to construct a pseudo-panel data set based on these two cross-sections. And, even more important for our analysis, we do not observe corporate income tax assessed and debt within one single tax statistic. Since the two statistics cannot be matched at the micro level we have used our aggregation scheme and additionally information on profit deciles to impute interest payments from the local business tax statistics.

For the construction of the pseudo-panel data set, we have grouped corporations according to their industries and the regional affiliation of their headquarters, where the lowest level of region is defined at the level of the 16 German federal states (*Bundeslaender*). We chose these criteria because both a corporation's industry and headquarter are supposed to remain unchanged over a short time horizon, i.e. their location decision is not likely to be influenced by the tax reform we analyze here. Grouping by industry is also natural because some of the variation in taxation rules takes place at the industry level.

We aggregated the micro data into groups by applying the following sequential procedure (see Appendix A1): First, we assessed the number of corporations within each industry at the two-digit level in the 2001 cross section data. For groups with a large number of corporations at this level we

[18] The local business tax statistics also include non-incorporated firms that we dropped from the data set.

[19] Information on depreciation allowances is pure statistical information (form ST) and not necessary for corporate income taxation. Unlike variables important to taxation, items in form ST are not verified by fiscal authorities. We therefore check the statements upon plausibility, exclude implausible values, and impute depreciation allowances for corporations which did not fill in form ST. We imputed depreciation allowances on the basis of our aggregation scheme which will be introduced in the following and which we additionally differentiated into profit deciles.

checked the number of corporations at the three-digit level. If there were more than 50 corporations at this level, we checked whether the industry could be disaggregated to the three-digit level given the requirement that there are at least 50 corporations within the resulting groups.[20] If this was not the case, we kept the group at the two-digit level. In this vein, we proceeded to the five-digit level. As it turned out, some groups are quite large even at the five-digit level, including several thousands of corporations. In that case we used regional affiliation as subordinate classification criterion and further differentiated the groups between Eastern and Western Germany, and if possible between federal states as well. By this procedure each corporation was attributed to one of 1,137 groups. The same classification of groups was applied to the 1998 cross section.[21]

3.2.2 Financial leverage and the effective tax rate

We measure the ***financial leverage*** by a corporation's ratio of debt to total capital. Total capital is calculated as the sum of debt, equity and the legal minimum deposit which amounts to 25,000 euros for private limited liability companies and to 50,000 euros for public companies.[22] As we do not have information on debt in the corporate income tax statistics we impute the information from the local business tax statistics.[23] The imputation takes place on the aggregation level of our pseudo-panel which we further differentiate into profit deciles to take differences in size into account. Using the debt *ratio* is appropriate in our study because we consider all corporations and do not restrict our analysis to those that issue new debt (for a discussion see Graham 1999).

Our measure of the ***effective tax rate***, ETR, is calculated for each corporation as the ratio of the corporate income tax assessed to its EBITD as defined in Section 3.1.[24] It differs from the statutory corporate tax rate by the difference between EBITD and Taxable Income, which is driven by different tax shields. In case the EBITD equals zero, the ETR is also set equal to zero. Corporations with a negative AGI in a particular year are excluded from the following analysis. The reason for

[20] As a robustness check we also constructed a pseudo panel with a minimum group size of 40 and 45, respectively. We find that, while the number of groups slightly increases with a lower minimum group size (plus 28 and 2 groups, respectively), our results remain unchanged.

[21] We thereby took into account that the classification of industries was partly changed between 1998 and 2001 by matching the old industry identifier to the new one. Since this was not always possible, we rearranged a few groups in a way to make the data sets for the two years comparable. We exclude those observations for which the industry is unknown or obviously erroneous. Revealing the industry is compulsory but leaves taxes for a given corporation unchanged; it is unlikely that there is any systematic concealment of the industry and therefore discarding those observations should not bias our results. We also drop all private households in the dataset because they were only partly included in the 1998 dataset and are not the focus of the present study.

[22] We do not have information on initial deposits. In case initial deposits exceed the legal minimum deposit, we underestimate total capital.

[23] The local business tax statistics contain information on interest payments for long term debt. Using average interest rates for firm credits, this allows us to infer long term debt.

