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# PROFIT TAXATION AND THE ELASTICITY OF THE CORPORATE INCOME TAX BASE: EVIDENCE FROM GERMAN CORPORATE TAX RETURN DATA

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*This paper estimates the elasticity of corporate taxable income with respect to the average corporate tax rate. To control for the endogeneity of the tax rate, we use an instrumental variable approach, calculating the counterfactual average tax rate that a corporation would have faced in a particular period had there been no endogenous change in corporate profits. This counterfactual rate is derived from a microsimulation model based on tax return data. A statistically significant and relatively large point estimate of the tax base elasticity implies that a reduction in the statutory corporate tax rate would reduce corporate tax receipts less than proportionally.*

*Keywords: corporate income taxation, tax base elasticity, micro simulation, tax shields, tax return data*

*JEL Classification: H25, H32*

## I. INTRODUCTION

Reforming the corporate income tax (CIT) persistently appears as a critical topic in both public finance and economic policy debates (Devereux and Sørensen, 2006; Organisation for Economic Cooperation and Development (OECD), 2007; Merrill, 2010). Most critics stress the negative effects of the CIT on economic efficiency and question its usefulness for raising tax revenues. International tax competition has also put pressure on CIT rates and could lead to a "race to the bottom" in the taxation of internationally mobile corporate capital. Statutory corporate tax rates have fallen in most OECD countries, a development that seems to have accelerated in recent years

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(OECD, 2007). For example, in Germany the statutory corporate tax rate on distributed profits declined from 45 percent in 1998 to 25 percent in 2001. As in other countries that reduced their statutory corporate tax rates, however, this reform has not resulted in a proportional decline in corporate tax revenues. This could be related to base broadening provisions that often accompany rate reductions, such as less generous depreciation allowances (Devereux, 2008). Alternatively, some tax rate reductions be partially or even fully "self-financing," if they result in sufficiently large increases in economic activity or reductions in income shifting and tax avoidance activities in the corporate sector. Furthermore, CIT revenue increases may occur due to income shifting within countries, as taxpayers use corporations to shelter their income from high personal tax rates (Gordon and Slemrod, 2000; Fuest and Weichenrieder, 2002).[1]

Empirical estimates of the elasticity of corporate tax bases to changes in corporate tax rates provide important information for assessing both the revenue and welfare implications of corporate tax policies. As Saez (2004) emphasizes, the elasticity of taxable income with respect to the marginal tax rate determines the ultimate efficiency of a tax system, ignoring any possible external effects of taxation.[2] Using accounting-based, industry-level panel data for publicly traded U.S. companies, Gruber and Rauh (2007) report an estimated CIT elasticity related to the net-of-tax marginal corporate tax rate of 0.2. This relatively small point estimate for the elasticity of the corporate tax base thus implies that the CIT is much less inefficient than often assumed. Gruber and Rauh further conclude, from the fairly small CIT elasticity relative to those estimated for individual income taxation, that absent external effects, the inefficiency of corporate taxation may be lower than the inefficiency of individual income taxation.[3] However, as stressed by Gravelle (2007) in her comment on Gruber and Rauh, the use of the CIT elasticity to evaluate efficiency is limited because it cannot identify the margin along which corporations adjust to tax rate changes.[4]

Determination of the efficiency effects of the CIT is further complicated because capital is effectively double-taxed in many countries, including the United States and

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[1] In the United States, revenue from the CIT fell from between 5 and 6 percent of GDP in the early 1950s to 1 percent of GDP in 2009, as discussed in Office of Management and Budget, Fiscal Year 2011 Budget, Table 2.3, "Receipts by Sources as Percentages of GDP, 1934–2015," http://www.whitehouse.gov/sites/default/files/omb/budget/fy2011/assets/hist02z3.xls.

[2] Saez, Slemrod, and Giertz (forthcoming) show that the elasticity of the tax base is not a sufficient statistic to measure welfare losses if behavioral responses involve changes in activities with externalities. Chetty (2009) points out that the use of this statistic may lead to an overestimation of economic inefficiencies if tax avoidance includes both resource and transfer costs. If we were willing to assume that tax sheltering only included transfer costs and reallocations of resources across agents, without reducing total output (resource costs), it would generate no efficiency loss.

[3] For a discussion of the deadweight loss caused by personal income taxation, see Feldstein (1999), Giertz (2009), and Saez, Slemrod, and Giertz (forthcoming).

[4] For example, one way corporations can react to changes in the CIT is by adjusting their debt ratio, which explains approximately one-third of the change in the corporate tax base induced by tax changes (Dwenger and Steiner, 2009).

Germany. As opposed to a consumption tax, the CIT thus distorts saving decisions. However, these challenges do not, in our opinion, imply that the corporate taxable income elasticity is useless for evaluating the efficiency of the CIT; it is certainly of great importance in terms of measuring the overall behavioral response of corporations to changes in the CIT rate under the existing tax structure and estimating the revenue effects of CIT reforms.

Despite its importance, no "benchmark" estimate of the corporate tax base elasticity currently exists for other OECD countries, nor is it known to what extent the U.S. results obtained by Gruber and Rauh might be typical of those for other countries and corporate tax regimes. Furthermore, estimated tax base elasticities may be sensitive to different definitions of the corporate tax base and tax rates, and are dependent on the structure of the corporate tax as well as on the modeling of the potential reverse causation (endogeneity) between the tax base and tax rate.

We contribute to the literature by estimating the elasticity of the corporate tax base with respect to the average corporate tax rate (*ATR*) in the German economy using a comprehensive CIT return data set. Unlike the progressive rate structure available in the United States, Germany applies a uniform CIT rate that is independent of the level of corporate profits. Accordingly, we need other sources of variation to identify the corporate tax base elasticity, and we show that it can be identified through the *ATR*, which differs from the statutory tax rate. Unlike the statutory tax rate our concept of the average tax burden is not confined to changes in the tax rate but can also capture base-broadening measures — a major advantage, because recent CIT reforms in Germany, as in other European countries, have been accompanied by simultaneous broadening of the tax base. The *ATR* varies across firms and over time due to huge differences in tax losses carried forward, differences in depreciation allowances and tax preferences, and as a result of the Tax Relief Act passed at the turn of the century. This tax reform significantly reduced the statutory CIT rate and simultaneously broadened the tax base by lowering depreciation allowances, restricting the use of a tax loss carryback, and changing the treatment of non-depreciable assets that lose and then regain value.[5]

However, for various reasons, the *ATR* may be endogenous in that it is partly determined by taxable income. To control for the endogeneity of changes in the *ATR*, we follow Gruber and Saez (2002) and Gruber and Rauh (2007) and estimate the tax base elasticity using an instrumental variable approach. As an instrument we use the counterfactual *ATR* that a corporation would have faced in a particular period, had there been no endogenous change in profits. To construct the *ATR* instrument, we use a detailed microsimulation model based on individual corporate tax return data.

[5] In Germany, if a non-depreciable good declines in value and if this decline is likely to be permanent, firms are allowed to deduct the difference between its historical cost and its current value. The firm is required to reinstate the initial value, however, if the decline in value is reversed. This may occur, for example, if the value of land bought by a firm for future use is initially devalued due to some government regulation but subsequently returns to its initial level because the respective regulation is repealed.

Tax return data provide broad coverage of the corporate sector and a detailed record of various tax shields, including used loss carry-forwards, which are relatively large for the corporate sector in the German economy.[6] Further, the data include the CIT actually assessed, together with components important for calculating the *ATR*. Because tax return data currently are available only as cross-sections, not as a panel, we built a pseudo-panel data set by aggregating firm-level corporate tax return data into approximately 1,000 groups defined by industry (up to the five-digit level) and region. With this pseudo-panel, we track groups of corporations rather than individual observations. Thus, we can control for observed and unobserved factors that may be correlated with both the corporate tax base and the *ATR*.

The remainder of this article proceeds as follows. In the next section we briefly review the related literature. Afterwards, as a basis for specifying our empirical model, we provide some background information about the measurement of the corporate tax burden and the corporate tax base. We then describe the data and detail our identification and estimation of the CIT base elasticity. Our preferred specification of the regression model, summarized in Section V.A, yields a statistically significant and large point estimate of the average tax base elasticity, which implies that reducing the (proportional) statutory corporate tax rate reduces corporate tax receipts but less than proportionally, primarily because corporations engage in income-shifting activities. Even at the substantially reduced statutory tax rates mandated by recent tax reforms in Germany, our relatively large estimate of the CIT base elasticity indicates that substantial distortions of the CIT remain. We also find statistically weak evidence for the hypothesis that the tax base is more responsive for corporations that can benefit from various tax shields. In Section VI, we summarize our main results and conclude.

## II. PREVIOUS LITERATURE

Tax base effects may arise because corporations respond to a reduction in the statutory tax rate by either increasing economic activity or by reducing income shifting. Various forms of income shifting have been studied in previous literature. Profits can be shifted between the corporate and personal sectors, depending on the change in the difference between the corporate and personal income tax rates (Gordon and Slemrod, 2000; Fuest and Weichenrieder, 2002). In addition, international income shifting may occur through corporate financing strategies or transfer pricing (Clausing, 2009).

Recent empirical studies based on aggregate OECD data (Clausing, 2007; Brill and Hassett, 2007; Devereux, 2007) suggest that countries with statutory tax rates exceeding 30 percent tend to be on the declining segment of the CIT Laffer curve, which implies that tax rate reductions would increase corporate tax revenues.[7] These studies are based on ordinary least squares (OLS) regressions of corporate tax revenues — normalized by gross domestic product — on the statutory tax rate, its square, and a couple of con-

[6] Similar developments in the United States are discussed by Auerbach (2007) and Altshuler et al. (2009).

[7] For a single tax rate, tax revenues are maximized when the elasticity of taxable income with respect to the marginal tax rate equals –1. More general results on the rate that maximizes tax revenues can be found in Saez (2004).

trol variables, estimated on a panel of pooled OECD time-series cross-sectional data. Because the regressions do not include country fixed effects that might be correlated with tax revenues and the statutory tax rate, it seems questionable whether they generate reasonable estimates of CIT base elasticities.[8] In contrast, using accounting-based, industry-level panel data for publicly traded U.S. companies, Gruber and Rauh (2007) report an estimated CIT elasticity related to the net-of-tax marginal corporate tax rate of 0.2. This elasticity is considerably smaller than the benchmark estimate of the elasticity of taxable *personal* income with respect to the net-of-tax marginal personal tax rate of roughly 0.4 obtained by Gruber and Saez (2002) for the United States.[9] This relatively small estimate of the elasticity of the corporate tax base implies that, at least in the United States, reductions of the CIT rate would be only partly self-financing and would substantially reduce corporate tax revenues.

