Corporate income taxation and firms' investment and financing decisions

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Dipl-Kffr. Nadja Dwenger
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Dekan:

Prof. Michael Kleinaltenkamp

Erstgutachter:

Prof. Viktor Steiner, Freie Universität Berlin und DIW Berlin

Zweitgutachter:

Prof. Alfons J. Weichenrieder, Goethe-Universität Frankfurt

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Preface

I had the opportunity to write this doctoral thesis as a research associate at the German Institute for Economic Research (DIW Berlin). While writing my thesis, I have benefited a lot from the inspiring and motivating atmosphere within the department of Public Economics. First and foremost, this stimulating research environment is the merit of my principle supervisor, Viktor Steiner, whom I would like to thank for his constant support and furtherance. He is a sincere, interested and personally dedicated teacher and co-author who opened up new horizons for my research. In particular, I am grateful for the time he spent discussing our papers (Chapters 3 and 4) and for unselfish advice at all stages of my thesis. I would also like to thank my second supervisor, Alfons J. Weichenrieder, for agreeing to supervise this work and for his thoughtful suggestions and recommendations. Thanks also go to Dorothea Kübler for accompanying me when I took the first steps towards my Ph.D. thesis.

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Chapter 1

Introduction

1.1 Motivation

Whether capital income should be taxed has long been debated among economists. Despite the popularity of the corporate income tax with most governments, researchers have regularly advocated the use of consumption or economic profit rather than income as a tax base. The fact that the corporate income tax is not very popular among economists is due to several inefficiencies it entails. For instance, the corporate tax structure is suspected to discourage the use of capital in the corporate sector, to distort financing decisions, and to cause a preference for retaining profits rather than distributing them. Kaplow thus concludes that "(...) the corporate income tax, an important component of many tax systems, is difficult to rationalize when taking an integrated view of the optimal taxation problem." (Kaplow, 2008, p. 238).

In spite of these potential inefficiencies, most developed economies, Germany included, traditionally have taxed corporate income. The main argument for maintaining the tax on corporate income has to do largely with progressivity, since higher-income individuals typically have a much larger share of their income from capital (Bach, Corneo, and Steiner, 2009). Arguing that individuals with capital endowment are supposed to make a larger contribution to fiscal revenue, politicians hence employ capital taxation for redistribution. In recent years, however, international tax competition has led to a continuous decline in tax rates. German tax authorities, for instance, have reduced the statutory corporate tax rate on retained earnings from 45 percent in 1998 to 15 percent in 2008. As in several other countries which reduced statutory corporate tax rates in recent decades, this has not resulted in a proportional decline in corporate tax revenues. This "self-financing" effect indicates that part of tax rate reductions may be compensated by higher economic activity or reduced income shifting and tax avoidance strategies of the corporate sector. Implying that the corporate tax base is elastic towards its tax rate, self-financing effects also hint at a reduction in deadweight losses associated with taxation.

In an influential pair of papers, Feldstein (1995, 1999) showed that the overall excess burden of personal income taxation can be calculated by estimating the effect of taxation on reported taxable income, i.e., the elasticity of the income tax base. The approach is elegant because one does not have to account for the various channels through which taxation might impact individual behavior (e.g., changes in effort, capital input, financial structure, transfer pricing) to measure efficiency costs.[1] However, while Feldstein's concept has been widely adopted in the literature on personal income taxation, empirical estimates of the corporate tax base elasticity are still scarce. The present doctoral thesis is the first microeconometric study based on taxation data providing evidence for whether firms react to corporate income taxation.

In this thesis, I predominantly rely on the German corporate income tax statistics which represent all corporations subject to the German corporate income tax. The

[1] As Chetty (2008) points out, the Feldstein approach may lead to an over-estimation of economic inefficiencies if tax avoidance includes both resource and transfer costs. If we are even willing to assume that tax sheltering only includes transfer costs, then tax avoidance leads to a reallocation of resources across agents rather than a reduction in total output, i.e., it generates no efficiency loss at all. A similar argument is put forward by Kopczuk (2009) in the context of real estate taxation: He underlines that taxation only causes inefficiencies if it affects estate accumulation but not if only avoidance is responsive to tax considerations. Further Saez, Slemrod, and Giertz (2009) show that the elasticity is not a sufficient statistic to measure welfare losses if the behavioral response involves changes in activities with externalities.

micro data set used is not only rich in terms of coverage but also in terms of variables, since it contains all items necessary to calculate the corporate income tax burden. In particular, it also includes information on corporations' tax loss carry-forward. As I show in my thesis, these tax losses carried forward are of major quantitative importance in Germany. I argue that yet unused losses from the past largely affect firms' effective (average) tax rate and thereby their behavior. As an innovation of the thesis, I thus account for tax losses carried forward in all estimations relying on the effective (average) tax rate. This is also true for the estimation of the tax base elasticity, where identification is partly driven by differences in tax loss carry-forward across firms and over time.

However, while the tax base elasticity helps assessing the overall excess burden of corporate income taxation, it does not reveal the firm decisions mostly affected by corporate taxation. For this reason, I go one step further and specifically evaluate to what extend corporate taxation distorts firms' financial structure and capital formation, in each case relative to the levels that would be chosen for nontax reasons. First, financial decisions might be influenced because interest payments on debt lower a company's profit liable for taxation while no similar deduction exists for the interest yield on equity, i.e., the corporate income tax applies only to the yield on corporate equity.[2] Such differential taxation tends to encourage the use of debt rather than equity. Despite extensive research effort, which is, as in all other chapters, reviewed in the chapter itself, researchers have had great difficulty to provide empirical evidence on the elasticity of financial leverage towards taxation. Second, because corporate income taxation generally increases the user cost of capital, firms might also use a capital stock below the one they would chose in a world without taxes. Beyond its influence on the long-term capital stock, taxation may also affect

[2]Under the tax-credit method which was applicable until 2000, this was partly mitigated, since the tax burden on the corporate level was credited against the personal income tax of the shareholder. Nevertheless, even under the tax-credit method, debt is preferable if shareholders do not exclusively realize gains as distributed earnings but also in the form of capital gains. The effects of corporate taxation on firms' payout policy is part of a follow-up paper together with Viktor Steiner, which is not part of this thesis.

investment dynamics. I thus assess whether dynamic models of investment provide an empirically fruitful framework for analyzing tax effects on changes in capital stock.

1.2 Contribution and main findings

The methodology applied throughout the dissertation combines microsimulation with microeconometric techniques. In Chapter 2, I briefly present a microsimulation model for the corporate sector, which I developed on the basis of corporate income tax statistics.[3] Moreover, I introduce the main data sets used in the course of the present thesis, i.e., the corporate income tax statistics and the Hoppenstedt balance sheet data set. Descriptive statistics of the former show that tax losses carried forward have surged in all economic situations since the 1990s. Further, only a surprisingly small share of tax losses is effectively used against profits. To achieve a deeper understanding of the data set, I explore this phenomenon quantitatively and qualitatively.

Chapter 3 focuses on the elasticity of the corporate income tax base with respect to the effective tax rate. For the first time I estimate this elasticity with tax data, and take tax losses carried forward as well as other tax shields into account. This is an important advantage over the small empirical literature on the elasticity of the corporate tax base. The main methodological problem is that, for various reasons discussed in the chapter, the effective tax rate is likely to be endogenous. To control for endogeneity of changes in the effective tax rate I thus apply an instrumental variable approach. As an instrument for the observed effective tax rate, I use the counterfactual effective tax rate a corporation would face in a particular period had there been no endogenous change of corporate profits. I find a statistically significant and relatively large point estimate of the average tax base elasticity. The estimate

[3]This model is part of the business tax simulation model BizTax of the DIW Berlin (Bach, Buslei, Dwenger, and Fossen, 2008).

of -0.5 implies that a reduction of the statutory corporate tax rate by 10 percent would reduce corporate tax receipts by 5 percent, i.e., less than proportionally due to increased real economic activity and to reduced income shifting strategies of the corporate sector. Moreover, I find some statistically weak evidence for the hypothesis that the tax base elasticity is higher in the manufacturing sector, in industries dominated by larger corporations and by corporations with a relatively high share of Foreign Direct Investment at the beginning of the observation period. Overall, my empirical results clearly show, for the Germany economy, that the corporate income tax affects corporate behavior.

While the elasticity of the corporate income tax base indicates the extent of economic inefficiencies, it does not allow to assess the different channels through which taxation might impact firm behavior. For this reason, I explicitly estimate the effect of corporate taxation on firms' financial structure in Chapter 4. More specifically, I estimate the elasticity of corporations' financial leverage with respect to the effective tax rate where I again control for endogeneity of changes in the effective tax rate by applying an instrumental variable approach. The point estimate for this elasticity amounts to 0.5 and suggests that corporate taxation indeed distorts firms' financial decisions: on average, an increase of the tax rate by 10 percent would increase firms' share of debt by about 5 percent. This average elasticity, however, hides important differences between corporations. I find that the debt ratio is less responsive for small corporations and for corporations that benefit from various other forms of tax shields, in particular depreciation allowances and tax loss carry-forward. In the chapter I also briefly discuss the relationship of the leverage and the tax base elasticity. In particular, I show that the elasticity of the corporate tax base can be traced back to one third to corporations adjusting their financial leverage.

Estimating a dynamic investment equation in Chapter 5, I additionally gauge whether firms alter real activity on account of changes in taxation. To be precise, I estimate the elasticity of capital with respect to its user cost in a dynamic framework and find an economically and statistically significant effect of the user cost of capital on investment. The contribution of this chapter is, first, in the methodology applied: Compared to the distributed lag model widely used in the literature, the error-correction model used in my study has the advantage that it yields an equilibrium relationship between capital, sales, and the user cost of capital which is consistent with a simple neoclassical model of the firm's demand for capital. As I will thoroughly discuss in the chapter, this dynamic specification seems to be more appropriate also from an econometric point of view. I find evidence that cash flow in distributed lag models acts as a proxy for omitted expected future profitability variables so that well documented cash flow effects rather point at dynamic misspecification than at the importance of financial constraints. A second improvement is that I correct for sample attrition in all estimations. Uncorrected sample attrition may have biased previous estimates, since dropping out of the panel is probably related to the decision to invest. Surprisingly, the fact that most (if not all) panel data sets on firms are incomplete, and the potential bias associated with this fact, have received little attention in previous papers on investment. Comparing results of models with and without the term correcting for sample attrition, however, shows that non-random sample attrition is present but does not influence the user cost elasticity.

Chapter 2

Microsimulation and German corporate tax losses

The aim of this introductory chapter is threefold. First, I introduce a microsimulation model for the corporate sector that is applied scientifically for the first time in the following chapters. Second, I present two data sets used in the course of my doctoral thesis. Descriptive statistics of the data reveal a surge in the yet considerable volume of tax losses carried forward since the 1990s. Third, to achieve a deeper understanding of the rise in tax loss carry-forward and the data, I plunge directly *in medias res* and explore this phenomenon quantitatively and qualitatively. In particular, I will take the microsimulation model to the data and examine whether restrictions in tax law may have caused a sharp increase in losses carried forward.

2.1 What is microsimulation?

All but the last chapter of this doctoral thesis draw on a microsimulation model. As the name suggests, microsimulation models try to simulate individual behavior on the level of micro units (e.g., individuals, firms) under current law as well as under past regulations and different reform scenarios. Then, the overall effects are found by aggregation. Since structural differences on the micro level are conserved, these aggregate effects can be split by group characteristics such as regions, industries or size to give distributional effects. Thereby, microsimulation allows *ex ante* policy evaluation of tax reforms regarding their fiscal costs and distributional effects. However, microsimulation models are also interesting from an academic point of view, since they, for instance, facilitate the construction of instrumental variables (Chapters 3 and 4). For these reasons, microsimulation models have become increasingly popular among both policymakers and researchers. However, whereas there exist plenty of models simulating household behavior, models focussing on firms are still scarce. To the best of my knowledge, there only exist five documented models: the Canadian corporate microsimulation model (Morin-Séguin, 2009), the models for the UK and Italy developed within the DIECOFIS project of the European Commission (Bardazzi, Parisi, and Pazienza, 2004; Parisi, 2003), the ZEW TaxCoMM (Reister, Spengel, Finke, and Heckemeyer, 2008), and the BizTax model of the DIW Berlin (Bach, Buslei, Dwenger, and Fossen, 2008). Models of firm behavior may be rare because of the scarcity of firm level information and because of the complexity and computational intensity which arise from interdependencies among firms, voluminous tax regulations, and discrepancies between commercial and tax law.

Under the microsimulation models for companies, BizTax, which has been developed at DIW Berlin in cooperation with the Federal Ministry of Finance, is the only one to draw on tax data. There are two modules of BizTax, a detailed local business tax module (Bach, Buslei, Dwenger, and Fossen, 2008; Fossen and Bach, 2008) and a module for the corporate sector, which I developed during my time at DIW Berlin. It is applied scientifically for the first time in my doctoral thesis. Currently, BizTax is a non-behavioral microsimulation model, i.e., it does not account for changes in firm behavior induced by tax reforms. The use of BizTax is thus limited to distributional and first-round effects. To extend its application it would be desirable to involve firms' behavioral responses even though modeling them is difficult, since firms may take decisions on several dimensions at the same time. For instance, a firm might simultaneously decide about market entry and about incorporation or about investment and financing of investment. Introducing the elasticities estimated in the following chapters into the model, however, could be a first step towards a behavioral model.

2.2 Data

The microsimulation model BizTax presented above rests on the corporate income tax statistics. Along with the balance sheet information provided by Hoppenstedt GmbH, the corporate income tax statistics is the main data base for my doctoral thesis.[1] Both data sources have specific advantages which make them particularly well-suited to my objectives. Below, I will briefly introduce both of them and show some basic descriptive statistics.

2.2.1 The corporate income tax statistics

The corporate income tax statistics are provided by the German Statistical Offices[2] and contain all corporations subject to German corporate income tax. While aggregate information on corporate taxation was also published formerly, statistical offices only started to provide micro data on corporate income taxation in 1992. Since then, the main parts of tax returns and information on legal form, industry, and region are retained for statistical purposes every three years (Gräb, 2006), with 2004 being the latest year currently available. This proceeding guarantees high precision of the data, since tax authorities check all items.[3] Data editing hence either

[1]Further data sources are the local business tax statistics, the value added tax statistics, and the Microdatabase Direct Investment. These complementary data sets are introduced in the course of the thesis.

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

[3]This is not true for information on depreciation allowances and accruals, since these items are purely statistical information and not necessary for corporate income taxation.

concerns inconsistencies in the coding, which arise from the German federal structure in tax collection,[4] or concerns missing values for some positions that could be (at least roughly) deduced from other variables. Further, I also correct transposed digits in the industry code and re-classify codes that have expired.

Besides tax items, the statistical data set also contains sub-totals which are generated during tax assessment (cf. Table A3.1 in the appendix of Chapter 3). These sub-totals include Adjusted Gross Income (AGI) or Taxable Income (TI). As is explained in more detail in Section 3, AGI can be derived from the corporation's profit as shown in its tax balance sheet by adding non-deductible expenses and deducting certain exemptions and allowable deductions. It primarily differs from TI by the amount of tax loss carry-back and carry-forward.[5] As a distinct advantage, tax return data also contain the corporate income tax assessed (TA).

All estimations in this thesis, for various reasons discussed in the following chapters, are based on the latest three waves. Each of these waves covers about 800,000 corporations. Basic descriptive statistics of the main variables, such as AGI and corporate income tax assessed, are summarized in Table 2.1.

As this table shows, average Adjusted Gross Income amounted to about 110,000 euro in 1998 but only to 39,000 euro (2001) and 61,000 euro (2004) in the following waves. The fluctuation in mean AGI is much less pronounced if the average is solely taken over companies with non-negative AGI. While the share of companies reporting a profit equal to zero is increasing slightly, the share with loss is stable over time: In all three years, about 40 percent of companies declare an AGI of equal to or less than zero.

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[4]The unity for some variables, for instance, differed across federal states (Pfennig instead of Deutsche Mark, cent instead of euro).

[5]In Germany, a net operating loss does not lead to an immediate tax rebate but is deductible against positive profits from other years: In the first place, companies that have paid corporate income tax in the year(s) before may "carry back" the loss and receive a tax refund. In this case, the tax statement in the profit year is modified and the data set contains both, the loss in the following year ("potential carry-back") and the amount of loss actually carried back. These two variables can differ because the loss in the following year(s) may exceed profits or a legally defined maximum carry-back. In that case, the remaining loss must be "carried forward" in time; the resulting tax loss carry-forward is deductible against future positive profits.

Table 2.1: Descriptive statistics for the corporate income tax statistics 1998, 2001, and 2004

	1998	2001	2004
Adjusted Gross Income (AGI) in 1,000 euro (average)			
All corporations	110.360	39.371	61.297
	(9,050.75)	(7,212.70)	(6,233.02)
All corporations with non-negative AGI	274.408	221.777	199.962
	(11,076.82)	(6,104.05)	(5,378.25)
Corporate income tax assessed (TA) in 1,000 euro (average)			
All corporations	49.089	31.276	26.486
	(2,586.61)	(1,206.70)	(832.92)
All corporations with non-negative AGI	79.493	48.641	40.924
	(3,180.88)	(1,503.88)	(1,035.37)
Tax loss carry-forward in 1,000 euro (average)			
All corporations	399.838	477.432	605.102
	(12,016.59)	(14,689.51)	(29,496.15)
All corporations with tax loss carry-forward	727.185	876.058	1,093.611
	(16,198.13)	(19,889.63)	(39,646.87)
Profits offset against ... in 1,000 euro (average)			
tax loss carry-back	1.235	1.878	0.791
	(21.67)	(157.10)	(12.61)
tax loss carry-forward	36.664	24.616	20.302
	(5,359.02)	(1,640.95)	(1,547.38)
Number of corporations			
All corporations	739,008	813,017	860,315
Corporations with AGI below 0	276,166	289,819	304,020
Corporations with AGI equal to 0	35,556	52,184	42,725
Corporations with tax loss carry-forward	406,339	443,076	476,018

Notes: All information is given on the firm level. Standard deviations of variables are given in parentheses.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998, 2001, and 2004.

Between 1998 and 2001 the Tax Relief Law (*Steuerentlastungsgesetz*) significantly lowered the statutory corporate income tax rate for most corporations. In principle, the tax rate was 45 percent for retained and 30 percent for distributed earnings in 1998, while the tax rate was generally reduced to 25 percent in 2001 and 2004. This decline in the statutory tax rate is also mirrored in the corporate income tax assessed; in 2001 and 2004, the average tax is about two third of that assessed in 1998.

More eye-catching is the sharp increase in the tax loss carry-forward. In 2004, the mean volume of tax losses carried forward is one and a half times the tax loss carry-forward the average company had six years before. By the end of 2004, it amounted to about 600,000 euro on average. If a company possessed a tax loss carry-forward, it was about 1,100,000 euro.[6] Companies, though, did not capitalize on these yet unused losses from the past. On average, the small amount of 37,000 euro (loss carry-forward) was used in 1998, i.e., less than 10 percent of losses carried forward. In 2001 and 2004, the profits offset against losses from the past were even lower. Tax loss carry-back was negligible in all years. If one is ready to assume that non-profitable companies drop out of the market in the long-run, few tax losses used are inconsistent with rising tax losses available. To better understand this empirical puzzle, I will examine the forces carefully which drive the surge in tax loss carry-forward. Before, I will introduce a second data source, the Hoppenstedt balance sheet database, that I will also use to explore the reasons for rising tax losses carried forward.

2.2.2 The Hoppenstedt balance sheet data set

The Hoppenstedt balance sheet data set provides accounting data for a large number of German corporations which are subject to publication requirements. Specifically, the database covers balance sheet positions and firms' profit and loss accounts in great detail. It further includes information on time invariant firm characteristics such as industry, region, legal form, and year of foundation. Unlike the corporate income tax statistics, however, it is neither representative nor comprehensive, since mainly large firms are affected by publication requirements in Germany. On the

[6] Since business profit in local business taxation ties in with profit used in corporate income taxation, tax loss carry-forward in both taxes are closely linked. In 2004, the only year in which the local business tax statistics provide information on tax loss carry-forward, 62 percent of corporations carried forward yet unused losses from the past. On average, tax loss carry-forward was about 480,000 euro. If only corporations with tax loss carry-forward are considered, the mean amounted to 780,000 euro. Even though the use of tax losses is limited in local business taxation because it does not allow for loss carry-back, average tax loss carry-forward are somewhat lower. This might be due to the fact that the local business tax includes elements of a property tax inhibiting large losses.

other hand, starting with 1987 the data set is available as a panel.

Table 2.2 gives basic descriptive statistics for selected years: 1998, 2001, and 2004. As expected, the table shows that the Hoppenstedt database mainly contains large corporations, since mean total assets amounted to 420 million euro in 1998 and to about 540 million euro in 2001 and 2004. Similarly, average sales were, after all, about 400 million euro in all years considered. The bias of the Hoppenstedt data set towards large firms is also reflected in the number of full-time employees. On average, corporations in the data set employed nearly 1,500 persons in 1998. While the number of employees declined to just about 1,250 in 2001, it again slightly increased to about 1,300 in 2004.

Table 2.2: Descriptive statistics for the Hoppenstedt company database (selected years)

	1998	2001	2004
Total assets in 1 million euro (average)			
All corporations	420.422	544.117	537.910
	(2,300.47)	(3,734.28)	(3,472.13)
Sales in 1 million euro (average)			
All corporations	375.649	415.213	404.623
	(1,728.98)	(1,892.91)	(2,229.00)
Number of (full-time) employees			
All corporations	1,488.31	1,244.517	1,294.117
	(8,268.78)	(6,013.68)	(7,892.26)
Profit / loss in 1 million euro (average)			
All corporations	11.312	18.697	9.310
	(71.38)	(288.96)	(110.598)
All corporations with positive profit	19.926	38.172	22.419
	(89.08)	(379.32)	(129.13)
Number of corporations			
All corporations	2,128	1,880	2,129
Corporations with loss	295	349	352
Corporations with profit equal to 0	505	453	527

Notes: All information is given at the firm level. Standard deviations of variables are given in parentheses.
Sources: Own calculations based on Hoppenstedt company database 1998, 2001, and 2004.

Probably due to selectivity, the average profit is much larger in the Hoppenstedt data set than in corporate tax statistics. In 1998, firms in the balance sheet data set reported a profit of 11 million euro on average. Profits peaked close to 19 million euro in 2001 but then receded to about 9 million euro in 2004. Again, if the average is only taken over corporations with positive annual result, the mean is about twice the one over all companies.

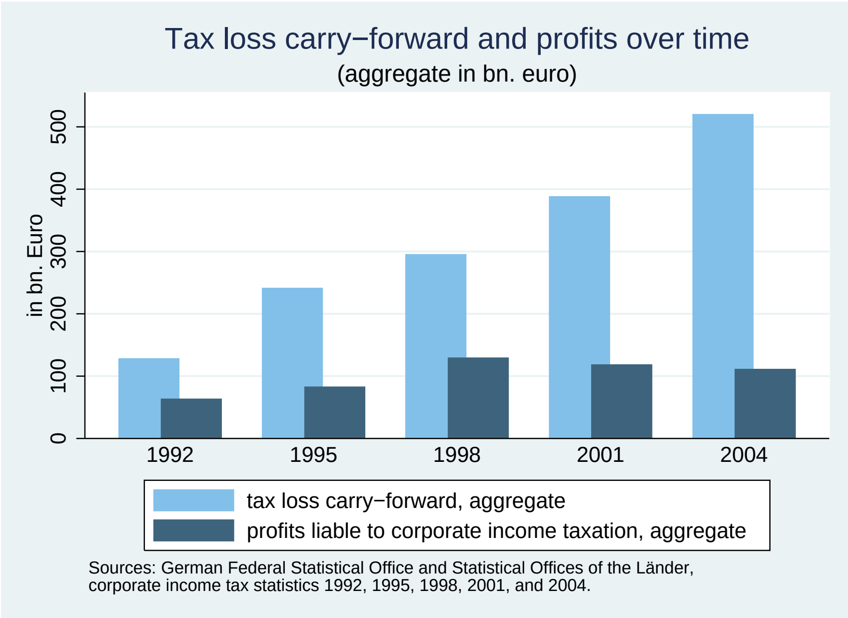
Interestingly, the share of companies reporting a loss or a profit equal to zero is also considerable in the Hoppenstedt database. Similar to what was found in the corporate income tax statistics, the share of these corporations is about 40 percent. However, the composition of the group is different. Less than 20 percent of companies exhibit a loss, while this percentage was about 35 percent in the tax data.

Unfortunately, there is no information on tax losses carried forward in the Hoppenstedt database. The accumulated deficit reported in the balance sheet is by no means comparable to the tax loss carry-forward. In spite of this cloud, the Hoppenstedt database will hopefully help to shed some light on the reasons to report a loss and might also help to understand why tax losses have increasingly been carried forward in the recent past.

2.3 Surge in tax loss carry-forward

For two reasons, the rise in tax loss carry-forward has provoked much public interest. First, one expects that losses and profits fluctuate with the business cycle. For this reason, unused losses are predicted to grow during an economic recession and to decline when the economy recovers. For German corporations, however, this is not observed. As the areas in light blue in Figure 2.1 show, aggregate tax loss carry-forward has significantly increased in all macroeconomic situations since 1992. Second, politicians have been concerned about a sudden drop in corporate tax receipts if a large number of companies make use of their losses simultaneously. Since no provisions for this event have been made, this could cause substantial problems to the federal budget for some years at least. Fiscal authorities are right to be worried; the areas in dark blue in Figure 2.1 demonstrate that tax losses largely exceeded profits liable for corporate income taxation in all years available. In 2004, for instance, aggregate tax loss carry-forward was more than four times larger than aggregate profits.

Figure 2.1: Aggregate tax loss carry-forward and profit over time (1992 to 2004)



For the US, Cooper and Knittel (2006) and Auerbach (2007) report a similar surge in corporate tax losses. Auerbach, for instance, finds that the ratio of losses to positive income was much higher during the recession period of 2001/2002 than in earlier recessions, even in recessions of greater severity. However, unlike in Germany, the volume of loss carry-forward has again receded in the US since 2002 (Altshuler, Auerbach, Cooper, and Knittel, 2008). Altshuler, Auerbach, Cooper, and Knittel find that losses in the US "went up because the average rate of return among these firms went down, and not because of an increase in the dispersion of returns or because of an increase in the gap between taxable income and a measure of income more useful for tracking economic returns." (Altshuler, Auerbach, Cooper, and Knittel, 2008, p.29). They tentatively conclude that the average rate of return might have been lowered by aggressive tax planning while it was raised again because of increased attention paid to corporate tax shelters.

In Germany, a full understanding of why tax losses have surged since the 1990s is still lacking. Bach and Dwenger (2007) show an increasing gap between corporate profits as measured by the National Income and Product Accounts (NIPA) and corporate profits subject to tax. On the reasons why profits as measured by the tax code are lower than in the NIPA, however, one can only speculate. Heckemeyer and Spengel (2008) focus on one potential reason, the existence of outward profit shifting within multinationals at the expense of Germany's national tax revenue. Contrasting tax law and the definition of the NIPA in great detail, they find that differences in profits taxed and profits in the NIPA are only partly attributed to outward profit shifting of multinationals.

While the rise in tax losses is still at the heart of a political debate, there is hardly any empirical evidence beyond aggregate figures. Aggregate figures, however, may hide important changes in the composition of firms that could account for an overall increase in tax losses. For instance, if mainly start-up companies incur a loss, tax losses might have risen over time because the share of newly founded corporations has increased. In the following, I therefore first provide descriptive statistics showing the distribution of losses over industries and firm size (Section 2.3.1).

Second, in Section 2.3.2, I apply the microsimulation model for the corporate sector to see whether the rise in tax losses follows from major changes in the legal provisions on the use of these losses. To evaluate the reforms in tax loss provisions, I consider two perspectives: The immediate effect on the national budget and the long-term impact. The latter greatly depends on the time span corporations restricted in the use of tax losses need to convert remaining losses into cash, i.e., on whether profitable and loss periods alternate. To assess this time span, I estimate transition probabilities between loss and profitable periods within a hazard rate model.

Last but not least, I analyze press reports and ad hoc disclosures for nearly 700 observations and provide some suggestive evidence on the reasons to report a loss (Section 2.3.3). As I will show, there is a variety of reasons to report a loss, though it is difficult to deduce from these results why tax losses have continued to rise in recent years.

2.3.1 Distribution of tax loss carry-forward

Table 2.3 gives the distribution of tax losses carried forward over industries. In view of the variety of industries and because of privacy restrictions, it mainly provides information on the 1-digit-level and optionally further differentiates up to the 3-digit-level in case an industry seems to be important in terms of loss carry-forward. Even though micro data on corporate tax returns is also available for 1992 and 1995, they could not be included in the analysis because classification of industries was changed, and it turned out to be impossible to classify industries in the data sets for 1992 and 1995 comparably to those used in 1998, 2001, and 2004.

As the table shows, tax losses carried forward are distributed unevenly over industries.[7] In 2004, for instance, nearly 40 percent of all tax losses carried forward occur in "real estate and renting". Another share of about 25 percent can be assigned to manufacturers. Corporations in other industries, like "agriculture", "hotels and restaurants", "public administration" and "health" only posses little tax loss carry-forward. Even though tax losses have also slightly increased in some of these industries, in all likelihood they have not caused the surge in tax losses. For this reason, I will focus on industries that seem to be more important in terms of tax loss carry-forward.

Most losses belong to corporations in "real estate and renting". On aggregate, losses of corporations in this industry more than doubled between 1998 (86 billion euro) and 2004 (200 billion euro). Within "real estate and renting", largest parts can be attributed to real estate activities and to other business activities, mainly holdings and consultants. For the latter losses surged from 45 billion euro in 1998

[7] While the number and size of firms also differ across industries, unreported analyses show that the uneven distribution of loss carried-forward cannot be mainly attributed to these differences. These further analyses can be obtained from the author upon request.

Table 2.3: Distribution of aggregate loss carry-forward (in million euro) over industries

Industry	1998	2001	2004
Agriculture, forestry, fishery, mining, quarrying	8,002	5,512	5,538
Manufacturing	91,459	96,247	121,757
Thereof: manufacture of food products, beverages, tobacco	5,170	5,437	24,886
Thereof: manufacture of coke, refined petroleum products and nuclear fuel; manufacture of chemical, chemical products and man-made fibres	7,711	5,871	11,601
Thereof: manufacture of basic metals and fabricated metal products	17,917	16,318	15,574
Thereof: manufacture of machinery and equipment	17,997	17,195	18,484
Thereof: manufacture of transport equipment	8.322	10,247	11,438
Electricity and water supply	9,533	8,119	8,662
Construction	13,896	17,736	20,134
Wholesale and retail trade, repair of goods	32,126	37,567	40,960
Thereof: wholesale trade and commission trade except of motor vehicles and motorcycles	20,560	22,963	25,077
Hotels and restaurants	3,382	3,692	4,433
Transport, storage and communication	22,845	31,065	42,379
Thereof: land transport; transport via pipelines	10,647	14,800	16,267
Thereof: post and telecommunications	5,810	5,952	15,369
Financial intermediation	7,542	17,588	38,064
Real estate and renting	85,578	146,330	200,482
Thereof: real estate activities	36,370	48,233	60,419
Thereof: other business activities	44,738	85,682	123,516
Thereof: legal, accounting, book-keeping and auditing activities; tax consultancy; market research, holdings, etc.	26,101	52,696	76,526
Public administration and defence; compulsory social security	1,339	126	104
Education	576	651	1,100
Health and social work	2,563	3,039	4,567
Other community, social and personal service activities	16,642	20,489	32,149
Total of tax losses carried forward	295,484	388,160	520,328

Notes: Tax loss carry-forward on December 31st of 1998, 2001, and 2004 in million euro.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998, 2001, and 2004.

to 124 billion euro in 2004.

