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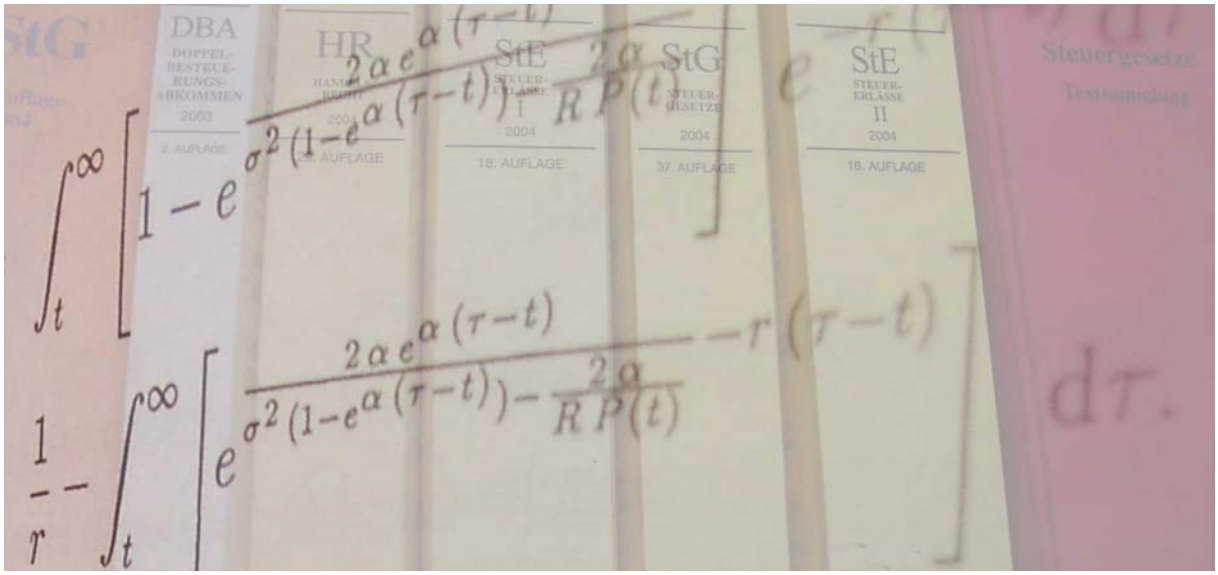

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- Evidence from German corporate tax return data

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Effective profit taxation and the elasticity of the corporate income tax base

Evidence from German corporate tax return data

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Abstract: We estimate the elasticity of corporate taxable income with respect to the effective corporate tax rate on the basis of a pseudo-panel constructed from corporate tax return micro data for the period 1998-2001, a period which saw the introduction of a major corporate tax reform in Germany. Endogeneity of the effective tax rate is controlled for by an instrumental variable approach. Our instrument for the observed effective corporate tax rate is the counterfactual effective tax rate a corporation would face in a particular period had there be no endogenous change of corporate profits. This counterfactual is obtained from a detailed microsimulation model of the corporate sector based on tax return micro data. We find a statistically significant and relatively large point estimate of the average tax base elasticity, which implies that a reduction of the statutory corporate tax rate would reduce corporate tax receipts less than proportionally due to income shifting activities. We also find some statistically weak evidence for the hypothesis that the tax base elasticity is higher for corporations that may benefit from various forms of tax shields.

JEL Classification: H32, H21, F23, C15

Keywords: corporate income taxation; tax base elasticity; micro simulation

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1 Introduction

Reforming the corporate income tax (CIT) has been an important topic both in public finance and in the economic policy debate (see, e.g., Devereux and Sørensen 2006, OECD 2007). Most critics of the CIT stress its perceived negative effects on economic efficiency and question its usefulness for raising tax revenues. Although the CIT raises little revenue in most OECD countries, supporters of the CIT are concerned that international tax competition will lead to a "race to the bottom" in the taxation of internationally mobile corporate capital. In fact, statutory corporate tax rates have been reduced in most OECD countries over the last several decades, and this development seems to have accelerated in recent years (see, e.g., OECD 2007). For example, in Germany the statutory corporate tax rate was reduced from 45 % in 1998 to 25 % in 2001. As in several other countries which reduced statutory corporate tax rates in recent decades, this has, however, not resulted in a proportional decline in corporate tax revenues. This indicates that part of tax rate reductions may be "self-financing" induced by higher economic activity or reduced income shifting and tax avoidance strategies of the corporate sector.

Empirical estimates of the elasticity of the corporate tax base to changes in the corporate tax rate provide important information for assessing both the revenue and welfare implications of corporate tax policy. Recent empirical studies based on aggregate OECD data (Clausing 2007, Brill and Hassett 2007, Devereux 2007) find that countries with statutory tax rates exceeding 30 % may have been on the declining segment of the CIT "Laffer curve", implying that tax rate reductions may even have increased corporate tax revenues in these countries. In contrast to these aggregate studies, using accounting-based industry-level panel data for publicly-traded companies in the US, Gruber and Rauh (2007) report an elasticity of taxable corporate income to the "effective" 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 marginal personal tax rate of -0.4 obtained by Gruber and Saez (2002) for the US.

This relatively small elasticity implies that, at least for the US, reductions of the CIT rate would only be partly "self-financing" and would substantially reduce corporate tax revenues. As stressed by Gruber and Rauh, this relatively small elasticity may also imply that the CIT is much less inefficient than is often assumed in the literature on corporate income taxation. However, it is not clear to what extent these results also hold for other countries and corporate tax regimes. Furthermore, estimated tax base elasticities may be sensitive to different definitions of the corporate tax base and "effective" tax rates as well as the way the potential

reverse causation ("endogeneity") between the tax base and the tax rate is modelled. In other words, there is currently no "benchmark" estimate of the corporate tax base elasticity.

In this paper, we estimate the elasticity of the corporate tax base with respect to the effective corporate tax rate (ETR) for the German economy using a comprehensive tax return data set. The main methodological problem is that, for various reasons, the ETR may be endogenous as it is partly determined by taxable income. To control for endogeneity of changes in the ETR we follow Gruber and Saez (2002) and Gruber and Rauh (2007) and estimate the tax base elasticity by an instrumental variable approach. As an instrument for the observed ETR we use the counterfactual ETR a corporation would face in a particular period had there be no endogenous change of corporate profits. This counterfactual is obtained from a detailed microsimulation model of the corporate sector based on tax return micro data for 1998 and 2001. This period saw the introduction of a substantial tax reform which provides sufficient exogenous variation in the ETR across corporations to identify the corporate taxable income elasticity.

Apart from its broad coverage, an important advantage of the tax return data used in this study is that they allow us to calculate ETR and the corporate income tax base taking into account various tax shields. In particular, these include used loss carry-forward which has become of major quantitative importance for the corporate sector also in the German economy (for similar developments in the US, see Cooper and Knittel 2006 and Auerbach 2007). The huge difference in the amount of used loss carry-forward across corporations also provides the exogenous variation in the ETR for our identification strategy of the tax base elasticity. For the estimation we use a pseudo-panel constructed by aggregation of the individual-level corporate tax return data into about 1,000 groups defined by industry (up to the 5-digit level) and by region. This pseudo panel allows us to control for observed and unobserved factors which may be correlated with both the corporate tax base and the ETR.

The remainder of this paper proceeds as follows. As a basis for the specification of our empirical model, in the next section we provide some background on the measurement of effective profit taxation and the corporate tax base and review the related empirical literature. Section 3 describes the data and details the identification and estimation of the tax base elasticity. Our preferred specification of the regression model, summarized in Section 4, yields a statistically significant and relatively large point estimate of the average tax base elasticity. This estimate implies that a reduction of the (proportional) statutory corporate tax rate would reduce corporate tax receipts less than proportionally due to income shifting activities. It also implies that, even at the substantially reduced statutory tax rates brought about by the recent tax reforms in Germany, substantial distortions of the CIT remain. We

also find some statistically weak evidence for the hypothesis that the tax base is more responsive for corporations that may benefit from various forms of tax shields. Section 5 summarizes our main results and concludes.

2 Effective Tax Rates, the Corporate Tax Base, and Behavioral Response

The public finance literature on corporate taxation distinguishes between "forward-looking" and "backward-looking" measures of "effective" corporate tax rates (for summaries see, e.g., Fullerton 1984, Devereux 2004, Gordon et al. 2004). Both measures in general differ from the statutory corporate tax rate, i.e. the nominal tax rate levied on taxable income at the corporate level. In most countries, including Germany on which we focus here, this statutory rate does not depend on the level of corporate profits, and the corporate tax assessed is proportional to taxable corporate income.[1] Only under very special circumstances would the statutory tax rates measure the incentive or revenue effects of the CIT.