There is also a large literature studying corporations' behavioral response to changes in cross-country and cross-region tax differentials. Previous research in the United States revealed surprisingly high elasticities of reported corporate income with respect to changes in the tax rates of "tax havens" (Hines and Rice, 1994). In Canada, provinces are free to set their corporate tax rate and income of corporate groups is not consolidated for tax purposes, with the result that provinces engage in tax competition and multijurisdictional companies with subsidiaries in several provinces have profit-shifting opportunities. Using administrative tax data for Canadian provinces, Mintz and Smart (2004) report high elasticities of taxable income with respect to subnational corporate tax rates. In several OECD countries, Bartelsman and Beetsma (2003) find that, on average and compared to a baseline that assumes no behavioral responses, two-thirds of the revenues that would be raised by a unilateral increase in the statutory tax rate in a single country are lost due to declines in reported income. Riedl and Rocha-Akis (2007) also use aggregate OECD data and find that the CIT base is negatively affected by a country's own tax rate and positively influenced by the tax rates of its neighbor countries.

Weichenrieder (2009) studies profit-shifting behavior of German multinationals in response to tax differentials. He shows that for inbound foreign direct investment (FDI), profit-shifting from the German affiliate to the home country of the parent is less profitable the smaller the tax differential between the German affiliate and the foreign parent. For directly owned German affiliates, Weichenrieder finds evidence that a 10 percentage point increase in the parent's home country tax rate reduces profit-shifting by increasing profitability of the German subsidiary by about 0.5 percentage point. Using the same database, Buettner et al. (2006) indicate that the impact of local taxes on corporations' investment decisions depends on legal restrictions on interest deductions on intercompany debt. Investment in high-tax Germany is found to increase with rising tax rate differentials between the German affiliate and the tax rate in the parent's home country (Overesch, 2009). Because of profit-shifting opportunities, multinational firms thus gain in competitiveness if the parent company is located in a lower-taxing country.

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[8] As Clausing (2007) and Devereux (2007) note, there is not enough within-country variation in statutory tax rates to identify the tax base elasticity conditional on country fixed effects.

[9] In Germany, the elasticity most directly comparable to Gruber and Saez's estimate is 0.6 (Gottfried and Schellhorn, 2004).

## III. MEASURING THE CORPORATE TAX BASE ELASTICITY

### A. Average Tax Rate

The public finance literature on corporate taxation distinguishes between forward- and backward-looking measures of effective corporate tax rates (Fullerton, 1984; Devereux, 2004; Gordon, Kalambokidis, and Slemrod, 2004). Both measures differ from the statutory corporate tax rate, which is the nominal tax rate levied on taxable income at the corporate level. In most countries, including Germany, the statutory rate does not depend on the level of corporate profits, and the corporate tax assessed is proportional to taxable corporate income.[10] To identify the corporate tax base elasticity for Germany we have to use a measure different from the statutory tax rate, namely the *ATR* that varies across corporations.

We construct the *ATR* using a backward-looking approach. These effective *ATR* measures are calculated ex post as the corporate tax actually assessed divided by some measure of economic corporate profits. Profits and the corporate tax assessed depend on previous corporate investment and financing decisions, as well as previous and future losses, which may be offset against current profits according to the provisions for loss carry-forward and loss carry-backward. Backward-looking measures therefore account for all the details of the tax system without the need to model them explicitly. In the literature, the average effective tax rate is considered appropriate for measuring the relationship between tax rates and tax receipts in the corporate sector (Gordon, Kalambokidis, and Slemrod, 2004).

Because this relationship is the focus of our study, we use a backward-looking measure of the tax burden derived from corporate tax return data. Unlike the effective *ATR*, the *ATR* used in our study is not based on economic profits but on adjusted taxable income. Our tax-return data do not contain information on capital expenditures and thus do not allow us to construct an economic measure of income. More precisely, our *ATR* measure equals the ratio of the corporate tax assessed in a given year to the net profit before loss carry-over (*NPBL*), i.e., *ATR* = corporate tax assessed / *NPBL*.[11] If *NPBL* equals 0, the *ATR* is also 0. The *NPBL* differs from taxable income (*TI*) mainly by the amount

[10] The United States, United Kingdom, and Japan tax corporate income for higher income brackets at a higher rate, whereas some European countries — e.g., Belgium, the Netherlands — provide a basic allowance for corporate income. Overall, there has been a tendency to reduce the "progressivity" of the CIT (e.g., OECD, 2007; Weichenrieder, 2007).

[11] Because the German CIT is proportional, our measure of the *ATR* as an *ATR* relative to *NPBL* equals the statutory tax rate and marginal tax rate as long as corporations earn positive profits and cannot use any loss carry-over (abstracting from allowable deductions for agricultural cooperatives and industrial/provident societies, as discussed in footnote 13). All three measures are also equal for firms incurring a loss that cannot be carried back. The statutory tax rate, marginal tax rate, and *ATR* differ, however, for firms with unused loss carry-forward or carry-backward that are deductible against positive profits. Corporations are also liable for the local business tax, levied on an adjusted profit measure (that includes a share of interest payments on long-term debt and leasing costs) at a rate which varies across municipalities (see Fossen and Bach, 2008). Since there was no change in the local business tax between 1998 and 2001 and the municipality specific rates hardly changed, we ignore it in out *ATR* simulation.

of a corporation's tax loss carry-back and carry-forward, which is deductible against current profits (a stylized calculation of these measures is provided in Table A1 in the Appendix),[12] as well as the amount of allowable deductions for certain corporations.[13] For a given level of current profits, corporations with unused tax loss carry-forwards or carry-backwards face very different *ATR*s compared with those that do not dispose of a stock of previously accrued losses.[14]

As we show subsequently, it is of great importance to account for these items, especially loss carry-forward, in calculating the corporate tax base.[15] Variations in the amount of loss carry-forward across corporations also provide exogenous variation in the *ATR* for identifying the tax base elasticity, in addition to the change in the CIT induced by the Tax Relief Act that we describe in Section IV.B.1. Because tax return data do not provide all the information necessary to construct the *NPBL* using the same definition for all observation periods, we assume that other deductions, such as changes in depreciation allowances induced by the Tax Relief Act, do not affect the estimated tax base elasticity.[16]

## B. Elasticity of the Corporate Tax Base

Our empirical analysis focuses on the elasticity of the corporate tax base, as measured by *NPBL*, with respect to the *ATR*: $\beta \equiv (\Delta NPBL/\Delta ATR) \times (ATR/NPBL)$. This elasticity

[12] In Germany, a net operating loss does not lead to an immediate tax rebate but is deductible against positive profits from other years. Companies that have paid corporate income tax in previous year(s) may carry back the loss and receive a tax refund. If the loss in the following year exceeds profits or a legally defined maximum carry-back, the remaining loss must be carried forward in time; the resulting tax loss carry-forward, which is valid for an unlimited period of time, is deductible against future positive profits.

[13] Agricultural cooperatives as well as industrial and provident societies benefit from an allowable deduction in the amount of €15,000.

[14] For our backward-looking measure of *ATR* we consider the amount of tax loss carry-forward effectively used to be the relevant factor. By contrast, a forward-looking measure of the tax burden would have to rely on the opportunity costs of the tax loss carry-forward used, which are given by $t(t^*) / (1 + r)^{t^*}$, where $t^*$ is the number of years until the firm returns to paying taxes, $t$ is the marginal tax rate applied in year $t^*$, and $r$ is the firm's discount rate.

[15] Bach and Dwenger (2007) show that the volume of past yet unused losses in the German corporate sector has increased from €128.3 billion (1992) to €520.3 billion (2004), or 470 percent of corporate profits in 2004. Cooper and Knittel (2006) find similar results in the United States and report that large stocks of net operating losses were generated around the turn of the millennium, which were highly concentrated among a relatively small number of U.S. companies.

[16] As Slemrod (1996) notes for personal income taxes, the estimated elasticity may be affected if the definition of the tax base changes substantially over time. Not using a concurrent income measure might bias the elasticity estimate, if there was correlation between the *ATR* and base-broadening not corrected for by our income measure. The base-broadening nature of past reforms suggests this correlation would be negative: corporations that had benefited from generous tax shields before 2001 had a lower *ATR*, ceteris paribus, and then saw their tax base broadened by the reform. Unfortunately, there is no information on base-broadening factors in the data set, hence we cannot test the relevance of potential bias due to base-broadening effects. We would argue, however, that instrumenting the *ATR* by its simulated counterpart circumvents this problem to a large extent because the simulated *ATR* by construction excludes such base-broadening effects.

relates to the relative change in the amount of corporate tax assessed ($TA$) to a relative change in the statutory tax rate ($\tau$) according to the formula

$$(1) \quad \Delta TA/TA = (\Delta\tau/\tau)(1 + \beta \times \eta_{TI,NPBL} \times \eta_{ATR,\tau}),$$

where $\eta_{TI,NPBL} \equiv (\Delta TI/\Delta NPBL) \times (NPBL/TI)$ and $\eta_{ATR,\tau} \equiv (\Delta ATR/\Delta\tau) \times (\tau/ATR)$. $TI$ and $NPBL$ only differ by deductions and allowances $D$ (Table A1 in the Appendix), so that $TI$ can be rewritten as $TI = NPBL - D$ and $ATR$ as $ATR = (TI \times \tau)/NPBL$. If the deductions and allowances $D$ were proportional to $NPBL$ with a factor of proportionality $d$, in the absence of loss carry-forward and carry-back, $TI = (1 - d) \times NPBL$, $ATR = (1 - d) \times \tau$, in this case $\eta_{TI,NPBL}$ and $\eta_{ATR,\tau}$ would simplify to $\eta_{TI,NPBL} = \eta_{ATR,\tau} = 1$. Thus, a certain percentage change in the statutory tax rate translates into a proportional change of $TA$, with the factor of proportionality given by $\beta$, which must be estimated econometrically. If deductions are not proportional to $NPBL$, or in the presence of loss carry-forward and carry-back, we also require estimates of the elasticities $\eta_{TI,NPBL} = (1 - \Delta D/\Delta NPBL) \times (NPBL/TI)$ and $\eta_{ATR,\tau} = 1 + \eta_{D,\tau}$, with $\eta_{D,\tau} \equiv (\Delta D/\Delta\tau) \times (\tau/D)$, which can be obtained by microsimulation (see Section V.A).