Within "manufacturing", tax losses carried forward have significantly risen for manufacturers of food products, beverages, and tobacco. For these corporations, starting from a relatively low level, tax losses have virtually quintupled between 1998 and 2004. Similarly, tax loss carry-forward has increased by 50 percent for manufacturers of coke and for manufacturers of chemicals. Tax loss carry-forward possessed by other manufacturers, by contrast, have slightly receded; for manufacturers of basic metals and fabricated metal products, tax losses carried forward have fallen from 18 billion euro in 1998 to about 16 billion euro in 2001 and 2004.

In the public debate, anecdotal evidence often blames public transport systems of exceptionally making losses. Table 2.3 provides empirical evidence that this industry indeed incurred losses. It, however, also shows that public transport companies are wrongly held responsible for the surge in loss carry-forward, since losses only moderately increased between 2001 and 2004 (from 15 million euro to 16 million euro). In the same time period, losses by corporations in "post and telecommunications" more pronouncedly rose from 6 billion euro to a little more than 15 billion euro.

One can only speculate on the reasons for the rise in tax loss carry-forward, since tax statistics provide no profit and loss account or further economic information. Companies operating in real estate activities might report tax losses due to depreciation allowances for buildings they operate but make use of tax losses carried forward when they sell buildings and release reserves. Anecdotal evidence further suggests that, in Berlin for instance, the public authorities sold their social housing activities and, under specific conditions, paid subsidies to the new operators in the first years after the sale. These subsidies led to low, unprofitable rents and, once subsidies ceased to apply, to operating losses of the new owners. There is also anecdotal evidence that the manufacture of food products and chemicals is associated with high research and developments costs. Costly developments in the past may thus have caused losses and increased corporations' tax loss carry-forward. If this is true, fiscal authorities need not worry about the surge in yet unused losses from the past:[8] Once corporations sell the patents associated with research and development costs, they will realize undisclosed reserves and (partly) settle realized gains against tax losses carried forward. Presumably, the increase in tax loss carry-forward for corporations in "post and telecommunications" is partly due to valuation adjustments of concessions for the Universal Mobile Telecommunications System (UMTS). As

[8]At least if patents have not been transferred to subsidiaries abroad.

Weichenrieder and Blasch (2005) show, telecommunications and holding companies also had an incentive to realize investment losses until 2002. Unfortunately, tax data do not provide any information about how the loss as shown in tax balance sheet came about, so that it is difficult to give more universal evidence beyond case studies.

Next, I will also provide some descriptives measuring the dispersion of tax losses carried forward. In economics, a variety of indicators has been developed (Cowell, 2008; Jenkins, 1991). Since they feature rather different characteristics, Table 2.4 provides several measures. First, the relative difference between mean and median tax loss carry-forward gives the skewness of the distribution, i.e., if tax losses carried forward become more concentrated in the upper half of the distribution, the relative difference will rise. This is exactly what I observe: The relative difference steadily increased from about 300 percent in 1992 to nearly 340 percent in 2004.

The Gini coefficient is relatively sensitive to changes in the middle of the distribution and varies between 0 and 1, where 0 indicates perfect equality and 1 indicates maximum inequality. As can be seen in the table, the Gini index is larger than 0.9 in all years, implying that tax losses have been highly concentrated. As the relative difference, the Gini coefficient slightly increased indicating growing inequality in the distribution of tax loss carry-forward. To also measure changes in the tails of the distribution, I provide Generalized Entropy measures GE(a). The larger a is, the more sensitive GE(a) is to differences at the top of the distribution. More specifically, I provide the mean logarithmic deviation GE(0) which reacts to changes at the "bottom" of the distribution, the Theil index GE(1), and the GE(2) which is "top sensitive".

As Table 2.4 shows, tax losses carried forward were particularly concentrated at the top of the distribution in 1992. The GE(2), reflecting half the squared coefficient of variation, even further increased from roughly 210 in 1992 to about 660 in 2004. While concentration eased between 1995 and 1998, it again sharply increased

Table 2.4: Distribution of tax loss carry-forward 1992-2004

	1992	1995	1998	2001	2004
Tax loss carry-forward at 1998 prices[a,b]					
Mean tax loss carry-forward (in 1,000 euro)	619	711	727	842	1,008
Median tax loss carry-forward (in 1,000 euro)	31	36	36	35	34
Relative difference[c]	299.4	298.3	300.5	318.0	338.9
Gini coefficient	0.9371	0.9404	0.9408	0.9474	0.9552
Generalized entropy measures[d]					
GE(0)	3.0165	3.1294	3.1796	3.3481	3.4842
GE(1)	3.6950	3.9188	3.8579	3.9794	4.3859
GE(2)	213.628	386.962	248.090	257.725	657.779
... of the population with tax loss carry-forward represent ... of aggregate tax loss carry-forward					
10%	0.01%	0.01%	0.01%	0.01%	0.01%
25%	0.13%	0.12%	0.11%	0.08%	0.07%
50%	0.89%	0.85%	0.80%	0.66%	0.54%
75%	3.35%	3.27%	3.22%	2.73%	2.25%
90%	8.29%	7.98%	7.95%	6.95%	5.83%
95%	13.49%	12.67%	12.69%	11.37%	9.70%
99%	31.84%	29.06%	29.29%	27.61%	24.60%
99.9%	63.07%	59.93%	60.34%	58.73%	52.83%
99.99%	85.44%	82.06%	83.63%	83.02%	76.74%
99.999%[e]	95.09%	93.49%	94.76%	95.11%	91.91%

[a] Mean and median tax loss carry-forward for corporations with tax loss carry-forward.
[b] Deflated by the overall price index.
[c] Difference of ln(mean) and ln(median).
[d] GE(0): mean logarithmic deviation, GE(1): Theil index, GE(2): half the squared coefficient of variation.
[e] In 1992: 99.9987%.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1992, 1995, 1998, 2001, and 2004.

between 2001 and 2004.

The lower part of the table also displays the distribution of tax loss carry-forward across selected fractiles of the population. From this more detailed picture one can see that 99 percent of corporations possessed only about 32 percent of aggregate tax loss carry-forward in 1992, and less than 25 percent in 2004. To turn the argument on its head, it means that the top 1 percent of the distribution, i.e., 4,760 companies, held more than 75 percent of yet unused tax losses in 2004. Further increasing in the distribution I find that in 2004, less than 50 companies (0.01 percent) possessed about 23 percent and less than 10 companies (0.001 percent) about 8 percent of aggregate tax loss carry-forward.

In summary, tax losses carried forward are highly concentrated in terms of both industry and volume. Tax authorities have reacted to aggregate tax losses by restricting their use in time and volume. In the next paragraph, I will apply the microsimulation model for the corporate sector to find out whether the tightening-up has also contributed to the rise in yet unused tax losses.

2.3.2 Tightening-up of tax loss offset restrictions

Legal provisions on the use of tax losses

In Germany, there are two possibilities to use a net operating loss: First, companies that have paid positive taxes in the years before may "carry back" the loss and receive a tax refund. Second, if the current loss exceeds positive profits in previous years or a legally defined maximum carry-back the remaining loss must be "carried forward" in time; the tax loss carry-forward is offset against future positive profits.[9]

Until 1998, profits could be carried back two years up to a value of 5.1 million euro. The tax loss carry-forward was unrestricted in time and volume. Since 1999, these regulations have been tightened (cf. Table 2.5). First of all, the tax loss carry-back was restricted to one year in 1999. Second, the tax loss carry-back was gradually reduced in volume; in 1999 and 2000 it was limited to 1 million euro and since 2001 it has been capped to 0.5 million euro. In 2004, the "minimum taxation" was additionally introduced, restricting the use of tax loss carry-forward in volume: Only up to 1 million euro are profits fully deductible against a tax loss carry-forward; exceeding profits can be offset up to 60 percent.

Companies that have to carry forward some portion of their loss only receive a partial refund of their tax loss because a tax loss carry-forward is not interest bearing. Thus, the real value of the loss erodes over time. The implicit tax penalty

[9] These inter-year loss offsetting rules are intended to alleviate fiscal burden for those companies which experience both, years with a profit and those with a loss. The main reason for having loss offset is to adjust for problems caused by taxation on the basis of yearly income. Without loss offset, firms with income fluctuations would be discriminated relative to firms with more stable income.

Table 2.5: Rules for the inter-year use of tax losses since 1984

	Volume (upper limit)	Time
Tax loss carry-back		
1984 - 1998	5.1 million euro (10 million DM)	2 years
1999 / 2000	1 million euro (2 million DM)	1 year
Since 2001	0.5 million euro (1 million DM)	1 year
Tax loss carry-forward		
1984 - 2003	unlimited	unlimited
Since 2004	1 million euro + 60% of the profit exceeding this threshold	unlimited

Sources: Own depiction. §8(1) Corporate Income Tax Law in conjunction with §10d Income Tax Law for the years 1984 to 2004.

on losses is a function of the time needed to use the tax loss. If a company can carry back the loss, it will receive an immediate tax refund and incurs no penalty. Note that, necessarily, the tightening-up in tax loss carry-back contributed to the growth in tax loss carry-forward between 1998 and 2001, since companies restricted in their carry-back had to carry unused losses forward.

In parallel to the tightening-up of loss carry-back and carry-forward, tax authorities have also restricted the use of losses acquired with the purchase of a corporate shell (*Mantelkauf*).[10] Unfortunately, tax statistics do not provide information on the fraction of shares transmitted. For this reason, changes in the provisions on purchased corporate shells cannot be evaluated on the basis of the present data set. Similarly, an analysis of legal changes on the use of losses in the context of spin-offs and mergers is impossible because of data limitations.[11] By contrast, what I can evaluate with corporate tax statistics are the restrictions in the volume of tax loss carry-back and carry-forward.

[10]Until 1996, losses could be still used if less than 75 percent of shares were transmitted and if the company has not ceased business operations (§8 (4) Corporate Income Tax Law 1996). From 1997 to 2007 the threshold was reduced to 50 percent; additionally, a tax loss carry-forward could only be used if the company continually ran business operations with the same working capital (§8 (4) Corporate Income Tax Law 1997). Since 2008 tax losses perish on a *pro rata* basis if more than 25 percent of shares are transmitted within five years; tax losses are completely lost if more than 50 percent of shares change hands (§8c Corporate Income Tax Law).

[11]Through 2005, tax losses carried over in mergers and spin-offs if business operations continued for at least five years (§12 (3) 2nd sentence Tax Reorganization Law 2004). Nowadays, mergers and spin-offs are put on a par with the purchase of a corporate shell, i.e., tax losses cannot be (fully) transmitted if more than (25 percent) 50 percent of the corporation are transferred.

Data and methodology

In the following, I use two different waves of the corporate income tax statistics to evaluate the restrictions in the use of tax loss carry-back and carry-forward. Two waves are needed because both reforms have taken place at two different moments in time: As shown above, the rules on the tax loss carry-back were altered in 1999 (scenario carry-back I) and 2001 (scenario carry-back II) while the tax loss carry-forward was restricted in 2004 (scenario minimum taxation). To analyze the first-round effects of the tightening-up, I need tax information at a time when the reforms were not publicly known. For the minimum taxation, this is fulfilled with the corporate income tax statistics 2001. To evaluate the tightening-up in tax loss carry-back, I take tax data from the year 1998, the year before the changes in carry-back were publicly known.[12]

Tables 2.6 and 2.7 provide descriptive statistics showing how many companies have potentially been affected by the tightening-up in the use of tax loss carry-back and carry-forward. The tables show that the number of companies potentially affected by the reforms is quite small: 327 companies may be hampered in the use of a tax loss carry-back (Table 2.6) and 2,065 companies are potentially restricted in the use of a tax loss carry-forward (Table 2.7), i.e., less than 1 percent of all companies liable for corporate income tax. This is consistent with the finding that tax losses carried forward are greatly concentrated on a small fraction of corporations.

Table 2.6 shows a breakdown of companies according to Adjusted Gross Income in 1998 and according to the volume of tax losses carried back into the year 1998. AGI is used because it gives profits not yet offset against losses from other years (cf. Table A3.1 in the appendix of Chapter 3). As already discussed in the section on the corporate income tax statistics (Section 2.2.1), nearly 40 percent of the population (276,166 companies) experienced a loss in 1998. These companies, of course,

[12] I could have also taken the corporate income tax statistics 1998 to evaluate both reforms. Since major changes occurred in tax law in 2001, I preferred to use the most current data set suitable to my analysis.

Table 2.6: Breakdown of companies according to Adjusted Gross Income and tax loss carry-back in 1998

Number of companies Regarding Adjusted Gross Income in 1998 in euro				Regarding the volume of loss carry-back: no tax loss carry-back (1)	1 euro to 511,500 euro (2)	above 511,500 euro (3)	Total (4)
Below 0			(1)	276,166	-	-	276,166
0	-	511,500	(2)	417,125	27,030	-	444,155
511,500	-	1,000,000	(3)	7,561	282	99	7,942
1,000,000	-	2,500,000	(4)	5,550	115	120	5,785
2,500,000	and above		(5)	4,806	46	108	4,960
		Total	(6)	711,208	27,473	327	739,008

Notes: Cells edged in black give the number of companies whose tax loss carry-back would have been restricted through the transitional rule effective in 1999 and 2000, which tightened the carry-back to 1 million euro.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998.

could not make use of a tax loss carry-back from 1999. By contrast, all remaining companies with a positive AGI in 1998 could theoretically benefit from a tax loss carry-back from 1999. In practice, however, most of them did not experience a loss in 1999. Only 27,800 companies reported a loss in 1999 and a profit in 1998, so that provisions on tax loss carry-back were important to them (columns (2) and (3), row (6)).

However, not all of these 27,800 corporations were affected by the restriction in tax loss carry-back. In fact, only those companies with tax loss carry-back exceeding 511,500 euro have been constricted. To gain a first impression on the reform's effects, Table 2.6 therefore further distinguishes between companies with tax loss carry-back below and above 511,500 euro. Column (3) contains the companies whose tax loss carry-back would have been restricted under current law; these are 327 companies. The cells edged in black comprehend all 228 companies whose AGI exceeded 1 million euro and whose tax loss carry-back was above 511,500 euro in 1998, i.e., all companies that would have been restricted under the transitional rule.[13]

[13] It would be preferable to restrict this group to all companies with both, AGI and tax loss carry-back, above 1 million euro. Unfortunately, this is not possible for reasons of privacy. Table 2.6 hence overestimates the group of companies potentially affected through the reform restricting the tax loss carry-back to 1 million euro.

It is important to notice, however, that we cannot directly deduce the number of companies which *really* have been affected through the reform: Several companies may have both, tax loss carry-back and carry-forward, and thereby substitute a restricted tax loss carry-back through a more extensive use of a tax loss carry-forward. By this means, they are not affected through the tightening-up in the tax loss carry-back - although the volume they carry back is lowered. To determine these counterbalancing effects accurately, I apply the microsimulation model for the corporate sector introduced in Section 2.1. Before coming to the results of the microsimulation, I will have a brief look on descriptive statistics for the minimum taxation.

Table 2.7: Breakdown of companies according to Adjusted Gross Income and tax loss carry-forward in 2001

Number of companies		Regarding the volume of loss carry-forward to the 31.12.2000				
Regarding Adjusted Gross Income in 2001		no loss carry-forward	1 to 1 m euro	1 m to 5 m euro	above 5 m euro	Total
Below 0		96,997	179,697	8,798	4,327	289,819
0	- 1 m euro	301,895	202,428	6,019	1,613	511,955
1 m euro	- 5 m euro	6,492	526	810	647	8,475
5 m euro	and above	2,073	87	103	505	2,768
	Total	407,457	382,738	15,730	7,092	813,017

Notes: Cells edged in black give the number of companies whose tax loss carry-forward is potentially restricted by the minimum taxation.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 2001.

Table 2.7 presents companies *potentially* affected through the minimum taxation, i.e., those 2,065 corporations with AGI and tax loss carry-forward exceeding 1 million euro. The corresponding cells are edged in black to facilitate reading the table. However, similarly to what was discussed for the restriction in the tax loss carry-back, this does not imply that these companies are *really* concerned by the minimum taxation. Since the maximum amount of profits offsetable against a tax loss carry-forward depends on a company's AGI, companies with a very large AGI but a somewhat smaller tax loss carry-forward are not affected by the reform. Consider, for instance, a company with AGI of 6 million euro and unused tax loss carry-forward amounting to 2 million euro. From its AGI, this company can immediately deduct tax loss carry-forward up to 1 million euro. The exceeding AGI can only be offset up to 60 percent against losses from previous years. More specifically, the company can maximally deduce another 3 million euro of tax loss carry-forward from its AGI: 0.6 * (6 million euro - 1 million euro) = 3 million euro. The remaining tax loss-forward of the company, however, amounts to 1 million euro only. In the example, the company thus has an AGI and tax loss carry-forward both exceeding 1 million euro but can fully use up tax losses; it is not affected by the minimum taxation.

In summary, it is thus fair to say that only a microsimulation model can provide the fiscal and distributional effects of changes in tax loss-offsetting provisions. Accounting for the firm-specific relationship between tax loss carry-back and tax loss carry-forward and for the individual ratio between AGI and tax loss carry-forward, I can neatly determine how many companies have been affected by the reforms and by how much the reforms have raised companies' corporate income tax.

Two angles: national budget and time value of money

In my analysis, I will evaluate the reforms in tax loss provisions from two angles. First, I will take up the perspective of tax authorities trying to safeguard tax revenues and consider *immediate* effects on the national budget. Immediate effects are conceived to capture the impact on tax revenue in the year when the restriction took hold for the first time. These immediate effects, however, largely over-estimate the *long-term* impact, since corporations restricted in the use of tax losses can carry-forward unused losses and lower tax liability in the future. The long-term impact of the tightening-up hence merely consists of the time value of money, and losses possessed by corporations that become insolvent.[14]

Whether companies are significantly constricted by the tightening-up of the tax

[14] The latter is neither observable in the corporate income tax statistics nor in the Hoppenstedt database.

loss carry-back thus depends greatly on the time span corporations need to convert remaining losses into cash, i.e., on whether profitable and loss periods alternate. For clearness let us assume a corporation with profit in 1998 and loss in 1999; the company is assumed restricted in the tax losses carried back to 1998 and thus carries forward the remaining loss. Two scenarios are possible: First, if the company reports a profit in 2000 and uses its tax loss carry-forward, the long-term effect of the restriction in carry-back is small. Second, if state dependence is large and if the company reports a loss anew in 2000, the time value of money lost and the restriction may be significant. A similar argument applies to the long-term effect of the minimum taxation: If a company reporting a profit in 2004 also does so in 2005, it will hardly be affected by the cap in tax loss carry-forward offsetable. By contrast, if profitable and loss fiscal years alternate or if profit years are sandwiched in several loss years, the minimum taxation may do serious harm.

For the long-term evaluation of the tightening-up, I therefore need the unconditional probability of reporting a profit after a loss year and the unconditional probabilities of experiencing a loss after one, two, three, and so on years of profits. Since to the best of my knowledge there is no empirical evidence on these probabilities so far, I estimate a hazard rate model. Unfortunately, the corporate tax statistics cannot be employed for the estimation because they do not include information about the duration in the current spell and are not available as a panel. For this reason, I draw on the Hoppenstedt database to estimate the hazard rate model. The panel structure of the Hoppenstedt balance sheet data set allows tracking firms over time and observing their spells in profitable and loss periods. Transition from profit to loss ("profit-to-loss-model") and from loss to profit ("loss-to-profit-model") are modeled analogously. In the "profit-to-loss-model", a spell k starts with a profit and ends with a loss; in the "loss-to-profit-model", the spell k starts with a loss and ends with a profitable year. To ease reading, I focus on the "profit-to-loss-model" in the following. All explanations analogously apply to the "loss-to-profit-model".

In the "profit-to-loss-model" the discrete hazard rate $h_i(t)$ is modeled as the conditional probability of transition from reporting a profit to sustain a loss in interval t, given the firm has been profitable until the beginning of this interval. The hazard rate is given by

$$h_{i,k}\left(t|x_i(t),\varepsilon_i\right) = Pr\left(T_{i,k} = t|T_{i,k} \geq t, x_i(t), \varepsilon_i\right) \tag{2.1}$$

where $T_{i,k}$ denotes the duration of k-th spell of firm i, and $x_i(t)$ is the vector of covariates, which includes a dummy indicating whether the company is listed on the stock exchange, a dummy indicating firms located in Eastern Germany, and the log of total assets. To avoid endogeneity problems, total assets are measured when the company is for the first time observed in the data set. Further, I allow for unobserved heterogeneity in firm characteristics which are, for instance, productivity, capacity for innovation, and managerial abilities. This unobserved heterogeneity ε_i is assumed to be uncorrelated with the explanatory variables.

The hazard rate is defined as a logistic hazard model:

$$h_{i,k}\left(t|x_i(t),\varepsilon_i\right) = \frac{exp\left(f(t) + x_i(t)\beta + \varepsilon\right)}{1 + exp\left(f(t) + x_i(t)\beta + \varepsilon\right)}, \tag{2.2}$$

where the function $f(t)$ is specified as a quadratic function denoting the dependence of the hazard rate on the spell duration (baseline hazard). When the hazard rate is small, the discrete time logistic hazard model approximates the underlying continuous time model with within-year durations following a log-logistic distribution (Sueyoshi, 1995). Organizing the data in firm-period format, I apply the "easy estimation method" proposed by Jenkins (1995) and use standard optimization procedures[15] to maximize the likelihood function with respect to the parameters of the baseline hazard and the explanatory variables. For a fully observed spell the contribution to the likelihood function is given by the probability of survival until the beginning of year t multiplied by the hazard rate in year t. For a right-censored spell the contribution to the likelihood function equals the survivor function, because it is only known that a firm "survived", i.e., still reported a profit at the end

[15]For the maximization I use the Stata command xtlogit for panel logit random effects estimation.

of the observation period, but not when the spell will end. Note I cannot correct for left-censored spells, i.e., for companies that enter the data set as firms reporting a profit. Since companies in the Hoppenstedt are in general observed for a long period of time (cf. Table A5.2 in the appendix of Chapter 5) and mostly incur a loss at least once while in the data set, this should, however, be of minor importance in my estimation.

Table 2.8 contains the marginal effects estimated at the sample mean and standard errors. Interestingly, companies listed on the stock exchange have a lower probability of transition from loss to profit and a higher probability of switching from profit to loss. The marginal effects indicate that the probability of transition from loss to profit (profit to loss) is 23 percentage points lower (25 percentage points higher) for companies listed on the stock exchange. Most importantly, the table shows that there is state dependence: In both models, loss-to-profit-model and profit-to-loss-model, the coefficient of the duration variable is negative and significant and that of the squared duration variable is positive and also significant, indicating that the hazard of transition first decreases with the duration of the spell and later increases. This finding is also confirmed by the failure function. In the median, a loss company reports a profit after three years; a company reporting a profit incurs a loss after four years in the median.

I therefore conclude that most companies restricted in their tax loss carry-back have to wait to use their losses for some time. To calculate the long-term effects of the restrictions, I assume on the basis of the failure function that the unused losses can be used over time as follows: 25 percent in the following year ($t+1$), 20 percent in $t+2$, 15 percent in $t+3$, $t+4$, and $t+5$ each, and the remaining 10 percent in year $t+6$.

Table 2.8: Marginal Effects: Transition between loss and profit

	Probability of switching from	
	loss to profit	profit to loss
Duration	-0.261	-0.282
	(0.031)	(0.029)
Duration squared	0.015	0.016
	(0.002)	(0.002)
Dummy indicating companies listed on the stock exchange[a]	-0.230	0.252
	(0.059)	(0.057)
Dummy indicating companies located in Eastern Germany[a]	0.022	0.177
	(0.072)	(0.078)
log(fixed assets$_{t-x}$)[b]	-0.120	0.041
	(0.012)	(0.011)
Agriculture, forestry, fishery[a]	0.485	0.336
	(0.240)	(0.202)
Mining and quarrying[a]	-0.427	0.319
	(0.272)	(0.275)
Consumer goods, goods for intermediate consumption[a]	-0.123	0.009
	(0.070)	(0.075)
Producers goods[a]	0.126	-0.076
	(0.070)	(0.073)
Electricity and water supply[a]	-0.567	-0.193
	(0.090)	(0.096)
Construction[a]	0.004	0.102
	(0.132)	(0.157)
Wholesale and retail trade, repair of goods[a]	0.134	-0.207
	(0.085)	(0.094)
Hotels and restaurants[a]	-0.166	-0.094
	(0.248)	(0.228)
Transport, storage and communication[a]	-0.331	-0.218
	(0.108)	(0.112)
Financial intermediation[a]	0.026	0.023
	(0.130)	(0.134)
Real estate and renting[a]	-0.016	-0.048
	(0.080)	(0.082)
Services for public sector and households[a]	0.081	-0.278
	(0.094)	(0.098)
Constant	2.328	-1.226
	(0.217)	(0.221)
Year dummies	included	included
Number of firms	4,261	4,136
Number of observations	13,670	17,236

[a] Marginal effect for discrete change of dummy from 0 to 1.
[b] To avoid endogeneity problems, fixed assets are measured when the company is observed in the data set for the first time.
Dependent variable: Binary indicator variable $y_{i,k,t}$ that equals one if company i completes spell k in period t and zero otherwise.
Notes: The industry "services for private sector", the most prevalent group, acts as base category for industry dummies.
Sources: Own calculations based on Hoppenstedt company database 1987 to 2007.

Since most companies reporting a profit also do so in the following year, most companies constrained by the minimum taxation probably have to postpone the use of their losses only slightly. Of course, transition probabilities can only be an indicator, since they do not reveal the amount of profits realized in the following year(s). To account for the fact that companies may only report a small profit which does not allow to completely compensate for the restriction incurred by the minimum taxation in the previous year, I assume that only 75 percent of these losses are deductible in the following year ($t + 1$); the remaining 25 percent are taken to equally distribute over years $t + 2$ to $t + 6$. To calculate the time value of money, I take an interest rate of 5 percent and apply the current statutory tax rate of 15 percent.

Empirical results

Immediate and long-term effects show that the tightening-up in the use of a tax loss carry-back is rather ineffective while the minimum taxation, which restricts the use of a tax loss carry-forward, has a strong fiscal impact. Both reforms exclusively affect large companies which cluster in certain industries and thereby imply distributional effects.

The tightening-up in the **tax loss carry-back** to a volume of 1 million euro (scenario carry-back I), which was effective in 1999 and 2000 only, had almost no effect on the corporation tax assessed. The immediate effect amounts to 9.5 million euro and the long-term effect to 1.3 million euro; compared to corporate tax revenue[16] the additional revenue generated by the restriction is negligible and not reported for the sake of brevity.[17]

The further tightening-up of the tax loss carry-back to 511,500 euro since 2001 (scenario carry-back II) has had a slightly larger impact: It immediately raised tax revenues by 17.7 million euro and increased corporate income tax assessed by 2.4

[16] Corporate tax revenue amounted to 21.7 billion euro in 2004 and 17.2 billion euro in 2001.
[17] More detailed results can be obtained from the author upon request.

million euro in the long-run. Table 2.9 shows the effects of the tightening-up along Adjusted Gross Income.

Table 2.9: Effects of the tightening in tax loss carry-back

	Adjusted Gross Income (in Euro)					
	below 0	0 to 511,500	511,500 to 1 m	1 m to 2.5 m	more than 2.5 m	Total
Tax loss carry-back						
Without restriction	-	547.3	118.5	128.5	118.4	912.6
With restriction	-	547.3	98.6	82.3	64.4	792.6
Substitution of tax loss carry-forward for carry-back	-	0	0	0.5	1.4	1.9
Effect on tax assessed						
Immediate effect	0	0	3.0	6.8	7.9	17.7
Long-run effect	0	0	0.9	2.2	2.5	2.4
Number of companies	276,166	444,155	7,942	5,785	4,960	739,008
Share of companies affected	0.00%	0.00%	1.25%	2.04%	2.17%	0.04%

Notes: Long-run effect calculated with an interest rate of 5% and the current statutory tax rate of 15%. For the long-run effect it is further assumed that the unused losses can be used over time as follows: 25% in the following year ($t + 1$), 20% in $t + 2$, 15% in $t + 3$, $t + 4$, and $t + 5$ each, and the remaining 10% in year $t + 6$.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998.

As the restriction only applies to firms with AGI exceeding 511,500 euro, most companies remained unaffected (columns (1) and (2)). By contrast, tax loss carry-back for the affected companies, i.e., companies with AGI exceeding this threshold, declined by 120 million euro compared to the simulation without restriction (columns (3) to (6), rows (1) and (2)). When discussing the descriptive statistics, however, I have shown that the effect of the restriction in tax loss carry-back cannot be directly inferred from comparing tax loss carry-back before and after the restriction took hold. This is because some of the companies may substitute a loss carry-forward for the loss carry-back. As Table 2.9 shows this indeed happens: 1.9 million euro, or 1.6 percent, of the reduction in tax loss carry-back is compensated by tax losses carried forward. This also explains why the number of companies actually affected by the restriction is lower than the number of companies exhibiting AGI and tax loss carry-back larger than 511,500 euro: 322 out of 327 potentially affected companies in fact have to pay higher taxes because of the tightening-up. Table A2.1 in the appendix shows that the companies affected cluster in five industries, which traditionally contain large players: consumer goods, producer goods, wholesale and retail trade, financial intermediation, as well as services for private sector. Quantitatively, however, tax losses carried back, their restriction, and the distributional effects of the reform are of minor importance.

Fiscal and distributional effects of the **minimum taxation** are larger. The microsimulation (scenario minimum taxation) shows that the minimum taxation affected 1,800 companies and immediately raised corporate income tax assessed by 704 million euro and by 56 million euro in the long-run. This is less than expected *prima facie* because the effect of the minimum taxation depends on the company's proportion of AGI to tax loss carry-forward.

Table 2.10: Effects of the minimum taxation

	Number of companies	Tax loss carry-forward used without	Tax loss carry-forward used with minimum taxation	Immediate ... effect on tax assessed	Long-run ... effect on tax assessed	Share of companies affected
Adjusted Gross Income		in million euro				
Below 0	289,819	0	0	0	0	0%
0 - 1 million	511,955	5,252	5,252	0	0	0%
1 million - 5 million	8,475	3,094	2,539	83.3	6.6	15.5%
5 million and above	2,073	12,484	8,346	620.7	49.4	23.4%
Total	813,017	20,830	16,137	704.0	56.0	0.2%

Notes: Long-run effect calculated with an interest rate of 5% and the current statutory tax rate of 15%. For the long-run effect it is further assumed that the unused losses can be used over time as follows: 75% in the following year ($t+1$) and the remaining 25% equally distributed over years $t+2$ to $t+6$.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 2001.

Further, Table 2.10 illustrates that the minimum taxation, albeit confined to few companies, significantly lowers the use of a tax loss carry-forward in the aggregate. This is compatible with the strong concentration of tax loss carry-forward observed in Section 2.3.1. Unlike the restriction in tax loss carry-back, the minimum taxation also implies significant distributional effects. I again see the industries consumer goods, producer goods, wholesale and retail trade, transport, storage, and communication, financial intermediation as well as services for private sector to be mostly affected with regard to the share of companies affected and to the rise in corporate income tax assessed (for details cf. Table A2.2 in the appendix).

All in all, it seems fair to conclude that the surge in tax loss carry-forward cannot be attributed to restrictions in the use of tax losses. In the next section, I explore press reports and ad-hoc disclosures to provide suggestive evidence on the reasons for reporting a loss. In an attempt to explain rising tax losses carried forward with structural differences, I also analyze whether the reasons to report a loss have changed over time.