Forward-looking ETR are intended to measure the incentive effects of the CIT and are usually derived on the basis of the King and Fullerton (1984) methodology. The marginal ETR measures the proportion on a marginal investment that is paid in tax. It is the difference between the before-tax and the after-tax rate of return, measured relative to the before-tax return. The ETR deviates from the statutory tax rate if "true" corporate income deviates from taxable income. Strictly speaking, this measure is only applicable to investments with zero excess profits, but can be extended to investments with positive profits as well (see Devereux 2004). Although this approach can also be extended to account for certain complexities of the tax code, such as special tax expenditures and deductions, this is usually very demanding in terms of data requirements. Thus, forward-looking ETR are usually calculated only for a few hypothetical cases of investment projects (see, e.g., Devereux et al. 2003).

Backward-looking measures of the ETR, in contrast, are based on information of the corporate tax actually assessed and some measure of corporate profits. They thus account for previous corporate investment and financing decisions, as well as for previous and future losses which may be offset against current profits by way of used loss carry-forward and loss carry-backward. A disadvantage of this measure of the ETR is that it might be of limited use for evaluating the incentives of the current tax system or of some proposed tax reform on

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

corporate investment decisions as far as current regulations concerning various tax shields are not expected to hold in the future as well.

Fullerton (1984) provides a long list of reasons why these measures of ETR may deviate from each other, and what the implications of these differences might be for tax revenues and economic efficiency. Which ETR is the most appropriate one obviously depends on the purpose to which it is applied. Fullerton (1984: 12) argues that average ETR are appropriate for measuring cash flows, while marginal ETR are designed to capture incentives to use new capital. Gordon et al. (2004) provide arguments why backward looking measures may be more useful in terms of explaining the relationship between tax rates and tax receipts in the corporate sector.

Since this is exactly the focus of our study we will use a backward-looking measure of the average ETR derived from corporate tax return data. Our measure of the ETR is the ratio of the corporate tax assessed in a given year to *Adjusted Gross Income (AGI)*. AGI differs from *Taxable Income (TI)* mainly by the amount of a corporation's tax loss carry-back and carry-forward set off against current profits (see the stylized calculation of these measures in Appendix A2). For a given level of current profits, corporations with unused tax-loss carry-forward or carry-backward may face very different ETR compared to those corporations that do not dispose of a stock of previous accrued losses. As we show below, it is of great importance to account especially for the use of loss carry-forward in the calculation of the corporate tax base.[2] The variation in the amount of used loss carry-forward across corporations also provides the exogenous variation in the ETR for our identification strategy of the tax base elasticity as described in Section 3.2.

Our empirical analysis will focus on the elasticity of the corporate tax base, as measured by AGI, with respect to the ETR, i.e. $b \equiv (\Delta AGI / \Delta ETR) \times (ETR / AGI)$. This elasticity is related to the relative change of the amount of *corporate tax assessed (TA)* to a relative change of the *statutory tax rate* (t) by the formula

$$\Delta TA / TA = (\Delta t / t)\left(1 + b \times h_{TI,AGI} \times h_{ETR,t}\right), \tag{1}$$

where $h_{TI,AGI} \equiv (\Delta TI / \Delta AGI) \times (AGI / TI)$ and $h_{ETRt} \equiv (\Delta ETR / \Delta t) \times (t / ETR)$.

If deductions and allowances D were proportional to AGI with factor of proportionality d, and in the absence of loss carry-forward and loss carry-back, $TI = (1-d) \times AGI$, $ETR = (1-d) \times t$

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

and $h_{TI,AGI} = h_{ETR,t} = 1$. Thus, a given percentage change in the statutory tax rate would translate into a proportional change of TA with the factor of proportionality given by b, which needs to be estimated econometrically. In case deductions are not proportional to AGI, or in the presence of loss carry-forward and loss carry-back, estimates of the elasticities $h_{TI,AGI} = (1 - \Delta D / \Delta AGI) \times (AGI / TI)$ and $h_{ETR,t} = 1 + h_{D,t}$, with $h_{D,t} \equiv (\Delta D / \Delta t) \times (t / D)$, are also required; these elasticities can be obtained by microsimulation (see Section 4.2).

The size of the tax base elasticity determines to what extent the direct change of tax receipts resulting from a change in the statutory tax rate is compensated for by real adjustment or income shifting activities of the corporate sector. Generally, b is expected to be negative but may vary between zero and -1. If corporations did not respond to tax rate changes, b = 0, a given percentage change of the statutory tax rate would reduce the corporate tax revenue by the same percentage. On the other hand, if b = -1, and assuming for simplicity that deductions are proportional to AGI, a reduction of the statutory tax rate would not change corporate tax revenue at all. For -1< b < 0, a reduction of the statutory tax rate by a percent would reduce corporate tax revenue by $a(1+b)$ %. In case b < -1, reduction of the statutory tax rate would increase tax revenue, which would correspond to the downward-sloping segment of the "Laffer curve" (see, e.g., Clausing 2007, Devereux 2007, Brill and Hassett 2007 for recent applications to corporate taxation).

The corporate tax base may react less than proportionally to a change in the statutory tax rate (-1< b < 0) due to corporations' real responses and to various forms of income shifting. Real responses may result by corporations increasing the volume of sales or real investment. Taxable income may deviate from "true" corporate profits due to various forms of income shifting (see e.g. Creedy and Gemmell 2007). First, profits may be shifted from the corporate to the personal sector depending on the difference of the tax rates by which the two are taxed nationally (see, e.g., Gordon and Slemrod 2000, Fuest and Weichenrieder 2002). International income shifting may occur based on either corporate financing strategies or by means of transfer pricing (for summaries see, e.g., Hines 1999, Newlon 2000).

Previous literature found surprisingly high elasticities of reported corporate income with respect to changes in "tax haven's" tax rates. For Canadian provinces, Mintz and Smart (2004) report high elasticities of taxable income with respect to tax rates based on administrative tax data. For a number of OECD countries, Bartelsman and Beetsma (2003) find that about two thirds of the revenues which could be expected to be raised in the absence of income shifting activities from a unilateral increase in the statutory tax rate is lost because of a decline in reported income. Also using aggregate OECD data, Riedl and Rocha-

Akis (2007) find that the corporate income tax base is negatively affected by a country's own tax rate and positively by the tax rates of its neighbor countries. For a sample of European multinationals, Huizinga and Laeven (2008) find an average elasticity of the reported tax base with respect to the statutory tax rate of .45. They also report below-average tax base elasticities for the larger European economies: The lowest elasticity estimate is obtained for Germany, which is explained by outward profit shifting induced by tax rate differentials and the high German statutory corporate tax rate in the observation period. Using data on German multinationals, Weichenrieder (2008) also finds some evidence for profit shifting behavior regarding the correlation between the home country tax rate of a parent and the net of tax profitability of its German affiliate as well as some indirect evidence for outbound profit shifting behavior. Using the same data base, Buettner et al. (2006) find some evidence that the impact of local taxes on corporations' investment decisions may be affected by legal restrictions on interest deductions on inter-company debt.

3 Data and Empirical Methodology

Our goal is to measure the impact of the effective tax rate faced by a given company on the level of its tax base, i.e. we want to estimate the elasticity of the corporate tax base with respect to the effective tax rate. For the reasons given in the previous section, we measure the corporate tax base by AGI and the ETR by the ratio of the corporate income tax assessed to the corporation's AGI in a given year. The main methodological problem is that, for various reasons, this elasticity is unlikely to be identified by a simple regression of log(AGI) on log(ETR). The ETR (unlike the proportional statutory tax rate) varies across corporations due to differences in deductible allowances and expenses which also determine the corporate tax base. Most importantly, as shown below, the ETR is strongly affected by the amount of loss carry-forward in a given year which, in turn, depends on a corporation's profit position in that year. In case the amount of profit is small relative to the volume of the corporation's tax carry-forward, its ETR will be relatively low, inducing a negative spurious correlation between these two variables. Furthermore, certain deductible allowances and expenses, which affect the corporation's assessed tax, may also be correlated with its profits, thereby also inducing spurious correlation between the corporation's tax base and ETR. In addition, there may be other observed and unobserved factors which may be correlated with both the AGI and the ETR and which need to be controlled for in the estimation of the tax base elasticity.