[24] Since our measure of EBITD is based on tax information and does not include earned interest, it is not fully congruent with the usual measure which is deduced from corporate balance-sheet data and also corrects for earned interest.

excluding these cases is that the tax return data provide no information on the determinants of current losses which could be used to predict future losses. As mentioned earlier we control for potential selection effects by including the change in the share of corporations reporting positive profits. The ETR is calculated at the individual level for 1998 and 2001 and then aggregated to the group level of the pseudo-panel structure described in the previous sub-section, where the aggregation takes into account differences in group size.

Appendix 3 shows that the average level of debt across all corporations increased from about 1,230 to 1,405 thousand €, which amounts to about 13 percent between 1998 and 2001, but only by about 5 percent for corporations with non-negative AGI. In the same period, average equity declined by almost 5 percent for all corporations but only by 3 percent for companies reporting a non-negative AGI. For these latter corporations the average debt ratio increased slightly form 0.567 to 0.575. At the same time, the ETR for corporations with non-negative AGI declined from 15.2 to 9.5 percent, compared to a drop of the statutory tax rate of 20 percentage points (from 45 percent in 1998 to 25 percent in 2001) for most corporations.

4 Estimation Results

4.1 Average tax effects on financial leverage

Table 1 reports OLS and IV regression results for average tax effects on financial leverage based on equation (1) in Section 3.1.[25] To account for heteroskedasticity due to differences related to group size and possibly also serial correlation of error terms we report robust standard errors of estimated coefficients in all regressions.

As shown in column (1), the simple correlation of changes in the corporate capital structure, measured by the debt ratio, and the ETR between 1998 and 2001 is negative and significant (two-sided test, *t*-value of -2.6). This correlation simply reflects the fact, mentioned in the previous section, that the debt ratio slightly increased while the ETR declined in the observation period. The negative correlation between these two variables becomes even stronger if control variables are added.

For the reasons mentioned in section 3.1, we would not expect OLS regressions of the change in debt ratio on the change of the ETR to identify the elasticity of debt. In fact, standard Hausman-Wu endogeneity tests strongly indicate that ETR is an endogenous variable and OLS estimates of the

[25] Since the ratio of long-term debt is zero even at the group level in a few cases, which we couldn't have used in the estimation of the specification given above, we have approximated $\log(debt\ ratio_{g,2001}/debt\ ratio_{g,1998})$ and $\log(ETR_{g,2001}/ETR_{g,1998})$ by, respectively, $[(debt\ ratio_{g,2001}-debt\ ratio_{g,1998})/.5(debt\ ratio_{g,2001}+debt\ ratio_{g,1998})]$ and $[(ETR_{g,2001}-ETR_{g,1998})/.5(ETR_{g,2001}+ETR_{g,1998})]$. A sensitivity check shows that restricting the sample to groups with positive a debt ratio and estimating the log-log specification given above does not significantly change estimation results.

elasticity are inconsistent. In particular, inclusion of the residual from a first-stage regression of $\log(ETR_{g,2001}/EGR_{g,1998})$ on the control variables Δx_g in the structural equation yields a *t*-value of -5.7; alternatively, a standard Hausman test of endogeneity of the ETR in equation (1) turns out significant at the 1 percent-level (*p*-value=0.000).

Before we comment on the IV estimation results in Table 1, we report the results of the first-stage regression with the *predicted* ETR as our instrument for the ETR actually observed in 2001. As shown in Appendix A4, the simple correlation between the relative change in the ETR actually observed and the one obtained by instrumenting ETR 2001 in this expression by the simulated ETR for 2001 is quite strong. In the first-stage regression including all control variables, the R^2 is almost 0.32 and the coefficient of our instrument has *t*-statistic of about 14. To explicitly test for the relevance of the instruments in our multivariate setting, we calculate the Partial R^2 regarding our instrument as suggested by Shea (1997) and Godfrey (1999), which yield a Partial R^2 of about 0.15. This clearly shows that our instrument is indeed highly correlated with the change in the actually observed ETR and that our IV estimation is not likely to suffer from the ubiquitous weak instrument problem (see, e.g., Stock et al. 2002).