2.3.3 Reasons for reporting a loss

Of course, tax statistics have been made anonymous and are subject to privacy laws. For that reason, I cannot scrutinize why corporations with tax loss carry-forward in tax statistics reported losses in the past: I neither have information on their balance sheet or on their profit and loss accounts nor am I allowed to access the firms' identity to pick up further information. On the assumption that losses in commercial and tax balance sheets coincide,[18] I can, however, use the Hoppenstedt balance sheet data set that is not under data privacy protection. Unfortunately, the database does not include information on tax loss carry-forward itself; losses carried forward for tax purposes do not match to the "loss brought forward" reported in the balance sheet for financial accounting purposes. I thus have to confine my analysis to corporations *currently* reporting significant losses. This is definitely a deficiency of the analysis. Since current losses and loss carry-forward probably highly correlate because of the state dependence of reporting a loss (Table 2.8), my analysis might nevertheless provide new insights into the reasons for high tax loss carry-forward.

For each year between 1992 and 2007, I draw a 1%-sample of companies reporting the largest losses in the respective year. Table A2.3 in the appendix shows that my

[18]There is no empirical evidence to what extent tax and commercial balance sheet results coincide. In Germany, the "authoritative principle" and the "reverse authoritative principle" in general require congruency of most items in the financial statement and tax accounts.

sample on average covers about 20 percent of aggregate ongoing losses reported in tax statistics. The sample includes 694 observations. For each of these observations, I evaluate press reports and ad hoc disclosures to learn more about why the company reported a loss.

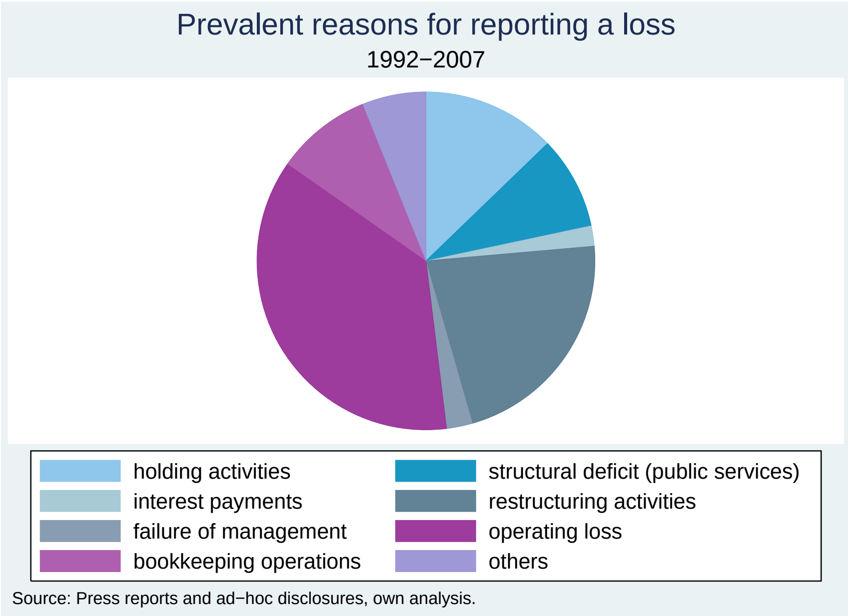
The first outcome of this exercise is that reasons for a loss are various and range from operating losses (e.g., Adam Opel GmbH,[19] Senator Entertainment AG,[20] Kathreiner AG[21]) to cracks in a nuclear reactor entailing large costs (RWE Power AG[22]). Several companies also deplored that politics interfered with their business and justified losses with changes in legal regulations. For instance, a recycling company ascribed its loss to the introduction of a deposit on beverage cans (Der Grüne Punkt-Duales System Deutschland AG[23]), a manufacturer of sugar explained its loss with the sugar policy within the European Union (Südzucker AG[24]) and the Fraport AG Frankfurt[25] experienced a loss because it had to write off the concessional contract for a terminal in Manila after a Philippine court had rescinded it. Other companies ascribed their loss to subsidiaries (e.g., EnBW Beteiligungen AG[26]) or to expenditures for restructuring loss-making business segments (for example, Wüstenrot Holding AG,[27] HIT International Trading AG[28]). There are also spectacular and singular causes, like the explosion of carrier rocket Ariane 5 (Astrium GmbH[29]), or the disastrous fire in the Düsseldorf airport (Flughafen Düsseldorf GmbH[30]).

To structure these various reasons, I classify them into eight categories: Operating loss, loss because of provisions, allowances, and adjustments, loss after failure of

[19] Reuters, REU2179 3 wi 149 FAD007949.
[20] Ad hoc disclosure Senator Entertainment AG, 20.8.2003.
[21] Lebensmittel Zeitung, 19.9.1997, "Kathreiner mit Rekordverlust".
[22] Stuttgarter Zeitung, 4.11.2000, "Der Riss in der Schweißnaht des Landtags".
[23] Financial Times Deutschland, 4.5.2004, "Konzerne ringen um Grünen Punkt".
[24] APA-Finance Briefing, 23.5.2007, "Südzucker-Dividende trotz Verlust unverändert".
[25] Reuters, REU8563 3 wi 252 L05237654.
[26] Energie & Management, 1.4.2004, "Noch nicht topfit, aber auf dem Wege der Besserung".
[27] Reuters, 3.12.2002, "Finanzkonzern W&W von Sachversicherern belastet".
[28] Reuters, 27.4.1998, "Bürowarenhersteller Herlitz erneut ohne Dividende".
[29] Frankfurter Rundschau, 11.2.2003, "Auftragseingang bei EADS bricht ein".
[30] Süddeutsche Zeitung, 6.8.1997, "Flughafen Düsseldorf im Minus'".

management, loss arising from holding activities, structural deficit stemming from general public services, loss attributable to large interest payments, loss due to restructuring expenditures, and other reasons. Figure 2.2 depicts the percentage of loss events that can be explained by the particular category.

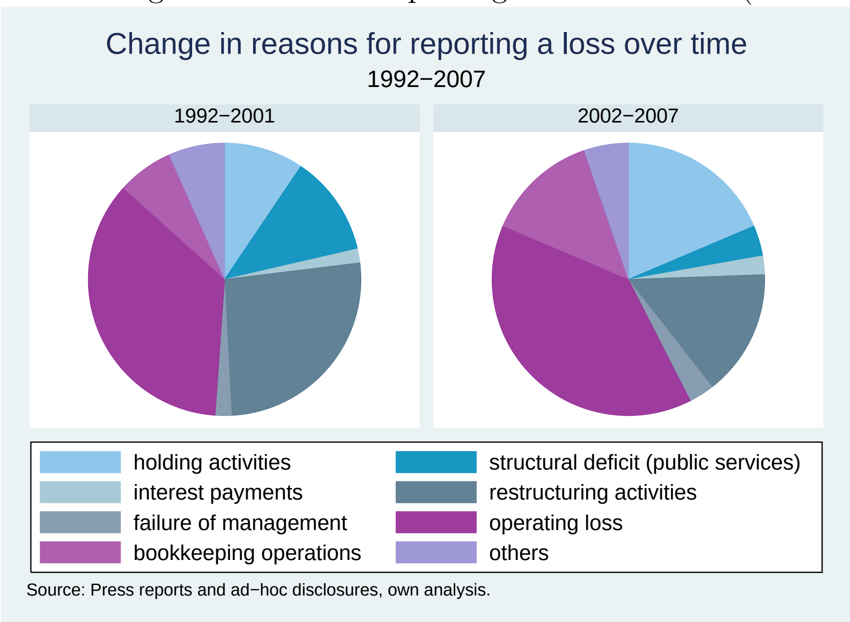
Figure 2.2: Prevalent reasons for reporting a loss (1992 to 2007)



It shows that more than one third of loss events between 1992 and 2007 can be explained by an operating loss. Restructuring measures account for another 22 percent. Holding activities (13 percent), general public services (9 percent), and bookkeeping operations like provisions, allowances, and adjustments (9 percent) are also common reasons, whereas failure of management (2 percent) and large interest payments (2 percent) are rarely held responsible for a loss.

What I am mostly interested in, however, is whether the reasons to report a loss have changed over time. Figure 2.3 provides the above pie chart distinguishing two periods, 1992 to 2001 (434 observations), and 2002 to 2007 (260 observations). First of all, the share of loss events explainable by a structural deficit associated with general public services declined from 12 percent (before 2002) to 4 percent (since 2002). Second, loss periods are nowadays less often driven by restructuring expenses. This decrease is in line with large capital expenditure to modernize plants located in Eastern Germany in the 1990s, which might have caused tax losses at that time. Unpredicted, however, is the rise in loss cases provoked by holding activities from 9 percent between 1992 and 2001 to 19 percent since 2002. For tax reasons alone, a reverse development would be expected because writedowns of investments in shares of affiliated companies were effective for tax purposes only until 2001 (for a discussion see, e.g., Weichenrieder and Blasch, 2005). Similarly, tax authorities started to question provisions more rigorously and have tightened depreciation allowances. I thus expect that the share of loss events explained by bookkeeping operations should have declined for tax reasons since 2001.

Figure 2.3: Change in reasons for reporting a loss over time (1992 to 2007)



As Figure 2.3 shows this is not observed in the Hoppenstedt sample; by contrast, the share of loss cases explained by bookkeeping activities rose from 7 percent in earlier years to 13 percent today.

One reason for the unexpected rise in loss cases ascribable to holding activities and bookkeeping operations might be plunging stock prices on the stock exchange in the years 2000 to 2003. If I exclude years 2000 to 2003, I indeed find fewer loss events attributable to holding activities and provisions for depreciation; however, I still see the share of loss periods explained by holding activities and bookkeeping operations rise. Another explanation for the reverse trend in the Hoppenstedt database might be that the Hoppenstedt data set provides commercial balance sheet information and not information relevant for taxation. Despite the "authoritative principle" and the "reverse authoritative principle", it cannot be ruled out that the loss reported in the commercial balance sheet differs from the one reported for tax purposes.

Thus, my analysis for the fist time provides some suggestive evidence for the reasons why corporations experience a *commercial* balance sheet loss. It is, however, difficult to infer from these reasons why aggregate *tax* losses carried forward have surged. To exclude all possibility of doubt, commercial balance sheet and tax information should be integrated (Bach, Buslei, Dwenger, Fossen, and Steiner, 2008). Unfortunately, a data set that provides tax items and economic background information of the respective company is still lacking for Germany so that the reasons for rising tax loss carry-forward remain in the dark. What is certain is that yet unused tax losses from the past lower a company's current effective (average) tax rate. In the next chapters, when I will evaluate the effects of corporate income taxation on firm behavior, it is thus important to take tax losses carried forward into account.

2.4 Appendix

Table A2.1: Effects of the tightening in tax loss carry-back by industries

Industry	Share of all firms (in percent)	Share of firms with carry-back (in percent)	Share of affected firms (in percent)	Immediate effect on the corporate income tax assessed (in million euro)	Long-run effect on the corporate income tax assessed (in million euro)
Agriculture, forestry, fishery, mining, quarrying	1.3	.	.	.	.
Consumer goods, goods for intermediate consumption goods industry	6.8	11.9	12.1	2.3	0.3
Producers goods	8.1	16.2	16.5	3.1	0.4
Electricity and water supply	0.9	2.4	2.5	0.5	0.1
Construction	12.1	5.2	5.3	0.8	0.1
Wholesale and retail trade, repair of goods	22.1	12.2	11.8	1.8	0.2
Hotels and restaurants	2.7	.	.	.	.
Transport, storage, and communication	3.5	5.5	5.6	1.0	0.1
Financial intermediation	1.6	18.3	18.6	2.9	0.4
Real estate and renting	8.0	4.3	4.0	0.6	0.1
Services for private sector	25.0	19.3	19.3	3.8	0.5
Service for public sector and households	7.9	3.7	3.4	0.7	0.1
Total	100.0	100.0	100.0	17.7	2.4

Notes: Long-run effect calculated with an interest rate of 5% and the current statutory tax rate of 15%. For the long-run effect it is further assumed that the unused losses can be used over time as follows: 25% in the following year $(t+1)$, 20% in $t+2$, 15% in $t+3$, $t+4$, and $t+5$ each, and the remaining 10% in year $t+6$.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998.

Table A2.2: Effects of the tightening in tax loss carry-forward (minimum taxation) by industries

Industry	all firms	Share of firms with loss carry-forward (in percent)	affected firms	Immediate effect on the corporate income tax assessed (in million euro)	Long-run effect on the corporate income tax assessed (in million euro)
Agriculture, forestry, fishery, mining, quarrying	1.2	5.1	1.1	10.0	0.8
Consumer goods, goods for intermediate consumption goods industry	6.2	10.9	13.4	17.3	5.7
Producers goods	7.8	11.7	16.9	157.2	12.5
Electricity and water supply	0.9	2.5	4.1	45.0	3.6
Construction	11.4	5.4	3.2	10.3	0.8
Wholesale and retail trade, repair of goods	20.0	14.9	13.8	54.2	4.3
Hotels and restaurants	2.6	2.0	1.4	4.2	0.3
Transport, storage, and communication	3.5	3.3	3.7	96.1	7.7
Financial intermediation	1.5	1.8	4.4	53.9	4.3
Real estate and renting	8.0	14.2	10.2	33.8	2.7
Services for private sector	28.3	18.5	20.6	148.9	11.8
Service for public sector and households	8.6	9.7	7.2	19.1	1.5
Total	100.0	100.0	100.0	704.0	56.0

Notes: Long-run effect calculated with an interest rate of 5% and the current statutory tax rate of 15%. For the long-run effect it is further assumed that the unused losses can be used over time as follows: 75% in the following year ($t+1$) and the remaining 25% equally distributed over years $t+2$ to $t+6$.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 2001.

Table A2.3: Coverage of Hoppenstedt 1%-sample compared to corporate tax statistics in terms of ongoing losses

	Aggregate ongoing losses reported in		Coverage
	Hoppenstedt 1%-sample	tax statistics	
1992	10.8 bn. euro	52.2 bn. euro	21%
1995	18.2 bn. euro	55.7 bn. euro	33%
1998	3.1 bn. euro	46.4 bn. euro	7%
2001	14.8 bn. euro	86.2 bn. euro	17%
2004	12.4 bn. euro	58.5 bn. euro	21%

Notes: Because tax statistics are collected on a triennial basis, comparison of the data sets is limited to the years reported.

Sources: Own calculations based on Hoppenstedt company database 1992, 1995, 1998, 2001, and 2004, German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1992, 1995, 1998, 2001, and 2004.

Chapter 3

The elasticity of the corporate tax base

3.1 Introduction

Reforming the corporate income tax (CIT) has been an important topic both in public finance and in the economic policy debate for many years (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 on distributed profits was reduced from 45 percent in 1998 to 25 percent 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 percent 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 chapter, we[1] 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

[1] This chapter is based on joint work with Viktor Steiner (Dwenger and Steiner, 2008a).

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 been no endogenous change of corporate profits. This counterfactual ETR is obtained from the microsimulation model of the corporate sector introduced in the previous chapter (Section 2.1). It is 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 the ETR and the corporate income tax base taking into account various tax shields. In particular, these include loss carry-forward which, as shown in Section 2.3, has become of major quantitative importance for the corporate sector also in the German economy (for similar developments in the US, see Auerbach, 2007; Altshuler, Auerbach, Cooper, and Knittel, 2008). 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 the chapter 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 3.3 describes the data on our level of aggregation and details the identification and estimation of the tax base elasticity. Our preferred specification of the regression model, summarized in Section 3.4, 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 3.5 summarizes our main results and concludes.

3.2 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, Kalambokidis, and Slemrod, 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.[2] 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.

[2] The US, the UK and Japan tax corporate income in higher income brackets at a higher rate, and 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).

The marginal ETR measures the proportion of 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 is enhanced to include 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, Spengel, and Lammersen, 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 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, p.12) argues that average ETR are appropriate for measuring cash flows, while marginal ETR are designed to capture incentives to use new capital. Gordon, Kalambokidis, and Slemrod (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 differs from *Taxable Income* 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 Table A3.1 in the appendix). 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 shown in Section 2.3, it is of great importance to account especially for the use of loss carry-forward in the calculation of the corporate tax base. 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 3.3.2.

Our empirical analysis will focus on the elasticity of the corporate tax base, as measured by AGI, with respect to the ETR, i.e., $\beta \equiv \frac{\Delta AGI}{\Delta ETR}\frac{ETR}{AGI}$. 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 (τ)* by the formula

$$\frac{\Delta TA}{TA} = \frac{\Delta \tau}{\tau}(1 + \beta\, \eta_{TI,AGI}\, \eta_{ETR,\tau}), \tag{3.1}$$

where $\eta_{TI,AGI} \equiv \frac{\Delta TI}{\Delta AGI}\frac{AGI}{TI}$ and $\eta_{ETR,\tau} \equiv \frac{\Delta ETR}{\Delta \tau}\frac{\tau}{ETR}$.

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, $TI = (1-d)AGI$, $ETR = (1-d)\tau$ and $\eta_{TI,AGI} = \eta_{ETR,\tau} = 1$. 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 β, which needs to be estimated econometrically. When deductions are not proportional to AGI, or in the presence of loss carry-forward and loss carry-back, estimates of the elasticities

$\eta_{TI,AGI} = (1 - \Delta D/\Delta AGI)(AGI/TI)$ and $\eta_{ETR,\tau} = 1 + \eta_{D,\tau}$, with $\eta_{D,\tau} \equiv (\Delta D/\Delta\tau)(\tau/D)$, are also required; these elasticities can be obtained by microsimulation (see Section 3.4.1).

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, β is expected to be negative but may vary between zero and -1. If corporations did not respond to tax rate changes, $\beta = 0$, a given percentage change of the statutory tax rate would reduce the corporate tax revenue by the same percentage. On the other hand, if $\beta = -1$, 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 $-1 < \beta < 0$, a reduction of the statutory tax rate by α percent would reduce corporate tax revenue by $\alpha(1+\beta)\%$. In case $\beta < -1$, 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 ($-1 < \beta < 0$) 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 income shifting activities (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) estimate an average elasticity of the reported tax base with respect to the statutory tax rate of -0.45. 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 (2009) 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, Büttner, Overesch, Schreiber, and Wamser (2006) present 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.

3.3 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. When 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 mainly come from corporate tax returns for the years 1998, 2001, and 2004. Since these data are currently only available for these three cross sections, we construct a pseudo-panel for the estimation, as described in Section 3.3.1. 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). Our instrument for the ETR is constructed by exploiting changes in the tax law in the period spanned by our pseudo-panel data and making use of the detailed microsimulation model based on the individual corporate tax return data.

3.3.1 Data

Construction of a pseudo-panel from corporate tax return data

In this study, we use the German corporate tax return data introduced in Section 2.2.1. We restrict our analysis to the period 1998-2004. 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. This is also true for the period 2001-2004, but we will use this extended period to check for longer term effects of the tax reform.[3] The year 1992 could not be included in our analysis because classification of industries was changed between 1992 and 1998, and it turned out to be 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.

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 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 from these data. In particular, we can only use three years of 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 three 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 (*Bundesländer*). We chose these criteria because both a corporation's industry and headquarters are supposed to remain unchanged over a short time horizon, i.e., their location decision is not

[3] Between 2001 and 2004, the only change in corporate tax law was the introduction of the minimum taxation analyzed in Section 2.3.2.

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 Figure A3.1 in the appendix): First, we assessed the number of corporations within each industry at the two-digit level. 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 four-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 all three cross sections.[5]

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

[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.

(for more details, see Table A3.1 in the appendix). In contrast to a corporation's *"Total Revenue"*, AGI also includes the revenue generated by its fiscal subsidiaries. It differs from *"Taxable Income"* 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. When 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 each year 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 3.1 presents means and standard deviations of AGI and ETR measured at the group level for the three years, as well as the relative changes between 1998 and, respectively, 2001 and 2004.

The upper part of the table shows a dramatic decline in TI between 1998 and 2001 and a stabilization at a very low level thereafter. Average positive AGI for all corporations declined by almost 20 percent between 1998 and 2001, on average, from about 320,000 to 265,000 euro, and by another 10 percentage points between 2001 and 2004.[6] Since AGI is negative for a large share of all corporations in each

[6]There are some groups where one corporation is 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, 2004: 1 corporation(s)) to avoid serious group dominance by a single corporation.

of the three years, we report statistics for these variables for all corporations and for those with non-negative AGI. For corporations with non-negative AGI, its average level amounted to almost 500,000 euro in 1998 which dropped by about 20 percent until 2001 and by more than a third until 2004. 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 euro (see Table A3.2 in the appendix).

Table 3.1: Descriptive statistics

	1998	2001	2004	$\%\Delta_{2001}$	$\%\Delta_{2004}$
Taxable Income (TI) in 1,000 euro (average)					
All corporations	127.26	14.17	14.83	-219.51	-214.96
	(1,393.43)	(1,134.31)	(1,171.79)		
Corporations with non-negative AGI	345.46	277.11	290.03	-22.05	-17.49
	(2,188.43)	(1,417.29)	(1,493.09)		
Adjusted Gross Income (AGI) in 1,000 euro (average)					
All corporations	321.21	265.21	238.11	-19.16	-29.94
	(2,205.67)	(1,402.41)	(1,171.45)		
Corporations with non-negative AGI	488.60	386.56	338.69	-23.43	-36.65
	(3,415.64)	(1,923.79)	(1,662.54)		
Share of corporations reporting a non-negative AGI	0.554	0.560	0.579	1.08	4.41
	(0.098)	(0.098)	(0.087)		
Effective Tax Rate (average)					
All corporations	0.1197	0.0772	0.0786	-43.86	-42.06
	(0.048)	(0.030)	(0.028)		
Corporations with non-negative AGI	0.1986	0.1231	0.1231	-47.83	-47.83
	(0.055)	(0.035)	(0.033)		
Potential tax loss carry-forward in 1,000 euro (average)					
All corporations	674.75	700.44	1,049.75	3.74	44.20
	(2,647.89)	(3,465.48)	(5,994.11)		
Corporations with tax loss carry-forward at the beginning of the year	1,245.92	1,466.15	2,123.66	-	-
	(6,391.2)	(6,953.6)	(13,484.9)		
Number of groups	1,137	1,137	1,137	-	-
Number of groups which exclusively contain corporations with non-negative AGI	1,074	1,074	1,074	-	-
Number of corporations within each group	641.61	714.68	750.03	10.79	15.61
	(995.65)	(1,120.32)	(1,287.54)		

Notes: All information is given on the aggregate level. Standard deviations of variables are given in parentheses. $\%\Delta_{2001}$ ($\%\Delta_{2004}$) is calculated as difference between logs in 2001 (2004) and 1998, i.e., $\%\Delta AGI_{2001} = \log(AGI_{2001}) - \log(AGI_{1998})$.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998, 2001, and 2004.

The Tax Relief Act (*Steuerentlastungsgesetz*) reduced the ETR by 4.25 percentage points on average,[7] compared to a drop of the statutory tax rate of 20 percentage points (from 45 percent in 1998 to 25 percent in 2001 and 2004) for most corporations. There are various factors that have contributed to this difference: First, the reduction was less pronounced for companies retaining most of their profits, since retained earnings were taxed at a lower rate of 30 percent in 1998. Second, the reduction of the tax rate was partly compensated for by the simultaneous broadening of the tax base. Third, the reduction in the statutory tax rate was lower for those corporations that benefited from a reduced tax rate in 1998. Fourth, corporations for whom the fiscal year differs from the calendar year were subject to a higher tax rate of 40 percent in 2001. Fifth, 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 percent) reporting a loss, a profit of zero or offsetting the whole of their profits against losses from other periods.[8] Table 3.1 shows that the potential loss carry-forward, which can be carried forward infinitely and be offset against future profits, on average amounted to about 675,000 (700,000) euro in 1998 (2001), thereby substantially exceeding the average AGI of corporations recording positive AGI in these years. In 2004, tax loss carry-forward peaked at 1,050,000 Euro.

Compared to other measures of the ETR in our observation period reported in the literature for Germany (see, e.g., Devereux, Spengel, and Lammersen, 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

[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 percent (or -100 percent).

[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 3.3.2

[9]These estimates also differ from those based on aggregate revenue data published by the OECD and the European Commission which do not consider the tax 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 euro. 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

limited, however, because our measure is based on the tax actually assessed 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 percent of all firms) reporting a loss or a profit of zero which significantly reduces average effective tax rates. Note that our measure of the ETR for corporations with non-negative AGI is substantially larger than the average ETR for all corporations (almost 20 percent in 1998), but the relative reduction of the ETR between 1998 and 2001 due to the tax reform is quite similar (-43.8 percent and -47.8 percent, respectively). Also note that between 2001 and 2004 there was no change in the ETR for those corporations with non-negative AGI, and only a very small change for all corporations, which is important for the identification of tax effects on the corporate income tax base to which we now turn.

3.3.2 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 individual corporation to identify the elasticity of the tax base with respect to the effective tax rate. Except for a cap in the use of tax loss carry-forward (minimum taxation) affecting only

includes unincorporated enterprises.

very few companies, the rate and structure of the CIT did not change between 2001 and 2004. Even though this period does not provide exogenous variation for the construction of our instrumental variable, we will use information on changes in the tax base in this period for the estimation of the long-term effects of the tax reform as described below.

Exogenous variation in the ETR induced by the Tax Relief Act

The Tax Relief Act significantly reduced the statutory corporate income tax rate: In 1998, the corporate income tax in principle amounted to 45 percent for retained earnings and to 30 percent for distributed earnings while the tax rate was generally reduced to 25 percent in 2001.[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 percent of German corporations use a tax loss carry-forward or a tax loss carry-backward to offset current profits. These corporations do not pay any corporate income tax and thus have an effective tax rate of zero

[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, Buslei, Dwenger, and Fossen, 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 percent in 1998, 2001, and 2004. As the solidarity surcharge is a proportional surcharge on the corporate income tax assessed, omitting the surcharge should not influence our results.

which remains unaffected by changes in the statutory tax rate. Please 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 to a corporate income tax rate of 45 percent; whereas a corporation which distributed its whole profit was subjected to a corporate income tax rate of 30 percent only. The splitting of the tax rate is a specific feature of the tax credit method.[12] It was abolished by the Tax Relief Act; since 2001, the tax rate on corporate income has been uniform and independent of a corporation's payout ratio.[13] This implies that the reduction in the effective tax rate was much larger for those corporations which retained most of their earnings than for the corporations distributing their whole profit.

Third, some corporations were subject to reduced statutory corporate income tax rates in 1998. Mutual insurance societies, private foundations, and business enterprises of a public corporation benefited from a reduced tax rate of 42 percent in 1998. At the same time a flat tax of 25 percent applied to different sources of foreign income. Since 2001, by contrast, there has been no reductions in statutory tax rates but a tax rate of 25 percent has equally applied 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 international bodies of water were liable for a reduced rate of 22.5 percent in 1998; in 2001, the universal tax rate of 25 percent applied.

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

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

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

years saw their tax base broadened in 2001 because of lower depreciation allowances for newly acquired goods compared to 1998.

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

Instrumental variable estimation

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. Simulated tax liabilities and effective tax rates are computed using the module for the corporate sector of the microsimulation model BizTax, which was introduced in Chapter 2. 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).[15] Using BizTax we then simulate the corporate tax liability according to the corporate income tax law 2001 based on the inflated income components. The simulated ETR for 2001 is obtained by relating the simulated tax liability for 2001 to the inflated 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

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

[15] 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.

losses from the past or from 1999 (loss carry-back) because the amount of profits that can be offset against losses from other periods is a function of the tax rules. The Tax Relief Act broadened the tax base and consequently increased 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.[16] 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 VAT, information on sales is missing. In some industries only part of their sales is liable to 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

[16]Since our microsimulation tax model currently 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.

1998, corporations sold goods to the value of about 130 million euro, on average, in 2001 sales amounted to almost 150 million euro. Mean sales thereafter declined to about 120 million euro in 2004. Descriptive statistics of sales and the other control variables are contained in the upper part of Table A3.2 in the appendix.

As described in Section 3.3.1, 40 percent of all corporations report a negative AGI in 1998, and this share decreased slightly in the observation period. 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 non-negative AGI and try, in an alternative model specification, to control potential selection effects by including the change in the share of corporations with non-negative profits within groups in the observation period.

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

$$\log\left(\frac{AGI_{g,t}}{AGI_{g,1998}}\right) = \alpha + \beta\log\left(\frac{ETR_{g,t}}{ETR_{g,1998}}\right) + \gamma'\Delta x_g + u_g, \quad t = 2001, 2004, \quad (3.2)$$

where α is a constant, β is the corporate tax base elasticity we want to estimate, γ 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 $u_g = u_{g,t} - u_{g,1998}$ 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 (2004) in the relative change in ETR will be instrumented by the simulated ETR for 2001 (2004) as described above. In this regression, the β 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. Since the rate and the structure of the CIT did not change between 2001 and 2004, differences in estimated β coefficients in regressions for the periods 1998-2001 and 1998-2004 indicate deviations of short-run from long-term tax elasticities.[17] 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.

3.4 Estimation results

3.4.1 Basic regression results

Table 3.2 summarizes OLS and 2SLS regression results for the regression model given by equation (3.2) in the previous section.[18] We will focus on the period 1998-2001 for which we observe exogenous changes in the ETR induced the tax reform, but also check (in column 7) whether our estimation results are changed by extending the observation period to 1998-2004. To account for heteroskedasticity due to differences related to group size and possibly also serial correlation of error terms we report robust standard errors of estimated coefficients in all regressions.

As shown in column (1), the simple correlation of changes in the corporate tax base, measured by non-negative 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 3.1), 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.

[17]Although the average ETR did not change between the two years (see Table 3.1), there is some small time variation in the ETR due to changes in loss carry-forwards which is accounted for by including the simulated ETR for 2004 in the regression.

[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 $\log(AGI_{g,t}/AGI_{g,1998})$ and $\log(ETR_{g,t}/ETR_{g,1998})$ by, respectively, $(AGI_{g,t}/0.5(AGI_{g,t}+AGI_{g,1998}))$ and $(ETR_{g,t}/0.5(ETR_{g,t}+ETR_{g,1998}))$. 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.

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 $\log(\frac{ETR_{g,2001}}{ETR_{g,1998}})$ on the control variables Δx_g in the structural equation yields a t" value of 18.3; alternatively, a standard Hausman test turns out to be significant at the 1%-level (p-value = 0.0106).

Table 3.2: Basic regression results

Dependent variable:	t=2001						t=2004
$\log(AGI_{g,t}/AGI_{g,1998})$	OLS		2SLS				2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\log(ETR_{g,2001}/ETR_{g,1998})$	0.240	0.164	-0.314	-0.347	-0.318	-0.533	-
	(0.109)	(0.131)	(0.180)	(0.178)	(0.178)	(0.197)	
$\log(ETR_{g,2004}/ETR_{g,1998})$	-	-	-	-	-	-	-0.589
							(0.278)
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	-0.022
		(0.100)		(0.104)	(0.099)	(0.100)	(0.076)
Dummy indicating groups which exclusively contain firms located in Western Germany	-	0.077	-	0.076	0.104	0.060	-0.047
		(0.041)		(0.041)	(0.041)	(0.041)	(0.040)
Change in sales	-	0.180	-	0.185	-	0.174	0.348
		(0.097)		(0.100)		(0.103)	(0.069)
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	0.059
		(0.105)		(0.121)		(0.124)	(0.015)
Change in the share of firms reporting non-negative AGI	-	-	-	-	-	1.440	1.191
						(0.453)	(0.533)
Constant	0.093	-0.011	-0.166	-0.257	-0.258	-0.320	-0.891
	(0.054)	(0.074)	(0.085)	(0.094)	(0.094)	(0.100)	(0.128)
R^2	0.005	0.064	-	-	-	-	-
Number of observations	1,074	1,065	1,074	1,065	1,074	1,065	1,065

Notes: The instrument for $\log(\text{ETR}_{g,t}/\text{ETR}_{g,1998})$ is $\log(\text{PETR}_{g,t}/\text{ETR}_{g,1998})$ with $\text{PETR}_{g,t}$ being the simulated ETR as described in the text. Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998, 2001, and 2004, value added tax statistics 1998, 2001, and 2004.