Whilst it seems impossible to control for these factors on the basis of a single cross section, we argue that the tax base elasticity can be identified by taking advantage of the pseudo-panel structure of our corporate tax return data and changes to the corporate tax

system introduced by the Tax Relief Act in the period 1998-2001. Our data come from corporate tax returns for the years 1998 and 2001. Since these data are only available for two cross sections, we construct a pseudo-panel for the estimation, as described in Section 3.1.1. We control for potential endogeneity bias by, first, accounting for fixed effects and, second, by instrumenting the ETR following the methodology proposed by Gruber and Saez (2002) and Gruber and Rauh (2007). As described in Section 3.1.2, our instrument for ETR is constructed by exploiting changes in the tax law in the period spanned by our pseudo-panel data and making use of a detailed microsimulation model based on the individual corporate tax return data.

3.1 Data

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

The German corporate tax return data we use in this study are provided by the German Federal Statistical Office every three years (Gräb 2006).[3] The latest year currently available is 2001. We restrict our analysis to the period 1998-2001. Although tax return data are also available for 1995, there was no tax reform between this year and 1998 affecting corporate taxation which we could use for our analysis. The year 1992, the only other year for which micro data on corporate tax returns is available, could not be included in our analysis because classification of industries was changed between 1992 and 1998, and it turned out impossible to classify industries in the data set for 1992 comparably to those used in 1998 and 2001, which is a requisite for the construction of the pseudo panel data.

The micro data on corporate tax returns represent all corporations subject to the German corporate income tax, which means nearly 740,000 firms in 1998 and about 810,000 in 2001. The data are constructed from all tax returns filed in a given year and provide information on more than 100 items that are relevant for calculating the corporate income tax. Information on taxable income and on the corporate income tax assessed is also part of the dataset. Furthermore, it records information on firms' characteristics such as industry, region, and legal form.

Tax return data have several distinct advantages compared to accounting data. First, they provide a broad coverage of the corporate sector. Second, they record the corporate income

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

tax actually assessed, together with taxable corporate profits. Third, they also contain certain components important for the calculation of the effective tax rate like the actual and potential amount of loss carry-forward. On the other hand, there are also some disadvantages of these data. In particular, we can only use the 1998 and 2001 cross-sections for our purpose and these data are currently not available as a panel. We, therefore, had to construct a pseudo-panel data set based on these two cross-sections.

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

We aggregated the micro data into groups by applying the following sequential procedure (see Appendix A1): First, we assessed the number of corporations within each industry at the two-digit level in the 2001 cross section data. For groups with a large number of corporations at this level we checked the number of corporations at the three-digit level. If there were more than 50 corporations at this level, we checked whether the industry could be disaggregated to the three-digit level given the requirement that there are at least 50 corporations within the resulting group.[4] If this was not the case, we kept the group at the two-digit level. In this vein, we proceeded to the five-digit level. As it turned out, some groups are quite large even at the five-digit level, including several thousands of corporations. In that case we used regional affiliation as subordinate classification criterion and further differentiated the groups between Eastern and Western Germany, and if possible between federal states as well. By this procedure each corporation was attributed to one of 1,137 groups. The same classification of groups was applied to the 1998 cross section.[5]

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

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

3.1.2 Corporate tax base and effective tax rate

Starting from a corporation's profit as shown in its tax balance sheet, our measure of the ***corporate tax base***, AGI, can be derived from the tax return data by adding non-deductible expenses and deducting certain exemptions and allowable deductions (for more details, see Appendix A2). In contrast to a corporation's *"Total Revenue"*, AGI also includes the revenue generated by its fiscal subsidiaries. It differs from *"Taxable Income" (TI)* by the amount of used tax loss carry-back and carry-forward and by the amount of allowable deductions for certain corporations. Corporations with a negative AGI in a particular year are excluded from the following analysis. The reason for excluding these cases is that the tax return data provide no information on the determinants of current losses which could be used to predict future losses. As discussed below, we try to control for potential selection effects resulting from the exclusion of these cases in the regression analysis.

Our measure of the ***effective tax rate***, ETR, is calculated for each corporation as the ratio of the corporate income tax assessed to its AGI in a given year. In case the AGI equals zero, the ETR is also set equal to zero. The ETR differs from the statutory rate in that tax credits for foreign-source income are deducted in the calculation of the corporate income tax assessed and by the difference between AGI and TI, which is mainly driven by the corporation's loss carry-forward.

AGI and ETR are calculated at the individual level for 1998 and 2001 and then aggregated to the group level of the pseudo-panel structure described in the previous sub-section, where the aggregation takes into account differences in group size. Table 1 presents means and standard deviations of AGI and ETR measured at the group level for 1998 and 2001 as well as the absolute and relative changes between the two years.

The upper part of the table shows that TI declined by about 113,000 Euros in the period 1998-2001. Average positive AGI for all corporations declined by 56,000 Euros (almost 20 %) between 1998 and 2001, on average, from about 320,000 to 265,000 Euros.[6] Since AGI is negative for a large share of all corporations in both years, we report statistics for these variables for all corporations and for those with non-negative AGI.[7] For corporations with non-negative AGI, its average level amounted to almost 500,000 Euros in 1998 which dropped by about 102,000 Euros (also about 20 %) in this period, while the share of

[6] In both cross sections there are some groups with one corporation being much larger in terms of AGI than the second biggest corporation in this group. We exclude corporations whose AGI exceed the second largest AGI by more than the factor 100 (1998: 11, 2001: 10 corporations) to avoid serious group dominance by a single corporation.

[7] When calculating the average ETR we assumed a rate of zero for corporations with negative AGI. In order to avoid problems with outliers we dropped corporations with an exceptionally large or small effective tax rate, i.e. with an effective tax rate exceeding 100 % (or -100 %).

corporations reporting a positive AGI increased slightly. The marked decline in the average AGI in the observation period occurred although economic activity as measured by average sales in nominal terms increased by roughly 18,000 euros (see Appendix A3).

Table 1: Descriptive statistics

	1998	2001	Δ	%Δ
Taxable Income in 1,000 € (average)				
all corporations	127.26 (1,393.43)	14.17 (1,134.31)	- 113.09 (1,653.27)	-219.51
corporations with non-negative AGI	345.46 (2,188.43)	277.11 (1,417.29)	-68.35 (1,433.54)	-22.05
Adjusted Gross Income (AGI) in 1,000 € (average)				
all corporations	321.21 (2,205.67)	265.21 (1,402.41)	- 56.00 (1,423.36)	-19.16
corporations with non-negative AGI	488.60 (3,415.64)	386.56 (1,923.79)	-102.04 (2,354.43)	-23.43
Share of corporations reporting a positive AGI	0.554 (0.098)	0.560 (0.098)	0.006 (0.076)	1.08
Effective Tax Rate (average)				
all corporations	0.1197 (0.048)	0.0772 (0.030)	- 0.0425 (0.025)	-43.86
corporations with non-negative AGI	0.1986 (0.0554)	0.1231 (0.0347)	- 0.0755 (0.0304)	-47.83
Potential tax loss carry-forward in 1,000 € (average)				
all corporations	674.75 (2,647.89)	700.44 (3,465.48)	25.69 (2,201.18)	3.74
corporations with tax loss carry-forward at the beginning of the year	1,245.92 (6,391.15)	1,466.15 (6,953.57)	-	-
Number of groups	1,137	1,137	-	-
Number of groups which exclusively contain corporations with non-negative AGI	1,074	1,074	-	-
Number of corporations within each group	641.61 (995.65)	714.68 (1,120.32)	73.06 (262.27)	10.79
Number of corporations				
all corporations	701,971	809,641	107,670	14.27
corporations with non-negative AGI	436,439	519,856	83,417	17.49
corporations with positive AGI and without tax loss carry-forward	243,364	280,155	36,791	14.08
corporations with tax loss carry-forward at the beginning of the year	354,471	404,524	50,053	13.21

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

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

At the same time, the ETR was reduced by 4.25 percentage points on average, compared to a drop of the statutory tax rate of 20 percentage points (from 45 % in 1998 to 25 % in 2001) for most corporations. There are various factors that have contributed to this difference: First, the reduction of the tax rate was partly compensated for by the simultaneous broadening of the tax base. Second, the reduction in the statutory tax rate was lower for those

corporations that benefited from a reduced tax rate in 1998. Third, corporations for whom the fiscal year differs from the calendar year are subject to a higher tax rate of 40 % in 2001. Fourth, for all corporations reporting a loss in both years the effective tax rate remained zero and did not change at all. And last but not least, AGI is lowered substantially by a large share of corporations (60 %) reporting a loss, a profit of zero or offsetting the whole of their profits against losses from other periods. [8] Table 1 shows that the potential loss carry-forward, which can be carried forward infinitely and be offset against future profits; on average amounted to about 675 (700) thousand Euros in 1998 (2001), thereby substantially exceeding the average AGI of corporations recording positive AGI in these years.