Table 1: Regression results explaining the relationship between changes in financial leverage and the effective tax rate
Dependent variable: $\log(debt\ ratio_{g,2001}/debt\ ratio_{g,1998})$

	OLS		**IV**		
	(1)	(2)	(3)	(4)	(5)
$\log(ETR_{g,2001}/ETR_{g,1998})$	-0.115 (0.044)	-0.182 (0.043)	0.463 (0.120)	0.463 (0.131)	0.540 (0.145)
share of corporations under the tax credit method	-	0.112 (0.178)	-	-0.307 (0.233)	-0.534 (0.269)
change in the number of corporations in the group	-	0.177 (0.048)	-	0.146 (0.054)	0.118 (0.057)
dummy indicating groups which exclusively contain firms located in Western Germany	-	-0.053 (0.024)	-	-0.076 (0.029)	-0.073 (0.030)
variation coefficient of sales / standard deviation of the variation coefficient	-	-0.057 (0.011)	-	-0.071 (0.017)	-0.070 (0.019)
$\log(equity_{g,1998})$	-	0.055 (0.010)	-	0.001 (0.016)	-0.008 (0.018)
change in the share of firms reporting non-negative AGI	-	-	-	-	-0.736 (0.310)
constant	-0.039 (0.016)	-0.813 (0.144)	0.132 (0.035)	0.209 (0.260)	0.347 (0.291)
R^2	0.014	0.108	-	-	-
Number of observations	1,029	1,029	1,029	1,029	1,029

Note: The instrument for $\log(ETR_{g,2001}/ETR_{g,1998})$ is $\log(PETR_{g,2001}/ETR_{g,1998})$ with $PETR_{g,2001}$ the simulated ETR as described in the text. Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses.

Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 to 2005, local business tax statistics 1998 and 2001.

As a benchmark, column (3) reports IV estimation results without further control variables. The estimated elasticity of corporate debt now becomes positive, with a point estimate of .46, which is statistically different from zero at the 1 percent level (two-sided test, *t*-value of 3.86). Adding the control variables to this regression leaves the point estimate of the estimated elasticity in column (4) virtually unchanged but slightly increases its estimated standard error.[26] In column (5) we report estimation results with the change of the share of corporations with non-negative AGI within groups included as an additional variable. This variable should control the potential selection bias resulting from the exclusion of corporations with negative AGI in the estimation. If this selection is determined by fixed group effects only, our first-difference estimation controls for it. However, it cannot be ruled out that the factors affecting this selection have been changing in the observation period. Since we do not observe factors which might be correlated with time-varying selection we cannot control for this by a formal selectivity correction, i.e. by the standard Heckman selection procedure. We can, however, approximate the selection term by the average probability of non-negative AGI in a particular group, i.e. by the share of corporations that report a non-negative AGI in a given year. Estimation results for this specification in column (5) show that this variable is significant but hardly affects the elasticity estimate; the point estimate increases to .54.

As discussed in section 3.1, from a policy perspective the elasticity of the financial leverage with respect to the statutory tax rate (τ), which is related to β by the relation $\eta_{debt\ ratio,\tau} = \beta \times \eta_{ETR,\tau}$, is of special interest. Since deductions are not proportional to EBITD, and because of the importance of loss carry-forward, an estimate of $\eta_{ETR,\tau}$ is required. Using our corporate tax microsimulation model BizTax we find $\eta_{ETR,\tau} = 0.983$.[27] Therefore, we may conclude that, on average, our estimate of β is virtually the same as that for the elasticity of the financial leverage with respect to the statutory tax rate. Thus, our IV estimates do suggest a relatively large average elasticity of the corporate leverage, as measured by the debt ratio, to tax changes with a point estimate of about 0.5 and a 95% confidence band of 0.25-0.83.