Before we comment on the 2SLS estimation results summarized in Table 3.2, 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 Table A3.3 in the appendix, the simple correlation between the relative change in the ETR actually observed and the one obtained by instrumenting the ETR in 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 a 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, Wright, and Yogo, 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 -0.31, which is statistically different from zero at the 10%-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 percent increase in sales raises the tax base by about 2 percent. 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

[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.

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 statistics 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 affect the volume of sales as long as this relation has not changed in the observation period.

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 in the short run 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 non-negative AGI within groups included as additional control variable. Estimation

[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 -0.029 with a t-value of 0.21.

results show that this variable is highly significant and has a relatively large effect on the elasticity estimate; it increases in absolute value to -0.533, with a t-value of -2.7.

Column (7) in Table 3.2 presents estimation results if the estimation period is extended to 1998-2004. The point estimate of sales for the period 1998-2004 amounts to 0.348 and doubles the one we find for the shorter time span. Regressing the relative change of sales between 1998 and 2004 on the relative change in the ETR within this period with the same instrument as in the tax base regression, yields a point estimate of -1.426, with a t-value of -2.19. We therefore conclude that there are real responses to the change in the ETR in the long run, while the ETR in the short run only affects the corporate tax base via income shifting activities. As shown by the last column in Table 3.2, the point estimate of the tax base elasticity changes little if the estimation period is extended to 1998-2004, thereby allowing an additional time span of three years for firms to adjust to the tax reform. The estimated standard error of this point estimate increases substantially and the estimate is not statistically different from our preferred elasticity estimate in column (6).[21] The increase in the standard error can be explained by insufficient independent variation in the ETR within groups in the period 2001-2004, which also suggests that identification of tax effects requires exogenous changes induced by a major tax reform. In the present application, we therefore focus on estimation results for 1998-2001.

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

[21] An alternative to the two-period first-difference estimator would be a group fixed effects regression using all three years (including year fixed effects). Estimating equation (3.2) in levels including group fixed effects and two time dummies yielded an estimated β of -0.744 with a (robust) standard error of 0.655. This extremely large standard error can be explained by insufficient independent variation in the ETR within groups in the period 2001-2004.

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 $\eta_{TI,\tau} \equiv (\frac{\Delta TI}{\Delta \tau}) \times (\frac{\tau}{TI})$, which we get by multiplying our elasticity estimate, $\eta_{AGI,ETR}$, by the product of the elasticity of TI with respect to AGI ($\eta_{TI,AGI}$) and the elasticity of the ETR with respect to the statutory corporate tax rate ($\eta_{ETR,\tau}$).

As discussed in Section 3.2, 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 elasticity and the change in tax revenues. In this case $\eta_{TI,AGI} = \eta_{ETR,\tau} = 1$, and our estimate of $\eta_{AGI,ETR} = -0.53$ would imply that a reduction of the statutory tax rate by 10 percent results in an increase of TI by about 5 percent. However, since deductions are not proportional to AGI, and because of the importance of loss carry-forward, to exactly calculate $\eta_{TI,\tau}$ estimates of $\eta_{ETR,\tau}$ and $\eta_{TI,AGI}$ are required. Using our corporate tax microsimulation model BizTax we find $\eta_{ETR,\tau} = 0.855$ and $\eta_{TI,AGI} = 1.062$.[22] Using these estimates and our preferred estimate for $\eta_{AGI,ETR}$, we find that a 10 percent reduction of the statutory tax rate increases TI by 4.8 percent, 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, $\eta_{AGI,ETR} \cong \eta_{TI,\tau}$ 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

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

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 percent reduction of the statutory corporate tax rate to result in a reduction of corporate tax revenues by 5 percent. This is only half of the loss in tax revenues resulting from a tax rate reduction by 10 percent in the absence of any income shifting and real responses of corporations to the tax change.[23]

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 percent.[24] Given these estimates and the decline of the statutory CIT rate from 45 percent to 25 percent 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.

[23]For an application of the elasticity to the Corporate Tax Reform 2008 (*Unternehmensteuerreform 2008*) see Dwenger and Steiner (2008b).

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

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 3.2), the tax base elasticity may differ by the degree of international tax competition and income shifting opportunities.[25] To account for these factors, we now turn to some further estimation results which take into account potential heterogeneity in tax base elasticities.

3.4.2 Heterogeneous tax base elasticities

In Table 3.3 we report estimated tax base elasticities by subgroups based on our preferred model specification in column (6) in Table 3.2. The first panel summarizes estimation results accounting for differences in 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 the average equity capital[26] measured at the start of our observation period in order to avoid the potential endogeneity of changes in the ETR and equity in the observation period. Splitting the sample at the median of the equity capital of the average corporations, we find evidence that the corporate tax base of larger firms (-0.52) tends to be more elastic than the one of smaller companies (-0.29).

[25]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.

[26]In the data set 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 euro for private limited liability companies and to 50,000 euro for public companies.

This difference, however, is statistically not well determined in our sample (F-test = 1.80).[27] Given the relatively large standard errors of the tax base elasticity in the estimation based on the divided sample, we cannot reject the null hypothesis of no population difference in tax base elasticities between smaller and larger firms.

Table 3.3: Tax base elasticities by subgroups - 2SLS estimation

Sub-sample by ...	$\log(\frac{ETR_{g,2001}}{ETR_{g,1998}})$	F-test of significant difference between the two sub-samples (p-value)	N
equity capital			
≤ median	-0.288		535
	(0.211)	1.80	
> median	-0.524	(0.181)	530
	(0.347)		
debt/equity ratio			
≤ median	-0.649		506
	(0.311)	1.52	
> median	-0.260	(0.218)	504
	(0.284)		
sector			
primary sector / services	-0.329		673
	(0.221)	2.88	
manufacturing	-0.634	(0.090)	392
	(0.382)		
FDI/equity ratio			
≤ median	-0.415		548
	(0.231)	3.84	
> median	-0.696	(0.050)	517
	(0.358)		

Notes: All regressions include a constant and the same control variables as those reported in Table 3.2. 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.

Second, we test the hypothesis that corporations benefiting from tax shields react less to changes in tax rates. In particular, since interest on a corporation's debt may

[27] The F-test is calculated from a regression including an interaction term between the tax rate and the equity ratio, where the interaction term is, of course, also instrumented by interacting the instrument with equity ratio.

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. At the group level, we measure the tax shield by the amount of interest paid by a corporation on its long-term debt relative to its equity capital.[28] 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. Estimation results in Table 3.3 indeed seem to support the hypothesis that corporations with tax shields react less: The point estimate of the tax base elasticity of -0.26 for groups with a relatively high debt/equity ratio, which is not statistically different from zero, is much lower than the estimated elasticity for the comparison group (-0.65). However, given the large standard errors of these estimates, we can again not reject the hypothesis that estimated tax base elasticities do not differ between the two groups (F-test = 1.52).

Third, we investigate whether international competition affects the elasticity of the corporate tax base. Since particularly manufacturing firms ("secondary sector") have been under considerable pressure from international competition during our observation period, we expect income shifting in the secondary sector to be more prevalent than in the service sector, where international competition is less intense. Estimation results accounting for sector differences are summarized in the third panel of Table 3.3. Since there are only very few groups in the primary sector (farming, forestry etc.), we aggregate these with the service sector.[29] Splitting the sample and

[28]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 for the years 1998 and 2001, 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 3.3.1). Access to the micro data of the 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. We excluded corporations with negative equity capital. 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.

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

estimating our regression model separately for the two sectors indicates 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 -0.63 in manufacturing, compared to only -0.33 in the primary and tertiary sector. For the secondary sector, the estimated tax base elasticity is statistically significantly different from zero at the 5%-level (two-sided t-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 can be detected. 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). 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 relevant differentiation of groups suggested by the recent literature on international tax competition and Foreign Direct Investment (FDI) is to distinguish by the FDI intensity within groups. Extending hypotheses from this literature (see, e.g., Hines, 1999; Bartelsman 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 data set 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.[30] 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.

Estimation results for these two sub-samples, summarized in the lower panel of Table 3.3, 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 FDI. For industries in the upper part of the FDI distribution, the point estimate implies a tax base elasticity of about -0.70, compared to about -0.42 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 FDI 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

[30] 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 amount of FDI 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.

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 -0.5, and there is relatively little variation across industries by sector, size, capital structure, and FDI intensity.

3.5 Conclusion

Our study 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 in the German economy, too. 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 ETR is obtained from the microsimulation model of the corporate sector introduced in Section 2.1. It is 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 ETR actually observed 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 percent would reduce corporate tax receipts by only 5 percent. 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 was not on the declining segment of the "Laffer curve" 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 strict conclusions for subgroups of our pseudo-panel. Testing hypotheses of differential tax base elasticities with greater statistical precision would probably require a true panel of corporate tax return data which is currently not available for most countries, including Germany.

The fact that effective profit taxation triggers behavioral responses, provokes the question as to how corporations adjust to changes in corporate taxation. Since a reduction in tax rates lowers the tax advantage of debt over equity, corporations might, for instance, change their financial structure in answer to tax cutting reforms and rely less on debt financing. Such a change in leverage would also imply "self-financing" effects discussed in this chapter. To see whether firms actually adjust their financial leverage, one needs to know the elasticity of corporate debt towards the effective corporate tax rate, which is estimated in the following chapter.

3.6 Appendix

Table A3.1: Components of the corporate tax base and the corporate income tax assessed

	Turnover
-	Deductions such as interest payments and depreciation allowances
+/-	(...)
=	***Profit as shown in tax balance sheet***
+/-	Correcting entry concerning valuation (adjustment of values of balance sheet items, non tax deductible losses and non tax relevant gains etc.)
+	Correction of activities that are related to shareholders (declared profit distributions and constructive dividends, repayment of capital or capital increase, hidden contribution and other deposits under company law)
+	Non-deductible operating expenses (especially taxes paid, 50% 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 (AGI)***
-	Loss carry-forward and loss carry-back
=	***Net Income***
-	Allowable deductions for non-incorporated firms and for commercial cooperatives
=	***Taxable Income (TI)***
×	Statutory tax rate
-	Tax credits for foreign-source income
=	***Corporate income Tax Assessed (TA)***

Source: Own presentation.

Figure A3.1: Sequential procedure for construction of the pseudo panel

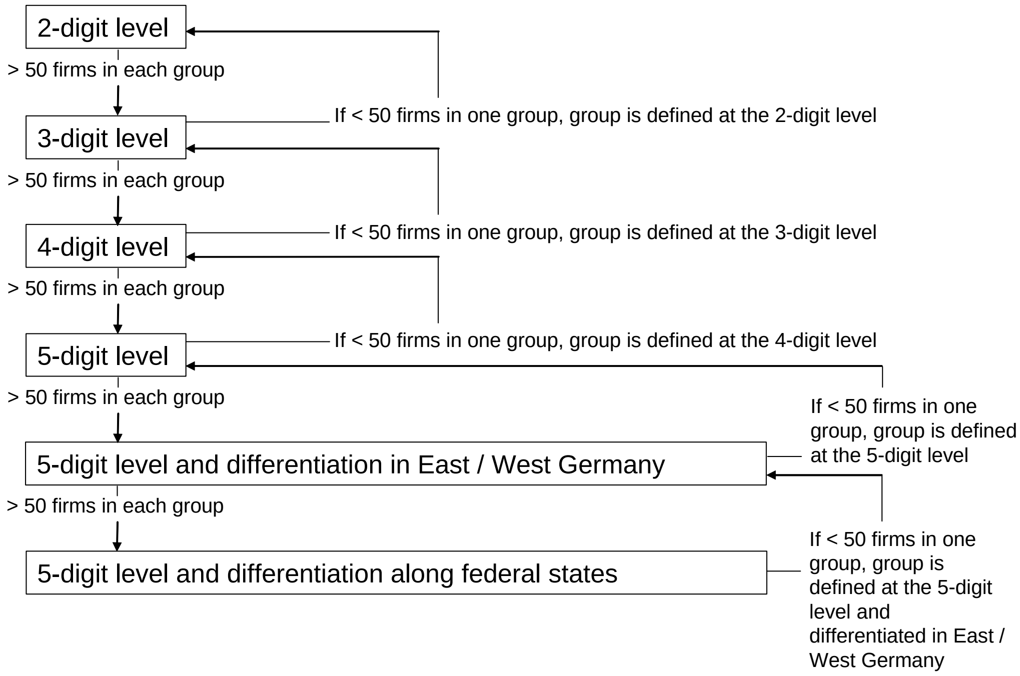


Table A3.2: Descriptive statistics for control variables - aggregate level

	1998	2001	2004	$\%\Delta_{2001}$	$\%\Delta_{2004}$
Share of corporations under the tax credit method	1.000	0.065	0.000	-273.34	-
	(0.000)	(0.051)	(0.000)		
Share of groups which exclusively contain firms located in Western Germany	0.217	0.217	0.217	0.00	0.00
	(0.413)	(0.413)	(0.413)		
Sales in million euro (average)	131.35	149.79	119.03	13.14	-9.85
	(381.56)	(452.01)	(350.38)		
Share of groups whose sales are not fully liable to sales tax	0.173	0.173	0.173	0.00	0.00
	(0.378)	(0.378)	(0.378)		
Sales × share of groups whose sales are not fully liable to sales tax	118.74	130.71	94.77	9.60	-22.55
	(354.81)	(411.76)	(287.95)		
Sector dummies					
Primary sector/services	0.635	0.635	0.635	0.000	0.00
	(0.482)	(0.482)	(0.482)		
Secondary sector	0.365	0.365	0.365	0.000	0.00
	(0.482)	(0.482)	(0.482)		
Equity capital in 1,000 euro (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 in 1,000 euro (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 at the individual level. FDI is not available at the group level but at a more aggregate level only (no differentiations across federal states or on the 4- or 5-digit industry level); at that aggregation level we have 45 observations. A few groups with negative debt/equity ratios are excluded (see text). Standard deviations of variables are given in parentheses. $\%\Delta_{2001}$ ($\%\Delta_{2004}$) is calculated as difference between logs in 2001 (2004) and 1998, i.e., $\%\Delta AGI_{2001} = \log(AGI_{2001}) - \log(AGI_{1998})$.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998, 2001, and 2004, value added tax statistics 1998, 2001, and 2004, local business tax statistics 1998, German Central Bank, micro database foreign direct investment 1998.

Table A3.3: First stage of the 2SLS regression

Dependent variable: $\log(\text{ETR}_{g,2001}/\text{ETR}_{g,1998})$	(1)	(2)
Simulated $\log(\text{ETR}_{g,2001}/\text{ETR}_{g,1998})$	1.589	1.499
	(0.054)	(0.054)
Share of corporations under the tax credit method	-	0.284
		(0.067)
Change in the number of corporations in the group	-	0.041
		(0.016)
Change in sales	-	0.025
		(0.014)
Interaction term between changes in sales and the dummy indicating industries whose sales are not fully liable for sales tax	-	0.006
		(0.017)
Dummy indicating groups which exclusively contain firms located in Western Germany	-	-0.023
		(0.009)
Change in the share of firms reporting non-negative AGI	-	0.524
		(0.064)
Constant	0.254	0.210
	(0.025)	(0.025)
R^2	0.444	0.489
Number of observations	1,074	1,065
F-Statistic	855.08	144.21
Partial R^2	-	0.418

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.

Chapter 4

Financial leverage and corporate taxation

4.1 Introduction

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

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

In this chapter, we[1] estimate the elasticity of the financial leverage to changes in the effective corporate tax rate (ETR) using a comprehensive tax return data set for the German economy. Following Gruber and Saez (2002), who applied this methodology to the estimation of the personal income tax elasticity, we control for potential endogeneity bias by instrumenting the observed tax rate by the counter-factual tax rate a corporation would face in a particular period had there been no endogenous change of the tax base. This counterfactual ETR is obtained from the corporate income taxation module of the microsimulation model BizTax (Chapter 2). As in the previous chapter, we use data out of the years 1998 and 2001. The Tax Relief Law introduced in this period provides sufficient exogenous variation in the ETR across corporations to identify the elasticity of corporate debt.

Since the German corporate income tax is proportional to taxable income, we cannot rely on the variation in statutory tax rates induced by the progressivity of the corporate tax schedule to identify tax effects on corporate leverage as, e.g., in Gordon and Lee (2001) in their study for the US. Rather, our identification is based on the variation of the ETR which also reflects various other tax shields, in particular unused loss carry-forward which has become of major quantitative importance for the corporate sector also in the German economy (see Section 2.3). The huge difference in the amount of loss carry-forward used and other tax shields across corporations

[1]This chapter is based on joint work with Viktor Steiner (Dwenger and Steiner, 2009).

provides the exogenous variation in the ETR for our identification strategy of the debt elasticity.

The estimation is based on the corporate income tax statistics and the local business tax statistics that cover all corporations in Germany. While the broad coverage and detailed information on various tax shields are distinct advantages, the data set has the drawback that it is not available as a panel. For the estimation we therefore again construct a pseudo-panel for 1998 and 2001 by 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 allows us to control for observed and unobserved time-invariant factors, which may be correlated with both the financial leverage and the ETR, and to derive an instrumental variable for the potentially endogenous ETR.

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

In the next section, we briefly review the empirical literature on the relationship between profit taxation and corporate leverage. Section 4.3 describes our empirical methodology to identify the leverage elasticity and the data set. Estimation results for our basic specification of the regression model are summarized and discussed in

Section 4.4.1. Results for alternative specifications allowing tax rate effects to differ by size and risk and by the availability of other tax shields are presented in Sections 4.4.2 and 4.4.3, respectively. Section 4.5 summarizes our main results and concludes.

4.2 Previous empirical literature

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

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

An alternative identification strategy using cross-section or panel data on corporations within a country is based on the “substitution hypothesis” proposed by DeAngelo and Masulis (1980). According to this hypothesis, other corporate tax shields, such as depreciation allowances and tax losses carried forward, may substitute for debt and thus affect the financial leverage elasticity with respect to the tax rate.[2] The older empirical literature (see, e.g., Bradley, Jarrell, and Kim, 1984; Marsh, 1982; Titman and Wessels, 1988; Fischer, Heinkel, and Zechner, 1989) could not find convincing evidence supporting this hypothesis.

Mackie-Mason (1990) argues that this may be due to the fact that previous studies focused on debt ratios which cumulate decisions made over many years, taken under varying circumstances. Instead, he suggests studying the decision to issue new debt. Furthermore, he argues that tax shields affect the tax rate by increasing the probability of tax exhaustion and thereby concludes that the substitution effect of tax shields should be more applicable to firms with a substantial probability of losing the deductibility of their tax shields. Then, available tax shields have little effect on financing decisions of firms far away from tax exhaustion but particularly matter for debt policy of firms that are likely to be tax-exhausted (“tax exhaustion hypothesis”). Focusing on incremental financial decisions and estimating a probit model on US register data for public offerings, MacKie-Mason shows that companies with high tax shields and a high probability of facing a zero tax rate are indeed less likely to finance by debt. Dhaliwal, Trezevant, and Wang (1992) and Trezevant (1992) also find that non-debt tax shields such as accelerated depreciations lead to a lower debt ratio if companies face a large risk of a tax rate of zero. This result was also replicated by Cloyd, Limberg, and Robinson (1997) as well as by Ayers, Cloyd, and Robinson (2001).

There is a potentially severe endogeneity bias in empirical estimates relying on

[2]Dammon and Senbet (1988) point out that an increase in investment-related tax shields does not necessarily lead to a decrease in debt. They argue that besides the substitution effect an income effect must be considered: Higher investment may lead to both higher output and earnings which turns interest deductions more valuable as tax shields.

the variation of after-financing tax rates across corporations to identify tax effects on financial leverage. This bias occurs because corporations with substantial debt have large interest deductions reducing their taxable income and their after-financing tax rate. There have been various attempts in the literature to account for this spurious correlation and the resulting endogeneity of the after-financing ("effective") tax rate.

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

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

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

4.3 Empirical methodology

4.3.1 Identification and estimation

We want to estimate the elasticity of the financial leverage with respect to the average after-financing effective tax rate. The ***financial leverage*** will be measured by a corporation's ratio of debt to total capital. Total capital is calculated as the sum of debt, equity, and the legal minimum deposit which amounts to 25,000 euro for private limited liability companies and to 50,000 euro for public companies.[3]

Our measure of the ***after-financing effective tax rate***, ETR, is calculated for each corporation as the ratio of the corporate income tax assessed to Earnings Before Interest, Taxes and Depreciation (EBITD) in a given year. EBITD thus measures profit liable to corporate income taxation before the use of various tax shields, i.e., before the deduction of interest payments, of tax losses carried forward or carried back, and before the deduction of depreciation allowances. EBITD can be calculated from our corporate income tax return data by adding interest payments and depreciation allowances to Adjusted Gross Income, see Table A3.1 in the appendix of Chapter 3.[4] The ETR differs from the statutory corporate tax rate due to the difference between EBITD and Taxable Income, which is driven by different tax shields.[5] When the EBITD equals zero, the ETR is also set equal to zero.

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

[4]We do not have to add a potential tax loss carry-forwards as the Adjusted Gross Income is the profit before the use of tax losses carried forward. Since our measure of EBITD is based on tax information and does not include earned interest, it is not fully congruent with the usual measure, which is deduced from corporate balance-sheet data and also corrects for earned interest.

[5]Information on depreciation allowances is pure statistical information (form ST) and not necessary for corporate income taxation. Unlike variables important to taxation, items in form ST

For our analysis, a relatively broad measure of profit is important to take interdependencies between different tax shields into account when analyzing tax effects on corporate leverage. For a given level of current profits, corporations with tax loss carry-forward, for instance, may face very different ETR compared to those corporations that do not possess a stock of previously accrued losses. As documented in Chapter 2, it is of great importance to account especially for tax losses carried forward in the calculation of the ETR. The variation in the amount of used loss carry-forward across corporations also provides one important source of exogenous variation in the ETR for our identification strategy. Other sources of variation are interest payments and depreciation allowances.

The main methodological problem in the estimation of the elasticity of financial leverage with respect to the ETR is that it is unlikely to be identified by a simple regression of log(debt ratio) on log(ETR), for two reasons. First, unobserved time-invariant factors which may be correlated with both the financial leverage and the ETR could confound the elasticity estimate. These factors may include firm-size effects (see, e.g., Lemmon, Roberts, and Zender, 2008) and persistent inter-industry differences in leverage ratios as documented by, e.g., Bradley, Jarrell, and Kim (1984). Second, spurious correlation between the debt ratio and the ETR may be induced by the relation of the corporate income tax assessed and the amount of used tax loss carry-forward. Furthermore, depreciation allowances not only affect the corporation's tax assessed, but may also be correlated with its debt ratio, thereby inducing spurious correlation between the corporation's debt ratio and its ETR.[6]

Whilst it seems therefore impossible to identify the financial leverage elasticity

are not verified by fiscal authorities. We therefore check the statements upon plausibility, exclude implausible values, and impute depreciation allowances for corporations which did not fill in form ST. We imputed depreciation allowances on the basis of our aggregation scheme which will be introduced in the following and which we additionally differentiated into profit deciles.

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

with respect to the ETR on the basis of a single cross section, we argue that this elasticity can be identified by taking advantage of the pseudo-panel structure of our corporate tax return data and changes to the corporate tax system introduced by the Tax Relief Act in the period 1998-2001. Our data come from corporate tax returns and from local business tax returns covering this period. Since these data are only available as single cross sections, we again construct a pseudo-panel for the estimation, as described in Section 3.3.1. We control for potential endogeneity bias by, first, accounting for fixed effects and, second, by instrumenting the ETR following the methodology which Gruber and Saez (2002) proposed for the estimation of the personal income tax elasticity. Our identification strategy consists of instrumenting a corporation's ETR for 2001 by the simulated ETR the corporation would face in 2001 if its 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 individual corporation to identify the elasticity of debt with respect to the ETR. The Tax Relief Act significantly reduced the statutory corporate income tax rate and simultaneously broadened the tax base. As described in the previous chapter (Section 3.3.2), the reform did not affect corporations alike but caused substantial variation in the change of their effective tax rates that we use to identify the elasticity of financial leverage.

In Germany, 40 percent of all corporations report a negative AGI, and this share slightly decreased between 1998 and 2001 (see Table A4.1 in the appendix). 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 non-negative AGI and try, in an alternative model specification, to control potential selection effects by including the change in the share of corporations with non-negative profits within groups in the observation period.

In the estimation we also control for other factors which might be correlated with both the debt ratio and the ETR. First, we estimate the regression of log(debt ratio) on log(ETR) in first differences, thus controlling for group-fixed effects which may be correlated with the ETR. Second, we control for time-varying factors including the number of corporations within a group and the share of corporations still taxed under the tax credit method in 2001. These variables should also control for changes within groups in the observation period which could affect the efficiency of our estimates, in particular the standard error of the estimated elasticity of the debt ratio.

As maintained in the literature summarized in Section 4.2, financial leverage may also depend on corporate size and on the economic risks corporations face. We control the effect of corporate size on financial leverage by the average amount of capital, which we measure at the start of our observation period in order to avoid the potential endogeneity of this variable. We measure economic risk by the variation coefficient of sales. This risk measure is calculated using sales information from the value added tax (VAT) statistics of the German Federal Statistical Office from 1998 to 2005. Sales information is available at the same level of aggregation as the one used for the construction of our pseudo-panel data. Descriptive statistics of this measure of risk and other control variables are contained in Table A4.1 in the appendix.[7]

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

$$\log \frac{debt\ ratio_{g,2001}}{debt\ ratio_{g,1998}} = \alpha + \beta \log \frac{ETR_{g,2001}}{ETR_{g,1998}} + \gamma' z_g + \delta' \Delta x_g + u_g, \qquad (4.1)$$

where g indicates the industry/region group, α is a constant, β is the elasticity of debt we want to estimate, γ and δ are column vectors of regression coefficients, z_g contains our measures of corporate size and economic risk as defined above, x_g is a column vector composed of first differences of the time-varying control variables,

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

and $u_g = u_{g,2001} - u_{g,1998}$ is a first-differenced error term, which may or may not be serially correlated.

Assuming the β coefficient can be consistently estimated by an IV regression based on equation (4.1), it measures the elasticity of corporate debt with respect to the ETR, i.e., $\beta \equiv (\frac{\Delta debt\ ratio}{\Delta ETR}) \times (\frac{ETR}{debt\ ratio})$. $\beta = 0$ implies that the debt ratio does not react to changes in the effective tax rate at all; $\beta = 1$ indicates that a decrease in the effective tax rate of one percent decreases the debt ratio by one percent. We will not only estimate β for the whole population of companies but also estimate separate elasticities by size, by risk, and by characteristics that may be related to other tax shields, such as generosity of depreciation allowances or the amount of unused tax loss carry-forward.

In the previous chapter, we saw that reductions of the statutory corporate tax rate are partly "self financing" by reducing corporate income shifting activities. In the end, however, the overall elasticity of the corporate tax base remained silent about how corporations exactly adjust. The elasticity of the financial leverage with respect to the ETR, β, bridges that gap. Relating the financial leverage elasticity β, interest deductions D, and the corporate income tax assessed TA yields the share of "self-financed" tax revenue falling upon changes in firms' financial leverage l:, where $l = (\beta \times D)/TA$.

4.3.2 Data

Just as in the previous chapter, we use a pseudo-panel constructed from the German corporate income tax return data and the local business tax statistics (detailed description in Section 3.3.1). The latest year currently available is 2004. Since corporate tax statistics 2004 do not include information on equity capital needed to calculate firms' debt ratio, we have to restrict our analysis to the period 1998-2001. In the data set till 2001, the amount of equity capital is recorded at the individual corporate level as the sum of retained earnings since 1977 and contributions to capital as far as they occurred after the company was founded.

Information on long-term debt is not available in the corporate income tax statistics but can be derived from the local business tax statistics, since half of the interest payments on long-term debt[8] is liable to the local business tax. Local business tax statistics cover the same population of corporations and are available for the same years as the corporate tax statistics but could not be matched at the micro level until 2004.[9] Therefore, we have imputed interest payments at the aggregation level of our pseudo panel.[10] We further differentiate by profit deciles to take into account differences in size. For 2004, corporate income and local business tax statistics could be matched at the micro level. As a sensitivity check of our imputation method, we used the integrated data set to compare imputed interest payments with the factual ones. On our aggregation level, we did not see any noteworthy difference in the mean of imputed and factual values (see Table A4.2 in the appendix).

Appendix A4.1 shows that the average level of debt across all corporations increased by about 13 percent between 1998 and 2001, from about 1,230,000 euro to 1,405,000 euro. In the same period, average debt increased less (by about 5 percent) for corporations with non-negative AGI. Average equity declined by almost 5 percent for all corporations but by only 3 percent for companies reporting a non-negative AGI. For the latter the average debt ratio increased slightly from 0.567 to 0.575. At the same time, the ETR for corporations with non-negative AGI declined from 15.2 to 9.5 percent, compared to a drop in the statutory tax rate of 20 percentage points (from 45 percent in 1998 to 25 percent in 2001) for most corporations.[11]

[8]The definition of long-term debt is quite broad including debt which is not paid back within 12 months and debt which is taken out to improve business operations or to expand.

[9]Similarly to the corporate income tax statistics, the local business tax statistics are constructed from all tax returns filed for local business taxation. The local business tax statistics also include non-incorporated firms that we dropped from the data set.

[10]Using average interest rates for firm credits of the *Deutsche Bundesbank* (series SU0506 and SU0509), this allows us to infer long-term debt.

[11]The ETR is calculated at the individual level for 1998 and 2001 and then aggregated to the group level of the pseudo-panel structure.

4.4 Results

4.4.1 Average tax effects on financial leverage

Table 4.1 reports OLS and IV regression results for average tax effects on financial leverage based on equation (4.1) in Section 4.3.1.[12] To account for heteroskedasticity due to differences related to group size and possibly also serial correlation of error terms, we report robust standard errors of estimated coefficients in all regressions.

Table 4.1: Regression results explaining the relationship between changes in financial leverage and the effective tax rate

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

Notes: The instrument for $\log(ETR_{g,2001}/ETR_{g,1998})$ is $\log(PETR_{g,2001}/ETR_{g,1998})$ with $PETR_{g,2001}$ being the simulated ETR as described in the text. Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, local business tax statistics 1998 and 2001, value added tax statistics 1998 to 2005.

[12] Since the ratio of long-term debt is zero even at the group level in a few cases, which we couldn't have used in the estimation of the specification given above, we have approximated $\log(\textit{debt ratio}_{g,2001}/\textit{debt ratio}_{g,1998})$ and $\log(ETR_{g,2001}/ETR_{g,1998})$ by, respectively, $((\textit{debt ratio}_{g,2001} - \textit{debt ratio}_{g,1998})/0.5(\textit{debt ratio}_{g,2001} + \textit{debt ratio}_{g,1998}))$ and $((ETR_{g,2001} - ETR_{g,1998})/0.5(ETR_{g,2001} + ETR_{g,1998}))$. A sensitivity check shows that restricting the sample to groups with positive debt ratio and estimating the log-log specification given above does not significantly change estimation results.

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

For the reasons mentioned in Section 4.3.1, we would not expect OLS regressions of the change in the debt ratio on the change of the ETR to identify the elasticity of debt. In fact, standard Hausman-Wu endogeneity tests strongly indicate that ETR is an endogenous variable and OLS estimates of the elasticity are inconsistent. In particular, inclusion of the residual from a first-stage regression of $\log(\frac{ETR_{g,2001}}{ETR_{g,1998}})$ on the control variables z_g and x_g in the structural equation yields a t-value of -5.7; alternatively, a standard Hausman test of endogeneity of the ETR in equation (4.1) turns out to be significant at the 1%-level (p-value=0.000).