Note that (1) also enables us to convert our estimate of the elasticity of $NPBL$ with respect to the $ATR$ into the elasticity of $TI$ with respect to the net-of-statutory CIT rate $(1 - \tau)$ which is most commonly used in the prior literature (Giertz, 2010). With $\eta_{TI,1-\tau} = \eta_{TI,\tau} \times (-1)\dfrac{(1-\tau)}{\tau}$, we can obtain an elasticity estimate comparable to that most often found in the literature using the following formula:[17]

$$\begin{aligned}(2) \quad \eta_{TI,1-\tau} &= \left[\left(\Delta NPBL / \Delta ATR\right) \times \left(ATR / NPBL\right)\right] \times \left[\left(\Delta TI / \Delta NPBL\right) \times \left(NPBL / TI\right)\right] \\ &\quad \times \left[\left(\Delta ATR / \Delta\tau\right) \times \left(\tau / ATR\right)\right] \times (-1)\frac{1-\tau}{\tau} \\ &= \beta \times \eta_{TI,NPBL} \times \eta_{ATR,\tau} \times (-1)\frac{1-\tau}{\tau}.\end{aligned}$$

The tax base elasticity $\eta_{TI,1-\tau}$ determines the extent to which the direct change in tax receipts resulting from a change in the statutory tax rate is offset by real adjustments or income-shifting activities in the corporate sector. Generally, $\beta$ should be zero or negative. If corporations do not respond to tax rate changes, $\beta = 0$, and a given percentage change in the statutory tax rate reduces corporate tax revenue by the same percentage. If $\beta = -1$ (assuming for simplicity that deductions are proportional to $NPBL$), a reduction in the statutory tax rate does not change corporate tax revenue at all. For $-1 < \beta < 0$, reducing the statutory tax rate by a percent reduces the corporate tax revenue by $\alpha(1 + \beta)$ percent. Finally, if $\beta < -1$, a reduction of the statutory tax rate increases tax revenue, implying that a country is on the downward-sloping segment of its Laffer curve.

[17] The calculation assumes that the statutory tax rate equals the marginal tax rate, which holds for German corporations with positive profits exceeding the level of loss carry-forward or carry-back.

## IV. DATA AND EMPIRICAL METHODOLOGY

To measure the impact of the *ATR* for a given company on the level of its tax base, we estimate the elasticity of the corporate tax base with respect to the *ATR*. For various reasons, however, this elasticity cannot easily be identified by a simple regression of log(*NPBL*) on log(*ATR*).

As we will show in Section IV.B.2, the *ATR* is strongly affected by the amount of loss carry-forward in a given year, which itself depends on the corporation's profit position that year. Imagine a corporation that earns a large absolute profit that seems small compared with the company's tax loss carry-forward volume. In this event, the corporation's *ATR* is small, because tax losses carried forward essentially offset the profit. A negative spurious correlation between a company's profit and its *ATR* could result. Furthermore, certain deductible allowances and expenses affect the corporation's assessed tax and may be correlated with its profits, which would introduce spurious correlations between the corporation's tax base and *ATR*. Finally, we acknowledge the potential for other observed and unobserved factors that may correlate with both *NPBL* and *ATR* and that need to be controlled for when we estimate the tax base elasticity.

Although it seems impossible to control for these factors on the basis of a single cross-section, we identify the tax base elasticity by taking advantage of the changes to the corporate tax system introduced by the Tax Relief Act during the period 1998–2001. Our data include corporate tax returns for the years 1998, 2001, and 2004. We construct a pseudo-panel for the estimation and control for potential endogeneity bias by accounting for fixed effects, as well as instrumenting the *ATR* following the methodology used by Gruber and Saez (2002) and Gruber and Rauh (2007). To construct the *ATR* instrument, we exploit changes in the tax law during the period spanned by our pseudo-panel data using a detailed microsimulation model based on individual corporate tax return data.

### A. Data

#### *1. Construction of a Pseudo-Panel from Corporate Tax Return Data*

The German corporate tax return data we use come from the German Federal Statistical Office, which publishes them every three years (Gräb, 2006).[18] The latest year available is 2004. We restrict our analysis to 1998–2004 because, even though tax return data are available for 1995, no tax reform pertaining to corporate taxation occurred between that year and 1998. The same point could be made for 2001–2004, but we use this extended

[18] Individual firm data are anonymous. Researchers may access the data through the "Research Data Centres of the Statistical Offices." The Federal and State Statistical Offices, www.forschungsdatenzentren.de. English-language information about these data is available at "Corporation Tax." Federal Statistical Office, http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/Navigation/Statistics/FinanzenSteuern/Steuern/Koerperschaftsteuer/Koerperschaftsteuer.psml.

period to check for any longer-term effects of the tax reform.[19] Furthermore, we could not include 1992 data because industry classifications changed between 1992 and 1998 and it was impossible to align the data for 1992 with those used in 1998 and 2001 by industry, which was necessary for the construction of the pseudo-panel data.

The micro-data represent all corporations subject to the German CIT, which equaled approximately 700,000 firms in 1998 and 860,000 in 2004. The data reflect all tax returns filed in a given year and provide information about more than 100 items relevant for calculating the CIT. The data set also includes information about taxable income and the CIT assessed, as well as details about firm characteristics, such as industry, region, and legal form.

To construct the pseudo-panel data set based on the three cross-sections, we grouped corporations according to industries and the regional affiliation of their headquarters. The lowest regional level refers to the 16 German federal states (*Bundesländer*). A corporation's industry and headquarters should remain unchanged over our short time horizon, so their location decision, for example, should not be influenced by tax reforms. Grouping by industry is natural, because some of the variation in taxation rules takes place at the industry level.

We aggregated the micro-level data into groups by applying a sequential procedure.[20] First, we assessed the number of corporations within each industry at the two-digit level. For groups with many corporations at this level, we checked the three-digit level. If there were more than 50 corporations at this level, we determined whether the industry could be disaggregated to the three-digit level, with the requirement that there must be at least 50 corporations within the resulting group.[21] If not, we kept the group at the two-digit level. Following this procedure we proceeded to the five-digit level; some groups were quite large even at the five-digit level and included several thousands of corporations. For these groups, we used regional affiliation as a subordinate classification criterion and further differentiated the groups between eastern and western Germany and, if possible, among federal states. We assigned each corporation to one of 1,137 groups using this procedure. The same classification of groups applied to all three cross-sections.[22]

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[19] From 2001–2004, the only change in corporate tax laws was the introduction of minimum taxation, which capped the use of tax loss carry-forward. The reform did not introduce much variation in average tax rates and affected only a small share of all corporations — 1,890 companies in 2004.

[20] An illustration of this procedure is available in a web appendix at http://www.wiwiss.fu-berlin.de/en/institute/wirtschaftspolitik-geschichte/steiner/index.html.

[21] As a robustness check, we constructed a pseudo-panel with minimum group sizes of 40 and 45. The number of groups slightly increases with a lower minimum group size (plus 28 and two groups, respectively), but the results remain unchanged.

[22] To address the slight change in the classification of industries from 1998–2001, we matched prior industry identifiers to the new ones. This match was not always possible, so we rearranged a few groups to make the data sets for the two years comparable. We excluded observations for which the industry was unknown or obviously erroneous. Revealing the industry is compulsory but leaves taxes for a given corporation unchanged; it is unlikely that there would be any systematic concealment of industry. Therefore, discarding these observations should not bias our results. We also drop all private households from the data set because they were only partly included in the 1998 data set and are not the focus of our study.

### 2. Descriptive Statistics

We calculated *NPBL* and *ATR* at the firm level for each year and then aggregated them to the group level of the pseudo-panel structure described in the previous subsection, taking into account differences in group size.[23] However, we excluded corporations with a negative *NPBL* in a particular year from the subsequent analysis because their tax return data provide no information about the determinants of current losses that could be used to predict future losses. We try to control for potential selection effects resulting from the exclusion of these cases in the regression analysis, as we discuss subsequently. In Table 1, we present the means and standard deviations of *NPBL* and *ATR*, measured at the group level for the three years, as well as the relative changes between 1998 and 2001 or 2004.

The upper part of Table 1 shows a dramatic decline in *TI* during 1998–2001 and a low-level of stabilization thereafter. This decline is probably related to the economic downturn that had already started in some sectors of the German economy in 2001. *TI* (and *NPBL*) declined most at the lower tail of the distribution, suggesting that the sharp drop is largely driven by a few very large companies. Firms had an incentive to realize investment losses before 2002, because writedowns of investments in shares of affiliated companies were effective for tax purposes only until 2001 (Blasch and Weichenrieder, 2005).

Furthermore, the amount of tax loss carry-forward has steadily increased in Germany since the 1990s. From 1998–2001, both the number of firms with tax losses carried forward and the amount of tax loss carry-forward increased (Table 1). This might explain why the decline in *TI* was more pronounced, on average, than the one in *NPBL* for all corporations with positive profits, which dropped by almost 20 percent from 1998–2001 — from €320,000 to €265,000 — and by another 10 percent in 2001–2004.[24]

Because *NPBL* is negative for a large share of all corporations in each of the three years, we report the statistics for all corporations and for those with nonnegative *NPBL* separately.[25] The average level for corporations with nonnegative *NPBL* amounted to almost €500,000 in 1998, dropped by 20 percent by 2001, and fell by more than one-third in 2004. The share of corporations reporting a positive *NPBL* increased slightly in this period. The declines are not due to changes in the definition of income because

[23] We estimate the tax base elasticity by applying first differences such that all variables are given as percentage changes, and we control for differences in firm size or other variables. Therefore, we do not need to use further weights, but can calculate the group information within each group *g* as the unweighted average of the individual information from firm *i*.