This is a large effect also relative to the effects of the other economic variables included in the model. Whereas the size of the average corporation in an industry/region group has no significant effect on financial leverage, an increase in the variation of sales by one standard error reduces the debt ratio by about 7 percentage points. Given that this change means a doubling of our risk

[26] Using the lagged ETR as an instrument instead yields a *t*-statistic of about -3.89 for its coefficient in the first-stage regression including all control variables; the R^2 of this regression is .21 and the Partial R^2 regarding this instrument is about 0.015. For specification (5) in Table 1, the point estimate for the β coefficient using the lagged ETR as instrument for the change of the ETR is .378 with a very large standard error of .529. Thus, the lagged value of the ETR seems to be a rather weak instrument.

[27] The simulations assume that any response of a tax rate change is already accounted for by our estimated elasticity of corporate debt.

measure (the sample mean of this variable is about 1, see Appendix A3) and given that the average debt ratio is about 57 percent in the sample, this is a relatively modest effect.[28]

4.2 Tax effects by corporate size and risk

Following the reasoning in the empirical literature – see section 2 – the financial leverage elasticity may differ by firm size and the economic risk a company faces. In the following we present estimation results from alternative specifications of our regression model which account for these factors.

Table 2 summarizes IV regression results based on our preferred specification (5) in Table 1 estimated on separate samples split by, respectively, the average size of corporations within groups and our measure for economic risks. Given the relatively small size of our pseudo panel, we simply differentiate between "small" and "large" corporation size defined by the median of the average amount of capital measured at the start of our observation period. Likewise, we split the sample into a group with the variation coefficient of sales below ("low risk") and above the median ("high risk").

Dividing the sample into sub-samples with average capital, respectively, below and above the median we find that the leverage elasticity for groups with relatively large corporations is substantially larger (point estimate of 0.78) compared to the one for the sub-sample with relatively small companies (0.27). This difference is statistically significant at the 10% level (*t*-value=1.73). This result is consistent with the hypothesis that small corporations with relatively little capital can only take limited tax advantage of debt financing because of credit constraints, whereas large firms do not face this constraint and can make full advantage of debt financing for tax purposes. Gordon and Lee (2001), by contrast, do not find a significant effect of the firm size on the elasticity of corporate debt. Their estimate for the elasticity of debt is between 0.14 and 0.21 for the largest and the smallest firms.

Splitting the sample into industries by the level of economic risks yields a slightly higher leverage elasticity for corporations with a below-average risk level compared to those with a relatively high level, but this difference is not statistically significant. The direct effect of the risk measure on the corporate debt ratio is now only statistically significant in the sub-sample with a

[28] There are two qualifications to this result, however: First, because the variation coefficient of sales is derived from the VAT statistics 1998 to 2005, it excludes exports which are not liable to VAT. Since the VAT statistic is the only data source available at a level of aggregation required to match the variation coefficient to our pseudo panel, we cannot adjust the variation coefficient for export shares. This data limitation should not matter as far as export shares have not changed between 1998 and 2005. Second, sales in post-reform years are also used to calculate our risk measure, which may induce correlation with the error term in the regression equation. To account for measurement error or potential endogeneity bias we have also estimated the regression without the variation coefficient of sales and found that the estimated tax elasticity remains unaffected whether we include the variation coefficient or not. Estimation results for this specification are available on request.

below-average risk level. This corroborates the finding that firms in risky industries are more conservative in the use of debt (Graham 2000).

Table 2: IV regression results explaining the relationship between changes in financial leverage and the effective tax rate by size and risk
Dependent variable: log(*debt ratio*$_{g,2001}$/*debt ratio*$_{g,1998}$)

	by size		***by risk***	
	small	*large*	*low risk*	*high risk*
	(1)	(2)	(3)	(4)
log(*ETR*$_{g,2001}$/*ETR*$_{g,1998}$)	0.274	0.776	0.572	0.516
	(0.201)	(0.210)	(0.264)	(0.162)
share of corporations under the tax credit method	-0.212	-0.738	-0.621	-0.526
	(0.313)	(0.472)	(0.348)	(0.412)
change in the number of corporations in the group	0.256	-0.026	0.019	0.198
	(0.075)	(0.101)	(0.092)	(0.073)
dummy indicating groups with firms located in Western Germany only	0.045	-0.216	-0.004	-0.134
	(0.032)	(0.061)	(0.027)	(0.052)
variation coefficient of sales / standard deviation of the variation coefficient	-0.063	-0.084	-0.029	-0.056
	(0.026)	(0.030)	(0.077)	(0.025)
log(equity$_{g,1998}$)	-0.007	-0.022	0.009	-0.017
	(0.041)	(0.033)	(0.020)	(0.027)
change in the share of firms reporting non-negative AGI	0.075	-1.570	-0.806	-0.691
	(0.378)	(0.539)	(0.524)	(0.385)
constant	0.183	0.650	0.114	0.437
	(0.571)	(0.525)	(0.350)	(0.427)
Number of observations	515	514	514	515