Compared to other measures of ETR in our observation period reported in the literature for Germany (see, e.g., Devereux et al. 2003; Nicodème 2001, 2002; Gorter and de Mooij, 2001; Buijink, Janssen and Schols 1999), our estimated rates seem surprisingly low.[9] Comparability across studies is limited, however, because our measure is based on the actually assessed tax and AGI, while the effective tax rate in these studies is calculated as the tax burden related to the profit in the commercial balance sheet or in the consolidated balance sheet. Importantly, in contrast to these studies, we take into account that profits can be offset against losses from other periods lowering the average effective tax rate in a given year. Our data set contains many firms (around 40 % of all firms) reporting a loss or a profit of zero which significantly reduces average effective tax rates.

3.2 Identification and estimation

We argue that the tax base elasticity can be identified by taking advantage of the pseudo-panel structure of our corporate tax return data and changes to the corporate tax system introduced by the Tax Relief Act in the period 1998-2001. Following the methodology proposed by Gruber and Saez (2002) and Gruber and Rauh (2007), our identification strategy consists of instrumenting a corporation's ETR for 2001 by the simulated ETR the corporation would face in 2001 if its real tax base had not changed *endogenously* between 1998 and 2001. Thereby, we only use changes in the tax law and macroeconomic effects exogenous to the

[8] These factors are related to the major CIT reform introduced in this period which will be exploited for the identification of the tax base elasticity as described in Section 3.2.

[9] These estimates also differ from those based on aggregate revenue data published by the OECD and the European Commission which are based not on assessed but pre-paid corporate taxes. For Germany, pre-paid taxes are only weakly correlated with assessed taxes in any given year. For example, in 2001 pre-paid corporate taxes were virtually zero whereas assessed corporate taxes amounted to about 20 billion Euros. Furthermore, the profit measure used for the calculation of average corporate tax rates also differs from corporate taxable income or AGI. For example, the European Commission (2003) uses the net operating surplus of the business sector which also includes unincorporated enterprises.

individual corporation to identify the elasticity of the tax base with respect to the effective tax rate.

The Tax Relief Law (*Steuerentlastungsgesetz*) significantly reduced the statutory corporate income tax rate: In 1998, the corporate income tax in principle amounted to 45 % for retained earnings and to 30 % for distributed earnings while the tax rate was generally reduced to 25 % in 2001.[10] It changed the taxation of dividends from the tax credit method ("imputation method") to the half-income method and thereby also affected personal income taxation.[11] The reform also broadened the tax base by lowering depreciation allowances, by introducing the requirement to reinstate original values, and by cutting the use of a tax loss carry-back. As the tax reform did not affect corporations equally, we observe substantial variation in the change of their effective tax rates, due to the following factors:

First, every year a share of 20 % of German corporations use a tax loss carry-forward or a tax loss carry-backward to offset current profits. These corporations do not pay any corporate income tax and thus have an effective tax rate of zero which remains unaffected by changes in the statutory tax rate. Note that the use of tax loss carry-forward is not at the corporation's discretion because unused tax loss carry-forward has to be set off in the full amount against current profits.

Second, the statutory and effective tax rate in 1998 was dependent on the ratio between retained and distributed earnings: A corporation which completely abstained from the distribution of earnings was liable for a corporate income tax rate of 45 %; whereas a corporation which distributed its whole profit was subjected to a corporate income tax rate of 30 % only. The splitting of the tax rate is a specific feature of the tax credit method.[12] It was abolished by the Tax Relief Law; since 2001, the tax rate on corporate income is uniform and does not depend on a corporation's payout ratio.[13] This implies that the reduction in the

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

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

[12] Under the tax-credit method the tax burden on the corporate level is only meant as a mean to ensure taxation of capital income and is credited against the personal income tax of the shareholder.

[13] Under the half income method the corporate income tax is definite. Half of the dividends are additionally subjected to personal income tax.

effective tax rate was much larger for those corporations which retained most of their earnings than for the corporations distributing their whole profit.

Third, some corporations were subject to reduced statutory corporate income tax rates in 1998. Mutual insurance societies, private foundations, and business enterprises of a public corporation benefited from a reduced tax rate of 42 % in 1998. At the same time a flat tax of 25 % applied to different sources of foreign income. The Tax Relief Law, by contrast, does not provide any reductions in statutory tax rates but equally applies the tax rate of 25 % to every corporation. As a result, the reduction in the statutory and in the effective tax rate between 1998 and 2001 was smaller for all those corporations which benefited from reduced taxation in the past. Some corporations even saw their tax rate rising: Operators of merchant ships in the international bodies of water were liable for a reduced rate of 22.5 % in 1998; in 2001, the universal tax rate of 25 % applied.

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

And fifth, corporations with a fiscal year differing from the calendar year only switched to the half income method and the lower tax rate in 2002. In 2001, they were still taxed under the tax credit method and had to pay a tax rate of 40 %. This means that the reduction in the effective tax rate for these particular corporations was much smaller than for the ones taxed according to the half income method in 2001.[14]

Simulated tax liabilities and effective tax rates are computed using the business taxation microsimulation model BizTax.[15] First, AGI and all income related components of the 1998 cross section are aged to 2001 values using a nominal growth rate which is exogenous to the individual corporation. There are 13 different inflation parameters for different sources of income (profits and losses, dividends and income from interest, differentiated by financial and non-financial corporations).[16] Using BizTax we then simulate the corporate tax liability

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

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

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

according to the corporate income tax law 2001 based on the inflated income components. The simulated ETR for 2001 is obtained by relating the simulated tax liability for 2001 to the inflated AGI for 1998.

One might be concerned that this simulated ETR is not completely exogenous for those corporations which offset part (or the whole) of their profits in 1998 against losses from the past or from 1999 (loss carry-back) because the amount of profits that can be offset against losses from other periods is a function of the tax rules. The Tax Relief Law broadened the tax base and consequently increased AGI. This had two implications: first, a rise in the effective tax rate, and second the need of a larger volume of losses from other periods to offset a higher AGI. The ability to offset a higher AGI resulting from the tax reform could be related to unobserved factors which may also influence the tax base itself. To address this potential endogeneity, we inflate the amount of profits which is offset against losses from other periods in 1998 and use this amount as an upper limit for the profits that can be offset against losses in our simulation of a corporation's ETR for 2001.[17] In a similar vein, we use the inflated amount of allowable deductions that are effectively used in 1998 when we simulate the corporation's ETR for 2001.

In the estimation we also control for other factors which might be correlated with both AGI and ETR. First, we estimate the regression of log(AGI) on log(ETR) in first differences allowing for group-fixed effects which may be correlated with ETR. Second, we control for time-varying factors by including 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 may also control for changes within groups in the observation period which could affect the efficiency of our estimates, in particular the standard error of the estimated tax base elasticity. Information on sales originates from the value added tax (VAT) statistics of the German Federal Statistical Office. It is available at the same level of aggregation as the one used for the construction of our pseudo-panel data. For a few industries, which are not liable to the VAT, information on sales is missing. In some industries only part of their sales is liable to the VAT, which we try to control for by including an interaction term between this variable and the group's sales. While we saw the AGI declining between 1998 and 2001, sales increased significantly in the same period. In 1998, corporations sold goods in the value of about 130 million Euros, on average, in 2001 sales amounted to almost 150 million Euros. Descriptive statistics of the other control variables are contained in the upper part of the table Appendix A3.

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

As described in Section 3.1.2, 40 % of all corporations report a negative AGI, and this share slightly decreased between 1998 and 2001. Our tax return data unfortunately do not contain information which would allow us to model these losses. We therefore restrict our regression analysis to corporations with positive AGI and try, in an alternative model specification, to control potential selection effects by including the change in the share of corporations with positive profits within groups in the observation period.

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

$$(2) \qquad \log\left(\frac{AGI_{g,2001}}{AGI_{g,1998}}\right) = a + b\log\left(\frac{ETR_{g,2001}}{ETR_{g,1998}}\right) + g'\Delta x_g + u_g$$

where a is a constant, b is the corporate tax base elasticity we want to estimate, g is a column vector of regression coefficients, Δx_g is a column vector composed of first differences of the control variables in group g introduced above, and $u_g = u_{g,2001} - u_{g,1998}$ is a first-differenced error term for each group, which may or may not be serially correlated but, conditionally on Δx_g, is assumed to be uncorrelated with the change in the ETR.