[24] In some groups, one corporation was much larger in terms of *NPBL* than the next largest corporation. We excluded corporations whose *NPBL* exceeded the second-largest *NPBL* by more than the factor 100 (1998 = 11, 2001 = 10, 2004 = 1) to avoid group dominance by a single corporation. A sensitivity check showed, however, that including these few outliers does not change the results.

[25] When calculating the average *ATR* we assumed a rate of zero for corporations with negative *NPBL*. To avoid problems with outliers, we dropped corporations with an exceptionally large or small average tax rate, exceeding 100 percent or –100 percent.

**Table 1**

Descriptive Statistics

| | 1998 | 2001 | 2004 | $\%\Delta_{2001}$ | $\%\Delta_{2004}$ |
|---|---|---|---|---|---|
| *TI* in €1,000 (average) | | | | | |
| All corporations | 127.26<br>(1,393) | 14.17<br>(1,134) | 14.83<br>(1,172) | –219.51 | –214.96 |
| Corporations with nonnegative *NPBL* | 345.46<br>(2,188) | 277.11<br>(1,417) | 290.03<br>(1,493) | –22.05 | –17.49 |
| Net profit before loss carry-over (*NPBL*) in €1,000 (average) | | | | | |
| All corporations | 321.21<br>(2,206) | 265.21<br>(1,402) | 238.11<br>(1,171) | –19.16 | –29.94 |
| Corporations with nonnegative *NPBL* | 488.60<br>(3,416) | 386.56<br>(1,924) | 338.69<br>(1,663) | –23.43 | –36.65 |
| Share of corporations reporting a positive *NPBL* | 0.554<br>(0.098) | 0.560<br>(0.098) | 0.579<br>(0.087) | 1.08 | 4.41 |
| *ATR* (average) | | | | | |
| All corporations | 0.1197<br>(0.048) | 0.0772<br>(0.030) | 0.0786<br>(0.028) | –43.86 | –42.06 |
| Corporations with nonnegative *NPBL* | 0.1986<br>(0.055) | 0.1231<br>(0.035) | 0.1231<br>(0.033) | –47.83 | –47.83 |

| | | | | | |
|---|---|---|---|---|---|
| Potential tax loss carry-forward in €1,000 (average) | | | | | |
| All corporations | 674.75<br>(2,648) | 700.44<br>(3,465) | 1,049.75<br>(5,994) | 3.74 | 44.20 |
| Corporations with tax loss carry-forward at the beginning of the year | 1,245.92<br>(6,391) | 1,466.15<br>(6,954) | 2,123.66<br>(13,485) | | |
| Number of groups | 1,137 | 1,137 | 1,137 | | |
| Number of groups containing only corporations with nonnegative *NPBL* | 1,074 | 1,074 | 1,074 | | |
| Number of corporations within each group | 641.61<br>(996) | 714.68<br>(1,120) | 750.03<br>(1,288) | 10.79 | 15.61 |
| Number of corporations | | | | | |
| All corporations | 701,971 | 809,641 | 860,315 | 14.27 | 20.34 |
| Corporations with nonnegative *NPBL* | 436,439 | 519,856 | 556,296 | 17.49 | 24.27 |
| Corporations with positive *NPBL* and without tax loss carry-forward | 243,364 | 280,155 | 306,669 | 14.08 | 23.12 |
| Corporations with tax loss carry-forward at the beginning of the year | 354,471 | 404,524 | 438,788 | 13.21 | 21.34 |

Notes: All information is at the aggregate level. Standard deviations of variables are in parentheses. The $\%\Delta_{2001}$ ($\%\Delta_{2004}$) value is the difference between logs in 2001 (2004) and 1998, e.g., $\%\Delta NPBL_{2001} = \log(NPBL_{2001}) - \log(NPBL_{1998})$.
Sources: Authors' calculations, based on German Federal Statistical Office and Statistical Offices of the Länder, and CIT statistics 1998, 2001, and 2004, as discussed in footnote 18.

the Tax Relief Act broadened the tax base and thus worked into the opposite direction. The marked decline in the average *NPBL* therefore occurred even though deductions for depreciation were reduced and economic activity, as measured by average sales in nominal terms, increased by roughly €18 million (as discussed in Table A2 in the Appendix).

The Tax Relief Act reduced the *ATR* by 4.25 percentage points on average, compared with a drop of the statutory tax rate by 20 percentage points for most corporations. Various factors contributed to this difference, which we exploit to identify the tax base elasticity; we discuss these factors in more detail in Section IV.B.2.

## B. Identification and Estimation

We identify the tax base elasticity by using the pseudo-panel structure of our corporate tax return data and the changes to the corporate tax system introduced by the Tax Relief Act during 1998–2001. Except for a cap on the use of tax loss carry-forward due to minimum taxation provisions that affected very few companies,[26] the rate and structure of the CIT did not change from 2001–2004. Because this period does not provide exogenous variation for the identification of tax effects, we rely only on exogenous changes in the CIT induced by the Tax Relief Act.

### *1. The German CIT System and the Tax Relief Act*

In Germany, as elsewhere, the CIT is levied on corporate enterprises, public and private limited companies, and other corporations (e.g., cooperatives, associations, foundations). Sole proprietorships and partnerships are not subject to the CIT; profits earned by an unincorporated firm are attributed to the firm's individual partners and taxed according to their personal income tax schedules. The assessment base of the CIT, or *TI*, can be derived from the amount of profits recorded in the tax balance sheet (Appendix A). Until 2000, the German CIT system was based on the tax credit method, such that the amount of CIT assessed was credited against the personal income tax of the shareholder, and retained earnings were subject to a higher tax rate than distributed profits (McDonald, 2001).

The Tax Relief Act eliminated the imputation system in favor of the half-income method. Since 2001, the tax rate on corporate income has been uniform and does not depend on a corporation's payout ratio. According to the half-income method, CIT is not allowable against other taxes and half of the dividends are subject to personal income tax.[27] In addition to significantly lowering the tax rate to 25 percent in 2001,[28] the reform

[26] Dwenger (2010) shows that the minimum taxation affected 1,800 companies in 2004; this corresponds to 0.2 percent of corporations subject to CIT in that year.

[27] Unfortunately, we do not have information about a corporation's shareholders. We neither know their participation quota nor have knowledge about other sources of income or their personal income tax. Personal income taxation in Germany is highly progressive and taxation partly depends on the participation quota. Therefore, without this information, we cannot include personal income taxation in our analysis.

[28] Since 2008, the uniform tax rate has amounted to 15 percent.

broadened the tax base, lowered depreciation allowances, introduced a requirement to reinstate original values, and cut the use of tax loss carry-backs.[29]

### 2. Exogenous Variation in the ATR Induced by the Tax Relief Act

The tax reform did not affect all corporations equally, and we observe substantial variation in the changes of their *ATR*s. First, every year, approximately 20 percent of German corporations use a tax loss carry-forward or carry-back to offset their current profits. These corporations do not pay any CIT and thus have an *ATR* of zero, which has remained unaffected by changes in the statutory tax rate. The use of tax loss carry-forward is not at the corporation's discretion though, because any unused tax loss carry-forward must be fully offset against current profits.

Second, the statutory tax rate and *ATR* in 1998 depended on the ratio between retained and distributed earnings. A corporation that distributed no earnings was subject to a CIT rate of 45 percent,[30] whereas one that distributed its whole profit was subject to a CIT rate of only 30 percent. Splitting the tax rate is a specific feature of the tax credit method. Therefore, the reduction in the *ATR* was much greater for corporations that retained most of their earnings compared with corporations that distribute all their profits.

Third, some corporations were entitled to reduced statutory CIT rates in 1998. Mutual insurance societies, private foundations, and business enterprises of public corporations 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 provided no reductions in statutory tax rates but instead applied the 25 percent tax rate equally to every corporation. Therefore, the reduction in the statutory tax rate and *ATR* between 1998 and 2001 was smaller for corporations that had benefited from reduced taxation in the past. Some corporations even saw their tax rate rise; for example, operators of merchant ships in international waters were liable for a reduced rate of 22.5 percent in 1998, but in 2001 they were subject to the universal tax rate of 25 percent.

Fourth, the change in the *ATR* depends on asset structures. For example, corporations with large real investments in both years saw their tax base broadened in 2001 because of the lower depreciation allowances for new acquired goods, compared with 1998.

Fifth, corporations that used a fiscal year different from the calendar year switched to the half-income method and 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. The reduction in the *ATR* for these corporations was in turn much smaller than that for corporations taxed according to the half-income method as of 2001.[31]

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[29] Until 1998, profits could be carried back two years up to a value of €5.1 million. In 1999, loss carry-back was restricted to one year. At the same time, it was reduced in volume; in 1999 and 2000, it was limited to €1 million and since 2001 it has been capped at €511,500 (Dwenger, 2010).

[30] In 1999 and 2000, the tax rate on retained earnings declined to 40 percent.

[31] Blasch and Weichenrieder (2007) present transitional rules and assess whether listed corporations align their fiscal year to the calendar year accordingly.

### 3. Instrumental Variable Estimation

Following the method used by Gruber and Saez (2002) and Gruber and Rauh (2007), we use the simulated *ATR* the corporation would have faced in 2001 if its real tax base had not changed endogenously during 1998–2001 as an instrument for a corporation's *ATR* in 2001. Thus, we only use changes in the tax law and macroeconomic effects that are exogenous to the individual corporation to identify the elasticity of the tax base with respect to the *ATR*. To compute simulated tax liabilities and the simulated *ATR*s, we use the business taxation microsimulation model BizTax.[32] The method first ages *NPBL* and all income-related components of the 1998 cross-section to 2001 values using a nominal growth rate that is exogenous to the individual corporation.[33] Thirteen inflation parameters pertain to different sources of income (e.g., profits and losses, dividends, and interest income from financial and non-financial corporations).[34] Using BizTax, we simulate the corporate tax liability according to the CIT law of 2001 based on the inflated income components. The simulated *ATR* for 2001 results from relating the simulated tax liability for 2001 to the inflated *NPBL* for 1998.