Notes: "Size" is measured by the average capital stock, "risk" by the standardized variation coefficient of sales. The instrument for log(*ETR*$_{g,2001}$/*ETR*$_{g,1998}$) is log(*PETR*$_{g,2001}$/*ETR*$_{g,1998}$) with *PETR*$_{g,2001}$ the simulated ETR as described in the text. Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses.

Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 to 2005, local business tax statistics 1998 and 2001.

4.3 Tax effects by other tax shields

As suggested by the "substitution hypothesis", other corporate tax shields, such as depreciation allowances and tax loss carry-forwards, may substitute for debt and thus affect the financial leverage elasticity with respect to the tax rate (see section 2). In the following we test for differences in tax effects on financial leverage with respect to the availability of depreciation deductions and unused tax loss carry-forwards. Our measure of the availability of depreciation allowances is the ratio of depreciation allowances to fixed assets. Table 3 summarizes the estimation results for these alternative specifications of our basic regression model. As before all specifications start from the specification with the full set of control variables as given by column (5) in Table 1. To avoid the potential endogeneity of changes in the ETR and our measure of heterogeneity, these variables are all measured at the start of our observation period in 1998. Given the relatively small size of our pseudo panel, we again simply differentiate between groups below and above the median of our heterogeneity variable.

Estimation results accounting for differences in the availability of depreciation allowances show that the elasticity of the debt ratio is lower for industries that already benefit from generous depreciation allowances. For them, the estimation results imply a leverage elasticity of about .15, which is not statistically significant even at the 10% level, compared to a large and statistically significant elasticity of .72 for industries with less generous depreciation allowances.[29] Thus, our estimation results confirm the substitution hypothesis with respect to depreciation allowances acting as an alternative tax shield to debt.

Table 3: IV regression results explaining the relationship between changes in financial leverage and the effective tax rate by the availability of other tax shields
Dependent variable: $\log(\textit{debt ratio}_{g,2001}/\textit{debt ratio}_{g,1998})$

	ratio of depreciation allowances to equity (in 1998) … median		***ratio of tax loss carry-forward to equity (in 1998) … median***	
	below	*above*	*below*	*above*
	(1)	(2)	(3)	(4)
$\log(ETR_{g,2001}/ETR_{g,1998})$	0.722	0.147	0.827	0.300
	(0.273)	(0.102)	(0.252)	(0.190)
share of corporations under the tax credit method	-1.068	0.314	-1.231	0.006
	(0.517)	(0.294)	(0.526)	(0.269)
change in the number of corporations in the group	-0.030	0.273	0.091	0.129
	(0.107)	(0.054)	(0.103)	(0.064)
dummy indicating groups which exclusively contain firms located in Western Germany	-0.132	0.013	-0.147	0.033
	(0.055)	(0.021)	(0.050)	(0.037)
variation coefficient of sales / standard deviation of the variation coefficient	-0.083	-0.010	-0.105	-0.002
	(0.029)	(0.021)	(0.035)	(0.020)
$\log(\text{equity}_{g,1998})$	-0.025	0.043	-0.010	0.003
	(0.031)	(0.013)	(0.029)	(0.023)
change in the share of firms reporting non-negative AGI	-1.158	-0.158	-1.214	-0.288
	(0.562)	(0.259)	(0.654)	(0.336)
constant	0.652	-0.555	0.542	0.025
	(0.527)	(0.209)	(0.482)	(0.367)
Number of observations	514	515	515	514

Note: The instrument for $\log(ETR_{g,2001}/ETR_{g,1998})$ is $\log(PETR_{g,2001}/ETR_{g,1998})$ with $PETR_{g,2001}$ the simulated ETR as described in the text. Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses.

Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 to 2005, local business tax statistics 1998 and 2001.

As the estimation results in columns (3) and (4) of Table 3 show, the substitution hypothesis is also confirmed with respect to the amount of unused tax loss carry-forwards: tax changes have a much stronger effect on the financial leverage for corporations with unused tax loss carry-forwards below the median (.83) than for those with relatively large tax loss carry-forward (.30); for the latter

[29] A formal statistical test on the pooled sample yielded a *t*-statistic of -1.97 (*p*-value = 0.049) for the interaction term between the tax variable and a dummy variable for the two groups, where all other control variables were interacted with this group dummy.

sub-sample the leverage elasticity is not statistically different from zero even at the 10% level.[30] We would expect that financial leverage in industries with substantial tax loss carry-forward is less responsive to changes in the ETR than those without such a tax shield for two reasons. First, tax loss carry-forwards can be used without time limit but are not interest bearing, which implies that they are devaluated over time. The prospect of not being able to use the whole of tax deductions provided by interest payments should cause corporations to limit their leverage. Second, a tax loss carry-forward already establishes a tax shield which renders debt less attractive as a tax shield.

5 Conclusion

In this paper we have estimated the elasticity of the financial leverage, as measured by the ratio of debt to total equity at the corporate level, with respect to the effective corporate tax rate, ETR, on the basis of tax return data for the German corporate sector and an instrumental variable approach to control for the endogeneity of the ETR. An important advantage of the tax return data used in this study is that they allow us to calculate the ETR taking into account various other tax shields, in particular loss carry-forward which has become of major quantitative importance for the corporate sector also in the German economy. As our instrument for the observed ETR we have used the counterfactual ETR a corporation would face in a particular period had there be no change of the corporation's capital structure within that period. This counterfactual is obtained from a microsimulation model of the corporate sector based on tax return data for 1998 and 2001. This period saw the introduction of a substantial tax reform, which provides sufficient exogenous variation in effective tax rates across corporations to identify the elasticity of corporate debt. Statistical tests strongly indicate that our instrument is highly correlated with the change in the actually observed ETR and that the well-known weak instrument problem does not invalidate our instrumental variable estimation.

Our preferred specification of the relationship between the financial leverage and the ETR yields an average elasticity of about 0.5. This estimate implies that a reduction of the (proportional) statutory corporate tax rate by 10 percent would reduce corporate debt by 5 percent. Compared to previous studies estimating tax effects on corporate capital structure, this indicates fairly strong tax effects on the corporate leverage. Our average elasticity estimate also indicates that the response of the corporate tax base to changes in the effective tax rate in Germany, as obtained in recent work by Dwenger and Steiner (2008), is to a large extent driven by changes in corporate leverage.

Our estimation results regarding the availability of other tax shields provide strong evidence for the substitutions hypothesis: the financial leverage of corporations with less generous depreciation

[30] In a pooled regression with all variables interacted by the group dummy, the value of the *t*-statistic for the interaction term between the tax variable and a dummy variable for the two groups is -1.67 (*p*-value = 0.096).

allowances or with a low level of unused tax loss carry-forward is more responsive to tax changes than for corporations that can take more advantage of these various other tax shields. Our estimation results are also consistent with the hypothesis that the debt ratio is less responsive for small companies which may have less opportunity to use debt as a tax shield due to capital market restrictions. However, although the financial leverage seems to be higher in industries with more stable sales, we could not find evidence supporting the hypothesis that tax effects are more important in less risky industries.

Overall, our empirical results clearly show, for the Germany economy, that the corporate income tax affects the capital structure of corporations, and that tax effects differ by corporate size and the availability of other tax shields. The magnitude of our elasticity estimates suggests that recent tax reforms which reduced statutory corporate income tax rates may have led to a less distorted capital structure in Germany. Although it remains unclear to what extent these results can be generalized to other countries, the empirical elasticity estimates provided in this paper could also be used to evaluate inefficiencies caused by the preferred tax treatment of debt over equity finance (see Weichenrieder and Klautke 2008).