Before we comment on the IV estimation results in Table 4.1, we report the results of the first-stage regression with the *predicted* ETR as our instrument for the ETR actually observed in 2001. As shown in Table A4.3 (appendix), 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 high. In the first-stage regression including all control variables, the R^2 is almost 0.32 and the coefficient of our instrument has a t-statistic of about 14. To explicitly test for the relevance of the instruments in our multivariate setting, we calculate the Partial R^2 regarding our instrument as suggested by Shea (1997) and Godfrey (1999), which yields a Partial R^2 of about 0.15. This clearly shows that our instrument is indeed highly correlated with the change in the actually observed ETR, and that our IV estimation is not likely to suffer from the ubiquitous weak instrument problem (see, e.g., Stock, Wright, and Yogo, 2002).

As a benchmark, column (3) reports IV estimation results without further control variables. The estimated elasticity of corporate debt now becomes positive, with a point estimate of 0.46, which is statistically different from zero at the 1%-level (two-sided test, t-value of 3.86). Adding the control variables to this regression leaves the point estimate of the estimated elasticity in column (4) virtually unchanged but slightly increases its estimated standard error.[13] In column (5) we report estimation results with the change of the share of corporations with non-negative AGI within groups included as an additional variable. This variable should control the potential selection bias resulting from the exclusion of corporations with negative AGI in the estimation. If this selection is determined by fixed group effects only, our first-difference estimation 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. As in the previous chapter, we can, however, approximate the selection term by the average probability of non-negative AGI in a particular group, i.e., by the share of corporations that report a non-negative AGI in a given year. Estimation results for this specification in column (5) show that this variable is significant but hardly affects the elasticity estimate; the point estimate increases to 0.54.

This is a large effect also relative to the effects of the other economic variables included in the model. Whereas the size of the average corporation in an industry/region group, as measured by the log of equity, has no significant effect on financial leverage, an increase in the variation of sales by one standard deviation reduces the debt ratio by about 7 percentage points. Given that this change means a doubling of our risk measure (the sample mean of this variable is about 1, see

[13]Using the lagged ETR as an instrument instead yields a t-statistic of about -3.89 for its coefficient in the first-stage regression including all control variables; the R^2 of this regression is 0.21 and the Partial R^2 regarding this instrument is only about 0.015. For specification (5) in Table 4.1, the point estimate for the β coefficient using the lagged ETR as instrument for the change of the ETR is 0.378 with a very large standard error of 0.529. Thus, the lagged value of the ETR seems to be a rather weak instrument.

Appendix A4.1), and given that the average debt ratio is about 57 percent in the sample, this is a relatively modest effect.[14]

As discussed in Section 4.3, our estimate also allows evaluating the share of "self-financed" tax revenue attributable to behavioral responses in corporations' financial leverage. In 2001, the corporate income tax assessed TA amounted to 25.43 billion euro and corporations' interest deductions D to 8.37 billion euro. Using these aggregates and our preferred estimate for β, we find that about one-third of "self-financed" tax revenue was due to firms' adjusting their financial leverage.

4.4.2 Tax effects by corporate size and risk

Following the reasoning in the empirical literature - see Section 4.2 - the financial leverage elasticity may differ by firm size and the economic risk a company faces. In the following we present estimation results from alternative specifications of our regression model which account for these factors.

Table 4.2 summarizes IV regression results based on our preferred specification (5) in Table 4.1 estimated on separate samples split by, respectively, the average size of corporations within groups and our measure for economic risk. Given the relatively small size of our pseudo panel, we simply differentiate between "small" and "large" corporation size defined by the median of the average amount of capital measured at the start of our observation period. Likewise, we split the sample into a group with the variation coefficient of sales below ("low risk") and above the median ("high risk").

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

Table 4.2: IV regression results explaining the relationship between changes in financial leverage and the effective tax rate by size and risk

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

Notes: "Size" is measured by the average capital stock, "risk" by the standardized variation coefficient of sales. The instrument for $\log(ETR_{g,2001}/ETR_{g,1998})$ is $\log(PETR_{g,2001}/ETR_{g,1998})$ with $PETR_{g,2001}$ being the simulated ETR as described in the text. Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 to 2005, local business tax statistics 1998 and 2001.

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

Splitting the sample into industries by the level of economic risk yields a slightly higher leverage elasticity for corporations with a below-average risk level compared to those with a relatively high level, but this difference is not statistically significant. The direct effect of the risk measure on the corporate debt ratio is now only statistically significant in the sub-sample with an above-average risk level. This corroborates the finding that firms in risky industries are more conservative in the use of debt (Graham, 2000).

4.4.3 Tax effects by other tax shields

As suggested by the "substitution hypothesis", other corporate tax shields, such as depreciation allowances and tax loss carry-forwards, may substitute for debt and thus affect the financial leverage elasticity with respect to the tax rate (see Section 4.2). In the following we test for differences in tax effects on financial leverage with respect to the availability of depreciation allowances and unused tax loss carry-forwards in each case normalized by total capital. To avoid the potential endogeneity of changes in the ETR and our measure of heterogeneity, these variables are all measured at the start of our observation period in 1998. Given the relatively small size of our pseudo panel, we again simply differentiate between groups below and above the median of our heterogeneity variable. Table 4.3 summarizes the estimation results for these alternative specifications of our basic regression model. As before, all specifications start from the specification with the full set of control variables as given by column (5) in Table 4.1.

Estimation results accounting for differences in the availability of depreciation allowances show that the elasticity of the debt ratio is lower for industries that already benefit from generous depreciation allowances. For them, the estimation results imply a leverage elasticity of about 0.15, which is not statistically significant even at the 10%-level, compared to a large and statistically significant elasticity of 0.72 for industries with less generous depreciation allowances.[15] Thus, our estimation

[15] A formal statistical test on the pooled sample yielded a t-statistic of -1.97 (p-value = 0.049)

Table 4.3: IV regression results explaining the relationship between changes in financial leverage and the effective tax rate by the availability of other tax shields

Dependent variable: $\log(debt\ ratio_{g,2001}/debt\ ratio_{g,1998})$	depreciat. allowances / total capital ... median		tax loss carry-forward / total capital ... median	
	below	above	below	above
	(1)	(2)	(3)	(4)
$\log(ETR_{g,2001}/ETR_{g,1998})$	0.722	0.147	0.827	0.300
	(0.273)	(0.102)	(0.252)	(0.190)
Share of corporations under the tax credit method	-1.068	0.314	-1.231	0.006
	(0.517)	(0.294)	(0.526)	(0.269)
Change in the number of corporations in the group	-0.030	0.273	0.091	0.129
	(0.107)	(0.054)	(0.103)	(0.064)
Dummy indicating groups which exclusively contain firms located in Western Germany	-0.132	0.013	-0.147	0.033
	(0.055)	(0.021)	(0.050)	(0.037)
Variation coefficient of sales	-0.083	-0.010	-0.105	-0.002
	(0.029)	(0.021)	(0.035)	(0.020)
$\log(\text{equity}_{g,1998})$	-0.025	0.043	-0.010	0.003
	(0.031)	(0.013)	(0.029)	(0.023)
Change in the share of firms reporting non-negative AGI	-1.158	-0.158	-1.214	-0.288
	(0.562)	(0.259)	(0.654)	(0.336)
Constant	0.652	-0.555	0.542	0.025
	(0.572)	(0.209)	(0.482)	(0.367)
Number of observations	514	515	515	514

Notes: Both ratio of depreciation allowances to equity and ratio of tax loss carry-forward to equity are measured in 1998 to avoid endogeneity problems. The instrument for $\log(ETR_{g,2001}/ETR_{g,1998})$ is $\log(PETR_{g,2001}/ETR_{g,1998})$ with $PETR_{g,2001}$ being the simulated ETR as described in the text. Heteroskedasticity-consistent robust (Huber-White) standard errors are reported in parentheses.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 to 2005, local business tax statistics 1998 and 2001.

results confirm the substitution hypothesis with respect to depreciation allowances acting as an alternative tax shield to debt.

As the estimation results in columns (3) and (4) of Table 4.3 show, the substitution hypothesis is also confirmed with respect to the amount of unused tax loss carry-forwards: tax changes have a much stronger effect on the financial leverage for corporations with unused tax loss carry-forwards below the median (0.83) than for those with relatively large tax loss carry-forward (0.30); for the latter sub-sample the leverage elasticity is not statistically different from zero even at the 10%-level.[16]

for the interaction term between the tax variable and a dummy variable for the two groups where all other control variables were interacted with this group dummy.

[16] In a pooled regression with all variables interacted by the group dummy, the value of the

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

4.5 Conclusion

This chapter has focused on the elasticity of the financial leverage, as measured by the ratio of debt to total equity at the corporate level, with respect to the effective corporate tax rate, ETR. It was estimated on the basis of tax return data for the German corporate sector and an instrumental variable approach to control for the endogeneity of the ETR. An important advantage of the tax return data used in this study is that they allow us to calculate the ETR taking into account various other tax shields, in particular loss carry-forward which has become of major quantitative importance for the corporate sector also in the German economy. As our instrument for the observed ETR we have used the counterfactual ETR a corporation would face in a particular period, had there been no endogenous change of the corporation's tax base within that period. This counterfactual ETR is obtained from the microsimulation model BizTax. Like in the previous chapter, the estimations are based on the years 1998-2001, a period which saw the introduction of a substantial tax reform. This tax reform provides sufficient exogenous variation in effective tax rates across corporations to identify the elasticity of corporate debt. Statistical tests strongly indicate that our instrument is highly correlated with the change in the actually observed ETR and that the well-known weak instrument problem does

t-statistic for the interaction term between the tax variable and a dummy variable for the two groups is -1.67 (p-value = 0.096).

not invalidate our instrumental variable estimation.

Our preferred specification of the relationship between the financial leverage and the ETR yields an average elasticity of about 0.5. This estimate implies that a reduction of the (proportional) statutory corporate tax rate by 10 percent would reduce corporate debt by 5 percent. Compared to previous studies estimating tax effects on corporate capital structure, this indicates fairly substantial tax effects on the corporate leverage. Our average elasticity estimate implies that the response of the corporate tax base to changes in the effective tax rate in Germany, as obtained in the preceding chapter, can be traced back to one third to corporations adjusting their financial leverage.

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

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

4.6 Appendix

Table A4.1: Descriptive statistics

	1998	2001	$\%\Delta_{2001}$
Debt in 1,000 euro (average)			
All corporations	1,230.07	1,405.32	13.32
	(10,696.66)	(9,765.67)	
Corporations with non-negative AGI	1,281.24	1,351.94	5.37
	(10,514.73)	(9,919.06)	
Equity in 1,000 euro (average)			
All corporations	3,981.04	3,793.33	-4.83
	(28,018.80)	(18,917.80)	
Corporations with non-negative AGI	3,641.49	3,530.76	-3.09
	(27,609.76)	(19,224.58)	
Debt ratio (average)			
Corporations with non-negative AGI	0.5666	0.5750	1.47
	(0.173)	(0.188)	
Share of corporations reporting a non-negative AGI	0.554	0.560	1.08
	(0.098)	(0.098)	
Effective Tax Rate (average)			
Corporations with non-negative AGI	0.1520	0.0953	-46.69
	(0.053)	(0.034)	
Variation coefficient of sales normalized by its standard deviation	0.985	-	-
	(1.000)	-	
Depreciation allowances/equity ratio (average in 1998)	0.356	-	-
	(0.460)		
Tax loss carry-forward/equity ratio (average in 1998)	0.215	-	-
	(0.272)		

Note: All information is given on the aggregate level. Standard deviations of variables are given in parentheses. $\%\Delta_{2001}$ is calculated as difference between logs in 2001 and 1998, i.e., $\%\Delta AGI_{2001} = \log(AGI_{2001}) - \log(AGI_{1998})$.
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, local business tax statistics 1998 and 2001, value added tax statistics 1998 to 2005.

Table A4.2: Effective Tax Rate with imputed and with firm-specific interest payments

	Effective Tax Rate (average)	
Percentiles	with imputed interest payments	with firm-specific interest payments
1%	0.0035	0.0039
5%	0.0143	0.0168
10%	0.0183	0.0220
25%	0.0269	0.0302
50%	0.0367	0.0405
75%	0.0484	0.0525
90%	0.0625	0.0666
95%	0.0791	0.0812
99%	0.1432	0.1365
Mean	0.0404	0.0422
Standard Deviation	0.0282	0.0505
Correlation coefficient	0.4385	

Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 2004, local business tax statistics 2004.

Table A4.3: First stage of the IV regression

Dependent variable: $\log(debt\ ratio_{g,2001}/debt\ ratio_{g,1998})$	(1)	(2)
Simulated $\log(ETR_{g,2001}/ETR_{g,1998})$	1.873	1.598
	(0.122)	(0.118)
Share of corporations under the tax credit method	-	0.771
		(0.155)
Change in the number of corporations in the group	-	0.120
		(0.035)
Dummy indicating groups which exclusively contain firms located in Western Germany	-	0.018
		(0.020)
Variation coefficient of sales	-	0.029
		(0.009)
$\log(\text{equity}_{g,1998})$	-	0.073
		(0.006)
Change in the share of firms reporting non-negative AGI	-	0.727
		(0.155)
Constant	0.521	-0.715
	(0.054)	(0.113)
R^2	0.188	0.319
Number of observations	1,029	1,029
F-Statistic	237.59	68.31
Partial R^2	-	0.153

Notes: Standard errors are reported in parentheses. Calculations of the Partial R^2 are described in Shea (1997) and Godfrey (1999).
Sources: Own calculations based on German Federal Statistical Office and Statistical Offices of the Länder, corporate income tax statistics 1998 and 2001, value added tax statistics 1998 to 2005, local business tax statistics 1998 and 2001.

Chapter 5

Corporate taxation and investment

5.1 Introduction

In this chapter I assess whether dynamic models of investment provide an empirically fruitful framework for analyzing tax effects on changes in the capital stock. The main focus of the chapter is the estimation of an error correction model which allows me to model investment dynamics explicitly. So far, drawing on the work by Chirinko, Fazzari, and Meyer (1999), other studies based on micro data have documented a significant response of capital spending to its user cost, where the user cost of capital combines prices, corporate income tax, allowances, interest, and depreciation rates. The empirical framework of these estimations, however, is based on autoregressive distributed lag models, where short-run dynamics result from an empirical specification search rather than being imposed *ex ante*; long-term effects are simply calculated as the sum of the coefficients of short-run adjustment.

Under certain testable assumptions, the autoregressive distributed lag model may be reparameterized as an error correction model. While short-run investment dynamics are again found from an empirical specification search, the long-term formulation of the capital stock in the error correction model is consistent with a simple neoclassical model of the firm's demand for capital. In the error correction model, the long-term level of capital thus equals the optimal capital stock, i.e., the level of capital that maximizes the discounted value of all future income streams. Since firms' optimal capital stock also depends on its user cost, a fall (rise) in the user cost of capital will lead firms to expand (reduce) their capital stock. Because of quadratic adjustment costs or adaptive expectations, they may not fully adapt in the first place but slowly shift their capital stock to the optimal one.[1] Both the adjustment process and the long-term equilibrium relationship are distinguishable in the error correction model.

In the following I will estimate two models: the distributed lag model to compare results to the existing literature,[2] and the error correction model to learn more about the dynamics of investment. There are several methodological problems which include unobserved firm heterogeneity, measurement error in the user cost of capital (Goolsbee, 2000), simultaneity bias (Goolsbee, 1998), and lagged dependent variable in the error correction model. While it seems impossible to control for these factors on the basis of a single cross section, I argue that the user cost elasticity can be identified by taking advantage of a panel and by using GMM methods. The panel data set I use for the estimations is the Hoppenstedt company database provided by Hoppenstedt firm information GmbH. The data set covers the years 1987 to 2007 and contains detailed accounting data for a large number of German non-financial corporations that are subject to publication requirements.

In spite of a variety of advantages, the use of a long panel data set implies one major problem, which is sample attrition. The longer the sequence of years, the more likely it is that firms drop out of the sample. Observations on firms may be miss-

[1] These factors would yield a simple specification of the form $k_t = \alpha_0 + \beta_1' X_t + \beta_2' X_{t-1} + \lambda k_{t-1} + u_t$, where k_t is the capital stock at time t, β_1 and β_2 are column vectors of regression coefficients, X_t and X_{t-1} are column vectors of explanatory variables at time t and $t-1$, and u_t is an unobserved error term.

[2] Chirinko, Fazzari, and Meyer (1999) and subsequent work have merely assumed extrapolative expectations and no adjustment costs. This assumption leads to a distributed lag model which does not include the lagged dependent variable. Further, Chirinko, Fazzari, and Meyer (1999) estimate the investment equation in rates of changes to account for large differences in firm size, i.e., they estimate a first-differenced distributed lag model.

ing for several reasons, including bankruptcy, cessation of business, merger, falling below thresholds which affect publication requirements, etc.. In theory, if firms are randomly missing, the investment function may be estimated using the incomplete panel data set as if it was complete. In practice, estimates can be biased without an appropriate correction if firms are missing for certain specific reasons which are, conditional on the explanatory variables included in the investment equation, not independent of the determinants of the decision to invest. In papers on investment, the fact that most (if not all) panel data sets on firms are incomplete, and the potential bias associated with this fact, have received little attention. To address the concern of non-random sample attrition, I include a correction term drawing on the work by Wooldridge (1995, 2002).

Estimating the first-differenced distributed lag model, I find a long-term user cost elasticity of -0.6. These estimates compare to what was documented for Germany in the literature (Chatelain, Hernando, Generale, von Kalckreuth, and Vermeulen, 2001; Harhoff and Ramb, 2001; von Kalckreuth, 2001). The only study with lower estimates for Germany is the study by Ramb (2007). Using the method of simulated marginal tax rates (Graham, 1996), Ramb estimates a long-term elasticity of the simulated marginal tax rate to investment activity between -0.2 and -0.1.[3] The estimation of the error correction model yields a robust, statistically significant, and relatively large point estimate of the user cost elasticity. The point estimate of the long-term elasticity of -1.3 implies that a decrease in the user cost of capital by 10 percent will increase capital by 13 percent. Further, I find that firms quickly adjust to the new optimal capital stock: about half of the gap between existing and optimal capital stock is closed within a year.

Interestingly, well-known cash flow effects are present in the distributed lag model

[3] In Ramb's study, the simulated tax rate is solely driven by the tax rate, loss offsetting rules, and the (simulated) tax base. All other effects incorporated in the user cost of capital such as depreciation allowances are assumed to be identical for all firms. For this reason, Ramb's estimate is not directly comparable to the studies estimating the user cost elasticity, the present doctoral thesis included.

but vanish in the error correction model. This finding conflicts with the view that cash flow effects can be seen as evidence for the importance of financial constraints (see, e.g., Fazzari, Hubbard, and Petersen, 1988, 2000). In fact, it suggests that in the distributed lag model, cash flow may act as a proxy for omitted expected future profitability variables (e.g., Kaplan and Zingales, 1997, 2000; Bond, Elston, Mairesse, and Mulkay, 2003) which becomes insignificant once the investment equation is dynamically correctly specified.

The remainder of the chapter is organized as follows. The next section briefly describes the user cost of capital and argues that the user cost provides sufficient variation to identify the user cost elasticity. The data set I use in the study and the empirical methodology are introduced in Section 5.3. Estimation results of the first-differenced distributed lag model and the error correction model are presented in Section 5.4. Section 5.5 summarizes my main results and concludes.

5.2 Firm-specific variation in the UCC

My goal is to estimate the user cost elasticity of investment. Identification of this elasticity comes from the user cost of capital (UCC), which varies across firms and over time. The definition of the UCC in this study is standard and based on the work by Jorgenson (1963), Hall and Jorgenson (1967), and King and Fullerton (1984). Following their approach, the UCC is the minimal rate of return a firm must earn on investments before taxes, i.e., it is the discount rate a firm should use in evaluating investment projects. As earnings from the investment are taxed and because the tax system provides for some allowances for investment goods, the UCC is not only a function of economic variables but also of taxation. This introduces further variation as major reforms in the tax system have taken place in Germany in recent years. In the following, I will briefly present the way I calculate the user cost of capital. In doing so, I will also introduce those features of the German tax system that are particularly relevant for the decision to invest.

The $UCC_{i,j,a,t}$ for firm i in industry j with asset a at time t is given by

$$UCC_{i,j,a,t} = \frac{p_t^I}{p_{j,t}^S} \frac{(1 - z_{a,t}) \left(\theta_{i,t} (r_{i,t} \kappa_{i,t}^f) + \delta_{j,a,t}^e \right)}{1 - \tau_t}, \tag{5.1}$$

where p_t^I is a price deflator for investment goods and $p_{j,t}^S$ is the industry j specific output price at time t. The ratio of these price indices reflects capital gains (or losses) that may occur if capital goods' prices are expected to rise (fall) relative to the prices of output goods. Capital gains alleviate the effect of economic depreciation ($\delta_{j,a,t}^e$) in lowering the asset's value. Assets are assumed to deteriorate exponentially, which renders the economic depreciation rate invariant to the interest rate (Auerbach, 1983). Information on economic depreciation is available at the industry-level for two different assets a, property with buildings and fixed tangible assets.

To account for deterioration, the tax system provides depreciation allowances.[4] Depreciation allowances $z_{a,t}$ follow different methods in Germany: While property with buildings is depreciated on a straight-line basis, fixed tangible assets could be depreciated according to the declining-balance method until 2007. Firms can change from the declining-balance to the straight-line method once the latter is beneficial. The rates of depreciation are set in the German income tax law and in industry-specific tables which are issued by the Federal Ministry of Finance. In recent years, these rates have been changed regularly (for details see the Data Appendix 5.6.1). When calculating the discounted value, I take changes in rates into account and also correct for inflation, since historical-cost depreciation acts to increase taxes with inflation. Note due to data restrictions I can only consider regular depreciation allowances. Accelerated depreciation allowances for investment in Eastern Germany which were introduced after reunification,[5] extraordinary depreciation allowances

[4]In Germany, an investment tax credit only exists for an initial investment in Eastern Germany (*Investitionszulage*). There is no investment tax credit for a replacement investment or an investment in Western Germany.

[5]See *Fördergebietsgesetz*.

for some industries (e.g., agriculture), and additional depreciation allowances for small and medium-sized businesses cannot be taken into account.

The tax rate τ_t includes the corporate income tax rate on retained earnings and the solidarity surcharge for Eastern Germany.[6] The solidarity surcharge was introduced in 1991. Since then, the solidarity surcharge has varied between 0 percent and 7.5 percent. Corporate income taxation has not only undergone changes in tax rates but also a fundamental change in the tax system:[7] While the German corporate tax system applied the tax-credit method until 2000, taxation has followed the half-income method since 2001. An overview of all corporate income tax and solidarity surcharge rates can be found in Appendix 5.6.2.[8]

Taxation also matters for firms' financial costs. King and Fullerton (1984) argue that the firm's financial cost $\theta_{i,t}$ in a world of distortionary taxes will differ from the market interest rate and, in general, will depend on the source of finance. Consequentially, the authors advocate a measure of financial cost which is a weighted average of the financial costs induced by the different financial sources, i.e., which considers a preferential tax treatment of debt.[9] As first pointed out by Hansson and Stuart (1985), such a measure may be less convincing on closer inspection than it appears at first glance. Drawing on an equilibrium perspective, they suggest that

[6] To keep things manageable I only include taxes on profit and do not consider the local business tax and the real estate tax. The real estate tax ties in with the assessed tax value of property. The assessed tax value cannot be deduced from the corporate balance sheet information but is calculated by the local tax authorities based on government tables using criteria such as the location, age, size, and characteristics of a property. Disregarding the local business tax and the real estate tax clearly leads to an underestimation of the user cost of capital. Leaving aside these taxes, however, is without loss of generality for my estimations in first-differences as long as the collection rates fixed by the municipality have not changed over time. Since these collection rates are very stable over time (see statistics on property taxes), disregarding the local business tax and the real estate tax should not change results.

[7] See Chapter 2.

[8] As already discussed in Chapter 2, the Hoppenstedt company database does not provide information on tax loss carry-forward. For that reason, I have to assume that the marginal tax rate τ_t equals the statutory corporate income tax rate plus solidarity surcharge even though the marginal tax rate τ_t might be zero for companies whose amount of profit is small relative to the volume of the corporation's tax loss carry-forward.

[9] This is in line with the pecking order theory of financing advocated by Myers and Majluf (1984) according to which firms prefer internal financing when available, and prefer debt over equity if external financing is required.

additional costs of debt, like bankruptcy costs, may balance the tax advantage of debt on the margin exactly. This implies that the difference between the rate of return to investment and the rate of return required by the investor does not always entirely consist of taxes but also of invisible costs. Then, observable differences in tax rates across sources of finance represent "an equilibrium in which additional marginal costs of using tax-favored sources just balance the tax advantages of these sources" (Hansson and Stuart, 1985, p.829). Hansson and Stuart thus claim that it is the maximum tax rate across sources of finance that should be taken instead of the weighted average of all sources. Getting to the bottom of their argument, Sinn (1993) presents a theoretical model of the firm's investment and financial decisions where invisible costs of debt finance such as risk of bankruptcy are taken into account. These invisible costs of debt finance are assumed to depend on the firm's stock of capital or on its stock of equity. In his "invisible cost model" Sinn shows that Hansen and Stuart have been mistaken: the (user) cost of capital is a weighted average of the cost of debt and the cost of retained earnings where the weights are marginal debt-asset and equity-asset ratios.[10]

Taking Sinn's finding seriously, I thus calculate firm-specific financial costs as a weighted average of after-tax interest rates, where the weights depend on the firm's mixture of financial sources. Following King and Fullerton (1984), I thereby distinguish three different sources of finance (retained earnings, debt, and new equity) and two types of investors (private and institutional shareholders). The calculation of the firm's financial costs $\theta_{i,t}(r_{i,t}\kappa_{i,t}^{f})$ is done in two steps. In the first step, I compute the after-tax interest rate for every source of finance f depending on the firm's interest rate $r_{i,t}$ and taxation (Table 5.1).[11]

In the second step, these firm-specific after-tax interest rates are weighted with

[10]The reasonable assumption behind this result is that the additional, invisible cost on debt is reduced *ceteris paribus* if equity financing is increased.

[11]Unfortunately, I am forced to neglect personal income taxation, since I do not have any information about a corporation's shareholders. However, comprehensive information on shareholders' other sources of income would be necessary to consider personal tax liabilities.

Table 5.1: After-tax interest rate $\theta_t(r_{i,t})$ by source of finance and by type of shareholder

Financing through...	**private shareholder**	**institutional shareholder**
retained earnings	$\theta_{i,t}^{retain,p}(r_{i,t}) = r_{i,t}$	$\theta_{i,t}^{retain,inst}(r_{i,t}) = r_{i,t}$
debt	$\theta_{i,t}(r_{i,t})^{debt,p} = r_{i,t}(1-\tau_t)$	$\theta_{i,t}^{debt,inst}(r_{i,t}) = r_{i,t}(1-\tau_t)$
new equity		
until 2000	$\theta_{i,t}^{new,p}(r_{i,t}) = r_{i,t}(1-\tau_t)$	$\theta_{i,t}^{new,inst}(r_{i,t}) = \frac{r_{i,t}}{1-\tau_t^{distr}}(1-\tau_t)$
since 2001	$\theta_{i,t}^{new,p}(r_{i,t}) = r_{i,t}(1-\tau_t)$	$\theta_{i,t}^{new,inst}(r_{i,t}) = r_{i,t}(1-\tau_t)$

Source: King and Fullerton (1984), own calculations.

the firm's share of fixed assets financed by retained earnings ($\kappa_{i,t}^{retain}$), debt ($\kappa_{i,t}^{debt}$), and new equity ($\kappa_{i,t}^{new}$) at time t.[12] I further assume that 70 percent of shareholder are institutional ($inst$) and 30 percent are private (p) shareholders:[13]

$$\begin{aligned}\theta_{i,t}(r_{i,t}\kappa_{i,t}^{f}) = (\kappa_{i,t}^{retain,p} + \kappa_{i,t}^{retain,inst})\theta_{i,t}^{retain} + (\kappa_{i,t}^{debt,p} + \kappa_{i,t}^{debt,inst})\theta_{i,t}^{debt} \\ + \kappa_{i,t}^{new,p}\theta_{i,t}^{new,p} + \kappa_{i,t}^{new,inst}\theta_{i,t}^{new,inst}.\end{aligned} \tag{5.2}$$

As pointed out by Weichenrieder (2008), the use of weighted averages also has its downside: Comparison of financial costs or the UCC over time (or across countries) may be blurred, since changes in taxation interact with changes in firms' financial structure. He therefore suggests simplifying firm- or industry-specific weighted averages to the overall cost of debt finance once the Miller equilibrium holds. In the Miller equilibrium (Miller, 1977), a clientele effect caused by the interaction of corporate and personal income taxation assimilates effective tax rates for retained earnings and debt.[14] Weichenrieder hence argues that the marginal investor in the Miller equilibrium should be indifferent between debt and equity. This leads him to conclude that in the Miller equilibrium financial costs can be approximated with

[12]Of course, these observable shares do not necessarily coincide with the *marginal* ratios. Unfortunately, the marginal financial structure cannot be deduced from the data. That is why I use the average within a given year as a proxy.

[13]Anecdotal evidence suggests that more than 50 percent of the shareholders are institutional ones (Deutsches Aktieninstitut, 2007). Experimenting with a segment of institutional shareholders amounting to 60 percent and 80 percent does not change results at all.

[14]Highly taxed investors prefer dividends and capital gains, since these sources of income are taxed at a lower personal income tax rate than interest payments. By contrast, individuals with low income prefer to save privately and to have interest payments taxed at a low personal income tax rate.

the overall interest rate. He underlines, however, that this approach also comes at a cost, since both personal income taxation at the shareholder level and corporate taxation interact. Given that I have to neglect personal income taxation because of data limitations, I cannot pursue this approach in all details. In a robustness check, however, I calculate the *UCC* using the overall yield on corporate bonds and see results unchanged.

Finally, the overall $UCC_{i,j,t}$ for firm i in industry j at time t is given by the weighted average of its asset-specific user costs:

$$UCC_{i,j,t} = \sum_{a} UCC_{i,j,a,t} \kappa_{i,t}^{a}, \tag{5.3}$$

where $\kappa_{i,t}^{a}$ is the firm-specific share of assets a in total assets. By this means, the user cost of capital is calculated for each firm. The *UCC* hence varies because of changes in taxation and in macroeconomic factors. Most variation, however, stems from varieties in the firms' financial structure and in the asset mix they use.

5.3 Data and estimation strategy

5.3.1 Data

The principal data requirement for the estimation of the user cost elasticity of the capital stock are cross-section and time-series micro data for the user cost of capital and the gross investment rate. For my study, I link two data sources that each provide information particularly well-suited to my objectives: detailed company accounting data made available by Hoppenstedt firm information GmbH, and industry-level information maintained by the German Statistical Offices and the German Central Bank.

Hoppenstedt provides accounting data for a large part of German corporations which are subject to publication requirements. It is hence neither comprehensive nor representative.[15] The data set includes information on time invariant firm characteristics such as industry, region, legal form, and year of foundation. Moreover, and most importantly for my analysis, the data set covers balance sheet positions and firms' profit and loss accounts in great detail. In particular, it records acquisition,[16] disposal, and withdrawal of fixed assets. This allows me to derive the firm-specific gross investment rate ($I_{i,t}$), which is normalized by the replacement cost value of capital stock ($K_{i,t-1}$). Replacement values are not available in the data but must be estimated from historic cost data using the perpetual inventory method. Cash flow ($CF_{i,t}$), which is income plus non-cash expenses like depreciation allowances, is also scaled by the beginning-of-period capital stock. Output is measured by sales ($S_{i,t}$). Nominal sales data are taken from the Hoppenstedt net sales figure and deflated by an industry-specific output price deflator. The growth rate of sales is defined as ($\Delta S_{i,t}/S_{i,t}$). The derivation of the replacement cost values of the capital stock and of the other explanatory variables used in my regression analysis are described in more detail in the Data Appendix 5.6.1.