We note the concern that this simulated *ATR* is not completely exogenous for corporations that offset part (or all) of their profits in 1998 against losses from the past or 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. Because the Tax Relief Act broadened the tax base and increased *NPBL*, it produced an increase in the *ATR* which implied a larger volume of losses from other periods would be needed to offset the higher *NPBL*. Even if the tax losses carried forward (back) were sufficient in volume to (mainly) offset profits before the reform, they might no longer be so after the broadening of the tax base. In turn, the *ATR* would increase for corporations without sufficient losses and stay unchanged for those with abundant losses. Because the ability to offset the higher *NPBL* that resulted from the tax reform might be related to unobserved factors, which also could influence the tax base itself, we acknowledge that tax loss carry-forward or carry-back could be endogenous. To address this potential endogeneity, we inflate the amount of profits offset against losses from other periods in 1998 and use this amount

[32] BizTax is a microsimulation model for business taxation in Germany that is based on official tax return data and developed at DIW Berlin, in cooperation with the Federal Ministry of Finance. In addition to a detailed local business tax module, it contains a CIT simulation module that replicates the CIT assessed by tax authorities for more than 99 percent of all corporations; these corporations also account for more than 99 percent of the overall CIT revenue. BizTax can simulate the CIT liability of each corporation under past regulations, current law, and different tax reform scenarios. Currently the model does not predict companies' potential behavioral responses to tax reforms, such as changes in their financing and investment decisions or entries and exits.

[33] We assume that income growth factors do not depend on the level of corporate income in 1998, conditional on group fixed effects (Gruber and Saez, 2002).

[34] The computation of these parameters ensured that inflated profits and interest reflected changes in the corresponding aggregates in the national accounts and the German Bundesbank corporate balance sheet statistics.

as an upper limit in our simulation of a corporation's *ATR* for 2001.[35] In a similar vein, we use the inflated amount of allowable deductions effectively used in 1998 when we simulate the corporation's *ATR* for 2001.

In the estimation, we control for other factors that might correlate with both *NPBL* and *ATR*. For example, we estimate the regression of log(*NPBL*) on log(*ATR*) in first differences and allow for group fixed effects that may be correlated with *ATR*. To control for time-varying factors, we include the number of corporations within a group, the share of corporations still taxed under the tax credit method in 2001, and average sales within a group. These variables also help control for changes within groups in the observation period, which could affect the efficiency of our estimates, especially the standard error of the estimated tax base elasticity. The information on sales came from the value-added tax (VAT) statistics of the German Federal Statistical Office, which were available at the same level of aggregation we used to construct our pseudo-panel data.[36] For a few industries that are not subject to the VAT, we lack information on sales; some industries have VAT liability for only part of their sales so we include an interaction term between VAT liability and group sales.

As noted earlier, we restrict our regression analysis to corporations with positive *NPBL*. In an alternative model specification, we control for potential selection effects by including the change in the share of corporations that report positive profits within the groups during our observation period.

Using our pseudo-panel and taking first differences of equations in log-levels, we derive an estimating equation

$$(3) \quad \log\left(\frac{NPBL_{g,t}}{NPBL_{g,1998}}\right) = \alpha + \beta \log\left(\frac{ATR_{g,t}}{ATR_{g,1998}}\right) + \gamma' \Delta x_g + u_g, \quad t = 2001, 2004,$$

where $\alpha$ is a constant, $\beta$ is the corporate tax base elasticity we estimate, $\gamma$ is a column vector of regression coefficients, and $\Delta \boldsymbol{x}_{\mathbf{g}}$ is a column vector composed of first differences of the control variables in group *g*. Furthermore, $u_g = u_{g,t} - u_{g,1998}$ is a first-differenced error term for each group, which may or may not be serially correlated but, conditional on $\Delta \boldsymbol{x}_{\mathbf{g}}$, is assumed to be uncorrelated with the change in the *ATR*. Because we estimate the equation in first-differences for two periods only, the constant $\alpha$ captures the overall time trend for 1998–2001 (2004).

We report simple OLS and two-stage least squares (2SLS) regression results. In the 2SLS regression, the *ATR* for 2001 (2004) in the relative change in *ATR* is instrumented with the simulated *ATR* for 2001 (2004). Because the rate and the structure of the CIT

[35] Because our microsimulation tax model does not include a switching rule between loss and profit, we assume a corporation reporting a profit in 1998 does so in 2001 as well.

[36] English-language information on these data is available at "Turnover Tax." Federal Statistical Office, http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/Navigation/Statistics/FinanzenSteuern/Steuern/Umsatzsteuer/Umsatzsteuer.psml.

did not change from 2001–2004, any differences in the estimated $\beta$ coefficients for the regressions in 1998–2001 and 1998–2004 indicate deviations of short-run versus long-run tax elasticities, assuming that all non-tax factors that influence corporate income are adequately controlled for in the estimation.[37] We also estimate separate elasticities according to characteristics that may relate to the ability to shift income, such as economic sector, average size of the corporations within sectors, or the intensity of FDI.

## V. ESTIMATION RESULTS

### A. Basic Regression Results

The simple correlation of changes in the corporate tax base, as measured by positive *NPBL*, and the *ATR* from 1998–2001 is positive and significant (coefficient of 0.240, *t*-value of 2.21); including control variables slightly reduces the coefficient to 0.164, which becomes statistically insignificant (*t*-value of 1.25). This result reproduces the correlation structure observed in our data (Table 1), that is, the decline in both *NPBL* and *ATR*.

As we noted previously, we did not expect OLS regressions of the change in *NPBL* on the change of the *ATR* to identify the tax base elasticity. Standard Hausman-Wu endogeneity tests strongly indicate that *ATR* is an endogenous variable, and that the OLS estimates of the tax elasticity are inconsistent. In particular, including the residual from a first-stage regression of $\log(ATR_{g,2001} / ATR_{g,1998})$ on the control variables $\Delta \boldsymbol{x}_g$ in the structural equation yields a *t*-value of 18.3; a standard Hausman test is significant at the 1 percent level (*p*-value = 0.0106).

Table 2 summarizes the 2SLS regression results for the model in (3).[38] We focus on 1998–2001, a period during which we observe exogenous changes in the *ATR* induced by the tax reform; we check whether our estimation results change when we extend the observation period to 2004 (column 6). To account for heteroskedasticity due to differences in group size and possibly serial correlation of the error terms, we report the robust standard errors of estimated coefficients in all regressions.

Before we comment on the 2SLS estimation results in Table 2, we consider the results of the first-stage regression with the simulated *ATR* as our instrument for the *ATR* actually observed in 2001. The simple correlation between the relative change in the *ATR* actually observed and the one obtained by the simulated *ATR* for 2001 is quite strong. In the first-stage regression including all control variables, the $R^2$ is almost 0.5, and the

[37] Although the average *ATR* did not change between the two years, we note some small time variation in the *ATR* due to changes in loss carry-forward, accounted for by including the simulated *ATR* for 2004 in the regression.

[38] Because *NPBL* is 0 even at the group level in a few cases, we could not have used these observations in the estimation with logs so we approximated $\log(NPBL_{g,t} / NPBL_{g,1998})$ and $\log(ATR_{g,t} / ATR_{g,1998})$ by, respectively, $[(NPBL_{g,t} - NPBL_{g,1998}) / 0.5(NPBL_{g,t} + NPBL_{g,1998})]$ and $[(ATR_{g,t} - ATR_{g,1998}) / 0.5(ATR_{g,t} + ATR_{g,1998})]$. A sensitivity check shows that restricting the sample to groups with positive *NPBL* and estimating the log-log specification does not significantly change estimation results.

**Table 2**

Basic Regression Results

| Dependent variable: $\log(NPBL_{g,t}/NPBL_{g,1998})$ | $t = 2001$ | | | | | $t = 2004$ |
|---|---|---|---|---|---|---|
| | 2SLS | | | | | 2SLS |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\log(ATR_{g,2001}/ATR_{g,1998})$ | –0.314 | –0.347 | –0.318 | –0.533 | –0.487 | |
| | (0.180) | (0.178) | (0.178) | (0.197) | (0.196) | |
| $\log(ATR_{g,2004}/ATR_{g,1998})$ | | | | | | –0.589 |
| | | | | | | (0.278) |
| Share of corporations under the tax credit method | | 0.528 | 0.638 | 0.947 | 0.880 | |
| | | (0.448) | (0.433) | (0.447) | (0.446) | |
| Change in the number of corporations in the group | | –0.007 | 0.146 | 0.046 | 0.032 | –0.022 |
| | | (0.104) | (0.099) | (0.100) | (0.100) | (0.076) |
| Dummy indicating groups that contain exclusively firms located in Western Germany | | 0.076 | 0.104 | 0.060 | 0.054 | –0.047 |
| | | (0.041) | (0.041) | (0.041) | (0.041) | (0.040) |
| Change in sales | | 0.185 | | 0.174 | 0.183 | 0.348 |
| | | (0.100) | | (0.103) | (0.102) | (0.069) |
| Interaction term between changes in sales and dummy indicating industries whose sales are not fully subject to VAT | | 0.137 | | 0.146 | 0.137 | 0.059 |
| | | (0.121) | | (0.124) | (0.123) | (0.015) |
| Change in the share of firms reporting positive *NPBL* | | | | 1.440 | 1.331 | 1.191 |
| | | | | (0.453) | (0.460) | (0.533) |
| $NPBL_{g,1998}$ in €billion | | | | | –0.010 | |
| | | | | | (0.004) | |
| Constant | –0.166 | –0.257 | –0.258 | –0.320 | –0.289 | –0.891 |
| | (0.085) | (0.094) | (0.094) | (0.100) | (0.099) | (0.128) |
| Number of observations | 1,074 | 1,065 | 1,074 | 1,065 | 1,065 | 1,065 |

Notes: All regressions are based on corporations with nonnegative *NPBL*. Heteroskedasticity-consistent robust (Huber-White) standard errors are in parentheses.