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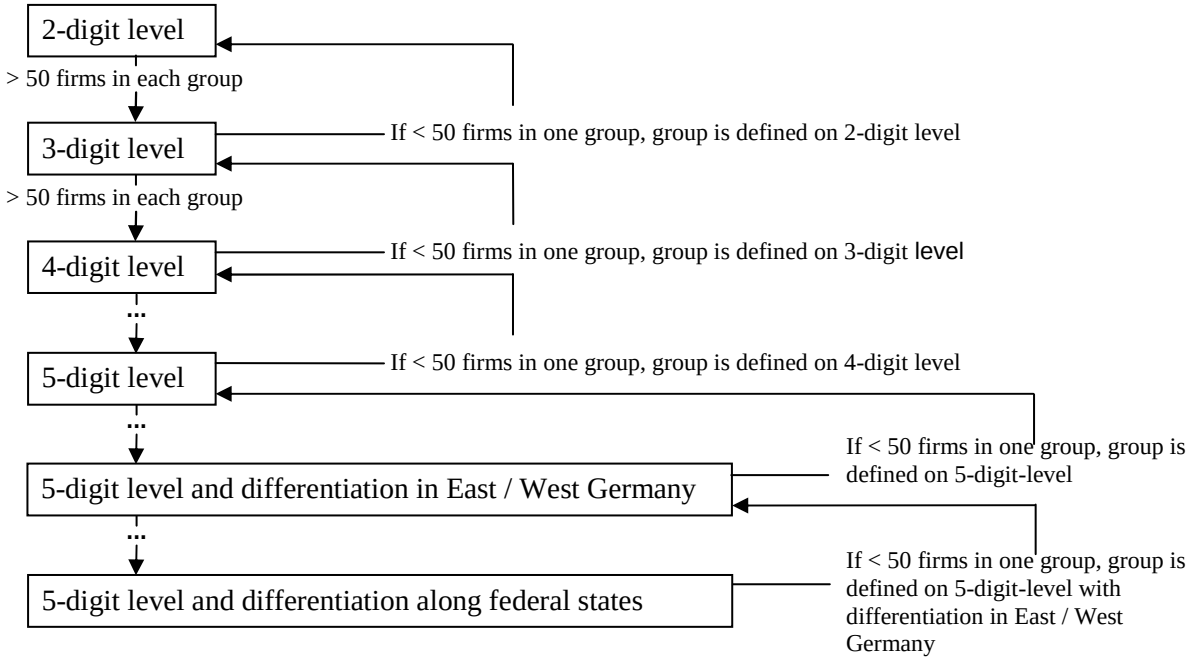
Appendix

A1: Sequential procedure for construction of pseudo panel



A2: Components of the corporate income tax assessed

Sales

- deductions such as interest payments and depreciation allowances

+/- (...)

Profit as shown in tax balance sheet

+/- correcting entry concerning valuation (adjustment of values of balance sheet items, non tax deductible losses and non tax relevant gains etc.)

+ correction of activities that are related to shareholders (declared profit distributions and constructive dividends, repayment of capital or capital increase, hidden contribution and other deposits under company law)

+ non-deductible operating expenses (especially taxes paid, 50 percent of payment to members of the supervisory board, penalties)

+/- non tax relevant domestic increases and decreases in net worth (inter-company dividends, investment subsidies etc.)

+/- corrections related to double taxation agreements, tax legislation relating to non-residents, and fiscal units

= ***Total Revenue***

- allowable deductions for agriculture and forestry

- deductible donations and contributions

+/- income generated by fiscal subsidiaries

= ***Adjusted Gross Income***

- loss carry-over and loss carry-back

= ***Net Income***

- allowable deductions for non-incorporated firms and for commercial cooperatives