Below we will report simple OLS and 2SLS regression results where the ETR for 2001 in the relative change in ETR will be instrumented by the simulated ETR for 2001 as described above. In this regression, the b coefficient measures the elasticity of the corporate tax base with respect to the effective tax rate: a value of zero implies that the tax base does not react to changes in the effective tax rate at all; a coefficient of -1 indicates that a decrease in the effective tax rate of one percent increases the tax base by one percent. We will also estimate separate elasticities by characteristics that may be related to the ability of income shifting, such as economic sector, the average size of corporations within sectors or the intensity of foreign direct investment.

4 Estimation Results

4.1 Basic regression results

Table 2 reports OLS and 2SLS regression results for the regression model given by eq. (2) in the previous section.[18] To account for heteroskedasticity due to differences related to group

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

size and possibly also serial correlation of error terms we report robust standard errors of estimated coefficients in all regressions.

Table 2: Basic regression results
Dependent variable: $\log(AGI_{g,2001}/AGI_{g,1998})$

	OLS		2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)
$\log(ETR_{g,2001}/ETR_{g,1998})$	0.240	0.164	-0.314	-0.347	-0.318	-0.533
	(0.109)	(0.131)	(0.180)	(0.178)	(0.178)	(0.197)
share of corporations under the tax credit method	-	0.430	-	0.528	0.638	0.947
		(0.426)		(0.448)	(0.433)	(0.447)
change in the number of corporations in the group	-	-0.002	-	-0.007	0.146	0.046
		(0.100)		(0.104)	(0.099)	(0.100)
dummy indicating groups which exclusively contain firms located in Western Germany	-	0.077	-	0.076	0.104	0.060
		(0.041)		(0.041)	(0.041)	(0.041)
change in sales	-	0.180	-	0.185	-	0.174
		(0.097)		(0.100)		(0.103)
interaction term between changes in sales and the dummy indicating industries whose sales are not fully liable to sales tax	-	0.118	-	0.137	-	0.146
		(0.105)		(0.121)		(0.124)
change in the share of firms reporting positive AGI	-	-	-	-	-	1.440
						(0.453)
constant	0.093	-0.011	-0.166	-0.257	-0.258	-0.320
	(0.054)	(0.074)	(0.085)	(0.094)	(0.094)	(0.100)
R^2	0.005	0.064	-	-	-	-
Number of observations	1,074	1,065	1,074	1,065	1,074	1,065

Note: Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses.

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

As shown in column (1), the simple correlation of changes in the corporate tax base, measured by positive AGI, and the ETR between 1998 and 2001 is positive and significant. This simply reproduces the correlation structure already observed in our data (see Table 1), where we observed both the AGI and the ETR decline in this period. The correlation remains positive but becomes insignificant if the control variables introduced in the previous section are added.

For the reasons mentioned in the previous section, we would not expect OLS regressions of the change in AGI on the change of the ETR to identify the tax base elasticity. In fact, standard Hausman-Wu endogeneity tests strongly indicate that ETR is an endogenous variable and OLS estimates of the tax elasticity are inconsistent. In particular, inclusion of the residual from a first-stage regression of $\log(ETR_{g,2001}/EGR_{g,1998})$ on the control variables Δx_g in the structural equation yields a t-value of 18.3; alternatively, a standard Hausman test turns out significant at the 1 %-level (p-value = 0.0106).

Before we comment on the 2SLS estimation results reported in Table 2, we report the results of the first-stage regression with the *simulated* ETR as our instrument for the ETR actually observed in 2001. As shown in Appendix A4, the simple correlation between the relative change in the ETR actually observed and the one obtained by instrumenting ETR 2001 in this expression by the simulated ETR for 2001 is quite strong. In the first-stage regression including all control variables, the R^2 is almost 0.5 and the coefficient of our instrument has t-statistic of about 30. To explicitly test for the relevance of the instruments in our multivariate setting, we calculate the Partial R^2 regarding our instrument as suggested by Shea (1997) and Godfrey (1999), which yields a Partial R^2 of about 0.42. This clearly shows that our instrument is indeed highly correlated with the change in the actually observed ETR and that our 2SLS estimation is not likely to suffer from the ubiquitous weak instrument problem (see, e.g., Stock et al. 2002).

As a benchmark, column (3) reports 2SLS estimation results without further control variables. The estimated tax base elasticity now becomes negative, with a point estimate of -.31, which is statistically different from zero at the 10 percent level (two-sided test, *t*-value of -1.75). Adding the control variables to this regression leaves the point estimate of the estimated tax base elasticity in column (4) virtually unchanged but somewhat reduces its estimated standard error; the elasticity becomes significant at the 5 level (*t*-value=-1.96).[19]

The only control variable which seems to be significant in the regression is the relative change of sales: a 10 % increase in sales raises the tax base by about 2%. As the sales variable is derived from the VAT statistics, which only includes sales liable to VAT, it only represents part of sales for a few groups in our pseudo-panel. To account for this, we include an interaction term of the sales variable with a dummy variable for groups whose sales are not fully liable to VAT in the regression. More importantly, exports are not liable to VAT in Germany and are thus not included in our sales variable. Since the VAT statistic is the only data source available at a level of aggregation required to match sales data to our pseudo panel, we cannot adjust the sales data for export shares. As far as export shares have not changed in the observation period, this measurement error should be accounted for by the group-fixed effects or, in other words, purged from the first-differenced regression. This also holds for shocks to the corporate tax base which may also affect the volume of sales as long as this relation has not changed in the observation period.

[19] As a sensitivity check we also included the square of the tax variable to pick up nonlinear effects of tax changes on changes of the corporate tax base. Estimated coefficients of the linear and quadratic term of the tax variable remained jointly statistically significant at the 10 % level and estimated elasticities, evaluated at sample means, were virtually identical in the two specifications.

Since both of these assumptions might be questioned, we have also estimated the regression without the potentially endogenous sales variable (and the interaction term). As shown by column (5), this has almost no effect on the estimated tax base elasticity. This indicates that a change in the ETR has little effect on sales and affects the corporate tax base via income shifting responses rather than real responses as far as these are related to changes in the volume of sales.[20]

Another potential bias may result from a selection effect since we only include corporations with non-negative AGI in the estimation. If this selection is determined by fixed group effects only, our first-difference estimation should control for it. However, it cannot be ruled out that the factors affecting this selection have been changing in the observation period. Since we do not observe factors which might be correlated with time-varying selection we cannot control for this by a formal selectivity correction, i.e. by the standard Heckman selection procedure. We can, however, approximate the selection term by the average probability of non-negative AGI in a particular group, i.e. by the share of corporations that report a non-negative AGI in a given year. Thus, in the regression reported in column (6) we report estimation results with the change of the share of corporations with positive AGI within groups included as additional control variable. Estimation results show that this variable is highly significant and has a relatively strong effect on the elasticity estimate; it increases in absolute value to -.533, with a *t*-value of -2.7.

Thus, although somewhat sensitive to the treatment of corporate losses, our 2SLS estimates do suggest a relatively strong elasticity of the tax base, as measured by AGI, to a corporation's ETR. How does this tax base elasticity compare to the one obtained by Gruber and Rauh (2007), the study most closely related to the present one? Comparing our elasticity estimate to the one of -0.2 reported by Gruber and Rauh, one has to keep in mind that their estimate refers to the elasticity of taxable income with respect to the marginal CIT rate. This rate is (slightly) progressive in the US, whereas the statutory corporate tax is constant in Germany. Thus to make the two estimates roughly comparable, we have to calculate $h_{TI,t} \equiv (\Delta TI/\Delta t)\times(t/TI)$, which we get by multiplying our elasticity estimate, $h_{AGI,ETR}$, by the product of the elasticity of TI with respect to AGI ($h_{TI,AGI}$) and the elasticity of the ETR with respect to the statutory corporate tax rate ($h_{ETR,t,}$).

As discussed in Section 2, only in the unlikely case that deductions and allowances are proportional to AGI, and in the absence of loss carry-forward and loss carry-backward, is there a simple relationship between changes in the statutory corporate tax rate, the tax base

[20] A bivariate IV regression of the relative change in sales on the relative change of the ETR with the same IV as in the tax base regression yielded a coefficient estimate of -.029 with a *t*-value of 0.21.

elasticity and the change in tax revenues. In this case $h_{TI,AGI} = h_{ETR,t} = 1$, and our estimate of $h_{AGI,ETR} = -0.53$ would imply that a reduction of the statutory tax rate by 10 % would results in an increase of TI by about 5 %. However, since deductions are not proportional to AGI, and because of the importance of loss carry-forward, to exactly calculate $h_{TI,AGI}$ estimates of $h_{ETR,t}$ and $h_{TI,AGI}$ are required. Using our corporate tax microsimulation model BizTax we find $h_{ETR,t} = 0.855$ and $h_{TI,AGI} = 1.062$.[21] Using these estimates and our preferred estimate for $h_{AGI,ETR}$, we find that a 10 % reduction of the statutory tax rate increases TI by 4.8 %, which is only slightly smaller than the estimate obtained under the assumption of proportionality of deductions and AGI.