Sources: Authors' calculations based on German Federal Statistical Office and Statistical Offices of the Länder; CIT statistics 1998, 2001, and 2004 as discussed in footnote 18; and value-added tax statistics 1998, 2001, and 2004, discussed in footnote 36.

coefficient of our instrument achieves a *t*-statistic of approximately 30. We calculated the partial $R^2$ for our instrument to test for the relevance of the instruments explicitly in our multivariate setting — as suggested by Shea (1997) and Godfrey (1999) — and obtained a value of 0.42. Our instrument thus is highly correlated with the change in the actually observed *ATR* and our 2SLS estimation is not likely to suffer from the weak instrument problem (Stock, Wright, and Yogo, 2002).[39]

As a benchmark, column 1 reports the 2SLS estimation results without control variables. The estimated tax base elasticity is negative, with a point estimate of –0.31, which is statistically different from zero at the 10 percent level (two-sided test, *t*-value = –1.75). Adding the control variables leaves the point estimate of the estimated tax base elasticity in column 2 virtually unchanged but reduces its estimated standard error; the elasticity becomes significant at the 5 percent level (*t*-value = –1.96).[40]

The only control variable that seems significant in the regression is the relative change of sales: a 10 percent increase in sales raises the tax base by approximately 2 percent. As described earlier, the sales variable is derived from VAT statistics, the only data source available at a level of aggregation that matches the data in our pseudo-panel. In Germany, exports are exempt from VAT and thus not included in our sales variable, which potentially introduces measurement error. However, assuming export shares did not change in the observation period, this measurement error should be accounted for by the group fixed effects. This assumption also holds for shocks to the corporate tax base, which may affect the volume of sales as long as this relation has not changed during the observation period.

Since both these assumptions clearly could be questioned, we estimated the regression without the potentially endogenous sales variable (and the interaction term). In column 3, this approach has virtually no effect on the estimated tax base elasticity and a change in the *ATR* appears to have little effect on sales. We interpret this evidence to suggest that the change in the *ATR* affects the corporate tax base through income-shifting responses rather than real responses related to changes in the volume of sales.[41]

Another potential bias may result from a selection effect; we only include corporations with nonnegative *NPBL*. If this selection is determined by fixed group effects, our first-difference estimation should control for it. However, we cannot rule out the possibility that the factors that affect this selection change over the observation period. Because we do not observe factors that might correlate with time-varying selection, we

[39] The full first-stage regression results are available in a web appendix at http://www.wiwiss.fu-berlin.de/en/institute/wirtschaftspolitik-geschichte/steiner/index.html.

[40] As a sensitivity check, we included the square of the tax variable to identify any non-linear effects of tax changes on changes of the corporate tax base. The estimated coefficients of the linear and quadratic terms of the tax variable remained jointly statistically significant at the 10 percent level and the estimated elasticities, evaluated at the sample means, were virtually identical in the two specifications.

[41] A bivariate instrumental variable regression of the relative change in total sales from 1998–2001 on the relative change of the *ATR* in this period with the same instrument as in the tax base regression yielded a coefficient estimate of 0.056 with a *t*-value of 0.38.

cannot control for them using a formal selectivity correction (i.e., standard Heckman selection procedure). We can, however, approximate the selection term as the average probability of nonnegative *NPBL* in a group, in terms of the share of corporations that report nonnegative *NPBL* in a given year (column 4). The change of the share of corporations with positive *NPBL* is highly significant and has a relatively strong effect on the elasticity estimate; it increases in absolute value to –0.533, with a *t*-value of –2.7.[42]

The change in tax base in the observation period may correlate with its level in 1998, perhaps due to a regression-to-the-mean effect (Gruber and Saez, 2002, discuss this issue in a related context). To account for potential changes in tax base over time with respect to the initial tax base, we control for the first-period *NPBL* in column 5. Including the level of the tax base in 1998 has virtually no effect on the estimated tax base elasticity (point estimate = –0.487). We interpret this information as alleviating potential concerns about the exclusion of lagged levels of the tax base from our estimating equation and maintain our focus on the estimation results of column 4.

The last column in Table 2 shows that the point estimate of this elasticity changes little when we extend the estimation period to 1998–2004, which gives more time for firms to adjust to the tax reform.[43] The limited independent variation in the *ATR* in this latter period implies that the estimated standard error of this long-run elasticity increases substantially, and its point estimate is not statistically different from our preferred elasticity estimate in column 4. We obtained similar results when we estimated the alternative specifications of our basic regression model for the extended time period.[44]

An alternative to the two-period first-difference estimator is a group fixed effects regression using all three years and including year fixed effects. Estimating (3) in levels, including group fixed effects and two time dummies, yields an estimated $\beta$ of –0.744 with a (robust) standard error of 0.655. This extremely large standard error results from the insufficient independent variation in the *ATR* within groups during 2001–2004 and suggests that the identification of tax effects requires exogenous changes induced by a major tax reform. We therefore maintain our focus on the estimation results for 1998–2001.

Although somewhat sensitive to the treatment of corporate losses, our 2SLS estimates suggest a relatively strong elasticity of the tax base, as measured by *NPBL*, to a corporation's *ATR*. Tax policy directly affects the statutory CIT rate rather than the *ATR*, which is determined by the interaction between the statutory tax rate and the tax base, and is targeted at taxable income driving tax revenues rather than *NPBL*. To determine

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[42] Adding the squared selection term leaves our estimation results unchanged. The coefficient for the tax base elasticity is –0.529 with a *t*-value of –2.70.

[43] The point estimate for sales from 1998–2004 approximately doubles that of the 1998–2001 period. A bivariate regression of the relative change in total sales over 1998–2004 on the relative change of the *ATR* in this period — the same instrumental variable as in the tax base regression — results in a coefficient of –1.426 (*t*-value = –2.19). Unlike in the short run, a change in the *ATR* may influence real activity in the long term. Reestimating column 6 without changes in sales and the related interaction term still indicates not much effect on the elasticity of the CIT base: the tax base coefficient is –0.496, with a *t*-value of 1.77.

[44] These regression results are available in a web appendix at http://www.wiwiss.fu-berlin.de/en/institute/wirtschaftspolitik-geschichte/steiner/index.html.

the elasticity of *TI* with respect to the statutory CIT rate, we calculate $\eta_{TI,\tau} \equiv (\Delta TI/\Delta\tau) \times (\tau/TI)$ by multiplying our elasticity estimate, $\eta_{NPBL,ATR}$, by the product of the elasticity of *TI* with respect to *NPBL* ($\eta_{TI,NPBL}$) and the elasticity of the *ATR* with respect to the statutory corporate tax rate ($\eta_{ATR,\tau}$).

As we discussed in Section III.B, only in the unlikely case that deductions and allowances are proportional to *NPBL* and in the absence of loss carry-forward and loss carry-backward is there a simple relationship among changes in the statutory corporate tax rate, the tax base elasticity, and change in tax revenues. In this case, $\eta_{TI,NPBL} = \eta_{ATR,\tau} = 1$, and our preferred estimate of $\eta_{NPBL,ATR} = -0.53$ implies a reduction of the statutory tax rate by 10 percent would result in an increase of *TI* by 5 percent. However, because the deductions are not proportional to *NPBL*, and considering the importance of loss carry-forward, we need estimates of $\eta_{ATR,\tau}$ and $\eta_{TI,NPBL}$ to calculate $\eta_{TI,\tau}$. Again turning to our corporate tax microsimulation model BizTax, we find $\eta_{ATR,\tau} = 0.855$ and $\eta_{TI,NPBL} = 1.062$.[45] With these estimates and our preferred estimate for $\eta_{NPBL,ATR}$, we find that a 10 percent reduction of the statutory tax rate increases *TI* by 4.8 percent and $\eta_{TI,NPBL}$ to calculate $\eta_{TI,\tau}$, which is only slightly smaller than the estimate we obtained with an assumption of proportionality of deductions and *NPBL*. Thus, we may conclude that, at least for our application, $\eta_{NPBL,ATR} \cong \eta_{TI,\tau}$.

How does this tax base elasticity compare with that obtained by Gruber and Rauh (2007)? They report an elasticity estimate of 0.2, yet their estimate refers to the elasticity of taxable income with respect to the net-of-marginal CIT rate. The statutory and marginal tax rates are (slightly) progressive in the United States, whereas the statutory corporate tax is constant in Germany. Further, Gruber and Rauh base their estimation on the effective net-of-tax rate while we focus on the average *ATR*.[46] To make the two estimates roughly comparable, we calculate $\eta_{TI,1-\tau} \equiv (\Delta TI/\Delta(1-\tau)) \times ((1-\tau)/TI) = (-1) \times \eta_{TI,\tau} \times (1-\tau)/\tau$. Multiplying $\eta_{TI,\tau} = -0.48$ by $(-1) \times (1-\tau)/\tau = (-1) \times (1-0.45)/0.45 = -1.22$ yields the elasticity of taxable income with respect to the net-of-tax rate, $\eta_{TI,1-\tau} = -.48 \times -1.22 = 0.58$.[47] This net-of-tax rate elasticity — which is comparable to the estimate obtained by Gruber and Rauh (2007) — is more than double their estimate of 0.20 for U.S. data.

We highlight two main reasons for this difference, apart from the obvious differences in the two countries. First, their study is based on accounting data and only covers part of the corporate sector. In the United States, companies that choose to be organized as S-corporations are taxed solely under the personal tax code, whereas in Germany corporations cannot adjust along this margin. For this reason we would expect a smaller

[45] These simulations assume any response to a tax rate change is accounted for by the estimated tax base elasticity.

[46] Note that if increases in *NPBL* do not increase *TI*, these increases effectively face a zero marginal tax rate. Conversely, increases in *NPBL* that are fully driven by *TI* face a marginal tax rate larger than the *ATR*. This might also partly explain the larger elasticity estimate we obtain relative to the one reported by Gruber and Rauh.

[47] The factor (1 – 0.45) / 0.45 refers to the statutory CIT rate for retained profits in 1998.

elasticity for the United States. It should be noted, however, that the data used by Gruber and Rauh only include publicly traded C-corporations; how this data restriction affects the estimated elasticity is unclear. Second, their effective tax rate measure mainly affects marginally profitable investments and does not account for various tax shields, such as the tax loss carry-forward.

Let us now turn back to our estimate of the tax base elasticity with respect to the *ATR*, which also can answer questions about how changes in the statutory tax rate affect corporate tax revenues (as shown in (1)). Taking our elasticity estimate of –0.5 and assuming for simplicity that proportionality exists between deductions and *NPBL*, we expect that a 10 percent reduction of the statutory corporate tax rate reduces corporate tax revenues by 5 percent. This amount is only half the loss in tax revenues that results from a tax rate reduction, in the absence of any income shifting and real responses of corporations to the tax change.