To calculate the UCC as described before, I complement the data set with information on the prices of investment goods (p_t^I) and output prices ($p_{j,t}^S$), as well as on economic depreciation rates for buildings and fixed tangible assets ($\delta_{j,a,t}^e$). This industry-level information is merged with the individual data and was obtained from the German Statistical Offices; it is also described in more detail in the Data Appendix 5.6.1.

At the time of writing this chapter the Hoppenstedt company database contained financial statements from 1987 to 2007. I exclude companies which have changed

[15]Unfortunately, I cannot compute the coverage of the Hoppenstedt balance sheet database concerning the whole corporate sector because it is unknown how much non-financial corporations in Germany invest per year. Information is available for mining, quarrying, and manufacturing firms (incorporate and non-incorporate companies), which invested about 47.7 billion euro in 1997 (in the middle of my observation period). In the same year, Hoppenstedt corporations in these industries used in the estimations invested about 21.8 billion euro. Further, companies in mining, quarrying, and manufacturing all together employed about 7.8 million persons; of which, 4.1 million were employed at corporations in the Hoppenstedt database.

[16]This includes direct purchases of new fixed assets and those gained through acquisitions.

their accounting year during this period, so that all sets of accounts used would cover a 12-month period. Further excluding companies with less than four records,[17] and restricting my sample to firms with limited liability, leaves me with an unbalanced sample of 4,642 non-financial firms. The number of records per firm varies between four and twenty-one. In the appendix, descriptive statistics are provided which show the structure of the sample by number of observations per company (Table A5.2), the distribution of observations over years (Table A5.3), and the distribution of firms over industries (Table A5.4).

In contrast to what was used in earlier studies for Germany (e.g., Harhoff and Ramb, 2001), I exclusively use individual financial statements. One might object that subsidiaries do not have a free hand in taking their investment decisions because of the group structure. Even though there is no information about it, it seems plausible that it is the mother company (and not subsidiaries) that takes the decision to invest. Notwithstanding this aspect, I argue that capital formation depends on the user cost of capital at the *firm* level - and not at the group level. This is because depreciation allowances etc. are applied to the firm capitalizing the good. My argument becomes clearer if we think about a conglomerate, which consists of subsidiaries active in different industries. If a change in politics raises the UCC for subsidiary A but reduces it for subsidiary B, this may leave the UCC at the group level unchanged. However, a change in user cost of capital at the firm level may well lead subsidiary A to disinvest and subsidiary B to invest. Using consolidated financial statements we lose a lot of information, since neither the change in user cost of capital nor the change in capital might be observed.[18]

Table 5.2 provides some descriptive statistics of the variables used in the estimation over the period 1987 to 2007. As noted earlier, the Hoppenstedt company

[17] As a minimum I include two lags into my regression analysis. In my analysis, I consider changes in the explanatory variables, which means that the firm must have been in the data set in the three preceding years; this implies that I need at least four records per firm.

[18] A similar argument applies to the question whether data on business units should be used. Since it is again the firm level where tax rules are applied, I argue that not data on business units but firm data is appropriate.

database contains accounting information for corporations subject to publication requirements. In Germany, mainly large and very large firms are liable to publication requirements. This is also reflected in the average capital stock which amounts to about 70 million euro. On average, a firm's gross investment represents 13.1 percent of its existing capital stock. This average rate and the median gross investment to capital ratio (6.2 percent) are compatible with moderate capital stock growth.[19] Both mean and median sales grew very slowly in the sample at a rate of 0.1 percent and 0.6 percent, respectively. In the observation period, the user cost of capital grew slightly on average (+1.6 percent) but declined for the median company (-1.4 percent). A decline in the *UCC* is exactly what we would expect as tax reforms significantly reduced the corporate income tax rate for all companies; because output prices and economic depreciation rates developed unequally over industries, it is nevertheless conceivable that the user cost of capital grew marginally for some firms.

Table 5.2: Descriptive statistics for micro data

Variable	Mean	Median	Within-firm stand. deviat.[a]	Firm-specific time variation[b]
$K_{i,t}$ (in 1,000 euro)	69,498	12,283	23,539	0.998
$I_{i,t}/K_{i,t-1}$	0.131	0.062	0.192	0.999
$S_{i,t}$ (in 1,000 euro)	268,000	70,700	191,067	0.996
$\Delta S_{i,t}/S_{i,t-1}$	0.001	0.006	0.202	0.995
$CF_{i,t}/K_{i,t-1}$	0.053	0.012	0.118	0.998
$UCC_{i,t}$	0.140	0.135	0.030	0.782
$\Delta UCC_{i,t}/UCC_{i,t-1}$	0.016	-0.014	0.282	0.940
Number of observations			29,595	

Notes: $I_{i,t}/K_{i,t-1}$ is the ratio of investment to the beginning-of-period capital stock, $S_{i,t}$ are firms' real sales in 1,000 euro, $\Delta S_{i,t}/S_{i,t-1}$ is firm sales growth, $CF_{i,t}/K_{i,t-1}$ is the ratio of firm cash flow to the beginning-of-period capital stock, $UCC_{i,t}$ is the User Cost of Capital, and $\Delta UCC_{i,t}/UCC_{i,t-1}$ is the percentage change in this variable.

[a] Using mean-differenced variables, the within-firm standard deviation measures variation in the time dimension of the panel only.

[b] Following Chirinko, Fazzari, and Meyer (1999), this measure is computed as one minus the R^2 statistic from a regression of each mean-differenced variable on a set of time dummies.

Source: Hoppenstedt company database, own calculations, 1987 to 2007.

[19] The economic depreciation rate is about 3% to 5% for structures and 8% to 12% for fixed tangible assets.

The within-firm standard deviation shows that there is substantial variability over time. This is particularly true for changes in the user cost of capital which are driven by tax reforms, financing costs, and price trends. Identification, however, is not mainly based on aggregate time trends but on firm-specific variation. Drawing on the calculations in Chirinko, Fazzari, and Meyer (1999), I measure the firm-specific time variation as one minus the R^2 statistic from a regression of each mean-differenced variable on a set of time dummies. The firm-specific time variation in the data that is not due to aggregate time effects is given in the last column of Table 5.2. This proportion is high for the variables in rows one to five where it amounts to more than 99 percent. It is lower for the user cost of capital because to a larger extent variation in the *UCC* is determined by aggregate factors such as tax rates or price trends. Firm-specific variation is further reduced as I do not have firm-specific economic depreciation rates or price indices but have to resort to industry-level information. These aggregate factors, albeit important, do not fully explain time-series variation in the user cost of capital. On the contrary, there is still substantial micro-level variation as 78 percent of the variation in the *UCC* is due to firm-specific factors.

5.3.2 Models and estimation strategy

The main focus of the chapter is to estimate both short-term and long-term effects of changes in corporate taxation on a firm's investment decision and capital stock. While the error correction model has the drawback of relying less on theory, it has the advantage of imposing less structure than Q or Euler equation models (Bond, Elston, Mairesse, and Mulkay, 2003). In particular, it does not require quadratic adjustment costs.[20] Even though the error correction model cannot be explicitly derived from a dynamic optimization problem such as Q or Euler models, the long-term formulation for the level of capital is consistent with a simple neoclassical model

[20] Quadratic adjustment costs have been criticized as empirically implausible (Doms and Dunne, 1998) and too strict in the context of investment under (partial) irreversibility (Dixit and Pindyck, 1994).

of the firm's demand for capital. This and the dynamics in its modeling makes the error correction model superior to the (first-differenced) distributed lag model, which is the prevailing empirical specification. In the following, I will estimate both the error correction and the distributed lag model, and use the latter to compare results to the existing literature. Before briefly describing both models in the next paragraphs, I will first introduce the relationship between capital, the user cost of capital, and output.

The optimal capital stock

The demand for capital and, in a dynamic perspective, the demand for investment can be derived from the first-order conditions of profit-maximizing behavior with static expectations (Eisner and Nadiri, 1968). Using a production function with constant elasticity of substitution (σ) between capital and labor,[21] the optimal capital stock $K^*_{i,t}$ for firm i at time t can be written (Arrow, Chenery, Minhas, and Solow, 1961; Behrman, 1982) as

$$K^*_{i,t} = A_i T_t S_{i,t}{}^{\beta} UCC_{i,t}^{-\sigma}, \tag{5.4}$$

where $\beta = \sigma + \frac{1-\sigma}{\nu}$.

The optimal level of capital depends on a firm's level of output or sales $S_{i,t}$, on a firm-specific distribution parameter A_i explaining firm-specific relative factor shares of labor and capital,[22] on technology T_t as well as on the firm's user cost of capital as defined in equations (5.1) and (5.3). In this partial analysis, the optimal capital stock is independent of the wage level, i.e., companies are assumed to be price-takers on the labor market.[23] Note the elasticity of capital to sales is unity ($\beta = 1$) if the production function has constant returns to scale ($\nu = 1$) or if the

[21] A production function with constant elasticity of substitution nests Leontief ($\sigma = 0$) and Cobb-Douglas ($\sigma = 1$) production functions.

[22] Beyond firm-specific relative factor shares, the parameter might also capture a firm-specific price markup in monopolistic markets.

[23] In the econometric analysis differences in the wage level over time and across firms are captured in the deterministic time trend and in the firm-specific effects.

elasticity of substitution equals one ($\sigma = 1$), i.e., with a Cobb-Douglas production function. The parameter of interest in this chapter is the long-term elasticity of capital stock with respect to the UCC which is given by $-\sigma$.

In a frictionless world, the log of the current optimal capital stock $k^*_{i,t}$ is simply a long-linear function of current sales in log ($s_{i,t}$), logarithmized current user cost of capital ($ucc_{i,t}$), a firm-specific effect a_i, and a deterministic time trend capturing technological progress:

$$k^*_{i,t} = c + a_i + \beta s_{i,t} - \sigma ucc_{i,t} + \sum_{t=1}^{T-1} \tau d_t. \tag{5.5}$$

If, however, costs of adjustment and uncertainty are introduced, the current capital stock depends on both, the *current* values of sales and user cost of capital in logs and the *past* values of these variables as well as of the capital stock.[24] Appending a stochastic error term $\varepsilon_{i,t}$ the current capital stock can be expressed as follows:

$$k_{i,t} = c + a_i + \sum_{h=1}^{H} \phi_h k_{i,t-h} + \sum_{h=0}^{H} \beta_h s_{i,t-h} - \sum_{h=0}^{H} \sigma_h ucc_{i,t-h} + \sum_{t=1}^{T-1} \tau d_t + \varepsilon_{i,t}. \tag{5.6}$$

It is important to note that expectational variables in the process generating the data imply potential problems in the estimation of short-run effects and long-term solutions. To be precise, the investment equation cannot be identified without knowledge of the series underlying the expectation formation process. Since in that case the explanatory variables are not contemporaneously uncorrelated with the error term for the parameters of interest, short-run and long-term effects are possibly not consistently estimated. As is shown in more detail by Banerjee, Dolado, Galbraith, and Hendry (1993), however, non-stationarity of capital and co-integration

[24] Adjustment costs are assumed to be a function either of the rate of gross or net investment and are rationalized by reference to the costs of disruption, the training of workers, management problems and the like (e.g., Eisner and Strotz, 1963; Lucas, 1967; Gould, 1968; Treadway, 1969). They may also be justified by reference to supply side factors, by supposing that the supply curve of capital goods to the firm is upward sloping (e.g., Foley and Sidrauski, 1970, 1971). Nickell (1977) rationalizes lags by combining delivery lags and uncertainty. Harvey (1990) neatly distinguishes both effects. He shows that in a world with adaptive expectations, the optimal capital stock depends on lagged sales and user cost of capital whereas the currently optimal capital stock depends on lagged capital stock if capital is only partially adjusted.

between capital, sales, and user cost of capital can lead to consistent estimation of the long-term solution in an error correction framework in spite of the lack of weak exogeneity. Nevertheless, in the presence of expectational variables, the short-run coefficients remain mis-estimated in the error correction model, too. For this reason, I will mainly focus on the long-run coefficient that are consistently estimated in either case.

The (first-differenced) distributed lag model

Since firm-data are usually right skewed and show large differences in firm size, Eisner and Nadiri (1968) and Chirinko, Fazzari, and Meyer (1999) propose to specify the equation for capital with all variables as ratios or rates. Taking differences of equation (5.6) and accounting for partial adjustment and extrapolative expectations leads to the following first-differenced autoregressive distributed lag model:

$$\Delta k_{i,t} = \sum_{h=1}^{H} \phi_h \Delta k_{i,t-h} + \sum_{h=0}^{H} \beta_h \Delta s_{i,t-h} - \sum_{h=0}^{H} \sigma_h \Delta ucc_{i,t-h} + \Delta\varepsilon_{i,t}. \tag{5.7}$$

Next, the change in capital can be approximated by investment. For this purpose I divide investment into replacement components (I_t^r) and net investment (I_t^{net}). Following Chirinko, Fazzari, and Meyer (1999) I assume that capital depreciates geometrically at a firm-specific constant rate (δ_i), which varies with a firm's mix of capital assets; this means that replacement investment is proportional to the capital stock available at the beginning of the year. Net investment is the change in the capital stock between years t and $t-1$. Investment can hence be written as

$$I_{i,t} = I_{i,t}^r + I_{i,t}^{net} = \delta_i K_{i,t-1} + (K_{i,t} - K_{i,t-1}). \tag{5.8}$$

I then scale investment by the beginning-of-year capital stock and use equation (5.8) to obtain an approximation for the change in capital

$$\frac{I_{i,t}}{K_{i,t-1}} - \delta_i = \frac{K_{i,t} - K_{i,t-1}}{K_{i,t-1}} \simeq k_{i,t} - k_{i,t-1}. \tag{5.9}$$

Substituting this approximation into equation (5.7) leads to

$$\frac{I_{i,t}}{K_{i,t-1}} = \delta_i + \sum_{h=1}^{H} \phi_h \frac{I_{i,t-h}}{K_{i,t-h-1}} + \sum_{h=0}^{H} \beta_h \Delta s_{i,t-h} - \sum_{h=0}^{H} \sigma_h \Delta ucc_{i,t-h} + \Delta\varepsilon_{i,t}. \tag{5.10}$$

In their seminal paper, Chirinko, Fazzari, and Meyer (1999) did not include the lagged dependent variable and simplified the model above to a (first-differenced) distributed lag model. As the latter model has since prevailed in the literature, I estimate their simplified specification, too.[25] Similarly, I also include cash flow relative to the existing capital stock as a measure of liquidity (cf. Fazzari, Hubbard, and Petersen, 1988, 2000). This leads to the following estimation equation:

$$\begin{aligned}\frac{I_{i,t}}{K_{i,t-1}} = \delta_i + \sum_{h=0}^{H} \beta_h \Delta s_{i,t-h} - \sum_{h=0}^{H} \sigma_h \Delta ucc_{i,t-h} \\ + \sum_{h=0}^{H} \gamma_h \frac{CF_{i,t-h}}{K_{i,t-h-1}} + \Delta\varepsilon_{i,t}.\end{aligned} \tag{5.11}$$

It is worth noting that a significant cash flow effect can reflect the presence of financing constraints on investment. However, its is well known that financial constraints are not the only possible interpretation of significant coefficients on the cash flow variables. If investment depends on expected future sales and if cash flow acts as a proxy for these omitted expected future profitability variables, cash flow coefficients would be significant even in the absence of financing constraints (e.g., Kaplan and Zingales 1997, 2000).

In the estimation equation above, the long-term user cost elasticity of capital is captured by the sum of the σ's. There is no explicit modeling of the equilibrium relationship between capital, output, and user cost of capital. To learn more about this long-term relationship and the dynamics of investment, I also estimate an error correction model, which is derived in the next paragraph.

[25] Unlike, for instance, Chatelain, Hernando, Generale, von Kalckreuth, and Vermeulen (2001) and Harhoff and Ramb (2001) I do not think that time trends in growth rates are sensible and for this reason do not include time dummies into the first-differenced equation.

The error correction model

The error correction model was first introduced into the investment literature by Bean (1981). The main idea is to nest a long-term specification for the firm's demand for capital (depending on sales and the user cost of capital) within a regression setting that immediately yields parameters describing the extent of short-run adjustment to disequilibrium. As a prerequisite, capital, sales, and the user cost of capital must be co-integrated. Whether this holds can be tested using a panel co-integration test (Westerlund, 2007).[26] Once the variables are co-integrated, the parameter estimates are consistent and follow the standard normal distribution asymptotically, i.e., usual t-tests are valid.

Reparameterizing equation (5.6),[27] reducing the auto-regressive component to one lag, and approximating the change in capital stock by equation (5.9) leads to the error correction model:

$$\begin{aligned}\frac{I_{i,t}}{K_{i,t-1}} &= c_{ECM} + \sum_{h=0}^{H} \mu_h \Delta s_{i,t-h} - \sum_{h=0}^{H} \alpha_h \Delta ucc_{i,t-h} \\ &\quad + (\phi - 1)\left[k_{i,t-1} - c + \sigma ucc_{i,t-1} - \beta s_{i,t-1} - \sum_{t=1}^{T-1} \tau' d_t - \eta_i'\right] + \varepsilon_{i,t},\end{aligned} \tag{5.12}$$

where $\tau' = -\frac{1}{(\phi-1)}\tau$ and $\eta_i' = -\frac{1}{(\phi-1)}(a_i + \delta_i)$.

This estimation equation separates out short-run and long-term effects of a change in sales or user cost of capital. Immediate effects of a change in the user cost of capital are captured by α_0, i.e., a reduction in the UCC by 10 percent will immediately increase capital by α_0 times 10 percent. Further, a change in the UCC will influence capital in the long-run, since capital, user cost of capital, and output also have an equilibrium relationship. This equilibrium effect is given by $-\sigma$.

[26] I am aware of the fact that the test has higher power in samples where T is substantially larger than N. Even in small samples, however, the Westerlund test outperforms residual-based panel co-integration tests (Westerlund, 2007).

[27] For reparametrization one has to replace $k_{i,t}$ by $k_{i,t} = k_{i,t-1} + \Delta k_{i,t}$. Subtracting and adding $\beta_h s_{i,t-h}$ and $\sigma_h ucc_{i,t-h}$ and rearranging yields equation (5.12).

It is important to underline, however, that $-\sigma$ in the error correction model is not directly comparable to what is estimated as long-term elasticity in the estimation equation according to Chirinko, Fazzari, and Meyer (1999): They estimate equation (5.6) in changes without including lagged capital (*first-differenced* distributed lag model); the error correction model is a direct reparametrization of equation (5.6), i.e., of the *autoregressive* distributed lag model in *levels*.

The term $(\phi - 1)$ in the error correction model reveals how fast firms adapt their capital stock to the optimal one in equilibrium. If $(\phi - 1)$ is small in absolute value, capital is slowly adjusted while it quickly comes close to its equilibrium value if $(\phi - 1)$ is large in absolute terms. As a general rule, error correcting behavior requires that $(\phi - 1)$ is negative. A negative coefficient implies that a capital stock below the optimal level is associated with investment and *vice versa*. Whether the actual capital stock is below or above its equilibrium value can be seen from the term in squared brackets, which also involves the variables in levels. If levels were omitted only short-run dynamics would be picked up which is inappropriate as long as capital adjusts slowly.

The "classical" error correction model is estimated in two steps (Engle and Granger, 1987). First, the long-term parameters are estimated by running a static regression in levels. Second, the dynamics are estimated using the error correction term, which is the residuals from the static regression. Stock (1987) and Banerjee, Dolado, Hendry, and Smith (1986) present evidence that this estimator is consistent if the variables are co-integrated but may lead to a finite sample bias. In practice, this finite sample bias might be of particular importance if the error term is auto-correlated. In either case, the proceeding leads to inconsistent standard errors of the equilibrium estimates. To avoid biased estimates in small samples and to facilitate the estimation of the equilibrium parameters, Bewley (1979) proposed a one-step error correction model that I will adopt in the following. The Bewley transformed version of the error correction model allows for a single-step estimation and can be written as follows:

$$\begin{aligned} k_{i,t} = c'_{ECM} + \vartheta' k_{i,t-1} + \sum_{h=0}^{H} \mu_h \Delta s_{i,t-h} - \sum_{h=0}^{H} \alpha_h \Delta ucc_{i,t-h} \\ - \sigma' ucc_{i,t-1} + \beta' s_{i,t-1} + \sum_{t=1}^{T-1} \tau d_t + a_i + \varepsilon_{i,t}, \end{aligned} \tag{5.13}$$

where $c'_{ECM} = c_{ECM} - (\phi - 1)c$, $\vartheta' = 1 + (\phi - 1)$, $\sigma' = -(\phi - 1)\sigma = -(\vartheta' - 1)\sigma$, and $\beta' = -(\phi - 1)\beta = -(\vartheta' - 1)\beta$.

While the short-run effects in the Bewley transformed model directly correspond to the ones estimated in two-steps, the long-term impact of the user cost on capital must be calculated as $-\sigma = \frac{\sigma'}{\vartheta' - 1}$. The standard error for the long-term multiplier is not directly estimated but can be derived with the help of the delta method.

Note one could also estimate a different version of the model, which is appealing, since long-term multipliers come along directly with their standard error.[28] This model, however, also comes at a cost, since the short-run effects are not for direct reading.[29] For this reason, I prefer the Bewley-transformed error correction model.

Estimation strategy

The Bewley-transformed error correction model includes the lagged dependent variable. Because the lagged dependent variable in panel data is necessarily correlated with a firm-specific effect,[30] a simple Ordinary Least Squares (OLS) regression is

[28] This model can be written as follows:

$$\begin{aligned} k_{i,t} = c''_{ECM} - \vartheta'' \Delta k_{i,t-1} - \sum_{h=0}^{H} \mu''_h \Delta s_{i,t-h} + \sum_{h=0}^{H} \alpha''_h \Delta ucc_{i,t-h} \\ - \sigma ucc_{i,t-1} + \beta s_{i,t-1} + \sum_{t=1}^{T-1} \tau d_t + a_i + \varepsilon_{i,t}, \end{aligned}$$

with $c''_{ECM} = \frac{1}{1-\phi} c$, $\vartheta'' = -\frac{1}{1-\phi}\phi$, $\mu_h'' = -\frac{1}{1-\phi}\mu_h$, and $\alpha_h'' = -\frac{1}{1-\phi}\alpha_h$.

[29] They must be calculated as $\mu_h = -\mu''_h(1 - \phi)$ and as $\alpha_h = -\alpha''_h(1 - \phi)$ which is a bit tedious, since the velocity of adjustment $(\phi - 1)$ is not directly estimated. As $(\phi - 1)$ is negative, this implies that all short-run effects are given with opposite sign.

[30] Such unobserved firm characteristics might be a firm's capacity for innovation or managerial abilities. The firm-specific effect can also be interpreted as a component of the usual rate of investment at which the firm's adjustment costs are zero.

biased and inconsistent. The estimation of the Bewley-transformed error correction model thus calls for an instrumental variable (IV) technique.

Besides the inclusion of the lagged dependent variable, there are two more reasons to use instruments. First, Goolsbee (2000) has shown that the coefficient of the user cost of capital in an OLS regression is considerably biased towards zero because of measurement error in the UCC (attenuation bias). As, for instance, information on economic depreciation rates is not available for each single firm but only at the industry level, measurement error is probably also present in my user cost variable. Second, with an upward sloping supply curve for capital, a reduction in tax rates drives up prices in the short-run, which in turn might inhibit an expected increase in investment (Goolsbee, 1998, 2004). I therefore have to deal with a simultaneity bias between the UCC and investment shocks which distorts the user cost elasticity towards zero. A similar argument suggests that simultaneity between investment shocks and interest rates biases the coefficient of the user cost of capital (Chirinko, Fazzari, and Meyer, 1999). Further, investment shocks may be contemporaneously correlated with output and cash flow. Both measurement error and simultaneity bias require an instrumental variable estimation which results in consistent and unbiased estimates.

I therefore estimate the dynamic regression model above using Generalized Method of Moments (GMM) which controls for biases due to endogenous explanatory variables and firm fixed effects. In the chapter, I report results for the heteroscedasticity-robust two-step "System-GMM". This estimator uses the lagged levels of dependent and independent variables as instruments for the difference equation and the lagged difference of dependent and independent variables as instruments for the level equation (Blundell and Bond, 1998).[31] Since standard errors in the usual

[31] I do not report results estimated with "Difference-GMM" (Arellano and Bond, 1991) and "Forward-GMM" (Arellano and Bover, 1995). These estimators can be subject to large finite-sample biases, since the correlation between the explanatory variables in differences and their lagged levels becomes weak in highly persistent series (Blundell and Bond, 1998). One indication of whether these biases are likely to be serious can be obtained by OLS levels and within-groups estimates which are biased upwards and downwards, respectively. These estimations show that

two-step GMM estimator are downward biased in finite samples, the Windmeijer correction is used (Windmeijer, 2005).

Only in the absence of higher-order serial correlation in the error $\varepsilon_{i,t}$, does the GMM estimator provide consistent estimates of the parameters in the investment equation. To test for second-order serial correlation in the differenced residuals, I use the Arellano-Bond test (Arellano and Bond, 1991).[32] In this context I also report robust Sargan tests of overidentifying restrictions.

The last methodological topic I want to raise is sample attrition. Since I use panel data over a horizon of twenty years, I see firms dropping out of my sample. The reasons for attrition are manifold, they include bankruptcy, cessation of business, merger, and falling below the thresholds for disclosure requirement. If firms are randomly missing, sample attrition will not bias results; the investment function could be estimated using the incomplete panel data set as if it was complete. However, one might argue that dropping out of the sample does not randomly occur but is related to investment. There might be unobservable characteristics affecting the survival of firms or their size relevant to publication requirements which are correlated with unobservable firm characteristics that also affect the decision to invest.[33] In this case, estimation of the investment function without an appropriate correction can be biased. Surprisingly, this problem has received little attention in papers on investment so far. To allay doubts about the unbiasedness of my estimates, I include a term which corrects for sample attrition. Following a three-step procedure proposed by Wooldridge (1995, 2002),[34] I first estimate the probability of dropping out

firms' capital stock is highly persistent: an OLS regression of the current capital stock on the one in the previous year leads to a coefficient of 0.95 and the within estimation to an estimate of 0.70.

[32]For consistent estimation, the error $\varepsilon_{i,t}$ is required to be serially uncorrelated. If $\varepsilon_{i,t}$ are serially uncorrelated, then $\Delta\varepsilon_{i,t}$ are necessarily correlated with $\Delta\varepsilon_{i,t-1}$, but $\Delta\varepsilon_{i,t}$ will not be correlated with $\Delta\varepsilon_{i,t-k}$ for $k \geq 2$. If the estimation requirements are fulfilled, I therefore expect to reject the Arellano-Bond test for zero autocorrelation in the first-differenced errors at order 1 but not at order 2.

[33]If attrition only operates through the firm-specific, time-invariant effect a_i (δ_i), first-differencing the estimation equation solves selection. By contrast, if attrition operates both through a_i (δ_i) and $\varepsilon_{i,t}$ a correction term is needed.

[34]Errors in the selection equation are allowed to display serial correlation and unconditional

of the sample in the following period. In probit models, this probability is estimated separately for each year.[35] Second, I calculate the inverse Mills ratio for each period ($\lambda(x_i d_t)$) and third, add it to the estimation equation. Since usual standard errors are inconsistent, I bootstrap standard errors in all regressions.

5.4 Results

In this section, I present regression estimates for the user cost elasticity. I begin with GMM results for the (first-differenced) distributed lag model, which eliminates firm-specific effects and accounts for possible endogeneity problems. The Westerlund panel co-integration test (Westerlund, 2007) reveals co-integration between capital, user cost of capital, and sales (Table A5.5). The test result thus calls for a specification that nests the equilibrium relationship. For this reason, I estimate the one-step Bewley-transformed error correction model.[36] This estimation leads to my preferred, relatively large estimate of the user cost elasticity, which is about -1.3 in the long-run.

5.4.1 Estimates comparable to the literature

Table 5.3 presents GMM estimates of equation (5.11), with and without cash flow. The instruments used were at least twice lagged values of the explanatory variables,

heteroscedasticity but are assumed to be normally distributed. The procedure does not impose distributional assumptions about the error term and the firm-specific effects in the equation of interest. The unobserved effect and regressors are allowed to be arbitrarily correlated and attrition may depend on the unobserved effect. Though, the correction procedure requires that the functional form of the conditional mean of the firm-specific effects in the equation of interest is specified. Further, the cross-section observations are assumed to be independent and identically distributed. In the original model the assumption of strict exogeneity of the regressor is imposed. Wooldridge, however, argues that it is possible to allow for variables that are not strictly exogenous under reasonable extensions of the assumptions.

[35] Explanatory variables in this estimation are: Firm size (number of employees, balance sheet total), variables indicating economic difficulties (reduction in employees by more than 10 percent compared to the previous year, annual loss), and year of foundation.

[36] As a supplement, I also provide results for the "classical" two-step error correction model in the appendix (Table A5.6).

which allows for contemporaneous correlation between these variables and shocks to the investment equation, as well as correlation with unobserved firm-specific effects. Hence, current user cost of capital, output, and cash flow are treated as being potentially endogenous. In addition to the Sargan-Test for overidentifying restrictions, I also report the Arellano-Bond-Test testing for serial correlation in the differenced residuals.

Table 5.3: Results estimated with (first-differenced) distributed lag model and Generalized Method of Moments

$I_{i,t}/K_{i,t-1}$	**Excluding cash flow**	**Including cash flow**
$\lambda(x_i d_t)$	0.031	0.073
	(0.006)	(0.029)
$\Delta ucc_{i,t}$		
σ_0	-0.190	-0.266
	(0.053)	(0.092)
σ_1	-0.228	-0.268
	(0.075)	(0.106)
σ_2	-0.127	-0.136
	(0.072)	(0.074)
σ_3	-0.010	0.050
	(0.158)	(0.159)
SUM(σ)	**-0.553**	**-0.620**
	(0.254)	**(0.215)**
$\Delta s_{i,t}$		
β_0	0.055	0.084
	(0.036)	(0.036)
β_1	0.048	0.057
	(0.045)	(0.044)
SUM(β)	**0.103**	**0.141**
	(0.074)	**(0.074)**
$CF_{i,t}/K_{i,t-1}(\gamma)$	-	0.138
	-	(0.003)
Number of firms	3,968	3,968
(Number of observations)	(24,762)	(24,762)
Sargan-Test (p-value)	0.999	0.787
Arellano-Bond-Test (p-value), order 1	0.090	0.155
Arellano-Bond-Test (p-value), order 2	0.788	0.636

Notes: Estimates with micro data and Generalized Method of Moments as described in the text. A full set of time dummies is included. Bootstrapped standard errors are in parentheses. The instruments for the first-differenced regression are the values (in levels) of $\Delta ucc_{i,t}$ lagged two through nine years and $\Delta s_{i,t}$ and $CF_{i,t}/K_{i,t-1}$ lagged two through three years.
Source: Hoppenstedt company database, own calculations, 1987 to 2007.

The estimates in Table 5.3 are directly comparable to the existing literature using distributed lag models. As noted before, the (long-term) user cost elasticity in this model is given by the sum of σ's. Estimating the model without cash flow I find an elasticity of -0.55 while it amounts to about -0.62 when I include cash flow. In the model without cash flow the null hypothesis of capital being inelastic with respect to its user cost can be rejected at the 5%-level, while the variable is significant at every conventional significance level in the model including cash flow.