Thus, we may conclude that, at least for our application, $h_{AGI,ETR} \cong h_{TI,t}$ which implies that our estimate of the tax base elasticity is more than double the size of the estimate obtained by Gruber and Rauh in their study for the US. There are at least two reasons for this difference, apart from the obvious one that these estimates refer to two different countries: First, the study by Gruber and Rauh is based on accounting data and only covers part of the corporate sector. Second, their effective tax rate measure mainly affects marginally profitable investments and does not account for various tax shields, especially tax loss carry-forward.

Our estimate of the tax base elasticity can also be used to answer the question of how changes in the statutory tax rate affect corporate tax revenues. This is of great importance for fiscal policy because the statutory corporate tax rate is a policy variable whereas the ETR cannot directly be manipulated for tax policy purposes. Taking our elasticity estimate of about -0.5, and assuming for simplicity that the proportionality assumption between deductions and AGI holds, we would expect a 10 % reduction of the statutory corporate tax rate to result in a reduction of corporate tax revenues by 5 %. This is only half of the loss in tax revenues resulting from a tax rate reduction by 10 % in the absence of any income shifting and real responses of corporations to the tax change.

Thus, our estimate of the tax base elasticity implies that tax rate reductions are partly "self financing", but does not support recent "Laffer curve" estimates for the corporate sector by Clausing (2007), Devereux (2007) and Brill and Hassett (2007). These authors report a revenue-maximizing statutory CIT rate in the range between about 20 and 35 %.[22] Given

[21] These simulations assume that any response of a tax rate change is already accounted for by our estimated tax base elasticity.

[22] These studies are based on simple OLS regressions of corporate tax revenues, normalized by GDP, on the statutory tax rate, its square and a couple of control variables estimated on a panel of pooled OECD time series-cross section data. Since these regressions do not include country fixed effects that might be correlated with both tax revenues and the statutory tax rate it seems questionable whether these estimates can be interpreted as tax base elasticities, however. As reported by Clausing (2007) and Devereux (2007), there is not

these estimates and the decline of the statutory CIT rate from 45 % to 25 % between 1998 and 2001, the German corporate sector should have been on the declining segment of the "Laffer curve", and the reduction of the statutory rate should have increased corporate tax revenues. Of course, there was no corresponding increase in corporate tax revenues in this period, although the revenue decline was much less severe than it would have been in the absence of any behavioral response, which is compatible with our preferred empirical tax base elasticity.

Although this average elasticity is not compatible with a "Laffer curve" effect for the whole corporate sector in Germany, certain sub-groups of corporations may well be much more responsive to tax rate changes. That is, this average tax base elasticity may hide important differences between corporations, and this heterogeneity may provide crucial information for tax policy. In particular, as stressed by recent literature (see Section 2), the tax base elasticity may differ by the degree of international tax competition and income shifting opportunities.[23] To account for these factors, we now turn to some further estimation results which take into account potential heterogeneity in tax base elasticities to some extent.

4.2 Heterogeneous tax base elasticities

First, we look at differences in tax base elasticities in the manufacturing ("secondary sector") compared to other sectors of the economy. In Germany, the manufacturing sector is still relatively large compared to other developed market economies and has been under considerable pressure from international competition during our observation period. Income shifting in this sector may be expected to be more prevalent than in the service sector which is also much less exposed to international competition. Furthermore, certain regulations introduced by the Tax Relief Law, such as changes in the depreciation rules, might have had a stronger impact on the manufacturing sector. Second, we investigate whether estimated tax base elasticities differ by the average size of corporations within groups. Third, we test whether differences in the capital structure of corporations affect the tax base elasticity, because deductible interest payments may act as a tax shield. And finally, we test whether the tax base elasticity differs by the intensity of international tax competition as measured by the FDI intensity within groups.

enough within-country variation in statutory tax rates to identify the tax base elasticity conditional on country fixed effects.

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

Table 3: Tax base elasticities by subgroups – 2SLS estimation
Dependent variable: $\log(AGI_{g,2001}/AGI_{g,1998})$

Sub-sample / interaction by ...	$\log\left(\frac{ETR_{g,2001}}{ETR_{g,1998}}\right)$	$\log\left(\frac{ETR_{g,2001}}{ETR_{g,1998}}\right)$ × interaction	interaction	*F*-test (*p*-value)	N
sector					
× manufacturing	-0.378	-0.241	-0.232	2.88	1,065
	(0.215)	(0.413)	(0.197)	(0.090)	
primary sector / services	-0.329	-	-	-	673
	(0.221)				
manufacturing	-0.634	-	-	-	392
	(0.382)				
sales					
× (> median)	-0.602	0.266	-0.021	1.28	1,065
	(0.241)	(0.366)	(0.175)	(0.258)	
≤ median	-0.561	-	-	-	532
	(0.248				
> median	-0.465	-	-	-	533
	(0.316)				
wages					
× (> median)	-0.374	-0.131	-0.178	3.01	1,065
	(0.233)	(0.354)	(0.168)	(0.080)	
≤ median	-0.259	-	-	-	534
	(0.234)				
> median	-0.615	-	-	-	531
	(0.305)				
equity capital					
× (> median)	-0.384	-0.076	-0.202	1.80	1,065
	(0.209)	(0.383)	(0.184)	(0.181)	
≤ median	-0.288	-	-	-	535
	(0.211)				
> median	-0.524	-	-	-	530
	(0.347)				
debt/equity ratio					
× (> median)	-0.626	0.289	0.268	1.52	1,010
	(0.296)	(0.391)	(0.183)	(0.218)	
≤ median	-0.649	-	-	-	506
	(0.311)				
> median	-0.260	-	-	-	504
	(0.284)				
FDI/equity ratio					
× (> median)	-0.473	-0.194	-0.065	3.84	1,065
	(0.229)	(0.400)	(0.189)	(0.050)	
≤ median	-0.415	-	-	-	548
	(0.231)				
> median	-0.696	-	-	-	517
	(0.358)				

Notes: All regressions include a constant and the same control variables as those reported in Table 2. Robust standard errors are given in parentheses below 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. *p*-values for significance of the test are given in parentheses below the *F*-test statistic.

Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 and 2001, local business tax statistics 1998, German Central Bank, micro database foreign direct investment 1998.

Table 3 summarizes the estimation results for these alternative specifications of our basic regression model. All specifications start from the 2SLS model with the full set of control

variables as given by column (6) in Table 2. Interaction terms are, of course, also instrumented by interacting the instrument with the respective variable used to measure heterogeneity in our sample.

Estimation results accounting for sector differences are summarized in the first panel of Table 3. Since there are only very few groups in the primary sector (farming, forestry etc.), we aggregate these with the service sector[24] and interact the tax variable with a dummy for the secondary sector. Estimation results in column (1) indicate that the tax base in the secondary sector (manufacturing) is higher than in the primary and tertiary (service) sector. The point estimates imply a tax base elasticity of about -.6 (=-.38 + -.24) in manufacturing, compared to only -.38 in the primary and tertiary sector. However, this difference is statistically not well determined in our sample. Although the coefficient on the tax variable and the sector interaction term are jointly significant at the 10 % level (F-value = 2.88), the coefficient of the interaction term is not significant (t-value = -0.58).

Splitting the sample and estimating our regression model separately for the two sectors, thus also allowing the coefficients of the control variables to differ between sectors, confirms that the relatively high average tax base elasticity is mainly related to the high elasticity in the secondary sector (see rows (2) and (3) in Table 3). For the secondary sector, the estimated tax base elasticity is statistically significantly different from zero at the 5 % level (two-sided test), whereas the much smaller (in absolute value) estimated tax base elasticity for the primary and tertiary sector is only marginally significant at the 10 % level. However, given the relatively large estimated standard errors, no statistically significant sector difference in estimated tax base elasticities between the two sectors can be detected. In other words, pooling the two sectors and estimating the tax base elasticity on the pooled sample is not rejected by the data. We would expect that this is mainly related to the strong remaining heterogeneity (high error variance) within sectors, but the sample size of our pseudo panel puts tight limits on the possibility of further sector differentiation.