Thus, our estimate implies tax rate reductions are partly self-financing, but it does not support recent Laffer curve estimates for the corporate sector (Clausing, 2007; Devereux, 2007; Brill and Hassett, 2007), which imply that a reduction of the statutory CIT rate increases corporate tax revenues. Even though the revenue decline was much smaller than it might have been in the absence of any behavioral response,[48] consistent with our empirical tax base elasticity measure, we did not observe any increase in corporate tax revenues in this period.

Although our estimated average elasticity is not compatible with a Laffer curve effect for the corporate sector overall in Germany, certain subgroups may be more responsive to tax rate changes. That is, the average tax base elasticity may hide important differences across corporations, and such heterogeneity may provide crucial information for developing tax policy. In particular, the tax base elasticity may differ according to income-shifting opportunities.[49] We undertake further estimations to account at least partially for potential heterogeneity in tax base elasticities.

### B. Heterogeneous Tax Base Elasticities

In Table 3, we report the estimated tax base elasticities by subgroups, according to our preferred model specification in column 4 of Table 2. The first panel summarizes the estimation results when we account for differences in the average size of corporations within groups. Large corporations might have better tax-shifting opportunities than small firms, as well as more means at their disposal to take advantage of these opportunities. For example, firms might face fixed costs to set up affiliates to use as

[48] In 1998, the CIT assessed was €30.56 billion, while it amounted to €24.79 billion in 2001, i.e., CIT assessed declined by €5.77 billion. Without any tax base effects the reduction in the CIT rate by 44 percent would have resulted in a decline of CIT assessed by 0.44 × €30.56 billion = €13.45 billion.

[49] In his study of the elasticity of taxable personal income with respect to the personal marginal income tax, Kopczuk (2005) shows that the size of this elasticity depends on the degree to which induced changes in the tax base vary across taxpayers.

**Table 3**

Tax Base Elasticities by Subgroups: 2SLS Estimation

(Dependent Variable: log ($NPBL_{g,2001}$ / $NPBL_{g,1998}$))

| Subsample by … | $\log\left(\frac{ATR_{g,2001}}{ATR_{g,1998}}\right)$ | *F*-Test of Significant Difference Between Subsamples (*p*-Value) | N |
|---|---|---|---|
| *Equity capital* | | | |
| ≤ median | –0.288 | 1.80 | 535 |
| | (0.211) | (0.181) | |
| > median | –0.524 | | 530 |
| | (0.347) | | |
| *Sector* | | | |
| Farming, forestry, mining/trade, and services | –0.329 | 2.88 | 673 |
| | (0.221) | (0.090) | |
| Manufacturing | –0.634 | | 392 |
| | (0.382) | | |
| *FDI-to-equity ratio* | | | |
| ≤ median | –0.415 | 3.84 | 548 |
| | (0.231) | (0.050) | |
| > median | –0.696 | | 517 |
| | (0.358) | | |
| *Debt-to-equity ratio* | | | |
| ≤ median | –0.649 | 1.52 | 506 |
| | (0.311) | (0.218) | |
| > median | –0.260 | | 504 |
| | (0.284) | | |

Notes: All regressions are based on corporations with nonnegative *NPBL*. Regressions include a constant and the control variables from column 4 of Table 2. Robust standard errors are in parentheses below the coefficient estimates. The *F*-test refers to the joint test of significance of the tax rate coefficient and the interaction between the tax rate and the respective variable. The *p*-values for the test appear in parentheses below the *F*-test statistic.

Sources: Authors' calculations based on German Federal Statistical Office, CIT statistics 1998 and 2001, discussed in footnote 18; value-added tax statistics 1998 and 2001, discussed in footnote 36; local business tax statistics 1998, discussed in footnote 55; data from the German Bundesbank; and the micro database FDI 1998, discussed in footnote 53.

tax shelters and tax shifting costs per euro also might decline with the volume of tax avoidance. To measure such scale effects we use average equity capital,[50] measured at the beginning of our observation period to avoid the potential endogeneity of changes in the *ATR* and equity in the observation period. By splitting the sample at the median in terms of equity capital, we find that the corporate tax base of larger firms (–0.52) tends to be more elastic than that of smaller companies (–0.29). This difference, however, is not statistically well determined in our sample (*F*-test = 1.80),[51] i.e., we cannot reject a null hypothesis of no difference in tax base elasticities between smaller and larger firms.

Next we investigate whether manufacturing firms are more sensitive to the *ATR* than firms in the service sector are. Studying multinational firms' investment in tax havens, Gumpert, Hines, and Schnitzer (2011) find that for manufacturers the probability that a firm invests in a tax haven positively depends on taxation in non-haven countries. In contrast, for firms in the service sector taxation in non-haven countries does not influence tax haven investment, despite their widespread presence in tax havens. The authors argue that this finding is due to service firms' low fixed cost of setting up a tax haven affiliate; manufacturers face higher fixed costs in setting up an affiliate so that only those firms which have a large tax incentive for tax haven investment choose to bear these costs. If this relationship holds true we expect manufacturing firms to react more strongly to a change in the *ATR* than firms in the service sector or in agriculture.

Estimation results are given in the second panel of Table 3. Because there are few groups in farming, forestry, and mining, we aggregate them with the service and trade sector.[52] When we split the sample by sector and estimate the regression model separately, we find that the tax base effect in manufacturing is greater than in the agriculture and service sectors. The point estimates imply a tax base elasticity of –0.63 in manufacturing (statistically significantly different from 0 at the 5 percent level, two-sided test), compared with only –0.33 in the combined agriculture and service sector (marginally significant at the 10 percent level). The relatively large estimated standard errors prevent us from detecting statistically significant sector differences in the estimated tax base elasticities. Although the coefficient of the tax variable and the sector interaction term are jointly significant at the 10 percent level (*F*-value = 2.88), the coefficient of the interaction term is not significant (*t*-value = –0.58). In other words, the data do not reject pooling the two sectors and estimating the tax base elasticity on this pooled

[50] The data set records the amount of equity capital at the individual corporation level as the sum of retained earnings and contributions to capital if they occurred after the company was founded and after 1977. We approximate the average corporate capital stock within each group by adding the legal minimum deposit, which amounts to €25,000 for private limited-liability companies and €50,000 for public companies.

[51] The *F*-test applies to a regression that includes an interaction term between the *ATR* and the equity ratio, where the interaction term also is instrumented by the interaction between the simulated *ATR* and the equity ratio.

[52] Excluding corporations in farming, forestry, and mining from the estimation sample as a robustness check had very little effect on the estimation results.

sample. We believe that this finding mainly reflects the strong heterogeneity (high error variance) within sectors, though the sample size of our pseudo-panel puts tight limits on possibilities for further sector differentiation.

Another relevant differentiation of groups, suggested by the recent literature on international tax competition and FDI, distinguishes by FDI intensity within groups (e.g., Hines, 1999; Bartelsman and Beetsma, 2003). We might expect corporations that undertook relatively significant FDI in the past to have better future opportunities to reduce their tax liabilities at home through transfer pricing, debt shifting, and other tax shields provided by affiliates abroad. Thus, future changes in tax rates might have stronger effects, ceteris paribus, on corporations with a relatively large FDI stock.

To test this hypothesis we obtained group-level FDI information from the Micro-database Direct Investment (MiDi) of the German Bundesbank. These data include information on German parent corporations and their foreign affiliates. The parents are required by law to report information on their FDI if the balance sheet total of the affiliate and the ownership share are larger than a given threshold (Lipponer, 2003).[53] The information is available at a slightly more aggregate level than our grouping,[54] but on the basis of this information, we can calculate the ratio of FDI to equity capital in 1998 and define two subsamples, one with an FDI ratio less than or equal to the median, and one with an FDI ratio above the median.

The estimation results for these two subsamples, summarized in the third panel of Table 3, are compatible with the hypothesis that corporations with large direct investments abroad and thus better profit-shifting opportunities respond more strongly to changes in the *ATR* than do groups with a lower level of FDI. For industries in the upper part of the FDI distribution, the point estimate implies a tax base elasticity of approximately –0.70, compared with –0.42 for groups with an FDI share below the median. Again, this difference is poorly determined statistically in our sample. The coefficient on the tax variable and the FDI interaction term are jointly significant at the 5 percent level ($F$-value = 3.84) in the pooled regression, but the coefficient of the interaction term is not statistically significantly different from 0. Nor can we reject the hypothesis that the average tax base elasticity of firms with a high FDI ratio is –1 and that it is 0 in the sector with a low ratio; our elasticity estimates differentiated by subgroups are not precise enough to distinguish these alternative hypotheses. The average tax base elasticity across both groups remains at –0.5.

We also test the hypothesis that corporations benefiting from tax shields react less to changes in tax rates. Interest on a corporation's debt may act as such a shield; we expect

[53] The threshold varies over time. In 1998, reporting was mandatory if the foreign affiliate's balance sheet total exceeded €5.1 million and ownership shares/voting rights of the German parent company were between 10 percent and 50 percent. If the foreign affiliate's balance sheet total was between €0.5 million and €5.1 million, reporting was only necessary if owenership shares/voting rights were above 20 percent. Researchers have access to the data, "Micro Data." Deutsche Bundesbank, http://www.bundesbank.de/vfz/vfz_forschungsdaten_einzeldaten.en.php.

[54] The MiDi data do not allow aggregation by federal states or industries at the four- or five-digit level. To merge the MiDi data with our pseudo-panel, we impute the FDI per sales share from the MiDi data at the three-digit industry level for Germany overall to the four- and five-digit level.

the tax base of corporations with a relatively high debt-to-equity ratio to respond less to tax changes than would corporations that can take less advantage of this particular shield. The reason for this is that a corporation with deductions for interest payments is subject to a lower *ATR* when compared to a company without such a tax shield, implying that the reduction in the statutory tax rate is less valuable to the debt-financed corporation. At the group level, we measure the tax shield as the amount of interest paid by a corporation on its long-term debt relative to its equity capital.[55] Interest should be proportional to the level of corporate long-term debt, so we refer to this variable as the debt/equity ratio. The estimation results in the lower part of Table 3 support the hypothesis that corporations with tax shields react less strongly, as the point estimate of the tax base elasticity for groups with a relatively high debt-to-equity ratio is –0.26, not statistically different from 0, and much lower than the estimated elasticity for the comparison group (–0.65). However, the large standard errors of these estimates again do not enable us to reject the hypothesis that estimated tax base elasticities do not differ between the two groups ($F$-test = 1.52).