= ***Taxable Income***

* statutory tax rate

- tax credits for foreign-source income

= ***Corporate income tax assessed***

A3: Descriptive statistics

	1998	2001	Δ	%Δ
Debt in 1,000 € (average)				
all corporations	1,230.07 (10,696.66)	1,405.32 (9,765.67)	175.25 (8,845.35)	13.32
corporations with non-negative AGI	1,281.24 (10,514.73)	1,351.94 (9,919.06)	70.70 (8,896.48)	5.37
Equity in 1,000 € (average)				
all corporations	3,981.04 (28,018.80)	3,793.33 (18,917.80)	-187.71 (15,031.98)	-4.83
corporations with non-negative AGI	3,641.49 (27,609.76)	3,530.76 (19,224.58)	-110.73 (13,907.14)	-3.09
Debt ratio (average)				
corporations with non-negative AGI	0.5666 (0.173)	0.5750 (0.188)	0.0083 (0.128)	1.47
Adjusted Gross Income (AGI) in 1,000 € (average)				
all corporations	321.21 (2,205.67)	265.21 (1,402.41)	- 56.00 (1,423.36)	-19.16
corporations with non-negative AGI	488.60 (3,415.64)	386.56 (1,923.79)	-102.04 (2,354.43)	-23.43
Share of corporations reporting a positive AGI	0.554 (0.098)	0.560 (0.098)	0.006 (0.076)	1.08
Effective Tax Rate (average)				
corporations with non-negative AGI	0.1520 (0.0534)	0.0953 (0.0338)	- 0.0567 (0.0294)	-46.69
Potential tax loss carry-forward in 1,000 € (average)				
all corporations	674.75 (2,647.89)	700.44 (3,465.48)	25.69 (2,201.18)	3.74
corporations with tax loss carry-forward at the beginning of the year	1,245.92 (6,391.15)	1,466.15 (6,953.57)	-	-
Share of corporations under the tax credit method	1.000 (0.000)	0.065 (0.051)	- 0.935 (0.051)	- 273.34
Share of groups which exclusively contain firms located in Western Germany	0.217 (0.413)	0.217 (0.413)	0.000 (0.000)	0.00
Share of corporations reporting a positive AGI	0.938 (0.053)	0.905 (0.075)	0.032 (0.050)	- 3.58
variation coefficient of sales normalized by its standard deviation	0.985 (1.000)	-	-	-
ratio depreciation allowances to equity (average in 1998)	0.356 (0.460)	-	-	-
ratio tax loss carry-forward to equity (average in 1998)	0.215 (0.272)	-	-	-
Number of corporations within each group	641.61 (995.65)	714.68 (1,120.32)	73.06 (262.27)	10.79
Number of corporations				
all corporations	701,971	809,641	107,670	14.27
corporations with non-negative AGI	436,439	519,856	83,417	17.49
corporations with positive AGI and without tax loss carry-forward	243,364	280,155	36,791	14.08
corporations with tax loss carry-forward at the beginning of the year	354,471	404,524	50,053	13.21

Notes: All information is given on the aggregate level. Standard deviations of variables are given in parentheses. %Δ is calculated as difference between logs, i.e. $\%\Delta AGI = \log(AGI_{2001}) - \log(AGI_{1998})$.

Source: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, local business tax statistics 1998 and 2001.

A4: First stage of the IV regression

Dependent variable: log(*debt ratio*$_{g,2001}$/*debt ratio*$_{g,1998}$)

	(1)	(2)
simulated log($ETR_{g,2001}/ETR_{g,1998}$)	1.873 (0.122)	1.598 (0.118)
share of corporations under the tax credit method	-	0.771 (0.155)
change in the number of corporations in the group	-	0.120 (0.035)
dummy indicating groups which exclusively contain firms located in Western Germany	-	0.018 (0.020)
variation coefficient of sales / standard deviation of the variation coefficient	-	0.029 (0.009)
log(equity$_{g,1998}$)	-	0.073 (0.006)
change in the share of firms reporting a positive AGI	-	0.727 (0.155)
constant	0.521 (0.054)	-0.715 (0.113)
R^2	0.188	0.319
Number of observations	1,029	1,029
F-Statistic	237.59	68.31
Partial R^2	-	0.153

Notes: Standard errors are reported in parentheses. Calculations of the Partial R^2 are described in Shea (1997) and Godfrey (1999).

Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 to 2005, local business tax statistics 1998 and 2001.

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