Another source of heterogeneity relates to the average size of corporations within groups. It could be argued that large corporations might have better tax shifting opportunities than small firms, and also have better means at their disposal to take advantage of these opportunities. For example, there might be fixed costs of setting up affiliations used as tax shelters or, more generally, tax shifting costs per euro might decline with the volume of tax avoidance. We try to approximate such scale effects by various alternative measures: the average volume of sales, the wage sum, and the average equity capital. These variables are

[24] Excluding corporations in the primary sector from the estimation sample as robustness check had very little effect on estimation results.

measured at the start of our observation period in order to avoid the potential endogeneity of changes in the ETR and these variables in the observation period. Given the relatively small size of our pseudo panel, we simply differentiate between "small" and "large" corporation size defined by the median of these variables.

Estimation results summarized in Table 3 show that, contrary to our expectation, there seems to be no statistically significant difference in the estimated tax base elasticity between groups differentiated by the average sales volume. This is also confirmed by the insignificance of the coefficient on the interaction term between the tax variable and sales in the pooled regression (*t*-value=.73). Thus, pooling all observations and estimating the tax base elasticity on the pooled sample again is not rejected by the data. However, our sales variable may not be a very good indicator for the size of corporations in particular industries because, due to the data restrictions mentioned above, it does not include exports.

The potential for profit shifting is perhaps better approximated by our second measure of size, the wage sum. Dividing the sample into groups with wage sum below and above the median we find that the point estimate for groups with relatively large corporations is larger compared to the one for groups with relatively small companies. Nevertheless, due to the large standard errors in both estimations we cannot reject the hypothesis that the elasticity is the same for both groups.

A similar result is found when we use our third measure of size, the average equity capital within groups, where we split the sample into groups whose "average" corporation has equity below the median and groups with corporate equity higher than the median.[25] The third panel of Table 3 indeed shows that the point estimate of the tax base elasticity for larger corporations exceeds the point estimate for those groups with relatively small corporations, but this difference again is not statistically significant. Given the large standard errors of the tax base elasticity in the estimation based on the sample split, we cannot reject the null hypothesis of no population difference in tax base elasticities between the two groups.

A better indicator for tax-shifting possibilities than the volume of equity capital per se might be a corporation's capital structure which we measure, at the group level, by the amount of interest paid by a corporation on its long-term debt relative to it equity capital.[26]

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[25] In the dataset the amount of equity capital is recorded at the individual corporate level as the sum of retained earnings and contributions to capital as far as they occurred after the company was founded. We approximate the average corporate capital stock within a group by adding the legal minimum deposit which amounts to 25,000 euros for private limited liability companies and to 50,000 euros for public companies.

[26] Information on interest on long-term debt is not available in the corporate income tax statistics but can be derived from the local business tax statistics which covers the same population of corporations and is available for the same years as the corporate tax statistics. Since the two statistics cannot be matched on the micro level we have imputed information on interest payments from the local business tax statistics using the same aggregation scheme as the one for our pseudo-panel data (see Section 3.1.1). Access to the micro data of the

Given that the interest should be proportional to the level of corporate long-term debt, we refer to this variable as the debt/equity ratio. To avoid the potential endogeneity of changes in the ETR and capital structure, the debt/equity ratio is measured at the start of our observation period in 1998. Since interest on a corporation's debt may act as a tax shield, we would expect the tax base of corporations with a relatively high debt/equity ratio to respond *less* to tax changes than does the tax base of corporations that can take less advantage of this particular tax shield. Estimation results in Table 3 indeed seem to support this hypothesis: The point estimate of the tax base elasticity of -.65 for the groups with a relatively low debt/equity ratio is much larger than the estimated elasticity for the comparison group, which is not statistically different from zero. However, given the large standard errors of these estimates, we also cannot reject the hypothesis that estimated tax base elasticities do not differ between the two groups, as indicated by the insignificant coefficient of the interaction term in the pooled regression.

Another relevant differentiation of groups suggested by the recent literature on international tax competition and foreign direct investment is to distinguish by the FDI intensity within groups. Extending hypotheses from this literature (see, e.g., Hines 1999, Bartelsmann and Beetsma 2003) we would expect corporations which undertook relatively large FDI in the past to have better future opportunities to reduce their tax liabilities at home by way of transfer pricing, creative financing, and other tax shields provided by their 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 FDI information at the group level from the Microdatabase Direct Investment (MiDi) of the *Deutsche Bundesbank*, the German Central Bank. This statistic includes corporations with minimum levels of FDI relative to total shares (see Lipponer 2003). Information is available at a slightly more aggregate level as implied by our grouping.[27] On the basis of this information we have calculated, at the group level, the ratio of FDI to equity capital in 1998 and defined two sub-samples, one with a FDI ratio below or equal to the median and one with a FDI ratio above the median. Again, we use the stock of FID at the start of our observation period to avoid the potential endogeneity between tax changes and FDI in the observation period.

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local business tax statistics is also possible through the research centres of the Statistical Offices (www.forschungsdatenzentren.de). Equity capital may become negative due to differences in tax and commercial balance sheet valuation and the transition rules from the tax credit to the half income method. As a sensitivity check, we also included these rare cases in the estimation sample which had almost no effect on the tax base elasticity in the sub-group with a relatively low debt/equity ratio.

[27] The MiDi data do not allow aggregation by federal states or industries at the 4- and 5-digit level. To merge the MiDi data to our pseudo-panel in these cases, we had to impute the same FDI/equity share from the MiDi data at the 3-digit industry level for Germany overall to the 4- and 5-digit level specified for our pseudo-panel data.

Estimation results for these two sub-samples, summarized in the lower panel of Table 3, are compatible with the hypothesis that corporations more exposed to international competition, as measured by a relatively high share of FDI, respond more strongly to changes in the ETR than groups with a lower level of FID. For industries in the upper part of the FDI distribution, the point estimate implies a tax base elasticity of about -.7, compared to about -.42 for those groups with a FDI share below the median. Regarding the point estimates, the relatively large tax-base elasticity seems compatible with the observed sector differences, given that a relatively large share of manufacturing industries have FDI ratios exceeding the population median. However, as before, this difference is statistically not well determined in our sample. Although the coefficient on the tax variable and the FDI interaction term are jointly significant at the 5 % level (F-value = 3.84) in the pooled regression, the coefficient of the interaction term is not statistically significant different from zero. Neither can the hypothesis be rejected that the average tax base elasticity in the sector with a high FID ratio is -1, and in the sector with a low ratio is zero; our elasticity estimates differentiated by sub-groups are not precise enough to distinguish between these alternative hypotheses. However, the average tax base elasticity across all groups would still be about -0.5.

Overall, although we do find some suggestive evidence for differences in tax base elasticities with respect to variables which are related to income shifting activities discussed in the recent literature, such as sector, a corporation's size, its capital structure and FDI intensity, these differences are not statistically significant. This is probably due to the limitations of our relatively small pseudo panel data set to further split up the sample in smaller subgroups in combination with the well-known property of the IV estimator to yield fairly large standard errors of estimated coefficients in small and medium-sized samples. Thus, based on our preferred specification we would conclude that the average corporate tax base elasticity is about -.5, and there is relatively little variation across industries by sector, size, capital structure, and the FDI intensity.

5 Conclusion

This paper contributes to the small empirical literature on the elasticity of the corporate tax base with respect to the effective corporate tax rate. Knowing the size of this elasticity is important to evaluate both the revenue and welfare implications of corporate tax policy. An important advantage of the tax return data used in this study is that they allow us to calculate effective corporate tax rates and the corporate income tax base taking into account various tax shields, in particular loss carry-forward which has become of major quantitative importance for the corporate sector also in the German economy. For the estimation we use a pseudo-

panel constructed from aggregating the individual-level corporate tax return data into about 1,000 groups defined by industry (up to the 5-digit level) and by region. This pseudo panel also allows us to control for unobserved group-fixed effects which may be correlated with both the corporate tax base, which we measure by Adjusted Gross Income, and the effective tax rate.

The main methodological problem in the estimation of this elasticity is that the ETR may be endogenous as it is partly determined by taxable income. To control for this endogeneity we have applied an instrumental variable approach. As our instrument for the observed ETR we have used the counterfactual ETR a corporation would face in a particular period had there be no change of profits within the corporation's control within that period. This counterfactual is obtained from a microsimulation model of the corporate sector based on tax return data for 1998 and 2001. This period saw the introduction of a substantial tax reform, which provides sufficient exogenous variation in effective tax rates across corporations to identify the corporate taxable income elasticity. Statistical tests strongly indicate that our instrument is indeed highly correlated with the change in the actually observed ETR and that the well-known weak instrument problem does not invalidate our instrumental variable estimation.