Overall, we find some suggestive evidence of differences in tax base elasticities with respect to variables related to income-shifting activities and tax shields, such as the sector, a corporation's size, its FDI intensity, and its capital structure. Yet these differences are not statistically significant. This insignificance probably reflects the limitations of our relatively small pseudo-panel data set, which does not allow us to split the sample effectively into smaller subgroups. In addition, instrumental variable estimators tend to yield fairly large standard errors of estimated coefficients in small and medium-sized samples. Our preferred specification thus implies that the average corporate tax base elasticity is –0.5 and there is relatively little variation across industries in terms of sector, size, capital structure, or FDI intensity.

## VI. CONCLUSION

This study contributes to the small empirical literature that investigates the elasticity of the corporate tax base with respect to the corporate tax rate. Knowledge of the magnitude of this elasticity is important for evaluating the revenue and welfare implications of

[55] Information about interest on long-term debt is not available in the corporate income tax statistics but can be derived from local business tax statistics, which cover the same population of corporations and are available for the same years as the corporate tax statistics. The two statistics cannot be matched on the micro level, however, so we imputed information on interest payments from the local business tax statistics using the same aggregation scheme as for our pseudo-panel data (Section IV.A.1). Access to the micro-level data of the local business tax statistics is provided by "Research Data Centres of the Statistical Offices." The Federal and State Statistical Offices, www.forschungsdatenzentren.de. English-language information about these data is available at "Trade Tax." Federal Statistical Office, http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/Navigation/Statistics/FinanzenSteuern/Steuern/Gewerbesteuer/Gewerbesteuer.psml. Equity capital may be negative due to differences in tax and commercial balance sheet valuations, as well as the transition rules from the tax credit to the half-income method. As a sensitivity check, we included the rare cases with negative equity capital in the estimation sample; they had almost no effect on the tax base elasticity in the subgroup with a relatively low debt-to-equity ratio.

corporate tax policies. An important advantage of the tax return data used in this study is that they enable calculation of *ATR*s and the CIT base taking into account various tax shields, including unused loss carry-forwards that are of great quantitative importance for the corporate sector in the German economy for the time period analyzed. For the estimation, we used a pseudo-panel constructed from our aggregation of individual-level corporate tax return data into groups defined by industry and region. With this pseudo-panel, we can control for unobserved group fixed effects, which may correlate with both the corporate tax base (i.e., *NPBL*) and the *ATR*.

The main methodological concern for our estimation of this elasticity is the potential endogeneity of the *ATR*, which is partly determined by taxable income. To control for this, we used as an instrumental variable the counterfactual *ATR* a corporation would have faced in a particular period had there been no change in profits within the corporation's control during the period. This counterfactual value stems from a microsimulation model of the corporate sector, based on tax return data for 1998 and 2001. During this period, the German government introduced a substantial tax reform that provided sufficient exogenous variation in *ATR*s across corporations to identify the corporate taxable income elasticity. Statistical tests indicate our instrument is highly correlated with the change in the actually observed *ATR,* and that the well-known weak instrument problem does not invalidate our instrumental variable estimation.

Our 2SLS estimation of the basic regression model with the whole sample yields a statistically significant, relatively large point estimate of the tax base elasticity of approximately –0.5, implying that a reduction of the (proportional) statutory corporate tax rate by 10 percent would reduce corporate tax receipts by roughly 5 percent. Converting our estimate into the elasticity of taxable income with respect to the net-of-tax rate yields an estimate of 0.6, on average. This is more than double the estimate obtained with the net-of-tax rate for the United States by Gruber and Rauh (2007). Thus, our estimates imply that reductions of the statutory corporate tax rate are roughly one-half self-financing, in that they significantly reduce corporate income-shifting and other activities that lower the CIT base, but the German corporate sector is not on the declining segment of its Laffer curve. Because the estimated tax base elasticity is not sensitive to the growth rate of sales at the industry level, we interpret the response of the tax base to changes in the *ATR* as primarily a result of income-shifting activities, rather than real economic responses by the corporate sector related to sales volume (for discussions of taxable income elastiticies in the United States, see Gravelle (2007) for the CIT, Kopczuk (2005) for the personal income tax).

We find some tentative evidence that certain subgroups of corporations may be much more responsive to tax rate changes than the average tax base elasticity for the whole corporate sector indicates. The estimation results regarding heterogeneous tax base elasticities are consistent with the hypothesis that the tax base is more elastic among corporations that can benefit from income shifting, such as large corporations and corporations with a relatively high share of FDI. We also find evidence that manufacturers which might face higher fixed costs in setting up new affiliates react more strongly to tax incentives in their home country, compared to firms in the primary and tertiary sector.

As we expected, the tax base of corporations with a relatively high debt-to-equity ratio responds less to tax changes. However, the weak statistical precision of these results prevents us from drawing overly strong conclusions from our pseudo-panel. Testing hypotheses about these differential effects across firms with greater statistical precision would require a true panel of corporate tax return data, which currently is not available for most countries, including Germany.

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## APPENDIX

**Table A1**

Components of the Corporate Tax Base and Corporate Income Tax Assessed

| | |
|---|---|
| | ***Sales*** |
| +/– | deductions such as interest payments and depreciation allowances, etc. |
| | ***Profit as shown in tax balance sheet*** [1] |
| +/– | correcting entry concerning valuation (adjustment of values of balance sheet items, non-tax-deductible losses, non-tax-relevant gains, etc.) |
| + | correction of activities related to shareholders (declared profit distributions, constructive dividends, repayment of capital or capital increase, hidden contribution, other deposits under company law) |
| + | nondeductible operating expenses (especially taxes paid, 50 percent of payment to members of the supervisory board, and penalties) |
| +/– | non-tax-relevant domestic increases and decreases in net worth (intercompany dividends, investment subsidies) |
| +/– | corrections related to double taxation agreements, tax legislation relating to non-residents, and fiscal units |
| = | ***Net profit before consolidation and loss carry-over*** |
| – | allowable deductions for agriculture and forestry |
| – | deductible donations and contributions |
| +/– | income generated by fiscal subsidiaries |
| = | ***Net profit before loss carry-over (NPBL)*** |
| – | loss carry-forward and loss carry-back |
| = | ***Net Income*** |
| – | allowable deductions for agricultural cooperatives |
| = | ***Taxable Income* (*TI*)** |
| * | statutory tax rate |
| – | tax credits for foreign-source income |
| = | ***Corporate income tax assessed* (*TA*)** |

[1] The basis for computing a corporation's profit as shown in the tax balance sheet is its commercial (financial) balance sheet, with adjustments prescribed by tax law. These adjustments are necessary as commercial law usually permits greater latitude in the valuation of assets, accruals, and liabilities than tax law. Because the commercial balance sheet is based on historical book values, neither commercial nor tax balance sheets include unrealised profits and losses; profits are rather determined on an accruals basis. The European Commission (2005) provides details on the concept of tax balance sheet in Germany and on the amendments necessary between commercial and tax balance sheet.

## Table A2

Descriptive Statistics for Control Variables: Aggregate Level

| | 1998 | 2001 | 2004 | $\Delta\ \%_{2001}$ | $\Delta\ \%_{2004}$ |
|---|---|---|---|---|---|
| Share of corporations under the tax credit method | 1.000 (0.000) | 0.065 (0.051) | 0.000 (0.000) | –273.34 | |
| Number of corporations within each group | 641.61 (995.65) | 714.68 (1,120.32) | 750.03 (1,287.54) | 10.79 | 15.61 |
| Share of groups that contain exclusively firms located in Western Germany | 0.217 (0.413) | 0.217 (0.413) | 0.217 (0.413) | 0.00 | 0.00 |
| Sales in €million (average) | 131.35 (381.56) | 149.79 (452.01) | 119.03 (350.38) | 13.14 | –9.85 |
| Share of groups whose sales are not fully subject to sales tax | 0.173 (0.378) | 0.173 (0.378) | 0.173 (0.378) | 0.00 | 0.00 |
| Sales × share of groups not fully subject to sales tax | 118.74 (354.81) | 130.71 (411.76) | 94.77 (287.95) | 9.60 | –22.55 |
| Share of corporations reporting a positive *NPBL* | 0.938 (0.053) | 0.905 (0.075) | 0.922 (0.062) | –3.58 | –1.72 |
| *Sector dummies* | | | | | |
| Farming, forestry, mining/trade, and services | 0.635 (0.482) | 0.635 (0.482) | 0.635 (0.482) | 0.00 | 0.00 |
| Manufacturing | 0.365 (0.482) | 0.365 (0.482) | 0.365 (0.482) | 0.00 | 0.00 |
| *Equity capital in €1,000 (average in 1998)* | | | | | |
| All groups | 2,368.45 (18,201.99) | | | | |
| Low share (≤ 50%) | 32.45 (248.46) | | | | |
| *Debt-to-equity ratio (average in 1998)* | | | | | |
| All groups | 0.273 (4.183) | | | | |
| Low share (≤ 50%) | 0.038 (0.026) | | | | |
| *FDI-to-equity ratio (average in 1998)* | | | | | |
| All groups | 0.009 (0.145) | | | | |
| Low share (≤ 50%) | 0.001 (0.001) | | | | |

Notes: Sales and FDI are not available at the individual level. FDI is available only at a more aggregate level (no differentiation across federal states or four- or five-digit industry level); at that aggregation level, we have 45 observations. A few groups with negative debt-to-equity ratios are excluded. All information is given at the aggregate level. Standard deviations are reported in parentheses. The $\%\Delta_{2001}$ ($\%\Delta_{2004}$) value is calculated as the difference between logs in 2001 (2004) and 1998, e.g., $\%\Delta NPBL_{2001} = \log(NPBL_{2001}) - \log(NPBL_{1998})$.

Sources: Authors' calculations are based on data from the German Federal Statistical Office; CIT statistics 1998, 2001, and 2004, discussed in footnote 18; value-added tax statistics 1998, 2001, and 2004, discussed in footnote 36; local business tax statistics 1998 (see footnote 55); data from the German Bundesbank; and micro database foreign direct investment 1998, discussed in footnote 53.