Compared to the existing literature, my point estimates without and with cash flow are surprisingly similar,[37] even though there are several differences between my estimation and previous studies: First, Harhoff and Ramb (2001), von Kalckreuth (2001) and Chatelain, Hernando, Generale, von Kalckreuth, and Vermeulen (2001) use consolidated and not individual financial statements as I do. Second, all three studies use the German Central Bank's corporate balance sheet database. This data set may be sampled differently as it does not rely on publication requirements but originates from the Central Bank's function of performing credit assessments within the scope of its rediscount-lending operations (for details and additional bibliographical references see von Kalckreuth, 2001). Third, previous studies do not explicitly control for sample attrition while a correction term is included in all specifications in the present study.[38] Since a two-sided t-test reveals that the correction term ($\lambda(x_i d_t)$) is statistically significantly different from zero at the 1%-level (without cash flow) and 5%-level (with cash flow), firms indeed seem to leave the data set non-randomly. Thus uncontrolled sample attrition potentially biased results in earlier studies. However, comparing regression results from Table 5.3 to the coefficients estimated in a model without selection correction does not show any important differences.[39] This indicates that, even though companies drop out of the sample non-randomly, controlling for sample attrition has almost no effect on the user cost

[37]Compared to the elasticity of -0.25 estimated by Chirinko, Fazzari, and Meyer (1999) for the US, the user cost elasticity of German companies seems to be larger in general.

[38]In first-difference estimations, time-invariant sampling schemes are purged from the regression by fixed effects. If the sampling, however, has changed, explicit selection correction is warranted.

[39]Results can be obtained upon request.

elasticity, at least for the Hoppenstedt database.

Similar to what was found in the literature before, the sum of the coefficients of sales is clearly below one (point estimate of 0.10 without and 0.14 with cash flow) and not compatible to what is usually assumed in theory.[40] The point estimate for cash flow, by contrast, is statistically significant and relatively large: Increasing cash flow by 10 percent immediately increases capital by 1 percent. Insofar as cash flow seems to be an important determinant of investment, omitting it from the estimation equation will lead to an omitted variable bias in the estimated user cost elasticity if the user cost of capital and cash flow are correlated.

In general, cash flow effects are interpreted either as evidence for the importance of financial constraints (e.g., Fazzari, Hubbard, and Petersen, 1988, 2000) or as a proxy for future profitability (e.g., Kaplan and Zingales, 1997, 2000). Differentiating the "financial" versus the "fundamental" determinants of investment is fruitful, since financial frictions might translate into important efficiency costs of profit taxation (Keuschnigg and Ribi, 2009). In the following, I will argue that cash flow effects may result from dynamic misspecification, since they disappear once investment dynamics are correctly specified within the error correction model. This is in line with what was found by Bond, Elston, Mairesse, and Mulkay (2003) in the context of financial factors and investment.

5.4.2 Investment dynamics

Since the first-differenced distributed lag model does not account for the equilibrium relationship between capital, sales, and user cost, I prefer estimating an error correction model. As discussed above, this model can be used to estimate the long-term elasticity of the capital stock with respect to its user cost, while allowing for the fact that this adjustment does not occur immediately. Because of the drawbacks

[40] As shown in Section 5.3.2 constant returns to scale imply a point estimate of one. A point estimate below one implies increasing returns to scale.

associated with the "classical" two-step error correction model, I confine these results to the appendix (Table A5.6) and exclusively present results of the single-step estimation in the main text.

The GMM results for the one-step error correction model are summarized in Table 5.4. Beforehand, the estimation results have undergone several robustness check and are not sensitive to the instrumentation choices.[41]

First, I refer to regression results in column (1) which is without cash flow. All point estimates have the expected sign. The long-term user cost elasticity is calculated as $-\sigma'$ divided by $-(1-\vartheta')$. This yields a statistically significant and relatively large long-term multiplier which amounts to -1.29 (standard error of 0.18). Hence, a rise in the user cost of capital by 10 percent decreases capital by about 13 percent in the long run. A two-sided Chi-square test suggests that the elasticity is not statistically different from minus one (p-value: 0.107).[42] Compared to the point estimate of -0.6 in the previous section, the coefficient appears rather large. It is, however, not uncommon that equilibrium elasticities are large *vis-à-vis* the effects estimated in distributed lag models: Exploiting co-integration methods, Caballero, Engel, and Haltiwanger (1995) estimate the long-term relationship between logarithmized capital-output ratio and user cost of capital. They report an average elasticity of investment with respect to capital of -1.0, the neoclassical benchmark. Cummins, Hassett, Hubbard, Hall, and Caballero (1994) use tax reforms as natural experiments for evaluating the responsiveness of investment to its user cost and find long-term elasticities between -0.5 and -1.0. In an earlier study based on aggregate data, Caballero (1994) reports an elasticity of the capital-output ratio to the cost of capital close to minus one.[43]

[41] Mairesse, Hall, and Mulkay (1999), Harhoff and Ramb (2001), and von Kalckreuth (2001) report on instability in their estimation results regarding the choice of instruments.

[42] Of course, the model could be also estimated under the restriction of a Cobb-Douglas production function. To allow for a maximum of flexibility, I estimate the model without restriction but use the parameter estimate for a plausibility check.

[43] Note that researchers who have worked with aggregate data have had great difficulty in providing empirical evidence that taxes matter for capital formation (cf. Chirinko, 1993; Caballero, 1999; Hassett and Hubbard, 2002 for surveys of this literature). The reasons for the failure were

Table 5.4: Results estimated with one-step error correction model and Generalized Method of Moments

$k_{i,t}$	**Without cash flow** (1)	**With cash flow** (2)
$k_{i,t-1}(\vartheta')$	0.318	0.294
	(0.057)	(0.054)
Selection correction ($\lambda(x_i d_t)$)	-0.082	-0.087
	(0.018)	(0.019)
User cost of capital (σ')	-0.881	-0.861
	(0.138)	(0.145)
Sales (β')	0.447	0.448
	(0.072)	(0.075)
$\Delta ucc_{i,t}$		
α_0	-0.537	-0.515
	(0.079)	(0.084)
α_1	-0.139	-0.137
	(0.034)	(0.035)
α_2	-0.050	-0.050
	(0.017)	(0.017)
$\Delta s_{i,t}$		
μ_0	0.283	0.277
	(0.059)	(0.063)
μ_1	0.070	0.072
	(0.021)	(0.022)
μ_2	0.035	0.038
	(0.014)	(0.015)
$CF_{i,t}/K_{i,t-1}$		
γ_0	-	-0.014
	-	(0.011)
Constant	2.051	2.483
	(1.254)	(1.298)
Number of firms	3,968	3,968
(Number of observations)	(24,762)	(24,762)
Sargan-Test (p-value)	0.775	0.642
Arellano-Bond-Test (p-value), order 1	0.002	0.007
Arellano-Bond-Test (p-value), order 2	0.366	0.273

Notes: Estimates with micro data and Generalized Method of Moments as described in the text. A full set of time dummies is included. Bootstrapped standard errors are in parentheses. The instruments for the first-differenced regression are the values (in levels) of $\Delta ucc_{i,t}$ and $\Delta s_{i,t}$ lagged two through seven years.
Source: Hoppenstedt company database, own calculations, 1987 to 2007.

The coefficients on the short-run effects show that companies relatively quickly adjust to a change in user cost of capital. α_0 implies that a reduction of the user cost by 10 percent will immediately increase capital by 5 percent, i.e., about half

various: insufficient variation in the user cost of capital to identify tax effects, measurement error in that investment depends upon observed current and expected future values of many fundamentals, and small samples problems of co-integrating procedures that tend to downward bias the user cost elasticity particularly when adjustment costs are important.

of the gap between current and optimal stock of capital is closed in the first year. This finding might be important news for policymakers who can stimulate short-term capital spending and stabilize business fluctuations by lowering the user cost of capital.

Let me now turn to the equilibrium relationship between capital and sales. The long-term effect of output on capital is given by $-\beta'$ divided by $-(1-\vartheta')$. At 0.65 (standard error of 0.10), the effect of output on capital in equilibrium is larger than what was found in the first-differenced distributed lag model but still implies increasing returns to scale; a two-sided Chi-square test rejects the null hypothesis of constant returns to scale at any conventional level (p-value: 0.000). Since the data set in this study mainly contains large corporations which potentially benefit from increasing return to scale, a point estimate below one is plausible.[44] In either case, the estimate is much closer to theoretical predictions than the estimate usually found in distributed lag models. Again, the coefficients on the short-run effects of sales on capital suggest that companies relatively quickly shift their capital stock if sales increase or decrease.

The coefficient on the selection term is highly significant. To determine whether estimates in earlier studies on investment, not accounting for non-random sample attrition, have been biased, I compare the point estimates to a regression without correction term. The comparison again shows that there is virtually no difference between the estimates of the two regressions.[45] This implies, at least for the data set used in this study, that sample attrition is present but does not affect the user cost elasticity.

Let me now turn to the regression including cash flow (Table 5.4, column (2)). First of all, the estimation results show that including cash flow in the regression

[44] Note this does not conflict with an equilibrium perspective, since optimal, finite firm size might be defined by other factors such as managerial capacity limits or provisions on the employment rights of employees operating the machines, which are more generous for employees working for larger firms (e.g., employees of larger firms are entitled to a works council). Firm growth may also be limited by legal rules or the antitrust agency.

[45] Results can be obtained upon request.

equation does not change results. Second, the point estimate for cash flow is close to zero and insignificant. Since both results also hold if several lags of cash flow are introduced, I do not reproduce results here. This finding contradicts significant cash flow effects in the distributed lag model but is in line with results reported by other researchers. Not including the user cost of capital, Bond, Elston, Mairesse, and Mulkay (2003) analyze the effects of output and cash flow on capital in different countries. They remark that significant cash flow effects have been present in restricted reduced-form specifications but have vanished in more complete dynamic specifications. They therefore conclude that “there is some indication that the cash-flow variables proxy for omitted dynamics in simpler dynamic specifications” (Bond, Elston, Mairesse, and Mulkay, 2003, p.160).[46] To be precise, financial variables may appear to be significant in distributed lag models, even though they play no role in the structural model for investment but merely help to forecast future values of the fundamental determinants of investment.[47] For this reason, I cannot concur with other authors (e.g., Harhoff and Ramb, 2001) stating that the (first-differenced) distributed lag model produces the most appropriate estimation results. On the contrary, I suspect well documented cash flow effects in the distributed lag model may appear merely because of dynamic misspecification. Accounting for co-integration between capital, user cost of capital, and sales, I further find more plausible estimates for the long-term effect of output on capital than in the distributed lag model.

For these reasons, my preferred specification is the one-step error correction model without cash flow. This specification gives an estimate for the long-run effect

[46]Another strand of the literature associates significant cash flow effects with measurement errors in Q-models. For instance, Bond, Klemm, Newton-Smith, Syed, and Vlieghe (2004) find that cash flow effects disappear when analysts’ earnings expectations are included in the investment regression. Similarly, Erickson and Whited (2000) use information in higher-order moments to control for measurement error in q and obtain insignificant cash flow coefficients. An overview of the associated literature is given in Cummins, Hassett, and Oliner (2006).

[47]This shows that reduced form models are subject to the famous Lucas critique (Lucas, 1976) because parameters of the structural adjustment process are interfused with parameters of the expectation formation process.

of the user cost of capital on capital formation of -1.29. The user cost of capital, however, is influenced by a mixture of variables including interest rate, tax rate, economic depreciation rate etc.. That is, it cannot be directly influenced by policymakers who can only determine depreciation allowances, tax rates, and the fiscal treatment of different financial sources. To evaluate the effect of changes in these variables on the user cost of capital and the capital stock, I simulate the policy implications of the most recent tax reform in Germany, the Corporate Tax Reform 2008 (*Unternehmensteuerreform 2008*). This reform reduced the uniform corporate income tax rate from 25 percent to 15 percent. At the same time, the tax base was broadened by deteriorating depreciation allowances. In particular, the option to depreciate fixed assets according to the declining-balance method was abolished. *Ceteris paribus*, the lowering of the corporate income tax rate led to a reduction in the user cost of capital; this decrease, however, was partly compensated for by the deterioration of depreciation allowances. In my sample, the reform lowered the user cost of capital by 0.08 percent, on average.[48] Applying my elasticity estimate of -1.29, I would expect that the reform increases capital stock by only 0.11 percent in the long run. Hence, any expectation of a large increase in investment because of the reform seems inappropriate, since the rather strong reduction in corporate income tax rate was undermined by stricter depreciation allowances.

5.5 Conclusion

Using a firm-level panel data set I estimate the user cost elasticity of capital in a dynamic framework. More precisely, I estimate an error correction model where short-run adjustments and long-term equilibrium effects can be distinguished. So far, drawing on the work by Chirinko, Fazzari, and Meyer (1999), other studies based on micro data have focused on (first-differenced) distributed lag models, which do

[48] In 2001, the average user cost of capital was 0.14589; applying the tax rules 2008 yields a user cost of capital of 0.14577 *ceteris paribus*.

not explicitly allow for an equilibrium relationship between capital, its user cost, and sales. Short-run dynamics result from an empirical specification search rather than being imposed *ex ante*; long-term effects are simply calculated as the sum of the coefficients of short-run adjustment.

To account for non-random sample attrition which may bias estimation results, all regressions include a term correcting for firms dropping out of the sample. Surprisingly, this issue has not been raised in previous studies even though most (if not all) panel data sets on firms are incomplete and estimates may be biased for this reason. While the coefficient of the selection term is statistically significant, it is found to be of minor importance for the estimation of the user cost elasticity, at least for the Hoppenstedt database used in this study.

First, I estimate the popular (first-differenced) distributed lag model to compare results to estimates from previous studies. This regression setting yields a user cost elasticity of -0.6 which is very similar to what was found by Harhoff and Ramb (2001) (-0.4), von Kalckreuth (2001) (-0.5), and Chatelain, Hernando, Generale, von Kalckreuth, and Vermeulen (2001) (-0.7). Similar to what was previously found in the literature, the (first-differenced) distributed lag model leads to implausible low point estimates for output which casts doubt on the validity of these estimates.

Second, as a novel contribution to the literature on tax effects in investment equations, I estimate an error correction model. Since the "classical" two-step error correction model suffers potentially from finite sample biases, I mainly rely on a one-step Bewley-transformed error correction model. My estimation yields a robust, statistically significant, and relatively large user cost elasticity. My preferred estimate of -1.3 implies that a decrease in the user cost of capital by 10 percent will increase the firm's capital stock by 13 percent, on average. Taking my elasticity estimate to the Corporate Tax Reform 2008, the most recent tax reform in Germany, I would expect that the reform only slightly increases capital stock, since the rather strong reduction in corporate income tax rate was partly compensated for by stricter depreciation allowances. Further, my preferred specification shows that firms quickly adjust to the new optimal capital stock: about half of the gap between the existing and the optimal capital stock is closed within a year. Implying increasing return to scale the elasticity of capital towards output seems to be below unity but is more reasonable in size than in the (first-differenced) distributed lag model.

Investment dynamics appear to be crucial not only for the effect of output on capital but also for the effect of cash flow variables in investment equations. While well-known cash flow effects are present in the (first-differenced) distributed lag model, they vanish in the error correction model. This finding conflicts with the view that cash flow effects can be seen as evidence for the importance of financial constraints (e.g., Fazzari, Hubbard, and Petersen, 1988, 2000). In fact, it rather suggests that cash flow may act as a proxy for omitted expected future profitability variables (Kaplan and Zingales, 1997, 2000; Bond, Elston, Mairesse, and Mulkay, 2003) which becomes insignificant once the investment equation is dynamically correctly specified. For this reason I cannot agree with Harhoff and Ramb (2001) when they state that the distributed lag model produces the most appropriate estimation results. On the contrary, sensitivity of cash flow coefficients leads me to conclude that well documented cash flow effects point at dynamic misspecification.

5.6 Appendix

5.6.1 Data

This appendix describes the calculation of the principle variables used in the estimation and the data sources used in the study.

(Gross) Investment $I_{i,t}$

Gross investment is defined as additions to fixed tangible assets and structures less disposals from fixed tangible assets and structures.

Sales $S_{i,t}$

Sales is measured by revenue/turnover from Hoppenstedt, and it is deflated by industry-specific output price indices provided by German Statistical Office.

Cash flow $CF_{i,t}$

Cash flow is the sum of several variables from Hoppenstedt. Cash flow includes:

1. Income before extraordinary items
2. Depreciation
3. Deferred taxes
4. Extraordinary items and discontinued operations.

Income before extraordinary items and depreciation are seldom missing from firms' profit and loss accounts. If information on these two items is missing, cash flow is also assumed to be a missing value. The other two items (deferred taxes and extraordinary items), by contrast, are missing for a large share of companies. Following Chirinko, Fazzari, and Meyer (1999) I assume their values to be zero when they are missing. Most firms' profit and loss account in the data set follow the whole expenditure method. While depreciation for these firms refers to the whole amount of depreciation in a given year, deprecation of firms applying the cost of sales method only refers to depreciation attributable to goods sold. These differences in definition are neglected in the construction of my cash flow variable.

Capital stock $K_{i,t}$

Capital input is measured by the real replacement value of equipment and structures. The real replacement value of capital is not available in the data, and must be estimated from historic cost data. The replacement cost value of tangible fixed assets and structures are assumed to equal their historic costs in the first year a firm appears in the data set (adjusted for previous years' inflation). Thereafter, the replacement cost value is updated using the perpetual inventory formula:

$$P_t^I K_t = (1-\delta) P_{t-1}^I K_{t-1} \frac{P_t^I}{P_{t-1}} + P_t^I I_t \tag{5.14}$$

where $t = 1987, ..., 2007$,

K_t capital stock,

P_t^I price of investment goods,

I_t real investment,

δ depreciation rate.

Depreciation rates of 12.25 percent per year for fixed tangible assets and 3.61 percent per year for buildings are assumed. These values are taken from OECD (1991). As a sensitivity test, I recalculated the capital stock taking a depreciation rate of 8 percent from (Bond, Harhoff, and Van Reenen, 2003). This did not change regression results.

Price indices p_t^I and $p_{j,t}^S$

There are two price indices: The national price index for investment goods (p_t^I) and the price index for output goods ($p_{j,t}^S$). The German Statistical Office constructs p_t^I on the country level only (*Investitionsgüterindex*). $p_{j,t}^S$ is available for manufacturers on a disaggregate level (*Erzeugerpreisindex*): These days firms have to declare their price of sale for approximately 1,600 representative types of goods. On the basis of these prices, the Statistical Offices calculate detailed sales price information for each industry j. I use this information at the 4-digit industry level.

Rate of economic depreciation $\delta^e_{a,j,t}$

The rate of economic depreciation $\delta^e_{a,j,t}$ can be derived from information out of the national accounts' capital stock (*Kapitalstockrechnung*), which is provided by the German Statistical Office. The rate varies across assets a, i.e., fixed assets and structures, industries j (4-digit level), and over time. I calculated the rate as economic depreciation for asset a in prices of 2000 divided by stock of asset a in prices of 2000.

Depreciation allowances $z_{a,t}$

Depreciation allowances $z_{a,t}$ follow different methods in Germany: While structures are depreciated on a straight-line basis, fixed assets could be depreciated according to the declining-balance method until 2007. When calculating depreciation allowances, I considered these differences. Depreciation allowances also vary over time as fiscal rules were changed several times.

Structures: Until 2000, the taxation-relevant lifetime of structures was 25 years. Since 2001 this lifetime has been prolonged to $33\frac{1}{3}$ years.

Fixed assets: Until 2000, the yearly rate for the declining-balance method was 0.3. In 2001 it was reduced to 0.2. If depreciation allowances on the straight-line basis exceed those on the declining-balance method, firms are allowed to switch methods. This privilege is taken into account. Unfortunately, there is no information on the relevant lifetime for different fixed assets, which vary considerably. I therefore assumed that the relevant lifetime amounts to 10 years (year 1997) on average. A research project on depreciation allowances in Germany concludes that reforms in 1998 and 2001 worsened depreciation allowances by approximately 30 percent (Oestreicher and Spengel, 2002). I scaled the average lifetime accordingly (1998 to 2000: 13 years, 2001 to 2008: 16.9 years).

Firm-specific interest rate $r_{i,t}$

The firm-specific interest rate $r_{i,t}$ is approximated as interest payments in a given year divided by long term debt at the end of the year.

Overall yield on corporate bonds r_t

In a robustness check, I use the overall yield on corporate bonds r_t. This information is provided by the German Central Bank in its series "Yields on debt securities outstanding issued by residents / Corporate bonds / Monthly average" (WU0022).

5.6.2 Statutory tax rates

Table A5.1 shows the evolution of tax rates over time.

Table A5.1: Statutory tax rates 1987-2008

year	Corporate income tax on retained profits	Corporate income tax on distributed profits	Solidarity surcharge
1987	56%	36%	-
1988	56%	36%	-
1989	56%	36%	-
1990	50%	36%	-
1991	50%	36%	3.75%
1992	50%	36%	3.75%
1993	50%	36%	-
1994	45%	30%	-
1995	45%	30%	7.5%
1996	45%	30%	7.5%
1997	45%	30%	7.5%
1998	45%	30%	5.5%
1999	40%	30%	5.5%
2000	40%	30%	5.5%
2001	25%	25%	5.5%
2002	25%	25%	5.5%
2003	26.5%	25%	5.5%
2004	25%	25%	5.5%
2005	25%	25%	5.5%
2006	25%	25%	5.5%
2007	25%	25%	5.5%
2008	15%	15%	5.5%

Sources: Own presentation, corporate income tax law, 1987 to 2008, solidarity surcharge law, 1991 to 2008.

5.6.3 Additional descriptives and results of the two-step error correction model

My sample consists of 4,642 firms which have at least four records in the data set (Table A5.2). Table A5.3 shows the distribution of observations over years. Most firms have their headquarters in Western Germany; only about 13 percent of all firms are located in Eastern Germany. All companies were allocated to thirteen industries according to their main activity as is shown in Table A5.4.

Table A5.2: Number of records per company

Number of records per company	Number of companies
4	685
5	553
6	491
7	438
8	379
9	285
10	227
11	192
12	168
13	255
14	263
15	94
16	110
17	102
18	52
19	26
20	84
21	238
Total	4,642

Source: Hoppenstedt company database, own calculations, 1987 to 2007.

Table A5.3: Composition of the sample: years

Year	Number of observations with at least three lags
1990	888
1991	1,089
1992	1,110
1993	1,151
1994	1,211
1995	1,230
1996	1,286
1997	2,267
1998	2,128
1999	1,981
2000	1,873
2001	1,880
2002	1,952
2003	2,032
2004	2,129
2005	2,092
2006	1,990
2007	1,306
Total	29,595

Source: Hoppenstedt company database, own calculations, 1987 to 2007.

Table A5.4: Composition of the sample: industries

Industry	Number of companies
Agriculture, forestry, fishery	26
Mining, quarrying	30
Consumer goods, goods for intermediate	
Consumption goods industry	791
Producers goods	829
Electricity and water supply	505
Construction	122
Wholesale and retail trade, repair of goods	475
Hotels and restaurants	27
Transport, storage and communication	275
Financial intermediation	68
Real estate and renting	507
Services for private sector	649
Services for public sector and households	338
Total	4,642

Source: Hoppenstedt company database, own calculations, 1987 to 2007.

Table A5.5: Westerlund panel co-integration test

Westerlund test statistic	Value	z-value	p-value
Group-mean tests			
Gt[a]	-2.904	-28.416	0.000
Ga[a]	-128.683	-573.736	0.000
Panel tests			
Pt[b]	-9.550	-40.686	0.000
Pa[b]	-18.152	-66.146	0.000

Notes: Westerlund panel co-integration test calculated with Stata command xtwest (Persyn and Westerlund, 2008).

[a] For group tests: $H_0^G : \alpha_i = 0 \ \forall i$ versus $H_1^G : \alpha_i < 0$ for at least some i; a rejection should be taken as evidence of co-integration for at least one of the cross-sectional units.

[a] For panel tests: $H_0^P : \alpha_i = 0 \ \forall i$ versus $H_1^P : \alpha_i < 0 \ \forall i$; a rejection should be taken as evidence of co-integration for the panel as a whole.

Sources: Hoppenstedt company database, own calculations, 1987 to 2007.

Table A5.6: Results estimated with two-step error correction model and Generalized Method of Moments

$I_{i,t}/K_{i,t-1}$	**Two-step estimation**
1. step: equilibrium effects	
User cost of capital (σ)	-1.687
	(0.036)
Sales (β)	0.635
	(0.006)
Constant	1.739
	(0.128)
Year dummies	included
Firm-specific effect	included
2. step: investment dynamics	
Selection correction ($\lambda(x_i d_t)$)	-0.078
	(0.089)
$\Delta ucc_{i,t}$	
α_0	-0.422
	(0.173)
α_1[a]	-0.707
	(0.360)
α_2	0.078
	(0.069)
$\Delta s_{i,t}$	
μ_0	0.238
	(0.160)
μ_1[b]	0.441
	(0.182)
μ_2	0.015
	(0.061)
Velocity of adjustment $(1-\phi)$[c]	-0.478
	(0.263)
Constant	0.589
	(0.310)
Number of firms	3,968
(Number of observations)	(24,762)
Sargan-Test (p-value)	0.999
Arellano-Bond-Test (p-value), order 1	0.094
Arellano-Bond-Test (p-value), order 2	0.870

[a] Note that, while the change in the first year is given by α_0, the effect in the second year cannot be directly taken out of the regression output. Calculating it leads to an estimate of -0.38: $-(\sigma-1)(1-\phi)-\alpha_0-(1-\phi) = -(-1.687-1)(-0.478)-(-0.422)-(-0.478) = -0.38$.
[b] The effect in the second year is given by: $(\beta-1)(1-\phi)-\mu_0-(1-\phi) = 0.41$.
[c] In every year, 47.8 percent of the remaining gap between current and optimal capital stock are removed. In the first year $(1-\phi) = 48\%$ directly gives the percentage of capital adjusted. In the second year the adjustment amounts to $(1-\phi)$ times one minus the adjustment in the first year ($(1-\phi)(1-0.48) = 48\%(1-0.48) = 24.96\%$) and so on.
Notes: Estimates with micro data and Generalized Method of Moments as described in the text. A full set of time dummies is included. Bootstrapped standard errors are in parentheses. The instruments for the first-differenced regression are the values (in levels) of $\Delta ucc_{i,t}$ lagged two through seven years and $\Delta s_{i,t}$ lagged two through five years.
Source: Hoppenstedt company database, own calculations, 1987 to 2007.

Chapter 6

Conclusion

6.1 Main results

The empirical results derived in this doctoral thesis show that taxes are important determinants when corporations decide on their financial structure (Chapter 4) or on investment projects (Chapter 5). That is, companies' decisions differ in a world with taxation and without taxation. As is shown in Chapter 3 both real response and reduced tax avoidance strategies lead to an increase in the corporate tax base if the statutory corporate income tax rate is reduced. The empirical estimate of this tax base elasticity suggests that reductions of the statutory corporate income tax rate are partly "self-financing". Unlike authors of previous studies, the estimation of the tax base elasticity is not based on accounting data but on tax statistics which allow me to take various tax shields into consideration. In particular, I account for yet unused tax losses carried forward that are shown to be of major importance in Germany (Chapter 2).

As already described in Bach and Dwenger (2007), tax loss carry-forward has persistently increased since the 1990s. In 2004, the latest year available, corporate tax losses in Germany peaked at 520.4 billion euro. Aggregate tax losses carried forward were more than five times larger than profits subject to corporate income taxation in that year. While the rise in tax losses has worried tax authorities and has been at the heart of a political debate, there has been hardly any empirical evidence beyond aggregate figures.

Descriptive statistics (Chapter 2) show that losses are unequally distributed over industries. Yet unused losses are particularly concentrated on corporations engaged in real estate, holding, and consultancy activities (nearly 40 percent of aggregate tax loss carry-forward). They are also clustered within corporations in "post and telecommunications" as well as within manufacturers of food products, coke, and chemicals. By contrast, public transport systems, often blamed in the public debate of being exceptionally loss making, are shown not to be responsible for the surge in tax loss carry-forward. Measures of statistical dispersion reveal that yet unused losses from the past are highly and increasingly concentrated: In 2004, about 75 percent of aggregate tax loss carry-forward are allotted to 1 percent of German corporations. This pronounced concentration may partly result from small unconditional probabilities of switching from loss to profit that I estimate within a hazard rate model framework. The marginal effects estimated at the sample mean indicate that the hazard of transition between profitable and loss periods (and *vice versa*) first decreases with the duration of the profitable (loss) period and later increases. In the median, a loss company reports a profit after three years; the median company reporting a profit incurs a loss after four years. These results, however, should be interpreted with caution. Because of data restrictions within the corporate income tax statistics I could only estimate them using the Hoppenstedt balance sheet database, which is neither comprehensive nor representative.

Since fiscal authorities have constantly restricted the use of tax losses, unused losses might also have increased in volume because corporations could not convert them into cash. To evaluate the tightening-up in tax loss carry-back and carry-forward, I use the BizTax microsimulation model for the corporate sector that I developed during my time at DIW Berlin. Both reforms are shown to have a minor impact as to both number of companies affected and fiscal revenue. To gain more insight into the potential reasons for reporting a loss, I evaluate press reports and ad-hoc disclosures for nearly 700 observations. The analysis shows that the reasons for a loss are varied; the most prevalent ones are an operating loss (34 percent), restructuring measures (22 percent), and holding activities (13 percent). Failure of management (2 percent) and large interest payments (2 percent), by contrast, are rarely held responsible for a loss. I also find suggestive evidence that loss events driven by firms providing general public services and driven by restructuring expenses have declined since the early 1990s. This finding is in line with large capital expenditure to modernize plants located in Eastern Germany in the 1990s. On the other hand, the same period of time has also seen a rise in loss cases provoked by holding activities and bookkeeping operations. This is the reverse of what is expected for tax reasons alone, since writedowns of investments in shares of affiliated companies were effective for tax purposes only until 2001. Similarly, tax authorities started to question provisions more rigorously and have tightened depreciation allowances. I thus conclude that, at present, deviation of the commercial from the tax result of the year and poor data records do not allow to reveal the reasons why tax losses have surged in recent years.

In the light of their quantitative importance, these yet unused losses from the past presumably nevertheless have broader implications on corporate behavior. In particular, companies with tax loss carry-forward face a lower effective average tax rate than they would do without losses from the past. In the estimation of the corporate tax base elasticity (Chapter 3), tax losses carried forward as well as other tax shields are thus taken into account. This approach is an important improvement of the estimation strategy applied in the small empirical literature on the elasticity of the corporate tax base which typically relies on aggregate data or on accounting-based micro data. Methodologically, the main problem is that, for various reasons, the effective tax rate might be endogenous. To control for endogeneity of changes in the effective tax rate, I thus apply an instrumental variable approach. The instrumental variable is the counterfactual effective tax rate a corporation would face in a particular period had there be no change of taxable income within the corporation's control within that period. The estimation of the average tax base elasticity yields a statistically significant and relatively large point estimate of about -0.5. This estimate implies that a reduction of the (proportional) statutory corporate tax rate by 10 percent would raise the corporate tax base by 5 percent on average. Policymakers deciding on a cut in tax rates, however, are interested in the costs induced rather than in the tax base itself. Relating a change in the statutory corporate tax rate and the tax base elasticity to tax revenues, a cut in the statutory corporate tax rate by 10 percent is shown to reduce corporate tax receipts by only 5 percent.

As the average tax base elasticity may hide important differences between corporations, it is important to look at potential heterogeneity in tax base elasticities. In particular, I check whether the elasticity differs by the degree of international tax competition and income shifting opportunities. The point estimates 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. They 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 Foreign Direct Investment (FDI). Further, since interest payments on a corporation's debt act as a tax shield, the tax base of corporations with a relatively high debt/equity ratio is found to respond less to tax changes than does the tax base of corporations that can take less advantage of this particular tax shield. However, the low statistical precision of these estimation results by subgroups does not allow me to draw too substantial conclusions. Testing hypotheses of differential tax base elasticities with greater precision would probably require a true panel of corporate tax return data which is at present not available for Germany.