Our preferred 2SLS estimation of the basic regression model estimated on the whole sample yields a statistically significant and relatively large point estimate of the tax base elasticity of about -0.5. This estimate implies that a reduction of the (proportional) statutory corporate tax rate by 10 % would reduce corporate tax receipts by only 5 %. Since the estimated tax base elasticity is not sensitive to the control of the growth rate of sales at the industry level, we may interpret the response of the tax base to changes in the ETR as resulting from income shifting activities rather than real economic response of the corporate sector as far as this is related to sales volume. This average elasticity is more than double the size of the one estimated for the US by Gruber and Rauh (2007), the study which is most closely related to the present one. Thus, reductions of the statutory corporate tax rate are partly "self financing" by reducing corporate income shifting activities, but the corporate sector has not been on the declining segment of the "Laffer curve", even before the substantial reduction of statutory corporate tax rates recently introduced in Germany.

We do find some evidence that certain sub-groups of corporations may well be much more responsive to tax rate changes than indicated by our estimate of the average tax base elasticity for the whole corporate sector. The estimation results regarding heterogeneous tax base elasticities are consistent with the hypothesis that the tax base is more responsive for corporations that may benefit from income shifting. Our point estimates indicate that tax base elasticities may be above average in the manufacturing sector, in industries dominated by

larger corporations, and by corporations with a relatively high share of FDI at the beginning of our observation period. The tax base of corporations with a relatively high debt/equity ratio responds less to tax changes than does the tax base of corporations that can take less advantage of this particular tax shield. However, the statistical precision of these estimation results prevents us from drawing too strong conclusions for subgroups of our pseudo-panel.

Improving statistical precision of testing alternative income-shifting hypotheses would probably require a true panel of corporate tax return data which is currently not available for most countries, including Germany. Another possibility could be to add additional years to the pseudo-panel structure and exploit changes in regulations affecting corporate tax shields. This would also provide the opportunity to test for the longer-term effects of tax changes.

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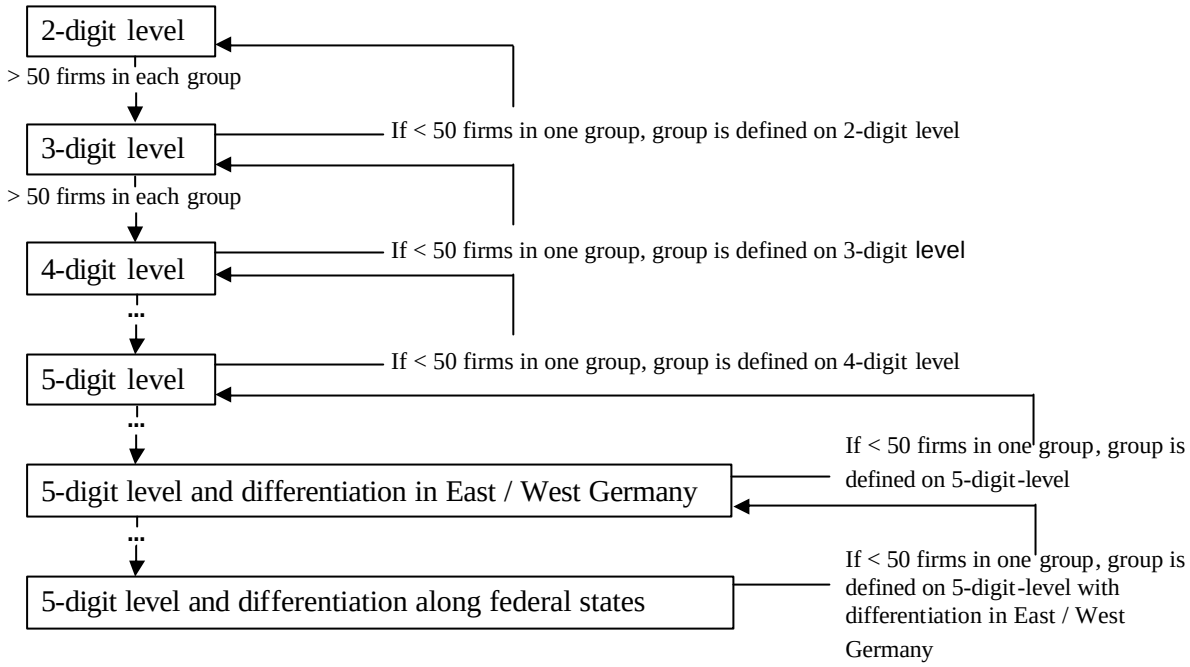
Appendix

A1: Sequential procedure for construction of pseudo panel



A2: Components of the corporate tax base and corporate income tax assessed

Profit as shown in tax balance sheet

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

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

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

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

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

= *Total Revenue*

\- allowable deductions for agriculture and forestry

\- deductible donations and contributions

+/- income generated by fiscal subsidiaries

= *Adjusted Gross Income*

\- loss carry-over and loss carry-back

= *Net Income*

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

= *Taxable Income*

* statutory tax rate

\- tax credits for foreign-source income

= *Corporate income tax assessed*

A3: Descriptive statistics for control variables – aggregate level

	1998	2001	Δ	Δ %
Share of corporations under the tax credit method	1.000 (0.000)	0.065 (0.051)	- 0.935 (0.051)	- 273.34
Number of corporations within each group	641.61 (995.65)	714.68 (1 120.32)	73.06 (262.27)	10.78
Share of groups which exclusively contain firms located in Western Germany	0.217 (0.413)	0.217 (0.413)	0.000 (0.000)	0.00
Sales in 1,000 € (average)	131,346.33 (381,558.06)	149,787.05 (452,014.23)	18,440.42 (166,116.23)	13.14
Share of groups whose sales are not fully liable to sales tax	0.173 (0.378)	0.173 (0.378)	0.000 (0.000)	0.00
Sales × share of groups not fully liable to sales tax	118,737.21 (354,810.39)	130,707.22 (411,759.87)	11,970.01 (119,485.84)	9.60
Share of corporations reporting a positive AGI	0.938 (0.053)	0.905 (0.075)	0.032 (0.050)	- 3.58
sector dummies				
primary sector/services	0.635 (0.482)	0.635 (0.482)	0.000	0.00
secondary sector	0.365 (0.482)	0.365 (0.482)	0.000	0.00
sales in 1,000 € (average in 1998)				
low share (= 50 %)	9,211.25 (8,322.21)	-	-	-
wages in 1,000 € (average in 1998)				
all groups	1,152.06 (6,902.44)	-	-	-
low share (= 50 %)	21.28 (6.84)	-	-	-
equity capital in 1,000 € (average in 1998)				
all groups	2,368.45 (18,201.99)	-	-	-
low share (= 50 %)	32.45 (248.46)	-	-	-
debt/ equity ratio (average in 1998)				
all groups	0.273 (4.183)	-	-	-
low share (= 50 %)	0.038 (0.026)	-	-	-
FDI / equity ratio (average in 1998)				
all groups	0.009 (0.145)	-	-	-
low share (= 50 %)	0.001 (0.001)	-	-	-

Notes: Sales and foreign direct investment (FDI) are not available on the individual level. FDI is not available on the group level but on a more aggregate level only (no differentiation across federal states or on the 4- or 5-digit industry level); on that aggregation level we have 45 observations. A few groups with negative debt/equity ratios are excluded (see text). Standard deviations are reported in parentheses.

Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 and 2001, local business tax statistics 1998, German Central Bank, micro database foreign direct investment 1998.

A4: First stage of the 2SLS regression

Dependent variable: $\log(ETR_{g,2001}/ETR_{g,1998})$

	(1)	(2)
simulated $\log(ETR_{g,2001}/ETR_{g,1998})$	1.5891	1.4986
	(0.0543)	(0.0544)
share of corporations under the tax credit method	-	0.2837
		(0.0668)
change in the number of corporations in the group	-	0.0407
		(0.0159)
change in sales	-	0.0254
		(0.0137)
interaction term between changes in sales and the dummy indicating industries whose sales are not fully liable for sales tax	-	0.0055
		(0.0172)
dummy indicating groups which exclusively contain firms located in Western Germany	-	-0.0228
		(0.0088)
change in the share of firms reporting a positive AGI	-	0.5235
		(0.0640)
constant	0.2544	0.2099
	(0.0249)	(0.0254)
R^2	0.4437	0.4885
Number of observations	1,074	1,065
F-Statistic	855.08	144.21
Partial R^2	-	0.4181

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

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

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Henriette Houben / Ralf Maiterth: Zur Diskussion der Thesaurierungsbegünstigung nach § 34a EStG
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