Overall, the empirical results presented in this thesis clearly show, for the German economy, that the corporate income tax affects corporate behavior. One potential avenue for companies to adapt to changes in effective tax rates might be their financial structure. Chapter 4 therefore focuses on the elasticity of corporations' financial leverage with respect to effective profit taxation. The effect of taxes on corporate leverage may also vary with economic risk, since the asymmetric treatment of profits and losses discourages borrowing if companies face larger risks. Within the estimations, I therefore consider economic risk as measured by the variation coefficient of sales. To also control for the effect of corporate size on financial leverage, I further include the average amount of capital measured at the start of the observation period to avoid potential endogeneity of the variable. Using firm-specific variation in effective tax rates and controlling for endogeneity by an instrumental variable approach yields a statistically and economically significant point estimate. My preferred specification gives a point estimate of 0.5 and suggests that corporate taxation indeed distorts firms' financial decisions: On average, an increase of the tax rate by 10 percent would increase financial leverage by about 5 percent. The inefficiencies associated with this fact are found to be particularly severe for large firms and for companies that do not benefit from various other forms of tax shields, in particular depreciation allowances and tax loss carry-forward. However, although the financial leverage is higher in industries with more stable sales, I could not find evidence supporting the hypothesis that tax effects are more important in less risky industries.

I also briefly discuss the relationship of the two elasticities, leverage and tax base elasticity. In 2004, interest payments for long-term debt amounted to 30.2 billion euro, i.e., the tax relief for interest was about one third of corporate income tax assessed.[1] As I show in Chapter 4, this implies that the elasticity of the corporate tax base can be traced back to one third to corporations adjusting their financial leverage. The remaining share ist at least partially caused by real economic response of the corporate sector, since a bivariate instrumental variable regression of the

[1]Corporate income tax assessed was about 22.8 billion euro in 2004. In that year, the corporate income tax rate was 25 percent. That is interest payments of 33.5 billion euro corresponded to a tax relief amounting to 7.5 billion euro.

change in sales on the change in the ETR between 1998 and 2004 yields a coefficient of -1.4 (t-value of -2.19).

One way of real economic adjustment to changes in corporate taxation is capital formation. In Chapter 5, I gauge whether firms alter real activity on account of changes in taxation. More precisely, I estimate the elasticity of capital with respect to its user cost in a dynamic framework. The error-correction model I use to this end allows me to explicitly distinguish short and long-term effects. It further has the advantage of yielding the long-term (equilibrium) relation between the capital stock, sales, and the user cost of capital which is consistent with a simple neoclassical model of the firm's demand for capital. Previous studies focused on distributed lag models and have found the long-run effect by adding up the significant coefficients of the user cost variable, i.e., the long-term effect results rather from an econometric specification search than from being imposed *ex ante*.

Estimating the (first-differenced) distributed lag model, as a benchmark, I find a long-term elasticity of capital of -0.6, which is comparable to the existing literature. Similar to previous studies, the estimates imply tiny effects of output on capital which is inconsistent with theory. Also conflicting with theory are significant cash flow effects that are often interpreted as a measure for being financially constrained. In the error correction model, the long-term elasticity of capital with respect to its user cost is -1.3, implying that a decrease in the user cost of capital by 10 percent will increase capital by 13 percent in the long run. Taking my elasticity estimate to the Corporate Tax Reform 2008, the most recent tax reform in Germany, I would expect that the tax reform only slightly increases capital stock, since the rather strong reduction in corporate income tax rate was partly compensated for by stricter depreciation allowances.

Exploring investment dynamics, I find that firms relatively quickly adjust to the new optimal capital stock: about half of the gap between existing and optimal capital stock is closed within a year. What inspires confidence in the model is the point estimate for output which is still below unity, implying increasing returns to scale, but more reasonable in size than what is usually found in (first-differenced) distributed lag models. The point estimates thus indicate that a dynamic framework yields more sensible results than does the model widely used in the literature.

Investment dynamics appear to be crucial, not only for the effect of output on capital but also for the coefficient of the cash flow variable. While well-known cash flow effects are present in the (first-differenced) distributed lag model, they vanish if the adjustment process is modeled in the error correction model. This finding conflicts with the view that cash flow effects can be seen as evidence for the importance of financial constraints. In fact, it rather suggests that cash flow may act as a proxy for omitted expected future profitability variables pointing at dynamic misspecification in distributed lag models.

Unlike in all other chapters, the estimations of capital formation are not based on tax statistics, since they do not include any information on capital stock or investment. Instead, I linked the Hoppenstedt balance sheet database with industry-level information on the prices of investment and output goods as well as on economic depreciation rates for buildings and fixed tangible assets maintained by the German Statistical Offices. Applying the Generalized Method of Moments to the Hoppenstedt panel data set allows me to control for unobserved firm heterogeneity, measurement error in the user cost of capital, and simultaneity bias.

The use of a panel is thus crucial for estimating the investment equation but entails one major problem which is sample attrition. If dropping out of the sample is related to the decision to invest, sample attrition leads to biased estimates. Surprisingly, the fact that most (if not all) panel data sets on firms are incomplete has received little attention in papers on investment. I control for leaving the sample by including a selection term in all estimations. The coefficient of this term is significant and indicates that firms drop out of the sample non-randomly. Comparing the coefficients of regressions with an without selection term, however, I virtually find no difference in the point estimates. This implies, at least for the Hoppenstedt database used in my study, that sample attrition is present but does not affect the user cost elasticity.

6.2 Policy implications

The evaluation of corporate income taxation reveals that corporate income taxation indeed entails several inefficiencies: It is shown to foster the use of debt at the expense of equity and to distort the decision to invest. Further, the asymmetric treatment of profit and loss as well as the tightening-up in the use of losses discriminate against risky projects.

A policy reform lowering the corporate income tax rate hence also lowers the distorting influence of taxation on corporate decisions. From the point of view of a policymaker, such a cut in statutory tax rates might also come at a cost, since it may come along with a decline in fiscal revenues. Contrasting the finding of previous studies based on aggregate data, the estimated tax base elasticity clearly shows that Germany is not on the declining segment of the "Laffer curve". Hence, reductions in statutory tax rates do not increase but lower corporate tax revenues. The decline in corporate tax receipts, however, is less than proportional due to higher economic activity and reduced tax avoidance strategies of the corporate sector.

In Germany, income shifting activities seem to be an important determinant of such a "self-financing" effect in the short run. For this reason it may be advantageous for fiscal authorities to target their reforms for very responsive companies. To display heterogeneity, the elasticity of the tax base was also estimated for different subgroups. These estimations show that the elasticities might be above average in the manufacturing sector, in industries dominated by larger corporations, by corporations with a relatively large stock of FDI, and by corporations without other tax shields. Even though these estimates might hint at the companies that should be targeted, I prefer not to draw forceful conclusions because of the low statistical precision of these estimates, which is probably due to the pseudo-panel structure of the data set.

An important part of companies' behavioral response to changes in corporate taxation is driven by adjustments in their financial structure. Taxes matter for financing because payments on debt, but not the yield on equity, are tax deductible. This implies that, compared to a world without taxation, companies rely excessively on debt. Thereby taxation might undermine a politically pronounced intention, which is to boost equity financing: High equity ratios serve as security in distressed economic conditions, since equity generally does not constitute an obligation to pay interests on a regular basis. In the light of the current banking crisis and credit rationing, politicians might again become more closely involved with the goal to strengthen firms' equity base. One way to do this is to reconcile the tax treatment of debt and equity, since the average elasticity of corporate leverage indicates fairly substantial tax effects.

Taking the riskiness of a business projects into consideration, one further has to conclude that risky business concepts and investments are seriously encumbered by the asymmetric treatment of profits and losses. This is because tax losses do not lead to an immediate tax refund, but are only deductible against positive profits from other years; thereby, the real value of tax losses erodes over time, since tax losses carried forward are not interest bearing. In recent years, the use of losses has been further restricted in Germany. Whilst the reforms' long and short-run effects are shown to be negligible, the signal of tax authorities to further tighten the use of losses might have deterred companies from investing in risky projects.

In general, corporate income taxation increases the user cost of capital, that is the discount rate a firm should use in evaluating investment projects. As predicted in theory, the relatively large point estimate for the elasticity of capital with respect to its user cost implies that higher user cost significantly lowers the capital stock used in production both in the short and in the long run. Aside from the induced decline in capital use, the higher cost of capital also leads to the choice of less durable capital goods. While recent cuts in the corporate tax rates have lessened economic inefficiencies, the simultaneous broadening of the tax base have changed investment incentives. Since policymakers have in particular broadened the tax base by degrading depreciation allowances, the user cost of capital for real investment has been affected by two opposing trends. On the one hand, it has been lowered because of the decrease in statutory tax rate, and on the other hand, it has been increased because of less generous depreciation allowances. In contrast to financial investments, however, the relative attractiveness of real investment has been worsened at any rate. This implies that recent tax reforms have increased incentives to invest in financial rather than real assets. Since particularly real investments are believed to create new jobs, the relative deterioration of real to financial investment may have had unintended effects. Against this background the reintroduction of the declining-balance method for fixed assets purchased in 2009 and 2010 is a step in the right direction.

6.3 Further research

The present doctoral thesis has contributed to the small empirical literature on corporate income taxation and firms' investment and financing decisions. In particular, providing average elasticities for the corporate tax base, financial leverage, and capital formation, it showed that inefficiencies associated with corporate taxation are substantial. These empirical elasticities provide important information for assessing both the revenue and welfare implications of corporate tax policy. Since companies are largely heterogeneous entities, the average elasticities may, however, hide important differences between corporations, and this heterogeneity may provide crucial information for tax policy. For instance, if policymakers know about the behavioral response of companies with certain characteristics (such as size, industry, financial structure), they can target fiscal law more effectively. Whilst the present doctoral thesis has provided some evidence on different sub-groups, these behavioral responses were imprecisely estimated because tax statistics have only been available as a pseudo panel but not as a panel. For further research, it is hence desirable to create a true panel of corporate tax return data and to further explore heterogeneity between firms.

Among other things, firms distinguish themselves by the amount of tax losses carried forward. On aggregate, these yet unused losses from the past have surged since the 1990s. For the first time, this phenomenon was explored quantitatively and qualitatively in this dissertation; my analyses provided first insights in the distribution of losses, in the duration of profitable and loss periods, and in the reasons of reporting a loss. Unfortunately, transition probabilities could not be estimated with tax statistics, since these are currently not available as a panel and do not provide any information on how long a firm has been reporting a loss or a profit. Because the data set used instead (the Hoppenstedt company database) oversamples large and very large firms, estimates may only be generalized cautiously and should be re-estimated using panel tax statistics.

Data restrictions also affected my study of the reasons to report a loss. While tax statistics provide all items relevant for taxation, they do not include balance sheet items or information out of firms' profit and loss accounts. The reasons why firms reported a loss and why aggregate tax loss carry-forward has sharply increased can thus not be revealed. Hoppenstedt, by contrast, offers detailed commercial balance sheet positions but does not provide any information on taxable income. Since it is still unclear to what extent the "authoritative principle" and the "reverse authoritative principle" tie commercial and tax result together, my analysis on the reasons to report a (commercial) balance sheet loss can only provide suggestive evidence for the reasons to provide a tax loss. To allay these concerns and to explore more the economic background of firms, commercial balance sheet and tax information should be integrated.

In the current stage, the microsimulation model for the corporate sector is a purely static model, i.e., it models first-round effects exclusively. There are various studies providing empirical evidence for behavioral responses of companies induced by tax reforms. Tax effects are found for taxation and firms' entry and exit decisions (e.g., Fossen and Steiner, 2009; Fossen, 2007), for taxation and Foreign Direct Investment (for instance, Ramb and Weichenrieder, 2005; Mintz and Weichenrieder, 2005; Becker, Fuest, and Hemmelgarn, 2006; Büttner and Ruf, 2007) as well as for factor demand distortions induced by formula apportionment in German local business taxation (Riedel, 2009). The present doctoral thesis has shown that corporate income taxation is an important factor in firms' decision about their tax base, financial structure, and investment. It is left to further research to empirically study tax induced employment effects, reactions in corporations' payout policy, and behavioral responses in the choice of site and legal form.

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List of abbreviations

AGI	Adjusted Gross Income
CIT	Corporate Income Tax
EBITD	Earnings Before Interest, Taxes and Depreciation
ETR	Effective corporate Tax Rate
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
IV	Instrumental Variable
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
TA	Corporate income Tax Assessed
TI	Taxable Income
NIPA	National Income and Product Accounts
UCC	User Cost of Capital
UMTS	Universal Mobile Telecommunications System

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German summary

Es ist unter Ökonomen umstritten, ob Unternehmensgewinne besteuert werden sollen. Während sich die Körperschaftsteuer unter Politikern großer Beliebtheit erfreut, haben Wissenschaftler regelmäßig für eine Konsumsteuer oder die Besteuerung des ökonomischen Gewinns plädiert, weil die Körperschaftsteuer möglicherweise Ineffizienzen verursacht. Zum Beispiel steht die Körperschaftsteuer im Verdacht, das in Körperschaften investierte Kapital zu verringern, Finanzierungsentscheidungen zu verzerren und Ausschüttungen gegenüber der Einbehaltung von Gewinnen zu begünstigen. Kaplow kommt daher zu dem Schluss, dass „die Körperschaftsteuer, wesentlicher Bestandteil vieler Steuersysteme, bei einer ganzheitlichen Betrachtung des optimalen Besteuerungsproblems nur schwer zu rechtfertigen ist." (Kaplow, 2008, p. 238, Übers. d. Verf.).

Trotz dieser potentiellen Ineffizienzen besteuern die meisten entwickelten Länder, und so auch Deutschland, das Einkommen von Körperschaften. Politiker verwenden die Körperschaftsteuer um sicherzustellen, dass Steuerpflichtige mit hohem Einkommen einen größeren Beitrag zum Steueraufkommen leisten, also für Umverteilungsziele. Die Wahl der Politiker fällt auf die Körperschaftsteuer, da Steuerpflichtige mit hohem Einkommen traditionell einen größeren Anteil ihres Einkommens aus Kapital beziehen (Bach, Corneo und Steiner, 2009). In den letzten Jahren hat der internationale Steuerwettbewerb jedoch dazu geführt, dass die Steuersätze auf Kapitaleinkommen kontinuierlich gesunken sind. In Deutschland sank der Körperschaftsteuersatz auf einbehaltene Gewinne beispielsweise von 45 Prozent im Jahr 1998 auf 15 Prozent im Jahr 2008. Wie in anderen Ländern auch, ist das Steueraufkommen dabei nicht proportional mit dem Steuersatz zurückgegangen. Dieser „Selbstfinanzierungseffekt“ deutet darauf hin, dass die Steuerausfälle, die mit einer Steuersatzsenkung verbunden sind, teilweise durch eine höhere ökonomische Aktivität oder geringere Steuervermeidungsaktivitäten der Steuerpflichtigen kompensiert wurden. Das impliziert auch, dass eine Steuersatzsenkung die bereits angesprochenen Ineffizienzen der Körperschaftsteuer verringern kann.

In zwei einflussreichen Papieren hat Feldstein (1995, 1999) gezeigt, dass es möglich ist, die mit der Einkommensbesteuerung verbundenen Ineffizienzen über die Elastizität des steuerlichen Einkommens zu quantifizieren. Dieser Ansatz ist deshalb so elegant, weil er eine Abschätzung der Ineffizienzen erlaubt, ohne dass die einzelnen Anpassungsreaktionen der Steuerpflichtigen (zum Beispiel Änderungen in der Motivation, im Kapitalstock, der Finanzierungsstruktur, der Verrechnungspreisgestaltung) berücksichtigt werden müssen. Während Feldstein's Konzept allerdings im Bereich der persönlichen Einkommensteuer weit verbreitet ist, gibt es nur wenige Schätzungen zur Elastizität der körperschaftsteuerlichen Bemessungsgrundlage. Die vorliegende Dissertationsschrift ist die erste mikroökonometrische Studie, die anhand von *Steuerdaten* Aussagen darüber macht, wie stark Unternehmen auf die Körperschaftsteuer reagieren.

Während die Elastizität der körperschaftsteuerlichen Bemessungsgrundlage angibt, wie stark Unternehmen auf die Körperschaftsteuer reagieren, erlaubt sie es nicht abzuschätzen, welche unternehmerische Entscheidungen vor allem von der Besteuerung beeinflusst sind. Um dieser Frage nachzugehen, stellen weitere Kapitel der Dissertation einzelne Unternehmensentscheidungen in den Vordergrund. Insbesondere wird untersucht, inwieweit sich die Besteuerung auf die Verschuldung oder den Kapitalstock eines Unternehmens auswirkt.

Methodisch verbindet meine Arbeit Mikrosimulation und Mikroökonometrie. Wesentliche Datengrundlage für die Schätzungen sind zwei verschiedene Datensätze: Die Körperschaftsteuerstatistiken sowie die Hoppenstedt Bilanzdatenbank. Beide

Datensätze werden in Kapitel 2 der Dissertationsschrift vorgestellt. Die Körperschaftsteuerstatistik ist eine umfassende Statistik aller körperschaftsteuerpflichtigen Unternehmen in Deutschland und enthält sämtliche Größen, die für die Berechnung der Körperschaftsteuer nötig sind. Daher ist die Körperschaftsteuerstatistik ideale Datengrundlage für ein Mikrosimulationsmodell. Kapitel 2 stellt ein solches Mikrosimulationsmodell für die Körperschaftsteuer vor, das ich im Rahmen des BizTax-Projekts am DIW Berlin entwickelt habe.

Neben den Einzelgrößen, die für die festgesetzte Körperschaftsteuer eines Unternehmens relevant sind, enthält die Körperschaftsteuerstatistik auch Informationen zum Verlustvortrag der Unternehmen, der seit 1992 stark auf 520 Milliarden Euro im Jahr 2004 angestiegen ist. Bislang ist wenig darüber bekannt, warum der aggregierte Verlustvortrag in allen Konjunkturlagen zugenommen hat. Da sich die politische Diskussion bislang auf aggregierte Informationen beschränkt hat, ist zudem unklar, wie sich die ungenutzten Verluste über Branchen und Unternehmen verteilen. Eindeutig ist jedoch, dass ein vorhandener Verlustvortrag die effektive Steuerbelastung eines Unternehmens verändert und damit auch unternehmerische Verhaltensreaktionen mitbestimmen dürfte. Als Vorbereitung auf die Schätzungen in den darauf folgenden Kapiteln, die den Verlustvortrag als zukünftige Steuererleichterung berücksichtigen, bietet Kapitel 2 daher deskriptive Statistiken zur Verteilung bzw. Konzentration der Verlustvorträge und diskutiert mögliche Ursachen für den starken Anstieg.

Ein denkbarer Grund für den Anstieg ist, dass die Regelungen zur Nutzung eines Verlustvor- bzw. -rücktrags in den vergangenen Jahren beständig verschärft wurden. Mit Hilfe des Körperschaftsteuer-Mikrosimulationsmodells BizTax lässt sich allerdings zeigen, dass von den Reformen jeweils nur wenige Unternehmen betroffen waren, und die Beschränkungen bei der Verlustverrechnung nicht für den Anstieg verantwortlich gewesen sein dürften. Ein Übergangsmodell zeigt, dass die Wahrscheinlichkeit, nach einem Verlust einen Gewinn (bzw. nach einem Gewinn einen Verlust) auszuweisen, von der Dauer der Verlustphase (bzw. der Gewinnphase) ab-hängt: Die unbedingte Übergangswahrscheinlichkeit nimmt mit der Dauer zunächst ab und später wieder zu. Im Median kehrt ein Verlustunternehmen nach drei Jahren wieder in die Gewinnzone zurück; ein Gewinnunternehmen erleidet im Median nach vier Jahren einen Verlust.

Kapitel 3 meiner Arbeit legt den Schwerpunkt auf die Elastizität der körperschaftsteuerlichen Bemessungsgrundlage bezüglich des effektiven Steuersatzes. Die geschätzte Elastizität berücksichtigt dabei erstmalig auch Steuererleichterungen (*tax shields*), wie sie beispielsweise mit einem vorhandenen Verlustvortrag verbunden sind. Gegenüber den wenigen bisherigen Studien ist dies eine entscheidende Weiterentwicklung. Die hierfür notwendigen Steuerstatistiken liegen derzeit allerdings nur als Querschnittsdaten vor, so dass für die Schätzung der Elastizität ein Pseudo-Panel konstruiert werden musste.

Methodisch liegt die Herausforderung bei der Schätzung der Bemessungsgrundlagen-Elastizität vor allem in der Endogenität des effektiven Steuersatzes. Um das Endogenitätsproblem zu lösen, stütze ich mich auf die Instrumentvariablen-Methode nach Gruber and Saez (2002); die verwendete Instrumentvariable ist der (simulierte) effektive Steuersatz, also der Steuersatz den ein Unternehmen leisten müsste, wenn es nicht auf eine Änderung des tariflichen Steuersatzes reagiert hätte. Dadurch wird die Elastizität der Bemessungsgrundlage nur über Änderungen des Steuerrechts und über makroökonomische Faktoren identifiziert, die nicht durch ein einzelnes Unternehmen beeinflusst werden können.

Der Punktschätzer für die durchschnittliche Elastizität ist statistisch signifikant und relativ groß. Der Koeffizient von -0,5 impliziert, dass das Steueraufkommen bei einer Senkung des tariflichen Steuersatzes um 10 Prozent lediglich um 5 Prozent zurückgeht. Das heißt, dass das Steueraufkommen aufgrund von realen Anpassungen der Unternehmen und schwächeren Steuervermeidungsaktivitäten lediglich unterproportional sinkt. Die Schätzungen liefern außerdem Hinweise dahingehend, dass große Körperschaften, Unternehmen mit hohen ausländischen Direktinvestitionen in der Vergangenheit und Körperschaften, die von Steuererleichterungen unterschiedlichster Art profitieren, stärker auf Änderungen des tariflichen Steuersatzes reagieren. Wegen der Pseudo-Panel-Struktur des Datensatzes ist die hierfür gefundene empirische Evidenz statistisch nur schwach signifikant. Insgesamt kann allerdings klar dargelegt werden, dass die Körperschaftsteuer unternehmerisches Verhalten beeinflusst.

Wie bereits angedeutet, lässt die Elastizität der körperschaftsteuerlichen Bemessungsgrundlage offen, welche Unternehmensentscheidungen hauptsächlich von der Besteuerung beeinflusst werden. Kapitel 4 analysiert daher explizit, wie sich die Körperschaftsteuer auf die Finanzierungsstruktur eines Unternehmens auswirkt. Ich schätze die Elastizität des Verschuldungsgrads bezüglich der effektiven Steuerbelastung, wobei die endogene Änderung des effektiven Steuersatzes erneut mit der simulierten Änderung des Effektivsteuersatzes instrumentiert wird. Der Punktschätzer für diese Elastizität beträgt 0,5 und legt nahe, dass die Körperschaftsteuer in der Tat die Finanzierungsentscheidung der Unternehmen verzerrt: Im Durchschnitt erhöht ein Anstieg des tariflichen Steuersatzes um 10 Prozent den Verschuldungsgrad eines Unternehmens um 5 Prozent. Diese durchschnittliche Elastizität verschleiert möglicherweise entscheidende Unterschiede zwischen den Unternehmen. So zeigt sich, dass kleinere Unternehmen und Körperschaften, die von Steuerbegünstigungen wie zum Beispiel Abschreibungen und Verlustvortrag profitieren, ihre Finanzierungsstruktur weniger stark anpassen. Zusammenfassend kann man sagen, dass die empirischen Ergebnisse in der vorliegenden Dissertationsschrift zeigen, dass sich die Besteuerung von Körperschaften auf ihren Verschuldungsgrad auswirkt.

Kapitel 5 dieser Dissertationsschrift beschäftigt sich mit der Frage, ob die Besteuerung auch den Kapitalstock der Unternehmen beeinflusst. Für diesen Zweck schätze ich die Elastizität des Kapitals bezüglich der Kapitalkosten. Diese Elastizität beträgt -1,3 und ist statistisch signifikant, das heißt eine Erhöhung der Kapitalkosten um 10 Prozent verringert das in der Volkswirtschaft eingesetzte Kapital durchschnittlich um 13 Prozent.

Der erste wissenschaftliche Beitrag meiner Untersuchung zur Elastizität des Kapitalstocks liegt in der angewandten Methode: Im Vergleich zu dem bislang in der Literatur verwendeten rationalen Lag-Modell (*distributed lag model*), liegt der Vorteil des in meiner Studie verwendeten Fehlerkorrekturmodells (*error correction model*) vor allem in der formulierten Gleichgewichtsbeziehung. Diese Langfristbeziehung zwischen Kapital, Kapitalkosten und Umsatz im Fehlerkorrekturmodell entspricht der Kapitalnachfrage eines Unternehmens in einem einfachen neoklassischen Modell. Auch aus ökonometrischer Perspektive ist das Fehlerkorrekturmodell dem rationalen Lag-Modell vorzuziehen. Vieles weist darauf hin, dass verfügbare Mittel (*cash flow*) in rationalen Lag-Modellen nur deshalb einen signifikanten Einfluss auf das Investitionsverhalten entfalten, weil sie stellvertretend für die im Modell fehlende zukünftige Ertragskraft des Unternehmens stehen. Häufig dokumentierte cash flow-Effekte deuten daher eher auf dynamische Fehlspezifizierung im rationalen Lag-Modell hin; sie lassen sich weniger dahingehend interpretieren, dass Unternehmen Investitionen unterlassen, weil ihnen die finanziellen Mittel fehlen.

Die zweite Innovation gegenüber der Literatur besteht in einer Korrekturvariablen für Panelsterblichkeit. Eine solche Korrektur ist notwendig, falls Unternehmen nicht zufällig aus dem Datensatz ausscheiden. Unterbleibt eine solche Korrektur, obwohl die Panelsterblichkeit mit der Investitionsentscheidung zusammen hängt, sind unter Umständen die Punktschätzer aller Variablen verzerrt. Firmen können aus zahlreichen Gründen, wie zum Beispiel Fusion, Insolvenz, Geschäftsaufgabe oder schwächeren Offenlegungspflichten, aus dem Datensatz ausscheiden. Da nicht auszuschließen ist, dass diese Ereignisse mit dem Investitionsverhalten der Unternehmen zusammenhängen, erscheint eine Korrektur unumgänglich. Erstaunlicherweise wurde das Problem der Panelsterblichkeit in bisherigen Studien zum Investitionsverhalten nicht thematisiert. Da der Punktschätzer für die Korrekturvariable in allen Schätzungen hoch signifikant ist, scheinen Unternehmen wie erwartet nicht zufällig aus dem Datensatz auszuscheiden. Ein Vergleich der Schätzergebnisse mit und ohne Selektionskorrektur zeigt jedoch, dass der Korrekturfaktor ohne Einfluss auf die Elastizität des Kapitalstocks bleibt.

Zusammenfassend kann gesagt werden, dass die Körperschaftsteuer für Ineffizienzen verantwortlich ist: Sie führt zu Gewinnverlagerungsaktivitäten, fördert die Finanzierung über Fremd- statt über Eigenkapital und verzerrt die Investitionsentscheidung der Unternehmen. In den vergangenen Jahren ist die Bedeutung der Körperschaftsteuer und der mit ihr verbundenen Ineffizienzen allerdings zurückgegangen. Der internationale Steuerwettbewerb um mobiles Kapital hat zu sinkenden Steuersätzen geführt, so dass Politiker die Körperschaftsteuer immer weniger zur Erreichung von Umverteilungszielen einsetzen.

Aus Sicht eines Finanzpolitikers verringern sinkende Körperschaftsteuersätze jedoch nicht nur ökonomische Verzerrungen sondern führen auch zu geringeren Steuereinnahmen. Deutschland befindet sich, entsprechend der hier geschätzten Bemessungsgrundlagen-Elastizität und anders als dies von früheren Studien anhand aggregierter Daten nahegelegt wurde, nicht auf dem fallenden Ast der „Laffer-Kurve“. Allerdings gehen die Steuereinnahmen unterproportional zurück, da geringere Steuersätze weniger Anreize zu Gewinnverlagerungsaktivitäten bieten und stimulierend auf die Geschäftstätigkeit der Unternehmen wirken. Zu circa einem Drittel sind diese „Selbstfinanzierungseffekte“ darauf zurückzuführen, dass sich Unternehmen weniger stark über steuerlich begünstigtes Fremdkapital sondern vermehrt über Eigenkapital oder einbehaltene Gewinne finanzieren.

Unternehmen reagieren also durchaus auf steuerliche Anreize. Für die Politik bedeutet dies, dass die steuerliche Begünstigung von Zinsaufwendungen tendenziell dazu führt, dass sich Unternehmen übermäßig über Fremdmittel finanzieren. Unter Umständen unterläuft die Steuerpolitik damit das wirtschaftspolitische Ziel, die Eigenkapitalausstattung der Unternehmen zu stärken: In ökonomisch schwierigen Konjunkturlagen bietet eine hohe Eigenkapitaldecke Schutz, da Eigenkapital in der

Regel keine Pflicht zu regelmäßigen Zinszahlungen beinhaltet. Angesichts der derzeitigen Bankenkrise und Kreditrationierung ist denkbar, dass Politiker die Förderung von Eigenkapital wieder neu für sich entdecken. Eine Möglichkeit, dieses Ziel zu erreichen, ist, Eigen- und Fremdkapital steuerlich gleich zu behandeln.

Die verbleibenden zwei Drittel des Selbstfinanzierungseffekts dürften zumindest teilweise auf reale Anpassungen der Unternehmen zurückzuführen sein. Bivariate Instrumentvariablen-Schätzungen legen nahe, dass die Umsätze der Unternehmen nicht kurz- aber langfristig auf den effektiven Steuersatz reagieren. Das bestätigt die Elastizität des Kapitalstocks, die zeigt, dass Unternehmen auch in ihren realwirtschaftlichen Aktivitäten von der Steuerpolitik beeinflusst werden.

Während die durch die Körperschaftsteuer hervorgerufenen Ineffizienzen in den letzten Jahren durch niedrigere Steuersätze reduziert wurden, hat die Gegenfinanzierung dieser Reformen zeitgleich die Investitionsanreize verändert. Steuersatzsenkungen wurden im Wesentlichen über eine Verbreiterung der Bemessungsgrundlage, wie zum Beispiel verschlechterte Abschreibungsbedingungen, gegenfinanziert. Die Kapitalkosten wurden folglich von gegenläufigen Entwicklungen bestimmt. Zum einen hat die Senkung der tariflichen Steuersätze in den letzten Jahren die Kapitalkosten reduziert und damit Anreize für Investitionen geschaffen. Zum anderen sind die Kapitalkosten aufgrund der weniger großzügigen Abschreibungsbedingungen gestiegen.

Mit der jüngsten großen Steuerreform, der Unternehmensteuerreform 2008, wurde der Körperschaftsteuersatz von 25 Prozent auf 15 Prozent gesenkt. Gleichzeitig wurde die degressive Abschreibung für Abnutzung für bewegliche Wirtschaftsgüter abgeschafft. Im Hoppenstedt-Datensatz hat die Reform zu einer Senkung der Kapitalkosten um durchschnittlich 0,08 Prozent geführt. Die Reform dürfte den Kapitalstock daher *ceteris paribus* langfristig um lediglich 0,11 Prozent erhöht haben.

Verglichen mit Finanzinvestitionen hat sich die Attraktivität der Sachinvestitionen jedoch durch die Reform verschlechtert. Das bedeutet, dass die vergangenen Steuerreformen Anreize dafür geschaffen haben, in Finanz- und nicht in Sachanlagen zu investieren. Unterstellt man jedoch, dass vor allem Sachkapital zur Schaffung neuer Arbeitsplätze - einem vorrangigen Ziel der Politik - führt, dann ist davon auszugehen, dass die relative Verschlechterung der Sach- gegenüber den Finanzinvestitionen von der Politik nicht intendiert war. Vor diesem Hintergrund ist die Wiedereinführung der degressiven Abschreibung für bewegliche Wirtschaftsgüter des Anlagevermögens, die 2009 oder 2010 angeschafft werden, zu begrüßen.